

Past NEFMC SSC Discussions Relevant to Dynamic Reference Points

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1.0 Document Overview

This document summarizes some of the key themes and Scientific and Statistical Committee (SSC) discussion points regarding the potential need for dynamic reference points (DRPs) across species managed by the New England Fishery Management Council (NEFMC). It draws on SSC reports regarding specifications from 2016-2025, with the year(s) in which relevant SSC discussions took place noted in parentheses. It should be considered as a reference in conjunction with the tables of recent assessments/specifications for five key stocks (workshop document #6) and the spreadsheet that summarizes Biological Reference Point (BRP) approaches across NEFMC- and Mid-Atlantic Fishery Management Council (MAFMC)-managed stocks (workshop document #7).

Some high-level takeaways from SSC discussions across stocks include:

- The SSC has repeatedly noted the impact of environmental drivers such as temperature, ecosystem, and predation on stock productivity and the need to consider DRPs.
- Numerous stocks have demonstrated persistent low recruitment and a lack of rebuilding despite dramatically reduced fishing mortality (F), suggesting a reduction in stock productivity (and more generally non-stationarity in productivity).
- BRPs based on historical productivity regimes may not reflect a stock's current productivity based on ecosystem/environmental factors.
- Inconsistency in recruitment assumptions used for calculating BRPs and those used for projections can present challenges.
- Responses to evidence of changing productivity in setting of Acceptable Biological Catches (ABCs) have largely been ad hoc.

2.0 General considerations for calculating BRPs (from groundfish discussions)

- Appropriately defining BRPs is integral to ABC control rules that are based on them (2023).
- The SSC has broadly recognized that there are documented climate impacts on groundfish that have not yet been accounted for in assessments and the definition of BRPs (2023)
- The SSC has recommended exploring directly calculating Maximum Sustainable Yield (MSY) BRPs for stocks that currently use proxies (2022). For stocks that use a proxy for an F rate that produces MSY such as $F_{40\%}$, the assumption that it is a good proxy in a changing ecosystem should be reexamined (2023).
- There is no clear mechanism for revising F-based proxy BRPs in response to changing environmental conditions, which can lead to maintaining high F on a declining stock. F- and biomass reference points must change in tandem to avoid overfishing a declining stock (2023).¹
- There is a need for a formal discussion on DRPs (2022).

¹ While not explicitly addressed by the SSC, the converse can also be true, where not revising BRPs as stock productivity increases can lead to foregone yield.

- The SSC has noted that using a moving window/trailing average of recruitment can be a pragmatic approach for informing BRPs under changing conditions, but truncation can make it harder to estimate BRPs and there can be a long lag time before realizing that a new regime has started.
- In reviewing Draft Technical Guidance for Estimating Status Determination Reference Points and their Proxies in Accordance with the National Standard 1 Guidelines², the SSC noted that additional guidance and case studies on methods for applying regime-specific averages would be useful, including a) best approaches (recruitment, recruits per spawner, etc.) and data sources (survey indices, model estimates) to characterize productivity; and b) more details on methods to detect regime shifts.

Considerations for setting ABCs:

- Broadly, the SSC has recommended examining environmental factors and their impact on stock dynamics to inform assessment and management approaches—for example, using more caution if levels of an environmental covariate known to affect productivity are present (2017, 2022).
- In cases where assessments have had strong retrospective patterns and/or recruitment assumptions that appear overly optimistic, the SSC has often recommended constant ABCs (2020).
- The SSC has recognized that modifying ABC control rules to account for challenges such as revised perceptions of productivity may improve accounting for risk when giving catch advice (2022). That being said, the performance of ABC control rules as ocean conditions change has not been vetted (2023).

