

Demonstration of the New England Fishery Management Council's New Risk Policy in the Context of ABC Control Rules.

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Background

The Magnuson-Stevens Act requires that each Council's Scientific and Statistical Committee (SSC) recommends an acceptable biological catch (ABC) for every managed stock. These are calculated based on ABC control rules that the Council establishes in consultation with its SSC to account for scientific uncertainty and the Council's Risk Policy. These control rules account for scientific uncertainty through a precautionary buffer that adjusts the ABC downward from the Overfishing Limit (OFL), which is defined as the expected catch associated with fishing at F_{MSY} (or an F_{MSY} proxy). The magnitude of the reduction can be related to the degree of scientific uncertainty. Management uncertainty is then accounted for by setting the annual catch limit (ACL) at or below the ABC to account for conservation objectives, socioeconomic concerns, management goals, and implementation uncertainty (i.e., the uncertainty associated with achieving a certain target catch).

The U.S. fishery management councils use a wide-range of ABC control rules, guided by their respective Council's Risk Policy, that account for uncertainty in different ways when setting catch advice. Alternative approaches range from fully quantitative (e.g., P-star used by the Mid-Atlantic Fishery Management Council, in which greater assessment uncertainty results in a larger buffer between the OFL and ABC; Shertzer et al. 2008), to semi-quantitative (e.g., risk tables used by the North Pacific Fishery Management Council, in which tiers of uncertainty dictate which harvest control rule to apply; Dorn and Zador 2020), to fully qualitative (e.g., Risk Policy Roadmap and risk matrices previously used by the New England Fishery Management Council (NEFMC; NEFMC 2016).

The NEFMC implemented a new Risk Policy concept at the start of 2025 that aims to more explicitly define the level of risk tolerance associated with management-decisions, including setting catch advice (NEFMC 2025). It is designed to incorporate a variety of factors that characterize both biological and socioeconomic conditions of a stock and fishery, ultimately providing a quantitative determination of risk tolerance. Full implementation of the revised Risk Policy will occur over two phases: Alpha and Beta. Initially, during the Alpha phase its use will remain qualitative, but once the Beta phase is complete, which is anticipated in 2027, quantitative applications will also be possible.

Fully understanding how the new Risk Policy will integrate with current NEFMC ABC Control Rules is complex. The Council's Risk Policy Working Group has suggested that the quantitative output of the revised Risk Policy could be integrated into existing ABC control rules, such that the precautionary buffer between the OFL and ABC is more dynamic than under the current control rules and more responsive to a broader set of criteria (NEFMC 2024). However, the NEFMC uses seven Fishery Management Plans, each with distinct ABC control rules, to manage 26 species as 39 stocks. Many stocks (~44%) use analytical (i.e., model-based) stock assessments to inform ABC control rules that could readily integrate the revised Risk Policy (e.g., probability-based, tiered, or ramped). The majority of stocks, however, are assessed and managed with empirical approaches, which can vary greatly. Some stocks, such as those that rely on exploitation rates or fishing mortality rates, could also readily integrate the revised Risk Policy. Others, like those that derive a multiplier to modify recent catch, might require additional procedures to bridge the Risk Policy output and the ABC.

In parallel to revising the Risk Policy, the NEFMC has initiated a process to modify the existing Northeast Multispecies (groundfish) ABC control rules (Framework 68, <https://www.nefmc.org/library/northeast-multispecies-groundfish-framework-68>). Goals for the forthcoming control rules were developed through a facilitated workshop to incorporate feedback from diverse stakeholder groups including recreational and commercial representatives as well as members of the Council's SSC, Groundfish Committee and Plan Development Team (PDT). To better address the objectives of the groundfish Fishery Management Plan, the new control rules should incorporate increasing uncertainty/variability in stock assessments, changing environmental conditions, and National Standard Guidelines. They should produce catch advice that prevents overfishing, rebuilds stocks, improves attainment of optimum yield, and minimizes large changes in catch advice as appropriate. In response to these goals the new Risk Policy directly incorporated stock status, assessment uncertainty, climate impacts on fish biology, and socioeconomic considerations. Therefore, ABC control rules that quantitatively integrate the new Risk Policy may satisfy many of the goals for Framework 68, but to fully quantify the degree to which objectives are met will require simulation testing.

Objectives

In the current groundfish ABC control rule, the buffer between the OFL and ABC is defined only by stock status. Formally integrating the Risk Policy would allow this buffer to change in response to a variety of biological, ecosystem, and socioeconomic considerations. However, the exact approach for converting the Risk Policy results into a scientific

uncertainty buffer is unresolved. Here, we demonstrate potential approaches, focusing on groundfish stocks. To do this, we:

1. Summarize the current groundfish ABC control rules and how they have recently been applied across stocks (as of September 2025).
2. Demonstrate the application of the revised Risk Policy for all 22 groundfish stocks, including risk factor scoring and risk tolerance calculations.
3. Outline three potential approaches for integrating the quantitative Risk Policy output into the existing groundfish ABC control Rules.

Current Groundfish ABC Control Rules

The current ABC control rule for the Northeast multispecies (groundfish) fishery management plan states:

These ABC control rules will be used in the absence of better information that may allow a more explicit determination of scientific uncertainty for a stock or stocks. If such information is available - that is, if scientific uncertainty can be characterized in a more accurate fashion - it can be used by the SSC to determine ABCs, these ABC control rules can be modified in a future Council action (an amendment, framework, or specification package):

- A. ABC should be determined as the catch associated with 75% of F_{MSY}.
- B. If fishing at 75% of F_{MSY} does not achieve the mandated rebuilding requirements for overfished stocks, ABC should be determined as the catch associated with the fishing mortality that meets rebuilding requirements (F_{rebuild}).
- C. For stocks that cannot rebuild to B_{MSY} in the specified rebuilding period, even with no fishing, the ABC should be based on incidental bycatch, including a reduction in bycatch rate (i.e., the proportion of the stock caught as bycatch).
- D. Interim ABCs should be determined for stocks with unknown status according to case-by- case recommendations from the SSC.

The four levels of the groundfish ABC control rule specify different approaches for setting catch advice based on stock status (NEFMC 2023). Below we characterize which of the 22 groundfish stocks have used each level of the control rule as of September 2025 (Table 1). Because the purpose of this demonstration is to compare the current control rule to potential Risk Policy integrated approaches, it is critical to temporally align the “current” specifications with the data used to demonstrate the Risk Policy scoring, which was executed in the summer of 2025. Therefore, for this demonstration we used the

specifications that were in place through September 2025, not including the most recent changes made at SSC meetings in October and November of 2025.

Control rule A is the default for stocks with known status that are not overfished. It is the most commonly applied aspect of the rule and typically accounts for scientific uncertainty by defining the ABC as the catch associated with 75% of F_{MSY} . For most groundfish stocks, F_{MSY} is not directly estimated but rather calculated as a proxy ($F_{40\%}$) based on spawner per recruit analysis. When stocks with known status are in a rebuilding plan and fishing at 75% of F_{MSY} will not meet the requirement to rebuild under the specified timeline, control rule B is applied.

