New England Fishery Management Council
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John Pappalardo, *Chairman* | Paul J. Howard, *Executive Director*

April 6, 2009

TO: Council Members

FROM: Paul J. Howard, Executive Director

SUBJECT: SSC Recommendations for Amendment 15 Social and Economic Methods, Monkfish Amendment 5 Methods for Determining Annual Catch Limits and the EFH Omnibus Amendment 2 Analytical Tool

The Scientific and Statistical Committee reviewed and discussed the above listed topics and provides its recommendations to the Council. Several of the memos are directed to the Council's Plan Development Teams. The background materials on which their comments are based were mailed to the Council prior to the meeting. Dr. Steve Cadrin will present the SSC's findings on Tuesday, April 7 at 3:30 p.m.

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To: Paul J. Howard, Executive Director
From: Dr. Steve Cadrin, Chairman, Scientific and Statistical Committee
Date: April 7, 2009

Subject: Methods for economic and social impacts for Scallop Amendment 15

The SSC was asked to review the methods for the assessment of economic and social impacts for Scallop Amendment 15, including alternatives to address excess capacity in the limited access scallop fishery and provide more flexibility for efficient utilization of the resource through various stacking and leasing alternatives. Concerns have been raised that if DAS and access area trips are sold or leased from vessels with lower fishing power to vessels with higher fishing power, overall effort will increase. Therefore, Amendment 15 includes several fishing power adjustment alternatives to address this concern.

Technical documents on socio-economic methods for Scallop Amendment 15 were reviewed in preparation for the February 6 2009 SSC meeting, but the agenda item was re-scheduled to the March 17 2009 meeting. The SSC corresponded with the Scallop Plan Development Team to review a bioeconomic model to estimate producer and consumer benefits, a price model to predict prices, the fixed and trip costs used in the analyses, and a production model developed to identify appropriate fishing power adjustment (FPA) alternatives for the leasing and stacking alternatives under consideration.

On March 17 2009, the SSC reviewed the Council request, presentations by the Scallop PDT, and four background documents:

1. Sections of Scallop Amendment 15 DEIS – Description of stacking and leasing alternatives only
2. Summary of methods used for economic analyses
3. Addendum to Methods used for Economic Analyses
4. Summary of issues that will be considered in the social impact assessment

The SSC recognizes that although much of its agenda and energy is focused on providing acceptable biological catch recommendations associated with National Standard 1, National Standard 8 is no less important: "*Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data, in order to provide for the sustained participation of such communities, and to the extent practicable, minimize adverse economic impacts on such communities.*"

The SSC agrees with the PDT's general approach of comparing changes in economic surplus between management alternatives and estimating differences in fishing power for evaluating the

effects of consolidation through leasing or stacking permits. However, coefficients for fishing power adjustment were estimated using catch and effort data that were observed in the context of fishery management regulations (e.g., crew size limits, trip limits) that tended to equalize fishing power among vessels. Accordingly, the estimated coefficients may not reflect the differences in fishing power if those regulations are relaxed (i.e., differences among vessels should become greater). Therefore, leasing or stacking from less powerful vessels to more powerful vessels may increase fishing capacity of the fleet if other management measures are changed.

The SSC is concerned that the assumption that fishing power of a vessel increases when allocated more days-at-sea is inconsistent with observations from other fisheries and may not be correct. Although the observed data suggest that catch rates slightly increase when vessels are allocated more days, the result may be an artifact produced by other factors, and the pattern may not continue, particularly if effort consolidation exceeds the observed range of days-at-sea allocations. Other variables that explain differences in productivity between vessels should be explored.

Although the PDT expects that most alternatives under consideration will not have substantial social impacts, the scope of the social impact assessment should be as comprehensive as possible. More detailed technical feedback to the Scallop PDT on the following recommendations is attached.

