Agendum C.6.c
SSC Report
September 2004

Final Draft – July 22, 2004

Review of Fishing Impacts on Groundfish Essential Fish Habitat

**– A Report of the SSC Economics and Groundfish Subcommittees –
Based on a Meeting Held at the Alaska Fisheries
Science Center, May 24-25, 2004**

SSC Members Present:

Dr. Mike Dalton (Chair)
Mr. Steve Berkeley (Rapporteur #1)
Mr. Tom Jagielo (Rapporteur #2)
Dr. Martin Dorn
Dr. André Punt
Dr. Hans Radtke
Ms. Cindy Thomson

Introduction

The National Marine Fisheries Service (NMFS) has developed an analytical framework to evaluate effects of alternative management actions on Pacific coast groundfish Essential Fish Habitat (EFH). A schedule for the Pacific Fishery Management Council (PFMC) to designate EFH is mandated by court order and requires that a range of alternatives be available for consideration at the September 2004 Council meeting. Because of the scientific and technical issues involved, the Council requested a review of the EFH analytical framework by the Scientific and Statistical Committee (SSC) prior to formulation of management alternatives.

The SSC Groundfish Subcommittee met with members of the EFH Technical Review Committee (TRC), and the EFH Analytical Team to review the analytical framework on February 23-24, 2004 at the Alaska Fisheries Science Center in Seattle, Washington. The analytical framework is composed of an EFH identification tool, to assist in the designation of EFH, and a fishing impacts model to determine where adverse impacts from fishing occur.

The EFH identification component of the analytical framework was ready for review in February and was endorsed by the SSC in March. However, the structure of the EFH fishing impacts model was not complete in February, and only a partial review of the model was possible then. Given the tight schedule of court deadlines, the SSC made recommendations in February to prioritize work on the fishing impacts model during spring 2004, which are documented in the SSC report from February.

In March, the Council requested a follow up review of the EFH fishing impacts model by the SSC before the June Council meeting. For the follow up review, members of both the economics and groundfish subcommittees of the SSC met with members of the TRC, and the EFH Analytical Team on May 24-25, 2004 at the Alaska Fisheries Science Center. An overview of changes to the fishing impacts model and supporting data since February are described below. Strengths and weaknesses of the current version of the fishing impacts model and data are also described, and the SSC's assessment of the current version of the model, based on progress since February, is given.

Data on Gear Impacts

Data on gear impacts were collapsed into those for five generic gear types: dredge, bottom trawl, nets, pots and traps, and hook-and-line. Matrices of habitat sensitivities and recovery times were created using all fifty mapped habitat types. Many cells did not have data and were filled using expert judgment extrapolated from a limited number of empirical studies. The SSC has remaining questions about the decision rules used to assign data to different cells and recommends further documentation (e.g., a description of how values and variances were assigned to cells with little or no data).

The relationship between sensitivities and gear-type is not linear, so a doubling of the value of the sensitivity from one gear type to another does not imply twice the habitat impact. Only the bottom trawl category has an explicit unit of effort (trawl hours), emphasizing the difficulty in cross–gear-type comparisons (e.g., how many units of hook-and-line gear are equivalent to an hour of bottom trawling?). Additional comments on the data on which the habitat sensitivity and recovery rate matrices are based are provided in the report from the SSC review in February.

Benchmarks for sensitivity and recovery rates are interpreted in the model as changes from a pristine state. However, the recovery time matrices are currently defined in terms of changes in habitat from a detectable impact to an undetectable one. Because the studies on which these results are based come from field observations (impacted areas compared to control areas) with low statistical power, failure to detect a difference is not the same as recovery to a pristine condition. In addition, recovery in the model is represented by a change from a damaged or impacted state to a pristine one, but this interpretation is not necessarily consistent with the baseline in studies from which the recovery times are taken.

Data on Fishing Effort

Trawl logbooks are the sole source of coastwide data on the spatial distribution of fishing effort. Consequently, an important restriction on the fishing impacts model is that only data on trawl gears are used to assess effects of fishing on EFH. However, other gear types probably have important effects. For example, a pilot project described by the EFH Analytical Team in February estimated the spatial extent of fishing effort with fixed gears off the Oregon Coast. In March, the SSC endorsed the approach taken in the pilot project, but time and budget constraints prevented using the approach for a coastwide assessment.

