Public Testimony Sign-Up Sheet

Agenda Item D-3 Ecosystem Issues (HAPC) Research Plan

	NAME (PLEASE PRINT)	AFFILIATION
1	Dorothy Childers	AMCC
2	Bubba Cook	WWF
3	JOHN GAUVIN	BUC
4	Jon Warrenchuk	Oceana
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

NOTE to persons providing oral or written testimony to the Council: Section 307(1)(I) of the Magnuson-Stevens Fishery Conservation and Management Act prohibits any person " to knowingly and willfully submit to a Council, the Secretary, or the Governor of a State false information (including, but not limited to, false information regarding the capacity and extent to which a United State fish processor, on an annual basis, will process a portion of the optimum yield of a fishery that will be harvested by fishing vessels of the United States) regarding any matter that the Council, Secretary, or Governor is considering in the course of carrying out this Act.

NPFMC Proposed HAPC Identification Process[1]

April 2005

1 Introduction and Background

In April 2005, the Council formally revised its approach to the designation of habitat areas of particular concern (HAPCs) within essential fish habitat (EFH), by adopting a site-based approach to identifying HAPCs, analyzed in the *Environmental Impact Statement for EFH Identification and Conservation in Alaska* (EFH EIS). The Council developed the process to be used to identify HAPC sites in the future, which was described in Appendix J of the EFH EIS, and is included below. The Council may modify this HAPC process over time, as warranted.

To date, there has been one HAPC nomination process, initiated in October 2003, which resulted in the implementation of several HAPC designations in the Gulf of Alaska and the Aleutian Islands in 2006. For the initial 2003-2004 HAPC process, the Council identified two specific priority areas for HAPC proposals:

1. Seamounts in the exclusive economic zone (EEZ), named on National Oceanic and Atmospheric Administration (NOAA) charts, that provide important habitat for managed species.
2. Largely undisturbed, high-relief, long-lived hard coral beds, with particular emphasis on those located in the Aleutian Islands, which provide habitat for life stages of rockfish or other important managed species.

This document describes the Council's process and timeline for setting HAPC priorities and calling for nominations for candidate HAPC sites, for reviewing HAPC proposals, and for Council action to establish HAPC designations for specific sites.

2 HAPC Considerations and Priorities

The Council will call for HAPC nominations through a proposal process that will focus on specific sites consistent with HAPC priorities designated by the Council. The Council may designate HAPCs as habitat sites, and management measures, if needed, would be applied to a habitat feature or features in a specific geographic location. The feature(s), identified on a chart, would have to meet the considerations established in the regulations and would be developed to address identified problems for FMP species. They would have to meet clear, specific, adaptive management objectives. Evaluation and development of HAPC management measures, where management measures are appropriate, will be guided by the EFH Final Rule.

2.1 HAPC Considerations

HAPCs are those areas of special importance that may require additional protection from adverse effects. 50 CFR 600.815(a)(8) provides that FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations:

1. The importance of the ecological function provided by the habitat.

[1] Adapted from Appendix J of the *Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska.* April 2005. U.S. DOC, NOAA, NMFS, Alaska Region. PO Box 21668, Juneau, AK.

2. The extent to which the habitat is sensitive to human-induced environmental degradation.
3. Whether, and to what extent, development activities are, or will be, stressing the habitat type.
4. The rarity of the habitat type.

The Council will consider HAPCs that meet at least two of the four HAPC considerations above, and rarity will be a mandatory criterion of all HAPC proposals.

2.2 HAPC Priorities

The Council will set priorities at the onset of each HAPC proposal cycle.

2.3 HAPC Proposal Cycle

HAPC proposals may be solicited every 3 years or on a schedule established by the Council.

2.4 HAPC Process

The HAPC process will be initiated when the Council sets priorities, and a subsequent request for HAPC proposals is issued. Criteria to evaluate the HAPC proposals will be reviewed by the Council and the Scientific and Statistical Committee (SSC) prior to the request for proposals. Any member of the public may submit a HAPC proposal. Potential contributors may include fishery management agencies, other government agencies, scientific and educational institutions, non-governmental organizations, communities, and industry groups. A step-by-step outline is attached as Figure 1.

2.5 HAPC Call for Proposals

A call for proposals will be announced during a Council meeting, and will be published in the Federal Register, as well as advertised in the Council newsletter. Scientific and technical information on habitat distributions, gear effects, fishery distributions, and economic data should be made easily accessible for the public, simultaneous with issuing a call for proposals. For example NMFS' Alaska Region website has a number of valuable tools for assessing habitat distributions, understanding ecological importance, and assessing impacts. Information on EFH distribution, living substrate distribution, fishing effort, catch and bycatch data, gear effects, known or estimated recovery times of habitat types, prey species, and freshwater areas used by anadromous fish is provided in the EFH EIS. The public will be advised of the rating criteria with the call for proposals.