3.0 Stocks of particular relevance to DRPs

3.1 Georges Bank Yellowtail Flounder

- The fact that biomass has not shown a positive response to a drastic reduction in catch, coupled with low recruitment and poor fish condition, suggests that environmental factors (i.e., factors external to fishing) are having a strong effect on stock dynamics and that stock productivity is declining³ (2016-2020, 2022, 2024).
- The SSC has noted that the fishery does not appear to be the main driver limiting stock recovery and that it is well known that yellowtail recruitment is subject to environmental

² Methot, R. D., Karp, M. A., Cope, J. M., et al. (2023). *Technical guidance for estimating status determination reference points and their proxies in accordance with the National Standard 1 guidelines*. NOAA Technical Memorandum NMFS-F/SPO. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

³ Tableau, A., Collie, J. S., Bell, R. J., & Minto, C. (2019). *Decadal changes in the productivity of New England fish populations*. Canadian Journal of Fisheries and Aquatic Sciences, 76(9), 1528–1540. <https://doi.org/10.1139/cjfas-2018-0255>.

factors,⁴ although the exact mechanism governing yellowtail recruitment is unknown. Climatic conditions may have contributed to slow recovery of the species in the 1970s and 1990s,⁵ and there is an estimated negative directional effect of changing climate on yellowtail flounder⁶ (2019).

- While fishing is not limiting stock recovery, low catch levels should be maintained until environmental conditions become favorable for recruitment (2022).
- There is a need to investigate environmental drivers affecting this species at both the juvenile and adult life stages (2021-2024).
- The 2025 management track assessment using the Woods Hole Assessment Model (WHAM) assumed current and future recruitment is and would remain lower than historical levels based on a change-point analysis of bottom temperature. The SSC noted key uncertainties with the assessment, including 1) the WHAM model may make it difficult to parse environmental versus fishery effects on the stock; and 2) environmental forecasting could be developed and potentially integrated into future recruitment estimates (2025).

3.2 Southern New England/Mid -Atlantic Yellowtail Flounder

- The SSC has expressed concerns with stock projections being overly optimistic given low biomass and recruitment failure (2022).
- There has also been discussion regarding the potential stock impacts of the Cold Pool warming/contracting (2022).
- In 2022, the SSC recommended exploring state-space modeling tools such as WHAM to better account for environmental impacts on the stock.
- In 2025, WHAM was used for the management track assessment, which used an average value for the Gulf Stream Index from 2012-2024 to inform recruitment for projections (2025).
- With the 2025 assessment, the SSC struggled to understand the concurrent decrease in the biomass-based BRP proxy and increase in the F proxy, both of which are based on a Spawning Potential Ratio (SPR) proxy estimate assuming a target SPR of 40%. The SSC suggested investigating whether yield per recruit has changed, which could necessitate revisiting the 40% SPR proxy (2025).

⁴ Miller, T. J., Hare, J. A., & Alade, L. A. (2016). *A state-space approach to incorporating environmental effects on recruitment in an age-structured assessment model with an application to southern New England yellowtail flounder*. Canadian Journal of Fisheries and Aquatic Sciences, 73(8), 1261–1270.

⁵ Brodie, W. B., Walsh, S. J., & Maddock Parsons, D. (2010). *An evaluation of the collapse and recovery of the yellowtail flounder (Limanda ferruginea) stock on the Grand Bank*. ICES Journal of Marine Science, 67, 1887–1895.

⁶ Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., et al. (2016). *A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. continental shelf*. PLoS ONE, 11(2), e0146756. <https://doi.org/10.1371/journal.pone.0146756>.

