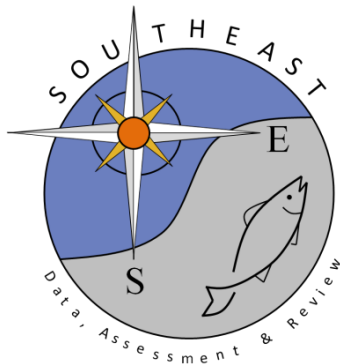


# Sandbar Shark Discard Estimates from the Northeast Fisheries Observer Program

Alexander Hansell<sup>1</sup>, Tobey Curtis<sup>2</sup> and Camilla McCandless<sup>3</sup>

SEDAR101-DW-20

14 April 2026



*This information is distributed solely for the purpose of pre-dissemination peer review. It does not represent and should not be construed to represent any agency determination or policy.*

Please cite this document as:

Hansell, Alexander, Curtis, Tobey and Camilla McCandless. 2026. Sandbar Shark Discard Estimates from the Northeast Fisheries Observer Program. SEDAR101-DW-20. SEDAR, North Charleston, SC. 13 pp.

1 Draft: Sandbar Shark Discard Estimates from the Northeast Fisheries Observer  
2 Program

3

4

Alexander Hansell<sup>1</sup>, Tobey Curtis<sup>2</sup>, Camilla McCandless<sup>3</sup>

5

1. Northeast Fisheries Science Center, Woods Hole, MA, USA

6

2. Highly Migratory Species Management Division, Gloucester MA, USA

7

3. Northeast Fisheries Science Center, Narragansett RI, USA

8

9

**Abstract:**

10

Dead and live discards of sandbar sharks were estimated from the Northeast Region's gillnet and trawl fisheries. Both numbers and weights were estimated from 1995-2025. Historical discard estimates (1964-1994) were produced for each gear type using a variety of different methods.

13

14

**Introduction:**

15

The Northeast Fisheries Observer Program deploys scientists on commercial vessels to collect information on catch and discards. Observers are tasked with collecting information on fishing gear, fishing location, weather, demographic information and disposition of discarded fish. The program operates from North Carolina to Canada. Sampling priorities are based on funding but a primary goal of the program is to cover enough of the fishing fleet to produce discard estimates that have a 30 % coefficient of variation. This dataset is routinely used to produce discard estimates for stock assessment in the Northeast; however, it has not previously been used in coastal shark assessments. Sandbar sharks have been targeted historically in the region; however, they have been prohibited since 2008. Sandbar shark bycatch continues to occur as far north as the southern Gulf of Maine. This working paper develops discard ratios and uses an expansion method to produce gillnet and trawl fishery fleet wide estimates of sandbar shark discards from 1964-2025.

26

27

**Methods:**

28

Observer records from the gillnet and trawl fishery were obtained from 1989 to 2025. All data explored was collected directly by the observer program. Data included: Number of sharks caught, fork length and total length of captured sharks, gear type, haul duration, year of capture, month of capture, water temperature at capture, location of capture, and disposition of discards. Individual shark observations were not included before 1995 due to possible species identification issues (McCandless and Mello 2021).

34

Discards were estimated using the ratio-estimators based on methodology in Wigley et al. (2007). The ratio uses the relationship between discards and total fish kept. All trawl and gillnet trips were included

35

36 in the analyses. Mesh size or geographic area was not used to exclude trips. If fish status was unknown  
 37 at haul back or when discarded, the fish was considered dead. Sandbar shark weights were estimated  
 38 using a length weight equation from Natanson et al. (2022). If fork length measurements were not  
 39 available, they were back-calculated from total length using the equation in Natanson et al. (2022). For  
 40 calculating total catch, all weights were converted to round live weight using the Catch Accounting and  
 41 Monitoring System conversion factors.

42 The discard ratio ( $R_h$ ) for sharks in stratum  $h$  (annual quarter) is the sum of discard number or weight  
 43 ( $d_{ih}$ ) for all observed trips ( $i$ ) divided by the sum of total species kept weights ( $k_{ih}$ ) for all observed trips:

$$44 \quad R_h = \frac{\sum_{i=1}^{n_h} d_{ih}}{\sum_{i=1}^{n_h} k_{ih}}$$

45  
 46 The stratum discard estimate ( $D_h$ ) is simply the product of the discard ratio  $R_h$  and the total species kept  
 47 weight for the fishery ( $K_h$ ) within that annual quarter,  $D_h=R_hK_h$ . Annual discard estimates ( $\hat{D}$ ) are the  
 48 sum across strata. The variance ( $V$ ) for each annual discard estimate is defined as:

$$49 \quad V = \sum_{h=1}^L K_h^2 \left( \frac{N_h - n_h}{n_h N_h} \right) \frac{1}{\left( \frac{\sum_{i=1}^{n_h} k_{ih}}{n_h} \right)^2} \left[ \frac{\sum_{i=1}^{n_h} (d_{ih}^2 + R_h^2 k_{ih}^2 - 2R_h d_{ih} k_{ih})}{n_h - 1} \right]$$

50  
 51 Where  $N_h$  and  $n_h$  are the number of total trips and observed trips within stratum  $h$ , respectively.  $L$   
 52 represents the four strata (quarters) within a year. The coefficient of variation (CV) for each annual  
 53 discard estimate ( $\hat{D}$ ) is defined as:

$$54 \quad CV = \frac{\sqrt{V}}{\hat{D}}$$

55 Discard estimates were back-calculated to 1964, the first year of electronic landings records, using the  
 56 average discard ratio across all strata for live and dead discards by weight. Not all Mid-Atlantic states  
 57 reported until 1989; therefore, the estimates before this time are likely underestimated. Multi-year  
 58 block averaging of the discard ratios was used to improve the discard estimate trend by reducing  
 59 variability and providing estimates for years with zero discards during observed trips (McCandless et al.  
 60 2019). The following management measures were considered in the block averaging:

- 61 • 1998 –New England and Mid-Atlantic time/area closures to gillnets due to harbor porpoise
- 62 interactions
- 63 • 2001 – Shark Finning Prohibition Act; LCS quota cut in half (set to 1997 levels that were not
- 64 enacted until lawsuit was settled)
- 65 • 2003 – Move to regional quotas and trimester seasons, split LCS quota between ridgeback and
- 66 non-ridgeback sharks, NC time/area closure
- 67 • 2008 – Shark Research Fishery implemented, sandbar sharks prohibited outside of research
- 68 fishery, sharks landed with all fins attached

69 These measures resulted in three blocks: 1995-1997, 1998-2007, and 2008-2025.

70

71 **Results:**

72 The majority of gillnet discards occurred east of Long Island, New York, while trawl discards are more  
73 widely distributed (Figure 1). Total discard estimates by fleet varied across years, with more discards  
74 occurring in the gillnet fishery (Figure 2 and Table 1 & 2). For 1995-2025, average annual total catch  
75 from the trawl fleet was 26 sharks and from the gillnet fleet was 36 sharks. The size distribution was  
76 similar between gear types (Figure 3). Similarly, hindcast estimates had similar trends across the  
77 different methods (Table 3:5; Figure 4).

