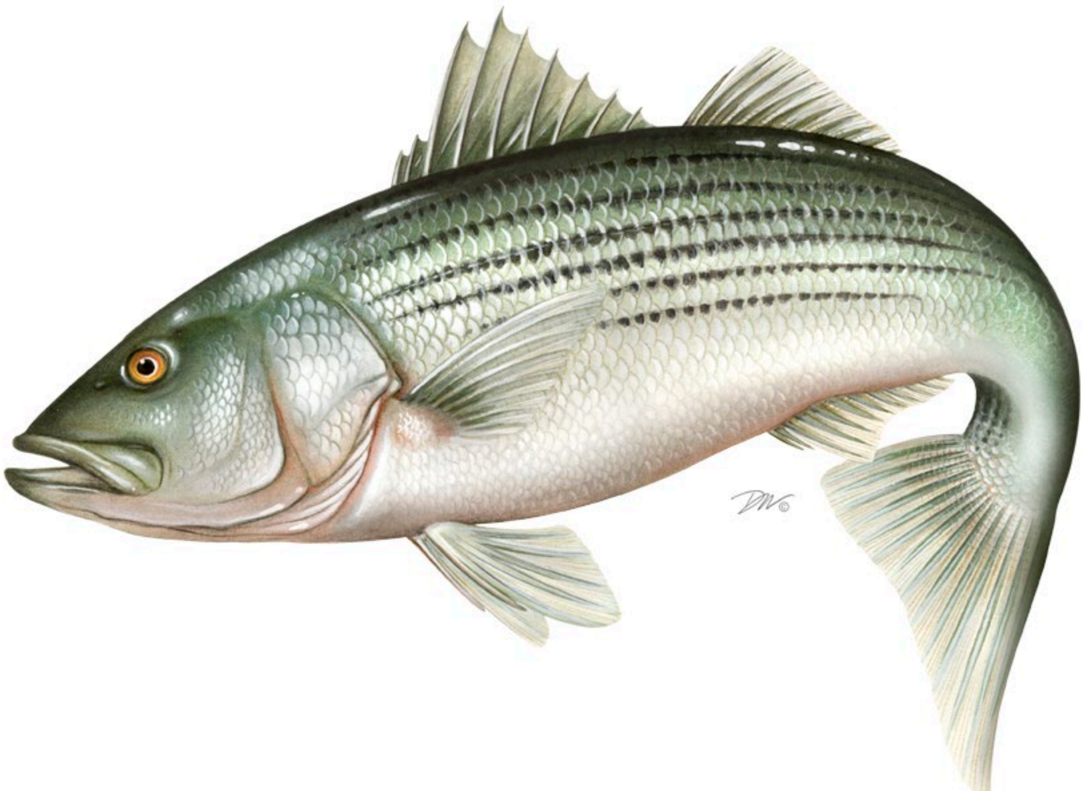
Atlantic States Marine Fisheries Commission

2022 Atlantic Striped Bass Stock Assessment Update Report



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Atlantic States Marine Fisheries Commission

Atlantic Striped Bass Stock Assessment Update

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EXECUTIVE SUMMARY

The time series of striped bass removals and indices from the 2018 benchmark assessment was updated to include data from 2018-2021. Total removals from 2018-2021 averaged 5.37 million fish annually, a 24% decrease from 2017, the terminal year of the last assessment when the stock was experiencing overfishing. From 2018-2021, recreational release mortality made up 50% of total removals, with recreational harvest making up 37%, commercial harvest making up 11%, and commercial discards making up 2% of the total.

COVID-19 affected fishery-dependent and fishery-independent sampling for state surveys and the MRIP dockside intercept program, although the level of impact varied from state to state. The assessment model was able to accommodate the missing index data, but overall, COVID-19 increased uncertainty in the 2020 and 2021 data.

The single-stock statistical catch-at-age (SCA) model was updated through 2021. The model parameterization was the same as in the benchmark assessment, with the exception of a new selectivity block from 2020-2021 in the Bay and Ocean fleets, to account for the regulation changes from Addendum VI. Sensitivity runs were conducted to look at the effect of only including a new selectivity block in the Ocean fleet and the effect of not including any new selectivity blocks.

Because the recruitment trigger in Amendment 7 was tripped in 2021 for the Maryland juvenile abundance index, the biological reference points were updated using the low recruitment regime assumption. This resulted in a lower *F* target and *F* threshold compared to the benchmark assessment.

In 2021, the Atlantic striped bass stock was overfished but was not experiencing overfishing. Female spawning stock biomass 2021 was estimated at 64,805 metric tons (143 million pounds) which is below the updated SSB threshold of 85,457 metric tons (188 million pounds), and below the updated SSB target of 106,820 metric tons (235 million pounds). Total fishing mortality in 2021 was estimated at 0.14 which is below the updated *F* threshold of 0.20 per year, and below the updated *F* target of 0.17 per year.

The sensitivity run with the new selectivity block for the Ocean fleet only produced very similar results to the base run, while the sensitivity run with no new selectivity blocks produced higher estimates of *F* and lower estimates of SSB in 2020-2021. However, stock status was the same for all three runs.

The retrospective pattern remained moderate to low in magnitude for the assessment update, but reversed direction compared to the benchmark; the model underestimated *F* and overestimated SSB in the most recent peels. The retrospective-adjusted estimates of *F* and SSB were within the 90% confidence intervals of the unadjusted estimates, so correcting for retrospective pattern was not necessary for status determination or projections.

Projections were run to determine the probability of SSB being at or above the SSB target by 2029, the rebuilding deadline. Under the current *F*, there is a 78.6% chance the stock will be rebuilt by 2029, indicating a reduction in catch is not necessary at this time.

The sensitivity run with a new selectivity block in the Ocean fleet only produced very similar results to the base model, but the run with no new selectivity blocks was more pessimistic about rebuilding, requiring an 8.6% reduction in removals to have a 50% chance of being at or above the SSB target in 2029. However, there was a greater than 50% chance of being above the SSB threshold by 2029 for all three runs.

	Target	Threshold	2021 Value	Status
Fishing Mortality	0.17	0.20	0.14	Not overfishing
Female SSB	106,820 mt (235 million lbs)	85,457 mt (188 million lbs)	64,805 mt (143 million lbs)	Overfished

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TERMS OF REFERENCE (TOR)

TOR 1. Update fishery-dependent data (landings, discards, catch-at-age, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

The time series of striped bass recreational and commercial removals from the 2018 benchmark assessment (NEFSC 2019) was updated to include data from 2018-2021. This included recreational harvest, recreational release mortalities, commercial harvest, and commercial discards.

Total removals from 2018-2021 averaged 5.37 million fish annually, a 24% decrease from 2017, the terminal year of the last assessment when the stock was experiencing overfishing (Table 1, Figure 2). Approximately 62% of the removals came from the ocean fleet over that time period, while 38% came from the Chesapeake Bay fleet, consistent with the overall percentages for the whole time series (Table 1, Figure 1).

From 2018-2021, recreational release mortality made up 50% of total removals, with recreational harvest making up 37% and commercial harvest making of 11% of the total (Figure 2). Commercial dead discards made up approximately 2% of the total removals.

COVID-19 had an impact on fishery-dependent data collection during 2020. Biological sampling levels for the recreational and commercial fisheries were reduced, which increased uncertainty somewhat in the catch-at-age for both fisheries. The MRIP effort survey continued uninterrupted, but the Access Point Angler Intercept Survey (APAIS) was suspended for part of 2020. Data from 2018 and 2019 were used to impute total recreational catch rates for 2020 where necessary. Overall, 29% of recreational harvest rate information and 15% of released alive rate information was attributed to imputed catch data for 2020 (Table 2). The percentage of imputed information in 2020 recreational catch rates varied from state to state, depending on the length of time that APAIS was suspended. Although COVID likely affected the overall harvest from the commercial fishery, it did not significantly impact reporting the catch.

The MRIP CPUE index of abundance was updated with data through 2021. The index was developed using the same species associations identified in the previous benchmark. Imputed records were excluded from the intercept data pull for 2020. The index declined somewhat from 2018-2021.

TOR 2. Update fishery-independent data (abundance indices, age-length data, etc.) that were used in the previous peer-reviewed and accepted benchmark stock assessment.

Where possible, the fishery independent age-1+ and recruitment indices used in the most recent benchmark assessment (Table 3) were updated through 2021. Several surveys were impacted by COVID and other issues in the most recent years (Table 4 and Table 5).

The assessment used seven fishery independent indices of age-1+ abundance: the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), the Maryland Spawning

Stock Survey (MDSSN), the Delaware Spawning Stock Electrofishing Survey (DESSN), the Delaware 30' Bottom Trawl Survey (DE30), the New York Ocean Haul Seine (NYOHS), the New Jersey Bottom Trawl Survey (NJTRL), and the Connecticut Long Island Sound Trawl Survey (CT LISTS). The NJ Trawl did not operate from 2019-2021 due to COVID and vessel issues. ChesMMAP changed vessels in 2018 and the calibration process has not been finished, so calibrated estimates were not available for 2019-2021 in time for this update. The DE SSN and CT LIST surveys did not operate in 2020 due to COVID. The MD SSN was interrupted for two weeks in 2021 due to COVID. Age-1+ surveys with data through 2021 showed mixed trends, with some surveys increasing since 2017 and some decreasing (Figure 3).

The assessment uses four age-0 juvenile abundance indices (JAI) and two age-1 indices as recruitment indices: the MD, VA, NJ, and NY JAIs and the MD and NY age-1 indices. The MD and VA JAIs were combined into a single composite JAI for Chesapeake Bay using the Conn (2010) method. The NJ JAI was the only survey that did not occur in 2020 due to COVID, although the start of the NY Age-1 survey was delayed. 2018 values indicated a strong year class in most indices, but 2021 was generally low (Figure 4 and Figure 5). The MD JAI tripped the recruitment trigger in 2021, with three consecutive years below the Amendment 7 recruitment threshold.

TOR 3. Tabulate or list the life history information used in the assessment and/or model parameterization (M, age plus group, start year, maturity, sex ratio, etc.) and note any differences (e.g., new selectivity block, revised M value) from benchmark.

Model equations are shown in Appendix 1 Table 1. The model parameterization was the same as used in the benchmark assessment (NEFSC 2019), with the exception of a new selectivity block from 2020-2021 in the Bay and Ocean fleets, to account for the regulation changes from Addendum VI (Table 6). In initial runs, the exponential-logistic and double-logistic selectivity equations were used to explore if the selectivity during 2020-2021 changed to dome-shaped due to changes in size-limits, particularly in the Ocean. Initial results showed that the 2020-2021 selectivity pattern in the Bay remained dome-shaped, and the 2020-2021 selectivity pattern in the Ocean remained flat-topped. Therefore, the exponential-logistic and Gompertz functions were used to model selectivity for 2020-2021.

Re-weighting of survey indices was required with the addition of four years of removal data and missing index data for several surveys. Survey CVs were adjusted to bring the RMSE close to one and effective sample sizes were adjusted once by using the Francis multipliers (Francis 2011). The RMSEs, CV weights and effective samples from the 2018 benchmark and 2022 assessment models are given in Table 2 in Appendix 1. The largest change in CV weight occurred for the NJ Trawl survey, where the correct CV time series was substituted for the incorrect values input in the benchmark.

No changes were made to the life history information used in the assessment (Table 7).

TOR 4. Update accepted model(s) or trend analyses and estimate uncertainty. Include sensitivity runs and retrospective analysis if possible and compare with the benchmark assessment results. Include bridge runs to sequentially document each change from the previously accepted model to the updated model.

Model Fit

The model fit the observed total catches and catch age compositions of all fleets well (Appendix 2). The model fit the MDYOY (1970-1981) and MD & VA composite indices very well and the MD Age1, NYOHS, and MDSSN poorly. It fit the other indices reasonably well (Appendix 2).
The predicted trends matched the observed trends in age composition of survey indices reasonably well for NYOHS, MDSSN, MRIP, CTLIST, and ChesMMAP. The model fit the age composition of NJTrawl, DESSN, and DE30FT survey adequately. Resulting contributions to total likelihood are listed in Table 3 of Appendix 1. Estimates of fully-recruited fishing mortality for each fleet and total fishing mortality, recruitment, parameters of the selectivity functions for the selectivity periods, catchability coefficients for all surveys, and parameters of the survey selectivity functions are given in Table 4 of Appendix 1.

Estimates of the catch selectivity patterns for each fleet showed that, although the patterns varied over time with changes in regulation, selectivity was dome-shaped for Chesapeake Bay and primarily flat-topped for the Ocean over time (Figure 6). There was a steep shift in the descending limb of the selectivity pattern in 2020-2021 for Chesapeake Bay compared to the previous selectivity block, and a shift in the selectivity in 2020-2021 for the Ocean to lower ages (Figure 6).

Fishing Mortality

Fully-recruited annual fishing mortality in 2021 for the Bay and Ocean was 0.05 and 0.10 (Figure 7), and peaked at ages 6 and 10-15, respectively. Total fully-recruited *F* in 2021 was 0.14 (Table 8, Figure 7) and peaked at age 6. Coefficients of variation indicated region-specific and total fishing mortality estimates were precise (CVs mostly less than 0.20) (Table 4 of Appendix 1).

Recruitment

Recruit numbers increased steadily through 1993 (Figure 8). Large recruitment events occurred in 1994, 1997, 2002, and 2004 as the large Chesapeake Bay 1993, 1996, 2001 and 2003 year-classes became age-1. Average to below-average year-classes were produced during 2004-2010, which resulted in a decline of age-1 numbers. Subsequently, strong year-classes were produced in 2011 and 2015. After 2016, recruit abundance fluctuated slightly and has averaged 123.5 million fish (Table 8, Figure 8). Four of the last five year-classes since 2015 have been below average, although not as low as the levels seen from 2004-2010; the 2018 year-class was above average (Table 8, Figure 8). The below-average 2020 and 2021 recruits will start contributing to SSB in 2027 and 2028 as those fish approach full maturity.

Population Abundance (January 1)

Striped bass abundance (1+) increased steadily from 1982 through 1997 when it peaked around 422.4 million fish (Table 8, Figure 9). Total abundance fluctuated without trend through 2004. From 2005-2009, age 1+ abundance declined to about 181.2 million fish. Thereafter, total abundance peaked in 2012 and 2016 as a result of two large year-classes (2011 and 2015) entering the age-1+ population (Table 8, Figure 9). From 2017-2019, total abundance averaged 243.3 million fish. Abundance declined slightly through 2021 to 218.9 million fish (Figure 9).

Abundance of striped bass age 8+ increased steadily through 2004 to 16.6 million fish, but then declined to 11.4 million fish through 2010 (Table 8, Figure 9). A small increase in 8+ abundance occurred in 2011 as the 2003 year-class became age 8 (Table 8, Figure 9). Abundance of age 8+ fish declined steadily through 2018 but has increased recently to an average of 6.7 million fish as the 2011 aged recruited to the age-8+ group (Table 8, Figure 9).

Spawning Stock Biomass and Total Biomass

Female SSB grew steadily from 1982 through 2003 when it peaked at about 113,000 metric tons (Table 8, Figure 10). Female SSB declined steadily from 104,749 metric tons in 2010 to 55,120 metric tons in 2018, but in recent years, has steadily increased (Table 8, Figure 10). Estimates of female spawning stock biomass were very precise (CVs less than 0.14; Table 10 of Appendix 1).

Exploitable biomass (January 1) increased from 36,985 metric tons in 1982 to its peak at 333,000 metric tons in 1999 but declined steadily through 2015 (Figure 10). Since 2016, exploitable biomass steadily increased albeit at a slow pace.