Control rule B specifies that the stock should be fished at $F_{rebuild}$, which is either defined through simulation or specified by the National Marine Fisheries Service (e.g., $F_{rebuild} = 70\%$ of F_{MSY}). Typically, groundfish stocks in rebuilding plans define the ABC as the catch associated with 70% of F_{MSY} , but lower proportions have been applied in the past (e.g., 60% for Gulf of Maine cod).

Control rule C is reserved for stocks that are not expected to rebuild with any level of fishing. It sets the ABC to allow incidental bycatch only. Because defining a level of catch based on bycatch levels can be challenging and often requires review of fisheries interactions by groups such as the Groundfish PDT, it was only recently applied for the first time, for Southern New England and Mid-Atlantic yellowtail flounder. This was recommended by the SSC in October 2025, so for the purposes of this demonstration this stock is classified as applying Option B, which was in place at the time of our Risk Policy scoring demonstration.

Lastly, Control Rule D is used for stocks with unknown status and the ABC is set on a case-by-case basis. All groundfish stocks that use level D have empirical assessments with no defined reference points for status determination. The ABC is defined differently for each of these stocks, but most use an approach based on some baseline exploitation or fishing mortality rate (Table 1).

Table 1. The assessment type, stock status, and level of the current method to calculate the Acceptable Biological Catch (ABC) for each groundfish stock.

Assessment Type	Stock	Stock Status	Control Rule	ABC =
Analytical	Acadian redfish Unit Stock	Known	A	75 % F_{MSY}
	American Plaice Unit Stock	Known	A	75 % F_{MSY}
	Atlantic wolffish Unit Stock	Known	A	75 % F_{MSY}
	Cape Cod/Gulf of Maine yellowtail flounder	Known	A	75 % F_{MSY}
	Georges Bank haddock	Known	A	75 % F_{MSY}
	Pollock Unit Stock	Known	A	75 % F_{MSY}
	White hake Unit	Known	A	75 % F_{MSY}
	Eastern Gulf of Maine cod	Known	A*	75 % F_{MSY}
	Georges Bank cod	Known	A*	75 % F_{MSY}
	Southern New England cod	Known	A*	75 % F_{MSY}
	Western Gulf of Maine cod	Known	A*	75 % F_{MSY}
	Southern New England/Mid-Atlantic winter flounder	Known	A*	50 % F_{MSY}
	Georges Bank winter flounder	Known	B	70 % F_{MSY}
	Southern New England/Mid-Atlantic yellowtail flounder	Known	B	70 % F_{MSY}
	Gulf of Maine haddock	Known	Emergency Action	90% F_{MSY}
Empirical	Gulf of Maine winter flounder	Known	A	75 % E_{MSY}
	Southern windowpane flounder	Known	A	75 % F_{MSY}
	Atlantic halibut Unit Stock	Unknown	D	Previous year catch with multiplier
	Georges Bank yellowtail flounder	Unknown	D	Limiter Approach
	Northern windowpane flounder	Unknown	D	70% F_{MSY} proxy
	Ocean pout Unit Stock	Known	D	70% of F_{MSY} proxy
	Witch flounder Unit Stock	Unknown	D	Exploitation as $F_{rebuild}$ proxy

** Southern New England/Mid Atlantic winter flounder operates under control rule level A because it has known status and is not in a rebuilding plan but has an ad hoc F_{MSY} adjustment. All four cod stocks were estimated to be overfished but fished at 75% F_{MSY} under level A in 2025 because a rebuilding plan has not officially been initiated due to the recent change in stock structure.*

Risk Policy Demonstration

To explore integrating the Council’s new Risk Policy with ABC control rules, we first demonstrated the performance of the Risk Policy for each groundfish stock. The details and results are reported in a report to the Risk Policy Working Group (Kerr, Brothers and Schneider 2025), but for context, we provide a brief overview here. A key feature of the Council’s new Risk Policy are the factors that characterize risk. Seven factors were identified by the Risk Policy Working Group that span three categories: 1) stock status and uncertainty, 2) climate and ecosystem, and 3) economic and community (Table 2). These factors are to be weighted by the Council, indicating the relative importance of each factor, and scored by Plan Development Teams according to a rubric and prescribed information sources (NEFMC 2024). The combination of the scores and weights for each factor will be used to calculate a recommended level of risk tolerance.

Table 2. Factors included in the NEFMCs new Risk Policy and source materials identified to score factors.

Category	Factor	Representative of	Source Material
Stock Status and Uncertainty	Biomass	Current Productivity	Current stock assessment
	Recruitment	Future productivity	Current stock assessment
	Assessment type and uncertainty	Assessment performance	Current stock assessment
Climate and Ecosystem Considerations	Climate vulnerability	Vulnerability to environmental change	Climate vulnerability analysis (Hare et al. 2016)
	Fish condition	Ecosystem productivity	State of the Ecosystem report

Economic and Community	Commercial fishery characterization	Commercial fishery performance	Revenue, market value, lease value information from PDTs/NEFSC social science branch
	Recreational fishery characterization	Recreational fishery presence and performance	State of the Ecosystem report, Marine Recreational Information Program

For our demonstration, we scored the 5 possible factors (Figure 1) according to the rubrics provided in the Risk Policy Concept (NEFMC 2025). For some factors (e.g., recruitment) we had to make assumptions or modifications to the Risk Policy rubrics to demonstrate scoring. We do not describe these here, because it is not the focus of this report, but we have outlined them in detail in summaries to the Risk Policy Working Group, including a presentation (Kerr, Brothers, Behan and Schneider 2025) and a report (Kerr, Brothers and Schneider 2025).

The scoring rubrics for both fishery characterization factors were still in development at the time of this analysis, so we could not demonstrate scoring empirically. Instead, to include these two factors in the risk tolerance calculations and the subsequent control rule demonstrations, we assumed a score of 0 for all stocks and both fishery factors. This helps to ensure that the quantitative results are in an appropriate numerical range, even though these aspects of the Risk Policy are still in development. Although unresolved, a score of 0 will likely reflect stocks with no socioeconomic concerns and stocks without recreational components.