The SSC considers the current imbalance among gear types in the EFH fishing impacts model to be a major weakness, and addressing this gap in the data is among the most important tasks for future work. For a more representative distribution of impacts, the SSC recommends developing spatial data on fishing effort for fixed gear and recreational sectors of the groundfish fishery. In this regard, a logbook program for the fixed gear fleet, like that for trawlers, would be a valuable source of information.

Due to data constraints on the actual location of trawl tracks, data for fishing effort were assigned to 10-minute blocks of latitude and longitude, based on the starting points for tows recorded in trawl logbooks (page 22, Section 3.2.2, EFH Impacts Assessment, June 2004). Trawl effort data summaries include the total number of tows and total duration of tows in each block, by month for each year 1998-2002, and annual summaries for the years 1987-2002. The data summaries for each block exclude mid-water trawls. Spatial data on habitat sensitivity and recovery were used to calculate the proportion of each block occupied by each habitat type.

Structure of the Fishing Impacts Model

The EFH Model Development Team presented the most recent version of the fishing impacts model. Appendix 8 from the February meeting describes the general structure of the previous version of the fishing impacts model. In the previous version, as in the current version, habitat consists of a large number of individual sites, or patches, that are in either in a pristine or impacted state. The habitat impacts index takes values between zero and one. Effects of a unit of fishing effort on the habitat impact index depend on the gear type, and sensitivity of the habitat type to that gear, using the data on gear impacts described above.

The model's current documentation describes the index value as representing the fraction of impacted sites. According to the documentation, a value of zero represents a pristine habitat, and a value of one represents habitat that is "totally functionally destroyed" (page 23, Section 3.3, EFH Impacts Assessment, June 2004). In other words, the fishing impacts model is structured as an absolute measure of habitat damage. On the other hand, results with the fishing impacts model should be interpreted only as a relative measure of habitat damage (page 33, Section 4.2.1, EFH Impacts Assessment, June 2004). This discrepancy between absolute and relative interpretations is confusing, and creates problems for the model's results.

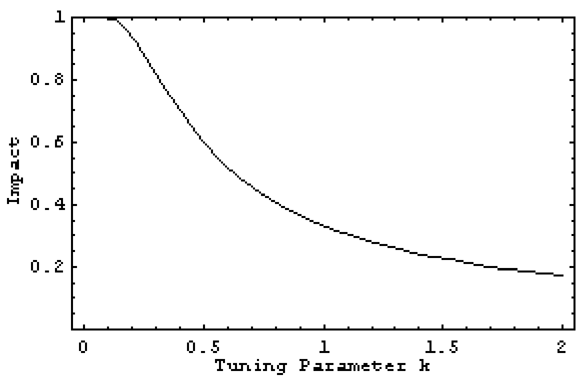
The version of the fishing impacts model in Appendix 8 from February consists of a recovery function, a damage function, and a dynamic relationship for the habitat impact index, with the percentage change in impacted habitat proportional to the current rate of recovery minus the current rate of impact. However, Appendix 8 does not contain a complete description of how the damage function in the fishing impacts model relates to the data for fishing effort.

In February, the SSC recommended (1) including logistic (S-shaped) recovery profiles, and (2) developing a spatially explicit model of gear effects to incorporate the notion of a gear footprint, such as area swept by trawls. These recommendations are described in the SSC report from the February meeting.

The SSC's first recommendation was incorporated into the fishing impacts model, although, in a way that raised important questions during the review about appropriate values for the model's tuning parameter *k*. The need for a tuning parameter is due to the current absence of a theoretical framework, and sound empirical basis, for relating fishing effort to habitat damage. Therefore, any current method for determining values of *k* will be ad-hoc.

One method of determining values for the tuning parameter *k* was discussed at the May meeting. This method works by choosing an arbitrary maximum value near the asymptote of the cumulative equivalent effort curve (page 25, Section 3.3.2, EFH Impacts Assessment, June 2004). Other procedures for choosing *k* are possible, but no alternatives were presented, and no criteria have been developed to evaluate the merits of different procedures. The current method for determining values of *k* does provide a starting point for analysis to make relative comparisons between areas. However, values of *k* are critical to the shape of the recovery curves and the implied impacts on habitat. The figure below demonstrates the sensitivity of the fishing impacts model to values of the tuning parameter.

Figure 1: Impact of a unit of fishing effort, measured in units of duration, for values of the tuning parameter *k* from 0.1 to 2.0 (MRAG recommended values), with a habitat sensitivity parameter of *s* = 0.9. Further information is provided in the appendix.



