Omnibus Acceptable Biological Catch and Risk Policy Framework Adjustment

Framework Meeting 2 Discussion Document

December 9, 2019

Annapolis, Maryland

Introduction:

In 2011, the Mid-Atlantic Fishery Management Council (Council) implemented the current risk policy and Acceptable Biological Catch (ABC) control rule to comply with the 2006 re-authorization of the Magnuson-Stevens Act (MSA)[1]. The risk policy specifies the Council's acceptable level of risk (i.e., the probability of overfishing, P*) and works in conjunction with the Scientific and Statistical Committees (SSC) application of the ABC control rule to account for scientific uncertainty to determine an ABC for a specific stock. Five years after implementation, the Council agreed to conduct a review of the current risk policy and determine if any modifications were necessary to meet the Council's goals and objectives for its managed fisheries. During the risk policy review, the Council expressed interest in evaluating not only biological factors but to also more comprehensively consider economic and social factors and the potential implications of any risk policy alternatives. The Council specified that the evaluation should assess the short and long-term trade-offs between stock biomass protection, fishery yield, and economic benefits. In addition, the Council agreed that any alternatives considered would retain the biologically based foundation of the existing risk policy of specifying a probability of overfishing (P*) that is conditional on the current stock biomass relative to B_{MSY} and would not explicitly include but consider economic factors, targets or thresholds.

In 2019, a workgroup comprised of NOAA Fisheries staff, SSC members, academia and Council staff was formed and tasked with further developing and analyzing the current risk policy and any potential alternatives. Members of the workgroup built off their existing biological[2] and economic[3] management strategy evaluation (MSE) models. These models were updated to include the summer flounder benchmark assessment data, the new MRIP recreational catch information and refined to address specific Council objectives. The workgroup met on five separate occasions to review and discuss risk policy alternatives, conduct new and additional analyses needed to evaluate the biological and economical trade-offs associated with each alternative, and provide any recommendations and considerations.

The Council held the first framework meeting in August 2019[4] and reviewed and approved nine different alternatives for further analysis and evaluation. The Council is scheduled to take final action on the omnibus risk policy framework at their December 2019 meeting. provide feedback and approve draft alternatives for further analysis and evaluation.

This discussion document contains an overview of the different risk policy alternatives being considered by the Council, a summary of the results of the biological and economic MSE analyses, and the staff recommendation to help support Council deliberations. Comprehensive

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[1] For more information on the development and implementation of the risk policy and ABC control rule, please see the omnibus amendment at: http://www.mafmc.org/s/2011-Omnibus-ABC-AM-Amendment.pdf

[2] For more information on the biological MSE, see summary report and presentation in the February 2018 Council meeting materials at: http://www.mafmc.org/briefing/february-2018.

[3] For additional details on the summer flounder economic MSE, please see summary report and presentation in the December 2018 Council meeting materials at: http://www.mafmc.org/briefing/december-2018.

[4] See the August 14, 2019 omnibus acceptable biological catch and risk policy framework adjustment discussion document. Available at: http://www.mafmc.org/s/Tab09_Risk-Policy-Framework_2019-08.pdf

final reports outlining the methods, model structure, and results of the biological and economic models are included as materials in the December briefing book.

Overview of Alternatives:

There are nine different risk policy alternatives, including *status quo*, for Council consideration. Six of the alternatives (Alternatives 1 – 5 and 9) were previously provided to the Council during the initial framework review in 2017. Three new alternatives were identified and analyzed during this framework process. Alternatives 6 and 7 were developed by the workgroup and presented to the Council as part of framework meeting 1. During that review and discussion, the Council developed a new alternative (Alternative 8) that combined certain aspects of Alternatives 6 and 7. Alternative 9, removal of the typical/atypical designation, does not specify a risk policy but could be applied to any of the other eight alternatives.

Under any of the risk policy alternatives provided below, the existing language on the application of the risk policy to stocks under a rebuilding plan or for those stocks with no OFL, or OFL proxy, would remain as currently implemented (see page 3 of the August 2019 risk policy discussion document for more details).

Below is the rationale and description on how the risk policy would be applied for each alternative.

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1. **Current risk policy/*status quo* – linear ramping with a maximum P* of 0.4 when the B/B$_{MSY}$ ratio is equal to or greater than 1.0**

This alternative would retain the existing risk policy with the acceptable probability of overfishing (P*) for a given stock conditional on current stock biomass relative to B_{MSY} and a maximum P* set at 0.4 (see Figure1). The stock replenishment threshold defined as the ratio of B/B_{MSY} = 0.10, is utilized to ensure the stock does not reach low levels from which it cannot recover. The probability of overfishing is 0 percent (i.e., no fishing) if the ratio of B/B_{MSY} is less than or equal to 0.10. The P* increases linearly as the ratio of B/B_{MSY} increases, until the inflection point of B/B_{MSY} = 1.0 is reached. A maximum P* of 0.4 or 0.35 is utilized (typical or atypical stock, respectively) for ratios equal to or greater than 1.0. The SSC determines whether a stock is typical or atypical each time an ABC is recommended.

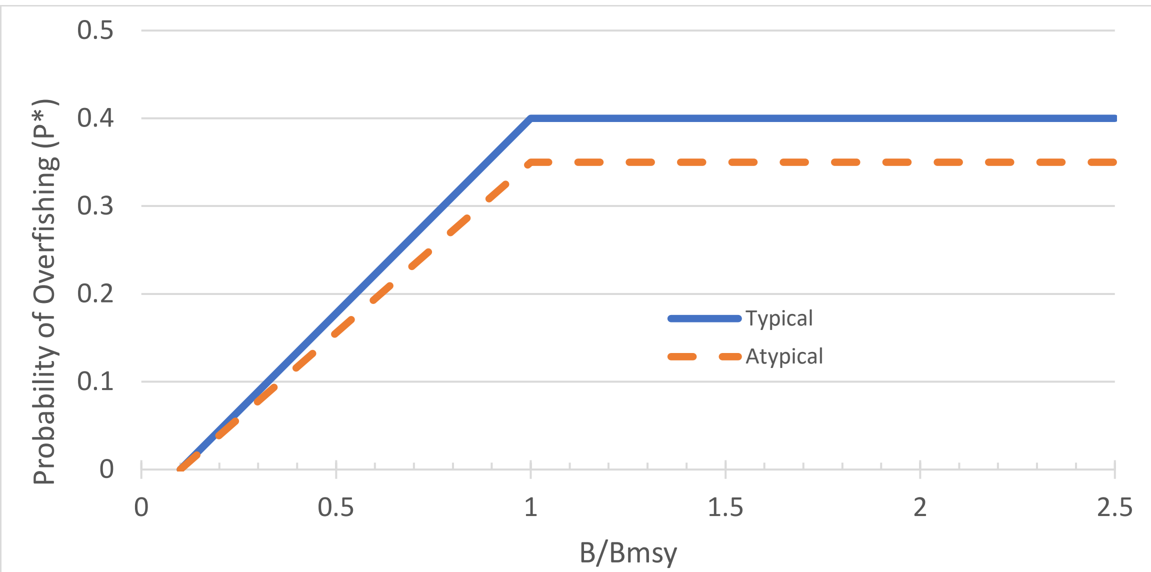

Figure 1: Alternative 1, *status quo* – the current Mid-Atlantic Fishery Management Council risk policy.

2. **Linear ramping with a maximum P* of 0.45 when the B/B$_{MSY}$ ratio is equal to or greater than 1.0**

Under this alternative, the Council would assume a higher level of risk (P*=0.45) than the current policy (P*=0.40) in cases where the stock biomass was greater than the B_{MSY} target. Under this alternative, the P* would be variable and conditioned on current stock biomass when stock size falls below B_{MSY} as per the current risk policy but would be held constant at 0.45 when stock size exceeds B_{MSY} (Figure 2A). The maximum P* of 0.45 is higher than the current Council risk policy but is lower than the 0.50 maximum allowed under the MSA.