Retrospective Analysis

Moderate retrospective patterning (<15%) was evident in the more recent estimates of fully-recruited total *F* and female SSB (Figure 11). The retrospective pattern suggested that fishing mortality is likely slightly under-estimated (<12%) and female spawning biomass is over-estimated by 5-17%. Recruitment appeared to be over-estimated in most years, although underestimation did occur in a few years (Figure 11). The Mohn's rho values for fishing mortality, female SSB and recruitment were estimated to be -0.087, 0.103 and 0.156, respectively.

The current retrospective trends are different from what was observed in the 2018 benchmark and earlier assessments (NEFSC 2019). The past retrospective patterns showed that female SSB was typically under-estimated and fishing mortality was over-estimated. Exploratory analyses indicated that the change was due, in part, to the addition of new data and changes in index weighting. When the index CV weightings from the 2018 benchmark assessment was used in the current assessment, the past retrospective pattern was reproduced through the 2016 peel and then changed to what is observed currently, albeit at a lower level of percent difference (Appendix 1).

Sensitivity Runs

The NY Age-1 seine survey and MD SSN survey were completed in all years, but the timing of each was affected by the COVID pandemic: the NY Age-1 survey started later than usual in 2020 and the MD SSN survey was suspended for two weeks in 2021. To determine if these potentially biased values influenced the results of the assessment, a run was made in which those index values were coded as missing. Comparison of results (Figure 12) showed that the missing values had little influence on the time series of *F* and SSB estimates.

Two additional runs were made to explore the influence of using the new selectivity blocks in 2020-2021. One run was made in which a new 2020-2021 selectivity block was created only for the Ocean region and a second was made in which no new selectivity periods were created. Full results and diagnostics for these sensitivity runs are presented in Appendix 3 and 4.

Comparison of residual plots, particularly for the fleet age composition, showed that the base run produced the smallest residuals in 2020-2021 (Appendices 2-4). Based on Mohn's rho, the base model had the lowest retrospective pattern (*F*=-0.087; SSB=0.103) compared to the Ocean only run (*F*=-0.094; SSB=0.121) and the no new selectivity blocks run (*F*=-0.107; SSB=0.177).

The run with the new selectivity for the Ocean fleet only produced very similar results to the base run, but the run with no new selectivity blocks produced higher estimates of *F* and lower estimates of SSB in 2020-2021 (Figure 13).

Comparison of Results from the 2018 Benchmark Assessment with 2022 Update Assessment

Fully-recruited fishing mortality and female spawning stock biomass estimates from the update and benchmarks assessments are shown in Figure 14. The updated assessment produced higher estimates of fishing mortality in 2012-2017 and lower estimates of female spawning stock biomass from 1992-2001 and 2012-2017.

TOR 5. Update the biological reference points or trend-based indicators/metrics for the stock. Determine stock status.

The fishing mortality and spawning stock biomass reference points were updated using the same methods as the benchmark assessment (NEFSC 2019). The spawning stock biomass threshold is the 1995 estimate of SSB from the current assessment and the SSB target is 125% of the threshold. Using a stochastic projection drawing recruitment from empirical estimates and a distribution of starting population abundance at age, fishing mortalities associated with the SSB target and threshold were determined. Empirical estimates of recruitment, selectivity, and the starting population came from the SCA model results. The selectivity pattern used in the projections was calculated as the geometric mean of the 2020-2021 total *F*-at-age, scaled to the highest *F*-at-age (Figure 15). Estimates of recruitment were restricted to 2008-2021 to represent the "low" recruitment regime. The population was projected for 100 years and fully-recruited F was adjusted until the median of the projected SSB reached the SSB target or threshold.

The updated SSB reference points and associated fishing mortalities are:

$SSB_{threshold}$ = 85,457 metric tons	**$F_{threshold}$ = 0.20**
SSB_{target} = 106,820 metric tons	**F_{target} = 0.17**

Status of the Stock

Before stock status can proceed, analyses must be done to determine if the estimates of F and SSB in 2021 should be corrected for the apparent pattern observed in the retrospective analyses. Here we used the National Marine Fisheries Service standard procedure in which the estimates are adjusted for the retrospective pattern using Mohn's rho values (average of proportion differences over seven-year peels) and then compared to the unadjusted estimates and their associated 90% confidence intervals. If either retrospective-adjusted value falls outside an unadjusted value's 90% confidence intervals, then the retrospective-adjusted values are used. If not, the unadjusted values are sufficient for stock determination. Figure 16 shows a bivariate plot of the unadjusted estimates and their associated 90% confidence interval along with the retrospective-adjusted values. Because the retrospective-adjusted values fall within the 90% confidence intervals, retrospective adjustment is not needed.

In 2021, the Atlantic striped bass stock was overfished but was not experiencing overfishing based on the point estimates of fully-recruited fishing mortality and female spawning stock biomass relative to the reference points defined in this assessment. Female spawning stock biomass in 2021 was estimated at 64,805 metric tons (143 million pounds) which is below the SSB threshold of 85,457 metric tons (188 million pounds), and below the SSB target of 106,820 metric tons (235 million pounds) (Table 9, Figure 17). However, because of error associated with these estimates, there is a 0.9% probability that the 2021 female SSB estimate is above or equal to the SSB threshold and a 0% probability that the 2021 estimate is above the target.

Total fishing mortality in 2021 was estimated at 0.14 which is below the *F* threshold of 0.20 and the *F* target of 0.17 (Table 9, Figure 17). There is a 99.6% probability that the 2021 fully-recruited fishing mortality is below the fishing mortality threshold, and a 91% probability that the value is below the F target.

Although the estimate of *F* in 2021 was higher for the sensitivity run with no new selectivity blocks, stock status was the same for all three sensitivity runs: overfishing was not occurring and the stock was overfished.

TOR 6. Conduct short term projections when appropriate. Discuss assumptions if different from the benchmark and describe alternate runs.

Three scenarios were run to determine when female SSB is expected to reach the SSB target under the "low" recruitment regime. In the first run, the population was projected over ten years assuming the *F* observed in 2021 (0.14) was the same in 2022-2030. In the second and third runs, the population was projected assuming fishing mortality in 2022-2030 was equal to *F* associated with the *F* target and *F* threshold values. Because the retrospective adjusted values of *F* and SSB fell within the 90% confidence intervals of the unadjusted estimates, retrospective-adjustment was not needed.

The projections used the same methods as the benchmark assessment (NEFSC 2019). For each scenario, the model begins in year 2021 with the estimates of January-1 abundance-at-age and associated standard errors from the SCA assessment model. The fully-recruited *F* estimate and associated standard errors in 2021 (F=0.14), selectivity-at-age in 2021, Rivard weights in 2021, natural mortality, female sex proportions-at-age, and female maturity-at-age are used to calculate female SSB as modeled in the SCA model. For 2022, the January-1 abundance-at-age is calculated from the known values of 2021 abundance-at-age, 2021 selectivity and fully-recruited F for 2021. For the remaining years, the January-1 abundance-at-age is projected and is calculated by using the previous year's abundance-at-age, the scenario fully-recruited F, and natural mortality following the standard exponential decay model. Female spawning stock biomass is calculated using the average Rivard weights-at-age from 2017-2021 along with proportion of female by age and maturity-at-age.

For each iteration of the simulation, the abundance and fishing mortality-at-age values in 2021 are randomly drawn from a normal distribution parameterized with the associated standard errors from the SCA assessment model. For the remaining years, abundance of age-1 recruits is randomly drawn from 2008-2021 recruitment estimates. An age-15 plus-group is assumed. For years 2022-2030, selectivity-at-age is assumed equal to the geometric mean selectivity for years 2020-2021. Female spawning stock biomass was calculated by using geometric mean Rivard weight estimates from 2017-2021, sex proportions-at-age, and female maturity-at-age. For each year of the projection, the probability of SSB being above the SSB target and threshold reference points was calculated from 10,000 simulations using function *pgen* in R package *fishmethods*.

Results

Under current fully-recruited fishing mortality (*F*=0.14), female SSB is expected to reach or exceed the SSB threshold by 2023 with a probability of 70.2%, and exceed or reach the SSB target by 2025 with a probability of 56.1% (Table 10, Figure 18). By the rebuilding deadline of 2029, there is a 78.6% chance the stock will be at or above the SSB target and a 96.7% chance the stock will be at or above the SSB threshold. Under *F* target (*F*=0.17), female SSB is expected to reach or exceed the SSB threshold by 2023 with a probability of 61.9%, and exceed or reach the SSB target by 2028 with a probability of 52.0% (Table 10, Figure 18). Under *F* threshold (*F*=0.20), female SSB is expected to reach or exceed the SSB threshold by 2023 with a probability of 53.2%, but has a less than 50% probability of reaching the SSB target in any year (Table 10, Figure 18).

The sensitivity run with a new selectivity block in the Ocean fleet only produced very similar results to the base model, but the run with no new selectivity blocks was more pessimistic about rebuilding, with the stock having a less than 20% chance of rebuilding under current *F* by 2029 (Appendix 4). An 8.6% reduction in removals would be required to have a 50% chance of being at or above the SSB target in 2029 under that model configuration. However, the stock did have a greater than 50% chance of being above the SSB threshold by 2029 in all three runs.

TOR 7. Comment on research recommendations from the benchmark stock assessment and note which have been addressed or initiated. Indicate which improvements should be made before the stock undergoes a benchmark assessment.

The research recommendations identified in the benchmark assessment (NEFSC 2019) remain relevant, particularly the research recommendations on enhanced collection of life history and biological information including paired scale-otolith samples, migration rates, and sex ratio data. Additional work on refining migration rates and stock composition estimates as well as incorporating tagging data into the spatial statistical catch-at-age model will be required before the next benchmark assessment.

Literature Cited

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List of Appendices (which can be found here)

Appendix 1: Model structure and detailed results for the base model run.

Appendix 2. Diagnostic plots for the base model in which new 2020-2021 selectivity blocks were added for the Bay and Ocean regions.

Appendix 3. Diagnostic plots and results for a model run in which a new 2020-2021 selectivity block was added for the Ocean region only.

Appendix 4. Diagnostic plots and results from the SCA model with no new selectivity blocks added to the model.

TABLES

Table 1. Total removals by fleet in numbers of fish

Year	Bay Fleet	Ocean Fleet	Total Removals
1982	229,161	677,600	906,761
1983	339,515	709,879	1,049,394
1984	479,009	357,555	836,564
1985	48,686	853,917	902,603
1986	100,649	307,312	407,961
1987	44,939	231,939	276,878
1988	124,365	332,720	457,085
1989	85,092	521,339	606,431
1990	663,884	574,713	1,238,597
1991	790,833	927,478	1,718,311
1992	986,955	1,243,234	2,230,189
1993	941,415	1,088,947	2,030,362
1994	1,326,775	1,585,122	2,911,897
1995	1,978,738	3,049,239	5,027,977
1996	2,514,266	3,749,942	6,264,208
1997	3,166,575	4,214,559	7,381,134
1998	2,949,332	4,961,986	7,911,318
1999	3,195,145	4,867,163	8,062,308
2000	3,432,148	4,955,360	8,387,508
2001	2,586,938	5,184,845	7,771,783
2002	2,673,581	5,513,147	8,186,728
2003	3,333,975	5,528,236	8,862,211
2004	3,327,387	6,195,000	9,522,387
2005	2,971,213	6,137,340	9,108,553
2006	4,083,679	6,983,996	11,067,675
2007	3,162,774	5,132,018	8,294,792
2008	2,630,471	5,592,223	8,222,694
2009	3,151,161	4,880,287	8,031,448
2010	2,936,586	5,433,285	8,369,871
2011	2,520,001	5,037,736	7,557,737
2012	2,671,307	4,411,580	7,082,887
2013	2,752,138	5,754,205	8,506,343
2014	3,231,424	3,839,183	7,070,607
2015	2,788,075	3,315,477	6,103,552
2016	3,589,860	3,601,305	7,191,165
2017	2,495,418	4,553,797	7,049,215
2018	2,367,605	3,420,077	5,787,682
2019	2,114,336	3,344,764	5,459,100
2020	2,006,072	3,080,791	5,086,863
2021	1,633,797	3,510,737	5,144,534

Table 2. Contribution of imputed data to 2020 MRIP catch rate estimates by state. Imputed data were 2018 and 2019 intercepts that were used to supplement 2020 APAIS data in strata that were under-sampled due to COVID-19.

State	Harvest Rate (A+B1)	Released Alive Rate (B2)
Maine	0%	0%
New Hampshire	15%	7%
Massachusetts	3%	3%
Rhode Island	0%	13%
Connecticut	77%	56%
New York	53%	9%
New Jersey	51%	32%
Delaware	49%	13%
Maryland	9%	7%
Virginia	7%	36%
North Carolina (ocean only)	--	72%
Coastwide	29%	15%

Table 3. **Summary of indices used in the striped bass stock assessment model.**

Index Name	Index Metric	Design	Time of Year	Years	Age
MRIP Total Catch Rate Index	Total catch per unit effort	Stratified random	Mar-Dec	1982-2021	1+
Connecticut Long Island Sound Trawl Survey (CTLISTS)	Mean number per tow	Stratified random	Apr-Jun	1984-2021	1+
New York Ocean Haul Seine (NYOHS)	Geometric mean per haul	Fixed station	Sep-Oct	1987-2006	1+
New York Young-of-the-Year (NYYOY)	Geometric mean per haul	Fixed station	Jul-Nov	1985-2021	YOY
New York Western Long Island Beach Seine Survey (NY Age-1)	Geometric mean per haul	Fixed station	May-Aug	1984-2021	1
New Jersey Bottom Trawl Survey (NJTRL)	Stratified mean per tow	Stratified random	April	1990-2018	1+
New Jersey Young-of-the-Year Survey (NJYOY)	Geometric mean per haul	Fixed station	Aug-Oct	1982-2021	YOY
Delaware Spawning Stock Electrofishing Survey (DESSN)	Geometric mean per tow	Fixed station	Apr-Jun	1996-2021	1+
Delaware 30’ Bottom Trawl Survey (DE30)	Geometric mean per tow	Fixed station	Nov-Dec	1990-2021	1+
Maryland Spawning Stock Survey (MDSSN)	Selectivity-corrected CPUE	Stratified random	Mar-May	1985-2021	1+
Maryland Young-of-the-Year and Yearlings Surveys (MDYOY and MD Age-1)	Geometric mean per haul	Fixed station	Jul-Sep	1954-2021	0-1
Virginia Young-of-the-Year Survey (VAYOY)	Geometric mean per haul	Fixed station	Jul-Sep	1980-2021	YOY
Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP)	Stratified mean per tow	Stratified random	Mar-Nov	2002-2018	1+

Table 4. Status of age-1+ striped bass surveys from 2018-2021. Empty cells indicate the survey occurred without interruption.

Year	CT LISTS	NJ TRL	DE SSN	DE 30'	MD SSN	ChesMMAP
2018						
2019		Did not occur				Unavailable
2020	Did not occur	Did not occur	Did not occur			Unavailable
2021		Did not occur			Delayed	Unavailable

Table 5. Status of striped bass recruitment surveys from 2018-2021. Empty cells indicate the survey occurred without interruption.

Year	NY JAI	NY Age-1	NJ JAI	MD JAI	MD Age-1	VA JAI
2018						
2019						
2020		Interrupted	Did not occur			
2021						

Table 6. Model structure summary for the 2021 striped bass update.

Value(s)	
Years in Model	1982-2021
Size/Age Plus Group	15+
Fleets	2 (Bay and Ocean)
Selectivity blocks	Bay fleet: 1982-1984, 1985-1989, 1990-1995, 1996-2019, 2020-2021 Ocean fleet: 1982-1984, 1985-1989, 1990-1996, 1997-2019, 2020-2021

Table 7. Striped bass life history information used in the 2021 stock assessment update.

