

**Scup Management Track Assessment for 2021**  
**(Lead: Mark Terceiro)**

**State of Stock:** This 2021 Management Track Assessment (MTA) of scup (*Stenotomus chrysops*) is an update through 2019 of the commercial and recreational fishery catch data and any available research survey indices of abundance. Assessment model estimates of stock size and fishing mortality are updated through 2019.

The stock was not overfished and overfishing was not occurring in 2019 relative to the updated biological reference points (Figure 1). Spawning stock biomass (SSB) was estimated to be 176,404 mt in 2019, about 2 times the updated biomass target reference point  $SSB_{MSY} \text{ proxy} = SSB_{40\%} = 90,019$  mt (Table 1, Figure 2). There is a 90% chance that SSB in 2019 was between 154,000 and 210,000 mt. Fishing mortality on the fully selected age 4 fish was 0.136 in 2019, 68% of the updated fishing mortality threshold reference point  $F_{MSY} \text{ proxy} = F_{40\%} = 0.200$  (Table 1, Figure 3). There is a 90% probability that the fishing mortality rate in 2019 was between 0.106 and 0.166. The average recruitment from 1984 to 2019 is 136 million fish at age 0. The 2015 year class is estimated to be the largest in the time series at 415 million fish, while the 2017-2019 year classes are estimated to be below average, with the 2019 year class the smallest in the time series (Table 1, Figures 2 and 4).

The model estimate of SSB in 2019 adjusted for internal retrospective error (-14.4%) is within the model estimate 90% confidence interval. The model estimate of F in 2019 adjusted for internal retrospective error (+20.2%) is also within the model estimate 90% confidence interval. Therefore, no adjustment of these terminal year estimates has been made for stock status determination or projections. While the stock sustained catches above MSY during 2013-2019, stock biomass is projected to decrease toward the target unless more above average year classes recruit to the stock in the short term.

**OFL Projections:** Projections using the results of the 2021 MTA model (data through 2019) were made to estimate the OFL catches for 2022-2023. The projections assume that the 2020 and 2021 ABCs of 16,227 mt and 15,791 mt were caught and sample from the estimated recruitment for 1984-2019. **The preliminary estimate of 2020 catch is 15,226 mt, 94% of the 2020 ABC.** The OFL projection uses  $F_{2022-F2023} = \text{updated } F_{MSY} \text{ proxy} = F_{40\%} = 0.200$ . The OFL catches are 14,770 mt in 2022 (CV = 18%) and 13,626 mt in 2023 (CV = 18%).

| Year | Catch  | OFL for 2022-2023              |          |       |         |
|------|--------|--------------------------------|----------|-------|---------|
|      |        | Catches and SSB in metric tons |          | F     | SSB     |
|      |        | Landing                        | Discards |       |         |
| 2020 | 16,227 | 14,300                         | 1,927    | 0.137 | 191,096 |
| 2021 | 15,791 | 13,799                         | 1,992    | 0.166 | 173,993 |
| 2022 | 14,770 | 12,112                         | 2,658    | 0.200 | 156,850 |
| 2023 | 13,626 | 10,596                         | 3,030    | 0.200 | 139,337 |

**Catch:** Reported 2019 commercial landings were 6,252 mt = 13.783 million lb. Estimated 2019 recreational landings were 6,403 mt = 14.116 million lb. Total commercial and recreational landings in 2019 were 12,655 mt = 27.899 million lb. Estimated 2019 commercial discards were 2,779 mt = 6.127 million lb. Estimated 2019 recreational discards were 560 mt = 1.235 million lb. The estimated total catch in 2019 was 15,994 mt = 35.261 million lb (Catch and Status Table below; Table 2). MSY is estimated to be 12,054 mt = 26.575 million lb.

**Catch and Status Table: Scup**

Catch weights in metric tons (mt); spawning stock biomass thousands of metric tons; recruitment in millions of age 0 fish; min, max and arithmetic mean values are for 1981/1984-2019. Commercial catches are latest reported landings and estimated discards. Recreational catches are ‘New’ MRIP calibrated landings and discards estimates.

| Year                     | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   |
|--------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Commercial landings      | 4,866  | 6,819  | 6,751  | 8,105  | 7,239  | 7,725  | 7,147  | 7,007  | 6,064  | 6,252  |
| Commercial discards      | 2,639  | 1,236  | 1,002  | 1,350  | 981    | 1,718  | 2,778  | 4,733  | 3,293  | 2,779  |
| Recreational landings    | 5,660  | 4,682  | 3,751  | 5,739  | 4,659  | 5,527  | 4,536  | 6,143  | 5,887  | 6,403  |
| Recreational discards    | 787    | 516    | 636    | 568    | 480    | 581    | 862    | 1,079  | 644    | 560    |
| Catch used in assessment | 13,952 | 13,253 | 12,139 | 15,762 | 13,359 | 15,550 | 15,332 | 18,961 | 15,888 | 15,994 |
| Spawning stock biomass   | 226    | 229    | 230    | 233    | 224    | 195    | 210    | 213    | 199    | 176    |
| Recruitment (age 0)      | 149    | 217    | 125    | 122    | 283    | 415    | 143    | 84     | 100    | 34     |
| Full F (age 4)           | 0.076  | 0.079  | 0.078  | 0.115  | 0.105  | 0.140  | 0.114  | 0.126  | 0.111  | 0.136  |

| Year                     | Min   | Max    | Mean   |
|--------------------------|-------|--------|--------|
| Commercial landings      | 1,207 | 8,105  | 4,887  |
| Commercial discards      | 436   | 4,733  | 1,819  |
| Recreational landings    | 824   | 6,430  | 3,893  |
| Recreational discards    | 30    | 1,079  | 336    |
| Catch used in assessment | 3,485 | 18,961 | 11,430 |
| Spawning stock biomass   | 4     | 233    | 95     |
| Recruitment (age 0)      | 34    | 415    | 136    |
| Full F (age 4)           | 0.052 | 1.655  | 0.525  |