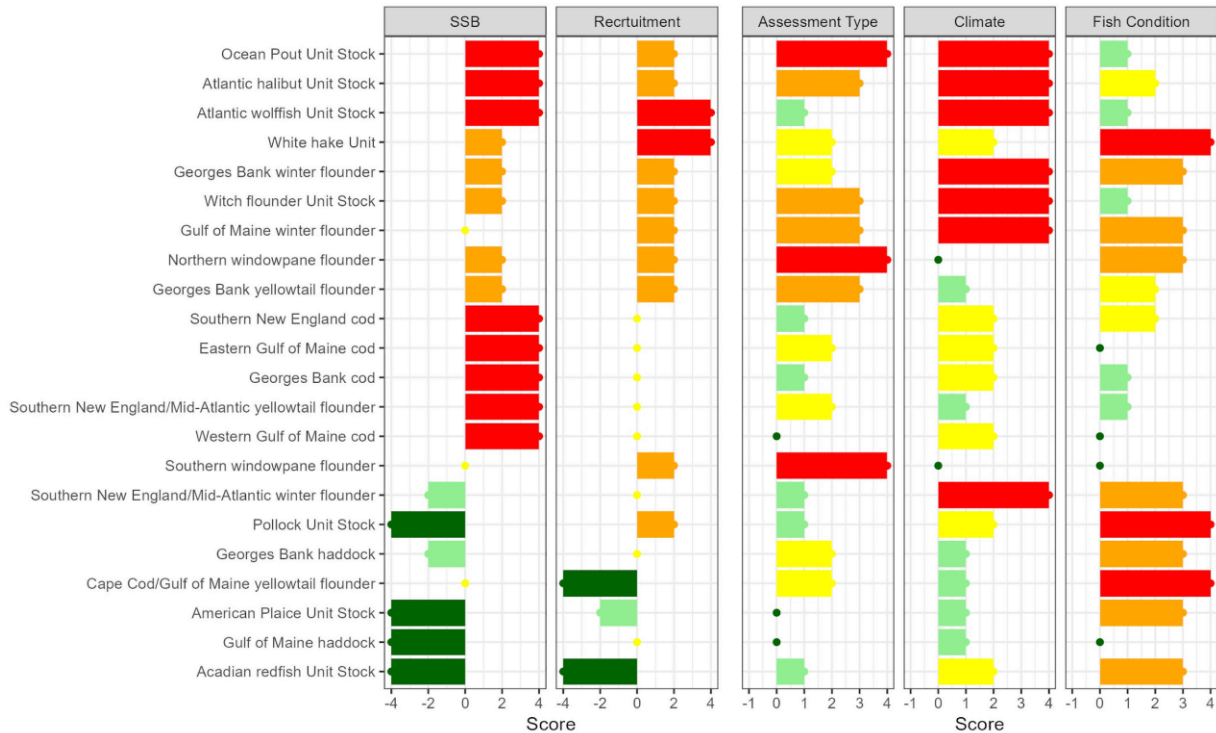


Figure 1. Factor scores for groundfish stocks in New England. Dots represent a score of 0. Note that spawning stock biomass (SSB) and recruitment are scored from a minimum score of -4 to a maximum score of 4, while assessment type, climate, and fish condition are scored from a minimum score of 0 to a maximum score of 4. Low factor scores are associated with positive stock condition (e.g., -4 = high SSB) and high factor scores are associated with poor stock condition (e.g., 4 = overfished). The stocks are ordered from the highest Z-Score (top) to the lowest Z-Score (bottom).

Factor scores were used to calculate a combined Z-score for each stock by weighting the individual factor scores and summing the resulting values. We weighted each factor according to the mock weighting exercise conducted in April 2025 that asked Council members to rate each factor on a scale of relative importance. As specified by the Risk Policy (NEFMC 2025), the composite Z-scores were used in a logistic function (Equation 1) to calculate a numerical value designed to measure whether the holistic conditions across factors warrant high or low risk tolerance; this quantitative output is defined by the Risk Policy as the recommended probability of achieving a desired management outcome (e.g., not overfishing). Stock conditions that might require increased caution (e.g., low biomass, low recent recruitment, climate vulnerability), produce higher values, implying a greater need to ensure that overfishing is avoided (Figures 2 and 3). This could mean increasing the buffer between the OFL and the ABC. Stock conditions that promote risk tolerance (e.g.,

high biomass, high recent recruitment, signs of socioeconomic stress in the fishery), produce lower values, implying that catch advice could be set closer to the OFL. As specified in the Risk Policy, these recommended probabilities cannot fall below 50% and therefore stocks that receive a negative Z-score default to a logistic output of 50% (the highest possible level of risk tolerance).

$$\frac{1}{1 + e^{-z}}$$

(2)

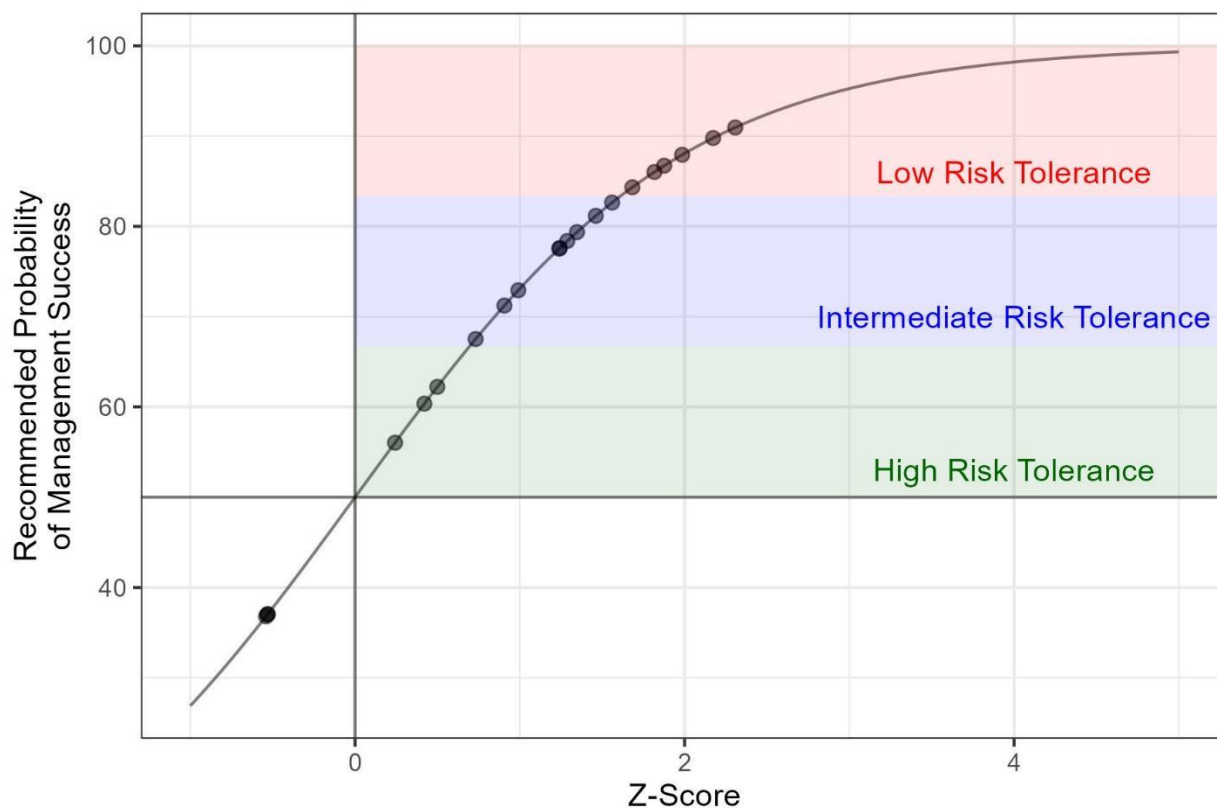


Figure 2. The curve represents the logistic relationship between Z-scores and the recommended probability. The 22 groundfish stocks are shown with dark circles. Note the break positions demonstrate equal proportions for each risk band. It is important to note that the Risk Policy specifies that negative Z-scores will default to 0. In turn, the lowest possible measure of risk tolerance the Risk Policy can produce is a recommended probability of 50%. For this figure, however, we have not defaulted negative z-scores to 0 and instead show the raw Z-scores and corresponding recommended probability values that result from the logistic equation.