Age	Proportion Mature	Proportion Female	Natural Mortality
1	0	0.53	1.13
2	0	0.56	0.68
3	0	0.56	0.45
4	0.09	0.52	0.33
5	0.32	0.57	0.25
6	0.45	0.65	0.19
7	0.84	0.73	0.15
8	0.89	0.81	0.15
9	1	0.88	0.15
10	1	0.92	0.15
11	1	0.95	0.15
12	1	0.97	0.15
13	1	1	0.15
14	1	1	0.15
15+	1	1	0.15

Table 8. **Population estimates from the 2021 striped bass assessment update.**

Year	Full *F*	Recruitment (millions of age-1 fish)	Female SSB (mt)	Total Abundance (millions of fish)	Age 8+ Abundance (millions of fish)
1982	0.17	36.2	18,498	54.5	1.7
1983	0.14	70.1	15,614	92.4	1.5
1984	0.07	60.5	15,783	95.8	1.3
1985	0.19	66.8	16,452	106.2	1.5
1986	0.05	64.5	14,838	109.0	1.7
1987	0.03	71.2	18,247	118.9	2.0
1988	0.04	92.5	24,125	145.2	2.5
1989	0.05	104.6	36,060	167.5	3.3
1990	0.07	128.3	42,017	201.1	5.3
1991	0.09	100.6	49,377	186.7	6.5
1992	0.11	106.0	62,663	190.7	7.5
1993	0.09	131.1	70,390	217.9	8.0
1994	0.12	285.6	79,213	382.5	8.6
1995	0.21	184.3	85,457	336.1	9.6
1996	0.27	232.1	95,380	378.2	9.9
1997	0.21	261.2	90,227	422.4	10.2
1998	0.22	147.1	83,863	325.8	9.7
1999	0.21	152.1	83,024	304.0	9.3
2000	0.21	121.4	95,101	263.3	9.7
2001	0.20	192.2	99,421	318.3	13.6
2002	0.22	228.7	111,329	369.2	14.1
2003	0.24	118.3	113,506	276.1	15.3
2004	0.26	323.3	109,337	453.8	16.6
2005	0.26	157.0	108,416	340.1	14.5
2006	0.30	138.7	102,105	293.5	13.1
2007	0.23	81.2	99,830	216.9	10.9
2008	0.24	131.8	106,075	240.7	11.6
2009	0.23	70.6	104,599	181.2	12.8
2010	0.27	92.3	104,749	182.0	11.4
2011	0.28	118.3	97,556	203.0	14.5
2012	0.28	208.6	95,936	297.5	12.8
2013	0.39	63.6	84,750	182.7	11.2
2014	0.31	76.9	73,346	162.6	8.1
2015	0.27	152.4	63,415	228.0	7.5
2016	0.31	238.7	64,227	333.0	6.2
2017	0.35	101.7	57,106	231.5	5.6
2018	0.26	130.7	55,120	234.8	5.4
2019	0.23	159.6	56,634	263.7	7.4
2020	0.14	109.5	59,980	223.1	6.4
2021	0.14	116.0	64,805	218.9	6.6

Table 9. Updated biological reference points and 2021 estimates for *F* and female SSB compared with the estimates from the 2018 benchmark.

Metric	2018 Target	2018 Threshold	2021 Target	2021 Threshold	2021 Value
Fishing Mortality	0.20	0.24	0.17	0.20	0.14
Female SSB	114,295 mt (252 million lbs)	91,436 mt (202 million lbs)	106,820 mt (235 million lbs)	85,457 mt (188 million lbs)	64,805 mt (143 million lbs)

Table 10. Probability of SSB being at or above the SSB threshold or target under different constant *F* scenarios. Shaded row indicates 2029, the rebuilding deadline.

Year	Probability SSB ≥ SSB threshold under current *F*	Probability SSB ≥ SSB target under current *F*	Probability SSB ≥ SSB threshold under *F* target	Probability SSB ≥ SSB target under *F* target	Probability SSB ≥ SSB threshold under *F* threshold	Probability SSB ≥ SSB target under *F* threshold
2021	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	34.4%	0.4%	34.5%	0.4%	34.5%	0.4%
2023	70.2%	14.9%	61.9%	13.1%	53.2%	11.6%
2024	86.0%	39.0%	74.1%	29.2%	61.8%	23.2%
2025	91.8%	56.1%	79.3%	40.3%	64.3%	28.6%
2026	94.1%	65.7%	81.4%	45.5%	63.4%	30.3%
2027	95.7%	72.7%	82.8%	49.9%	63.4%	31.9%
2028	96.4%	76.6%	82.8%	52.0%	61.7%	31.6%
2029	96.7%	78.6%	82.4%	52.5%	59.4%	30.5%
2030	97.0%	80.6%	82.8%	53.7%	58.6%	30.5%

FIGURES

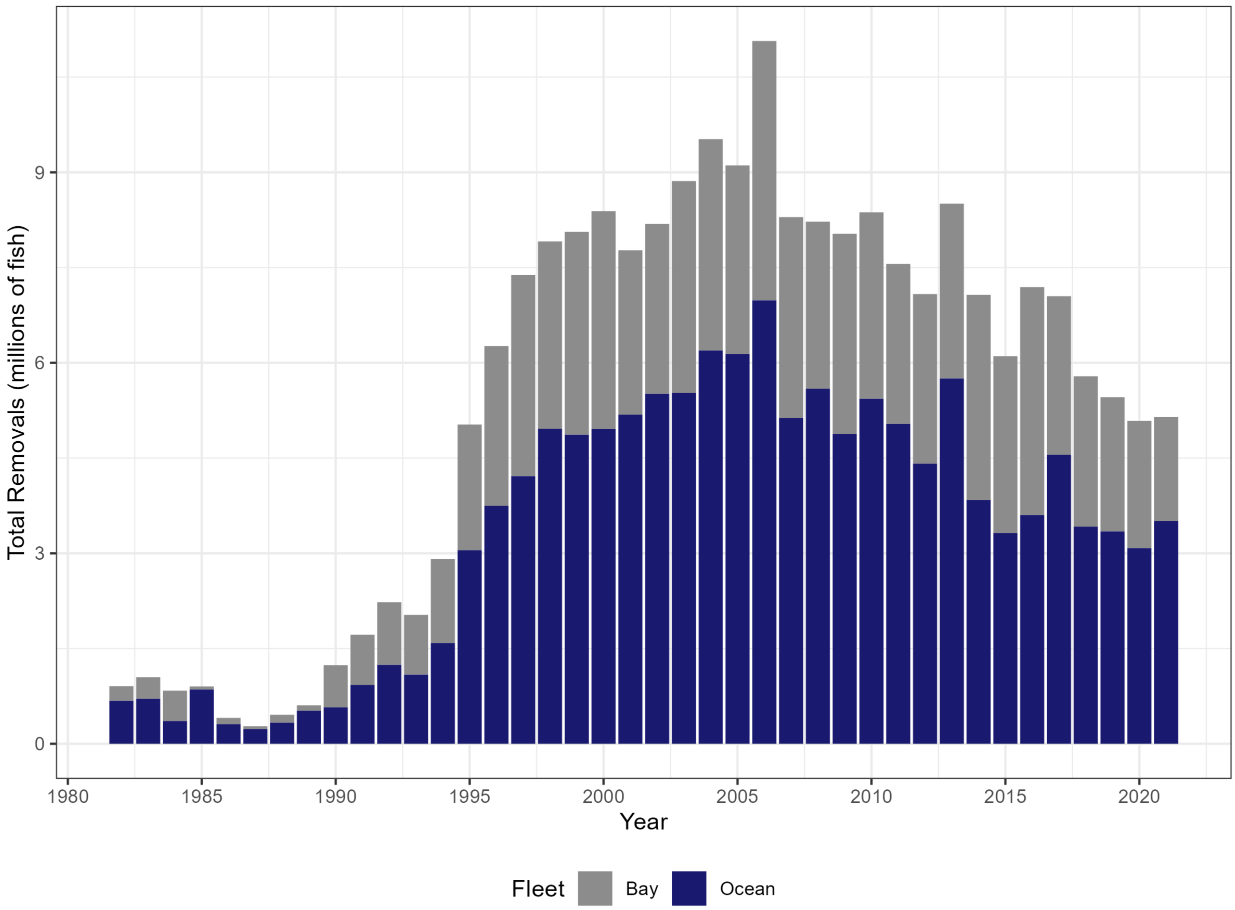

Figure 1. Total striped bass removals by fleet.

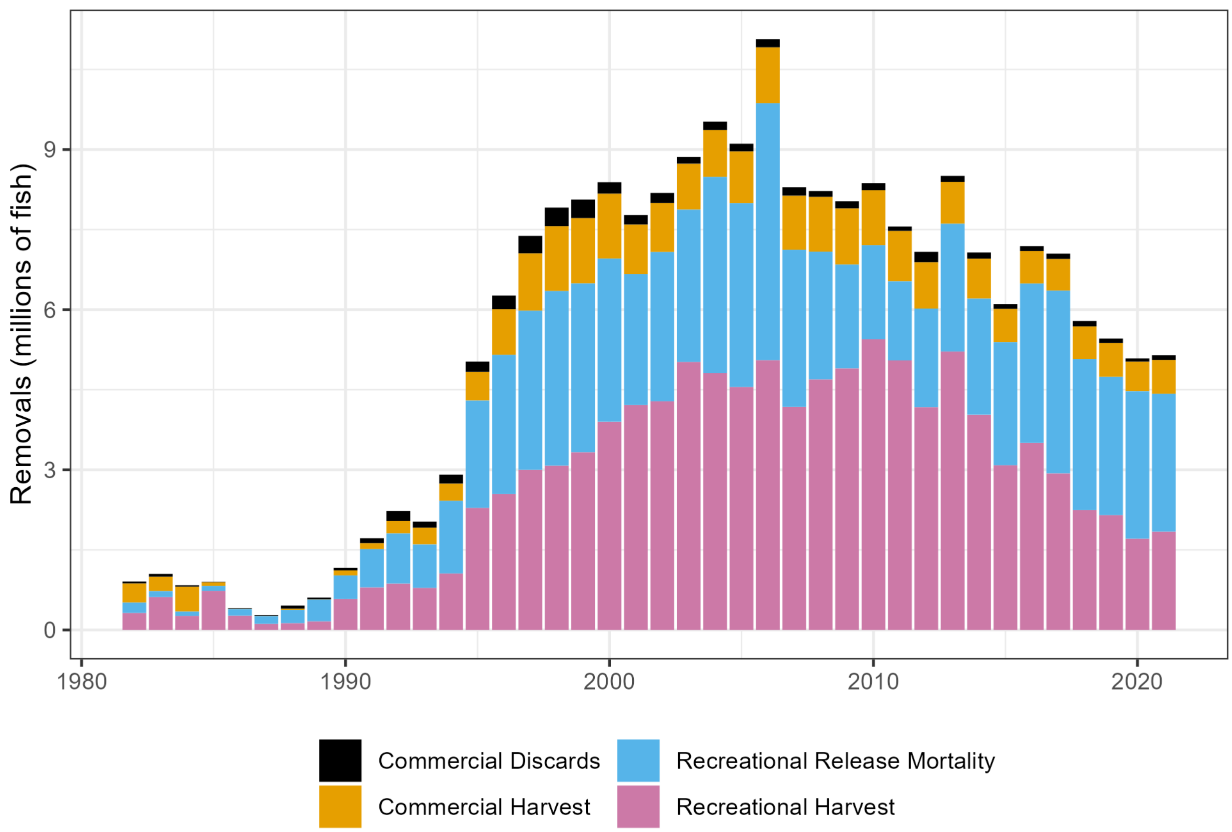

Figure 2. Total striped bass removal by sector.