78

79 **References:**

80 McCandless, CT, JJ Mello, and KA Sosebee. 2019. Estimation of blacktip shark, *Carcharhinus limbatus*,  
81 discards in the northeast gillnet fishery using data collected by the NOAA Northeast Fisheries Observer  
82 Program. SEDAR65-DW14. SEDAR, North Charleston, SC. 7 pp.

83 McCandless, Camilla T. and Joseph J. Mello. 2021. Estimation of scalloped and smooth hammerhead  
84 discards in the northeast gillnet fishery using data collected by the NOAA Northeast Fisheries Observer  
85 Program. SEDAR77-DW27. SEDAR, North Charleston, SC. 19 pp.

86 Natanson, L. J., McCandless, C. T., Passerotti, M. S., Belcher, C. N., Bowlby, H. E. A. T. H. E. R.,  
87 Driggers III, W. B., ... & Joyce, W. A. R. R. E. N. (2022). Morphometric conversions for 33 shark species  
88 from the Western North Atlantic Ocean.

89 Wigley, SE, PJ Rago, KA Sosebee, and DL Palka. 2007. The Analytic Component to the Standardized  
90 Bycatch Reporting Methodology Omnibus Amendment: Sampling Design, and Estimation of Precision  
91 and Accuracy (Second Edition) NOAA/NMFS/NEFSC. NEFSC Reference Document 07-09.

92

93 Table 1: Discard estimates of sandbar sharks in the northeast trawl fishery.

| Year | STATEND | Catch | Number of lengths | Observed discards (lbs) | Annual CV | Discard ratio | Fleetwide expanded discards (lbs) |
|------|---------|-------|-------------------|-------------------------|-----------|---------------|-----------------------------------|
| 1995 | Dead    | 2     | 29                | 42                      | NA        | 4.60E-05      | 3865                              |
| 1996 | Alive   | 1     | 1                 | 2                       | 1.34      | 1.42E-06      | 149                               |
| 1996 | Dead    | 1     | 1                 | 6                       | 1.34      | 3.34E-06      | 353                               |
| 1996 | Unknown | 7     | 7                 | 46                      | 1.34      | 2.64E-05      | 2797                              |
| 1997 | Alive   | 1     | 1                 | 1                       | NA        | 3.53E-07      | 42                                |
| 1998 | Dead    | 1     | 1                 | 53                      | NA        | 8.44E-05      | 12032                             |
| 1999 | Alive   | 12    | 12                | 205                     | 0.9       | 7.74E-05      | 15013                             |
| 1999 | Dead    | 3     | 3                 | 8                       | 0.9       | 9.12E-06      | 1139                              |
| 2001 | Alive   | 2     | 2                 | 30                      | 0.59      | 2.10E-05      | 2587                              |
| 2001 | Unknown | 1     | 1                 | 12                      | 0.59      | 8.67E-06      | 1066                              |
| 2004 | Alive   | 14    | 14                | 312                     | 1.15      | 1.03E-05      | 2176                              |
| 2004 | Dead    | 1     | 1                 | 12                      | 1.15      | 9.08E-07      | 133                               |
| 2005 | Alive   | 66    | 66                | 1586                    | 2.05      | 6.13E-05      | 16218                             |
| 2005 | Dead    | 13    | 13                | 88                      | 2.05      | 1.86E-06      | 786                               |
| 2006 | Alive   | 6     | 6                 | 70                      | 0.59      | 4.17E-06      | 999                               |
| 2006 | Dead    | 3     | 3                 | 41                      | 0.59      | 3.27E-06      | 699                               |
| 2007 | Alive   | 81    | 81                | 678                     | 1.68      | 2.45E-05      | 8065                              |
| 2007 | Dead    | 30    | 30                | 137                     | 1.68      | 7.31E-06      | 1633                              |
| 2007 | Unknown | 219   | 219               | 3455                    | 1.68      | 0.000281      | 23819                             |
| 2008 | Alive   | 40    | 40                | 700                     | 0.83      | 1.09E-05      | 3425                              |
| 2008 | Dead    | 3     | 3                 | 37                      | 0.83      | 2.31E-06      | 280                               |
| 2008 | Unknown | 9     | 9                 | 287                     | 0.83      | 1.78E-05      | 2161                              |
| 2009 | Alive   | 58    | 58                | 1933                    | 1.01      | 3.29E-05      | 7198                              |
| 2009 | Dead    | 71    | 71                | 1185                    | 1.01      | 1.33E-05      | 4476                              |
| 2009 | Unknown | 18    | 18                | 251                     | 1.01      | 4.22E-06      | 950                               |
| 2010 | Alive   | 22    | 22                | 439                     | 1.06      | 3.22E-06      | 1130                              |
| 2010 | Dead    | 13    | 13                | 289                     | 1.06      | 2.64E-06      | 697                               |
| 2010 | Unknown | 8     | 8                 | 238                     | 1.06      | 7.92E-06      | 720                               |
| 2011 | Alive   | 51    | 51                | 1068                    | 1.6       | 2.07E-05      | 3225                              |
| 2011 | Dead    | 2     | 2                 | 9                       | 1.6       | 1.76E-07      | 26                                |
| 2011 | Unknown | 6     | 6                 | 42                      | 1.6       | 1.76E-06      | 125                               |
| 2012 | Alive   | 9     | 9                 | 286                     | 1.34      | 7.25E-06      | 876                               |
| 2012 | Dead    | 6     | 6                 | 17                      | 1.34      | 3.56E-07      | 63                                |
| 2012 | Unknown | 13    | 13                | 74                      | 1.34      | 9.57E-07      | 217                               |
| 2013 | Alive   | 13    | 13                | 556                     | 0.86      | 1.18E-05      | 2082                              |
| 2013 | Dead    | 13    | 13                | 403                     | 0.86      | 4.95E-06      | 1427                              |
| 2013 | Unknown | 1     | 1                 | 53                      | 0.86      | 1.77E-06      | 184                               |
| 2014 | Alive   | 62    | 62                | 1724                    | 1.17      | 2.27E-05      | 5655                              |