A P* of 0 percent if the ratio of B/B_{MSY} is less than or equal to 0.10 would remain to ensure a stock does not reach low levels from which it cannot recover. It is worth noting that by increasing the maximum P* to 0.45 under this alternative, the slope of linear ramping portion to determine a P* for stocks whose biomass is less than B_{MSY} is also modified (Figure 2B). Therefore, when compared to the current risk policy, this alternative would result in slightly higher P* values (higher risk of overfishing) under the same current stock biomass when less than B_{MSY}.

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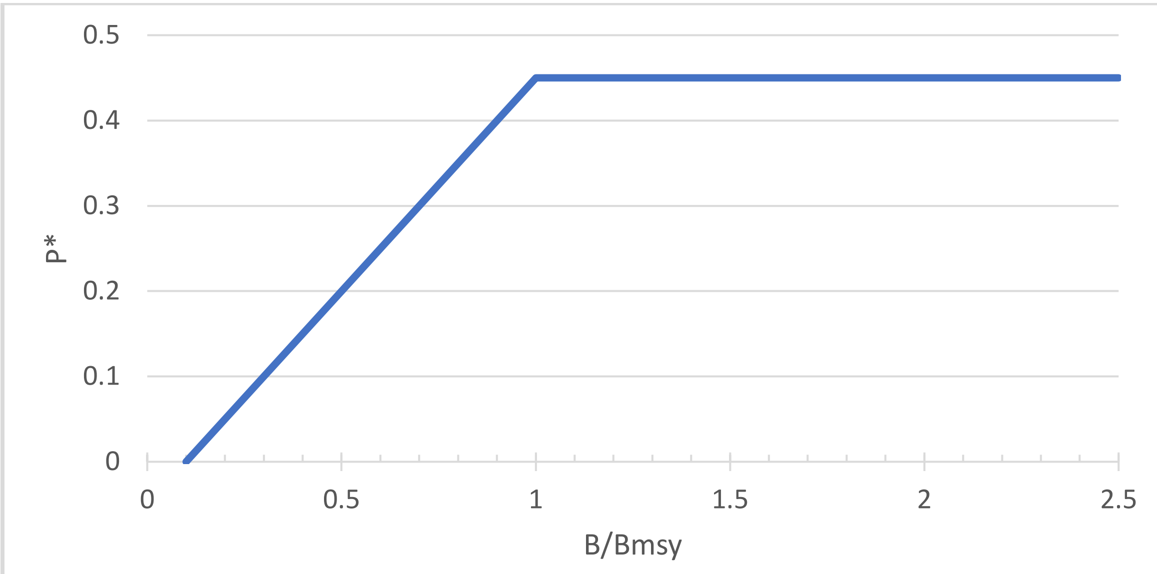

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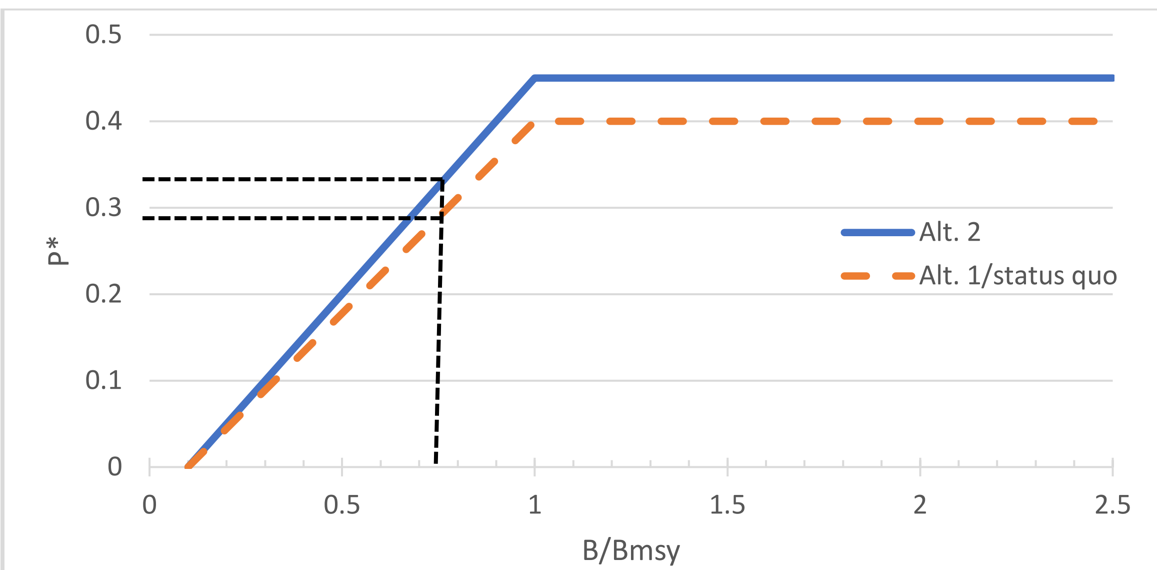


Figure 2: A) Alternative 2 with a variable probability of overfishing (P*) up to a maximum P* of 0.45 when the B/B_{MSY} ratio is equal to or greater than 1.0. **B)** Comparison between Alternative 1/*status quo* (typical life history) and Alternative 2. Dashed lines show the difference between the two alternatives in the P* calculation under the same biomass ratio.

3. **Constant P* equal to 0.40**

Under this alternative, the variable P* as a function of stock biomass would be removed and a constant P* equal to 0.4, the current maximum P* value, would be maintained under all circumstances (Figure 3). The P* of 0.4 would be applied regardless of current stock biomass, rebuilding status, life history etc. The current ramping of the P* conditioned on biomass is an attempt to prevent stocks from being overfished by reducing the probability of overfishing as stock size falls below B_{MSY}. However, this feature of the current risk policy is not a mandatory requirement of the MSA.

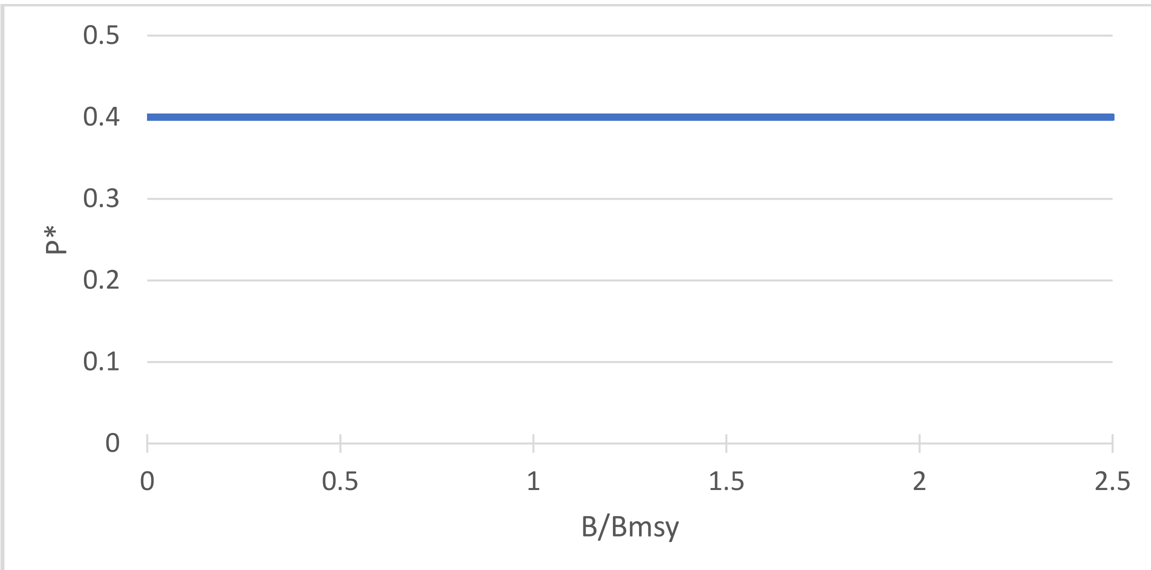


Figure 3. Alternative 3 with a constant P* equal to 0.40 under all stock biomass conditions.

