# Public Testimony Sign-Up Sheet

## Agenda Item D-3 Habitat Conservation

| | NAME (PLEASE PRINT) | AFFILIATION |
|---|---|---|
| 1 | James T. Sipary SR | Nelson Island Tribal Council Elders |
| 2 | David Bill SR | " " |
| 3 | ~~Austin Ahmasuk~~ | ~~Kawerak Inc~~ |
| 4 | Jana Sky Starkey | Attorney for Elder Sports Villages |
| 5 | Jennifer Hooper | AVCP |
| 6 | Dorothy Childers & Muriel Morse | AK Marine Conserv. Council |
| 7 | Alyssa McDonald | IPIFA - Harbor Crown SF |
| 8 | Bubba Cook | WWF |
| 9 | Joseph G. Stonyheart SR. | Nunam Iqua Tribe |
| 10 | GEORGE PLETNIKOFF | GREENPEACE ☺ |
| 11 | JOHN GAUVIN | H+G WORKGROUP |
| 12 | Jon Warrenchuk + Susan Murray | Oceana |
| 13 | Paul MacGregor | At-Sea Processors Assn. |
| 14 | ~~Todd Loomis~~ | ~~Cascade Fishing Inc~~ |
| 15 | LORI SWANSON | GROUNDFISH FORUM |
| 16 | DAVE Benton | MCA |
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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.

AGENDA D-3(a-b)
JUNE 2007

# MEMORANDUM

TO: Council and AP Members

FROM: Chris Oliver
Executive Director

DATE: May 29, 2007

SUBJECT: Habitat Conservation

ESTIMATED TIME
6 HOURS

ACTION REQUIRED:

a) Final action on Bering Sea habitat conservation measures.

b) Review HAPC priorities and timing, and take action as necessary.

BACKGROUND:

The Council took action in February 2005 to conserve essential fish habitat (EFH) from potential adverse effects of fishing. The EIS prepared for the action concluded that while fisheries do have long term effects on benthic habitat, these impacts were minimal and had no detrimental effects on fish populations. The Council adopted several new measures to minimize the effects of fishing on EFH in the Aleutian Islands and Gulf of Alaska. In evaluating alternative measures for the Eastern Bering Sea area, the Council determined that additional habitat protection measures were not required, and that an expanded analysis should be conducted prior to taking action.

In December 2005, the Council began the process of developing alternatives and a problem statement to conserve fish habitat in the Bering Sea. Alternatives for the analysis were developed over the course of several meetings in 2006. Although the draft problem statement did not specifically mention a particular gear type, Council discussion and deliberation of alternatives focused on reducing impacts of bottom trawling on benthic habitat. Thus, staff added the term 'non-pelagic trawl' in the draft problem statement to make it clear to the public that the Council's intent with this analysis was to consider only alternatives to address impacts of bottom trawl gear.

In March 2007, the Council reviewed an initial draft of the analysis, and refined the alternatives and options (motion attached as Item D-3(a)(i)). A revised draft analysis was mailed to you three weeks ago; the executive summary is attached as Item D-3(a)(ii). Final action on Amendment 89 is scheduled for this meeting.

Habitat Areas of Particular Concern (HAPC)

HAPCs are site-specific areas of EFH for managed species. Identification of HAPCs provides focus for additional conservation efforts for those habitat sites that are ecologically important, sensitive to disturbance, exposed to development activities, or rare.

In December 2006, the Council received a staff report on the HAPC identification process. At that meeting, the Council decided that skate nurseries would be considered as a priority in the next HAPC cycle, as recommended by the SSC. Additionally, the Council scheduled for the March meeting a discussion of possible HAPC priorities and a schedule for solicitation of HAPC proposals. Due to scheduling constraints in March, the Council deferred this item until this meeting.

The HAPC identification process is defined in Appendix J of the EFH EIS (attached as Item D-3(b)(i)). The HAPC cycle begins with a call for HAPC nominations, with a focus on specific sites consistent with HAPC priorities designated by the Council. Appendix J specifies that HAPC proposals may be solicited every 3 years or on a schedule established by the Council. For the 2004 cycle, the Council designated as priorities named seamounts in the EEZ and areas with coral associated with rockfish. The Council received 23 HAPC proposals from six different organizations. After an initial screening by staff, the proposals were reviewed by the Plan Teams and underwent an initial review to consider management, enforcement, and socioeconomic issues. Ultimately, the Council identified a range of alternatives, staff completed an analysis, and the Council established several new HAPCs. Management measures for these HAPCs were implemented in July 2006. The timeline for the 2004 process is captured in the table below:

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|---|---|
| October 03 | Council Identifies HAPC Priorities<br>FR Notice to Initiate Call for HAPC Proposals |
| January 04 | Comment Period Closes |
| February 04 | Council review and decision as to which ideas should be forwarded for Plan Team review. |
| March 04 | Plan Team Review- Special Meeting<br>Preliminary Enforcement and Socioeconomic Reviews |
| April/June 04 | Council Identifies HAPC Alternatives for Analysis |
| December 04 | Initial Review |
| February 05 | Final Review |

At this meeting, the Council may wish to discuss HAPC priorities and a timeline for the next HAPC identification process. Council options include the following:

a. Initiate a call for HAPC proposals with priority only for skate nursery areas.
b. Initiate a broader call for HAPC proposals, identifying skate nursery areas and other habitat types as priorities.
c. Initiate a call for the public to suggest potential HAPC priorities for consideration by the Council at a future meeting, and defer a decision on whether to solicit specific HAPC proposals.
d. Take no action.

If the Council initiates a call for proposals, the Council would be under no obligation to establish new HAPCs. The Council could decide at a future meeting whether to proceed with an analysis. Likewise, if the Council proceeds with the identification of HAPCs, the Council could choose either to establish management measures for any new HAPCs or to designate the areas as HAPCs with no new management measures.

Note that a new language has been added to the MSA (Section 318) directing the Secretary (in consultation with the Council) to establish a cooperative research program and provide funding based on regional fishery management needs, with priority consideration given to, among other things, "Projects for the identification of habitat areas of particular concern and for habitat conservation."

**Motion on D-3 (a,c) Habitat Conservation**
**April 3, 2007**

**D-3-a: Bering Sea Habitat Conservation** Motion: The Council adopts the Draft initial review EA/RIR/IRFA for EFH with the following changes and requests it be sent out for final review with final action in June 2007.

1) The Problem Statement is modified by replacing "managed fish species." with "Council managed species." as noted by staff. A final sentence is added "EFH closures for habitat delineation shall be done in consideration of local community use."

2) The Council moves to adopt the agreed upon southern boundary at Nunivak Island, Etolin Strait and Kuskokwim Bay by the AVCP/industry working group. The Council will, 2 years after implementation, review the results of the AVCP/industry working group to decide if further refinement of the southern boundary line near Nunivak Island/Etolin Strait is needed. The Council will use the process used in the AVCP/industry working group discussions to refine this southern boundary line to inform the Council on how to meet the goals of their Policy Planning document. (Options 2 & 3)

3) Measures establishing non-pelagic trawl (NPT) closures around Nunivak, St. Matthew, and St. Lawrence Islands are separate actions and not affected by any measures developed for the Northern Research Area ([NRA] Option 4).

Clarification of Option 4 (NRA): Inside the NRA, NPT fishing would be prohibited for a period of time during which a management plan for the NRA will be developed for Council review. The plan will consider and identify protection measures as may be necessary within the NRA for king and opilio crab, marine mammals, ESA listed species, and subsistence needs for Western Alaska costal communities in nearshore areas. In addition to establishing these protection measures, the plan will identify areas where NPT fishing is allowed pursuant to a scientific research plan. In these open areas, control closures will be established based on representative habitats needed to allow scientifically valid comparisons of the effect of NPT fishing. Access to the NRA by NPT will be established once the protection measures and control areas described above are delineated. The plan shall be developed within 18 months and implemented within 3 years of final action on this item. Council will review this program in 5 years.

4) A new Suboption to Alternative 2 and Option 4 is added that defines the northern boundary. The wedge, as described by the attached map, would move a portion of the northern boundary northward between Nunivak and St. Matthew Islands to 61° N. This boundary would be analyzed to consider the spatial distribution of the flathead sole fishery.

5) The analysis will include a discussion of the monitoring and enforcement issues for the alternatives and options. NMFS will consult with the USCG and OLE in development of the discussion, including the use of VMS for enforcement of the closure areas. The VMS discussion will include the current use of VMS by the non-pelagic trawl fishery and the additional VMS that may be needed under the alternatives and options.

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Additionally the Council will forward a letter to the NPRB and request that they set the issues described in the NRA above, including seabirds, as well as Bering Sea Canyons, described in the December 2006 Review document, as research priorities.

# EXECUTIVE SUMMARY

The purpose of this analysis is to evaluate impacts of alternatives to further conserve fish habitat in the Eastern Bering Sea (EBS). In February 2005 the Council took final action on the EFH EIS (NMFS 2005) to adopt a suite of measures to conserve EFH in the Gulf of Alaska (GOA) and Aleutian Islands (AI) from potential impacts due to fishing. Those measures primarily addressed the impacts of non-pelagic trawl gear. At the time of final action, the Council took no action to implement additional conservation measures in the EBS, as the analysis found such additional measures were neither required by law nor necessary or practicable measures. Further, the alternatives considered for Bering Sea habitat conservation required additional 'fine-tuning' before they could be considered as practicable measures. Alternatives to modify non-pelagic trawl gear had not been sufficiently researched to understand the scale of beneficial effects on habitat. The alternatives for the open areas had left out historically important and lucrative fishing grounds, and included rotating closures that were found to have questionable merit. So to address these issues, the Council notified the public that it planned to take a more focused examination of potential measures to further conserve fish habitat, including EFH, in the Eastern Bering Sea by initiating a separate analysis that would tier off of the EFH EIS. After several meetings deliberating on this issue, the Council decided to focus on reducing the effect of non-pelagic trawling. The reason for this focus is that non-pelagic trawling uses gear that fishes hard on the bottom, non-pelagic trawling had high long term effect indices (LEI) on habitat based on the EIS evaluation, the non-pelagic trawl fishery is widely distributed (i.e., a large footprint), and effort could potentially increase dramatically pending future increases in total allowable catch (TAC) limits for flatfish species. This analysis provides an examination of a range of reasonable alternatives to conserve fish habitat in the EBS by reducing potential impacts of non-pelagic trawling.

The need for this analysis is the recognition that additional analysis beyond the EFH EIS is needed to consider measures for the conservation of fish habitat in the Bering Sea. New information on potential gear modifications to protect bottom habitat has become available since the EFH EIS and allows for a gear modification alternative that could not have been considered in the EFH EIS. The Council wishes to protect fish habitat in support of commercial fisheries and subsistence activities in the Eastern Bering Sea, ensuring consistency with national standard 8 of section 301 of the Magnuson-Stevens Act. Thus, evaluation of additional measures, and possible implementation of them, provides a precautionary approach in light of incomplete knowledge of fish dependence upon habitat, and the effects of fisheries on that habitat. The problem statement adopted by the Council for this analysis is provided below:

Problem Statement: The Council intends to evaluate potential new fishery management measures to protect Essential Fish Habitat (EFH) in the Bering Sea. The analysis will tier off of the 2005 EFH Environmental Impact Statement and will consider as alternatives open and closed areas and gear modifications. The purpose of the analysis is to consider practicable and precautionary management measures to reduce potential adverse effects of non pelagic trawl fishing[1] on EFH and to support the continued productivity of Council managed species. Any new management measures will be developed in consideration of local community use.

[1] Staff added the term 'non-pelagic trawl' in the draft problem statement to make it clear to the public that the Council's intent with this analysis was to consider only alternatives to address impacts of non-pelagic trawl gear. See section 2.1 for detailed explanation of process of alternative development.