|      |         |     |     |      |      |          |       |
|------|---------|-----|-----|------|------|----------|-------|
| 2014 | Dead    | 19  | 20  | 213  | 1.17 | 2.87E-06 | 771   |
| 2014 | Unknown | 23  | 23  | 352  | 1.17 | 4.93E-06 | 1320  |
| 2015 | Alive   | 35  | 35  | 960  | 0.95 | 3.29E-05 | 7043  |
| 2015 | Dead    | 16  | 16  | 374  | 0.95 | 1.83E-05 | 2588  |
| 2015 | Unknown | 3   | 3   | 65   | 0.95 | 3.37E-06 | 474   |
| 2016 | Alive   | 50  | 50  | 1617 | 0.91 | 3.66E-05 | 7360  |
| 2016 | Dead    | 72  | 72  | 499  | 0.91 | 1.49E-05 | 2871  |
| 2016 | Unknown | 38  | 38  | 287  | 0.91 | 1.60E-05 | 1205  |
| 2017 | Alive   | 74  | 74  | 2769 | 1.61 | 8.30E-05 | 17048 |
| 2017 | Dead    | 9   | 9   | 292  | 1.61 | 8.79E-06 | 1819  |
| 2017 | Unknown | 5   | 5   | 233  | 1.61 | 2.46E-05 | 1658  |
| 2018 | Alive   | 56  | 56  | 1868 | 1.87 | 7.66E-05 | 13372 |
| 2018 | Dead    | 7   | 7   | 261  | 1.87 | 1.57E-05 | 1864  |
| 2018 | Unknown | 3   | 3   | 59   | 1.87 | 3.57E-06 | 418   |
| 2019 | Alive   | 97  | 97  | 3779 | 1.09 | 0.000193 | 18722 |
| 2019 | Dead    | 15  | 15  | 745  | 1.09 | 2.71E-05 | 3755  |
| 2019 | Unknown | 35  | 35  | 925  | 1.09 | 3.36E-05 | 4555  |
| 2020 | Alive   | 11  | 11  | 213  | 0.82 | 3.83E-05 | 1575  |
| 2020 | Dead    | 3   | 3   | 126  | 0.82 | 2.26E-05 | 930   |
| 2020 | Unknown | 1   | 1   | 18   | 0.82 | 3.19E-06 | 131   |
| 2021 | Alive   | 30  | 30  | 974  | 0.95 | 7.28E-05 | 8253  |
| 2021 | Dead    | 12  | 12  | 533  | 0.95 | 4.00E-05 | 4477  |
| 2021 | Unknown | 6   | 6   | 289  | 0.95 | 2.09E-05 | 2577  |
| 2022 | Alive   | 68  | 68  | 1909 | 1.23 | 7.71E-05 | 6458  |
| 2022 | Dead    | 5   | 5   | 148  | 1.23 | 1.34E-05 | 585   |
| 2022 | Unknown | 4   | 4   | 101  | 1.23 | 4.34E-06 | 371   |
| 2023 | Alive   | 125 | 125 | 4716 | 1.4  | 8.69E-05 | 14994 |
| 2023 | Dead    | 48  | 48  | 1183 | 1.4  | 2.95E-05 | 3794  |
| 2023 | Unknown | 10  | 10  | 363  | 1.4  | 1.36E-05 | 1161  |
| 2024 | Alive   | 48  | 48  | 2195 | 0.96 | 9.69E-05 | 8709  |
| 2024 | Dead    | 18  | 18  | 1814 | 0.96 | 8.48E-05 | 7575  |
| 2024 | Unknown | 9   | 9   | 277  | 0.96 | 1.18E-05 | 1062  |
| 2025 | Alive   | 27  | 27  | 1409 | 1.22 | 0.000129 | 6669  |
| 2025 | Dead    | 3   | 3   | 103  | 1.22 | 9.46E-06 | 488   |

94

95 Table 2: Discard estimates of sandbar sharks in the northeast gillnet fishery.

| YEAR | STATEND | Catch | Number of lengths | Observed discards (lbs) | Annual CV | Discard ratio | Fleetwide expanded discards (lbs) |
|------|---------|-------|-------------------|-------------------------|-----------|---------------|-----------------------------------|
| 1995 | Alive   | 17    | 17                | 63                      | 1.47      | 2.90E-05      | 2052                              |
| 1995 | Dead    | 5     | 532               | 6                       | 1.47      | 3.62E-06      | 199                               |

