Research Track Steering Committee October 2024 Meeting - Background Information

October 15-16, 2024 1 - 4pm EDT

Google Meet joining info:
Video call link: https://meet.google.com/dzj-qcrv-hsu
Or dial: (US) +1 478-419-0143 PIN: 749 352 960#

TABLE of CONTENTS

2027 RT Research Priorities Progress Updates

Striped Bass

Summary of Research Progress (since April 2024)
No updates available.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Develop more robust estimates of stock composition and migration rates for the Atlantic striped bass stock complex.	This would address a recommendation from SARC 66 and provide important data to support a multi-stock model.	
Continue development of a multi-stock model and conduct additional simulation testing.	This would address SARC 66 Panel comments.	
Transition the current custom single-stock model to another modeling framework such as Stock Synthesis.	This would allow the assessment to take advantage of more modern statistical approaches and more complex dynamics for the catch-and-release component of the fishery, as well as reduce the burden on the lead analyst and Stock Assessment Subcommittee for future model development and updates, if the multi-stock model requires more development.	

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Continue collection of paired scale and otolith samples, particularly from larger striped bass, to facilitate development of		

Important Research	**Rationale** *(include source, if applicable)*	**Update**
otolith-based age-length keys and scale-otolith conversion matrices.		
Collect sex ratio information on the catch and improve methods for determining population sex ratio for use in estimates of female SSB and biological reference points.		

Areas of Concern

Monkfish

Summary of Research Progress (since April 2024)
None. Monkfish Research Track Working Group will be formed in late 2024.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Aging	Required for age-based assessment. However, no currently accepted approach, and no indication of accepted approach in near future.	None
Stock Structure	Assessment and management approach (North and South) does not match current genetics (one stock). RT would move ahead with one stock without additional research showing two stocks is appropriate.	None

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Assessment Modeling	Current Ismooth approach considered too variable from year to year by some and does not provide biological reference points. Delay-difference or SPiCT approaches could be considered.	None
Monkfish RSA	Two current projects estimating CPUE/LPUE. Could be used in Ismooth or other assessment approaches if thought to represent population trend not management/market changes.	None

Areas of Concern

While advancement on the understanding of stock structure for monkfish has been made (although still not definitive), one of the main goals of the RT for monkfish is developing an age-based assessment. Due to a lack of research progress supporting this goal in preparation for the Monkfish RT, this will not be achievable. Another goal is to use data-poor methods to develop reference points for monkfish; this may not be achievable either. Substantial limitations on research progress within an RT for this stock are present.

Projections

Summary of Research Progress (since April 2024)

Modest progress has been made by NEFSC staff over the past six months on items that will support work of the RTWG once it forms later this year. Work under the RESTORE-funded project at the SEFSC is underway and will likely help inform this RT. The utility of other external supporting research listed below to this RT remains unclear.

Draft Terms of Reference

1. **Evaluate the past performance of stock assessment projections in the Northeast.** This ToR aims to update and expand on previous research examining projection performance in our region. Quantifying projection accuracy, and uncertainty, relative to the most recent assessment across a range of stocks provides a baseline for subsequent improvements.

2. **Determine the most important sources of error in the projections.** Possible sources of error include inaccurate biological rates (e.g., growth, maturity, or natural mortality), misspecified selectivity, inappropriate assumptions of future recruitment, or inaccurate initial abundance estimates. Building on previous work, a retrospective projection analysis could be carried out to evaluate this ToR.

3. **Establish guidelines for projecting recruitment.** Recruitment is often projected without temporal correlation, and time spans of past recruitment used in projections can be difficult to justify. The importance of recruitment assumptions will vary by stock, with short-lived, young-harvested stocks being the most impacted in short-term projections. The aim of this ToR would be to establish good practices for projecting recruitment and its uncertainty.

4. **Examine methods for projecting biological rates (e.g., growth, maturity, and natural mortality).** Biological rates are typically projected by assuming that the recent average rate will continue into the future. However, the accuracy of this approach has not been comprehensively evaluated. Averaging approaches could be compared to more sophisticated methods, such as modeling temporal and cohort correlation, and explicit linkages to driving variables.