3.3 Southern New England/Mid-Atlantic Winter Flounder

- In the past, there have been overly optimistic projections for this stock due to overestimating recruitment, and the SSC has noted that the stock appears to be in a period of low recruitment and it is not reasonable to assume higher recruitment for projections (2017).
- 2019 assessment abandoned the stock-recruitment curve and shifted from a stock-recruitment relationship to estimate F_{MSY} to using $F_{40\%}$ as a proxy, which significantly reduced BRPs. In addition, the ASAP model incorporated a temperature-dependent stock-recruitment model,⁷ which provided an explanation for low recruitment in recent warm years (2020).
- The 2022 assessment truncated the recruitment stanza used in estimating BRPs and projections to reflect current (reduced) stock productivity, and found that based on these BRPs the stock is not overfished, overfishing is not occurring, and the stock is rebuilt, despite no change in indicators. The SSC recognized the risk of adjusting management targets to reflect decreased productivity, which can increase F on a stock under stress. The SSC has had concerns about the continued appropriateness of the F_{MSY} proxy ($F_{40\%}$), which is not influenced by the change to a low stock productivity assumption, and has recommended fitting a stock-recruitment model to test whether $F_{40\%}$ remains a good proxy. For recent specifications, the SSC has recommended setting the ABC more conservatively based on recent research that calculated DRPs for the stock⁸ (2022, 2025).
- *“The SNE/MA winter flounder stock represents one of the first applications of revised productivity assumptions integrated into projections and biological reference points for a groundfish stock. At this stage, the SSC is considering these situations on a case-by-case basis to determine the appropriate management response to updates to address prevailing conditions. However, a larger conversation may be warranted as to how to address these situations across other stocks in the Northeast U.S. experiencing impacts of climate change” (2022).*
- There is a need to continue exploring best practices for integrating prevailing biological conditions to inform projections and BRPs in order to provide realistic management/rebuilding targets. (2022, 2025).
- Similarly, the SSC has recommended continued investigation of environmental drivers affecting stock productivity. While there was work to transition the assessment to a WHAM model that would explore the potential utility of including environmental covariates within the model, because the research track was paused, the treatment of environmental influences on stock dynamics will need to be explored through another pathway such as the next management track (2025).

⁷ Bell, R., Wood, A., Hare, J., Richardson, D. E., Manderson, J., & Miller, T. (2018). *Rebuilding in the face of climate change*. Canadian Journal of Fisheries and Aquatic Sciences, 75, 1405–1414.

⁸ Collie, J. S., Bell, R. J., Collie, S. B., & Minto, C. (2021). *Harvest strategies for climate-resilient fisheries*. ICES Journal of Marine Science, 78(8), 2774–2783. <https://doi.org/10.1093/icesjms/fsab152>.

3.4 White Hake

- Over the past five years, there have been multiple SSC discussions regarding assumptions of white hake recruitment for the purposes of developing BRPs, projections, and rebuilding plans.
- In 2022, the SSC expressed concern that the SSB_{MSY} BRP is based on recruitment from 1963-2019, while projections are based on recruitment from 1995-2019, and noted that use of different recruitment time series may not be appropriate. As a result, it recommended exploring internal consistency between BRPs and projections and consideration of a) change point analysis or b) recruit-per-spawner analysis to inform appropriate recruitment time stanzas.
- In 2023, two contractors presented their analyses examining recruitment assumptions used in white hake stock projections to provide info on rebuilding/ABC setting in the absence of a management track assessment.
 - Dr. Steve Cadrin's analysis determined that a change-point analysis did not identify any significant change points, but did find that recruitment and recruitment rate are strongly autocorrelated. He recommended that short-term projections assume autocorrelated recruitment and that long-term recruitment distribution be consistent with BRPs. This would represent a change from the approach of using long-term recruitment distribution for BRPs but more recent recruitment distribution for projections.
 - The SSC shared comments/concerns regarding the change-point analysis, including a) that there should be an effort to identify the causal mechanism if a change point is detected and b) there is no certainty that an identified new regime will persist, which can make projections challenging.
 - Dr. Jeremy Collie used dynamic linear modeling to fit stock-recruitment models using white hake recruitment and spawning stock biomass from the assessment model, then used them to calculate BRPs, short-term projections and rebuilding projections. He found support for using time-varying stock-recruitment models that account for a) variation in recruitment rate and b) density-dependence, and recommended using a dynamic stock-recruitment relationship to calculate BRPs and projections.
 - The SSC discussed the importance of clarifying the appropriate pathway for incorporating such new information into ABC setting/rebuilding plan revisions. In addition, they have recommended considering how the consultant analyses regarding recruitment assumptions should be considered for BRPs development and projections (2025).
- Since the consultant analyses, the SSC has recommended catch advice based on autocorrelated long-term recruitment for the short-term projections rather than the recent recruitment time series (1995-2019), while maintaining long-term recruitment assumptions for rebuilding plan BRPs. However, shifting to this approach has indicated that the time to rebuild may be delayed by as much as 6 years (2024). The different recruitment assumptions for short-term projections and BRPs has continued to be a major source of uncertainty (2025).