This EA/RIR/IRFA evaluates the impacts of two primary alternatives to the status quo, along with several minor components which are considered as options to the alternatives. The alternatives are not mutually exclusive any combination can be selected. The options can be chosen in any combination with the alternatives, including the status quo. The locations (latitudes and longitudes) of these areas are attached as Appendix A.

The alternatives and options are as follows:

Alternative 1: Status quo. No additional measures would be taken to conserve benthic habitat (Figure ES-1).

Alternative 2: Open area approach. This alternative would prohibit non-pelagic trawl gear outside of a designated 'open area'. Non-pelagic trawl gear would be prohibited in the northernmost shelf area and the deepwater basin area of the Bering Sea. There is only one open area analyzed, which is based on the EFH EIS area, modified using non-pelagic trawl effort distribution data through 2005 (Figure ES- 2).

Suboption: A new open area approach is added that defines the northern boundary. The wedge would move a portion of the northern boundary northward between Nunivak and St. Matthew Islands to 61° N (Figure ES- 3).

Alternative 3: Gear modifications. This alternative would require gear modifications for all non-pelagic trawl gear used in flatfish target fisheries. Specifically, this alternative would require discs on non-pelagic trawl sweeps to reduce seafloor contact and/or increase clearance between the sweep and substrate. A performance standard of at least 2.5 inches elevation of the sweep from the bottom would be required.

The options below could be selected in combination with any Alternative(s) and more than one option can be chosen. All current management actions are still in place (i.e., Pribilof Habitat Conservation Area, Red King Crab Closure Area).

Option 1. Close the area around St. Matthew Island to non-pelagic trawl gear. This area would be configured such that the area near St. Matthew Island is closed to conserve blue king crab habitat (Figure ES- 4).

Option 2. Close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait. This area would be configured such that the area around Nunivak Island and Etolin Strait is closed to conserve nearshore habitats, and minimize potential interactions with community use and subsistence fisheries taking place in the nearshore areas (Figure ES- 5).

Option 3. Close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait and Kuskokwim Bay. This area would be configured such that the area in southern Etolin Strait and Kuskokwim Bay is closed to conserve nearshore habitat and minimize potential interactions with community use and subsistence fisheries taking place in the nearshore areas. The boundaries of this closure area are the result of negotiations by representatives of the flatfish industry and coastal communities (Figure ES- 6).

Option 4: Close an area to non-pelagic trawl gear from the northern boundary line of the open area under Alternative 2, stretching from the Russian border around the southern end of St. Matthew Island to and around the southern portion of Nunivak Island and across Kuskokwim Bay to Cape Newenham and designate it as the Northern Bering Sea Experimental Fishing Area (NBSRA). The NBSRA would be closed while a management plan will be developed for Council review. The plan will consider and identify protection measures as may be necessary within the NBSRA for king and C. opilio crab, marine mammals, ESA listed species, and subsistence needs for Western Alaska costal communities in nearshore areas. In addition to establishing these protection measures, the plan will identify areas where non-pelagic trawl fishing is allowed pursuant to a scientific research plan. The Council requests the NOAA/NMFS Alaska Fisheries Science Center design an adaptive management experiment in the closed northern area described under this option to study the effects of non-pelagic trawl gear in previously untrawled areas. The study should include open and closed areas and appropriate monitoring to study fishing impacts on benthic communities and ecological process, particularly as this relates to juvenile C. opilio crab. In these open areas, control closures will be established based on representative habitats needed to allow scientifically valid comparisons of the effect of non-pelagic trawl fishing. Access to the NBSRA by non-pelagic trawl will be established once the protection measures and control areas described above are delineated. The adaptive management experiment design will include review by the science and statistical committee (SSC). NMFS will provide the draft adaptive management experiment design to the Council for review within 18 months following the Federal Register publication of the final rule for this action (Figure ES-7).

Suboption: A new closure is added that defines the northern boundary. The wedge would move a portion of the northern boundary northward between Nunivak and St. Matthew Islands to 61° N (Figure ES- 8).

Option 5: Close the area to non-pelagic trawl gear around St. Lawrence Island. This area would be configured such that the area around St. Lawrence Island is closed to non-pelagic trawl gear to conserve blue king crab habitat and minimize potential interactions with community use and subsistence fisheries taking place in nearshore areas (Figure ES- 9).

The analysis of direct, indirect, and cumulative effects for the proposed action indicated no significant impacts on the human environment from the alternatives. None of the alternatives place significant gross first wholesale revenues at risk that cannot easily be mitigated with minimal to no added cost to the primary affected head and gut catcher processor fleet sector. Some western community concern has been presented and may need addressing in this analysis in terms of buffer zones for subsistence use close to villages or used shorelines. Ongoing discussions are occurring amongst the fishing industry and the communities on this issue. The separate options may address some of these concerns.

The status quo provides protection for vulnerable benthic habitat with existing bottom trawl closures. The EFH EIS (NMFS 2005) concluded that the effects of fishing on EFH in Alaska are minimal and no additional measures were required by law nor necessary or practicable measures. Thus, Alternative 1 is not likely to result in any significant effects regarding habitat, target species, non-target resources, marine mammals, and seabird species or the ecosystem.

The impacts of Alternative 2 are likely similar in magnitude to Alternative 1 due to the slight size change of the open areas and the status quo given the recent and historic distribution of fishing effort. From an environmental perspective, Alternative 2 may have beneficial effects on Steller's Eiders and Spectacled Eiders and have insignificant short-term effects regarding habitat, target species, non-target resources, marine mammal and seabird species or the ecosystem. Nevertheless, an open area approach may be a precautionary measure in terms habitat protection by preventing northward expansion of the non-pelagic trawl fishery. Basically, Alternative 2 would set aside areas that would remain in a relatively pristine condition in the future. Alternative 2 could have some economic costs to the fishery relative to options to protect communities as well as future northward fishery expansion in particular to the head and gut (H&G) catcher processor sector.

From 2003 through 2005, first wholesale gross revenue at risk from the proposed area closure under Alternative 2 averaged $2.4 million or 1.19% of status quo gross revenue. Flatfish and Pacific cod represented the largest proportions of first wholesale gross revenue at risk over the three-year period. Retained flatfish revenue at risk would have been $0.96 million or 1.32% of the $72.72 million of status quo first wholesale gross revenue in 2003, $2.83 million or 3.37% of the $83.98 million status quo first wholesale gross revenue in 2004, and $2.22 million or 1.83% of the $121.33 million status quo first wholesale gross revenue in 2005. Pacific cod revenue at risk would have been $0.25 million or 0.69% of the $35.91 million status quo first wholesale gross revenue in 2003, $0.57 million or 1.23% of the $46.39 million status quo first wholesale gross revenue in 2004, and $0.19 million or 0.72% of the $44.3 million status quo first wholesale gross revenue in 2005.

Given that the Alternative 2 open area encompasses more than 95% of current fishing area, the first wholesale gross revenue that would be placed at risk under the proposed action could likely be mitigated by additional fishing effort in the area remaining open to non-pelagic trawl. Such mitigation would not be expected to increase operational costs because a similar level of effort (number of tows) is expected to be needed to mitigate revenue at risk by relocating some tows within the area remaining open under this alternative. However, this finding assumes that the distribution of fish stocks, and the resulting catch rates of target species and prohibited species, remains similar to presently observed distribution within the open area.

The suboption to Alternative 2 would move a portion of the northern boundary of the open area northward between Nunivak and St. Matthew Islands to 61° N. Analysis of this wedge has not revealed any non-pelagic trawl effort in this area during 2003-2005. Thus, the suboption does not affect the estimates of Alternative 2 revenue at risk. However, this northward boundary shift may serve to offset, to an unknown extent and duration, potential northward movement of groundfish stocks potentially brought about by changing climactic conditions. The suboption allows for increased movement of some flatfish species stocks and allows the fleet to compensate for that in the future. In particular the flathead sole fishery has moved an average of 20 miles a year both north and south within the same longitudinal range although has not fished within the extent of the suboption.

In addition to the evaluation of the effects on current fisheries, a designation of an open area could have future effects, depending on fish stock distribution and fishing distribution. Potential economic impact from the open area alternative depends to some extent on how and where fish stocks and fishers change their distributions in the future. If the fish distribution remains static, the impacts will be negligible. However, if a substantial portion of the flatfish and cod stocks redistribute outside of the open area in the future – and assuming that other stocks don't take their place – there could be some economic impacts to the fleet if they were unable to catch the TACs.

The impacts of Alternative 3 result from reducing gear contact with the bottom. From an environmental perspective, Alternative 3 would have beneficial effects regarding habitat, and insignificant effects regarding target species, non-target resources, marine mammals and seabird species, and the ecosystem. The proposed gear modifications will likely result in additional equipment costs for vessels to comply with the addition of disks to the trawl sweeps and on some vessels may result in modification to operations and/or the cost of additional deck equipment. Gear manufacturers estimate this cost at just under $4,000, per vessel or about 33% more than the sweep alone.

Option 1 would close the area around St. Matthew Island to non-pelagic trawl gear to conserve blue king crab habitat. This option would provide some positive benefits to the blue king crab habitat that extends southwest- protecting juvenile, non-ovigerous (egg-bearing) female and male blue king crab habitat, and northeast protecting ovigerous females' habitat. This crab stock is severely depleted and designated as overfished. There has historically been minor trawl effort, targeting Pacific cod and flatfish species just to the north of St. Matthew. Maps of fishing effort by Fritz et al. (1998) indicate that a strip of area immediately north of St. Matthew has been an area with very high CPUEs for Pacific cod and more recent observer data indicates high catch per unit effort (CPUEs) of flatfish species. It is unknown at this time how many vessels, or how much fish has been harvested by non-pelagic trawls fishing this area. At a maximum, the number of vessels targeting groundfish and the revenue at risk would be the same as calculated for Option 4. There may be economic benefits of Option 1 to crab fishermen associated with reduced impacts on crab; however, these effects are likely to be minor given that blue king crab bycatch is thought to be low in this area (NMFS data review by crab plan team) and the area to the north does not seem as important to blue king crab as compared with the area to the south and area within State waters.

The RIR provides estimates of the revenue and the percent of baseline revenue potentially placed at risk potentially placed at risk at risk under Option 1. Average revenue at risk from 2003 through 2005 is estimated to be $0.31 million, or 0.15% of the status quo average revenue of $201.73.

Option 2 would close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait to conserve nearshore habitats, and minimize potential interactions with community use and subsistence fisheries. This option would provide some positive benefits to communities to minimize potential interactions with commercial fishing gear and provide protections to nearshore habitats for subsistence use and fisheries. Option 2 may have beneficial effects on Steller's Eiders. The area south of Nunivak Island and Etolin Strait has seen increasing effort by vessels targeting yellowfin sole in recent years, but should not be impacted by this option. There is opportunity costs associated with prohibiting vessels from fishing in other areas. Such impacts were previously discussed in general terms in the evaluation of Alternative 2. The majority of revenue at risk under Option 2 is derived from flatfish. Flatfish revenue at risk would have been $0.57 million or 0.78% of the $72.72 million status quo first wholesale gross revenue in 2003, $1.86 million or 2.21% of the $83.98 million status quo first wholesale gross revenue in 2004, and $0.06 million or 0.05% of the $121.33 million status quo first wholesale gross revenue in 2005.

