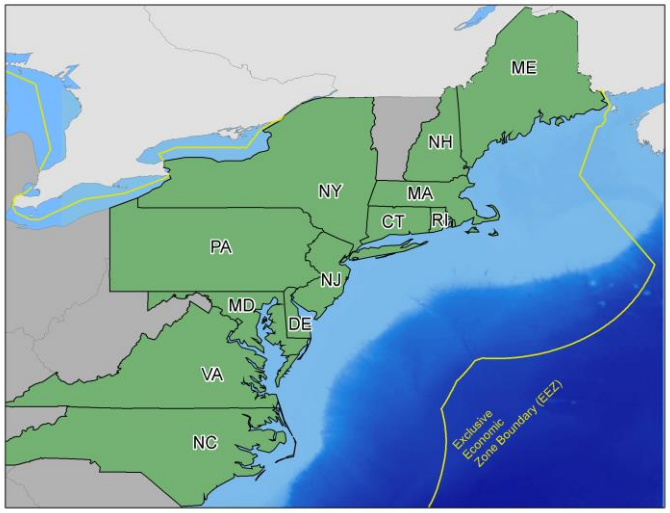
NORTHEAST REGION COORDINATING COUNCIL

FALL 2014 MEETING

October 21-22, 2014

Providence Marriott – Providence, Rhode Island



Meeting Briefing Book Table of Contents

(*hyperlinked*)

To be distributed via e-mail prior to meeting:

Alaska Management Process (presentation to the NRCC)
GARFO Strategic Plan Materials
Offshore Aquaculture Information

2014 FALL NRCC MEETING AGENDA

Providence Marriott—Providence, Rhode Island

All times are approximate

Tuesday, October 21

0900

1. Welcome, introductions, modifications and additions to agenda, announcements (Bullard, Karp, Ruccio)

0905-1530

2. Stock Assessment Priority Setting: Scheduling and Specific Assessment Topics
   Discussion leader: Karp
   - Report on 2014 Stock Assessment Program Review and Related Changes (Karp)
   - Review Spring 2014 NRCC Assessment Schedule
     i. Update, as needed on previously established 2015 schedule
   - Discuss a process for scheduling assessments beyond 2015
   - GB cod assessment request
   - Offshore Herring Sea Fishery Spawning Data Collection Project Update (Kerns/Karp/Rago)
   - Black Sea Bass Assessment Timing and Implementation Issues (Moore/Kerns/Pentony)
   - Completed NRCC documents: SARC 60 ToRs; SAW Public Comment Policy

Break 1030-1045

1045-1200

3. Continue Assessment Related Discussion
   Discussion leader: Karp

Working lunch break 1200-1220

1220-1530

4. Continue Assessment Related Discussion
   Discussion leader: Karp

Break 1530-1545

1545-1600

5. Offshore Aquaculture Policy Discussion
   Discussion leader: Alves (GARFO); Bullard
   - Overview of comprehensive Gulf of Mexico offshore aquaculture amendment
   - NRCC discussion of policy development needs/Council involvement in Greater Atlantic Region aquaculture policy

1600-1630

6. Update and Discussion of GARFO Strategic Plan
   Discussion leader: Bullard (Mears, GARFO)

1630-1700

7. Update and Discussion of NEFSC Strategic Plan
   Discussion leader: Karp

1700-Day 1 Wrap Up; Prep for Day 2 Discussions
1730 Adjourn Day 1
1800(ish): Dinner, Joe's American Bar and Grill, Providence Place

Wednesday, October 22

0800-0945

8. Priority setting discussion
   - NEFMC, MAFMC, ASMFC, GARFO, and NEFSC outline priorities
   - Discuss prioritization and coordination of resources, as needed

0945-1000

9. NRCC SAFE Report Working Group Follow up Discussion
   Discussion leader: Weinberg

Break 1000-1015

1015-1115

10. Overview of Alaska Management Process
    Discussion leader: Pentony, (Presentation --Heil, Kelly GARFO SFD)

1115-1130

11. Follow up discussion: Possible role of the NRCC in observer prioritization
    Discussion leader: Karp

1130-1200

12. Ongoing Actions Status Update
    Discussion leader: Pentony
    - Industry funded monitoring amendment
    - Vessel baseline/Upgrade restriction amendment
        i. Includes discussion on potential Council-initiated amendment to develop additional streamlining measures
        ii. Discuss agency support levels for additional amendment

Working lunch break 1200-1215

1215-1245

13. Fishery Dependent Data Collection Project

Discussion leader: Brown

- Update on ongoing collaborative GARFO/NEFSC comprehensive data collection revamp

1245-1300

14. Discussion on coordinating research priorities
    Discussion leader: Karp/Robins

1300-1315

15. 5-year catch share program review
    Discussion leader: Pentony
    Discussion of process and planning for required program review

1315-1330

16. Update on NS 1 Guidelines Revision Proposed Rule
    Discussion leader: Pentony
    Update on rulemaking status; potential impact or Council agenda planning

1345-1500 (including break, as needed)

17. Meeting wrap up
    - Complete any unfinished discussions or unresolved new business
    - Review action items and assignments
    - Identify mid-term call date/time (ca. mid-January to early February 2015)
    - Identify 2015 Spring (MAFMC host) and Fall (NEFSC host) meeting dates
    - Adjourn meeting

18. Post meeting: GARFO-NEFSC-NEFMC operating agreement discussion

Note: hard stop for all participants at 4:00

NRCC Spring Meeting 2014 Action Items

April 29-30, 2014—Hotel at Arundel Preserve, Hanover, MD

Color code key:	
ASMFC	MAFMC
NEFMC	NEFSC
NERO	NRCC

1. SAW Participation Working Group
   -Revise alternatives based on Spring 2014 NRCC discussion
   -GC to provide assistance on the statutory authority of a SAW WG and guidance on the disclosure, retention, and disposal of information
   Responsible parties: NEFSC (lead), MAFMC, NEFMC, GARFO, and ASMFC
   Due Date: NEFSC distribute revised SAW documents by June 1, 2014
   NRCC provide written comments to NEFSC, and discussion at mid-term call
   Final version by Council meetings (August MAFMC and October NEFMC)

2. Explore timing options from Fall 2015 Groundfish updates
   -20 groundfish stock updates scheduled for late September 2015
   -NEFMC and GARFO implementation options for updated information
   Responsible parties: GARFO (lead) and NEFMC
   Due Date: GARFO to provide summary at Fall NRCC meeting

3. Black Sea Bass Benchmark Assessment Work Plan
   -Develop a committee
   Responsible parties: MAFMC (lead), NEFSC, NEFMC, GARFO, and ASMFC
   Due Date: Assign membership by June 1, 2014
   Provide BSB WG update at Fall NRCC meeting

4. ASMFC Atlantic Herring Study Proposal
   -NEFSC to review research study proposal
   Responsible parties: NEFSC, NEFMC, and ASMFC
   Due Date: NEFSC to provide comments by mid-term call

5. Climate Change
   -Continue next steps after climate change workshop and discussion on governance
   -Distribute report on climate change and governance workshop when available
   Responsible parties: NEFSC, MAFMC, NEFMC, GARFO, and ASMFC
   Due Date: Provide update at Fall NRCC meeting

6. NRCC Involvement in Observer Prioritization
   -Develop NRCC WG to examine the NRCC's role in observer prioritization
   Responsible parties: NEFSC, MAFMC, NEFMC, GARFO, and ASMFC
   Due Date: Assign membership by June 1, 2014
   Mid-term update in summer 2014
   WG to develop a white paper for Fall NRCC meeting

7. Aligning Research Priorities
   -Ensure adequate time on agenda and discussion at Fall NRCC meeting

8. Alaskan Model of Assessments and Implementation
   -Examine how science advice is incorporated into rulemaking
   Responsible parties: GARFO (lead)
   Due Date: Update at mid-term call, report at Fall NRCC Meeting

Upcoming Meeting Dates
Mid-Term Call – July, 21 - Afternoon ~ 2hours
Fall 2014 – GARFO –October 21, 22

NOAA FISHERIES
Northeast Fisheries Science Center

Stock Assessment Process and Modeling Program Review
Northeast Fisheries Science Center Summary and Response
August 2014

Introduction

In May, 2014, six peer reviewers evaluated the Northeast Fisheries Science Center's (NEFSC's) processes and modeling approaches used to develop stock assessments in support of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as reauthorized in 2006. This review focused on the overall program of assessment modeling, the use and evaluation of various assessment methods, the Center's assessment review processes, and the extent and adequacy of communications/interactions with the Center's partners, clients, stakeholders, and other users of our stock assessment results. The reviewers were asked to consider NEFSC's stock assessment program, processes, and modeling approaches within eight themes (or terms of reference --TORs), which are discussed in the body of this memorandum. The panelists were:

- John Armor (Chair), NOAA National Ocean Service
- Mark Dickey-Collas, International Council for the Exploration of the Sea
- Patricia Livingston, NOAA Fisheries/Alaska Fisheries Science Center
- Gunnar Stefansson, University of Iceland
- Jon Helge Vølstad, Institute of Marine Research, Norway
- Stephen Walsh, Department of Fisheries and Oceans, Canada

Center scientists and partner organizations provided the review panel with presentations and information relevant to each of the themes. Each reviewer subsequently provided a report documenting observations, findings, and recommendations. The chair's report summarized and synthesized comments provided by the entire panel.

The Center has established a public website for its program reviews. Here you will find meeting information, documents, presentations, review panel reports, and panelists' resumes for both this review and the 2013 review of the NEFSC stock assessment data collection programs:
http://www.nefsc.noaa.gov/program_review/

The reviewers were presented with a wealth of information covering all aspects of our stock assessment program. I would like to express my appreciation to Center staff and others who prepared documents and presentations for the review and otherwise ensured that we were well-prepared and responsive to the reviewers' needs. I would also like to thank the reviewers for their committed and insightful participation and for their comments and suggestions, both during the proceedings and in their written reports. This review was open to the public and I am grateful to our partners and stakeholders who participated and contribute positively and constructively to the process.

Readers of this document should be aware of the role of the Northeast Regional Coordinating Council (NRCC) in planning, prioritizing, and overseeing the Center's MSA stock assessment activities. The NRCC consists of the leadership of the Center and the Center's four primary management partners: the Atlantic States Marine Fisheries Commission (ASMFC), the NOAA Fisheries Greater Atlantic Fisheries Office (GARFO), the Mid- Atlantic Fishery Management Council (MAFMC), and the New England Fishery Management Council (NEFMC).

Promoting Innovation and Increasing Efficiency

The reviewers provided strong positive feedback regarding the quality and integrity of the Center's stock assessment processes and products, as well as on the productivity, commitment, and professionalism of the Center's stock

assessment staff. Activities carried out by the Center in support of MSA requirements are among our highest priorities and I am very pleased to see us receive this type of recognition. Nevertheless, there is opportunity and need for substantive improvement to address public confidence in the results of our assessments, to invest in research and development of methodological improvements, to develop and implement changes that recognize the importance of an ecosystem approach to fisheries management, and to improve our efficiency and our responsiveness to management needs.

A key issue, relevant to all areas of the review and articulated repeatedly by the reviewers, is that the Center's assessment staff are severely overburdened by demands for stock assessments, related analytical products, and regulatory support. Furthermore, reviewers recognized that failing to address this overarching concern presents risks. They emphasized that our stock assessment system has become "overly complicated," and that unsustainable demands placed on the Center's stock assessment scientists may compromise "the quality and timing of the advice provided to fishery management authorities." We agree with the reviewers' observations that demands placed on stock assessment scientists also preclude them from engaging in research to improve stock assessments or otherwise develop their professional skills. We will take a series of steps to remedy this situation.

The eight themes, or TORs, for this review address different aspects of our work to provide sound scientific advice for fisheries management. However, the individual themes interconnect in many ways and this was evident in the discussions and in the reviewers' reports. Therefore we begin by proposing a series of overarching, multi-thematic measures as elements of a strategic approach to reform our stock assessment enterprise. In some cases these measures also support broader, Center-wide change. Later in the document, I will return to the individual TORs and some specific concerns. Please note that some of the following initiatives are already underway and will be informed by the results of this review, while others will be initiated in the coming months.

1. **NEFSC Strategic Science Planning.** The Center is developing a new strategic science plan. Through this process, we are reviewing and updating our research priorities. We are also seeking ways to break down barriers that currently hinder interdisciplinary science and crosscutting research. Upon completion of the new plan, we will review the Center's organizational structure and, potentially, make changes to address this need. During this process we will consult broadly with partners, stakeholders and staff.

2. **Improvements in Fishery Dependent Data and Information Systems - Developing an Integrated and Comprehensive Fishery Dependent Data System (Data Visioning Project).** Our ability to complete stock assessments in a timely and accurate manner is greatly constrained by antiquated and poorly integrated data collection and management systems that have evolved over time to meet changing needs for management and stock assessment. We recognize the importance of building a new, integrated state-of-the-art system that will greatly improve data quality and timeliness. We are working with the GARFO and other partners on this multi-year initiative. I am confident that this process will greatly improve efficiency and bring substantive improvements in stock assessment quality and timeliness.

3. **Improvements in Stock Assessment Process and Efficiency**

   a. **Stock Assessment Process Efficiency Initiative.** This program complements the Data Visioning Project. It is designed to streamline the preparation of data inputs to stock assessment models, focus the model outputs for management decisions, and simplify the internal review process while ensuring adequate oversight and quality control. The goal is to provide more timely information for management. Standardized databases for processed fishery-independent and fishery-dependent data are under development. We will also identify ways to reduce and simplify the document preparation workload, while improving communication with interested stakeholders. This is an ongoing project, and some process improvements have already been implemented.

   b. **Assessment Staff Time-Budgeting.** The demand for stock assessment advice exceeds our current capacity to provide it. To ensure that the Center is responsive to NRCC partners and that some fraction of staff time is available for research and professional development, we will work with the NRCC to implement a new approach to allocating staff time. We will create a staff time-budget composed of the estimated number of staff days available per year to conduct stock assessments and to respond to other analytical requests, and the number of days available per year for each assessment scientist to conduct research, professional development, and administrative duties. We will work with the NRCC to allocate this staff time-budget among the partners and use it to address and prioritize assessments within each partner's budget.

c. Stock Assessment Prioritization and Process Rationalization. NMFS is drafting a national stock assessment prioritization process that uses objective criteria to guide frequency, timing, and level of analytical approach for assessment of individual stocks. We will work with the NRCC to develop and implement a similar framework for the Northeast Region, and to reinitiate a plan for rationalizing the regional stock assessment process that was first proposed in 2011. Together with the aforementioned assessment budgeting proposal, we expect this will lead to a more consistent and efficient approach for determining the type of assessment that is appropriate and necessary for a specific stock, as well as to determine assessment frequency and timing.

d. Regulatory Support Management. We will work directly with the Councils to better manage staff participation on Plan Development Teams and Fishery Management Advisory Teams, and in providing review and analytical support related to development of regulatory documents. When possible, we will seek staff expertise from Center research groups that are not heavily utilized to address GARFO and Council needs. We will also strive to better balance responsibilities and workload associated with these functions among staff from the NRCC partners.

4. **Management Strategy Evaluation/Management Procedures (MSE/MP).** Management Strategy Evaluation (MSE), or the Management Procedure (MP) approach, is designed to identify and operationalize fishery management strategies that are robust to several types of uncertainty and capable of balancing multiple economic, social, and biological objectives. Many of the panelists for this review, as well as those for the 2013 review, recommended the use of MSE approaches for evaluating alternative sampling methodologies and data processing strategies, structural uncertainty in assessment models, and analyses of harvesting policy alternatives. These approaches will also provide tools for NRCC partners to use in analyzing the risks of alternative management actions. MSE requires cross-disciplinary expertise in mathematics, statistics, and decision theory, as well as large-scale computer simulations and database management. In coordination with a similar national effort, we will develop an initiative to establish a cross-cutting MSE capacity in the Center and bring resources to bear in developing the necessary skills. Initial funding for this initiative will be provided in FY15. We expect this innovation to bring multiple benefits, including improved ability to make staffing and other Center resource allocation decisions (such as data collection resources) relative to both assessment and management uncertainty.

5. **Incorporating Ecosystem Processes into Stock Assessments.** The Center is working with NRCC partners to bring broader ecosystem considerations into MSA stock assessments as we move toward a more integrated, ecosystem approach to fisheries management. Center staff are working with both Councils on how best to meet this challenge. Within the Center we have established a Climate, Ecosystem, Habitat, and Assessment Steering Group (CEHASG), which includes representation from all Center Science Divisions and Programs. The steering group is working on protocols for drafting ecosystem and climate TORs to be considered during benchmark stock assessments. We have already demonstrated some success in this regard. Through our strategic planning, we will work on ways to break down barriers within the Center that impede our ability to bring a more holistic approach to the stock assessment process. We will also consider how best to meet information needs for this approach. In the coming fiscal year, the Center plans to develop and test a multispecies stock assessment model and to evaluate the potential for deriving management advice from this type of approach.

Reviewer's Comments on Specific Themes and Proposed Solutions

Does the Center apply a suitable scientific/technical approach to fishery stock assessment modeling?

Panelists found the Center's approach generally suitable and that Center scientists are working on improvements. However, they expressed concerns regarding the complexity of the review process leading to management advice and the heavy burden placed on stock assessment scientists, which in turn limits opportunities for investigating new modeling techniques and provides few opportunities to work on improving existing models. They also expressed concern about reliance on the NOAA Fisheries Stock Assessment Toolbox.

The panelists recommended moving forward with the assessment staff time-budgeting concept, ensuring that emphasis is placed on setting aside sufficient time for staff to engage in essential research, methods development,

training, and professional development. We agree with this recommendation and will begin working with the NRCC to develop and implement the concept.

The Center is participating in a national effort to improve the NOAA Fisheries Toolbox and to secure a programmer to develop the next generation of stock assessment models. We will continue internal efforts to improve and support existing modeling software and to add new software when appropriate. We will also continue to test the integrated modeling approaches and various state-space models such for stock assessments in the Northeast.

Is the assessment process efficient, effective and clearly described, including terms of reference for assessment reports?

Panelists found the assessment process to be highly complex, inefficient, and burdensome. They observed differences in the way that assessment processes are described among regional and fishery management plans and noted the potential for adding complex (and perhaps unnecessary) TORs for stock assessments. They noted that inefficiencies in the assessment process are caused mostly by problems with data-streams, excessive reporting demands, and an overly complex and time-consuming meeting schedule related to the peer-review process.

Panelists recommended reducing the number of TORs, and moving some to a research-only (benchmark) track. Those moved to the research track would only be brought forward as a formal TOR when ready for inclusion in an assessment. They also recommended instituting an improved, automated fishery-dependent data collection and transfer system to minimize lags in delivery times, as well as streamlining the assessment process to improve delivery of scientific advice. In particular, they recommended moving forward with improvements described under our Stock Assessment Prioritization and Process Rationalization initiatives.

We concur with these recommendations. In addition to our Prioritization and Rationalization Initiative, our Data Visioning Project, Stock Assessment Process Efficiency Initiative, and MSE initiative address concerns raised under this theme. In particular, we will conduct the following two projects under the MSE initiative:

- Conduct a comprehensive evaluation of the monitoring program for biological samples. A primary focus will be on the effective sample size of current designs for estimation of catch-at-age, length frequencies, and other biological information such as maturity and sex.
- Investigate methods to automatically process age-length keys to estimate catch-at- age

Does the Center, in conjunction with other entities such as the Councils' Scientific and Statistical Committees, have an adequate peer review process?

In general, panelists found the peer review process to be thorough and appropriate. However, they identified some possibilities for improvement through streamlining to enhance timeliness of scientific advice. They cautioned that improvements should not compromise the independence of the reviews. They noted potential problems resulting from lack of continuity among reviewers (i.e., always bringing new and different Center for Independent Experts (CIE) reviewers to assessments of the same or similar stocks), and functional differences between the NEFMC and MAFMC Scientific and Statistical Committees (SSCs), control rules, and criteria for acceptance of assessments. The specific responsibilities and skills of CIE reviewers were also the subject of some reviewers' comments, with suggestions that these types of reviewers are best at evaluating assessment methodology, but less likely to understand regional or local conditions that may influence stock dynamics.

Panelists recommended keeping at least one CIE reviewer at consecutive reviews of the same stock, or having an SSC member chair the assessment meetings (as is done currently in some cases). They also underscored the importance of the role the SSC chair plays, or should play, to ensure reviewers understand the results and recommendations from the previous assessments, and that they focus on the primary TORs and requirements for setting acceptable biological catch (ABC) and overfishing limits (OFLs). We acknowledge the concerns expressed by the panelists and will determine whether some changes can be made in the contract with the CIE in response. We will also work with the Councils and SSCs, directly and through the NRCC, to address concerns regarding unnecessary TORs and/or prioritization of TORs.

Does the Center work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessments according to a set of priorities?

Panelists felt that priority-setting should be improved and better coordinated to improve the stock assessment process at the Center. In particular they felt that the NRCC has not been effective in prioritizing stock assessments objectively. They were also concerned that the efficiency of stock assessment scientists is compromised by requirements for them to attend numerous scientific review and regulatory support meetings.

Panelists recommended considering whether non-stock assessment personnel could participate in Plan Development Teams to free up stock assessment scientist time. NEFSC research could still be brought to bear to assist in analyses, but in some cases Council or GARFO staff could play a greater role than they do at present. They also recommended managing the time spent on assessment work by individual staff members through the assessment budgeting approach.

Many of the broad-based initiatives described earlier are responsive to these concerns. In particular, through the Stock Assessment Process Efficiency Initiative, we will work with the NRCC to improve the utility of assessment reports while providing the information necessary for the SSCs to properly evaluate risk and uncertainty. We will ensure that we meet the needs of GARFO for determination of stock status, rebuilding plans, and reporting to national databases. We will also continue our active engagement with the two regional SSCs to ensure that we tailor assessment outputs for direct use in setting ABCs and annual catch limits.

Does the Center achieve adequate assessment accomplishments relative to mandates?

Most panelists expressed satisfaction that the Center's stock assessments were meeting the demands of managers. However, many felt some streamlining was needed to sustain the current level of service. They expressed concerns over the impacts on the timeliness of assessments caused by inadequate fishery-dependent data systems and data delivery lag times. They also suggested that research recommendations emanating from stock assessments be reviewed and prioritized through the NRCC.

The Data Visioning Project is directly responsive to concerns about data quality and timeliness, although it should be noted that many current fishery data collection systems were not designed to meet the spatial (and, in some cases temporal) resolution needs required for some management programs. Inadequate spatial resolution can be constraining in stock assessment as well. These concerns will be discussed within the NRCC, since it is important that we have a mutual understanding of the limitations of existing monitoring and sampling programs, and that increases in data collection and monitoring will be achieved at the expense of other Center priorities.

Does the Center have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

Panelists felt that the initial steps taken by NEFSC on the ecosystem approach to fisheries management were encouraging. Some felt that incorporation of ecosystem considerations is currently most appropriate for strategic advice, rather than operational annual advice, and that reference points should reflect the reality of the ecosystem dynamics. It was also remarked that lack of research resources for developing modeling approaches and inadequate resources for ecosystem surveys were problematic. They recommended that ecosystem surveys be funded to the extent possible. They also recommended better integration among stock assessment and ecosystem assessment scientists to encourage modeling and methods development, better implementation of tools for spatial analysis, and a more holistic approach to stock and ecosystem assessment. NEFSC concurs with these concerns and recommendations. Funding and prioritization for ecosystem surveys must be considered together with other funding and prioritization challenges but we will endeavor to maintain an adequate investment in these activities.

We will continue to advance our work in this area through the CEHASG, and by encouraging Center branches and programs to contribute data and analysis and participate in working groups focused on incorporating ecosystem and climate factors into stock assessments. Through our strategic planning, we will examine approaches supporting more interdisciplinary science within the Center (and with our partners) and we will consider organizational change to facilitate this need. We also view the MSE initiative as a powerful opportunity to address the multidisciplinary research and data collection that is necessary to move us toward integrated ecosystem science and assessment, as well as to evaluate strategies and set priorities.

Does the Center adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

Panelists felt the Center does a good job communicating with stakeholders and others about the stock assessment process and related results although they did suggest that more dialog would be beneficial. They suggested that the NRCC should play a greater communications role during the assessment process and with the general public. They also suggested that the closed report-writing period of the Stock Assessment Review Committee be made open to the public. We will work with the NRCC to follow up on the suggestion regarding their role in communication. We will also work with the CIE on making the report-writing sessions open to the public.

Regardless of the panelists' positive comments, the Center is subject to criticism from stakeholders regarding opacity in the stock assessment process and in communicating results. We take these concerns seriously. Within our Stock Assessment Process Efficiency Initiative we will evaluate how well we communicate process and results to stakeholders. We will also develop improved communications approaches, using both web-based and paper-based approaches.

Are there opportunities for improving stock assessments and the stock assessment process?

Panelists offered many suggestions for improving the Center's stock assessment process. These include streamlining and improving assessment process efficiency, developing and implementing an effective and objective process for prioritizing assessments and assessment TORs, and use of MSEs to evaluate alternative sampling and assessment strategies. They also recognized that improvements can only be made by working closely with our assessment partners through the NRCC. Some very specific recommendations focused on research priorities and areas of expertise. In particular, panelists recognized the importance of addressing research needs identified during assessments in a manner that supports information needs for subsequent assessments and in improving the fishery-dependent information systems that support the Center's assessments. One comment, reiterating a theme articulated throughout the review, deserves direct quotation:

> *It is extremely important for assessment personnel to also be researchers, actively publishing research papers. The assessment scientists thus need to be given time for this purpose. This is not for academic reasons, but for personal development and simultaneously keeping assessment methods up-to-date. Most assessments automatically include some new development. Such developments must be evaluated for adequacy and their effects and these tests commonly lead to results, which can and should be published in scientific journals.*

All of these concerns and suggestions and others raised under this TOR have been discussed in our description of initiatives or in responses to panelists' comments and recommendations related to individual TORs. All of the initiatives are responsive to the reviewers' guidance on the need and opportunity for change and improvements, and the results of this review will be considered carefully as we move forward with each initiative. Of very high priority among these initiatives are the need for stock assessment prioritization and process rationalization and the related need for assessment budgeting that recognizes the importance of providing dedicated time for research and professional development of stock assessment staff.

Closing Comments

This was a rigorous review that asked a great deal of Center staff, partners and, of course, the review panel. I consider it to have been a worthwhile and productive exercise both for the reviewers' assertion that we are performing stock assessment responsibilities well under difficult conditions and for their constructive guidance, creative suggestions and enthusiastic support for initiatives that are either underway or were discussed during the review. The program of reform and improvement proposed here is essential to the overall success of the Center as well as our ability to meet burgeoning needs for assessment and management advice from our NRCC partners. I am committed to moving forward with our initiatives and to addressing the specific concerns as outlined above. Senior staff will be assigned lead responsibilities for initiatives and specific actions and we will report back on progress annually, through the Center's web site.

Table 1: Summary of Major Action Items and Schedules

Action Item	Schedule
Develop and implement an assessment staff time budgeting process	Initial presentation and discussion will occur in October 2014, with full implementation expected in 2016
Participate in national effort to improve the NOAA Fisheries Toolbox	New hire to support this effort in 2015
Evaluate integrated modeling and state-space models	New integrated modeling approach presented at ICES in 2014, and further developments will occur in 2015
Improve fishery-dependent data quality and timeliness	Target date for full implementation is May 2017
Implement NEFSC Stock Assessment Process Efficiency Initiative	Initial implementation in 2015 for 20 groundfish stocks, further refinement will occur in 2016
Implement NEFSC Management Strategy Evaluation Initiative	First two MSE projects will be completed in FY16, and additional projects will occur over several years
Implement standardized stock assessment prioritization process and re-initiate plan for rationalizing the regional stock assessment process	Initial discussions with NRCC in 2014, full implementation over a two-year period.
Improve management of staff participation in Council teams and committees, and in review and analytical support related to the regulatory process	Discussions between GARFO and NEFSC have been initiated, improvements expected over a two-year period.
Strive to keep at least one CIE reviewer at consecutive reviews of the same stock, and have an SSC member chair each assessment meeting. Work with the CIE to open the SARC report-writing session to the public.	NEFSC will work with the CIE and the Councils in 2015 to determine if these changes can be made for 2016
Work with the Councils and SSCs to address concerns regarding unnecessary ToRs and prioritization of ToRs	Ongoing. Initial improvements are expected with standardized assessment of 20 groundfish stocks in 2015
Bring broader ecosystem considerations into stock assessments	Work internally and with partners on draft protocols for ecosystem and climate ToRs, to be implemented initially in 2015
Develop and test multispecies stock assessment models and evaluate of their potential for supporting management advice	Ongoing. Evaluation and recommendations expected in 2016
Improve communication with stakeholders on the assessment process and its results	During 2015, review and develop a plan for improved communication for implementation will in 2016. Initial discussions with NRCC on enhancing their role in this process will occur in 2014.

CHAIR'S SUMMARY OF
PROGRAM REVIEW OF STOCK ASSESSMENT PROCESS
NORTHEAST FISHERIES SCIENCE CENTER
WOODS HOLE, MA
MAY 19-23, 2014

I. Review Panel Members

John Armor (Chair)	NOAA National Ocean Service
Mark Dickey-Collas	International Council for Exploration of the Sea
Patricia Livingston	NOAA/NMFS Alaska Fisheries Science Center
Gunnar Stefansson	University of Iceland
Jon Helge Vølstad	Institute of Marine Research, Norway
Stephen Walsh	Department of Fisheries and Oceans, Canada

II. Background and Overview of Meeting

From May 19-23, 2014, the National Oceanic and Atmospheric Administration's Northeast Fisheries Science Center (Center) convened a panel to examine and evaluate the Center's fishery stock assessment program pursuant to the Magnuson-Stevens Act (2006) and comparable international agreements. The review focused on the overall program of assessment modeling, approach, review process and communication. Panelists received most presentations and other background documentation prior to arriving in Woods Hole. Throughout the week, Center scientists provided the six panelists with presentations and information on these topics to inform the recommendations. Presentations also provided the scientists' perceptions of the perceived strengths, challenges, and opportunities for solutions on each topic.

The following is the panel chair's summary of the other five panelists' individual reports. This summary includes observations and recommendations that two or more panelists had in common, however, they should not be considered consensus recommendations of the group. General overarching observations and recommendations are provided first, followed by observations and recommendations for each term of reference. The material provided in this summary is very cursory by design. Details and rationale behind observations and recommendations can be found in the panelists' individual reports.

III. General Observations & Recommendations

The Center's leadership and scientists do a tremendous job dealing with the extraordinary complexity of their tasks: performing assessments for more than 60 species and providing scientific input for 18 fishery management plans, two regional fishery management councils, and one interstate fishery commission. In addition, there are numerous *ad hoc* requests for information and follow-ups from GARFO, councils, commission, external partners and headquarters.