2.6 Contents of HAPC Proposals

The format for a HAPC proposal should provide/include the following:

- Name, address, and affiliation.
- Title for the HAPC proposal and a single, brief paragraph concisely describing the proposed action.
- Identify the habitat and FMP species that the HAPC proposal is intended to protect.
- Statement of purpose and need.
- Describe whether and how the proposed HAPC addresses the four considerations set out in the final EFH regulations.

- Define the specific objectives for this proposal.
- Propose solutions to achieve these objectives [How might the problem be solved?].
- Establish methods of measuring progress towards those objectives.
- Define expected benefits of the proposed HAPC; provide supporting information/data, if possible.
- Identify the fisheries, sectors, stakeholders, and communities to be affected by establishing the proposed HAPC [Who would benefit from the proposal; who would it harm?] and any information you can provide on socioeconomic costs.
- Clear geographic delineation for the proposed HAPC (written latitude and longitude reference point and delineation on an appropriately scaled NOAA chart).
- Best available information and sources of such information to support the objectives for the proposed HAPC (citations for common information or copies of uncommon information).

2.7 HAPC Initial Screening

Council staff will screen proposals to determine consistency with Council priorities, HAPC criteria, and general adequacy. Staff will present a preliminary report of the screening results to the Council. The Council will determine which of the proposals will be forwarded for the next review step: scientific, socioeconomic, and enforcement review.

3 HAPC Review Process

3.1 Scientific Review

The Council will refer selected proposals to the plan teams (Gulf of Alaska groundfish; Bering Sea groundfish; Bering Sea crab, scallop, and salmon). The teams will evaluate the proposals for ecological merit.

There will always be some level of scientific uncertainty in the design of proposed HAPCs and how they meet their stated goals and objectives. Some of this uncertainty may arise because the public will not have access to all relevant scientific information. Recognizing time and staff constraints, however, the staff cannot be expected to fill all the information gaps of proposals. The Council will have to recognize data limitations and uncertainties and weigh precautionary strategies for conserving and enhancing HAPCs while maintaining sustainable fisheries. The review panels may highlight available science and information gaps that may have been overlooked or are not available to the submitter of the HAPC proposal.

3.2 Socioeconomic Review

Proposals will be reviewed by Council or agency economists for socioeconomic impact. The Magnuson-Stevens Act states that EFH measures are to minimize impacts on EFH "to the extent practicable," thus, socio-economic considerations have to be balanced against expected ecological benefits at the earliest point in the development of measures. NMFS' Final Rule for developing EFH plans states specifically that FMPs should "identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable" (50 CFR 600.815(a)(2)(ii)). In contrast to a process where the ecological benefits of EFH or HAPC measures are the singular initial focus and a later step is used to determine practicability, this approach would consider practicability simultaneously.

Proposals should also be rated as to whether they identify affected fishing communities and the potential effects on those communities, employment, and earnings in the fishing and processing sectors and the related infrastructure, to the extent that such information is readily available to the public. Management and enforcement will also provide input during the review to evaluate general management cost and enforceability of individual proposals.

3.3 Management and Enforcement Review

Proposals will be reviewed for management and enforceability.

3.4 Evaluation of Candidate HAPCs

The reviewers may rank the proposals by using a system like the matrix illustrated in the table below, and provide their recommendations to the Council. In the NPFMC Environmental Assessment of Habitat Areas of Particular Concern (NPFMC 2000), proposed HAPC types and areas were evaluated by using a ranking system that provided a relative score to the proposed HAPCs; they were weighed against the four considerations established in the EFH Final Rule. One additional column was added to the matrix to score the level of socioeconomic impact: the lower the impact, the higher the score. The Data Level column was split into two columns, Data Level and Data Certainty, to reflect not only the amount of data available, but also the scientific certainty of the information supporting the proposal. A written description should accompany the scoring so that it is clear what data, scientific literature, and professional judgments were used in determining the relative score.

Proposed HAPC area	Data Level	Data Certainty	Sensitivity	Exposure	Rarity	Ecological Importance	Socioeconomic impact level
Seamounts and Pinnacles	1	1	Medium	Medium	High	Medium	Low
Ice Edge	3	1	Low	Low	Low	High	Low
Continental Shelf Break	3	2	Medium	Medium	Low	High	Medium
Biologically Consolidated Sediments	1	3	Low	Medium	Low		Unknown

4 Council Action

4.1 Council Assessment of Proposal Reviews

Staff will provide the Council with a summary of the ecological, socioeconomic, and enforcement reviews.

4.2 Council Selection of HAPC Proposals for Analysis

The Council will select which proposal or proposals will go forward for analysis for possible HAPC designation. The Council may modify the proposed HAPC sites and management measures.

4.3 Potential Outcomes

Each proposal received and/or considered by the Council would have one of three possible outcomes:

1. The proposal could be accepted, and, following review, the concept from the proposal could be analyzed in a NEPA document for HAPC designation.
2. The proposal could be used to identify an area or topic requiring more research, which the Council would request from NMFS or another appropriate agency.
3. The proposal could be rejected.

