Mid-Atlantic Fishery Management Council
Scientific and Statistical Committee

OFL CV Guidance Document

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Introduction

The Mid-Atlantic Fishery Management Council's (MAFMC) Scientific and Statistical Committee (SSC) currently uses a control rule to specify the acceptable biological catch (ABC; catch level that sets an upper bound for the Annual Catch Limit) for stocks that have accepted estimates of the overfishing limit (OFL; the catch that is expected to achieve the fishing mortality threshold (FMT)). The control rule is based on the P* (probability of overfishing) approach, which is used to calculate a catch level that is expected to achieve a pre-specified probability (P*) of exceeding the maximum fishing mortality rate reference point. In addition to the P*, specified by the MAFMC (Figure 1), the control rule requires a probability distribution for the OFL to describe uncertainty. Because of the difficulty in accurately quantifying the total uncertainty in the OFL, the SSC currently specifies a distribution for the OFL. The point estimate of the OFL from the stock assessment is used as the median of a lognormal distribution with a coefficient of variation (CV) specified by the SSC.

The true uncertainty in the OFL is needed to achieve the MAFMC's goal of a catch limit that meets a specific probability of overfishing. If the CV of the OFL is underestimated, the probability of overfishing will be higher than desired, and, conversely, if the CV of the OFL is too high, then the probability of overfishing will be lower than specified by the Council. The OFL CV is uncertain and difficult to estimate accurately. Three primary sources of uncertainty affect uncertainty in the OFL: uncertainty in the current stock biomass, uncertainty in the FMT and the OFL derived from it, and uncertainty from projecting into the future. Uncertainties in biomass and OFL derive from similar sources. Uncertainty is introduced by sampling variability when data are collected. Additional uncertainty is introduced as a result of assumptions and parameter estimates used in the assessment models. Because assessment models are simplifications of the real world, important uncertainties may be entirely uncharacterized.

Therefore, the OFL is subject to substantial uncertainty, and the true uncertainty (instead of assessment model precision) is very difficult to estimate.

The SSC believes that no single model or even an ensemble of models can fully capture assessment uncertainty. Rigorous consideration of key assessment parameters and assumptions and comparison among model simulations can improve one's understanding of the true but essentially unknowable uncertainty. This document describes the criteria used for determination of bins of uncertainty levels. The ABC is derived from the OFL by assigning the assessment to an appropriate uncertainty bin. Ultimately, the final determination is dependent on expert judgment and qualitative evaluation of a suite of factors that affect uncertainty of the OFL.

The MAFMC SSC has used a range of values, 60-150%, for the CV of the OFL distribution in determining the ABC. However, the MAFMC, stakeholders, and even the SSC itself have questioned the rationale for various values of the OFL CV that have been applied by the SSC as well as the consistency underlying the decisions about OFL CVs among assessed stocks. When the ABC control rule was initially adopted, a default amount of uncertainty was estimated from a meta-analysis of accuracy of estimates from simulation studies of statistical catch-at-age model performance, including the uncertainty in biomass in the last year, uncertainty in the fishing mortality reference point, and their covariance[1]. This analysis indicated that a CV = 100% was a reasonable value for the average CV of the OFL distribution. Since that time, the SSC has chosen CVs for the OFL distribution that differ among stocks (Figure 2, Table 1).

New research[2] looking across many jurisdictions and stock assessments has quantified the level of uncertainty in the OFL estimate among multiple assessments of the same stock. This "inter-assessment consistency" sets a lower bound on the true uncertainty in the OFL, i.e., it is only equal to the true uncertainty if the estimates are centered on the true (but unknown) OFL. Results from this study suggest that the range of OFL CV bins used by the MAFMC SSC is reasonable, and perhaps a bit optimistic on the 60% end. Therefore, unless a stock meets the criteria defined below for a 60% CV, which are largely dependent on data quality rather than assessment decisions, 100% CV will be the minimum uncertainty by default.

The SSC's intent for this document is to elevate confidence in ABC recommendations by continuing to develop and implement a replicable process that meets Council risk policy objectives and identifies relevant components of assessment uncertainty to be provided to the SSC. The approach outlined here will not resolve all scientific uncertainties and problems, and exceptions will arise that are not specifically addressed in this document; however, this

[1] For more information, please see the SSC white paper titled "Description and Foundation of the Mid-Atlantic Fishery Management Council's Acceptable Biological Catch Control Rule" found at: http://www.mafmc.org/s/MAFMC-ABC-Control-Rule-White-Paper.pdf.

