Developing Practical Guidelines for Integrating Dynamic Reference Points into Fisheries Stock Assessment and Management

A Workshop of the New England Fishery Management Council's Scientific and Statistical Committee

June 1-2, 2026

Hampton Inn Boston Seaport District, Boston, MA

New England Fishery Management Council

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Executive Summary

Workshop Purpose and Context

The New England Fishery Management Council's (NEFMC) Scientific and Statistical Committee (SSC) convened a two-day workshop in Boston, MA on June 1–2, 2026 to develop practical guidance for evaluating and implementing Dynamic Reference Points (DRPs) for New England fisheries. Building on recommendations from recent workshops and NOAA Fisheries guidance, participants explored approaches for applying DRPs within existing assessment, management, and legal frameworks to better account for persistent changes in stock productivity resulting from changing ocean conditions.

Where We Are in 2026

Presentations and case studies highlighted growing evidence that productivity has changed for several NEFMC-managed stocks and illustrated how assumptions of stationarity can lead to misspecified stock assessments and ineffective management recommendations (e.g., provisioning of catch advice and rebuilding plans). Examples of New England stocks that have explored or adopted revised reference points include Atlantic herring, yellowtail flounder, winter flounder, and white hake. Review of these case studies demonstrated the variety of approaches currently being used to account for changing productivity, as well as the scientific and management challenges associated with their application.

Evaluating Reference Points and Potential Guidelines

Workshop participants generally agreed that no single indicator should trigger consideration of a DRP. Instead, decisions should be informed by a structured weight-of-evidence approach that may incorporate biological, environmental, socioeconomic, and management information. Participants emphasized that DRPs should be considered primarily in response to persistent productivity changes rather than short-term variability, and that approaches should be tailored to individual stocks based on available data, assessment methods, and management objectives.

Management Applications, Implementation Challenges, and Opportunities

SSC members discussed the potential benefits and risks associated with DRPs, as well as the management and legal considerations associated with implementation. The SSC highlighted the importance of considering how revisions to reference points could affect the components of the management system, including projections, control rules, rebuilding plans, status determination criteria, and catch advice. Participants also emphasized the need for transparent decision-making processes and clear communication regarding the rationale for revising reference points.

Toward Operational Guidance and Next Steps

A major focus of the workshop was moving toward practical implementation. Through breakout discussions and concept-mapping exercises, participants identified potential pathways for evaluating productivity changes, revising reference points, and integrating DRPs into existing scientific and management processes. As an initial step forward, the SSC identified white hake, Georges Bank cod, and witch flounder as potential candidate stocks for further DRP exploration in the near term. In addition, the SSC identified several priorities for future work, including further developing indicators in coordination with the Northeast Fisheries Science Center, more regularly evaluating the applicability of DRPs across stocks, and exploring implementation of flexible status determination criteria to more nimbly respond to changes in productivity.

1.0 Introduction

1.1 Workshop Background

Biological Reference Points (BRPs) are the benchmarks used to evaluate stock status and form the foundation of many fisheries management decisions, including stock status determination, catch limits, and rebuilding plans. Traditionally, BRPs have been estimated with the assumption of relatively stable stock productivity through time. However, growing evidence suggests that changing environmental conditions and ecosystem dynamics are altering stock productivity, potentially reducing the relevance and effectiveness of these static BRPs. Workshops convened in 2024 by the Cooperative Institute for the North Atlantic Region (CINAR)[1] and the Council Coordination Committee's Scientific Coordination Subcommittee (SCS8)[2] explored the scientific basis for Dynamic Reference Points (DRPs) and identified key research, assessment, and management considerations associated with their implementation. NOAA Fisheries, meanwhile, developed guidance in 2025 on how BRPs may be updated as environmental conditions change.[3]

To move the discussion from broad concepts toward practical application, members of the New England Fishery Management Council's (NEFMC) Scientific and Statistical Committee (SSC) convened in Boston, MA on June 1-2, 2026.[4] This facilitated workshop aimed to develop guidance for evaluating when DRPs may be warranted and how they could be incorporated into stock assessment and fisheries management processes. A five-member Steering Committee consisting of SSC members, NOAA Fisheries Northeast Fisheries Science Center (NEFSC) staff, and other subject matter experts met regularly with NEFMC staff and workshop facilitators in the months leading up to the workshop to refine goals

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[1] Kerr, L.A., J. Jesse, and S.X. Cadrin (eds.). 2024. *Defining Biological Reference Points in a Dynamic Northeast U.S. Marine Environment*. CINAR Workshop Report. https://d23h0vhsm26o6d.cloudfront.net/CINAR_BRP_Workshop_Final_Report.pdf.

[2] Kerr, L., R. Feeney, and C. McManus (eds.). 2024. *Eighth National Meeting of the Scientific Coordination Subcommittee of the Council Coordination Committee*. https://static1.squarespace.com/static/56c65ea3f2b77e3a78d3441e/t/67d476df853919069a3ea40c/1741977315669/SCS+8+Workshop+Report+2024.pdf.

[3] Methot, R.D., et al. 2025. *Technical Guidance for Estimating Reference Points Used for Stock Status Determination in Accordance with the National Standard 1 Guidelines*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-261. Available at: https://spo.nmfs.noaa.gov/sites/default/files/NOAA-TM-NMFS-F-SPO-261.pdf.

[4] While this was an in-person workshop, members of the public were able to attend via a listen-only webinar component.

and outcomes, develop the agenda (Appendix II), prepare background materials to provide in advance of the workshop (Appendix III), and discuss logistics.

1.2 Defining Biological Reference Points/Dynamic Reference Points

Prior to the workshop, including at the March 30, 2026, SSC meeting, the Steering Committee and SSC developed draft definitions for both BRPs and DRPs to ensure that all participants were operating from the same fundamental understanding during workshop discussions.[5] These definitions were further refined throughout the planning process and during the workshop itself.

Biological Reference Points (BRPs) are the targets and thresholds by which the status of a stock is determined. BRPs can be derived either empirically or analytically and are typically estimated under the assumption that population dynamics are constant and/or in equilibrium.

The traditional approach to BRP calculation has typically assumed stationary population dynamics. While there is some updating that occurs in recalculating BRPs with updated data on certain vital rates (e.g., a recent five-year average of weight-at-age and maturity-at-age), in the case of stocks with an analytical assessment, there are usually stationarity assumptions regarding recruitment and natural mortality. With empirically derived BRPs, stock biomass and exploitation levels from certain time periods are assumed to be reference levels from which to measure relative change. The time periods used can vary across stocks, potentially using a historical period where a stock was assumed responsive to management or had high, sustained productivity that may reflect Maximum Sustainable Yield (MSY), or a contemporary period of sustained recent conditions.

A challenge in characterizing BRPs as conditions change over time is complying with the requirements of National Standard 1 (NS1) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; 6 U.S.C. §§ 1801–1884). The NS1 Guidelines define MSY as "the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technological

[5] Draft BRP and DRP definitions were included in the workshop background materials: https://d23h0vhsm26o6d.cloudfront.net/3_Reference-Point-Definitions.pdf.

characteristics (e.g., gear selectivity), and the distribution of catch among fleets" (50 CFR § 600.310(e)(1)(i)(A)). Similarly, NS1 guidance requires respecifying of one or more Status Determination Criteria (SDC)[6] components if "environmental, ecosystem, or habitat changes affect the long-term reproductive potential of the stock or stock complex" (50 CFR § 600.310(e)(2)(iii)(B)). However, as changing ocean and fishery conditions impact a stock's productivity, defining "prevailing conditions" and changes to "long-term reproductive potential" can be difficult because it is often unclear if the observed changes constitute a long term shift or are just ephemeral.

Dynamic Reference Points are time-varying targets and thresholds that adjust for non-stationarity in stock productivity.

Dynamic [Biological] Reference Points (DRPs) are time-varying targets and thresholds that adjust for non-stationarity in stock productivity. DRPs can enable more responsive management by accounting for the impacts of broad and persistent ecosystem change or regime shifts to better reflect recent past and projected future stock conditions. As with conventional BRPs, DRPs can be biomass- and/or fishing mortality-based and may use proxies depending on data availability (e.g., spawning potential ratio). In some cases, DRPs are informed by environmental conditions and/or influences on productivity.

1.3 Goals and Outcomes

Workshop goals and intended outcomes focused on practical guidelines for integrating DRPs into stock assessment and management processes:

Goals:

1. Establish a **shared understanding** of current approaches and recommendations from regional and national workshops on defining DRPs, including the challenges of implementation and human dimensions.

[6] NS1 guidance defines Status Determination Criteria as "the measurable and objective factors, MFMT [Maximum Fishing Mortality Threshold], OFL [Overfishing Limit], and MSST [Minimum Stock Size Threshold], or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished" (50 CFR § 600.310(e)(2)(i)(A)).

2. Recommend ways to evaluate the effectiveness of existing BRPs for NEFMC stocks to **determine when it may be more appropriate** to use DRPs.
3. **Evaluate alternative approaches to defining BRPs** that can account for non-stationarity, appropriateness of methods for NEFMC stocks (given data), and potential challenges in application.
4. **Identify tradeoffs, pathways and potential stocks** for implementing DRPs within the current scientific process to inform management.

OUTCOMES:

1. A preliminary **suite of indicators and guidelines** for evaluating whether to use DRPs and potentially candidate stocks.
2. Consensus on recommendations for developing, reviewing, and maintaining DRPs, building on existing CINAR, SCS8, and NS1 guidance (e.g., **evaluation standards, evidence thresholds**).
3. A stepwise **implementation roadmap** that aligns scientific advances with management, legal, and capacity constraints and identifies potential risks.
4. A prioritized **list of research recommendations** that could advance our understanding of DRPs and future development of best practices for implementation.

2.0 WELCOME AND OPENING REMARKS

SSC Chair Dr. Conor McManus opened the meeting and facilitated introductions before turning to NEFMC Executive Director Dr. Cate O'Keefe and Chair Dan Salerno.

Chair Salerno emphasized the complexity of managing stocks in the Northeast where the NEFMC is responsible for 10 Fishery Management Plans (FMPs) comprising 39 stocks and 28 species. Effective management of these stocks requires close coordination with other management entities such as the Mid-Atlantic Fishery Management Council (MAFMC), Atlantic States Marine Fisheries Commission (ASMFC), NOAA Fisheries, and Canada's Department of Fisheries and Oceans. A changing environment adds an additional layer of complexity when it comes to achieving management goals, especially given historical assumptions of stationarity.

Dr. O'Keefe outlined some of the key challenges that the NEFMC faces. Unknown stock status from rejected analytical assessments can lead to ill-defined management targets, triggers and thresholds. Subsequently, this lack of direct benchmarks can lead to inconsistent rationale for catch advice. Stationarity assumptions can also increase uncertainty in catch advice; these assumptions can lead to unrealistic (and continually extended) rebuilding targets if they are based on a stock's long-term productivity, which may differ from current conditions, driving reductions in fishing effort and reduced catch limits even as there is no progress toward rebuilding. These issues collectively may result in setting very low catch limits for some stocks that constrain the ability of harvesters to target healthy co-occurring species. The use of stationarity assumptions when there are signals that the system is changing can have substantial management consequences.

Despite the growing consensus that fishing is likely not the main driver for status of some stocks, operationalizing a dynamic approach that considers environmental conditions has proven challenging due to a lack of formal guidance. For example, doing so may require revision of the NEFMC's Risk Policy and Harvest Control Rules, as well as developing consistent approaches for considering changing productivity in setting catch limits. There has been some reluctance to new approaches from managers, and implementation must also consider potential socioeconomic impacts to fishing communities, such as decreased stability in catch advice.

Dr. O'Keefe described some of the ongoing efforts of the NEFMC to better align management with biological and environmental realities. She reiterated that management considerations may be less important if ocean conditions are what most impact stock status, and as a result those efforts have failed to meet conservation objectives. The NEFMC is currently developing an evaluation process for potentially designating stocks as Ecosystem Component Species/Stocks (ECS) that have experienced climate-driven changes in distribution, abundance, and productivity and whose low availability (e.g., Annual Catch Limits [ACLs] on the order of tens of metric tons) and rigid management constrain fishery success. A stock designated as an ECS would continue to be monitored and managed, but would not be subject to ACLs or Accountability Measures. The NEFMC is developing a guidance document to apply to ECS candidate species.

In addition, the NEFMC is nearing completion of a 3-year effort to revise its Risk Policy that will more explicitly account for biological, environmental, and socioeconomic factors in informing risk tolerance. Specifically, these revisions will account for changing productivity regimes and climate change and will eventually be integrated into Acceptable Biological Catch (ABC) control rules to better consider tradeoffs between risk and value.

Chair Salerno concluded with the recognition that while several NEFMC-managed stocks are experiencing declines, the application of dynamic processes could provide potential for increased fishing opportunities for healthy stocks currently constrained by choke species. He emphasized that this workshop is a critical opportunity to think through implementing approaches that consider these dynamic processes—in particular with regard to reference points.

