Review of the Draft of Appendix B: Evaluation of Fishing Activities That May Adversely Affect Essential Fish Habitat, prepared by scientists at the National Marine Fisheries Service

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Executive Summary

The Magnuson-Stevens Fishery Conservation and Management Act requires that every fishery management plan describe and identify Essential Fish Habitat (EFH) for the fishery and minimize to the extent practicable the adverse effects of fishing on EFH. The National Marine Fisheries Service (NMFS) and the North Pacific Fishery Management Council recently developed a draft environmental impact statement (DEIS) that considers the impacts of fishing on EFH for multiple species of managed fish stocks. Appendix B of the DEIS contains the technical details of the evaluation including a habitat reduction model. A review of the model and its application, as well as the assessment of the impacts of fishing on habitat was carried out.

The quantitative model to assess the impact of fishing on different habitat types was dependent upon the number of times the fishing gear impacted the habitat type, the damage done by the gear to the habitat and the recovery rate of the habitat. In addition to the model, the criterion of the abundance relative to Minimum Stock Size Threshold (MSST) was used to assess whether the loss of habitat was affecting the fish productivity by species. Separate evaluations were then carried out by assessment scientists on the effects of fishing on spawning and breeding, on feeding, and on growth to maturity for the commercial species. For all species examined, the evaluation was either that the effects were minimal or temporary (MT, approximately 58%) or unknown (the remaining 42%).

While the habitat reduction model was considered reasonable, uncertainties in parameter values together with the lack of information on sediments, habitat types, and fishing effort distribution, means that the model must be considered as very approximate. Validation of the model using data from other regions needs to be carried out.

The model does not determine the effects of habitat reduction on fish productivity and thus the abundance level of the stocks relative to MSST was used. I feel that this criterion is not totally appropriate since habitat effects are only one of many factors that influence the stock abundance.

Several short-term suggestions were aimed at improving the quantitative assessment of evaluations; some of the more important recommendations are listed below.

a. Compare the spatial pattern in the CPUE from the groundfish surveys and/or the commercial fishery and of condition (length-weight relationships) to the fishing effort pattern.
b. Use the model to back-calculate the time to pristine conditions and compare with the known time that trawling began.
c. Examine the assumption of random spatial distribution of fishing effort using the observer data.
d. Estimate the rate of destruction of hard corals and sponges from the groundfish survey data.
e. Re-evaluate the effects of fishing on habitat after completing the above suggestions and taking into account the precautionary approach.

In addition some long-term research should be carried out including the following.

a. The habitat associations (temperature, depth, type of habitat, etc.) of the various species should be determined from the groundfish survey data.
b. Monitoring and comparisons of the habitats and fish abundances in the closed and open areas should be carried out.
c. Establish field programs to measure the recovery rates of different types of habitat.
d. Carry out surficial sediment surveys.
e. Identify the influence of habitat on different life history stages for the major commercial species through observational studies.

1. 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 for Alaska. 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 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 several input parameters, the results of the model are displayed not only as point estimates but also as a range of percentage habitat reduction.

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 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 for Alaska 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.

2. Terms of Reference for the Review Panel

Given the context of the Magnuson-Stevens Act requirements and the EFH regulations, we, the reviewers appointed by the Center for Independent Experts (CIE), were asked to 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?

3. Description of Review Activities

The review panel consisted of Drs. Asgeir Aglen, Ken Drinkwater (Chair), Ken Frank, Tony Koslow, Pierre Pepin and Paul Snelgrove. The panel met with Dr. Jon Kurland and his staff at the Alaska Fisheries Science Center in Seattle, Washington, on June 29, 2004. Presentations were made to the review panel by the scientists involved in the evaluation process after which the panel members asked questions. On June 30 a meeting of the

panel was held at the University Towers Hotel in Seattle to discuss the issues and the results of the previous day's meeting. This meeting was chaired by K. Drinkwater.