4. **Two step P* - constant P* equal to 0.40 for B/B_{MSY} ratios less than 1.0 and a constant P* at 0.45 for B/B_{MSY} ratios equal to or greater than 1.0**

Under this alternative, current stock biomass relative to B_{MSY} would be considered but instead of applying a variable P* associated with the current policy, a constant P* equal to 0.40 or 0.45 would be applied depending upon the B/B_{MSY} ratio (Figure 4). For stocks whose biomass is less than B_{MSY} (B/B_{MSY} ratio less than 1.0), a constant P* equal to 0.40, the current maximum P* value, would be applied. For stocks whose biomass is equal to or greater than B_{MSY} (B/B_{MSY} ratio equal to or greater than 1.0), a constant P* equal to 0.45 would be applied. This maximum P* value is higher than the current Council risk policy maximum but lower than the 0.50 maximum allowed under the MSA.

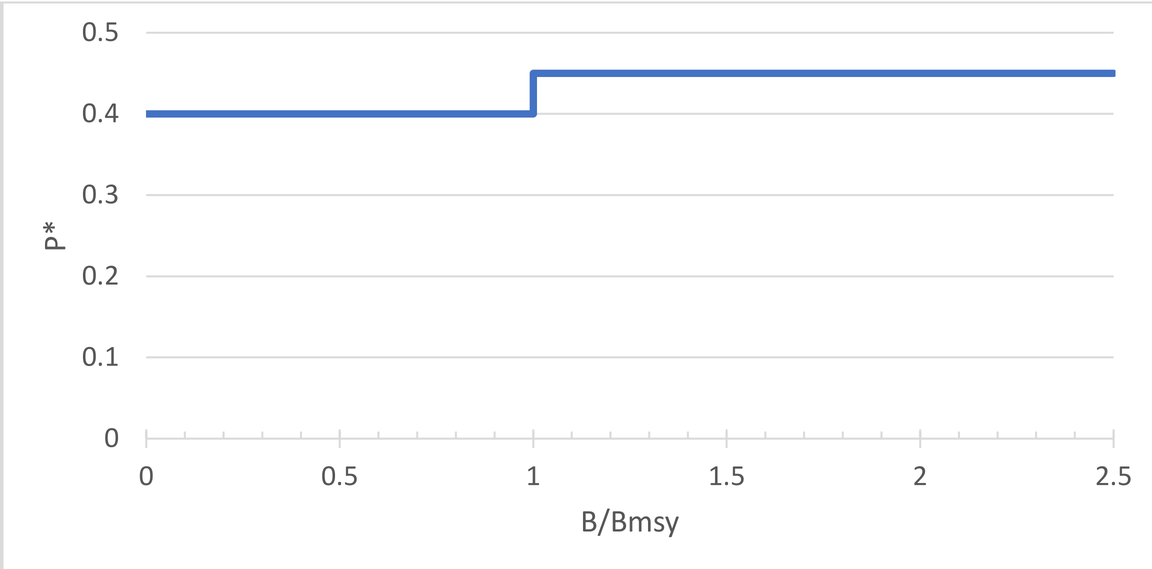


Figure 4. Alternative 4, a two-step P* with a constant P* equal to 0.40 when the B/B_{MSY} ratio is less than 1.0 and a constant P* equal to 0.45 when the B/B_{MSY} ratio is equal to or greater than 1.0.

5. **Three step P* - constant P* equal to 0.35 when the B/B_{MSY} ratio is less than 0.75, constant P* of 0.40 when the B/B_{MSY} ratio is between 0.75 and 1.0 and a constant P* of 0.45 when the B/B_{MSY} ratio is equal to or greater than 1.0**

Similar to Alternative 4, under this alternative, current stock biomass relative to B_{MSY} would be considered but instead of applying a variable P* associated with the current policy, a constant P* equal to 0.35, 0.40 or 0.45 would be applied depending upon the B/B_{MSY} ratio (Figure 5). For stocks whose biomass is more than 25 percent below B_{MSY} (B/B_{MSY} ratio less than 0.75), a lower risk would be assumed and a constant P* equal to 0.35 would be applied. When stock biomass is less than B_{MSY} but equal to or less than 25 percent below B_{MSY} (B/B_{MSY} ratio equal to or greater than 0.75 but less than 1.0), a constant P* of 0.40 would be applied. For stocks whose biomass is equal to or greater than B_{MSY} (B/B_{MSY} ratio equal to or greater than 1.0), a higher risk would be assumed and a constant P* equal to 0.45 would be applied. This alternative considers current stock biomass and would implement a lower risk tolerance under lower stock biomass conditions and increasing risk with increasing stock biomass.

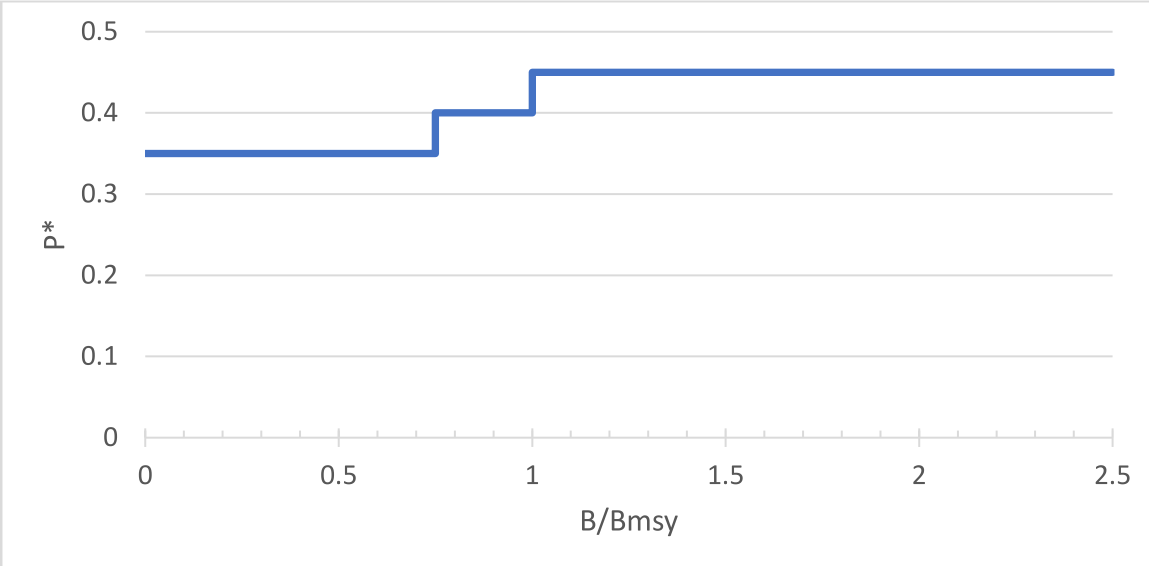


Figure 5. Alternative 5, a three-step P* with a constant P* equal to 0.35 when the B/B_{MSY} ratio is less than 0.75, a constant P* equal to 0.40 when the B/B_{MSY} ratio is greater than or equal to 0.75 but less than 1.0, and a P* equal to 0.45 when the B/B_{MSY} ratio is greater than or equal to 1.0.