4.4 Stakeholder Input

The Council may set up a stakeholder process, as appropriate, to obtain additional input on proposals.

4.5 Technical Review

The Council may obtain additional technical reviews as needed from scientific, socioeconomic, and management experts.

4.6 NEPA Analysis

Staff will prepare a National Environmental Policy Act (NEPA) analysis and other analyses necessary under applicable laws and Executive Orders.

4.7 Public Comment on NEPA Analysis

The Council will receive a summary of public comments and take final action on HAPC selections and management alternatives.

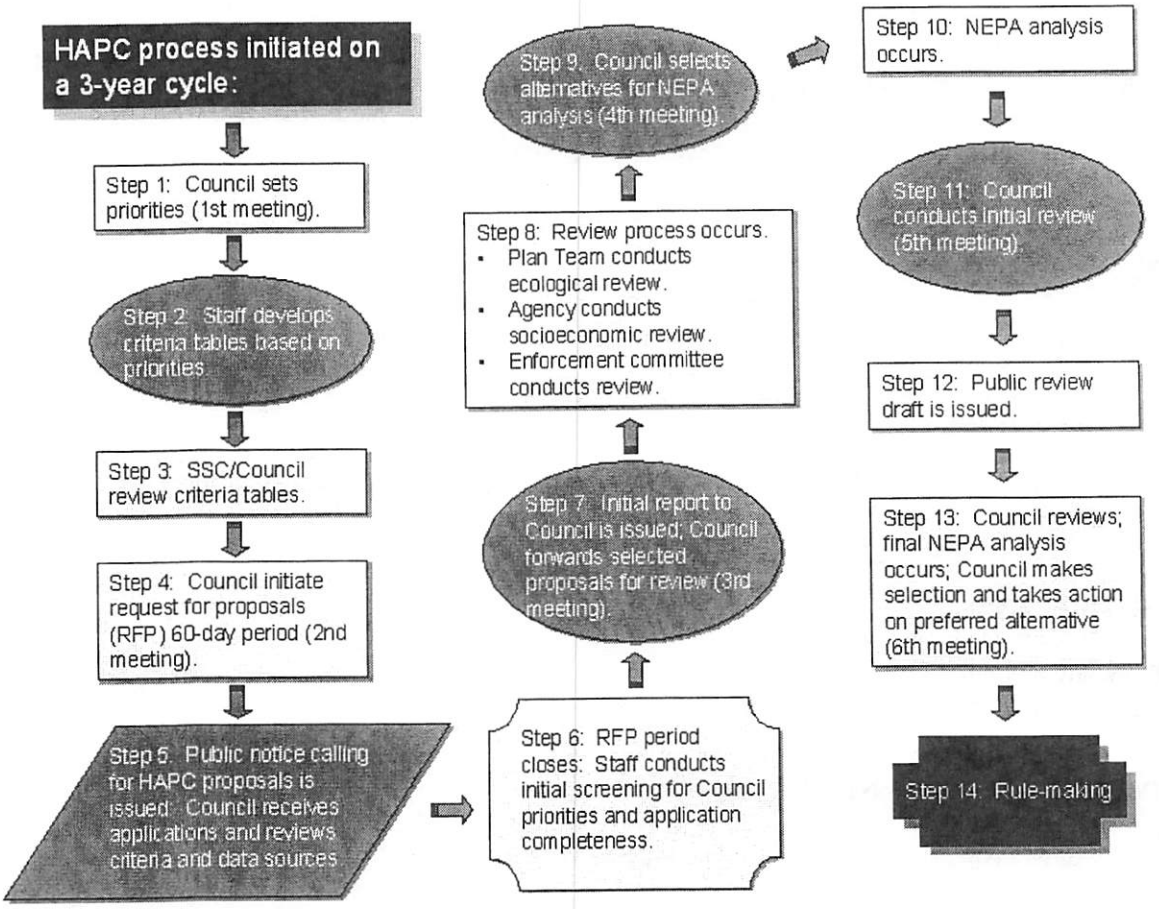
4.8 Periodic Review

The Council may periodically review the efficacy of existing HAPCs and allow for input on new scientific research.

5 Literature Cited

NPFMC. 2000. Draft Environmental Assessment/Regulatory Impact Review. Habitat Areas of Particular Concern. North Pacific Fishery Management Council. Anchorage, AK.

Figure 1 HAPC Process Sequential Steps



Outline of a Research Plan for the Northern Bering Sea Research Area (NBSRA)
Prepared by the NOAA Alaska Fisheries Science Center (AFSC) for comment by the NPFMC SSC at the June 2009 meeting

Background

An ecosystem shift associated with climate change and loss of sea ice in the Bering Sea is expected to extend the distributions of fish and crab populations northward to the subarctic regions. A corresponding movement of nonpelagic bottom trawl fisheries northward into the Northern Bering Sea (NBS) is also expected. Amendment 89 to the Fishery Management Plan (FMP) for Groundfish of the Bering Sea and Aleutian Islands (BSAI) Management Area establishes the NBSRA for studying the possible impacts of nonpelagic trawling on bottom habitat.