[2] Bi, R., Collier, C., Mann, R., Mills, K.E., Saba, V., Wiedenmann, J. and Jensen, O.P., 2023. How consistent is the advice from stock assessments? Empirical estimates of inter-assessment bias and uncertainty for marine fish and invertebrate stocks. Fish and Fisheries, 24(1), pp.126-141.

approach should help alleviate many issues and provide a clear, consistent, and transparent process that documents the SSC deliberations and conclusions.

The SSC's approach to setting OFL CVs is intended to:

- Lead to prudent decisions for catch advice that are consistent in meeting the objectives of the Council's Risk Policy;
- Be based on clear decision criteria that are consistently applied across stocks; and
- Be supportable with scientific evidence.

Decision Criteria

The SSC originally included nine decision criteria to help define an appropriate OFL CV when setting new or revised ABC recommendations. Several years after initial implementation, the SSC reviewed the application and relevance of all nine criteria and reduced the number of criteria to six. All six decision criteria will be considered by the SSC; however, the relative importance and "weighting" of each criteria may be different for each stock and consistent with the approaches and analyses evaluated within each assessment framework. In addition, while these criteria were specifically developed to help in SSC deliberations, they may also be helpful to stock assessment workgroups as they consider and evaluate data and model appropriateness and uncertainty.

The six decision criteria are provided below with supporting language that generally describes the considerations and ideal information the SSC may utilize when considering each criterion.

Of the six criteria considered for setting an overall CV for the OFL, three stand out as the most critical: 1. Data quality; 2. Model appropriateness and identification during the assessment process; and 3. Informed by retrospective pattern. For example, the assigned overall OFL CV should not be lower than the ranking for data quality, as data quality determines uncertainty throughout the assessment process -- an excellent model cannot overcome substantial data deficiencies. Even with data of good quality, poor model choice, or large retrospective patterns in the data due to factors other than data collection, can also seriously and negatively affect the overall uncertainty. Therefore, when evaluating all six criteria, the choice of an overall CV value for the OFL should be no lower than the value of the lowest CV value assigned for any of the first three criteria, collectively called **Tier 1 criteria**.

1. **Data quality (Tier 1)**
    a. Types and quality of available data are primary determinants of the accuracy of any assessment model;
        i. Therefore, this criterion is weighted higher than all others;
    b. Important fishery-independent data considerations include survey design, coverage (of the unit stock area), and efficiency of survey gear;
        i. 60% CV in simulation studies was achieved when survey indices were accurate. In the real world, important considerations for achieving this criterion is that the survey coverage matches the stock's range in time and space;

ii. Missing temporal and spatial survey coverage in areas important to a species increases uncertainty;

c. Fishery-dependent considerations include accuracy and precision of landings and discards;
    i. 60% CV in simulations occurs when fishery catch is known with low uncertainty, e.g., <10%
    ii. For some species, data quality (e.g., predominance of recreational catch) often leads to inherently higher uncertainty that cannot be overcome by low uncertainty in other criteria listed below;
    iii. Need informative data to conduct a stock assessment (would replace criterion 8): the fishery needs to have a measurable effect on the population for typical stock assessments to perform well;
d. Availability of age and/or length data for fishery-independent and dependent sources; validity of underlying assumptions and any potential data borrowing (i.e., gap filling);
    i. 60% CV in simulations was achieved when age data are accurate and highly precise (i.e., no aging error and a random sample from the catch or survey);
e. Data in support of key model parameters;
    i. 60% CV in simulations has M specified at the correct value and relies on appropriate models for catchability and selectivity.