Option 3 would close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait and Kuskokwim Bay to conserve nearshore habitat and minimize potential interactions with community use and subsistence fisheries. Option 3 may have beneficial effects on Steller's Eiders. This option would provide some positive benefits to communities to minimize potential interactions with commercial fishing gear and provide protections to nearshore habitats for subsistence use and fisheries. Because the final boundaries of this closure area are the result of negotiations by representatives of the flatfish industry and coastal communities, it is difficult to quantify the economic impacts. Nonetheless, given the relatively limited amount of effort in the Etolin Strait portion of the closure, and virtually no effort in Kuskokwim Bay, the economic impacts would be relatively minor. Catch data from 2003-2005 indicate that less than 5,000 mt of flatfish (all species) were caught in the closure proposed under Option 3. The majority of revenue at risk under Option 3 is derived from flatfish. Flatfish revenue at risk would have been $1.02 million or 1.4% of the $72.72 million status quo first wholesale gross revenue in 2003, $2.98 million or 3.55% of the $83.98 million status quo first wholesale gross revenue in 2004, and $0.99 million or 0.81% of the $121.33 million status quo first wholesale gross revenue in 2005. On average, this potential revenue at risk impacts appears relatively minor. However, testimony at the Council meetings has suggested that this is an important area to the fleet because the catch rates for yellowfin sole can be high while encountering low halibut bycatch rates.

Average revenue at risk from 2003 through 2005 for the combination of Option 1 and Option 3 (equivalent to Option 4, which includes these areas and unfished area to the North) is estimated to be $1.98 million, or 0.98% of the status quo average revenue of $201.73 million. Revenue at risk during the analysis period is estimated to be highest in 2004 with $3.67 million, or 1.88% of the 2004 status quo revenue of $195.51 million. The low would have occurred in 2005 with $1.04 million, or 0.42% of the 2005 status quo revenue of $247.96 million. The majority of this revenue at risk is derived from flatfish. Flatfish revenue at risk would have been $1.06 million or 1.45% of the $72.72 million status quo first wholesale gross revenue in 2003, $3.10 million or 3.69% of the $83.98 million status quo first wholesale gross revenue in 2004, and $0.99 million or 0.82% of the $121.33 million status quo first wholesale gross revenue in 2005.

Option 4 would establish a Northern Bering Sea Experimental Fishing Area, which would be entirely closed to fishing with non-pelagic trawl gear at least in the short term, until an adaptive management experiment design was developed and approved. The option to provide a closure area in the Northern Bering Sea may be a precautionary measure in terms of habitat protection by preventing northward expansion of the non-pelagic trawl fishery. However research and an exempted fishing permit would still provide future access to the area. The option would close roughly 188,157 $km^2$ of BS shelf (shelf area to 1,000 m depth) or 23.8% of the 791,731 $km^2$ of BS benthic habitat currently open to non-pelagic trawling (shelf area to the 1,000 m depth contour). In terms of revenue at risk, Option 4 is equivalent to the combination of Option 1 and Option 3.. This is because Option 4 includes the area of Option 1 and Option 3 as well as additional unfished area to the North. Thus, Option 4 revenue at risk is identical to that presented previously for the combination of Option 1 and Option 3.

Option 4 Suboption 1: The suboption to Option 4 would move a portion of the northern boundary of the open area southward between Nunivak and St. Matthew islands. This is essentially the reverse of the suboption of Alternative 2. Thus, the suboptions are mutually exclusive and only one or the other can be chosen. The suboption allows for increased movement of some flatfish species stocks and allows the fleet to compensate for that in the future, and reduces the area that would be protected from fishing gear affects. Analysis of this wedge has not revealed any non-pelagic trawl effort in this area during 2003-2005. Thus, the suboption does not affect the estimates of Option 4 revenue at risk.

Option 5 would close the area to non-pelagic trawl gear around St. Lawrence Island to conserve blue king crab habitat and minimize potential interactions with community use and subsistence fisheries. Because there is currently no non-pelagic trawl effort as far north as St. Lawrence, there are no economic impacts to the trawl fleet given the current and historic distribution of target species. Potential future effects of a change in fish distribution were discussed under Option 4, although the impacts of Option 5 would be substantially smaller based on total area closed.

Closures of Etolin Strait waters under Options 2, 3, and 4 may protect walrus during migration through this area from potential incidental takes. At this time there is no indication that commercial groundfish fishing vessels have disturbed walrus. Alternative 2 and Options 2, 3, and 4 may provide some protection from any potential disturbance by non-pelagic fishing vessels by closing waters near areas used by walruses.

Alternative 2 and Options 4 and 5 would prohibit non-pelagic trawling in a portion or most of the spectacled eider designated critical habitat. Alternative 2 and Option 4 would prohibit non-pelagic trawl gear in nearly the entire area of critical habitat. Option 5 would prohibit trawling only in the northeast corner of critical habitat, but may provide protection to habitat for those Spectacled Eiders that move to the north side of the island in search of ice leads. Alternative 2 and Option 4 may have more of an impact on the Spectacled Eiders since they would prohibit non-pelagic trawl gear in areas where the birds have been observed.

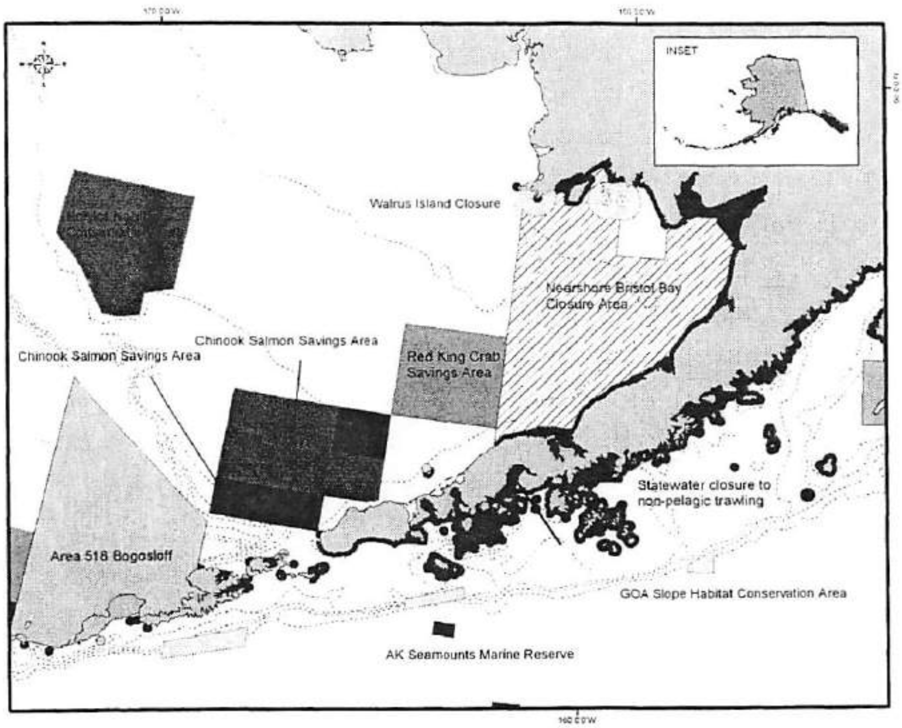



**Figure ES- 1. Fishery Closures to certain non-pelagic trawl fisheries thru 2006, these closures represent the current status of fishing available to non-pelagic trawl gear under the Status quo. Further information on fishery closures is provided in 50CFR 679.22.**


**Figure ES- 2. Alternative 2 Open Area Approach for Bering Sea. This alternative would prohibit non-pelagic trawl gear outside of a designated 'open area'. Non-pelagic trawl gear would be prohibited in the northernmost shelf area and the deepwater basin area of the Bering Sea.**

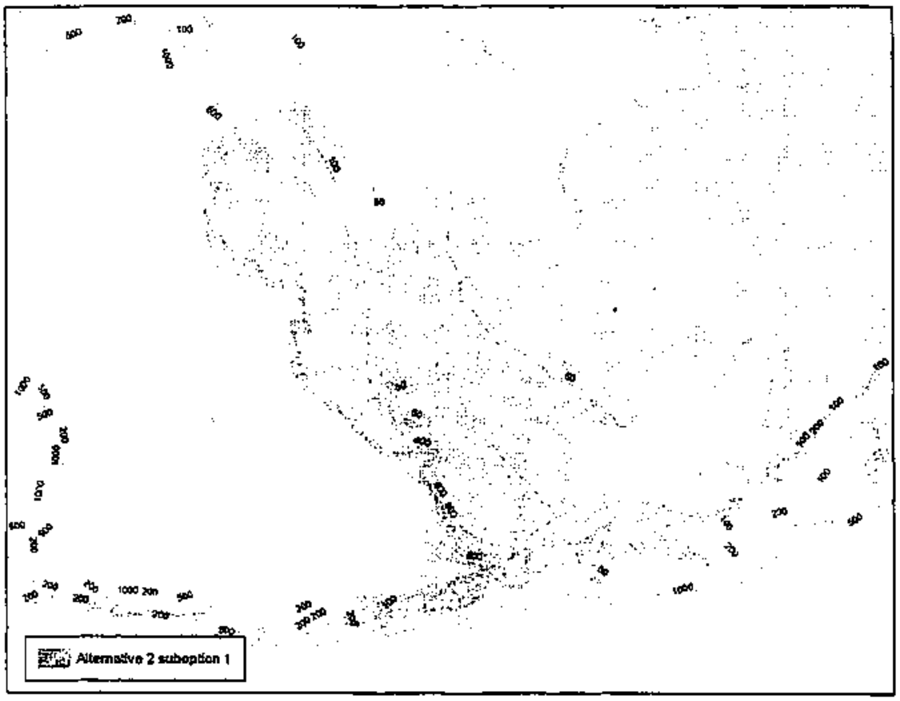



**Figure ES- 3. Alternative 2 suboption1. Open Area Approach for Bering Sea. The suboption would move a portion of the northern boundary northward between Nunivak and St. Matthew Islands to 61° N This alternative would prohibit non-pelagic trawl gear outside of a designated 'open area'. Non-pelagic trawl gear would be prohibited in the northernmost shelf area and the deepwater basin area of the Bering Sea**

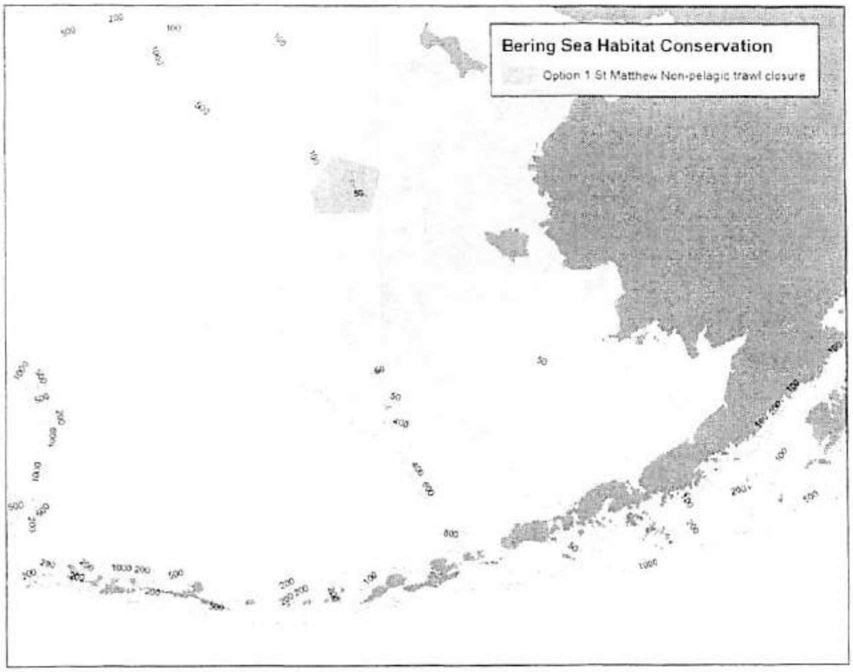



**Figure ES- 4. Option 1. Close the area around St. Matthew Island to non-pelagic trawl gear to conserve blue king crab habitat.**