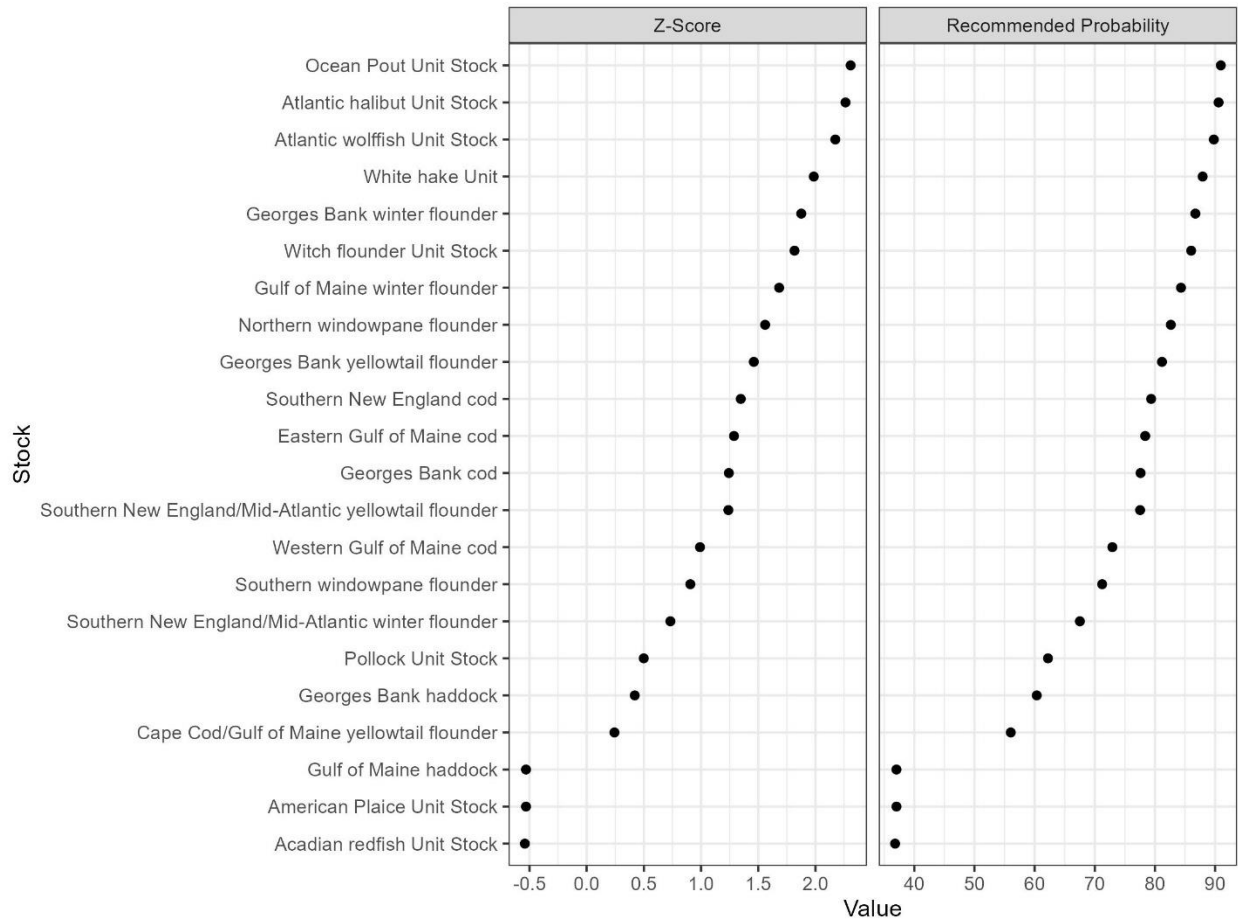


Figure 3. The range of Z-Scores (x-axis of Figure 2) and recommended probabilities (y-axis of Figure 2) for the 22 individual NEFMC groundfish stocks. These values use the demonstrated scoring for the five risk policy factors that have established rubrics (Figure 1) and assume a score of 0 for both fishery factors. The factor weightings defined by the Council’s mock weighting exercise were used to calculate the Z-Scores. Note that in practice Z-Scores less than 0 would be adjusted to a Z-Score of 0 and the recommended probabilities would be 50%.

Potential Risk Policy Integrated ABC Control Rules

Using these demonstrated Risk Policy results, we also demonstrated three potential ways to integrate the quantitative output into ABC control rules. The logistic output of the Risk Policy is defined as the recommended probability of achieving a management goal, such as avoiding overfishing. When these recommended probabilities are high it indicates a low risk tolerance and when these recommended probabilities are low it indicates a high risk

tolerance. Below, we outline three alternative approaches to translating these values into the scientific uncertainty buffers used to define an ABC. These include a dynamic buffer control rule, a tiered control rule, and a combined approach.

To demonstrate the differences, the three approaches encompassed a common range of recommended risk tolerance. In addition, for all three, the lowest level of risk tolerance resulted in an ABC defined by fishing at 50% F_{MSY} , intermediate levels of risk tolerance resulted in an ABC defined by fishing at 75% F_{MSY} proxy, and the highest level of risk tolerance resulted in an ABC defined as fishing at 100% F_{MSY} (i.e., ABC is equal to the OFL, Figure 4). The range of uncertainty buffers (i.e., 50% to 100% of F_{MSY}) and the boundaries between levels in the tiered and combined approaches were chosen to demonstrate the differences between the alternative control rules. However, we do not suggest that the range of proportions or transitions between Risk Tiers demonstrated here are optimal. Instead, we acknowledge that the final details are yet to be determined and will be a policy decision made by the Council. Stocks with negative Z-scores defaulted to a recommended probability of 50%, the highest level of tolerance allowed by the risk policy.

Dynamic buffer control rule

The dynamic buffer approach uses a linear relationship to continuously change the proportion of F_{MSY} used to define the ABC in response to the quantitative results of the Risk Policy (Equation 2, where $p(Z)$ is the recommended probability coming out of the Risk Policy). Specifically, when the recommended probabilities produced by the Risk Policy increased (implying a decrease in risk tolerance) the ABC dynamically moved farther from the OFL (Figure 4).

$$F_{target} = [1 - p(Z) - 0.5] \times F_{MSY}$$

(2)

Tiered control rule

The tiered approach used the quantitative output of the Risk Policy to define three risk tiers, which each applied a different proportion of F_{MSY} to define the ABC. Stocks that fell in the upper third of recommended probabilities (83.3% to 100%) were categorized as low risk tolerance and defined the ABC as 50% of F_{MSY} . Stocks that fell in the middle third of recommended probabilities (66.7% to 83.3%) were categorized as intermediate risk tolerance and defined the ABC as 75% of F_{MSY} . Stocks that fell in the lower third of recommended probabilities (50% to 66.7%) were categorized as high risk tolerance and defined the ABC as 100% of F_{MSY} .