**Stock Distribution and Identification:** The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Joint Fishery Management Plan defines the management unit as all scup from Cape Hatteras, North Carolina northeast to the US-Canada border (MAFMC 1999).

**Assessment Model:** The assessment model for scup is a complex statistical catch-at-age model (ASAP SCAA; Legault and Restrepo 1998; NFT 2013) incorporating a broad range of fishery and survey data (NEFSC 2015). The model assumes an instantaneous natural mortality rate ( $M$ ) = 0.2. The fishery catch is modeled as four fleets: commercial landings, recreational landings, commercial discards and recreational discards.

Indices of stock abundance from NEFSC winter, spring, and fall, Massachusetts DMF spring and fall, Rhode Island DFW spring and fall, University of Rhode Island Graduate School of Oceanography (URIGSO), RI Industry Cooperative trap, Connecticut DEEP spring and fall, New York DEC, New Jersey DFW, Virginia Institute of Marine Science (VIMS) Chesapeake Bay, VIMS juvenile fish trawl, and NEAMAP spring and fall trawl surveys were used in the 2015 SAW 60 benchmark assessment (NEFSC 2015) and the 2017 (NEFSC unpublished report to the MAFMC SSC) and 2019 (NEFSC 2020) Operational Assessment updates. All indices were updated for this assessment.

There is a minor retrospective pattern evident in the scup assessment model. The internal model retrospective error tends to underestimate SSB by -14.4% and overestimate  $F$  by +20.2% over the last 7 terminal years. The model estimate of SSB in 2019 adjusted for internal retrospective error (201,806 mt) is within the model estimate 90% confidence interval (154,192 mt; 210,285 mt). The model estimate of  $F$  in 2019 adjusted for internal retrospective error (0.109) is within the model estimate 90% confidence interval (0.106; 0.166). Therefore, no adjustment of these terminal year estimates has been made for stock status determination or projections.

The ‘historical’ retrospective analysis (comparison between assessments) indicates that the general trends in spawning stock biomass, recruitment, and fishing mortality have been consistent over the history of the assessment (Figure 5).

**Biological Reference Points (BRPs):** Reference points were calculated using the non-parametric yield and SSB per recruit long-term projection approach. The cumulative distribution function of the 1984-2019 recruitment (corresponding to the period of input fishery catches-at-age) was re-sampled to provide future recruitment estimates for the projections used to estimate the biomass reference point.

The existing biological reference points for scup are from the 2019 Operational Assessment (NEFSC 2020). The reference points are  $F_{40\%}$  as the proxy for  $F_{MSY}$ , and the corresponding  $SSB_{40\%}$  as the proxy for the  $SSB_{MSY}$  biomass target. The  $F_{40\%}$  proxy for  $F_{MSY} = 0.215$ ; the proxy estimate for  $SSB_{MSY} = SSB_{40\%} = 94,020$  mt = 207.279 million lb; the proxy estimate for the  $\frac{1}{2}$   $SSB_{MSY}$  biomass threshold =  $\frac{1}{2}$   $SSB_{40\%} = 47,010$  mt = 103.639 million lb; and the proxy estimate for  $MSY = MSY_{40\%} = 12,927$  mt = 28.499 million lb.

The  $F_{40\%}$  and corresponding  $SSB_{40\%}$  proxy biological reference points for scup were updated for this assessment. The updated fishing mortality threshold  $F_{40\%}$  proxy for  $F_{MSY} = 0.200$ . The updated biomass target proxy estimate for  $SSB_{MSY} = SSB_{40\%} = 90,019$  mt = 198.458 million lb and the updated biomass threshold proxy estimate for  $\frac{1}{2}$   $SSB_{MSY} = \frac{1}{2}$   $SSB_{40\%} = 45,010$  mt = 99.230 million lb. The

updated proxy estimate for  $MSY = MSY40\% = 12,671 \text{ mt} = 27.935 \text{ million lb.}$

### **Qualitative status description:**

The age structure in current fishery and survey catches is greatly expanded compared to the truncated distribution observed in the early 1990s. Most survey aggregate biomass indices have recently been near their time series high. Survey indices suggest the recruitment of several large year classes during 2000-2015. These simple metrics indicate that mortality from all sources was lower than recruitment inputs to the stock during this period, which has resulted in a spawning stock biomass that is well above the management target. The high stock biomass sustained catches above MSY during 2013-2019. However, most recent indices suggest the 2017-2019 year classes are below average. Spawning stock biomass is projected to decrease toward the target unless more above average year classes recruit to the stock in the short term.