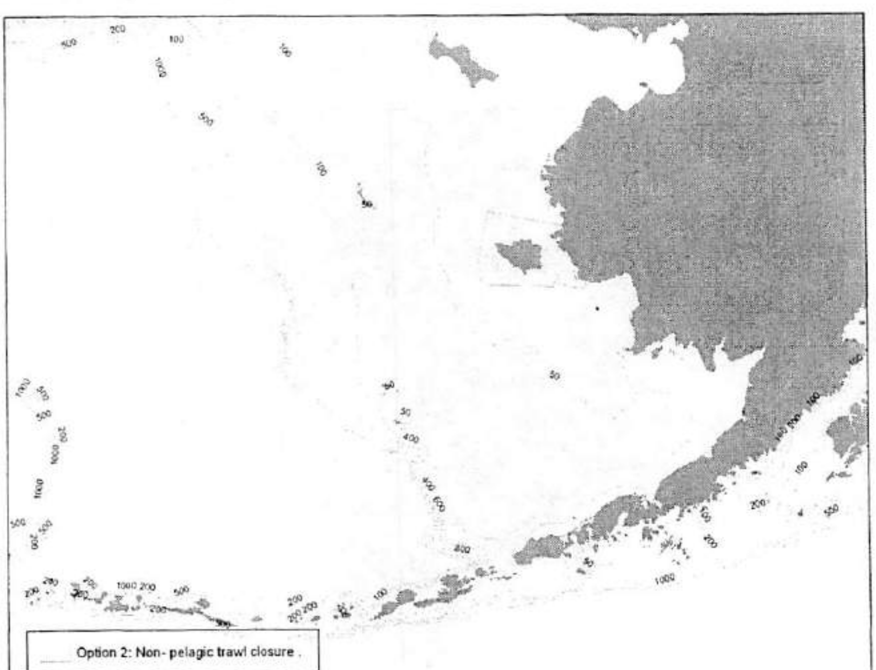



**Figure ES- 5. Option 2. Close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait such that the area is closed to conserve nearshore habitats, and minimize potential interactions with community use and subsistence fisheries taking place in the nearshore areas.**

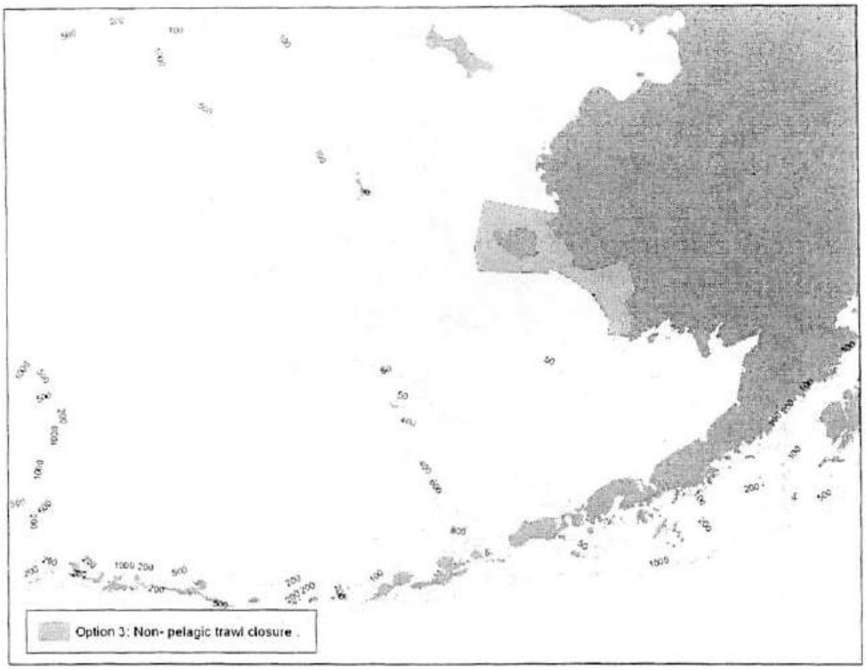



**Figure ES- 6. Option 3. Close an area to non-pelagic trawl gear around Nunivak Island with the southern border extending along the nearshore portion of Etolin Strait and Kuskokwim Bay to conserve nearshore habitat and minimize potential interactions with community use and subsistence fisheries taking place in the nearshore areas. The boundaries of this closure area are the result of negotiations by representatives of the flatfish industry and coastal communities.**

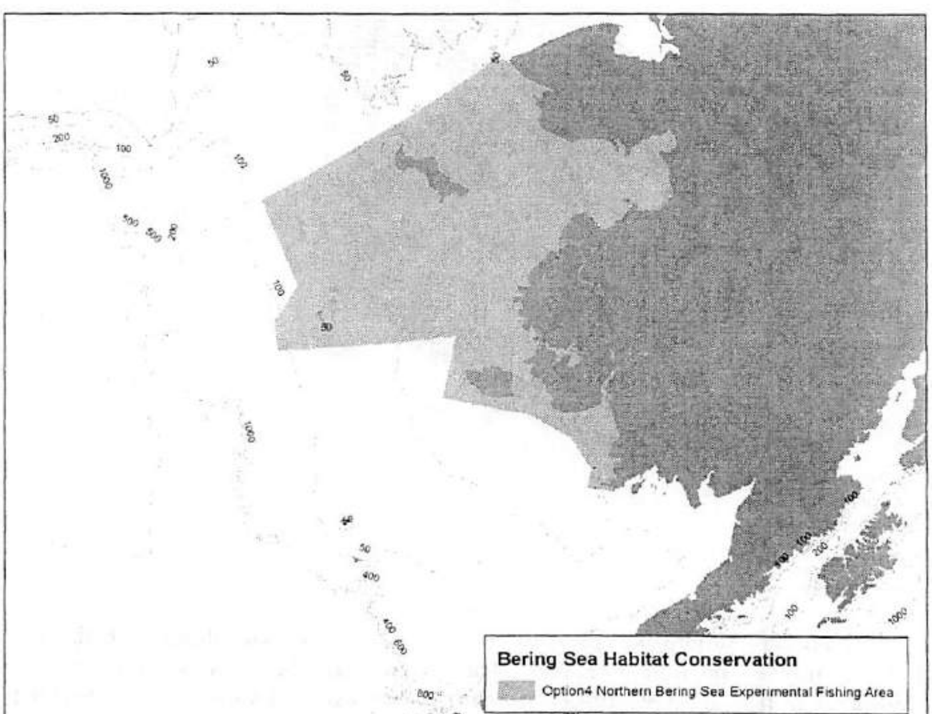



**Figure ES- 7. Option 4 the Northern Bering Sea experimental fishing area would be closed to fishing with non-pelagic trawl gear.**

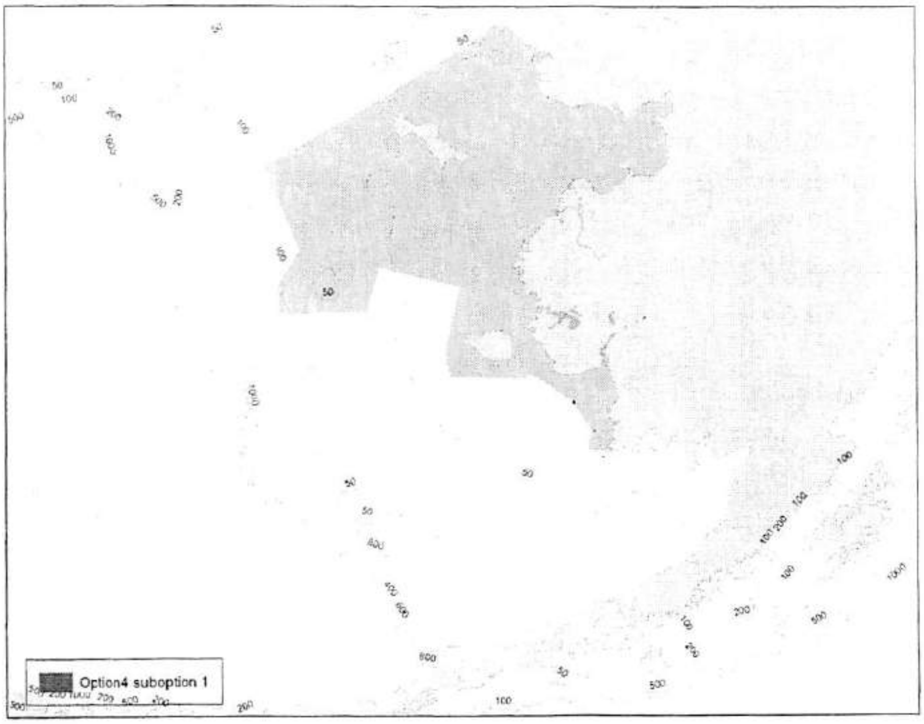



**Figure ES- 8. Option 4 suboption. The Northern Bering Sea experimental fishing area would be closed to fishing with non-pelagic trawl gear. The suboption would move a portion of the northern boundary northward between Nunivak and St. Matthew Islands to 61° N. A scientific research plan will be developed for Council review within 18 months and implemented within 3 years of final action of this item.**

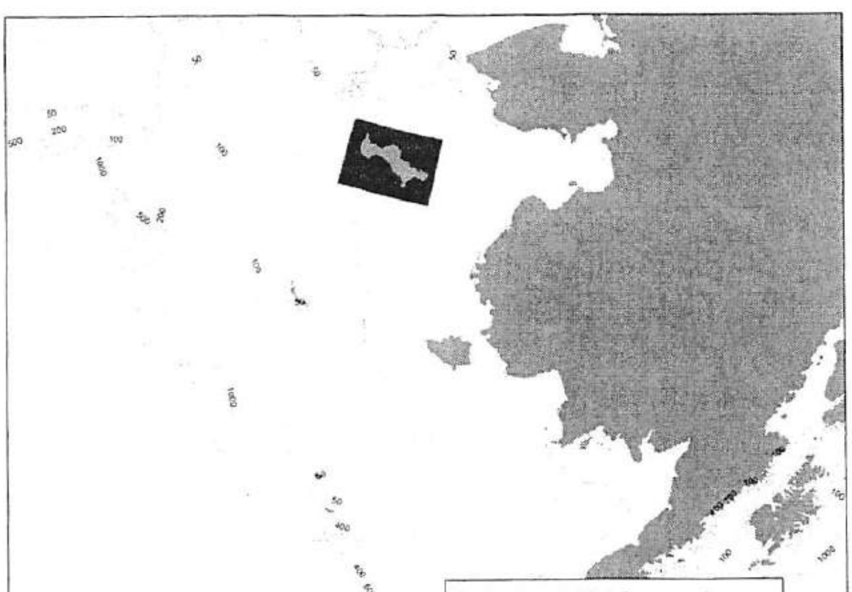



**Figure ES- 9. Option 5 Close the area to non-pelagic trawl gear around St. Lawrence Island to conserve blue king crab habitat and minimize potential interactions with community use and subsistence fisheries taking place in nearshore areas.**

# Appendix J
# Proposed HAPC Identification Process

**Prepared by**

**North Pacific Fishery Management Council**

**April 2005**

# CONTENTS


**J.1 Introduction and Background** ........ J-1

**J.2 HAPC Considerations and Priorities** ........ J-1
J.2.1 HAPC Considerations ........ J-2
J.2.2 HAPC Priorities ........ J-2

**J.3 Proposal Cycle** ........ J-2

**J.4 HAPC Process** ........ J-2
J.4.1 Call for Proposals ........ J-2
J.4.1.1 Contents of Proposals ........ J-3
J.4.2 Initial Screening ........ J-3
J.4.3 Review Process ........ J-3
J.4.3.1 Scientific Review ........ J-3
J.4.3.2 Socioeconomic Review ........ J-4
J.4.3.3 Management and Enforcement Review ........ J-4
J.4.4 Evaluation of Candidate HAPCs ........ J-4