The complexity of the Center's task and the regulatory environment, however, seems to have given rise to an overly complicated stock assessment process that seems to (in some cases) undermine the quality and timing of the advice provided to fishery management authorities.

IV. Major Observations & Recommendations by TOR

TOR 1: Does the Center apply a suitable scientific/technical approach to fishery stock assessment modeling?

Panelists found the Center's approach generally suitable and that Center scientists are working to improve the approach. However, panelists noted:

- The overly complex review process leading up to the quota advice not only overburdens the assessment scientists, but also adds a possible substantial error to assessment process since the ABC may be based on 2-year old fishery-independent and fishery-dependent survey data.
- Data processing issues centered on the often late arrival of catch data from federal and coastal state fisheries results in large and unacceptable lag times for completing the assessment process.
- Staff are being severely burdened by the number of stocks that have to be assessed annually and the frequency demanded by Councils and Commission, including too many terms of references and ad hoc requests.
- There is also very little time to investigate new modelling techniques, e.g. SURBA, Stock Synthesis, recent developments in statistical assessment models (SAMs), etc., and little opportunities to work on improving existing models.
- The NOAA Fisheries toolbox provides many advantages (particularly as a tool for rapid responses to additional analysis requests in the review process and communicating with stakeholders) but also creates some limitations (particularly the complexity resulting from multiple programming languages, the data led introductory interface and the resulting issues with keeping the system up to date).

Panelists recommended:

- The "assessment bucks" concept may have some promise to help achieve some balance in staff focus and energy.
- Refocusing staff time on increasing knowledge necessary for tackling critical research questions, such as changes in natural mortality, catchability, ecosystem interactions, and climate impacts, may yield improvements to stock assessment approaches and results.
- Staff development should consist of training in new stock assessment methods, participation in international meetings and working groups such as ICES, NAFO and NASCO, etc. to keep abreast in new developments in data collection, surveys and modelling, and promotion of scientific writing for primary publications.

TOR 2: Is the assessment process efficient, effective and clearly described, including terms of reference for assessment reports?

In general, panelists found the assessment process to be highly complex and burdensome. Specific observations included:

- The assessment process was described and varied depending on the FMP and region.
- The process for developing terms of reference for the assessment reviews was described and seemed fraught with the potential to add any number of items for consideration in the assessment, with varying priority.
- The process is over engineered, inefficient, and is not necessarily within the control of the NEFSC.

Panelists recommended:

- Consider ways to reduce terms of reference or to move some to a research only track and only brought forward when ready for inclusion.
- Investigate and institute a better delivery system for fishery dependent data collection and transfer using automation to minimize time lags in arrival times.
- The assessment process itself needs to be more streamlined to improve delivery.

TOR 3: Does the Center, in conjunction with other entities such as the Councils' Scientific and Statistical Committees, have an adequate peer review process?

In general, panelists found the peer review process to be very thorough and appropriate, however, there is some room for streamlining to enhance timeliness of scientific advice. Some specific observations included:

- Attempts to maintain stability or improve timeliness may well be needed but care must be taken that this is not done at the expense of the independence of the reviews.
- The peer review process is adequate but there are many complexities introduced because of the lengthy timing of the SAW/SARC process, the different reviewers involved in the review of a particular assessment across time in the SAW/SARC, the two different SSCs with different control rules and criteria for acceptance of assessments.
- The SAW/SARC process tends to be somewhat disjoint because the CIE experts come and go and may make recommendations that are more in line with practices in other countries.

Panelists recommended:

- Consider either keeping at least one CIE member at consecutive reviews, or have a chair from SSC.
- Revising TORs of the contract to the CIE for obtaining reviewers may be needed. It should be (and perhaps already is recognized to be) incumbent on the SSC chair to ensure there is good communication of the results and recommendations from the previous SAW/SARC and keeping reviewers on track with considering the primary TORs and what is needed for ABC/OFL setting.
- Efforts should continue to communicate which TORs are important, provide each SAW/SARC panel with sufficient history of the previous peer review, what was worked on and what was not worked on and why (i.e., low priority or inadequate data, etc.) to give context to these independent but perhaps naïve in the US ACL setting process reviewers of what is trying to be accomplished. Separating immediate TORs for ACL setting from medium term to longer term TORS for strategic improvement of the assessment should be part of the communication process, if it is not already done.

TOR 4: Does the Center work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessments according to a set of priorities? Considerations should include program structure, staffing, funding, and the stock assessment prioritization process.

In general, panelists found priority-setting could be improved and better coordinated to improve the overall stock assessment process at the Center. Some specific observations included:

- There was little evidence that the Northeast Regional Coordinating Council (NRCC) has led to effective prioritization.
- There is also some indication that staff time may be taken up with a large number of the science review meetings. Consideration should be given when assigning staff to reduce back to back assessments, and prioritizing who needs to attend various review meetings.
- Trying to ensure that staff have time after the completion of a SAW/SARC to work on finalizing reports and publishing results should be considered to the extent possible.

Panelists recommended:

- Consider whether non-stock assessment personnel participate in PDTs and free up stock assessment scientist time. NEFSC research can be brought to bear to assist in necessary Council analyses but it may not be necessary for the stock assessment scientist to sit on the PDT or actually write the analytical document. Depending on the analysis, Council or Regional office staff should have the lead.
- Consider staffing levels for each SAW working group and how many of these each stock assessment scientist participates in per year. Consideration could be given to reducing that load by including only the most necessary stock assessment scientist in each. Ways to reduce the allocation of stock assessment time to non-essential tasks should part of the assessment bucks concept.
- Apply a systematic approach for addressing problems in the stock assessment process. There is a need to have one body set the priorities in frequency and time-lines for assessments (benchmark vs updates) using a defined set of criteria.

TOR 5: Does the Center achieve adequate assessment accomplishments relative to mandates particularly with respect to the number of Fishery Management Plan (FMP) species assessed?

Panelists generally thought the Center's stock assessments were meeting the demands of managers, however, many felt some streamlining was needed to sustain the current level of service. Some specific observations included:

- The number of benchmark assessments has declined over time but the total of number of assessments has not.
- Timeliness of data inputs to the stock assessment process is hindering the quality and timing of advice.
- Improvements to the fishery dependent data availability problem along with the schedule mandated by the peer review and GARFO process are the most essential for getting the most timely data into stock assessments for ABC/OFL setting.

TOR 6: Does the Center have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

In general, panelists found the Center's efforts to take climate change and ecosystem impacts into stock assessments are laudable but that improvements could certainly be made. Some specific observations included:

- With regards to the ecosystem approach to fisheries management, the initial steps taken by NEFSC are encouraging.
- Incorporation of ecosystem considerations is currently most appropriate for strategic advice, rather than operational annual advice (called tactical by some at the center). Limit reference points should reflect the reality of the ecosystem dynamics.
- Challenges relate to research time to develop modeling approach, and cuts in ecosystem monitoring surveys.

The panel recommended:

- Stabilizing or increasing funding for ecosystem surveys.
- Secure time for stock assessment and ecosystem modelers to work together on methods development.

TOR 7: Does the Center adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

In general, panelists felt the Center does a good job communicating with stakeholders and others about the stock assessment process. Some specific observations included:

- The NEFSC puts out an impressive array of documents and communicates face-to-face through the public meetings set up for the formal SAW/SARC and SSC interactions surrounding the ABC/OFL setting process.
- Communication is not the same as dialogue.
- The entire assessment process is very transparent and there are no obvious problems in this regard.

Panelists recommended:

- Members of NRCC should take an active role in increasing communication within the assessment process and outside to the general public.
- Center staff should be given ample opportunities to publish results from stock assessment model development and critical research areas to enhance the scientific integrity of the Center.
- The one exception to transparency seems to be that the SARC has a closed-door writing session at the end of each meeting. This is a subject of some controversy and there have been calls for opening this session. Interestingly there (a) seems to be little reason for having this writing session closed and (b) there would be little benefit to transparency to opening it. Opening the session should be considered, if only to make the entire process transparent.

TOR 8: Are there opportunities for improving stock assessments and the stock assessment process?

In general, panelists had multiple suggestions for improving the Center's stock assessment process. Refer to panelists' individual reports for details. A few of the suggestions included:

- The system needs to keep its legitimacy and yet needs to be radically streamlined. Researchers need some space to explore ideas. The center should consider the greater use of management strategy evaluation as a tool.
- The management systems in the NEFMC and MAFMC areas are evolving and the science is evolving with it. The challenges will be communicating the highest priority issues to deal with and making the resources and institutional linkages necessary to implement those.
- Many of those issues are outside the control of the NEFSC. GARFO, NEFMC, MAFMC, and ASMFC should be working together with the NEFSC to solve those problems.
- The Centre needs to avail of (or obtain) expertise in gear technology to address issues of calibration and selectivity; 2) apply management strategy evaluation (MSE) to stock assessment issues such as retrospective problem and decisions on catch advice; and 3) use funding from the set aside (RSA) programs to tackle immediate, critical research issues such as an independent estimate of natural mortality, movement and stock size for Georges Bank yellowtail and cod, e.g., with a re-introduction of tagging programs.
- Priorities must be set on terms of reference and research proposals coming out of the assessment process. The natural place for these to be discussed is at the NRCC meetings.
- The full process, from time of data collection through implementation, needs to be shortened. The assessment part is a minor part of the full process.
- One of the biggest potentials for improvement in the stock assessment likely relates to improving the quality of the fishery-dependent information. The current system of data-collection is largely ad-hoc (refer to the 2013 program review), which can result in variable bias of unknown magnitude.

Stock Assessment Science Program Review- Northeast Fisheries Science Center, 2014

Reviewer: 1

May 22, 2014

Background and General Comments

The NEFSC conducts stock assessments under numerous FMPs for two regional fishery management councils and a fishery commission. There are numerous challenges with respect to dealing with the complexities that result from the number of FMPs, organizations, data availability and timing, and the peer review process. The NEFSC has talented, dedicated stock assessment scientists and also long time series of information to use to inform stock assessments. Last year's program review was on the fishery dependent and independent data components that feed into stock assessment. Acting on the recommendations from that review is essential for improving the stock assessment enterprise. Some of those recommendations may get repeated below to emphasize those that are seen as bottlenecks or key to the process. Additional challenges involve the high scrutiny placed on stocks with poor status that may constrain fishing opportunities.

Reviewers were asked to organize comments according to eight themes that define the stock assessment program and provide advice to the Center on the direction and quality of the stock assessment science program and suggest areas of improvement.

THEME 1: Does the Center apply a suitable scientific/technical approach to fishery stock assessment modeling?

The NEFSC employs a variety of modeling approaches ranging from age and length based approaches for more data rich stocks to index methods for more data poor stocks. There are 61 stocks and 63 models. The diversity of modeling approaches can be viewed as both as a strength and a weakness. Having models tailored for the stock's particular life history and fishery characteristics and type of data available is important. In addition, there are assessments that do incorporate ecosystem factors. There is more movement towards statistical based modeling approaches, which are more commonly used in West coast and Alaska fishery stock assessments. The case studies provided indicated appropriate model choice given data availability for particular stocks.

There are challenges involved in maintaining and improving individual models such as staff time available to develop and test new model features. Also, the NMFS Toolbox interface would need to be modified to accommodate the new model, if it was one in the Toolbox. The use of the Toolbox to easily make changes during review meetings was seen as a transparent, documentable way of showing changes and when changes were made, which may be important in the environment of NEFSC stock assessment. Center scientists are making contributions to improving the suite of modeling approaches that go into the National Stock Assessment Toolbox.

It does appear that integrated modeling packages such as SS3 have been considered for stock assessments and one assessment at NEFSC does rely on the SS3 framework. When given sufficient time to work on modeling improvements, it appears those do get accomplished. The appropriateness of the analytical framework for assessments does appear to have been tested and show that they are using the appropriate

framework though there are indications that improvements are desired for many assessments. Not all improvements may be high priority, however, and that should be considered in this process. Using a model update only approach for some stocks could be an alternative to consider to help in stock assessment throughput.

THEME 2: Is the assessment process efficient, effective, and clearly described, including terms of reference for assessment reports?

The assessment process was described and was varied depending on the FMP and region. The process for developing TORs for the assessment reviews was described and seemed fraught with potential to add any number of items for consideration in the assessment, with varying priority among TORs. There was much discussion of the need to reduce TORs or to move some to a research only track and only brought forward when ready for inclusion. Also, the 2011 document on "A New Process for Assessment of Managed Fishery Resources off the Northeastern United States" was presented as a process that has been vetted through the NRCC as a way to deliver operational assessments, define a research track, and TORs for each of these along with defining responsibilities.

High priority should be placed on implementing the recommendations of this document. Some are being done but it appears that not all have been. In particular, using a common reporting format for assessments seems not to have been implemented. Presenting this document's recommendations again to the respective SSCs would be important. With respect to implementing the stock assessment format template, it seems that there was some desire for authors to use a common method such as Latek for inputting figures, etc. However, that should not be seen as a requirement for moving forward Some of the recommendations in the "New Process" document are even more important to implement, and involve the protocols for remand, re-examination, addressing error or new information into improved stock assessments, and developing a rational schedule for operational assessments. These will make significant progress in making the stock assessment process more efficient.

Stock assessment authors sometimes appear to be driven to try numerous modeling approaches to try to "fix" a problem that ultimately may not be solved through modeling but are rather an indication that there is incomplete knowledge of a process or inadequate data. Although stock assessment scientists are being responsive to demands being placed on them in this regard, there needs to be a process for identifying when modeling is not the answer to the assessment problem and ability to move those issues to the research track and brought back when sufficiently mature for consideration. It should be recognized that not every assessment needs to be brought up to the highest tier. The NMFS survey prioritization tool that will be employed regionally should be helpful in deciding where to allocate scarce assessment resources.

One very troubling aspect of the stock assessment process was the sheer amount of time and effort that assessment scientists must spend on processing the fishery dependent data. This is highly inefficient and is a definite bottleneck. Extremely high priority should be placed on making the recommended improvements to the timeliness and quality of fishery dependent data system from last year's fishery dependent and independent data review. The need for an integrated catch accounting system that is available in a centralized place is critical not only for timely fishery management but also for timely fish stock assessments. It should not be incumbent upon individual analysts to spend months vetting these data sources but should be a responsibility that GARFO and ASMFC should be working together to accomplish. Fishery dependent data systems in other regions should be examined to see if there are ways

to implement an integrated system as quickly and efficiently as possible even in the light of changing management, which is a given in fisheries management. The NMFS Alaska Region has an efficient system and also a method for estimating rates spatially (Catch in Areas Database). There may also be ways to improve the timeliness of fishery dependent data used in stock assessments by methods for estimating the remainder of the year catch instead of waiting for the full year of terminal catch to be available. If there are ways to deal with some cross cutting TORs by one person such as doing survey data updates, bycatch estimation, that should be considered. Ways to incorporate the most recent data, not just fishery dependent data, should be considered.

THEME 3: Does the Center, in conjunction with other entities such as the Council's Scientific and Statistical Committees, have an adequate peer review process?

The peer review process is adequate but there are many complexities introduced because of the lengthy timing of the SAW/SARC process, the different reviewers involved in the review of a particular assessment across time in the SAW/SARC, the two different SSCs with different control rules and criteria for acceptance of assessments. Consideration should be given to having some stability in at least one of the SAW/SARC reviewers from one benchmark assessment to the next, although the practice of having an SSC member chair the SAW/SARC may also help with that process. Revising TORs of the contract to the CIE for obtaining reviewers may be needed. It should be (and perhaps already is recognized to be) incumbent on the SSC chair to ensure there is good communication of the results and recommendations from the previous SAW/SARC and keeping reviewers on track with considering the primary TORs and what is needed for ABC/OFL setting. Upon completion of the SAW/SARC process, the SSC can play a role in helping advise stock assessment scientists on the importance of dealing with research recommendations that come out of the SAW/SARC and what may or may not be valuable to address in the next SAW/SARC or sent on to the research track. Those recommendations should similarly be reviewed and discussed within the NEFSC and communications back to the SSC should be made to alert them and the Council about what can realistically be dealt with given the data or resource availability. The research track would be the best place to deal with vetting outside ideas for stock assessment improvement that come from industry consultants and other entities. These should not be dealt with during the ABC/OFL setting process.

It appears that there may be scheduling problems with getting SSC review of numerous annual updates. Perhaps an SSC member from the NEFMC and MAFMC can attend other region's SSC meetings such as NPFMC (December SSC meeting) to see how the annual updates can be reviewed and received. Operationally, consolidating some FMPs for species with similar fishing years could help in reducing complexity and make the process more efficient. Definition of a benchmark assessment requiring SAW/SARC review seems to be very strict and consideration should be given to whether the SAW/SARC process should be used more for strategic review of the assessment models, data inputs, and research enterprise supporting these outside of the annual ABC/OFL setting process.

THEME 4: Does the Center work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessment according to a set of priorities? Considerations should include program structure, staffing, funding, and the stock assessment prioritization process.

The NRCC process seems to be useful for discussing timing conflicts and working out priorities between regions. Although the Councils think the current peer review process is rigorous and desirable, there is also conflict between that goal and the ability to schedule the SAW/SARC and SSC reviews in a fashion that meets all the goals for desired timeliness for ABC/OFL setting. Ultimately, it appears the GARFO regulatory deadlines are also a large driver in terms of the scheduling and also add a significant amount of time at the end of the review process to account for time needed to get the recommendations implemented. This is puzzling given the ability of AKRO to implement catch recommendations so much more quickly.

Councils feel that the NEFSC is responsive to their needs given the constraints of staffing and scheduling. There seems to be support across all the entities for the idea of doing operational updates and streamlining the data update process to free up time for improving key assessments. This needs to be implemented. There is also some indication that staff time may be taken up with a large number of the science review meetings and consideration should be given to assignments for staff to reduce back to back assessments and who needs to attend various review meetings. Trying to ensure staff have time after the completion of a SAW/SARC to work on finalizing reports and publishing results should be considered to the extent possible. Can non-stock assessment personnel participate in PDTs and free up stock assessment scientist time? NEFSC research can be brought to bear to assist in necessary Council analyses but it may not be necessary for the stock assessment scientist to sit on the PDT or actually write the analytical document. Depending on the analysis, Council or Regional office staff should have the lead. It isn't clear how many stock assessment scientists are on each SAW working group and how many of these each stock assessment scientist participates in per year. Consideration could be given to reducing that load by including only the most necessary stock assessment scientist in each. Ways to reduce the allocation of stock assessment time to non essential tasks should part of the assessment bucks concept. This is not just a stock assessment branch issue but one that NEFSC, GARFO, and the Councils should consider in their priorities and assignments for accomplishing priorities.

THEME 5: Does the Center achieve adequate assessment accomplishments relative to mandates particularly with respect to the number of Fishery Management Plan species assessed?

The number of benchmark assessments has declined over time but the total of number of assessments has not. Timeliness of data in the stock assessment has already been mentioned previously and this is a feature of the fishery dependent data availability problem already discussed along with the schedule mandated by the peer review and GARFO process. Improvements in those processes are the most essential for getting the most timely data into stock assessments for ABC/OFL setting.

THEME 6: Does the Center have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

There are clear examples of the incorporation of ecosystem and climate change factors into the stock assessment process. The NEFSC has done a good job at working on this and is thinking at both the tactical and strategic levels of how to make this happen. Obviously, there is lots of discussion around the US and worldwide about the ways to incorporate multispecies and ecosystem models into the fishery management process. It appears that both Councils are thinking about this and there is good communication between ecosystem scientists and the stock assessment enterprise about ways to move forward.

The information shown on climate effects on changes in spatial distribution and overlap of species and biological parameters are important considerations for Councils and thinking strategically about fishery management adaptation under climate change.

THEME 7: Does the Center adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

The NEFSC puts out an impressive array of documents and communicates face-to-face through the public meetings set up for the formal SAW/SARC and SSC interactions surrounding the ABC/OFL setting process. The SAW/SARC process tends to be somewhat disjoint because the CIE experts come and go and may make recommendations that are more in line with practices in other countries. Efforts should continue to communicate which TORs are important, provide each SAW/SARC panel with sufficient history of the previous peer review, what was worked on and what was not worked on and why (i.e., low priority or inadequate data, etc.) to give context to these independent but perhaps naïve in the US ACL setting process reviewers of what is trying to be accomplished. Separating immediate TORs for ACL setting from medium term to longer term TORS for strategic improvement of the assessment should be part of the communication process, if it is not already done.

Having an SSC member chair the SAW/SARC process can help in this process but there may need to be more communication of NEFSC with the SSC outside of the immediate SAW/SARC process to arrive at a common understanding of the standards for accepting models and material that each SSC hopes to receive in order to make ABC/OFL determinations from the SAW/SARC advice. It is not clear if the SSCs or Councils on the east coast arrange for workshops with scientists to discuss how to move forward in these areas but that is a common practice in the Alaska region. The SSC in that region looks to the Science Center to help advance the science and propose potential scientific avenues to move forward in areas needing attention such as stock structure, dealing with recruitment, etc. These are done in the form of both workshops and working groups that advance white papers for SSC discussion. It appears on the east coast that the SSCs do more of the initiating of working groups and white papers but involving center scientists in these interactions and working groups would be most helpful to make sure that there is a common understanding of the science issues and ability to advance them to meet Council needs.

It is important for NEFSC stock assessment scientists to participate in regional, national, and international working groups to communicate and advance stock assessment science. It appears there is participation of NEFSC staff in these areas. Stock assessment scientists also need to communicate their science advancements through the peer reviewed literature and it isn't clear how much that has been happening recently.

THEME 8: Are there opportunities for improving stock assessments and the stock assessment process?

There are always needs for improving stock assessments through improvements in the data inputs and in the models based on changing inputs and understanding of the processes influencing stock dynamics. The challenge is to identify the highest priority improvements and the resources to complete those. It is clear that improvements in the fishery dependent data stream need to be made and have already been commented earlier in this document. There are also research issues that could be dealt with by NEFSC survey and gear scientists, such as those dealing with catchability. Obtaining estimates of catchability

may be very useful for stocks where there is uncertainty about both catchability and natural mortality. Field studies to estimate catchability are more tractable than those to estimate natural mortality. It isn't clear what the process is for communicating and prioritizing research to improve stock assessments within the Center but the new science planning process should further facilitate that. AFSC scientists currently identify cross cutting research issues and jointly work on research activity plans that can address those. A recent example is an identified need to improve the research on fish maturity, which has been an ad hoc area of research improvement in Alaska until now. AFSC scientists held a workshop that involved stock assessment scientists needing the information, and survey and observer program personnel who would obtain and process samples. They are in the process of identifying current resources available to accomplish what they view are the highest priority items and also what additional resources are needed. This will go into the AFSC's science planning process for the next year to see if there are additional resources to accomplish this. Like most other centers, however, the AFSC will likely need to find additional resources through preparing proposals to compete for funds through regional or national RFPs. But it will be well positioned to do so because there has been a collaborative effort among stock assessment scientists and other research programs at the center.

Other research efforts may take the form of identifying modeling strategies or approaches for catch advice. These have been well articulated at this program review and the NEFSC appears to be making progress on many of these issues, such as incorporating climate and ecosystem factors into individual assessments and working on multispecies and ecosystem approaches. The management systems in the NEFMC and MAFMC areas are evolving and the science is evolving with it. The challenges will be communicating the highest priority issues to deal with and making the resources and institutional linkages necessary to implement those. As mentioned throughout this report, many of those issues are outside the control of the NEFSC. GARFO, NEFMC, MAFMC, and ASMFC should be working together with the NEFSC to solve those problems.

NOAA Fisheries Science Centre Stock Assessment Science Program Reviews

NEFSC fishery stock assessment programme

Review Report- 2 30 May 2014

This report reflects the personal views of the author, and was written independent of the other panel members. It leads with text describing the general impression and then reflects on the 8 terms of reference specific to the NEFSC review and finishes with personal recommendations. It will undoubtedly contain errors with regards to the scientific and management structures as a result of the complexity in the system and ignorance of the reviewer.

The review is written under the assumption that best practice for the provision of fisheries scientific advice is through a participatory process that is transparent, accountable and based on the best available science at the time; and that it is communicated in an effective manner. This assumption is not dissimilar to the objectives of NS2. Stock assessments are a tool for the provision of fisheries management advice. The stock assessment must be fit for purpose.

The preparation and cooperation by the NEFSC staff for the review was greatly appreciated.

General Impressions

The NEFSC was and still is one of the preeminent operational stock assessment centres in the world. While focus is often drawn to the troublesome New England groundfish assessment and management challenges, the large majority of the stock assessments carried out by the centre provide the effective evidence base for fisheries management advice across the region (invertebrates, pelagic and coastal fish, Mid-Atlantic fisheries). The researchers at NESFC work extremely hard and experience a very high work load. The review highlighted a need to reduce the operational “crank-the –handle” work carried out by the staff to allow the development of approaches to resolve current and future challenges to fisheries management in the North East Atlantic region. This was termed “research track” by the centre management. The research track or development work is crucially needed to enable innovative and responsive solutions to be found for assessment and management problems.

The centre is wonderfully rich in data. This is a huge resource. The data led approach however seeps into the approaches used by the stock assessors. The precision of the assessments, or uncertainty in the advice is provided based on uncertainty from data or model fits. Reduced attention appears to be given to uncertainty in structural knowledge, or stock assessment model assumptions. Science is about increasing knowledge through the testing of ideas against the evidence. The evidence in this case is the data. I feel that the centre needs to give increased attention to the development of ideas. For this, the researchers need space to think (including space to read and write). This search for the best fit to the data, contrasting to the best provision of knowledge to the management issue leads to the “best fit” approach to stock assessments. Globally the “best fit” approach is being challenged, often because it

fails to explore uncertainty due to model assumptions. The recent World Conference on Stock Assessment Methods and Deroba et al (in press)[1] highlight the issues. The researchers at the centre should be aware of the limitations of the "best fit" approach. The NOAA Fisheries toolbox provides many advantages but also creates some limitations. It leads the user into a data-led approach to management challenges, rather than a conceptual one.

Many of the strains in the NEFSC stock assessment system appear to be due to the demands of the regulatory management system and the peer review process. Much of these appear to be the product of regional norms rather than national requirements. To an outsider, and despite the work of the NRCC, there appears little prioritisation of stock assessment or research needs. At the current programme review, the regional Fisheries Management Councils and Commission stated that they wanted more assessments, more often and delivered quicker. When questioned, they described a system of competition for NEFSC resources and research which made prioritisation difficult. This high demand from the fisheries management system needs to be addressed as it appears non-sustainable. The demand from the management side, made me question the lack of management strategy evaluation (MSE)[2] used by the group at NESFC. I understand the concern expressed by NEFSC researchers that some forms of MSE could blur the boundaries between the provision of scientific evidence for decision making and entering the environment of making policy decisions. However experience from Australia, South Africa, the International Whaling Commission and Europe shows that when handled carefully MSE provides powerful and robust tools for exploring research and exploitation challenges and provides a mechanism for the development of participatory processes with partners and stakeholders. Many of the management challenges and suggested changes to the stock assessments could be explored using MSE. These MSEs could occur prior to the investment of resources or to test the likely effectiveness of proposed adaptions or management actions. MSE should be used to engage with stakeholders and partners to explore potential management options, and likely consequences of scientific developments.

The effort to populate and maintain the fisheries management plans (FMP) is huge. I could not see the rationale for the number of FMP in the NEFMC area as the system was currently constructed. There are contradictions across the plans (see figure). The NEFMC concept of a fisheries management plan was slightly alien to me. My lived experience is that many of the problems in mixed- groundfish fisheries cannot be solved with single species approaches. Thus I would expect FMPs to be fleet oriented and relate to the organisms that these fleets catch or impact, rather than be a collection of single species targets within a management area. This later approach works well when fisheries target and catch single species in an area, but not when the fisheries catch are mixed. I know that the FMP are legal agreements, but the definition of FMP in the Magnuson-Stevens Act and NS1 appears to allow for fleet based approaches.

Publishing scientific developments and results is a crucial part of a stock assessors work. Apart from the standard reporting, this is best done through peer review publications. The process of publishing in the

[1] *Deroba et al. in press. Simulation testing the robustness of stock assessment models to error: some results from the ICES Strategic Initiative on Stock Assessment Methods. ICES Journal of Marine Science doi:10.1093/icesjms/fst237*

[2] *Or in a broader sense managent proceedure evaluations*

primary literature ensures that the researchers are up to date with global methods and it provides extra scrutiny to the methods developed and conclusions reached (extra peer review). Whilst the current system requires traceable and auditable stock assessments, I doubt that the provision of large stock assessment documents with varying structure is the best use of stock assessors' time. I know that the NEFSC strategic plan has proposed approaches to resolve the challenge. Preparation for the extensive peer review process takes a large commitment by NEFSC researchers.

Conflicts in NEFMC FMP. (Slide 11 from Gaichas et al presentation, 22 May 2014).

The NEFSC, NEFMC, MAFMC, ASMFC and GARFO need to develop mechanisms to engage and utilise any proposed alternative approaches to the stock assessments, i.e. approaches coming from outside NEFSC. A suggested mechanism should be participatory and not confrontational. The work load of the centre researchers is high, so I would encourage further partnerships with academics and other researchers to solve stock assessment challenges.

With regards to the ecosystem approach to fisheries management, the initial steps taken by NEFSC are encouraging. I welcomed the acceptance that incorporation of ecosystem considerations is currently most appropriate for strategic advice, rather than operational annual advice (called tactical by some at the centre). Limit reference points should reflect the reality of the ecosystem dynamics[3]. The stock assessors should accept that data sources come with varying precision. This varying precision does not negate the usefulness of the information, but may require the development of new techniques. The aim of including greater ecosystem knowledge should not just be the improvement of fisheries management advice, but also the increasing the robustness of the model assumptions. Including knowledge for knowledge sake is not appropriate, but a model that successfully uses process information to determine growth or condition in a time series would be more robust for projections into unknown space (temporal or spatial) that projecting recent empirical findings. The SARC system needs to find approaches that can allow greater cross-disciplinary review of ecosystem considerations.

[3] *I welcome the 2013 report "Evaluating the Effectiveness of Fish Stock Rebuilding Plans in the United States"*

The political solution of the TRAC for Georges Bank cod and haddock appeared difficult to justify in terms of fisheries science (use of different methods in a subset of the area).

For future research needs and developments, I would have liked to have seen an NEFSC roadmap with proposed timelines for the delivery of new products, including the streamlining of data delivery, the incorporation of ecosystem approaches and the delivery of the 2011 new process for the assessment of managed fishery resources in the north east Atlantic region.

Terms of Reference

1) Does the Centre apply a suitable scientific/technical approach to fishery stock assessment modelling?

The centre uses a range of approaches, most crafted to the specific data set concerned. Most stock assessments function well as advisory tools. The centre should consider other length based, ecosystem based and data poor approaches within its tool box. The centre needs to find a mechanism to incorporate alternative assumptions into their modelling approaches.