4. Summary of Findings

The EFH model

The model developed to determine the effects of fishing on habitat is dependent upon the rate of habitat destruction by fishing and the recovery rate of the particular habitat:

$$\partial H / \partial t = \left(- I * H + \rho * e^{-I} * h \right)$$

where H is the portion of the habitat feature unaffected by fishing, h is the portion affected, I is the rate at which fishing damages the habitat and ρ is the recovery rate of the habitat. Fishing damage is given by

$$I = f * q$$

where f is the fishing gear contacts per time and q is the proportion of the contacted area damaged. H as a function of time, t, is found by integration to be

$$H_t = H_0 (Ie^{-(I+\rho e^{-I})t} + \rho e^{-I}) / \left(I + \rho e^{-I} \right)$$

where H_0 is the amount of habitat at t=0. At very long times (t=∞), a balance is reached between the fishing damage and the recovery rate such that the amount of habitat remaining (H_{equil}) becomes

$$H_{equil} = H_0 \rho e^{-I} / \left(I + \rho e^{-I} \right).$$

I begin by answering the questions posed to the review committee.

Question 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?

The model developed by the NMFS describes the reduction in useable habitat. I believe it is well conceived and has the advantage of being simplistic and easy to understand but still contains the main elements of the problem. It depends upon only three parameters: the number of times fishing gear hits bottom, f, and the amount of damage done during each hit, q (which together with f determines I) and the recovery rate of the habitat, ρ. However, as acknowledged in the DEIS, these parameters are not well resolved and have high uncertainty, due in large part to a paucity of data.

Does the model incorporate the best available scientific information? While generally I believe it does, improvements can be made. Below are some suggestions for additional analyses as well as suggestions to the text to better explain what was done.

Estimates of f for each square were based on observer data during the 5-year period 1998-2002. The DEIS provides sufficient description of the methods used to estimate f. However:

- The use of the end position to assign the trawl to a 5 km x 5 km area underestimates the effects as discussed by J. Tagart in his comments. If the latitudes and longitudes of the tows are recorded on a continuous basis could they be proportionally assigned to the correct area and avoid this bias? Even if only the start and end of the tows were recorded, a simple estimate of how much of the tow could be assigned to each square could have been attempted using some simplifying assumptions. While these assumptions might be invalid, they would at least be better than the present method.
- The report indicates the assumption of random distribution of tows in a square is likely invalid due to concentrating fishing effort on where the fish are. A quantitative estimate of this could have been achieved by estimating the actual area trawled compared to the total area of the square. This could be carried out in all squares or for at least a few squares and the results applied in order to scale other areas appropriately.
- The report should indicate how fishing effort has changed over time including estimates of the fishing effort prior to 1998. This would provide information to assess the assumption in the model that the fishing pressure is relatively constant and will remain so.

Estimates for q for bottom trawl gear were determined from the literature and described in Section 3.4.3 (which we were provided during the presentations). It was acknowledged, however, that the available estimates have high uncertainty.

- For scallop trawls and other gear besides bottom trawls the report states that "professional judgment" was used to assess their effect on habitat. It is unclear what this means and hence how reliable the estimates are.
- The report also indicates that studies on the effects of bottom trawl gear on the habitat that did not meet the necessary criteria were examined for consistency with the excepted studies but there was no indication whether they were consistent or not. Such information needs to be included in the report.
- For damaged organisms, a decrease function of 50% was assumed but there was no indication of how this value was derived.
- The adjustment for multiple contacts does not consider the frequency of contact. The frequency relative to the recovery time must be considered.

The recovery rate, ρ, of the different habitats was also primarily determined from the literature. A reasonable description of the procedure was presented in the DEIS.

- In cases when Alaskan data were unavailable, estimates of recovery were made based on data from other regions, including some in tropical or temperature waters. For living biological material, given that growth rates are often temperature related, would using data from warm water regions not overestimate the growth rates in Alaska waters? Was this taken into account or considered?
- There is no discussion of how ρ varies with time. The model seems to imply that the habitat recovers linearly with ρ. Is this supported by the available data? How is this measured? Are the recovery rates based upon the quality or the quantity or both of the habitat?

The report indicates a lack of surficial sediment data for Alaskan waters resulting in a rather coarse representation of the types of sediment habitat types. This was further reiterated during the presentations to the review panel. Have, indeed, all avenues been exhausted for sediment data, such as from the US Geological Survey? Are there preliminary data that could be used to better resolve the sediment types? Were the data from the paper by McConnaughty and Smith used? Current meter data from models can be used to help refine the sediment information. Was this attempted?

