# Revised stock assessments of Black Sea Bass, Blueline Tilefish, Red Grouper, and Vermilion Snapper in the U.S. South Atlantic region

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## 1 Executive Summary

This report presents results from four SEDAR stock assessments revised to account for recently adjusted MRIP estimates of recreational catch in the South Atlantic region. The four stocks are Black Sea Bass (SEDAR-56), Blueline Tilefish (SEDAR-50), Red Grouper (SEDAR-53), and Vermilion Snapper (SEDAR-55). In each case, assessment and projection methodologies were identical to those applied previously, and the sole differences in model inputs were the MRIP time series of recreational landings and discards. On average across species, the adjusted MRIP estimates were about twice as large as they were in the previous SEDAR assessments. That ratio varied annually but generally trended upward over the last decade, when the adjusted catch ranged between two and three times as large as before. Across species, the primary effect of increased recreational catch estimates was to scale up the total abundance perceived by the assessment model. The effects on stock status (SSB/MSST or B/MSST) and fishery status ($F_{current}/F_{MSY}$) differed by species, and in some cases altered the qualitative results of the assessment. For Black Sea Bass, the stock was found to be overfished ($SSB_{2016}$/MSST=0.98) and experiencing overfishing ($F_{current}/F_{MSY}$=1.4), results that were qualitatively different from SEDAR-56 for both status indicators. For Blueline Tilefish south of Cape Hatteras, the stock was found to be above the overfished threshold ($B_{2015}$/MSST=1.09), but unlike the finding of SEDAR-50, was found by this assessment to be experiencing overfishing ($F_{current}/F_{MSY}$=1.44). Blueline Tilefish north of Cape Hatteras were assessed using data-limited methods in SEDAR-50, and those models were re-run to provide adjusted Total Allowable Catch. For Red Grouper, the stock was found to be overfished ($SSB_{2015}$/MSST=0.25) and experiencing overfishing ($F_{current}/F_{MSY}$=3.43), similar to the findings of SEDAR-53 but more extreme in both status indicators. For Vermilion Snapper, the stock was found to be above the overfished threshold ($SSB_{2016}$/MSST=0.1.38), and was not experiencing overfishing ($F_{current}/F_{MSY}$=0.85), similar to previous findings. For each of the revised assessments, this report characterizes uncertainty in stock status, fishery status, and other management quantities, and it repeats projection scenarios that previously were adopted for setting ABCs and OFLs, and in the case of red grouper, a rebuilding time frame.

**2 Data Update**

In July 2018, the Marine Recreational Information Program (MRIP) provided revised estimates of recreational landings, discards, and effort to calibrate for the transition from the Coastal Household Telephone Survey (CHTS) to the Fishing Effort Survey (FES) as well as the Access Point Angler Intercept Survey (APAIS).

Prior to MRIP providing calibrated estimates, uncalibrated MRFSS/MRIP estimates (BASE) were used in stock assessments. Recent stock assessments in the South Atlantic, including those of Black Sea Bass, Blueline Tilefish, Red Grouper, and Vermilion Snapper, utilized MRIP data based on the APAIS-calibrated estimates (ACAL). The new calibration method utilizes APAIS- and FES-calibrated estimates (FCAL).

To adjust the ACAL landings and discard estimates for these four recent stock assessments, data were downloaded from the MRIP website (Calibration Catch Estimates Comparison Query) for each species (landings and discards). A 'scaling' vector was calculated as FCAL/ACAL, to determine the differences between these two estimates by year (Table 2.1). This scaling vector was then multiplied by the previous ACAL estimates of landings or discards used in the previous assessment to convert to FCAL estimates, and these FCAL values were used in these current assessments (Table 2.2).

For developing the scaling vectors, we used the same MRIP modes that were considered in the previous assessments, as described in the SEDAR assessment reports. Black Sea Bass and Red Grouper included all modes, and Blueline Tilefish and Vermilion Snapper included only charter and private boats.

Blueline Tilefish had limited data available to create the FCAL/ACAL scaling vector. Therefore Snowy Grouper and Tilefish (Golden) were used as a proxy for adjusting the landings estimates, and Snowy Grouper, Tilefish (Golden), and Red Porgy were used as a proxy for adjusting the discard estimates. In both cases (landings and discards), FCAL/ACAL vectors were computed for each of the proxy species, and then averaged into a single vector.

MRIP data begin in 1981, and the initial year of each assessment was prior to 1981. Thus, for years prior to 1981, adjustments to landings and discards were computed using the geometric mean of the scaling vector from the period 1981-1990.

Table 2.1. Vectors of scaling for each species applied to landings (L) and discards (D). For years pre-1981, the geometric mean of the scaling vector was estimated from the period 1981–1990.

| | Red Grouper | | Black Sea Bass | | Vermilion Snapper | | Blueline Tilefish | |
|---|---|---|---|---|---|---|---|---|
| Year | L | D | L | D | L | D | L | D |
| *pre-1981* | *2.19* | *2.63* | *1.83* | *2.36* | *1.55* | *1.64* | *1.67* | *1.57* |
| 1981 | 2.87 | 1.00 | 2.83 | 3.08 | 2.77 | 1.00 | 4.43 | 1.00 |
| 1982 | 1.82 | 3.50 | 1.90 | 2.35 | 1.34 | 1.15 | 1.00 | 2.34 |
| 1983 | 2.36 | 1.44 | 1.42 | 2.33 | 1.28 | 1.00 | 1.59 | 1.00 |
| 1984 | 2.56 | 7.07 | 1.82 | 2.04 | 1.04 | 1.00 | 3.98 | 1.00 |
| 1985 | 1.40 | 3.13 | 1.78 | 2.09 | 1.38 | 3.49 | 1.21 | 1.51 |
| 1986 | 2.10 | 1.54 | 2.12 | 2.76 | 2.37 | 1.33 | 1.47 | 1.97 |
| 1987 | 2.37 | 4.04 | 1.65 | 1.95 | 1.46 | 1.05 | 1.07 | 1.73 |
| 1988 | 2.80 | 2.01 | 1.81 | 2.61 | 1.72 | 2.16 | 1.77 | 0.95 |
| 1989 | 1.26 | 1.64 | 1.57 | 2.34 | 1.37 | 2.58 | 1.31 | 3.24 |
| 1990 | 3.28 | 2.68 | 1.71 | 2.23 | 1.49 | 2.73 | 1.37 | 2.50 |
| 1991 | 1.60 | 1.33 | 1.85 | 2.28 | 1.31 | 1.17 | 1.00 | 1.00 |
| 1992 | 1.56 | 2.23 | 1.97 | 2.35 | 1.14 | 2.19 | 1.72 | 1.32 |
| 1993 | 2.66 | 2.44 | 1.80 | 2.24 | 1.60 | 2.02 | 1.00 | 1.38 |
| 1994 | 2.01 | 2.09 | 1.71 | 1.92 | 1.15 | 1.83 | 1.15 | 1.08 |
| 1995 | 1.52 | 1.73 | 1.52 | 1.91 | 1.27 | 1.66 | 1.00 | 1.71 |
| 1996 | 1.44 | 2.35 | 1.94 | 2.12 | 1.69 | 1.92 | 1.60 | 2.03 |
| 1997 | 1.22 | 1.84 | 1.74 | 2.03 | 1.30 | 1.87 | 1.27 | 3.41 |
| 1998 | 1.81 | 1.57 | 1.88 | 2.20 | 1.35 | 2.53 | 1.27 | 2.34 |
| 1999 | 2.06 | 2.75 | 2.09 | 2.77 | 1.61 | 1.85 | 1.00 | 2.11 |
| 2000 | 1.83 | 2.56 | 2.09 | 2.29 | 1.61 | 1.75 | 1.10 | 2.39 |
| 2001 | 1.95 | 2.06 | 2.17 | 2.19 | 1.65 | 1.99 | 1.06 | 1.88 |
| 2002 | 1.67 | 2.86 | 2.26 | 2.52 | 1.41 | 2.40 | 1.07 | 1.33 |
| 2003 | 1.75 | 2.44 | 1.82 | 2.11 | 1.85 | 2.37 | 1.24 | 1.77 |
| 2004 | 1.69 | 2.12 | 2.02 | 2.12 | 1.38 | 1.78 | 1.22 | 1.64 |
| 2005 | 1.91 | 2.05 | 2.01 | 2.25 | 1.37 | 1.83 | 1.04 | 1.76 |
| 2006 | 1.59 | 2.13 | 2.20 | 2.31 | 1.63 | 2.59 | 1.39 | 1.10 |
| 2007 | 1.70 | 1.60 | 1.73 | 1.98 | 1.76 | 1.62 | 1.06 | 1.23 |
| 2008 | 1.75 | 2.19 | 1.89 | 2.03 | 1.74 | 2.04 | 1.00 | 1.78 |
| 2009 | 2.53 | 2.50 | 2.32 | 2.69 | 2.13 | 2.45 | 2.38 | 2.07 |
| 2010 | 1.72 | 2.72 | 2.55 | 2.55 | 1.73 | 1.99 | 1.88 | 1.46 |
| 2011 | 2.22 | 2.25 | 2.33 | 2.77 | 2.60 | 2.47 | 1.54 | 1.71 |
| 2012 | 2.34 | 2.31 | 2.11 | 2.44 | 1.39 | 2.36 | 2.02 | 1.46 |
| 2013 | 2.84 | 2.51 | 2.56 | 2.56 | 2.30 | 2.07 | 1.72 | 1.47 |
| 2014 | 2.45 | 4.64 | 2.98 | 3.09 | 2.34 | 2.87 | 1.51 | 2.54 |
| 2015 | 3.03 | 2.98 | 3.25 | 3.28 | 2.19 | 2.45 | 1.72 | 1.71 |
| 2016 | 2.50 | 2.65 | 2.73 | 3.19 | 2.68 | 3.06 | 1.63 | 2.83 |
| 2017 | 3.75 | 2.07 | 2.99 | 3.47 | 2.70 | 2.38 | 1.35 | 1.89 |

Table 2.2. The adjusted landings (L) and discards (D) used in these revised assessments by stock. Units for Blueline Tilefish landings and discards are 1000 lb, as are units for Black Sea Bass landings; units for all other columns are 1000 fish.

| | Red Grouper | | Black Sea Bass | | Vermilion Snapper | | Blueline Tilefish S Cape Hatteras | | Blueline Tilefish N Cape Hatteras | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | L | D | L | D | L | D | L | D | L | D |
| 1947 | | | | | 7.7 | 3.5 | | | | |
| 1948 | | | | | 15.4 | 7.0 | | | | |
| 1949 | | | | | 23.1 | 10.5 | | | | |
| 1950 | | | | | 30.9 | 14.0 | | | | |
| 1951 | | | | | 38.6 | 17.6 | | | | |
| 1952 | | | | | 46.3 | 21.1 | | | | |
| 1953 | | | | | 54.0 | 24.6 | | | | |
| 1954 | | | | | 61.7 | 28.1 | | | | |
| 1955 | | | | | 69.4 | 31.6 | | | | |
| 1956 | | | | | 76.2 | 34.7 | | | | |
| 1957 | | | | | 83.0 | 37.8 | | | | |
| 1958 | | | | | 89.8 | 40.9 | 0.2 | 0.0 | 0.2 | 0.0 |
| 1959 | | | | | 96.6 | 43.9 | 0.1 | 0.0 | 0.2 | 0.0 |
| 1960 | | | | | 103.4 | 47.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1961 | | | | | 112.7 | 51.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1962 | | | | | 122.1 | 55.6 | 0.7 | 0.0 | 0.4 | 0.0 |
| 1963 | | | | | 131.4 | 59.8 | 0.7 | 0.0 | 0.2 | 0.0 |
| 1964 | | | | | 140.8 | 64.1 | 0.1 | 0.0 | 0.6 | 0.0 |
| 1965 | | | | | 150.2 | 68.3 | 5.5 | 0.0 | 0.0 | 0.0 |
| 1966 | | | | | 151.0 | 68.7 | 1.0 | 0.0 | 0.0 | 0.0 |
| 1967 | | | | | 151.9 | 69.1 | 2.4 | 0.0 | 0.0 | 0.0 |
| 1968 | | | | | 152.8 | 69.5 | 1.1 | 0.0 | 0.0 | 0.0 |
| 1969 | | | | | 153.7 | 69.9 | 0.8 | 0.0 | 0.0 | 0.0 |
| 1970 | | | | | 154.6 | 70.3 | 2.2 | 0.0 | 0.0 | 0.0 |
| 1971 | | | | | 169.8 | 77.3 | 4.3 | 0.0 | 0.0 | 0.0 |
| 1972 | | | | | 185.1 | 84.2 | 2.6 | 0.0 | 0.0 | 0.0 |
| 1973 | | | | | 200.4 | 91.2 | 27.4 | 0.0 | 0.0 | 0.0 |
| 1974 | | | | | 215.7 | 98.1 | 44.5 | 0.0 | 0.0 | 0.0 |
| 1975 | | | | | 230.9 | 105.1 | 55.9 | 0.0 | 0.0 | 0.0 |
| 1976 | | | | | 233.5 | 106.3 | 63.9 | 0.0 | 0.0 | 0.0 |
| 1977 | | | | | 236.2 | 107.5 | 38.1 | 0.0 | 0.0 | 0.0 |
| 1978 | | | | | 238.8 | 108.6 | 80.6 | 0.0 | 31.5 | 0.0 |
| 1979 | | | | | 241.4 | 109.8 | 60.6 | 0.0 | 9.9 | 0.0 |
| 1980 | | | | | 244.0 | 111.0 | 163.5 | 0.0 | 10.6 | 0.0 |

Table 2.2 (cont.)