|      |         |     |     |      |      |          |       |
|------|---------|-----|-----|------|------|----------|-------|
| 1996 | Alive   | 92  | 92  | 374  | 1.06 | 0.000276 | 13207 |
| 1996 | Dead    | 46  | 152 | 271  | 1.06 | 0.000137 | 10675 |
| 1996 | Unknown | 6   | 6   | 15   | 1.06 | 1.16E-05 | 608   |
| 1997 | Alive   | 47  | 47  | 179  | 0.74 | 5.99E-05 | 5631  |
| 1997 | Dead    | 8   | 16  | 85   | 0.74 | 5.12E-05 | 2620  |
| 1997 | Unknown | 1   | 1   | 16   | 0.74 | 1.82E-05 | 379   |
| 1998 | Alive   | 63  | 63  | 825  | 1.44 | 0.000285 | 24244 |
| 1998 | Dead    | 42  | 53  | 1766 | 1.44 | 0.000936 | 53819 |
| 1998 | Unknown | 6   | 6   | 95   | 1.44 | 5.51E-05 | 2949  |
| 1999 | Alive   | 18  | 18  | 148  | 1.1  | 8.28E-05 | 5956  |
| 1999 | Dead    | 28  | 51  | 459  | 1.1  | 0.000248 | 18286 |
| 1999 | Unknown | 26  | 26  | 102  | 1.1  | 0.000127 | 2353  |
| 2000 | Alive   | 121 | 121 | 550  | 1.3  | 0.000338 | 19376 |
| 2000 | Dead    | 2   | 18  | 18   | 1.3  | 1.81E-05 | 699   |
| 2000 | Unknown | 1   | 1   | 16   | 1.3  | 3.22E-05 | 625   |
| 2001 | Alive   | 46  | 46  | 153  | 1.95 | 6.75E-05 | 5575  |
| 2001 | Dead    | 15  | 77  | 34   | 1.95 | 3.04E-05 | 1276  |
| 2001 | Unknown | 50  | 50  | 789  | 1.95 | 0.001115 | 22544 |
| 2002 | Alive   | 63  | 63  | 144  | 1    | 0.000139 | 7519  |
| 2002 | Dead    | 36  | 36  | 79   | 1    | 6.87E-05 | 3844  |
| 2002 | Unknown | 1   | 1   | 2    | 1    | 4.20E-06 | 79    |
| 2003 | Alive   | 27  | 27  | 59   | 1    | 2.83E-05 | 1783  |
| 2003 | Dead    | 10  | 11  | 55   | 1    | 3.38E-05 | 2251  |
| 2003 | Unknown | 1   | 1   | 2    | 1    | 3.54E-06 | 81    |
| 2004 | Alive   | 34  | 34  | 109  | 0.8  | 2.67E-05 | 2083  |
| 2004 | Dead    | 20  | 47  | 310  | 0.8  | 8.78E-05 | 5074  |
| 2005 | Alive   | 37  | 37  | 214  | 0.61 | 5.08E-05 | 3605  |
| 2005 | Dead    | 4   | 179 | 41   | 0.61 | 3.17E-05 | 1265  |
| 2006 | Alive   | 43  | 43  | 312  | 0.84 | 0.000143 | 10463 |
| 2006 | Dead    | 6   | 103 | 64   | 0.84 | 4.04E-05 | 2233  |
| 2007 | Alive   | 62  | 62  | 901  | 1.44 | 0.000261 | 17182 |
| 2007 | Dead    | 11  | 29  | 275  | 1.44 | 0.000304 | 6866  |
| 2008 | Alive   | 27  | 27  | 532  | 1.14 | 0.000245 | 18276 |
| 2008 | Dead    | 14  | 51  | 334  | 1.14 | 0.000156 | 10846 |
| 2009 | Alive   | 3   | 3   | 12   | 0.36 | 2.04E-05 | 426   |
| 2009 | Dead    | 1   | 2   | 15   | 0.36 | 2.54E-05 | 716   |
| 2010 | Alive   | 67  | 67  | 277  | 1.61 | 0.000162 | 9817  |
| 2010 | Dead    | 33  | 33  | 156  | 1.61 | 2.16E-05 | 1909  |
| 2011 | Alive   | 14  | 14  | 208  | 1.42 | 3.53E-05 | 2314  |
| 2011 | Dead    | 32  | 32  | 688  | 1.42 | 0.000332 | 7510  |
| 2012 | Alive   | 18  | 18  | 111  | 1.03 | 4.56E-05 | 1564  |
| 2012 | Dead    | 6   | 7   | 92   | 1.03 | 2.19E-05 | 917   |
| 2013 | Alive   | 28  | 28  | 129  | 0.79 | 4.07E-05 | 2393  |

|      |         |     |     |      |      |          |       |
|------|---------|-----|-----|------|------|----------|-------|
| 2013 | Dead    | 16  | 37  | 100  | 0.79 | 2.03E-05 | 1776  |
| 2014 | Alive   | 79  | 79  | 612  | 1.6  | 0.000118 | 9051  |
| 2014 | Dead    | 79  | 148 | 1259 | 1.6  | 0.000184 | 18299 |
| 2015 | Alive   | 108 | 108 | 459  | 1.95 | 9.73E-05 | 6695  |
| 2015 | Dead    | 67  | 73  | 1141 | 1.95 | 0.000228 | 28153 |
| 2016 | Alive   | 97  | 97  | 1084 | 1.23 | 0.000194 | 13732 |
| 2016 | Dead    | 64  | 66  | 845  | 1.23 | 0.000156 | 11592 |
| 2016 | Unknown | 2   | 2   | 19   | 1.23 | 7.13E-06 | 248   |
| 2017 | Alive   | 290 | 290 | 2552 | 1.42 | 0.000444 | 34356 |
| 2017 | Dead    | 114 | 136 | 1615 | 1.42 | 0.000283 | 21742 |
| 2017 | Unknown | 2   | 2   | 11   | 1.42 | 7.52E-06 | 156   |
| 2018 | Alive   | 118 | 118 | 1246 | 1.34 | 0.000305 | 17148 |
| 2018 | Dead    | 25  | 26  | 492  | 1.34 | 0.000224 | 10046 |
| 2018 | Unknown | 2   | 2   | 5    | 1.34 | 2.31E-06 | 50    |
| 2019 | Alive   | 59  | 59  | 342  | 1.69 | 6.23E-05 | 3907  |
| 2019 | Dead    | 64  | 67  | 1450 | 1.69 | 0.000369 | 16825 |
| 2019 | Unknown | 1   | 1   | 16   | 1.69 | 1.08E-05 | 178   |
| 2020 | Alive   | 49  | 49  | 376  | 1.34 | 0.000196 | 6476  |
| 2021 | Dead    | 35  | 35  | 828  | 0.65 | 0.000404 | 10529 |
| 2022 | Alive   | 13  | 13  | 46   | 1.35 | 1.37E-05 | 519   |
| 2022 | Dead    | 36  | 37  | 885  | 1.35 | 0.000394 | 9952  |
| 2022 | Unknown | 3   | 3   | 84   | 1.35 | 7.40E-05 | 941   |
| 2023 | Alive   | 26  | 26  | 206  | 0.83 | 5.72E-05 | 2766  |
| 2023 | Dead    | 25  | 25  | 635  | 0.83 | 0.000186 | 6275  |
| 2024 | Alive   | 20  | 20  | 86   | 0.77 | 2.81E-05 | 642   |
| 2024 | Dead    | 3   | 9   | 84   | 0.77 | 4.76E-05 | 1041  |
| 2025 | Alive   | 8   | 8   | 43   | 1.56 | 2.34E-05 | 665   |
| 2025 | Dead    | 8   | 8   | 125  | 1.56 | 0.000127 | 2477  |