Combined approach

Lastly, we explored an approach that combined the dynamic and tiered control rules. Similar to the tiered approach, the combined approach has three levels of risk tolerance: high, intermediate, and low (Figure 4). Stocks with recommended probabilities from 87.5 to 100% recommended probability were categorized as low risk tolerance and the ABC defined as 50% of F_{MSY} . Stocks with recommended probabilities from 50 to 62.5% recommended probability are categorized as high risk tolerance and defined the ABC as 100% of F_{MSY} . Stocks that fall within 62.5% and 87.5% recommended probability are categorized with the intermediate risk tolerance tier and their ABC is defined by a linear relationship between the recommended probability and the percentage of F_{MSY} , similar to the dynamic buffer approach.

$$ABC = \frac{2.25 - 2 \times p(Z)}{100} \quad (3)$$

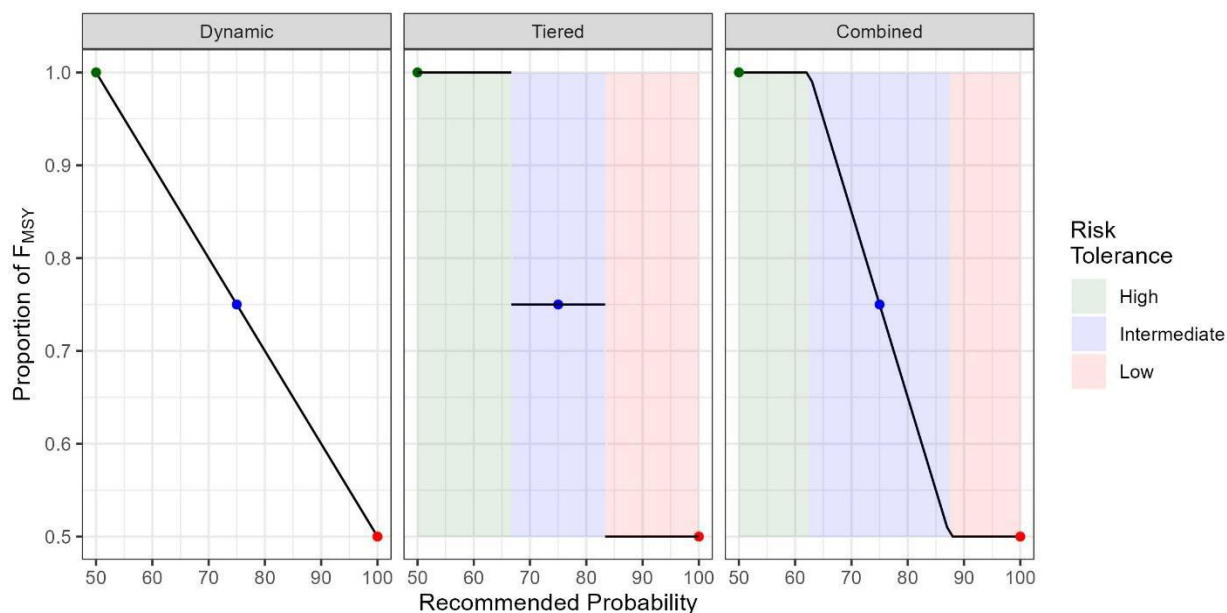


Figure 4. Three potential approaches for ABC control rules that quantitatively integrate the 2025 Risk Policy. All three change the scientific uncertainty buffer between the OFL and ABC in accordance with the results of the Risk Policy by using the calculated recommended probabilities to determine the proportion of F_{MSY} used to define the ABC. Colored points represent shared proportions of F_{MSY} and recommended probabilities across control rules options, all control rules associate a 50% recommended probability with an ABC equal to 100% of F_{MSY} , a 75% recommended probability with an ABC equal to 75% of F_{MSY} , and a 100% recommended probability with an ABC equal to 50% of F_{MSY} .

Demonstrated Results of Risk Policy Integrated Control Rules

Using the Risk Policy results demonstrated above we applied each of the three potential Risk Policy integrated Control Rules, reporting the proportions of F_{MSY} that would define the ABC under each approach. We then compared the demonstrated results of the three Risk Policy integrated control rules with the proportions of F_{MSY} that are currently applied for each stock (Table 1). We did this for all stocks in the groundfish Fishery Management Plan, except Atlantic halibut, which uses a unique empirical control rule that adjusts prior catch levels rather than F_{MSY} . Note that the Risk Policy output and resulting percentage of F_{MSY} for Georges Bank yellowtail flounder use data from its 2024 empirical assessment, but as of Fall 2025, there is now an updated analytical assessment.

When averaged across the 21 groundfish stocks the three alternative control rules used similar proportions of F_{MSY} to define the ABC; the dynamic buffer resulted in a mean of 77% of F_{MSY} , the tiered control rule resulted in a mean of 75% of F_{MSY} , and the combined approach resulted in a mean of 74% of F_{MSY} . Despite similar means, however, the three approaches resulted in considerably different distributions of the proportion of F_{MSY} applied for each stock (Figure 5).

When using the dynamic buffer, no stocks defined the ABC as 50% of F_{MSY} . The lowest proportion of F_{MSY} was 59% and 3 stocks (14%) applied 100% of F_{MSY} . The tiered approach produced the most extreme results, with the majority of stocks defining the ABC as either 50% of F_{MSY} or 100% of F_{MSY} (29% of stocks in both the high and low risk tier). The remaining 42% of stocks fell in the intermediate risk tier, defining the ABC as 75% of F_{MSY} . Under the combined approach, 14% of stocks defined the ABC as 50% of F_{MSY} and 29% of stocks defined the ABC as 100% of F_{MSY} . The intermediate risk tier of the combined approach included 57% of stocks with the percentage of F_{MSY} ranging from 51% to 90%.

Across the three control rules, when the Risk Policy produced a high recommended probability (i.e., low risk tolerance), the dynamic buffer approach defined the ABC as the greatest proportion of F_{MSY} and the tiered control rule defined the ABC as the lowest proportion of F_{MSY} . However, when the Risk Policy produces a low recommended probability (i.e., high risk tolerance) this relationship was reversed, with the tiered control rule defining the ABC as the greatest proportion of F_{MSY} and the dynamic buffer using the lowest (Figure 6, 7).