SSC Recommendations:

1. **Differences in fishing power among vessels should be considered in effort consolidation alternatives (e.g., permit stacking or leasing). The proposed fishing power adjustments are conditional on the recent and current suite of regulations that affect fishing power. If a reduction in fishing capacity is desired, fishing power adjustments should be re-estimated under alternative sets of regulations under consideration in Amendment 15.**

2. **The positive relationship between catch rate and days-at-sea allocation should be further explored before incorporating the proposed 'increased returns' adjustment.**

3. **The scope of the social impact assessment should address several general issues, including preservation of traditional and cultural values, cultural diversity, community stability, and the livelihood of fishermen; equity among user groups; diversity among recreational and commercial users; and the role of the fishing community in American culture and tradition.**

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To: Deirdre Boelke, Chair, Scallop Plan Development Team
From: Dr. Steve Cadrin, Chair, Scientific and Statistical Committee
Date: April 7, 2009

Subject: **Methods for economic and social impacts for Scallop Amendment 15**

The SSC developed consensus recommendations for the Council on methods for economic and social impacts for Scallop Amendment 15. This technical feedback is provided with the intention of working with the habitat PDT to improve the analyses.

SSC Recommendations to the Council are:

1. *Differences in fishing power among vessels should be considered in effort consolidation alternatives (e.g., permit stacking or leasing). The proposed fishing power adjustments are conditional on the recent and current suite of regulations that affect fishing power. If a reduction in fishing capacity is desired, fishing power adjustments should be re-estimated under alternative sets of regulations under consideration in Amendment 15.*
2. *The positive relationship between catch rate and days-at-sea allocation should be further explored before incorporating the proposed 'increased returns' adjustment.*
3. *The scope of the social impact assessment should address several general issues, including preservation of traditional and cultural values, cultural diversity, community stability, and the livelihood of fishermen; equity among user groups; diversity among recreational and commercial users; and the role of the fishing community in American culture and tradition.*

More detailed feedback is organized by topic.

- Fishing Power Adjustments
  - Coefficients for fishing power adjustment should be revised if regulations affecting fishing power (e.g., crew size, trip limits) are relaxed. Note that fishing power adjustments for stacking cannot be adjusted after the stacking occurs.
  - The proposed method to estimate 'fishing power adjustments' among groups of vessels, by size and horsepower, was preferred over paired comparisons among all vessels in the fleet, because aggregate adjustment coefficients are a more efficient use of the data.
  - The positive relationship between LPUE and DAS allocation implied by the Cobb-Douglas production model is inconsistent with trends observed in other fisheries in which LPUE is greater at moderate allocations of days, presumably because fishermen cannot select the most efficient conditions when fishing full-time. The domed relationship implied by the 'translog' model more accurately captures the increased efficiency from few days to a moderate allocation of days to maintain a regular operation as well as the diminishing returns associated as the allocation approaches full-time fishing. Therefore, a simple 'increasing returns' adjustment may not be appropriate, and other variables that explain differences in productivity between vessels should be explored.

- Cost-Benefit Modeling
  - The low portion of explained variance in the fixed costs model (R^2=0.31) may result from data quality problems. The source of information (e.g., vessel owners' survey or observer data) should be identified, and data quality issues should be investigated to use the data most appropriately and develop recommendations for collection of better fixed cost data.
  - Co-linearity of explanatory variables may be a problem for linear models that include multiple variables associated with vessel size (e.g., the fixed costs model includes both horsepower and length). For these models, revisions should be considered that either select the single vessel size variable that explains the most variance or uses composite variables.
- Social impact assessment methods
  - The social impact assessment should document the social context of the fishery prior to permit leasing and stacking as well as the expected social context of each alternative under consideration.
  - The approaches to assessing the social impacts can be both qualitative and quantitative.
  - Output from economic analysis is one tool to help guide the social impact assessment but should not be the primary approach to guide and inform the assessment for each management alternative. There may be a need for the collection of sociological data to adequately assess the social consequences of the social impact assessment.
  - Information from the recent community profiling project should be considered, but the nature of Amendment 15 may require a profile of fishing sectors as opposed to communities.
  - Examination of the public comments obtained from scoping meetings and public hearings should be used to identify and direct the literature review as well as the collection and analysis of secondary and primary data needed to complete the social impact assessment. The public comment and transcripts from hearings could be reviewed and coded using qualitative text analysis tools.
  - Primary and secondary impacts from shore side businesses that are directly and indirectly associated with the scallop fishery should be included in the analysis.
  - Several other relevant fisheries should be included in the literature review, in additional to those identified by the PDT:
    - Western Australia Rock Lobster.
    - Canadian Atlantic Herring
    - South Africa Rock Lobster
    - Australian southern Bluefin Tuna
    - Netherlands North Sea Flatfish, Round fish, Herring/Mackerel
    - Namibian hake
    - Chile