2. <u>Model appropriateness and identification during the assessment process (Tier 1)</u>

a. Model selection process and tests are important for choosing assessment models that are likely to be more accurate (e.g., model sensitivities within a given model structure);
b. Comparison among the assessment baseline model and models with different structures is important to determine the effects of assumptions;
    i. In general, multiple models providing similar information and trends are assigned the lowest uncertainty bin, however;
    ii. Diverging models do not necessarily indicate increased uncertainty. In many cases, models with different assumptions should provide different estimates. If the causes of differences among models are understood, it may still be assigned a lower uncertainty;
    iii. In addition, not all models are equal and some assessment models are known to provide more accurate estimates than other approaches;
    iv. Consistency among models may be because of data processing decisions (e.g., assumptions about age-length keys) rather than model structure;
c. Model appropriateness in capturing species and fishery-specific traits, such as biological characteristics, life history patterns, spatial/stock structure, and fleets;
d. Amount of model testing with consistent or divergent estimates (particularly for management relevant quantities, for example, the OFL or stock status);
e. Appropriateness of model assumptions during the projection period resulting in the catch advice;

f. Current criterion #9 (informed by MSE) could be accounted for here if available in the future.

3. <u>Informed by retrospective analysis (Tier 1)</u>

a. Retrospective pattern is evidence of model misspecification and suggests directionality of change with respect to "true" or at least improved model rather than an unspecified set of alternative models;
b. Recent research[3] suggests that adjustments for retrospective bias perform better than data-limited methods but this adjustment introduces an additional source of uncertainty;
c. Comparison of the adjusted OFL to the uncertainty of the OFL estimated from the baseline model to determine if retrospective pattern is a larger portion of uncertainty.

4. <u>Model estimates informed by comparison with empirical or experimental analyses (Tier 2)</u>

a. Swept area biomass or gear comparisons that suggest appropriate minimum scale of population (maximum gear efficiency, fishing or natural mortality or migration from tagging studies, discard mortality studies etc.);
b. Comparison with other empirical or simpler measures of trend; e.g., survey Z, Beverton-Holt length-based Z.

5. <u>Informed by ecosystem factors or comparisons with other species (Tier 2)</u>

a. Ecosystem factors considered may reduce or increase uncertainty; simply considering an ecosystem factor does not automatically decrease uncertainty;
b. Stock-relevant ecosystem factors directly included in the assessment model, e.g.,:
    - Environmentally dependent growth or other population processes;
    - Environmentally dependent availability or other observation processes;
    - Factors limiting/enhancing stock productivity (habitat quality, etc.);
    - Predation, disease, or episodic environmental mortality (e.g., red tide);
    - Time varying inputs such as empirical weight at age or stanzas of growth not explicitly tied to ecosystem factors are considered under criterion #2, not here. Stanzas of recruitment not explicitly tied to ecosystem factors are considered under criterion #6;
c. Ecosystem factors outside the stock assessment affecting short term prediction can inform uncertainty, e.g.,:
    - General measures of ecosystem productivity and habitat stability (e.g., primary production amount and timing, temperature trends, and other MAFMC EAFM risk assessment indicators at the stock or ecosystem level);

[3] Legault, C.M., Wiedenmann, J., Deroba, J.J., Fay, G., Miller, T.J., Brooks, E.N., Bell, R.J., Langan, J.A., Cournane, J.M., Jones, A.W. and Muffley, B., 2022. Data-rich but model-resistant: an evaluation of data-limited methods to manage fisheries with failed age-based stock assessments. Canadian Journal of Fisheries and Aquatic Sciences, 80(1), pp.27-42.

- Climate vulnerability or other risk assessment evaluation of potential for changing productivity under changing conditions;
- Acute ecosystem events potentially affecting stock dynamics across the stock range over the short term (e.g., marine heat waves, acidification or hypoxia events, harmful algal blooms);

d. Comparisons among related species; e.g., recruitment, growth, condition patterns across Mid Atlantic fish species that are: stable (low uncertainty), varying synchronously (supports common environmental driver, lower uncertainty), or varying unpredictably (higher uncertainty).

6. **<u>Informed by appropriate stanzas in recruitment (primarily affecting the accuracy of forecasts) (Tier 2)</u>**
   a. Uncertainty increases as recruitment patterns become less consistent, or if there is no recruitment estimate to inform short term predictions;
   b. Potentially decreased uncertainty if linked to environmental driver (see above);
   c. Uncertainty can be mitigated by recognizing stanzas of abundance for recruits; for example, decreasing R/SSB as SSB decreases (evidence of depensation). Depending on degree of depensation observed, an ABC set to zero may be warranted.