- Broadly, the SSC continued to be concerned about the lack of recruitment despite low harvest and has discussed whether this may signal a long-term change in productivity, which contrasts with maintaining long-term recruitment assumptions for BRPs (2024, 2025). Shifting the assessment from the ASAP to the WHAM model could allow for exploring potential environmental effects on stock productivity and experimenting with different recruitment options (2025).

3.5 Atlantic Herring

- Low recent recruitment and performance of short-term projections have been persistent concerns. While the 2018 benchmark assessment indicated that the stock was not overfished nor experiencing overfishing, the SSC expressed concerns with recent low recruitment and using 1965-2015 data to project age 1 recruitment for 2019-2021. The SSC recommended an assessment update in 2020 to verify the projected trends in recruitment and biomass (2018).
- The SSC has recommended investigating potential environmental drivers of low recruitment such as temperature, food availability, and predation (2018, 2020, 2021, 2024).
- In 2021, the PDT developed projections for rebuilding plans using 1) average recruitment and b) autocorrelated recruitment. The SSC supported the autocorrelated recruitment method for better capturing short-term recruitment.
- The SSC has supported continued PDT exploration of alternative modeling techniques such as empirical dynamic modeling (2021) or dynamic linear modeling (2024).
- The 2022 management track assessment shortened the recruitment stanza used to derive BRPs to 1992-2019 based on a changepoint analysis to represent the species' low productivity regime. The SSC recommended investigating whether, in addition to the biomass BRP, the $F_{40\%MSY}$ proxy should also be reduced in a low productivity regime (2022). In reviewing the 2024 management track assessment, the SSC noted that while it is a standard practice to add new years of data onto a truncated recruitment stanza, doing so may not be optimal. (2024).

4.0 Atlantic Cod

4.1 Gulf of Maine

- Assumptions about natural mortality (M) used in projections raised SSC concerns and led to its rejection of the projections used to set the ABC (2019).
- There is a need for additional research on selection of an appropriate recruitment stanza to inform projections, and the impact of changing conditions on aspects of productivity such as M and recruitment needs to be considered in future assessments (2021). Toward that end, the SSC has recommended that the Plan Development Team (PDT) develop alternative rebuilding strategies that consider uncertainties in M and recruitment (2022).
- For the newly defined-Western Gulf of Maine stock, the SSC recommended further work to define the appropriate approach for defining short-term projections and BRPs for this stock, and the continued evaluation of the appropriate recruitment time period to inform future stock productivity expectations (2024).

4.2 Georges Bank

- The SSC noted this stock's lack of rebuilding despite reduced catch levels and highlighted that several studies have noted the importance of climate influences on cod productivity.^{9,10} (2022)
- The SSC has recommended investigating environmental drivers affecting stock productivity (2022).
- In developing ABC recommendations for 2023-2024, a minority of the SSC recommended a lower ABC given the stock's low biomass, no information to indicate improved recruitment, and no improvement of environmental conditions which have likely resulted in poor recruitment (2022).
- Research recommendation: define the appropriate approach for estimating the stock's BRPs and evaluating whether using the full time series of recruitment is appropriate for informing future expectations of stock productivity (given evidence of environmental factors affecting stock productivity and distribution).

5.0 Haddock

5.1 Gulf of Maine

- The 2022 management track assessment indicated a large reduction in estimated biomass and the SSC discussed that there could be mis-specified biological characteristics such as M which would impact understanding of stock productivity (2023).
- In reviewing the 2024 management track assessment, the SSC was concerned about the higher recruitment, biomass, and MSY BRPs compared to the 2022 assessment. The drivers of these changes were unclear (2024).

5.2 Georges Bank

- The SSC has noted a steady decline in size-at-age for this stock and noted that if the trend continued and fixed weight-at-age is assumed for projections, then projections could lead to an inflated estimate of OFL and ABC (2019, 2020).
- Research recommendation: better understand environmental effects on stock recruitment and growth to inform the assessment as well as consideration of age-dependent M (2020).