6. **Linear ramping with a maximum P* of 0.40 when the B/B_{MSY} ratio is less than or equal to 1.0 and a linear ramping with a maximum P* of 0.49 when the B/B_{MSY} ratio is equal to or greater than 1.5**

Under the alternative, linear increases in the P* would occur as the ratio of B/B_{MSY} increases to a maximum of 0.40 at the inflection point of B/B_{MSY} = 1.0. This is consistent with the current risk policy. Once stock biomass exceeds B_{MSY} and the B/B_{MSY} ratio is equal to or greater than 1.0, linear increases in the P* would then occur to a maximum P* of 0.49 at the inflection point of B/B_{MSY} = 1.5. The maximum P* of 0.49 would then be applied when B/B_{MSY} ratios are equal to or greater than 1.5 (Figure 6). This alternative seeks to prevent stocks from being overfished by reducing the probability of overfishing as stock size falls below $B_{MSY;}$ while also allowing for increased risk under high stock biomass conditions that are 1.5 times greater than B_{MSY}. Consistent with the current risk policy, this alternative would also implement a P* of 0 percent if the ratio of B/B_{MSY} is less than or equal to 0.10 would remain to ensure the stock does not reach low levels from which it cannot recover.

A B/B_{MSY} ratio of 1.5 indicates a very robust stock with favorable conditions that are substantially above the B_{MSY} target, even with uncertainty in the terminal year biomass estimate. These very high biomass conditions have not been observed frequently throughout the Council's management history. Currently, only scup and black sea bass have a B/B_{MSY} ratio greater than 1.5. Butterfish, surfclam and ocean quahog have B/B_{MSY} ratios between 1.0 and 1.5 which, under this alternative, would result in a P* between 0.4 and 0.48.

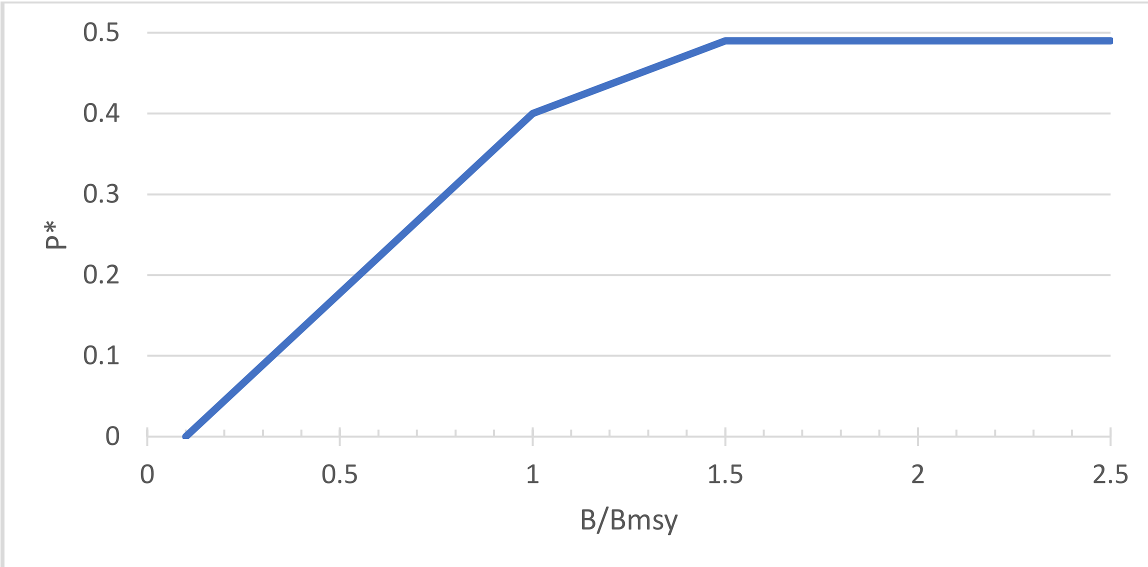


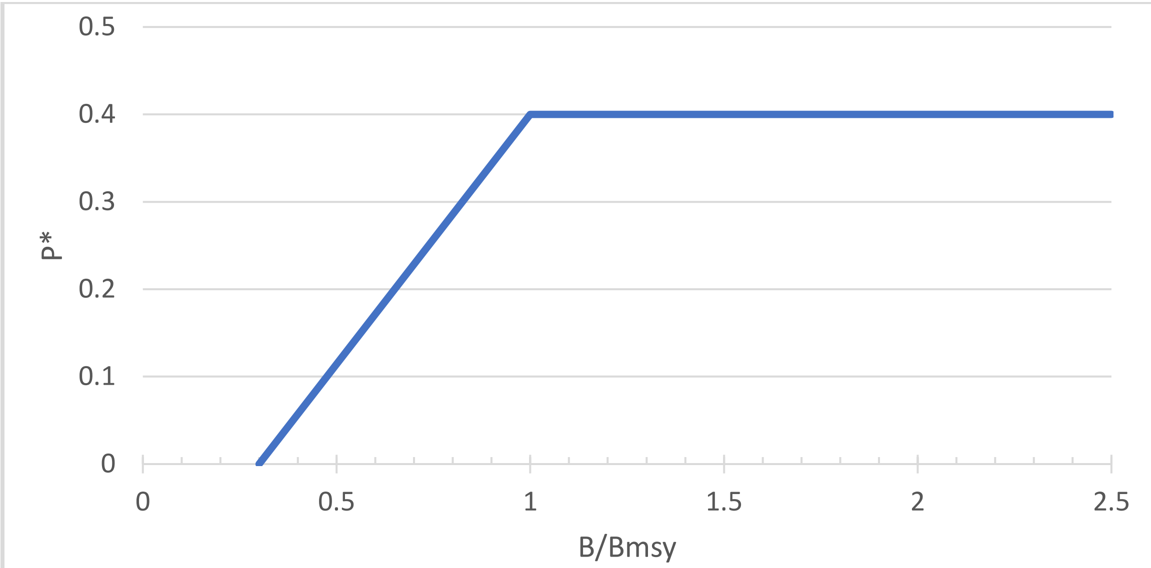
Figure 6. Alternative 6, linear ramping with a maximum P* of 0.40 when the B/B_{MSY} ratio is less than 1.0 and a linear ramping with a maximum P* of 0.49 when the B/B_{MSY} ratio is equal to or greater than 1.5.

7. Current risk policy with a stock replenishment threshold equal to 0.3

Under this alternative, the current risk policy would remain with the P* for a given stock conditional on current stock biomass relative to B_{MSY} and a maximum P* set at 0.4 when the B/B_{MSY} ratio is equal to or greater than 1.0; however, the P* will be set equal to 0 percent (i.e., no fishing) if the ratio of B/B_{MSY} is less than or equal to the stock replenishment threshold of 0.3 instead of the current threshold of 0.1 (Figure 7A). This alternative is more risk adverse than the current risk policy and attempts to minimize the likelihood of getting to an overfished condition and increase the probability of stock recovery in shorter period of time (Figure 7B).

The current stock replenishment threshold was determined by expert opinion but was not quantitively derived and may be too low to adequately provide for stock recovery. This alternative allowed for a comprehensive evaluation to quantify the implications and trade-offs associated with the cost of closing a fishery and minimizing the risk of reaching an overfished condition under different stock replenishment thresholds. However, it should be noted that once the B/B_{MSY} ratio is less than 0.5, the stock is declared overfished and a rebuilding plan is implemented. Therefore, some caution in evaluating the implications of the different stock replenishment thresholds under very low biomass levels is needed since the standard application of the risk policy, as depicted in the figures, may not be used under a rebuilding plan.