3.0 Where We Are in 2026

3.1 Current Approaches and Challenges to Implementing Dynamic Reference Points

Dr. Lisa Kerr and Ms. Jerelle Jesse (University of Maine) updated SSC members on the current state of knowledge regarding the integration of DRPs into management contexts. Despite dramatic reductions in fishing mortality, some stocks have failed to rebuild, a pattern that is increasingly being attributed to climate change impacts. As changing ocean conditions affect stock productivity, redefining BRPs and rebuilding targets may be warranted.

DRPs can acknowledge changes in stock productivity, and there are a range of DRP approaches that can be applied based on data availability and/or stock assessment model type. Some approaches include:

- Test for regime shifts in productivity
- Apply moving windows to characterize changing productivity
- Model time varying productivity (e.g., through random effects and propagating process error into reference points)
- Use dynamic stock-recruit relationship
- Use dynamic unfished biomass (B_0)
- Model linkage with environmental driver (temperature)
- Model linkage with ecosystem models

An overview was provided of how the NEFMC currently defines reference points and sets catch for its 39 managed stocks. While frequent (every 1-3 years) age-structured analytical assessments are desirable for tactical decision-making, empirical approaches are often used when age-structured assessments have failed or when data are limited (Figure 1).

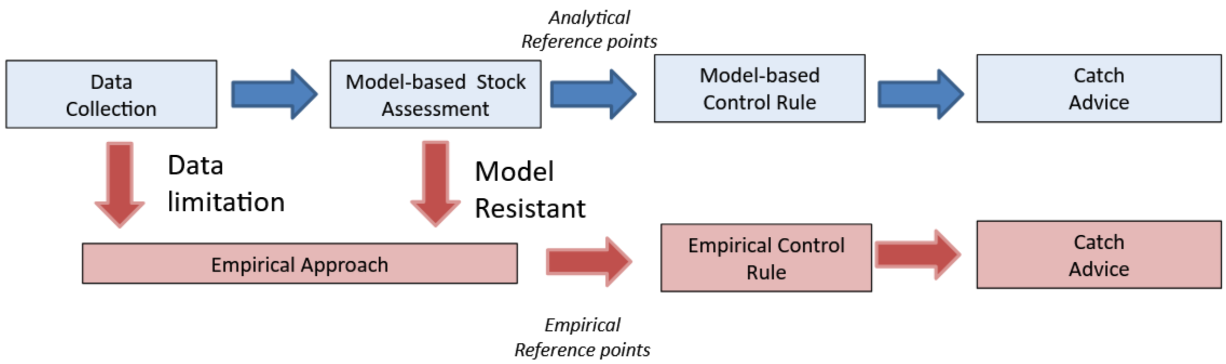

Figure 1. Pathways for setting BRPs, ABC control rules, and catch advice based on data availability and model resistance.

Currently, empirical approaches (e.g., index-based methods) are used to assess 21 NEFMC stocks, while model-based analytical assessments are applied to 18 stocks. Despite the broad recognition of climate impacts on productivity for some stocks, it has historically been challenging to account for such changes in the assessment process. Among the 39 NEFMC-managed stocks, BRPs are defined for 18 analytically assessed stocks and for 13 of the 21 empirically assessed stocks.

NEFMC Stock Portfolio

39 Managed Stocks

18 Analytical Assessments → 100% have BRPs

21 Empirical Assessments → 13 have BRPs

While BRPs for analytically assessed stocks typically assume that future productivity will be similar to the time series average, there have been examples of revising recruitment assumptions to account for perceived shifts. In addition, flexible model frameworks such as the Woods Hole Assessment Model (WHAM), which allow for time-varying stock dynamics and linkage to environmental drivers, are increasingly being adopted to address such needs. That being said, in the case of the many analytically assessed stocks that use BRP proxies, assumptions of changing productivity that adjust biomass proxies are not reflected in fishing mortality proxies such as $F_{40\%}$, (which assumes stationary productivity), which can result in higher exploitation rates on species under stress.

For empirically assessed stocks with known stock status, reference time periods are used to define targets and thresholds, though applications of such reference periods are inconsistent (e.g., a historical period of high sustained productivity that may approximate MSY versus contemporary reference periods thought to better represent current conditions). The eight stocks with unknown status, meanwhile, have been subject to more ad-hoc approaches.

While the challenges associated with assumptions of stationarity are evident for some stocks, further guidance is needed regarding how to define BRPs in a dynamic environment. Similar challenges exist for the application of ABC control rules, which are unique to each FMP—namely, it is unclear whether current buffers to account for scientific uncertainty are sufficient given changes to stock productivity.

Outcomes of Regional Workshops Related to DRPs and What Has Changed

Dr. Kerr and Ms. Jesse also recapped two workshops held in 2024 to advance understanding and application of DRPs.[7]

The January 2024 CINAR workshop[8] developed recommendations for estimating BRPs for stocks in a changing ecosystem, while the August 2024 SCS8 meeting, entitled “Applying Acceptable Biological Catch (ABC) Control Rules in a Changing Environment”,[9] also identified challenges and provided actionable guidance/recommendations for application of DRPs. Some of the key recommendations are in Table 1.

[7] An comprehensive overview of recommendations from each workshop can be found in the final workshop reports or in the workshop background materials, which is available at https://d23h0vhsm26o6d.cloudfront.net/4_DRP-State-of-Play.pdf.

[8] Kerr, L.A., J. Jesse, and S.X. Cadrin (eds.). 2024. *Defining Biological Reference Points in a Dynamic Northeast U.S. Marine Environment*. CINAR Workshop Report. https://d23h0vhsm26o6d.cloudfront.net/CINAR_BRP_Workshop_Final_Report.pdf.

[9] Kerr, L., R. Feeney, and C. McManus (eds.). 2024. *Eighth National Meeting of the Scientific Coordination Subcommittee of the Council Coordination Committee*. https://static1.squarespace.com/static/56c65ea3f2b77e3a78d3441e/t/67d476df853919069a3ea40c/1741977315669/SCS+8+Workshop+Report+2024.pdf.

Table 1. Key recommendations from recent prior workshops.

January 2024 CINAR Workshop	August 2024 SCS8 Workshop
• Consider both **ecosystem-wide (e.g., regime shifts) and stock-specific (e.g., productivity shifts) indicators** of change to assess whether it is appropriate to revise BRPs. • Consider both **short-term and long-term solutions** to inform how to revise BRPs. Short-term solutions could include routine examination of key assumptions such as stock-recruitment functions, while long-term approaches may include adopting assessment models that account for time-varying stock dynamics and/or environmental covariates.	1. To address the challenge of data limits, **identify information available** to understand ecosystem and productivity changes and scale goals to address each regional fishery management council's unique needs based on data availability. 2. To address the challenge of inertia in the science and management processes, **better leverage analytical advances** to further integrate climate impacts into the assessment and BRP estimation processes. 3. To understand how BRPs may perform under changing ocean conditions, use **simulation testing** (such as through Management Strategy Evaluation [MSE]) to test their robustness to a changing environment; share best practices and lessons learned. 4. Given the current rigidity of the council management process, pursue **proactive actions** that will allow future flexibility and nimbleness—for example, through changes to council FMPs, risk policies, and procedures.

Key science and policy changes that occurred in the two years since these workshops were noted. There has been increased movement away from assumptions of status-quo conditions (i.e., stationarity) in defining BRPs with the adoption of models such as WHAM that incorporate time-varying properties or even include an environmental linkage. Such approaches enable management to be increasingly responsive to changing conditions, although there has not yet been full advancement or adoption of *proactive* approaches that anticipate future conditions and adjust accordingly. Another major change has been the reduced availability of federal resources to support stock assessments, which has resulted in the pause of research track stock assessments (RTAs) and less frequent management track assessments (MTAs), thereby slowing progress on integrating climate information into assessments and defining BRPs.

3.2 Evolving Approaches to Revise Biological Reference Points in New England

SSC Chair Dr. McManus provided an overview and facilitated a panel on how assessment scientists and the SSC have considered changing environmental conditions and impacts on productivity. The panel focused on five NEFMC-managed stocks as examples of estimating BRPs and providing catch advice. The four panelists are involved in the assessment and/or management processes for the five stocks:

- Dr. Lisa Kerr, University of Maine, SSC Member (white hake)
- Dr. John Deroba, NEFSC (Atlantic herring)
- Dr. Alex Hansell, NEFSC, SSC Member (Georges Bank and Southern New England/Mid-Atlantic [SNE/MA] yellowtail flounder)
- Dr. John Wiedenman, Rutgers University, SSC member (SNE/MA winter flounder)

Panelists discussed approaches used in these cases for detecting changes in stock productivity and evaluating whether revisions to BRPs were warranted. Key themes included considering multiple lines of evidence, differences in approaches for analytically and empirically assessed stocks, and the need to consider how revised BRPs would play out in the broader management process. Many of the specific points brought up by the panel were elaborated upon in the subsequent discussion by workshop participants, detailed in Section 3.3.

Atlantic Herring

For Atlantic herring, persistent low recruitment (Figure 2) and low stock abundance despite reduced fishing pressure have highlighted the need to better understand environmental influences on productivity. The Atlantic Herring Plan Development Team (PDT) has considered projections using both the recruitment average from the full time series and autocorrelated recruitment, and the SSC has recommended new modeling tools such as dynamic linear modeling as well as reconsidering use of the $F_{40\%}$ proxy, which may not be appropriate in a low-productivity regime.

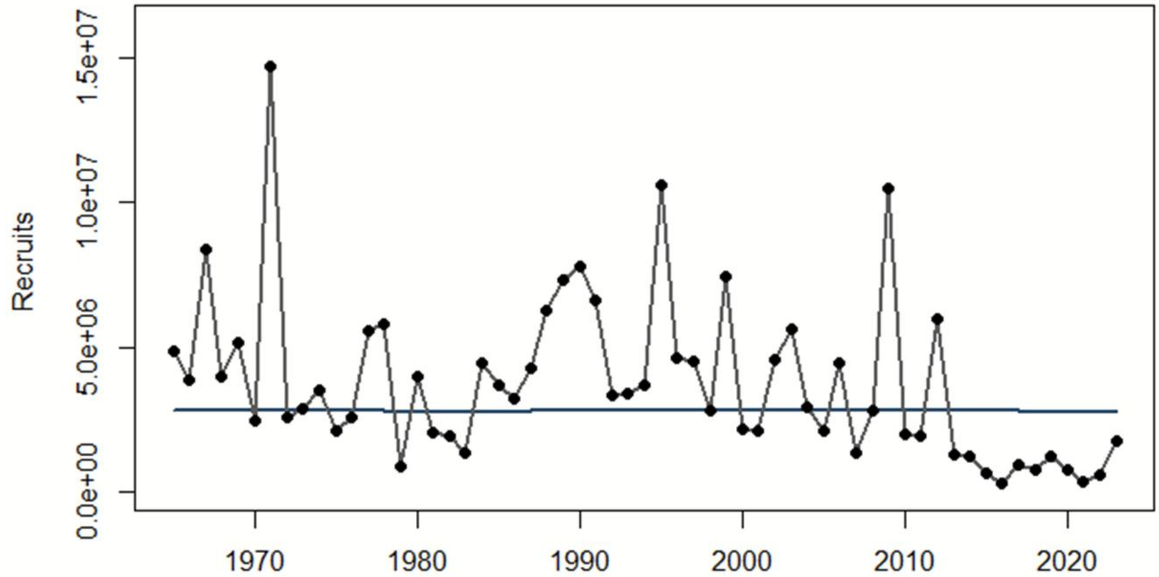

Figure 2. Atlantic herring recruitment over time. The dark blue horizontal line denotes the long-term average.

The 2022 and 2024 MTAs, which used the Age Structured Assessment Program (ASAP) model, identified three discrete productivity (recruits per spawner) time stanzas since the 1960s and supported using recruitment from the most recent stanza (1992-2021) to calculate BRPs. This had the effect of reducing the $B_{40\%}$ proxy compared to the 2020 assessment. The 2025 RTA, however, applied WHAM, which shortened the model time series and introduced recruitment process random effects; this new model did not lend support to the truncated recruitment time series identified in the previous MTA. The takeaway from these assessments and ensuing discussions was that while reductions in recruitment *may* reflect changing stock productivity, they could also be due to other factors such as low spawning stock biomass, and low recruitment alone is insufficient evidence to support a truncated productivity time series for calculating BRPs. As a result, recruit-per-spawner stanzas should be interpreted with caution, although state-space models and removal of historic information from model time series may alter the evidence previously used to identify regime/productivity shifts.

While the abundance of Georges Bank and SNE/MA yellowtail flounder has consistently been low in recent years under historically low harvest and bycatch, fishing mortality is not considered to be the main driver of stock dynamics. Rather, environmental changes such as bottom temperature and the Gulf Stream Index may be impacting recruitment dynamics. These environmental time series were included as covariates in the 2024 RTA WHAM model via stock-recruit dynamics for each stock and were used to define recruitment stanzas for projections (Figure 3). These assessments resulted in a change in BRPs for both stocks and, in the case of Georges Bank yellowtail flounder, allowed for abandoning proxy reference points and directly estimating BRPs.