The amount of habitat impacted by fishing was estimated as a percent of the total area. My understanding is that this is based upon the total amount of this type of habitat or sediment type available and was not weighted to the distribution of fish. However, the distribution of fish will depend upon many factors, including hydrographic conditions, food, predators, currents, turbulence, etc. I believe that the area should be weighted relative to the fish distributions. An average weighting using several years would seem appropriate, or perhaps using the distribution during a period when the abundance is high, which hopefully should cover most of the territory that the fish consider as useable.

The statement is made that vessels <60 feet in length take less than 1% of the fish so their effect on habitat is considered negligible. While the conclusion is probably true, the criterion used is not correct unless an equivalent amount of trawling in the small and large fishing vessels produces the same catch. Is this true? One method to explore this is to examine the CPUE data for different size vessels. Differences may be related to efficiency of the trawls, the concentration of fish, the size of the trawls (if not accounted for), etc. Further justification of the neglect of the trawling of these smaller vessels is required in the report.

In regards to whether the model provides a reasonable approach to understanding the effects of fishing on habitat, it must be realized that the model assesses the amount of habitat reduced by fishing at an equilibrium state. However, it does not indicate the effect of this reduction on fish stocks or on their sustainability. Given that it is a habitat reduction model, nowhere does the report address the issue of what percentage loss of habitat would be considered to have a significant effect on fish. Instead, a different parameter, the Minimum Stock Size Threshold (MSST) is used to assess if there is an effect on the managed fish stocks. However, MSST depends upon many factors, not just habitat, so I do not think that it is an adequate measure of whether fishing is having an effect on useable habitat. I shall return to this point later.

G. Shester, in his comments on the DEIS, presented a model that did attempt to consider the effects of reduction of habitat on the fish stocks. This was represented in the model by the parameter, K, the carrying capacity of the fish stock. While the model has a scientific appeal, it has limitations because it is not clear how K can be estimated. Also, this model is reasonably applied on local scales but has limitations when applied to the entire population. This is because populations, when they expand, tend to move into territory beyond their usual boundaries but when the population is in decline they often shrink back to their usual and presumably preferred habitat. It is not clear how the Shester model would handle this situation. Having said that, the Shester model at least attempts to assess the affects of habitat loss on the fish stocks, not just the reduction in habitat loss.

During the questioning by the review panel, the NMFS team indicated that other Fisheries Councils are wrestling with these same issues. They further stated that as far as they know, the AFSC is as far along in the development of a fish habitat model, or in fact further ahead, compared to most other councils. I think that a paragraph or two or perhaps a short section in the EIS describing other models and why the AFSC chose the one they have would help convince the reader. Given that each of the councils are attempting to deal with this issue, I think it would be reasonable for them to monitor each other's progress and share information on the development of such models, including their advantages, disadvantages, data requirements, etc. if they are not already doing so.

Returning to the habitat reduction model in the DEIS, it is an equilibrium model, with estimates of H_{equil} being estimated based upon recent fishing effort. The change in habitat is relative to a pristine state, unaffected by trawling and other methods of fishing. However, we know that fishing, including trawling, has been ongoing for some time. Are we near equilibrium for any of the habitat types or are we continuing to lose habitat? The model should be used to back calculate where we might be relative to H_{equil} by using whatever data are available from the past or by making assumptions on the amount of trawling and the impacts of trawling in the past. Where are we relative to pristine conditions, based upon the data and/or reasonable assumptions?

It is important to recognize that the reduction of habitat, or the Long-term Effect Index (LEI), is essentially a scaled index of the fishing effort. In other words, where the fishing effort is greater, the reduction in the habitat is greater. The scaling is not linear, however.

The model has not been validated or tested against known effects. Although I recognize that this may be difficult, the model could be used in other regions where the data are more complete, perhaps on Georges Bank for example, although it could be applied anywhere in the world where the parameters can be adequately evaluated. In addition to validation, a sensitivity analysis should be carried out to determine the most critical parameter, parameters or ratio of parameters. The estimated parameter space for the different habitats should be clearly displayed in the EIS report. Finally, the model can and should be used to determine the effects of different fishing efforts.

Question 2a: Does the DEIS apply an appropriate standard for determining whether fishing alters the capacity of EFH to support managed species either for a sustainable fishery or to contribute to a healthy ecosystem.