**J.5 Council Action** ........ J-5
J.5.1 Council Assessment of Proposal Reviews ........ J-5
J.5.2 Council Selection of HAPC Proposals for Analysis ........ J-5
J.5.2.1 Potential Outcomes ........ J-5
J.5.3 Stakeholder Input ........ J-5
J.5.4 Technical Review ........ J-5

**J.6 NEPA Analysis** ........ J-5
J.6.1 Public Comment on NEPA Analysis ........ J-5

**J.7 Periodic Review** ........ J-5

**Literature Cited** ........ J-5


## TABLES


**Table J-1** Evaluation Matrix of Proposed HAPC Types and Areas, with Sample Proposals for Illustration Only ........ J-4


## FIGURES


**Figure J-1** HAPC Process Sequential Steps ........ J-6

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| Council | North Pacific Fishery Management Council |
| EFH | essential fish habitat |
| EIS | environmental impact statement |
| EEZ | exclusive economic zone |
| FMP | Fishery Management Plan |
| HAPCs | habitat areas of particular concern |
| NEPA | National Environmental Policy Act |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| SSC | Scientific and Statistical Committee |

## J.1 Introduction and Background

In June 1998, the North Pacific Fishery Management Council (Council) identified several habitat types as habitat areas of particular concern (HAPCs) within essential fish habitat (EFH) amendments 55/55/8/5/5. Habitat types, rather than specific areas, were identified as HAPCs because little information was available regarding specific habitat locations. These HAPC types included the following:

1. Areas with living substrates in shallow waters (e.g., eelgrass, kelp, and mussel beds)
2. Areas with living substrates in deep waters (e.g., sponges, coral, and anemones)
3. Freshwater areas used by anadromous fish (e.g., migration, spawning, and rearing areas)

The history of North Pacific Council HAPC designations is provided in Chapter 2 of the EFH environmental impact statement (EIS). In April 2001, the Council formed the EFH Committee to facilitate industry, conservation community, Council, and general public input into the EFH EIS process. The committee worked cooperatively with Council staff and the National Marine Fisheries Service (NMFS) to identify alternative HAPC criteria, as well as approaches that could be used to designate and manage HAPC areas. The Committee aided in formulating the HAPC designation alternatives referred to in Chapter 2 and developed recommendations for a HAPC process.

In October 2003, the Council chose a preliminary preferred alternative for a HAPC approach: HAPCs will be site-based, and the three HAPC types listed above will be rescinded.

For the initial 2003 HAPC process, the Council recommended that the proposals focus on sites within two specific priority areas:

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

Nominations were based on best available scientific information and included the following features:

1. Sites must have likely or documented presence of Fishery Management Plan (FMP) rockfish species.
2. Sites must be largely undisturbed and occur outside core fishing areas.

This appendix summarizes the process that will be used to identify HAPC sites in the future, consistent with the HAPC approach chosen through Action 2, Adopt an Approach for Identifying HAPCs, of this EIS. The Council may modify this HAPC process over time, as warranted.

## J.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.

### J.2.1 HAPC Considerations

HAPCs are those areas of special importance that may require additional protection from adverse effects. Regulations at 50 CFR 600.815(a)(8) provide the following:

> 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:
>
> (i) The importance of the ecological function provided by the habitat.
> (ii) The extent to which the habitat is sensitive to human-induced environmental degradation.
> (iii) Whether, and to what extent, development activities are, or will be, stressing the habitat type.
> (iv) 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.

### J.2.2 HAPC Priorities

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

## J.3 Proposal Cycle

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

## J.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 J-1.

### J.4.1 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.

#### J.4.1.1 Contents of Proposals

The format for a HAPC proposal should include the following:

- Provide the name of the proposer, address, and affiliation.
- Provide a 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.
- State the 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.
- Provide a clear geographic delineation for the proposed HAPC (written latitude and longitude reference point and delineation on an appropriately scaled NOAA chart).
- Provide the 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).

### J.4.2 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.

### J.4.3 Review Process

#### J.4.3.1 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.

#### J.4.3.2 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," so socioeconomic 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.

#### J.4.3.3 Management and Enforcement Review

Proposals will be reviewed for management and enforceability.

### J.4.4 Evaluation of Candidate HAPCs

The reviewers may rank the proposals by using a system like the matrix illustrated in Table J.1 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.

**Table J-1.** Evaluation Matrix of Proposed HAPC Types and Areas, with Sample Proposals for Illustration Only

| 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 | Unknown |

## J.5 Council Action

### J.5.1 Council Assessment of Proposal Reviews

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

### J.5.2 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.

#### J.5.2.1 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.

### J.5.3 Stakeholder Input

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

### J.5.4 Technical Review

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

## J.6 NEPA Analysis

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

### J.6.1 Public Comment on NEPA Analysis

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

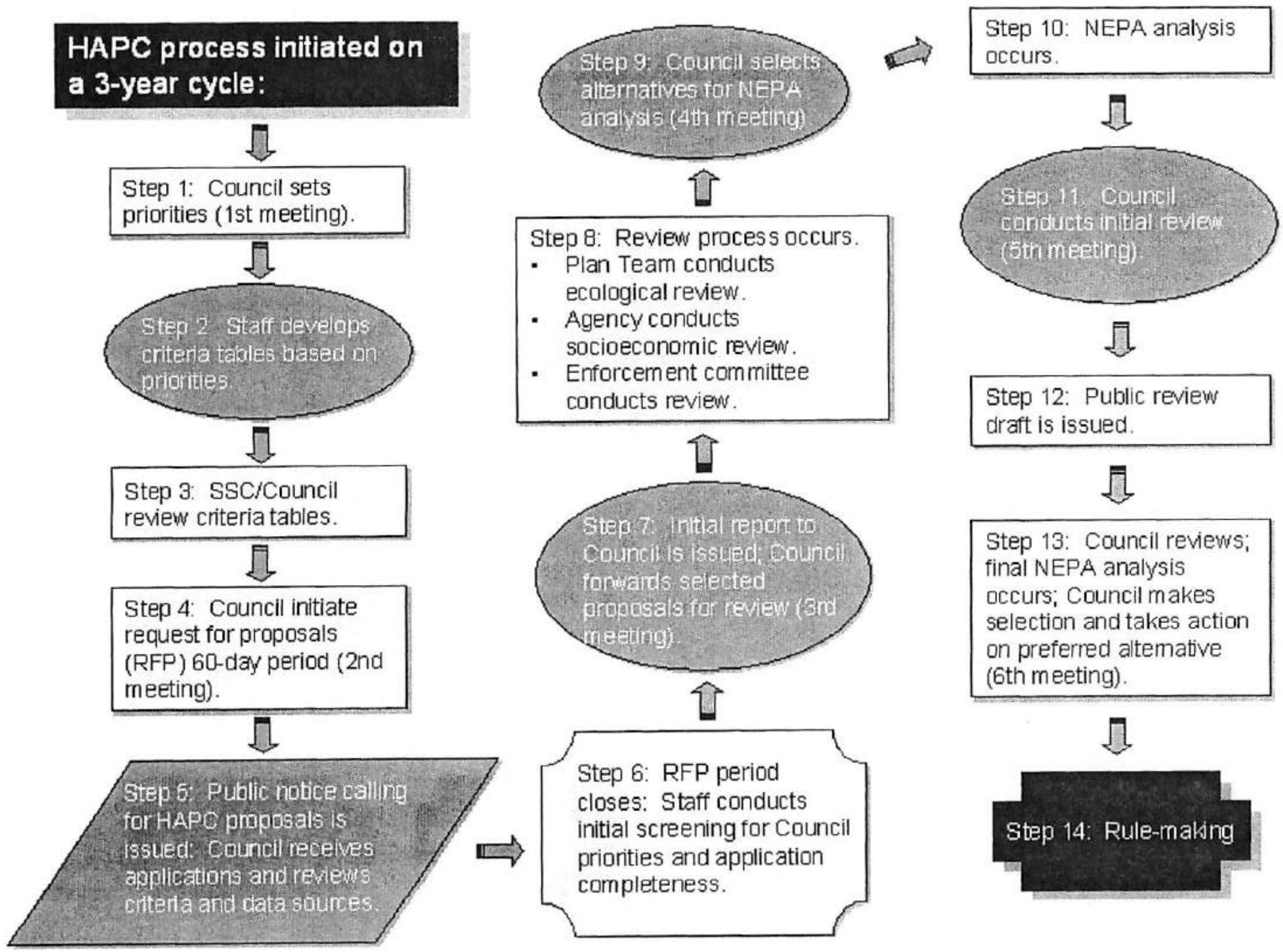
## J.7 Periodic Review

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

## LITERATURE CITED

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

**Figure J-1.** HAPC Process Sequential Steps



AGENDA D-3
Supplemental
JUNE 2007

KAWERAK, INC. ○ P.O. Box 948 ○ Nome, AK 99762

TEL: (907) 443-5231 • FAX: (907) 443-4452

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HISHMAREF
OLOMON
S
T. MICHAEL
ELLER
NALAKLEET
ALES
HITE MOUNTAIN

May 7, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fisheries Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

RECEIVED
MAY 14 2007
N.P.F.M.C.

**RE: Bering Sea Habitat Conservation**

Dear Ms. Madsen & Mr. Mecum,

Kawerak would like to express its concern regarding Bering Sea habitat conservation. The North Pacific Fishery Management Council is considering alternatives and options for controlling the impact of bottom trawling, including establishing areas to be open and closed to bottom trawling. We are concerned about the fate of subsistence and fishery resources and their habitat in our region if bottom trawling were to move northward from where it has occurred in the past. We recommend establishing a northern boundary for bottom trawling based on the current trawl footprint.

Kawerak is a Native non-profit association organized to promote the social and economic welfare of residents in 20 villages in the Bering Strait Region. Kawerak provides services to 3 culturally distinct groups of Eskimo people (Inupiaq, Yupik and St. Lawrence Island Yupik). Kaweraks Vision Statement serves as the guiding principal for Kaweraks role and function in the region: Building on the inherent strength of our cultural values, we shall assist our tribes to take control of their future.

Kawerak staff has reviewed the Bering Sea Habitat conservation issues the North Pacific Fisheries Management Council has taken up. Kawerak staff have attended North Pacific Fisheries Management Council meetings to become informed of the issues. It is expected that Kawerak staff will attend future North Pacific Fisheries Management Council meetings to voice our opposition to any trawling efforts north of 61 degrees North. In particular Kawerak staff has reviewed the Initial Review Draft of the Environmental Assessment, Regulatory Impact Review, Initial Regulatory Flexibility Analysis, for Amendments to the Fishery Management Plan, for Groundfish of the Bering Sea and Aleutian Islands, and regulatory amendments for Bering Sea Habitat Conservation, dated March 2007.

- Kawerak supports Alternative #2 (northern boundary). We do not support Alternative 2, suboption 1 which opens additional area to bottom trawling north of the historical trawl footprint. Kawerak does not support Alternative #1 (status quo).

- We do not support Alternative #3 (gear modification) as the sole measure to address Bering Sea habitat conservation. Kawerak believes that Alternative #3, which raises trawls 2 ½ inches off the seafloor is just as destructive as hard bottom trawling and strongly urges the North Pacific Fisheries Management Council to further investigate impacts from elevated trawls, especially how they may affect pristine benthic habitats that have never had any trawling efforts. Kawerak believes that information about elevated trawl and gear modifications are skewed and are derived from areas where trawling has been occurring, and has not investigated or determined affects to pristine benthic environments.
- Kawerak supports Option 5 closing the area around Saint Lawrence Island. Kawerak believes that at least 150 miles of protection are needed from any point of land on Saint Lawrence Island or the Punuk Islands in order to protect marine animals, such as whale, walrus, birds, seals, fish and shellfish. The vast migratory nature of marine animals means that areas in proximity or overlapping subsistence use areas requires conservation. The best option is to maintain at least a 150 mile buffer from Saint Lawrence Island.