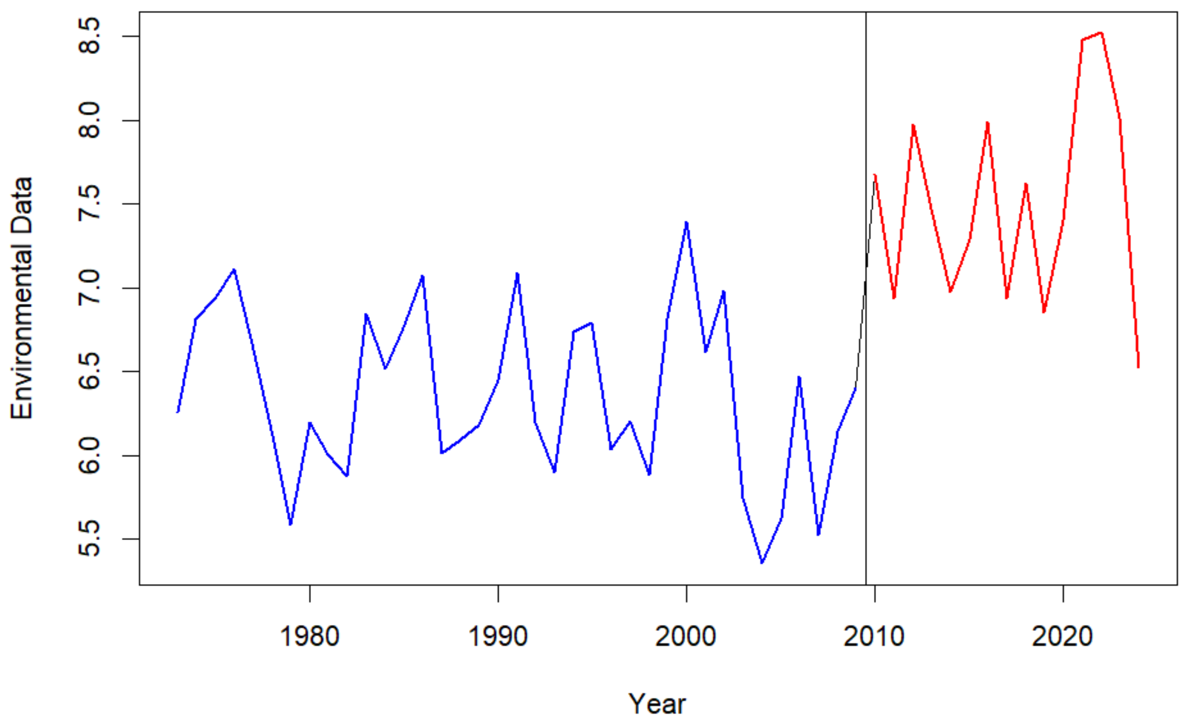

Figure 3. Recruitment stanzas (red and blue lines, with a breakpoint at 2009/2010) based on bottom water temperature (Y-axis values) identified in the 2024 RTA for Georges Bank yellowtail flounder.

In 2025, the SSC reviewed the changes to BRPs included in 2025 MTAs for these stocks. For the Georges Bank stock, the group noted the challenge of parsing environmental versus fishery effects and emphasized the importance of working toward environmental forecasting to more proactively respond to forecasted changes in recruitment. For the SNE/MA stock, the SSC questioned the continued use of the $F_{40\%}$ proxy given the perceived shift to the new productivity regime.

SNE/MA Winter Flounder

The SNE/MA winter flounder stock provided another example of a stock for which environmental changes appear to be a primary driver on stock dynamics. Previous research has identified the impacts of ocean conditions on the stock-recruitment relationship,[10] with projections indicating that as ocean conditions continue to warm, rebuilding becomes highly unlikely.

Recognizing changes to stock productivity, the 2022 MTA moved from using recruitment from the entire time series (1981-2021) to a more recent period and using a 20-year moving window to inform projections. With these changes, the revised BRPs altered stock status, as the stock was now found to be rebuilt even though both recruitment and abundance were near all-time lows.

Although projections using the revised recruitment stanza and the implications of change in stock status on use of the ABC control rule indicated that the stock could sustain catches over four times higher (based on revised BRPs) than recent years, the SSC responded cautiously in Fall 2022. Despite the ABC control rule prescribing catch to be set at 75% F_{MSY}, the SSC instead adopted a quasi-ad hoc approach, setting the ABC at 50% F_{MSY}.

White Hake

Productivity assumptions for white hake (currently in a rebuilding plan and assessed using the ASAP model), have been a frequent topic of SSC discussion in recent years. For rebuilding projections based on BRP proxies, recruitment is sampled from a cumulative distribution function for 1963-2022. For short-term projections for catch advice, meanwhile, recruitment is sampled from a cumulative distribution function of a truncated time series from 1995-2022. These two projection setting methods can lead to diverging trajectories for white hake, with the full recruitment time series indicating that the stock could rebuild by 2031, but the truncated time series indicating that it could not; the SSC

[10] Bell, R.J., J.A. Hare, M. Asch, M.F. Stachura, A.W. Wood, K.A. Richardson, E.J. Teeters, and W.E. Morrison. 2014. *An Evaluation of the Effect of Climate Change on Atlantic Fish Stocks of the Northeast U.S. Continental Shelf*. NOAA Technical Memorandum NMFS-NE-229. Woods Hole, MA. Available at: https://www.st.nmfs.noaa.gov/Assets/ecosystems/habitat/pdf/11-004_Bell_etal2014.pdf.

noted that these inconsistencies may not be appropriate and could lead to uncertainty about the outcomes of catch advice (Figure 4).

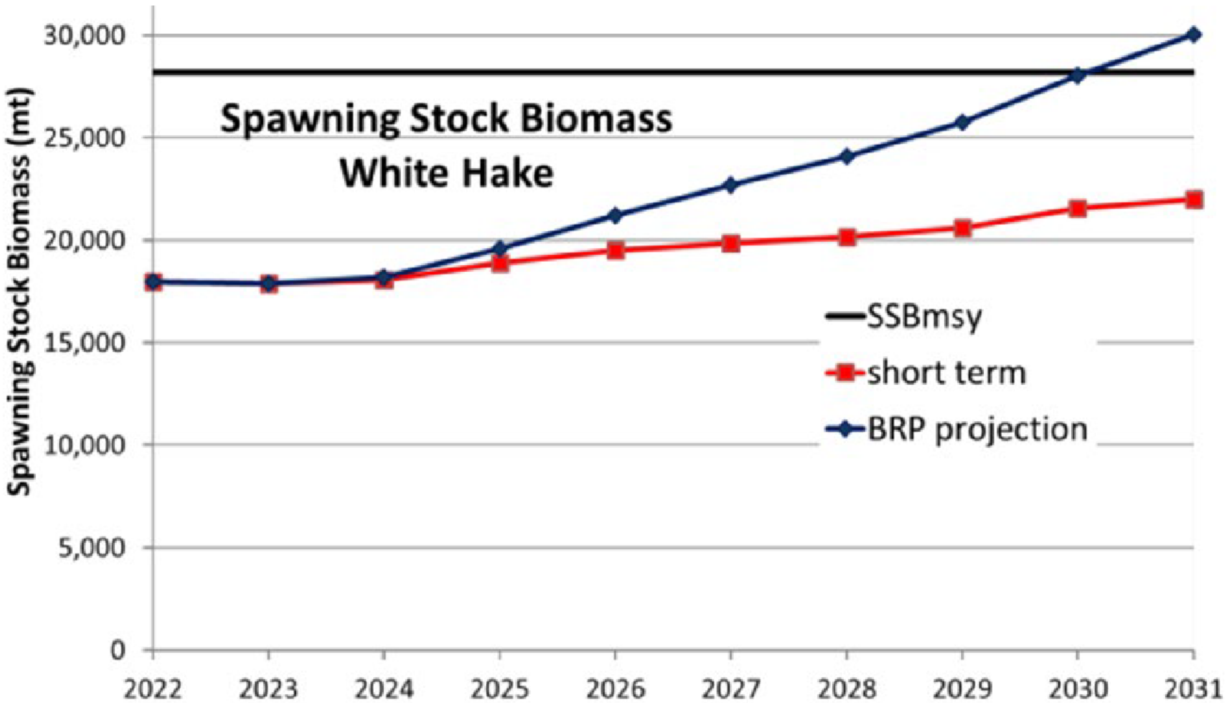

Figure 4. White hake stock rebuilding projections from 2022-2031, based on recruitment assumptions used for BRPs (1963-2022; dark blue line) and for catch advice (1995-2022; red line), respectively (Source: NEFSC 2022).

To help inform a path forward, the SSC reviewed studies by 1) Dr. Steve Cadrin (University of Massachusetts Dartmouth School for Marine Science and Technology) and 2) Drs. Jeremy and Samuel Collie (Natural Capital Consulting). Dr. Cadrin conducted a change-point analysis to determine whether there were changes in white hake recruitment and recruitment rate. While no change points were identified, the study recommended that short-term catch projections assume autocorrelated recruitment to better align with rebuilding projections associated with BRPs. The Collies used dynamic linear modeling and found support for time-varying stock-recruit models that indicated a decline in productivity starting in 1990. They recommended applying a dynamic stock-recruitment relationship to calculate BRPs, short-term projections, and rebuilding projections. Based on these studies, the SSC recommended running short-term projections assuming autocorrelated recruitment, with potential for considering dynamic stock-recruit analyses for projections in the next MTA. Three years later, the SSC remains concerned about low recruitment despite historically low harvest and continues to support using autocorrelated recruitment for short-term projections as well as an eventual transition from an ASAP model to WHAM to adopt the recommendations of the Collies.

3.3 Opportunities, Challenges and Unintended Consequences

Following the panel discussion, the workshop explored (a) opportunities to improve climate-responsive management (Table 2), (b) challenges associated with revising BRPs (Table 3), and (c) scientific risks and unintended consequences that should be considered when evaluating dynamic approaches (Table 4). The key points highlighted below reflect conversations from both the panel discussion (See Section 3.2) and SSC dialogue.

Table 2. Opportunities to improve climate-responsive management.

Revising DRPs	Management
• Increase adoption of **flexible model frameworks (e.g., WHAM)** to account for environmental drivers of productivity and thus better reflect changing conditions/BRPs. • **Dynamic stock-recruit analyses** (e.g., white hake) • Tools such as the State of the Ecosystem Report's Operational Ocean Forecast can help inform more **proactive revisions.**	• **ECS consideration** for stocks that have remained at low levels despite reduced fishing and which are no longer the target of fisheries. • Ongoing **revisions to the NEFMC's Risk Policy** which includes recruitment and climate vulnerability as factors and anticipated integration with ABC control rules may enable a more standardized approach to setting catch advice as stock productivity changes. • Developing a **continuum of stock status based on the primary driver** (i.e., fishing versus environment), and developing indicators to designate such status.

Table 3. Challenges associated with revising BRPs.

Detecting Productivity Shifts	Revising DRPs	Management
● **Low recruitment should be interpreted with caution:** Recruits per spawner can shift due to changes in biomass unrelated to environment (e.g., depensatory dynamics resulting from fishing). ● **Treatment of Numbers-At-Age (NAA) random effects** in a WHAM model, which could obscure the effects of environmental factors on recruitment. ● **SSC members cannot independently and readily access certain fishery-dependent data** (quota use, price, etc.) due to confidentiality concerns, which precludes examination of potential indicators to determine whether a change to BRPs is warranted.	● **Stock dynamics may still be changing after BRPs are revised (i.e., the stock has not reached a new equilibrium) →** must continuously monitor metrics of productivity and revise assumptions as needed. ● Changes to both **SSB and F-based BRPs should be considered,** particularly for those stocks that rely on proxy-based BRPs. ● When considering BRP revisions, **empirical stocks cannot be left behind** as model-based approaches are advanced for analytical stocks.	● Solutions are needed to anticipate and more **smoothly adjust management responses to revised BRPs**, which can dramatically alter perceptions of stock status.

Table 4. Risks and unintended consequences that should be considered when evaluating dynamic approaches.

Stock Impacts	Management Outcomes
● Incorrectly attributing depletion to the environment when it is actually due to fishing could result in **continually revising numerical estimates of BRPs down** through time until the stock size is close to zero. ● Adjustment of management targets to reflect decreased productivity could result in **higher exploitation rates on populations under stress** (e.g., SNE/MA winter flounder). ● **Inconsistency in recruitment assumptions** for BRPs v. projections can result in overly optimistic expectations of long-term productivity (e.g., white hake). (See "Managing Uncertainty About Productivity Drivers" in Section 5.2)	● How scientific decisions may play out in management context (to avoid "buyer's remorse"); **model BRP revisions through** to the broader implications of the ABC setting process. ● Public scrutiny for "moving the goal posts"—there is a need to **clearly communicate the rationale for revising reference points**. The management approach must be deliberate.

4.0 Evaluating Reference Points and Considering Potential Guidelines

4.1 Considerations Regarding When to Change from Static to Dynamic Reference Points

Dr. Jon Deroba of the NEFSC provided an overview of how to evaluate when to make the shift from static BRPs to DRPs. While there is no clear answer applicable across all stocks and circumstances, there are a variety of tools that assessment scientists, members of the SSC, and managers can consider.

