Review of

The National Marine Fisheries Service and the North Pacific Fishery Management Council

Draft Environmental Impact Statement with Respect to Essential Fish Habitat:

Evaluation of Fishing Activities that May Adversely Affect Essential Fish Habitat

July 2004

By

Dr. Paul Snelgrove

8 Spray Lane, Torbay, Newfoundland Canada A1K1A7

1. Executive Summary

The National Marine Fisheries Service and the North Pacific Fishery Management Council have proposed to address the effects of fishing on Essential Fish Habitat (EFH) in Alaskan waters through the application of a spatially explicit model that evaluates fishing activities in different habitat types in order to generate a measure of habitat loss. This information is subsequently used in conjunction with estimates of MSST (Minimum Sustainable Spawning Threshold) for individual species in order to determine whether current fishing practices are having a significant effect on EFH for that species. The habitat model is appealing in its relative simplicity and intuitive nature, and has promise as a useful tool in evaluating EFH losses. Like any model, the quality of the output will vary as a function of the data input, which is limited in this case by poor habitat data and the assumptions that are subsequently necessary to generate measures of impact. There is substantial information (observer data, log books, published studies), which, though less than perfect, could be utilized to improve on the habitat characterization used in the current model. Public consultation with fishers on this issue could also be illuminating, particularly if a mechanism could be developed to transfer their knowledge to the NMFS. In the long term, this limitation can be resolved by prioritizing habitat mapping.

It is likely that some habitats such as corals and sponges have recovery times that are substantially longer than those discussed here, and re-examination of these habitat impacts is strongly encouraged. Increased scrutiny of published studies could be particularly relevant to improving estimates of damage and mortality for these organisms given that information of this type from the Alaskan region is scant. Published studies could also help in evaluating the utility of the model output, and determining whether the predicted responses of EFH correspond to outcomes reported for other areas of the world. Many of the published studies on fishing impacts have not been considered because the data is incomplete for the needs of the model, but incomplete data could nonetheless be useful for verification purposes. Sensitivity analysis could also be used to explore how assumptions on habitat composition influence the predicted impacts.

Another shortcoming of the habitat model is the presumed equilibrium state of present communities and the implicit assumption that maintaining the current stock sizes is sufficient. Current fishing levels may be sustainable but they may represent a reduced fraction of the potential yield based on historical population levels. It may be possible to hindcast the model to examine how habitat has deteriorated over the last decades of fishing. Comparisons of closed areas (some of which have not been fished for decades) to actively fished areas could also be very illuminating in this respect. This type of approach could also allow the examination of impact responses other than fish productivity (e.g. benthic diversity, species composition).

Fish productivity represents a tertiary response to disturbance that may not yield clear answers on EFH loss until a habitat is severely degraded and productivity changes suddenly. The very nature of EFH, and its importance to multiple life stages and activities renders MSST a very insensitive measure of the ramifications of EFH loss because MSST operates on a spatial scale that is unlikely to respond in the short term to local habitat effects. It is this delayed response in MSST that suggests its use as a primary diagnostic tool is the antithesis of any precautionary approach. Regional comparisons of growth and fecundity in relation to habitat disturbance and fishing activity is much more likely to identify EFH effects before damage becomes largely irreversible and changes in fish productivity become apparent, and these types of comparison should be considered as an alternative to MSST. The use of MSST for species where effectively nothing is known on EFH for spawning, feeding and growth represents a strong deviation from the precautionary principle and places a potentially unattainable burden of proof on fisheries data. With such an approach it will be extraordinarily difficult to prove productivity effects even in situations where spawning, feeding and/or growth are being systematically reduced. Thus, the conclusion that current fishing activities are having no effect on EFH is premature at best, and potentially dangerous for the long-term sustainability of Alaskan fisheries. Regime shifts add further noise that may camouflage any response in MSST related to EFH decline.

The habitat model approach proposed by Council has promise, but it can be significantly improved by the use of better habitat data and application of metrics other than MSST to evaluate habitat loss effects. Some approaches proposed by outside organizations are intuitively interesting but the caliber of data needed for effective application is currently unavailable and unlikely to be available in the foreseeable future.

2. *Background*

The collapse of many fisheries worldwide underscores a need for changes in the way that commercial fisheries are managed. Although some fisheries have continued to flourish, even under intense fishing activity, only about a third of global fisheries are considered to be below a fully or over-exploited state (Schiermeier 2003). Myriad reasons have contributed to the declines of different fisheries and the failures of management schemes to maintain sustainable and healthy fisheries, but within the last decade there has been increasing emphasis on moving away from traditional, single-species models to more holistic, ecosystem approaches (Pauly and MacLean 2003). This shift in thinking has stemmed from recognition of the complexity of how species interact with their environment, and the role that other biotic and abiotic variables can play in the population dynamics and productivity of a given fish species (where "fish" is defined broadly and encompasses scallop, shrimp and other commercial species of invertebrates). One ecosystem issue that has received particular interest is that of *Essential Fish Habitat (EFH)*, which is habitat that is necessary to the productivity of a given species. The habitat may be biotic or abiotic in nature, and may be habitat that is utilized by eggs, larval, juvenile, and/or adult fishes. EFH may be important as a spawning or breeding site, an area that is conducive to feeding (larval, juvenile, adult), or that enhances growth to maturity (e.g. predator refuges). One such example is juvenile cod (Laurel et al. 2003) or scallops (Irlandi and Peterson 1991), which have been shown to utilize seagrass habitat to reduce predation pressure and increase recruitment success. Activities that reduce seagrass habitat may subsequently reduce recruitment success, so that the loss of EFH will ultimately reduce the productivity of the target species. Such studies have so far demonstrated habitat effects on growth and predation losses but have not attempted to link these effects with large-scale population biology.

Another issue for managers is the role that EFH may play in maintaining healthy ecosystems. Within the last few years there has been increasing interest in the concept of ecosystem services and function (e.g. Dailey 1997), where ecologists have argued that living organisms provide key ecosystem services (fisheries, clean water) and functions (nutrient cycling, habitat creation, habitat stabilization etc.). Within the oceans, these include production of food for human consumption, but also shoreline and sediment stabilization, provision of habitat for other organisms, biogeochemical cycling (including nutrients, carbon, oxygen), and pollutant cycling and breakdown (Snelgrove et al. 1997; Snelgrove 1999). Marine scientists have only recently (e.g. Emmerson et al. 2001; Bolam et al. 2002; Biles et al. 2003) attempted to link these services and functions to biodiversity and are subsequently lagging behind their terrestrial counterparts (e.g. Naeem and Li 1997; Loreau et al. 2001; Wardle et al. 2003) but evidence to date suggests that loss of some types of species (e.g. those that form biotic structures) will compromise ecosystem health (Snelgrove et al. in press). But the field is in its infancy and ocean managers face the challenge of extracting resources from the marine environment with minimal impact on the long-term sustainability of target species and the long-term health of the oceans. These goals must be met using knowledge that is very incomplete.

In the United States, the Magnuson-Stevens Fishery Conservation and Management Act requires that every fishery management plan describe and identify Essential Fish Habitat (EFH) for the fishery, minimize to the extent practicable the adverse effects of fishing on EFH, and identify other measures to promote the conservation and enhancement of EFH. The National Marine Fisheries Service (NMFS), the federal agency that oversees management of marine living resources, and the North Pacific Fishery Management Council, one of eight regional management councils, recently developed a draft environmental impact statement (DEIS) to consider the impacts of incorporating new EFH provisions into the Council's fishery management plans. The DEIS evaluates three actions: (1) describing and identifying EFH for fisheries managed by the Council; (2) adopting an approach for the Council to identify Habitat Areas of Particular Concern within EFH; and (3) minimizing to the extent practicable the adverse effects of Council-managed fishing on EFH. This third objective is the focus of this review.

Most of the controversy surrounding the level of protection needed for EFH concerns the effects of fishing on sea floor habitats. Substantial differences of opinion exist as to the extent and significance of habitat alteration caused by bottom trawling and other fishing activities (Dayton et al. 1995; Auster et al. 1996; Hall 1999; Collie et al. 2000; Dayton et al. 2002; Koslow et al. 2001; 2002; Thrush and Dayton 2002). Although an increasing body of scientific literature discusses the effects of fishing on habitat, there is no clear consensus within the scientific community on an appropriate methodology for analyzing potential adverse effects. This lack of consensus hamstrings managers and generates considerable controversy with far-reaching ramifications for management of marine resources.