| Year | Red Grouper | | Black Sea Bass | | Vermilion Snapper | | Blueline Tilefish S Cape Hatteras | | Blueline Tilefish N Cape Hatteras | |
|---|---|---|---|---|---|---|---|---|---|---|
| | L | D | L | D | L | D | L | D | L | D |
| 1981 | 333.8 | 16.8 | 2159.4 | 5958.8 | 37.5 | 63.6 | 417.3 | 0.0 | 25.4 | 0.0 |
| 1982 | 283.1 | 57.7 | 4507.5 | 2822.1 | 179.6 | 27.0 | 1074.7 | 0.0 | 25.2 | 0.0 |
| 1983 | 650.3 | 216.7 | 1698.5 | 1163.3 | 432.9 | 0.4 | 552.9 | 0.0 | 31.7 | 0.0 |
| 1984 | 650.8 | 1282.3 | 4561.7 | 2581.1 | 95.1 | 6.6 | 487.3 | 0.0 | 42.1 | 0.0 |
| 1985 | 133.2 | 15.7 | 2771.9 | 2690.8 | 475.2 | 32.5 | 318.2 | 0.0 | 21.2 | 0.0 |
| 1986 | 238.4 | 48.9 | 1682.9 | 2928.4 | 111.3 | 30.5 | 245.6 | 0.0 | 20.8 | 0.0 |
| 1987 | 221.0 | 427.5 | 2147.9 | 2904.5 | 187.0 | 2.7 | 137.5 | 0.0 | 26.2 | 0.0 |
| 1988 | 119.3 | 78.4 | 4436.1 | 3388.1 | 198.7 | 149.2 | 92.6 | 0.0 | 29.7 | 0.0 |
| 1989 | 111.2 | 9.4 | 1992.2 | 2689.0 | 312.0 | 414.9 | 98.9 | 0.0 | 28.2 | 0.0 |
| 1990 | 36.3 | 38.9 | 1365.1 | 1356.5 | 198.9 | 550.2 | 138.9 | 0.0 | 43.4 | 0.0 |
| 1991 | 12.0 | 198.2 | 2312.3 | 2349.6 | 210.4 | 135.0 | 181.9 | 22.2 | 62.7 | 0.0 |
| 1992 | 41.5 | 331.7 | 1714.2 | 2524.0 | 94.4 | 270.8 | 206.9 | 9.3 | 77.4 | 0.0 |
| 1993 | 148.3 | 154.1 | 1094.4 | 2161.7 | 158.1 | 230.4 | 193.4 | 0.0 | 39.5 | 0.0 |
| 1994 | 83.6 | 233.4 | 1146.8 | 3245.2 | 62.0 | 266.5 | 147.3 | 0.0 | 42.3 | 0.0 |
| 1995 | 64.8 | 177.9 | 1102.5 | 2400.6 | 76.8 | 457.3 | 172.4 | 0.0 | 31.0 | 0.0 |
| 1996 | 78.9 | 691.0 | 1565.9 | 2210.3 | 113.0 | 122.4 | 122.8 | 0.0 | 43.6 | 0.0 |
| 1997 | 57.7 | 571.8 | 1157.0 | 2870.4 | 105.2 | 115.1 | 163.6 | 0.0 | 165.4 | 0.0 |
| 1998 | 72.2 | 139.2 | 814.9 | 2225.4 | 85.4 | 342.2 | 88.7 | 3.5 | 19.4 | 0.0 |
| 1999 | 48.5 | 241.8 | 805.0 | 4117.5 | 197.0 | 983.8 | 86.3 | 45.1 | 33.4 | 0.0 |
| 2000 | 38.2 | 625.1 | 853.4 | 4665.3 | 308.5 | 937.6 | 92.4 | 1.3 | 20.4 | 0.0 |
| 2001 | 41.9 | 289.6 | 1537.7 | 4917.1 | 275.4 | 518.4 | 108.1 | 0.0 | 47.4 | 0.0 |
| 2002 | 85.5 | 238.4 | 960.2 | 3808.1 | 188.1 | 626.1 | 88.1 | 0.7 | 178.1 | 0.0 |
| 2003 | 95.0 | 288.7 | 956.2 | 3713.5 | 297.2 | 985.6 | 101.8 | 7.0 | 118.3 | 35.7 |
| 2004 | 100.0 | 403.9 | 3011.1 | 7314.8 | 261.3 | 453.9 | 78.0 | 0.9 | 75.8 | 0.9 |
| 2005 | 75.5 | 368.7 | 1882.9 | 6672.0 | 141.7 | 295.1 | 62.2 | 41.5 | 114.4 | 20.0 |
| 2006 | 151.5 | 331.0 | 1769.1 | 7304.2 | 321.1 | 465.8 | 73.3 | 0.0 | 527.6 | 8.9 |
| 2007 | 255.1 | 161.8 | 1111.9 | 6671.3 | 188.7 | 545.0 | 58.0 | 1.2 | 646.7 | 31.4 |
| 2008 | 398.9 | 218.1 | 928.9 | 6310.0 | 393.2 | 2217.2 | 53.2 | 0.0 | 805.6 | 1.1 |
| 2009 | 404.0 | 302.3 | 952.4 | 6679.9 | 379.0 | 936.5 | 136.2 | 11.6 | 755.4 | 1.2 |
| 2010 | 38.1 | 295.4 | 1967.7 | 8626.1 | 124.0 | 376.8 | 124.2 | 0.0 | 505.6 | 21.2 |
| 2011 | 81.5 | 173.0 | 1406.5 | 10833.0 | 188.5 | 163.9 | 38.1 | 0.3 | 259.0 | 4.6 |
| 2012 | 209.7 | 223.6 | 1248.1 | 14883.2 | 75.8 | 250.4 | 100.4 | 4.5 | 529.1 | 11.8 |
| 2013 | 84.4 | 313.3 | 753.7 | 7184.0 | 185.1 | 35.6 | 636.2 | 6.5 | 368.0 | 2.0 |
| 2014 | 64.3 | 488.2 | 1419.4 | 15253.0 | 466.7 | 501.5 | 146.3 | 47.1 | 470.5 | 3.4 |
| 2015 | 78.2 | 277.4 | 949.2 | 10842.9 | 314.4 | 598.4 | 108.9 | 70.0 | 262.3 | 17.2 |
| 2016 | | | 676.4 | 10244.1 | 523.9 | 818.6 | | | | |

**3 Black Sea Bass**

3.1. Assessment methods

This revised Black Sea Bass assessment applied methods identical to those of the most recent SEDAR assessment (SEDAR-56 2018). Details can be found in that report, and therefore the methods are only reviewed briefly here. The assessment model was an integrated age-structured model fitted to data on landings and discards, indices of abundance, and age or length compositions. It was implemented using the Beaufort Assessment Model (BAM), including the Monte Carlo/Bootstrap (MCB) approach to quantify uncertainty. The assessment time frame was 1978–2016.

The only difference in input data between this assessment and that of SEDAR-56 was the adjustment to MRIP landings and discards (Section 2). Annual recreational landings estimates were on average about 2 times higher than before the adjustment (range: 1.4 to 3.2 times higher), and annual recreational discard estimates about 2.4 times higher (range: 1.9 to 3.3 times higher).

The lower bound set for the range of catchability of the CVID index had to be lowered, as the parameter hit the lower bound in initial runs with the new MRIP data. No further bounding issues were observed.

The fishing status reported in SEDAR-56 2018 was computed as the geometric mean from the period 2015–2016, although the SEDAR-56 report erroneously stated that it was from 2014–2016. For direct comparison to previously reported values, this report uses the geometric mean from the period 2015–2016. The geometric mean fishing status from SEDAR-56 for 2014–2016 was $F_{2014–2016}/F_{MSY}$ = 0.79, and for 2015–2016 was $F_{2015–2016}/F_{MSY}$ = 0.64. The choice of years does not affect projections, as only the terminal year's F (i.e., $F_{current}=F_{2016}$) was used to forecast catch in the interim years.

3.2. Assessment results

The model fits to all data sources were quite similar to those from SEDAR-56, as were other model diagnostics. The primary effect of increased MRIP estimates was that the assessment model required more fish to match the larger level of landings and discards. In effect, the perceived scale of abundance is larger, which the assessment model accomplished by increasing the estimate of unfished age-0 recruitment, $R_0$. The SEDAR-56 estimate was $\widehat{R_0} = 359{,}280$ fish, whereas the revised estimate is $\widehat{R_0} = 545{,}945$ fish, which is about 1.5 times higher. This translates into higher levels of SSB and recruits (Fig. 3.1). However, the estimate of $SSB_{MSY}$ (Table 3.1) increased by about the same ratio (1.57), so the trend in the relative status time series ($SSB/SSB_{MSY}$ and SSB/MSST) changed little with this revision (Fig. 3.1). Similarly, the estimated time series of fishing mortality rate changed little (Fig. 3.1), because the model predicted more fish available to support the increased level of removals. The exception to this was in the terminal years of the assessment, where the revision estimated higher levels of fishing than were previously predicted. This occurred because the MRIP-adjusted removals during the last several years of the assessment period were all above average, including landings and discard adjustments that were 1-2.5 standard deviations above normal. The higher values of $F/F_{MSY}$ near the end of the assessment period led to increased certainty about the overfishing status (Fig. 3.2).

Contrary to SEDAR-56, this revised assessment found the stock to be overfished and experiencing overfishing (Table 3.1; Fig. 3.2). The stock status was estimated to be $SSB_{2015}$/MSST=0.98, and the fishing status was estimated to be $F_{2015–2016}/F_{MSY}$=1.4. These qualitative findings (overfished, overfishing) were displayed by almost 60% of the MCB runs, though the results exhibit considerable uncertainty (Fig. 3.2).

## 3.3. Projections

Two projection scenarios were identified as necessary for management for SEDAR-56. Using methodology identical to SEDAR-56 (2018), the two scenarios were repeated here:

- Scenario 1: $F=F_{MSY}$
- Scenario 2: F at P*=0.375 with low recruitment (taken from 1991-2016)

Scenario 1 was included for quantifying OFL and Scenario 2 was included for quantifying ABC.

Results for Scenario 1 and 2 are provided in Tables 3.2 and 3.3 respectively.

## 3.4. Discussion and recommendations

In SEDAR-56, the general recreational fleet was the dominant source of Black Sea Bass landings and discards, and thus it is not surprising that assessment results are somewhat sensitive to those inputs, particularly the perceived scale of absolute abundance estimated by the assessment. Given that the assessment model appeared robust to the MRIP-adjusted landings and discards, as evidenced by fits to data and standard model diagnostics, the assessment results and corresponding projections appear to be adequate for resource management.

## 3.5. References

SEDAR-56. 2018. SEDAR 56 – South Atlantic Black Seabass Assessment Report. SEDAR. North Charleston SC. Available online at: http://sedarweb.org/sedar-56.

Table 3.1. Status indicators, benchmarks, and related quantities for Black Sea Bass. Estimates are values from the base run of the assessment model, after adjusting for MRIP revisions to estimates of recreational landings and discards. Median values and measures of precision (standard errors, SE) are from the Monte Carlo/Bootstrap analysis. For comparison, the previous SEDAR-56 estimates are in parentheses.

| Quantity | Units | Estimate (Previous) | Median | SE |
|---|---|---|---|---|
| $F_{MSY}$ | $y^{-1}$ | 0.29 (0.31) | 0.32 | 0.06 |
| 85%$F_{MSY}$ | $y^{-1}$ | 0.19 (0.26) | 0.27 | 0.06 |
| 75%$F_{MSY}$ | $y^{-1}$ | 0.13 (0.23) | 0.24 | 0.05 |
| 65%$F_{MSY}$ | $y^{-1}$ | 0.09 (0.20) | 0.21 | 0.05 |
| $B_{MSY}$ | mt | 10775.9 (6824) | 10443.8 | 1549 |
| $SSB_{MSY}$ | 1E10 eggs | 471.5 (300) | 456.0 | 64.5 |
| MSST | 1E10 eggs | 292.4 (186) | 286.2 | 52.7 |
| MSY | 1000 lb | 1272.4 (935) | 1311.1 | 325.7 |
| $D_{MSY}$ | 1000 fish | 2194.2 (1421) | 2082.1 | 357.6 |
| $R_{MSY}$ | 1000 age-0 fish | 55649.2 (36400) | 54431.4 | 12067 |
| Y at 85%$F_{MSY}$ | 1000 lb | 1261.1 (793.9) | 1299.7 | 323.3 |
| Y at 75%$F_{MSY}$ | 1000 lb | 1238.0 (701.25) | 1276.2 | 318.3 |
| Y at 65%$F_{MSY}$ | 1000 lb | 1198.5 (607.75) | 1236.1 | 309.8 |
| $F_{2015–2016}/F_{MSY}$ | – | 1.40 (0.64) | 1.31 | 0.52 |
| $SSB_{2016}$/MSST | – | 0.98 (1.15) | 0.93 | 0.19 |
| $SSB_{2016}/SSB_{MSY}$ | – | 0.61 (0.71) | 0.58 | 0.11 |

Table 3.2. Black Sea Bass projections with $F=F_{MSY}$ starting in 2019. R = number of age-0 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1E10 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with $SSB \geq SSB_{MSY}$. The extension “b” indicates expected values (deterministic) from the base run; the extension “med” indicates median values from the stochastic projections. The last column (extension “un”) is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b (1000) | R.med (1000) | F.b | F.med | S.b (1E10 eggs) | S.med (1E10 eggs) | L.b (1000) | L.med (1000) | L.b (1000 lb) | L.med (1000 lb) | D.b (1000) | D.med (1000) | D.b (1000 lb) | D.med (1000 lb) | pr.reb | L.b.un (w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 47708 | 38883 | 0.46 | 0.53 | 242 | 233 | 1116 | 1109 | 1522 | 1513 | 1475 | 1270 | 768 | 658 | 0 | 792 |
| 2018 | 48757 | 38758 | 0.62 | 0.72 | 262 | 234 | 1092 | 1078 | 1522 | 1510 | 2204 | 1924 | 1071 | 899 | 0 | 792 |
| 2019 | 49686 | 38594 | 0.29 | 0.32 | 280 | 245 | 400 | 369 | 543 | 504 | 1328 | 1096 | 653 | 536 | 0.006 | 803 |
| 2020 | 52097 | 41182 | 0.29 | 0.32 | 340 | 299 | 420 | 389 | 530 | 493 | 1809 | 1524 | 960 | 788 | 0.035 | 705 |
| 2021 | 53372 | 42486 | 0.29 | 0.32 | 380 | 336 | 501 | 466 | 597 | 560 | 1937 | 1625 | 1053 | 864 | 0.09 | 695 |
| 2022 | 54210 | 43747 | 0.29 | 0.32 | 410 | 365 | 616 | 577 | 731 | 688 | 1994 | 1681 | 1084 | 892 | 0.162 | 735 |
| 2023 | 54740 | 44617 | 0.29 | 0.32 | 431 | 387 | 719 | 678 | 874 | 825 | 2066 | 1751 | 1127 | 930 | 0.228 | 786 |