⁹ Gröger, J. P., & Fogarty, M. J. (2011). *Broad-scale climate influences on cod (*Gadus morhua*) recruitment on Georges Bank*. ICES Journal of Marine Science, 68(3), 592–602. <https://doi.org/10.1093/icesjms/fsq196>.

¹⁰ Pershing, A. J., Alexander, M. A., Brady, D. C., Brickman, D., Curchitser, E. N., Diamond, A. W., McClenachan, L., Mills, K. E., Nichols, O. C., Pendleton, D. E., Record, N. R., Scott, J. D., Staudinger, M. D., & Wang, Y. (2021). *Climate impacts on the Gulf of Maine ecosystem: A review of observed and expected changes in 2050 from rising temperatures*. *Elementa: Science of the Anthropocene*, 9(1).

6.0 Yellowtail Flounder

6.1 Cape Cod/Gulf of Maine

- While the 2025 research track assessment using WHAM found a correlation between bottom temperature and recruitment, no environmental covariates were included in the final assessment model (2025).
- Recruitment for this stock has been weak to moderate and generally declining since 2017, prompting the SSC to recommend exploring environmental drivers of recruitment and population distribution (2025).

7.0 Pollock

- In response to fishing community observations, the SSC has recommended research investigating potential changes in maturity-at-age and weight-at age in the context of potential ecosystem drivers. Moving from the Age Structured Assessment Program (ASAP) model to the WHAM model when feasible could help address this (2024).

8.0 American Plaice

- The SSC has recommended research exploring potentially adding environmental covariates that may impact stock dynamics in the WHAM model used for the stock (2024).

9.0 Witch Flounder

- The SSC has recommended evaluation of the appropriate time period for defining empirical BRPs along with further consideration regarding how best to use empirical BRPs in stock status determination (the stock is qualitatively considered overfished and is in a rebuilding plan) (2024).
- The SSC has also recommended exploring the potential influence of environmental factors on the stock's population dynamics (2017).

10.0 Winter Flounder

10.1 Gulf of Maine

- The SSC highlighted the stock's lack of response to low exploitation and the possibility of effects not included in the assessment such as climate and predation effects impeding stock recovery.¹¹ Both of those potential impacts should be considered in future assessments (2020).
- In setting catch levels for 2023-2025, the SSC did express some concern with a large increase in catch despite the stock's poor condition that had persisted even with low fishing pressure. However, there was also recognition that utilization has likely been low

¹¹ Hare et al. (2016) noted winter flounder as having high climate vulnerability. Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., et al. (2016). *A vulnerability assessment of fish and invertebrates to climate change on the Northeast U.S. continental shelf*. PLoS ONE, 11(2), e0146756. <https://doi.org/10.1371/journal.pone.0146756>.

due to other constraining factors and that the ABC was not likely to result in overfishing (2022).

10.2 Georges Bank

- The SSC has noted weaker than expected recruitment, which suggests that biomass is not increasing and leads to uncertainty in projections that assume higher recruitment (2019, 2020). It has recommended exploring the basis of recruitment assumptions in projections, including considering alternative projections and/or use of a moving window of recruitment (2020, 2022).
- M is also an important source of uncertainty in the assessment and in setting BRPs and should be further explored (2019, 2025).
- The SSC has recognized that if recruitment assumptions were to change, BRPs would need to be re-estimated as well, and has recommended further researching environmental drivers of productivity (2022, 2025).
- In setting the ABC for 2023-2025, the SSC expressed concern with the large ABC increase compared to 2022, which the PDT suggested could be due to weight-at-age data used in BRP calculations (2022).

11.0 Atlantic Halibut

- While there are no BRPs for this stock, which uses an index-based assessment, the SSC has recognized that changes to stock productivity over time may be possible (2022, 2024).

12.0 Redfish

- In 2025, the SSC recommended using the currently employed WHAM model to test possible environmental effects on redfish recruitment or other biological characteristics.