Assessment scientists can **look for stanzas, or discrete time periods of a productivity variable**, that could signal stock productivity shifts. For example, for Atlantic herring, changes in the recruits per spawner time series provided evidence of an environmental shift. However, solely examining trends in recruits per spawner is insufficient and should not be considered in isolation. Other analyses, such as the relationship between recruits per spawner and biomass over time, can help determine whether the stock-recruit relationship deviates from the expected inverse relationship (Figure 5). Only examining time series plots (Figure 5, panel A) may not clearly show evidence of a shift, but using a variety of tools, such as recruits per spawner or recruits versus SSB (Figure 5, panel B) may be more informative.

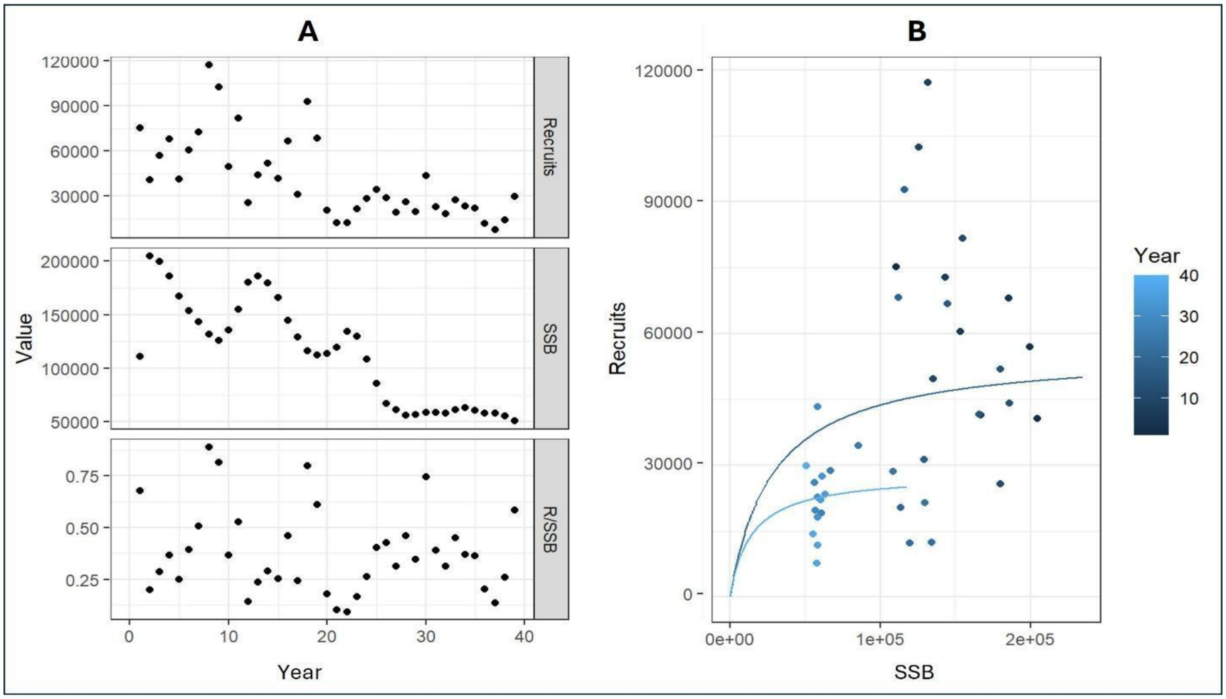

Figure 5. Simulation example demonstrating how some indicators may not indicate a productivity shift (A). Multiple analyses, including recruits per spawner over time (B), should be considered (Adapted from C. Legault, NEFSC).

A **strength-of-evidence** approach can provide a structured, if still somewhat subjective, rubric for determining whether a regime shift has occurred. Klaer et al. (2015)[11] proposed scoring different elements of a stock and its assessment (Figure 6).

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[11] Klaer, N.L., R.N. O'Boyle, J.J. Deroba, S.E. Wayte, L.R. Little, L.A. Alade, and P.J. Rago. 2015. *How much evidence is required for acceptance of productivity regime shifts in fish stock assessments: Are we letting managers off the hook?* Fisheries Research 168: 49–55. https://doi.org/10.1016/j.fishres.2015.03.021.

Table 1
Scoring guidelines.

Score	Observed change in a productivity indicator	Understanding of assessment model input data	Understanding of assessment model structural assumptions	Explanatory hypothesis
0	Short period less than one generation	Model input uncertainties are unknown	Key population parameters affected have not been identified	The mechanism is unknown
1	More than one generation	A number of model inputs are uncertain and the extent of uncertainty has not been characterised	Modeled changes in one or more key population parameters have fitted with observed biomass changes	A plausible mechanism for productivity shift has been developed from general knowledge of biophysical processes
2	Multiple generations and across several assessment/management cycles	Uncertain model inputs have been characterised and plausible ranges for those uncertainties have been investigated	Modeled changes in key production parameters have been somewhat validated by investigation of alternative model structures and/or improved model behaviour such as the removal of retrospective patterns	Output from a limited biophysical or multispecies model is consistent with observed patterns of change in productivity
3	Multiple generations and across many regular assessment/management cycles in the same timeframe	The character of model inputs is well understood and uncertainty has largely been eliminated or well estimated statistically	Validated modeled changes are consistent with output from a biophysical or multispecies model	Output from a comprehensive biophysical multispecies model is consistent with observed patterns of change in productivity

Figure 6. Scoring guidelines for determining whether a productivity shift has occurred based on four categories. A score of 7 or greater is considered strong evidence (Source: Klaer et al. 2015).

A **dynamic B_0 approach** uses an assessment model to project what a stock's SSB would be in the absence of fishing, to evaluate the impacts of fishing. Dynamic B_0 values change annually and assume that recruitment is independent of the fishing process. This approach relies heavily on a well-determined stock-recruitment curve, which can present a challenge in a dynamic system if the stock-recruitment relationship is changing regularly. That being said, simulation studies have shown that it performs better than a static B_0 approach if productivity changes directionally across years.[12]

If the **stock-recruitment relationship is driven by an environmental factor**, as with Georges Bank yellowtail flounder (see Section 3.2), it can be extremely helpful for estimating BRPs. However, it does not address all issues, such as how to project the environmental factor into the future (e.g., recent average or future projection).

The presence of **NAA random effects** in assessment models can obscure the impact of environmental factors on recruitment and make it unclear whether DRPs are needed. In short, NAA random effects imply that a stock's cohort strength (another potential measure of productivity) is not based solely on the number of recruits, but also on the increases or decreases in cohort strength caused by the random effects, which can represent changes in natural mortality, immigration-emigration, unreported fishing effects, or other causes.

[12] Berger, A.M. 2019. *Character of temporal variability in stock productivity influences the utility of dynamic reference points*. Fisheries Research 217: 185–197. https://doi.org/10.1016/j.fishres.2018.11.028.

NAA random effects can also lead to counterintuitive or unexpected projection outcomes, such as a large recruitment event not contributing much to SSB in the future because the cohort can decline rapidly due to the random effects.

Breakout Session: When to Change to DRPs

Building on the morning's discussions, the SSC divided into three breakout groups to further define when a transition to using DRPs may be warranted. This included the identification of potential indicators, the process by which such indicators should be evaluated, and how such indicators - and the appropriateness of applying DRPs - should be monitored and reviewed over time. Each group focused on a different perspective: 1) social/economic; 2) stock assessment/biology; and 3) environment/ecosystem. Highlights from across the groups are described in Table 5.

Table 5. When a transition to DRPs may be warranted.

When are DRPs Appropriate?	Monitoring and Review Considerations
• A formalized **weight-of-evidence approach** using identified indicators (see Section 6.1) should be developed for NEFMC-managed stocks to help determine whether a transition to DRPs is warranted. • The **Northeast Region Coordinating Council (NRCC)**, through its Assessment Working Group, could provide key input on when current approaches to BRPs are not working and whether a change is warranted, keeping in mind needed resources to adopt DRPs and the overall assessment schedule. • An **inclusive, integrated** approach that brings together the SSC, NEFSC assessment and ecosystem scientists, managers, industry, and other groups is important for ensuring an evaluation is complete. Example: A theme-based RTA could evaluate DRP needs across multiple stocks simultaneously rather than on a stock-by-stock basis. • Understanding the **ecosystem context** for a stock (e.g., predator, key forage species, etc.) is helpful for evaluating the biological or ecological risk of shifting to DRPs (e.g., management for some stocks may need to be more precautionary based on their ecosystem role). • Regime shifts may not always be the "smoking gun," nor are they a necessary condition for adopting DRPs; **ensemble models** can be helpful for detecting other changes.	• Incorporate indicator monitoring into **existing scientific and management processes** rather than create entirely new review structures. • In addition to assessments, **Data Updates, Ecosystem and Socioeconomic Profiles**[13]**, and industry input** (e.g., advisory panels, questionnaires, interviews, etc.) are useful sources for tracking biological, ecosystem, and socioeconomic indicators over time. • **Regular review of indicators** included within a weight-of-evidence framework could help identify when further evaluation of a stock's BRPs is warranted. Monitoring frequency and review schedules should be tailored to individual stocks based on life-history.

[13] NOAA Fisheries. Ecosystem and Socioeconomic Profile Development and Reports. https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/ecosystem-and-socioeconomic-profile-development-and-reports.

4.2 How to Change to Dynamic Reference Points and What Are The Practical Constraints

Dr. Jamie Cournane (NEFMC) provided an overview of the current NEFMC process from science to management, changes that are currently underway, and where/how a shift to DRPs could occur. Typically, research concerning BRPs is used to inform a stock assessment, which then undergoes peer review before moving to the PDT for additional analysis (e.g., impacts analysis). The assessment and PDT analysis are then passed to the SSC, which makes recommendations not only on catch advice but also on whether it is sensible to adopt a new approach to BRPs—for example, a shift to DRPs—as the basis for status determination. The NEFMC then considers that advice in making recommendations through a Council action (specifications, framework adjustment or amendment) that are passed to NOAA Fisheries for approval and implementation. This entire process can take a year or longer (Figure 7).

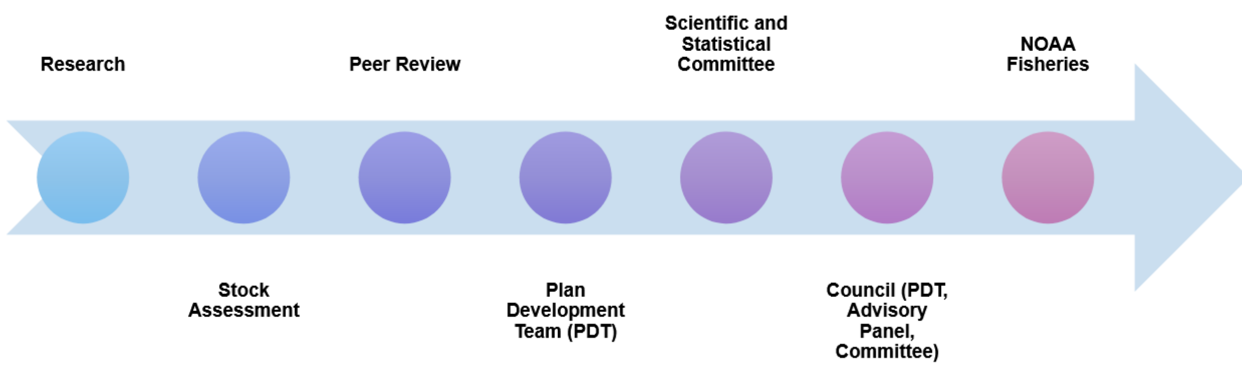

Figure 7. Schematic overview of the NEFMC's current science-to-management process.

Breakout Session: How to Change to DRPs

SSC members divided into three assigned groups to discuss processes by which a shift to DRPs could occur, including potential pathways for DRP implementation across stocks and possible challenges and open questions to address. Key topics that emerged during the breakout session and ensuing plenary discussion are summarized in Table 6.

Table 6. How to transition to DRPs.

Implementation Mechanisms	Practical Considerations
• Non-assessment on-ramps to revising BRPs include the **peer review process, SSC recommendations (either to revise BRPs directly or as a research recommendation), or recommendations from the NEFMC itself**. Risk: time lags. • Planned revisions to the **NEFMC's ABC control rules and Risk Policy** to provide a systematic mechanism for incorporating changing productivity into catch advice. • **Simulation testing** is an important tool for evaluating whether proposed DRPs would improve management outcomes and for understanding interactions among BRPs, ABC control rules, and risk policies. • Where BRPs are built directly into FMPs[14], an **FMP amendment** is needed to enable more rapid future adjustment (perhaps an omnibus amendment covering multiple FMPs which directly specify BRPs). • **Building SDC flexibility into FMPs** (see Section 5.1) could improve responsiveness to new information and would also address the process issue of using certain SDCs early in the process (assessment and review) prior to rulemaking and their formal inclusion in the FMP. Tradeoff: A frontloaded process would mean that the NEFMC would have a less direct role in setting SDCs. • Because DRPs have largely been discussed in the context of analytical assessments where productivity can be directly evaluated, the implications for empirical control rules remain less clear. The SSC has historically directly modified BRPs for some empirically managed stocks, suggesting that **implementation pathways may differ among stock types.**	• **NOAA Fisheries capacity** limitations and the fact that the assessment process is in flux raises concerns about the ability to conduct the required work to revisit BRPs moving forward. • If large changes to catch advice result from implementing DRPs, **phasing in the change** over several years may be prudent, although the legal implications of such an approach are unclear. • Greater use of **F-based BRPs**, rather than biomass-based BRPs, could offer additional flexibility in some circumstances. Some fisheries have shifted to rely only on F-based reference points (e.g., international Atlantic bluefin tuna management) in response to uncertainty regarding biomass-based BRPs. This shift may also avoid certain management constraints associated with biomass-based stock status determinations and rebuilding requirements.