Table 3.3. Black Sea Bass projections with F fixed at P*=0.375 starting in 2019 with low recruitment (1991-2016). R = number of age-0 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1E10 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with SSB ≥ $SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections. The last column (extension "un") is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b (1000) | R.med (1000) | F.b | F.med | S.b (1E10 eggs) | S.med (1E10 eggs) | L.b (1000) | L.med (1000) | L.b (1000 lb) | L.med (1000 lb) | D.b (1000) | D.med (1000) | D.b (1000 lb) | D.med (1000 lb) | pr.reb | L.b.un (w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 42734 | 36357 | 0.46 | 0.53 | 252 | 230 | 1116 | 1109 | 1522 | 1513 | 1464 | 1271 | 767 | 658 | 0.00 | 792 |
| 2018 | 42734 | 36245 | 0.62 | 0.72 | 249 | 222 | 1091 | 1078 | 1522 | 1510 | 2151 | 1905 | 1063 | 896 | 0.00 | 792 |
| 2019 | 42734 | 35988 | 0.26 | 0.29 | 269 | 238 | 371 | 342 | 506 | 469 | 1169 | 962 | 588 | 481 | 0.00 | 746 |
| 2020 | 42734 | 36022 | 0.26 | 0.29 | 308 | 275 | 389 | 359 | 497 | 463 | 1506 | 1293 | 810 | 674 | 0.01 | 658 |
| 2021 | 42734 | 36044 | 0.26 | 0.29 | 335 | 303 | 457 | 424 | 556 | 521 | 1571 | 1368 | 865 | 733 | 0.01 | 635 |
| 2022 | 42734 | 36267 | 0.26 | 0.29 | 352 | 321 | 548 | 515 | 666 | 628 | 1576 | 1387 | 869 | 746 | 0.03 | 646 |
| 2023 | 42734 | 36424 | 0.26 | 0.29 | 361 | 332 | 622 | 591 | 774 | 737 | 1577 | 1388 | 870 | 746 | 0.04 | 665 |

Figure 3.1. Comparison of time series estimates for Black Sea Bass from this revised assessment (MRIP revision) and from the previous SEDAR-56 assessment. A) SSB; B) Recruits; C) F; D) $SSB/SSB_{MSY}$; E) SSB/MSST; and F) $F/F_{MSY}$.

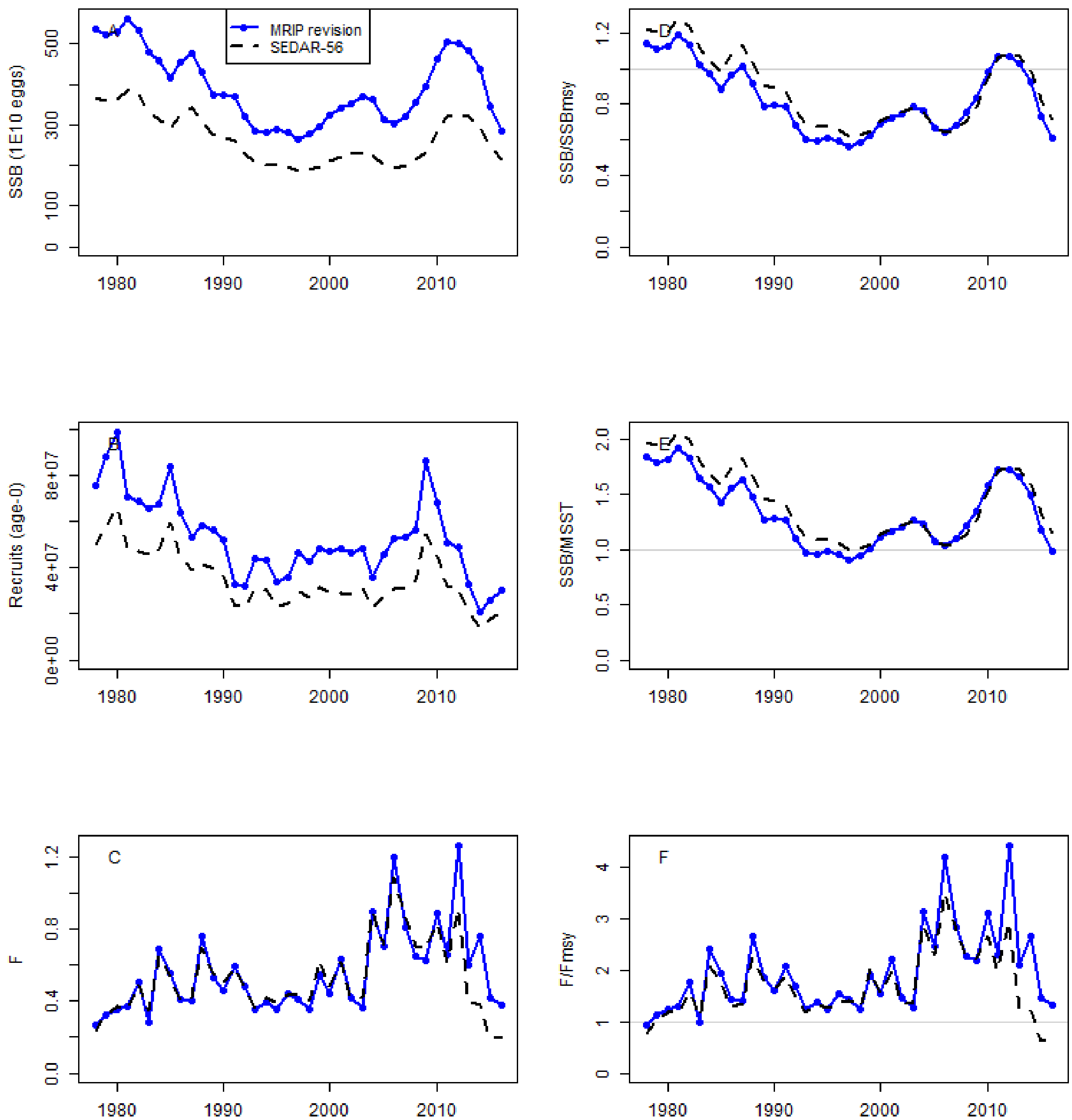
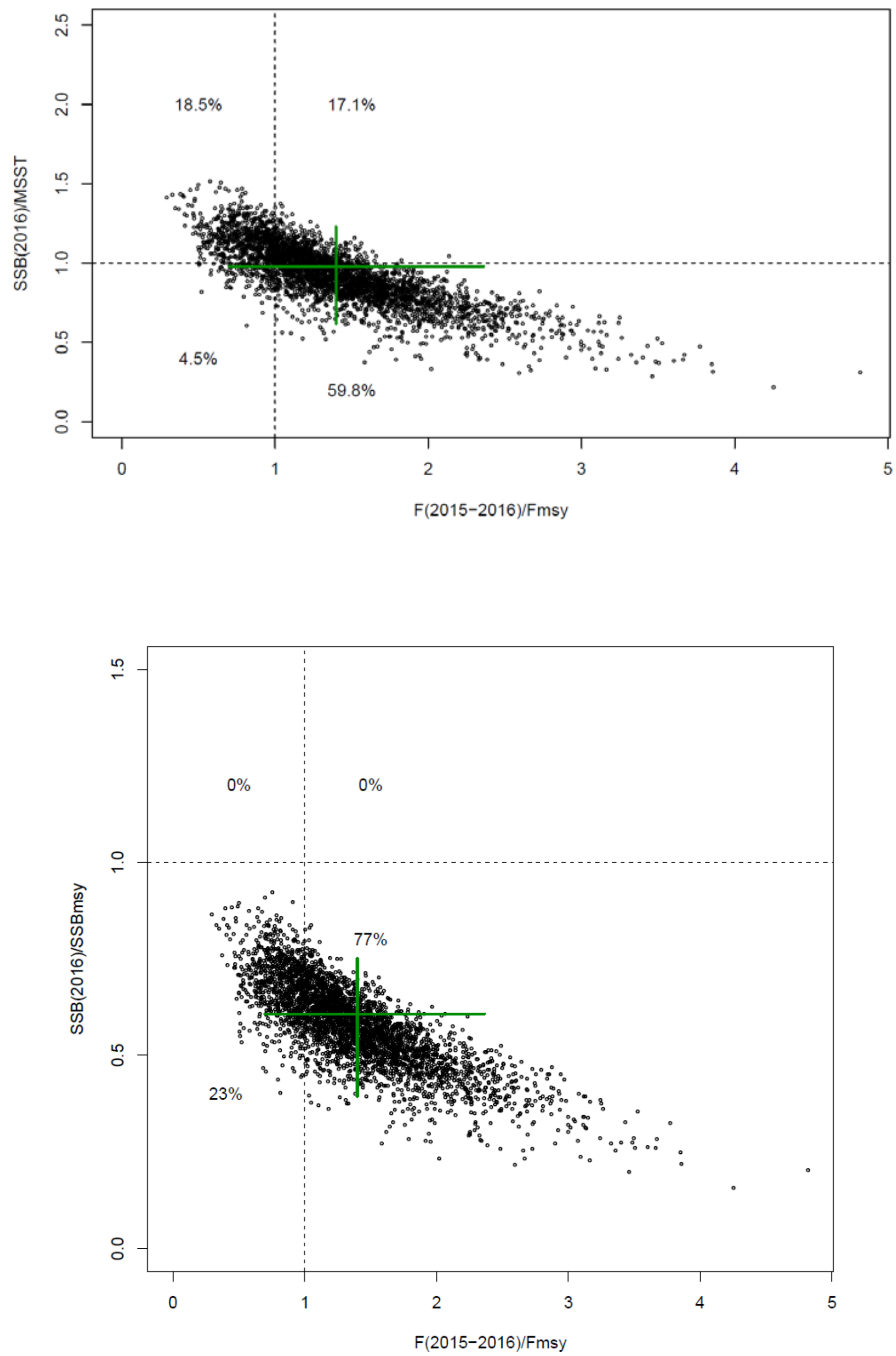


Figure 3.2. Phase plots of terminal status estimates for Black Sea Bass. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5th and 95th percentiles. Proportion of runs falling in each quadrant indicated. Top panel indicates stock status relative to MSST; bottom panel indicates stock status relative to $SSB_{MSY}$



**4 Blueline Tilefish**

As in SEDAR-50, separate analyses were conducted for Blueline Tilefish in the Atlantic south and north of Cape Hatteras. These analyses are described in separate sections below.

4.1 South of Cape Hatteras

4.1.1. Assessment methods

This revised Blueline Tilefish assessment applied methods identical to those of the most recent SEDAR assessment (SEDAR-50 2017) for the Atlantic **south of Cape Hatteras, Assessment Workshop Base Model (AW Base)**. Details can be found in that report, and therefore the methods are only reviewed briefly here. The assessment model was an age-aggregated surplus production model fitted to indices of abundance. It was implemented using A Stock–Production Model Incorporating Covariates (ASPIC 7), including a bootstrap approach to quantify uncertainty and projection methods. The assessment time frame was 1958–2015. During SEDAR 50 the AW Base model was selected by the Assessment Panel and, ultimately, recommended by the Science and Statistical Committee (SSC).

The only difference in input data between this assessment and that of SEDAR-50 was the adjustment to MRIP landings and discards (Section 2). Annual recreational landings estimates were on average about 1.6 times higher than before the adjustment (range: 1.0 to 4.4 times higher), and annual recreational discard estimates were about 1.7 times higher (range: 0.9 to 3.4 times higher).

4.1.2. Assessment results

The model fits to both the handline and longline indices were quite similar to those from SEDAR-50, as were other model diagnostics. The increased MRIP estimates led to small increases in MSY and $F_{MSY}$ (SEDAR 50: MSY = 212,000 lb, $F_{MSY}$ = 0.146; MRIP Revision: MSY =225,000 lb, $F_{MSY}$ = 0.157) and a slight decrease in $B_{MSY}$ (SEDAR 50: $B_{MSY}$ = 1,467,000; MRIP Revision: $B_{MSY}$ = 1,443,000); Table 4.1.1). However, the most substantial effect of the MRIP revised removals occurred in 2013, when estimates were already relatively high.

In SEDAR-50, total recreational landings (889,661 lb) and dead-discards (125,268 lb) made up relatively small percentages of the total removals (12% and 1.7% respectively). However, recreational landings in 2013 were very high (332,130 lb) due to high MRIP landings in the Florida east region. In the current analysis, the MRIP landings adjustment for 2013 was a scaling factor of 1.7. As a result, total removals for 2013 changed from 406,888 to 642,703 lb, having a substantial effect on the assessment.

For most of the time series, annual estimates of biomass (B) and fishing mortality (F) are fairly similar between SEDAR-50 and the current estimates. However, due to increased 2013 removals, the 2013 estimate of F went up considerably compared to SEDAR-50. Estimated biomass in 2014 and 2015 were subsequently lower compared with SEDAR-50, with estimates of $B/B_{MSY}$ <1 (Figure 4.1.1).