2) Is the assessment process efficient, effective and clearly described, including terms of reference for assessment reports?

The process is over engineered, not efficient, but this is not necessarily within the control of the NEFSC.

3) Does the Centre, in conjunction with other entities such as the Councils' Scientific and Statistical Committees, have an adequate peer review process?

Generally the peer review process is extremely robust and perhaps overly burdensome. Improved peer review of innovations on climate change, spatial approach and incorporation of ecosystem dynamics needs to be addressed in the future. The current system is creating a "snowball" effect caused by researchers responding to reviewers concerns made at each review iteration.

4) Does the Centre work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessments according to a set of priorities? Considerations should include program structure, staffing, funding, and the stock assessment prioritization process.

There was little evidence that the NRCC has led to effective prioritisation. Within NEFSC there also appeared to be little structured prioritisation other than day to day needs. It was pointed out that a large proportion of NEFSC researchers time was spent dealing with "non-standard" Council or Commission requests.

5) Does the Centre achieve adequate assessment accomplishments relative to mandates particularly with respect to the number of Fishery Management Plan (FMP) species assessed?

I am unclear about the meaning of this ToR.

6) Does the Centre have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

A process is developing, and examples were shown. The lack of a committed budget line to ecosystem monitoring and development of the ecosystem approach is a challenge. Considering that this is seen as a policy priority, this lack of budgetary commitment should be seen as a major concern. The population

dynamics group and the ecosystem assessment must further integrate to allow more spatial tools to be developed and for the groups to catalyse each other.

7) Does the Centre adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

Engagement with managers, policy developers and stakeholder appears multi-layered. It appears to be based on the objective of transparent communication of decisions and process rather than a participatory dialogue. The best engagement is a dialogue based around a participatory process rather than a "communication" of results. In a participatory and transparent process, the engagement should be equitable. This requires stakeholders and researchers to work together on challenges. Clearly pre-define responsibilities prevent any blurring of the role of the provision of scientific knowledge and the roles of deciding or lobbying for specific management objectives.

8) Are there opportunities for improving stock assessments and the stock assessment process?

The system needs to keep its legitimacy and yet needs to be radically streamlined. Researchers need some space to explore ideas. The centre should increase the use of MSE as a tool for investigating management approaches, resourcing of scientific priorities and building dialogue with partners and stakeholders. The NEFSC should consider approaches for multi-model inference.

Recommendations

NEFSC leadership should:

- Create an NEFSC roadmap with proposed timelines for the integration of new methods and delivery of products, including the streamlining of data delivery, the incorporation of ecosystem approaches and the delivery of the 2011 process for the assessment of managed fishery resources.
- Challenge the existing over-burdensome peer review process, and management system.
- Challenge the NRCC to prioritise stock assessment and research and development needs.
- Implement the research track including the creation of space for conceptual development and mentoring for publishing in the peer reviewed literature.
- Encourage the Population Dynamics group to further think outside the single species box (e.g. fleet based approaches, spatial dynamics of fish populations, MSEs and exploration of management objectives for regional fisheries).
- Review whether the "best fit" approach to the provision of fisheries advice is most appropriate, being aware of the regulatory implications of such a review.
- Develop further mechanisms to increase operational interaction between the Ecosystem Assessments and Population Dynamics groups in NEFSC.
- Consider the operational and conceptual impact of the stock assessment tool box, suggest creating a new entrance page and including more approaches in the suite of models.

Reviewer report 3

1 Introduction

The meeting was provided with extensive documentation as well as presentations from scientists, NEFSC management and Council/Commission views. The structure and presentations were excellent but the complexity of the overall process of proving and implementing management advice implies that a one-week meeting is somewhat short for an extensive review.

This reviewer's report is split into a few sections, followed by a short summary, which links conclusions to the terms of reference.

There is some room for improvement on several fronts, and some of these can lead to a reduction in total processing times. It must be emphasized, however, that these improvements will generally not drastically change the total amount of time from data collection through implementation of the management decision: The total amount of time is to a very large extent determined by meetings which are neither determined by nor limited by Center staff time.

As a general comment, the overall performance of the Center seems to be very good, but the friction between the different partners/stakeholders makes the general environment very difficult. This is not unusual around the world, but the interactions are particularly complex here.

2 Assessment Process, Tasks and Timeliness

When any advisory process and implementation is considered as a whole, this naturally includes the analyses of data, developments or modifications of assessment models, running the models, writing reports and paper, presentations in-house and work at workshops, followed by political negotiations and eventual implementation. Different parts of this process vary in importance and duration on a case-by-case basis.

At the NEFSC the assessment scientists also have a suite of responsibilities, which range from attending SARC/SSC to PDT and SC meetings as well as other review meetings. These are all a part of the process from data through assessments to implementation.

In addition to the assessment process, again in an international context, “other work” is given to assessment scientists and there is considerable variation in how much this is.

In the assessment process under consideration here, the entire process is unusually complex and the resulting path from data to implementation is very long indeed. Parts of

the process can probably be shortened. For example, under Data Handling below, some possible methods are mentioned which might shorten the data processing steps and under Alternative Harvest Rules, some methods are discussed which might possibly alleviate some of the assessment issues. Unfortunately, this is not likely to have a major effect on the length of the process as a whole: The real bottleneck on time does not seem to be within the NEFSC but in the following regulatory/review/implementation process which takes much longer than the time from data becoming available through the assessment becoming available.

On timeliness, the panel was presented with the following example:

> ... catch data from 2013 that become available in May 2014 would be analyzed and reviewed at a November 2014 SARC, reviewed by the SSC in January 2015, considered by the Plan Development Team (PDT) and Council Committees throughout 2015 with Acceptable Biological Catch (ABCs) to be implemented by GARFO at the start of the 2016 fishing year in May 2016.

In this example, the December 2013 catch data has been through the complete assessment process by January 2015, i.e. in just over 12 months. This is long, but the remaining political process adds another 16 months to this and it is therefore important to consider the data-assessment-implementation process as a whole.

The general issue of timeliness is important: Having a long time period from an assessment to implementation has various implications, which can be very serious in certain scenarios. To mention an extreme case, consider a harvest control rule, which sets a quota as a proportion of a survey abundance index. In this case, there is no reason for lengthy annual discussions on methods: Upon completion of the survey, everything follows from a given method of computation. If the stock is likely to be in a poor state, then it would in most places be considered unacceptable to wait for two years for a decision: There would already be 2-3 new measurements of stock size before the fishery started and these could easily demonstrate that the stock was in better or worse shape than predicted. This also applies in the more complex cases of using an assessment, and even though completing and reviewing an assessment does take somewhat longer than just computing a simple index, it does not add years on top.

3 Development of Assessment Methods and the Fisheries Toolbox

For assessments to be reliable, correct and satisfy modern standards, the assessment scientist need to be up to date on recent research and ideally to be researchers, directly involved in model development or developers of surveys, sampling schemes etc. It is therefore crucial for any research center that their scientists are also active researchers.

The NOAA Fisheries Toolbox has many similarities to work in other locations. For comparisons, another toolbox will be mentioned here: GADGET (Globally applicable

Area-Disaggregated General Ecosystem Toolbox, at http://www.hafro.is/gadget/), which is open-source and written with a similar purpose in mind.

The Fisheries Toolbox has several important design features, such as disentangling model runs from the graphical user interface (GUI). This was also done in the case of GADGET (based on experience from previous attempts).

The development of a GUI as a part of an assessment toolbox is a somewhat contentious issue in the first place. On the one hand GUI development requires enormous resources, which might potentially be used on improving models, but on the other, the GUI facilitates teaching and presentation in a working group meeting. In this particular case, the GUI has clear benefits in terms of how it can be (and is) used within the advisory process, e.g. to immediately evaluate the effects of minor changes in assessment assumptions. Unfortunately one of the obvious drawbacks to the Fisheries Toolbox is the internal programming language used for the GUI, since Visual Basic is really quite outdated and non-portable.

Hopefully the more general and multi-platform R can be used more in the Fishery Toolbox in the future, moving away from difficulties in using specific features of specific versions of specific operating systems, and this is clearly the desire of many Center staff. This will also make it much easier for individual staff to add new features to the system, e.g. in the form of new plotting routines or diagnostics.

The approach taken here is thus in many ways the same as has been taken e.g. in some European projects (with GADGET used in several of those), which takes all data from files and outputs all results to files. As with the Center, developmental add-ons are underway to provide R commands for plots and controlling GADGET assessment runs.

The Center appears to have been quite heavily involved in the development of the Toolbox. This development, along with the use of the Toolbox constitutes an important assessment accomplishment.

The Toolbox includes stock synthesis, which is one of the most elaborate statistical single-stock assessment tools on the planet (not developed at the Center).

The Center has developed several assessment methods well beyond the basic "canned" methods provided by commonly available tools. As always, such developments range from the use of a regression covariate through an entire new assessment method, such as length-based scallop assessment method.

An alternative approach, which is also used at the Center, is to have a basic tool, which can fit a range of models of varying complexity to any number of data sources. The approach implies that one can start with simple models and add complexity or data as needed for a particular stock, at each stage verifying fits and the need for complexity (at

least in principle). This can be done using tools such as ASAP[4], generic ADMB[5] and GADGET and Stock Synthesis (SS)[6], but the extensibility of these varies quite a bit, some of them permitting specific extensions and others being completely open-ended. Notably, a staff member is one of two authors on the ASAP assessment methodology.

4 Data Handling

The Center collects, receives and uses data from a wide variety of sources. The incoming annual data need to be verified and appropriately processed for storage in relevant databases. It is important that these databases are appropriately designed and the preprocessing of the data be made as automatic as possible. These issues have been addressed by all fisheries centers around the world but not always very successfully.

Usually raw data are stored in the institutional database and any processing normally takes place outside those databases. It has been found extremely useful in some cases to implement "back-ends" which automatically extract and preprocess all data to be used in single- and multi-species assessments into a new "summary database", which is "mildly aggregated", only to the finest level of aggregation which will be used for any of the tools. If this is done carefully, then this is the step when all error-handling and filtering is done.

The next step in data handling includes aggregation to appropriate regions and time steps, as well as any kind of imputation or prorating or "borrowing" data from adjacent time cells or spatial cells. This step can be completely automated and be based only on metadata files, which describe the aggregation mechanisms from the summary database, as required for a particular assessment.

When this approach is taken one sees immediate benefits in terms of time spent by the users, particularly for new users who are given ready-made extraction scripts which completely automatically generate syntactically correct input files for the assessment programs.

Another virtue of going through formal and automated database schemes is that they can be formally tested using bootstrapping or similar methods. In at least one case this has been use to test the entire process from database of raw data through the assessment and reference points. In that example no difference was found between the automated methods and the nitty-gritty manual means of scrutinizing every data value and choices of how to combine age-length keys etc. Obviously such individual results may not carry over to other cases.

[4] http://nft.nefsc.noaa.gov/ASAP.html or Legault and Restrepo (1998).
[5] http://admb-project.org/
[6] http://nft.nefsc.noaa.gov/Stock_Synthesis_3.htm

Many of the data sets used in assessments are externally provided and the Center has limited control over their timeliness. The NRCC may want to consider whether they, as a body, can assist to influence such processes.

Within the Center there is some room for improvement on exactly the issue of data handling prior to assessments. Work on such improvements should of course be a continuous part of the Center, but a long-term strategy is needed on the data-flow, from data sources into the databases and onwards, possibly through an intermediate database, finally to input files for assessment routines.

5 Assessment Issues, Updates and Alternative Harvest Rules

The panel was presented with a number of assessments, assessment methods, issues and solutions. It is abundantly clear that the assessments overall are of a high standard and the data are usually both appropriate and appropriately used.

Pollock assessments are an example of a particularly difficult assessment. Problems with pollock assessments are known in other regions and probably pertain to the biology and behavior of the species rather than specific problems with pollock in this region. It is therefore unlikely that modifications to or further development of assessment methods will yield a grand truth on the state of the stock. It is more likely that basic research is needed for new biological information or completely new data sources. Alternatively, one might want to consider management strategies, which involve simpler quantities rather than uncertain assessments (unfortunately it is not obvious what quantities could be used in the case of pollock).

Georges Bank yellowtail flounder assessments were presented and discussed several times during the meeting. Like the pollock assessment, these are also very difficult and currently there is no obvious single answer to what the best stock estimate should be. Again, it is not obvious that putting tremendous effect into assessments alone will give the results needed for traditional assessments to become an acceptable and reliable basis for management.

However, the 25% rule based on indices and catch is an example of a harvest control rule (HCR), which gets around the assessment issues. This is an excellent example of how one might proceed to alleviate a whole suite of problems (subject to appropriate tests).

Testing such rules is basically a management strategy evaluation (MSE), which is often a very useful method to move away from a stalemate in an assessment-implementation scenario. An MSE approach is always tailored to a specific situation and is one way to bring all the partners to the table.

The EGB cod and EGB haddock components appear to be assessed and managed somewhat inconsistently from the corresponding complete stocks and the TRAC-

derived allowable catches are simply subtracted from the total. There is a lot to be said for consistency.

Moving some assessments to "updates" is clearly a step forward in terms of reducing workload on the assessment team, and gives staff more time to focus on stocks where it is important to do more comprehensive assessments.

6 Process for Setting Priorities on Research Questions:

It seems to this reviewer that it is important to funnel as many *ad hoc* requests, pressures or other outside research requests into a formal scheme, to move towards longer-term research objectives instead of treadmill-style assessments with the same main issues recurring year after year.

SARC may recommend research but there is no obvious procedure for taking these into action. This contrasts ICES WGs which can e.g. send research questions, in the form of proposed terms of reference, up through the system, which might then set up new working groups on the topic. Councils do have research set-aside programs, but not such a formal channel. The center has internal procedures for multi-year strategic research planning and of course handles internal research proposals, but there is no formal procedure for including recommendations from the assessment process. Some sort of formal channel for setting research priorities based on recommendations coming out of the assessment process should be useful input for the NEFSC.

NRCC appears to be the obvious place to set priorities. Although it may be difficult since the NEFMC, ASMFC, and MAFMC compete for the “resources” of the NEFSC, that very fact also makes the NRCC the most appropriate place to figure out these priorities.

7 Transparency, communication and CIE Reviews

The Center has quite an amazing number of communication and educational roles, many of which were presented to the panel.

The entire assessment process is very transparent and there are no obvious problems in this regard.

The one exception to transparency seems to be that the SARC has a closed-door discussion session at the end of each meeting. This is a subject of some controversy and there have been calls for opening this session. Interestingly there (a) seems to be little reason for having this writing session closed and (b) there would be little benefit to transparency to opening it. Opening the session should be considered, if only to make the entire process transparent.

The CIE reviewers form an important part of the full assessment-regulatory process, but

there are several difficulties associated with having independent reviews. If all reviewers are to be independent of each other and of the institutes involved then there are obvious potential problems of stability: Sequential SARC/CIE review panels can potentially reach opposing conclusions, e.g. on whether to accept or reject assessments. Put bluntly, the selection of CIE reviewers may affect the conclusion.

The principle of having independent reviews is quite important and it avoids historical (and international) problems of a lock-in on procedures, which eventually become outdated. So care needs to be taken to maintain the independence (not to drop the "I" in "CIE").

There is always room for improvement, however, and one may think of many ways to modify the CIE involvement. For example, the above stability issues may be an indication that the ToR for SARC/CIE panels need to be sharpened, or specifying that at least one member (or an SSC chair) should continue to sit on consecutive review panels.

The SAW-SARC-SSC part of the process takes considerable time and the Center has certainly tried many approaches to limit this. One may want to consider limiting CIE involvement further, e.g. to only extensive strategic reviews. Changes such as modifications to selection patterns or natural mortality currently go through the review process, but one might argue that if a SARC with CIE input provides longer term strategic input, then that would include directions on what should be tested (i.e. a research direction), which then results in assessment method development which get implemented, used and further developed until a new review with CIE involvement takes place.

To this reviewer it does not seem particularly useful to get an outside review in order to modify a selection pattern. Such changes should be data driven.

Finally on the topic of communication, several projects around the world have placed an emphasis on developing management regimes from scratch in a cooperative manner. These approaches may not be led by management agencies. In extreme cases management regimes have only social input and no biological feedback. This contrasts other approaches, which may be completely dominated by biologists and modelers and/or political inputs.

These recent developments include implementations of management schemes in Australian waters, which have taken a multitude of different objectives into account, through current European research projects on co-creating management systems and decision support frameworks[7]. By including all interested parties in the creation of the entire system, the hope is that the usual antagonism will be less than that observed in systems which are mandated completed top-down.

[7] MareFrame: http://www.mareframe-fp7.org/

These bottom-up approaches are no panacea and may be impossible to implement within a given legal framework, but as a long-term project it is almost certain that getting the partners around one table to discuss the entire process is beneficial in terms of reducing friction.

8 Human Resources and Funding

The various assessments and data handling are of the sort of quality expected from an institute with a good international reputation, done by a correspondingly qualified staff.

The Center is, however, extremely stretched on staff resources. This has a number of implications. In the short-term, there are potential implications in how it may not be possible to include a variety of potential improvements in an assessment. This becomes much more of an issue in the longer-term, however, since stretching the human resources will can easily lead to a brain-drain and steadily declining quality of assessments. It is imperative that the staff be given the opportunities to conduct research on assessment methods, including studies of alternative methods, development of new ones and

The panel was informed that 10-15% of the Center's funding was from competitive research funds. Although this might potentially be increased, it is not a likely source for major increase given that the Center can not receive NSF grants. These external schemes have funded some very important research projects including the HABCAM development.

Assuming that there are no immediate new sources for funding, the question remains as to how to best use the available human resources. The Center presented approaches, which had been or could be taken for improvement.

Although the focus above (and during the meeting) focused on the assessment-related issues and timing, it is important to note that various "additional requests" tax the human resources considerably. When staff time is considered, these additional requests also need to be accounted for.

As pointed out above, it is extremely important for assessment personnel to also be researchers, actively publishing research papers. The assessment scientists thus need to be given time for this purpose. This is not for academic reasons, but for personal development and simultaneously keeping assessment methods up-to-date. Most assessments automatically include some new development. Such developments must be evaluated for adequacy and their effects and these tests commonly lead to results, which can and should be published in scientific journals.

9 Ecosystem considerations

The ongoing work by the ecosystem group is very advanced and has already led to changes and new views in the assessment process, but it is “ongoing work”. With the current resources it will be difficult to extensively include ecosystem concerns into the assessment process. That may not be the most difficult part of including ecosystem effects, since the entire advisory process is very single-species oriented, including such concepts as biological reference points.

Some particular ecosystem/environmental effects have from time to time been included as extensions in single species assessments. These include the effects of consumption on prey mortality, the relationships between temperature, salinity or visibility and survey catchability and the effect on environment on the stock-recruitment relationship. Examples of each of these go back a few decades, and one can find examples not only of statistical significance but also of considerable importance in terms of effects on assessment results.

One fundamental problem with these analyses remains. In statistical circles this is called hunting for significance with a shotgun, i.e. searching through potential explanatory variables until something significant is found. This aspect is quite important due to the sheer number of potential environmental variables in any given case study. In the examples shown to the panel, this is unlikely to be an issue (the variables are well justified), but needs to be considered whenever stock assessment scientists are considering multiple environmental variables for inclusion into an assessment.

The use of an environmental/ecological variable to explain natural mortality (M) or catchability (q) implies the potential for disentangling the effects of M and q in the assessment. Normally these two quantities are completely confounded but the inclusion of explanatory variables might make it possible to estimate both. This is well established, when natural mortality is estimated through consumption and q is estimated freely, but the unusual potential here is to force q to have a link through an explanatory variable (thermal habitat change) and estimate M freely. As always, care is needed in how this is done and various criteria can be used to verify just what model is most appropriate.

Finally, the panel was presented with an operating model for simulating an ecosystem to test several simpler multi species approaches. The operating model will initially be Hydra, possibly followed by Atlantis. This is an example of state-of-the art research, which, if the assessment team is included, has tremendous potential in terms of moving assessment methods forward and towards ecosystem-based assessments.

The ecosystem operating model should in principle be able to test almost any of the assessment models used by the Center. As such it can become an extremely important research tool providing important feedback into the assessment process in the longer term. It is important to ensure that the operating model can output data, which can be automatically uploaded into the other models and in this context it should be useful to consider some of the database issues raised above.

10 Summary

The following section is a summary of the above, with recommendations arranged by term of reference.

Issues pertaining to ToR1 (appropriate models) are discussed above in sections 3 and 5. In short, the approach is suitable and the Center is involved in furthering these approaches to improve them. The main problem is one of allocation of resources to research on methods (including self-improvement).
Recommendations:

- Staff should be allocated time for research, publications and similar activities.

Issues pertaining to ToR2 (assessment process efficiency) are discussed above in section 2. In short, the full process is extremely long, but only a minor part of that is due to the time taken by the Center. There are a few potential areas where data handling or assessment time might possibly be reduced, but that would not have major impact on the total length of time to implementation, given the current process. The fact that up to over 2 years pass from data availability through implementation is really quite serious, but this can, apparently, only be drastically changed by shortening parts of the process over which the Center has no control. Modifications to the data handling schemes are likely to improve many aspects of the process however. Similarly, moving species to "update" status can have a considerable effect.
Recommendations:

- Generic methods of data handling across species, areas and data sources should be considered, with the aim of increasing automation, consistency and timeliness.
- Considerations of timeliness should consider the entire process from data collection through implementation.

Issues pertaining to ToR3 (peer review) are discussed above in section 7. In short, the review process appears quite adequate. Attempts to maintain stability or improve timeliness may well be needed but care must be taken that this is not done at the expense of the independence of the reviews.
Recommendations:

- Considerations should be given to either keep at least one CIE member at consecutive reviews, or have a chair from SSC.

Issues pertaining to ToR4 (efficiency and funding) are discussed above in section 8
Recommendations:

- The Center's population dynamics branch does seem to work very effectively
- Research priorities need to be set in a more structured manner.

Issues pertaining to ToR5 (assessment accomplishments) are discussed above in sections 2, 3, 6 and 8. In short, the Center has a fair list of assessment accomplishments, ranging from new methods of assessments (notable scallops) to moves to updates instead of extensive assessments in an attempt to improve

timeliness. Similarly, proposals to replace full-blown assessments on extremely difficult stocks by simpler harvest control rules are potentially major improvements, but of course they need to take appropriate input from stakeholders. To move further on the various issues, priorities need to be set as to where to put research effort.

Recommendations:

- The NRCC should consider research recommendations coming out of the assessment process and assign priorities, which the Center can subsequently use for guidance.

Issues pertaining to ToR6 (ecosystem and climate effects) are discussed above in section 9. In short, excellent work is being conducted on ecosystem models and several attempts have been made at including ecosystem/environmental considerations into single-species assessments.

Recommendations:

- The various processes of extending single species models to incorporate environmental/ecosystem effects should be continued.
- The process of setting up an ecosystem operating model should be a high priority within the ecosystem group.

Issues pertaining to ToR7 (stakeholder engagement and communication) are discussed above in section 7. In short, transparency is extremely important as are research publications. In a few other areas research has been conducted and even implementations exist, where bottom-up approaches have been used to redefine the entire fisheries management system. Whether the friction inherent between partners/stakeholders can be alleviated in the present setting using such bottom-up approaches is not clear, but there is enough at stake that this should be investigated.

Recommendations:

- Whenever possible the assessment process should be transparent, even including writing sessions if this leads to reduced tension.
- Developments of methods (assessments, surveys etc) can and should be published.
- Methods for "co-creating" management strategies should be investigated with the longer-term goal of reducing friction between the partners.

Issues pertaining to ToR8 (improving the assessment and the process) are discussed above in sections 2 and 5. Needless to say, any assessment procedure (or human-defined process) can be improved. One example of potential improvement is the 25% rule for yellowtail. A full study of such rules would constitute a Management Strategy Evaluation (MSE).

Recommendations (see also under ToR1):

- Priorities must be set on terms of reference and research proposals coming out of the assessment process. The natural place for these to be discussed is at the NRCC meetings.
- The full process, from time of data collection through implementation, needs to be shortened. The assessment part is a minor part of the full process.
- Simplifying methods such as the 25% rule for yellowtail should be extensively

studied and evaluated.

NOAA Northeast Fisheries Science Center (NEFSC)

Stock Assessment Science Program Review

Reviewer 4

Fisheries and Oceans Canada

The objective for this review was to examine and evaluate each Center's fishery stock assessment program that is conducted pursuant to the Magnuson-Stevens Act (2006) and comparable international agreements. Panel was provided with sufficient materials (document plus ppt presentations) to comment on 8 themes that define the stock assessment program.

Overview

Many of these ToRs are related and posed a problem in commenting on them separately. As a consequence there is some repetition, and several of my observations could easily fit under more than one ToR.

1. **Does the Center apply a suitable scientific/technical approach to fishery stock assessment modeling?**

- Observations: The Centre has a strong stock assessment modelling capacity and apply best scientific practices in modeling to achieve their goals.

- Strengths: 1) Many of the staff are internationally recognized from their publications and participation at Canadian, NAFO, NASCO and ICES fora, and demonstrate commitment to scientific integrity in their work; 2) There are long time series for annual multiple surveys and landings; competent aging and biological groups; and a good port and observer program; and 3) the use of NOAA Fisheries Toolbox programs is a mainstay to many of the current stock assessments.
- Challenges: 1) Data processing issues centered on the often late arrival of catch data from federal and coastal state fisheries which results in large and unacceptable lag times for completing the assessment process; 2) staff are severely burden by the number of stocks that have to be assessed annually and the frequency demanded by Councils and Commission, including too many Terms of References and ad hoc requests; and there is also very little time to investigate new assessment models or modelling approaches, e.g. SURBA, Stock Synthesis, etc., and little opportunities to work on improving existing models.

Recommendations to address the issue: 1) The Center should reinstate its Methods Working Group and expand it to include experts from the other groups in the Population Dynamics Group to discuss commonality in approaches to assessment modelling which could reduce individual

modeling workloads, e.g., projections methods. Here also staff would be discussing and sharing new innovations in current models and the results of investigations into new models e.g. SURBA and other similar survey based assessment models, and framework approaches such as integrated analysis (IA), e.g. stock synthesis, MULTIFAN-CL, etc.; 2) the Centre needs to find a mechanism to reduce the assessment workload of staff generated by Councils, Commission and the Centre; and 3) the Centre needs to refocus (>20%) staff time on increasing biological knowledge necessary for tackling critical research questions such as changes in M, catchability, movements of stocks, the retrospective patterns that are occurring in many stocks, and improvements to stock assessment approaches. Staff development should consist of training in new stock assessment methods, participation in international meetings and working groups such as ICES, NAFO and NASCO, etc. to keep abreast in new developments in data collection, surveys and modelling, and promotion of scientific writing for primary publications.

2. **Is the assessment process efficient, effective and clearly described, including terms of reference for assessment reports?**

- Observations: The current stock assessment cycle of fulfilling the need of the Councils and Commission, additional assessment demands following the SAW/SARC/SCC process and numerous ad hoc request from the regulatory bodies has resulted in no downtime. Time for current assessments are compromise to deal with many of these extra demands. More importantly, the stock assessment results to set ABCs may have catch data that can be up to 3 years old because of delays in data arrival and is unacceptable for giving management advice on current stock status and projections. The whole lengthy assessment process and the extended 2 tier review process of SARC and SSC, the Council/Commission process, the management plan formulation and the public comment process periods is too long and needs to be streamlined. All of this can undermine the quality of the science. No Panel member reported this happening in their respective countries.

- Strengths: The Centre produces high quality assessments, and the NOAA Toolbox plays a large role in delivering the assessment products. The staff try to balance their assessment workloads with additional major demands.

- Challenges: 1) the ever increasing work load of the Centre staff does not permit them time to deal assessment related issues such as catchability, dome-shaped and/or time-varying selectivity, M, stock productivity, and characterization uncertainty. Many of these are common problems across many species. Staff feel they are on a treadmill with no time to make improvements to the models or the science; and 2) sensitivity tests on various parameter estimations are carried out, but there minimal mention of risk analysis being performed so I am not fully aware of the extent of its usage.

Recommendations to address the issue: 1) investigate and institute a better delivery system for fishery dependent data collection and transfer using automation to minimize time lags in arrival

times at the Centre. Also the trip identifier issue needs to be resolved quickly. It was noted that ICES reduces the complexity of the science to meet delivery of data, analysis, and implementations within the same year; 2) The assessment process itself needs to be more streamlined to improve delivery. Chief among this is limiting the number of ToRs coming in from all levels of the assessment process. This should be undertaken by the NRCC who should screen and prioritize the ToR timelines.

3. **Does the Center, in conjunction with other entities such as the Councils' Scientific and Statistical Committees, have an adequate peer review process?**

- Observations: the peer review process is extensive and thorough with sufficient transparency, and takes into consideration qualifications of experts, balance of perspective, conflict of interest, and independence. This holds true for SAW/SARC, TRAC, operational and update assessments. The Centre does not seem to have established protocols for considering and including input from scientists not on the agency assessment team. The hiring of scientists by industry to conduct independent modelling is starting to become commonplace and the Centre has to develop these protocols.
- Strengths: the peer review process is extensive and thorough with sufficient transparency

- Challenges: Securing qualified experts for reviews both internally within the system and outside agencies such as CIE.

Recommendations to address the issue: 1) A further step to streamline the SAW/SARC assessment process timing is to eliminate one of the 2 peer review groups by merging responsibilities of the SSC into the SARC; and 2) operational assessment which involve the application of existing models with update data may be a quick answer to handle the increasing number of assessments per year efficiently, while reducing the overall process time especially the peer review process (only SSC involved). However it must be recognized that this approach would severely limited improvement to existing models or development of new models or assessment frameworks

4. **Does the Center work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessments according to a set of priorities? Considerations should include program structure, staffing, funding, and the stock assessment prioritization process? *AND* 5. Does the Center achieve adequate assessment accomplishments relative to mandates particularly with respect to the number of Fishery Management Plan (FMP) species assessed?**

- Observations: 1) The Centre is approaching the breaking point in exceeding intellectual capacity to carry out its mandate due to the increase analytical and review demands from GARFO, Councils, Commission, TRAC and headquarters. These demands are outstripping the resources of the Centre, and Centre management needs to make all internal and external partners aware of this situation; and 2) it was voiced that industry wants more benchmarks because they perceive benchmark assessments will lead to increase quotas so there is pressure to have more – this perception has to change.

- Strengths: Talented but overworked staff are able to meet most of the regional expectations in terms of quantity and quality in both data poor and full assessments.

- Challenges: Some protocols seem to exist within the stock assessment process to prioritize need, frequency and appropriate level of stock assessments but there does not seem to be one decision making body to govern the process.