Nonpelagic bottom trawling in the Bering Sea catches mainly flatfishes (e.g. yellowfin sole, rock sole, flathead sole, turbot, and arrowtooth flounder), and may also include other groundfishes (e.g. sablefish, rockfish, and Pacific cod). Nonpelagic bottom trawling may directly impact benthic communities and increase interaction with protected species in the NBS. Indirectly, the effects of bottom trawling can propagate to higher trophic levels, the pelagic environment, and human communities in the ecosystem. Specifically, a number of threatened, endangered, or otherwise sensitive species (crabs, marine mammals, and seabirds) depend on benthic prey. Nonpelagic bottom trawling may also conflict with subsistence fishing by native communities.

Historically, there has been very low nonpelagic bottom trawling effort and limited fisheries-related research activities in the NBS. According to bottom trawl impacts studies (National Research Council), the effects of bottom trawling on seafloor habitats are relatively more pronounced in untrawled than in trawled areas. The effects are also relative to the types of bottom habitats that are in contact with the trawl gear. Presently, there is a lack of up-to-date baseline information on the bottom habitats and community ecology of the NBS for assessing the effects of nonpelagic bottom trawling.

As required by the actions taken by the North Pacific Fishery Management Council as part of Amendment 89 to the BSAI Groundfish FMP, a research plan for the NBSRA is outlined here to address research needs. The objective of the research plan is to evaluate the effects of nonpelagic trawling on the benthic habitat in the NBSRA. It does not address the management of the habitat, species, or human activities in this area. As such, the plan consists of four components: (1) bottom trawl surveys; (2) nonpelagic trawl impacts studies; (3) fishery-dependent research; (4) ecological studies.

Bottom trawl surveys

A bottom trawl survey of the NBSRA is the first step to establishing the distribution and abundance of nonpelagic trawl species in the area. Recurring systematic surveys, such as extending the annual AFSC summer bottom trawl surveys in the Bering Sea into the NBSRA, are necessary for assessing the feasibility of commercial nonpelagic trawling, and for predicting the trends of fishing and of the fished populations.

Nonpelagic trawl impacts studies

A fishery-independent study is necessary to assess nonpelagic trawl impacts on the benthic habitat. Normal commercial nonpelagic trawling gear and activities do not meet research needs. For example, repetitive sampling with scientific instruments (e.g. sidescan sonar, underwater camera, benthic grab) at precise locations and prescribed intervals over several years is necessary to assess recovery rates. A detailed outline for non-pelagic trawl impacts studies in the NBSRA is appended (Appendix: Outline for NBSRA Trawl Impacts Studies).

Fishery-dependent research

Should nonpelagic trawling be allowed under exempted fishery permits (EFP) in the NBSRA before conclusive results from nonpelagic trawl impacts studies are available, it is recommended that fishing be initially limited to south of the 63°N parallel (Fig. 1). The 63°N parallel divides the NBSRA into two approximately equal areas (excluding protected areas), both of which containing a range of soft bottom types suitable for nonpelagic trawling (Fig. 2). The NBSRA area north of 63°N will initially be closed to commercial nonpelagic trawling but open to research, pending results of trawl impacts studies. This closed area includes Norton Sound (king crab habitat) and waters surrounding major fishing communities (e.g. Gambell, Savoonga, Nome). It is also proximal to the Bering Strait, which is an important migration corridor and high concentration area for marine mammals and birds with conservation status in the Arctic.

Trawling is not permitted in state waters (within 3 nmi of coastline), which will generally protect the shallow, rocky bottom where red and blue king crabs are believed to settle. Nonpelagic trawling is not permitted in the St. Lawrence Island Habitat Conservation Area (HCA) within the NBSRA (Fig. 1). The Steller Sea Lion No-Trawl Area is only designated closed to fishing for pollock, Pacific cod, and Atka mackerel, but should also be closed to nonpelagic trawling since it lies within the St. Lawrence Island HCA. It is also recommended that the Spectacled Eiders Critical Habitat, established under the Endangered Species Act (ESA), be closed to nonpelagic bottom trawling.

Observers on fishing vessels will collect standard catch and effort data, which includes: species composition, sex, length, weight, otoliths, geographic location, depth, duration, bycatch, and other interactions with protected species, etc., for assessing fisheries dynamics.

Ecological studies

Ecological research in the NBS has been sparse until recent motivation by climate change issues. Current research activities (e.g. Bering Ecosystem Study (BEST)/Bering Sea Integrated Ecosystem Research Program (BSIERP)) are principally concentrated in the NBS shelf south of St Lawrence Island. Knowledge of the current state of the NBS ecosystem, processes and linkages is necessary for studying nonpelagic trawl impacts - from designating study sites to the ecological interpretation of impacts. The tasks of assembling existing data, identifying data gaps, and conducting pertinent research are enormous. It is necessary to coordinate with current research programs, agencies, industry and communities on this effort.