General Framework Discussion Table

The framework table is intended to provide qualitative assessment of the six criteria and is not to be used to tabulate a specific score. Instead, the table will help the SSC document deliberations, ensure a consistent process is followed for all species and assessments, and help the Council and public understand the rationale for the decision reached by the SSC.

The table currently has OFL CV default values (bins) of 60%, 100%, and 150%, which were derived from a variety of simulation analyses, MSE evaluations, and expert judgment by the SSC. As new information, analyses, and assessment methods become available, the SSC may modify the default OFL CV bins or recommend a different OFL CV for a specific species assessment. If any changes to the current default OFL CV values are warranted, the SSC will provide justification and supporting documentation as to why a different value was recommended.

The framework table below provides general evaluation metrics associated with the six decision criteria for each OFL CV bin. The focus of this table is to characterize uncertainty for the catch specification period for the stock (next 2-6 years).

Decision Criteria	Default OFL CV=60%	Default OFL CV=100%	Default OFL CV=150%
Data quality	One or more synoptic surveys of the whole stock area for multiple years. High quality monitoring of landings and size and age composition. Long term, precise monitoring of	Low precision synoptic surveys or one or more regional surveys which lack coherency in trend. Age and/or length data available with uncertain quality. Lacking or imprecise	No reliable abundance indices. Catch estimates are unreliable. No age and/or length data available or highly uncertain. Natural mortality rates are unknown or suspected to be

	discards. Landing estimates highly accurate.	discard estimates. Moderate accuracy of landings estimates.	highly variable. Incomplete or highly uncertain landings estimates.
Model appropriateness and identification process	Multiple differently structured models agree on outputs; many sensitivities explored. Model appropriately captures/considers species life history and spatial/stock structure.	Single model structure with many parameter sensitivities explored. Moderate agreement among different model runs indicating low sensitivities of model results to specific parameterization.	Highly divergent outputs from multiple models without indication of which scenario is most likely or no exploration of alternative model structures or sensitivities.
Retrospective analysis	Minor retrospective patterns.	Moderate retrospective patterns.	No retrospective analysis or severe retrospective patterns (e.g., terminal year values adjusted and outside confidence region).
Comparison with empirical measures or experimental analyses	Assessment biomass and/or fishing mortality estimates compare favorably with empirical estimates.	Moderate agreement between assessment estimates and empirical estimates or simpler analyses.	Estimates of scale are difficult to reconcile and/or no empirical estimates.
Ecosystem factors accounted	Assessment considers habitat and ecosystem effects on stock productivity, distribution, mortality and quantitatively includes appropriate factors reducing uncertainty in short term predictions. And/or evidence outside the assessment suggests that ecosystem productivity and habitat quality are stable or accountable. And/or ecosystem events affecting stock in the short term are absent. And/or comparable species in the region have synchronous production characteristics and stable short-term predictions. And/or climate vulnerability analysis suggests low risk of change in productivity due to changing climate.	Assessment considers habitat/ecosystem factors but does not demonstrate either reduced or inflated short-term prediction uncertainty based on these factors. And/or evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable. And/or acute ecosystem events are likely to have a low to moderate risk of affecting the stock in the short term. And/or mixed productivity and uncertainty signals among comparable species in the region. And/or climate vulnerability analysis suggests moderate risk of change in productivity from changing climate.	Assessment either demonstrates that including appropriate ecosystem/habitat factors increases short-term prediction uncertainty, or does not consider habitat and ecosystem factors. And/or evidence outside the assessment suggests that ecosystem productivity and habitat quality are variable and degrading. And/or acute ecosystem events are likely to have a high risk of affecting the stock in the short term. And/or comparable species in the region have high uncertainty in short term predictions. And/or climate vulnerability analysis suggests high risk of changing productivity from changing climate.
Appropriate stanzas in recruitment	Consistent recruitment pattern with no trend.	Moderate levels of recruitment variability or modest consistency in pattern or trends. OFL estimates adjusted for recent trends in recruitment. OFL estimate appropriately accounted for recent trends in recruitment.	Recruitment pattern highly inconsistent and variable. Recruitment trend not considered or no recruitment estimate.

A worked example evaluation of the six criteria provided in the table above is provided for Scup (see page 9).