13.0 Windowpane Flounder

13.1 Gulf of Maine/Georges Bank (Northern)

- To set ABCs for 2021-2023, the SSC decided to calculate average exploitation rates based on the 10-year period (2010-2019) when possession was not permitted. Using the full time series (1975-2019) would include a period of overfishing on the stock (2020).
- The SSC has recommended investigating potential environmental drivers of stock dynamics/productivity given the decline in the survey index despite limited catch (2023).

13.2 Southern New England/Mid-Atlantic (Southern)

- The SSC has noted that the time period used for setting the stock's F_{MSY} proxy is somewhat subjective (based on 1995-2001, when the stock responded to reduced F), and recommends improved criteria for determining the appropriate time period for informing BRP proxies (for this and other stocks) (2023).
- The AIM (An Index Method) assessment model assumes population response to different levels of F, but survey declines over a decade of low catch may be due to environmental

influences such as warming on productivity. As a result, the AIM model may no longer be appropriate (2023).

14.0 Wolffish

- The SSC has discussed the stock's persistent low stock status and recruitment over several decades and the potential for environmental factors' playing a role given that fishery removals had been far below the ABC. It recommended research on the impact of environmental factors on wolffish survival and reproduction, perhaps through use of a different assessment model (2022, 2025).

15.0 Ocean Pout

- The SSC has noted that despite two decades of F below the F_{MSY} proxy, biomass has continued to decline and remains near historic lows. It highlighted that the F_{MSY} BRP may no longer be appropriate, as it is based on a period of very high abundance and productivity and thus could have played a greater role in the stock's decline than previously thought. The SSC recommended that both the assessment method and the basis for BRPs be explored during the next assessment. As with other stocks, ocean pout could potentially be exhibiting a change in productivity associated with climate or potentially depensatory mechanisms (2022, 2025).

16.0 Sea Scallop

- Over the past decade, the SSC has noted and supported spatial differences in growth rate, shell height to mean weight (SHMW) ratios, M , and fishery selectivity for developing catch advice. It has also recommended exploring environmental drivers of these differences.
- Specific spatial differences:
 - Decreasing growth rates in the Nantucket Lightship (NLS) area, potentially caused by lower food availability, higher density, and cooler temperatures (2016, 2017, 2018).
 - Declining recruitment and higher M for the Virginia and Delmarva areas, potentially due to higher bottom temperatures and other environmental stressors (2022, 2023, 2025).
- In 2017, the SSC noted that the upcoming benchmark assessment would be a good opportunity to evaluate BRPs and the scallop control rule, especially regarding the spatial nature of scallop management. The fishery operates under one F rate, but each area may have its own specific rates. As of the 2025 research track assessment, the fishery is still considered one stock unit with one set of BRPs.
- In 2019, the SSC noted low recent recruitment and the more rapid disappearance of strong year classes than expected in some areas when considering assumed F and M , warranting close monitoring.
- The SSC has recommended a more holistic (as opposed to ad hoc) consideration of the Scallop Area Management Simulator (SAMS) model's biological parameters in the future to account for changing stock dynamics. Past estimates have been overly optimistic due

to issues with model assumptions regarding growth, recruitment, and M . There is a need to evaluate potential drivers (e.g., changing ocean conditions) and adjusting model parameters to account for these changes (2021, 2022).

- In 2023, the SSC recommended that the upcoming research track assessment consider ecosystem/climate impacts on population dynamics.
- In 2024, the SSC discussed how transitioning the Catch at Size Analysis (CASA) to a state-space model with parameters that can be connected to environmental variables could result in more accurate estimates of biomass and F and BRPs, thereby improving understanding of the relationship between scallops and the ecosystem.
- In 2025, the SSC noted that the assessment considered one stock unit despite different trends and environmental impacts across areas—for example, F in Georges Bank in the assessment's terminal year was higher than F_{MSY} , so if it were considered its own stock it would be experiencing overfishing. There is thus a risk that regional variations are not captured when region specific reference points are combined into one overall set of BRPs. Specifically, the SSC discussed whether the Mid-Atlantic Bight and George Bank should be considered different stocks given differences in fishing effort, growth rates, and natural mortality under changing environmental conditions.