Conclusion

It is recommended that a workshop be convened to consult with experts and interested parties on the details of the research components, at ample time before the due date of the final NBSRA plan. Topics for further discussion include, e.g., the open and closed areas/times to nonpelagic trawling and research, potential interaction with pelagic trawling, bycatch and gear restrictions, habitat and species conservation, and other ecological and socio-economic considerations.

Invitees to the workshop will include representatives of native organizations and nonpelagic trawling industry; experts on trawl impacts studies, marine mammals, and seabirds from government agencies and academic institutions; and researchers on benthic processes. The details of the list of invitees, agenda, the date, and location of the workshop are to be decided after receiving feedback from the SSC on this research outline. It is important to first clarify the amount of resources available and the schedule for delivery of products, so that effort can be tailored accordingly.

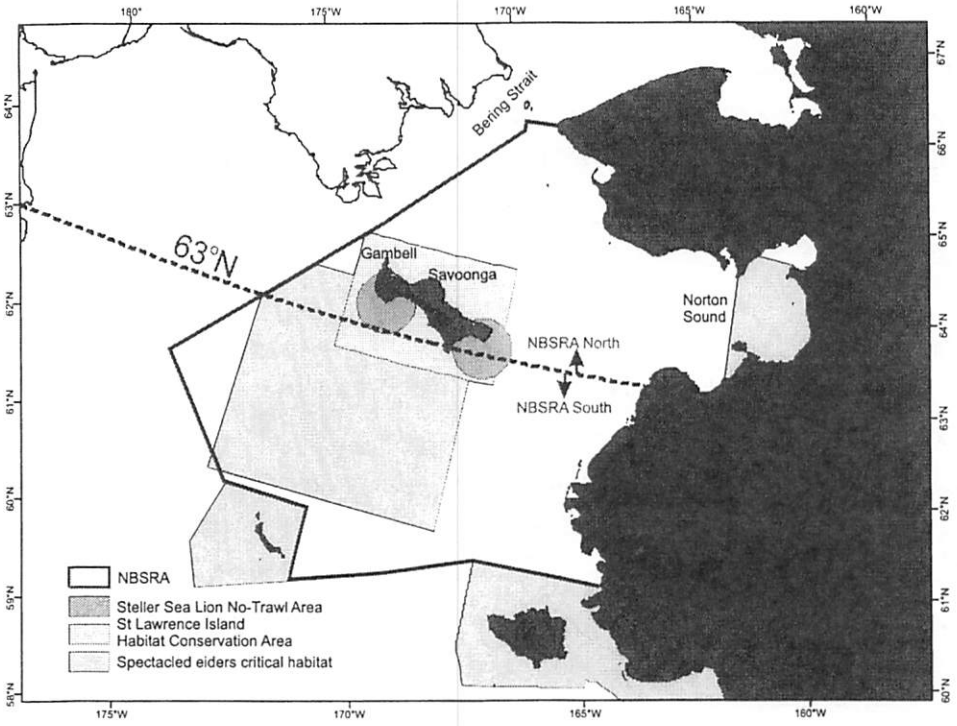


Figure 1. Northern Bering Sea Research Area (NBSRA)