The SSC looks forward to working with the PDT in the refinement of socioeconomic methods. Please contact me, Dan Georgiana (the SSC lead for scallop economic analyses) or Rob Robertson (the SSC lead for social analyses) as these methods develop.

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To: Paul J. Howard, Executive Director
From: Dr. Steve Cadrin, Chairman, Scientific and Statistical Committee
Date: March 30, 2009

Subject: Monkfish Amt. 5 – Methods for Determining Annual Catch Limits

The SSC was asked to review the Monkfish Plan Development Team's proposed methods for determining Annual Catch Limits according to three terms of reference:

1. *Review and provide guidance on the PDT's approach to setting reference points, including MSY, OFL, ABC and ACL. In particular, the Council seeks SSC input on consideration of scientific uncertainty in setting the ABC and ACL.*
2. *Review and provide guidance on the use of proactive and reactive accountability measures. In particular, the Council seeks SSC input on consideration of management uncertainty in setting the AMs.*
    a. *Proactive AMs – The Council is considering use of Annual Catch Targets (ACT) and Target Total Allowable Landings (TTAL) as proactive AMs. The Council seeks input from the SSC concerning the two methods for establishing ACTs proposed by the PDT that utilize different approaches for considering management uncertainty.*
    b. *Reactive AMs - Council could include in-season actions to be taken to prevent the ACL from being exceeded, and/or post-season actions in the event of an ACL overage. The Council seeks SSC input on what types of reactive AMs would be appropriate for consideration.*
3. *The Council seeks the SSC's guidance on an appropriate and reasonable range of assessment results that could be used to address the issue of the timing of the assessment. Since the terminal year of the last stock assessment was 2006, since short-term projections are not technically feasible, and since another assessment is scheduled for mid-2010, about the time the Council will be submitting Amendment 5, it is considering adopting a set of control rules for establishing the values associated with the various reference points and catch targets that will automatically update when the assessment is completed.*

On March 17 2009, the SSC reviewed the Council request, presentations by the Monkfish Plan Development Team, and seven background documents:

1. Initial Report of the Monkfish PDT to the NEFMC's Scientific and Statistical Committee
2. Haring, P., and Maguire, J.J., 2008. The monkfish fishery and its management in the northeastern USA. In: ICES Journal of Marine Science. 65: 1370-1379.
3. Northeast Data Poor Stocks Working Group. 2007. Monkfish Assessment Summary for 2007. Northeast Fisheries Science Center Reference Document 07-13.
4. Richards, R.A., Nitschke, P. C., and Sosebee, K. A.. 2008. Population biology of monkfish Lophius Americanus. In: ICES Journal of Marine Science. 65: 1291 -1305.

5. Northeast Data Poor Stocks Working Group. 2007. Monkfish Assessment Report for 2007. Northeast Fisheries Science Center Reference Document 07-21.
6. Presentation - Initial Report of the Monkfish PDT to the NEFMC's Scientific and Statistical Committee
7. Presentation – Monkfish Assessment Summary

The background information, general approach and details of the PDT's proposal were reviewed and discussed. The SSC developed consensus recommendations for the Council on methods for determining Overfishing Level of catch (OFL), interim methods for deriving Acceptable Biological Catch (ABC) and provide input on the Annual Catch Target (ACT) and accountability.