### **Research and Data Issues:**

#### **2015 SAW 60**

A standardized fishery dependent CPUE of scup targeted tows, from either NEFOP observer samples or the commercial study fleet, might be considered as an additional index of abundance to complement survey indices in future benchmark assessments: *completed for 2015 SAW 60, CPUE indices not included model calibration*

Explore additional sources of length/age data from fisheries and surveys in the early parts of the time series to provide additional context for model results: *no success, likely alternative is to begin model in 1984 in next RTA*

Explore experiments to estimate the catchability of scup in NEFSC and other research trawl surveys (side-by-side, camera, gear mensuration, acoustics, etc.): *no progress*

Refine and update the Manderson *et al.* availability analysis when/if a new ocean model is available (need additional support). Explore alternative niche model parameterizations including laboratory experiments on thermal preference and tolerance: *no progress*

Explore the Study fleet data in general for information that could provide additional context and/or input for the assessment: *completed for 2015 SAW 60, CPUE indices not included model calibration*

A scientifically designed survey to sample larger and older scup would likely prove useful in improving knowledge of the relative abundance of these large fish: *no progress*

#### **2019 OA**

The recent recruitment of the largest year class in the assessment time series (the 2015 year class) has contributed to recent high commercial fishery discards. The exploration of management actions to reduce discarding in the event of future high recruitment events might include modification of the commercial fishery Gear Restricted Areas and modified commercial mesh sizes: *considered annually as part of the*

*specifications process*

There is evidence of a decreasing trend in mean weights at age and maturity, perhaps indicative of density dependent effects. Potential effects on reference points and projected fishery yield should continue to be closely monitored: *ongoing monitoring in assessment*

### **MAFMC SSC 2019-2020**

Characterize the pattern of selectivity for older ages of Scup in both surveys and Fisheries: *ongoing estimation in assessment*

Explore the applicability of the pattern of fishery selectivity in the model to the most recent catch data to determine whether a new selectivity block in the model is warranted: *updated in 2021 MTA – new 2013+ selectivity block added to model*

Mean weights-at-age have declined and age-at-maturity has increased slightly (the proportion mature at age 2 has decreased) in recent years. Continued monitoring of both is warranted: *ongoing monitoring in assessment*

It was conjectured that the increase in stock biomass since 2000 resulted from increased recruitments due to the imposition of gear restriction areas (GRAs), to minimize interactions between Scup and squid fisheries, and from increases in commercial mesh sizes. Long-term climate variation is a potential alternative explanation for increased recruitments from 2000 to 2015. Research to explore the validity of both hypotheses is warranted: *no new research progress*

Improve estimates of discards and discard mortality for commercial and recreational fisheries: *no progress, but no concerns expected if current levels of sampling are maintained*

Evaluate the degree of bias in the catch, particularly the commercial catch: *no stock-specific progress, but GARFO/NEFSC CAMS proposed for 2020+ data*

Conduct experiments to estimate catchability of Scup in NEFSC surveys: *no progress*

Explore the utility of incorporating ecological relationships, predation, and oceanic events that influence Scup population size on the continental shelf and its availability to resource surveys used in the stock assessment model: *no new research progress*

Explore additional source of age-length data from historical surveys to inform the early part of the time series, providing additional context for model results: *no success, likely alternative is to begin model in 1984 in next RTA*

An MSE could evaluate the effectiveness of Scup management procedures: *no progress*

The Scup Statistical Catch at Age assessment model uses multiple selectivity blocks. The final selectivity block (2006-2018) is the longest in the model. The applicability of the most recent selectivity block to the current fishery condition is uncertain. If the fishery selectivity implied in this block changes, estimates of stock number, spawning stock biomass, and fishing mortality become less reliable: *updated in 2021 MTA – new 2013+ selectivity block added to model*

Recruitment indices for Scup have been declining in recent years. The 2021 management track assessment should consider the implications on stock biomass projections should this trend continue: *evaluated in the 2021 MTA assessment model and associated projections*

Most of the fishery-independent indices used in the model provide estimates of the abundance of Scup < age 3. One consequence is that much of the information on the dynamics of Scup of older ages arises largely from the fishery catch-at-age and from assumptions of the model, and are not conditioned on fishery-independent observations. As a result, the dynamics of these older fish remain uncertain. Knowledge of the dynamics of these older age classes will become more important as the age structure continues to expand: *no new research progress, but assessment indicated the abundance of older fish in increasing in fishery and survey catches, and there is evidence of possible density dependent effects on growth and maturity*

The projection on which the ABC was determined assumes that the quotas would be landed in 2019, 2020, and 2021; however, landings in recent years have been below the quotas and perhaps a more realistic assumption should be used in future projections: *given the uncertainty of fishery dynamics and catch estimated for 2020, the 2021 MTA projections assumed the ABCs would be caught in 2020-2021*

Uncertainty exists with respect to the estimate of natural mortality used in the assessment: *no new research progress*

Uncertainty exists as to whether the MSY proxies (SSB40%, F40%) selected and their precisions are appropriate for this stock: *no new research progress*

Survey indices are particularly sensitive to Scup availability, which results in high inter-annual variability. Efforts were made to address this question in the Stock Assessment Workshop and Stock Assessment Review Committee (SAW/SARC) in 2017 that should be continued in the 2021 management track assessment: *no new research progress*

## References:

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Mid-Atlantic Fishery Management Council. (MAFMC). 1999. Amendment 12 to the summer flounder, scup, and black sea bass fishery management plan. Dover, DE. 398 p + appendix.