The primary standard used to determine if the EFH is able to support a sustainable fishery was chosen to be the MSST. If the stock was above or equal to the MSST or projected to be above within 10 years, the stock was considered to be in good shape. Such a result would lead to the conclusion that habitat degradation due to fishing was not an issue. The MSST was based upon the recruitment levels since the late 1970s. Where MSST could not be estimated, other proxies were used or baring these, the MSST was considered as being "unknown".

- The DEIS states that MSST was chosen for consistency with National Standard Guidelines. However, it was not justified scientifically. The discussion of the advantages and disadvantages of using MSST should be expanded further in the EIS report, if it is to be used.
- I personally have difficulties with the use of MSST as a means of measuring fishing effects on habitat. First, MSST is based upon long-term recruitment estimates, which in turn is influenced by fishing, directly through its affect on the spawning stock biomass, by environmental conditions, by predators, by food, by competitors and sometimes by disease in addition to changes in habitat. In regards to environmental conditions on recruitment, the report notes, and it was further elaborated during the presentations, that Alaskan waters are subject to regime shifts. These shifts occur roughly simultaneously throughout the North Pacific and are a result of changes in atmospheric forcing. In the late 1970s, there was a shift from an invertebrate dominated fishery to an explosion of groundfish. If another major shift occurred such that we were to shift back again to invertebrates and the groundfish abundances decreased, the application of the present method would suggest that it may be related to fishing effects on habitat when it would not be.
- The corollary of the MSST applied criterion used in the report is that habitat degradation is an issue if the stock is below MSST. However, in the only case for which the stock was reported to be below MSST (blue king crab) it was suggested that the reason for the low stock was not habitat related but due to other factors. While this may be easily justified (but was not in the DEIS), it makes it very unclear what conditions will actually be used to determine an effect of fishing on habitat. There is no discussion of what conditions will be interpreted as an effect of habitat reduction when the stock is below MSST. This had me wondering as to usefulness of the process.
- The habitat reduction model was run for almost all species and the report discusses the results species by species. However, the model results were seldom used when and if the MSST was available.
- In recent years, the precautionary approach has been applied in reference to fisheries. Thus, in the absence of conclusive proof that destruction of habitat is not having an effect on a sustainable fishery, one should proceed with caution. I

think that this standard should be applied in this case. Yet, there is little to no discussion of the precautionary approach within the report.

- There was little assessment or discussion that I could see on the effects of fishing on the spawning beds or the spawning aggregations. If trawling, or any other form of fishing, disrupted the fish during spawning this would likely cause a reduction in spawning success. This of course will depend upon the seasonal distribution of the fishing. This temporal aspect of the trawling was not addressed in the DEIS report but could be easily determined from the observer data.
- If the habitat is being destroyed, it may take time for its effects to be observed. Certainly it is expected that the effect would probably be felt gradually. If this were combined with a large spawning stock biomass, it could be difficult to detect a habitat influence on the stock for a while after the habitat was damaged, perhaps until it was too late, i.e. too much of the habitat was destroyed. For this reason the use of the precautionary approach is paramount. This is especially true for those habitats with long recovery times, e.g. hard corals and sponges.
- In terms of the role of the fish in a healthy ecosystem there is little discussion of what a healthy ecosystem is or how it is to be measured. During the presentations, I sensed that the team was given little guidance on how to address this issue nor did they quite know how to proceed or did not have the time to explore possibilities. Some ecosystem indices need to be defined and their time series developed. These could include indices of biodiversity, trophic level changes, condition factors, demersal to pelagic ratio, habitat complexity, etc. Indeed, there is ongoing work on this issue throughout the marine science community. In Paris during March-April 2004, a major symposium was held entitled Quantitative Ecosystem Indicators for Fisheries Management (http://www.flmnh.ufl.edu/fish/organizations/ssg/ecosymp2004.pdf). Many other sources on this same topic of ecosystem indicators are available on the web that would help to determine what should be done in regards to the role of the managed fish stocks in a healthy ecosystem.

Question 2b: 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?

No, I do not think that adequate consideration was given to localized habitat. The effects of fishing on each of the species were almost exclusively based on MSST, a population index. There was little discussion of whether localized habitat was being destroyed at a rate that was unsustainable.

It is unclear and was not discussed whether it would be better to concentrate fishing in particular locations and sacrifice the habitat in those areas, or to spread the effort out as evenly as possible.