[14] An example of the Northeast Skate Complex FMP. NEFMC. 2003. *Northeast Skate Complex Fishery Management Plan (FMP).* Final Environmental Impact Statement. September 18, 2003. Available at: https://d23h0vhsm26o6d.cloudfront.net/FINAL.Skate-FMP.EIS.FINAL.VOL.pdf.

5.0 Management Applications, Implementation Challenges, and Opportunities

5.1 Policy and Legal Implications - National and Regional Perspectives

Dr. Wendy Morrison (NOAA Fisheries) presented NOAA Fisheries guidance regarding the shift to DRPs and how other regions have worked to incorporate DRPs into the assessment and management process. While there are some strict criteria specified in MSA regarding preventing overfishing and achieving rebuilding, there is some flexibility in the National Standard Guidelines developed by NOAA Fisheries that afford opportunities to change BRPs in response to changing environmental conditions.

Nationwide, only five federally assessed stocks include an explicit linkage between an environmental driver and a stock assessment parameter.

The MSA specifies that FMPs include criteria for identifying when a fishery is overfished (i.e., SDCs) and NS1 clarifies that SDCs be specified for overfishing. There are pathways for developing flexible SDCs[15] that reduce the lag time between the completion of a stock assessment and official determination of stock status whenever new or different criteria than the SDC specified in the FMP are determined to be a better indicator of stock status. Rather than requiring an FMP amendment when new criteria are determined to be the best scientific information available, a flexible approach automatically adopts the new SDCs, streamlining implementation and reducing administrative burden on the Council. This would require an initial FMP amendment to specify the flexible SDC and should include broad language about basing SDCs on the best scientific information available. Tiered approaches could be developed for empirical/data-poor stocks that allow for changes in SDC methodology as more information becomes available.

There are several examples where other regions have implemented or made progress toward implementing DRPs. In the North Pacific, all groundfish assessments have truncated the time series of recruitment to 1977-present given evidence of a climate

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[15] NOAA Fisheries. 2024. *Flexible Status Determination Criteria: Examples and Their Application*. White Paper developed by the NOAA Fisheries Climate, Ecosystems, and Fisheries Initiative. Available at: https://d23h0vhsm26o6d.cloudfront.net/8_Flexible-Status-Determination-Criteria-Examples-and-their-Application-White-Paper-FINALwithNOAAlogo.pdf.

regime shift at that time—similar to the truncation approach used for some NEFMC-managed stocks (e.g., Georges Bank yellowtail flounder). There are only five assessments for federally managed stocks that include a direct, explicit linkage between a climate/environmental driver and a stock assessment parameter. However, such linkages are being explored for other stocks (Figure 8). Pacific sardine is the only federally managed stock where the harvest control rule is linked to an environmental variable. However, the North Pacific Fishery Management Council's risk tables do include environmentally conditioned scientific buffers to inform catch advice (i.e., for reducing OFL to ABC).

*Accepted in Research track assessment, not yet in management track
presented in exploratory/alternative models but not accepted in operational model

Model Term	Linkage Approach	Environmental Factor(s)	Example Species
Catchability	Covariate in model	Temperature-dependent, survey/spawn timing; Atlantic Multi-decadal Oscillation	Walleye Pollock (GOA)#, **Yellowfin Sole (EBS), Arrowtooth Flounder (BSAI), Pacific Cod (GOA); Swordfish (North Atlantic)**
Recruitment	Covariate in model	Sea surface height; Temperature-dependent; Marine heatwave	**Sablefish (West Coast)**, Petrale Sole#; Black sea bass (Mid-Atlantic)*; Pacific Cod (GOA)#
Growth	Covariate in model	Temperature-dependent	Pacific cod (GOA)#
	Time-blocks	Pacific Decadal Oscillation	Chilipepper Rockfish
Mortality	Time-blocks	Harmful algal blooms; Marine Heatwave	Gag Grouper, Red Grouper; Pacific cod (GOA), Snow crab (EBS)
	Covariate in model	Marine Heatwave	Pacific Cod (GOA)#

Figure 8. Examples of stocks for which environmental covariates have been considered in assessments. Stocks in bold denote assessments that include a direct linkage; stocks not in bold implicitly account for environmental variability. (Source: NOAA Fisheries)

While the policy implications of implementing DRPs have not yet been fully considered, there is agreement that stability in BRPs (and the resulting catch rates) through time is important for management, business planning, and trust/buy-in of the fishing community. A key concern continues to be parsing out productivity shifts that are due to environmental changes, fishing, or both. Current guidance from NOAA Fisheries suggests that the burden of proof should rest on demonstrating that the environment caused a change that would require updating BRPs (i.e., the default assumption is that fishing was the driver of stock decline).[16] In some cases, the productivity impact may be multifaceted—for example, excessive age truncation from fishing can then lead to an increase of the impact of environmental variability on stock productivity. Accounting for this cumulative effect remains a challenge.

Dr. Morrison reviewed some examples regarding the implications of potential changes to BRPs and how management could respond. First, as with SNE/MA winter flounder, a downward revision of BRPs could result in a low-productivity stock being considered rebuilt because the biomass target decreased, suggesting that fishing mortality could be maintained or increased. An appropriate management response may be to reconsider the fishing mortality proxy BRP. The opposite can also occur (e.g., Cape Cod/Gulf of Maine yellowtail flounder), where a stock's productivity increased (i.e., BRPs increased) but the biomass has not yet caught up, resulting in an "overfished" designation despite a lack of overfishing; it is unclear how to appropriately respond.

5.2 Perspectives from Other Fishery Management Councils and the ASMFC

Representatives from the MAFMC, South Atlantic Fishery Management Council (SAFMC), and ASMFC shared how those entities are addressing issues of changing productivity through application of DRPs.

Mid-Atlantic Fishery Management Council

Dr. Mike Wilberg (University of Maryland Center for Environmental Science; MAFMC SSC) described that while the MAFMC has not yet adopted DRPs, it has made species-specific and broad-scale efforts to address changing conditions. For Atlantic mackerel, which has in recent years experienced much lower recruitment than historically, the MAFMC has used more recent recruitment windows to inform the target fishing mortality rate for rebuilding. For other stocks, the MAFMC's SSC has regularly used shorter, more recent time series of recruitment for projections to inform setting of ABCs. While not a DRP per se as defined for the purposes of the workshop, the MAFMC also regularly adjusts BRPs

[16] Methot, R.D., et al. 2025. *Technical Guidance for Estimating Reference Points Used for Stock Status Determination in Accordance with the National Standard 1 Guidelines*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-261. Available at: https://spo.nmfs.noaa.gov/sites/default/files/NOAA-TM-NMFS-F-SPO-261.pdf.

across stocks using the most recent weight-at-age and maturity-at-age information as is also common practice for NEFMC stocks.

South Atlantic Fishery Management Council

Dr. Kai Lorenzen (University of Florida), who sits on both the NEFMC and SAFMC SSCs, explained that the only SAFMC stock for which DRPs have been considered is black sea bass, which underwent rapid decline in the South Atlantic. However, it is unclear whether the change is environment- or fishing-driven. An evaluation used the Klaer et al. (2015) method, but the criteria were not met for adopting DRPs. Dr. Lorenzen suggested that in this case, as with others where a long-term decline is expected and there is no prospect of rebuilding, it may be sensible to explore ECS designation.

More broadly, as in other regions, the SAFMC is applying more recent recruitment information to set projections, even as BRPs continue to be based on long-term recruitment. In lieu of applying DRPs, there has also been discussion of moving away from F_{MSY} to instead use a relatively conservative proxy ($F_{40\%}$), which was supported by a previous MSE.

Atlantic States Marine Fisheries Commission

ASMFC Senior Stock Assessment Scientist Jeff Kipp explained that, unlike the Councils, the ASMFC is not bound by the requirements of MSA such as setting BRPs, harvest control rules, and rebuilding targets, and has explored DRP applications for multiple species. For American lobster, empirical static BRPs became decoupled from current productivity regimes as the species' abundance increased to the north and decreased in the south due, in part, to climate impacts. More recent assessments have looked at key environmental indicators and breakpoints; those breakpoints were applied to model-estimated abundance to develop BRPs. Future work includes linking fishing mortality-based BRPs to dynamic productivity indicators as well as a potential MSE to explore performance of DRPs. A proposal for an initial step of a future MSE (management objectives identification process) is currently being developed with subsequent technical steps and goals of a full MSE to be determined.

DRPs have already been developed for other ASMFC-managed species. For Atlantic menhaden, the ASMFC has adopted Ecological Reference Points, which are developed using ecosystem dynamics models and account for the species' key role as forage when setting catch limits. The ecosystem dynamics models incorporate predator species abundance levels as a component of ecosystem conditions and update ecological reference points as ecosystem conditions change through time. There is future interest in linking environment to spatial distribution and movement of the species and how that impacts ERPs.

For striped bass, for which environmental conditions have contributed to recent low recruitment, the ASMFC approved an FMP amendment that established a trigger mechanism based on juvenile abundance indices to dictate which recruitment regime/time series to use to set fishing mortality BRPs. Future work may include reconsidering empirical biomass-based BRPs given the apparent decrease in stock productivity.

Group Discussion

In discussing the perspectives of the three panelists, the SSC built on previous dialogue concerning necessary evidence for adopting DRPs, as well as potential unconventional indicators to help identify or even anticipate the need to change BRPs.

Managing Uncertainty About Productivity Drivers

The SSC discussed the challenge of determining whether changes in stock productivity are primarily driven by fishing pressure, environmental conditions, or a combination of both. Atlantic mackerel was cited as an example where uncertainty remains regarding the causes of persistently low recruitment. **In situations where the driver of productivity change is unclear, participants noted that maintaining BRPs informed by long-term productivity while using more recent productivity information in short-term projections may provide a practical interim approach**. This approach has been used by the NEFMC for white hake and was viewed as a potential way to balance stability in BRPs with responsiveness to changing conditions

Expanding the Use of Indicators Beyond Traditional BRPs

Participants highlighted the ***economic indicator*** developed for Gulf of Maine/Georges Bank lobster. Unlike BRPs, this indicator is designed to signal potential socioeconomic concerns at levels well before biological thresholds are reached, providing an opportunity for management review and consideration of potential actions. The discussion illustrated how biological, environmental, and socioeconomic indicators may serve different but complementary roles in adaptive fisheries management.

5.3 Concept Mapping of DRP Implementation

SSC members divided into three breakout groups to develop an implementation roadmap that defined the necessary steps and responsible parties for advancing DRPs, while acknowledging potential constraints and risks. Each group was assigned one of three representative NEFMC stocks to help the discussion be as specific as possible:

1. **White hake**, an analytically assessed stock that has demonstrated evidence of changing productivity and for which the potential application of DRPs has been extensively discussed (See Section 3.2).
2. **Georges Bank haddock**, which is assessed using a state-space analytical model. While the current stock status is above B_{MSY}, it has been subject to boom-bust cycles, with large recruitment pulses that cycle through the fishery and can result in demonstrative swings in catch advice over small (e.g., two year) time spans. These cycles could be thought about in the context of regimes that could warrant development of DRPs.
3. **Monkfish,** which is empirically assessed (I-smooth) and is considered data-limited for evaluating stock status (currently unknown) and detecting potential changes in productivity. Furthermore, there is little basic biological information on the species (e.g., age data).

Each breakout group developed a concept map describing five key steps: 1) Scoping/ Screening; 2) Evaluation of Evidence; 3) Integration into Science: 4) Integration into Management; and 5) Ongoing Monitoring. The general process identified during breakout sessions and ensuing discussion is summarized below and in Figure 9; stock-specific concept maps developed by the SSC can be found in Appendix V.

Step 1: Scoping/Screening

- Input for determining which stocks are **priority candidates for DRPs could come from numerous sources**, including the SSC, NEFSC, relevant Advisory Panels, industry, cooperating management entities for jointly managed stocks, (e.g., MAFMC, ASMFC, or Canada) or the NEFMC itself.
- A **semi-systematic scoping approach/rubric** that considers relevant (and appropriately weighted) indicators could be used to determine whether a stock meets a low "burden of proof" for a more thorough investigation of whether BRPs should be applied (in Step 2). The indicators used to inform this process would differ between analytical and empirical/data-limited stocks; the latter, for example, may rely more on fishery-dependent and socioeconomic data.
- For stocks of key interest, the **SSC could recommend adjusting the Term of Reference (TOR) on BRPs** to more explicitly consider DRPs.
- Recommendations for priority stocks should occur **well in advance of the next scheduled assessment**.
- Ideally, identifying DRP candidate stocks would occur in **consultation with the NRCC** to help prioritize assessments for which DRPs may be warranted.