Northeast Fisheries Science Center (NEFSC). 2009. The Northeast Data Poor Stocks Working Group Report, December 8-12, 2009 Meeting. Part A: Skate species complex, deep sea red crab, Atlantic wolffish, scup, and black sea bass. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 09-02; 496 p.

Northeast Fisheries Science Center (NEFSC). 2015. 60<sup>th</sup> Northeast Regional Stock Assessment Workshop (60<sup>th</sup> SAW) Assessment Report. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 15-08; 870 p.

Northeast Fisheries Science Center (NEFSC). 2020. Operational Assessment of Black Sea Bass, Scup, Bluefish, and Monkfish Stocks, Updated Through 2018. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 20-01; 160 p.

NOAA Fisheries Toolbox (NFT). 2013. Age Structured Assessment Program (ASAP) version 3.0.11. (Internet address: <http://nft.nefsc.noaa.gov>).

## Tables

Table 1. Summary assessment results; Spawning Stock Biomass (SSB) in metric tons (mt); Recruitment (R) at age 0 in millions; Fishing Mortality (F) for age of peak fishery selection (S = 1) age 4.

| Year | SSB     | R       | F     |
|------|---------|---------|-------|
| 1984 | 11,660  | 145,686 | 0.854 |
| 1985 | 15,176  | 133,452 | 1.076 |
| 1986 | 14,343  | 92,479  | 1.033 |
| 1987 | 11,901  | 69,155  | 1.066 |
| 1988 | 9,520   | 129,722 | 1.069 |
| 1989 | 8,891   | 74,488  | 1.029 |
| 1990 | 11,316  | 112,867 | 0.844 |
| 1991 | 9,280   | 99,376  | 1.419 |
| 1992 | 7,537   | 39,627  | 1.469 |
| 1993 | 5,729   | 39,796  | 1.361 |
| 1994 | 4,223   | 72,976  | 1.655 |
| 1995 | 3,535   | 42,726  | 1.267 |
| 1996 | 6,146   | 37,025  | 1.069 |
| 1997 | 6,350   | 93,345  | 0.751 |
| 1998 | 7,682   | 106,668 | 0.457 |
| 1999 | 16,216  | 223,962 | 0.301 |
| 2000 | 31,752  | 147,688 | 0.259 |
| 2001 | 58,646  | 141,201 | 0.133 |
| 2002 | 81,326  | 89,909  | 0.094 |
| 2003 | 102,041 | 91,455  | 0.137 |
| 2004 | 113,083 | 138,744 | 0.112 |
| 2005 | 115,917 | 218,815 | 0.069 |
| 2006 | 127,368 | 255,024 | 0.088 |
| 2007 | 140,420 | 257,622 | 0.087 |
| 2008 | 166,177 | 227,491 | 0.052 |
| 2009 | 187,171 | 129,655 | 0.058 |
| 2010 | 226,142 | 149,488 | 0.076 |
| 2011 | 228,854 | 216,850 | 0.079 |
| 2012 | 230,141 | 124,572 | 0.078 |
| 2013 | 233,337 | 122,412 | 0.115 |
| 2014 | 223,673 | 282,838 | 0.105 |
| 2015 | 195,380 | 415,041 | 0.140 |
| 2016 | 210,325 | 142,853 | 0.114 |
| 2017 | 213,059 | 84,306  | 0.126 |
| 2018 | 198,750 | 100,436 | 0.111 |
| 2019 | 176,404 | 34,113  | 0.136 |



Table 2. Total catch (metric tons) of scup from Maine through North Carolina. Commercial discards for 1981-1988 calculated from the mean ratio of discards to landings for 1989-1991.