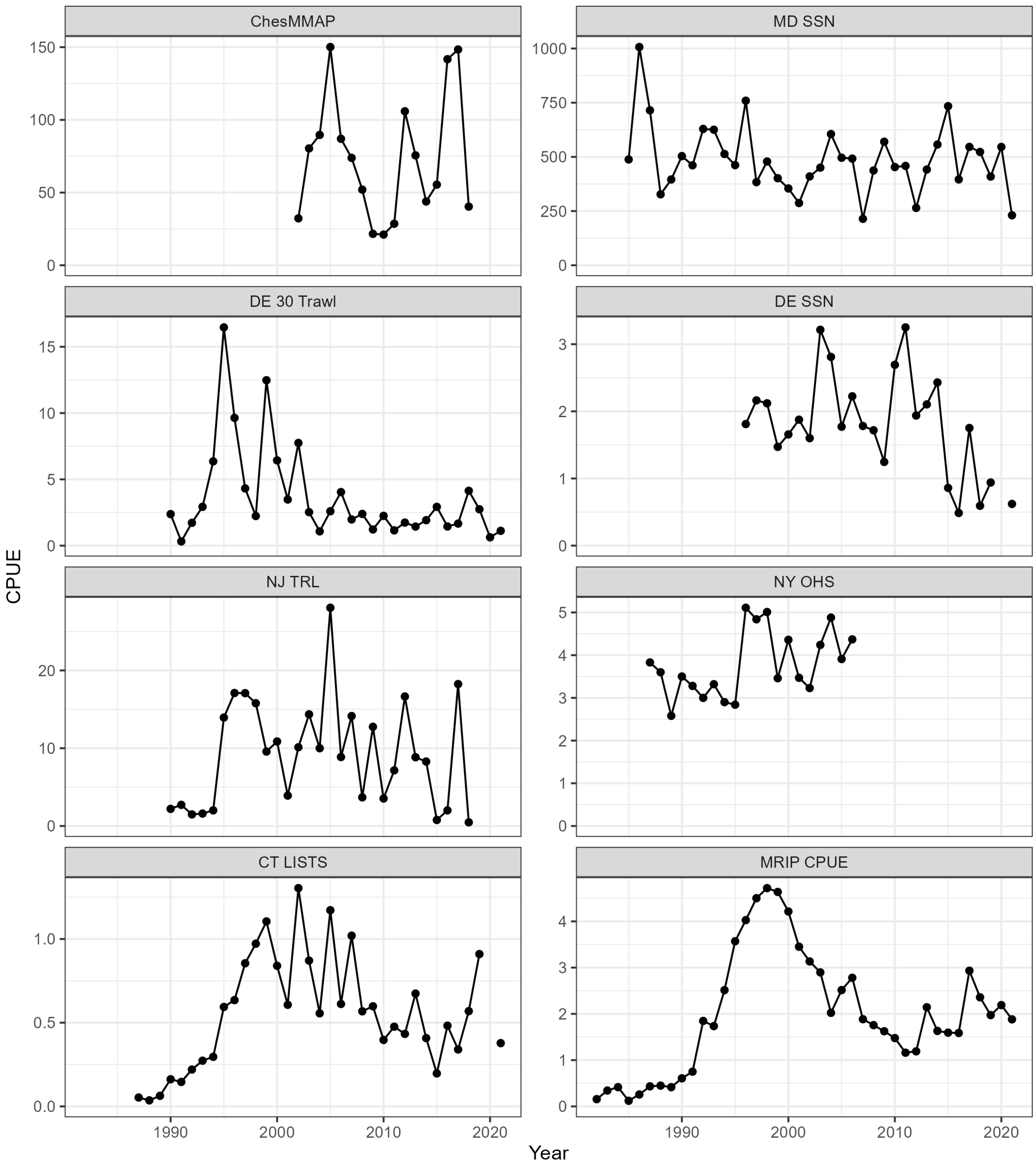

Figure 3. **Indices of age-1+ abundance for striped bass, 1982-2021.**

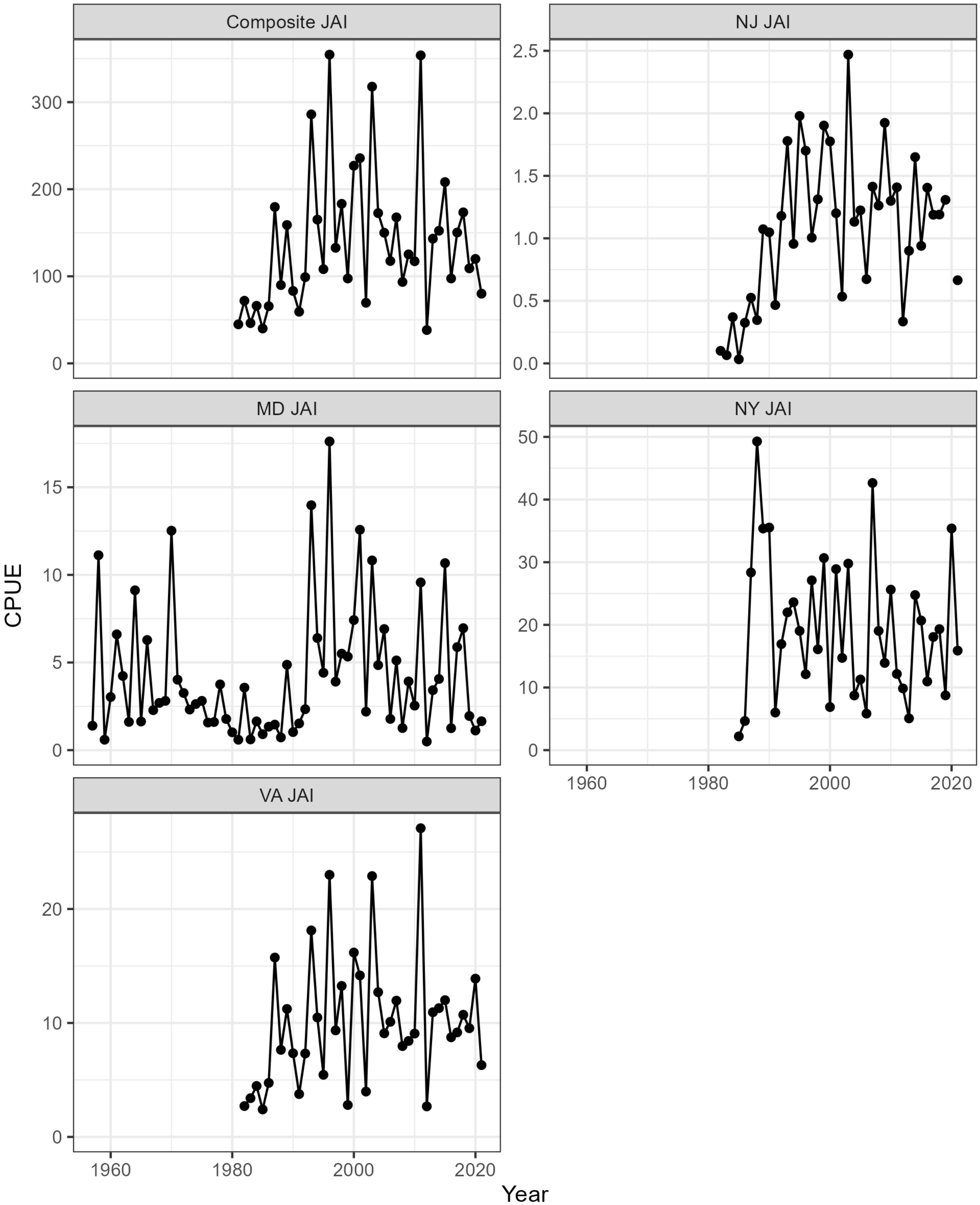

Figure 4. Striped bass juvenile abundance indices, including the composite Chesapeake Bay index (MD-VA), 1954-2021.

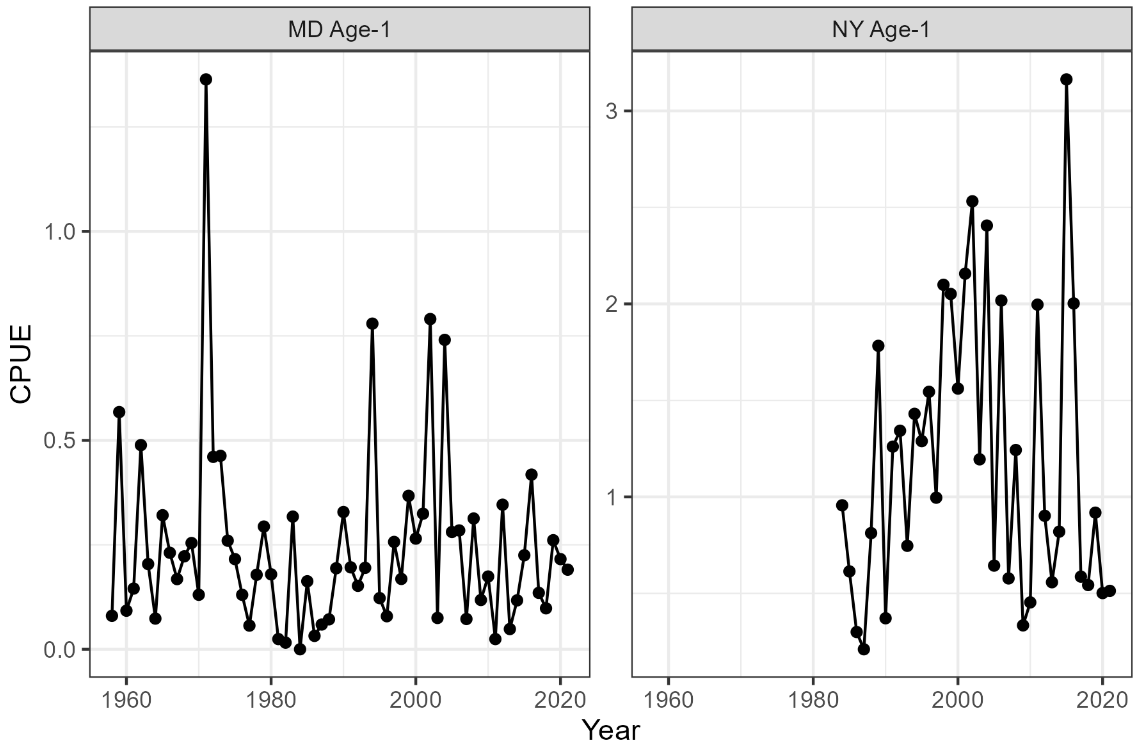

Figure 5. **Age-1 recruitment indices for striped bass, 1954-2021.**

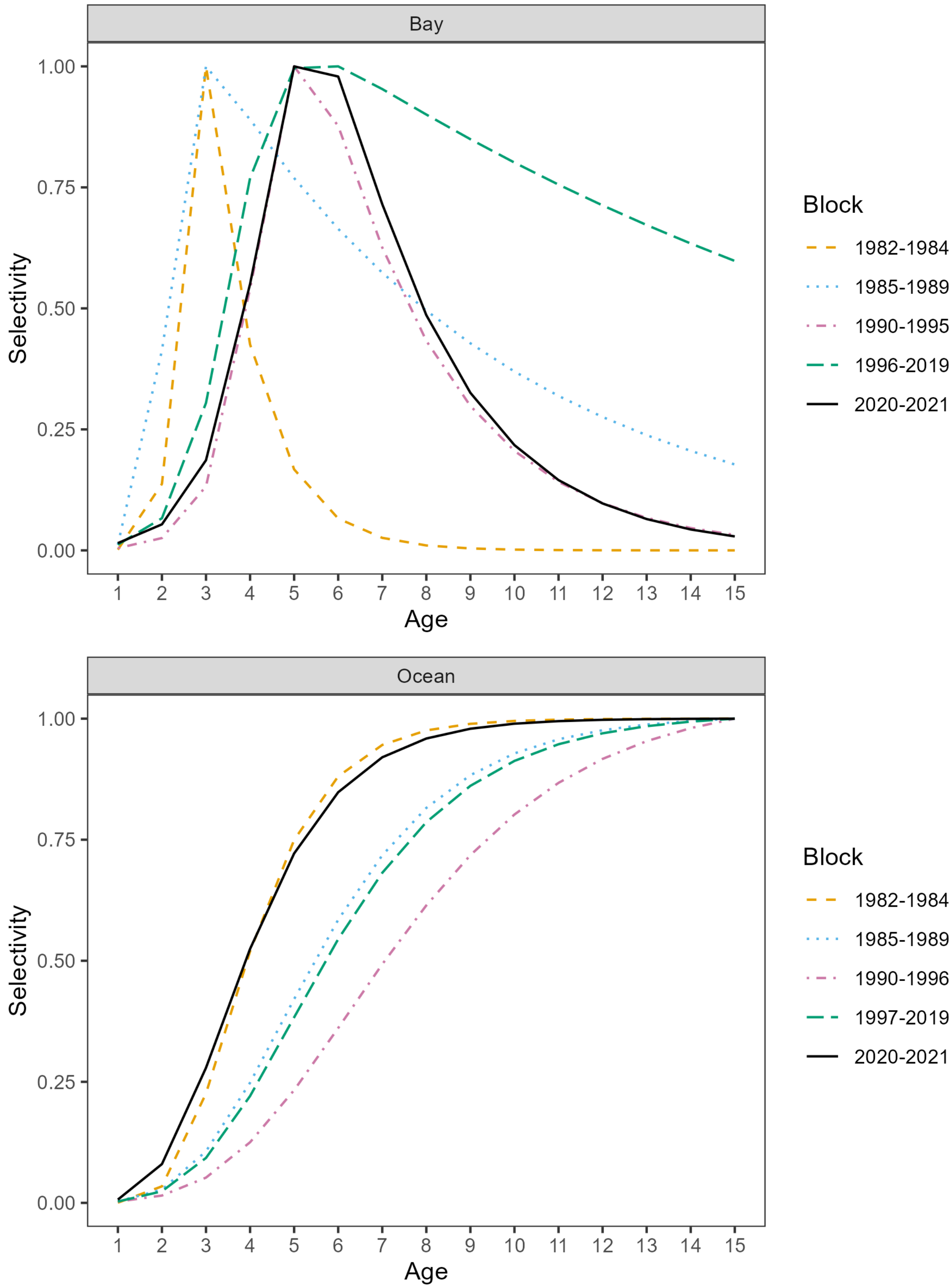

Figure 6. Selectivity patterns for the Bay fleet (top) and the Ocean fleet (bottom).

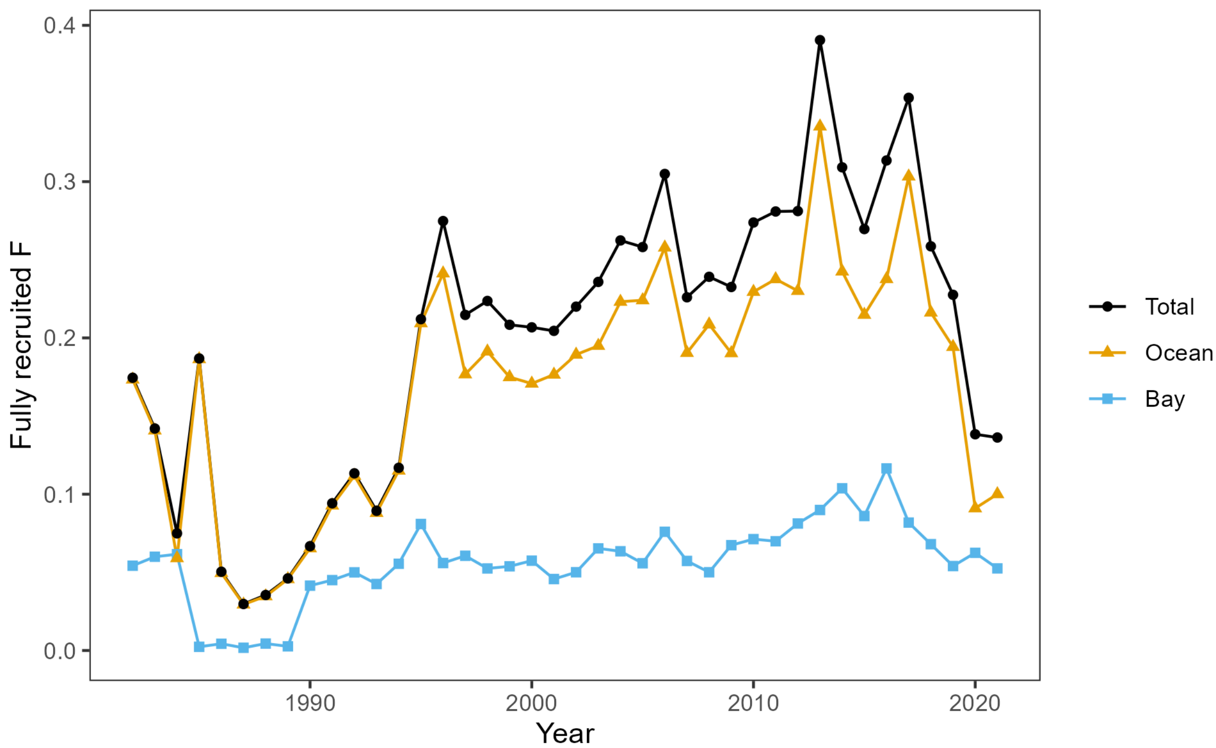

Figure 7. Fully recruited fishing mortality for the Bay and Ocean fleets plotted with the total fully recruited *F*.

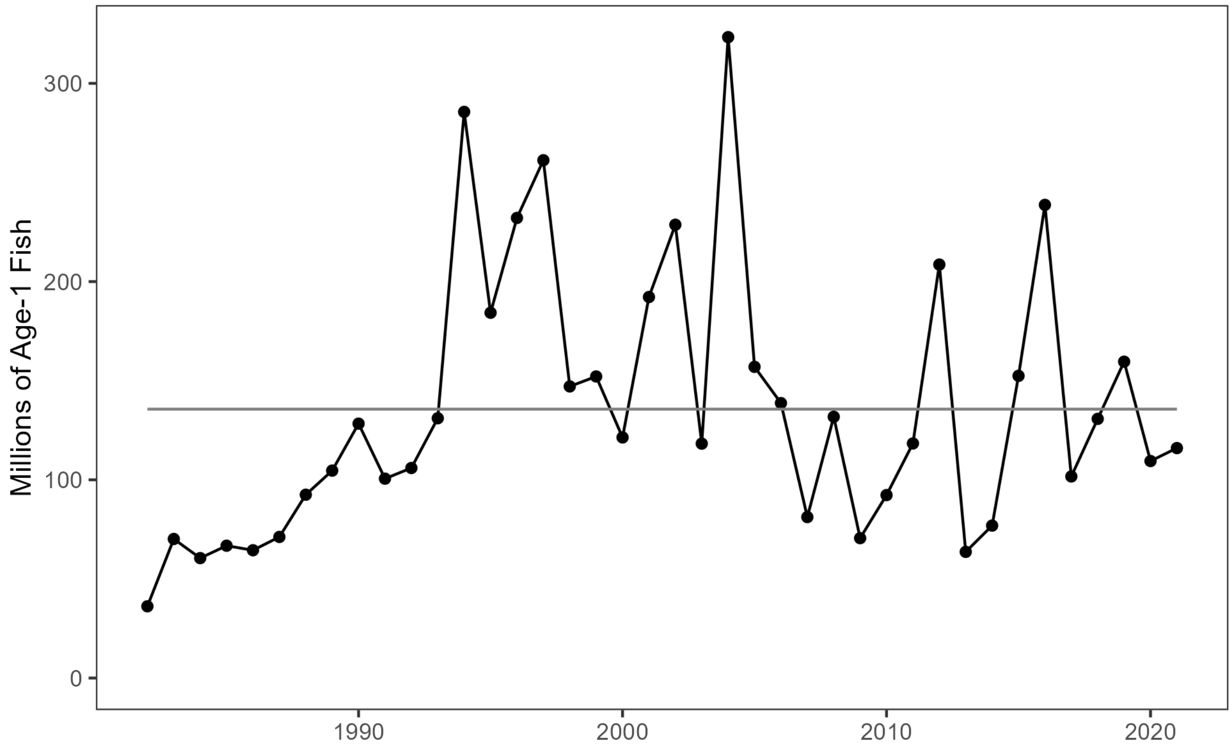

Figure 8. Estimates of striped bass recruitment plotted with the time series mean.