Process for OFL Determination

The SSC's consideration, evaluation, and discussion of the six decision criteria in determining the appropriate OFL CV level could potentially become cumbersome and time-consuming to be handled effectively during an SSC meeting, particularly if multiple species-specific ABC recommendations are required. In an effort to add efficiency to the ABC-setting process while still allowing for extensive SSC input and discussion, the SSC species lead will develop a draft, non-binding document evaluating the six decision criteria ahead of the SSC meeting. This document will be posted as part of the SSC meeting materials and available to SSC members for review ahead of the meeting in which an ABC recommendation is required. The process for developing the pre-decisional document and the SSC's OFL CV determination will follow the steps outlined below:

- Upon completion of a stock assessment, the appropriate SSC species lead, seeking input on critical factors and information to highlight from the stock assessment lead and Council staff as necessary, will evaluate the six decision criteria and develop a draft summary document that provides an overview of relevant assessment information, key findings, and any additional pertinent information for each decision criterion. The summary document would also include a draft narrative (see example narrative on page 12 below) that identifies the most important decision criteria specific to the species and stock assessment under consideration and highlights any other relevant information. The narrative would not include an OFL CV recommendation.
- The draft summary document and narrative will be provided to the full SSC and posted as part of the meeting materials in advance of the meeting in which the ABC recommendations will be made.
- During the SSC deliberations to address the ABC Terms of Reference, the SSC species lead will provide an overview of the pertinent information associated with the six decision criteria and draft narrative.
- SSC members present at the meeting will discuss and deliberate any/all information available in order to make an OFL CV recommendation. The SSC meeting summary report will contain both the completed framework table with an evaluation and rationale of the six decision criteria and a summary narrative. Providing both the framework table and narrative in the meeting summary will provide a comprehensive record of the SSC's deliberations and justification for their recommendation for future reference.

Given the additional work and preparation necessary prior to a scheduled SSC meeting as described above, increased coordination among the SSC, NEFSC, and Council staff will be critical to ensure stock assessment documents and information are available in a timely manner. Ideally, stock assessment documents and any other pertinent information would be available at least three weeks prior to the scheduled SSC meeting. The SSC species lead would provide the draft summary document to the SSC chair, vice chair, assessment lead, and Council staff at least

two weeks prior to the scheduled SSC meeting for review and feedback. The draft summary document would then be available to the SSC and posted to the meeting materials at least one week prior to the scheduled SSC meeting. In addition, continued SSC involvement in the NRCC stock assessment process[4] that includes research track and management track assessments (i.e., chairing research track and management track assessment reviews, embedding with the assessment work group) will play a critical and informative role in the process to help ensure the timing and deadlines are achieved.

Worked Example

Below is a worked example for Scup based on the results of the 2023 Management Track assessment. The worked example includes the SSC OFL recommendation, an evaluation of the six decision criteria as outlined in the framework table and a short narrative documenting key conclusions.

Based on an evaluation of the six decision criteria, the SSC recommends a CV of 100% be applied to the OFL estimate to derive an appropriate ABC for Scup in fishing years 2024-2025.

Decision Criteria	Summary of Decision Criteria Considerations	Assigned OFL CV Bin (60/100/150)
Data quality **Tier 1**	**Surveys** ● Synoptic surveys over the stock area include the NEFSC spring and autumn bottom trawl surveys, but these surveys show large interannual fluctuations that reflect availability rather than abundance in any single year. ● Surveys generally rarely catch fish age three and older, although older ages are present in commercial and recreational catch at ages. Other surveys do not cover the entire stock area, and most catch few fish over age 2. The inclusion of multiple state surveys, which by themselves are geographically restricted, enable broader coverage of the stock area in aggregate. ● Covid-related issues limited coverage of state and federal surveys in recent years (2020-2022). **Landings and discards** ● Commercial landings have been well sampled for length and age since 1995. Some concern about declining commercial port sampling in 2022 should this continue because older age groups are caught in the commercial fishery..	60%

[4] For more information, please see: New England and Mid-Atlantic Region Stock Assessment Process (updated Feb 2022)