As in SEDAR-50, this revised assessment found Blueline Tilefish in the Atlantic **south of Cape Hatteras not** to be overfished, but in considerably poorer status than SEDAR-50. In contrast with SEDAR-50 the revised assessment found the stock to be experiencing overfishing (Table 4.1.1; Fig. 4.1.2). The stock status was estimated to be $B_{2015}$/MSST = 1.09, and the fishing status was estimated to be $F_{2013–2015}/F_{MSY}$ = 1.44. These qualitative findings (not overfished, overfishing) were displayed by 41.5% of all bootstrap runs, while another 24.5% of runs were overfished and overfishing (Fig. 4.1.2).

4.1.3. Projections

Two projection scenarios were identified as necessary for management. Using methodology identical to SEDAR-50 (2017), those two scenarios were repeated here:

- Scenario 1: $F_{2016} = F_{current}$, $F_{2017–2020} = F_{P*30\%}$
- Scenario 2: $F_{2016-2017} = F_{current}$, $F_{2018–2020} = F_{P*30\%}$

Results for Scenarios 1 and 2 are provided in Tables 4.1.2 and 4.1.3, respectively.

4.1.4. Discussion and recommendations

In SEDAR-50, the commercial fleet was the dominant source of Blueline Tilefish landings and discards overall, though recreational landings were high in recent years, especially 2013. The fit of the assessment model did not change substantially, but further increases to recent landings had a considerable effect on status indicators. Given that the assessment model appeared robust to the MRIP-adjusted landings and discards, as evidenced by fits to data, the assessment results and corresponding projections appear to be adequate for resource management.

4.2 North of Cape Hatteras

4.2.1. Assessment methods

This revised Blueline Tilefish assessment applied methods identical to those of the most recent SEDAR assessment (SEDAR-50 2017) for the Atlantic **north of Cape Hatteras**. Details can be found in that report, and therefore the methods are only reviewed briefly here. The assessment methods used for this region were several data limited methods (DLM), implemented using the R package DLMtool (Carruthers and Hordyk 2016; R Core Team 2016).

The only difference in input data between this assessment and that of SEDAR-50 was the adjustment to MRIP landings and discards as indicated in section 4.1.1. However minor methodological changes made during webinars with the Mid-Atlantic Blueline Tilefish Working Group were also included in this revision. The time series of landings in the AvC.recent method was extended to include 2002–2015 (Fig. 4.2.1), and the CV of catch (CV_Cat) was based on the CV for that time series.

4.2.2. Assessment results

The TAC distributions of the DLMtool methods were generally similar to SEDAR-50, though they tended to be shifted somewhat higher (Table 4.2.1, Fig 4.2.2). The overall median TAC is 250,000 lb compared with 193,000 lb from SEDAR-50. Most of these methods are dependent upon average or recent catches, which are higher following the MRIP revisions. Following the MRIP revisions, annual removals of Blueline Tilefish north of Cape Hatteras increased from 0-24%. This largest increase was 146,000 lb in 2009. The proportion of total removals among all years attributed to the recreational fleet is now 48% compared with 45% in SEDAR-50.

4.2.3. Projections

No projections were conducted for Blueline Tilefish in the Atlantic **north of Cape Hatteras.**

4.2.4. Discussion and recommendations

In SEDAR-50, the commercial fleet was the only source of Blueline Tilefish landings and discards historically, though recreational landings have increased substantially in recent years. Some of the DLM tool methods are simply statistical summaries of input data (e.g. AvC, CC1, CC2, AvC.early, AvC.late). There are no available diagnostics associated with any of the methods, for example, for judging quality of fits. Thus, the appropriateness of the results of this analysis compared with SEDAR-50 should be judged based on the quality of the data inputs. The DLMtool methods also do not provide any indications of status. Thus in considering the effects of the MRIP revisions on Blueline Tilefish north of Cape Hatteras, it is worth noting that while the value of MSY south of Cape Hatteras also increased following the MRIP revisions, Blueline Tilefish south of Cape Hatteras were simultaneously estimated to be in much poorer status and to be undergoing overfishing. Given that the updated MRIP landings and discard adjustments were recommended by the data providers, these results appear to be adequate for resource management. Resource managers might consider the effects of the MRIP revisions on Blueline Tilefish south of Cape Hatteras when making decisions about the area north of Cape Hatteras.

## 4.3. References

Carruthers, T., and A. Hordyk. 2016. DLMtool: Data-Limited Methods Toolkit. URL https://CRAN.R-project.org/package=DLMtool.

R Core Team. 2016. R: A language and environment for statistical computing R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org.

SEDAR. 2017. SEDAR 50 – Atlantic Blueline Tilefish Assessment Report. SEDAR, North Charleston SC. 542 pp. available online at: http://sedarweb.org/sedar-50.

Table 4.1.1. Status indicators, benchmarks, and related quantities for Blueline Tilefish from ASPIC, averaged between the handline and longline models for the Atlantic south of Cape Hatteras. Estimates are values from the AW base model, after adjusting recreational landings and discards based on the MRIP revision. Median values and measures of precision (standard errors, SE) are from the bootstrap analysis. The definition of MSST considered in this assessment is MSST=75%$B_{MSY}$. For comparison, the previous SEDAR-50 estimates are in parentheses.

| Quantity | Units | Estimate (Previous) | Median | SE |
|---|---|---|---|---|
| $F_{MSY}$ | $y^{-1}$ | 0.157 (0.146) | 0.163 | 0.115 |
| 85%$F_{MSY}$ | $y^{-1}$ | 0.134 (0.124) | 0.138 | 0.098 |
| 75%$F_{MSY}$ | $y^{-1}$ | 0.118 (0.109) | 0.122 | 0.087 |
| 65%$F_{MSY}$ | $y^{-1}$ | 0.102 (0.095) | 0.106 | 0.075 |
| $B_{MSY}$ | 1000 lb | 1443 (1467) | 1421 | 620 |
| MSST | 1000 lb | 1082 (1100) | 1066 | 465 |
| MSY | 1000 lb | 225 (212) | 231 | 76 |
| Y at 85%$F_{MSY}$ | 1000 lb | 220 (NA) | 226 | 75 |
| Y at 75%$F_{MSY}$ | 1000 lb | 211 (NA) | 217 | 72 |
| Y at 65%$F_{MSY}$ | 1000 lb | 197 (NA) | 203 | 67 |
| $F_{2013–2015}/F_{MSY}$ | – | 1.44 (0.92) | 1.30 | 2.82 |
| $B_{2015}$/MSST | – | 1.09 (1.41) | 1.27 | 0.45 |
| $B_{2015}/B_{MSY}$ | – | 0.82 (1.06) | 0.96 | 0.34 |

Table 4.1.2. Projection results with fishing mortality fixed at $F = F_{P*30}$ starting in 2017, based on adjusted (A) and unadjusted (B) MRIP landings, for Blueline Tilefish for the Atlantic south of Cape Hatteras. For years prior to 2018 , $F = F_{current}$. $F$ = fishing mortality rate (per year), $P(B>B_{MSY})$ = proportion of stochastic projection replicates exceeding $B_{MSY}$, $P(B>\text{MSST})$ = proportion of stochastic projection replicates exceeding MSST, $B_{median}$ = median biomass (1000 lbs) estimate among projections, $B$ = deterministic biomass (1000 lbs) estimate, $Y$ = deterministic yield (1000 lbs) estimate, Sum $Y$ = cumulative sum of deterministic yield (1000 lbs). Yield includes landings and dead discards. Note that observed dead discards were 1, 24 and 39% of total removals from 2013 to 2015 respectively in the current projections (A) and were 1, 13, and 40% in the previous projections (B). Previous projections (B) analogous to the current projections but with unadjusted MRIP landings (previously provided to SAFMC staff, Dec 2017) are included here only for comparison to the current projections.

A. Current projections based on adjusted MRIP landings and discards

| Year | $F$(per yr) | $P(B > B_{MSY})$ | $P(B > \text{MSST})$ | $B_{median}$ | $B$ | $Y$ | Sum $Y$ |
|---|---|---|---|---|---|---|---|
| 2016 | 0.226 | 0.49 | 0.77 | 1406 | 1224 | 271 | 271 |
| 2017 | 0.157 | 0.42 | 0.72 | 1333 | 1173 | 187 | 458 |
| 2018 | 0.157 | 0.42 | 0.72 | 1356 | 1206 | 192 | 649 |
| 2019 | 0.157 | 0.42 | 0.72 | 1369 | 1235 | 196 | 846 |
| 2020 | 0.157 | 0.43 | 0.72 | 1374 | 1262 | 200 | 1046 |
| 2021 | | 0.44 | 0.72 | 1379 | 1285 | | |

B. Previous projections based on unadjusted MRIP landings and discards

| Year | $F$(per yr) | $P(B > B_{MSY})$ | $P(B > \text{MSST})$ | $B_{median}$ | $B$ | $Y$ | Sum $Y$ |
|---|---|---|---|---|---|---|---|
| 2016 | 0.134 | 0.77 | 0.95 | 1702 | 1606 | 215 | 215 |
| 2017 | 0.103 | 0.76 | 0.95 | 1682 | 1603 | 167 | 383 |
| 2018 | 0.103 | 0.78 | 0.96 | 1714 | 1647 | 172 | 554 |
| 2019 | 0.103 | 0.80 | 0.96 | 1739 | 1685 | 175 | 730 |
| 2020 | 0.103 | 0.81 | 0.96 | 1757 | 1718 | 178 | 908 |
| 2021 | | 0.82 | 0.96 | 1771 | 1746 | | |

Table 4.1.3. Projection results with fishing mortality fixed at $F = F_{P*30}$ starting in 2018, based on adjusted (A) and unadjusted (B) MRIP landings, for Blueline Tilefish for the Atlantic south of Cape Hatteras. For years prior to 2018 , $F = F_{current}$. $F$ = fishing mortality rate (per year), $P(B>B_{MSY})$ = proportion of stochastic projection replicates exceeding $B_{MSY}$, $P(B>MSST)$ = proportion of stochastic projection replicates exceeding MSST, $B_{median}$ = median biomass (1000 lbs) estimate among projections, $B$ = deterministic biomass (1000 lbs) estimate, $Y$ = deterministic yield (1000 lbs) estimate, Sum $Y$ = cumulative sum of deterministic yield (1000 lbs). Yield includes landings and dead discards. Note that observed dead discards were 1, 24 and 39% of total removals from 2013 to 2015 respectively in the current projections (A) and were 1, 13, and 40% in the previous projections (B). Previous projections (B) analogous to the current projections but with unadjusted MRIP landings (previously provided to SAFMC staff, Dec 2017) are included here only for comparison to the current projections.

A. Current projections based on adjusted MRIP landings and discards

| Year | $F$(per yr) | $P(B > B_{MSY})$ | $P(B > MSST)$ | $B_{median}$ | $B$ | $Y$ | Sum $Y$ |
|---|---|---|---|---|---|---|---|
| 2016 | 0.226 | 0.49 | 0.77 | 1406 | 1224 | 271 | 271 |
| 2017 | 0.226 | 0.42 | 0.72 | 1333 | 1173 | 260 | 531 |
| 2018 | 0.157 | 0.37 | 0.66 | 1273 | 1130 | 180 | 712 |
| 2019 | 0.157 | 0.38 | 0.66 | 1296 | 1167 | 186 | 898 |
| 2020 | 0.157 | 0.39 | 0.66 | 1310 | 1200 | 191 | 1088 |
| 2021 | | 0.40 | 0.66 | 1322 | 1230 | | |

B. Previous projections based on unadjusted MRIP landings and discards

| Year | $F$(per yr) | $P(B > B_{MSY})$ | $P(B > MSST)$ | $B_{median}$ | $B$ | $Y$ | Sum $Y$ |
|---|---|---|---|---|---|---|---|
| 2016 | 0.134 | 0.77 | 0.95 | 1702 | 1606 | 215 | 215 |
| 2017 | 0.134 | 0.76 | 0.95 | 1682 | 1603 | 215 | 430 |
| 2018 | 0.103 | 0.74 | 0.95 | 1668 | 1600 | 167 | 597 |
| 2019 | 0.103 | 0.76 | 0.96 | 1705 | 1644 | 171 | 769 |
| 2020 | 0.103 | 0.78 | 0.96 | 1733 | 1683 | 175 | 944 |
| 2021 | | 0.80 | 0.96 | 1750 | 1716 | | |

Table 4.2.1. TAC quantiles for all DLM methods for Blueline Tilefish for the Atlantic north of Cape Hatteras (1000 lb). For comparison, the previous SEDAR-50 estimates are in parentheses in the TOTAL column.

| Quantile | AvC | CC1 | CC4 | Fdem.ML | SPMSY | YPR.ML | AvC.early | AvC.late | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| 2.50% | 119 | 230 | 156 | 58 | 11 | 80 | 27 | 279 | 31 (30) |
| 5% | 128 | 250 | 170 | 77 | 18 | 100 | 29 | 299 | 35 (40) |
| 10% | 136 | 270 | 188 | 112 | 32 | 139 | 30 | 319 | 43 (49) |
| 25% | 156 | 317 | 219 | 201 | 64 | 225 | 34 | 360 | 142 (103) |
| 50% | 179 | 372 | 259 | 395 | 120 | 428 | 40 | 409 | 250 (193) |
| 75% | 204 | 443 | 312 | 929 | 183 | 897 | 45 | 468 | 401 (413) |
| 90% | 229 | 507 | 361 | 2011 | 239 | 2198 | 51 | 537 | 600 (619) |
| 95% | 246 | 566 | 404 | 3060 | 266 | 3451 | 55 | 588 | 1105 (998) |
| 97.50% | 264 | 616 | 439 | 5348 | 283 | 5654 | 57 | 613 | 2077 (1854) |

Figure 4.1.1. Comparison of time series estimates for Blueline Tilefish for the Atlantic south of Cape Hatteras, from this revised assessment (MRIP revision) and from the previous SEDAR-50 assessment. A) B; B) blank panel; C) F; D) B/$B_{MSY}$; E) B/MSST; and F) F/$F_{MSY}$.