Recommendations to address the issue: Apply a systematic approach for addressing problems in stock assessment process. There is a need to have one body set the priorities in frequency and time-lines for assessments (benchmark vs updates) using a defined set of criteria. In addition the huge demand for ad hoc requests from all players in the assessment process during the year also needs to be prioritize. That body should include the Centre and the Councils and Commission chairs and should be an extension of the duties of the NRCC.

6. Does the Center have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

- Observations: The Center does consider ecosystem and environmental factors affecting fish stocks and their assessments. There are some recent examples of using ecosystem data to improve assessment performance in yellowtail flounder, butterfish, and herring. In addition a collaborative multispecies assessment project between Centre ecosystem and assessment scientists for Georges Bank has just begun which could, at a later date, address stock spatial issues, migration/movement, and other technical aspects of the assessment.

- Strengths: 1) The Centre has an outstanding history of ecosystem monitoring, data collection, and research; and extensive food habits database in the Food Web Dynamics program. 2) Several scientist in these groups are both nationally and internationally known.

- Challenges: The integration of ecosystem information into stock assessment is complex and challenging. This process is being hampered by budget cuts to the ecosystem observation surveys and the overcapacity in stock assessment workload. Scrutiny of ecosystem results in the stock assessment by the peer-review process may be biased or glossed over due to inexperience of experts in this combine research field.

Recommendations to address. 1) at the bare minimum ecosystem funding should be stabilized or increased; and 2) more integration within the Centre of analytical stock assessment and ecosystem experts to address common approaches and methods.

7. Does the Center adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

- Observations: The Centre has an elaborated communication setup to effectively communicate results to clients and the general public

- Strengths: Talented staff with good resources; well organised process sanctioned by NRCC; Council members can attend assessment peer reviews (SARC and SSC)

- Challenges: there is problem how to deal with public perception of external comments on assessment results; in addition SSC reviews may conflict with assessment results and generate negative perception in assessment integrity.

Recommendations to address the issue: Members of NRCC should take an active role in increasing communication within the assessment process and outside to the general public. Centre staff should be given ample opportunities to publish results from stock assessment model development and critical research areas to enhance the scientific integrity of the Centre.

8. Are there opportunities for improving stock assessments and the stock assessment process?

- Observations: There are several research areas that need to be address such as calibration of survey catchability (fixing Q will improve estimation of M) and selectivity (dome shape or not) in survey and fishery data; investigating underlying causes of retrospective

patterns; incorporating environmental data into stock assessment and characterization of uncertainty.

- Strengths: talented staff that have the intellectual capacity to adapt to new challenges.

- Challenges: problems with cleanup and timely delivery of fishery dependent data; freeing up of staff time away from stock assessment workload to work on these neglected research areas.

Recommendations to address the issue: 1) The Centre needs to avail of (or obtain) expertise in gear technology to address issues of calibration and selectivity; 2) apply management strategy evaluation (MSE) to stock assessment issues such as retrospective problem and decisions on catch advice; and 3) use funding from the set aside (RSA) programs to tackle immediate, critical research issues such as an independent estimate of natural mortality, movement and stock size for Georges Bank yellowtail and cod; e.g. with a re-introduction of tagging programs.

NEFSC Program Review May 19-22, 2014

NOAA Northeast Fisheries Science Center 2014 Stock Assessment Science Program Review

Reviewer 5

Background

The National Marine Fisheries Service's Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts, conducted an external review from May 19 to 23, 2014, to examine and evaluate the NEFSC fishery stock assessment program. The focus was on the overall process including data preparation, assessment modeling, peer review process and communication. A review of the scientific data gathering and data management procedures related to fishery stock assessments conducted by the in the NEFSC was conducted in August 2013.

All background materials were provided to the Panel electronically through the Center (or Office of Science and Technology) website well in advance of the review. All presentations were provided to the Panel, through the website, at the beginning of the review. A booklet folder with copy of all presentations was provided to the Panel.

During informational presentations each day there were specific intervals included for public comment. Stakeholders were invited to participate as observers and to comment during the daily public comment sessions. At the close of the review, the Panel and Center Directorate met to discuss the results of the review in closed session.

Some general comments and impressions

The peer-review process was very well organized, with the only critique being some overlap between TORs which will be reflected in the comments to each TOR. The quality of the scientific background material and the presentations and the very professional organization of the review meeting show that NEFSC have a highly skilled, motivated, and dedicated scientific and technical staff. It is also apparent that the NEFSC staff has a very high workload, while still delivering high quality science. The Population Dynamics Branch conducts assessment of around 60 species caught in commercial and recreational fisheries which is an incredible achievement given the number of staff. The data preparation, analysis, and the comprehensive review process that is part of the assessment process, seems to be so demanding that NEFSC will not have sufficient time to develop and implement solutions to some of the challenges they have identified related to climate change and changes in the ecosystem. The overly complex review process leading up to the quota advice not only overburdens the assessment scientists, but also may add substantial error to the assessment process since the ABC and quota may in actuality be based on 2-year old scientific survey and catch monitoring data. The timing and also quality requirements for each stock assessment would ideally be prioritized to carve out more time for research and development. Improved allocation of NEFSC staff time between routine assessments and research for methods development has potential for substantial advancements in the scientific basis for the fisheries management advice. In particular, it is important that time be freed up to make capacity for the planned re-designing of the fishery-dependent data collection system, and for the development of assessment methods that better can account for factors related to climate and ecosystem changes. The NEFSC has tremendous data and expertise in food web modeling, and research teams that combines expertise in ecosystem modeling and assessment modeling (which requires that time be freed for assessment scientists to participate) could facilitate much greater contribution to stock assessments. Providing time for such cutting-edge modeling efforts can also aid in retaining key staff that might otherwise be lost due to burnout.

Comments on the 8 questions in the terms of reference

1) Does the Center apply a suitable scientific/technical approach to fishery stock assessment modeling?

The Northeast Fisheries Science Center (NEFSC) employs suitable peer-reviewed stock assessments models. Models included in the NOAA Fisheries Toolbox which are used for the

assessment of a majority of stocks are peer-reviewed and accepted in the scientific community. One advantage with the Toolbox as identified by the NEFSC staff is that it allows rapid update runs during the assessment process, for example in response to requests during the review-process. Also, it is easier for new staff to get up to speed with assessment modeling, especially since the format for input data is standardized. However, a downside of the GUI interface developed in Visual Basic is that it can be time-consuming to implement new models, or model updates, so the models actually used in the assessments may not be the best available in some cases. The frequent updates in the stock-synthesis model are an example where the current version in the Toolbox is not up-to-date. It is also well recognized by the NEFSC that the toolbox has limitations for incorporating ecosystem considerations in the stock assessment process. Also, it could be beneficial to expand the suite of statistical assessment models available through the Toolbox to include for example the ICES SAM model (Anders Nielsen, DTU Aqua) and other recent developments. I am confident that the very strong modelers at NEFSC would have developed more cutting-edge methods if they were provided time and resources. For example, the Toolbox currently available does not include any modeling tools that can account for multiple species interactions, and none of the models are spatially explicit. NEFSC has already developed several assessment modeling approaches in addition to the Toolbox to deal with stocks where the Toolbox models are not suitable. The Toolbox is not used or is not applicable for ca. 25% of stocks, including scallops. The scallop assessment for example is based on the CASA (Catch at Size Analysis) model, with overall biomass and recruitment information obtained from several surveys. More recently, the NEFSC scallop survey has evolved into a combined dredge and optical survey (HabCam) which provides abundance data of exceptional quality. The stock assessment for scallop is performing very well, and has allowed catch levels resulting in fishing mortality close to reference points.

According to the presentations and material provided for the review it appears that diagnostics of the model performance of at least the age-based assessment models focus on retrospective patterns. Diagnostics related to the quality of input data presented appeared to be limited, which makes it more difficult to assess the reasons for poor model performance. In some cases it seems like a fairly large effort is spent on trying fixing retrospective patterns, when perhaps the real problem is model assumptions or inadequate input data from the surveys and biological sampling of catches. For age-based assessments, tables of # aged fish per species were presented as an indication of the information available for estimating abundance indices or catch at age. It is recommended that NEFSC consider using some of the data quality diagnostic currently being developed in ICES (e.g., ICES WKPICS). Because of the multi-stage sampling, where primary sampling units (PSUs) typically are trips, the number of fish aged is not very useful for evaluating if there is sufficient data to estimate catch-at-age adequately. The effective sample size for estimating catch-at-age is largely driven by the number of primary sampling units (PSUs). Even if a large number of fish is aged, the precision in estimated catch-at-age may be very poor if the biological samples for length and age compositions are collected from only a few

vessels and trips in the observer and port sampling programs. Also, the precision of abundance indices by age and length are driven by the number of trawl stations, and much less by the number of fish measured for length and age. If assessments are conducted for stocks that occupy relatively small spatial areas, then the number of trawl haul, and the number of trips sampled for length and age may be quite small, resulting in poor precision in key input data to the stock assessment models. I therefore recommend that diagnostics to go along with age-based assessments include number of trawl hauls (in the fishery-independent surveys) and the number of vessels and trips with age-samples by gears and area for the fishery-dependent data. The separate stock assessment of cod and haddock for portions of the Georges Bank (EGB cod, and EGB haddock), as part of the Transboundary Resources Assessment Committee (TRAC), is an example where a thorough evaluation of the data-support (e.g., number of trips where catches were sub-sampled for age) likely would reveal that catch-at-age cannot be estimated with adequate precision. Also, for a small geographic area, only a limited number of trawl stations in the fishery-independent survey would provide data on numbers-at-age, resulting in poor precision.

2) Is the assessment process efficient, effective and clearly described, including terms of reference for assessment reports?

The assessment process leading to the catch advice appears to be inefficient due to problems with data-streams, excessive reporting demands, and an overly complex and time-consuming meeting schedule related to the peer review process. The timing of availability of raw input data for stock assessments are scheduled to be available by early April, but in practice timing is variable so data may be received up to a month behind schedule in some years. This is incompatible with a rigid schedule of assessment reviews. The handling of fisheries-dependent data to prepare the input data to stock assessments takes significant time. The assessments are generally completed within 2-4 months of receiving the input data. With the time added to complete the following review process leading up to the ABC and catch quota advice the whole assessment process can take more than a year. The proposed streamlining of assessment reporting has the potential to significantly reduce workloads in the long-run. Also, NEFSC staff suggested that the number/amount and type of information requests from CIE reviewers be restricted. In the current system, there are situations where many requests (which could entail a lot of extra work for NEFSC scientists) likely provide information of limited value for determining if the assessments are adequate.

The stocks assessed by NEFSC are managed under fisheries management plans (FMPs) from the Northeast and Mid-Atlantic Management Councils and the Atlantic States Fisheries Management Commission. The assessments of fish stocks in the offshore US waters of the northwest Atlantic are subject to a very thorough scientific peer-review process through the Northeast Regional Stock Assessment Workshop (SAW). The SAW protocol is used to prepare and review

assessments. Assessments are prepared by SAW working groups (federally led assessments) or Atlantic States Maine Fisheries Commission (ASMFC) technical assessment committees (state led assessments) and reviewed by an independent panel of stock assessment experts called the Stock Assessment Review Committee (SARC), which includes reviewers from the Center of Independent Experts (CIE). On top of this, the Statistical and Scientific Committee conducts reviews of the reviews before coming up with the quota recommendation. This Stock Assessment Review layer is so cumbersome that it can compromise the assessment process. Due to the significant delay in the determination of ABC that is the basis for the quota, and the time to put catch quotas into regulations by GARFO (including the EIS process) may result in the final quota being based on 2 year old data. This is clearly risky, since it essentially means that the quota is based on a 2-year forward projection that adds significant uncertainty on top of the uncertainty in the stock assessment results. In addition, the enormous workload on NEFSC assessment scientists is at the expense of time for research and innovation to develop assessment models that are better suited to deal with the ecosystem approach to fisheries management.

It is critical that the assessment process be more streamlined and timely, and that the workload for NEFSC assessment associated with routine production assessments be significantly reduced to allow for more time for research. The current situation is not sustainable and there is a clear risk that NEFSC can lose highly talented staff if it is not resolved quickly. One of the proposed solutions that benchmark only is required when stock assessments are supported by new data or new model development, which I agree with. The current process seems like over-kill.

3) Does the Center, in conjunction with other entities such as the Councils' Scientific and Statistical Committees, have an adequate peer review process?

The high focus on the review process related to stock assessments conducted by NEFSC is commendable. In addition to the very thorough reviews conducted through SAW/SARC and the SSC as part of the routine process, there have been several comprehensive review meetings since 2000. In particular, the Groundfish Assessment Review Meetings (GARM): 2001:GARM I—Benchmark all stocks; 2005: GARM II—Update all stocks; 2008 GARM III Benchmark for all 19 stocks, and the Data Poor Workshop 2009.

The inclusion of CIE in the review process is very important, and demonstrates that NOAA has a strong commitment to move towards best available science, and not just best available NMFS science. This very strong focus on independent peer-reviews of stock assessments and assessment methods, and the transparency (e.g., the SSC open meetings) is lacking in Europe. While this thorough and open review process sets a standard internationally, and has many advantages, the burden on staff doing stock assessments is too high. The current multi-layer review process is not sustainable given current staffing levels. The tentative processes to reduce number of peer reviews by allowing for operational assessments where a certain level of changes can be implemented without a full review cycle is promising. There appears to be some duplication of peer-reviews in SARC and SSC. A reduction in meetings can maybe be achieved through a merging or better coordination of the SARC and SSC, a stricter prioritization of TOR for reviews, and by focusing on the identification of essential research questions that can realistically be addresses within available funding.

Some additional observations:

It appears that there is no organized way of presenting all the recommendations coming from the peer reviews, and responses to these recommendations over time. It could be beneficial to have a SharePoint website where research requests are presented for each review, along with the follow-up research to address the requests.

It was also noted that there are no defined standards to determine when an assessment should be rejected or accepted, and this can be particularly problematic when there are many review panels operating independently. The proposed prosess of conducting operational assessments for a number of stocks, and then deal with a å more limited number of stock assessments where major advances are needed through a research track assessments, is promising.

It was also pointed out that CIE reviewers may not be familiar with complex management system in Atlantic States, which can result in misconceptions. Some limitations on the type of requests in the CIE review process could likely reduce the work-load on NEFSC staff without jeopardizing the independence of the review.

4) Does the Center work effectively internally and in coordination with the NEFMC, MAFMC, ASMFC, and GARFO to accomplish needed assessments according to a set of

priorities? Considerations should include program structure, staffing, funding, and the stock assessment prioritization process.

The current situation where the population dynamics branch is overburdened by the stock assessment process suggests that the NEFSC, MAFMC, ASMFC, and GARFO have not managed to set priorities that sufficiently considers NEFSC staffing level and the need to secure time for professional development. Ability to innovate is not fully at NEFSC met because of continued overload. It appears that there is little room for NEFSC to prioritize because of mandates driven by the Councils, the ASMF, and the Magnuson Stevens act. The many demands from the NEFMC, MAFMC, and ASMFC do not seem to fully take into account the availability of staff and funding at NEFSC to address all the requests. There is clearly a need for prioritization. The assessment buck idea presented by Paul Rago is one possible way of improving the stock assessment prioritization process. In particular, it appears that a large number of requests from MAFMC, ASMFC, and GARFO throughout the year are not related to stock assessments. Clearly, there is a need to coordinate and prioritize the requests from all these stakeholders so that the required work can be achieved without over-burdening NEFSC.

5) Does the Center achieve adequate assessment accomplishments relative to mandates particularly with respect to the number of Fishery Management Plan (FMP) species assessed?

Given the available staffing and funding, the answer is clearly yes. Given the complexity of the management system, and in particular the fact than many stocks falls under more than one FMP, and the very large number of research requests it is remarkable that the population dynamics branch manages to deliver the stock assessments requested every year.

6) Does the Center have an effective process in place for taking ecosystem and climate change factors into consideration in the stock assessment process?

The current high reliance on the Toolbox, combined with very limited time for research for the assessment scientists, is likely to be a bottleneck for the process of developing new modeling approaches that can incorporate ecosystem and climate change. Research teams with ecosystem and stock assessment modelers have the potential to make significant advances in the stock assessment process that are not yet fully realized because of the heavy workload required for stock assessments. The NEFSC is in an exceptional position with a very strong ecosystem assessment research team, a very strong team of assessment scientists, and exceptional time series of data to support the incorporation of climate and ecosystem factors in the assessment process. The NEFSC has a formal process to incorporate ecosystem approach. Challenges relate to research time to develop modeling approach, and cuts in ecosystem observational surveys.

7) Does the Center adequately engage stakeholders in the stock assessment process and communicate assessment-related results, needs, and research to them effectively?

My impression is that NEFSC has a strong system for engaging stakeholders, and that assessment-related results are communicated effectively. When presenting information about uncertainty to the fishery industry and other stakeholders it may be useful to separate uncertainty related to random sampling errors (precision) versus bias that can results from poor coverage of the stocks in fisheries-dependent surveys for example, or from poor model formulation. It is important to communicate that it cost money to improve accuracy of stock assessments. Emphasizing what sources of uncertainty that is quantified (known) versus uncertainty than cannot be quantified is important. This becomes particularly important for defending the level of monitoring required to achieve adequate stock assessments. I think the issue of uncertainty is particularly important related to the spatial resolution of stock-assessments and demands for fisheries-management. Quota allocation at finer spatial scales, and for métiers defined by area and gear-combinations, will have to take into account the data-support for the stock-assessments. I believe that the higher demand for assessment results for small spatial areas, and time periods, is incompatible with the level of sampling effort in the fishery-dependent and fishery-dependent surveys. The reason, again, is that the effective sample sizes for estimating abundance-indices and catch at length or age is driven by the number of PSUs sampled, which usually are quite few for species that occupies small areas, or for fisheries that concentrates in smaller areas. The assessment of George bank cod and haddock, where separate estimates are required for subareas of the Georges Bank, is an example where uncertainty in the stock assessment results would be substantially increased because of the reduction in effective sample sizes of the input data.

As part of the outreach, it is also recommended that NEFSC place more emphasis on scientific publications related to stock assessment methods, which is important for recognition in the scientific community.

8) Are there opportunities for improving stock assessments and the stock assessment process?

This is partly addressed in TORs 1,2, 6. I would also like to add that there could be improvements made by moving away from VPA type assessment models. More research on statistical assessment models that fully can account for sampling errors (including clustering effects) in fishery-dependent and fishery-independent survey data, could lead to improvements especially for age-based assessments. One of the biggest potentials for improvement in the stock assessment likely relates to improving the quality of the fishery-dependent information. The current system of data-collection is largely ad-hoc (ref. 2013 Program review), which can result in variable bias of unknown magnitude.

The stock assessment process as discussed above under several TORs has many rooms for improvements - in particular a more efficient peer review process that can improve timeliness and thus improve the basis for quota advice. Also, a streamlining of the reporting requirements, as for example the proposed standardization of the stock assessment reports. Use of Sharepoint for large number of figures and graphs that are not essential to include in the main report could be useful. Also, a better system to track research recommendations in the peer-revie process, and

the advancement on solving these, would be beneficial. This could perhaps also be done through a Sharepoint site.

Draft Scheduling Worksheet for Stock Assessments. **date: Oct. 10, 2014**

Basis for entries in Table: April 2014 NRCC meeting + clarification from MAFMC

	2014: 1st half	2014: 2nd half
1	N. shrimp - SARC 58, Jan. 27-31	GOM haddock - SARC 59, July 15-18
2	Tilefish - SARC 58	Scallops - SARC 59
3	Butterfish - SARC 58	
4		
5	(GB YT Alternative - April 14-19, WH)	(Pollock, GOM winter fl, GB winter fl, Aug 11-13, Oper. Assessment Process)
6	(Model Review - May 19-23)	
7	(TRAC - EGB cod, EGB haddock, GB YT) June 23 -27, WH	(GOM cod, Aug. 28-29, Oper. Assessment)
8		
9	(Updates: Bluefish, BlkSeaBass [data update; research report], Scup [data update], Fluke [data update], Mackerel [data update, research plan]), squids [data update])	(Updates: Dog [data update], skates, hakes [silver, red, offshore])

	2015: 1st half	2015: 2nd half
1	Scup - SARC 60, June 2-5 , might be done with incomplete 2014 data	
2	Bluefish - SARC 60 June 2-5 , might be done with incomplete 2014 data	
3		
4	(ASMFC - Sturgeon -Feb). (delayed??)	(20 Groundfish Stocks, Operational Assessment, Sept. 21-25)
5	(ASMFC - Lobster peer review -Spring 2015)	
6	(Scallop Survey Methods- March 17-19, WH)	
7	(Herring, Operational Assessment, May)	
8	(TRAC - EGB cod, EGB haddock, GB YT - June)	
9	(Protected species: Program Review - DATE in 2015 TBD)	
10	(Updates: BlkSeaBass [data update],Fluke, surfclam [data update], Dog, skates, Mackerel (data update), butterfish (data update), tilefish [data update], squids (data update))	

	2016: 1st half	2016: 2nd half
1		
2		
3		
4		
5		
6		
7		
8		

	2017: 1st half	2017: 2nd half
1		
2		
3		
4		
5		
6		
7		
8		

Key:

Italics = Under consideration, but not officially scheduled.

"( )" = not in the SARC process.

Cells filled with gray = work completed.

Scheduling Worksheet for Stock Assessments. **date: May 15, 2014-b**

Basis for entries in Table: April 2014 NRCC meeting + clarification from MAFMC

	2013: 1st half	2013: 2nd half
1	White hake - SARC 56, Feb 19 -22, 2013	Striped bass - SARC 57, [July 23-26]
2	Atlantic surfclam - SARC 56	Summer flounder - SARC 57
3		
4		
5	(River herring - Extinction Risk Analysis)	(Data Review, August 5-9)
6	(EGB cod benchmark - Ap. 9-11, 2013, TRAC)	
7	(TRAC - EGB cod, EGB haddock, GB YT - June 25-27 Canada)	
8	(Updates: Bluef, Scup [w/ SSC], Dog, skates, monkfish -Ap. 8-9 Op. Assess., Ocean quahog, Mackerel, butterfish, tilefish, squid	

	2014: 1st half	2014: 2nd half
1	N. shrimp - SARC 58, Jan. 27-31	GOM haddock - SARC 59, July 15-18
2	Tilefish - SARC 58	Scallops - SARC 59
3	Butterfish - SARC 58	
4		
5	(GB YT Alternative - April 14-19, WH)	(Pollock, GOM winter fl, GB winter fl, Aug 11-13, Oper. Assessment Process)
6	(Model Review - May 19-23)	
7	(TRAC - EGB cod, EGB haddock, GB YT) June 23 -27, WH	
8		
9	(Updates: Bluefish, BlkSeaBass [data update; research report], Scup [data update], Fluke [data update], Mackerel [data update, research plan]), squids [data update])	(Updates: Dog [data update], skates, hakes [silver, red, offshore])

	2015: 1st half	2015: 2nd half
1	Scup - SARC 60, June 2-5 , to be done with incomplete 2014 data	
2	Bluefish - SARC 60 June 2-5 , to be done with incomplete 2014 data	
3		
4	(ASMFC - Sturgeon -Feb).	(20 Groundfish Stocks, Operational Assessment, Sept. 21-25)
5	(ASMFC - Lobster peer review -Spring 2015)	
6	(Scallop Survey Methods- March 17-19, WH)	
7	(Herring, Operational Assessment, May)	
8	(TRAC - EGB cod, EGB haddock, GB YT - June)	
9	(Protected species: Program Review - DATE in 2015 TBD)	
10	(Updates: BlkSeaBass [data update],Fluke, surfclam [data update], Dog, skates, Mackerel, butterfish, tilefish [data update])	

	2016: 1st half	2016: 2nd half
1	*Skates - SARC 61, Month TBD*	*Mackerel, Black sea bass, monkfish -- SARC 62, Nov./Dec.; pick 2; choice dependent on research progress; or possibly schedule NE Groundfish benchmarks*
2	*Ocean quahog - SARC 61*	
3		
4	*(TRAC - EGB cod, EGB haddock, GB YT - June)*	
5	*(Black sea bass - SARC or another process run by ASMFC)*	
6	*(Cumul. Discard Methodology - January)*	
7	*(Ecosystem Applications, Management, Habitat : Program Review - DATE TBD)*	
8	*(Updates: BlkSeaBass [data update],Fluke, surfclam [assessment update], Dog, Mackerel, butterfish, tilefish [data update])*	

Key:

Italics = Under consideration, but not officially scheduled.

"( )" = not in the SARC process.

Cells filled with gray = work completed.

~/sarc/boilerplate/Schedule-worksheet-assessments(date).xls 5/15/2014-b

New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
E.F. "Terry" Stockwell III, *Chairman* | Thomas A. Nies, *Executive Director*

October 14, 2014

Dr. William Karp
Science and Research Director
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1026

Dear Bill:

At the September 30 – October 1, 2014 meeting of the New England Fishery Management Council, the Council passed the following motion:

> *Motion: "to request the Northeast Fisheries Science Center review, summarize and communicate as quickly as possible the most recent updated information on Georges Bank cod (including available survey indices, catch and recruitment indicators)." The motion carried on a show of hands (13/1/4).*

The Council makes this request in light of the current condition of the Eastern Georges Bank cod management unit. The Transboundary Resources Assessment Committee determined that spawning stock biomass for this stock continues to be extremely low, with poor recruitment and lack of rebuilding. The Council understands that an updated assessment of the Georges Bank cod stock will be conducted in the fall of 2015, but having an update on the condition of Georges Bank cod would aid in preparing appropriate future management actions.

The Center recently completed the 2014 assessment update for Gulf of Maine cod that determined the SSB for this stock decreased in 2013 to a time-series low of 3-4%. This result was a surprise to many and the Council is struggling to develop measures to address this situation in time for FY 2015. Providing information on the status of GB cod this fall will help avoid a similar surprise after next year's assessment, and will provide the Council more time to develop appropriate management measures.

Thank you for considering this request of the Council. Please contact me with any questions.

Sincerely,

Thomas A. Nies

Thomas A. Nies
Executive Director

Guidelines on Comments during SARC Peer Review Meetings

(Prepared by NEFSC, with NRCC review. Completed: 10/16/2014)

Introduction:

The Stock Assessment Review Committee (SARC) is part of the Stock Assessment Workshop (SAW) process, which includes preparation of stock assessments, peer review, and publication. The main purpose of the SARC is to provide an independent peer review of fish and invertebrate stock assessments in the Northeast US, which includes both New England and the Mid-Atlantic. The SARC chair is responsible for running the peer review, controlling the flow of the meeting in relation to the meeting agenda, and deciding who may speak and for how long. SARC peer review meetings are open to the public and include public comment. This document provides written guidelines regarding the timing and types of comments[1] that may be taken from attendees (i.e., public comment) during future SARC peer review meetings.

Definition of "attendees":

Attendees include a broad diversity of people at the SARC meeting, all of whom are seated in the audience (i.e., not at the front table). Those seated at the front table during the SARC are not considered to be attendees.

Two members of the SAW Working Group (WG) are seated at the front table during the peer review: the SAW WG chair and the lead assessment scientist. Other SAW WG members who are not seated at the front table are considered to be attendees. The role of SAW WG members is described further in the section "Guidelines for SAW Working Group members".

The chair of the SAW process, the Chief of the Population Dynamics Branch, and a rapporteur are seated at the front table and are not considered to be attendees. Their roles are described in the "Description of the current process".

A designated fishery management representative from the NEFMC, MAFMC, or ASMFC will be included with those seated at the front table during the peer review of a managed stock, and that person is not considered to be an attendee. The role of this person is described in the section "Designated representatives of fishery management agencies".

Other members of the public who are seated in the audience are considered to be attendees.

[1] This document acknowledges that there are different types of comments, and they are sometimes difficult to categorize. They are provided to serve as guidelines for running SARC peer meetings.

Description of current process, used through 2013/2014:

The SARC Chair is responsible for running the peer review meeting. He/she controls the flow of the meeting, calls on people to speak, and decides which topics are to be discussed along with the amount of time per topic. The Chair should not allow any "attendee" to dominate the meeting by speaking for long amounts of time or by repeating points already made. The Chair should give people at the front table precedence in speaking before others. Those seated at the front table during the peer review include the SARC peer review panel, two principal members of the SAW WG (the SAW WG chair and the lead stock assessment scientist), a rapporteur, the chair of the SAW process, and the chief of the NEFSC Population Dynamics Branch. The chair of the SAW process and the NEFSC Population Dynamics Branch Chief coordinate the meeting and try to clarify issues that arise during the peer review. The rapporteur takes notes. The peer review meeting is broadcast to the public via conference call and Webex. The SARC peer review meeting has five stages, the first four of which are open to the public.

Stage 1. **Assessment presentation.** This is given by the lead stock assessment scientist. Comments from those at the front table and from attendees are generally restricted to clarifications and corrections (note: identification of needed corrections is allowed throughout the meeting).

Stage 2. **Discussion of the assessment presentation.** This involves the SARC panel, the lead stock assessment scientist, and SAW WG chair, all of whom are seated at the front table. Comments from attendees may be taken and can include clarifications and other types of comments (e.g., questions and opinions).

Stage 3. **Consideration of new analyses**. SARC panel considers new analyses prepared by the SAW WG at the request of the SARC panel. Comments from attendees may be taken and can include clarifications and other types of comments (e.g., questions and opinions).

Stage 4. **Edit draft Assessment Summary Report**. The SARC panel edits the draft Assessment Summary Report in consultation with others seated at the front table. The SARC panel edits the draft report so that it expresses—and is consistent with—the conclusions of the peer review. Comments may be taken from attendees and can include clarifications and other types of comments (e.g., questions and opinions).

Stage 5. **Writing of review panel reports.** The SARC panel meets in closed session to write its reports. Panel members draft their reports based on discussions during the open periods, and the panelists should not change any decisions made during the open periods. There is no public comment.

Changes to the current process:

Compared to the current process, the new guidelines reduce certain types of comments from attendees during Stage 4, but increase comments from attendees during a newly defined period following Stage 2 (**Table 1**). The types of comments taken during other meeting stages will remain the same as in the past. Likewise, the responsibility of the SARC Chair to run and control the flow of the meeting and to determine who may speak remains the same.

The new time slot for public comments between Stages 2 and 3 increases the opportunity for attendees to speak during the meeting. There will be a requirement to sign up to speak, and there will be a time limit per speaker (still to be determined, but on the order of a few minutes each).

Comments from attendees during Stage 4 will be limited to clarifications and corrections. The SARC Chair will generally not take other types of comments from attendees during Stage 4. However, as explained in subsequent sections, the SARC Chair still has flexibility in this regard.

A designated representative from the primary fishery management agency (NEFMC, MAFMC, or ASMFC) responsible for managing the stock will be included with those seated at the front table. (For details, see section "Designated representatives of fishery management agencies".)