An additional area of recent debate is the application of a precautionary approach to fisheries and shifting the burden of proof (Dayton 1998) from management to users. Both of these issues are linked to the inherent uncertainty in estimation of human-induced changes in populations and environments against a background of natural variation. It is this very uncertainly that has led many ecologists to recommend a precautionary approach, such as that outlined in the UNICED Rio Declarations which advocates, among other things, that "where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource". This leads directly to burden of proof. Many ecologists now accept that all fishing activities have environmental impacts, and it is inappropriate to assume that these impacts are negligible until proven otherwise. In other words, the burden of proof is shifted from managers or conservationists having to prove significant effects to resource users who must prove there is no significant effect. This is particularly relevant to fish production because it is often difficult to link production unambiguously to essential fish habitat, even where anecdotal evidence clearly suggest that the link exists.

In the case of the Magnuson-Stevens Fishery Conservation and Management Act, as in any law, some degree of interpretation is required. Part of the act that pertains to the act reads that the fisheries management plan must "*minimize to the extent practicable adverse effects on such habitat caused by fishin*g, and identify other actions to *encourage the conservation and enhancement of such habitat*. Key aspects of interpreting this statement are the uses of the terms practicable and that adverse effects must be <u>identifiable</u> (=measurable). The ultimate precautionary approach would be to close marine areas to all activities that may cause any harm, but this is clearly not practicable from a social or economic perspective and potentially even from a fish production perspective. Likewise, it could be argued that the presence of any dead or damaged organisms on the seafloor demonstrates measurable and identifiable adverse effects on the bottom habitat, but whether such damage is cause for concern, and subsequently linking this damage to EFH and decline in the utility of EFH is far more difficult. And finally, actions that encourage the conservation and enhancement of such habitat are typically at odds with fishing activity, so how can this goal of the Act be achieved while also satisfying other goals?

The national EFH regulations (50 CFR 600.815(a)(2)) require an evaluation of the effects of fishing on EFH, and this evaluation appears in Appendix B to the DEIS. The draft evaluation has two components. First, a quantitative mathematical model has been developed to examine the expected long-term effects of fishing on habitat based on estimates of habitat distribution, fishing intensity within different habitats, and the anticipated mortality associated with fishing impacts. This habitat model approach provides a mechanism by which to evaluate effects on the habitat and perhaps eventually develop conservation and enhancement schemes, but there is no existing mechanism by which to link EFH to fish production. The Council therefore proposes to use a qualitative assessment of how those changes affect managed fish stocks by examining stock levels over time and how they relate to the potential fishing yield of the stock.

The habitat model estimates the proportional reductions in habitat features relative to an unfished state, assuming that fishing will continue at the current intensity and distribution until the alterations to habitat and the recovery of disturbed habitat reach equilibrium. The model brings together information on the effects of fishing on habitat, such as fishing gear types and sizes used in Alaska fisheries, fishing intensity information from observer data, and gear impacts and recovery rates for different habitat types based largely on quantitative published studies from other regions. There is very large uncertainty associated with many input parameters (e.g., recovery rates of different habitat types), and the authors therefore provide a range of potential effects based on different input parameter estimates in addition to point estimates.

After considering the available tools and methodologies for assessing effects of fishing on habitat, the Council and its Scientific and Statistical Committee concluded that the model incorporates the best available scientific information and provides a good approach to understanding the impacts of fishing activities on habitat. Nevertheless, they recognized that the model and its application have many limitations, which are discussed in Appendix B. They also acknowledge that the novelty of the model limited the quality and quantity of available data in order to estimate input parameters, preventing a clear assessment of the effects of fishing on EFH. The model incorporates assumptions about habitat and fishing effort, habitat recovery rates, habitat distribution, and habitat use by managed species. The quantitative outputs of the analysis subsequently convey an impression of rigor and precision, but the results actually are uncertain. This final point cannot be overemphasized.

One major limitation of the model is that it does not consider the habitat requirements of managed species or the distribution of their use of habitat features. Quantitative data on this issue are few, and the habitat model is therefore difficult to relate directly to productivity estimates, which is a key parameter in determining whether current practices comply with the Magnuson-Stevens Act. DEIS analysts were therefore asked to use the model output, on a species-by-species basis, to address whether current fishing activity is likely to alter the sustainability of a given managed species over the long term. In other words, are the fisheries, as they are currently conducted, affecting habitat that is essential to the welfare of each managed species? To help answer that question, the analysts considered available information about the habitats used by each managed species. The analysts also considered the capacity of each stock to stay above its minimum stock size threshold (MSST), after at least thirty years of fishing at equal or higher intensities. MSST is the level below which a stock is in jeopardy of not being able to produce its maximum sustainable yield on a continuing basis.

The DEIS analysis concluded that despite persistent disturbance to some habitats, the effects on EFH are minimal because there is no indication that continued fishing activities at the current rate and intensity would alter the long-term capacity of EFH to support healthy populations of managed species. This conclusion is drawn despite the clear acknowledgement that the model output is known to be highly uncertain. The DEIS therefore concluded that no Council-managed fishing activities have more than minimal and temporary adverse effects on EFH, which is the regulatory standard requiring action under the Magnuson-Stevens Act. Additionally, the analysis concludes that all fishing activities combined have minimal, but not necessarily temporary, effects on EFH. These findings suggest that no additional management actions are required to modify current fishing activities pursuant to the EFH regulations.

In order to provide an independent assessment of the DEIS and its conclusions, NMFS contracted with the Center for Independent Experts (CIE) to conduct a peer review of the evaluation of the effects of fishing on Essential Fish Habitat (EFH) in Alaska, which was completed in support of the Draft EFH EIS. The CIE is a University of Miami organization that provides independent peer reviews of NMFS science nationwide, including reviews of stock assessments for fish and marine mammals. Given the newness of the model, the importance of this analysis for Alaska's fisheries, and the controversial nature of the subject matter, NMFS determined that an outside peer review would be a prudent step that would add credibility to the final analysis and the EIS process. The review panel included members with expertise in benthic ecology, fishery biology, fishing gear technology and biophysical modeling. My own background is in benthic ecology and larval transport. In the last 7 years I have been more active in applying these interests to fisheries questions.

3. Description of Review Activities

Review activity involved five stages. First, advance material was provided by the CIE through their web site, which allowed reviewers to download the documents listed in Appendix A of this document. Reviewers read the documents and, in some cases, posed questions through Dr. Jon Kurland that they wished to see addressed by the authors of the report. Prior to the meeting, some additional published work was reviewed (see papers cited in Background), including syntheses that I have been involved in that focuses on ecosystem function in sediments and additional material on deep-water fisheries (again see citations in Background).

The second stage required traveling to Seattle, WA to meet with the authors of the model. During the morning of the first day, a series of PowerPoint presentations summarized key aspects of the model and the subsequent evaluation of fishing effects. Although there was no formal response to the questions that had been submitted by reviewers prior to the meeting, it was clear that many of the questions had helped to shape the talks that were given. Paper copy summaries of all presentations were supplied to reviewers. Presenters and the titles were:

1. Dr. Jon Kurland - Background behind the EFH Environmental Impact Statement.
2. Drs. Jeff Fujioka and Craig Rose - Fishing effects model
    - development and evolution of the model
    - application of the model to the EFH EIS

3. Drs. Craig Rose and Anne Hollowed - Analytical approach for assessing effects on EFH and managed species.

The third stage followed immediately after the presentations had been completed, and involved a question and answer period with all of the speakers. All members of the review panel had the opportunity to seek clarification on the EFH document and to challenge the authors on aspects of the document and presentation that they felt required closer scrutiny. Although the question period occupied only half a day, there was sufficient time to cover all of the questions raised, and when the question period ended, all members of the review panel felt satisfied that the discussion had been productive and thorough.

The fourth stage of the review took place the following morning, when review panel members met privately to discuss the EFH model and analysis. The meeting went smoothly and the group went collectively through the summary questions posed by the CIE (see Conclusions and Recommendations below). The panel was largely in agreement on the major points raised in this discussion, and although we had requested that the authors of the report be available to respond to any additional questions, it was not found to be necessary to query them any further. The panel disbanded mid-afternoon with the understanding that each of the six members would prepare an independent report that would reflect the differences in expertise and perception of the materials we had read and the presentations we had seen. This document represents one of those reports, which is the fifth and final stage of the review process.