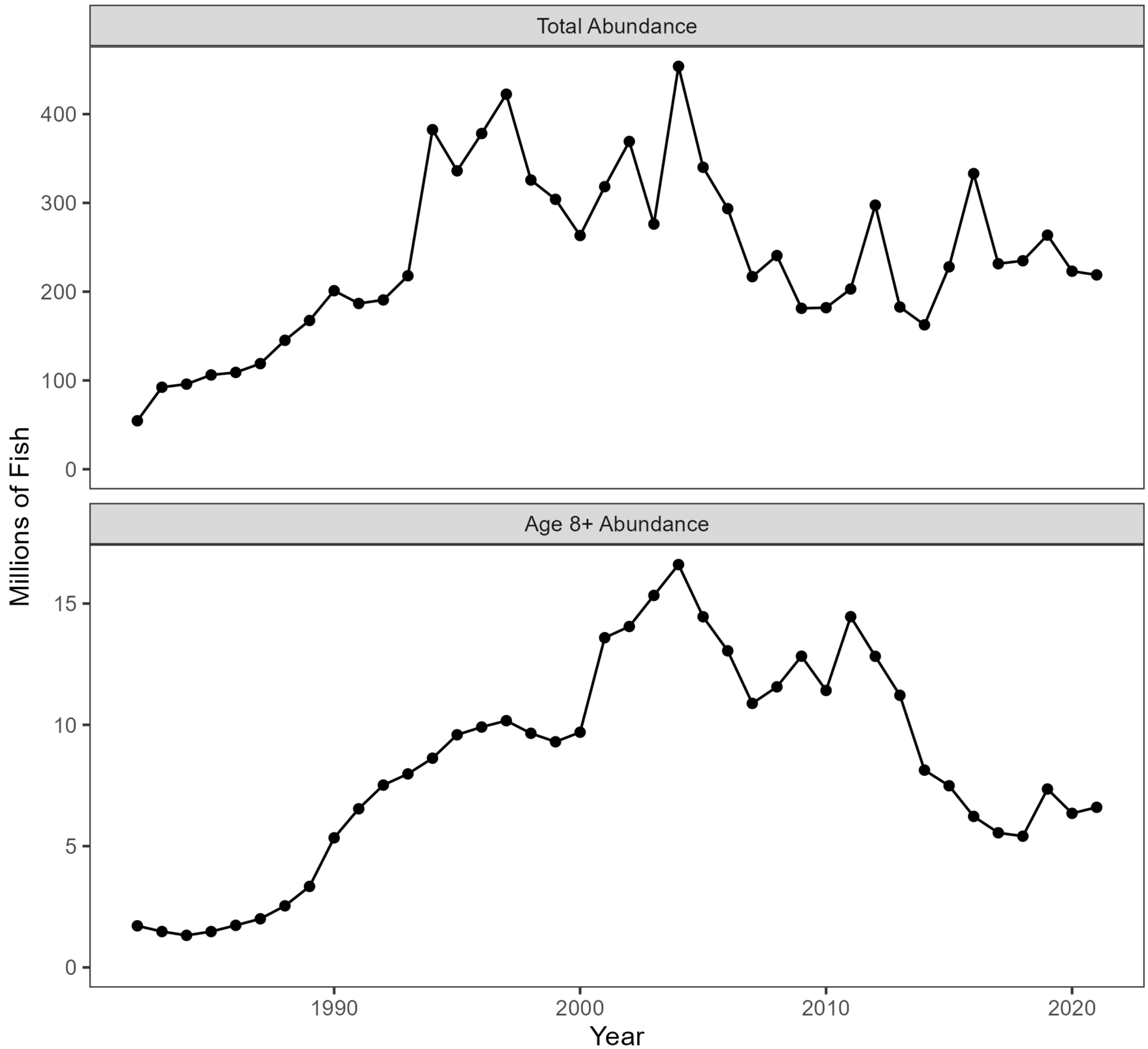

Figure 9. Total abundance (top) and age-8+ abundance of striped bass over time.

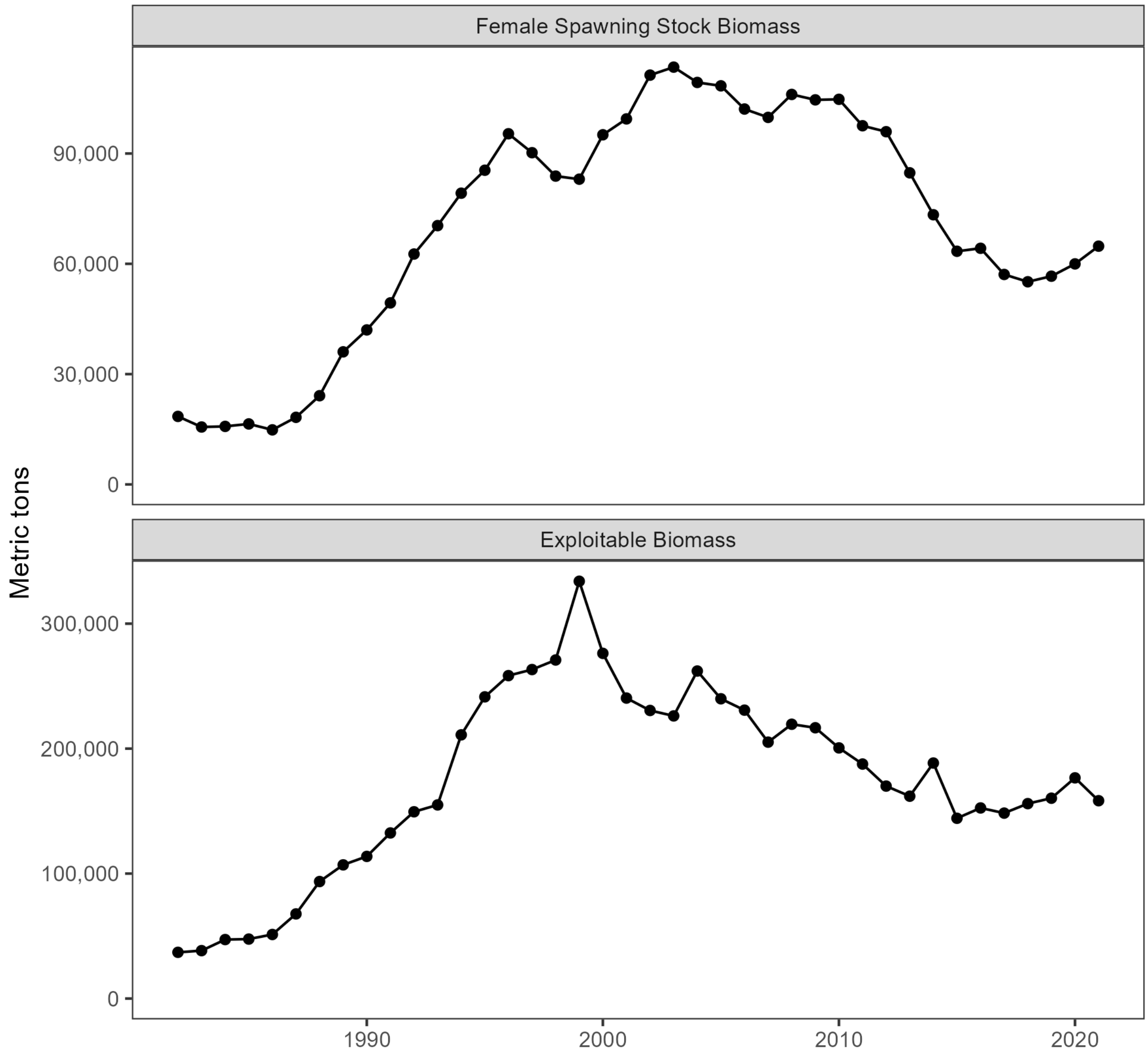

Figure 10. Female spawning stock biomass (top) and exploitable biomass of striped bass over time.

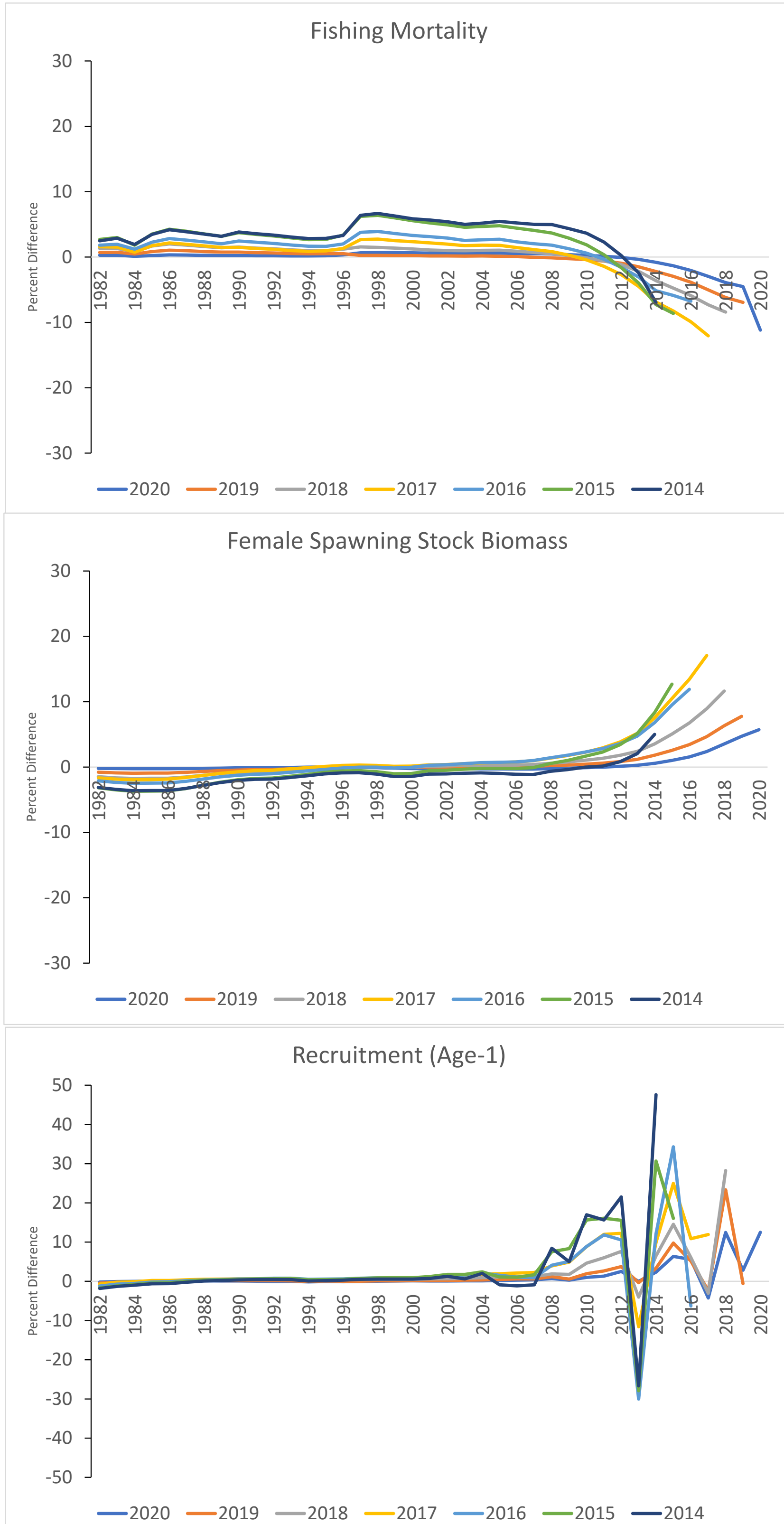

Figure 11. Retrospective plots of seven-year peels for fishing mortality (top), female spawning stock biomass (middle), and recruitment (bottom).

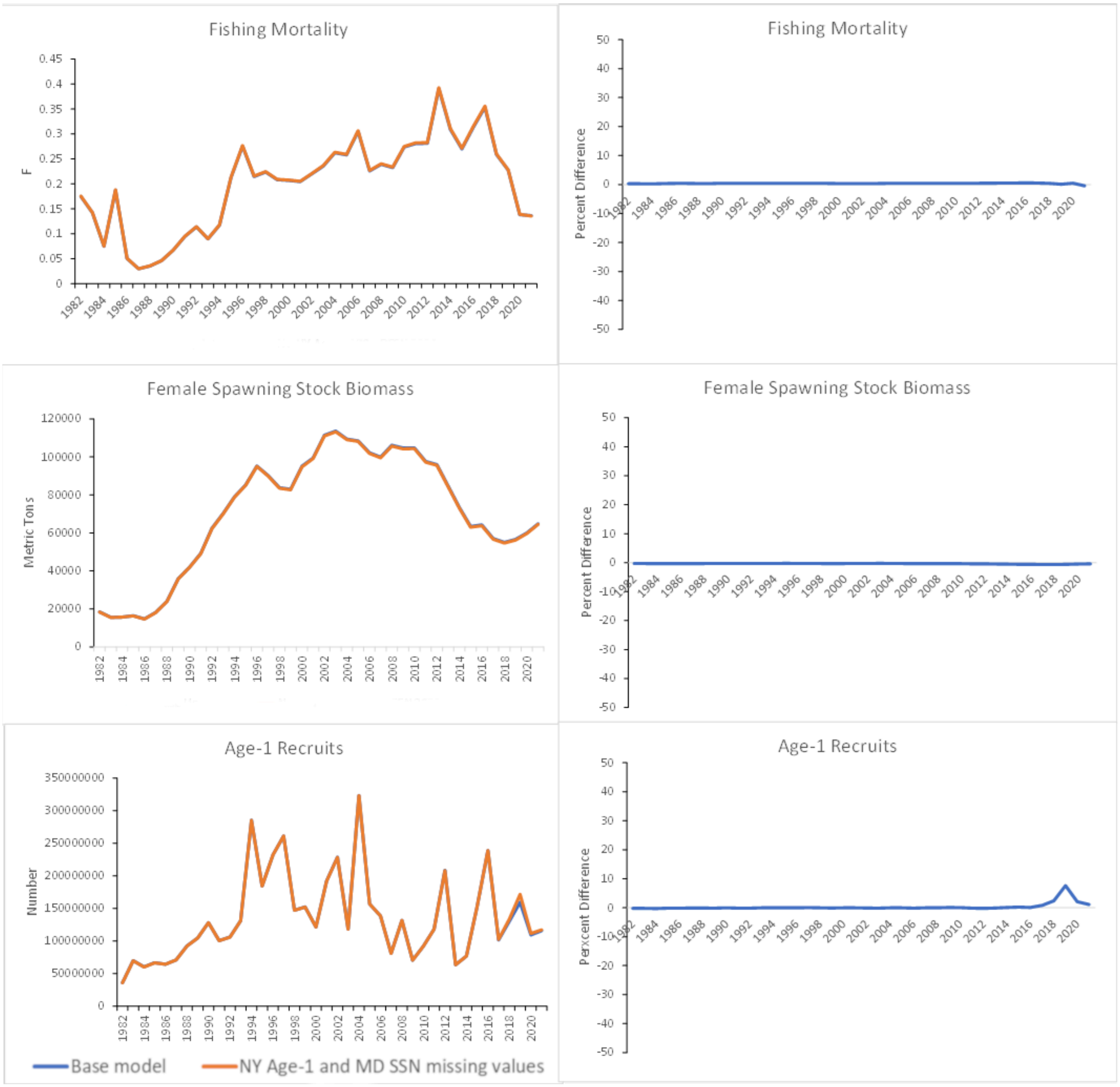

Figure 12. Comparison of fishing mortality (top), female SSB (middle), and recruitment (bottom) estimates from the update assessment and an assessment in which the 2020 NY Age 1 and 2021 MDSSN index values were set as missing. Absolute values are on the left and relative percent difference is on the right.