Kawerak is strongly concerned about the impacts of bottom trawling on subsistence resources. Kawerak is also concerned about the effects of mid-water trawls or so called soft bottom trawls on subsistence resources. At this time Kawerak can not support any trawling efforts north of 61 degrees North even experimental fishing. Our Eskimo people depend so heavily on marine mammals for their cultural, spiritual, and economic survival that any commercial or experimental trawling efforts in the Bering Sea north of 61 degrees North would likely erode our subsistence livelihood.

Management actions must be consistent with the Magnuson-Stevens Act national standards. National Standard 8 requires that federal fisheries management take into account the importance of fishery resources to communities and "provide for sustained participation and minimize adverse economic impacts on communities. The draft Environmental Assessment poorly assesses consistency with National Standard 8. The document provides a superficial description of our communities and their deep reliance on marine and coastal resources. The North Pacific Fisheries Management Council should obtain more information about communities than is contained in the regulatory review.

The North Pacific groundfish fisheries are managed under the Bering Sea/Aleutian Islands Fishery Management Plan (FMP), which is required by the Magnuson-Stevens Act and was adopted by the Council and approved by the Secretary of Commerce. The FMP contains objectives including the following:

> *Promote Sustainable Fisheries and Communities*
> *(6) Promote conservation while providing for optimum yield in terms of the greatest overall benefit to the nation with particular reference to food production and sustainable opportunities for recreational, subsistence and commercial fishing participants and fishing communities.*
> *(7) Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.*

We believe the FMP reflects the Council's intent to manage fisheries in a manner that protects our subsistence economy and opportunities.

In reviewing the alternatives and options, Alternative 2 best meets the spirit of National Standard 8 and best contributes to the fulfillment of the FMP objectives and the Council's commitment to sustainable communities.

Thank you for your time and consideration. If you have any questions please feel free to contact Austin Ahmasuk, Kawerak, Subsistence Director at the above address or directly at (907) 443-4265 or e-mail sub.rec@kawerak.org.

Sincerely,

Loretta Bullard, President
Kawerak, Inc.

North Pacific Fishery Management Council
605 West 4th Avenue, Ste 306
Anchorage, Alaska 99501-2252
Phone: (907) 271-2809
Fax: (907) 271-2817

RECEIVED
APR 1 ? 2007
N.P.F.M.C.

Pls CC: Secretary of Commerce Carlos Gutierrez
NMFS Director Hogarth; NPFMC

April 16, 2007

Dear Chris Oliver, Executive Director:

**RE: Bering Sea Habitat Conservation – Northern Trawl Boundary**
**For the Official Record in Opposition of Extension Northward for NPT**

I currently hold halibut quota in all Area 4 designated areas, and fish Opilio and Bairdi crab in the Bering Sea. I oppose any northward extension of non-pelagic trawling (NPT zones), even for experimental fisheries.

Any extension will have "significantly adverse impacts" on other species and I do not favor any further openings of NPT. To keep these areas closed to further encroachment -- which is solely designed to serve economic greed of the bottom trawlers -- will not unduly constrain fishing.

Also, we do need the Option 1 closure around St. Matthew Island to aid rebuilding plans for Blue Crab.

Thank you for your consideration.
Respectfully,

Ludger Dochtermann, F/V Stormbird & F/V North Point
P.O. Box 714; Kodiak, Alaska 99615 Tel: 907.486.5450

RECEIVED
MAY 2 2 2007
N.P.F.M.C

March 28, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

RE: Agenda Item D-3, Bering Sea Habitat Conservation

Dear Madame Chair and Mr. Mecum:

The Eskimo Walrus Commission (EWC) at Kawerak, Inc. in Nome was formed in 1978. EWC is a recognized statewide entity working on resource co-management issues, specifically the Pacific walrus, on behalf of 19 Alaskan Yup'ik, St. Lawrence Island Yupik, and Inupiaq communities who rely on it as an essential cultural, natural, and subsistence resource. EWC works cooperatively with the U.S. Fish and Wildlife Service (FWS) to encourage subsistence hunters' participation in conserving and managing walrus in the coastal communities.

EWC is providing this letter to express concerns regarding potential detrimental long-term impacts of bottom trawling in waters critical to Pacific walrus and coastal subsistence communities. We therefore provide the following comments with respect to the draft EA for Bering Sea Habitat Conservation:

a. EWC only supports Alternative 2 as a minimum measure for precautionary management of Bering Sea habitat. The other proposed alternatives may result in significant impacts to walrus and subsistence hunting communities. We encourage the North Pacific Fishery Management Council to constrain high impact fishing techniques such as bottom trawling on the Bering and Chukchi Sea shelf areas until more is known about the impacts to critical ecological and subsistence resources. We further encourage the Council to close important walrus habitat and subsistence hunting areas to bottom trawling that are currently within the trawl footprint and we look forward to helping you identify those areas.

b. EWC endorses the comments of our co-management partner the U.S. Fish and Wildlife Service, with respect to their concerns about disturbance and impacts to the Pacific walrus population.

c. EWC believes that there has been inadequate official consultation with organizations such as ours in the production of this EA.

Although EWC's position is to not support bottom trawling on the Bering and Chukchi Sea shelf areas, we are also concerned with the preparation and content of the draft EA. We feel that the preparation did not involve significant consultation with communities that stand to be impacted from activities related to this EA, and the content of the EA is neither sufficient, nor precautionary in its approach when considering bottom trawling activities. These activities could

lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic sustenance.

Sincerely,

VMetcalf for Charles D.N. Brower

Charles D.N. Brower, Chair
Eskimo Walrus Commission

cc: Vera Metcalf, Director, Eskimo Walrus Commission
Loretta Bullard, President, Kawerak, Inc.
Rosa Meehan, Supervisory, USFWS

GREENPEACE
125 Christensen Dr., Suite 2
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May 18. 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Forth Ave., Suite 306
Anchorage, Alaska 99501

**Re: NPFMC June 6-12, 2007 Meeting in Sitka, agenda item D-3(a), Bering Sea Habitat Conservation Measures.**

Dear Ms. Madsen:

I am writing to you today on behalf of Greenpeace and our millions of members and supporters about your pending final action on Bering Sea Habitat Conservation. Greenpeace supports Alternative 2 for agenda item D-3(a). "Freezing the bottom trawl footprint" is the only responsible choice to ensure sensitive marine habitats are protected from adverse fishing impacts.

Last year the NPFMC adopted and implemented this exact approach, 'freezing the footprint', in the AI/GOA areas and was praised by industry as "setting the world's gold standard for precautionary habitat management". The habitat conservation precedent set in the AI/GOA needs to be extended to the northern Bering Sea. Doing the habitat mapping and receiving recommendations for appropriate uses from your scientists gives the Council the opportunity to fulfill it's obligations under the August 26, 2004 Record of Decision to incorporate ecosystem-based considerations into management decisions. Preserving the natural function of the ecosystem is the best insurance for sustainable fisheries and the communities that depend on them.

Commercial fishing in the southern Bering Sea, Aleutian Islands and around the Pribilof Islands has disrupted the ecosystem and done tremendous damage to the traditional food base upon which our people and communities depend. This loss of access to our foods is a driving force in the loss of our culture itself. This travesty must not be repeated by allowing industrial commercial fishing to move further north. Our subsistence and cultural needs, and protections for a naturally functioning ecosystem must be included in fishery management plans prior to expanding fisheries north of the vast areas already being fished. Marine Cultural Heritage Zones are needed now.

Greenpeace urges the NPFMC to pass Alternative 2, for D-3 (a) as a first step in developing true ecosystem based fishery management for the Bering Sea.

Thank you for you attention, I remain

George

George Pletnikoff
Alaska Oceans Campaign

Dear members of the North Pacific Fishery Management Council,

I am writing to urge you to protect essential fish habitat in the Bering Sea by adopting Alternative 2 to freeze the footprint of bottom trawling in the Bering Sea. Alternative 2 would provide the most reasonable protection from damage to the wildlife, communities + ocean habitats of the Northern Bering sea while having a minimal impact on the economic health of existing fisheries + fishing communities

Thank you.

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MAY 2 5 2007
N.P.F.M.C.

Audubon ALASKA
715 L Street, Suite 200
Anchorage, AK 99501

RECEIVED
MAY 29 2007
N.P.F.M.C

May 29th, 2007

North Pacific Fisheries Management Council
605 West 4th Avenue, Suite 306
Anchorage, AK 99501
Fax: (907) 271-2817

Members of the North Pacific Fisheries Management Council,

Re: <u>Essential Fish Habitat of the northern Bering Sea</u>

Around the world, bottom trawl fishery activities are known to disrupt benthic communities and can permanently damage benthic ecosystems. Areas subject to bottom trawling are generally found to have reduced benthic habitat complexity, altered benthic community composition, diminished biodiversity, and decreased biomass and productivity.

As you are well aware, the Bering Sea is home to many species of rare and endangered marine mammals and seabirds, including the federally-listed Spectacled Eider (*Somateria fischeri*). In 2001, the US Fish & Wildlife Service designated areas of critical habitat for Spectacled Eiders, including a large block of wintering habitat between St. Lawrence Island and St. Matthew Island. These areas of critical habitat were selected based on a number of constituent elements, including the underlying marine benthic community. These birds rely on mollusks on the seafloor as a critical food source for much of the year.

Bottom trawling would destroy the habitat of the northern Bering Sea floor on which the Spectacled Eider and many other species depend. Thus, I am writing to urge you to protect essential fish and eider habitat in the northern Bering Sea by adopting Alternative 2, which would freeze the footprint of bottom trawling in the Bering Sea and prevent further northward expansion.

Clearly, Alternative 2 provides the greatest level of protection for the wildlife, communities, and benthic habitats of the northern Bering Sea, with minimal impact on the economic health of existing fisheries and fishing communities.

Thank you for your consideration.

Sincerely,

Iain J. Stenhouse

Iain J. Stenhouse, PhD
Director of Bird Conservation

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MAY 2 ) 2007
N.P.F.M.C

6400 Andover Circle
Anchorage, AK. 99516
May 24, 2007

North Pacific Fisheries Management Council
605 West 4th Avenue, Suite 306
Anchorage, AK
99501-2252

Dear Members of the North Pacific Fisheries Management Council,

I urge you to protect essential fish habitat in the northern Bering Sea by adopting Alternative 2, which would stabilize the footprint of bottom trawling.

The Bering Sea is home to many species of fish and wildlife including rare and endangered marine mammals and seabirds such as the federally-listed Spectacled Eider. These birds rely on mollusks on the seafloor as a critical food source. Bottom trawling would destroy the essential fish habitat of the Bering Sea floor on which the Spectacled Eider and many other species depend.

Clearly, Alternative 2 provides the greatest protection for the wildlife, communities, and benthic habitats of the northern Bering Sea, while having a minimal impact on the economic health of existing fisheries and fishing communities.

Thank you for your consideration.

Sincerely yours,

Glenn Elison

RECEIVED
MAY 29 2007
N.P.F.M.C

# International Bering Sea Forum

May 25, 2007

Stephanie Madsen
North Pacific Fishery Management Council
605 W. 4th Ave, Suite 306
Anchorage, AK 99501

Doug Mecum
NOAA Fisheries
Alaska Region
709 W. 9th St.
Juneau, Alaska 99802-1668

RE: Bering Sea Essential Fish Habitat

Dear Ms. Madsen and Mr. Mecum:

Attached is a resolution on bottom trawling recently passed by the International Bering Sea Forum. The International Bering Sea Forum is an international, non-governmental network comprised of NGOs, representatives from Bering Sea communities, indigenous leaders, policy makers, scientists, fishermen and other interested parties that are committed to the sustainable management of the Bering Sea. The three primary goals of the Forum are to:

1. Share information, foster greater international collaboration and promote greater understanding of the importance of Bering Sea protection across political boundaries;
2. Advocate for the protection of the Bering Sea environment and the species that depend upon the Bering habitat for their survival;
3. Promote the sustainable livelihood of local communities that depend upon the resources of the Bering Sea, including coastal communities, indigenous communities and local family fishermen.