In addition to the activities directly associated with preparation and participation in the workshop, additional activities have included searching through websites to try to understand better the management structure and how it deals with EFH (specific websites include www.fakr.noaa.gov/npfmc/about.htm, www.fakr.noaa.gov/npfmc/current_issues/efh/efh.htm Additional time was spent trying to determine whether there might be additional information available with respect to habitat mapping. All panelists were initially incredulous that agencies such as The US Geological Survey did not have some types of maps of bottom habitat available. One such website visited for mapping was www.doi.gov/pfm/ar4gs.html, and http://marine.usgs.gov/cgi-bin/locator?selected_topic=n&selected_region=1&selected_content=n Additional effort was made to try to determine the status of ongoing research that might assist in some of the issues identified here such as coral habitat usage and degradation (e.g. http://www.afsc.noaa.gov/abl/MarFish/pdfs/R0304%20Progress%20May-June%202003.pdf)

Other Literature Cited

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.L.S. Donaldson, E.W. Langton, A.N. Shepard and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (northwest Atlantic): Implications for conservation of fish populations. *Reviews in Fisheries Science* 4: 185-202

Biles, C.L., M. Solan, I. Isaksson, D.M.Paterson, C. Emes, and D.G. Raffaell. 2003. Flow modifies the effect of biodiversity on ecosystem functioning: an in situ study of estuarine sediments. *Journal of Experimental Marine Biology and Ecology* 285-286: 165-177.

Bolam, S.G., T.F. Fernandes, and M. Huxham. 2002. Diversity, biomass, and ecosystem processes in the marine benthos. *Ecological Monographs* 72: 599-615.

Botsford, L.W., J.C.Castilla and C.H. Peterson. 1997. The management of fisheries and marine ecosystems. *Science* 277: 509-515.

Collie, J.S., S.J. Hall, M.J.Kaiser and I.R. Poiner. 2000. Shelf sea fishing disturbance of benthos: trends and predictions. *Journal of Animal Ecology* 69: 785-798.

Dailey, G.C. (ed.) 1997. *Nature's services: societal dependence on natural ecosystems.* Washington, DC: Island Press.

Dayton, PK. 1998. Reversal of the burden of proof in fisheries management. *Science* 279: 821-822.

Dayton, P. K., S. F. Thrush, M. T. Agardy and R. J. Hofman. 1995. Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems* 5: 205-232.

Dayton, P. K., S. Thrush and F. C. Coleman. 2002. Ecological effects of fishing in marine ecosystems of the United States. Pew Oceans Commission, Arlington, Virginia.

Emmerson, M.C., M. Solan, C. Emes, D.M. Paterson and D. Raffaelli. 2001. Consistent patterns and the idiosyncratic effects of biodiversity in marine ecosystems. *Nature* 411: 73-77.

Hall, S. 1999. *The effects of fishing on marine ecosystems and communities.* Oxford: Blackwell Sciences Ltd.

Hall-Spencer, J.V. Allain and J.H. Fossa. 2002. Trawling damage to Northeast Atlantic ancient coral reefs. *Proceedings of the Royal Society of London, Series B:* 269: 507-511.

Hall-Spencer, J.M. and P.G. Moore. 2000. Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science* 57:1407-1415.

Irlandi, E.A., C.H. Peterson. 1991. Modification of animal habitat by large plants: Mechanisms by which seagrasses influence clam growth. *Oecologia*. 87: 307-318.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J. Erlandson, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange, H.S. Lenihan, J.M. Pandolfi, C.H. Peterson, R.S Steneck, M.J. Tegner and R.R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293:629-638.

Jennings, S. and M.J. Kaiser. 1998. The effects of fishing on marine ecosystems. *Advances in Marine Biology* 34: 201-352.

Kaiser M.J., K. Ramsay, C.A. Richardson, F.E. Spence and A.R. Brand. 2000.Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology* 69: 494-503.

Koslow, J.A., G.W. Boehlert, J.D. Gordon, R.L. Haedrich, P. Lorance and N. Parin. 2000. Continental slope and deep-sea fisheries: implications for a fragile ecosystem. *ICES Journal of Marine Science* 57: 548-557.

Koslow, J.A., K. Gowlett-Holmes, J.K. Lowry, T. O'Hara, G.C.B. Poore, and A.Williams. 2001. Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. *Marine Ecology Progress Series* 213: 111-125.

Laurel, B.J., R.S. Gregory, and J.A. Brown. 2003 Predator distribution and habitat patch area determine predation rates on Age-0 juvenile cod Gadus spp. Marine Ecology Progress Series 251: 245-254.

Leys, S.P. and N.R.J. Lauzon. 1998. Hexactinellid sponge ecology: growth rates and seasonality in deep water sponges. *Journal of Experimental Marine Biology and Ecology* 230: 111-129.

Loreau M, Naeem S, Inchausti P, et al. 2001. Ecology - Biodiversity and ecosystem functioning: Current knowledge and future challenges. *Science* 294: 804-808.

Naeem S. and S.B. Li. 1997. Biodiversity enhances ecosystem reliability. *Nature* 390: 507-509.

Pauly, D. and J. MacLean. 2003. *In a Perfect Ocean. The State of Fisheries and Ecosystems in the North Atlantic Ocean*. Island Press. 175 pp.

Sala, E., O. Aburto-Oropeza, G. Paredes, I. Parra, J.C. Barrera, and P.K. Dayton. 2002. A general model for designing networks of marine reserves. *Science* 298: 1991-1993.
Schiermeier, Q. 2002. How many more fish in the sea? Nature 419: 662-665.
Snelgrove, P.V.R. (1999) Getting to the bottom of marine biodiversity: Sedimentary habitats. *BioScience* 49: 129-138.
Snelgrove, P.V.R. T.H. Blackburn, P. Hutchings, D. Alongi, J.F. Grassle, H. Hummel, G. King, I. Koike, P. J.D. Lambshead, N.B. Ramsing, V. Solis-Weiss, D.W. Freckman (1997) The importance of marine sediment biodiversity in ecosystem processes *Ambio* 26: 578-583.
Snelgrove, P.V.R., M.C. Austin, S.J. Hawkins, T.M. Iliffe, R.T. Kneib, R.B. Whitlatch, L.A. Levin, J.M. Weslawski & J.R. Garey (in press) Vulnerability of Marine Sedimentary Ecosystem Services to Human Activities. In: *Sustaining biodiversity and ecosystem services in soils and sediments,* SCOPE Series, vol. 64. edited by. D.H. Wall. Island Press.
Thrush, S.F. and P.K. Dayton. 2002. Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. *Annual Review of Ecology and Systematics* 33:449-473.
Wardle D.A., Hornberg G., Zackrisson O., Kalela-Brundin M., Coomes, DA. 2003. Long-term effects of wildfire on ecosystem properties across an island area gradient. *Science* 300: 972-975.
Worm B & Myers RA (2003) Meta-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. *Ecology* 84: 162-173

4. Summary of Findings

This panel could significantly influence the present and future Alaskan fisheries for a long time to come, and we expect that Council will weigh this meeting and the review that panelists present very heavily in their decisions. We welcome the opportunity to provide an outside perspective on the report and trust that our comments will be constructive.

The report is generally very well written, and it is clear in its methods and goals. The flow of ideas was easy to follow, and reflected good organization and logical progression of ideas. There are a few typographical areas scattered throughout the manuscript but the report is a careful synthesis of the approach and the authors are to be commended for the care they have taken in preparing it. Indeed, it is very clear that a tremendous amount of work and thought have gone into the preparation of this document, and the scientists involved are of a very high caliber.

The model for fishing effects on habitats is appealing in that it provides a reasonable way to deal with a complex problem; how to determine fishing effects over a very broad and variable landscape. The explanation of the model is good, as is the cautionary note that is included with it. The issue that caused most discussion was not the model itself but rather the application of the model and subsequent interpretation. The major concerns raised are the quality and quantity of data available for the model and the way that these data are used to determine fishing effects on habitat. An additional issue is the way that the model is subsequently linked to fish production for individual species. These concerns are described in greater detail below.

There are two broad considerations here. Are there improvements to the application of this model that can realistically be made in the short term, and what sorts of recommendations can improve the utility of this approach in the long term? Both could potentially be very useful to Council and, as will be described below, there are suggestions that pertain to both time scales that could enhance NMFS management of the Alaskan marine ecosystem.

Report Section B.1. Overview

The report overview provides many of the key definitions in a clear manner, but it does leave some legal issues and definitions unresolved. On page B-2 the term “healthy ecosystem” is noted in several places, yet the potential role of fishing activity on the ecosystem is ultimately really only considered in terms of the health of fisheries production. These issues are not unrelated but the focus of the analysis is exclusively fish production, and it is not difficult to conceive of very unhealthy ecosystems that can still support production of some species. I have some recollection, for example, that Boston Harbor at its worst supported a large biomass of (admittedly diseased) flounder. Is this an acceptable outcome relative to the legal responsibilities of NMFS according to the Magnuson-Stevens Act? This point needs further clarification. Moreover, if healthy ecosystems are not within the purview of NMFS management goals then perhaps reference to the issue should be removed. A second point is the statement that “…this does not mean that site-specific effects are not assessed, rather that their cumulative consequences must be considered to evaluate the effects of the EFH on each species.” This statement is subsequently borne out as the document unfolds in that a spatially explicit habitat model that operates on a relatively fine grain (5 km x 5 km) is quickly scaled to a regional assessment. This evaluation is paired with a single parameter (MSST) for a given species that operates on the population scale, which is extremely course grained and often represents 1-3 numerical values that are calculated to represent the entire Alaskan management region.