A)



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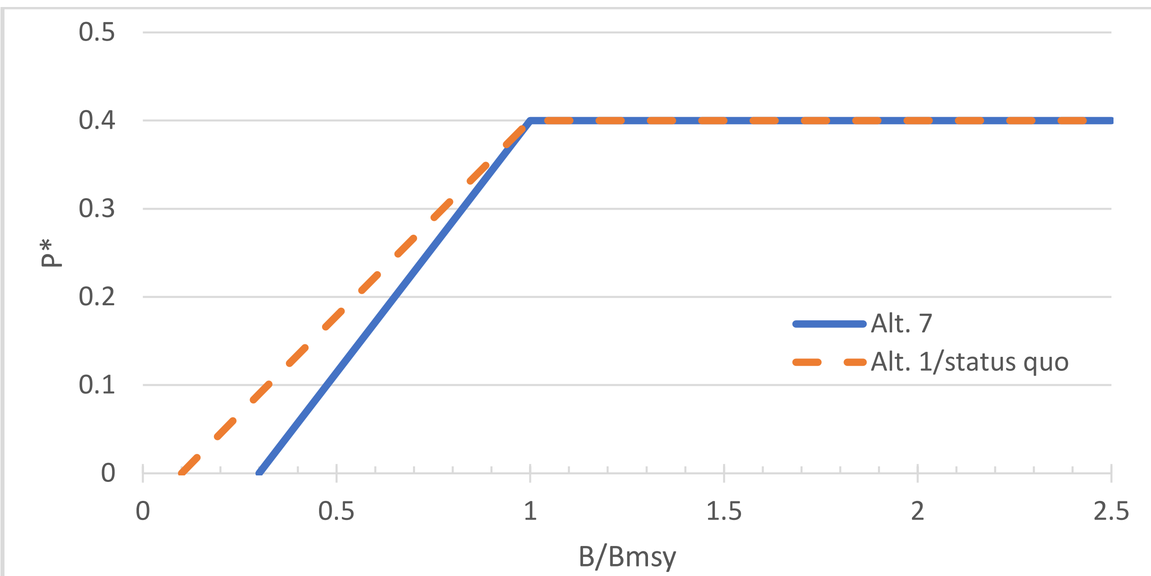
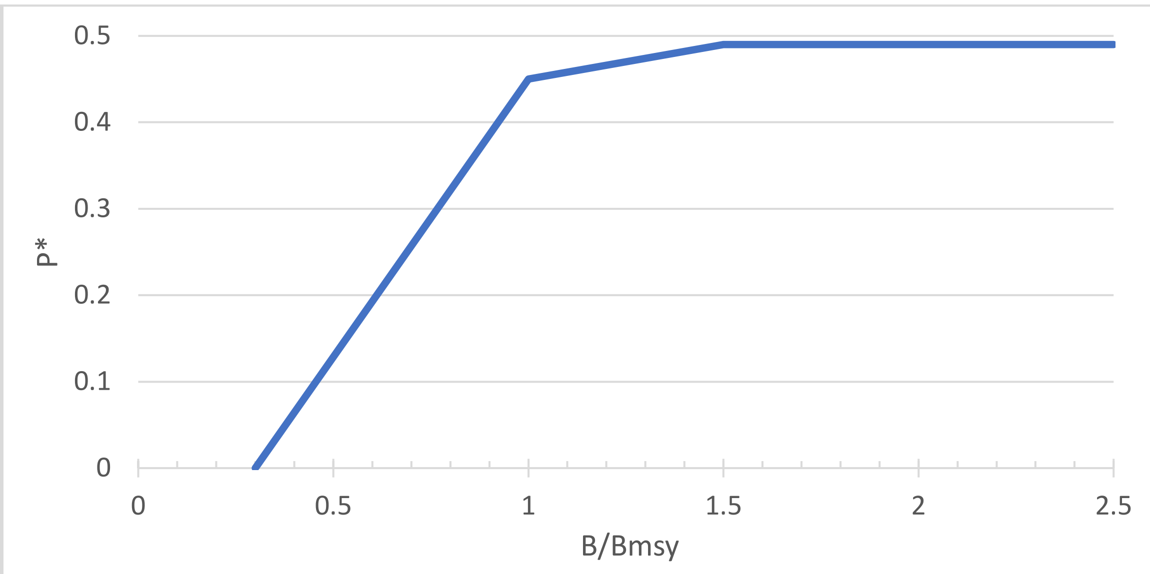


Figure 7: A) Alternative 7 with a variable probability of overfishing (P*) up to a maximum P* of 0.40 when the B/B_{MSY} ratio is equal to or greater than 1.0 and a P* of 0 if the ratio of B/B_{MSY} is less than or equal to the stock replenishment threshold of 0.3. **B)** Comparison between Alternative 1/*status quo* (typical species) and Alternative 7.

8. **Linear ramping with a maximum P* of 0.45 when the B/B_{MSY} ratio is less than or equal to 1.0, and a linear ramping to a maximum of 0.49 when the B/B_{MSY} ratio is equal to or greater than 1.5 and a P* equal to 0 when the B/B_{MSY} ratio less than or equal to 0.3**

This alternative was developed by the Council during framework meeting 1 deliberations and integrates certain elements of Alternatives 6 and 7 (Figure 8A). Similar to Alternative 6, this alternative would have two different linear ramping functions with a maximum P* = 0.49 when the B/B_{MSY} ratio is greater than or equal to 1.5. However, this alternative allows for linear increases in the P* as the ratio of B/B_{MSY} increases to maximum P* of 0.45 at the inflection point of B/B_{MSY} = 1.0, while Alternative 6 sets the maximum P* = 0.40 at this biomass ratio. Similar to Alternative 7, this alternative would set the P* = 0 (i.e., no fishing) if the ratio of B/B_{MSY} is less than or equal to the stock replenishment threshold of 0.3. This alternative provides for increasing risk under higher stock biomass, particularly when biomass is near or above the target, and would be more risk adverse as a stock biomass declines to minimize the risk of reaching an overfished condition (Figure 8B).

A)



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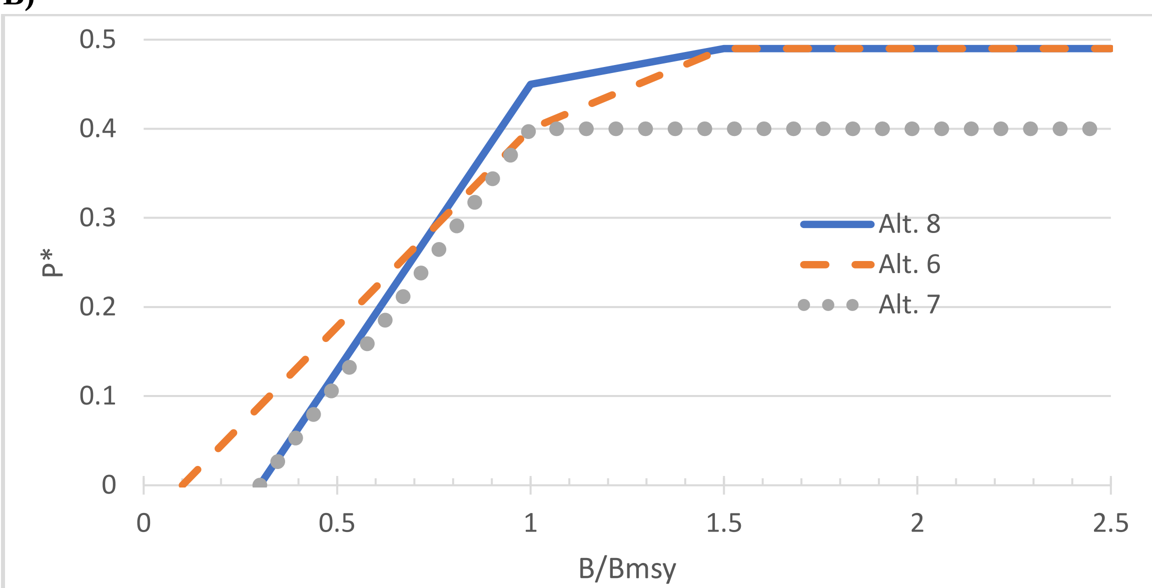

Figure 8: A) Alternative 8 with a linear ramping to a maximum P* of 0.45 when the B/B_{MSY} ratio is less than or equal to 1.0, and a linear ramping to a maximum of 0.49 when the B/B_{MSY} ratio is equal to or greater than 1.5 and a P* = 0 when the B/B_{MSY} ratio is less than or = 0.3. **B)** Comparison between Alternatives 6 and 7 and Alternative 8, a modified hybrid alternative that incorporates elements of both Alternatives 6 and 7.