| Year | Commercial Landings | Commercial Discards | Recreational Landings | Recreational Discards | Total Catch |
|------|---------------------|---------------------|-----------------------|-----------------------|-------------|
| 1981 | 9,856               | 4,495               | 5,054                 | 108                   | 19,514      |
| 1982 | 8,704               | 3,970               | 3,908                 | 169                   | 16,751      |
| 1983 | 7,794               | 3,555               | 3,911                 | 76                    | 15,336      |
| 1984 | 7,769               | 3,543               | 1,489                 | 34                    | 12,836      |
| 1985 | 6,727               | 3,068               | 5,122                 | 72                    | 14,989      |
| 1986 | 7,176               | 3,273               | 6,430                 | 86                    | 16,965      |
| 1987 | 6,276               | 2,862               | 4,722                 | 42                    | 13,902      |
| 1988 | 5,943               | 2,710               | 3,191                 | 38                    | 11,882      |
| 1989 | 3,984               | 1,277               | 4,781                 | 54                    | 10,097      |
| 1990 | 4,571               | 2,466               | 3,254                 | 59                    | 10,350      |
| 1991 | 7,081               | 3,388               | 5,857                 | 75                    | 16,401      |
| 1992 | 6,259               | 1,885               | 4,288                 | 63                    | 12,496      |
| 1993 | 4,726               | 1,510               | 2,101                 | 31                    | 8,368       |
| 1994 | 4,392               | 962                 | 1,964                 | 30                    | 7,348       |
| 1995 | 3,073               | 974                 | 1,030                 | 38                    | 5,114       |
| 1996 | 2,945               | 870                 | 2,004                 | 55                    | 5,874       |
| 1997 | 2,188               | 675                 | 1,152                 | 38                    | 4,053       |
| 1998 | 1,896               | 705                 | 824                   | 60                    | 3,485       |
| 1999 | 1,505               | 735                 | 2,098                 | 51                    | 4,390       |
| 2000 | 1,207               | 592                 | 5,167                 | 249                   | 7,216       |
| 2001 | 1,729               | 1,671               | 4,434                 | 417                   | 8,251       |
| 2002 | 3,173               | 1,284               | 2,826                 | 427                   | 7,710       |
| 2003 | 4,405               | 436                 | 7,806                 | 462                   | 13,109      |
| 2004 | 4,209               | 1,324               | 5,819                 | 620                   | 11,972      |
| 2005 | 3,711               | 565                 | 1,949                 | 413                   | 6,637       |
| 2006 | 4,081               | 896                 | 2,688                 | 639                   | 8,304       |
| 2007 | 4,193               | 1,364               | 3,221                 | 407                   | 9,184       |
| 2008 | 2,370               | 2,254               | 2,613                 | 608                   | 7,845       |
| 2009 | 3,721               | 3,184               | 2,851                 | 552                   | 10,308      |
| 2010 | 4,866               | 2,639               | 5,660                 | 787                   | 13,952      |
| 2011 | 6,819               | 1,236               | 4,682                 | 516                   | 13,253      |
| 2012 | 6,751               | 1,002               | 3,751                 | 636                   | 12,139      |
| 2013 | 8,105               | 1,350               | 5,739                 | 568                   | 15,762      |
| 2014 | 7,239               | 981                 | 4,659                 | 480                   | 13,359      |
| 2015 | 7,725               | 1,718               | 5,527                 | 581                   | 15,550      |
| 2016 | 7,147               | 2,778               | 4,536                 | 862                   | 15,322      |
| 2017 | 7,007               | 4,733               | 6,143                 | 1,079                 | 18,961      |
| 2018 | 6,064               | 3,293               | 5,887                 | 644                   | 15,888      |
| 2019 | 6,252               | 2,779               | 6,403                 | 560                   | 15,994      |

## Figures

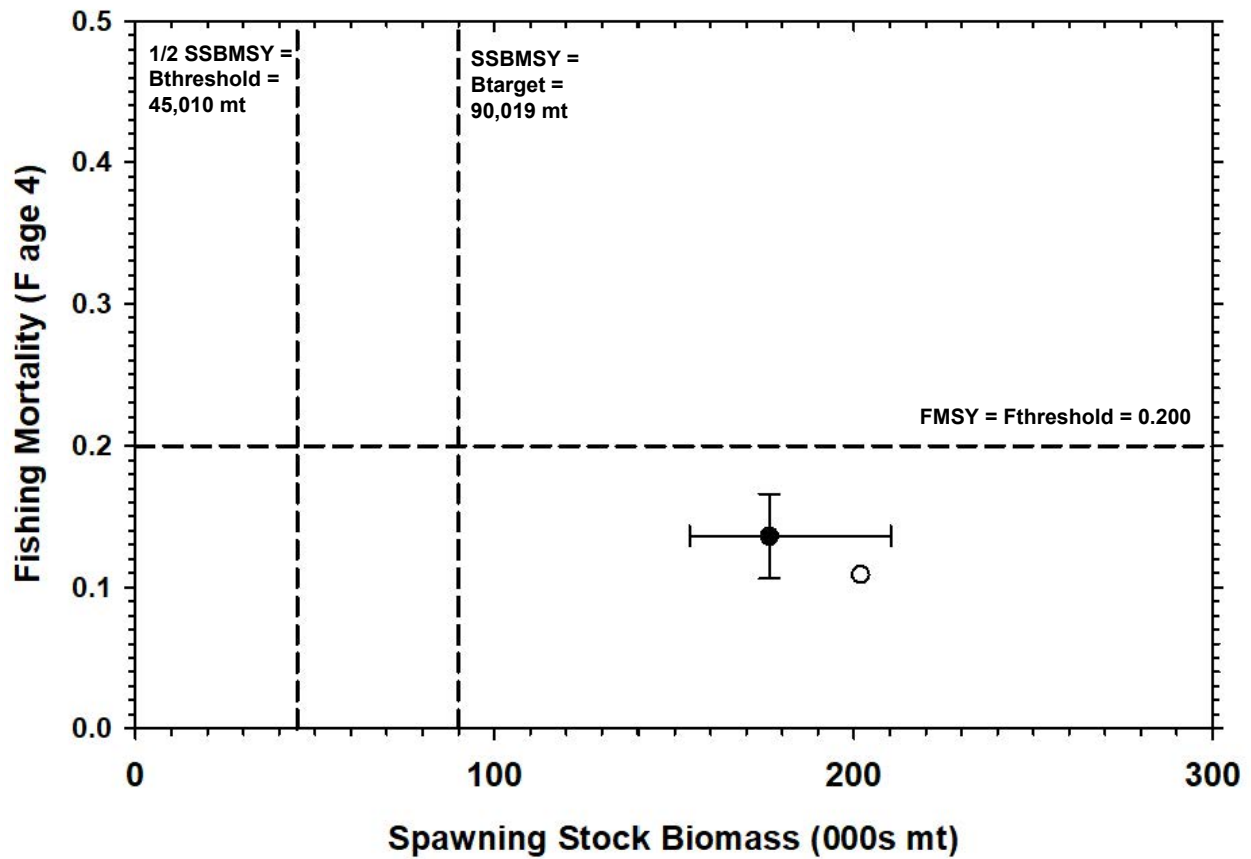


Figure 1. Estimates of scup spawning stock biomass (SSB) and fully-recruited fishing mortality (F, peak at age 3) relative to the updated biological reference points. Filled circle with 90% confidence intervals shows the assessment point estimates. The open circle shows the retrospectively adjusted estimates.