The literature review is far from exhaustive and tends to focus primarily on studies from environments similar to Alaska. Because much of the available literature is from other regions, and the numbers of studies from environments that are very similar to Alaska are few, this bias results in an overly narrow perspective that fails to capture the full range of scientific discussion. Deep-water studies are one instance where studies in very different geographic regions are particularly relevant to potential fishing effects on Alaskan EFH. This point becomes particularly relevant when considering the model results and inferring whether they provide a realistic and reliable description of fishing damage to EFH.

One other issue is that the concept of equilibrium is introduced, but what equilibrium is intended here? Apparently foreign fishing prior to the establishment of the 200-mile limit was intense, so is the “equilibrium” being considered here relevant only to the decades since NMFS did stock assessments for this large area?

Jon Kurland’s presentation contained some refinements of definitions (e.g. temporary, minimal) that might be helpful if incorporated into the introduction.

Report Section B.2. Effects of Fishing Analysis

The effects of fishing analysis is comprised of four elements: intensity of fishing, sensitivity of habitat features to contact with fishing gear, recovery rates of habitat features and distribution of fishing effort relative to different types of habitat. The authors correctly note that the quality of data available for each of these elements varied considerably, ranging from reasonably good for fishing activity to very poor for habitat distribution. It was also noted in this section that considerable caution should be exercised and that “*While quantitative output may provide an impression of rigor, the results are subject to considerable uncertainty.* This statement is absolutely correct, but subsequent sections of the report (discussed in greater detail below) do not adhere to this warning as clearly as they should.

Report Section B.2.1 The Effect and Recovery Model

The presentation of the Effect and Recovery Model is clearly written and makes good intuitive sense. One point of note is that fishermen are very good at finding fish, which by definition aggregates fishing efforts at EFH. The Long-term Effect Index (LEI) as used here assumes that all locations in each habitat have equal value, which is unlikely to be true even with a 5 km x 5 km grid, and fishing activity may tend to aggregate around habitat of highest value. The division of the region into grid segments reduces the significance of the assumption on habitat value at the regional scale. But this is true if the habitat assignment and gridding can be done in a reasonably accurate way, and there is reason to believe this is definitely not the case. This point is elaborated on below.

Report Section B.2.3 Analysis Process

This section of the report correctly notes that key assumptions and simplifications were necessary in order to mate the available data with the data needs of the model. This is the crux of the matter; does the data that is used in the model reflect the best available data, is this data sufficient, and in instances where the data is weak or absent do the assumptions that are subsequently made introduce excessive error or uncertainty in the output? For some of the key input parameters I would assert that the data is extremely weak and in the short term there may be additional data sources that could be tapped into to improve the situation. Moreover, there is a real urgency in the longer term to collect that that could plug these holes.

Report Section B.2.4 Parameter Estimates

One of the most significant shortcomings with the application of the habitat model is the appallingly poor data that is available on habitat type. The situation for the Bering Sea is somewhat better in that five habitat categories can be identified, but in the Gulf of Alaska and Aleutian Islands extrapolation must be made from very limited data. The importance of habitat type is correctly noted in the report where they state that "*designation of substrate type is useful since much of the recovery rate and fishing effect studies are specific to particular substrates*". A further precautionary note is added at the end of this section states "*The insufficient amount of real data on the types, proportions, and distribution of substrates in the GOA and Aleutian Islands should engender great caution in the application of the analysis*…"

There are several sources of data that could improve on the abysmally poor data on habitat. Bycatch data from fisheries observers, log books from fishing boats and discussions with fishermen. Over a longer time period, priority should be given to efforts to map habitat and work in tandem with groups such as the USGS and National UnderSea Research Center that include habitat-mapping initiatives as part of their mandate. This type of data is already being collected but will be slow in becoming fully available, but every effort should be made to utilize whatever data are available and incorporate new findings as they emerge.

Although it is certainly true that EFH is normally more easily defined for bottom environments (B-8), it is noteworthy that spawning aggregations can occur in the water column at specific geographic locales. This particular "pelagic effect" merits additional attention.

The establishment of a separate category for living structure should be expanded to include sponges, which are thought to also be slow growing and long-lived species (Leys and Lauzon 1998).

It would be appropriate to cite any additional data that support the argument that vessels less than 60 feet take less than 1% of groundfish and are therefore unimportant. Data on bottom area trawled, for example, would alleviate any concern that inshore vessels could be causing disproportionate damage to EFH because they fish in areas that have already been depleted or fish in areas with especially high proportions of EFH.

The parameter used to describe calculating gear contact (q) is obviously important in calculating the effect on habitat. Comparisons between gears contained some surprises, such as the frequency of contact of the pelagic trawl with the bottom and the subsequent contribution to q. The relative rankings of the gear made sense otherwise, and the calculation of q seemed reasonable. The limited impact of the pelagic gear is also sensible.

Distribution of fishing effort was determined primarily from data provided by fishing organizations (B-9). In other areas of the world, misreporting in terms of location and intensity of activity has contributed to the collapse of fisheries, and any information that can increase confidence in this data would be useful. Some nations have adapted black boxes to determine exactly where and when fishing activity takes place. In the long term, similar approaches would likely improve the management capacity of NMFS.

It is stated (B-11) that because fish aggregate, fishing effort also aggregates, with the subsequent result that fishing effects are over estimated by the model. But as stated earlier, by definition fishes may aggregate around EFH. EFH could therefore be disproportionately impacted by fishing activity relative to a random distribution of fishing effort and therefore <u>underestimate</u> impacts.

One point made regarding sensitivity (B-11, last line) is that studies that did meet certain criteria is estimating q were not included but “were examined for consistency with the results of the studies used”. Given the very few numbers studies that were actually used, it would be useful to document how the broader range of ecological studies was considered. Indeed, on pages B-13 it would appear that effectively all of the conclusions regarding fishing impacts on infaunal benthos were based on just 3 studies. Although it is true that these studies were probably those that were most relevant to Alaska, it is a very small number of studies on which to base many important decisions. One criticism that emerged at the panel meeting was that the literature cited was thin and many studies appeared to be ignored because they did not fulfill all of the criteria necessary for the model. But the feeling of the panel was that these studies could be used to verify the validity of the model output, and if the model developers did, in fact, complete such an exercise then they should report it. A similar situation is observed with fishing effects on epifauna. But it is the sections on Living Structure and Hard Coral that seems to omit the most published studies (e.g. seamounts, see review of Koslow et al. 2001) that could be used to support the decisions and outcomes produced with the habitat model.

In terms of recovery rates from fishing impacts, some would argue that virtually every fishable bottom habitat on Earth has been fished. If this is the case, then recovery rates (B-18) refer to recoveries to some post-impact state where the truly pristine status of habitats is effectively unknown (e.g. Jackson et al. 2001). This gets back to the idea that the modern equilibrium assumed by the model may represent a mere shadow of the “true” MSY (maximum sustainable yield) prior to fishing depletion. As in the previous section, more information on other studies that have examined recovery rates (i.e. a more exhaustive literature review) would instill greater confidence in the values used.

<u>Report Section B.2.5 Results of the Analysis of Effects of Fishing on Habitat Features</u>

The analysis of Long-term Ecosystem Impacts (LEIs) presents a range of possible outcomes based on assumptions regarding sensitivity parameters as well as a mean (or possibly median, not clearly stated) value. Indicating the range is commendable because it gives some feel for the uncertainty in the estimate. But having said that, I cannot help feel that there is greater uncertainty than is indicated. First, there is a wider range of predicted outcomes in the literature than presented here, and it would be worthwhile to revisit some of the studies that were discarded to see how their estimates compare. The estimates for living habitat such as coral and sponge look particularly low. Of course assumptions would have to be made, but that is par for the course given the amount of available data. Second, this issue of equilibrium arises and this “equilibrium is one that reflects recent history, as mentioned earlier. Third, the LEI is based on very weak habitat data.