The purpose of Stage 5 is to provide a time for the review panel to write its reports. This stage was formerly closed to the public. It will now be open, but only for the public to observe. There will be no public comment.

Table 1. Comparison between the current process used through 2013/2014 and the new process for use at SARC peer review meetings. For explanation of SARC review stages, see earlier section "Description of current process, used through 2013/2014".

Process	Stage within the SARC Review					
	Stage 1	Stage 2	Comments	Stage 3	Stage 4	Stage 5
Used through 2013/2014	**C**	**C,O**	**N/A**	**C,O**	**C,O**	**-**
New for the future	**C**	**C,O**	**Comments**	**C,O**	**C**	**-**

Key to Symbols in Table:		
		= Some form of Public Comment allowed
	N/A	= Not applicable
	-	= No Public Comment
	C	=Clarifications and Corrections allowed
	O	= Other forms of comments
	Comments	=A Defined time on agenda for Public Comments

Guidelines for SAW Working Group members:

The two SAW WG members who are seated at the front table (i.e., SAW WG chair and lead assessment scientist) represent the SAW WG. They are expected to speak for the WG in most situations during each stage of the peer review. SAW WG members who are not at the front table should speak if called on by the SARC chair, but they should allow the two SAW WG members seated at the front table to handle nearly all presentation and discussion that takes place during the peer review (but note "Exceptions", below).

Designated representatives of fishery management agencies:

Designated representatives of fishery management agencies (e.g., MAFMC, NEFMC, ASMFC) are familiar with management measures and regulations for the stocks under review. During the peer review meeting, a designated fishery management representative for that stock can sit at the front table. The SARC chair may seek information, primarily about management and regulatory issues, from the designated representative. The designated representative is not a member of the peer review panel. The representative should be well informed about pertinent management issues related to that stock, and should prepare for the peer review by participating in SAW WG meetings and reading the assessment and background reports.

Exceptions:

1. For Presenters. If SAW WG members who are not normally seated at the front table are scheduled to give a presentation as part of the SARC meeting agenda, then these individuals should move up to the front table for their presentation and afterward return to a seat that is not at the front table.

2. For Attendees. It is the responsibility of the SARC chair to control the flow of the meeting so that it makes progress and to decide who may speak and for how long. The SARC chair is allowed to call on attendees during Stages 1-4 of the peer review if the SARC chair needs to acquire additional information that is not available from those seated at the front table. The SARC chair will make this decision on a case by case basis. An example of an appropriate use of this exception would be if the SARC requires information about a new topic that has not already been presented or discussed during the peer review.

60th SAW/SARC: Final Stock Assessment Terms of Reference

(file vers.: 10/16/2014)

A. Scup

1. Estimate catch from all sources including landings and discards. Include recreational discards, as appropriate. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. Present the survey data being used in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.). Characterize the uncertainty and any bias in these sources of data.

3. Describe the thermal habitat and its influence on the distribution and abundance of scup, and attempt to integrate the results into the stock assessment.

4. Estimate annual fishing mortality, recruitment and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Include a historical retrospective analysis to allow a comparison with previous assessment results and previous projections.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer reviewed accepted assessment) and with respect to a new model developed for this peer review.

a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.

b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level) (see Appendix to SAW TORs for definitions).

a. Provide numerical annual projections (3 years). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.

c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Review, evaluate and report on the status of the SARC, SSC, and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports. Identify new research recommendations.

B. Bluefish

1. Estimate catch from all sources including landings and discards. Evaluate and if necessary update the discard mortality estimate. Describe the spatial and temporal distribution of landings, discards, and fishing effort. Characterize the uncertainty in these sources of data.

2. Present and evaluate data and trends on life history information including, age, growth, natural mortality, food habits, and maturity.

3. Present the survey data available for use in the assessment (e.g., indices of relative or absolute abundance, recruitment, state surveys, age-length data, etc.), evaluate the utility of the age-length key for use in stock assessment, and explore standardization of fishery-independent indices. Investigate the utility of recreational LPUE as a measure of relative abundance. Characterize the uncertainty and any bias in these sources of data, including exploring environmentally driven changes in availability and related changes in size structure. Explore the spatial distribution of the stock over time, and whether there are consistent distributional shifts.

4. Estimate relative fishing mortality, annual fishing mortality, recruitment, total abundance, and stock biomass (both total and spawning stock) for the time series, and estimate their uncertainty. Explore inclusion of multiple fleets in the model. Include both internal and historical retrospective analyses to allow a comparison with previous assessment results and previous projections. Explore alternative modeling approaches if feasible.

5. State the existing stock status definitions for "overfished" and "overfishing". Then update or redefine biological reference points (BRPs; point estimates or proxies for B_{MSY}, $B_{THRESHOLD}$, F_{MSY} and MSY) and provide estimates of their uncertainty. If analytic model-based estimates are unavailable, consider recommending alternative measurable proxies for BRPs. Comment on the scientific adequacy of existing BRPs and the "new" (i.e., updated, redefined, or alternative) BRPs.

6. Evaluate stock status with respect to the existing model (from previous peer review accepted assessment) and with respect to a new model developed for this peer review.
    a. When working with the existing model, update it with new data and evaluate stock status (overfished and overfishing) with respect to the existing BRP estimates.
    b. Then use the newly proposed model and evaluate stock status with respect to "new" BRPs and their estimates (from TOR-5).

7. Develop approaches and apply them to conduct stock projections and to compute the statistical distribution (e.g., probability density function) of the OFL (overfishing level; see Appendix to the SAW TORs).
    a. Provide annual projections (3 years). For given catches, each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass. Use a sensitivity analysis approach in which a range of assumptions about the most important uncertainties in the assessment are considered (e.g., terminal year abundance, variability in recruitment).

b. Comment on which projections seem most realistic. Consider the major uncertainties in the assessment as well as sensitivity of the projections to various assumptions.
c. Describe this stock's vulnerability (see "Appendix to the SAW TORs") to becoming overfished, and how this could affect the choice of ABC.

8. Review, evaluate and report on the status of the SARC and Working Group research recommendations listed in most recent SARC reviewed assessment and review panel reports, as well as MAFMC SSC model recommendations from 2005 and the research recommendations contained in its 23 September 2013 report to the MAFMC. Identify new research recommendations.

Appendix to the SAW Assessment TORs:

Clarification of Terms used in the SAW/SARC Terms of Reference

On "Overfishing Limit" and Acceptable Biological Catch" (DOC Nat. Stand. Guidel. Fed. Reg., v. 74, no. 11, 1-16-2009):

> *Acceptable biological catch (ABC)* is a level of a stock or stock complex's annual catch that accounts for the scientific uncertainty in the estimate of [overfishing limit] OFL and any other scientific uncertainty…" *(p. 3208) [In other words, OFL ≥ ABC.]*
>
> *ABC for overfished stocks.* For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect annual catch that is consistent with schedule of fishing mortality rates in the rebuilding plan. *(p. 3209)*
>
> NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. (p. 3180)
>
> ABC refers to a level of ''catch'' that is ''acceptable'' given the ''biological'' characteristics of the stock or stock complex. As such, [optimal yield] OY does not equate with ABC. The specification of OY is required to consider a variety of factors, including social and economic factors, and the protection of marine ecosystems, which are not part of the ABC concept. (p. 3189)

On "Vulnerability" (DOC Natl. Stand. Guidelines. Fed. Reg., v. 74, no. 11, 1-16-2009):

> *"Vulnerability.* A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality)." (p. 3205)

Interactions among members of a SAW Assessment Working Group:

> Anyone participating in SAW assessment working group meetings that will be running or presenting results from an assessment model is expected to supply the source code, a compiled executable, an input file with the proposed configuration, and a detailed model description in advance of the model meeting. Source code for NOAA Toolbox programs is available on request. These measures allow transparency and a fair evaluation of differences that emerge between models.

One model or alternative models:

> The preferred outcome of the SAW/SARC is to identify a single "best" model and an accompanying set of assessment results and a stock status determination. If selection of a "best" model is not possible, present alternative models in detail, and summarize the relative utility each model, including a comparison of results.

Report of the

National Standard 2 SAFE Report Committee

RECOMMENDATIONS ON THE APPLICATION OF NS2 GUIDELINES IN THE GREATER ATLANTIC REGION

Submitted to the

Northeast Regional Coordinating Committee

October 6, 2014

Contents

Summary

Recent revisions to the National Standard 2 (NS2) guidelines[1] established new requirements for Stock Assessment and Fishery Evaluation (SAFE) reports. The revised guidelines specify the types of information that should be included in SAFE reports, and state that the reports must be made publicly available on a Council or NMFS website. In May 2014, a regional NS2 SAFE Report Committee (Committee) was formed to develop alternatives for complying with these guidelines in the Greater Atlantic Region.

The Committee developed two sets of options to address the following questions:

1. How will the SAFE Reports be produced?
2. Where and how will SAFE reports be housed?

For producing SAFE reports, the Committee recommends maintaining the current report writing process with the addition of a cohesive summary document that would be developed by a GARFO fishery analyst. For housing SAFE reports, the Committee recommends posting them to a searchable database located on the GARFO website.

This report summarizes the options developed by and recommendations of this Committee. Regardless of which options are ultimately selected, the Committee stresses that improving SAFE reports and housing them on a website will require all partner organizations (GARFO, both Councils, NEFSC) to make this effort a priority.

Introduction

The NS2 guidelines[1] call for the use of SAFE reports to help inform management decisions, including the determination of ACLs. SAFE reports summarize recent significant trends or changes in the resource, marine ecosystems, and fishery conditions. SAFE reports should also contain information on bycatch and safety concerns in each fishery, an explanation of information gaps, and the need for future scientific work (Table 1). The SAFE report may be used to update or expand previous environmental and regulatory impact documents and ecosystem descriptions. The Secretary has the responsibility to ensure that SAFE reports are prepared and made available on a Council or NMFS public website. SAFE reports should include a summary of the information they contain and an index or table of contents.

The NS2 guidelines recognize and allow for differing regional practices regarding SAFE report preparation and structure - a SAFE report can be a single document or compilation of documents. SAFE reports prepared by NMFS vary greatly among regions, and even among FMPs within the Greater Atlantic Region. Complying with the revised guidelines in a more systematic and uniform way within the Greater Atlantic Region could require substantial time and resources to change report coordination, style, content, and distribution. To address this potentially considerable task, a Committee was formed in May 2014 with staff members from the NEFSC, GARFO, and both Councils. This group was charged with compiling an inventory of SAFE reports and identifying a "single, accessible place where the public can go to find information" on the status of fish stocks and the fisheries that harvest them, consistent with the NS2 guidelines.

[1] Federal Register, Vol. 78, No. 139, July 19, 2013

Committee Members

The following individuals served on the Committee: Doug Christel (GARFO), Mary Clark (MAFMC), Rachel Feeney (NEFMC), Teri Frady (NEFSC), and Jim Weinberg (Committee lead; NEFSC).

How is the Greater Atlantic Region Currently Meeting the NS2 Guidelines?

Although only a few reports have been specifically identified as "SAFE Reports" in the Greater Atlantic Region, many of the documents produced regularly by the Councils, GARFO, and the NEFSC contain content required by the NS2 guidelines. The Committee conducted an inventory of recently prepared reports within the Greater Atlantic Region (Table 2). For each FMP, there is content that addresses each general topic (Table 1) outlined in the guidelines, though some gaps in specific content were noted. The Committee also noted that these reports have been developed by various offices in an uncoordinated manner and often without a regular or synchronized production schedule. All of these reports are publicly available on the NMFS and Council websites, but they are not posted in a centralized location.

While the Committee was not charged with conducting a thorough review of how other regions develop and publish SAFE reports, the Committee noted that in the North Pacific, stand-alone documents titled "SAFE" reports are produced on an annual basis for each FMP (Appendix 1). The Alaska Fisheries Science Center (ASFC) leads SAFE report preparation in most cases, in collaboration with the North Pacific Fishery Management Council (NPFMC), plan development teams, and the State of Alaska. Most reports are posted on a webpage of the ASFC, though reports for two fisheries (crab, scallop) are posted on the NPFMC website.

Options for Meeting NS2 Requirements in the Greater Atlantic Region

The Committee developed two sets of options for addressing the separate questions of *how* the reports will be produced and *where* the reports will be housed. Although the Committee considered various combinations of options for SAFE report production and housing, some combinations may be more appropriate than others.

Production of SAFE Reports

The Committee developed four options for producing SAFE reports, each associated with progressively greater costs (as well as potential benefits). Logistical, human resource, and funding considerations for each option are summarized in Table 3.

Option 1: Status Quo

This option would entail no changes in how reports that contain SAFE information are written. Various offices would continue to produce reports, though not necessarily in a coordinated fashion. This option would be the least complex to implement and could be done relatively quickly, but it may provide less utility to the public and to fishery managers than Options 2-4. This approach would not facilitate identification of data gaps and redundancies.

Option 2: Status Quo + Brief Description

This option would still produce the set of reports that are currently written, but with the addition of brief content descriptions (2-3 sentences) of each SAFE report component document. These short descriptions would be written by appropriate staff (e.g., a GARFO fishery analyst) and would be posted adjacent to the full reports in the central location where SAFE documents are housed. This option would be a more organized approach than Option 1. Having brief

descriptions of each report would make SAFE documents more user friendly and would make it easier to find information and identify data gaps and redundancies, which may lead to improvements indirectly.

Option 3: Status Quo + Summary Document

As with Option 2, Option 3 would still produce the set of source reports that are currently written. But in Option 3, appropriate staff (e.g., a GARFO fishery analyst) would excerpt specific summary text from the source documents and compile that into a cohesive stand-alone report that would be specifically titled the "SAFE report". The summary would reference the source documents. By excerpting source text, the risk of introducing interpretation errors by a third party would be minimized. This option would provide end users with one document that has all the essential SAFE report content briefly contained therein.

Option 4: Stand-Alone SAFE Report

Option 4 would create a comprehensive, stand-alone report that contains all information that belongs in a SAFE report, **and replace some or all original source documents**, akin to the model used in the North Pacific. An appropriate staff person (e.g., possibly the GARFO FMP coordinator) would lead report coordination, with components of the report authored by other offices (e.g., NEFSC for stock assessment information). Of the four options, this one would be the most significant departure from the Greater Atlantic Region's current process and would incur high transition costs. Although this model would require a large investment of resources and staff time, development of stand-alone SAFE reports may eventually reduce the time needed to produce some fishery reports and could eliminate the need to produce some reports that are currently written.

Several important details of Option 4 would need to be worked out. For example, given that each stock in a fishery is assessed separately, it is not clear whether SAFE reports would be developed at the stock or the FMP level. Decisions would also be required about how to treat the various types of assessments that are done in the region, synchronizing the production schedules, and whether the new SAFE reports would replace the Affected Environment section of EAs and EISs. Unless these issues are resolved, redundancies with the current set of reports would persist.

Housing of SAFE Reports

The Committee developed two options for the housing of SAFE reports on a public website. Each option includes two sub-options. Logistical, human resource, and funding considerations are summarized in Table 4. Under each option, the most recent version of the relevant documents, as well as a catalog of historic documents, would be made available.

Option 1: Post Reports on a GARFO Website

Under Option 1, the reports would be posted on a new webpage of the GARFO website dedicated to SAFE reports. This option allows for regional control of the website, with all SAFE documents residing on a local server.

- *Sub-Option 1A*: List the reports on a page on the GARFO website, perhaps in a tabular format. This option would be relatively simple to implement, but could quickly become cumbersome as more reports get posted over time.

- *Sub-Option 1B*: House the reports within a searchable database (e.g., date, FMP, key word), perhaps akin to the Northeast Consortium's Project Information Database.[2] This option would require additional resources to create the database, but the end product may be more user-friendly and require no more effort to maintain than sub-Option 1A.

Option 2: Post Reports on an Existing NMFS Website

Under Option 2, the reports would be posted to an existing national NMFS website, and an appropriate GARFO staff member would work with the HQ staff to post reports. Regional websites would need to link to the national site.

- *Sub-Option 2A:* House the reports on the Fish Watch website.
- *Sub-Option 2B:* House the reports on the Species Information System Public Portal (SIS).

Option 2 may be the best way to achieve the goal of having a single accessible place (nationally) where the public can find SAFE information, if other regions began posting SAFE reports there as well. However, this option would require close coordination with NMFS HQ and would result in the region having little control over the website. Successful implementation of this approach would require development of strong working relationships with NMFS HQ personnel who operate and maintain the national website. NMFS HQ would bear the costs of website modification and maintenance and would need to be able to post reports in a timely manner. Sub-Option 2A may be less appropriate than sub-Option 2B, because the target audience of Fish Watch is fish consumers, whereas the focus of SIS is stock status.

Committee Recommendations

Regardless of which options are ultimately selected, the Committee stresses that improving SAFE reports and housing them on a website will require all partner organizations (GARFO, both Councils, NEFSC) to make this effort a priority.

Report Production

The Committee recommends **Option 3** for the production of SAFE reports. This approach would maintain most aspects of the current reporting processes, which would keep transition costs reasonable. It would include having appropriate staff excerpt and compile content into a cohesive "SAFE" summary document with references to source documents. In the event that a stand-alone SAFE report is produced for a fishery, as is occasionally done, those could substitute for the summary document.

While Options 2 and 3 are similar, the Committee agreed that a summary document (Option 3) would provide greater utility than brief 2-3 sentence content descriptions (Option 2). Because GARFO plays a central coordinating role among the Councils, NEFSC, and NMFS, the Committee recommends that a GARFO fishery analyst should be the lead on developing the summary document.

The Committee recognizes that the production of stand-alone SAFE reports under Option 4 would offer many benefits, and that this approach should be considered as a possible long-term goal for the region. However, the Committee identified a number of significant costs and

[2] http://www.northeastconsortium.org//projects.shtml

impediments associated with Option 4. For example, the region produces a range of assessments (from benchmarks to data updates) with varying amounts of peer review. These "assessments" are produced throughout the year rather than all at once, and they support multiple FMPs, with fishing years that start on different dates, and are used by two Fishery Management Councils. In addition to the stock assessment information that is typically included in assessment reports, SAFE reports might include additional information (the role of the ecosystem, social and economic information, and EFH). Under Option 4, the Greater Atlantic Region would need to be more organized and coordinated on systematically producing SAFE reports, with commitments and understandings between GARFO, NEFSC, and the Councils about who would take the lead and contribute to the work. If the Greater Atlantic Region is not ready to adopt Option 4, Option 3 represents an improvement over the current situation, and is likely to foster greater coordination between these organizations in the future.

Report Housing

The Committee recommends **Option 1B** for the housing of SAFE reports—posting the reports within a searchable database (e.g., by date, FMP, key word) located on a new GARFO website. Since SAFE reports are not currently coordinated on a National level, the regional approaches under Option 1 would offer significantly more flexibility and would allow the region to tailor its approach over time. Given the large volume of documents that will need to be posted and regularly updated, the Committee agreed that the long-term benefits of having a searchable database would outweigh the short-term setup and implementation costs. The Committee discussed the possibility of posting reports to the websites of the NEFSC or of each Council, but does not recommend this option, as it would not achieve the goal of having a central location for all SAFE report documents. The communications team at GARFO is better equipped than that of the NEFSC or Councils to create and maintain such a website.

Table 1 - Contents of SAFE reports

Biological
Condition of the stocks, stock complexes, and marine ecosystems in the fishery management unit; past, present and possible future conditions; status determination criteria (maximum F threshold, minimum stock size threshold), OFL, OY or ABC and other information necessary to set ACLs; fishery bycatch; document significant trends; data gaps and needs for future work; bycatch; information on whether overfishing is occurring or being prevented and rebuilding targets met; methods for data collection, estimation methods, consideration for uncertainty; whether F is approaching F_{max}; whether stock size is approaching a minimum threshold; catch and bycatch in other fisheries; all sources of fishing mortality (landings and discards).
Essential Fish Habitat
Past, present and possible future conditions; document significant trends; data gaps and needs for future work; required FMP content (description and identification of EFH, including habitat info by life stage, minimizing adverse impacts, etc.).
Socioeconomics
Recreational and commercial fisheries, fishing communities, and fish processing industries; safety; past present and possible future conditions; document significant trends; data gaps and needs for future work.
Assessment and Management
Update or expand previous environmental and regulatory impact documents and ecosystem descriptions; stock assessment document and associated peer review reports, recommendations and reports from the SSC; summary of previous ACLs, ACTs, AMs and management uncertainty. Summary of all above information in a table of contents/index.

Table 2 – General list of documents produced in the Greater Atlantic Region that contain SAFE information

Document	Contents	Lead	Notes
Stock assessment reports from SAW/SARC and TRAC	Stock status and projections, survey and catch time series, species interactions with the ecosystem (climate, habitat).	NEFSC	
Fishery performance reports for groundfish FMP	Fishing effort, landings, price, revenue, vessels, fleet concentration and distribution of revenues.	NEFSC	Annual since FY2010
Ecosystem advisory reports	Time series of sea temperature, plankton blooms, zooplankton.	NEFSC	
Protected species reports	Population trends and status of whales, dolphins and seals.	NEFSC	
EFH source documents	Distribution and abundance of various life stages for each managed stock, in relation to water temperature, depth, and habitat type.	NEFSC or Councils	Updated approximately every 5 years
MAFMC Fishery Information Documents	Summary of catch, landings and effort, often based on unpublished information.	MAFMC	Annual since 2013
MAFMC Advisory Panel fishery performance reports	Summaries of fishermen's perspectives about fishing effort, market trends, environmental factors. Includes interpretation of MAFMC Fishery Information Documents.	MAFMC	Annual since 2013
Environmental assessments or environmental impact statements [a]	History of the FMP, physical environment and essential fish habitat, target species stock status, bycatch, interactions with protected species, descriptions of fishing communities, employment, fleet characteristics, commercial and recreational fishing effort and catch, landings and revenue, trade and processing sectors.	Councils/ GARFO	Some also titled "SAFE Report."
Reports titled "SAFE report"	Fishing effort, landings, price, revenue, vessels, fleet concentration and distribution of revenues, employment, dealers. Information to support ABC determination.	NEFMC PDTs	Sometimes produced in years when no EA/EIS is produced

Table 3 - Options for SAFE report production

Option	Logistical	Human Resources[3]	Cost
Option 1. Use existing reports.	Least complex, requiring no new coordination. Any data gaps and duplication would continue.	No additional human resources. Potentially inefficiencies would persist.	-
Option 2. Use existing reports and create brief description of contents for each FMP or species.	More user-friendly than Option 1. Source document data gaps and redundancies may be realized and mitigated.	A fishery analyst would create and update the description at least annually, if new information is available. Estimated staff time: one day per year per FMP for one fishery analyst.	$
Option 3. Create summary SAFE report for each FMP or species, with a summary document comprising excerpts from source documents.	More user-friendly and complex than Option 2 in creating a new document with excerpts existing documents. Source document data gaps and redundancies may be realized and mitigated.	A fishery analyst would create and update the summary document at least annually, if new information is available. More human effort than Options 1 and 2. Estimated staff time: five days per year per FMP for one fishery analyst.	$$
Option 4. Create new stand-alone SAFE report for each FMP or species, with an index/table of contents and a newly drafted comprehensive summary.	Most complex. Requires substantial change to report generation processes. With multiple stocks in a fishery, would combining assessment reports be feasible?	Report components would be authored by multiple offices (e.g. NEFSC for stock assessment), but a fishery analyst or other staff person (most likely from GARFO) would need to coordinate development of the report. Estimated staff time: four weeks per year per FMP for one GARFO staff, plus several weeks of Council and NEFSC staff to co-author.	$$$$

[3] These are preliminary estimates of human resource and funding requirements necessary to implement each option *relative to the status quo*. These estimates do not include the time required to maintain the current report production process. It is possible that some efficiencies would be established over time.

Table 4 - Options for SAFE report housing

Option	Logistical	Human Resources[4]	Funding
Option 1A. Create a new GARFO webpage with reports listed by FMP.	The simplest option. May get unwieldy with the number of documents to include.	Simplest option to set-up. Ongoing work to maintain. GARFO fishery analyst to give PDFs to communications staff for posting.	Set up Webmaster: 5 days Maintenance Webmaster: 5 days per year. Analyst: half day per year per FMP.
Option 1B. Create a new GARFO webpage with reports archived in a searchable database.	More user friendly product than Option 1A. Will require additional time, resources, and skill to set up.	More complicated set-up to create the database. Perhaps less work to maintain than Option 1A if the database is set up well. GARFO fishery analyst to give PDFs to communications staff for posting.	Set up Webmaster: 5 days May need new software. Maintenance Webmaster: 1 day per year. Analyst: half day per year per FMP.
Option 2A. Add to a pre-existing website: Fish Watch.	Requires coordination with NMFS HQ. Builds on pre-existing websites. FishWatch is consumer-oriented and increasingly mobile.	Requires HQ commitment to set-up and maintain. Key GARFO staff would receive PDFs and provide to HQ contact.	Set up HQ Webmaster: 5 days GARFO Analyst: 5 days Maintenance HQ Webmaster: 5 day per year. GARFO Analyst: half day per year per FMP.
Option 2B. Add to a pre-existing website: Species Information System Public Portal.	Requires coordination with NMFS HQ. Builds on pre-existing websites. Portal doesn't house reports currently.	Requires HQ commitment to set-up and maintain. Key GARFO staff would receive PDFs and provide to HQ contact.	Set up HQ Webmaster: 5 days GARFO Analyst: 5 days Maintenance HQ Webmaster: 5 day per year. GARFO Analyst: half day per year per FMP.

[4] These are preliminary estimates of human resource and funding requirements necessary to implement each option relative to the status quo. These estimates do not include the time required to maintain the current report housing process. It is possible that some efficiencies would be established over time.

Appendix: SAFE Report Production in the North Pacific

SAFE report	Approach to SAFE report production
Gulf of Alaska (GOA) groundfish	Largely authored by the Alaska Fisheries Science Center. Stock assessment authors perform their evaluation and present it to the groundfish plan team at public meetings in September and November every year. Fishermen (or their representatives) often attend to provide comments that could inform future survey plans or data interpretation. The plan team comments and writes an executive summary that ties the various assessments together into one SAFE document. The plan team is co-staffed/coordinated by one Council staff person and a lead NMFS staff. The GOA stocks are surveyed every other year. In the off years, the SAFE report is more of an updated or tweaked version of the previous GOA groundfish SAFE, with other data included (acoustic surveys, age data). The SSC also reviews the assessments that go into the report, serving as a peer review that the document represents the "best available" information.
BSAI groundfish	BSAI groundfish SAFE report is developed in a manner similar to the process used to develop the GOA groundfish SAFE reports, except that some rockfish stocks have full assessments every other year based on annual survey data.
GOA and BSAI groundfish economics	The SAFE is written by the NMFS economists at the AFSC. They receive data support from AKFIN (Alaska Fisheries Information Network) of the Pacific States Marine Fisheries Commission. AFSC staff writes the document each year and presents it to the SSC, AP and Council.
Crab	Though the fishery is primarily managed by the State of Alaska, stock assessment and SAFE report authors are divided between ADF&G and AFSC/NOAA.
Crab economics	The Crab economic report is developed in a manner similar to that of the GOA and BSAI groundfish economic SAFE report. This SAFE report has just recently started to be produced.
Scallop	This fishery is primarily managed by the State of Alaska. State staff mainly conduct the surveys and contribute to the report, but there is a plan team that is coordinated by a Council staff person. The Council staff compiles the SAFE report. It is also reviewed by the SSC, Advisory Panel, and the NPFMC. The plan teams meet approximately once a year. An economic overview is included within the scallop SAFE.
Ecosystem	The SAFE is a collaboration between all relevant agencies, but the NMFS ASFC takes the lead. Other contributors include the State of AK (ADF&G) and US Fish and Wildlife Service.
Notes: A new SAFE is produced every year (for all 6 SAFE reports). This is largely driven by the NPFMC's expectation that an update will be considered as part of the harvest specification process (ABCs, TACs) at its December meeting. All of these annual reports take a significant amount of effort to prepare and are hundreds of pages long (BSAI is >1,600p). The components of SAFEs written by plan teams (Introduction/executive summary) include OFL and ABC recommendations for every stock. *Source:* Email correspondence with NPFMC staff. A summary of the preparation and review process is at: http://www.npfmc.org/wp-content/PDFdocuments/resources/SAFE/AFSCsafeReviewProcess.pdf	

Prioritizing Fish Stock Assessments

NOAA Fisheries

February 2014

TABLE OF CONTENTS

Prioritizing Fish Stock Assessments

NOAA Fisheries

February 2014

EXECUTIVE SUMMARY

Assessments for managed fish and shellfish stocks are an important core activity of NOAA Fisheries. The Magnuson-Stevens Act (MSA) requires that fisheries management be based on the best scientific information available, thus the need for stock assessments. Well-established protocols for these assessments have been developed and highly focused deliverables satisfy the MSA requirements. Stock assessments analyze fishery catch monitoring, fishery-independent surveys of fish abundance, biological and other data to produce the required outputs. These data collection and analysis activities constitute a considerable portion of the NOAA Fisheries budget and it is important that they be prioritized to focus on the most important needs.

The prioritization system described here encompasses the updating of assessments for previously assessed stocks and first time assessments for stocks that have never been assessed. Given that the status of many stocks remains listed as "unknown", a comprehensive scan across all stocks can guide priority for first time assessment among the unassessed stocks. These priorities should be based on fishery importance, ecosystem importance, biological vulnerability to overfishing, and preliminary information on fishery impact level (stock status). This simple overview of information may identify stocks of low importance and risk such that further assessment is a low priority. Some high priority assessments may not be feasible to immediately implement due to lack of data or staff.

For stocks that have been previously assessed, the prioritization approach has three components: (1) setting the target assessment level (how comprehensive an assessment is needed), (2) setting the target assessment frequency, and (3) setting the priority among stocks for conducting assessments to achieve their target levels and frequencies, given available data and assessment capacity. The factors that contribute to setting target levels, frequencies and priorities include: fishery importance, ecosystem importance, stock status, and stock biology. In addition, the recent history of new data acquisition and assessment updates contribute to deciding whether the next assessment should be conducted as an update, which uses the same approach as previous assessments and simply incorporates more recent data of the same types, or as a benchmark assessment that involves a more thorough analysis of alternative approaches and requires a more extensive peer review before accepting results.

A stock's target assessment level, e.g. degree of comprehensiveness, has a large impact on the data requirements to conduct the assessment. Stocks with high fishery importance, high ecosystem importance, and biological factors that lead to high natural fluctuations will warrant high level assessments. High level assessments typically need precise and accurate fishery

independent surveys and data on fish ages from the fishery and the surveys. These high level assessments provide more direct information on fishing mortality and on fluctuations in stock productivity (recruitment), and thus can be more accurate and provide better forecasts of needed changes in annual catch limits. Stocks at moderate levels of importance or expected fluctuations can suffice with less data-rich assessments. Some stocks will be identified as sufficiently minor components of the fishery such that their assessments need not extend beyond baseline monitoring of catch and simple indicators. At all assessment levels, there should be consideration of environmental and ecosystem factors to help distinguish natural from fishery effects on the stocks.