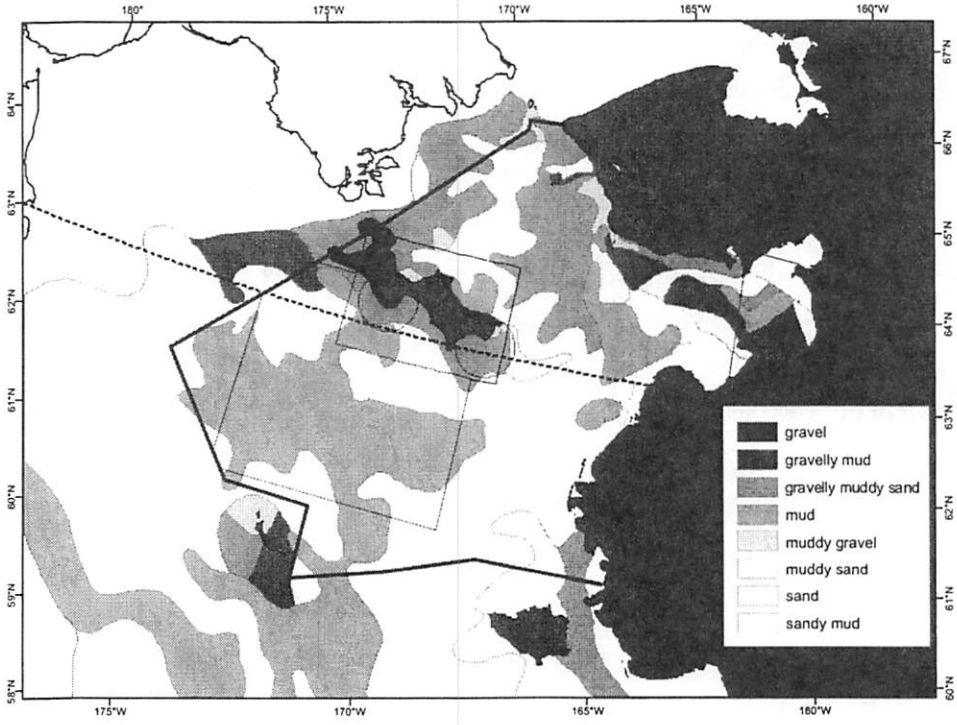


Figure 2. Sediment classes in Northern Bering Sea (digitized from: U.S. Dept. of Commerce, NOAA, 1988. Bering, Chukchi, and Beaufort Seas: Data Atlas. Rockville, MD. Source: NOAA NMFS Alaska Regional Center)

Appendix

Outline for NBSRA Trawl Impacts Studies
Prepared for the June 2009 Meeting of the NPFMC
by Bob McConnaughey, AFSC

Background

The North Pacific Fishery Management Council (NPFMC) has mandated a research program to examine potential effects of bottom trawls in the newly designated Northern Bering Sea Research Area (NBSRA; Fig. 1). In general, the process of understanding mobile gear effects has three distinct phases: (1) experiments to identify changes caused by gear contact, (2) ecological studies to determine the consequences of these changes, and (3) decision-making based on a cost-benefit analysis. Nearly all of the experiments to date have focused on benthic invertebrates and the specific changes that occur after mobile fishing gear, particularly bottom trawls, contact the seabed. This worldwide emphasis on benthic invertebrates reflects their limited mobility and high vulnerability to bottom-tending gear, and observations that structurally complex seabeds are an important element of healthy and productive ecosystems. The effects are typically measured as changes in community structure, abundance or biomass of populations, or the mean size of organisms. Although generalizations about the effects are possible, site-specific responses are likely, given variation in the composition of the benthos and differences in the intensity, severity and frequency of both natural and anthropogenic disturbances. Moreover, it must be remembered that the non-random selection of study areas makes it extremely tenuous to apply research findings from one geographic area to another. As such, the eventual management of bottom-trawling activity in the NBSRA by the NPFMC should be based on a rigorous experiment designed specifically for the area.

Investigating the effects of bottom trawls

Research to understand and quantify the effects of bottom trawls has occurred throughout the world in a variety of benthic marine habitats (NRC, 2000; Barnes and Thomas, 2005). Most of these studies have used methods based on one of two experimental approaches. Short-term (acute) effects are studied by comparing conditions in experimental corridors before and after a single pass or repeated passes of the gear. Occasionally, the recovery process is examined by resampling at a later date; these studies incorporate untrawled control corridors into the sampling program in order to account for natural variability during the study period (a before–after, control–impact, or BACI, experimental design; Green, 1979). Multiple trawled and control corridors are preferred for statistical reasons. This approach provides insights about the process of trawl disturbance and is the basis for most knowledge about trawling effects. Longer-term (chronic) effects are studied by comparing conditions in heavily fished and lightly fished or

unfished areas and, as such, measure the cumulative effects of fishing. These experiments are relatively uncommon because high-quality historical fishing-effort data are frequently unavailable, and their designs are often flawed because the (unfished) "control" areas have previously been fished or they are fundamentally different than the corresponding experimental units (NRC 2002).

Previous research in the Bering Sea

Since 1996, the TRAWLEX project[1] has been investigating potential adverse effects of bottom trawls at sites in the Bristol Bay region of the eastern Bering Sea (EBS). These sites are relatively shallow (44-57 m), have sandy substrates, show a high level of natural disturbance, and support a rich invertebrate assemblage. Both chronic and short-term effects on the benthos have been studied.

Chronic effects of bottom trawls

The well-documented development of commercial trawl fisheries in the EBS since 1954 presented a unique opportunity to investigate the chronic effects of bottom trawling on soft-bottom benthos (McConnaughey *et al.* 2000; McConnaughey *et al.* 2002). Using detailed accounts of closures and fishing activity, it was possible to reconstruct historical effort and identify untrawled (UT) areas immediately adjacent to areas that had been heavily trawled (HT) over many years. For most of the benthic invertebrate species examined, it was determined that biomass and mean body size were reduced as a result of heavy trawling, suggesting a general population decline. In a few cases, greater overall biomass accompanied the observed body-size reduction, suggesting a proliferation of relatively small individuals in the HT area. The only exception to the pattern of smaller individuals in the HT area was red king crab. In this case, mean body size was greater in the HT area, due to substantially fewer small crabs in the HT area than in the UT area. Since biomass in the HT area was lower than that in the UT area, the red king crab response to chronic bottom trawling was fewer individuals of greater mean size. Overall, these effects on body size were relatively small when compared with natural variability in a large, adjacent area closed to commercial trawling. From a community perspective, the HT benthos was less diverse, was dominated by the purple-orange seastar (*Asterias amurensis*), had less emergent epifauna and less biogenic substrate (shell) resulting in reduced structural complexity, and was more patchy overall.