But there are still indications that habitat loss in some cases would be in the double digits, even if the issues outlined above are ignored. Presumably if all habitat of a given type is of equal value then one might surmise that 10-20% habitat loss is not going to have devastating effect on the overall value of the EFH (though values for habitats used by some species are even higher). But because the information is so poor on habitat distribution and utilization, these double-digit values do raise concern. This further emphasizes the need for better habitat data to examine sensitivity. Again, another look at published studies could be illuminating, and this would certainly help to ensure that the LEIs are not underestimated as a result of focusing on too few studies. Perhaps the model could be run in a hindcast mode to determine what “pristine” would look like. Such an effort could be undertaken in the short term

The issue of sensitivity needs a closer look for long-term as well as short-term strategies. Specifically, experiments should be undertaken to look at how assumptions on impact and recovery rates are supported by benthic communities that are currently found in areas that are off limits to fishing compared with those that are fished. The Southeast Alaska trawl closure area is ideal for such a study. Additional experimental studies on trawl impact could also be undertaken, perhaps even in a portion of the closed area. Such experiments could also address other measures of community change beyond mortality, such as diversity and dominance, as well as species composition. It is certainly easy to envision that changes in species composition with EFH could alter the utility of the EFH for those fish species that utilize it, but this model is unlikely to detect such changes.

<u>Report Section B.2.6 Effects of Habitat Features – Summary</u>

The conclusion that across broad habitats, LEI values were generally small is true, but caution must be exercised for the reasons stated in the previous section. To be fair, the summary does acknowledge that in some individual locations the LEI values were “quite substantial”, particularly for living structure. There is also consideration of the fact that the patchy nature of corals makes them particularly vulnerable to bias. The statement that the presence of living structures will tend to move fishing effort away is not backed up by evidence, and I suspect that some types of trawling gear move through corals and sponges with great ease. Indeed, we have heard from several sources that coral and sponge can be abundant bycatch in trawls; if they destroyed fishing gear then they wouldn’t be abundant bycatch. Moreover, there is evidence that some fishes (e.g. rockfish) do actively aggregate around these structures (thus EFH!) and, as stated before, fishermen are very good at finding aggregations of fish.

<u>Report Section B.3 Evaluation of Effects on Managed Species</u>

One of thorniest issues in dealing with EFH is how to translate impacts on EFH to fisheries management. The approach taken here is to examine response to fishing activity on a species by species basis for those species that are managed. Given the scale and complexity of the problem it is difficult to envision any mechanism for this particular issue other than a single species approach to attain this goal. But the specific approach taken has some problems. The use of MSST (Minimum Sustainable Spawning Threshold) is a useful point of reference for managing an individual species at a population level, but it is problematic to apply this measure to EFH. The inherent assumption of this approach is that there is a linear relationship between spawning biomass of the entire population of a given species and the availability of EFH, which was evaluated on a finer scale (5 km x 5 km grids). The drawbacks of this approach are: (1) the relationship between spawning biomass and EFH could work as a step function, so that there could be no sign of a decline in biomass until a precipitous collapse occurs once some key subunit of EFH or threshold level is reached. (2) Because the MSST approach works on a population level, it is likely to be an extremely insensitive measure of EFH loss. In areas where EFH loss is severe, it is easy to envision, for example, that fishes have reduced their use of that area or that they have reduced growth, fecundity etc. in areas that are most intensively fished. (3) If EFH itself is of interest to NMFS, rather than simply fish production, then response of fish populations is a poor metric. Whether EFH per se is important depends on exactly how one interprets the Magnuson-Stevens Act.

If the use of a reference point for a given species is insensitive, then clearly an alternative approach is needed. Ideally this approach would take advantage of existing data, and preferably a data time series (which would be less vulnerable to spurious fluctuations) rather than individual observations. One possibility is to look at data on size at age (if available), time series in size structure, measures of condition (e.g. liver indices), and measures of fecundity, but in a spatially structured format that more closely resembles the design of the habitat model. Most of this type of data is routinely collected during the stock surveys that are conducted by regulatory agencies, and it is likely that such data exist in a format that would readily allow this type of analysis.

A second approach is to find whatever data is available on life-stage usage of EFH for different species. To some extent this has already been attempted but with many pieces of missing data. Indeed, it is probably not possible to fully answer this question with existing data for many species. This approach may therefore represent a long-term priority, namely to determine how larval, juvenile, and spawning adults may utilize EFH. As mentioned earlier, if juvenile fish use a given EFH and fishing pressure is slowly degrading that EFH, then the use of MSST may significantly delay detection of any effect.

An overriding source or variability and “noise” in this system is that of regime shifts associated with meteorological/oceanographic shifts. Apex predators such as seabirds and sea lions could serve as indicators of change. In this system there can be regime shifts, where energy flows to benthic invertebrates rather than groundfish; these sorts of changes further complicate efforts to detect impacts on EFH, particularly through measures that are as indirect as MSST. Similar regime shifts in fish stocks have been documented elsewhere in the world (Worm and Myers 2003), and the complication this adds should not be ignored. But rather than treating these shifts as noise that swamps any EFH signal, efforts must be made to extract that signal from any created by habitat degradation. Experimental approaches and more direct measures of EFH usage (e.g. fecundity, condition) will help in that process.

The use of MSST resulted in conclusions that were surprising in their outcome uniformity and the absence of any clear precautionary approach. For some taxa, where the authors acknowledged that effectively nothing was known about spawning/breeding, feeding, or growth to maturity, the evaluation for the species was listed as minimal and temporary, or no effect. Using just about any measure other than MSST would lead most scientists to pause and at least acknowledge that EFH impacts are completely unknown rather than minimal or of no effect. In the report, this type of interpretation is routinely applied to species where more than one of the life history categories was completely unknown, but in at least one case (northern rockfish (BSAI) it was applied to species about which effectively nothing is known yet the evaluation was a "minimal or temporary effect". As an example of how these standards were applied, for northern rockfish (GOA) the following sentences actually appear in sequence. "*There is no information on larval and early juvenile fish biology or habitat. Consequently, there is no evidence (e.g. publications, field studies etc.) that links habitat features with northern rockfish accomplishing the spawning/breeding process*." This is the sort of statement that one expects to see an oil company make rather than a fisheries management team, and illustrates the folly of using MSST as sole criterion. In short, it sidesteps any precautionary approach and shifts a very heavy burden of proof on scientists (or environmental groups) to collect serious data before any concern is raised. It appears that for each species, the manager responsible has been asked to look at MSST and then infer whether it looks problematic and only then look at EFH. Not surprisingly, there is no concern raised about EFH losses. Curiously, there are no red flags raised where MSST trends and other bits of information look worrisome, including red king crab, blue king crab, snow crab, and Greenland turbot. Within some of these stocks there is potentially important overlap in trawling and breeding areas, and they may well serve as a poster child for the argument that not all habitat of a given type is of equal value as EFH.

5. Conclusions & Recommendations

Although it will result in some repetition, I have chosen to deal with the conclusions and recommendations from the report by organizing them around the questions posed by CIE in their initial package. These questions do query the most important points, and provide a logical framework for dealing with the very long and complex document that is represented by Appendix B.

Question 1

a. **Does the model incorporate the best available scientific information**?

Although the model itself is quite useful, it is severely constrained by the data that have been used. To a large extent this reflects an absence of suitable information, but not entirely. There are additional parameters that could be considered, including secondary effects such as changes in spawning habitat, or use of territories, which are not particularly well represented in the model. The literature review was lacking in some areas in setting up the problem, and the sorts of data that were included for the model were very narrowly prescribed despite the fact that there are sources that could have been used to strengthen the precision of the estimates. For example, recovery rates rho were based on very few studies because the criteria for considering them were set so stringently. Rho is obviously very important, and the most realistic values possible are needed. There are existing data for coral and sponges that suggest the recovery times identified in the report may be optimistic, and special consideration is needed for these environments.

The habitat data is woeful, which represents perhaps the single greatest problem with the application of this model. In the short term it should be possible to incorporate other sources such as observer data, bycatch data, or discussions with fishermen and the information that may be sitting in their logbooks. Sensitivity analysis using Bering Sea data could help address whether the lack of data elsewhere was an issue (i.e. change the assumptions regarding habitat categories and determine how if influences model output). It is truly shocking that there is no other substrate data, from USGS, the navy or other sources. Are there any 3-D circulation data that could be used to infer substrate composition? It is undeniable that such an approach would be crude, but not as crude as some of the current approaches. Any available surficial sediment maps could be used, even if it necessitates changing scale for some cells. Poor quality data are also preferable to no data. There is ongoing submersible work and sidescan mapping going on, and every effort should be made to integrate with the National Undersea Research Center and any other activities that could help alleviate this gap. This information may be of a small scale and too recent to be included, but its existence should be acknowledged and brought into the model as soon as can realistically be achieved. Mapping is a very key long-term objective.