Preliminary runs of the model presented at the May meeting produced results showing that habitat in some blocks is close to the asymptotic value of one, and according to the model, these blocks have received maximum impacts. However, some of these areas are still trawled, and apparently remain productive. Different values of the tuning parameter *k* affect this result (e.g., Figure 8, EFH Impacts Assessment, June 2004, page 38). A more realistic interpretation of the asymptote is that a state has been reached where additional contact with trawl gear has negligible effects on the habitat's condition. However, the relationship between habitat condition and function is presently unknown. Values close to one indicate a reduction in fishing effort will likely have little effect on the impacts index, at least in the short-run.

Application of the Risk Assessment

The EFH analytical team outlined options and tools for developing policy alternatives. In general, fishing activity can be mitigated if it causes impacts that are more than minimal, and not temporary in nature. Possible elements in future risk assessments are listed below.

Examples of tools for impact assessment:

1. Fishing impact model for trawl gears.
2. Maps of habitat sensitivity and recovery to nontrawl gears.
3. Maps of habitat rarity.
4. Maps of intensity of habitat use.

Ways to identify areas for short-term mitigation:

1. Spatial patterns in impacts of trawl gears.
2. Location of the most sensitive habitats.
3. Time trends in the net impact of trawl gears.
4. Location of habitats with longest recovery times.
5. Areas with greatest damage to EFH for a species or group of species.

Potential management actions for short-term mitigation:

1. Closed areas.
2. Gear modifications.
3. Rotating closures.
4. Closed seasons.
5. Effort reduction.

Examples of problems for long-term mitigation:

1. Lack of spatially-explicit fishing effort data.
2. Lack of a common measure for impacts assessment.
3. Redistribution of fishing effort.
4. Relationships between habitat and stock status.

Potential management actions for long-term mitigation:

1. Collection of fishing effort data for nontrawl sectors through VMS, or logbooks (e.g., fixed-gear logbooks).
2. Development of an economics component to the impacts model (this work is proceeding).
3. Establish research reserves.

Assessment of the Fishing Impacts Model

The fishing impacts model could be used for a variety of purposes, including:

1. Evaluation of the future impacts of closures, changes in fishing effort, and modifications to gear characteristics in an absolute sense.
2. Evaluation of these impacts in a relative sense.
3. Evaluation of which areas are most impacted.

The SSC considered the utility of the model relative to each of these purposes.

The ability to make predictions in an absolute and, to a somewhat lesser extent, relative sense depends on resolving the issue of how to specify values for the tuning parameter *k*. Therefore, the development of a transparent method for determining values of *k*, based on observable data, will be necessary before the fishing impacts model is useful for policy analysis. Additional data are clearly needed to specify reliable, or even plausible, values for *k*, but agreement was not reached about what data could be used, or a suitable approach for constructing values.

Because of unresolved issues with the tuning parameter, the SSC questions whether the current structure of the fishing impacts model, which is quite specialized, is appropriate for identifying where adverse fishing impacts occur. For example the SSC's second recommendation from February, developing a spatially explicit model of gear effects, may resolve the need for a tuning parameter. However, this recommendation was not incorporated into the fishing impacts model because of data limitations and other constraints.

A serious spatial inconsistency exists between the resolution of the fishing impacts model, which is limited by the resolution of the fishing effort data to aggregated blocks, and the finer scale EFH polygons within each block. Summing effort for each block implicitly assumes that fishing effort is distributed uniformly within that block, but this assumption is generally false. For example, tows tend to stay on either soft or hard bottoms, depending on whether flatfish or rockfish are the target.

The spatial inconsistency between fishing impacts and habitat in the fishing impacts model is a serious concern. The SSC acknowledges the complexity of the issue and the importance of data gaps in limiting information about location of individual trawls. However, this inconsistency severely limits the ability to evaluate the areas most severely impacted. Further development of the model and additional data will be necessary before the SSC can endorse use of the fishing impacts model for the purpose of identifying where adverse fishing impacts occur.

Consequently, the SSC does not recommend use of the current EFH fishing impacts model for risk assessment or in the development and evaluation of management alternatives. In particular, the SSC does not recommend using the fishing impacts model for the risk assessment or to produce maps of intensity of habitat use (Items 1 and 4 listed above as tools for the impact assessment). The SSC also does not recommend using the fishing impacts model for estimating spatial patterns in impacts of trawl gears, time trends in the net impact of trawl gears, or for identifying areas with greatest damage to EFH for a species or group of species (Items 1, 3, and 5 listed above as ways of identifying areas for short-term mitigation in the risk assessment).