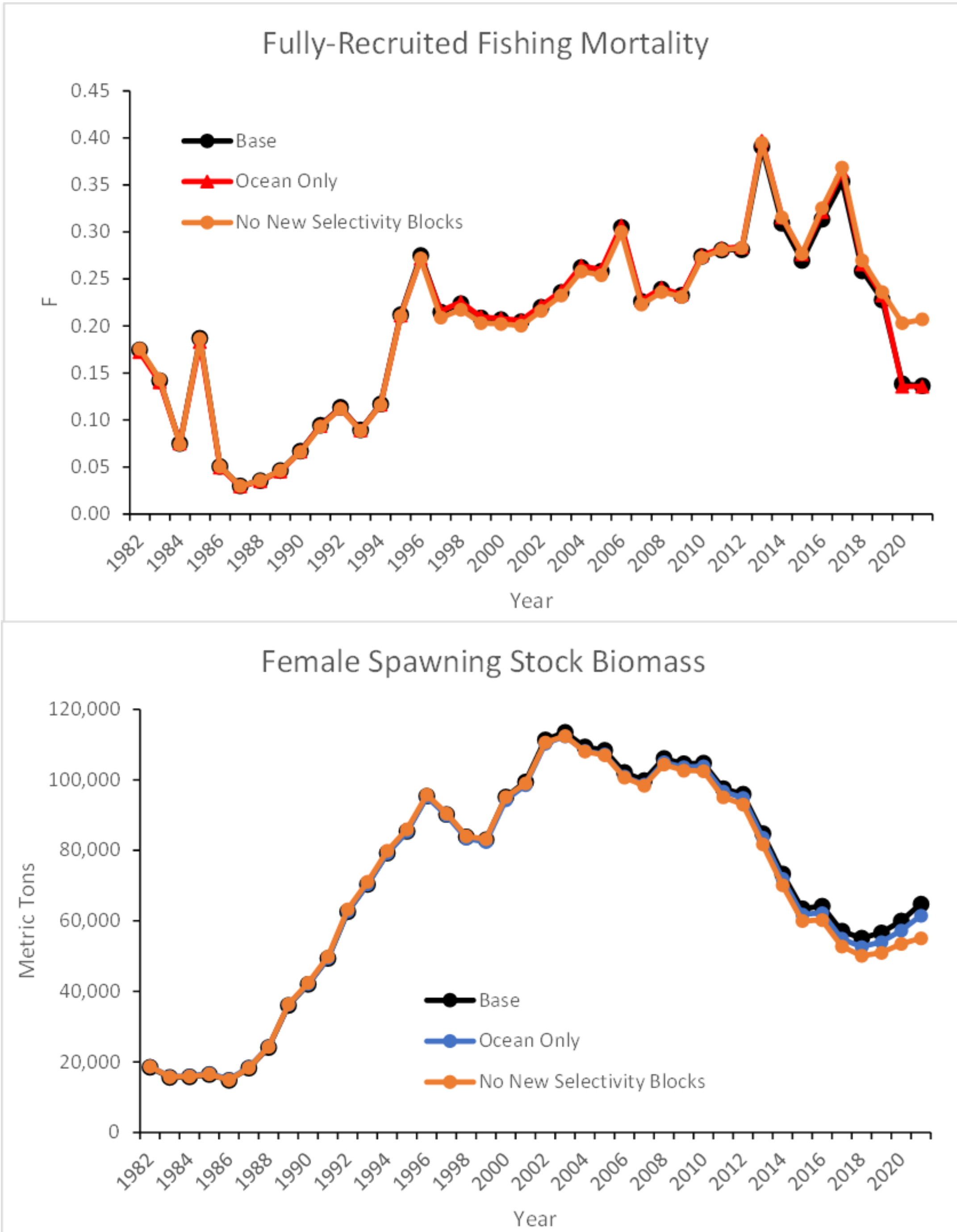

Figure 13. Comparison of fully-recruited fishing mortality (top) and female SSB (bottom) from the update assessment base model and sensitivity runs with a new 2020-2021 selectivity block for the Ocean region only and no new selectivity blocks.

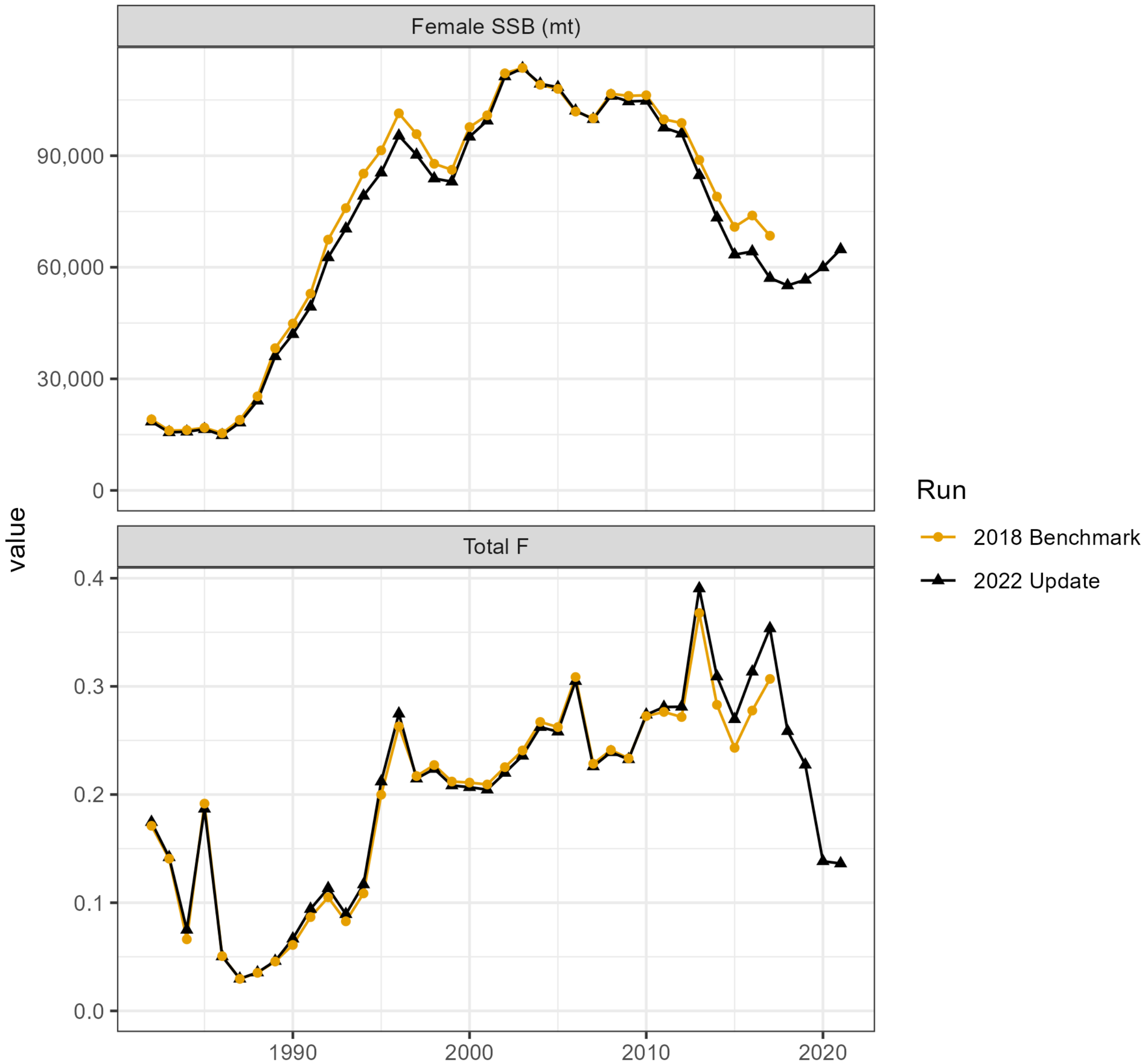

Figure 14. Comparison of estimates of female spawning stock biomass (top) and total fishing mortality (bottom) from the 2018 benchmark assessment and current assessment update.

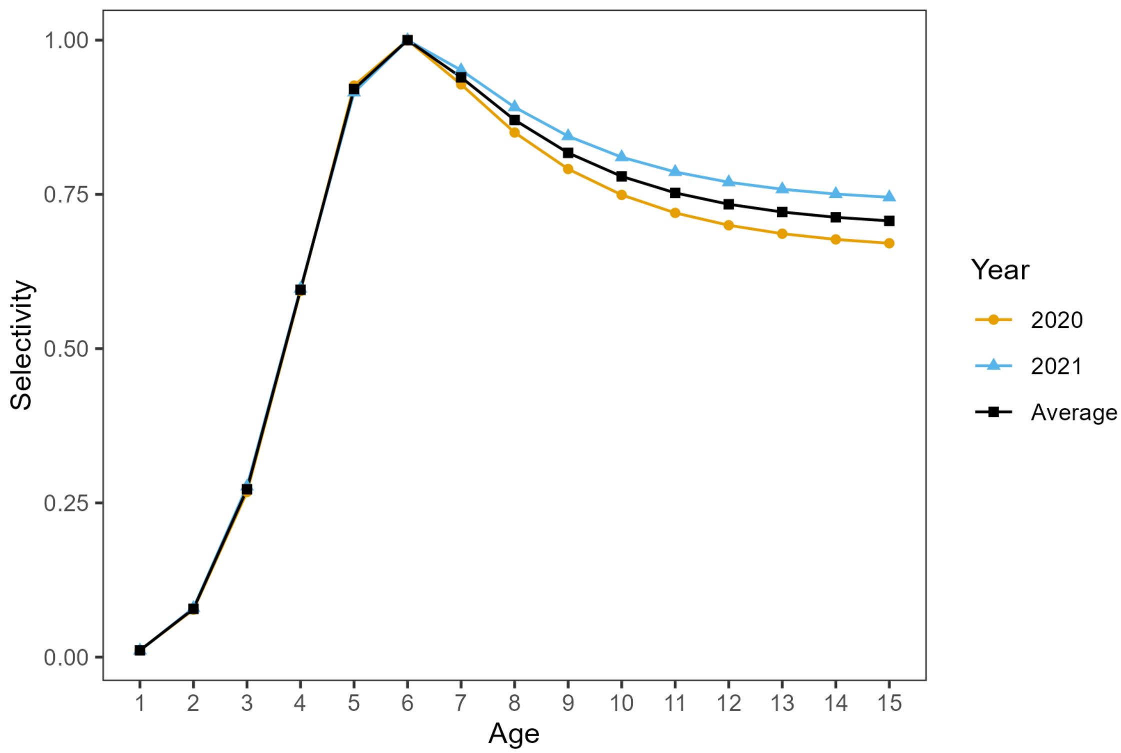

Figure 15. 2020-2021 average selectivity pattern used in the projections to determine fishing mortalities associated with the SSB threshold and targets compared to the overall selectivity in each individual year.

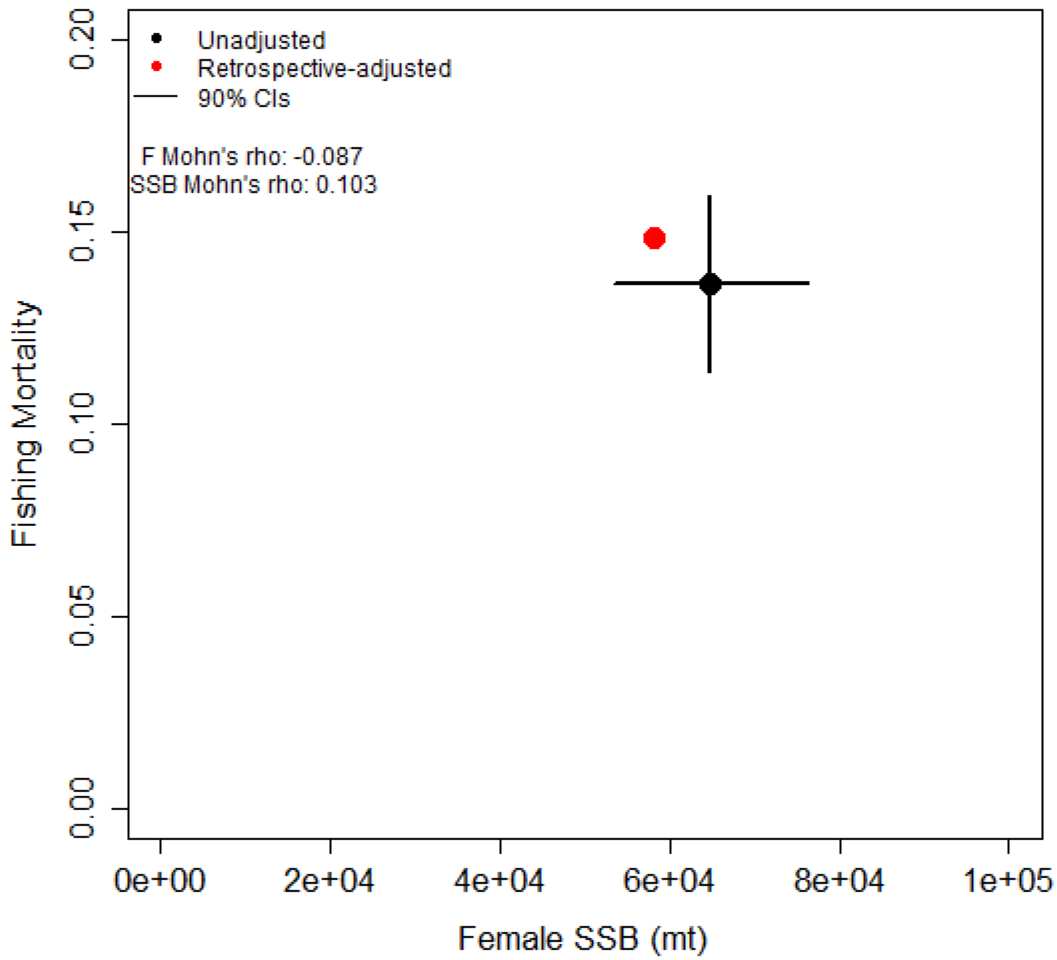

Figure 16. Plot comparing the 2021 retrospective-adjusted *F* and female SSB values with the unadjusted *F* and SSB estimates and their associated 90% confidence intervals.