A stock's target assessment frequency should depend on its intrinsic variability over time as well as its importance to the fishery and ecosystem. The greatest fluctuations are expected for stocks with short life spans and high variability in productivity. Stocks with longer lifespans tend to fluctuate less because of the many age classes in the population. High fluctuations create a greater need for frequent updates in annual catch limits. Stocks with high fishery and/or ecosystem importance need more frequent assessment updates to quickly provide access to increases in abundance while keeping the chance of overfishing at an acceptable level. Target update periods are expected to typically be 1-3 years, but some may range up to about 10 years.

The priority for updating an assessment depends principally upon the degree to which it is overdue relative to its target frequency. Stocks that are more overdue will have highest priority for updates. For stocks that are equally due or overdue according to their target frequency, priority will be given to stocks that are on rebuilding plans or are at risk of overfishing or depletion. Among stocks that are still tied, priority would go to stocks that have new information indicating a drift from the previous forecast and to stocks with higher fishery importance.

It is not realistic to create a single national prioritization list because of the importance of regional fishing communities. Further complications include regional differences in total fishery value, assessment data availability, and long-standing processes for arriving at regional assessment prioritization decisions. Additional prioritization challenges are incurred for those Centers that engage in assessments with various international fishery management organizations. While the ideas presented here may be useful in those international settings, the principle focus of this prioritization process will be for domestic stocks in federal fishery management plans.

The proposed prioritization approach centers on the delivery of consistent information to each science/management group to help support and standardize their decision-making with regard to assessment priorities. This report and a database containing all the factor scores will be updated and made available to all parties involved in deliberations regarding assessment prioritization. The first time each Center works on prioritization with its respective management group (Fishery Management Council, regional or international commission, NMFS region or headquarters) may take some time, but subsequent updates should be straightforward and not require a large effort. A portfolio of assessments is expected to evolve, with some activity directed towards first-time assessments, some towards baseline monitoring of low priority stocks, some towards high quality assessments of high priority stocks, and some towards more intensive investigation of ecosystem linkages where needed.

As each region [1]deliberates on its assessment prioritization process, there also should be consideration of the process and time needed to conduct reviews of assessments and to move assessment results into implementation of management actions. It is recommended that each region conduct management strategy evaluations on a few representative stocks in order to understand the implications of stock variability, assessment imprecision, assessment frequency, and time lags between assessment and management implementation. In the future, this prioritization process can provide the necessary framework to guide wise national investments in improving survey and staffing capabilities for more accurate, precise, and timely scientific information in support of stock assessment requirements.

[1] The generic term "region" is used to refer to the group composed of a NMFS Science Center and its management partners.

BACKGROUND

SITUATION

The Magnuson-Stevens Act provides the foundation by which Fishery Management Plans (FMP) are created for fisheries that are in need of conservation and management. Each FMP lists fish stocks that are managed under that plan, and the FMP then specifies optimum yield for that fishery, criteria to determine whether overfishing is occurring or if any of the stocks have become overfished (depleted), and specifying annual catch limits such that overfishing does not occur. Determination of overfishing and overfished levels and annual catch limits is required to be guided by the best scientific information available. Fish stock assessments are designed to provide exactly the quantitative scientific information needed to determine the status of fish stocks and to guide annual catch limits.

Stock assessments are analyses of the population dynamics of the stock. Full assessments utilize catch data from fishery monitoring programs, stock abundance data from fishery-independent surveys or fishery catch rates, and data on the biology of the stock from various sources. These data feed into stock assessment models which integrate the information from the various sources and provide estimates of stock abundance, stock productivity, and fishing mortality over time. If the assessment is based on weak, imprecise data or has not been updated recently, there is a chance that it is providing guidance that is either allowing overfishing or is forgoing available fishing opportunities. It is impossible to confidently prevent overfishing while attaining a yield that is a large fraction of the theoretical Maximum Sustainable Yield (MSY) without having an accurate, precise and timely stock assessment to guide frequent adjustments to catch levels. With accurate and precise stock assessments, the recommended catch can approach the theoretical MSY while having only a small chance of overfishing. Thus, it is important that stocks for which the fishery strives to achieve as large an optimum yield as possible are supported by data-rich, frequently updated stock assessments.

Stock assessments are conducted principally by the six NMFS Science Centers in collaboration with State, Council, international and academic partners. Assessment results are delivered to the NMFS fishery managers, the Fishery Management Councils and international fishery management organizations for their use in developing recommendations for management of the fishery. Because assessments directly support the regulatory process, the assessment results can be contentious. For stocks managed under federal Fishery Management Plans, the MSA's National Standard 2 Guidelines defines the requirement for certifying that the assessment represents the best scientific information available. The reauthorization of the MSA in 2006 specifically addresses this review issue by establishing an opportunity for the Secretary of Commerce with each Council to establish a peer review process, and by designating the Council's Scientific and Statistical Committee with specific roles in providing the Council with scientific advice on fishing levels including the acceptable biological catch that would prevent overfishing. The relationship between NMFS science programs and the regional Fishery management Councils, NMFS regulatory offices and various international partners for highly migratory and other treaty-managed stocks, such as those off Antarctica, is important for successfully turning assessment data into useful management advice on a timely basis. These relationships should include an objective

process to determine which stocks are priorities for assessment, and then to effectively conduct, review, and communicate the assessment to the affected public.

Since publication of the Marine Fish Stock Assessment Improvement Plan (SAIP) (Mace et al, 2001), numerous national programs and working groups have been developed to improve assessments. These include:

- National Stock Assessment Workshops and National SSC Workshops provide a forum for development and advancement of the scientific approaches and protocols;
- Advanced Sampling Technology Working Group develops improved data collection and processing technologies;
- Fisheries Information System program management team coordinates catch monitoring nationally;
- National Observer Program and Marine Recreational Information Program do the same for at-sea observers and recreational fishery catch monitoring, respectively;
- Assessment Methods working group focuses on improvement of the analytical stock assessment methods.
- Species Information System provides a national, web-based portal to all assessments and fishery status determinations and provides outputs that can be efficiently provided to inquiries at both the regional and national level
- Fisheries and the Environment (FATE) and the Habitat Assessment Improvement Plan work to improve the inclusion of environmental, ecosystem and habitat information in assessments.

Collectively, these national groups achieve a federated stock assessment enterprise under the leadership of the NMFS Science Board. This assessment enterprise meets national mandates established by the MSA and other legislation and executive orders, and is responsive to regional assessment needs and opportunities.

The cost associated with conducting a particular assessment is complicated. Each assessment is not an individually contracted task. There is a complex, many-to-many relationship between the several assessments conducted in each region and the several multi-species data sources that support those assessments. Most funds go into large scale, long-term data collection programs that simultaneously collect data on many co-occurring stocks. Assessment programs encompass a broad portfolio of activities from basic fishery data collection, to surveys, conducting standard assessments, and studies to improve consideration of ecosystem, environmental and habitat effects on fish stocks. The fishery-dependent aspect of the overall program is conducted in strong partnership between the Science Centers, Regional Offices, coastal states and marine fisheries commissions and Councils. The fishery-independent aspect of the program is partially conducted through use of the NOAA OMAO Fishery Survey Vessels, as well as fishing vessels contracted by the Science Centers and various partners, state surveys, and cooperative research programs. Further the costs of conducting assessments vary tremendously depending on the type of assessment, size of the stock, its range and habitat. The many-to-many relationship between funding of data collection programs and resultant assessment outcomes confounds detailed budget accounting. Thus, identification of which assessments would be conducted on the basis of new funds is fundamentally fuzzy. New funds build regional assessment capacity, including expanded

data collection. The returns on these investments result in improved assessment output some years hence depending on the specifics of the situation.

The SAIP in 2001 provided a baseline description of the NOAA Fisheries' stock assessment enterprise. It set the goal of at least baseline monitoring (basically just catch and perhaps some simple indicators) for all stocks, standard assessments for core stocks, ecosystem-linked assessments for select stocks. The SAIP defined five levels at which an assessment could be conducted:

1. Assessment based on empirical trends in relative stock abundance;
2. Assessment based on a snapshot equilibrium calculation;
3. Assessment based on time series of catch and an abundance index to support application of a dynamic model;
4. Assessment is age-structured, so needs time series of age and/or size data and can now estimate changes in fishery characteristics over time and can estimate fluctuations in annual recruitment, and has direct information on the fishing mortality of each year class entering the stock;
5. These assessments link to ecosystem, habitat or climate factors to help explain and forecast the fluctuations that are empirically measured in a level 3 or 4 assessment.

Today, assessments at level 3 are generally considered to be able to determine overfishing and overfished status, but are marginal for the purpose of forecasting changes in annual catch limits. Most assessments are conducted at level 4 today and a few have achieved a level 5 status. Several different modeling approaches are used, but there has been evolution towards models that are internally age-structured but very flexible in data requirements. A revision of these levels is underway as an update of the SAIP.

NEED FOR PRIORITIZATION

The demand for rapid updating of assessments became acute with the requirement for annual catch limits in all fisheries. If stocks fluctuate in abundance and an annual catch limit is to be set at a level that will attain a target level of fishing mortality, then the ACL must be updated sufficiently close to the onset of a fishing season in order to take advantage of timely information on the forecast abundance of the fish stock. This is because the ACL is effectively the product of a target fishing mortality level (F) and the forecast of the available stock biomass (B) in the upcoming fishing year. So if the actual B in the upcoming year differs from the forecast B, then catching the ACL will over- or under-achieve the target F level. Hence, consideration of the target assessment frequency should also take into account the time it takes to make management updates (including ACL adjustments) on the basis of assessment updates. Where there are high fluctuations in B, there is greater need for shortening the timeframe between data collection and management implementation. For example, to the assessment to management transition is just a few months for short-lived species like Pacific salmon managed by the Pacific Fishery Management Council and by the US-Canada process managing the highly fluctuating Pacific whiting stock which begins entering the U.S. fishery at age 2. Other regions have developed short-turnaround processes for some key stocks, but there are insufficient resources to assess all stocks on an annual basis, and many stocks

do not need annual assessments. Hence an objective and quantitative approach for establishing assessment priorities is necessary.

NMFS Science Centers have recognized the need for prioritization and streamlining of the assessment process. For example, the Northeast Fisheries Science Center, at the request of the Northeast Regional Coordinating Committee, created and used a revised process in conducting assessment updates in 2012 (NEFSC, 2012). A particular focus of this revision was an effort to move more assessments from a time-intensive benchmark assessment process, to a streamlined update process. Many of the concepts embodied in the NE process are represented in the national prioritization process presented here.

Other nations have also recognized the need for coordinating the pace of assessments and the expectations for timeliness of management updates. In Australia, Dowling et al. (2013) investigated the historical patterns of investment to attempt to better understand the trade-off between research and management costs, risk to the stock and ecosystem, and level of allowable catch. In Europe, the ICES organization formed a working group (WKFREQ) to investigate factors that could allow for reduced frequency from their typical annual assessment updates (ICES, 2012). In 2011, ICES conducted annual assessment updates for 144 stocks and biannual assessments for 48 stocks, thus nearly twice the number of assessments than are conducted in the U.S. each year The ICES report reached the following conclusion with regard to reducing assessment frequency and deriving multi-year management advice from some assessments:

> *"WKFREQ suggests that multiannual management approaches can only be considered for a limited subset of ICES stocks, namely those with robust assessments and modest exploitation, those with a limited amount of new information each year, those with very noisy data, those in which management is only weakly directed by assessments, and those in which individuals are very long lived and exploitation is (again) modest. Stocks in any other circumstances are unlikely to be suitable for a multiannual approach.*
>
> *Even in suitable cases, the risk of changing to a multiannual system needs to be evaluated using a quantitative approach such as an Management Strategy Evaluation. Such an evaluation needs to consider the assessment model used and its uncertainty, survey and recruitment variability, the initial state and trajectory of the stock, the management approach used, how well the fishery performs economically, and more qualitative aspects such as political sensitivity. An evaluation that ignores one or more of these aspects in determining suitability may well reach the wrong conclusion, with potentially damaging consequences."*

The U.S. situation differs from the European situation in that we have been successful in reducing overfishing, thus achieving a more modest exploitation rate for more stocks, a situation that is more amenable to reduced assessment frequency. Nevertheless, the WKFREQ recommendation for Management Strategy Evaluation holds true for the U.S. as well. A prioritization system informed by MSE will be more objective and transparent as to its expected benefits.

Scope: Stocks and Regional Scale

The species (stocks) to be considered in an assessment prioritization scheme are numerous and diverse. In some cases, a managed stock is a geographic subset of a species. In other cases, the

stock is a complex containing a few to many species. The total number would be greater than 1000 if all species within complexes were counted individually. The fact that some species have been lumped into a complex for management purposes does not completely discharge stewardship responsibility to assure that members of the complex are not being unduly affected by the fishery. Across the nation, FMPs have varied tremendously in the degree to which they have included species within the plans. Some are single-species plans and some include a wide range of species that are targets of the fishery or associated with these target species in some way. In some cases, the FMPs have included a large number of co-occurring species which, by their inclusion, would inherit the requirements for status determinations and annual catch limits. The 2009 update of the National Standard 1 Guidelines recognized this conundrum and established a category termed "ecosystem component species". A species can be placed in the ecosystem component category if it is not targeted or retained by the fishery and its level of bycatch is determined to have a negligible impact to the stock. Thus, a low-level stock assessment is to determine if a species is a member of a management unit or is an ecosystem component species . In 2013, there are 478 managed stocks and stock complexes in the fishery management plans.

The species scope for this plan is also complicated by our engagement in the international arena. In some cases the managed stocks are included in fishery management plans, but the assessments occur in an international working group setting that is not under Council or NMFS control and involves factors that would not be easily incorporated into a US domestic prioritization process. In other cases, there are internationally managed stocks such as CCAMLR managed Antarctic stocks, that are outside of FMPs but still require use of US assessment resources.

In 2005, the Fish Stock Sustainability Index (FSSI) was created and the 230 stocks included in this index effectively became the previously undefined "core" stocks from the SAIP. FSSI stocks contribute 90% of the catch, although some stocks are on this list because of a history of overfishing or other reasons to establish importance. A Departmental-level performance measure was created to track progress in improving the FSSI and in providing adequate assessments for these 230 FSSI stocks. An adequate assessment is considered to be one that can provide information relative to status determination criteria[2] on both overfishing and overfished status (SAIP level 3), has been updated within the past 5 years, and has been validated as best scientific information by a review process. The breakout of stocks and stock complexes is shown in Table 1. They are unequally distributed among the jurisdictions of NMFS regions, regional Fishery Management Councils, and Fishery Management Plans. These 46 FMPs each contain from 1 to many tens of managed stocks.

The proposed schedule for application of the prioritization process would have each Center take a tiered approach with their respective Regional Council or other partners to cover all stocks in their jurisdiction. The first tier would cover the domestically assessed and managed FSSI stocks. The second tier would extend to other managed stocks, species within managed stock complexes, ecosystem component stocks, non-FMP internationally managed stocks, and state/commissioned managed stocks as appropriate for the particular Center.

[2] Note that level 1 and 2 assessments support some status determinations and status determinations are retained even when assessments are more than 5 years old.

We propose to take a regional scope to prioritization because of the large challenge in calculating each stock's contribution to national benefits. Optimum yield from fisheries should be defined in terms of benefits to the nation, so it is logical that the prioritization of assessments also be in national terms. In practice, however, the degree to which social, economic, ecological and biological analyses can quantify optimum yield in terms of benefits to the nation is quite limited. The importance of regional communities is a challenge to quantify. Typically, optimum yield is defined only in terms of an amount of catch for a particular stock and is not even extended to a multi-species analysis within an FMP. Consequently, it will not be feasible to quantitatively define absolute priorities for stock assessment at a national level. The assessment prioritization process described here will focus on facilitating the standardization of regional prioritization processes and providing a national reporting system for the results of this regional prioritization. Higher level decisions regarding allocation of national resources between regions can be guided indirectly by the results of the regional prioritization.

PRIORITIZATION OVERVIEW

In brief, the proposed prioritization process involves the following steps:

1. Target Assessment Level and Frequency: Among unassessed and previously assessed stocks, set medium-term assessment goals
   - Among stocks that never have been assessed, set priority for first-time assessment, if any, or conclude that current level of baseline monitoring is sufficient.
   - For stocks that need assessment, set target assessment level; this drives the data requirements
   - Set target assessment update frequency for each stock
2. Prioritize to Achieve Targets: Annually update priorities for conducting assessments, with a portfolio approach to allocate assessment capacity to achieve a mix of first-time, benchmark, and update assessments:
   - Benchmark assessments for assessments needing improvement or for which new data will allow advancing to higher level;
   - Update assessments for stocks that are at or exceed their target update period.

The Target-Setting stage is important because it is not possible to prioritize without having clear targets to be achieved. These targets relate to how comprehensive the assessment should be (e.g. its assessment level) and how frequently it should be updated. While it is inevitable that current data availability will influence consideration of a stock's target level, this should not be an overriding influence. It will be better to establish goals that are independent of current data and then to consider the gap between current data and the stock's goal. The Prioritization stage then directs assessment efforts to accomplish these targets. The "First Time Assessments" distinction is needed because it is not realistic to establish a single set of factors that encompasses both the updating of assessments for previously assessed stocks and first time assessments for stocks that have never been assessed. For stocks that have never been assessed, we lack the information needed to establish longer-term expectations for its assessment level and frequency. In the sections

below, we will first describe the factors to be considered in the process, and then describe how these factors are used to assign targets and priorities to stocks.

FACTORS TO CONSIDER IN TARGET SETTING AND PRIORITIZATION

The major factors that influence the setting of assessment targets and priorities are described in this section and summarized in Table 2. These factors are:

1. fishery importance (commercial and recreational value to the regional fishing communities, with additional considerations);
2. ecosystem importance (role of the stock in the ecosystem and strength of its interactions with other species);
3. stock status (relative to target and limit levels of abundance and fishing mortality);
4. stock biology (how much change is expected per year, on average);
5. history of assessment, including availability of new information to resolve extant issues or indicate a change in stock abundance.

FISHERY IMPORTANCE

Fishery importance on a per stock basis would best be described in terms of benefits to the nation from fishing activities affecting that stock. As described earlier, it is not feasible to quantify importance in these terms, nor would it be politically feasible to create a system that ignored the regional importance to coastal fishing communities. It would be ideal to be able to calculate the incremental value to the nation of conducting an assessment on one stock versus another stock, but such a detailed economic analysis is not feasible. Consequently, the proposed system described here will use both commercial landed value and recreational catch, while providing an opportunity to adjust a stock's importance level according to less quantifiable factors, including stocks that are limiting factors in mixed stock fisheries, stocks that have recognizable non-catch value to society, and stocks that contribute to subsistence fisheries. Importantly, the commercial and recreational scores will be provided separately and not explicitly added together.

For a stock's commercial importance, the landed value of the catch will be the data from which a non-linear ranking would be calculated. If raw catch value is used, then the most valuable stocks would overwhelm the low valued stocks and there would be little ability for other factors to establish a priority for assessment of the low valued stocks, for which there still is a mandated need to prevent overfishing. On the other hand, if the stock-specific catch values were binned into categories with equal numbers of stocks and bins were assigned scores of 1 to 5, then then high value stocks would receive only a small amount of higher priority than the low value stocks. The proposed progressive score transforms the raw catch values as $\log_{10}(1.0 + \text{landed value})$ to reduce the range, and then scales this range to have a maximum value of 5.0.

Although good databases with commercial catch by species are available, commercial and recreational catch values on a stock-specific basis for all stocks are not readily available. A preliminary exercise collected catch information from each region for all stocks in 2009. It is used here to demonstrate some general characteristics of the range of catch across stocks. Annual updating of this stock-specific catch information is underway to provide commercial and

recreational catch relative to annual catch limits. These data will be used for the prioritization process when they become available.

An example exercise for fishery importance used the commercial domestic landed catch amount in 1000s of pounds of whole weight for 2009. On this basis, stocks with a catch of approximately 100 million lbs would have a score of 4.0 (after rescaling so that the maximum score would be 5.0), 5.5 million for a score of 3, 310 thousand for a score of 2, and 16 thousand for a score of 1.0. With this approach, many FSSI stocks would have values in the range of 2-3 (Figure 1a), and most non-FSSI stocks would have values less than 1.0, and many would score near 0. Note however that some of these zero scores were because catch data on some of the minor, unassessed stocks were not available.

Recreational catch in 2009 was processed in the same way as the commercial catch, e.g. the recreational score is $\log_{10}$(1.0 + retained catch in 1000 lbs), then scaled to have a maximum score of 5.0. As with commercial, this is done on a national basis. There are 134 FSSI stocks and 215 non-FSSI stocks for which we found no reported recreational catch in 2009 (Figure 1b). The top three recreational stocks (Table 3), with catches of 9-17 million pounds, were: Summer flounder - Mid-Atlantic Coast, Bluefish - Atlantic Coast, and Yellowfin tuna - Central Western Pacific.

Scaling each of commercial and recreational to have a maximum scale of 5.0 on a national basis has desirable characteristics for this exercise, but should not be interpreted as a judgment that commercial and recreational value are of equal importance. It would take a very involved economic analysis to actually place recreational value on the same basis as commercial value. Consequently, the commercial and recreational scores will be kept separate. With catch ranked nationally in this way it is still feasible to use the national values within each region or within FMP. By using a maximum of 5.0 for each, this essentially places commercial and recreational importance on the same scale nationally, however this will play out differently within each region as these scores are used to actually assign assessment priorities. Off Alaska, recreational catch of federally managed stocks is very small compared to commercial catch so the low recreational score for all stocks will have negligible effect on the relative ranking of stocks. Whereas in the Southeast, recreational catch is greater than commercial catch for many stocks, so both the commercial and recreational rankings will have an impact on prioritization. The scaling of commercial versus recreational value and the inclusion of non-catch and subsistence would need further attention if comparisons between regions are to be considered.

Figure 2 shows that the stocks with highest recreational score nationally tend to have at least a moderate score on the commercial scale. This is true for both the FSSI stocks and for the non-FSSI stocks. On the other hand, stocks with the highest commercial score nationally tend to have very low recreational catch.

The values displayed here have been based on landed catch amount, not value, and have only been displayed nationally, not regionally, so these figures and lists are preliminary and will certainly change as landed value, not catch, is used as the common metric.

FISHERY IMPORTANCE MODIFIERS

In addition to the commercial and recreational score, additional factors can contribute to the fishery importance score for a stock. These include:

- +1.0 for stocks on rebuilding plans because their recent catch value is depressed below long-term potential;
- +1.0 for stocks that have a particularly high constituent demand for excellence in stock assessment. For example, stocks that are in catch shares programs or stocks that are in a multi-stock fishery and their status is limiting the fishery's ability to harvest more productive stocks in that multi-stock fishery. In this case, good assessment of the smaller, less valuable stock is important to prevent undue restriction on harvesting of the more valuable stock. A cap on the percentage of stocks that can receive this bonus will need to be established to prevent excessive usage rendering it meaningless.
- +1.0 for stocks that have a high non-catch value (for example underwater viewing of reef fish).
- +1.0 for stocks important to subsistence fishing.

ECOSYSTEM IMPORTANCE

All species have ecosystem importance but their importance increases if they constitute a major forage species for one or more managed species, or if their role as a predator is important for structuring ecosystems, including changing the natural mortality rate of other species. Importance would increase further if the forage species was critical for an endangered or protected species. The ability to define ecosystem importance for predator species is more difficult since the consequences of apex predator depletion are often difficult to trace, much less quantify. However a mixture of food habits data, basic ecological information and model exploration (when available) can usually identify ecosystem components that have potential or likely substantive impacts on predation mortality rates or community structure. As the data and models to make such determinations are evolving, default scores of 1 are likely to be most reasonable for most species in the absence of evidence of some sort to the contrary.

Ecosystem Score considers both bottom up and top down possibilities where:

"Bottom-up" (Forage or habitat) score

1. if only a minor dietary or habitat provider for managed stocks (e.g., Pacific grenadier)
2. if major dietary or habitat component for one or more managed stocks (e.g., Pacific cod, corals)
3. if major dietary or habitat component for a broad range of managed stocks, or an endangered or otherwise protected and vulnerable stock (e.g., walleye pollock, skipjack tuna, menhaden, krill, shrimp)

"Top-down" (predator/ecosystem interaction) score

1. if change in abundance would likely have minor or unmeasurable impacts on other managed stocks (e.g., splitnose rockfish)

2. if change in abundance would likely have notable changes in predation mortality, recruitment or other vital rates for one or more managed stocks (e.g., lingcod, marlin)
3. if change in abundance would likely result in substantive changes in predation mortality, recruitment or other vital rates for one or several managed stocks (e.g., arrowtooth flounder in Gulf of Alaska).

Ecosystem score = maximum of above scores, so could be up to 3. Assignment of scores will need to be an iterative process to achieve a balanced approach across regions.

Ecosystem Effects

The discussion above with regard to ecosystems is based upon the degree to which harvested fish stocks are important to ecosystems, thus harvest levels for these fish stocks must be managed to protect the ecosystem of which they are members. The converse is also true; changes in the ecosystem, climate, and habitat will affect the productivity of fish stocks and better assessments will take these effects directly into account. More complete single species stock assessments are designed to be flexible enough to track the fish stock's response to these factors, but the assessments do not include the factors directly, so their response at best will lag behind true changes and forecasts can be biased. Here in this prioritization document, we have not attempted to include the need for studies to better understand these effects on fish stocks and to incorporate them directly into the assessments. NOAA recognizes the need for such work, otherwise we risk losing sight of the forest while focusing too closely on the trees. At this time, NOAA Fisheries is working on an update to the Stock Assessment Improvement Plan (2001). There the issue of expanding assessments to more directly account for these effects will be addressed. Future evolution of a prioritization process should seek a more broadly balanced portfolio that includes such ecosystem work.

Stock Status

The stock's status is based on the most recent estimates of the stock's abundance (spawning biomass, SB) and fishing mortality rate (F) relative to limits and targets for these quantities. For stocks that have previously been assessed, the intent would be to use the results of the most recent assessment to guide the importance of conducting an update of that assessment. The minimum score is 2 for a stock that has a low F, is abundant, and is not on a rebuilding plan. The maximum score is 9 for a stock that is overfished, is experiencing overfishing, and is on a rebuilding plan. Stocks that are near their target level of F and SB will have a score of 4. Stocks that are currently unknown with regard F and SB will have a score of 6.

F Category	Score		Abundance Category	Score
LOW IMPACT $F_C <= 0.25*F_{MSY}$	1		ABOVE TARGET $SB_C > 1.25*SB_{MSY}$	1
MODERATE IMPACT $0.25*F_{MSY} < F_C <= 0.9*F_{MSY}$	2		NEAR TARGET $MSST < SB_C < =1.25*SB_{MSY}$	2
CAUTION or UNKNOWN $F_C <> F_{MSY}$ is unknown	3		CAUTION or UNKNOWN $SB_C <>$ MSST is unknown	3
HIGH IMPACT $F_C > 0.9*F_{MSY}$	4		OVERFISHED $SB_C <=$ MSST	4
			On Rebuilding Plan	" +1"

Where:

F_C is the most recent (e.g. current) fishing mortality rate

SB_C is the most recent spawning biomass

SB_{MSY} is the target spawning biomass level, or suitable proxy such as 40% of $SB_{unfished}$

F_{MSY} is the limit fishing mortality rate, or suitable proxy, above which overfishing is occurring

MSST is the limit spawning biomass level, or suitable proxy, below which overfished status occurs.

Among 220 assessed stocks with information on F/Fmsy in 2013, the range of values is displayed in Figure 3. 88% have F/Fmsy < 1.0. Below that level, there is no obvious clustering or breakpoints; stocks are nearly uniformly distributed according to this ratio as shown by the nearly linear pattern for the lower 80% of the stocks. There are 187 stocks in 2013 with information on B/Bmsy. Of these, there are 49% with B/Bmsy > 1.25 and 65% with B/Bmsy > 1.00.

Over time, the boundaries between the levels may needed to be adjusted, or replaced by a system that uses the estimated ratios directly rather than use scores associated with binned values. For example, the F score could be equal to 4.0*F/Fmsy, and the B score could be 2.0*Bmsy/B (note the inverted ratio). For now, the binned approach has the advantage of providing a scoring system even when only approximate values are available.

STOCK BIOLOGY

The consideration of stock biology is important because it sets the scale for how much the stock abundance, and hence its ACL, is expected to change between assessments. This will be a factor in determining the types of data needed and a primary factor in setting the target frequency of assessment updates. There are two counter-acting forces to consider.

- One factor is the annual fluctuations in recruitment of young fish into the stock. This "recruitment variability" has a coefficient of variation often near 60% and can be greater than 100% for some stocks. Stocks may also fluctuate over time if there are changes in adult natural mortality and/or growth.
- The counter-acting force is the inertia to change that result from the fact that there typically are many age groups in the stock, so the total stock abundance tends to average out the fluctuations. When adult mortality is high, the occurrence of older age

groups is diminished. Since the goal is inertia that opposes too frequent changes in annual catch limits, a suitable proxy is the mean age of fish in the catch multiplied by some factor to be determined later. The mean age should be measured as an average over several years to smooth out the effect of recruitment fluctuations, and in cases where it cannot be directly calculated, it should be estimated from life history correlates.

For the purposes of setting target levels for various data types (see Target Assessment Level below), it is suitable to simply categorize stocks as having a low, moderate, or high expected degree of fluctuation. For the purposes of setting the target period between assessments, the protocol will use the mean age of fish in the catch multiplied by a factor, and then to add or subtract one year based on the degree of recruitment variability.

Another aspect of stock biology that was considered, but not quantitatively included here, is the susceptibility of the stock to the adverse effects of overfishing. Here the arguments with regard to overfishing and overfished are different, but both related to the inertia concept. For short-lived stocks, which have high natural mortality rates, the target levels of fishing mortality are correspondingly high, and the fraction of the stock that is caught each year is high. Thus, if the ACL is set too high due to scientific uncertainty, or it is exceeded, then the fraction of the stock that escapes the fishery could be quite low. If the stock is able to continue to produce good recruitment from this low spawning biomass (i.e. high recruitment resiliency), then it should recover quickly from this overfishing event. On the other end of the spectrum are stocks with low natural mortality rates and low target fishing mortality rates (sometimes <5% of the available stock). In this case, a one year excess catch will have little impact on the fraction of the stock that escapes the fishery that year. However, if the assessment is not updated for several years, or the same assessment bias persists for several assessment updates, then the catch overage will compound annually. Although such long-lived stocks are only slowly affected by short-term moderate overfishing, if they do decline into an overfished condition then it could take many years for them to rebuild because annual recruitment is a small fraction of the standing stock. The Productivity-Susceptibility Analysis (PSA) (Patrick et al. 2010) includes vulnerability due to slow-recovery and low M, and will be used in the examination of stocks for first-time assessments in the next section. For the prioritization of previously assessed stocks, we have not included the PSA score directly because several of the PSA factors (natural mortality rate, F/Fmsy, etc.) are already included elsewhere in the prioritization.