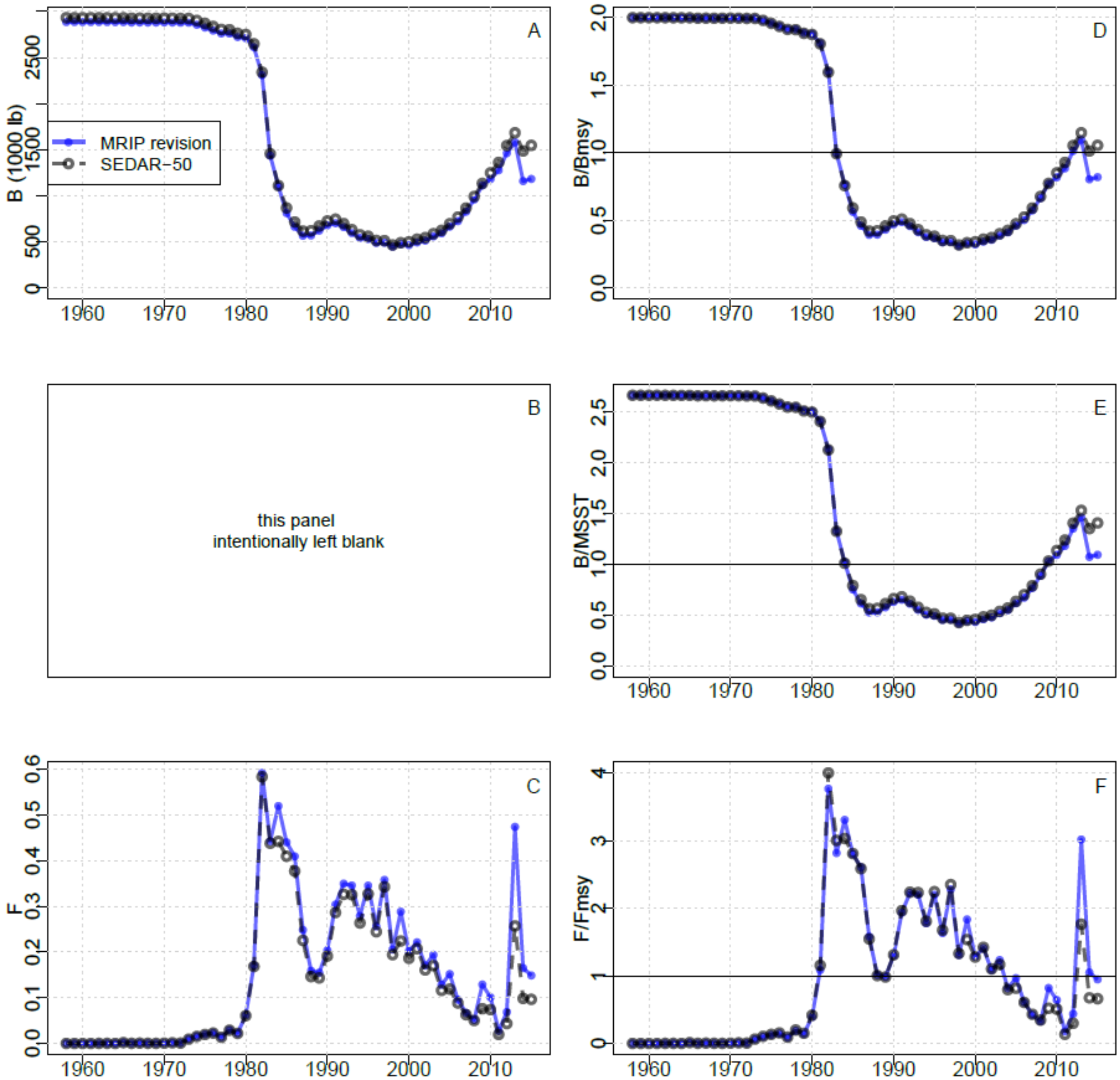
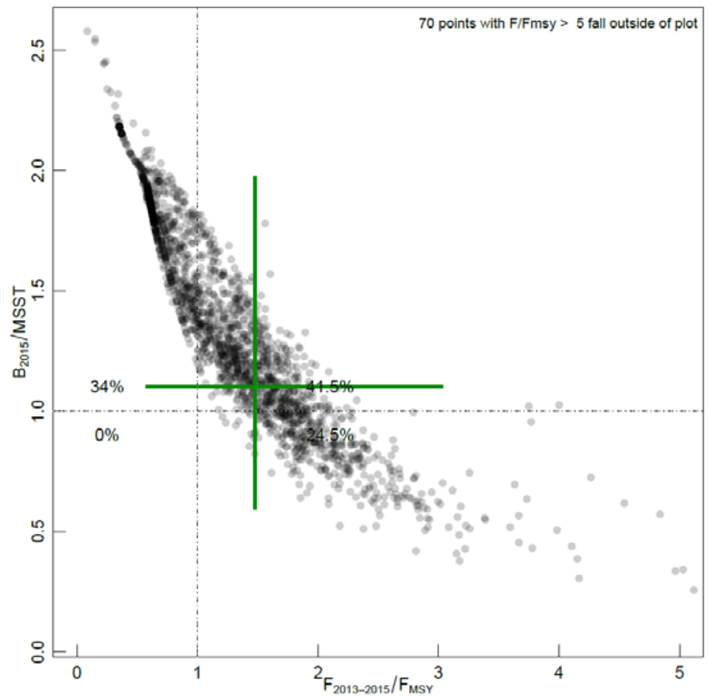


Figure 4.1.2. Phase plots of terminal status estimates for Blueline Tilefish for the Atlantic south of Cape Hatteras. The intersection of crosshairs indicates estimates from the ASPIC AW base run (average of handline and longline models); lengths of crosshairs defined by 5th and 95th percentiles. Percent of runs falling into each quadrant indicated. Top panel indicates stock status relative to MSST; bottom panel indicates stock status relative to $B_{MSY}$



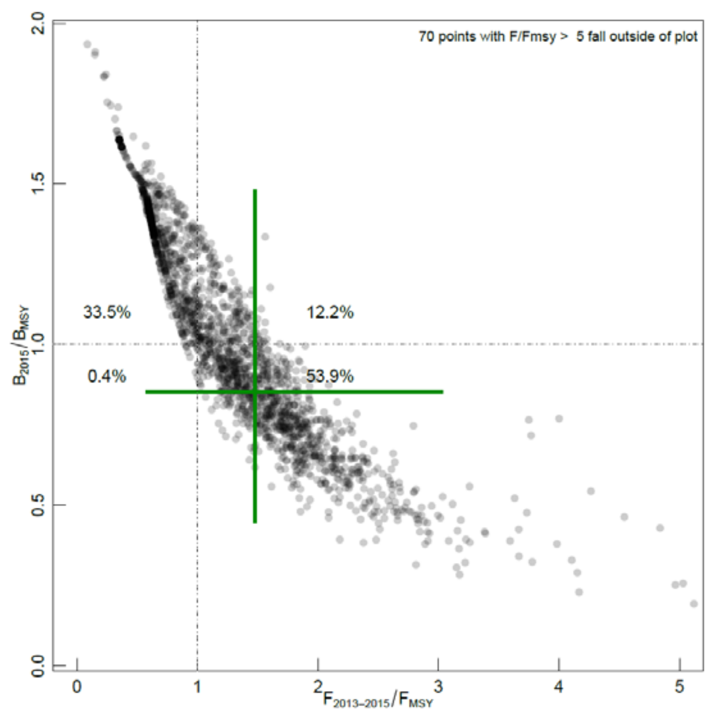



Figure 4.2.1. Catch series used in DLM analysis, for Blueline Tilefish for the Atlantic north of Cape Hatteras. Here the AvC method was applied to three different time periods: the time since the fishery in this area effectively began (AvC, 1978-2015); the early part of this time series before the spatial shift in effort (AvC.early, 1978-2001), and during the more recent period after the increase in landings (AvC.late, 2002-2015).

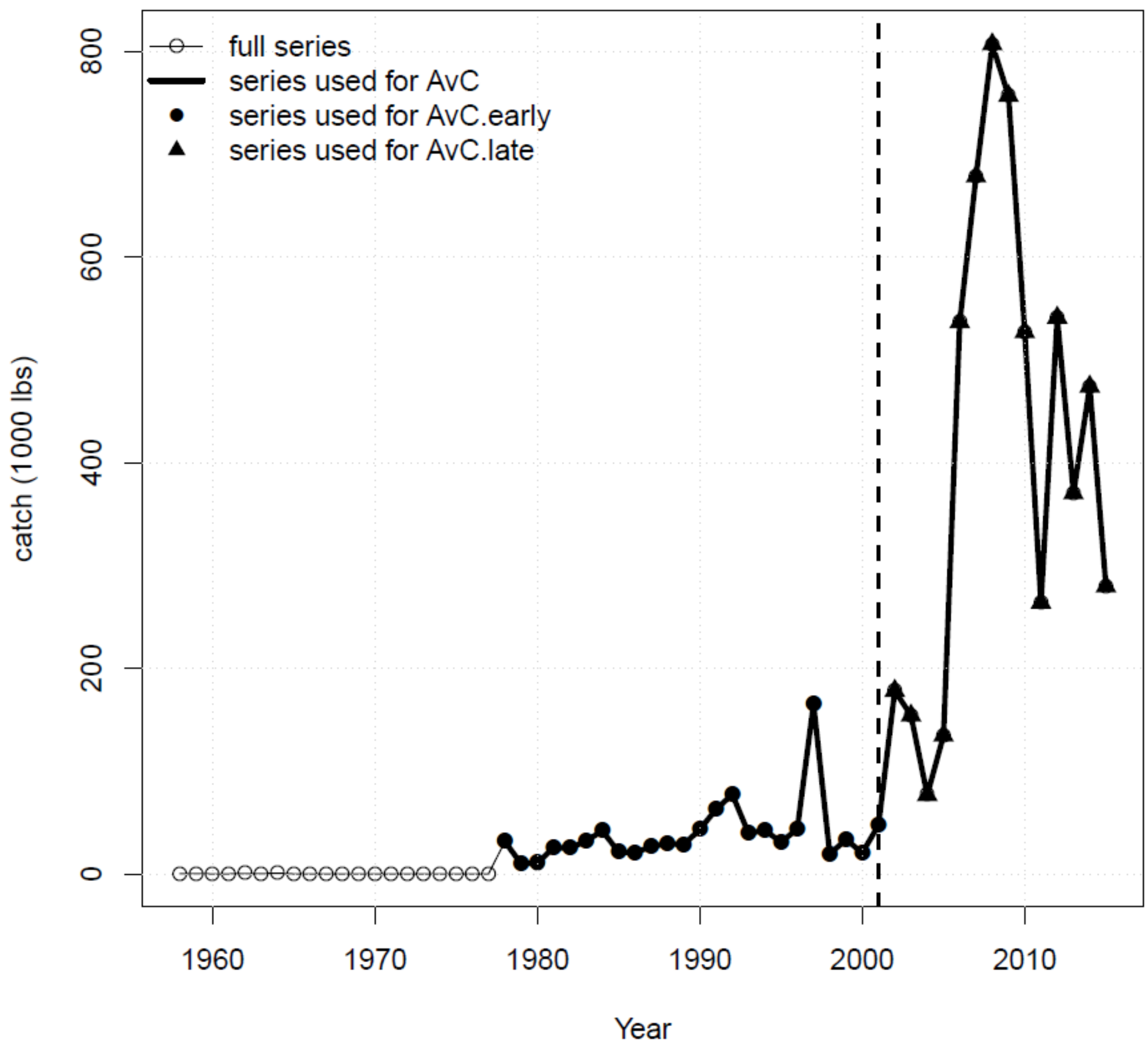
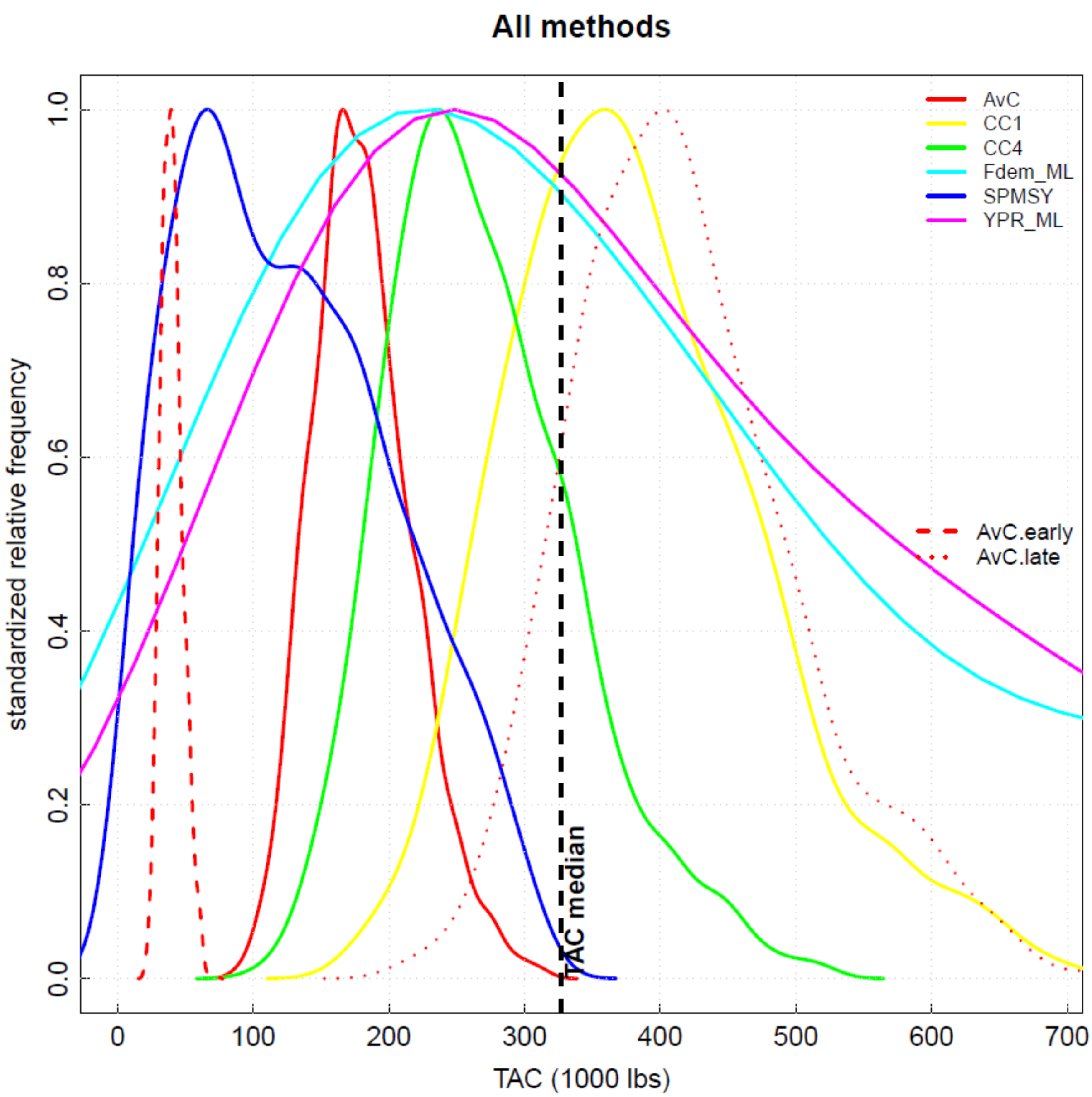


Figure 4.2.2. Distributions of TACs for DLM analysis, for Blueline Tilefish for the Atlantic north of Cape Hatteras. Here the AvC method was applied to three different time periods: the time since the fishery in this area effectively began (AvC, 1978-2015); the early part of this time series before the spatial shift in effort (AvC.early, 1978-2001), and during the more recent period after the increase in landings (AvC.late, 2002-2015).