9. Eliminate the typical/atypical distinction in the risk policy

Similar to the approach taken with the current risk policy for "typical" species, the P* associated with an "atypical" species is conditional on current stock biomass relative to B_{MSY} but has a maximum P* set at 0.35 instead of 0.4 (Figure 1). This measure was originally implemented by the Council reflecting the Council's lower risk tolerance for species whose life histories make them more vulnerable to over-exploitation. Currently, ocean quahog is the only stock in which the SSC applied the atypical designation when making an ABC recommendation. Under this option, the P* would be the same for all species regardless of their life histories. Eliminating or retaining the typical/atypical designation could be implemented in conjunction with either fixed or variable P* alternatives considered here.

Summary of Management Strategy Evaluation Results:

The updated MSE conducted by Dr. John Wiedenmann from Rutgers University considered the biological and fishery yield implications of the different risk policy alternatives[5]. The MSE was conducted for summer flounder, scup, and butterfish and included updated stock assessment information, the new MRIP estimates, assessment timing base on the new NRCC assessment schedule, an assumed 100% OFL CV distribution, and variable natural mortality, recruitment and stock assessment bias to evaluate the robustness of the risk policy alternatives to changing stock conditions.

Consistent with previous analyses, the results of the updated MSE indicate that all of risk policy alternatives generally limited the risk of overfishing under "average" and "good" conditions; while the linear ramping P* alternatives (i.e., those like the current Council risk policy) were better at preventing overfishing and reduced the risk of a population declining to low levels particularly under "poor" conditions (i.e. above average natural mortality and below average recruitment). On the other hand, the constant and stepped alternatives generally produced higher catch, greater economic welfare, and limited catch variability, particularly within the first five years of projections. However, these results are highly dependent upon the starting condition of the stock.

For scup, where the biomass is nearly twice the B_{MSY} target, all of the alternatives performed equally well at limiting risk to the stock with only a 1% - 2% difference between the ramped alternatives and the constant and stepped alternatives. Short and long-term catch of scup was also

[5] To find more information on the biological MSE conducted by Dr. Wiedenmann, please see the full report at: http://www.mafmc.org/briefing/december-2019.

similar among the alternatives, except for Alternative 7 which resulted in consistently lower catch. The maximum P* value (0.4, 0.45, or 0.49) played a larger role in short and long-term scup yield than any specific control rule shape.

For butterfish, where the starting biomass is about 41% higher than the B_{MSY} target, the results show very distinct differences between the risk policy alternatives. The constant and stepped alternatives consistently resulted in higher short and long-term catch across all productivity scenarios. Butterfish catch was typically 50% greater, and in some cases as much as 10 times greater, under the constant and stepped alternatives. However, the constant and stepped alternates also resulted in higher risk and were consistently higher, sometimes significantly, than the ramped alternatives. In a number of scenarios the constant and ramped alternatives resulted in exceeding the 50% probability of overfishing or the stock becoming overfished. Butterfish stock dynamics, such as highly variable recruitment, play a large role in these results with the ramped alternatives providing for greater stock protection and stability.

For summer flounder, where the starting biomass is 22% below B_{MSY} target, the results are mixed. All alternatives performed well under average and good stock productivity conditions but under poor stock productivity scenarios the constant and stepped alternatives resulted in situations close to or exceeding the 50% probability of overfishing. Overall, the constant and stepped alternatives were 31% higher on average in the probability of overfishing and 11% higher on average in the probability of becoming overfished than the ramped alternatives. Since summer flounder biomass is below the B_{MSY} target, the ramped alternatives have a lower starting P* than the constant and stepped alternatives and therefore, consistently result in lower short-term catch under all stock productivity scenarios. However, as stock biomass increases and stabilizes over time, the long-term catch and economic welfare is generally the same across all alternatives, except for *status quo* and Alternative 7 which produced the lowest catch and economic welfare.

The results also highlight the importance and potential biological and management implications of assessment bias. When a stock assessment underestimates terminal year biomass, all of the risk policy alternatives perform well, except for butterfish where other stock dynamics play a greater role in the outcomes. However, consistently overestimating the terminal year biomass can substantially increase the probability of a stock becoming overfished regardless of the risk policy implemented. This situation could undermine management actions to control catch and prevent overfishing and should be closely monitored and evaluated following each stock assessment.

Dr. Doug Lipton (NMFS Office of Science and Technology) and Dr. Cyrus Teng (post-doctoral fellow with the University of Maryland) where then able to utilize the summer flounder outputs from the biological MSE and integrate with a summer flounder economic model to evaluate the economic effects of the different risk policy alternatives[6]. The results indicate differences in the total net economic benefits between the risk policy alternatives with the current policy and Alternative 7, the two most conservative approaches, providing the lowest net economic benefit.

[6] To find more information on the economic MSE conducted by Dr. Lipton and Dr. Teng, please see the full report at: http://www.mafmc.org/briefing/december-2019.

Similar to the results noted above, the differences between the alternatives were highly influenced by the starting condition of the summer flounder biomass with lower catch and, therefore, lower net economic benefit for some harvest control rules when stock biomass is below the B_{MSY}. As biomass stabilizes around B_{MSY}, there was a much smaller difference in the long-term net economic benefits between all of the alternatives as they effectively become equivalent to each other at higher biomass levels. Based on the quantitative assessment conducted for scup, the total economic welfare is likely to be much more similar across the alternatives given the overall similarity in short and long-term catch across the alternatives and the lower market price and lower sensitivity to recreational trips for scup. Drawing specific economic welfare conclusions for butterfish is more difficult given its low commercial price flexibility.

Staff Recommendation:

Based on a review of the both MSE model results, evaluating the biological and economic trade-offs associated with each alternative, and considering Council goals and objectives for its managed fisheries, staff recommend the Council adopt Alternative 2, linear ramping with a maximum P* of 0.45 when the B/B_{MSY} ratio is equal to or greater than 1.0. This alternative performed well across all three species and all stock productivity scenarios evaluated and best balanced biological and fishery trade-offs by minimizing overall risk while allowing for moderate increases in yield and economic welfare when compared to the current risk policy.

There were five different linear ramping alternatives, including the current/*status quo* alternative, evaluated during this risk policy review (Alternatives 1, 2, 6, 7, and 8). These linear ramping alternatives are intended to prevent stocks from becoming overfished by reducing the probability of overfishing as the stock size falls below the B_{MSY} target. The risk policy MSE analyses conducted for this action support the effectiveness of this approach as the linear ramping alternatives generally performed better than the constant or stepped alternatives, particularly under poor stock productivity scenarios. As previously noted by staff, these ramped risk policy alternatives may provide for additional stock protection as environmental conditions become increasingly variable and continue to change in the Mid-Atlantic as a result of climate change and therefore, the use and implementation of the linear ramping approach should continue.

When comparing the ramped alternatives, Alternative 2 did result in slightly higher risk (higher probability of overfishing and becoming overfished) when compared to the *status quo* and Alternative 7, the most risk adverse alternative, but was lower than the other two ramped alternatives. However, even with this slight increase in risk, there was no scenario in which Alternative 2 resulted in a probability of overfishing that exceeded 50% and only under persistent poor stock productivity conditions did the probability of becoming overfished exceed 50%, which occurred for all alternatives considered (Tables 1A, 2A, and 3A). Alternative 2 also resulted in greater benefits to the fishery (catch, economic benefit and stability) by 6% on average when evaluating across all species and all scenarios compared to the *status quo* alternative and, according to the economic model, would result in an annual increase in economic welfare of $7.2 million ($36 million over five years) to the summer flounder fisheries over the *status quo* alternative. Except for short-term catch of scup, Alternative 2 outperformed all other ramped alternatives for all three species under the different stock productivity scenarios in terms of short or long-term catch and economic welfare by 3% - 13% on average (Tables 1B, 2B, and 3B). In addition, Alternative 2 minimized catch variability when compared to the other ramped alternatives, providing the additional benefit of increased stability.