The panel had the feeling that the modeling effort and those individuals doing individual habitat studies and stock assessments did not integrate well with each other. Every effort should be made to improve this situation.

b. **Does the model provide a reasonable approach to understanding the effects of fishing on habitat in Alaska?**

The model is intuitively simple and appealing but it loses a lot of information such as EFH species composition that could be important and are never really considered. This does not mean the model is inappropriate but it does mean that validation could be improved in a variety of ways. Bringing in studies from other areas could help quite substantially with this issue (e.g., Georges Bank). A more extensive literature could be helpful, and the mismatch in data quality would subsequently be less of an issue. In other words, would the model predict the sorts of patterns that have been found in other areas of the world? It is important to note that the issue of missing citations is not simply brought up to encourage slavish listing of more studies – the issue is that the background data that are available have been undervalued. The authors of the report may well have examined many of these studies and discarded them.

The model could also be used for exploration, which was never really done as extensively as it could have been. For example, additional sensitivity analyses could be performed to address the gravity of some of the assumptions. The model could be run in reverse to infer how far the system is from pristine. A general assumption is that the current equilibrium is the most relevant consideration, but we know the system has been fished intensively for some time that exceeds the quantitative data sets collected by NMFS. Within-community variability in recovery trajectories can result in an altered community that will respond in ways that the model cannot predict. Thus, some caution must always be exercised. We may have lost significant habitat, but the way the model is applied does not allow examination of further degradation beyond the current situation. The availability of closed areas could be used as part of this validation exercise by comparing a variety of response variables with fished areas. Community structure questions could then be addressed, including everything from biomass to diversity. Such an approach could determine whether the exclusion of species data from the habitat model reduces its effectiveness.

Presumably some of the data on individual fish species (e.g. length-weight comparisons inside and outside of closed areas) is readily available and could be examined with respect to the existing model output as well as some of the variations described above, though collection of new data may be more of a long-term objective.

An additional issue here is that the model would likely underestimate the impacts of trawling in new areas (rho values calculated from fished areas would not be representative). This is probably less of an issue with Bering Sea type habitat that has been heavily fished for a long time, but it should be considered for areas where less fishing has taken place historically. Fishing practices can change, and effort may well be redistributed if stocks decline.

One final point is that trawling activity may or may not coincide with reproduction of organisms associated with bottom environments, which could elevate (or reduce) impacts.

Question 2

Does the DEIS Appendix B analysis provide a reasonable approach for identifying whether any Council-managed fishing activities adversely affect EFH in a manner that is more than minimal and not temporary in nature? (For purposes of this question, the terms "temporary" and "minimal" should be interpreted consistent with the preamble to the EFH regulations: "Temporary impacts are those that are limited in duration and that allow the particular environment to recover without measurable impact. Minimal impacts are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.") To answer this question, the panel shall address at least the following issues:

a. **Does the DEIS Appendix B analysis apply an appropriate standard (including the consideration of stock status relative to MSST) for determining whether fishing alters the capacity of EFH to support managed species, a sustainable fishery, and the managed species' contribution to a healthy ecosystem?**

The use of MSST, while understandable from a logistics perspective, is potentially problematic. Whenever MSST was available for a given species, it seemed to be used as a sole criterion and the substrate model was largely ignored. MSST is a second or third order effect, skipping over the issues of feeding and early recruitment success that could be strongly related to EFH but would be difficult to detect with MSST, particularly in species with slow growth and late reproduction that create long time lags in their life cycles (e.g. rockfish). The spatially explicit model for habitat is, in a sense, mismatched with population-scale temporal data that are linked to biological reference points for individual species. Linkages between stock decline and changes in EFH are also likely to be most evident only when it is too late to do anything about EFH. MSST is also somewhat insensitive to the shifting baseline, and stocks today are very likely well below their potential productivity.

There was some inconsistency in interpretation of the data for individual species, probably because different individuals were responsible for drafting each section. Nonetheless, some sort of normalization/standardization would be appropriate. An additional aspect that could have been helpful was to compare critically the outputs of the habitat model with more detailed knowledge of individual species to determine how well the model complied with other methods of evaluation. The adherence to MSST has perhaps resulted in less likelihood that the managers of individual species would use their natural history skills to give a more comprehensive consideration of EFH effects.

So what to do? There is a spatially explicit model for habitat that appears to be useful and intuitive, and presumably there is also spatial information on population growth rates, condition and a whole suite of indicators that could be applied to each of the managed species in a way that is likely to be more sensitive than MSST. Differences in recovery time must also be considered. For example, a long-lived species that reproduces at a late age will have a significant lag with

MSST. Note that genetic analysis can be deceptive with respect to addressing whether population substructure exists, in that the absence of genetic structure does not mean that specific geographic areas are not used for specific stages or sub-populations because there may be sufficient exchange of individuals to mask any genetic signal.

b. Does the DEIS Appendix B analysis give appropriate consideration to localized habitat impacts that may reduce the capacity of EFH to support managed species in a given area, even if those impacts do not affect a species at the level of an entire stock or population?

It is my opinion that localized habitat impacts are definitely NOT dealt with an appropriate manner by the approach outlined in Appendix B. For the reasons stated above, MSST does not respond to localized habitat impacts on a time scale that is useful for EFH conservation, and even non-local impacts may not be easily detected by such an approach. For this question in particular there is a serious mismatch of scale.

Regime shifts, while masking EFH issues, particularly at the local scale can also create situations that magnify the importance of EFH. Thus, we could currently be in favorable climate regime that is masking the importance of EFH and a regime shift could crash populations. As a hypothetical example, there are types of EFH such as coral that could become reduced in area by an oceanographic regime shift, so that remaining areas could become increasingly important. In addition, the potential of regime shifts on MSST as a measure of population health is not well considered. We know that the Alaska system can move from a system that is dominated by groundfish to one where much of the energy flows through benthic invertebrates. Loss of Stellar sea lions in the past decades suggests something in the system is out of synch (though there is some evidence of improvement for that species). Ecosystem health could also be evaluated by looking at apex predators (e.g. seabirds), and as stated earlier, long-term analysis of closed versus fished areas could be used to evaluate benthic ecosystem health.

Spawning habitat and the effect of fishing activities are not carefully considered, and this issue requires more thought. Is there elevated risk for benthic spawners? As an example, Pacific cod eggs don’t attach to the bottom well, and could be dislodged and swept away after disturbance. On a more general note, for benthic and pelagic spawners are there spawning aggregations that might be disturbed by fishing activities that might subsequently lead to reduced fertilization or movement to less favorable areas. Even for some of the shallow spawners, there is a lot of unprotected habitat in the Bering Sea where this could be an issue.

The long and the short of it is that the conclusion that current fishing practices have no effect on EFH is premature and inconsistent with any sort of a precautionary approach.

<u>*Question 3*</u>

What, if any, improvements should NMFS consider making to the model, or to its application in the context of the DEIS, given the limited data available to use for input parameters?

To some extent this question has been addressed through the previous question but there are several other issues that merit mention here.

A precautionary approach is not evident in Appendix B. Whether this stance is appropriate or not is for NMFS to decide, but the lack of a precautionary approach in many other areas of the world (including mine) has lead to disastrous results that were not completely obvious even a few years before stocks collapsed. For the discussions of individual species, it appears that many of them with unknown life history characteristics are not listed as requiring any sort of special concern. This is not helped by the fact that a lot of the statements on individual species were not backed up with citations or data, and appear to be based on qualitative feelings of individual stock assessment biologists. The bar is set rather high for "proving" a link between EFH and fish production and the burden of proof is clearly shifted to those who believe EFH is important. If this is the criterion that NMFS chooses to use then it will most certainly not be precautionary in any sense.

Another area that could help is to bring in outside groups to get their input and data. One mechanism might be a public consultation that embraces fishing groups. Such an approach would serve the dual function of filling some of the gaps in data (particularly as it pertains to habitat) and also help to create a spirit of cooperation with fishermen.

There appears to be little interest outlined in Appendix B for setting aside any additional protected areas, yet these areas could be very useful not only in terms of potentially enhancing adjacent fisheries, ensuring healthy ecosystem functioning (which fished areas may not do) and ultimately in complying with a broader interpretation of the Magnuson-Stevens act beyond fish productivity alone (Botsford et al. 1997; Sala et al. 2002). One compelling reason to establish a greater proportion of area that receives some degree of protection is the future expansion of fishing effort. There is compelling evidence that much of the current fishing effort is concentrated in some areas whereas other areas are largely unfished. Ease of access and damage to fishing gear are two of the most obvious reasons for this bias. But decreases in stocks or increases in numbers of licensees could easily result in changes in fishing patterns, and any efforts to protect habitat at that stage would be difficult to move forward quickly. Indeed it might be argued that establishing a more comprehensive mosaic of protected habitat may be much easier to achieve if fishermen are involved in the process and understand that areas that are *not* currently fished are of particular interest for conservation initiatives. Such an approach has worked successfully in Australia recently, and resulted in a large increase in the proportion of protected marine habitat and therefore a much stronger buffer in the long term for fish production, changes driven by climate shifts rather than proximal human activities, and healthy ecosystem functioning that cannot be guaranteed in systems that are chronically disturbed.