Step 2: Research and Evaluation of Evidence

- If the screening process determines that DRPs may be warranted for a given stock, the NEFSC assessment analyst would lead a **rigorous, strength-of-evidence approach** to determine whether a shift to DRPs is warranted. A systematic and standardized approach (e.g., Klaer et al. 2015) that could apply to any stock would be beneficial and would streamline the decision-making/recommendation process.
- Such an evaluation should not only include the available information (e.g., point estimates from assessments), but also **any uncertainties regarding that information.**
- Because so many NEFMC-managed species are multi-stock, evaluation of potential utility of DRPs should be considered holistically, as **changes in productivity could occur at the species level** as well as just at the stock level.

Step 3: Integration into Science/Assessment

- **Adjusting the BRP TOR** to include consideration of DRPs compels the NEFSC analyst to consider productivity changes for both analytically and empirically assessed stocks, considering information generated during Step 2 (Research and Evaluation of Evidence). Ultimately, the analyst will recommend an approach; however, all various approaches could also be passed on for consideration during peer review, and would be subsequently reviewed by the SSC prior to catch advice recommendations to the Council.
- For empirical stocks, including those without BRPs, **integrating the information included in Data Updates with that in SOE reports** could help with inferences of environmental changes on stock dynamics.

Step 4: Management Implementation

- There could be an **action to create flexible SDCs through an omnibus amendment**, potentially facilitated by the temporary formation of a working group that includes both scientists and managers. Once implemented, flexible SDCs would enable a more efficient adjustment of BRPs and SDCs based on the assessment and subsequent recommendations.
- Modifications to the **Risk Policy and ABC control rules** will facilitate the ability to set catch advice in the face of changing conditions and stock productivity.
- For stocks that are no longer the target of directed fisheries, exploration of **ECS designation** may be warranted.

Step 5: Ongoing Monitoring

- Regularly **revisiting the analyses considered during Step 3** (Integration into Science), conducted by the NEFSC and reviewed by the SSC, will facilitate future adjustments if needed. For example, there could be gradual productivity shifts detected over time versus discrete change-points. Timing will depend on stock life-history and/or fishery conditions.
- To facilitate future monitoring and ensure continuity in the face of staff/SSC turnover, there needs to be a **clear roadmap regarding the pathway and decision-points** that resulted in development of DRPs for the stock. **A structured, stepwise decision-making process across all stocks** could facilitate this effort.

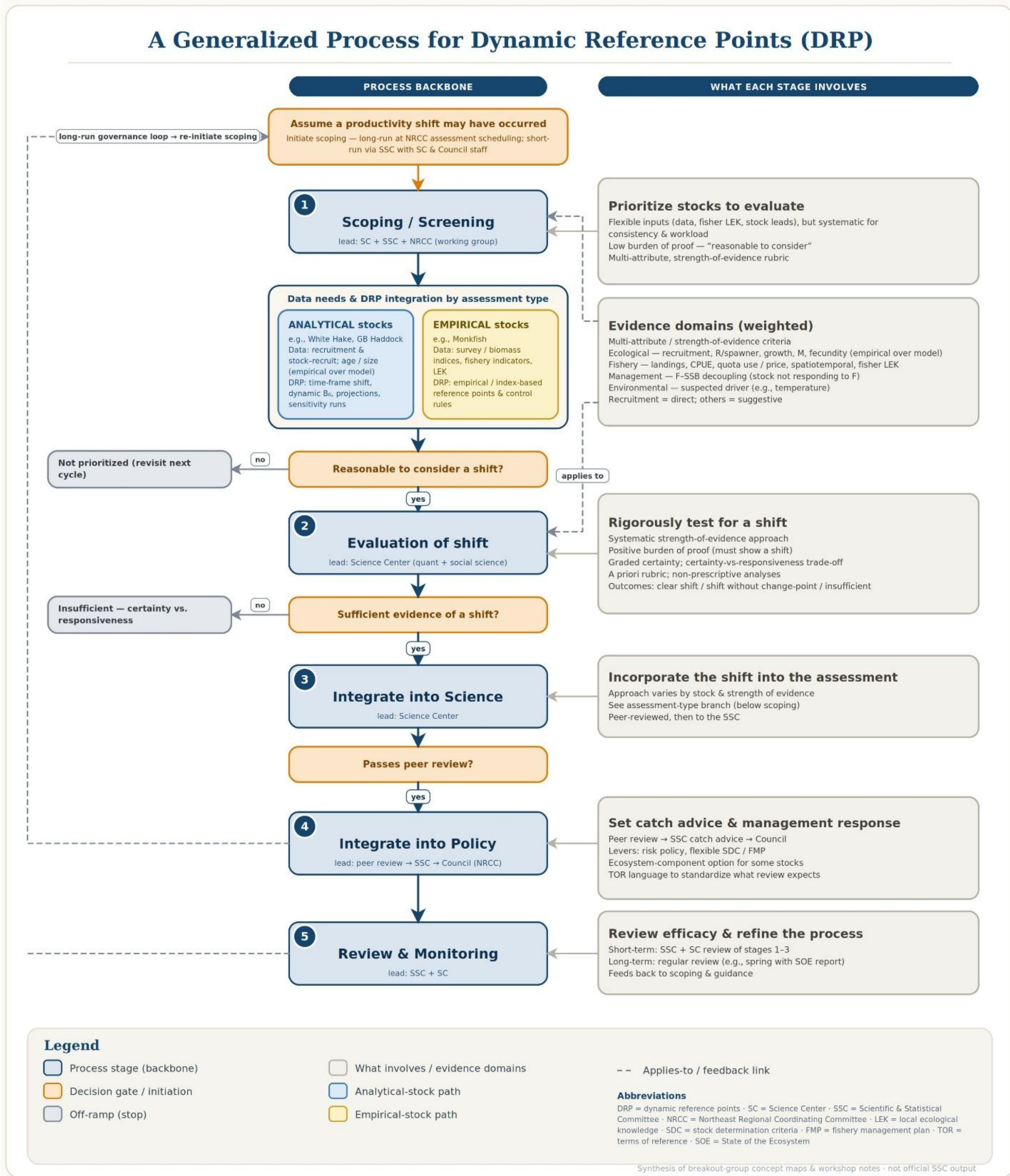


Figure 9. A generalized concept map for developing, implementing, and reviewing DRPs.

6.0 Toward Operational Guidance and Next Steps

6.1 Developing Operational Guidance for Dynamic Reference Points

Preliminary Identification of Priority Species/Stocks and Relevant Indicators

The SSC reviewed the 2027 stock assessment schedule and discussed whether it was worthwhile to pursue evaluating the utility of DRPs for any NEFMC-managed stocks on the list. This was a preliminary exercise to inform a more detailed subsequent SSC evaluation of each stock's DRP candidacy based on identified indicators and potentially an indicator-informed scoring rubric. Some SSC members felt that the full screening process should be applied before recommending any priority stocks, whereas others viewed the scheduled assessments as a logical starting point for exploring DRP applicability. For some stocks, the 2027 assessments may include significant changes (e.g., a transition to a new model) and new data streams, and thus are likely not appropriate DRP candidates at this time.

The SSC discussed consideration of DRP application for three initial stocks in 2027:

1. **White hake**, which has already been the subject of previous analyses pertaining to changes in productivity and is still assessed using the ASAP model (as opposed to WHAM), is likely best poised for immediate consideration for adopting DRPs.
2. **Georges Bank Atlantic cod**, which is assessed using WHAM, is data-rich and like other cod stocks is in a low-recruitment stanza; the recent RTA provides a helpful foundation for an evaluation of DRPs in 2027.
3. **Witch flounder** is an example of an empirically-assessed stock that already considers more contemporary time periods to account for productivity changes, but whose biomass BRP is not used to determine stock status. In addition, there is an age-structured witch flounder model that has in recent years been used as a "gut-check" to inform how well the empirical approach is working. Recommending DRP approaches for witch flounder assumes moving from an empirical to an analytically-based assessment.

Revisiting Indicators for Considering a Shift to DRPs

The SSC reviewed four categories of indicators for initial screening identified earlier in the workshop and discussed which indicators would meet the criteria for evaluating DRPs for each stock (Figure 10). There was general agreement that environmental indicators (e.g., an environmental linkage to productivity) were the most direct, while some combination of other indirect indicators could also meet the necessary threshold. For data-poor stocks, socioeconomic indicators may be particularly valuable. Some of these indicators could be evaluated through expert opinion (e.g., the SSC), while others would rely on data provided by the NEFSC. The SSC agreed to further discuss stock-specific indicators/metrics and the necessary weight-of-evidence approach at a subsequent meeting. In addition, there was broad agreement that close coordination between the SSC and the NEFSC (including the Social Sciences Branch) would be imperative. Moving forward, these indicators should regularly be revisited during assessment peer reviews (which often include SSC members) and at SSC meetings to evaluate whether DRPs are warranted (or continue to be warranted) and whether some indicators tend to be more useful than others.

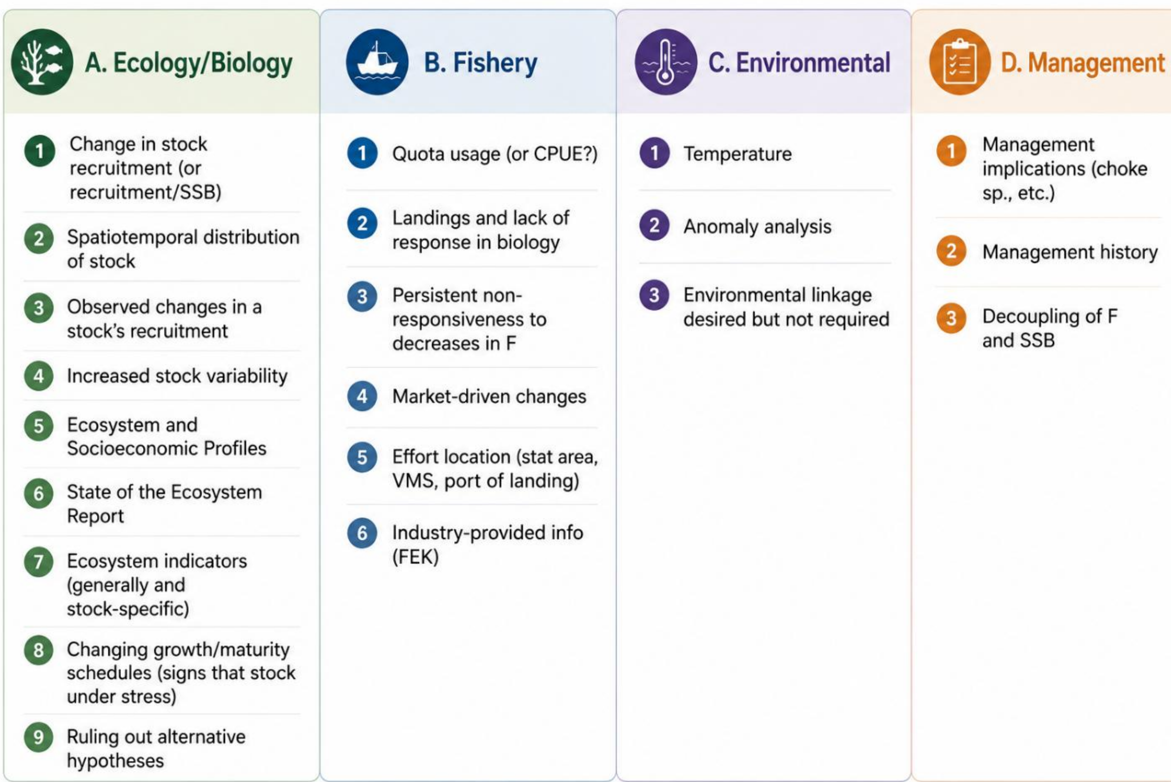


Figure 10. Preliminary list of indicators identified during the workshop.

6.2 Identification of Future Work, Research Priorities, and Next Steps

The SSC identified a suite of research and analysis priorities that could advance the application of DRPs moving forward, grouped into three broad themes:

1. Detecting Productivity Shifts
   - 1.1 Develop **guidance for which metrics to use to assess productivity** (e.g., recruitment, recruits per spawner, recruits per log-spawner, etc.). Explore other metrics that could be used to assess productivity besides those related to recruitment (e.g., fish condition).
   - 1.2 Identify **indicators of an imminent regime shift** to enable a proactive approach to adjusting BRPs.
   - 1.3 Investigate analytical approaches for using **fishery signals/catch accounting and socioeconomic indicators** to infer productivity shifts. Explore pathways for SSC members to readily and independently access such data.
   - 1.4 Explore/analyze patterns of whether multiple species show similar patterns of productivity shifts (i.e., **synchrony in stock dynamics**), which could potentially allow for use of proxies for data-poor stocks.
   - 1.5 Where data are available, examine strategies to **quantify whether fishing is a driver of stock health/decline.**

2. DRP Approaches
   - 2.1 Further explore appropriate **DRP approaches for empirical stocks**.
   - 2.2 For data-limited stocks, consider applying **economic reference points** to infer a reasonable level of fishing mortality (ASMFC American lobster example).
   - 2.3 Evaluate **assumptions in models that are used for projections** (e.g., NAA random effects).
   - 2.4 Examine **strategies for adjusting fishing mortality BRP proxies** (e.g. $F_{40\%}$) to ensure that they align with changes to biomass BRP proxies.
   - 2.5 Conduct a **retrospective on how BRPs have changed** over time (e.g., on a decadal scale) for certain stocks to lend context to current efforts.
   - 2.6 Investigate how to appropriately **account for age composition** in developing DRPs.