History of Assessment and New Information

Some new information is simply the addition of a new data point to the end of a time series in order to track changes in the stock. These new data will not perfectly match the forecast from the previous assessment because of two primary factors. One is that all data have some measurement error so they individually will not perfectly represent the state of the fish stock. The other is that all models are simplifications of the processes in nature so cannot take into account all factors that cause changes in fish stocks over time; if the forecasts could be perfect, new data would not be needed. So the new data are used to update the calibration of the model, but the updated model should not overreact to the new data because all data have measurement error. Assessment models are designed to get a good balance between tracking the process over time while not getting off

track due to noisy data. When data are noisy, it is best to wait a few years to accumulate data points to better average out the noise. But when data are of high quality, then they can be used to quickly update stock status.

Another kind of new information is of a more fundamental nature. For example, the introduction of a new survey that directly measures fish abundance, or the completion of a new research project that provides a more accurate measure of natural mortality. When situations like this occur, then it is important to conduct an assessment to take into account this new information. However, all assessments have some number of factors, such as natural mortality, for which the information has uncertainty. It is not useful to simply redo the assessment to re-examine these issues unless it is known ahead of time that new information to help resolve the issue will be available. Otherwise, the assessment effort is better directed to other stocks.

PRIORITIZATION PROCESS

The prioritization process uses the above factors in two steps. First is the setting of goals for the comprehensiveness and timeliness of assessments for each stock (Figure 4). This needs to be done as an initial step and updated occasionally, but not annually. This step includes consideration of which stocks need assessments and which of these assessments can be simple baseline monitoring. It is expected that these goals will outreach current capacity to conduct assessments. The second prioritization step is near annual evaluation of changing stock status, new information, fishery importance, etc. in order to establish priorities for conducting assessments (Figure 5) to achieve, to the extent possible, goals of comprehensiveness and timeliness.

SETTING ASSESSMENT GOALS

FIRST-TIME ASSESSMENTS

Many stocks, most with low amounts of catch, have never been assessed and have little data suitable for use in an assessment. Consequently, much of the information needed to establish targets and priorities for future assessments are not available. These unassessed stocks need a quick examination to determine which of these can stay at an unassessed level, which can be adequately tracked with simple baseline monitoring, and which need a first time assessment. Two recently developed tools can assist in this task.

One tool is the Productivity-Susceptibility Analysis (PSA) (Patrick et al., 2010). This procedure looks at simple information regarding the productivity of each stock and its exposure (susceptibility) to the fishery. Together these produce a score that ranks stocks according to their vulnerability to being overfished. Application of this procedure can identify those stocks that are potentially at risk and thus in need of assessment to provide a more complete evaluation of the status of the stock.

Another useful tool is designed to provide a data-poor approach to setting an Annual Catch Limit (Only Reliable Catch – ORCS) (Berkson et al., 2011). This tool looks at available information

regarding catch, other species in the fishery, and simple indicators of trends in stock abundance (see Table 4 which reproduces Table 4 from the ORCS report). It evaluates whether recent exploitation rate is light, moderate, or heavy; then provides advice on an Annual Catch Limit that should prevent overfishing until a more complete assessment can be completed.

The priority for first-time assessment of stocks can then be based on the PSA's biological vulnerability to overfishing, the ORCS' information on fishery impact level (stock status), and fishery and ecosystem importance. PSA scores range from 1.0 for the lowest vulnerability to 3.0 for the highest vulnerability. The ORCS score for exploitation status also ranges up to a maximum value of 3.0. These two scores will be added to a fishery importance score and ecosystem importance score to obtain an overall score. In some cases, data to even implement PSA and ORCS will be lacking and expert judgment will be needed. The result will be a set of scores within a region to rank stocks according to their need for a first time assessment. Some of these will show a high need, but sufficient data to conduct the assessment may be lacking. Others may have sufficient data for an assessment, usually because data has been collected by a multi-species sampling program that provides data on all encountered species. Some species will score low on this scale, so have low priority for immediate assessment. They should not be ignored. Baseline monitoring to the extent feasible should continue and PSA and ORCS should be updated on a 5-10 year basis.

Previously Assessed Stocks

After a stock has been assessed once, there should be enough information available to evaluate medium term goals for future assessments. Ideally the goal would be stated in terms of a desired degree of statistical confidence in assessment results. While many assessments present results with confidence intervals, the methods are too diverse to support direct comparison and all are not yet able to incorporate the effect of changing ecosystem factors on uncertainty in assessment results. Consequently, a simpler approach is to establish a target for the comprehensiveness (level) of each assessment, and a target frequency for updating the assessment.

Level and frequency are considered separately because the types of resources needed to accomplish them are quite different. Increasing the level of an assessment generally requires acquiring a new kind of information. For example, going to an age-based assessment requires routine collection of data on fish ages. Addition of fishery-independent survey is another type of investment that can improve assessments. Increasing the frequency of assessments does not require new kinds of data, but does require addressing bottlenecks that impede conducting more assessments each year. For example, these bottlenecks could be more age readers to process existing age samples more quickly, more scientists to simultaneously work on more assessment updates, and/or better assessment standardization to streamline the assessment review process.

TARGET ASSESSMENT LEVEL

High level assessments that need more types of data should be reserved for situations with high ecosystem importance, high fishery importance, and/or biological factors that create a high level of natural fluctuations. Stocks that are only moderately important to the fishery and ecosystem and which are not expected to fluctuate much in abundance (and hence ACL) can suffice with a lower level assessment and may not warrant the extra expense to develop a targeted fishery-independent survey and collect extensive age data in order to conduct a higher level assessment.

Fishery importance affects the target level because higher assessment levels (e.g. with routine age-structured data) are more responsive to changing conditions, so can more closely track stock abundance for these high value stocks. Models that use age data can have improved forecasts of upcoming changes in stock abundance and potential yield. Low value stocks are unlikely to warrant the extra expense for collection of age data or instituting a dedicated fishery-independent survey. High value species tend to be more abundant and thus easier to survey because they are detected in most samples. Paradoxically, species that are less common are difficult to survey because their low encounter rate means that even more sampling stations may be needed to attain adequate precision. Fortunately, many fishery-independent surveys are able to simultaneously collect data on a wide range of species regardless of their value to the fishery.

Stocks with high ecosystem importance warrant higher level assessments to guard against ecosystem harm. Assessments backed by fishery-independent surveys and age composition are better able to investigate ecosystem interactions and work towards taking these interactions into account in the assessment.

The biology of the stock influences the assessment level. Stocks with high fluctuations in productivity benefit from age-structured assessments that can better track and forecast the fluctuations. These stocks are exhibiting sensitivity to ecosystem/habitat/climate shifts that warrant age-structured assessments to track these fluctuations and perhaps ecosystem investigations to incorporate the factors causing the fluctuations into the assessment. Note that a stock's sensitivity to ecosystem and environmental change is different from a stock's importance to the ecosystem.

Additional types of data allow for improved assessment calibration. Some assessments simply use a sufficiently long time series of a fishery-dependent stock abundance indicator and catch to calculate the degree to which changing levels of catch cause changes in the stock indicator. A more important stock may warrant requesting a more expensive fishery-independent stock abundance indicator, rather than a fishery-dependent indicator, to have more confidence in the standardization of the indicator over long time periods. Moving to an age-based assessment can provide a more direct indicator of the level of fishing mortality and an ability to account for natural fluctuations in stock productivity (recruitment). These assessments require addition of size and/or age data. These data require biological sampling of the fisheries and surveys, followed by laboratory processing to determine the ages of the sampled fish. Where time series are short and not informative about the impact of the fishery on the stock, then addition of advanced technology data collection can provide a directly calibrated measure of fish abundance. Where changes in fish stocks over time are not explainable simply by fishery effects, then addition of information about changing ecosystem/environmental/ habitat factors can help resolve the impact of fisheries.

The assessment levels in the SAIP (Mace et al, 2001) were described in terms of the type of model used. Separate factors were used to score the quality of the fishery-dependent biological data and the fishery-independent survey data. Since that time, evolution of assessment software has blurred these assessment model levels such that it now seems more important to focus on the types of data available than the model itself. For the purposes of prioritization, a system that relates directly to possible investment decisions is more pertinent. Higher levels of assessment modeling require more types of data and it is the acquisition of these data on an ongoing basis that constitutes much of the cost of more comprehensive and more completely calibrated assessments. The SAIP is currently being updated and a revision of the categorization used to describe the level of data available for each stock will be included and then used for this prioritization process also. While the SAIP will be descriptive of the current state of data availability, the prioritization process will add consideration of whether this state is satisfactory or if improvements are needed.

These target assessment levels will serve two purposes. First, as new data become available to move a stock up to its target level for a data type, then priority for updating that stock's assessment to use these new data will increase. Second, investment decisions can be guided by the gap between current data availability and the data needed for that target level.

TARGET ASSESSMENT FREQUENCY

The period between assessments defines how closely the assessment will be able to track fluctuations in stock abundance and to forecast corresponding changes in the annual catch limit. Stocks with short life spans and/or high fluctuations in productivity are most in need of frequent updating to keep catch limits up-to-date. Fishery importance also is recognized as a factor in the frequency of updates.

One paradox occurs when the survey or fishery data used to track stock abundance are noisy relative to the magnitude of the real fluctuations in the stock. Often the new survey result will lead to constituent requests to quickly update the assessment because the data seem to indicate a change in stock abundance. Unfortunately, the models will tend to track the noise in the latest datum and cause excessive fluctuations in management advice. A better response when the signal/noise ratio is low could be to slow down the frequency of assessment updates so that a modified assessment setup is better able to smooth out these data fluctuations and provide more stable management advice. Ideally, one would conduct a management strategy evaluation to determine the degree to which uncertainty in the assessment increases as the interval between assessments increases. It is recommended that such evaluations occur on some example stocks in each region.

Stocks that are expected to have high natural fluctuations not only need frequent updating, they also need suitable data to use in this updating. For short-lived species, this means an indicator of changes in stock abundance must be very quickly (months) turned into management advice on catch limits for the upcoming fishery season. This is a major rationale for the exemption from ACLs for stocks with one-year life spans; otherwise the ACL would always be out of date relative to the current fluctuation in actual stock abundance. For medium lifespan species, this generally means

that size and/or age data needed for estimation of incoming recruitment will need to be collected and processed quickly to enable a quick turnaround from data collection to management action.

Factors Affecting Target Assessment Frequency

A pragmatic starting point is to use the mean age of fish in the catch as the target interval between assessments. Alternatively, one could use a formula based on total mortality (Z) or natural mortality (M) as roughly equivalent (Fig. 6). If all fish are recruited at age 1, then mean age in the catch is closely approximated by 0.5+(1/Z), or by 0.5+(1/(2*M)). It may be necessary to multiply this mean age by a scaling factor to achieve a good overall level of assessment frequency, and to average mean age data over several years to remove the effect of variable recruitment. The value of this scaling factor will be set after enough of the data elements are collected to do a preliminary application of the target setting process. Then decrease this interval by a specific amount for stocks with high levels of recruitment variability, or increase by a specified amount for stocks with low variability. A nonlinear scale or a cap may be needed so that very long-lived stocks are not assigned an unreasonably long assessment interval. Evaluation and refinement of this approach and consideration of additional biological factors must wait for collation of life history information for more stocks.

Fishery importance and ecosystem importance should affect the target frequency of assessments because of the improved fishing opportunity obtained by quickly tracking upturns in stock abundance, and conversely the fishery and ecosystem risk avoided by preventing acceleration of downturns.

Arguably, stock status could influence the target frequency because stocks that are known to be approaching an overfished or overfishing condition need to be watched more closely to enable ACL adjustments to avoid crossing into overfishing or overfished conditions. Because stocks that are approaching overfishing or overfished status will also tend to be stocks that have high fishery importance, and because a stock's status is constantly changing, it seems preferable to use fishery importance in setting the target assessment frequency and then use stock status in the prioritization step as a tie-breaker among stocks that are equally due for assessment. While stocks that are on rebuilding plans, or approaching an overfishing or overfished condition need somewhat more frequent updates because these conditions are indications of changing stock abundance or fishing mortality rates, the prioritization system should ward against excessive diversion of assessment efforts from healthy stocks that are supporting major fisheries. Doing so will weaken tracking of these stocks and hinder close tracking of their available yield. The proposed system will prevent this diversion because the years overdue will be a primary factor in setting assessment priorities.

Target Assessment Frequency

1. **Mean Age of Fish in Catch * Scaling Factor**
2. **Adjust for recruitment variability:**
    a. **-1 year(e.g. more frequent) for stocks with high recruitment variability;**
    b. **+ 1 year for stocks with low recruitment variabilityvariability**
3. **Adjust for fishery value:**
    a. **– 1 year for stocks with commercial or recreational score above a level to be specified**
    b. **+ 1 year for stocks with commercial and recreational score below a level to be specified**
4. **Adjust for ecosystem importance similarly to fishery value**

EXAMPLE:

1. **Mean age in catch is 4.5 years and scaling factor is 1.0;**
2. **Recruitment variability is high (so subtract 1 year);**
3. **Fishery value is high for commercial but low for recreational (so subtract 1 year);**
4. **Ecosystem importance is moderate (so no change to target);**
5. **Target Assessment Frequency = 4.5*1.0 -1 -1 +0 = 2.5 years**
6. **Round down to 2 years.**

SETTING PRIORITIES FOR ASSESSMENTS

The priority for updating an assessment starts with the number of years that it is overdue relative to its target update frequency, but allows for new data availability, fishery importance and stock status to adjust this priority.

Once a target frequency for assessment updates has been established, the goal is to keep as close to this schedule as possible given available resources. Conducting assessments more frequently is an inefficient use of assessment expertise and burdens the regulatory system with too frequent and unnecessary changes. Waiting too long to conduct an update means that management is based upon increasingly stale information. With each passing year, there is a greater chance that

the stock has drifted off the previous forecast and the fishery is being overly or insufficiently restricted.

After accounting for the years overdue, then additional factors of stock status, new information, and fishery importance are added as fractional values in order to keep them from overly influencing the prioritization. First, stock status (which has values of 1 to 9) is divided by 10 and added to the number of years overdue. This means that stocks on rebuilding plans, or stocks approaching an overfished or overfishing condition, will have priority over stocks that are equally due/overdue but have a less at-risk status. However, at-risk stocks that are not yet due relative to their target frequency will not leapfrog ahead of stocks that are overdue for assessment. This approach will provide a balanced portfolio that will address the most overdue assessments, then the stocks with more at-risk status, and then the less at-risk stocks that are at their target frequency of updating.

When the target interval between assessment updates is several years, then it may be possible to make a quick evaluation of new information as it becomes available and adjust the stock's priority for assessment up or down based upon how closely the new data match expectations from forecasts from the previous assessment. Note that adjustments of this sort are disruptive to an organized planning process and should be applied cautiously. Even making these quick evaluations involves data preparation, staff analysis, and report writing that will detract from the program's capability to conduct planned assessments. A score of up to 1.0 is allowed for this factor.

Fishery importance has already been taken into account when setting the target assessment frequency. However, it is reasonable to use fishery importance as a small factor when other factors are equitable. This is accomplished by adding the fishery value score divided by 10.

Assessment uncertainty is not included as a quantitative factor. For example, some assessments have high uncertainty because the time series of data is short. For these assessments, more frequent updates in the short-term could improve the assessment because data are accumulating rapidly. On the other hand, some assessments have high uncertainty because the data are inherently noisy or there are unknown factors causing fluctuations or retrospective patterns in the assessment. In such cases, it seems better to not shorten the time between assessments and instead to put the effort into better understanding of the factors causing the uncertainty. Consequently, past assessment uncertainty is only used as a factor if there are new information or research results available that are expected to resolve some of that uncertainty. Simply re-doing an assessment because the past assessment had uncertainty is undesirable because that assessment effort could more productively be directed to other stocks.

Prioritizing Assessments Updates

1. **Years overdue relative to target frequency;**
2. **Add stock status score divided by 10;**
3. **Add up to 1.0 if there is new information that indicates a chance from the past assessment;**
4. **Add fishery importance divided by 10;**

EXAMPLE:

1. **Assessment is 2 years past its target date for updating;**
2. **Stock status score is 6;**
3. **There is no new information that indicates an obvious change**
4. **Commercial value score is 3.5 and recreational score is 1.4 and no additional fishery importance factors;**
5. **Priority score = 2.0 + 6.0/10 + 0.0 + (3.5+1.4)/10 = 3.09**

Benchmark vs. Update Assessment

The history of recent assessments is primarily a factor in deciding between doing another update, or doing a full benchmark assessment[3]. The staff time and review effort needed to conduct a benchmark assessment is substantially greater than that needed to provide an update, so decisions to do full benchmarks should carefully consider the forgone opportunity to do updates for several stocks instead of the benchmark. There are three issues that contribute to a decision to do the benchmark assessment:

1. A new data type or research finding is available. A benchmark assessment is needed to fully investigate the assessment performance with this new information, especially if it would lead to elevating the level of the assessment.
2. The previous assessment identified a shortcoming that is not feasible to investigate with available methods and data. Simply re-doing a benchmark should be avoided unless there is good reason to expect more certainty to come from the new benchmark.
3. Several updates have been conducted and a refresh of selected aspects of the assessment is reasonable, although not specifically identified by either issue 1 or 2 above.

[3] An update assessment uses a previously reviewed modeling approach and data types and simply updates the assessment using the most recent data. Only minimal review is needed. A benchmark assessment introduces new methods or data types and may involve a thorough investigation of all aspects of the assessment. A fuller review commensurate with the degree of innovation and controversy is warranted.

Benchmarks should not be done if none of the three criteria are met, irrespective of the age of the assessment. Most of a region's assessments need to be conducted as simple updates if a high pace of assessments is to be accomplished, as in the North Pacific. The fact that a stock has high importance or a low status should not be a primary driver for doing full benchmark assessments. These factors have already contributed to setting target assessment frequency and prioritizing stocks relative to this update frequency. When benchmark assessments are done without having fundamentally new information to consider, the assessment generally treads over the same issues that were unresolved in the earlier assessment.

CHALLENGES

This proposed prioritization system is a first attempt at a comprehensive approach. It will need adjustments as it begins to be applied. Nevertheless, the compilation and presentation of information described in this document can immediately improve the basis on which priorities are set.

One challenge will be to ward against a lopsided application of the system. The goal is somewhere in between a situation in which all stocks are perceived to need equally good assessments, and a situation in which only the most important stocks get assessed. All stocks need some level of baseline assessment and the most important and vulnerable stocks need better assessments. The proposed system is designed to help achieve such a balance, but adjustments may be needed after a few years of implementation.

The degree to which this prioritization system addresses the need for inclusion of ecosystem factors is preliminary, at best. The focus has been upon getting basic assessments done. Ongoing work on an update of the Stock Assessment Improvement Plan should provide additional guidance on how to determine which stocks are most in need of a broader ecosystem consideration. All assessments should recognize that every fish stock exists within a regional ecosystem and the effect of ecosystem changes on the stock should always be considered to the extent feasible.

Many aspects of this prioritization approach are somewhat ad hoc. The ICES investigation of factors affecting assessment frequency clearly indicated that only through a management strategy evaluation can one ascertain the expected improved performance from better data and shorter time lags. This same situation is true for assessments and fishery management in the U.S.

Application of this prioritization system will not get more assessments done each year. The goal is to be more objective about which assessments get done. It is likely that many stocks will be identified as needing better assessments than present data allow, and many stocks for which more frequent assessments are needed. These gaps can identify needs, but filling these needs will require an expanded assessment program. Alternatively, the system could be used to determine what target level of assessment frequency is achievable given current assessment capacity.

The complete science-management system has more elements than the assessments themselves. There are potential bottlenecks associated with timing of peer reviews, time needed to develop management responses to updated assessments, alignment of assessments with start dates

of fishing years, etc. These additional steps in the overall process also warrant consideration as overall improvements in throughput are sought.

IMPLEMENTATION PLAN

- Distribute draft to Fishery Management Councils, NMFS Regional Offices, Fishery Commissions for comment – February 2014;
- Create database of needed information as an added table in the Species Information System – spring 2014;
- Each region begins work on comprehensive Productivity-Susceptibility Analysis and Only Reliable Catch Analysis to serve as baseline for determining which stocks need assessments – begin spring 2014;
- Test prioritization system to determine if adjustments to scaling factors are needed to achieve reasonable results – summer 2014;
- Make database available to regional coordinating committees charged with setting priorities for regional assessments – fall 2014; Create access through SIS public portal;
- Commission Management Strategy Evaluations to test the expected performance of this prioritization system over time – 2015;
- Explore Decision Support System facilitators to guide regional coordinating committees through application of the prioritization process – 2016.

REFERENCES

Berkson, J., L. Barbieri, S. Cadrin, S. L. Cass-Calay, P. Crone, M. Dorn, C. Friess, D. Kobayashi, T. J. Miller, W. S. Patrick, S. Pautzke, S. Ralston, M. Trianni. 2011. Calculating Acceptable Biological Catch for Stocks That Have Reliable Catch Data Only (Only Reliable Catch Stocks – ORCS). NOAA Technical Memorandum NMFS-SEFSC-616, 56 P.

Dowling, N.A., C.M.Dichmont, W.Venables, A.D.M.Smith, D.C.Smith, D.Power, D.Galeano. 2013. From low-to high-value fisheries: Is it possible to quantify the trade-off between management cost, risk and catch? Marine Policy 40: 41-52.

ICES. 2012. Report of the Workshop on Frequency of Assessments (WKFREQ). ICES CM 2012/ACOM34.

Mace, P.M., N.W. Bartoo, A.B. Hollowed, P. Kleiber, R.D. Methot, S.A. Murawski, J.E. Powers, G.P. Scott. 2001. National Marine Fisheries Service Stock Assessment Improvement Plan. Report of the NMFS National Task Force for Improving Fish Stock Assessments. NOAA Technical Memorandum NMFS-F/SPO-56. 76 pages.

Northeast Fisheries Science Center. 2012. Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010. US Dept Commer, Northeast Fish Sci Cent Ref Doc.12-06; 789 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

Patrick, W. et al. 2010. Using productivity and susceptibility indices to assess the vulnerability of United States fish stocks to overfishing. Fish. Bull. 108:305–322.

TABLES

Table 1. This table presents the distribution of FSSI and non-FSSI stocks among Councils and Science Centers in 2014. Each row in this table represents a category within which prioritization could occur, with exceptions in the note below.

Council	Centers	Non-FSSI	FSSI	All
CFMC	SE	37	8	45
Atl_HMS	SE	6	21	27
GMFMC	SE	15	23	38
SAFMC	SE	21	22	43
NEFMC	NE	2	37	39
MAFMC	NE	0	11	11
NPFMC	AK	30	35	65
PFMC	NW-SW	17	45	62
PFMC_salmon	NW-SW	67	0	67
Pac_HMS	SW-PI	14	18	32
WPFMC	PI	42	7	49
		251	227	478

Note: HMS refers to Highly Migratory Species. Stocks that are shared between the GMFMC and SAFMC would be covered by the GMFMC unless otherwise arranged by the SEDAR (Southeast Data and Assessment Review) committee. The MAFMC and NEFMC could be covered by the same prioritization process, as occurs now with the Northeast Regional Coordinating Committee.

Table 2. Summary of factors considered.

FACTOR	First-time assessments	Target assessment level	Target Assessment frequency	Priority for assessment	Priority for benchmark
Fishery importance	Yes	Yes	Yes	Yes	
Ecosystem importance	Yes	Yes	Yes		
Stock status	Yes, from ORCS & PSA			Yes	
Stock biology		Yes	Primary		
Assessment history; Due or overdue?				Primary	
New data indicates drift from forecast				Yes	
New data can raise level or resolve uncertainty					Yes

Table 3. This table shows the ranking of stocks with the largest commercial and recreational catch levels in 2009. Note that values are whole weight, not meat weight, so quahog and clam are higher than one would expect.

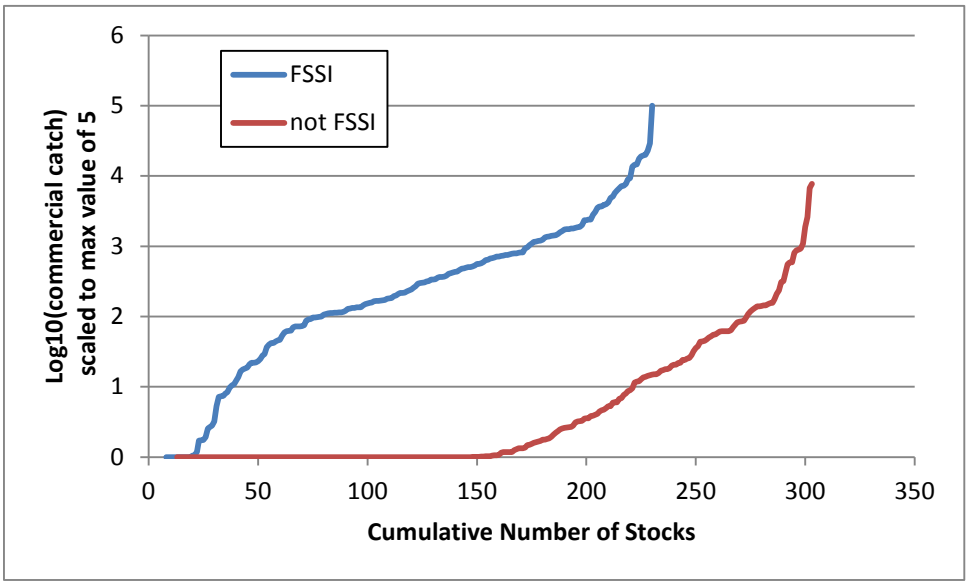
Top 20 Commercial Catch	Top 20 Recreational Catch	High Recr and Comm
Walleye pollock - Eastern Bering Sea	Bluefish - Atlantic Coast	Atlantic mackerel - Gulf of Maine / Cape Hatteras
Pacific cod - Bering Sea / Aleutian Islands	Yellowfin tuna - Central Western Pacific	Pollock - Gulf of Maine / Georges Bank
Ocean quahog - Atlantic Coast	Summer flounder - Mid-Atlantic Coast	Scup - Atlantic Coast
Yellowfin sole - Bering Sea / Aleutian Islands	Red snapper - Gulf of Mexico	Pacific chub mackerel - Pacific Coast
Atlantic surfclam - Mid-Atlantic Coast	King mackerel - Southern Atlantic Coast	Summer flounder - Mid-Atlantic Coast
Atlantic herring - Northwestern Atlantic Coast	Scup - Atlantic Coast	Dolphinfish - Southern Atlantic Coast / Gulf of Mexico
Opalescent inshore squid - Pacific Coast	Gag - Gulf of Mexico	Red grouper - Gulf of Mexico
Atka mackerel - Bering Sea / Aleutian Islands	Black sea bass - Mid-Atlantic Coast	Bluefish - Atlantic Coast
Pacific hake - Pacific Coast	King mackerel - Gulf of Mexico	Caribbean spiny lobster - Southern Atlantic Coast / Gulf of Mexico
Pacific sardine - Pacific Coast	Skipjack tuna - Central Western Pacific	Spanish mackerel - Southern Atlantic Coast
Walleye pollock - Gulf of Alaska	Spanish mackerel - Southern Atlantic Coast	Vermilion snapper - Gulf of Mexico
Pacific cod - Gulf of Alaska	Dolphinfish – Pacific	Yellowfin tuna - Central Western Pacific
Brown rock shrimp - Gulf of Mexico	Spanish mackerel - Gulf of Mexico	King mackerel - Southern Atlantic Coast
Brown shrimp - Gulf of Mexico	Little tunny - Gulf of Mexico	King mackerel - Gulf of Mexico
Bering Sea / Aleutian Is. Arrowtooth Flounder	Gray snapper - Gulf of Mexico	Red hake - Southern Georges Bank / Mid-Atlantic
White shrimp - Gulf of Mexico	Red grouper - Gulf of Mexico	Atlantic Large Coastal Shark Complex
Bering Sea / Aleutian Islands Other Species	Atlantic mackerel – Gulf Maine / Cape Hatteras	Red snapper - Gulf of Mexico
Sea scallop - Northwestern Atlantic Coast	Greater amberjack - Gulf of Mexico	Atlantic Small Coastal Shark Complex
Arrowtooth flounder - Gulf of Alaska	Cobia - Gulf of Mexico	Yellowtail snapper - Southern Atlantic Coast / Gulf of Mexico
Atlantic mackerel - Gulf of Maine / Cape Hatteras	Greater amberjack - Southern Atlantic Coast	

Table 4. Table of attributes for assigning stock status for historical catch-only assessments (from Berson et al 2011).

Overall scores are obtained by an unweighted average of the attributes for which scoring is possible, although alternative weighting schemes could also be considered. An initial assignment to a stock status category is: mean scores>2.5—heavily exploited; stocks with mean scores 1.5-2.5--moderately exploited; and stocks with mean scores<1.5--lightly exploited. When the attribute does not apply or is unknown it can be left unscored.