Short-term recommendations

- Take advantage of existing substrate data to provide a better "map" on which to apply the model.
- Use the model in a hindcast to examine past history of trawled areas and get a better understanding of how the existing equilibrium status of populations relates to historical patterns.
- Explore alternative models that take advantage of existing data on growth, fecundity etc. in different habitat types as an alternative to the MSST analysis. Specifically, a spatially explicit examination of parameters other than population abundance (e.g., growth rates, size at age, fecundity, condition etc.) is preferable.
- Verify model predictions using outputs from studies in other areas.

Long-term recommendations

- Map the habitats, including surficial sediment surveys and amounts of healthy and damaged EFH (e.g. coral).
- Conduct experiments that take advantage of the closed areas to monitor recovery trajectories.
- Examine patterns of fishing and how it clusters on habitat features

Appendix A: Bibliography

- Executive Summary from the *Draft Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska* (11 pages plus tables and figures);
- Evaluation of fishing activities that may adversely affect EFH (Appendix B to the DEIS; 76 pages plus tables and figures);
- EFH sections of the minutes of the Council's Scientific and Statistical Committee meetings in October 2002, December 2002, February 2003, April 2003, June 2003, and October 2003 (each is approximately 2 pages);
- Section 303(a)(7) of the Magnuson-Stevens Act;
- Pertinent excerpts from the NMFS regulations for EFH (50 CFR 600.10 and 600.815(a)(2)) and the associated preamble (67 FR 2354-2355);
- Pertinent excerpts from the Magnuson-Stevens Act National Standard 1 Guidelines (50 CFR 600.310(d));

Selected public comments on the DEIS that are pertinent to Appendix B, including criticisms of the analytical approach (comments to be selected by NMFS after the close of the public comment period on April 15, 2004). Including:

- Geoff Shester
- Marine Conservation Alliance
- Alaska Marine Conservation Council
- The Ocean Conservancy, Oceana, Alaska Oceans Program,
- National Environmental Trust, Center for Biological Diversity, and Defenders of Wildlife

<u>Other Literature Cited</u>

Auster, P.J., R.J. Malatesta, R.W. Langton, L. Watling, P.C. Valentine, C.L.S. Donaldson, E.W. Langton, A.N. Shepard and I.G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (northwest Atlantic): Implications for conservation of fish populations. *Reviews in Fisheries Science* 4: 185-202

Biles, C.L., M. Solan, I. Isaksson, D.M.Paterson, C. Emes, and D.G. Raffaell. 2003. Flow modifies the effect of biodiversity on ecosystem functioning: an in situ study of estuarine sediments. *Journal of Experimental Marine Biology and Ecology* 285-286: 165-177.

Bolam, S.G., T.F. Fernandes, and M. Huxham. 2002. Diversity, biomass, and ecosystem processes in the marine benthos. *Ecological Monographs* 72: 599-615.

Botsford, L.W., J.C.Castilla and C.H. Peterson. 1997. The management of fisheries and marine ecosystems. *Science* 277: 509-515.

Collie, J.S., S.J. Hall, M.J.Kaiser and I.R. Poiner. 2000. Shelf sea fishing disturbance of benthos: trends and predictions. *Journal of Animal Ecology* 69: 785-798.

Dailey, G.C. (ed.) 1997. *Nature's services: societal dependence on natural ecosystems.* Washington, DC: Island Press.

Dayton, PK. 1998. Reversal of the burden of proof in fisheries management. *Science* 279: 821-822.

Dayton, P. K., S. F. Thrush, M. T. Agardy and R. J. Hofman. 1995. Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems* 5: 205-232.

Dayton, P. K., S. Thrush and F. C. Coleman. 2002. Ecological effects of fishing in marine ecosystems of the United States. Pew Oceans Commission, Arlington, Virginia.

Emmerson, M.C., M. Solan, C. Emes, D.M. Paterson and D. Raffaelli. 2001. Consistent patterns and the idiosyncratic effects of biodiversity in marine ecosystems. *Nature* 411: 73-77.

Hall, S. 1999. *The effects of fishing on marine ecosystems and communities.* Oxford: Blackwell Sciences Ltd.

Hall-Spencer, J.V. Allain and J.H. Fossa. 2002. Trawling damage to Northeast Atlantic ancient coral reefs. *Proceedings of the Royal Society of London, Series B:* 269: 507-511.

Hall-Spencer, J.M. and P.G. Moore. 2000. Scallop dredging has profound, long-term impacts on maerl habitats. *ICES Journal of Marine Science* 57:1407-1415.

Irlandi, E.A., C.H. Peterson. 1991. Modification of animal habitat by large plants: Mechanisms by which seagrasses influence clam growth. *Oecologia*. 87: 307-318.

Jackson, J.B.C., M.X. Kirby, W.H. Berger, K.A. Bjorndal, L.W. Botsford, B.J. Bourque, R.H. Bradbury, R. Cooke, J. Erlandson, J.A. Estes, T.P. Hughes, S. Kidwell, C.B. Lange, H.S. Lenihan, J.M. Pandolfi, C.H. Peterson, R.S Steneck, M.J. Tegner and R.R. Warner. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293:629-638.

Jennings, S. and M.J. Kaiser. 1998. The effects of fishing on marine ecosystems. *Advances in Marine Biology* 34: 201-352.

Kaiser M.J., K. Ramsay, C.A. Richardson, F.E. Spence and A.R. Brand. 2000.Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology* 69: 494-503.

Koslow, J.A., G.W. Boehlert, J.D. Gordon, R.L. Haedrich, P. Lorance and N. Parin. 2000. Continental slope and deep-sea fisheries: implications for a fragile ecosystem*. ICES Journal of Marine Science* 57: 548-557.

Koslow, J.A., K. Gowlett-Holmes, J.K. Lowry, T. O'Hara, G.C.B. Poore, and A.Williams. 2001. Seamount benthic macrofauna off southern Tasmania: community structure and impacts of trawling. *Marine Ecology Progress Series* 213: 111-125.

Laurel, B.J., R.S. Gregory, and J.A. Brown. 2003 Predator distribution and habitat patch area determine predation rates on Age-0 juvenile cod Gadus spp. Marine Ecology Progress Series 251: 245-254.

Leys, S.P. and N.R.J. Lauzon. 1998. Hexactinellid sponge ecology: growth rates and seasonality in deep water sponges. *Journal of Experimental Marine Biology and Ecology* 230: 111-129.

Loreau M, Naeem S, Inchausti P, et al. 2001. Ecology - Biodiversity and ecosystem functioning: Current knowledge and future challenges. *Science* 294: 804-808.

Naeem S. and S.B. Li. 1997. Biodiversity enhances ecosystem reliability. *Nature* 390: 507-509.

Pauly, D. and J. MacLean. 2003. *In a Perfect Ocean. The State of Fisheries and Ecosystems in the North Atlantic Ocean*. Island Press. 175 pp.

Sala, E., O. Aburto-Oropeza, G. Paredes, I. Parra, J.C. Barrera, and P.K. Dayton. 2002. A general model for designing networks of marine reserves. *Science* 298: 1991-1993.

Schiermeier, Q. 2002. How many more fish in the sea? Nature 419: 662-665.

Snelgrove, P.V.R. (1999) Getting to the bottom of marine biodiversity: Sedimentary habitats. *BioScience* 49: 129-138.

Snelgrove, P.V.R. T.H. Blackburn, P. Hutchings, D. Alongi, J.F. Grassle, H. Hummel, G. King, I. Koike, P. J.D. Lambshead, N.B. Ramsing, V. Solis-Weiss, D.W. Freckman (1997) The importance of marine sediment biodiversity in ecosystem processes *Ambio* 26: 578-583.

Snelgrove, P.V.R., M.C. Austin, S.J. Hawkins, T.M. Iliffe, R.T. Kneib, R.B. Whitlatch, L.A. Levin, J.M. Weslawski & J.R. Garey (in press) Vulnerability of Marine Sedimentary Ecosystem Services to Human Activities. In: *Sustaining biodiversity and ecosystem services in soils and sediments*, SCOPE Series, vol. 64. edited by. D.H. Wall. Island Press.

Thrush, S.F. and P.K. Dayton. 2002. Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. *Annual Review of Ecology and Systematics* 33:449-473.

Wardle D.A., Hornberg G., Zackrisson O., Kalela-Brundin M., Coomes, DA. 2003. Long-term effects of wildfire on ecosystem properties across an island area gradient. *Science* 300: 972-975.