The 2007 Data Poor Stocks Workshop advanced the monkfish stock assessment as a basis for fishery management by developing an analytical model (Statistical Catch At LEngth, SCALE) that synthesizes all recent information available on the fishery and the resource (catch data, survey data, size distributions and life history). However, substantial sources of uncertainty remain in the SCALE analysis. Although the DPSW accepted the model to estimate stock size and fishing mortality, it was not a reliable basis to determine conventional MSY reference points. Yield-per-recruit was used to derive F_{max} as a proxy for F_{MSY}, and the average estimated biomass during the assessment time series was used as a data-poor proxy for B_{MSY}. The SSC recognizes the uncertainties described in the DPSW report (natural mortality rate, growth rate, magnitude of discards, uncertain survey indices, under-reported historical catch, and a short assessment series). The SCALE model was also not considered to be a suitable basis for projection by the DPSW; as stated in the 2007 assessment summary, "Further work is necessary to develop a complete forecasting approach." These uncertainties influence both components of OFL: the F_{MSY} proxy and stock biomass projections. Therefore, the SSC concludes that the information currently available for monkfish does not support a conventional approach to determining OFL and ABC as provided in National Standard 1 guidelines.

In lieu of a method that conforms to NS1 guidelines, the SSC recommends an interim method for determining ABC based on the product of the average exploitation rate during the recent period of stable or increasing trend in biomass in both management units and the most recent estimate or index of exploitable biomass. The data-poor default method for determining an interim ABC produces catch advice that is substantially less than the nominal OFL, but is not directly associated with overfishing (i.e., it is not directly based on OFL and its uncertainty).

Nominal estimates of OFL (derived from F_{max} and estimates of 2006 exploitable biomass from the SCALE model) are approximately 23,000mt for the northern management unit and 28,000mt for the southern management unit. Next month, Monkfish PDT will prepare analyses for an ABC recommendation by the SSC. As an example of results from the proposed ABC method, the product of exploitable biomass and mean exploitation rates since 1997 in the north, and since 1999 in the south applied to the most recent estimate of exploitable biomass produces an ABC of approximately 18,000mt for the north (78% of OFL) and 15,000mt for the south (52% of OFL). Although the interim ABCs are not derived as a function of scientific uncertainty, the resulting reductions from OFL are consistent with data-poor situations.

The PDT should apply projections of the assessment model to evaluate the consequences of these ABC scenarios in the short term to confirm that they maintain low probability of overfishing. Given the substantial uncertainties in the stock assessment, sensitivity analyses (e.g., alternative model

estimates that assume different values of natural mortality) may account for uncertainty in OFL more effectively than stochastic projection.

The PDT's proposal to define the annual catch limit (ACL) as equal to the ABC is consistent with the final guidelines to implementing National Standard 1. The buffer between ACL and ACT should account for management uncertainty, avoid exceeding the ACL and avoid reactive accountability measures. The magnitude of recent catch has low risk of exceeding the OFL or the proposed interim ABC. In 2006, total catch was 7,187mt in the north (32% of OFL) and 9,561mt in the south (34% of OFL). According to the PDT's estimate of 2007 landings and status quo discard rates, total catch in 2007 was approximately 5,400mt in the north (24% of OFL) and 8,800mt in the south (31% of OFL). Any reduction in the magnitude or rate of discards would reduce both scientific and management uncertainty.

SSC Recommendations:

1. **The SSC endorses the proxy reference points for F_{MSY} and B_{MSY} as well as the estimate of stock size derived by the 2007 Data Poor Stocks Workshop. However, considerable uncertainties in the assessment model preclude its use to determine probability of exceeding the projected Overfishing Level of catch.**

2. **An interim Acceptable Biological Catch should be derived as the product of the average exploitation rate during the recent period of stable or increasing trend in biomass for each management unit and the most recent estimate of exploitable biomass. Therefore, the method of determining ABC should be considered an interim proxy until Overfishing Level of Catch and its uncertainty can be projected.**

3. **Catch targets should be less than the interim ABC to avoid reactive accountability measures.**