When comparing Alternative 2 to the constant and stepped alternatives (Alternatives 3, 4, and 5), the results were more mixed but did a better job overall at balancing the biological and economic trade-offs. Alternative 2 outperformed all three alternatives, particularly Alternatives 4 and 5, from risk of overfishing and becoming overfished across all three species. However, Alternatives 4 and 5 consistently resulted in higher short-term catch and economic welfare for all three species compared to Alternative 2. Given the higher maximum P* associated with Alternative 2 compared to Alternative 3, 0.45 and 0.40 respectively, short-term catch of scup was higher for Alternative 2. Long-term catch performance between Alternative 2 and the constant and stepped alternatives was driven by starting biomass conditions. Alternative 2 performed slightly better or same for summer flounder, slightly worse or similar for scup, and worse for butterfish. The constant and stepped alternatives consistently resulted in lower catch variability on both an annual basis and in the maximum change in catch, a positive benefit of these risk policy alternatives.

Mid-Atlantic stock assessments and modeling approaches continue to make significant improvements and advancements and can more appropriately account for and address a species vulnerability to over-exploitation. These stock assessment improvements have also resulted in better quantitatively derived biological reference points to appropriately capture the unique life-history characteristics of a particular species. In addition, the new Northeast Region Coordinating Council (NRCC) stock assessment process designed to support research and stock assessment improvements will further enhance the regions stock assessment science to more comprehensively account for a species life-history dynamics. Given these improvements in accounting for a species vulnerability to over-exploitation and the limited use of the atypical designation by the SSC, <u>staff recommends the Council adopt Alternative 9 to remove/eliminate the typical/atypical designation.</u>

Staff also recommends the Council retain a single risk policy that is applied to all Council-managed stocks. The different analyses conducted to date do not show any measurable or specific benefit to implementing a different risk policy for each species, species groups, or based on different life histories. A consistent application of the risk policy across all species provides a more comprehensible and predictable process with understood outcomes. Different harvest policies using the same risk policy can occur across Council-managed species given stock assessment results that incorporate different life history parameters within approved biological and fishing mortality reference points.

If a new risk policy is recommended by Council, staff would recommend retaining the new risk policy for a several years (anywhere from 7-10 years) in order to fully evaluate its performance prior to any future review. The current risk policy has been in place for eight years and all of the alternatives considered during this review, including *status quo*, generally performed similarly well over the long-term, particularly under average conditions. In addition, the new NRCC stock assessment process will also allow for increased opportunities for the Council and SSC to receive updated stock status information and respond to stock changes, through the risk policy and ABC control rule, in a timely manner. Future reviews could then consider more fully implementing economic factors into the risk policy and other potential EAFM risk policy considerations such as a forage-based policy. These approaches would require the development of new and different models and analyses and will require significant time and input from the Council, SSC and stakeholders.

Table 1 – Summer flounder: A) Summary results from the biological MSE showing the probability of overfishing and the probability of becoming overfished for the eight risk policy alternatives under different stock productivity or assessment bias scenarios. **B)** Summary results from the economic and biological MSE showing short and long-term economic welfare compared to *status quo* and the average annual change and maximum annual change in catch. **C)** Average metric value across all productivity and/or assessment bias scenarios for both biological and economic metrics. For all tables, shading represents the relative difference and direction (better or worse) between an alternative compared to the *status quo* – white/light cells indicate the metric performs better or similar to the *status quo* and the darker the cell the worse it performed compared to *status quo* (black cells in Table A indicate the alternative exceeded the 50% probability of overfishing or being overfished).

A)

Metric Description	**Productivity or Assessment Error**	Alternative ***Status Quo***	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**	**Alt. 8**
Prob. of Overfishing	Average	0.13	0.23	0.13	0.19	0.19	0.19	0.1	0.26
	Good	0.0	0.0	0.0	0.0	0.0	0.03	0.0	0.06
	Poor	0.32	0.39	0.58	0.58	0.48	0.32	0.32	0.39
	Underestimate Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.06
	Overestimate Biomass	0.32	0.47	0.39	0.52	0.48	0.45	0.32	0.48
Prob. of Becoming Overfished	Average	0.14	0.23	0.15	0.24	0.23	0.24	0.14	0.27
	Good	0.03	0.05	0.03	0.05	0.05	0.06	0.02	0.06
	Poor	0.72	0.8	0.87	0.87	0.84	0.75	0.71	0.78
	Underestimate Biomass	0.0	0.01	0.0	0.02	0.01	0.02	0.0	0.04
	Overestimate Biomass	0.29	0.5	0.32	0.5	0.48	0.5	0.3	0.57

B)

Metric Description	**Productivity**	Alternative ***Status Quo***	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**	**Alt. 8**
Cumulative Short-Term (5-Year) Economic Welfare (in millions USD)	Average	0	36	72	82	67	7	-20	16
	Good	0	45	74	91	76	16	-20	30
	Poor	0	27	68	73	58	3	-19	6
Cumulative Long-Term (20-Year) Economic Welfare (in millions USD)	Average	0	7	6	11	9	0	-1	9
	Good	0	50	0	49	50	43	1	59
	Poor	0	3	14	13	12	-2	-4	-3
Avg. Change in Catch	Average	0.14	0.15	0.12	0.13	0.14	0.16	0.15	0.17
	Good	0.09	0.09	0.08	0.09	0.09	0.11	0.09	0.11
	Poor	0.18	0.2	0.14	0.15	0.16	0.19	0.2	0.23
Max Change in Catch	Average	0.36	0.42	0.26	0.31	0.34	0.45	0.4	0.51
	Good	0.31	0.34	0.27	0.3	0.31	0.4	0.32	0.4
	Poor	0.47	0.52	0.3	0.33	0.35	0.51	0.56	0.64

C)

Metric Description	Productivity or Assessment Error	Alternative							
		Status Quo	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Prob. of Overfishing	Avg. across all	0.15	0.22	0.22	0.26	0.23	0.20	0.15	0.25
Prob. of Becoming Overfished	Avg. across all	0.24	0.32	0.27	0.34	0.32	0.31	0.23	0.34
Cumulative Short-Term (5-Year) Economic Welfare (in millions USD)	Avg. across all	0	36	71	82	67	9	-20	17
Cumulative Long-Term (20-Year) Economic Welfare (in millions USD)	Avg. across all	0	20	7	24	24	14	-1	22
Avg. Change in Catch	Avg. across all	0.14	0.15	0.11	0.12	0.13	0.15	0.15	0.17
Max Change in Catch	Avg. across all	0.38	0.43	0.28	0.31	0.33	0.45	0.43	0.52

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Table 2 – Scup: A) Summary results from the biological MSE showing the probability of overfishing and the probability of becoming overfished for the eight risk policy alternatives under different stock productivity or assessment bias scenarios. **B)** Summary results from the biological MSE showing short and long-term catch compared to the *status quo* and the average annual change and maximum annual change in catch (note: there is no quantitative economic model for scup). **C)** Average metric value across all productivity and/or assessment bias scenarios for both biological and catch metrics. For all tables, shading represents the relative difference and direction (better or worse) between an alternative compared to the *status quo* – white/light cells indicate the metric performs better or similar to the *status quo* and the darker the cell the worse it performed compared to *status quo* (black cells in Table A indicate the metric exceeded the 50% probability of overfishing or being overfished).