5. **Establish procedures for determining when to incorporate ecosystem drivers into projections.** Incorporating ecosystem drivers is hypothesized to improve projections. However, methods for evaluating the robustness of these driving relationships, and their ability to be projected forward, are not well established. This ToR aims to determine when ecosystem drivers would be expected to be useful for improving projections.

Ongoing Research

- Inflation Reduction Act Projections Project – Coordinated by NMFS HQ; project not yet defined but is described as " a National project to help transform how the agency produces population projections in stock assessments and ensure we are able to continue supporting sustainable fisheries." A post-doc has accepted the position and will soon begin work on the project.

- Interdisciplinary Projections for EBFM – Led by HQ, project aims to use an interdisciplinary forecasting approach to achieve climate-ready, ecosystem-based, sustainable fisheries management.

- Building Next-Generation Fishery Forecasting Capacity: Building next-generation diagnostic and forecasting capacity to achieve management objectives by increasing stock assessment accuracy and throughput – Funded through a RESTORE Act grant in 2023. The project team will develop new methods and technological capacity to increase the accuracy of projection assumptions, improve transparency in the impact of structural assumptions made in model development, and increase the throughput of stock assessment models to improve the accuracy of management advice under changing environmental conditions.The team will develop, test, and implement capacity to 1) better incorporate known uncertainties and regulatory impacts into stock assessment model projections and management reference points; 2) facilitate multi-model ensemble inference approaches, though improved model diagnostics and interpretation techniques; and 3) utilize scalable model complexity between current full and interim assessment methods to iteratively update data sources and parameter estimates as available and appropriate to maximize the accuracy and timeliness of management advice. This project will reduce bias and uncertainty in the estimation of overfishing limits and acceptable biological catch limits critical to the management of fisheries in the Gulf of Mexico. This will be achieved by providing practical and actionable improvements to existing stock assessment modeling software in conjunction with focused training for stock assessment analysts integrated directly into current stock assessment workflows. Lead Investigator Nathan Vaughan, Vaughan Analytics. Work is scheduled for October 2023-September 2028. The project is currently focusing on testing common assumptions in projections and analyses of retrospective error.

- Under the CEFI initiative, NEFSC is working on environmentally informed recruitment forecasts for SNE and GB yellowtail flounder as part of the Research Track Assessment for yellowtail (scheduled for review in November 2024).

- NEFSC is leading ongoing work to develop a spatial forecasting model for sea scallops as part of the Research Track Assessment for that stock (scheduled for review in May 2025).

- NEFSC PDB has been including ongoing projections research as part of the Management Track Assessment process (e.g., stochastic projections for WGOM cod, retrospective forecasting for GOM haddock).

Areas of Concern
None at this time.

2028 RT Research Priorities Progress Updates

Silver Hake

Summary of Research Progress (since April 2024)
The main area of progress has been towards defining stock structure.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Attempt to derive analytical models, based on WHAM, including environmental covariates (predation and temperature)	The current assessment is index-based and the reference points are proxies (SARC 51, all MT assessments). This could be done with the existing stock structure but if the stock structure changes all input data would need to be revised well ahead of the RT	None; stock structure work needs to be completed first
Stock Structure	Work is being conducted but needs to be complete by early 2027 to be included.	Samples are being collected on United States and Canadian surveys, will likely be sent to AFSC for analysis early next year
Predation by large predators (marine mammals and sharks)	At SARC 51 predation was deemed to be very important but we were missing the impacts of the larger predators.	None

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Larval indices	Work was ongoing according to SARC51. This would give some information on recruitment or SSB as well as stock structure.	None but planned for 2025

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Examine data from the three monkfish surveys in deep water	These data may give some depth-related information about the two species currently included in the southern stock.	None

Areas of Concern

The current stock structure work will inform what the stock structure is in 2024. If there has been a change over time due to climate change, we will not necessarily know this. We do know that silver hake are being found farther north (Grand Banks) and are in sufficient numbers to be landed.