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To: Paul J. Howard, Executive Director
From: Dr. Steve Cadrin, Chairman, Scientific and Statistical Committee
Date: March 26, 2009

Subject: **Review of EFH Omnibus 2, Phase II, Analytical Tool (FiGSI)**

The SSC was asked to review and provide input on the Fishing Gear Seabed Impact Model, for application in the Essential Fish Habitat Omnibus Plan, according to specific terms of reference:

Evaluate the sufficiency of the Fishing Gear Seabed Impact (FiGSI) model as a basis for crafting and analyzing alternatives to minimize to the extent practicable the adverse effects from fishing on essential fish habitat. Specifically, provide the Council with commentary on the adequacy of the following components:

1. *Vulnerability Assessment*
    a. *Is the literature review comprehensive and well developed?*
        i. *Does it provide an adequate basis for the Vulnerability Assessment?*
        ii. *Does it adequately capture sources of uncertainty?*
    b. *Matrix-based evaluation*
        i. *Is the assessment's matrix-based structure appropriate to its intended use?*
        ii. *Are the assessment results consistent with the published literature? In cases where results are extrapolated are these cases treated appropriately?*
        iii. *Are sources of uncertainty adequately carried forward from the literature review?*
2. *Swept Area Seabed Impact (SASI) Model*
    a. *Is the model structure appropriate for its intended use?*
    b. *Are the data inputs (fishing effort) characterized appropriately?*
3. *Spatial Model*
    a. *Is the Critical Shear Stress Model appropriate for its intended use?*
    b. *Are the substrate data inputs characterized appropriately?*
4. *Fishing Gear Seabed Impact (FiGSI) Model*
    a. *Do the model results make sense in the context of fishery management decision making?*
    b. *Are the uncertainties previously noted adequately addressed?*

On March 18 2009, the SSC reviewed the Council request, presentations by the Habitat Plan Development Team, and five background documents:

1. Draft Summary of 03 March 2009 Habitat Oversight Committee meeting
2. Summary of 13 February 2009 Habitat PDT conference call
3. Summary of 11 February 2009 Habitat PDT meeting
4. Summary of 15 January 2009 Habitat Oversight Committee meeting
5. Summary of 05-06 January 2009 Habitat PDT meeting

The background, general approach and details of each component of the PDT's methodology were reviewed and discussed. The SSC developed consensus recommendations for the Council on the status and applicability of the methodology (below) and technical feedback for the Habitat PDT (attached).

The Council's request was to focus on Phase II of the EFH Plan, the evaluation of adverse effects from fishing on essential fish habitat. Therefore the appropriateness of how EFH or Habitat Areas of Particular Concern (HAPC) are defined in New England was not reviewed. The SSC felt that the PDT's general methodological approach to Phase II was consistent with Phase I in that it potentially includes all habitats within the Northeast U.S. EEZ for the evaluation of fishing effects. However, given the different objectives and methods used for Phase I and Phase II, results of vulnerability and sensitivity analyses may be different than HAPC determinations. The SSC also recognizes that the proposed methodology may not be appropriate for evaluating non-fishing impacts, because recovery expectations will vary according to the nature of the impact.

The SSC recognizes the challenges associated with the evaluation of adverse effects from fishing on essential fish habitat. The Habitat PDT includes members with diverse backgrounds and expertise, and we commend them for the compilation of information and methodological developments. Given the need for expertise in habitat impacts and recovery, Dr. Robert Whitlach (University of Connecticut) was invited to serve as a temporary SSC member for this review. His input was valuable and complementary to the expertise in fishery ecology provided by other SSC members. The SSC will continue to correspond with the Habitat PDT on methodology for the EFH Omnibus 2 Phase II Analytical Tool. More detailed technical feedback to the Habitat PDT on these recommendations is attached.