Attribute	Stock status		
	Lightly exploited (1)	**Moderately exploited (2)**	**Heavily exploited (3)**
Overall fishery exploitation based on assessed stocks	All known stocks are either moderately or lightly exploited. No overfished stocks	Most stocks are moderately exploited. No more than a few overfished stocks	Many stocks are overfished
Presence of natural or managed refugia	Less than 50% of habitat is accessible to fishing	50%-75% of habitat is accessible to fishing	>75% of habitat is accessible to fishing
Schooling, aggregation, or other behavior responses affecting capture	Low susceptibility to capture (specific behaviors depend on gear type)	Average susceptibility to capture (specific behaviors depend on gear type)	High susceptibility to capture (specific behaviors depend on gear type)
Morphological characteristics affecting capture	Low susceptibility to capture (specific characteristics depend on gear type)	Average susceptibility to capture (specific characteristics depend on gear type)	High susceptibility to capture (specific characteristics depend on gear type)
Bycatch or actively targeted by the fishery	No targeted fishery	Occasionally targeted, but occurs in a mix with other species in catches	Actively targeted
Natural mortality compared to dominant species in the fishery	Natural mortality higher or approximately equal to dominant species ($M \geq M$)	Natural mortality equal to dominant species ($M \approx M$)	Natural mortality less than dominant species ($M < M$)
Rarity	Sporadic occurrence in catch	Not uncommon, mostly pure catches are possible with targeting	Frequent occurrence in catch
Value or desirability	Low value (< $1.00/lb, often not retained (< 33% of the time)	Moderate value ($1.00 - $2.25), usually retained (34-66% of the time)	Very valuable or desirable (e.g., > $2.25/lb), almost always retained (>66% of the time).
Trend in catches (use only when effort is stable)	Catch trend increasing or stable (assign score of 1.5)	Catch trend increasing or stable (assign score of 1.5)	Decreasing catches

FIGURES



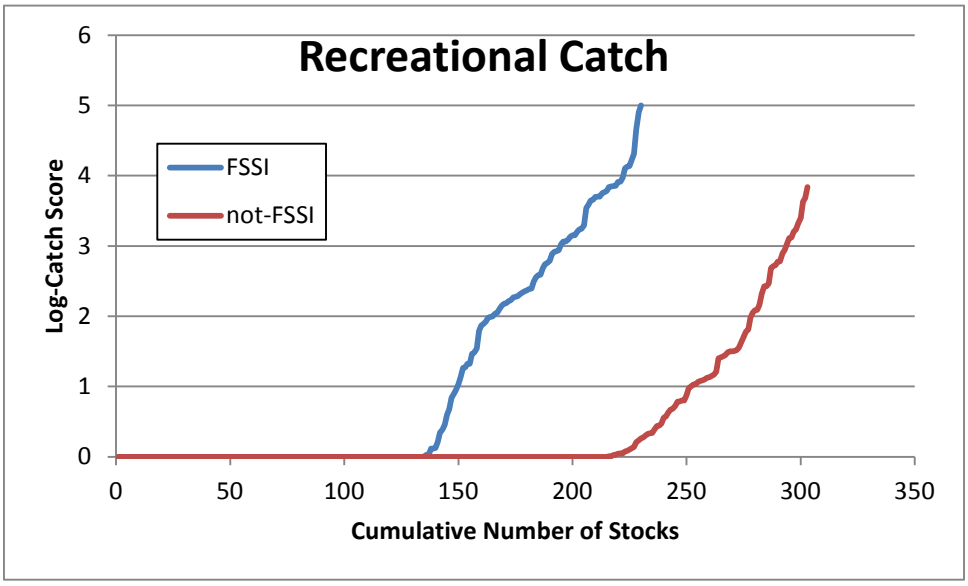
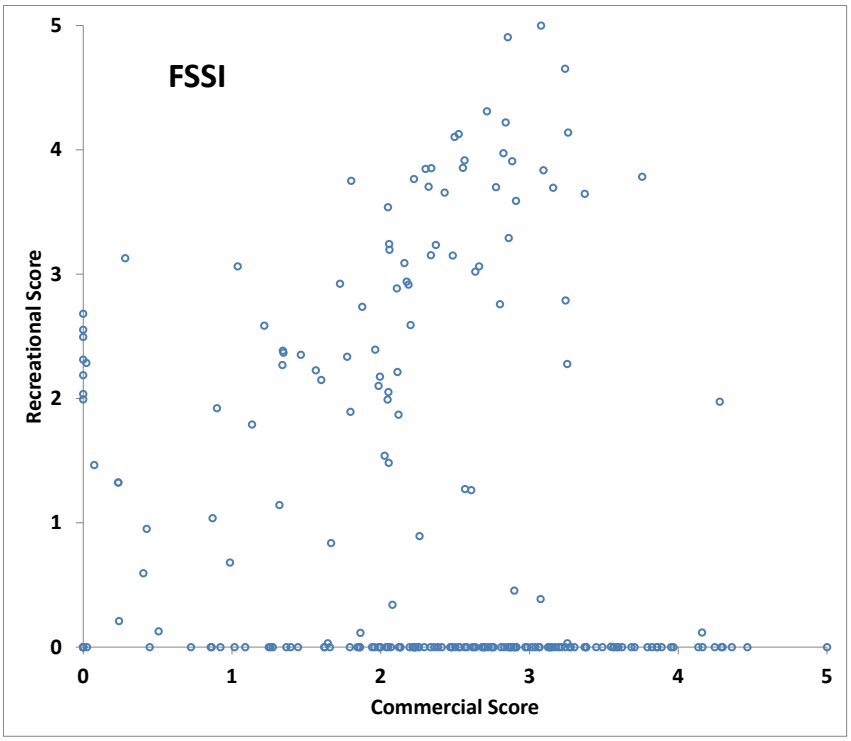


Figure 1. Ranking of stocks according to the amount of catch. Each stock's score is calculated as the log10(1.0+catch (in thousands of pounds)). (a) commercial catch results are shown at the top and (b) recreational catch is shown at the bottom. Results are shown separately for the 230 stocks included in the Fish Stock Sustainability Index (FSSI) and for the other stocks in Fishery Management Plans. For each plot, the stocks are re-ordered according to their catch.



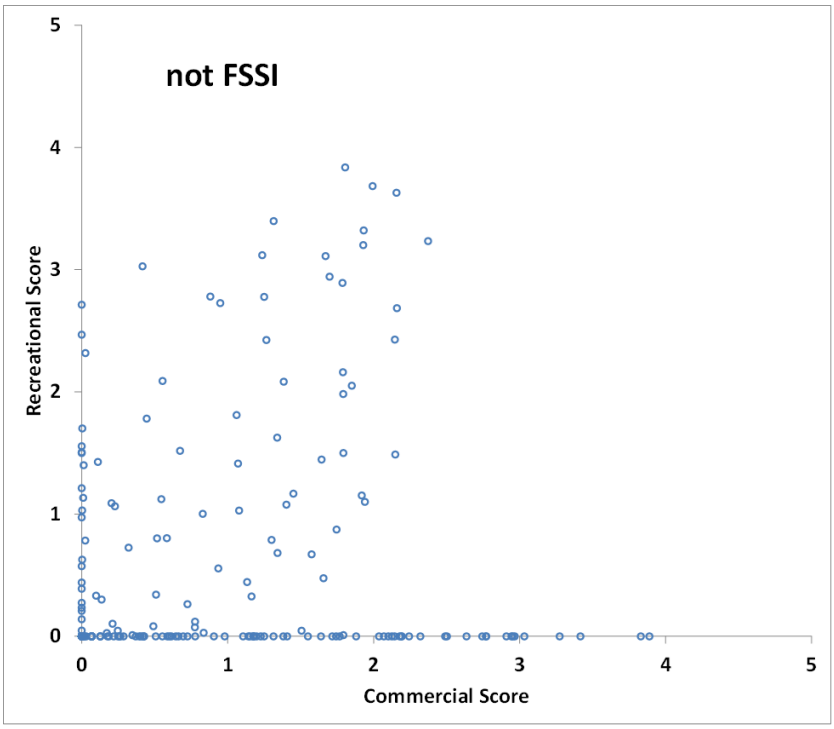


Figure 2. Preliminary relationship between commercial score and recreational score for FSSI stocks and non-FSSI stocks..

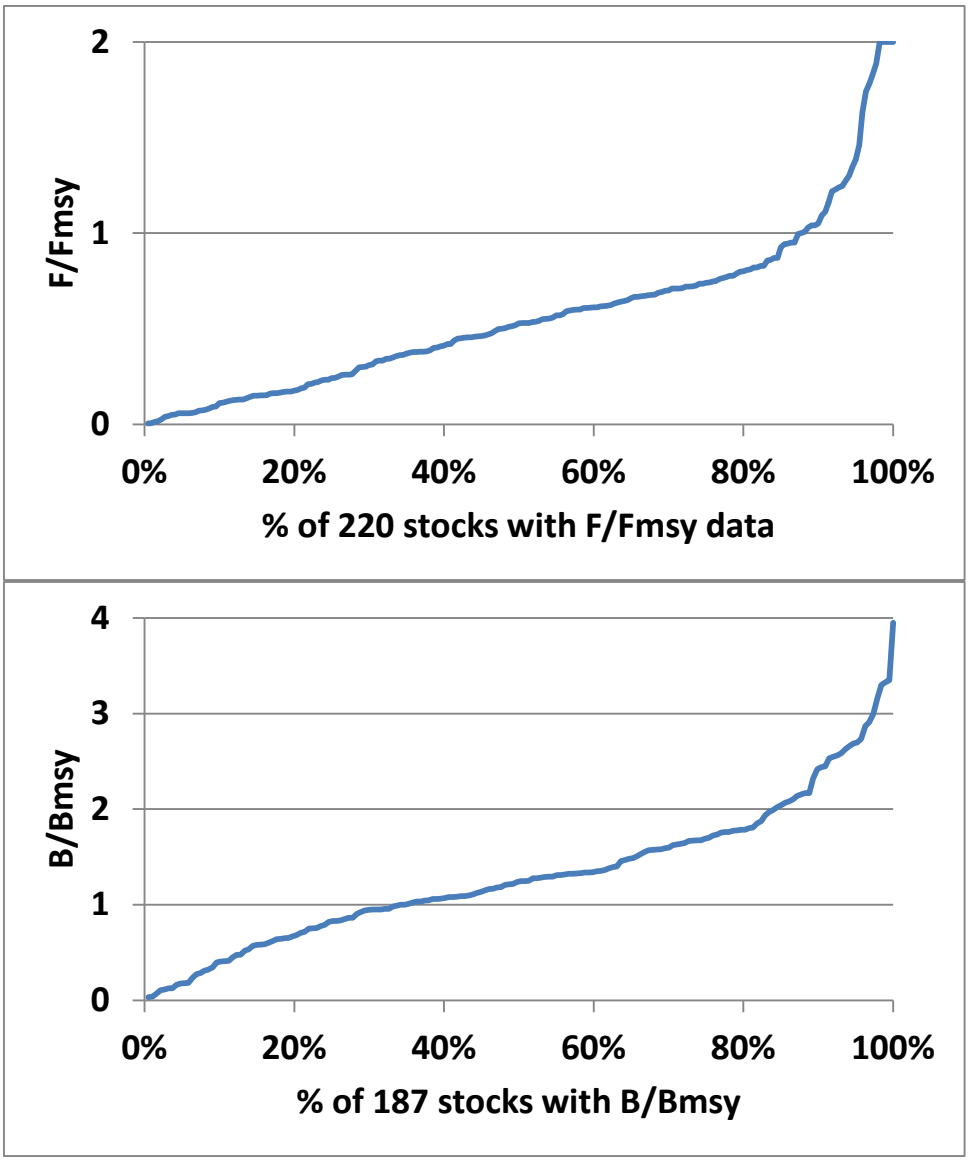


Figure 3. Cumulative distribution of the ratio of F to Fmsy in the most recent assessment of 220 stocks (upper panel), and cumulative distribution of B to Bmsy for 187 stocks in the lower panel

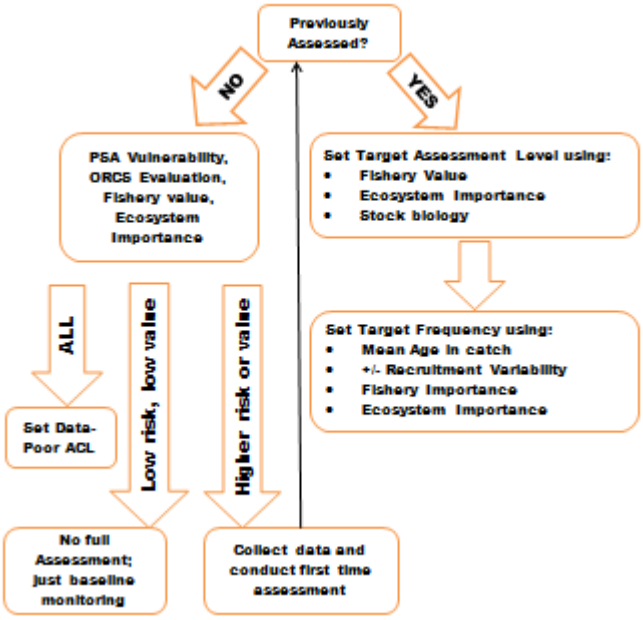


Figure 4. Flowchart showing steps in the setting of assessment target levels and assessment frequencies.

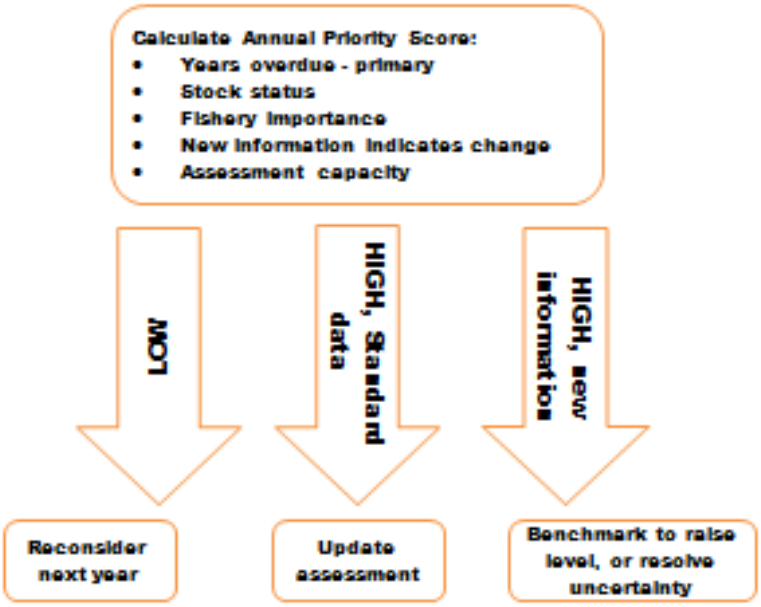


Figure 5. Flowchart showing steps in the setting of annual assessment priorities.

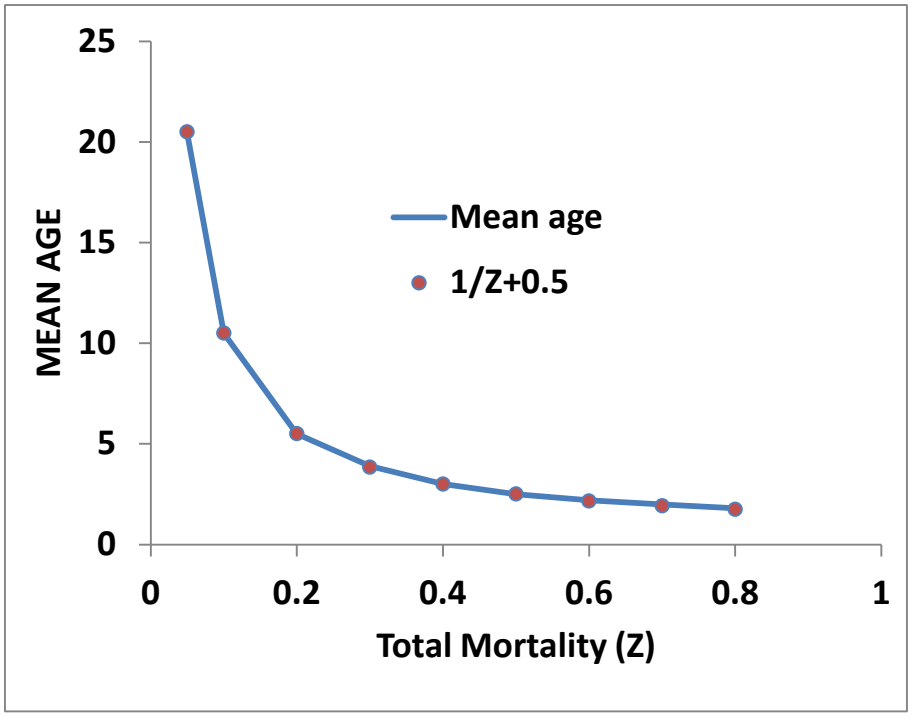


Figure 6. Relationship between total mortality rate (Z) and the expected mean age of fish in the stock.

Implementing an Assessment Prioritization Process

Briefing for
Northeast Regional Coordinating Committee
Hanover, MD
Apr 29, 2014

Why Prioritize?

- Some stocks need very good and timely assessments, but no assessment will ever provide perfect information, real-time
- All managed stocks need some level of assessment, but costs could exceed benefits for some low-valued stocks
- The goal is a prioritized portfolio of right-sized assessments for each stock
- Achieved through facilitation and standardization of each regional prioritization process
- Nationally, gaps in capability will be more apparent and can be considered for future investments

Assessment Goal

- Assessment goal is to provide scientific information needed to prevent overfishing (through forecast of annual catch limits), rebuild overfished stocks and achieve optimum yield
- How good does each stock's assessment need to be to achieve this goal?
- How frequently must it be updated?
- These stock-specific assessment goals allow us to quantify priorities among stocks

Assessment Prioritization History

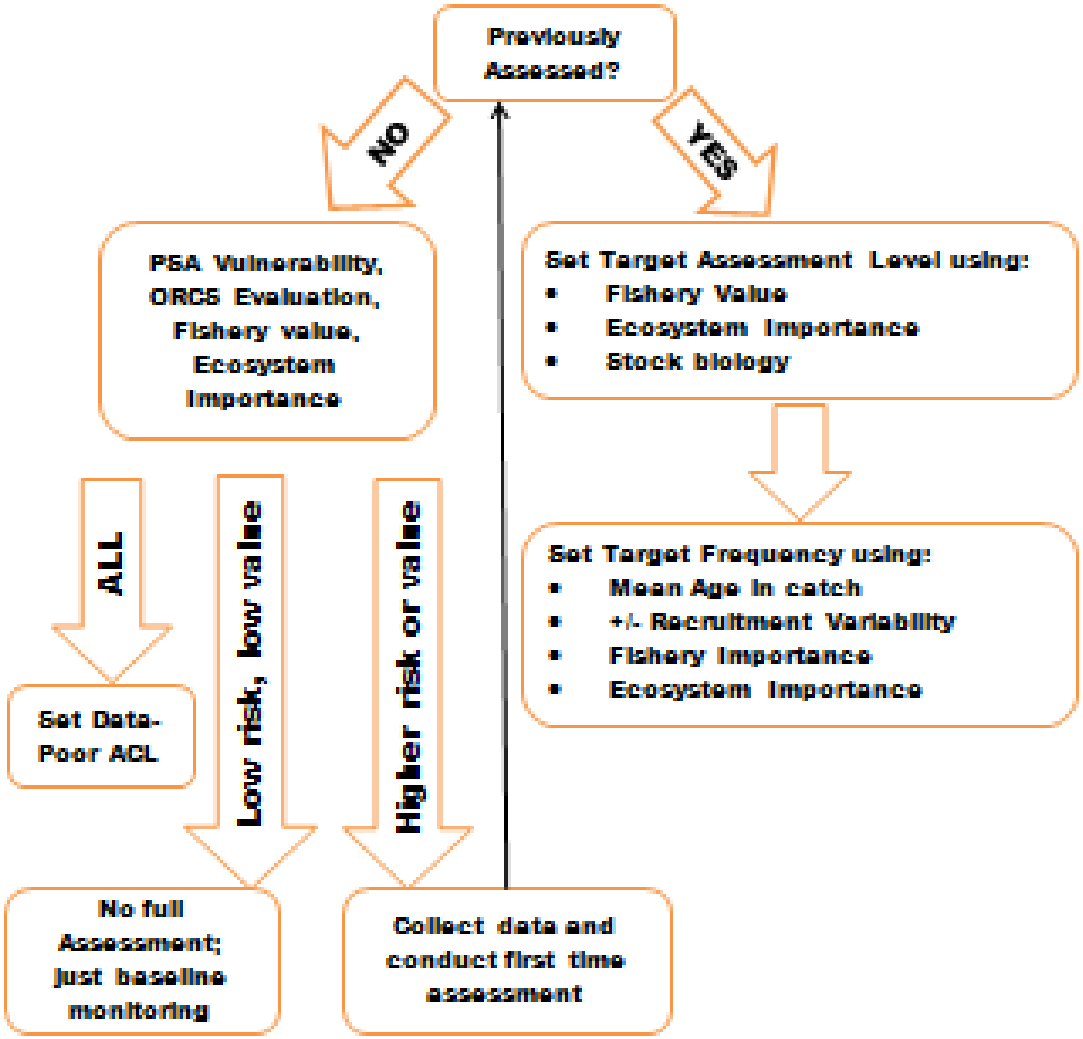
- Currently, stock assessment scheduling is region-specific under a national umbrella. Each region has a process (e.g. NRCC) involving the local NMFS Science Center, Fishery Management Council and Commission;
- OMB requested that NMFS develop a prioritization system for fish stock assessments
- Some regions, particularly NE and SE, have worked on assessment scheduling and prioritization in recent years
- A NMFS working group was formed in 2011 to develop a prioritization system
- In 2013, call for prioritization appeared in Congressionally requested GAO review of stock assessments, and in an introduced bill on improved science for MSA

Data Needed for Prioritization

- Commercial Fishery Importance
- Recreational Fishery Importance
- Ecosystem Importance
- Stock biology (principally: natural mortality rate and recruitment variability)
- Stock Status info from previous assessments
- Assessment history, unresolved uncertainties

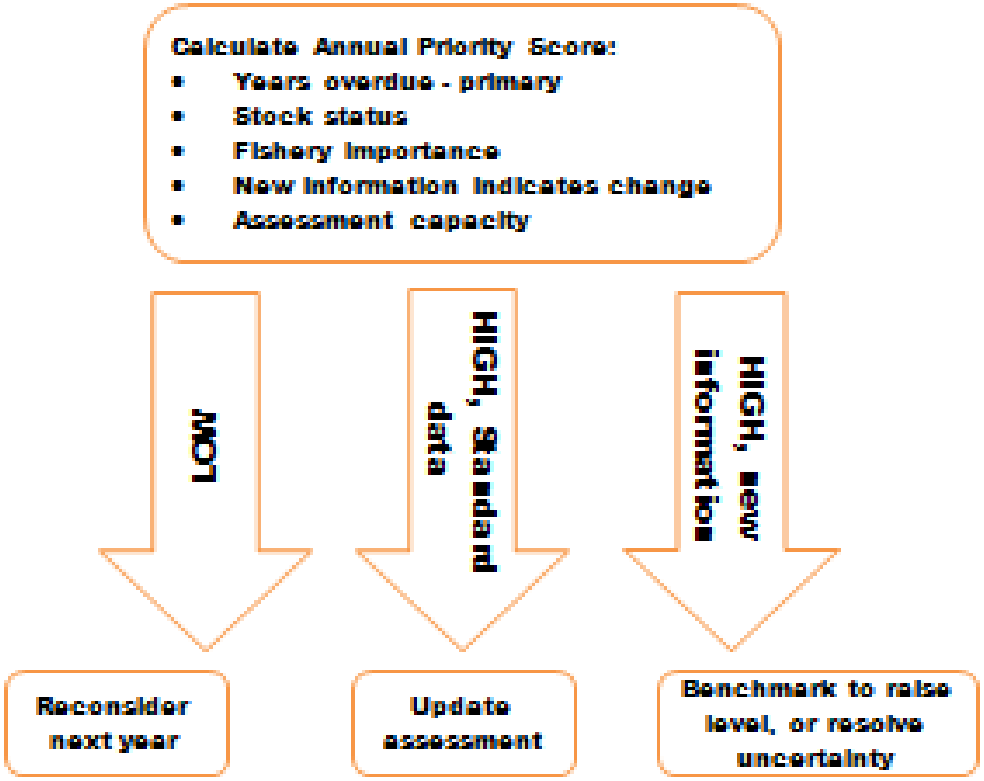
Prioritization Set-Up

- Among stocks that never have been assessed:
  - *Identify those OK with baseline monitoring, and*
  - *Those needing priority for first-time assessment*
- Among previously assessed stocks, set medium-term assessment goals
  - *target assessment level for each stock; this drives the data requirements*
  - *Set target assessment update frequency for each stock*



Setting Priorities

- Annually update priorities for conducting assessments (includes traffic light)
- Pass on stocks with low score
- Update assessments for stocks that are at or exceed their target update period
- Benchmark assessments for stocks for which new data or methods will allow resolving uncertainties or advancing to higher level



Prioritization Outcome

- The whole portfolio of assessment needs will be transparent to all participants in assessment process;
- Important assessments will get done when they need to get done, not sooner and not a lot later;
- This “right-sizing” of the assessment frequency for important tocks may help release some assessment effort for currently under-assessed stocks.

Implementation Steps

1. Distribute draft to Fishery Management Councils, NMFS Regional Offices, Fishery Commissions and to public via website – February 2014;
2. Create database of needed information as an added table in the Species Information System – begin winter 2014;
3. Receive comments from Council by May 1, 2014 and summarize to the May CCC;
4. Each region begins work on comprehensive Productivity-Susceptibility Analysis and Only Reliable Catch Analysis to serve as baseline for determining which stocks need assessments – begin spring 2014;
5. Test prioritization system to determine if adjustments to scaling factors are needed to achieve reasonable results – summer 2014;
6. Make database available to regional coordinating committees charged with setting priorities for regional assessments – fall 2014; Create access through SIS public portal;
7. Commission Management Strategy Evaluations to test the expected performance of this prioritization system over time – 2015;
8. Explore Decision Support System facilitators to guide regional coordinating committees through application of the prioritization process – 2016.

Challenges for Prioritization

1. Workload in getting initial information generated and organized;
2. Unsure that system will result in good balance of baseline monitoring for all and highest quality assessments for some;
3. Does not address prioritization of surveys and expanded scope to include ecosystem considerations;
4. May not get more assessments done, but can help identify needs;
5. Some constituents may be expecting a between region prioritization, rather than a national facilitation of within region prioritization;
6. Review processes and fishery management systems may also need tweaking to take best advantage of prioritized assessments.

BACKUP SLIDES

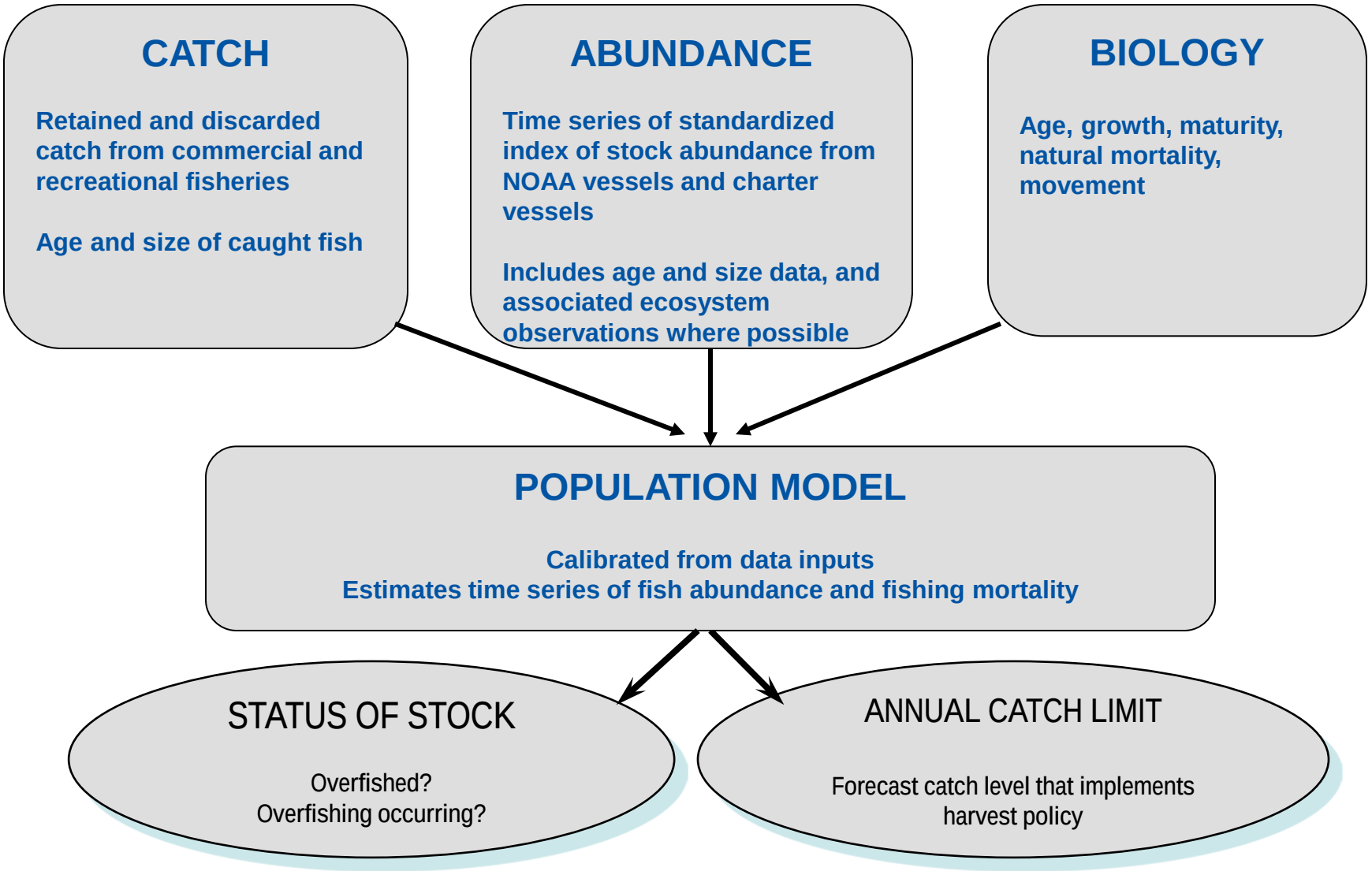
Why do we Assess Fish Stocks and Monitor Fisheries?

- Assessments provide a measure of how much can be caught, while monitoring determines how much has been caught
- Lack of good assessments creates high uncertainty, which can lead to either inadvertent overfishing or decreased yield due to large buffers
- Updated assessment are necessary for identifying when changes in fish stocks occur (due to ecosystem, environmental, or fishery factors)

Assessments Calculate:

- Long-term stock productivity and sustainable harvest rate
- Current stock abundance
- Current harvest rate
- Forecast of future stock abundance and available yield (OFL)
- Indicators of changes in ecosystem productivity

Stock Assessment Process



Linking Investments to Assessments

- Each stock's assessment uses data from many sources, as just shown
- Most data sources simultaneously provide data for many species
- This many-to-many relationship confounds accounting the cost per assessment
- Investments build regional assessment capacity, not individual assessment updates

Recent Assessment Frequency

	ASSESSMENT AGE															
	0	1	2	3	4	5	6	7	8	10	11	12	15	17	none	All
Alaska	31														4	35
Cal. Current	5	9		4	1	6		7						1	12	45
Caribbean															8	8
Gulf of Mexico	6	5	1	1	2							1			7	23
International - Atl	2	2	4													8
International - Pac	5	5		1	1										6	18
Northeast	18	2	6	2											20	48
Pacific Islands	2	1													4	7
Southeast	6	4	3	2	6		1		1	1	1		1		12	38
Grand Total	75	28	14	10	10	6	1	7	1	1	1	1	1	1	73	230

As of April 2012; Includes assessments at level 3 or higher

"none" includes some assessments done at lower levels