In that spirit, pleas accept the attached resolution, which explicitly supports freezing the footprint of bottom trawling by the adoption of Alternative 2 from the Bering Sea Habitat Conservation Environmental Assessment.

Thank you for considering these comments,

Walter B. Parker

Walter B. Parker
U.S. Chair, IBSF

# International Bering Sea Forum

## Resolution of the International Bering Sea Forum Regarding Bottom Trawling Activity in the Bering, Chukchi, and Beaufort Seas

## Резолюция МБФ о донным тралении в Беринговым, Чукчи, и Бофорт морях

**WHEREAS** the International Bering Sea Forum consists of members from the United States and the Russian Federation representing Bering Sea communities, indigenous leaders, policy makers, scientists, environmentalists, family fishermen, and fishing industry managers committed to sustainable management of the Bering Sea;

**WHEREAS** the International Bering Sea Forum has past voiced concern regarding the fishing technique of bottom trawling and the effects of bottom trawling that are in conflict with sustainable management of the Bering Sea;

In consideration of the facts:

The Bering, Chukchi, and Beaufort Seas are critical habitat for a wide array of species, including, but not limited to:

- Critical feeding and winter habitat for spectacled eider (*Somateria fischeri*) and Steller's eider (*Polysticta stelleri*) which breed in Russia and the U.S. These eiders rely on benthic invertebrates that live in and on the seafloor;
- Crab species, including commercially important but declining stocks of blue king crab (*Paralithodes platypus*), opilio crab (*Chionoecetes opilio*) and red king crab (*Paralithodes camtschaticus*);
- Pacific walrus (*Odobenus rosmarus*) that support important subsistence harvests; are wholly reliant on healthy and productive seafloor habitat of the northern Bering Sea and Chukchi Sea;
- Bowhead whales (*Balaena mysticetus*), grey whales (*Eschrichtis robustus*) and beluga whales (*Delphinapterus leucas)* that support vital subsistence harvests;

**FURTHERMORE** it has been demonstrated that;

- Bottom trawling reduces habitat complexity, diversity, and resilience of seafloor habitat;
- Seafloor habitat in Northern areas on the U.S. side have yet to be trawled, the majority of bottom trawling in U.S. waters has occurred south of St. Matthew Island;
- Expansion of industrial bottom trawling by factory trawlers will provide little economic benefit for coastal communities;
- A northern boundary to bottom trawling would not prevent the fishing industry to fully harvest quotas in the foreseeable future;

# International Bering Sea Forum

**WHEREAS** the National Marine Fisheries Service of the United States is now considering modifying their Fishery Management Plans to address this issue and has prepared a *Bering Sea Habitat Conservation Environmental Assessment;*

**WHEREAS** preventing expansion of bottom trawling is encompassed by *Alternative 2* in the above mentioned *Environmental Assessment*;

**NOW THEREFORE BE IT RESOLVED** that the International Bering Sea Forum supports *Alternative 2* in the above mentioned *Environmental Assessment*; and

**FINALLY, BE IT RESOLVED** that the International Bering Sea Forum supports efforts to identify and protect Important Ecological Areas which may be under stress from existing bottom trawling.

# NATIVE VILLAGE OF KWIGILLINGOK

Kwigillingok I.R.A Council
P.O. Box 49
Kwigillingok, Alaska 99622-0049
(907) 588-8114/8212
(907) 588-8429-fax
kwkadmin@starband.net



## RESOLUTION NO. 05-01-07

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Native Village of Kwigillingok is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS**: The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS**: Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS**: Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS**: Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS**: The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS**: Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes. and;

**WHEREAS**: Expansion of bottom trawl fishing into new areas will most certainly impact the ecology and subsistence foods negatively, and;

**WHEREAS**: The North Pacific Fisheries Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS**: The North Pacific Fisheries Management Council is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with Tribes about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT**: The Native Village of Kwigillingok requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT**: The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FINALLY RESOLVED THAT**: No high impact fishery should be introduced into the northern Bering Sea without consultation with Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by the Native Village of Kwigillingok on May 8, 2007 where a quorum of the Tribal Council was present.**

Tommy J. Andrew, President

Mary Ann Wilkinson, Secretary

**EEK TRADITIONAL COUNCIL**
**NATIVE VILLAGE OF EEK**



**RESOLUTION #07-07**

A RESOLUTION SUPPORTING THE ESTABLISHMENT OF A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES THAT WILL ULTIMATELY PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

Whereas: the Eek Traditional Council is a federally recognized tribe located on the Bering Sea coast; and

Whereas: the village depends on these waters and habitat for resources essential to our way of life; and

Whereas: our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring and salmon; and

Whereas: our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

Whereas: warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

Whereas: the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas: bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

Whereas; an expansion of bottom trawling into the northern Bering Sea would additionally impact these resources during this time of ecological change and uncertainty; and

Whereas: the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea.

Now Therefore Be It Resolved, that the Eek Traditional Council requests the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

Be It Further Resolved, that the Environmental Assessment is narrowly focused on fish habitat such that that effect of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

Be It Further Resolved, that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

## CERTIFICATION

Passed and Approved by the Eek Traditional Council with a quorum present and voting throughout this 9th day of May 2007 by a vote of 5 ayes, and Ø nays.

William F. Brown, President

Attest: Bessie Green

Bessie Green, Secretary

RECEIVED
MAY 22 2007
N.P.F.M.C.

# A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

Whereas, the King Island Native Community is a federally recognized tribe located on the Bering Sea coast; and

Whereas, the village depends on these waters and habitat for resources essential to our way of life; and

Whereas, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, salmon and crab; and

Whereas, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

Whereas, warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

Whereas, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas, bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

Whereas, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

Whereas, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

Therefore be it resolved the King Island Native Community requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

Be it further resolved that that the Environmental Assessment is narrowly focused on fish habitat such that that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

Be it further resolved that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

Adopted by King Island Native Community on May 10, 2007.

**CERTIFICATION**

The undersigned hereby certify that the foregoing resolution was adopted by a majority vote of members of King Island Native Community at a duly convened meeting of the Council in which a quorum was present, by a vote of 5 for, 0 against, and 0 abstaining, this 5th day of May, 2007.

Carmelit Notaqul
CHIEF

Jennifer Alvanna
SECRETARY

**TUNTUTULIAK TRADITIONAL COUNCIL**
**POB 8086**
**Tuntutuliak, Alaska 99680**
**(907) 256-2128 Telephone**
**(907) 256-2080 Fax**

RECEIVED MAY 2 9 2007

**RESOLUTION NO.** 07-05-01 N.P.F.M.C

**A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.**

**WHEREAS:** Tuntutuliak Traditional Council is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes. and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT**: Tuntutuliak Traditional Council requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT**: The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** Tuntutuliak Traditional Council only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT**: No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by Tuntutuliak Traditional Council on May ____, 2007 where a quorum of the Tribal Council was present.**

Henry Lupie, President

Nick David Jr., Secretary

**NATIVE VILLAGE OF MEKORYUK**
INDIAN REORGANIZATION ACT COUNCIL
P.O. Box 66
Mekoryuk, Alaska 99630
(907) 827-8826
Fax (907) 827-8133

RECEIVED
MAY 2 4 2007
N.P.F.M.C

# RESOLUTION NO. 05-01-07

**A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORHTERN BOUNDRARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.**

**WHEREAS:** The Native Village of Mekoryuk is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary to our survival, and;

**WHEREAS:** Our Cup'ig way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in ground fish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of ground fish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternative to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them,; and;

**NOW THEREFORE BE IT RESOLVED THAT:** The Native Village of Mekoryuk requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE IT RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival; and;

**NOW THEREFORE BE IT RESOLVED THAT:** The Native Village of Mekoryuk only agree to support Alternative 2 contingent on the NPFMC Committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for it's cultural and economic vitality.

**Adopted by the Native Village of Mekoryuk on May 24, 2007 where a quorum of the Tribal Council were present.**

[signature]
**Daniel Olrun Sr. President**
Vice - President

[signature]
**Albert R. Williams, Secretary**

*Native Village of Elim*
*Elim IRA Council*



Resolution 07-06

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTANCE RESOURCES

Whereas, the Native Village of Elim is a federally recognized tribe located on the Bering Sea coast; and

Whereas, the village depends on these waters and habitat for resources essential to our way of life, and

Whereas, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for [halibut, herring, salmon, and crab…]; and

Whereas, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence tradition and commercial fisheries; and

Whereas, warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

Whereas, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas, bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

Whereas, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

Whereas, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

Therefore be it resolved that the Native Village of Elim requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

Be it further resolved that the Environmental Assessment is narrowly focused on fish habitat such as that, its effects of bottom trawling on subsistence are not fully evaluated, Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

Be it further resolved that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

Adopted by the Native Village of Elim on May 01, 2007

**CERTIFICATION**

I hereby certify that the foregoing Resolution was adopted at a duly convened meeting of the Elim IRA Council at which a quorum was present, by a vote of 6 in favor, 0opposed, 0 abstained this 01 day of May, 2007.

Frederick B. Murray
FREDERICK B. MURRAY
PRESIDENT

Robert A. Keith
ROBERT A. KEITH
SECRETARY

# NATIVE VILLAGE OF GAMBELL

P.O. BOX 90 • Gambell, Alaska 99742
Telephone: (907) 985-5346 • FAX: (907) 985-5014



## RESOLUTION NO. 07-03

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Native Village of Gambell is a federally recognized tribe located on St. Lawrence Island, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea/ St. Lawrence Island subsistence resources necessary for our survival, and;

**WHEREAS:** Our St. Lawrence Island Yupik way of life includes use of marine and coastal resources such a fish, shellfish, marine mammals, and seabirds, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and around St. Lawrence Island, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

WHEREAS: The North Pacific Fisheries Management Council (NPFMC) is considering Management alternatives to control the impact of bottom trawling in the Bering Sea, and,

WHEREAS: The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and,

**NOW THEREFORE BE IT RESOLVED THAT:** The Native Village of Gambell requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT:** That Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The Native Village of Gambell only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast and St. Lawrence Island who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by The Native Village of Gambell on May 29, 2007 where a quorum of the Tribal Council was present.**

Eddie Ungott
President

Secretary

Native Village of Shaktoolik
ꞯA Council
O. Box 100
haktoolik, Alaska 99771-0100
Phone (907) 955-370
Fax (907) 955-23

RECEIVED
MAY 29 2007
N.P.F.M.C.

RESOLUTION 07-13

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

**WHEREAS**, the Native Village of Shaktoolik is an Alaskan Native Village organized as an Alaskan Native/American Indian Organization Act of 1934 as amended in 1936 for Alaska, and;

**WHEREAS**, the Native Village of SHaktoolik IRA Council is the elected governing body of the Alaska Native/American Indian People of the Native Village of Shaktoolik, and;

**WHEREAS**, the Native Village of Shaktoolik is located on the Bering Sea coast; and

**WHEREAS**, the village depends on these waters and habitat for resources essential to our way of life; and

**WHEREAS**, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for herring, salmon and crab; and

**WHEREAS**, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

**WHEREAS**, warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

**WHEREAS**, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

**WHEREAS**, bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

**WHEREAS**, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

**WHEREAS**, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

**Therefore be it resolved that** the Native Village of Shaktoolik requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

**Be it further resolved that** the Environmental Assessment is narrowly focused on fish habitat such that that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

**Be it further resolved that** no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

## Certification

We, the undersigned members of the Native Village of Shaktoolik IRA Council do hereby certify that the Native Village of Shaktoolik IRA Council is composed of 7 members, of whom 5 voted on this 8th day of May, 2007, and the foregoing resolution was adopted by a vote of 5 members.