3. Management Implementation

3.1 Follow up with NOAA Fisheries to better understand **whether transitioning to DRPs differs markedly from "routine" changes to BRPs** (e.g., updated weight-at-age estimates) for the purpose of setting SDCs.

3.2 Examine the **management implications of revising BRPs** for the ABC control rule process to foresee and address potential SSC/NEFMC implementation challenges.

3.3 Investigate the effect of different DRP methods on **stability of catch** (e.g., through simulation testing), and explore strategies to coordinate DRPs with ABC control rules to avoid large interannual shifts in catch advice and resulting industry impacts.

NEXT STEPS

The SSC agreed to several next steps to further advance the application of DRPs to NEFMC-managed species. At its next meeting in August 2026, the SSC will conduct a review of indicators and apply them to the three identified DRP candidate stocks to determine whether pursuit of DRPs for those stocks is warranted. If so, that recommendation will be forwarded to the NEFSC to inform the 2027 assessment cycle. This process may be replicated in future years, recognizing that such guidance is typically needed no less than 18 months in advance of the next assessment. In addition, the SSC's Social Sciences Subcommittee will continue the discussion of appropriate socioeconomic indicators for DRPs that began at the workshop.

The SSC identified three other priority actions to take to develop the necessary pathways for using DRPs:

1. Consider development of an **omnibus FMP amendment implementing flexible SDCs** across stocks to enable rapid implementation of DRPs where warranted. This effort may be informed by the assembly of a temporary workgroup to review current FMPs and SDCs and identify how such flexibility should be structured.

2. **Add evaluating applicability of DRPs as a TOR for the SSC** across stocks to ensure that this topic is thoroughly considered moving forward.

3. Plan a **joint meeting between the NEFSC and SSC** to discuss coordination regarding the development and screening of DRP indicators.

This workshop represented an important step in advancing the NEFMC's discussion of DRPs toward practical implementation. SSC members broadly recognized that changing productivity warrants greater consideration within assessment and management processes, while also recognizing that additional work is needed to develop standardized guidance, evaluate management implications, and ensure transparent implementation. The workshop provides a foundation for future SSC deliberations and continued development of practical approaches for incorporating DRPs into management for NEMFC-managed stocks.

APPENDIX I. WORKSHOP ATTENDEES

*Asterisk denotes Workshop Steering Committee Member

NEFMC SSC

Conor McManus (Chair)*	NOAA Fisheries Northeast Fisheries Science Center
Ed Camp (Vice-Chair)*	University of Florida
Alex Hansell	NOAA Fisheries Northeast Fisheries Science Center
Lisa Kerr*	University of Maine
Gareth Lawson	Conservation Law Foundation
Kai Lorenzen	University of Florida
Jason McNamee	Rhode Island Department of Environmental Management
Mateja Nenadovic	University of Rhode Island
Kevin St. Martin	Rutgers University
Michelle Staudinger	University of Maine
Hirotsugu Uchida	University of Rhode Island
John Wiedenmann	Rutgers University

Other Attendees

Kristan Blackhart	NOAA Fisheries Northeast Fisheries Science Center
Jon Deroba*	NOAA Fisheries Northeast Fisheries Science Center
Tara Dolan*	Massachusetts Division of Marine Fisheries
Jerelle Jesse	University of Maine
Jeff Kipp	ASMFC
Wendy Morrison	NOAA Fisheries Office of Sustainable Fisheries
Liz Sullivan	NOAA Fisheries Greater Atlantic Regional Fisheries Office
Mike Wilberg	University of Maryland Center for Environmental Science; MAFMC SSC

NEFMC Staff/Members

Jamie Cournane	Senior Fishery Analyst
Rachel Feeney	Senior Fishery Analyst
Cate O'Keefe	Executive Director
Dan Salerno	Chair

Facilitators

Willy Goldsmith	Pelagic Strategies
Hannah MacDonald	
Laura Singer	Sambas Consulting

In addition, 58 individuals listened to the workshop via webinar, including 9 NEFMC staff, 5 NEFMC members, 10 NOAA Fisheries staff, and 34 members of the public.

APPENDIX II. ABBREVIATIONS USED IN THIS DOCUMENT

ABC	Acceptable Biological Catch
ACL	Annual Catch Limit
ASAP	Age Structured Assessment Program (assessment model)
ASMFC	Atlantic States Marine Fisheries Commission
B_{MSY}	Biomass that enables a stock to deliver maximum sustainable yield
BRP	Biological Reference Point
CINAR	Cooperative Institute for the North Atlantic Region
Council	Regional Fishery Management Council
DRP	Dynamic Reference Point
ECS	Ecosystem Component Species (or Stock)
FMP	Fishery Management Plan
F_{MSY}	The fishing mortality rate that maximizes catch biomass in the long term
GARFO	NOAA Fisheries Greater Atlantic Regional Fisheries Office
MAFMC	Mid-Atlantic Fishery Management Council
MSA	Magnuson-Stevens Fishery Conservation and Management Act (6 U.S.C. §§ 1801–1884)
MSE	Management Strategy Evaluation
MSY	Maximum Sustainable Yield
MTA	Management Track Assessment
NAA	Numbers-at-Age
NEFMC	New England Fishery Management Council
NOAA	National Oceanic and Atmospheric Administration
NRCC	Northeast Regional Coordinating Council
NS1	National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act
OFL	Overfishing Limit

PDT	Plan Development Team
RTA	Research Track Assessment
SAFMC	South Atlantic Fishery Management Council
SCS8	The 8th national workshop of the Scientific Coordination Subcommittee, held in Boston, MA in 2024 and titled “Applying Acceptable Biological Catch (ABC) Control Rules in a Changing Environment”
SDC	Status Determination Criteria
SNE/MA	Southern New England/Mid-Atlantic
SSC	Scientific and Statistical Committee
TOR	Term of Reference
WHAM	Wood Hole Assessment Model

APPENDIX III. WORKSHOP BACKGROUND MATERIALS

In addition to the Workshop Agenda (Background Item #1) and Goals and Outcomes (#2), SSC members and other workshop attendees were provided with the following background materials prior to the workshop. These materials can be accessed via the NEFMC's website at: https://www.nefmc.org/calendar/jun-1-2-2026-ssc-meeting.

Background Materials:

3. Working definitions of BRPs/DRPs.
4. A summary of the current state of play with regard to DRP development and implementation, based on conversations at the 2024 CINAR and SCS8 workshops as well as a 2025 NOAA Fisheries Technical Memorandum entitled "Technical Guidance for Estimating Reference Points Used for Stock Status Determination in Accordance with the National Standard 1 Guidelines."
5. A synthesis of discussions related to DRPs at SSC meetings over the previous ten years.
6. Tables summarizing recent stock status and management actions for five NEMFC-managed stocks of particular relevance for DRPs: Atlantic herring; Georges Bank yellowtail flounder; SNE/MA yellowtail flounder, SNE/MA winter flounder, and white hake.
7. A table summarizing all reference points for NEFMC and MAFMC-managed stocks.
8. A NOAA Fisheries white paper entitled "Flexible Status Determination Criteria Examples and their Application."
9. A review of key peer-reviewed literature related to DRPs.

New England
Fishery Management
Council

NEFMC SSC Workshop on Dynamic Reference Points

June 1-2, 2026, Hampton Inn, Boston Seaport District
670 Summer Street; Boston, MA
Joseph T. O'Callahan Ballroom

AGENDA

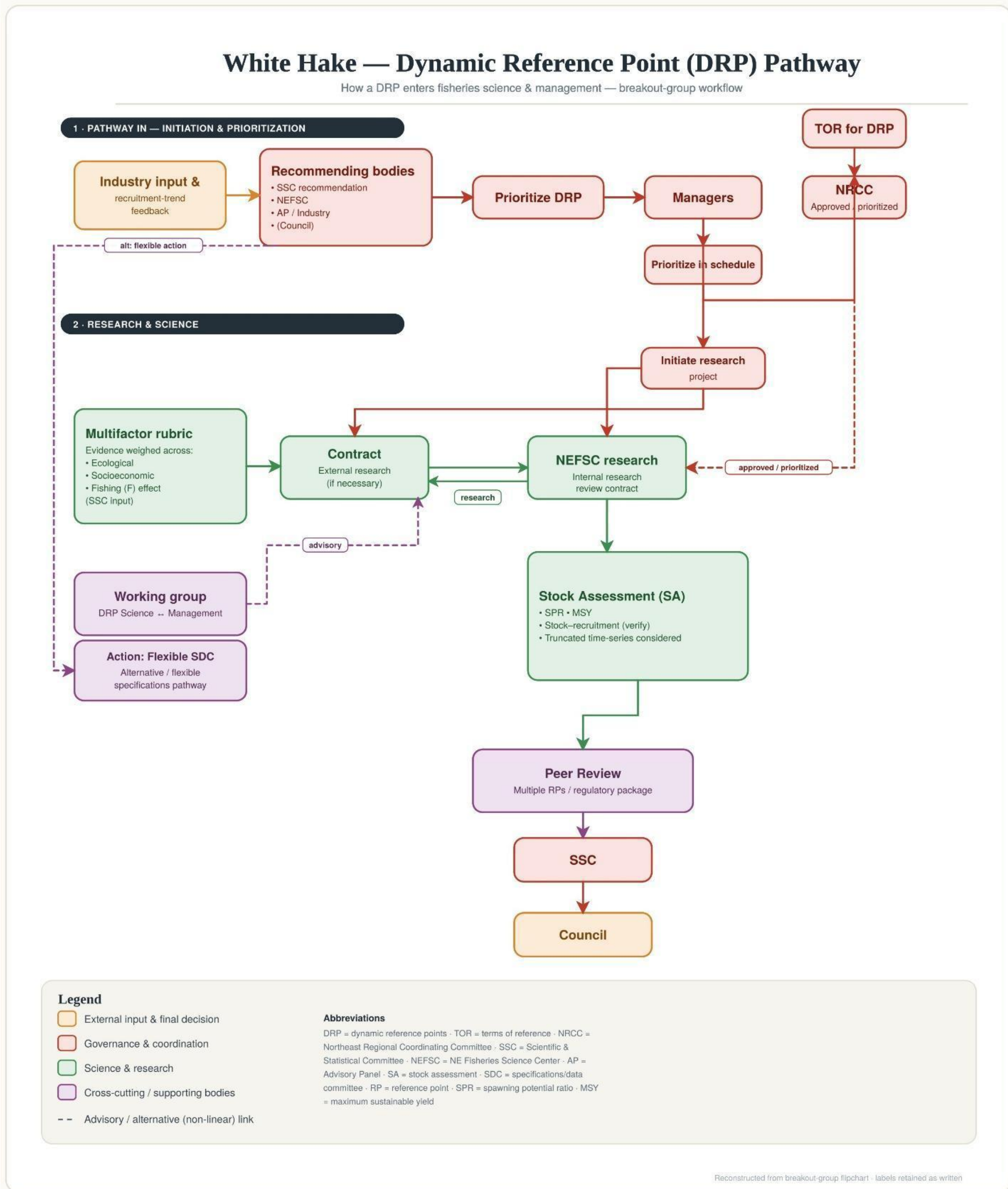
Monday, June 1			
Time	**Title**	**Presenter**	
8:30 - 9:00	Arrival and Coffee		
9:00 – 9:15	Welcome and Opening Remarks	Conor McManus Cate O'Keefe	NEFSC/SSC Chair NEFMC
9:15 – 9:30	Workshop Overview	Hannah MacDonald Laura Taylor Singer Willy Goldsmith	Facilitator SAMBAS Consulting Pelagic Strategies
MORNING SESSION: Setting the Stage – Where we are in 2026			
9:30 – 9:55	Presentation: Current Approaches and Challenges to Implementing Dynamic Reference Points	Lisa Kerr Jerelle Jesse	SSC & UMaine
9:55 – 10:15	Facilitated Discussion	All	
10:15 – 10:30	Break		
10:30 – 11:00	Presentation: Evolving Approaches to Revise Biological Reference Points in New England	Conor McManus	NEFSC/SSC
11:00 – 11:45	Panel Discussion	Lisa Kerr Jon Deroba Alex Hansell John Wiedenmann	UMaine/SSC NEFSC NEFSC Rutgers
11:45 – 12:15	Facilitated Discussion: Opportunities and Unintended Consequences	All	
12:15 – 1:15	Lunch		
AFTERNOON SESSION: Evaluating Reference Points and Considering Potential Guidelines			
1:15 – 1:30	Presentation: Considerations Regarding When to Change from Static to Dynamic Reference Points	Jon Deroba	NEFSC