## 5 Red Grouper

### 5.1. Assessment methods

This revised Red Grouper assessment applied methods identical to those of the most recent SEDAR assessment (SEDAR-53 2017). Details can be found in that report, and therefore the methods are only reviewed briefly here. The assessment model was an integrated age-structured model fitted to data on landings and discards, indices of abundance, and age or length compositions. It was implemented using the Beaufort Assessment Model (BAM), including the Monte Carlo/Bootstrap (MCB) approach to quantify uncertainty. The assessment time frame was 1976–2015.

The only difference in input data between this assessment and that of SEDAR-53 was the adjustment to MRIP landings and discards (Section 2). Annual recreational landings estimates were on average about 2 times higher than before the adjustment (range: 1.2 to 3.3 times higher), and annual recreational discard estimates about 2.5 times higher (range: 1.0 to 7.1 times higher).

### 5.2. Assessment results

The model fits to all data sources were quite similar to those from SEDAR-53, as were other model diagnostics. The primary effect of increased MRIP estimates was that the assessment model required more fish to match the larger level of landings and discards. In effect, the perceived scale of abundance is larger, which the assessment model accomplished by increasing the estimate of unfished age-1 recruitment, $R_0$. The SEDAR-53 estimate was $\widehat{R_0} = 359{,}749$ fish, whereas the revised estimate is $\widehat{R_0} = 614{,}798$ fish, which is about 1.7 times higher. This translates into higher levels of SSB and recruits (Fig. 5.1). However, the estimate of $SSB_{MSY}$ (Table 5.1) increased by about the same ratio (1.7), so the relative status time series ($SSB/SSB_{MSY}$ and SSB/MSST) changed little with this revision (Fig. 5.1). Similarly, the estimated time series of fishing mortality rate changed little (Fig. 5.1), because the model predicted more fish available to support the increased level of removals. The exception to this was in the terminal years of the assessment, where the revision estimated higher levels of fishing than were previously predicted. This occurred because the MRIP-adjusted removals during the last several years of the assessment period were all above average, including landings and discard adjustments that were 1-2 standard deviations above normal. The higher values of $F/F_{MSY}$ near the end of the assessment period led to increased certainty about the overfishing status (Fig. 5.2).

As in SEDAR-53, this revised assessment found South Atlantic Red Grouper to be overfished and experiencing overfishing (Table 5.1; Fig. 5.2). The stock status was estimated to be $SSB_{2015}/MSST=0.25$, and the fishing status was estimated to be $F_{2013-2015}/F_{MSY}=3.43$. These qualitative findings (overfished, overfishing) were displayed by all MCB runs, indicating high certainty in the results (Fig. 5.2).

### 5.3. Projections

Three projection scenarios were identified as necessary for management. Using methodology identical to SEDAR-53 (2017), those three scenarios were repeated here:

- Scenario 1: $F=F_{MSY}$ with low recruitment
- Scenario 2: $F=75\%F_{MSY}$ with low recruitment
- Scenario 3: $F=75\%F_{MSY}$ (i.e., $F_{REBUILD}$) with long-term expected recruitment, extended until SSB reaches $SSB_{MSY}$ with probability of 0.5

Scenario 1 was included for quantifying OFL, Scenario 2 was included for quantifying ABC, and Scenario 3 was included for (re)defining the rebuilding time frame.

Results for Scenario 1, 2, and 3 are provided in Tables 5.2, 5.3, and 5.4, respectively.

## 5.4. Discussion and recommendations

In SEDAR-53, the general recreational fleet was the dominant source of Red Grouper landings and discards, and thus it is not surprising that assessment results are somewhat sensitive to those inputs, particularly the perceived scale of absolute abundance estimated by the assessment. Given that the assessment model appeared robust to the MRIP-adjusted landings and discards, as evidenced by fits to data and standard model diagnostics, the assessment results and corresponding projections appear to be adequate for resource management.

## 5.5. References

SEDAR-53. 2017. SEDAR 53 – South Atlantic Red Grouper Assessment Report. SEDAR. North Charleston SC. Available online at: http://sedarweb.org/sedar-53.

Table 5.1. Status indicators, benchmarks, and related quantities for Red Grouper. Estimates are values from the base run of the assessment model, after adjusting for MRIP revisions to estimates of recreational landings and discards. Median values and measures of precision (standard errors, SE) are from the Monte Carlo/Bootstrap analysis. Spawning stock biomass (SSB) is measured as total (males and females) mature biomass. The definition of MSST considered in this assessment is MSST=75%$SSB_{MSY}$. For comparison, the previous SEDAR-53 estimates are in parentheses.

| Quantity | Units | Estimate (Previous) | Median | SE |
|---|---|---|---|---|
| $F_{MSY}$ | $y^{-1}$ | 0.12 (0.12) | 0.12 | 0.02 |
| 85%$F_{MSY}$ | $y^{-1}$ | 0.10 (0.10) | 0.10 | 0.01 |
| 75%$F_{MSY}$ | $y^{-1}$ | 0.09 (0.09) | 0.09 | 0.01 |
| 65%$F_{MSY}$ | $y^{-1}$ | 0.07 (0.08) | 0.08 | 0.01 |
| $F_{20\%}$ | $y^{-1}$ | 0.19 (0.20) | 0.20 | 0.02 |
| $F_{30\%}$ | $y^{-1}$ | 0.13 (0.14) | 0.14 | 0.02 |
| $F_{40\%}$ | $y^{-1}$ | 0.09 (0.10) | 0.10 | 0.01 |
| $B_{MSY}$ | mt | 7271.2 (4188.3) | 7267.3 | 2856.2 |
| $SSB_{MSY}$ | mt | 5558.9 (3183.4) | 5533.4 | 2456.5 |
| MSST | mt | 4169.2 (2387.6) | 4150.0 | 1842.4 |
| MSY | 1000 lb | 1303.6 (794.3) | 1322.9 | 374.3 |
| $D_{MSY}$ | 1000 fish | 114.1 (60.9) | 117.6 | 28.2 |
| $R_{MSY}$ | 1000 age-1 fish | 689.9 (399.9) | 721.3 | 149.9 |
| Y at 85%$F_{MSY}$ | 1000 lb | 1291.0 (787.0) | 1311.4 | 370.0 |
| Y at 75%$F_{MSY}$ | 1000 lb | 1265.7 (772.0) | 1286.7 | 361.7 |
| Y at 65%$F_{MSY}$ | 1000 lb | 1222.9 (764.4) | 1243.7 | 347.9 |
| D at 85%$F_{MSY}$ | 1000 fish | 100.0 (NA) | 102.9 | 25.1 |
| D at 75%$F_{MSY}$ | 1000 fish | 90.1 (NA) | 92.5 | 22.9 |
| D at 65%$F_{MSY}$ | 1000 fish | 79.6 (NA) | 81.9 | 20.5 |
| $F_{2013–2015}/F_{MSY}$ | – | 3.43 (1.54) | 3.27 | 1.08 |
| $SSB_{2015}$/MSST | – | 0.25 (0.38) | 0.25 | 0.13 |
| $SSB_{2015}/SSB_{MSY}$ | – | 0.19 (0.29) | 0.19 | 0.09 |

Table 5.2. Red Grouper projections with $F=F_{MSY}$ starting in 2018 and low recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with SSB ≥ $SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections. The last column (extension "un") is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b | R.med | F.b | F.med | S.b(mt) | S.med(mt) | L.b(n) | L.med(n) | L.b(w) | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb | L.b.un(w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 245 | 209 | 0.61 | 0.65 | 740 | 735 | 77 | 78 | 841 | 847 | 140 | 128 | 248 | 246 | 0 | 365 |
| 2017 | 245 | 208 | 1.22 | 1.31 | 407 | 402 | 82 | 81 | 841 | 837 | 222 | 188 | 392 | 334 | 0 | 365 |
| 2018 | 245 | 208 | 0.12 | 0.12 | 228 | 224 | 5 | 5 | 49 | 48 | 26 | 23 | 41 | 36 | 0 | 188 |
| 2019 | 245 | 208 | 0.12 | 0.12 | 313 | 305 | 7 | 7 | 61 | 60 | 36 | 32 | 67 | 60 | 0 | 196 |
| 2020 | 245 | 207 | 0.12 | 0.12 | 443 | 432 | 13 | 12 | 91 | 88 | 40 | 36 | 84 | 77 | 0 | 207 |
| 2021 | 245 | 207 | 0.12 | 0.12 | 609 | 600 | 19 | 19 | 136 | 134 | 40 | 36 | 88 | 80 | 0 | 219 |
| 2022 | 245 | 210 | 0.12 | 0.12 | 790 | 780 | 24 | 24 | 183 | 182 | 41 | 37 | 88 | 81 | 0 | 230 |
| 2023 | 245 | 208 | 0.12 | 0.12 | 970 | 959 | 28 | 28 | 227 | 226 | 41 | 37 | 88 | 81 | 0 | 239 |
| 2024 | 245 | 208 | 0.12 | 0.12 | 1135 | 1117 | 31 | 31 | 266 | 266 | 41 | 37 | 88 | 81 | 0 | 248 |
| 2025 | 245 | 207 | 0.12 | 0.12 | 1280 | 1256 | 34 | 33 | 300 | 300 | 41 | 37 | 88 | 81 | 0 | 255 |
| 2026 | 245 | 210 | 0.12 | 0.12 | 1406 | 1377 | 36 | 35 | 330 | 328 | 41 | 37 | 88 | 81 | 0 | 261 |
| 2027 | 245 | 210 | 0.12 | 0.12 | 1512 | 1479 | 37 | 36 | 355 | 353 | 41 | 37 | 88 | 81 | 0 | 266 |
| 2028 | 245 | 210 | 0.12 | 0.12 | 1600 | 1565 | 38 | 38 | 375 | 372 | 41 | 37 | 88 | 81 | 0 | 270 |
| 2029 | 245 | 208 | 0.12 | 0.12 | 1673 | 1636 | 39 | 38 | 392 | 388 | 41 | 37 | 88 | 81 | 0 | 273 |
| 2030 | 245 | 210 | 0.12 | 0.12 | 1733 | 1695 | 40 | 39 | 406 | 403 | 41 | 37 | 88 | 81 | 0 | 276 |

Table 5.3. Red Grouper projections with $F=75\%F_{MSY}$ starting in 2018 and low recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with SSB ≥ $SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections. The last column (extension "un") is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b | R.med | F.b | F.med | S.b(mt) | S.med(mt) | L.b(n) | L.med(n) | L.b(w) | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb | L.b.un(w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 245 | 209 | 0.61 | 0.65 | 740 | 735 | 77 | 78 | 841 | 847 | 140 | 128 | 248 | 246 | 0 | 365 |
| 2017 | 245 | 208 | 1.22 | 1.31 | 407 | 402 | 82 | 81 | 841 | 837 | 222 | 188 | 392 | 334 | 0 | 365 |
| 2018 | 245 | 208 | 0.09 | 0.09 | 230 | 226 | 4 | 4 | 37 | 37 | 20 | 17 | 31 | 27 | 0 | 143 |
| 2019 | 245 | 208 | 0.09 | 0.09 | 324 | 317 | 6 | 6 | 48 | 47 | 28 | 25 | 52 | 46 | 0 | 154 |
| 2020 | 245 | 207 | 0.09 | 0.09 | 470 | 459 | 10 | 10 | 73 | 71 | 31 | 28 | 66 | 60 | 0 | 167 |
| 2021 | 245 | 207 | 0.09 | 0.09 | 658 | 650 | 16 | 15 | 112 | 110 | 31 | 28 | 69 | 62 | 0 | 181 |
| 2022 | 245 | 210 | 0.09 | 0.09 | 870 | 862 | 20 | 20 | 152 | 152 | 31 | 28 | 69 | 63 | 0 | 194 |
| 2023 | 245 | 208 | 0.09 | 0.09 | 1084 | 1073 | 24 | 23 | 192 | 192 | 31 | 28 | 69 | 63 | 0 | 206 |
| 2024 | 245 | 208 | 0.09 | 0.09 | 1286 | 1270 | 26 | 26 | 228 | 229 | 31 | 28 | 69 | 63 | 0 | 217 |
| 2025 | 245 | 207 | 0.09 | 0.09 | 1470 | 1444 | 29 | 28 | 261 | 261 | 31 | 28 | 69 | 63 | 0 | 226 |
| 2026 | 245 | 210 | 0.09 | 0.09 | 1632 | 1603 | 30 | 30 | 290 | 289 | 31 | 28 | 69 | 63 | 0 | 234 |
| 2027 | 245 | 210 | 0.09 | 0.09 | 1773 | 1737 | 32 | 32 | 315 | 314 | 31 | 28 | 69 | 63 | 0 | 240 |
| 2028 | 245 | 210 | 0.09 | 0.09 | 1894 | 1855 | 33 | 33 | 336 | 334 | 31 | 29 | 69 | 64 | 0 | 246 |
| 2029 | 245 | 208 | 0.09 | 0.09 | 1996 | 1955 | 34 | 34 | 354 | 352 | 31 | 29 | 69 | 64 | 0 | 251 |
| 2030 | 245 | 210 | 0.09 | 0.09 | 2083 | 2040 | 35 | 34 | 369 | 367 | 31 | 28 | 69 | 64 | 0 | 255 |