17.0 Monkfish

- In 2024, the SSC noted that while the southern stock's abundance indices appear stable, the most recent three years are the lowest in the time series and far below historic levels, which could indicate that it is in a stable but depleted state.

18.0 Skates

- The SSC has discussed whether rebuilding (or lack thereof) for thorny skate is being influenced by climate effects and resulted in changed productivity/distribution. There have been positive responses to reduced fishing for some skate species but not for thorny skate, raising the question of whether F is the predominant driver (2021, 2023).
- More broadly, the SSC has discussed the notion of non-stationarity with regard to the skate complex and whether there was a need to redefine BRPs given changing ocean conditions and potential impacts on productivity (especially for thorny skate). This could be investigated in a future assessment, along with whether the different life history traits of skate complex species could be incorporated into BRP calculations or development of specifications (2021).
- Environmentally driven changes in thorny skate distribution may impact survey catchability and thus perceptions of stock abundance; if the stock is shifting inshore, state surveys may be an important tool (2023).
- While BRPs for the skate complex are index-based, the SSC has recommended exploring the feasibility of developing an analytical assessment model (perhaps length-based) (2023, 2025).

19.0 Small Mesh Multispecies

- The SSC has noted that trends in biomass for both whiting (silver hake) and red hake (i.e. increasing biomass in northern stocks and decreasing biomass in southern stocks) may reflect warming temperatures and thus call into question existing empirical BRPs used for each species. As a result, the SSC recommended conducting a benchmark assessment to revisit the suitability of the index-based BRPs (2017).

19.1 Silver Hake (Whiting)

- For both stocks (northern silver hake and the southern whiting complex, which includes southern silver hake and offshore hake), the SSC has recommended considering BRPs other than the 1973-1982 reference period, which assumes conditions have remained static. Exploring the sensitivity of stock status to the reference period selected could be a helpful approach (2020).
- In the absence of an analytical assessment, the SSC recommends investigating external indicators that suggest the population is undergoing a change, such as those available in the State of the Ecosystem Report (2020).
- In recognition of changing conditions, the SSC has recommended a) revisiting the reference period for defining the F_{MSY} proxy and b) developing criteria for defining reference periods in a changing environment (2023).

19.2 Red Hake

- For both the northern and southern stocks, the SSC set the exploitation rate used to inform setting of the ABC based on reference years when each stock appeared to respond to management. At the same time, the SSC recommended further investigating reference exploitation rate years (2020).
- The SSC has discussed the different exploitation rate reference periods used for the northern (1981-1994) and southern (2001-2019) stocks and the larger question of whether to use historical or contemporary periods to inform catch advice. There may be a need for different tools across stocks but the reasons are not well supported (2023).
- The SSC also recommended working to identify the environmental drivers of changing stock dynamics (i.e., increase in northern stock abundance and decrease in southern stock productivity) (2023).

20.0 Red Crab

- The SSC has noted that the current practice of harvesting only males could have implications for stock productivity, given the selectivity for large males and the fact that males need to be larger than females for reproduction (2023).

Appendix : Abbreviations

Abbreviation	Definition
ABC	Acceptable Biological Catch
AIM	An Index Method (assessment model)
ASAP	Age Structured Assessment Program (assessment model)
BRP	Biological Reference Point
CASA	Catch at Size Analysis model
DRP	Dynamic Reference Point
F	Fishing mortality
M	Natural mortality
MAFMC	Mid-Atlantic Fishery Management Council
MSY	Maximum Sustainable Yield
OFL	Overfishing Limit
NEFMC	New England Fishery Management Council
NLS	Nantucket Lightship
PDT	Plan Development Team
SSC	Scientific and Statistical Committee
SAMS	Scallop Area Management Simulator model
SHMW	Sea Scallop Shell Height to Meat Weight Ratio
WHAM	Woods Hole Assessment Model
TRAC	Transboundary Resources Assessment Committee