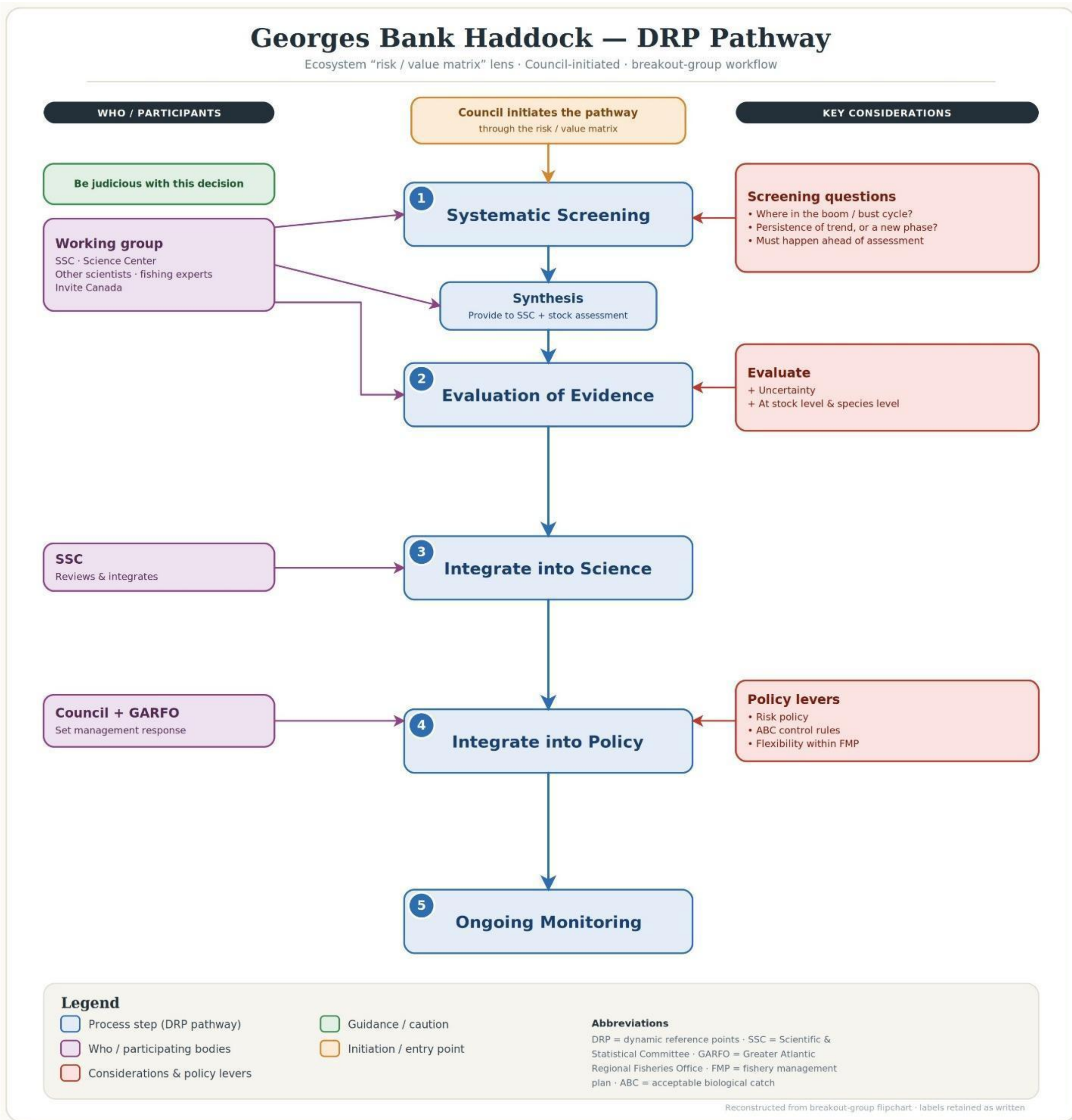
1:30 – 2:15	Breakout group discussions		
2:15 – 2:30	Break and return to plenary		
2:30 – 3:00	Plenary: Report out and discussion		
3:00 – 3:15	Presentation: How to Change Dynamic Reference Points and What are the Practical Constraints	Jamie Cournane	NEFMC
3:15 – 4:00	Breakout group discussions		
4:00 – 4:45	Plenary: Report out and discussion		
4:45 – 5:00	Wrap Up and Preview of Day 2	Hannah MacDonald Laura Singer	Facilitators
5:00	Adjourn		

Tuesday, June 2			
Time	**Title**	**Presenter**	
8:30 - 9:00	Arrival and coffee		
9:00 – 9:10	Welcome: Goal Setting and Day 2 Overview	Hannah MacDonald Laura Singer	Facilitators
MORNING SESSION: Management Applications, Implementations Challenges and Opportunities			
9:10 – 9:45	Presentation: Policy and Legal Implications – National and Regional Perspectives	Wendy Morrison	NMFS/HQ
9:45– 10:25	Panel: Perspectives from Other Fishery Management Councils & Fisheries Commission	Willy Goldsmith Mike Wilberg Kai Lorenzen Jeff Kipp	Facilitator MAFMC SSC NEFMC/SAFMC ASMFC
10:25 – 11:15	Breakout group discussions		
11:15 – 11:25	Break and return to plenary		
11:25 – 12:15	Plenary: Report Out and Discussion		
12:15– 1:15	Lunch		

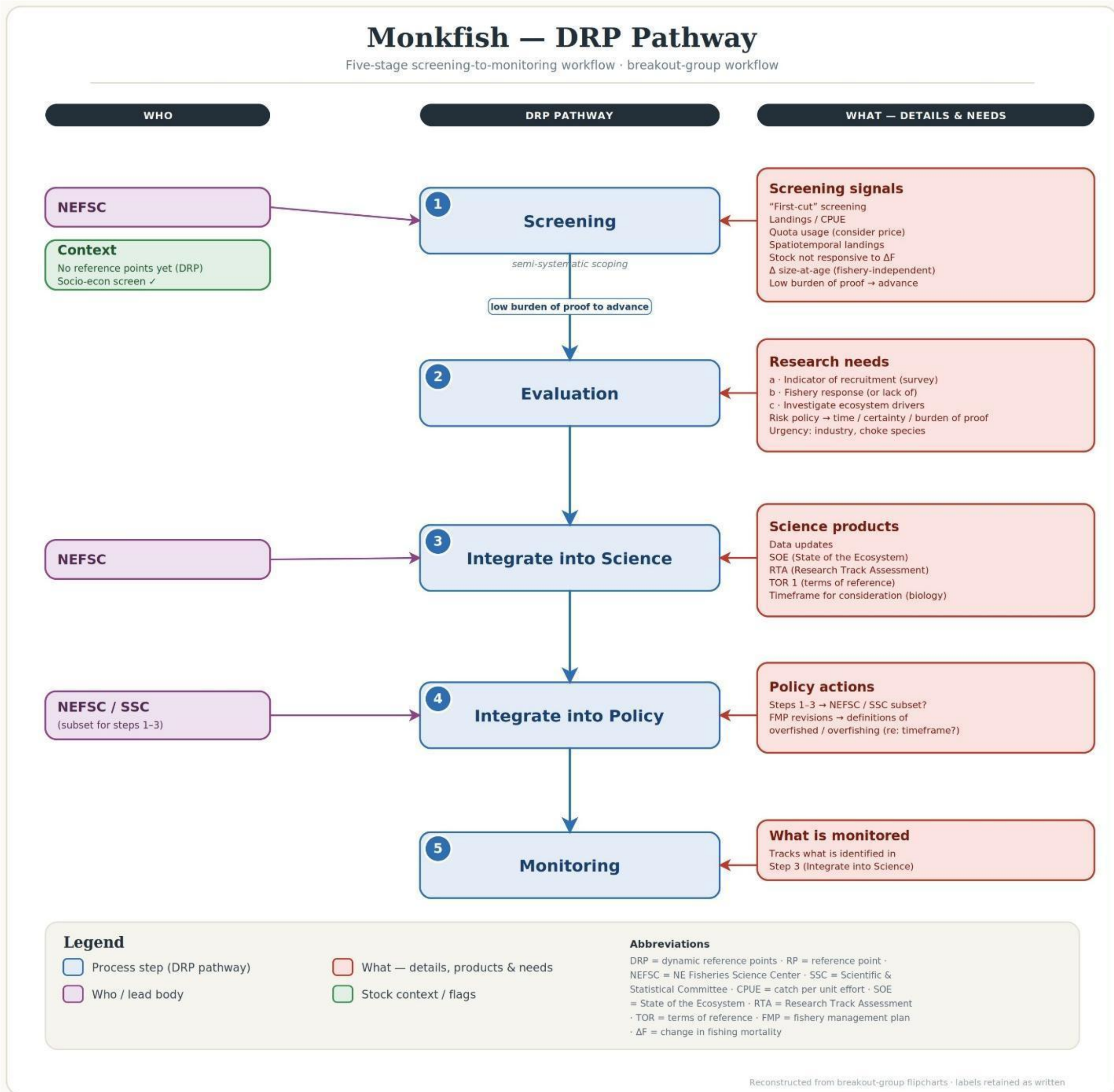
AFTERNOON SESSION: Toward Operational Guidance and Next Steps			
1:15 – 2:15	**Discussion: Developing Operational Guidance for Dynamic Reference Points**	Hannah MacDonald Laura Singer	Facilitators
2:15 – 2:30	**Break**		
2:30 – 3:20	**Discussion continued**		
3:20 – 4:00	**Discussion: Identification of Future Work and Research Priorities**		
4:00 – 4:30	**Presentation: Next Steps & Wrap Up**	Willy Goldsmith Hannah MacDonald Laura Singer	Consultant Facilitator Facilitator
4:30 – 4:45	**Closing Remarks**	Conor McManus	NEFSC/SSC
4:45	**Adjourn Workshop**		

APPENDIX V. STOCK-SPECIFIC DRP DEVELOPMENT AND IMPLEMENTATION CONCEPT MAPS





Georges Bank Haddock — DRP Pathway
Ecosystem "risk / value matrix" lens · Council-initiated · breakout-group workflow
WHO / PARTICIPANTS
Council initiates the pathway
through the risk / value matrix
KEY CONSIDERATIONS
Be judicious with this decision
1 Systematic Screening
Screening questions
• Where in the boom / bust cycle?
• Persistence of trend, or a new phase?
• Must happen ahead of assessment
Working group
SSC · Science Center
Other scientists · fishing experts
Invite Canada
Synthesis
Provide to SSC + stock assessment
2 Evaluation of Evidence
Evaluate
+ Uncertainty
+ At stock level & species level
SSC
Reviews & integrates
3 Integrate into Science
Council + GARFO
Set management response
4 Integrate into Policy
Policy levers
• Risk policy
• ABC control rules
• Flexibility within FMP
5 Ongoing Monitoring
Legend
Process step (DRP pathway)
Who / participating bodies
Considerations & policy levers
Guidance / caution
Initiation / entry point
Abbreviations
DRP = dynamic reference points · SSC = Scientific & Statistical Committee · GARFO = Greater Atlantic Regional Fisheries Office · FMP = fishery management plan · ABC = acceptable biological catch
Reconstructed from breakout-group flipchart · labels retained as written


Monkfish — DRP Pathway
Five-stage screening-to-monitoring workflow · breakout-group workflow
WHO
DRP PATHWAY
WHAT — DETAILS & NEEDS
NEFSC
Context
No reference points yet (DRP)
Socio-econ screen ✓
1
Screening
semi-systematic scoping
low burden of proof to advance
Screening signals
"First-cut" screening
Landings / CPUE
Quota usage (consider price)
Spatiotemporal landings
Stock not responsive to ΔF
Δ size-at-age (fishery-independent)
Low burden of proof → advance
2
Evaluation
Research needs
a · Indicator of recruitment (survey)
b · Fishery response (or lack of)
c · Investigate ecosystem drivers
Risk policy → time / certainty / burden of proof
Urgency: industry, choke species
NEFSC
3
Integrate into Science
Science products
Data updates
SOE (State of the Ecosystem)
RTA (Research Track Assessment)
TOR 1 (terms of reference)
Timeframe for consideration (biology)
NEFSC / SSC
(subset for steps 1–3)
4
Integrate into Policy
Policy actions
Steps 1–3 → NEFSC / SSC subset?
FMP revisions → definitions of
overfished / overfishing (re: timeframe?)
5
Monitoring
What is monitored
Tracks what is identified in
Step 3 (Integrate into Science)
Legend
Process step (DRP pathway)
Who / lead body
What — details, products & needs
Stock context / flags
Abbreviations
DRP = dynamic reference points · RP = reference point ·
NEFSC = NE Fisheries Science Center · SSC = Scientific &
Statistical Committee · CPUE = catch per unit effort · SOE
= State of the Ecosystem · RTA = Research Track Assessment
· TOR = terms of reference · FMP = fishery management plan
· ΔF = change in fishing mortality
Reconstructed from breakout-group flipcharts · labels retained as written