Scup

Summary of Research Progress (since April 2024)
Progress on scup age validation is underway and anticipated to be completed before the RTWG convenes. There has not been progress on the other items.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Transition from ASAP to WHAM	WHAM increases model flexibility by allowing for the inclusion of random effects and offering more comprehensive treatment of the relationships between environmental variables and population dynamic processes.	Limited progress. Lead scientist participated in WHAM training workshop.
Consider relationships among disparate survey indices	Seventeen fishery-independent indices are currently available to the scup assessment; the model currently fits to eleven of these. The assessment could benefit from examining statistical methods (VAST, hierarchical analysis, others) to consider age structured and/or YOY indices together to create index series with more synoptic spatio-temporal coverage that may be more representative of stock size.	None

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Integrate environmental data	Examine the impact of likely environmental/climate effects (e.g., temperature, salinity, Gulf Stream position index, North Atlantic Oscillation index, others) on scup population dynamics. Such	None

Important Research	**Rationale** *(include source, if applicable)*	**Update**
	environmental variables could be considered directly as covariates in the assessment model or to provide additional context to spatial and/or temporal changes. Determine whether recent decreases in mean weights-at-age and maturity are reversible density-dependent responses or arise from a different mechanism.	
Scup age validation	A 2014 scup aging workshop identified the need to validate scup otolith ages (Eric Robillard, personal communication). This research gap should be addressed prior to the Research Track so that the Working Group can address any aging issues that are identified.	NEFSC age and growth lab actively working on this, including photographing otoliths and measuring annuli. This is expected to be completed by the time the Research Track Working Group convenes.

Areas of Concern

Support towards development of a model-based synoptic survey index as well as consideration of environmental indices in advance of convening the RTWG for this assessment is important to the success of the stated goals and objectives of the RT.

Sturgeon

Summary of Research Progress (since April 2024)
No updates available.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Develop robust estimates of abundance and removals (bycatch and vessel strikes) by DPS where possible.	The 2017 peer review found that "The paucity of data available to develop reliable indices of abundance and the inability to distribute historical catches to specific rivers or DPSs precluded the application of traditional stock assessment methods, except at a coastwide level. The nature of the assessment used and the nature of available data did not warrant the determination of conventional fisheries reference points." (ASMFC 2017)	
Collect critical information for developing assessment models: DPS-specific age, growth, fecundity, and maturity information.	The 2017 peer review determined that there is a lack of data for South Atlantic fish, adult fish are not adequately represented in most data sets, and the age structure is not sufficiently documented for any DPS. They further stated that the representativeness of life history parameter estimates to the contemporary Atlantic sturgeon population, individual DPSs, or the general life history of the coastwide population is currently a significant source of uncertainty.	

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Continue development of the acoustic tagging model to refine estimates of survival, obtain abundance estimates, and incorporate movement.	Acoustic tagging of sturgeon represents some of the best available data for this species, and should be leveraged further (ASMFC 2017).	

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Maintain and support current networks of acoustic receivers and acoustic tagging programs to improve the estimates of total mortality. Expand these programs in underrepresented DPSs.	The data provided by this research is critical to continue developing the acoustic tagging model (ASMFC 2017).	

Areas of Concern

None

References

None

Acadian Redfish

Summary of Research Progress (since April 2024)
Little progress on the identified research goals has been made, although efforts to process age samples for the stock continues.

Updates for Specific Research Goals

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Evaluate alternative likelihood distributions for the fishery and survey age compositions.	From the 2024 Applied State Space Models Research Track: ● Expected to improve fits to the age compositions, reduce positive bias in the one step ahead age composition residuals, and could improve fits to the survey indices. Lack of fit to the survey indices has been a major concern since the 2020 assessment. ● Using a self-weighting distribution (e.g., logistic normal) would remove the need to specify effective sample sizes for the age compositions. ● ***This recommendation is planned to be addressed during the 2025 redfish management track assessment***.	None; still anticipated to be addressed during the 2025 redfish management track assessment

Critical Research	**Rationale** *(include source, if applicable)*	**Update**
Explore a full state space WHAM with survival-at-age modeled as random effects.	From the 2024 Applying State Space Models Research Track: ● Allow the model to account for processes other than F and M that may be affecting stock abundance (e.g., migration), which should improve fit to the survey indices. Lack of fit to the survey indices has been a major concern since the 2020 assessment. ● Would likely necessitate evaluating alternative assessment start years, due to the lack of fishery age and survey data in the early assessment years, 1913-1968. ● ***This recommendation is planned to be addressed during the 2025 redfish management track assessment***.	None; still anticipated to be addressed during the 2025 redfish management track assessment
Explore growth-model branch configurations of WHAM.	From the 2024 Applying State Space Models Research Track: ● A possible solution to the lack of fishery and spring survey age data. ● Explore using length compositions for years without age data. ● Explore using length compositions for all years with conditional age compositions when available (i.e., similar to stock synthesis). ● New age data would be added as it becomes available.	None; this may be addressed via the 2027 MT or during the 2028 RT