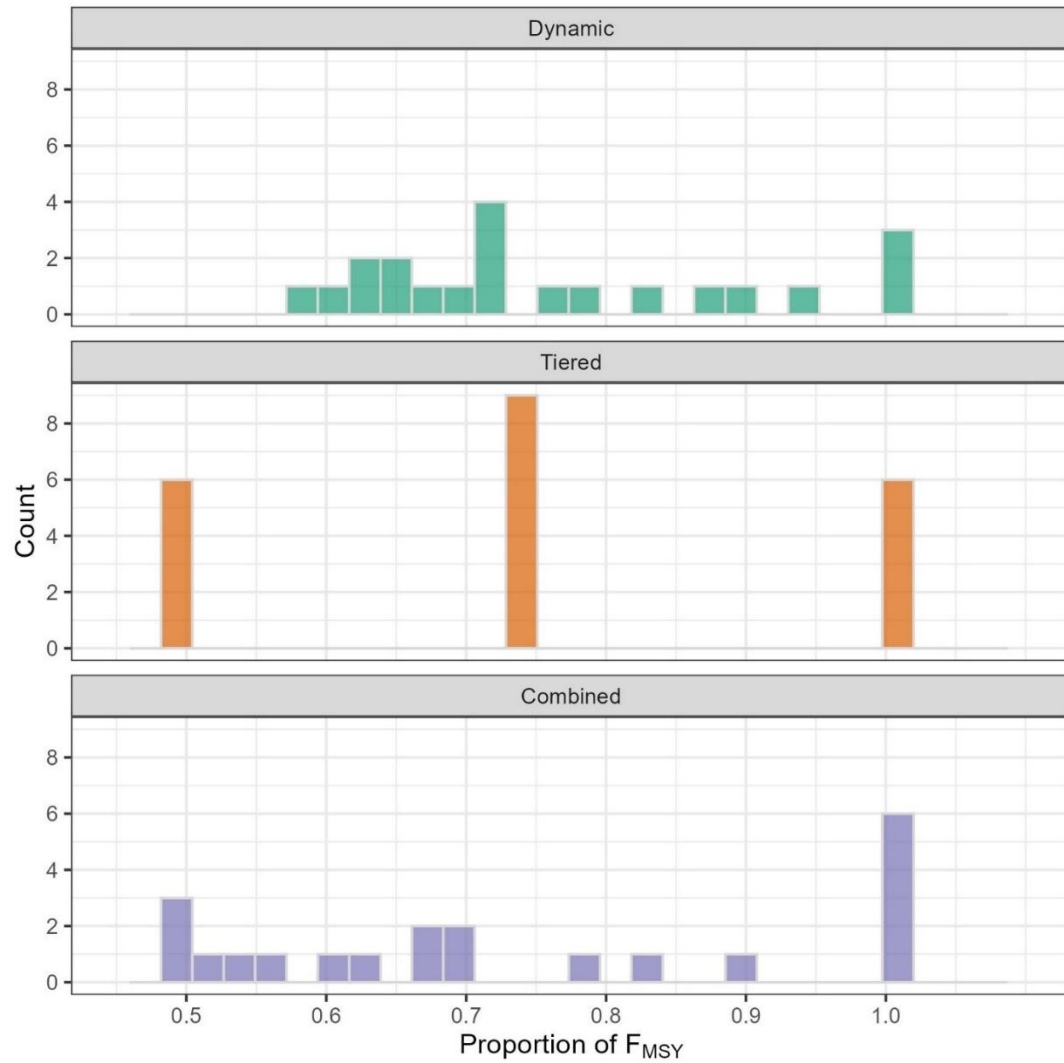


Figure 5. The distribution of the proportion of F_{MSY} resulting from each alternative Risk Policy integrated ABC control rule (Dynamic, Tiered, Combined).

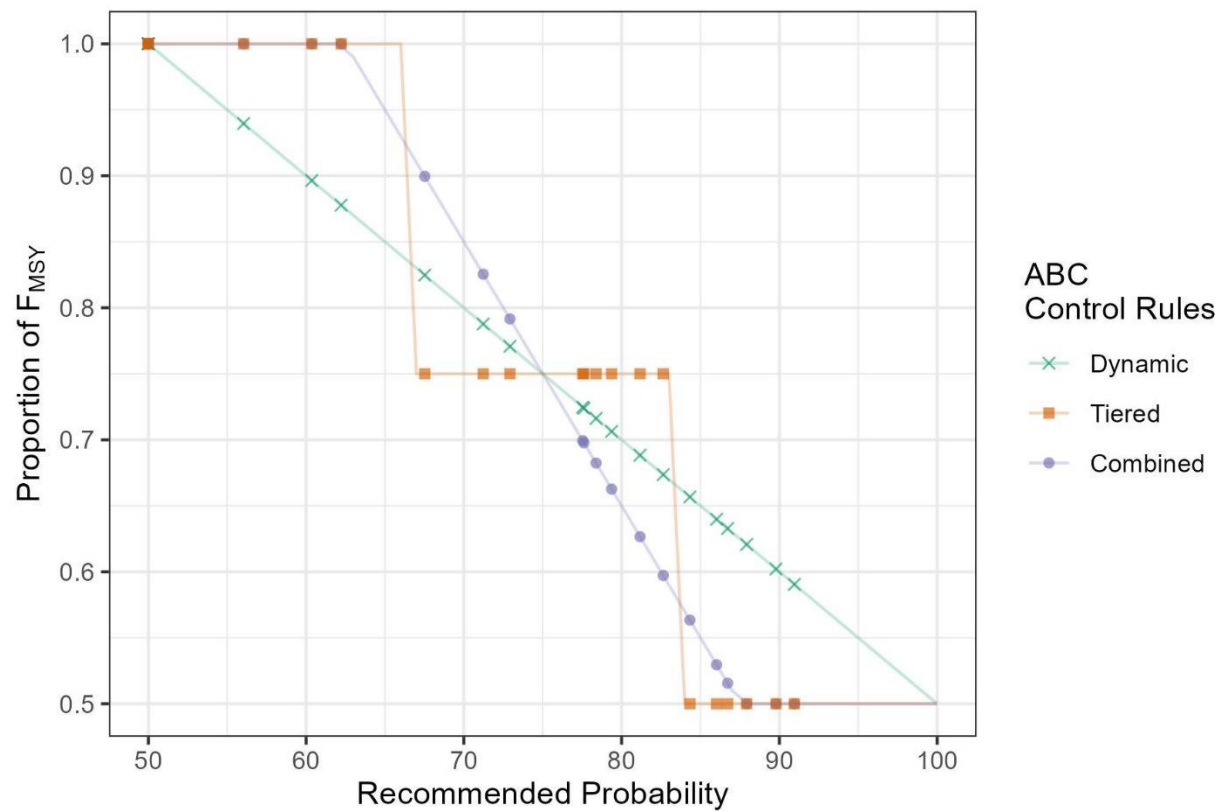


Figure 6. The relationship between the quantitative output of the Risk Policy (i.e., the recommended probability of management success) and the proportion of F_{MSY} determined by the three alternative Risk Policy integrated control rules. The lines represent the defined relationship and the points show the results of individual stocks.