Worm B & Myers RA (2003) Meta-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. *Ecology* 84: 162-173

Appendix B.

Statement of Work

Consulting Agreement between the University of Miami and Dr. Paul Snelgrove

Background

The Magnuson-Stevens Fishery Conservation and Management Act requires that every fishery management plan describe and identify Essential Fish Habitat (EFH) for the fishery, minimize to the extent practicable the adverse effects of fishing on EFH, and identify other measures to promote the conservation and enhancement of EFH. NMFS and the North Pacific Fishery Management Council recently developed a draft environmental impact statement (DEIS) to consider the impacts of incorporating new EFH provisions into the Council's fishery management plans. The DEIS evaluates three actions: (1) describing and identifying EFH for fisheries managed by the Council; (2) adopting an approach for the Council to identify Habitat Areas of Particular Concern within EFH; and (3) minimizing to the extent practicable the adverse effects of Council-managed fishing on EFH. Most of the controversy surrounding the level of protection needed for EFH concerns the effects of fishing on sea floor habitats. Substantial differences of opinion exist as to the extent and significance of habitat alteration caused by bottom trawling and other fishing activities. Although an increasing body of scientific literature discusses the effects of fishing on habitat, there is no consensus within the scientific community on an appropriate methodology for analyzing potential adverse effects.

The national EFH regulations (50 CFR 600.815(a)(2)) require an evaluation of the effects of fishing on EFH, and this evaluation appears in Appendix B to the DEIS. The evaluation has two components: a quantitative mathematical model to show the expected long term effects of fishing on habitat, and a qualitative assessment of how those changes affect fish stocks. The model estimates the proportional reductions in habitat features relative to an unfished state, assuming that fishing will continue at the current intensity and distribution until the alterations to habitat and the recovery of disturbed habitat reach equilibrium. The model provides a tool for bringing together all available information on the effects of fishing on habitat, such as fishing gear types and sizes used in Alaska fisheries, fishing intensity information from observer data, and gear impacts and recovery rates for different habitat types. Due to the uncertainty regarding some input parameters (e.g., recovery rates of different habitat types), the results of the model are displayed as point estimates as well as a range of potential effects.

After considering the available tools and methodologies for assessing effects of fishing on habitat, the Council and its Scientific and Statistical Committee concluded that the model incorporates the best available scientific information and provides a good approach to understanding the impacts of fishing activities on habitat. Nevertheless, the model and its application have many limitations. Both the developing state of this new model and the limited quality of available data to estimate input parameters prevent drawing a complete picture of the effects of fishing on EFH. The model incorporates a number of assumptions about habitat effect rates, habitat recovery rates, habitat distribution, and habitat use by managed species. The quantitative outputs of the analysis may convey an impression of rigor and precision, but the results actually are subject to considerable uncertainty.

One major limitation of the model is that it does not consider the habitat requirements of managed species or the distribution of their use of habitat features. Therefore, DEIS analysts were asked to use the model output to address whether continued fishing at the current rate and intensity is likely to alter the ability of a managed species to sustain itself over the long term. In other words, are the fisheries, as they are currently conducted, affecting habitat that is essential to the welfare of each managed species? To help answer that question, the analysts considered available information about the habitats used by managed species. The analysts also considered the ability of each stock to stay above its minimum stock size threshold (MSST), after at least thirty years of fishing at equal or higher intensities. MSST is the level below which a stock is in jeopardy of not being able to produce its maximum sustainable yield on a continuing basis.

The DEIS analysis concludes that despite persistent disturbance to certain habitats, the effects on EFH are minimal because there is no indication that continued fishing activities at the current rate and intensity would alter the capacity of EFH to support healthy populations of managed species over the long term. The DEIS finds that no Council-managed fishing activities have more than minimal and temporary adverse effects on EFH, which is the regulatory standard requiring action to minimize adverse effects under the Magnuson-Stevens Act. Additionally, the analysis concludes that all fishing activities combined have minimal, but not necessarily temporary, effects on EFH. These findings suggest that no additional management actions are required pursuant to the EFH regulations.

Expertise Needed for the Review

The review panel shall comprise six individuals. Panelists shall have expertise in benthic ecology, fishery biology, fishing gear technology, ecological modeling, and/or closely related disciplines.

Information to be Reviewed

The CIE panel shall review the following materials:

- The Executive Summary from the *Draft Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska* (11 pages plus tables and figures);
- The evaluation of fishing activities that may adversely affect EFH (Appendix B to the DEIS; 76 pages plus tables and figures);
- EFH sections of the minutes of the Council's Scientific and Statistical Committee meetings in October 2002, December 2002, February 2003, April 2003, June 2003, and October 2003 (each is approximately 2 pages);
- Section 303(a)(7) of the Magnuson-Stevens Act;
- Pertinent excerpts from the NMFS regulations for EFH (50 CFR 600.10 and 600.815(a)(2)) and the associated preamble (67 FR 2354-2355);
- Pertinent excerpts from the Magnuson-Stevens Act National Standard 1 Guidelines (50 CFR 600.310(d)); and

- Selected public comments on the DEIS that are pertinent to Appendix B, including criticisms of the analytical approach (comments to be selected by NMFS after the close of the public comment period on April 15, 2004).

Panelists should refer to the following website to access all background material.

http://www.fakr.noaa.gov/habitat/cie/review.htm

Questions to be Answered

Given the context of the Magnuson-Stevens Act requirements and the EFH regulations, the CIE reviewers shall address the following issues:

1. Does the model incorporate the best available scientific information and provide a reasonable approach to understanding the effects of fishing on habitat in Alaska?
2. Does the DEIS Appendix B analysis provide a reasonable approach for identifying whether any Council-managed fishing activities adversely affect EFH in a manner that is more than minimal and not temporary in nature? (For purposes of this question, the terms "temporary" and "minimal" should be interpreted consistent with the preamble to the EFH regulations: "Temporary impacts are those that are limited in duration and that allow the particular environment to recover without measurable impact. Minimal impacts are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.") To answer this question, the panel shall address at least the following issues:
    a. Does the DEIS Appendix B analysis apply an appropriate standard (including the consideration of stock status relative to MSST) for determining whether fishing alters the capacity of EFH to support managed species, a sustainable fishery, and the managed species' contribution to a healthy ecosystem?
    b. Does the DEIS Appendix B analysis give appropriate consideration to localized habitat impacts that may reduce the capacity of EFH to support managed species in a given area, even if those impacts do not affect a species at the level of an entire stock or population?
3. What if any improvements should NMFS consider making to the model, or to its application in the context of the DEIS, given the limited data available to use for input parameters?

Review Process, Deliverables, and Schedule

The review panel shall consist of six members, one of whom shall serve as the Chair, as specified below.

Duties of the Panelists

1. Each panelist shall attend in person and participate in a one-day meeting with the scientists who developed the fishing-effects model and the analytical approach used to evaluate the effects of fishing in the DEIS. The meeting will be held at the Alaska Fisheries Science Center in Seattle on June 29, 2004. The meeting will be open to the public to attend, but

there will be no opportunity for public testimony. The lead authors of the model, Dr. Jeffrey Fujioka and Dr. Craig Rose, will provide an overview of the model, how it was developed, how it was refined in response to comments from the Council's Scientific and Statistical Committee and other reviewers, and how it was used in the DEIS. The panel will have an opportunity to question Dr. Fujioka and Dr. Rose, as well as Dr. Anne Hollowed, who assisted in designing the analytical approach used to evaluate the effects of fishing in the DEIS. The panel shall meet in executive session at the Alaska Fisheries Science Center on June 30, 2004 to discuss the information presented, and to identify any unanswered questions.

2. Prior to the meeting, each panelist shall review the materials specified above. Panelists may submit written questions via e-mail to Jon Kurland (Jon.Kurland@noaa.gov), with copies to the Contracting Officer's Technical Representative (COTR), Stephen Brown (Stephen.K.Brown@noaa.gov), and to the CIE manager, Manoj Shivlani (mshivlani@rsmas.miami.edu) at least two weeks before the meeting to ensure topics of particular interest will be covered during the presentation.

3. Each panelist shall deliver an individual final written report containing answers to the questions posed above and any recommendations. These individual reports shall be submitted the Chair and to Dr. David Die of the University of Miami via e-mail at ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani via email at mshivlani@rsmas.miami.edu no later than July 15, 2004. The reports shall include the following sections: executive summary, background, description of review activities, summary of findings, conclusions/recommendations, bibliography of any materials relied upon by the panel, and a copy of this statement of work. Please refer to the following website for additional information on report generation: http://www.rsmas.miami.edu/groups/cimas/Report_Standard_Format.html.