96

97 Table 3: Hindcast discard estimates by fleet assuming an average discard ratio from 1995-1997.

| Year | Trawl tot (lbs) | Trawl discard ratio | Trawl discard (lbs) | Trawl CV | Gillnet tot lbs | Gillnet Discard Ratio | Gillnet discard (lbs) | Gillnet CV |
|------|-----------------|---------------------|---------------------|----------|-----------------|-----------------------|-----------------------|------------|
| 1964 | 54942705<br>3   | 1.55E-05            | 8515                | 0.3344   | 2974923         | 0.00014               | 417                   | 0.672337   |
| 1965 | 54083849<br>8   | 1.55E-05            | 8381                | 0.3145   | 2696450         | 0.00014               | 378                   | 0.545513   |
| 1966 | 51770320<br>6   | 1.55E-05            | 8023                | 0.29291  | 4157891         | 0.00014               | 583                   | 0.540214   |
| 1967 | 46764346<br>4   | 1.55E-05            | 7247                | 0.261066 | 4040138         | 0.00014               | 567                   | 0.550527   |
| 1968 | 45415143<br>3   | 1.55E-05            | 7038                | 0.302044 | 5576557         | 0.00014               | 782                   | 0.613388   |

|      |               |          |      |          |          |         |      |          |
|------|---------------|----------|------|----------|----------|---------|------|----------|
| 1969 | 42128092<br>8 | 1.55E-05 | 6529 | 0.217942 | 3913962  | 0.00014 | 549  | 0.622023 |
| 1970 | 38674212<br>8 | 1.55E-05 | 5993 | 0.244    | 3567372  | 0.00014 | 500  | 0.579826 |
| 1971 | 35084253<br>1 | 1.55E-05 | 5437 | 0.232505 | 3827836  | 0.00014 | 537  | 0.524745 |
| 1972 | 30669030<br>2 | 1.55E-05 | 4753 | 0.165128 | 6218194  | 0.00014 | 872  | 0.530599 |
| 1973 | 31255275<br>4 | 1.55E-05 | 4844 | 0.100298 | 6484564  | 0.00014 | 910  | 0.657173 |
| 1974 | 28424356<br>8 | 1.55E-05 | 4405 | 0.099592 | 10906354 | 0.00014 | 1530 | 0.435649 |
| 1975 | 26710515<br>7 | 1.55E-05 | 4139 | 0.091813 | 12183558 | 0.00014 | 1709 | 0.464747 |
| 1976 | 27797659<br>3 | 1.55E-05 | 4308 | 0.200563 | 18494383 | 0.00014 | 2594 | 0.521714 |
| 1977 | 33015100<br>5 | 1.55E-05 | 5116 | 0.158986 | 24944803 | 0.00014 | 3499 | 0.285642 |
| 1978 | 38924442<br>8 | 1.55E-05 | 6032 | 0.16408  | 34368995 | 0.00014 | 4821 | 0.409404 |
| 1979 | 39632384<br>0 | 1.55E-05 | 6142 | 0.151882 | 32413505 | 0.00014 | 4546 | 0.496442 |
| 1980 | 43121944<br>3 | 1.55E-05 | 6683 | 0.13511  | 44299196 | 0.00014 | 6214 | 0.533042 |
| 1981 | 39926296<br>6 | 1.55E-05 | 6187 | 0.140226 | 49835257 | 0.00014 | 6990 | 0.375712 |
| 1982 | 46245167<br>5 | 1.55E-05 | 7167 | 0.129158 | 36379507 | 0.00014 | 5103 | 0.672201 |
| 1983 | 45156387<br>4 | 1.55E-05 | 6998 | 0.16201  | 33298296 | 0.00014 | 4671 | 0.537312 |
| 1984 | 42609568<br>9 | 1.55E-05 | 6603 | 0.083478 | 40204876 | 0.00014 | 5639 | 0.666171 |
| 1985 | 35618763<br>1 | 1.55E-05 | 5520 | 0.1042   | 36622292 | 0.00014 | 5137 | 0.46606  |
| 1986 | 33940021<br>0 | 1.55E-05 | 5260 | 0.081514 | 40218115 | 0.00014 | 5641 | 0.442685 |
| 1987 | 31039831<br>7 | 1.55E-05 | 4810 | 0.112645 | 40099301 | 0.00014 | 5624 | 0.504852 |
| 1988 | 31069056<br>8 | 1.55E-05 | 4815 | 0.142336 | 42181938 | 0.00014 | 5917 | 0.440334 |
| 1989 | 32032259<br>6 | 1.55E-05 | 4964 | 0.415824 | 56714316 | 0.00014 | 7955 | 0.717295 |
| 1990 | 36748727<br>3 | 1.55E-05 | 5695 | 0.444854 | 62700569 | 0.00014 | 8795 | 0.719915 |
| 1991 | 39293830<br>0 | 1.55E-05 | 6089 | 0.435216 | 62081937 | 0.00014 | 8708 | 0.689504 |

|      |               |          |      |          |          |          |       |          |
|------|---------------|----------|------|----------|----------|----------|-------|----------|
| 1992 | 38469642<br>7 | 1.55E-05 | 5962 | 0.433336 | 61384420 | 0.00014  | 8610  | 0.651286 |
| 1993 | 35898011<br>9 | 1.55E-05 | 5563 | 0.367853 | 73529612 | 0.00014  | 10313 | 0.684967 |
| 1994 | 31910587<br>3 | 1.55E-05 | 4945 | 0.581605 | 84566181 | 6.66E-05 | 4251  | 1.463151 |