	• Commercial discards have been fairly well sampled since 2000, although discard observations are highly variable and skewed. • New MRIP data are now being used to estimate recreational landings and discards. • About 53% of the estimated total catch and discards in weight in 2022 was from the recreational fishery. • Length sampling of recreational landings has generally been adequate since 1988. • Recreational discard is low. • Covid-related issues introduced uncertainty into catch estimates, requiring imputation methods for 2020-2022 estimates.	
Model appropriateness and identification process **Tier 1**	• The assessment model is based on a complex statistical catch-at-age model (ASAP SCAA). • Catch is modelled as four fleets (commercial and recreational landings and discards). • Life history does not require special modelling adjustments. • Addition of new selectivity block improved the model diagnostics for the 2021 and 2023 management track assessments. • A significant portion of the stock biomass is represented by the plus group, which is assumed to be lightly exploited because of the selectivity pattern applied. • About 25 different configurations were explored in the 2015 benchmark. • Model results suggest that the population has responded as expected to changes in fishing mortality. Rates declined by more than four-fold over the assessment series, while SSB increased more than ten-fold. • The effect of new MRIP estimates on continued validity of prior sensitivity analyses depends on the magnitude of the change. Because the proportion of landings attributable to new MRIP estimates is relatively low, we could expect sensitivity analyses to remain valid. • Biological reference points were updated in the 2023 management track assessment.	100%
Retrospective analysis **Tier 1**	• Retrospective patterns were not degraded from earlier assessment results following the addition of the 2013-present selectivity block. • The retrospective pattern has become more pronounced over time leading to underestimation of SSB and overestimation of F. • Adjusted 2022 SSB estimates were outside the model-estimated 90% confidence intervals, thus a retrospective adjustment was made for both for the determination of stock status and for projections of catch and biomass in 2024 and 2025.	100%

	• General trends in retrospective patterns for SSB, R, and F have been consistent for the past five assessments. • Retrospective adjustment application at 90% CI threshold results in a discontinuity	
Comparison with empirical measures or simpler analyses **Tier 2**	• Age structure in fishery and survey catches has been expanding since the 1990s. • Aggregate survey indices remain near time series highs. • Several large recruitment events likely gave rise to survey index highs. • Given the potential effects of availability in any given year, swept area estimates of biomass are less reliable than for some other stocks. • No empirical estimates of scale are available.	100%
Ecosystem factors accounted **Tier 2**	• No ecosystem factors were considered in the assessment, but mean weights at age and maturity at ages 2 and 3 continue to decline. • Previous assessments examined thermal habitat models to evaluate factors affecting availability, but no strong signals were observed. • Scup are considered moderately vulnerable to climate effects in the Hare et al. (2016) report.	100%
Trend in recruitment **Tier 2**	• Recruitment has been consistent with no apparent trend; although the year classes in 2014 and (especially) 2015 were above average, the 2016 – 2021 year classes were below average. • R/SSB has declined over the time series and has remained low, as would be expected given the large stock size. • OFL projections were sampled from estimated recruitment for 1984-2022; the SSC found this to be appropriate.	60%

Example OFL CV Recommendation Narrative

Based on a stepwise evaluation of Tier 1 and Tier 2 criteria, the SSC recommends using an OFL coefficient of variation (CV) level of 100%. Tier 1 criteria establish the minimum possible value of the CV irrespective of how well other criteria are met. Under the Tier 1 criteria (Data quality, model appropriateness, and retrospective pattern), the need to adjust biomass and fishing mortality rates for retrospective pattern led the SSC to assign a CV=100%. While the model improvements were significant and data quality is high, they were insufficient to offset a trend toward increasing Mohn's Rho from earlier assessments. Statistically significant retrospective patterns suggest undetected changes in either data quality or process error. CVs assigned to the Tier2 criteria (empirical comparisons, ecosystem factors, and recruitment stanzas) ranged between 60 and 100% but did not alter the assignment of the overall CV. Details for these decisions are provided in Attachment 5.

The overall quality of the data supporting this assessment is high. Consistent signals from surveys and catch-at-age data agree with underlying theory. Several surveys show declines or low abundance in early years to record lows in the mid-1990s and increases in abundance thereafter. Age structure in surveys shows a decline or low abundance of older ages in survey catches in early years and increases in abundance of older ages in recent years. Age structure in commercial landings-at-age and recreational landings-at-age show similar trends of increasing abundance of older ages in the stock. Several large recruitment events have been indicated by survey indices. In combination, these trends are consistent with lower fishing mortality rates in recent years, and increasing stock abundance as indicated by model results.