Important Research	**Rationale** *(include source, if applicable)*	**Update**
Include additional new and historic age data in the assessment.	From 2020 and 2023 management track assessments: ● Continue process of filling gaps in the historic fishery and spring survey age compositions. May allow for estimation and use of time-varying weight-at-age and maturity-at-age as more age data become available.	Efforts to process age samples continue; age data for the 2015 spring BTS and 2023 fall BTS are now available
Conduct an evaluation of survey trends, including potential factors that may cause the trends to not reflect patterns in relative abundance.	From 2020 and 2023 management track assessments: ● Initial explorations could look for signals in age frequencies or Canadian survey data. ● Could include a genetic and/or tagging study to investigate transboundary stock movements.	None; could be addressed via RT or 2029 MT; not aware of any new genetic studies to investigate transboundary stock movement
Explore estimation of stock-recruit relationship internal and external to the assessment model.	From 2020 and 2023 management track assessments: ● Current WHAM uses Beverton-Holt stock-recruit relationship with annual deviations modeled as i.i.d. random effects.	None; could be addressed via RT or 2029 MT
Explore assumptions made about weight at age for female and male redfish in the assessment.	From the SSC after the 2023 management track assessment: ● Acadian redfish growth is sexually dimorphic , which could create inconsistencies among the weight-at-age used in the assessment, short-term projections, and biological reference points.	None; could be addressed via RT or 2029 MT

Important Research	Rationale *(include source, if applicable)*	Update
	• ***This recommendation was previously addressed through a sensitivity analysis in the 2020 management track assessment, but could be explored further as more age data become available.***	

Areas of Concern

A significant number of the goals of the RT for Acadian Redfish are anticipated to be completed via the Management Track before the RTWG convenes, leaving little progress to be made via a Research Track Assessment for this stock.

Review Research Recommendations for the 2029 Research Track Assessments

Witch Flounder - Draft Research Recommendation Priorities

Background

The last benchmark assessment was completed at SARC 62 in 2016. The VPA model used in the 2015 assessment was updated to incorporate re-estimated discards and recent catch, survey, and maturity data. The updated VPA model exhibited a major (rho adjusted estimates were outside the approximate 90% confidence region around the SSB and F point estimate) retrospective pattern that was similar in direction and magnitude as the previous VPA models in which F was underestimated and SSB and recruitment were overestimated. A new statistical catch at age model (ASAP) was developed in this assessment to better account for catch and survey data uncertainty. The ASAP model also exhibited a major retrospective pattern. The age structured model in the accepted final configurations provided calculated NEFSC survey q of approximately 4, exhibited major retrospective patterns requiring rho adjustments, and required a very large increase in catch or natural mortality (M) to remove the retrospective errors. The WG considered numerous sensitivity runs of the two analytical models (ASAP and another statistical catch at age [SCAA] model) and considered several empirical approaches (minimum swept area biomass, replacement yield model, and an empirical approach) in case analytical modeling approaches did not provide defensible results. The WG considered the pros and cons of each approach for determining stock status and catch advice. The WG noted that these data conflicts have been addressed in the previously accepted and current age structured models explicitly through a rho adjustment, without having to apply potentially implausible scalars of M or catch. The WG recommended the ASAP model (Run 9_5_v2) as the preferred model in which to evaluate stock status and provide catch advice. However, an analytical model for witch flounder was not accepted at SARC 62 due to the retrospective pattern.

Research Focus/Goals

Critical Research *(1-3; essential to RTA success)*	**Rationale** *(include source, if applicable)*
Port sampling	Improve biological port sampling by market category for determining number of landed fish at age.

Important Research	**Rationale** *(include source, if applicable)*
ME/NH inshore survey age data	Explore availability of any archived age structures from the ME/NH inshore trawl survey for use in future assessments.