In regards to localized habitat impacts, there was no discussion of substructure in the populations. Are there sub-populations of some or all of the species? Are some of these sub-populations threatened by habitat destruction? Earlier suggestions of exploring the spatial distribution of CPUE or condition indices might help to address this issue.

In regards to local habitats the destruction of corals and sponges with their long recovery times are of particular concern. I expect that these would at least be targeted as Habitat Areas of Particular Concern (HAPCs).

Question 3: What improvements could be made to the model, or to its application?

A number of suggestions have been made in commenting to the previous questions. Some of these will help the reader to better understand the model, how it was derived, and how it was applied.

Species Evaluations

Assessment biologists familiar with the stocks were given the task of determining the effect of fishing on the habitat.

- This might have lead to the few inconsistencies I noticed in the evaluation of the different species, primarily in terms of whether the evaluation was given a MT (minimum or temporary) or a U (unknown) when the data or information (or lack of them) appeared to be similar. I think that consistent evaluation of the criteria must be maintained.
- In spite of the independence of the evaluations, several of the species evaluations had exactly the same wording (including copied mistakes) in the write-ups. This may have been because the same individual did the evaluation although it was not clear whether that this was the case or if someone afterwards used the same wording.
- With the strict criteria of the model and MSST to determine the evaluation, perhaps the use of one assessment biologist to undertake the evaluation is reasonable. However, it would be worthwhile to enquire of others knowledgeable of the resources, such as those within the industry, on their views as to the state of the stocks.
- While the model of habitat reduction was applied for most species, it was not used very often to evaluate whether there might be an effect of fishing on habitat. Instead, the evaluations appeared to lean most heavily upon the MSST if the trawl fishing overlapped with the species distribution.
- Over 40% of the evaluations were classified as U (unknown), yet there is an implicit assumption throughout that if it is unknown, that there is no effect, or at least nothing should be done until more data are available (burden of proof argument). For example, even if one or two of the evaluations are listed as U, it is

often stated that fisheries are unlikely to adversely affect the EFH of the species in question. See comments above on the precautionary approach.

B.3.2.2 Weathervane Scallops

It states that the footprint of the scallop drags is small relative to the total amount of the type of habitat that is available. However, it is not shown or stated that scallops are likely to be equally present throughout the type of habitat (sand, mud, gravel), although it is assumed this in the calculation of the percentage of habitat affected by scallop drags. I expect that the scallops have more limited distribution, perhaps determined by currents that will partial retain the larvae.

It is also stated "the effects of scallop dredge gear on the bottom **are thought to be** higher than other gear types". Surely, the relative damage done by scallop draggers and trawling have been quantified.

The statement that "sediment resuspension by dredges can have positive or negative effects on scallop feeding" should be qualified as to why.

B.3.2.3 Red King Crab

On page 20 it states that closed areas were established to protect red king crab habitat. During the discussions other reasons were given as to the reason for the closures. The report should clearly state why the closures were established. If there were habitat issues, some details should be provided. Also, if it was to protect habitat then this is not consistent with an evaluation of MT. It should be MMNT although further restrictions need not apply if the closed areas are protecting the crabs. If the closed areas were not established to protect habitat, then the statement on page 20 should be removed.

B.3.2.4 Blue King Crab

The comments on the closure under Red King Crab, also apply to the Blue King Crab. The statement under the section on Growth that the "habitat conservation area was established in 1995 to eliminate potential effects of trawling on this habitat feature" again suggests that habitat was a major concern. This needs to be clarified.

In spite of the stock being below MSST, the conclusion is reached that it was not due to habitat degradation. While I do not necessarily have an argument with the conclusion in this case, it points out the problem of the use of MSST as a measure to evaluate the effects of habitat as indicated above.

B.3.2.5 Golden King Crab

It was stated "Spawning and breeding requirements for golden king crab are unknown" yet an evaluation of MT was given. Justification for the evaluation appears to be the lack

of overlap between the female crabs and fishing areas, although not stated specifically. It would help the reader if the reasons for the evaluation were clearly stated.

While it is stated that the overlap of groundfish trawl effort with female crabs is very limited, it is not clear what "very limited" means. It would help to be quantitative where possible and if not then indicate so.