Although 53% of the catch weight in 2022 is attributable to the recreational fishery, the increase in recreational catch related to the new MRIP estimation methodology is relatively low in comparison to other stocks. No clear trends in recent recruitment over the past decade are apparent but a declining trend in recruitment may be emerging. Restriction of projected recruitment to a more recent stanza currently appears unwarranted. There is no discernable impact of thermal habitat on interannual variation in availability, so adjustment of survey indices to account for thermal habitat effects also appears unwarranted.

The increase of the overall OFL CV from 60% in 2021 to 100% in 2023 is driven by the increase in retrospective pattern (Criteria 3) in Tier 1 from 60% to 100%. In the 2021 assessment, the Mohn's Rho was approaching, but not over, the 90% CI threshold. Mohn's Rho for SSB in the 2021 assessment was -14% and is now -21%; Mohn's Rho F in 2021 was +20% and has now increased to +42%. Since the adjusted 2022 SSB estimates based on the retrospective patterns were outside the model-estimated 90% confidence intervals, a retrospective adjustment (correction) was made for both the determination of stock status and for projections of catch and biomass in 2024 and 2025. Inclusion of the retrospective correction creates a discontinuity that affects the overall uncertainty in the OFL. The need for correction is indicative of lack of model fit and/or inconsistent data, and should be monitored in future assessments.

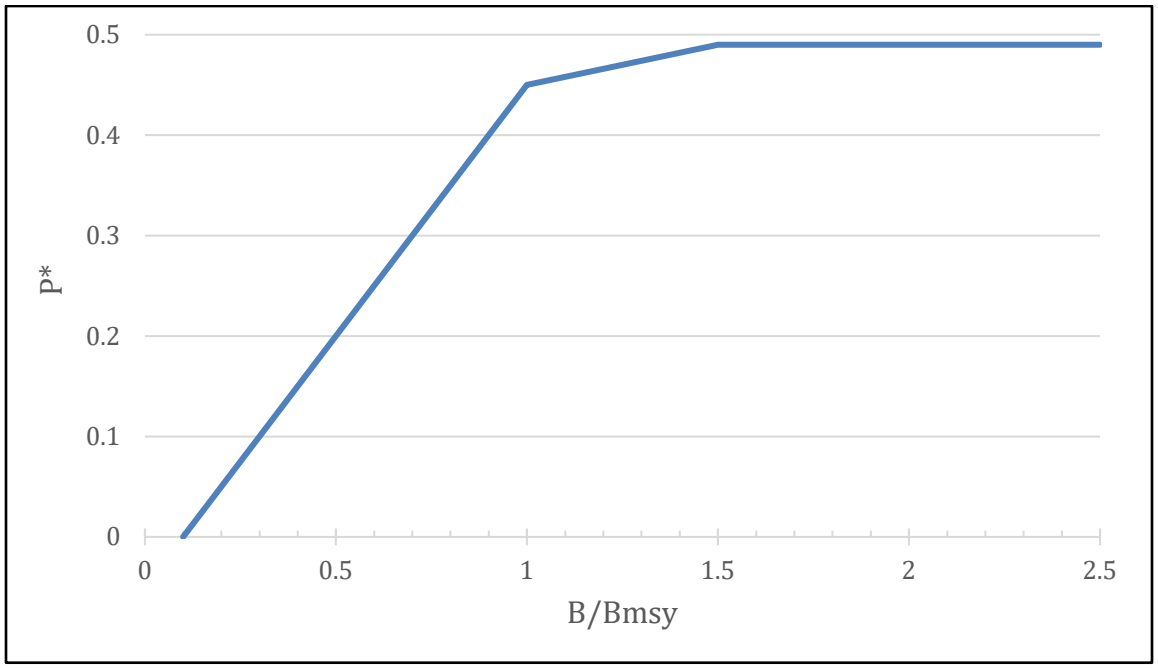

Figure 1. Acceptable probability of overfishing (P*) as a function of stock size adopted by the MAFMC (December 2020). The acceptable probability of overfishing is zero if relative biomass (projected biomass divided by the expected biomass if the stock was fished at the maximum fishing mortality rate threshold) is less than 0.1. The acceptable probability of overfishing increases to 0.45 as relative biomass approaches 1 and then increases to its threshold of 0.49 as the relative biomass approaches 1.5.