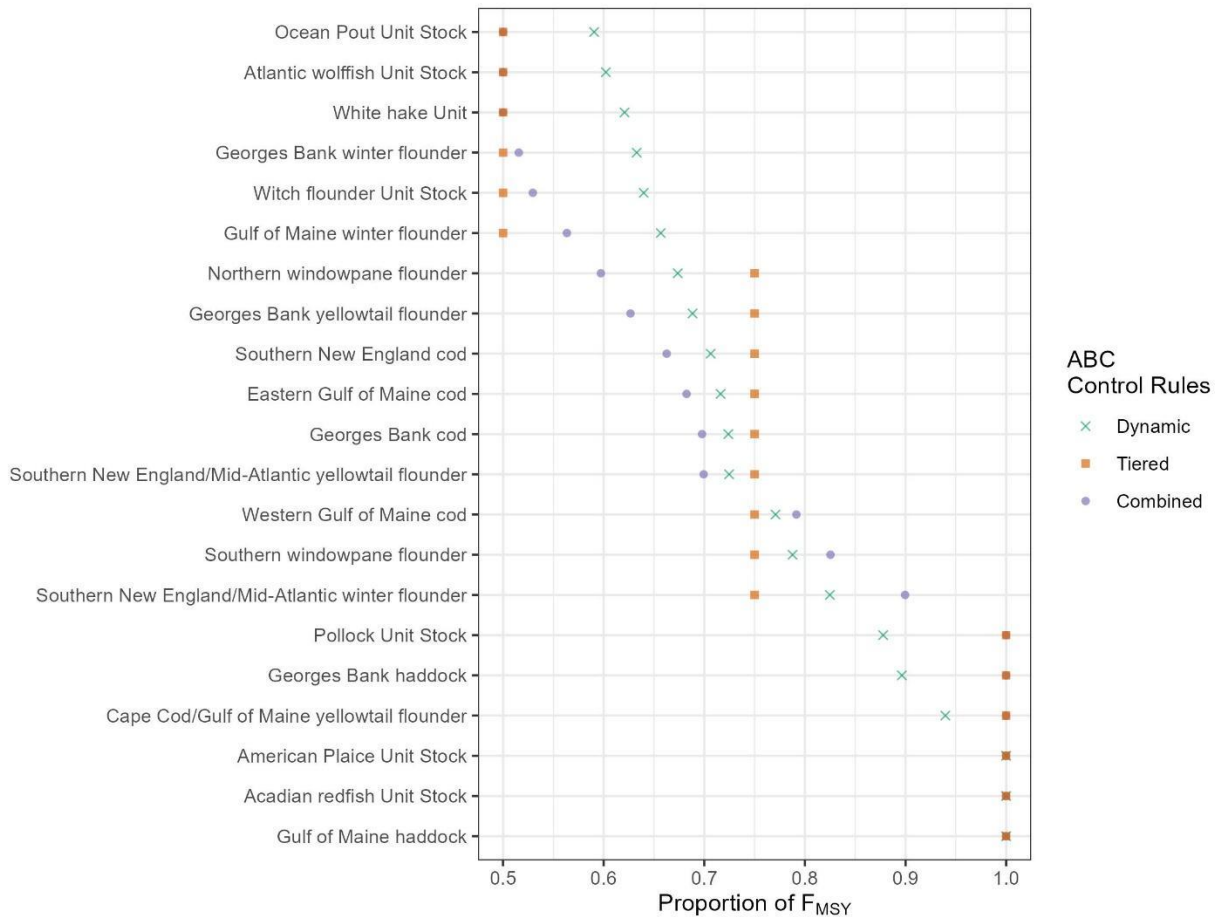


Figure 7. The proportion of F_{MSY} determined for each groundfish stock by the three alternative Risk Policy integrated control rules.

Comparison to the current groundfish control rule

Although the dynamic and combined Risk Policy integrated control rules produced different results for specific stocks, when compared to the current groundfish ABC control rules they performed similarly. For both approaches, approximately half of the groundfish stocks received a higher percentage of F_{MSY} than was used to define recent ABCs under the current control rule. The other half of stocks received a lower percentage of F_{MSY} than under the current control rule and no stock received the same percentage as has been applied recently. Under the dynamic buffer the prescribed percentage of F_{MSY} was higher than that from the current control rule for 10 of the 21 stocks and lower for the remaining 11. Under the combined approach the percentage was higher for 12 of the stocks and lower for the remaining 9. For the tiered approach, almost half of the 21 stocks ($n=10$, 48%) resulted in a higher percentage of F_{MSY} than under the current control rules. The percentage was lower for 6 stocks (24%) and equal for the remaining 5 (24%). Despite the potential Risk Policy integrated control rules resulting in a lower percentage of F_{MSY} for some stocks, other

stocks attained percentages of F_{MSY} that are currently only possible with emergency action (e.g., Gulf of Maine Haddock).

Under the current ABC control rules, most stocks (62%) have used 75% of F_{MSY} to define recent ABCs. For the eight stocks that used different percentages, there was synchrony between the directional change of the current control rule from the default application of 75% of F_{MSY} and the results of Risk Policy integrated control rules. For example, Gulf of Maine haddock recently used an emergency action to define recent ABCs at 90% of F_{MSY} , which aligns closely with the 100% of F_{MSY} produced by all three Risk Policy integrated approaches demonstrated here. For Georges Bank winter flounder, which recently used 70% of F_{MSY} under control rule B, the Risk Policy integrated control rules were more precautionary, using a smaller percentage of F_{MSY} to set the ABC (dynamic buffer: 63%, tiered control rule: 50%, combined approach: 52%). Similar trends hold true for Georges Bank yellowtail flounder, ocean pout, witch flounder, and northern windowpane flounder.

There is one exception: Southern New England/Mid-Atlantic winter flounder, which recently used 50% of F_{MSY} under control rule A, but the Risk Policy integrated approaches produced higher percentages of F_{MSY} , ranging from 75 to 90%. This discrepancy is due to recent change to the way reference points were calculated for this stock, which decoupled adjustment of SSB_{MSY} and F_{MSY} reference points, resulting in a sudden shift in the perceived stock status from overfished to well above the management target. Because of acknowledged issues with recent changes to reference points, the SSC decided to be more precautionary than they typically are for stocks with known status that are not in rebuilding plans. Within the Risk Policy, the revised biomass status results in a low Z-Score, which is associated with a high risk tolerance, leading to proportions of F_{MSY} that are less precautionary. This suggests that Risk Policy integrated control rules may need additional procedures to accommodate unique considerations of individual stocks or specific circumstances.

Importantly, the comparisons described here depend on details of the Risk Policy integrated control rules that are not yet defined and required assumptions to demonstrate potential approaches. For example, we constrained the possible range of uncertainty buffers to between 50% and 100% of F_{MSY} but altering these maximum or minimum values would change the results. The exact values we report also depend on the potential boundaries between risk tiers, which would be policy decisions made by the Council. Similarly, some aspects of the Risk Policy remain under development. For example, we assumed a score of 0 for both fishery factors because the rubrics are still being developed, but the details of the finalized rubrics will influence the results we have reported here. Therefore, whether Risk Policy integrated control rules result in proportions of F_{MSY} that are

higher or lower than those produced by the current ABC control rules depends, in part, on details currently under development within the potential control rules and the Risk Policy itself.