98

99 Table 4: Hindcast discard estimates by fleet assuming an average discard ratio from 1998-2008.

| Year | Trawl tot (lbs) | Trawl discard ratio | Trawl discard (lbs) | Trawl CV | Gillnet tot lbs | Gillnet Discard Ratio | Gillnet discard (lbs) | Gillnet CV |
|------|-----------------|---------------------|---------------------|----------|-----------------|-----------------------|-----------------------|------------|
| 1964 | 54942705<br>3   | 1.55E-05            | 8515                | 0.3344   | 2974923         | 0.00014               | 417                   | 0.672337   |
| 1965 | 54083849<br>8   | 1.55E-05            | 8381                | 0.3145   | 2696450         | 0.00014               | 378                   | 0.545513   |
| 1966 | 51770320<br>6   | 1.55E-05            | 8023                | 0.29291  | 4157891         | 0.00014               | 583                   | 0.540214   |
| 1967 | 46764346<br>4   | 1.55E-05            | 7247                | 0.261066 | 4040138         | 0.00014               | 567                   | 0.550527   |
| 1968 | 45415143<br>3   | 1.55E-05            | 7038                | 0.302044 | 5576557         | 0.00014               | 782                   | 0.613388   |
| 1969 | 42128092<br>8   | 1.55E-05            | 6529                | 0.217942 | 3913962         | 0.00014               | 549                   | 0.622023   |
| 1970 | 38674212<br>8   | 1.55E-05            | 5993                | 0.244    | 3567372         | 0.00014               | 500                   | 0.579826   |
| 1971 | 35084253<br>1   | 1.55E-05            | 5437                | 0.232505 | 3827836         | 0.00014               | 537                   | 0.524745   |
| 1972 | 30669030<br>2   | 1.55E-05            | 4753                | 0.165128 | 6218194         | 0.00014               | 872                   | 0.530599   |
| 1973 | 31255275<br>4   | 1.55E-05            | 4844                | 0.100298 | 6484564         | 0.00014               | 910                   | 0.657173   |
| 1974 | 28424356<br>8   | 1.55E-05            | 4405                | 0.099592 | 10906354        | 0.00014               | 1530                  | 0.435649   |
| 1975 | 26710515<br>7   | 1.55E-05            | 4139                | 0.091813 | 12183558        | 0.00014               | 1709                  | 0.464747   |
| 1976 | 27797659<br>3   | 1.55E-05            | 4308                | 0.200563 | 18494383        | 0.00014               | 2594                  | 0.521714   |
| 1977 | 33015100<br>5   | 1.55E-05            | 5116                | 0.158986 | 24944803        | 0.00014               | 3499                  | 0.285642   |
| 1978 | 38924442<br>8   | 1.55E-05            | 6032                | 0.16408  | 34368995        | 0.00014               | 4821                  | 0.409404   |
| 1979 | 39632384<br>0   | 1.55E-05            | 6142                | 0.151882 | 32413505        | 0.00014               | 4546                  | 0.496442   |
| 1980 | 43121944<br>3   | 1.55E-05            | 6683                | 0.13511  | 44299196        | 0.00014               | 6214                  | 0.533042   |

|      |               |          |      |          |          |          |       |          |
|------|---------------|----------|------|----------|----------|----------|-------|----------|
| 1981 | 39926296<br>6 | 1.55E-05 | 6187 | 0.140226 | 49835257 | 0.00014  | 6990  | 0.375712 |
| 1982 | 46245167<br>5 | 1.55E-05 | 7167 | 0.129158 | 36379507 | 0.00014  | 5103  | 0.672201 |
| 1983 | 45156387<br>4 | 1.55E-05 | 6998 | 0.16201  | 33298296 | 0.00014  | 4671  | 0.537312 |
| 1984 | 42609568<br>9 | 1.55E-05 | 6603 | 0.083478 | 40204876 | 0.00014  | 5639  | 0.666171 |
| 1985 | 35618763<br>1 | 1.55E-05 | 5520 | 0.1042   | 36622292 | 0.00014  | 5137  | 0.46606  |
| 1986 | 33940021<br>0 | 1.55E-05 | 5260 | 0.081514 | 40218115 | 0.00014  | 5641  | 0.442685 |
| 1987 | 31039831<br>7 | 1.55E-05 | 4810 | 0.112645 | 40099301 | 0.00014  | 5624  | 0.504852 |
| 1988 | 31069056<br>8 | 1.55E-05 | 4815 | 0.142336 | 42181938 | 0.00014  | 5917  | 0.440334 |
| 1989 | 32032259<br>6 | 1.55E-05 | 4964 | 0.415824 | 56714316 | 0.00014  | 7955  | 0.717295 |
| 1990 | 36748727<br>3 | 1.55E-05 | 5695 | 0.444854 | 62700569 | 0.00014  | 8795  | 0.719915 |
| 1991 | 39293830<br>0 | 1.55E-05 | 6089 | 0.435216 | 62081937 | 0.00014  | 8708  | 0.689504 |
| 1992 | 38469642<br>7 | 1.55E-05 | 5962 | 0.433336 | 61384420 | 0.00014  | 8610  | 0.651286 |
| 1993 | 35898011<br>9 | 1.55E-05 | 5563 | 0.367853 | 73529612 | 0.00014  | 10313 | 0.684967 |
| 1994 | 31910587<br>3 | 1.55E-05 | 4945 | 0.581605 | 84566181 | 6.66E-05 | 4251  | 1.463151 |

100

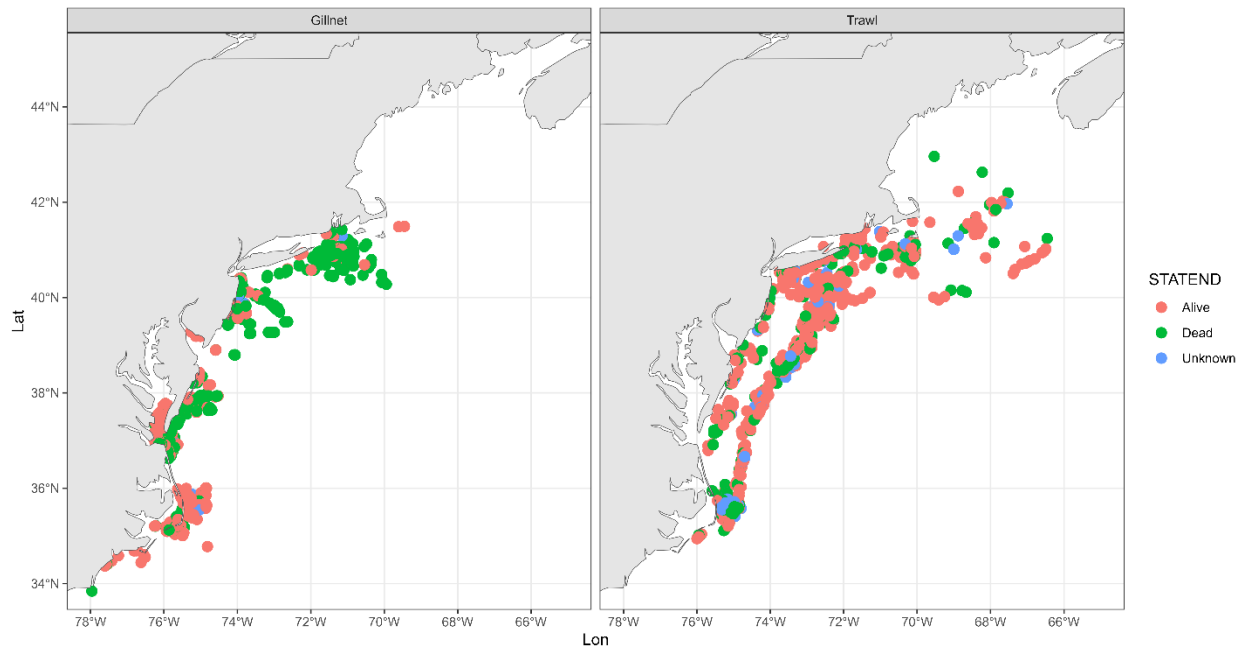
101 Table 5: Hindcast discard estimates by fleet assuming an average discard ratio from 2009-2025.