SSC Recommendations:

1. **Vulnerability Analysis:**

    a. **While the literature review may not be comprehensive, it is an adequate basis for the development of analytical tools for evaluating adverse effects of fishing and associated uncertainty.**

    b. **The general matrix-based structure is appropriate for evaluating vulnerability, includes information on uncertainty and is consistent with the literature review. However, the approach presented to the SSC only included one major aspect of habitat, namely the geophysical component. The biological components of habitat, which have yet to be addressed, are essential elements for the evaluation of vulnerability, and they are necessary for implementation in the Omnibus Amendment.**

2. **The analytical approach of swept area of fishing effort is appropriate for evaluating seabed impact, but some modifications to the characterization of fishing effort should be considered to refine the method.**

3. **The general approach to the spatial analysis is appropriate to overlay habitat and fishing effort, but several methodological refinements are needed to more accurately**

characterize habitat, including analysis of heterogeneous data and the inference of energy levels from shear stress.

4. **The proposed method for evaluation of impact of fishing on habitat has the potential to provide sensitivity-adjusted fishing areas for specific management alternatives. However, a more formal and transparent method is needed for the derivation of the sensitivity criterion used by the model and its uncertainty as a function of susceptibility and recovery. Higher spatial resolution of fishing effort is also needed.**

5. **In general, the SSC concludes that the PDT's general approach provides the best available approach to assessing the impacts of fishing on habitat. However, critical elements of the analysis need to be revised and the method needs to incorporate biological components before the methodology can be used to evaluate fishery management decisions. A revised methodology should be reviewed by the SSC or an external peer review before being applied as the analytical tool for the EFH Omnibus 2, Phase II.**

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To: Chad Demarest, Chair, Habitat Plan Development Team
From: Dr. Steve Cadrin, Chair, Scientific and Statistical Committee
Date: March 26, 2009

Subject: **Technical Feedback on EFH Omnibus 2, Phase II, Analytical Tool**

The SSC developed consensus recommendations for the Council on the status and applicability of the Fishing Gear Seabed Impact model as a basis for crafting and analyzing alternatives to minimize to the extent practicable the adverse effects from fishing on essential fish habitat. This technical feedback is provided with the intention of working with the habitat PDT to improve the analyses.

SSC Recommendations to the Council are:

1. *Vulnerability Analysis:*
    a. *While the literature review may not be comprehensive, it is an adequate basis for the development of analytical tools for evaluating adverse effects of fishing and associated uncertainty.*
    b. *The general matrix-based structure is appropriate for evaluating vulnerability, includes information on uncertainty and is consistent with the literature review. However, the approach presented to the SSC only included one major aspect of habitat, namely the geophysical component. The biological components of habitat, which have yet to be addressed, are essential elements for the evaluation of vulnerability, and they are necessary for implementation in the Omnibus Amendment.*
2. *The analytical approach of swept area of fishing effort is appropriate for evaluating seabed impact, but some modifications to the characterization of fishing effort should be considered to refine the method.*
3. *The general approach to the spatial analysis is appropriate to overlay habitat and fishing effort, but several methodological refinements are needed to more accurately characterize habitat, including analysis of heterogeneous data and the inference of energy levels from shear stress.*
4. *The proposed method for evaluation of impact of fishing on habitat has the potential to provide sensitivity-adjusted fishing areas for specific management alternatives. However, a more formal and transparent method is needed for the derivation of the sensitivity criterion used by the model and its uncertainty as a function of susceptibility and recovery. Higher spatial resolution of fishing effort is also needed.*
5. *In general, the SSC concludes that the PDT's general approach provides the best available approach to assessing the impacts of fishing on habitat. However, critical elements of the analysis need to be revised and the method needs to incorporate biological components before the methodology can be used to evaluate fishery management decisions. A revised methodology should be reviewed by the SSC or an external peer review before being applied as the analytical tool for the EFH Omnibus 2, Phase II.*

The SSC commends the PDT for compiling a large volume of information and developing innovative approaches to evaluating the impact of fishing on habitat. We recognize that the proposed methods are developmental, and we offer the following technical comments to help refine the methods toward developing the 'best science available' for this task. Comments are organized according to the Terms of Reference for our review:

1. Vulnerability Assessment

1a. Literature review

- The literature review may not be comprehensive, but it is adequate to proceed in the development of analytical tools for evaluating adverse effects of fishing. There are some conspicuous omissions from the literature review (e.g., Deiter et al. 2003, Løkkeborg 2005, NRC 2002) and areas of limited scope, but the published reviews included in the PDT's review include the major scientific advances and case studies for evaluating fishing effects, vulnerability, susceptibility and recovery. The PDT's literature review is well organized to apply results and conclusions to the evaluation of fishing impacts.
- The PDT may have been too selective in its use of a small subset of publications that are directly related to the impacts of fishing. Other publications on impacts and recovery may be indirectly related to fishing impacts and should be considered in the vulnerability assessment.
- The focus on benthic habitat is an appropriate initial step, because the benthic habitat is a critical component and should be a priority. However, the entire water column should eventually be considered, particularly for the prey component of habitat.

1b. Matrix-based evaluation of vulnerability

- The matrix-based approach is appropriate for the descriptive nature of much of the information on vulnerability, susceptibility, recovery and sensitivity. As scientific information and methods develop, it would be appropriate to transition to a quantitative model that is based on functional relationships.
- Despite a considerable amount of effort by the PDT to include a 'biological' component of habitat, the current evaluation is primarily based on the 'geological' component of habitat. The SSC concludes that 'biological' and 'prey' components of habitat are essential elements for the evaluation of vulnerability, because many substrate properties are more determined by the benthic community they support than their physical attributes. Therefore, application of the proposed methodology without those components may produce misleading results. Although the PDT proposes to eventually include all habitat components, the SSC advises that they are necessary for implementation in the Omnibus Amendment.
    - An alternative categorization of habitat components that would more closely reflect mandated requirements of EFH would be shelter and prey.
    - Ecological succession models may be an approach to determining biological components of habitat where observational data are lacking.
    - Although fine-scale spatial models are appropriate for characterizing the geological component of habitat, it may not be the optimal approach for some biological components (e.g., some forage species). Non-spatial alternatives, or broader-scale spatial models should be considered as a basis for the incorporation of biological components of habitat.
- Some of the categories in the matrix-based approach are arbitrary or subjective, and results may not be repeatable by a similar group of experts. Sensitivity analyses would be an informative approach to evaluating uncertainty in results.
    - 'Recovery' is appropriately evaluated as a function of high or low energy environments used to derive sensitivity score for spatial cells. However, sensitivity of result to the depth

threshold and energy threshold for determining high or low energy categories should be assessed.
    - The proposed matrix approach considers susceptibility and recovery of different habitats, but not their relative values for fishery resource production or ecosystem services. Future developments should consider habitat value. For example, 'mature' benthic communities (i.e., the climax stage of ecological succession for each physical habitat type) should be considered a high-value habitat.
- Methods for deriving quantitative indices from subjective determinations should be explored to more formally retain information from individual PDT members' scores, and analyze them in a statistically sound and repeatable way that includes variability among scores and uncertainty in derived decision variables (e.g., Saaty 2008).
- The PDT interpreted the EFH requirements of the Magnuson-Steven Act and associated guidelines to consider only adverse effects of fishing on habitat. An alternative interpretation of the guidelines would allow for consideration of positive habitat effects in the evaluation of net adverse effects.

2. Swept Area Seabed Impact (SASI) Model

- The analysis of swept area of fishing is appropriate, but some modifications should be considered to refine the method.
    - The assumption that epifaunal species are more sensitive than infaunal species may not be accurate, and three-dimensional impact (i.e., penetration of substrate) should eventually be incorporated into the evaluation of seabed impact.
    - Several specifications of fishing gear are not included because data are not available. Information should be collected and incorporated into the analysis, including weight of gear on the bottom (including buoyancy at depth and hydrodynamic lift), trawl foot rope type (e.g., cookies, rollers, tickler) should be considered.
    - The calculation of swept area assumes additivity of fishing effort. For the same gear type, there is no consideration of the relative impact of multiple passes. Similarly, interactive effects of different gear types on the same bottom are not considered.