Recommendations for Using the Current Version of the Impacts Model and Data

Data used with the fishing impacts model are informative on their own. A useful set of maps based on these data could be developed to aid formulation and evaluation of EFH management alternatives. For example, polygons of the most sensitive habitat types could be overlaid with the trawl start coordinates to provide an index of potential fishing impacts. While coastwide spatial data on fishing effort are available only for trawlers, habitat sensitivity and recovery rates are available for all gear types. Maps that associate habitat type to sensitivity and recovery for different gears could be used to develop and evaluate mitigation options.

Recommendations for Further Development of the EFH Fishing Impacts Model and Data

The EFH Analytical Team confronted several obstacles, including critical data gaps, during development of the current version of the fishing impacts model. Further development of the EFH impacts model and data are needed before the model is ready for conclusive policy analysis. Priority areas for future work are:

1. Expanding the set of spatial data on fishing effort for use with the model to include fixed-gear and recreational sectors of the groundfish fishery.
2. Improving the spatial resolution of the fishing impacts model to resolve the spatial inconsistency between fishing impacts and habitat.

In February, the EFH Analytical Team presented results from a set of focus group meetings with knowledgeable fishermen to develop baseline effort maps for trawl, long-line, and groundfish pot fisheries for an area off the Oregon Coast. The focus group meetings for the EFH project were conducted under sound socioeconomic research protocols (Final Report, Pilot Project to Profile West Coast Fishing Effort). In its report from the February meeting, the SSC endorsed the use of these methods to collect primary data based on fishermen's knowledge and expertise. The SSC repeats its recommendation from February to continue this work of collecting primary data on fishing effort off the West Coast. These data would be used to develop baseline effort maps for nontrawl sectors and provide the best available scientific information to an ongoing EFH process.

To improve the spatial resolution of the fishing impacts model for the trawl sector, the SSC recommends returning to the formulation given in Appendix 8 of materials from the February meeting. In particular, equation (2) provides a reasonable starting point for relating habitat damage at a location to habitat sensitivity, vessel speed, gear width, duration of contact, and other factors. Citing data limitations, the EFH Analytical Team moved away from the spatially explicit formulation in equation (2), and adopted the 10-minute blocks for fishing effort described above.

However, assigning individual tows to the fishing blocks, based on start point and gear type, loses information. As noted above, individual tows tend to stay in the habitat type in which they start (e.g., soft or hard bottom). In this case, the start point of each tow provides important information about the habitat type in which most of the tow probably occurred. On the other hand, the current version of the fishing impacts model uses the proportion of each habitat type, in each block, to assign probabilities for impacts. The EFH Analytical Team has defended this method of assigning probabilities to impacts as standard and conservative, and interprets it as generalizing the more detailed data (habitat) to the same spatial resolution as the less detailed data (trawling).

For the less detailed data, the SSC notes the degree of resolution (i.e., 10-minute blocks), was somewhat arbitrary, chosen by the EFH Analytical Team with input from the TRC (page 22, Section 3.2.2, EFH Impacts Assessment, June 2004). In other words, the method of assigning probabilities may be sensitive to the size of the blocks, for example those blocks on the edge of sensitive habitat. Therefore, the current method of assigning probabilities may not be conservative with respect to impacts on each habitat type. For example, rockfish tows on the edge of flatfish habitat are assigned to both habitat types because the impacts model generalizes habitat data to the scale of the fishing blocks.

Finally, trawl logbooks have information on the depth of each tow, and this information is available from other sources in the EFH framework. At the February meeting, the TRC noted that individual tows tend to follow the same depth contour, and a relationship exists between vessel speed during a tow and its depth. This information is not currently utilized in the EFH fishing impacts model. These relationships were discussed again at the March meeting. The SSC suggested then that focus groups, like those used to produce the baseline maps of fishing effort for the EFH project, or other socioeconomic research methods, could be used to collect data on relationships between tow depth, vessel speed, and other information. This information could be used to configure the spatial model of fishing effort in Appendix 8 from the February meeting.

Appendix: Derivation of Fig. 1

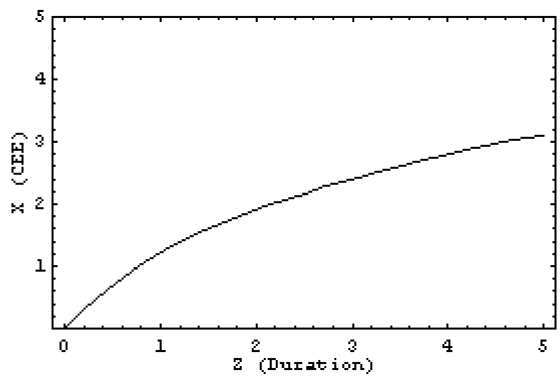
The derivation of SSC Figure. 1 is based on the fishing impacts model described in Section 3.3 of the EFH Impacts Assessment, June 2004.