[1] Point of contact for TRAWLEX research is Dr. Robert A. McConnaughey, RACE Division, Alaska Fisheries Science Center, Seattle, WA; 206-526-4150; bob.mcconnaughey@noaa.gov.

Short-term effects of bottom trawls and recovery

Another study is investigating short-term effects of bottom trawling and recovery using a BACI experimental design. This project is located inside the same closure area used for the chronic effects study. The primary research questions are: (1) Do bottom trawls have measurable and statistically significant effects on soft-bottom habitat in the EBS and, (2) if impacts are identified, does the affected area recover to its original condition in the absence of fishing (if so, how quickly?), or does it become fundamentally different? In general, this study addresses management issues related to the need for and efficacy of bottom-trawl prohibitions, as well as operational considerations related to management of closed areas.

Six pairs of experimental and control trawl corridors (statistical blocks) were established adjacent to one another in a previously untrawled area (Fig. 3). Each corridor was 19.4 km long, based on the average length of commercial bottom-trawl hauls in the area (10.5 km, using speed-duration pairs in fishery observer data) and operational considerations; each corridor was 100 m wide to contain all components of the commercial gear. The number of corridors was based on the projected number of sampling events and a statistical power analysis used to estimate the required number of samples. Three of the corridor pairs were oriented north-south and three were oriented east-west, to account for strong currents in the study area and possible directional effects.

Potential impacts were investigated with biological and geological sampling before and after four passes with a commercial bottom trawl (Nor'eastern Trawl System Inc. 91/140 two-seam Aleutian combination otter trawl with a 0.36 m footrope diameter). Invertebrates that live on the seafloor (epifauna) were sampled with 15 min tows at a speed of 3 kts, using a standard AFSC 83/112 bottom trawl that was modified to improve capture and retention of small organisms. At each of these locations, the invertebrates that live in the seafloor (infauna) and the physical-chemical properties of the surficial sediments were characterized with two pairs of grab samples collected prior to trawling for epifauna. Changes in seafloor morphology were assessed with side scan sonar surveys that were conducted at night prior to all sampling and the commercial-trawl disturbance. The sampling locations were randomly selected from uniform grids superimposed on the corridors (Fig. 4), and an ultra-short baseline (USBL) system provided precise positioning of the commercial trawl and all sampling gear. During the first year of the experiment (2001; 35 days at sea), a total of 36 epifauna samples and 144 grab samples were collected, and 12 corridors were surveyed with side scan sonar before the commercial trawling disturbance; with the same sampling effort ~ 2 weeks after the disturbance. The first recovery assessment in 2002 (21 days at sea) consisted of 36 epifauna samples and 144 grab samples, and all 12 corridors were resurveyed with side scan sonar. The epifauna, infauna, and geological data from the first two years of the experiment are currently in the final stages of statistical analysis. Overall, this experiment was

designed to accommodate one additional epifauna and multiple infauna-sediment sampling events.

Figure 3. Corridor layout for the Before-After Control-Impact bottom trawl impact experiment conducted in the eastern Bering Sea. Each of the six blocks represents a pair of Experimental (trawled) and Control (untrawled) corridors separated by 100 meters.

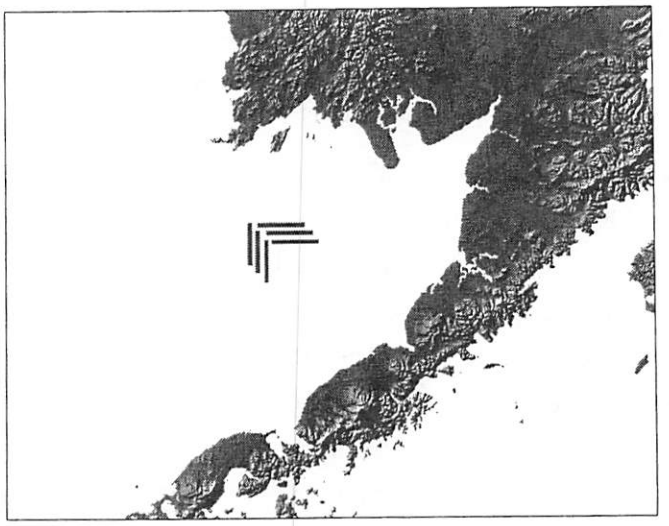
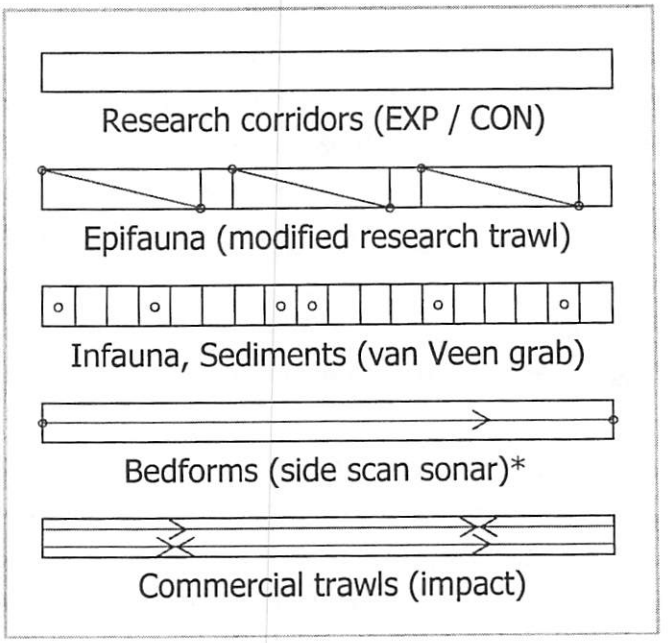