| Year | Trawl tot (lbs) | Trawl discard ratio | Trawl discards (lbs) | CV       | Gillnet tot (lbs) | Gillnet discard ratio | Gillnet discards (lbs) | Gillnet CV |
|------|-----------------|---------------------|----------------------|----------|-------------------|-----------------------|------------------------|------------|
| 1964 | 5.49E+08        | 3.04E-05            | 16676                | 0.3344   | 2974923           | 0.000146              | 434                    | 0.672337   |
| 1965 | 5.41E+08        | 3.04E-05            | 16415                | 0.3145   | 2696450           | 0.000146              | 394                    | 0.545513   |
| 1966 | 5.18E+08        | 3.04E-05            | 15713                | 0.29291  | 4157891           | 0.000146              | 607                    | 0.540214   |
| 1967 | 4.68E+08        | 3.04E-05            | 14193                | 0.261066 | 4040138           | 0.000146              | 590                    | 0.550527   |
| 1968 | 4.54E+08        | 3.04E-05            | 13784                | 0.302044 | 5576557           | 0.000146              | 814                    | 0.613388   |
| 1969 | 4.21E+08        | 3.04E-05            | 12786                | 0.217942 | 3913962           | 0.000146              | 571                    | 0.622023   |
| 1970 | 3.87E+08        | 3.04E-05            | 11738                | 0.244    | 3567372           | 0.000146              | 521                    | 0.579826   |
| 1971 | 3.51E+08        | 3.04E-05            | 10648                | 0.232505 | 3827836           | 0.000146              | 559                    | 0.524745   |
| 1972 | 3.07E+08        | 3.04E-05            | 9308                 | 0.165128 | 6218194           | 0.000146              | 907                    | 0.530599   |
| 1973 | 3.13E+08        | 3.04E-05            | 9486                 | 0.100298 | 6484564           | 0.000146              | 946                    | 0.657173   |
| 1974 | 2.84E+08        | 3.04E-05            | 8627                 | 0.099592 | 10906354          | 0.000146              | 1592                   | 0.435649   |

|      |          |          |       |          |          |          |       |          |
|------|----------|----------|-------|----------|----------|----------|-------|----------|
| 1975 | 2.67E+08 | 3.04E-05 | 8107  | 0.091813 | 12183558 | 0.000146 | 1778  | 0.464747 |
| 1976 | 2.78E+08 | 3.04E-05 | 8437  | 0.200563 | 18494383 | 0.000146 | 2699  | 0.521714 |
| 1977 | 3.3E+08  | 3.04E-05 | 10020 | 0.158986 | 24944803 | 0.000146 | 3640  | 0.285642 |
| 1978 | 3.89E+08 | 3.04E-05 | 11814 | 0.16408  | 34368995 | 0.000146 | 5016  | 0.409404 |
| 1979 | 3.96E+08 | 3.04E-05 | 12029 | 0.151882 | 32413505 | 0.000146 | 4730  | 0.496442 |
| 1980 | 4.31E+08 | 3.04E-05 | 13088 | 0.13511  | 44299196 | 0.000146 | 6465  | 0.533042 |
| 1981 | 3.99E+08 | 3.04E-05 | 12118 | 0.140226 | 49835257 | 0.000146 | 7273  | 0.375712 |
| 1982 | 4.62E+08 | 3.04E-05 | 14036 | 0.129158 | 36379507 | 0.000146 | 5309  | 0.672201 |
| 1983 | 4.52E+08 | 3.04E-05 | 13705 | 0.16201  | 33298296 | 0.000146 | 4859  | 0.537312 |
| 1984 | 4.26E+08 | 3.04E-05 | 12932 | 0.083478 | 40204876 | 0.000146 | 5867  | 0.666171 |
| 1985 | 3.56E+08 | 3.04E-05 | 10811 | 0.1042   | 36622292 | 0.000146 | 5344  | 0.46606  |
| 1986 | 3.39E+08 | 3.04E-05 | 10301 | 0.081514 | 40218115 | 0.000146 | 5869  | 0.442685 |
| 1987 | 3.1E+08  | 3.04E-05 | 9421  | 0.112645 | 40099301 | 0.000146 | 5852  | 0.504852 |
| 1988 | 3.11E+08 | 3.04E-05 | 9430  | 0.142336 | 42181938 | 0.000146 | 6156  | 0.440334 |
| 1989 | 3.2E+08  | 3.04E-05 | 9722  | 0.415824 | 56714316 | 0.000146 | 8276  | 0.717295 |
| 1990 | 3.67E+08 | 3.04E-05 | 11154 | 0.444854 | 62700569 | 0.000146 | 9150  | 0.719915 |
| 1991 | 3.93E+08 | 3.04E-05 | 11926 | 0.435216 | 62081937 | 0.000146 | 9060  | 0.689504 |
| 1992 | 3.85E+08 | 3.04E-05 | 11676 | 0.433336 | 61384420 | 0.000146 | 8958  | 0.651286 |
| 1993 | 3.59E+08 | 3.04E-05 | 10895 | 0.367853 | 73529612 | 0.000146 | 10730 | 0.684967 |
| 1994 | 3.19E+08 | 3.04E-05 | 9685  | 0.581605 | 84566181 | 6.85E-05 | 4376  | 1.483916 |