While the statement is made "Groundfish trawl fishing in the EBS slope is of some concern, however, any effects are thought to be minimal", no reason is given as to why there is concern or why it is thought to be minimal.

B.3.2.6 Scarlet King Crab

It is stated that the overlap of groundfish trawl effort with female scarlet king crabs is "likely very limited" and later that there is "almost no overlap", but it is not clear what these mean. As noted for the Golden King crabs, it would help to be quantitative where possible and if not then indicate so.

B.3.2.7 Tanner Crab

The statement that the overlap of the groundfish trawl effort with female tanner crabs "does occur to some degree" is again not quantitative. It is not clear why the overlap with the crab fishery with available benthic habitat "is very small" considering it is in the crab areas, unless the habitat for males and females differ substantially. Or perhaps this is based on the fact that the footprint for the traps and pots is so small that it is inconsequential. The report is not clear as to what the reasoning is for the conclusion.

It is stated "No studies indicate a direct dependence of juvenile Tanner crabs on any vulnerable habitat feature" but how many have looked?

B.3.2.8 Snow Crab

Given that the report for snow crab is identical to that for Tanner crab (including spelling mistakes), the comments for Tanner crabs apply to snow crab as well.

B.3.2.9 Deepwater Tanner Crabs

What are confidential landings? Why are the landings given? Are there are other landings data? How does this information help the evaluation?

This is another example where effects on feeding and growth to maturity were not known but the conclusion was the fisheries are unlikely to have an affect.

B.3.3.1 Walleye Pollock

The reference to Section 3.2.1.2.1 was of no help to us since we were not given access to this part of the DEIS.

B.3.3.2 Pacific Cod

The optimal salinity for incubation seems very low given that the eggs are on the bottom, especially if the spawning zones are any indication of the depths of the eggs, e.g. from 40 to 290 m. Was the optimal salinity range determined from laboratory studies? What is the reference?

How was the dependence on fishery discards as an important dietary item determined? This seems very strange to have included here. I would delete it.

B.3.3.3 Sablefish

Although the stock is above MSST, caution is suggested because of the dependence on benthic prey, little is known about sablefish spawning habitat, and the living structure and coral are substantially reduced in much of the area where sablefish are concentrated. In spite of this cautionary note, the evaluation is MT for all three criteria.

B.3.3.4 Atka Mackerel; B.3.3.5 Yellowfin Sole; B.3.3.6 Greenland Turbot

In spite of the role of habitat on spawning success not being known, the evaluation is MT on spawning because the stock is above MSST.

B.3.3.7 Arrowtooth Flounder (BSAI & GOA)

Again, in spite of the role of habitat on spawning success not being known, the evaluation is MT on spawning because the stock is above MSST.

B.3.3.8 Rock Sole (BSAI)

It states that there was a decline in weight and length at age between 1979 and 1987, although this was hypothesized to be due to density dependent effects. What has happened since 1987?

B.3.3.17 Shortraker and Rougheye Rockfish (BSAI)

It is unclear from the discussion whether the MSST is known or not.

B.3.3.20 Northern Rockfish (GOA)

The statement is made that “there is no information on larval and early juvenile biology or habitat” and then it goes on to say, “consequently, there is no evidence that links habitat features with northern rockfish”. What about the burden of proof argument or the precautionary approach?

B.3.3.24.1 BSAI sharks and B.3.3.24.2 GOA sharks

If the salmon sharks are found in pelagic waters and bottom trawling is not considered to affect pelagics, why would the effects of fishing on this species be unknown?

B.3.3.24.7 BSAI squids and B.3.3.24.8 GOA squids

Again, since squids are found in pelagic waters and bottom trawling is not considered to affect pelagics, why would the effects of fishing on this species be unknown?

5. Conclusions/Recommendations

As review panel members we have been asked to examine and comment on the model and methods used by the AFSC scientists to assess the effects of fishing on habitat. The assessment is restricted to the effects on managed species and their long-term productivity or sustainability as a fishery. The task given to the AFSC scientists was a difficult one because there is a general lack of data and knowledge on both how and when fish use particular habitats and how important habitat is relative to other issues such as environmental conditions, food, predators, etc. While their efforts have been commendable I do have several concerns with some of the decisions made.