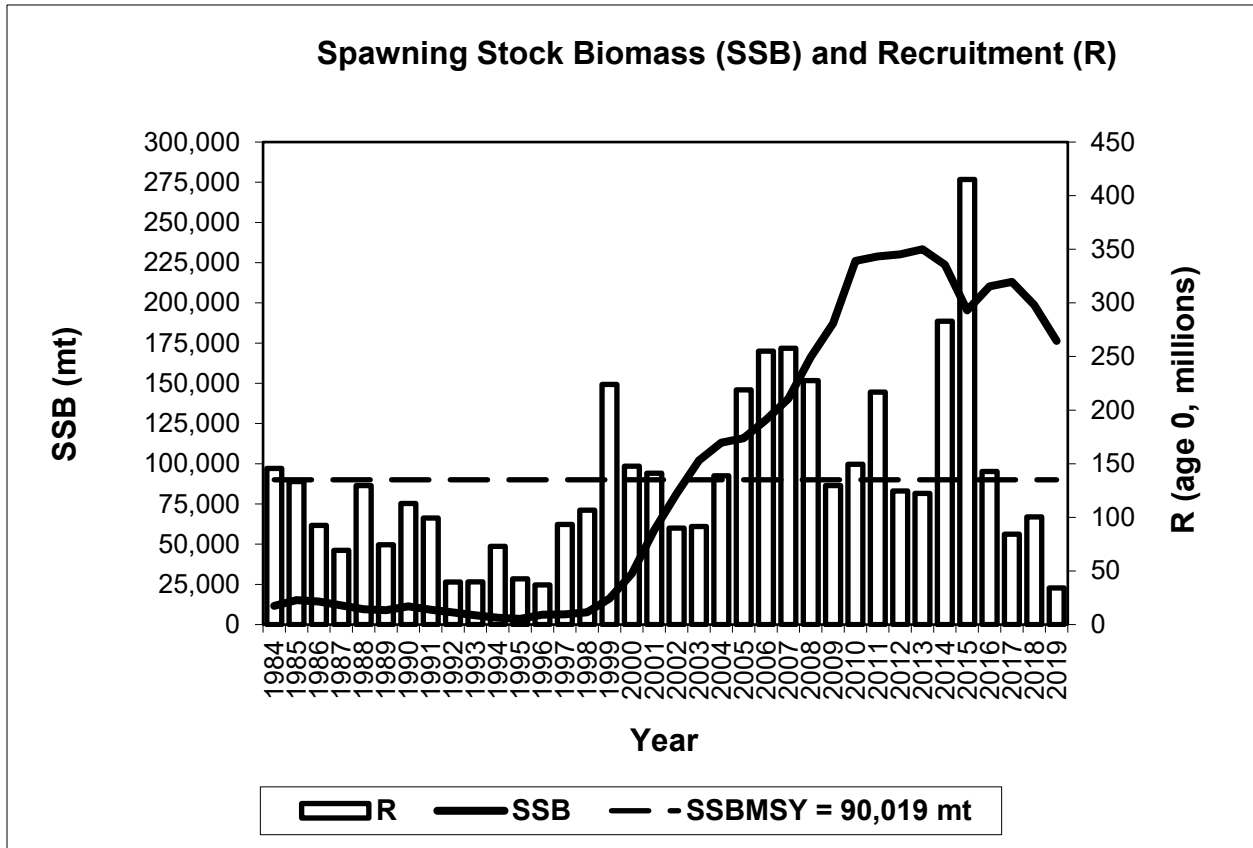


Figure 2. Scup spawning stock biomass (SSB; solid line) and recruitment at age 0 (R; vertical bars) by calendar year. The horizontal dashed line is the updated SSB<sub>MSY</sub> proxy = SSB<sub>40%</sub>. Note this figure only shows years when fishery age data are available in the model.