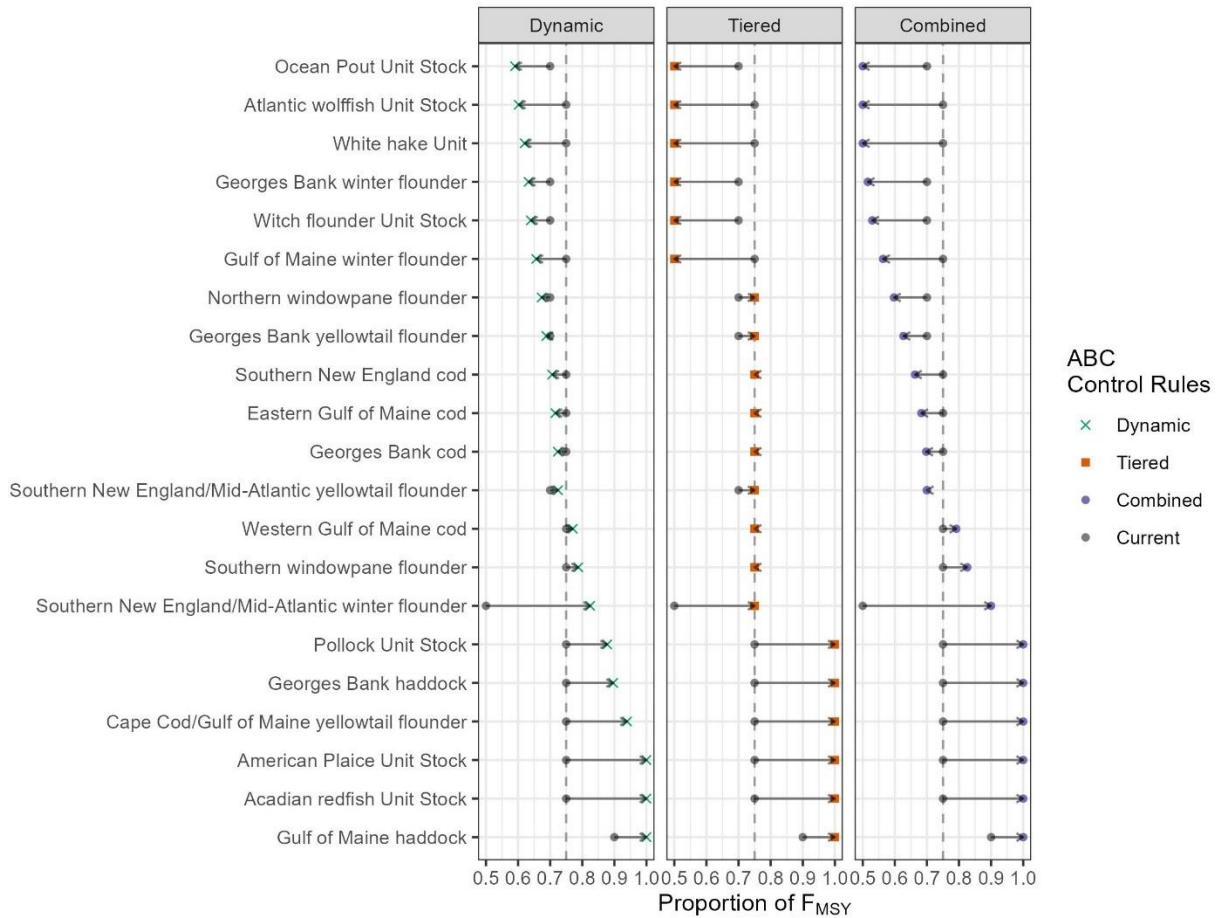


Figure 8. The proportion of F_{MSY} resulting from Risk Policy integrated control rules compared to those recently applied for each of 21 groundfish stocks (excluding Atlantic halibut). The vertical dashed line is at 75% of F_{MSY} . A proportion of F_{MSY} has not recently been specified for Witch flounder or Georges Bank yellowtail flounder. Instead, Witch flounder has recently used mean exploitation rate as a proxy for $F_{rebuild}$ and Georges Bank yellowtail flounder has relied on a unique empirical approach (i.e. The Limiter). However, both stocks have recently been in rebuilding plans and could readily transition to at Risk Policy integrated control rule. Therefore, for comparison, we assumed a “current” percentage of 70% as is typically applied during rebuilding plans.

Conclusions:

The integration of the Risk Policy with ABC control rules aims to address current management challenges recognized by the NEFMC (NEFMC 2023). These challenges include the performance of control rules in the context of 1) issues with stock assessment performance (i.e. analytical assessments with large retrospective patterns or empirical assessments with unknown status), 2) impacts of climate/ecosystem change, and 3) socioeconomic concerns. The new Risk Policy includes stock assessment uncertainty, climate vulnerability, fish condition, commercial fishery characterization, and recreational fishery characterization factors, which are intended to address these concerns. Integrating the Risk Policy output into ABC control rules would thereby incorporate assessment uncertainty, climate change, and socioeconomic concerns directly, and quantitatively, into setting catch advice.

Here, we demonstrated three potential approaches for integrating the Risk Policy with control rules. We outlined a dynamic approach with a linear relationship between the measure of risk tolerance and the percentage of F_{MSY} and a tiered approach that creates risk tolerance levels, each with associated percentages of F_{MSY} . We also tested a combined approach that integrates the dynamic linear relationship and the tiered approach. We demonstrated all three approaches using 50% as the minimum amount of F_{MSY} and 100% as the maximum amount of F_{MSY} . The final relationship between the measure of risk tolerance and the percent of F_{MSY} , and the maximum and minimum percentages of F_{MSY} are policy decisions that will be made by the Council. Each potential control rule has unique features and challenges that the Council may consider for a control rule; these nuances and decision points are summarized in Table 3.

The dynamic buffer has the potential to be the most responsive to changes in stock condition with the recommended percentage of F_{MSY} directly related to the outcome of the Risk Policy. In the tiered approach the percentage of F_{MSY} is held constant within each risk tier, potentially conferring more stability in catch advice. However, stocks with recommended risk tolerance that is close to the boundary between tiers may experience dramatic changes in catch advice with slight changes in Risk Policy output. For example, under the tiered approach, a change from 75% to 80% recommended probability of management success would decrease the recommended percentage of F_{MSY} from 75% to 50%. The combined approach has smooth transitions, similar to the dynamic buffer, but a faster rate of change because it concentrates the linear relationship within the intermediate risk tolerance level. Fluctuations in catch advice under these control rules could be minimized by constraining the range of percentages allowed (e.g., a maximum of 90% of F_{MSY} and a minimum of 60% of F_{MSY}). Similarly, reparametrizing the dynamic

relationship to an alternate shape (e.g., nonlinear relationship) may change the stability of catch advice from year to year. The stability of catch advice is also related to stock size and thus changes in the percentage of F_{MSY} is not the sole determinant for the stability of catch advice.

This demonstration of the Risk Policy, from factor scoring to ABC control rule integration, represents the initial phases of a larger simulation study that will quantitatively evaluate the performance of the Risk Policy in the context of ABC control rules for groundfish. The results of the simulations will provide insight into challenges raised by the SSC, the Council, and Groundfish Plan Development Team and Groundfish Committee, such as the performance of control rules that integrate climate, socioeconomic, and assessment uncertainty factors, the appropriateness of 75% F_{MSY} as a buffer, and the impact of control rules on catch stability (NEFMC 2023).

Table 3. Differences between the current groundfish ABC control rules and two alternative approaches for quantitatively integrating the Risk Policy.

	<i>Risk Tiers</i>	<i>Dynamic Buffer</i>
<i>Change from current ABC control rules for groundfish</i>	<i>Considers more than stock status (i.e., rebuilding plan or not) to change the buffer</i> <i>More tiers and ability to move between them</i>	<i>Continuously changing dynamic buffer between the OFL and ABC based on Risk Policy factor scores</i>
<i>Decision Points</i>	<i>Percent of F_{MSY} for each risk tier</i> <i>The probability of management success that defines each tier</i>	<i>The range of percents of F_{MSY}</i> <i>Form of relationship (linear, nonlinear)</i>
<i>Potential Performance</i>	<i>Abrupt changes in catch advice when moving between tiers</i>	<i>Highly responsive</i> <i>Smooth transitions</i>

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