Table 5.4. Red Grouper projections with $F=75\%F_{MSY}$ (i.e., $F_{REBUILD}$) starting in 2018 and long-term expected recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (mt), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with $SSB \geq SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections.

| Year | R.b | R.med | F.b | F.med | S.b(mt) | S.med(mt) | L.b(n) | L.med(n) | L.b(w) | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2016 | 489 | 407 | 0.61 | 0.65 | 740 | 735 | 78 | 78 | 841 | 847 | 222 | 191 | 332 | 309 | 0 |
| 2017 | 428 | 346 | 1.21 | 1.27 | 439 | 432 | 83 | 82 | 841 | 837 | 388 | 305 | 655 | 522 | 0 |
| 2018 | 329 | 226 | 0.09 | 0.09 | 281 | 275 | 5 | 5 | 42 | 41 | 30 | 23 | 50 | 41 | 0 |
| 2019 | 250 | 172 | 0.09 | 0.09 | 431 | 418 | 9 | 8 | 63 | 60 | 34 | 26 | 70 | 55 | 0 |
| 2020 | 326 | 215 | 0.09 | 0.09 | 626 | 609 | 15 | 14 | 103 | 98 | 38 | 28 | 80 | 62 | 0 |
| 2021 | 397 | 252 | 0.09 | 0.09 | 872 | 843 | 21 | 19 | 150 | 144 | 44 | 32 | 89 | 68 | 0.001 |
| 2022 | 459 | 287 | 0.09 | 0.09 | 1160 | 1107 | 26 | 24 | 199 | 191 | 52 | 38 | 106 | 79 | 0.004 |
| 2023 | 509 | 309 | 0.09 | 0.09 | 1487 | 1410 | 32 | 29 | 255 | 244 | 60 | 42 | 124 | 90 | 0.01 |
| 2024 | 549 | 338 | 0.09 | 0.09 | 1850 | 1735 | 39 | 36 | 320 | 305 | 66 | 46 | 139 | 99 | 0.022 |
| 2025 | 581 | 353 | 0.09 | 0.09 | 2241 | 2076 | 46 | 42 | 390 | 368 | 71 | 49 | 151 | 107 | 0.04 |
| 2026 | 606 | 366 | 0.09 | 0.09 | 2652 | 2419 | 53 | 48 | 464 | 434 | 75 | 51 | 161 | 113 | 0.065 |
| 2027 | 626 | 382 | 0.09 | 0.09 | 3068 | 2753 | 60 | 54 | 539 | 500 | 78 | 54 | 168 | 119 | 0.095 |
| 2028 | 641 | 395 | 0.09 | 0.09 | 3479 | 3078 | 66 | 59 | 613 | 565 | 80 | 56 | 174 | 123 | 0.13 |
| 2029 | 653 | 399 | 0.09 | 0.09 | 3875 | 3376 | 72 | 64 | 684 | 627 | 82 | 57 | 179 | 127 | 0.17 |
| 2030 | 663 | 406 | 0.09 | 0.09 | 4250 | 3658 | 77 | 69 | 751 | 686 | 84 | 58 | 183 | 129 | 0.212 |
| 2031 | 671 | 415 | 0.09 | 0.09 | 4598 | 3905 | 82 | 73 | 813 | 739 | 85 | 59 | 186 | 132 | 0.255 |
| 2032 | 677 | 426 | 0.09 | 0.09 | 4917 | 4124 | 86 | 75 | 870 | 785 | 86 | 60 | 188 | 134 | 0.296 |
| 2033 | 682 | 426 | 0.09 | 0.09 | 5205 | 4321 | 89 | 78 | 922 | 826 | 87 | 61 | 190 | 137 | 0.332 |
| 2034 | 686 | 430 | 0.09 | 0.09 | 5463 | 4499 | 92 | 81 | 967 | 862 | 87 | 62 | 192 | 138 | 0.368 |
| 2035 | 689 | 434 | 0.09 | 0.09 | 5692 | 4654 | 95 | 83 | 1008 | 895 | 88 | 62 | 193 | 139 | 0.403 |
| 2036 | 691 | 435 | 0.09 | 0.09 | 5894 | 4789 | 97 | 85 | 1044 | 922 | 88 | 63 | 194 | 141 | 0.436 |
| 2037 | 694 | 439 | 0.09 | 0.09 | 6071 | 4922 | 99 | 87 | 1075 | 948 | 88 | 64 | 195 | 143 | 0.466 |
| 2038 | 695 | 438 | 0.09 | 0.09 | 6225 | 5031 | 101 | 89 | 1103 | 971 | 89 | 64 | 195 | 144 | 0.492 |
| 2039 | 697 | 446 | 0.09 | 0.09 | 6359 | 5118 | 102 | 90 | 1126 | 992 | 89 | 64 | 196 | 143 | 0.515 |

Figure 5.1. Comparison of time series estimates for Red Grouper from this revised assessment (MRIP revision) and from the previous SEDAR-53 assessment. A) SSB; B) Recruits; C) F; D) $SSB/SSB_{MSY}$; E) SSB/MSST; and F) $F/F_{MSY}$.

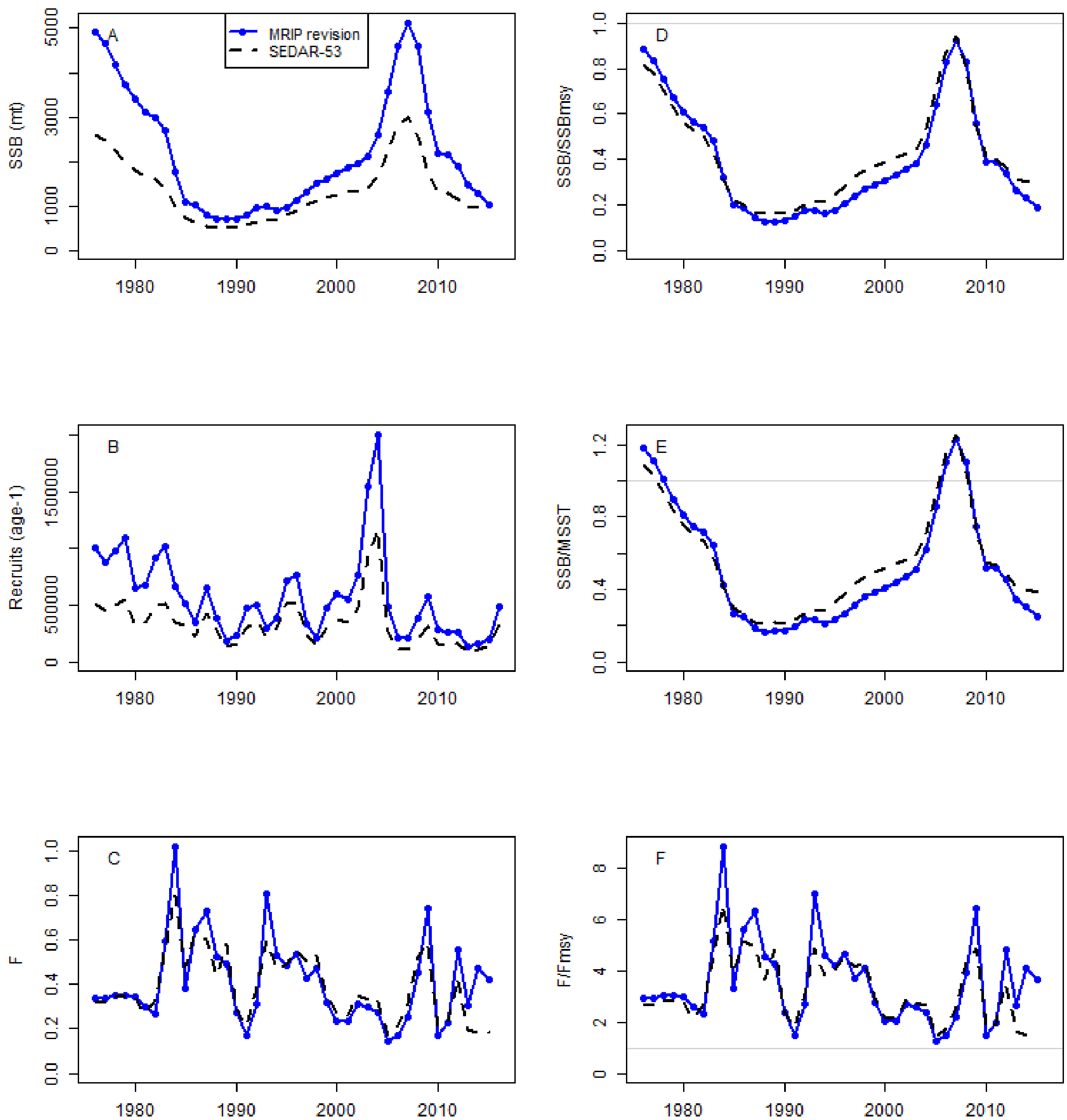
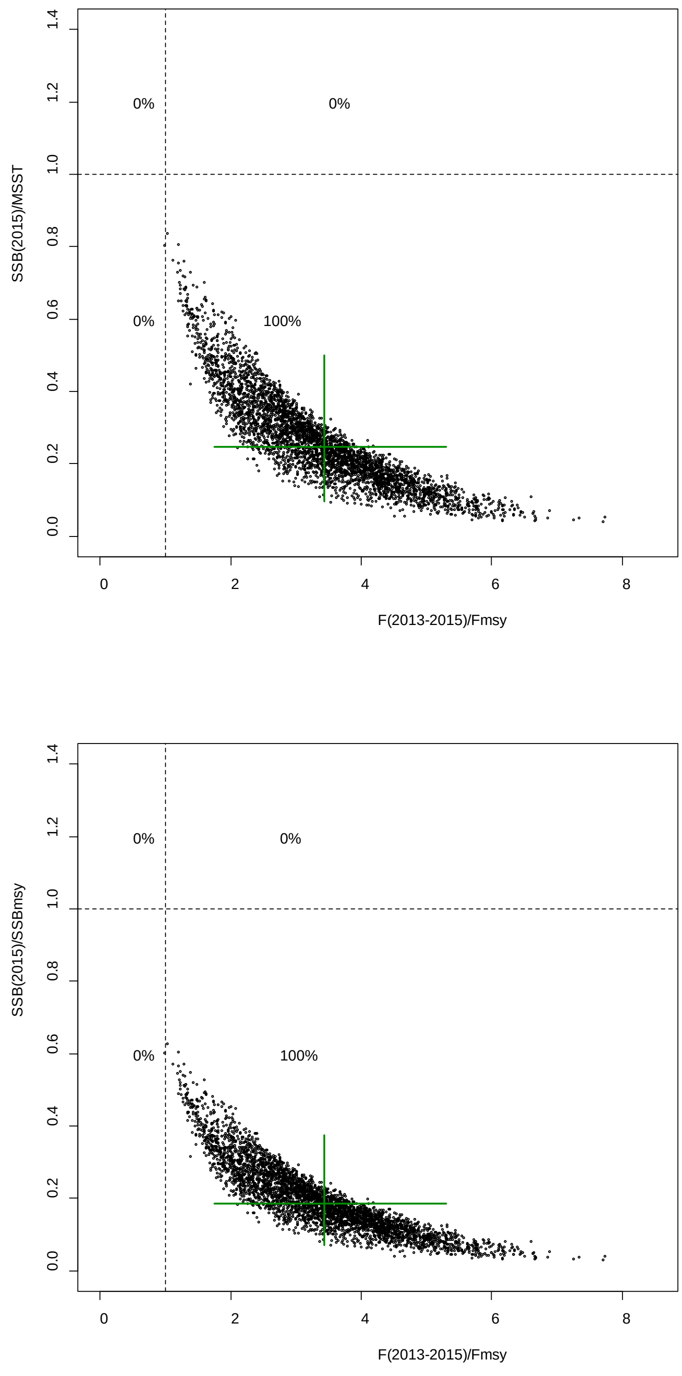


Figure 5.2. Phase plots of terminal status estimates for red grouper. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5th and 95th percentiles. Proportion of runs falling in each quadrant indicated. Top panel indicates stock status relative to MSST; bottom panel indicates stock status relative to $SSB_{MSY}$



**6 Vermilion Snapper**

6.1. Assessment methods

This revised Vermilion Snapper assessment applied methods identical to those of the most recent SEDAR assessment (SEDAR-55 2018). Details can be found in that report, and therefore the methods are only reviewed briefly here. The assessment model was an integrated age-structured model fitted to data on landings and discards, indices of abundance, and age or length compositions. It was implemented using the Beaufort Assessment Model (BAM), including the Monte Carlo/Bootstrap (MCB) approach to quantify uncertainty. The assessment time frame was 1947–2016.