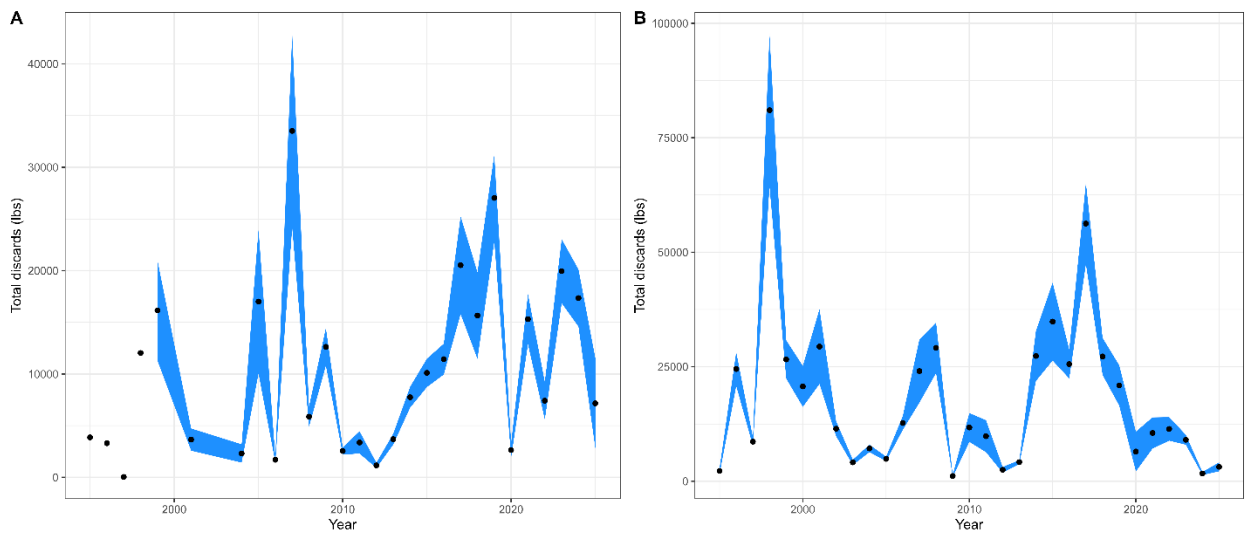
102

103



104

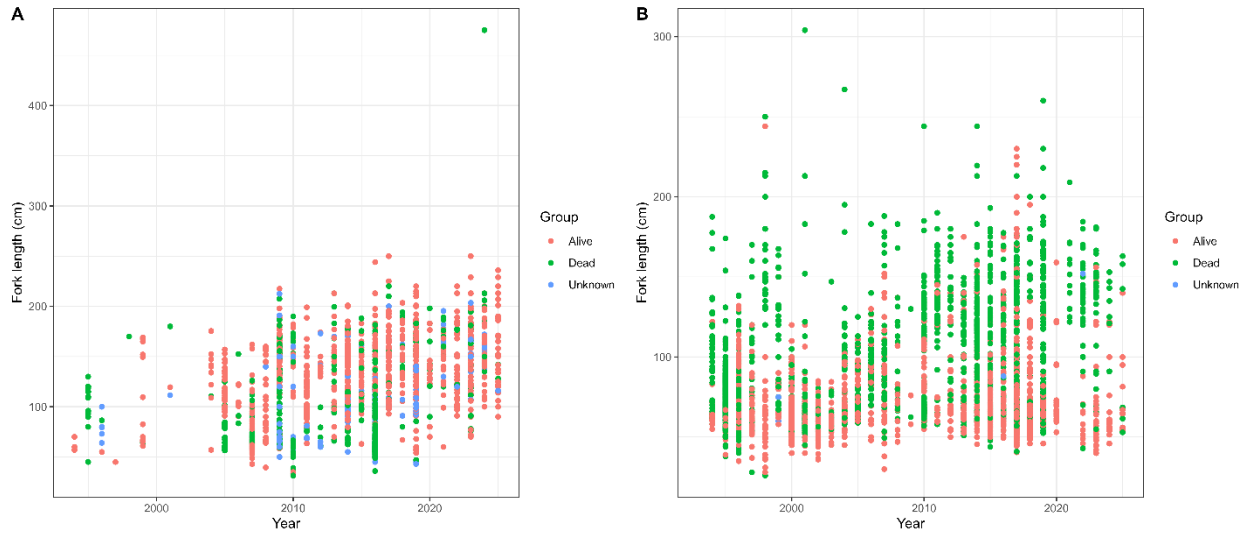
105 Figure1: Location of sandbar discards by disposition and gear type. Location points are enlarged and  
 106 slightly jittered to account for confidentiality.



107

108 Figure 2: Sandbar shark expanded fleetwide discard estimates for trawl (A) and gillnet (B) fisheries.

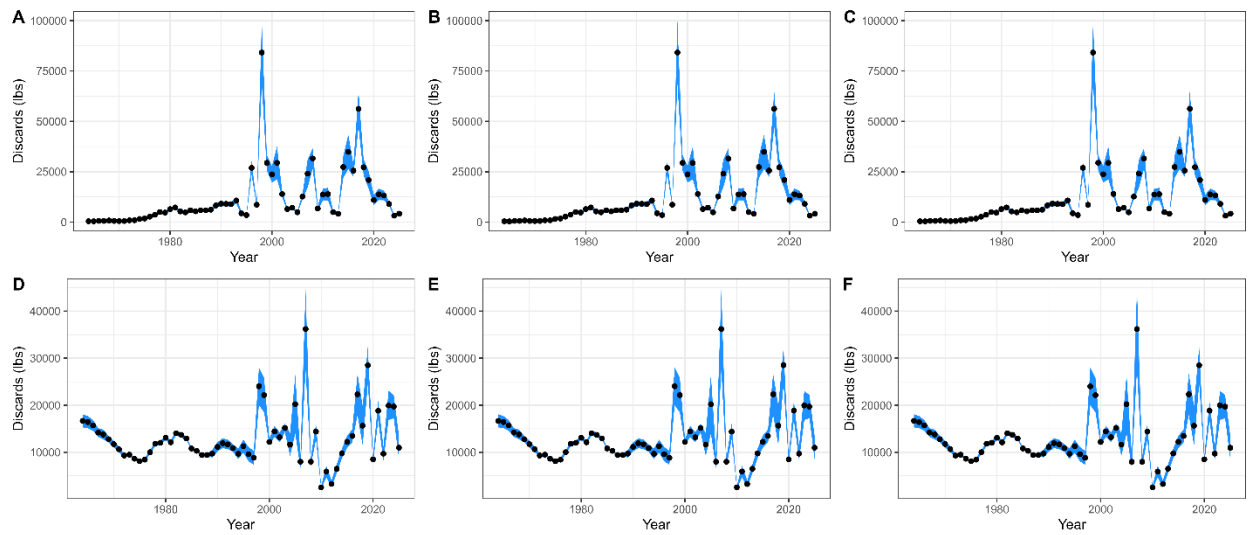
109



110

111 Figure 3: Lengths of discarded sandbar sharks for the trawl (A) and gillnet (B) fisheries.

112



113

114 Figure 4: Hindcast discard estimates using different grand means by gear type: (A) gillnet 1995-1998, (B)  
 115 gillnet 1999-2007, (C) gillnet 2008-2025, (D) trawl 1995-1998, (E) trawl 1999-2007, and (F) trawl 2008-  
 116 2025

117

118