Cumulative Equivalent Effort (CEE)

k = Tuning parameter
z = Duration in tow hours
x = CEE = *h(z, k)*

$$h(z,k) = \frac{1}{k} Log_{10}(z+1)$$

Plot of $h(z,k)$ with k = 0.25:

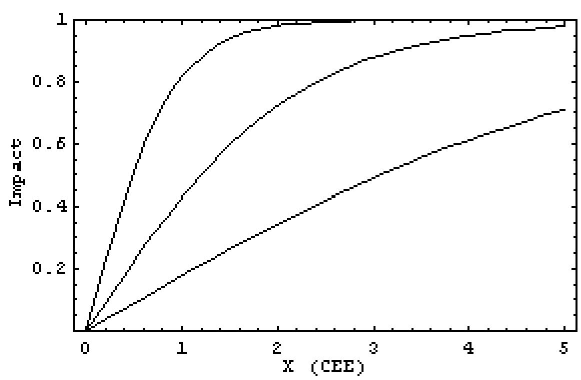


Impact Function

s = habitat sensitivity

$$f(x,s) = \frac{1-(1-s)^x}{1+(1-s)^x}$$

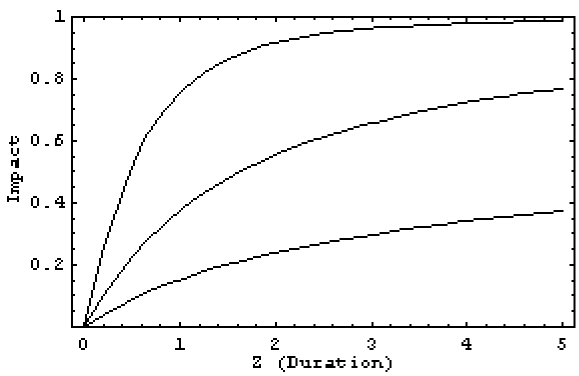
Plot of $f(x,s)$ with *k* = 0.25 and *s* = 0.3, 0.6, 0.9:



Composite CEE-Impact Function

$$g(z,k,s) = f(h(z,k),s)$$

Plot of $g(z,k,s)$ with duration z from 0 to 5, k = 0.25, and s = 0.3, 0.6, 0.9:



Agenda
Pacific Council Scientific and Statistical Committee
May 24-25, 2004

<u>May 24</u>

1:00 - 1:10 **Call to Order (Chair)**

- Review of committee business
- Review and adoption of the agenda

1:10 - 1:20 **NMFS Report (Copps)**

- Project status
- Revised timeline
- Planning and Oversight Process

1:20 - 1:30 **Recap of decision-making framework and intro to risk assessment document (Parkes)**

1:30 – 2:45 **Data update**

Updates to data on

- Fishing gear impacts: habitat sensitivity and recovery (Grizzle) 45min
- Indexing Spatial Data for Non-fishing Impacts? (Grizzle)
- GIS Summary (Bailey)
- Plans and status of making the database available over the internet

2:45 – 3:00 **Break**

3:00 – 4:00 **Explanation of the Impacts Model (Burn)**

- Effects of data on model specification
- The Impact Function
- The Bayesian Network Model for Impacts (Version 1)
- Discussion

4:00 - 4:30 **Application of the Risk Assessment**

- Example output for bottom trawls (Bailey/Burn)
- GIS Capabilities for Developing Alternatives
- Using the Model in the development and evaluation of Alternatives (Parkes/Burn/Bailey)
- Development of alternatives for non-trawl gears (CRA) (Parkes/Bailey)

4:30 - end **Public Comment and Committee Discussion**

- Overnight tasking

May 25

9:00 – 10:00 **Presentation of Overnight Tasks**

10:00 – 10:30 **Discussion with Technical Team on Application of the Risk Assessment**

10:30 – 10:45 Break

10:45 – 11:30 **Discussion with Technical Team on Application of the Risk Assessment (continued)**

11:30 – 12:00 **Remaining Issues**

- Future development of the EFH and Impacts models (current proposals)

12:00 – 1:00 **Lunch Break**

1:00 – 1:30 **Public Comment**

1:30 – end **Committee Discussion**

PFMC
08/30/04