The only difference in input data between this assessment and that of SEDAR-55 was the adjustment to MRIP landings and discards (Section 2). Annual recreational landings estimates were on average about 1.6 times higher than before the adjustment (range: 1.0 to 2.8 times higher), and annual recreational discard estimates about 1.8 times higher (range: 1.0 to 3.5 times higher).

6.2. Assessment results

The model fits to all data sources were similar to those from SEDAR-55, as were other model diagnostics. The primary effect of increased MRIP estimates was that the assessment model required more fish to match the larger level of landings and discards. In effect, the perceived scale of abundance is larger, which the assessment model accomplished by increasing the estimate of unfished age-1 recruitment, $R_0$, and the range of annual recruitment deviations (rec sigma). This translated into higher levels of SSB and recruits (Fig. 6.1). The estimate of $SSB_{MSY}$ (Table 6.1) increased slightly and the relative status time series ($SSB/SSB_{MSY}$ and SSB/MSST) decreased with this revision, but the biomass stock status did not change (Fig. 6.1). Similarly, the estimated time series of fishing mortality rate increased slightly (Fig. 6.1), because the model predicted more fish available to support the increased level of removals. The exception to this was in the terminal years of the assessment, where the revision estimated higher levels of fishing than were previously predicted. This occurred because the MRIP-adjusted removals during the last several years of the assessment period were all above average, including landings and discard adjustments that were 1-2 standard deviations above normal. $F/F_{MSY}$ suggested the stock was undergoing overfishing in the terminal year of the assessment (1.03), but not when averaged over the last three assessment years (0.85) (Fig. 6.2).

As in SEDAR-55, this revised assessment found South Atlantic Vermilion Snapper not to be overfished and not experiencing overfishing (Table 6.1; Fig. 6.2). The stock status was estimated to be $SSB_{2016}/MSST=1.38$, and the fishing status was estimated to e $F_{2014–2016}/F_{MSY}=0.85$. These qualitative findings (not overfished, not overfishing) were displayed by the majority of MCB runs, indicating reasonable certainty in the results (Fig. 6.2).

6.3. Projections

Two projection scenarios were identified as necessary for management. Using methodology identical to SEDAR-55 (2018), those three scenarios were repeated here:

- Scenario 1: $F=F_{MSY}$
- Scenario 2:P*=0.4

Scenario 1 was included for quantifying OFL and Scenario 2 was included for quantifying ABC.

Results for Scenario 1 and 2 are provided in Tables 6.2 and 6.3, respectively.

## 6.4. Discussion and recommendations

In SEDAR-55, the general recreational fleet was the dominant source of Vermilion Snapper landings and discards, and thus it is not surprising that assessment results are somewhat sensitive to those inputs, particularly the perceived scale of absolute abundance estimated by the assessment. Given that the assessment model appeared robust to the MRIP-adjusted landings and discards, as evidenced by fits to data and standard model diagnostics, the assessment results and corresponding projections appear to be adequate for resource management.

## 6.5. References

SEDAR-55. 2018. SEDAR 55 – South Atlantic Vermilion Snapper Assessment Report. SEDAR. North Charleston SC. Available online at: http://sedarweb.org/sedar-55.

Table 6.1. Status indicators, benchmarks, and related quantities for Vermilion Snapper. Estimates are values from the base run of the assessment model, after adjusting for MRIP revisions to estimates of recreational landings and discards. Median values and measures of precision (standard errors, SE) are from the Monte Carlo/Bootstrap analysis. Reproductive potential is measured as population fecundity. The definition of MSST considered in this assessment is $MSST=75\%SSB_{MSY}$. For comparison, the previous SEDAR-55 estimates are in parentheses.

| Quantity | Units | Estimate (Previous) | Median | SE |
|---|---|---|---|---|
| $F_{MSY}$ | $y^{-1}$ | 0.35 (0.41) | 0.42 | 0.19 |
| $85\%F_{MSY}$ | $y^{-1}$ | 0.30 (0.35) | 0.35 | 0.16 |
| $75\%F_{MSY}$ | $y^{-1}$ | 0.26 (0.31) | 0.31 | 0.14 |
| $65\%F_{MSY}$ | $y^{-1}$ | 0.23 (0.27) | 0.27 | 0.12 |
| $B_{MSY}$ | mt | 4743.1 (4249.2) | 4370.1 | 579.1 |
| $SSB_{MSY}$ | 1*E*12 eggs | 20.5 (18.3) | 18.7 | 2.68 |
| MSST | 1*E*12 eggs | 15.3 (13.7) | 14.0 | 2.01 |
| MSY | 1000 lb | 1298.7 (1305.8) | 1388.2 | 137.5 |
| $D_{MSY}$ | 1000 fish | 267.1 (245.9) | 172.4 | 77.1 |
| $R_{MSY}$ | 1000 age-1 fish | 6072 (5591) | 5698 | 1091 |
| Y at $85\%F_{MSY}$ | 1000 lb | 1292.1 (1300.3) | 1383.1 | 142.4 |
| Y at $75\%F_{MSY}$ | 1000 lb | 1277.9 (1288.2) | 1370.6 | 147.7 |
| Y at $65\%F_{MSY}$ | 1000 lb | 1252.1 (1266.0) | 1347.8 | 147.7 |
| $F_{2014–2016}/F_{MSY}$ | – | 0.846 (0.609) | 0.677 | 0.49 |
| $SSB_{2016}/MSST$ | – | 1.38 (1.51) | 1.50 | 0.33 |
| $SSB_{2016}/SSB_{MSY}$ | – | 1.03 (1.13) | 1.13 | 0.25 |

Table 6.2. Vermilion Snapper projections with $F=F_{MSY}$ starting in 2019 and low recruitment. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1*E*12 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with $SSB \geq SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections. The last column (extension "un") is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b | R.med | F.b | F.med | S.b(eggs) | S.med(eggs) | L.b(n) | L.med(n) | L.b | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb | L.b.un(w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 6118 | 5480 | 0.38 | 0.32 | 21 | 21 | 1446 | 1384 | 1479 | 1477 | 392 | 403 | 271 | 286 | 0.688 | 1220 |
| 2018 | 6080 | 5480 | 0.4 | 0.34 | 20 | 20 | 1502 | 1447 | 1479 | 1477 | 423 | 423 | 289 | 294 | 0.658 | 1220 |
| 2019 | 6051 | 5443 | 0.35 | 0.42 | 20 | 20 | 1323 | 1727 | 1265 | 1706 | 383 | 414 | 260 | 286 | 0.626 | 1669 |
| 2020 | 6046 | 5446 | 0.35 | 0.42 | 20 | 19 | 1353 | 1640 | 1273 | 1574 | 387 | 410 | 264 | 280 | 0.559 | 1538 |
| 2021 | 6054 | 5424 | 0.35 | 0.42 | 20 | 18 | 1367 | 1585 | 1279 | 1482 | 387 | 408 | 265 | 278 | 0.5 | 1459 |
| 2022 | 6059 | 5427 | 0.35 | 0.42 | 20 | 18 | 1373 | 1550 | 1283 | 1427 | 388 | 406 | 265 | 277 | 0.468 | 1411 |
| 2023 | 6062 | 5401 | 0.35 | 0.42 | 20 | 18 | 1376 | 1533 | 1286 | 1395 | 388 | 405 | 266 | 276 | 0.453 | 1380 |

Table 6.3. Vermilion Snapper projections with fishing mortality rate fixed at P*=0.4 starting in 2019. R = number of age-1 recruits (in 1000s), F = fishing mortality rate (per year), S = spawning stock (1*E*12 eggs), L = landings expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), D = dead discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), and pr.reb = proportion of stochastic projection replicates with SSB ≥ $SSB_{MSY}$. The extension "b" indicates expected values (deterministic) from the base run; the extension "med" indicates median values from the stochastic projections. The last column (extension "un") is from a previous projection analogous to this one but with unadjusted MRIP landings, and it is included here only for comparison to the current projection.

| Year | R.b | R.med | F.b | F.med | S.b(eggs) | S.med(eggs) | L.b(n) | L.med(n) | L.b | L.med(w) | D.b(n) | D.med(n) | D.b(w) | D.med(w) | pr.reb | L.b.un(w) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 6118 | 5480 | 0.38 | 0.32 | 21 | 21 | 1446 | 1384 | 1479 | 1477 | 392 | 403 | 271 | 286 | 0.688 | 1220 |
| 2018 | 6080 | 5480 | 0.4 | 0.34 | 20 | 20 | 1502 | 1447 | 1479 | 1477 | 423 | 423 | 289 | 294 | 0.658 | 1220 |
| 2019 | 6051 | 5443 | 0.3 | 0.36 | 20 | 20 | 1152 | 1509 | 1102 | 1492 | 331 | 422 | 226 | 291 | 0.648 | 1454 |
| 2020 | 6066 | 5465 | 0.3 | 0.36 | 21 | 20 | 1217 | 1488 | 1152 | 1439 | 339 | 422 | 232 | 290 | 0.637 | 1400 |
| 2021 | 6100 | 5470 | 0.3 | 0.36 | 21 | 19 | 1254 | 1470 | 1187 | 1398 | 342 | 423 | 236 | 291 | 0.619 | 1366 |
| 2022 | 6123 | 5490 | 0.3 | 0.36 | 21 | 19 | 1275 | 1458 | 1212 | 1372 | 344 | 423 | 238 | 291 | 0.614 | 1346 |
| 2023 | 6140 | 5476 | 0.3 | 0.36 | 22 | 19 | 1290 | 1453 | 1230 | 1355 | 346 | 423 | 240 | 292 | 0.61 | 1333 |

Figure 6.1. Comparison of time series estimates for Vermilion Snapper from this revised assessment (MRIP revision) and from the previous SEDAR-55 assessment. A) SSB; B) Recruits; C) F; D) SSB/$SSB_{MSY}$; E) SSB/MSST; and F) $F/F_{MSY}$.

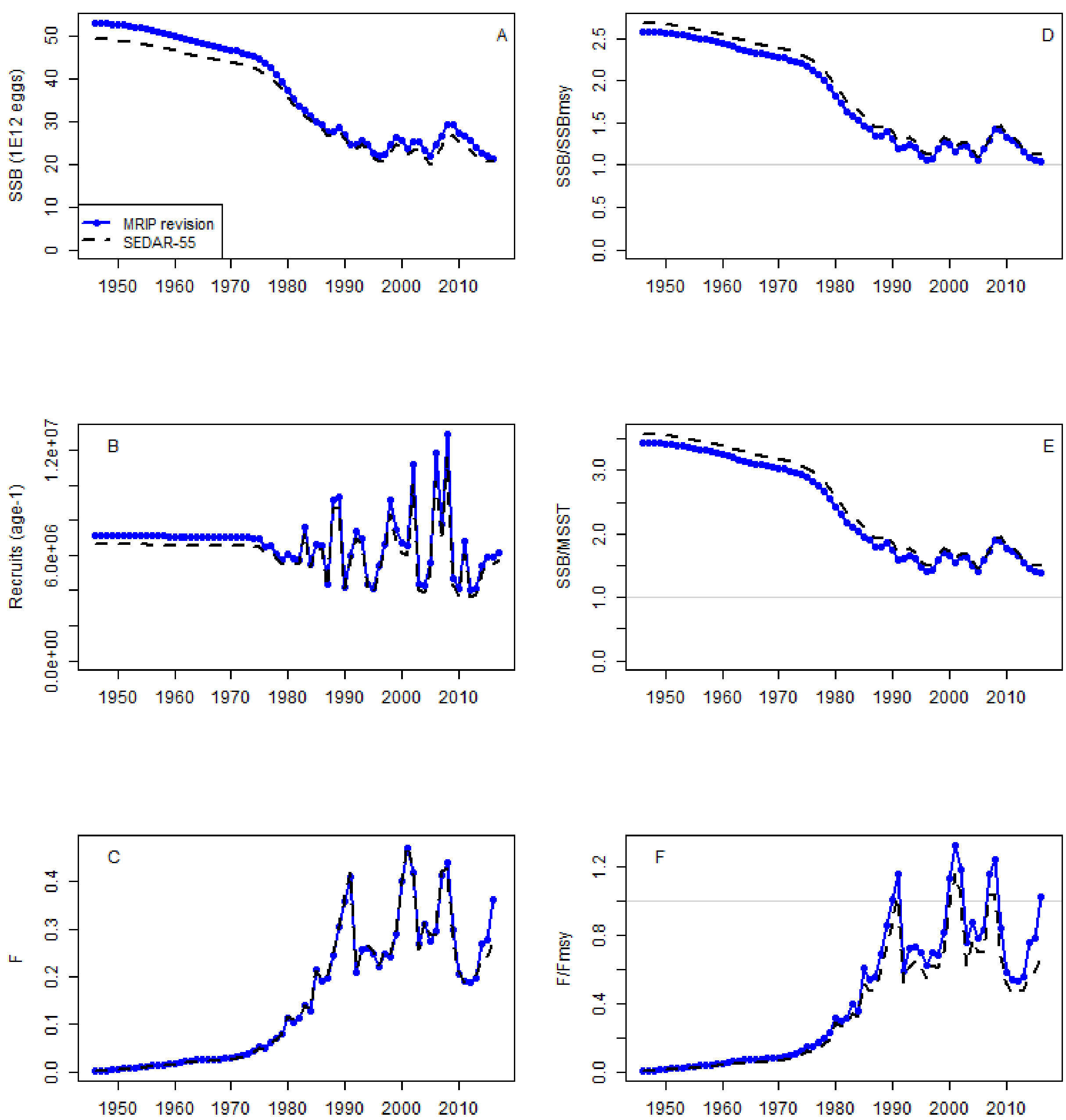


Figure 6.2. Phase plots of terminal status estimates for Vermilion Snapper. The intersection of crosshairs indicates estimates from the base run; lengths of crosshairs defined by 5th and 95th percentiles. Proportion of runs falling in each quadrant indicated. Top panel indicates stock status relative to MSST; bottom panel indicates stock status relative to $SSB_{MSY}$