Reference Documents

2024 Management Track Assessment Report (forthcoming)

2022 Management Track Assessment Report

- The witch flounder assessment could be improved with accurate catch statistics; catch statistics have been undermined by misreporting, as partially documented in the criminal case.
- The low commercial landings sampling in recent years impacts the ability to estimate numbers of fish landed at age and to track cohorts through time. It would be desirable to review the port and dockside monitoring sampling to better align sampling activities in accordance with market category landings and life history characteristics of witch flounder. Additional research recommendations are given [in NEFSC Center Ref Document 17-03]."

Stock Assessment Update of 14 Northeast Groundfish StocksThrough 2018

- The empirical approach does not incorporate age structure information. Consideration of incoming recruitment is critical for catch advice that supports stock rebuilding.

Operational Assessment of 19 Northeast Groundfish Stocks, Updated Through 2016

- The witch flounder assessment could be improved with research into the veracity of catch statistics.
- Additional research recommendations were provided in the recent benchmark stock assessment report and these should be addressed in an attempt to return to an analytical model.
- **2016 Benchmark Assessment Report (SAW 62)**

Biological Reference Points (BRPs) - Draft TORs and Supporting Research

Draft Terms of Reference (adapted from RTA Proposal)

1. **Describe methods for estimating BRPs in the Northeast Region.** Work under this TOR will review and describe the technical approaches currently used for estimating BRPs across stock assessments for Northeast Region stocks and form the basis for work in the other TORs.

2. **Define "non-stationarity" in stock population dynamics for fisheries assessment modeling.** This TOR aims to review common methods for identifying non-stationarity (e.g., regime shifts, change point analysis, environmental model covariates) in stock population dynamics, and develop good practice guidance for assessment scientists in the Northeast Region.

3. **Develop technical guidance and/or good practices for estimating BRPs, and consider how that guidance should be adjusted when non-stationary conditions are identified.** Specific points for consideration under this TOR include:
    a. Identify appropriate methods for long-term projections of recruitment
    b. Determine when using different assumptions for short vs. long-term projections is justified
    c. Building from the work in TOR2, investigate (e.g., through the use of closed loop simulations) methods for accounting for non-stationarity in determining BRPs
    d. Outline statistical approaches for estimating BRPs for stocks experiencing non-stationary effects using analytical assessment methods
    e. Development of a decision tree for practitioners identifying triggers for changing BRPs in response to non-stationary conditions

4. **Demonstrate RT guidance and good practices for estimating BRPs, including under non-stationary conditions, through the limited use of case studies for Northeast Region stocks.** Under this TOR, case studies of priority stocks identified by the RTWG will be used to demonstrate the guidance and principles developed in TORs 1-3, including under non-stationary conditions.

Supporting Research

- A workshop titled "*Defining Biological Reference Points in a Dynamic Northeast U.S. Marine Environment*" supported by CINAR funding and held in January 2024. This workshops objectives were to: 1) identify the need to redefine biological reference points (BRPs) in a changing ecosystem; 2) review existing approaches and challenges in defining BRPs; 3) evaluate approaches to defining BRPs in other areas of the US and globally; and 4) synthesize recommendations for estimating reference points for stocks in a changing Northeast ecosystem. The workshop was organized by Lisa Kerr (UMaine), Steve Cadrin (SMAST), and Jerelle Jesse (UMaine).

- NECLIM development and identification of climate/environmental indicators via Ecosystem and Socioeconomic Profiles (ESPs) for Northeast stocks; improved climate forecasting products via CEFI
- 2027 Research Track Assessment focused on Improving [Short-Term] Stock Assessment Projections
- NEFMC IRA-funded project "Operationalizing Ecosystem Approaches in New England Fisheries Management". One of the goals identified under this project is to "Provide a mechanism to integrate dynamic reference points into management decisions to respond to changing climate conditions." Planned activities include "Develop guidance and Best Management Practices to consider ecological and socioeconomic impacts associated with non-stationarity and dynamic reference points."
- 2024 NMFS-Sea Grant Fellowship, Jerelle Jesse (University of Maine): Redefining Biological Reference Points in a Dynamic Environment (Faculty Advisor: Lisa Kerr; NOAA Mentor: Tim Miller). Work will evaluate how BRPs can be adjusted to account for climate-driven changes in stock productivity in WHAM.
- A recent publication (Haines et al. 2024. Poor performance of regime shift detection methods in marine ecosystems. ICES Journal of Marine Science. https://doi.org/10.1093/icesjms/fsae103) found that the usual methods detected regime shifts that were not there in a simulation study. These false positives have consequences for decision making.