The habitat reduction model in the present DEIS is reasonable and logical but it suffers from several factors as acknowledged in the report. These include assumptions of constant fishing pressure, random distribution of fishing effort, coarse resolution of sediment and habitat types, as well as the high uncertainty in the damage done by the trawls, the number of times the trawls touch bottom, and the recovery rate of the habitat. For many of these, additional analyses could help to test the assumptions and either reduce or better define the uncertainties. Several suggestions have been given in previous Sections and I will not repeat them here. Even if the suggested analyses were carried out, the model still could only be considered as providing a rough guide as to the amount of habitat lost due to trawling.

The biggest problem, however, is that the model does not provide a measure of the effect of habitat destruction on the sustainability of the fish stocks. As a result the AFSC team used the MSST to determine if there has been a measurable effect of habitat loss. The assumption was that if habitat loss were a problem then it would be reflected in the state of the stock (i.e. recruitment) relative to MSST. One of the problems is that the stock's recruitment and its variability respond to many factors besides habitat changes. This is clearly demonstrated by the discussion of the blue king crab whose stock is below MSST but the conclusion was that it was not due to habitat although there was little justification within the report as to why this conclusion was reached. While I think the team probably had good reason to reject habitat loss as the main cause of the reduced abundance, it

made me question the objectivity of the process and ask under what conditions would habitat loss be considered to have affected fish stocks.

I think the report suffers in several places due to a lack of information, lack of quantification, or a lack of details. It may be that these were to be found elsewhere in the DEIS, perhaps in sections which we were not provided. One of the important issues that I feel was not covered at all was what level of loss of habitat might be considered unacceptable or at least significant enough to warrant concern. This needs to be discussed.

Given the high uncertainties and assumptions in the model and the dependence of the stock levels relative to MSST to factors besides habitat, I think that it is premature to conclude that there is no affect of fishing on habitat. Also, given that over 40% of the evaluations are labeled as "Unknown", I think that the precautionary approach should be applied.

The lack of surficial sediment information is surprising but it definitely hampers the ability to model and determine the effects of fishing on habitat. One of the serious faults of the model is the assumption of the distribution of fish. There is no attempt to adjust the potential area affected by trawling to the distribution of the fish. Instead it is based on the total area of the habitat type. This will underestimate the habitat affected by fishing since there are many reasons for the fish to be located in certain areas, not just the habitat type itself. This will include food, predators, currents, turbulence, temperature, stratification, etc.

Some Short term Recommendations

- In order to determine possible influences on fish due to destruction of habitat by fishing, the spatial pattern in the CPUE from the surveys or the commercial fishery could be estimated and compared to pattern of fish effort. Has the CPUE been declining in areas of heaviest fishing and where the habitat has been most affected?
- To further examine the possibility of habitat destruction affecting fish stocks, the spatial pattern of length-weight relationships for different species should be compared to the fishing effort pattern. If the fish in the heavily fished areas are in poorer condition (less weight for the same length fish) then this might argue for an affect of fishing through habitat.
- Attempts should be made to validate the habitat reduction model in regions or areas were data are available. If this is not possible, then careful consideration should be given on how to validate the model.
- Use the model to determine the time dependent nature of the loss of habitat for each of the species. How long does it take to reach "equilibrium" where the loss of habitat is balanced by the recovery rate? Does the model suggest that "equilibrium" has been reached? Back-calculate the time to pristine conditions given reasonable assumptions about the fish effort. How does this compare with when trawling began?

- Examine the observer data to determine spatial distribution of fishing effort to test the assumption of random spatial distribution of fishing effort. Also, the report should show the temporal distribution of fishing effort and discuss possible effects of fishing on the spawning process. It should also examine the time between multiple trawls in relation to the recovery time for the habitat.
- The rate of destruction of hard corals and sponges should be checked from the groundfish survey data, if the data were recorded, to determine the reliability of I in the habitat reduction model for these habitats.
- The evaluations of the effects of fishing on habitat need to be reconsidered after the above suggestions are completed. This information, plus results from other regions, should be taken into account along with the MSST and the model results. Where the data are unclear, or where habitat reduction is high even if the abundance levels are above MSST, the precautionary approach should be used. This may result in some habitats being classified as potentially impacted by fishing.