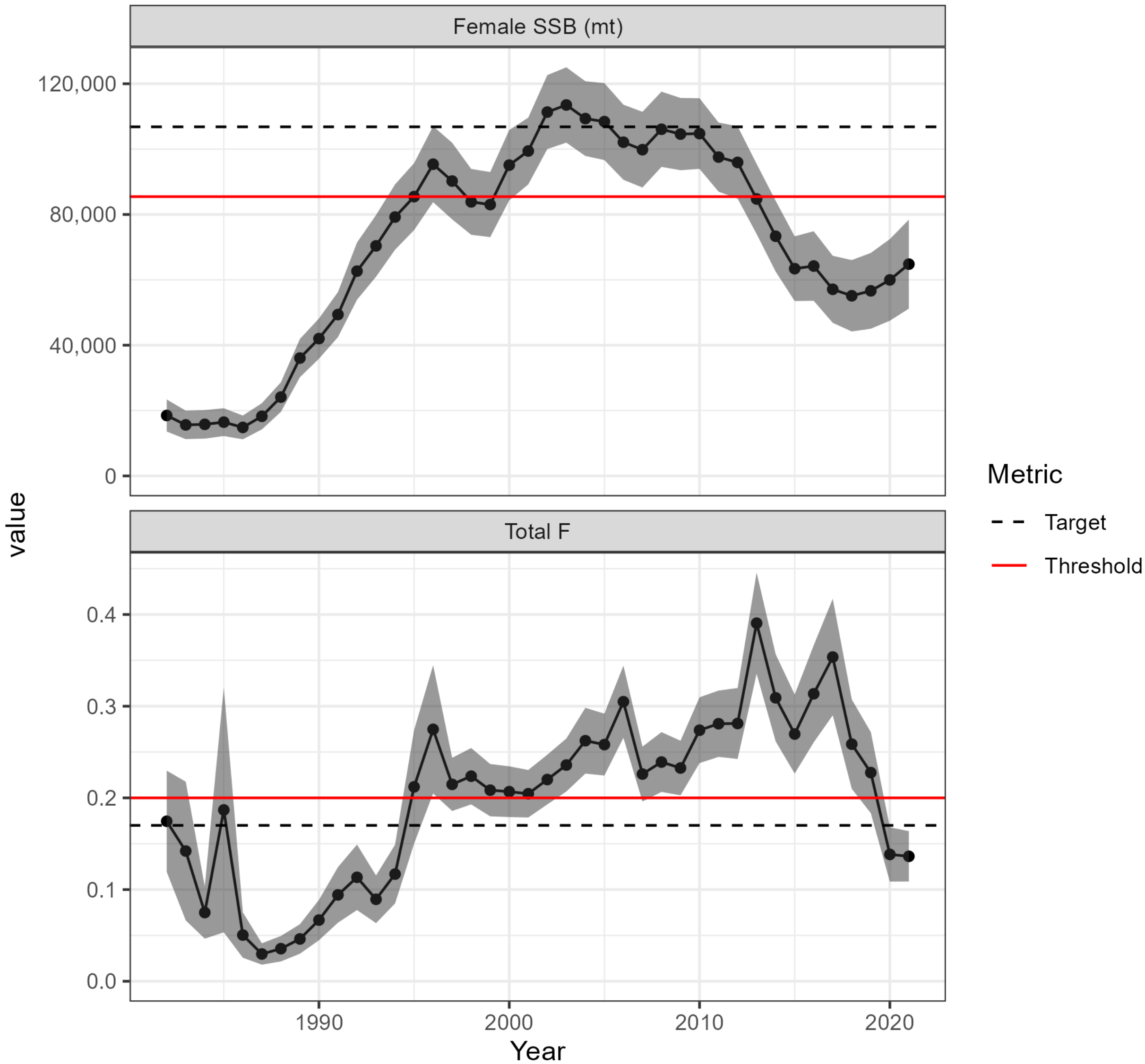

Figure 17. Female SSB (top) and total F estimates (bottom) plotted with their respective targets and thresholds. Shaded area indicates 95% confidence intervals of the estimates.

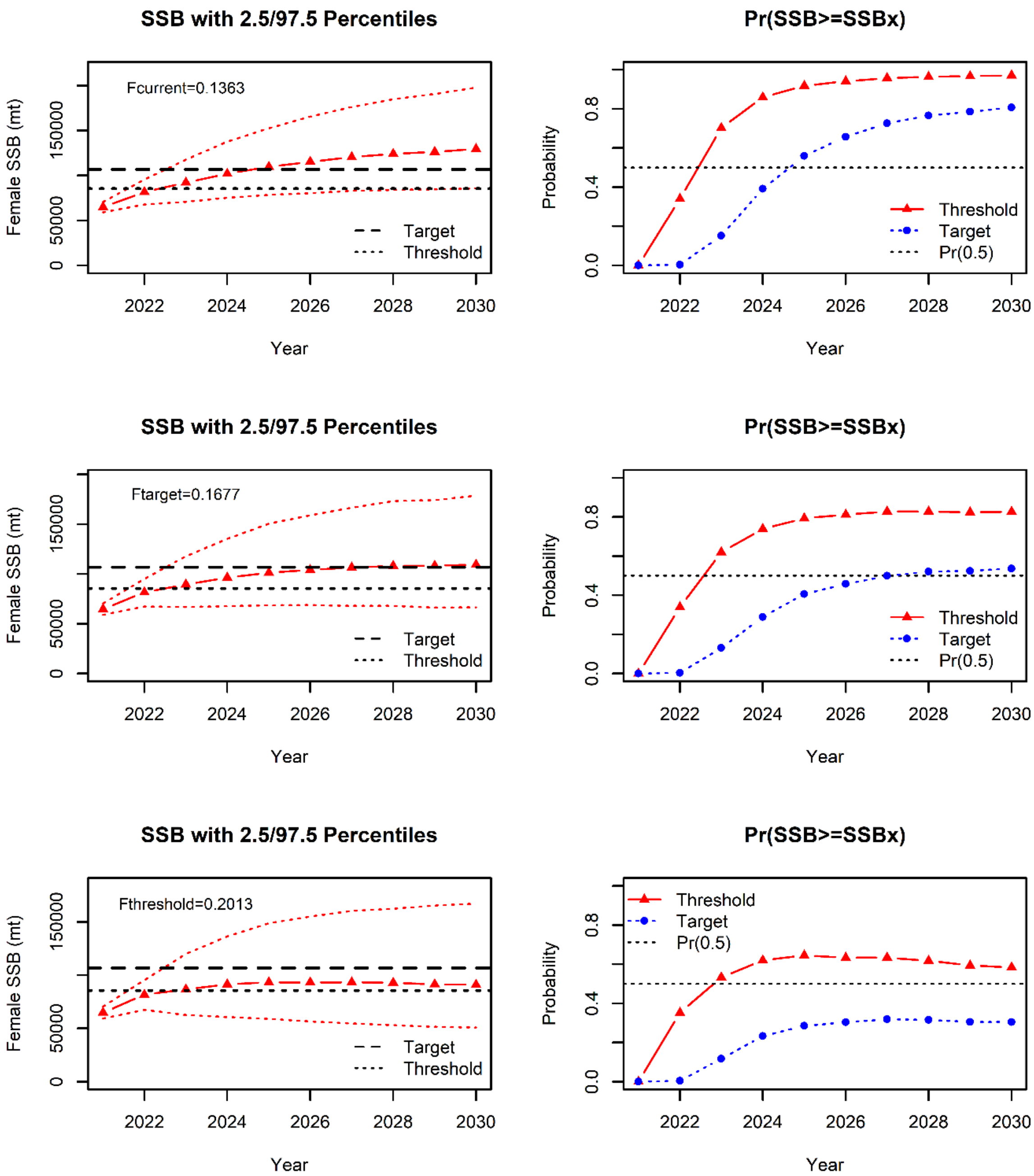

Figure 18. Projections of female spawning stock biomass through 2030 under current *F* (top), target *F* (middle), and threshold *F* (bottom). Absolute values are on the left and the probability of female SSB being above the target and threshold values is on the right.

Supplementary Report May 2023: Correction to Probabilities in 2022 Stock Assessment Update Report, and New Rebuilding Projections with 2022 Preliminary Data

Enclosed is a supplementary report from the Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee presented to the Atlantic Striped Bass Management Board on May 2, 2023. The report outlines a correction to the error around the short-term projections, and resulting probabilities, presented in the 2022 Atlantic Striped Bass Stock Assessment Update Report. The report also provides new stock rebuilding projections based on 2022 preliminary removals data.

Atlantic States Marine Fisheries Commission

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MEMORANDUM

TO: **Atlantic Striped Bass Management Board**

FROM: **Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee**

DATE: **April 17, 2023**

SUBJECT: **Rebuilding Projections with 2022 Preliminary Data and Ocean Commercial Quota Utilization Scenarios**

The Striped Bass Technical Committee (TC) and Stock Assessment Subcommittee (SAS) met via webinar on March 14 and March 30, 2023 to develop updated stock rebuilding projections as tasked by the Striped Bass Management Board. Before developing the projections, the TC-SAS reviewed a correction to the rebuilding probabilities in the 2022 Stock Assessment Update Report.

Correction to Short-Term Projections and Probabilities in 2022 Stock Assessment Update

The 2022 Atlantic Striped Bass Stock Assessment Update (terminal year 2021) was reviewed by the Board in November 2022. The assessment includes short-term projections estimating the probability of female spawning stock biomass (SSB) reaching the SSB threshold and SSB target (rebuilt) under three constant fishing mortality (*F*) scenarios. The projections and probabilities are summarized in Table 10 and Figure 18 of the assessment report.

After the assessment report was completed, the assessment team identified an issue with the calculated error around those projections. When the assessment report was developed, the projections inadvertently used standard error, instead of coefficient of variation (CV), in the error calculations. This resulted in larger error than should have been shown around the SSB projections. The projections were later corrected using CV in the error calculations. The corrected projections have a smaller error around the projected SSB, which results in updated probabilities. This update did not affect the median SSB projection, only the error around the projection and associated probabilities.

The TC-SAS reviewed this correction on March 14, 2023, and the 2022 Stock Assessment Update Report will be updated to reflect the correction. The updated Table 10 from the Assessment Report is enclosed as an Appendix to this memo showing the change.

New Rebuilding Projections

In November 2022 and January 2023, the Board tasked the TC-SAS with two items:

- Task 1: Evaluate whether 2022 removals remained at a level associated with the 2021 fishing mortality rate.

- Task 2: Conduct stock projections to determine how specific ocean commercial quota utilization scenarios would impact the stock rebuilding timeline.

The Board requested projections in time for the May 2023 Board meeting, and requested the projections include 2022 preliminary removals data. The TC-SAS developed the following suite of projections to address both Board tasks.

Data Inputs for New Projections

Projections were conducted using the 2022 stock assessment model configuration, including using the low recruitment assumption. Age-1 recruitment was estimated using the 2021 Maryland YOY index to predict 2022 recruitment, and using the 2022 Maryland YOY index to predict 2023 recruitment for the quota utilization scenarios. The low-recruitment assumption was used for all other years.

Preliminary 2022 removals were compiled in number of fish. Preliminary 2022 commercial landings were provided by each state. It is important to note that commercial landing estimates will likely be updated as states complete final harvest accounting in the coming months. Commercial discards for 2022 were estimated by applying the 2021 discard-to-landings ratios for each region to the preliminary 2022 commercial landings. For recreational removals, preliminary 2022 MRIP data were used for recreational harvest and release mortality (9% of recreational live releases). Final MRIP data are expected to be published in late April 2023.

Preliminary MRIP data for 2022 indicate a 91% increase in recreational harvest and 3% increase in recreational live releases, relative to 2021. This results in an overall 40% increase in recreational removals, with a preliminary estimate of 6.2 million fish in 2022 relative to 4.4 million fish in 2021.

Total preliminary removals from both sectors was estimated to be about 6.9 million fish in 2022, a 33% increase from 5.2 million fish in 2021. These removal estimates will be updated in August 2023 as part of the FMP Review Report for the 2022 Fishing Year based on state compliance reports, but the TC does not expect significant changes from these preliminary numbers.

For the ocean quota utilization scenarios, the projections assume there would be additional commercial harvest starting in 2023 to reflect using all, or most of, the ocean commercial quota. To estimate commercial harvest for 2023 under Scenario 2 (full ocean quota used), any unused 2022 ocean quota was converted from pounds to number of fish and added to the total removals. For states with active commercial fisheries, unused 2022 quota was converted to number of fish using state-specific average commercial fish weight. For states with inactive commercial fisheries (ME, NH, CT, NJ, and NC), unused quota was converted to number of fish using the coastwide ocean average commercial fish weight (15.3 pounds). For Scenario 3 (full ocean quota used except NJ), New Jersey’s quota in number of fish was subtracted from that additional harvest. Scenario 3 reflects the fact that New Jersey’s commercial quota is currently unavailable for quota transfers because it has been re-allocated to the recreational fishery.

Projection Scenarios and Assumptions
The TC-SAS focused on three scenarios with constant *F* projections through 2029. Scenario 1 is based on preliminary 2022 removals only. Scenarios 2 and 3 have different assumptions for 2023-2029 by accounting for the ocean commercial quota utilization scenarios requested by the Board and by using a constant removals assumption between years 2022 and 2023 instead of a constant *F* assumption as in scenario 1. The TC-SAS decided to apply these quota utilization scenarios starting in projection year 2023 because 2023 is the first year that quota transfers could potentially be permitted.

For 2023-2029 projection years, all three scenarios assume a constant three-year average *F.* The TC-SAS emphasized that striped bass catch and *F* rates vary from year-to-year, even under the same regulations. Using a three-year average acknowledges that variability. The estimated *F* rate for 2022 (scenario 1) or the estimated *F* rate for 2023 + additional quota utilization (scenarios 2 and 3) were averaged with *F* rates from 2019 and 2021. 2020 was not included due to COVID-19 uncertainty. The 3-year average *F* was very close to the $F_{prelim2022}$, and projections with constant $F_{prelim2022}$ were explored as a sensitivity run.

<u>Scenario 1</u> uses preliminary 2022 removals (6.9 million fish) to estimate *F* in 2022. For 2023-2029 projections, $F_{prelim2022}$ is averaged with F_{2019} and F_{2021}.

<u>Scenario 2</u> uses preliminary 2022 removals data to estimate *F* in 2022. Starting in 2023, *F* is adjusted to account for harvesting the full ocean quota each year; active fisheries use all their quota and inactive fisheries transfer all their quota via commercial quota transfers. $F_{2023+fullquota}$ is calculated assuming preliminary 2022 removals plus an additional commercial harvest (~41,500 fish) are removed from the 2023 population. For 2023-2029 projections, $F_{2023+fullquota}$ is averaged with F_{2019} and F_{2021}. Because the landed NJ commercial quota is counted both in the "full commercial quota" and in the re-allocation of the commercial quota to the recreational fishery, those fish are double-counted for this scenario.

<u>Scenario 3</u> uses preliminary 2022 removals data to estimate *F* in 2022. Starting in 2023, *F* is adjusted to account for harvesting the full ocean quota each year <u>except</u> for New Jersey's quota; active fisheries use all their quota and inactive commercial fisheries, except NJ, transfer all their quota via commercial quota transfers. $F_{2023+fullquotaminusNJ}$ is calculated assuming preliminary 2022 removals plus additional commercial harvest (~27,400 fish) are removed from the 2023 population. For 2023-2029 projections, $F_{2023+fullquotaminusNJ}$ is averaged with F_{2019} and F_{2021}.

Projection Results
For all scenarios, projected *F* rates were between the current *F* target of 0.17 and *F* threshold of 0.20. These projected *F* rates are higher than F_{2021} of 0.14. If *F* stays between the target and the threshold from 2023-2029, the probability of rebuilding the stock to SSB target by 2029 decreases substantially compared to the rebuilding probability associated with F_{2021}. The 3-year average *F* was very close to the $F_{prelim2022}$ and the projection results using $F_{prelim2022}$ as a sensitivity run were not substantially different from the results presented here.

Table 1 summarizes the projected *F* rates for each scenario and the associated rebuilding probability of reaching the SSB target by 2029. The table also includes the 2022 Stock Assessment Update projection based on F_{2021} for comparison.

Table 1.

Description	Scenario	Year	Projected *F*	Pr SSB > target in 2029	Pr SSB > thresh-old in 2029
2021 Fishing Mortality from 2022 Stock Assessment Update	-	2022-2029	*F* in 2021	97.5 %	99.9 %
2022 Preliminary Removals	1	2022	*F* in 2022	15 %	94 %
		2023-2029	Average *F* (2019,2021, 2022)		
2022 Preliminary Removals + Full Ocean Quota in 2023	2	2022	*F* in 2022	11 %	91 %
		2023-2029	Average *F* (2019,2021, 2023+fullquota)		
2022 Preliminary Removals + Full Ocean Quota minus NJ in 2023	3	2022	*F* in 2022	11 %	91 %
		2023-2029	Average *F* (2019,2021, 2023+fullquota minusNJ)		

Figure 1 shows the SSB projection and the probability curves for reaching the SSB threshold and SSB target for each scenario. For comparison, Figure 1 also shows the SSB projection and probability curves associated with constant F_{2021} from the 2022 Stock Assessment Update.