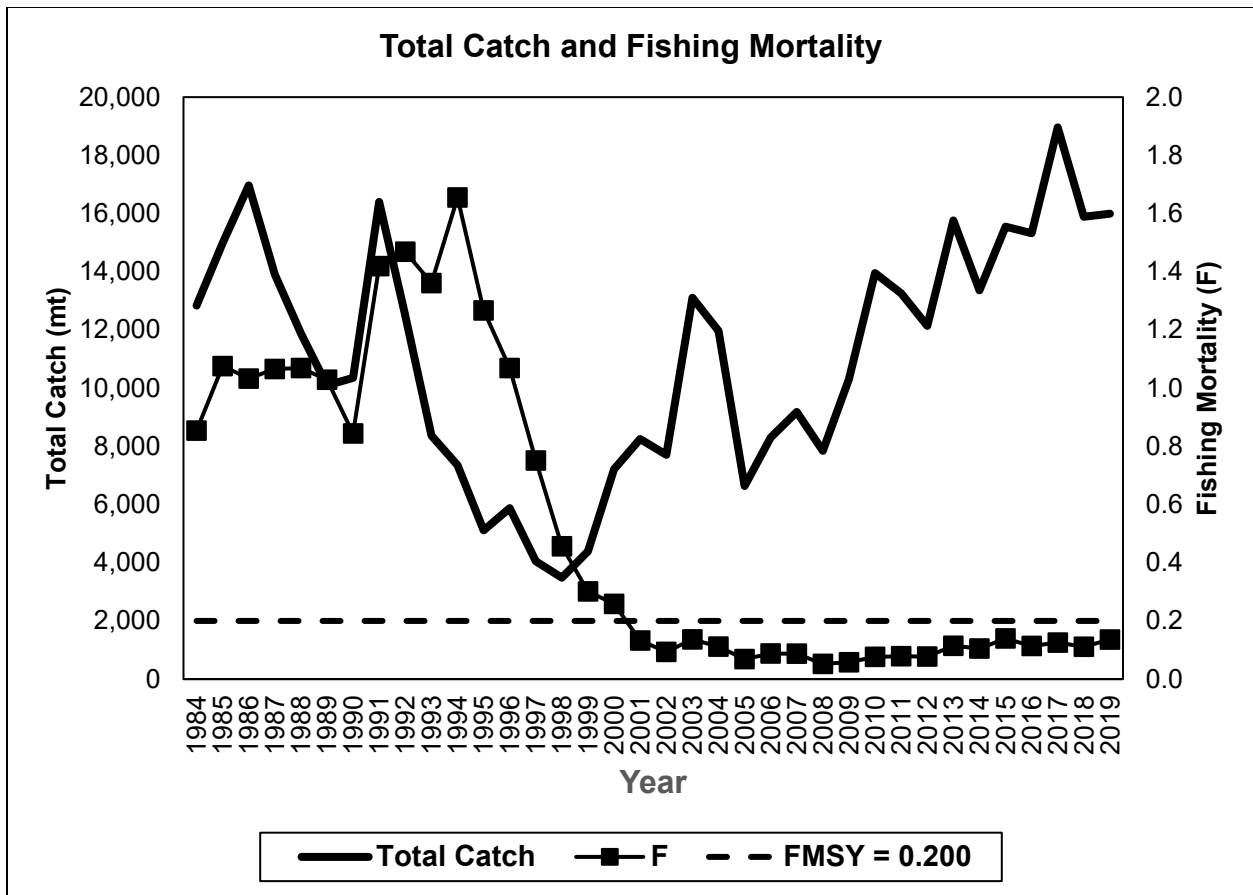


Figure 3. Total fishery catch (metric tons; mt; solid line) and fishing mortality (F, age 4 squares) for scup. The horizontal dashed line is the updated  $F_{MSY}$  proxy =  $F_{40\%}$ . Note this figure only shows years when fishery age data are available in the model.