3. Spatial Model

- The SSC agrees that the level of resolution should be optimized for each source of information independently. However, alternative levels of resolution and methods of aggregating multiple-observation cells should be examined for substrate data.
    - Averaging data within cells does not recognize the different nature of observations or the nonlinear relationship of grain sizes. For example, averaging a survey hang and a USGS sand observation to derive an average of gravel is not accurate. The simple arithmetic average implicitly assumes a linear scale of grain size. Extrapolation of grain size between two observations should be nonlinear (e.g., cubic extrapolation is conventional for volumetric processes).
    - An alternative approach to multiple-observation strata would be to express heterogeneity as percent-coverage (e.g., 10% boulder, 90% sand), similar to the characterization of heterogeneous ecological coverages in terrestrial applications of geographic information. Some aspects of ecological recovery may be associated with heterogeneity.
- Groundtruthing and cross-validation are needed to assess the accuracy of spatial extrapolations.
    - For example, it would be informative to compare USGS observations with the SMAST video survey observations in the same spatial cell.

- Point observations of benthic communities and sidescan acoustic imagery should be used to groundtruth inferred energy environments.
- Spatial results of ecosystem components from the ATLANTIS model could be used as source data or groundtruthing.

- Determination of 'boulders' habitat using trawl survey 'hangs' may inappropriately extrapolate the inference of hard bottom to nearby areas.
  - As illustrated in Figure 9 of Document 1, the area south of Cape Hatteras is determined to be boulder as a result of survey hangs with no associated substrate data in the area. The same inaccurate extrapolations are also likely in smaller areas throughout the region.
  - Information from fishermen may be a valuable source of information on hard-bottom areas.
  - Perhaps some information on area swept to boulder encountered would provide an estimate of boulder density that would be more informative that the presence or absence of a hang.
- The determination of high or low energy environments is critical for the evaluation of recovery. However, energy categories are inferred from shear stress calculations rather than direct observation. Deriving shear stress from an oceanographic model requires empirical information on bottom rugosity wherever it is available to avoid rugosity values that are adjusted to fit observed tidal dynamics.
- When the entire methodology is accepted as the basis for fishery management decisions, all spatial data will need to be documented, transparent and available upon request.

4. Fishing Gear Seabed Impact (FiGSI) Model

- The derivation of 'sensitivity' as a function of susceptibility and recovery scores (Document 1 Table 34) is not clearly documented and may not have appropriate properties for sensitivity-adjusted fishing effort.
  - The derived values are essentially non-ordinal ranks that have been assigned equal intervals between 0 and 1. However, the equal spacing between intermediate sensitivites and equal sensitivities of different combinations of susceptibility and recovery are difficult to justify. For example, Table 34 lists equal sensitivity values (Se=0.2) for two combinations of susceptibility and recovery (medium susceptibility-fast recovery or low susceptibility-moderate recovery), and both situations are score as 20% of the sensitivity of a high susceptibility-very slow recovery (Se=1.0) and about 50% more sensitive than low susceptibility-fast recovery (Se=0.13). Although the extreme values are logical, neither the rankings nor the intervals appear to be scientifically justified.
  - As noted above for the vulnerability assessment, aggregate indices of sensitivity should be based on a more formal and quantitative process that is repeatable and transparent.
  - Methods routinely used for multimetric indices of benthic habitat should be considered indices used to assess environmental quality (e.g., Karr and Chu 1997)
- The spatial resolution of fishing effort data from vessel trip reports is too crude to provide an informative analysis for fishery management decisions. Information from vessel monitoring systems, observers and study fleets should be explored for higher spatial resolution of fishing effort.

The SSC appreciates the progress made by the Habitat PDT in developing a methodology for evaluating fishing effects on habitat. The SSC looks forward to working with the PDT and learning

how best to manage the scallop fishery in conformance to the new guidelines. Please contact me or Dr. Jake Kritzer (the SSC lead for habitat) as these methods and analyses develop.

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