Areas of Concern

Discussions at the last RTSC and by the NRCC at its spring meeting noted the importance of research related to improving BRP estimation, but noted urgency for these results. As described above, there are numerous projects underway in the Northeast Region and elsewhere that are likely to support this RT, but may reduce its utility to regional resource managers as partners seek to address this priority issue before 2029.

Solicit Ideas for 2030 Research Track Proposals for Review at Spring 2025 Meeting

Skate Complex

Background
The skate complex is a 'data-poor' to 'data-moderate' set of stocks, with adequate estimates of total commercial fishery landings and discards, but the estimates of catch by species are highly uncertain. A single survey is used for stock status for each of the species although at least two surveys are available for each species. The last 'Benchmark' assessment was completed in 2008, with a data update nearly annually since and a Management Track assessment completed in 2023. Management Track updates are planned for 2025 and 2027.

Research Focus/Goals

1. Improve the allocation of catches to species (MT 2025).
    a. split the recreational catch using species proportions in inshore surveys
    b. re-estimate length-width equations for each species
    c. use a three-year moving average of commercial lengths and apply the proportions in survey length compositions for hindcast species split
2. update maturity information and calculate Spawning Stock Biomass (MT 2025)
3. conduct simulations of the skate index-based method using skate fishing and life histories (MT 2025)
4. aging studies have been published for 6 of the seven species but could be updated with structures in freezer and/or collection of new vertebrae and rosette could be aged (RT)
5. Attempt to use length-based models for at least winter, little, barndoor and thorny skate (RT and need adequate time before the RT)
6. Revisit reference points for all species, in particular thorny skate, and try to account for changes in the environment (including predator/prey) over time (RT)
7. Include new information about thorny skate stock structure as appropriate (Denton et al. 2024) (maybe MT 2025 or 2027 or a RT)

Spatial Stock Assessment Modeling

Background
There have been recent national (Bosley et al. 2021, Berger et al. 2017) and international (Spatial Stock Assessment Simulation Experiment, Goethel et al. 2024) projects examining the ability to include spatial information in stock assessments. These efforts have focused on the idea of mixing rates among genetically distinct stocks with emphasis on tagging data to estimate movement rates. Locally, the rapid development of offshore wind energy (see https://www.boem.gov/renewable-energy/offshore-renewable-activities) will create large areas that are not available to current surveying techniques and may limit or change the ability of fishing activities or fish density as well. There is a need for developing methods to incorporate different data types to account for these wind energy areas as well as models to handle these

changes. There have been a number of recent publications addressing the data collection and modeling challenges associated with offshore wind energy development (e.g., Hogan et al. 2023, Methratta et al. 2023, Methratta et al. 2023).

Research Focus/Goals

This research track will focus on applying the data collection and modeling issues associated with offshore wind energy development in the region in practice. Simulation studies will examine the ability to estimate stock abundance under varying levels of impact from the wind farms on fish behavior, fishery access, and survey catchability given expected levels of uncertainty in the different data sources. A default approach that ignores the wind energy areas and assumes a single homogenous stock will be compared to various area-based models in terms of bias and precision in stock estimates in these simulation studies. Results of these simulation studies will guide development of a closed-loop feedback simulation study (i.e., MSE) that explores the impact of the wind energy areas on different control rules to see if some are more robust than others in terms of preventing overfishing and the stock becoming overfished. The MSE could also be used to explore the impact of changes in precision and accuracy of survey data due to different designs and methods used in the wind energy areas. If time allows, case studies of specific stocks impacted by offshore wind energy will be explored using spatial approaches that appeared promising in the simulation studies.

Due to the rapid expansion of wind energy areas in the region, this research track will have to respond to developments between now and the start of the research track that cannot currently be predicted, so there will be a need for some leeway in developing Terms of Reference to account for the current state of understanding. This research track will require close collaboration among Population Dynamics Branch staff, Offshore Wind Energy Branch, Ecosystem Dynamics and Assessment Branch, local academics, and region managers to ensure full consideration of prioritized aspects are sufficiently addressed. It will build upon the rapidly growing literature on the effects of offshore wind energy on fish and fisheries.