Discussion of 2022 Removals

Increased recreational removals in 2022 are driving the increased *F* rates and lower rebuilding probabilities in all scenarios. The projections indicate SSB will increase over time before stalling between the target and threshold. Since the estimated $F_{prelim2022}$ (and all other projected fishing mortalities) is between the *F* target and threshold, it is expected that SSB will also remain between the SSB target and threshold, without fully rebuilding to the SSB target level. Because the *F* reference points are calculated to achieve the SSB reference points in the long-term, SSB will reach its target over the long-term only if *F* is at (or below) its target. In order to meet the SSB target by 2029 (i.e., a short-term timeline), *F* would need to be below its target, as demonstrated by the high rebuilding probabilities associated with F_{2021}, which was below *F* target.

While the projections indicate a low probability of rebuilding to the *target* by 2029 under these higher *F* rates, the probability of reaching the SSB threshold in 2029 (no longer overfished) is above 90% for all scenarios. The TC-SAS noted that angler effort and behavior continue to be an important factor and source of uncertainty. As the stock recovers and strong year classes become available to the recreational fishery, effort may increase, contributing to both increased harvest and live releases.

The outcome of projections is dependent on which constant *F* or catch level is assumed (as well as assumptions about recruitment and selectivity). The TC-SAS emphasized that projections assuming a constant *F* or constant catch are not necessarily representative of future years since striped bass catch and *F* vary from year-to-year. These new projections based on 2022 removals represent a higher catch outlook, while the projections based on 2021 removals represent a lower catch outlook (Figure 2). If future catch and *F* are somewhere in the middle, the rebuilding probability may also fall between the low 15% associated with 2022 removals and the high 97% associated with 2021 removals. The ocean quota utilization scenarios overlap almost completely with the 2022 removals scenario, indicating the additional quota utilization has a minimal impact on the projections compared to the increase in total removals from 2021 to 2022 (Figure 2). For the first years of the projections, the three new scenarios overlap significantly with the 2021-based projection, but diverge further in later years, where we have less confidence in our assumptions about *F* and recruitment (Figure 2).

Discussion of Quota Utilization Scenarios

The 2023-2029 projected *F* for the ocean quota utilization scenarios 2-3 is based on a worst-case scenario and is only about 2% higher than the projected *F* for the 2022 removals scenario 1. This slight increase in *F* results in a slightly lower (-4%) probability of rebuilding by 2029. However, this slight difference results from the assumptions used to generate the projected fishing mortality rates more than the addition of the ocean quota utilization. In scenario 1, an average *F* (2019,2021,<u>2022</u>) was applied to all remaining projection years (2023-2029), while in scenarios 2-3, an average *F* (2019,2021,<u>2023</u>) was applied to all remaining years (2023-2029). Consequently, both population dynamics between 2022 and 2023 and increased quota utilization are responsible for the differences between scenario 1 and 2-3.

The projections indicate that the impact of additional quota utilization on *F* and rebuilding probability is negligible. The maximum quota utilization scenario 2 only adds 41,500 extra fish to removals, which is less than 1% of total removals. The addition or subtraction at a scale of tens of thousands of fish relative to the total removals scale of several million has negligible impacts on overall *F*, as also demonstrated by the negligible difference between scenarios 2 and 3 (difference of 14,000 fish).

Discussion on Interim Projections

The TC-SAS discussed the benefits and challenges of conducting stock projections between stock assessments. In this case, the benefit of these interim projections is a timely update to the Board considering the significant increase in recreational catch in 2022 following two low catch years, which also included COVID-19 uncertainty. In addition, 2022 aligned with the emergence of the strong 2015-year class in the ocean fishery, which likely contributed to the large change between 2021 and 2022. The TC noted these projections are not the same as a full stock assessment update where the model would be re-run to include the 2022 catch-at-age and index data to produce estimates of *F* and SSB in 2022 to determine stock status.

The TC-SAS noted that conducting annual stock projections would not be particularly useful given interannual variability in removals under constant regulations, and the life history of striped bass (long-lived, slow to mature, etc.). Instead, the TC-SAS talked about the potential benefits of aligning projections and assessments with planned management changes.

If the Board is considering management changes, the TC-SAS recommends the Board be as specific as possible with the types of measures they would consider and their intent (e.g., reduce removals to a particular *F* rate or rebuilding probability, protect year classes, etc.).

TC-SAS Members in Attendance on March 14 and 30
Nicole Lengyel Costa (TC Chair, RI), Mike Celestino (SAS Chair, NJ), Michael Brown (ME), Kevin Sullivan (NH), Gary Nelson (MA), Kurt Gottschall (CT), Caitlin Craig (NY), Brendan Harrison (NJ), Tyler Grabowski (PA), Margaret Conroy (DE), Alexei Sharov (MD), Luke Lyon (DC), Ingrid Braun (PRFC), Brooke Lowman (VA), Joshua McGilly (VA), Charlton Godwin (NC), Steve Minkkinen (USFWS), John Sweka (USFWS), Tony Wood (NOAA)

Board Members and Public in Attendance on March 14 and 30
Chris Batsavage, David Borden, Emerson Hasbrouck, Max Appelman, David Sikorski, Mike Wilberg, Rob Latour, Adena Schonfeld, Samara Nehemiah, Alan Bianchi, Jessica Best, Evan Dintman, Glen Fernandes, Tony Friedrich, Peter Himchak, Jesse Hornstein, Nichola Meserve, Chris Moore, Marisa Ponte, Will Poston, Cody Rubner, Patrick Rudman, Antonia Santegata, Ross Squire, David Stormer, Taylor Vavra, Mike Waine, Esther Wang, Charles Witek, Steve Witthuhn, Michael Woods

ASMFC Staff: Katie Drew, Emilie Franke

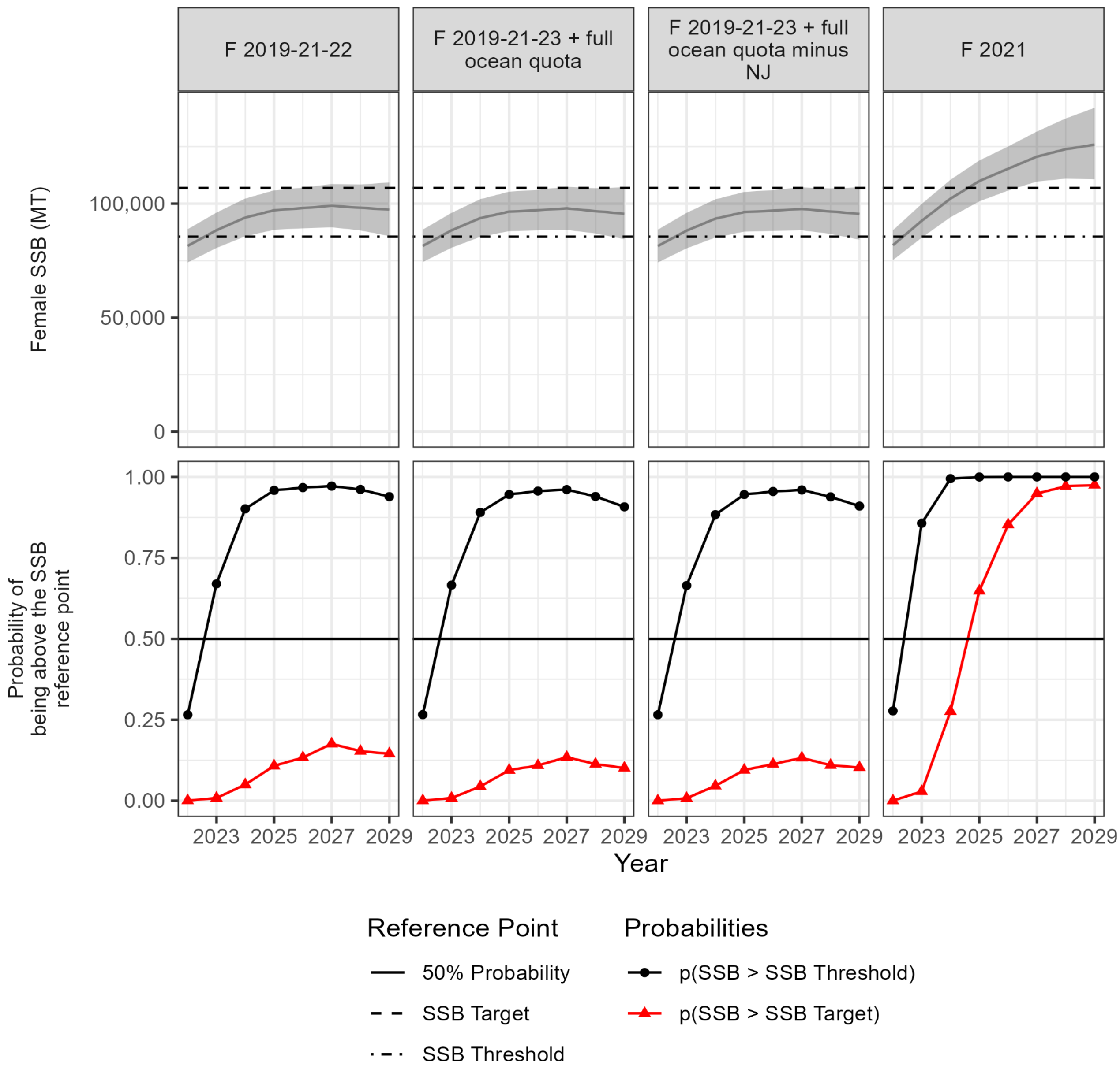

Figure 1. Projected female SSB with 95% confidence intervals (top row) and the probability of SSB being above the SSB reference point (bottom row) for the three new projection scenarios and for the original F_{2021} projection scenario from the 2022 assessment update.

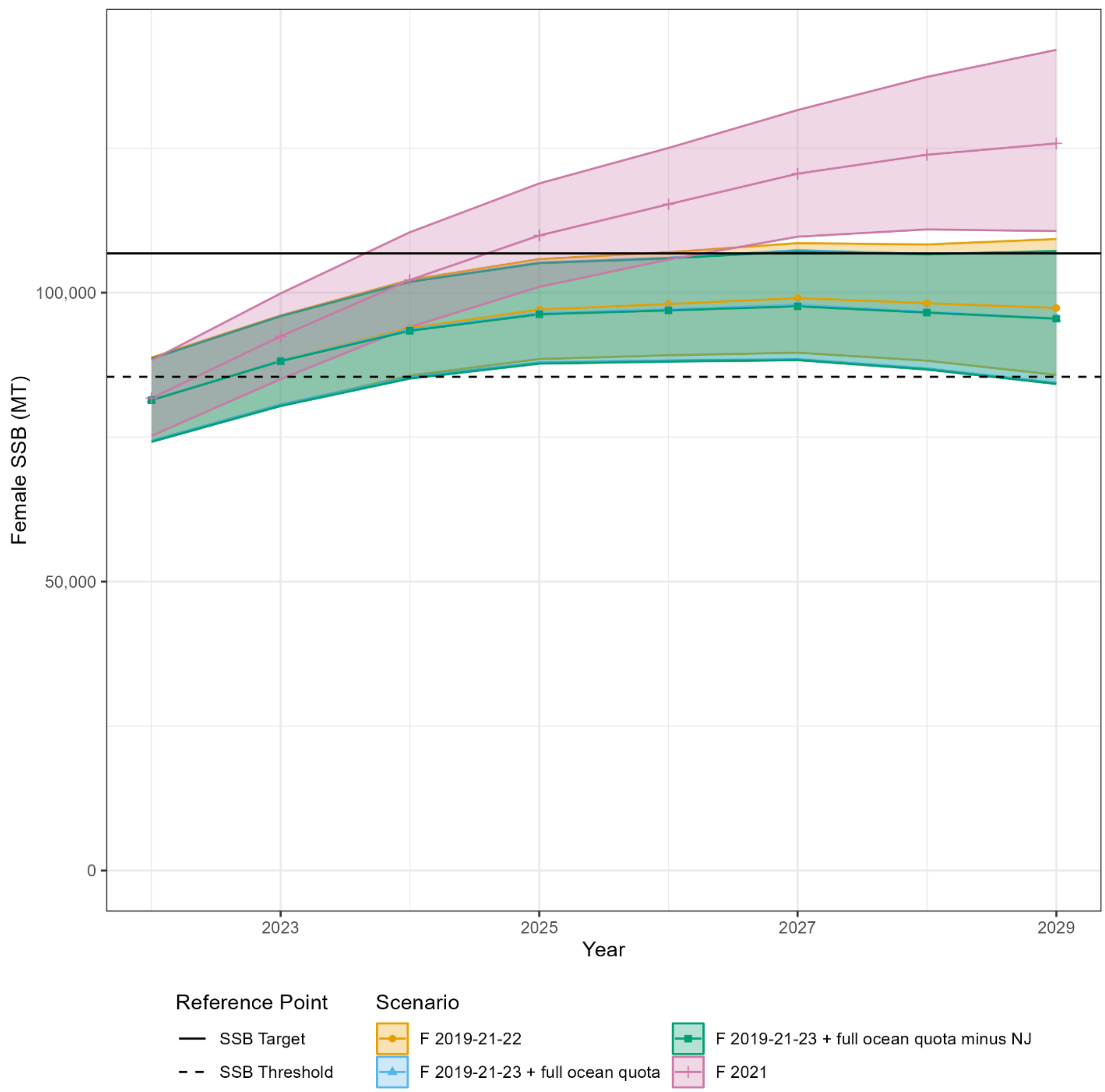

Figure 2. Projected female SSB with 95% confidence intervals for the three new scenarios (yellow, blue, green) and the original F_{2021} projection scenario from the 2022 assessment update (pink).

Appendix. Correction to 2022 Stock Assessment Update Report

Table 10 Corrected. Probability of SSB being at or above the SSB threshold or target under different constant F scenarios. Bolded final row indicates 2029, the rebuilding deadline. Shaded green columns are the corrected probabilities compared to the originally reported values in grey text.

Year	Probability SSB ≥ SSB threshold under current *F*		Probability SSB ≥ SSB target under current *F*		Probability SSB ≥ SSB threshold under *F* target		Probability SSB ≥ SSB target under *F* target		Probability SSB ≥ SSB threshold under *F* threshold		Probability SSB ≥ SSB target under *F* threshold	
2021	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	34.4%	27.9%	0.4%	0.0%	34.5%	27.4%	0.4%	0.0%	34.5%	27.4%	0.4%	0.0%
2023	70.2%	86.1%	14.9%	2.8%	61.9%	76.5%	13.1%	1.3%	53.2%	61.2%	11.6%	0.5%
2024	86.0%	99.3%	39.0%	27.6%	74.1%	95.3%	29.2%	10.0%	61.8%	80.7%	23.2%	2.2%
2025	91.8%	99.9%	56.1%	64.7%	79.3%	99.1%	40.3%	25.1%	64.3%	87.7%	28.6%	4.7%
2026	94.1%	99.9%	65.7%	85.1%	81.4%	99.6%	45.5%	36.7%	63.4%	88.3%	30.3%	5.3%
2027	95.7%	99.9%	72.7%	94.8%	82.8%	99.8%	49.9%	49.0%	63.4%	87.3%	31.9%	5.9%
2028	96.4%	99.9%	76.6%	97.2%	82.8%	99.8%	52.0%	53.4%	61.7%	83.5%	31.6%	5.7%
2029	**96.7%**	**99.9%**	**78.6%**	**97.5%**	**82.4%**	**99.6%**	**52.5%**	**53.9%**	**59.4%**	**76.9%**	**30.5%**	**5.4%**

Corrected values in green