Figure 4. Schematic of the random sampling plan for the Before-After Control-Impact bottom trawl impact experiment in the eastern Bering Sea. Different colors represent different sampling events (times) during the course of the experiment. Each grid location is sampled only once.



Scenario for an NBSRA BACI experiment

The environmental and biological characteristics of the NBSRA are largely unknown and, because it generally has not been trawled, it represents a very rare opportunity to study short-term trawling effects and recovery. Many of the handicaps that have constrained the design or interpretation of previous experimental work (e.g. uncertain disturbance history) are non-existent because of the historical ice cover. If commercial trawl fisheries ultimately develop due to a loss of sea ice, the cumulative effects of bottom-trawling disturbances could eventually be examined through a judicious use of closed-area boundaries and supporting effort information. In the meantime, one or more carefully designed BACI experiments (with directed use of the commercial trawl, as above) should be placed according to resource-management needs. Although an investigation involving more realistic fishing behavior is conceivable (e.g. Brown *et al.*, 2005), it is unlikely that there would be sufficient pattern in the intensity and distribution of fishing effort to permit a statistical analysis with an acceptable level of Type II error (in this case, failure to reject a false null hypothesis of no effect). Ultimately, the proven design of the BACI experiment in the EBS can be adapted to conditions in the NBSRA. With fishing industry input, corridor dimensions (length, width) could be adjusted to match the best estimates of tow length and total gear width. Similarly, the intensity of disturbance (number of passes) with the commercial trawl could be set based on relevant observations from the EBS, anticipated changes in fishery practices, and other resource management considerations.

NBSRA research summary and timeline

Design and execution of experiments to study the effects of bottom trawling in the NBSRA would entail the following:

1. Preliminary surveys (years 1-2+). Conduct two or more annual bottom trawl surveys to establish biological and environmental baselines (i.e. characterize pre-disturbance conditions and variability).
2. Precursory analysis (years 2-3). Use the trawl survey data: (1) in a statistical power analysis for designing the BACI experiment and (2) to examine the spatial structure of the benthic invertebrate communities, as a basis for stratifying the NBSRA for systematic trawl impact studies.
3. Trawl impact experiments (years 4-5+). Initiate a replicated set of Before-After Control-Impact (BACI) investigations of bottom trawl effects in distinct invertebrate communities (strata), preferably using contracted F/Vs and directed fishing with commercial gear.
4. Ecological studies (subsequent years). Conduct interpretive research on the ecology of the affected benthic invertebrates and their linkages to managed fish stocks.

Literature Cited

Barnes, P. W. and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland. 890 pp.

Brown, E. J., B. Finney, and S. Hills. 2005. Effects of commercial otter trawling on benthic communities in the southeastern Bering Sea. Pages 439-460 *in* P. W. Barnes and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

Green, R. H. 1979. Sampling design and statistical methods for environmental biologists. Wiley, New York.

NRC (National Research Council, Committee on Ecosystem Effects of Fishing). 2002. Effects of trawling and dredging on seafloor habitat. National Academy Press, Washington, D.C.

McConnaughey, R. A., K. Mier and C. B. Dew. 2000. An examination of chronic trawling effects on soft-bottom benthos of the eastern Bering Sea. ICES J. Mar. Sci. 57: 1377-1388.

McConnaughey, R. A. and K. R. Smith. 2000. Associations between flatfish abundance and surficial sediments in the eastern Bering Sea. Can. J. Fish. Aquat. Sci. 57: 2410-2419.

McConnaughey, R. A., S. E. Syrjala and C. B. Dew. 2005. Effects of chronic bottom trawling on the size structure of soft-bottom benthic invertebrates. Pages 425-437 *in* P. W. Barnes and J. P. Thomas, editors. Benthic habitats and the effects of fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

Yeung, C. and R. A. McConnaughey. 2006. Community structure of eastern Bering Sea epibenthic invertebrates from annual summer bottom trawl surveys, 1982-2002. Mar. Ecol. Prog. Ser. 318: 47-62.