Some Long-term Recommendations

- The habitat associations of the various species should be determined from the groundfish survey data. The habitat features should include at least temperature, depth and type of habitat. Analysis of the data could be carried out similar to that of Smith and Page (1996). This would help to determine what, if any, feature most affects the distribution of the various fish species.
- The presence of closed areas to trawling offers the potential for research on the influence on trawling on habitat. These should include monitoring of the closed and open areas and comparisons carried out between the two. Experimental field programs should be established to determine the recovery rates of different types of habitat to known trawling.
- Surficial sediment surveys need to be carried out throughout Alaskan waters.
- The influence of habitat on the life history of different species needs to be identified. This should be carried out through observational programs that would include the use of manned and unmanned submersibles.

References

Reviewed Documents

Enticknap, B. 2004. Letter providing comments on Draft Environmental Impact Statement for Essential Fish Habitat identification and conservation in Alaska, Submitted on behalf of the Alaska Marine Conservation Council, p. 20.

NMFS. 2004a. Executive Summary of the *Draft Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska,* 11 p. plus tables and figures

NMFS. 2004b. Appendix B: The evaluation of fishing activities that may adversely affect Essential Fish Habitat. Draft Environmental Impact Statement, 76 p. plus tables and figures

North Pacific Fishery Management Council. 2002. Essential Fish Habitat, p. 6, *In* Draft Minutes of the Scientific Statistical Committee for September 30-October 2, 2002.

North Pacific Fishery Management Council. 2003. Essential Fish Habitat, p. 3-4, *In* Draft Minutes of the Scientific Statistical Committee for December 2-4, 2002.

North Pacific Fishery Management Council. 2003. Essential Fish Habitat, p. 4-6, *In* Draft Minutes of the Scientific Statistical Committee for January 27-29, 2003.

North Pacific Fishery Management Council. 2003. Minutes of the Scientific Statistical Committee, Conference Call for June 26, 2003. 3 p.

North Pacific Fishery Management Council. 2003. Essential Fish Habitat, p. 2-4, *In* Draft Minutes of the Scientific Statistical Committee for March 31-April 2, 2003.

North Pacific Fishery Management Council. 2003. Essential Fish Habitat, p. 1-5, *In* Draft Minutes of the Scientific Statistical Committee for October 6-7, 2003.

Shester, G. 2004. Comments on Alaska Region Essential Fish Habitat Draft Environmental Impact Statement, p. 24.

Tagart, J.V. 2004. Technical Review of Appendix B: The evaluation of fishing activities that may adversely affect Essential Fish Habitat, part of the January 2004 Draft Environmental Impact Statement for Essential Fish Habitat identification and conservation in Alaska, Submitted on behalf of Marine Conservation Alliance, p. 26.

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

Associated Papers and Documents Read and/or Referenced

Conners, M.E., A.B. Hollowed and E. Brown. 2002. Retrospective analysis of Bering Sea bottom trawl surveys: regime shift and ecosystem reorganization. Progress in Oceanography 55: 209-222.

McConnaughey, R.A. and K.R. Smith. 2000. Associations between flatfish abundance and surficial sediments in the eastern Bering Sea. Canadian Journal of Fisheries and Aquatic Sciences 57: 2410-2419.

Smith, S.J. and F. Page. 1996. Associations between Atlantic cod (*Gadus morhua*) and hydrographic variables: implications for the management of the 4VsW cod stock. ICES Journal of Marine Science 53: 597-614.

Appendix: Statement of Work

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 Reviewed

I reviewed 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);
- Section 3.4.3 of the DEIS, 20 pages plus 1 table and 5 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/efh.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:

    b. 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?

    c. 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 Chair

1. The Chair shall moderate the June 29 meeting with the NMFS scientists as well as other meetings the panel may have to conduct its work.

2. The Chair shall compile all of the panelists' input from the meeting and from their review reports to prepare a summary report, and shall provide the summary report to Dr. David Die via e-mail at ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani via email at mshivlani@rsmas.miami.edu. This summary report shall accurately present all the opinions and findings of each individual panelist in an easily read summary, and shall not represent a consensus report. The Chair shall provide the summary report to the CIE no later than July 23, 2004.

3. The Chair shall present the results of the review to the Council and its Advisory Panel and Scientific and Statistical Committee at a meeting on or about October 6, 2004, in Sitka, Alaska.

Signed_____ Date_____