A)

Metric Description	**Productivity or Assessment Error**	Alternative ***Status Quo***	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**	**Alt. 8**
Prob. of Overfishing	Average	0.1	0.26	0.1	0.23	0.23	0.29	0.1	0.32
	Good	0.0	0.0	0.0	0.0	0.0	0.06	0.0	0.06
	Poor	0.32	0.39	0.39	0.45	0.42	0.39	0.32	0.39
	Underestimate Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Overestimate Biomass	0.47	0.55	0.52	0.58	0.58	0.55	0.45	0.58
Prob. of Becoming Overfished	Average	0.21	0.26	0.21	0.26	0.26	0.27	0.21	0.27
	Good	0.05	0.08	0.05	0.09	0.09	0.1	0.05	0.11
	Poor	0.55	0.61	0.57	0.63	0.62	0.6	0.55	0.63
	Underestimate Biomass	0.01	0.03	0.01	0.03	0.03	0.03	0.01	0.03
	Overestimate Biomass	0.44	0.51	0.45	0.51	0.51	0.53	0.44	0.54

B)

Metric Description	Productivity or Assessment Error	Alternative *Status Quo*	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Short-term (5-year) Catch	Average	0	992	0	992	992	1,861	0	1,861
	Good	0	1,079	0	1,079	1,079	2,000	0	2,000
	Poor	0	939	0	939	939	1,749	0	1,749
	Underestimate Biomass	0	2,844	3,257	5,386	4,707	1,844	-1,207	2,616
	Overestimate Biomass	0	2,489	2,673	5,419	5,019	2,807	-820	3,013
Long-Term (20-year) Catch	Average	0	584	84	746	685	670	-14	944
	Good	0	1,592	20	1,628	1,628	2,428	0	2,670
	Poor	0	111	473	502	355	-153	-28	9
	Underestimate Biomass	0	2,483	4,632	6,318	5,123	1,861	-1,526	1,787
	Overestimate Biomass	0	2,354	3,281	4,910	3,970	2,239	-962	2,482
Avg. Change in Catch	Average	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.12
	Good	0.08	0.08	0.08	0.08	0.08	0.09	0.08	0.08
	Poor	0.12	0.13	0.12	0.12	0.12	0.14	0.13	0.15
	Underestimate Biomass	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Overestimate Biomass	0.14	0.14	0.13	0.14	0.14	0.15	0.14	0.15
Max Change in Catch	Average	0.27	0.28	0.26	0.27	0.27	0.3	0.27	0.3
	Good	0.24	0.25	0.24	0.25	0.25	0.27	0.24	0.27
	Poor	0.32	0.34	0.28	0.29	0.3	0.36	0.35	0.42
	Underestimate Biomass	0.23	0.24	0.23	0.23	0.24	0.26	0.23	0.26
	Overestimate Biomass	0.34	0.37	0.32	0.34	0.34	0.38	0.34	0.4

C)

Metric Description	Productivity or Assessment Error	Alternative *Status Quo*	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Prob. of Overfishing	Avg. across all	0.18	0.24	0.20	0.25	0.25	0.26	0.17	0.27
Prob. of Becoming Overfished	Avg. across all	0.25	0.30	0.26	0.30	0.30	0.31	0.25	0.32
Short-Term (5-year) Catch	Avg. across all	0	1,669	1,186	2,763	2,547	2,052	-405	2,248
Long-Term (20-year) Catch	Avg. across all	0	1,425	1,698	2,821	2,352	1,409	-506	1,578
Avg. Change in Catch	Avg. across all	0.11	0.11	0.11	0.11	0.11	0.12	0.11	0.12
Max Change in Catch	Avg. across all	0.28	0.30	0.27	0.28	0.28	0.31	0.29	0.33

Table 3 – Butterfish: A) Summary results from the biological MSE showing the probability of overfishing and the probability of becoming overfished for the eight risk policy alternatives under different stock productivity or assessment bias scenarios. **B)** Summary results from the biological MSE showing short and long-term catch compared to the *status quo* and the average annual change and maximum annual change in catch (note: there is no quantitative economic model for butterfish). **C)** Average metric value across all productivity and/or assessment bias scenarios for both biological and catch metrics. For all tables, shading represents the relative difference and direction (better or worse) between an alternative compared to the *status quo* – white/light cells indicate the metric performs better or similar to the *status quo* and the darker the cell the worse it performed compared to *status quo* (black cells in Table A indicate the metric exceeded the 50% probability of overfishing or being overfished).

A)

Metric Description	**Productivity or Assessment Error**	Alternative ***Status Quo***	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**	**Alt. 8**
Prob. of Overfishing	Average	0.06	0.13	0.16	0.19	0.19	0.13	0.06	0.15
	Good	0.2	0.2	0.6	0.6	0.5	0.16	0.1	0.13
	Poor	0.13	0.19	0.32	0.35	0.29	0.19	0.16	0.23
	Underestimate Biomass	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.13
	Overestimate Biomass	0.19	0.27	0.26	0.35	0.32	0.26	0.19	0.29
Prob. of Becoming Overfished	Average	0.54	0.64	0.65	0.71	0.69	0.64	0.51	0.65
	Good	0.03	0.04	0.15	0.16	0.12	0.02	0.02	0.02
	Poor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Underestimate Biomass	0.5	0.57	0.6	0.66	0.63	0.55	0.4	0.57
	Overestimate Biomass	0.7	0.8	0.77	0.82	0.83	0.83	0.68	0.82

B)

Metric Description	Productivity or Assessment Error	Alternative *Status Quo*	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Short-term (5-year) Catch	Average	0	2,754	3,823	5,575	4,592	2,077	-895	2,257
	Good	0	5,248	14,250	15,755	12,452	676	-4,287	633
	Poor	0	1,306	3,930	4,591	3,553	671	-497	891
	Underestimate Biomass	0	2,844	3,257	5,386	4,707	1,844	-1,207	2,616
	Overestimate Biomass	0	2,489	2,673	5,419	5,019	2,807	-820	3,013
Long-Term (20-year) Catch	Average	0	2,464	4,547	5,981	5,022	1,699	-1,200	1,894
	Good	0	3,852	37,255	36,008	31,631	995	-43,270	-10,495
	Poor	0	1,094	2,979	3,623	2,828	790	-183	1,063
	Underestimate Biomass	0	2,483	4,632	6,318	5,123	1,861	-1,526	1,787
	Overestimate Biomass	0	2,354	3,281	4,910	3,970	2,239	-962	2,482
Avg. Change in Catch	Average	0.16	0.16	0.12	0.12	0.13	0.17	0.18	0.19
	Good	0.15	0.15	0.1	0.1	0.09	0.15	0.26	0.18
	Poor	0.2	0.21	0.12	0.13	0.14	0.21	0.25	0.27
	Underestimate Biomass	0.15	0.16	0.11	0.12	0.12	0.17	0.17	0.19
	Overestimate Biomass	0.17	0.18	0.13	0.14	0.15	0.19	0.18	0.2
Max Change in Catch	Average	0.38	0.41	0.27	0.27	0.29	0.44	0.45	0.52
	Good	0.5	0.51	0.32	0.32	0.31	0.49	0.64	0.59
	Poor	0.51	0.55	0.27	0.29	0.31	0.57	0.73	0.78
	Underestimate Biomass	0.37	0.39	0.26	0.27	0.28	0.43	0.44	0.51
	Overestimate Biomass	0.41	0.44	0.29	0.3	0.32	0.47	0.46	0.55

C)

Metric Description	Productivity or Assessment Error	Alternative *Status Quo*	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7	Alt. 8
Prob. of Overfishing	Avg. across all	0.11	0.18	0.29	0.33	0.29	0.17	0.11	0.19
Prob. of Becoming Overfished	Avg. across all	0.55	0.61	0.63	0.67	0.65	0.61	0.53	0.61
Short-Term (5-year) Catch	Avg. across all	0	2,928	5,586	7,345	6,065	1,615	-1,541	1,882
Long-Term (20-year) Catch	Avg. across all	0	2,449	10,539	11,368	9,715	1,517	-9,428	-654
Avg. Change in Catch	Avg. across all	0.17	0.17	0.12	0.12	0.13	0.18	0.21	0.21
Max Change in Catch	Avg. across all	0.43	0.46	0.28	0.29	0.30	0.48	0.54	0.59