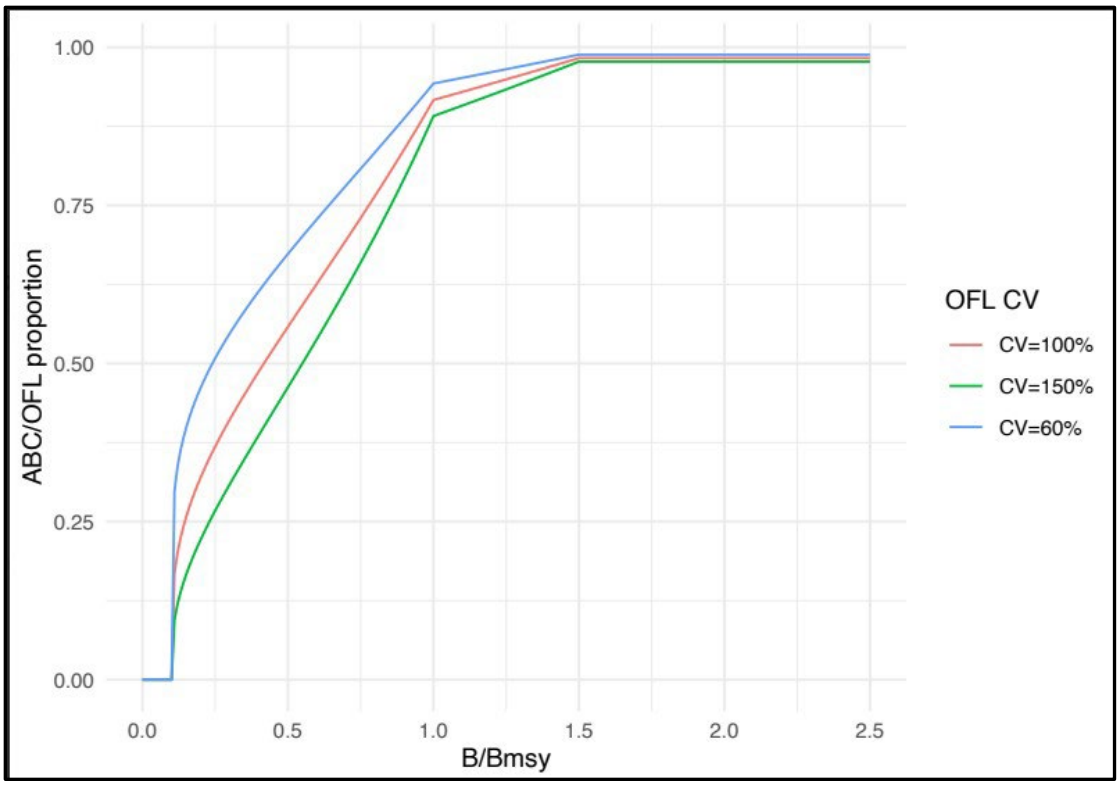

Figure 2. Effect of different CV values currently selected by the MAFMC SSC on the ratio of ABC to OFL for varying levels of biomass relative to the B_{MSY} as determined by the Council's risk policy (revised in 2021). Note that the decision on OFL CV makes the most difference for stocks with low biomass status.

Table 1. Example Acceptable Biological Catch (ABC) values derived from the application of the Mid-Atlantic Council's under the currently used OFL CV values. ABC values are in MT and assume an OFL of 1,000 MT. Note: stocks with a B/Bmsy ratio of ≤ 0.5 would be subject to a rebuilding plan and ABCs would be established as part of the rebuilding plan approved by the Council which may/may not be determined using the standard application of the risk policy and ABC control rule.

B/Bmsy ratio	ABC with a 60% OFL CV	ABC with a 100% OFL CV	ABC with a 150% OFL CV
≥ 1.50	986.2	979.3	973.2
1.25	959.1	939.3	921.5
1.00	932.7	900.7	872.5
0.75	777.5	685.4	611.0
0.50	627.1	496.2	401.0
0.25	450.1	301.6	209.5
0.10	0.0	0.0	0.0