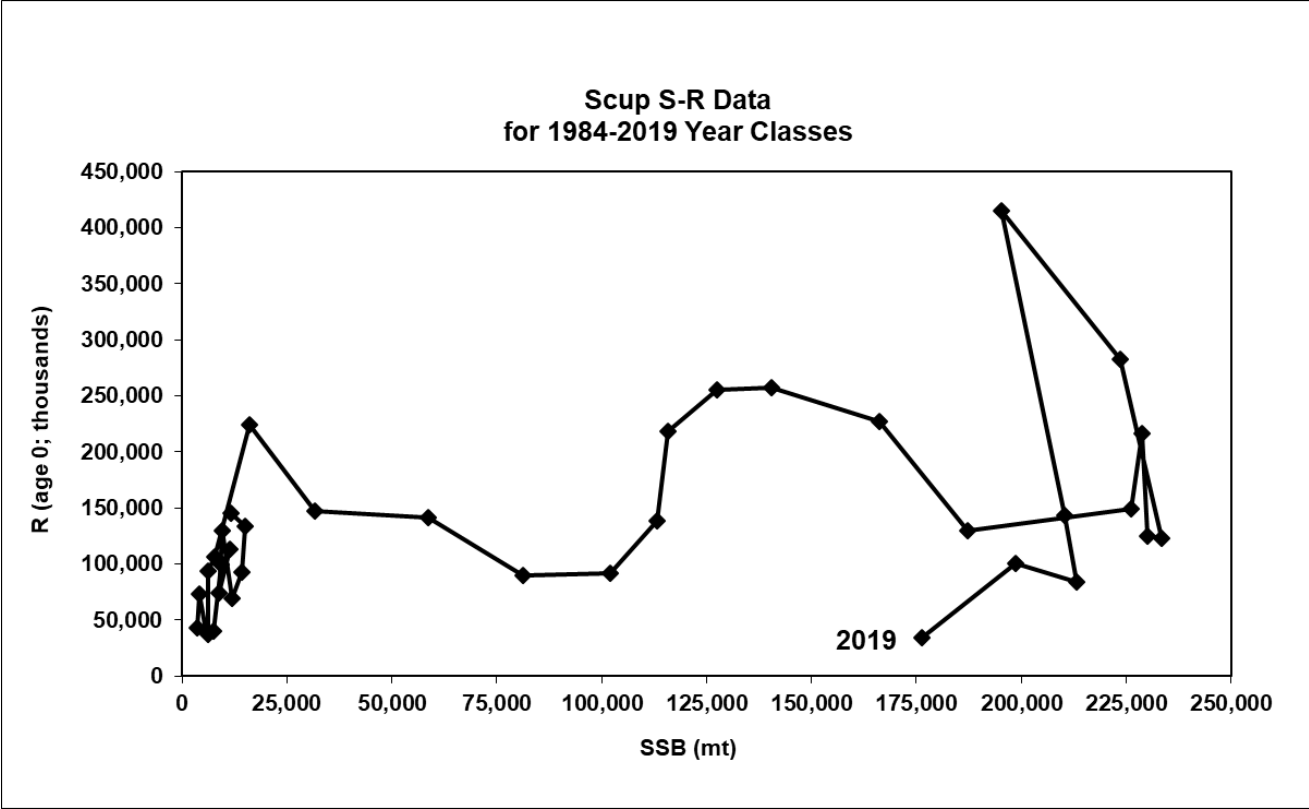


Figure 4. Spawning Stock Biomass (SSB) and Recruitment (R) scatter plot for scup. Note this figure only shows years when fishery age data are available in the model.

### Scup Historical Retrospective 2008-2021 Stock Assessments

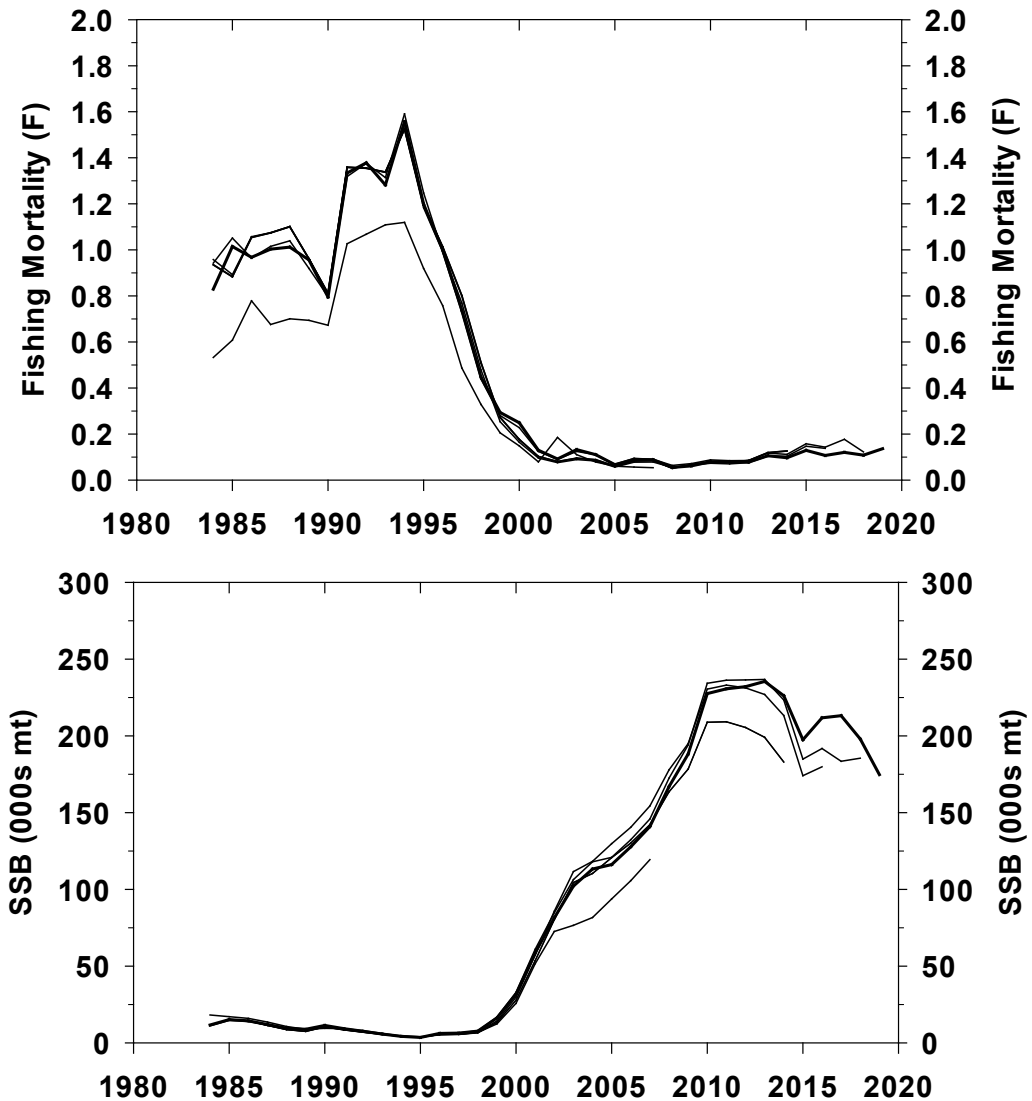


Figure 5. Historical retrospective of the 2008 (Data Poor Stocks; NEFSC 2009), 2015 (SAW 60; NEFSC 2015), 2017 (NEFSC unpublished report) and 2019 (Operational Assessment; NEFSC 2020) stock assessments of scup. The heavy solid lines are the current 2021 MTA estimates.