YES 5 NO 0 ABSTAIN ____ ABSENT 1

Simon L. Bekoalok Jr.
President

ATTEST:

Karlene Sagoonick,
Tribal Coordinator, Alt.

**STEBBINS COMMUNITY ASSOCIATION**
**POB 2**
**Stebbins, Alaska 99671**
**(907) 934-3561 Telephone**
**(907) 934-3560 Fax**

**RESOLUTION NO. 05-11-07-03**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** Stebbins Community Association is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS**: The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS**: Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS**: Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS**: Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS**: The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS**. Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS**: Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS**: The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS**: The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** Stebbins Community Association requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** Stebbins Community Association only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by Stebbins Community Association on May 11th, 2007 where a quorum of the Tribal Council was present.**

Frederick J. Pete, Sr.
President

Secretary

RECEIVED
MAY 2 2 2007
N.P.F.M.C.

KINGIKMIUT
NATIVE VILLAGE OF WALES

Native Village Of Wales
P.O. Box 549
Wales, Alaska 99783

Telephone (907) 664-3062
Fax (907) 664-2200
E-Mail to.waa@kawerak.org

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**RESOLUTION 07-12**

**A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.**

**WHEREAS,** the Native village of Wales is a federally recognized tribe located on the Bering Sea coast; and

**WHEREAS**, the village depends on these waters and habitat for resources essential to our way of life; and

**WHEREAS,** our way of life includes subsistence use of marine and coastal resources such as fish, marine mammals, seabirds, and small commercial fisheries for salmon; and

**WHEREAS,** our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

**WHEREAS,** warming ocean temperatures may result in ground fish moving northward into new areas of the Bering Sea; and

**WHEREAS,** the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that may have not been exposed to bottom trawling in the past; and

**WHEREAS,** bottom trawling is known to disturb seafloor habitats and result in significant by catch of fish and other marine life, including marine mammals; and

**WHEREAS,** an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

**WHEREAS,** the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

**NOW THEREFORE BE IT RESOLVED,** that the Native Village of Wales request that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment; and

**BE IT FURTHER RESOLVED**, that the Environmental Assessment is narrowly focused on fish habitat such that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternate 2 is the choice that best protects local commercial fisheries and subsistence resources, and

**BE IT FURTHER RESOLVED**, that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

## CERTIFICATION

**I hereby certify that the foregoing Resolution was adopted at a duly convened meeting of the Wales IRA Council at which a quorum was present, by a vote of 6 for, 0 against, and 0 abstaining.**

Winton Weyapuk Jr. — May 10, 2007
**Vice President: Winton Weyapuk Jr.** — **Date**

Madeleine B. Okpealuk — May 14, 2007
**Secretary: Madeleine B. Okpealuk** — **Date**

White Mountain
Alaska
The Fish River Tribe

*Native Village of White Mountain*
*IRA TRIBAL COUNCIL*
*P.O. Box 84082*
*White Mountain, AK 99784*
*TELEPHONE: (907) 638-3651 & FAX: (907) 638-3652*

**RESOLUTION NO. 2007-06**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

Whereas, the Native Village of White Mountain is a federally recognized tribe located on the Bering Sea Coast; and

Whereas, the village depends on these waters and habitat for resources essential to our way of life; and

Whereas, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, salmon, and crab; and

Whereas, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

Whereas, warming ocean temperatures may result in ground fish moving northward into new areas of the Bering Sea; and

Whereas, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas, bottom trawling is known to disturb seafloor habitats and result in significant by catch of fish and other marine life, including marine mammals; and

Whereas, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

Whereas, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

Therefore be it resolved that the Native Village of White Mountain requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environment Assessment.

Be it further resolved that the Environmental Assessment is narrowly focused on fish habitat such that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternate 2 is the choice that best protects local commercial fisheries and subsistence resources.

Be it further resolved that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

## CERTIFICATION

This Resolution No. 2007-06 was passed and approved by a duly constituted quorum of the White Mountain IRA Council this 24th day of May, 2006, with a vote of 8 in favor, 0 abstaining, and 0 absent.

SIGNED: ____________ ATTEST: ____________

Lincoln M. Simon Sr.
President

Rita Buck, Secretary

RECEIVED
MAY 2 2007
N.P.F.M.C.

March 28, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

RE: Agenda Item D-3, Bering Sea Habitat Conservation

Dear Madame Chair and Mr. Mecum:

The Eskimo Walrus Commission (EWC) at Kawerak, Inc. in Nome was formed in 1978. EWC is a recognized statewide entity working on resource co-management issues, specifically the Pacific walrus, on behalf of 19 Alaskan Yup'ik, St. Lawrence Island Yupik, and Inupiaq communities who rely on it as an essential cultural, natural, and subsistence resource. EWC works cooperatively with the U.S. Fish and Wildlife Service (FWS) to encourage subsistence hunters' participation in conserving and managing walrus in the coastal communities.

EWC is providing this letter to express concerns regarding potential detrimental long-term impacts of bottom trawling in waters critical to Pacific walrus and coastal subsistence communities. We therefore provide the following comments with respect to the draft EA for Bering Sea Habitat Conservation:

a. EWC only supports Alternative 2 as a minimum measure for precautionary management of Bering Sea habitat. The other proposed alternatives may result in significant impacts to walrus and subsistence hunting communities. We encourage the North Pacific Fishery Management Council to constrain high impact fishing techniques such as bottom trawling on the Bering and Chukchi Sea shelf areas until more is known about the impacts to critical ecological and subsistence resources. We further encourage the Council to close important walrus habitat and subsistence hunting areas to bottom trawling that are currently within the trawl footprint and we look forward to helping you identify those areas.

b. EWC endorses the comments of our co-management partner the U.S. Fish and Wildlife Service, with respect to their concerns about disturbance and impacts to the Pacific walrus population.

c. EWC believes that there has been inadequate official consultation with organizations such as ours in the production of this EA.

Although EWC's position is to not support bottom trawling on the Bering and Chukchi Sea shelf areas, we are also concerned with the preparation and content of the draft EA. We feel that the preparation did not involve significant consultation with communities that stand to be impacted from activities related to this EA, and the content of the EA is neither sufficient, nor precautionary in its approach when considering bottom trawling activities. These activities could

lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic sustenance.

Sincerely,

VMetcalf for Charles D.N. Brower

Charles D.N. Brower, Chair
Eskimo Walrus Commission

cc: Vera Metcalf, Director, Eskimo Walrus Commission
Loretta Bullard, President, Kawerak, Inc.
Rosa Meehan, Supervisory, USFWS

NATIVE VILLAGE OF GOODNEWS BAY
TRADITIONAL VILLAGE COUNCIL
P.O. BOX 138
GOODNEWS BAY, ALASKA 99589
PHONE (907) 967-8929 FAX (907) 967-8330
goodnews907@hotmail.com

RECEIVED
MAY 2 9 2007
N.P.F.M.C.

RESOLUTION # 07-05-03

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Native Village Of Goodnews Bay is a federally recognized tribe located on the Bering Sea coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yupik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in ground fish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of ground fish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The Northern Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** The Native Village Of Goodnews Bay requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and,

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The Native Village Of Goodnews Bay only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

Adopted by the Native Village Of Goodnews Bay on May 22nd, 2007 where a quorum of the Tribal Council was present.

Sally B. Martin, Secretary

George J. Bright, Sr., President

Traditional Council
Native Village of Kwinhagak
P.O Box 148
Alaska 99622-0049



RESOLUTION NO 07-05 02

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Native Village of Kwinhagak is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and:

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and,

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and,

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and:

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** Native Village of Kwinhagak requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and:

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and:

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The Native Village of Kwinhagak only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**We, the undersigned, hereby certify that the Native Village of Kwinhagak is composed of 7 members, of who 6 constituted a QUARUM were present and that the foregoing resolution was PASSED AND APPROVED by the Native Village of Kwinhagak Council this 23 day of May 2007.**

**CERTIFICATION**

Joshua Cleveland
President

[signature]
Secretary

MAY 2 0
N.P.F.M.C

NEWTOK TRADITIONAL COUNCIL
P.O. BOX 5545 NEWTOK, ALASKA 99559 PHONE (907) 237-2314 FAX (907) 237-2321

**RESOLUTION # 07-25**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

Whereas, the Newtok Traditional Council is a federally recognized tribe located on the Bering Sea coast; and

Whereas, the village depends on these waters and habitat for resources essential to our way of life; and

Whereas, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, salmon and crab…; and

Whereas, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

Whereas, warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

Whereas, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas, bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

Whereas, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

Whereas, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

**Whereas The North Pacific Fisheries Management Council is a federal agency and as such Must adhere to a federal policy that requires the U. S. Government to consult with individual Tribes about how federal actions may affect them; and**

NOW THEREFORE BE IT RESOLVED THAT the Newtok Traditional Council requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

Be it further resolved that that the Environmental Assessment is narrowly focused on fish habitat such that that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

**NOW THEREFORE BE IT FURTHER RESOLVED THAT we only agree to support Alternative 2 contingent on the North Pacific Fishery Management Council committing to a two (2) year review to address subsistence comprehensively.**

Be it further resolved that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

President

Secretary

Adopted by the Newtok Traditional Council on May 15, 2007.

Nightmute Traditional Council
POB 90021
Nightmute, Alaska 99690
(907) 647-6215 Telephone
(907) 647-6172 Fax

RECEIVED
MAY 2 3 2007
N.P.F.M.C

**RESOLUTION # 05-02-07**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Nightmute Traditional Council is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** The requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by the on May 16 , 2007 where a quorum of the Nightmute Traditional Council was present.**

Joe Post, President

Council Member

# City of Toksook Bay

P.O. BOX 37008
TOKSOOK BAY, ALASKA 99637
PHONE (907) 427-7613
FAX (907) 427-7811



**Resolution No. 07-01**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The City of Toksook Bay is the municipal governing entity of the Community of Toksook Bay, and;

**WHEREAS:** The community of Toksook Bay depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, seabirds and small commercial fisheries for halibut and herring, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and:

**WHEREAS:** The movement of the groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and:

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and:

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and most certainly impact the ecology and subsistence foods negatively, and:

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and:

**NOW THERFORE BE IT RESOLVED THAT:** The community of Toksook Bay requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THERFORE BE IT FUTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THERFORE BE IT FURTHER RESOLVED THAT:** The community of Toksook Bay only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively, and;

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by the Community of Toksook Bay on May 18, 2007 where a quorum of the Toksook Bay City Council was present.**

Pius Agimuk, Mayor

Priscilla Moses, Secretary

2?? - 5? ?3

NATIVE VILLAGE OF TUNUNAK
Tununak I.R.A Council
P.O. Box 77
Tununak, Alaska 99681-0077
(907) 652-6527-phone
(907) 652-6011-fax
Tribe2work@yahoo.com



**RESOLUTION NO. 05-07-06**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** The Native Village of Tununak is a federally recognized tribe located on the Bering Sea Coast, and,

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and,

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and,

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT**: The Native Village of Tununak requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and,

**NOW THEREFORE BE FURTHER RESOLVED THAT**: The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The Native Village of Tununak only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT**. No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by the Native Village of Tununak on May 7, 2007 where a quorum of the Tribal Council was present.**

George B. Hooper, Sr., President

Susie Walter, Secretary

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Chefornak Traditional Council
P.O. Box 110
Chefornak, AK 99561

Resolution No. 06-12-01

WHEREAS, the Chefornak Traditional Council is the recognized sole governing body of the Chefornak Native Village recognized by the United States; and

WHEREAS, the North Pacific Fishery Management Council is in charge of management and conservation of Bering Sea Fisheries under federal jurisdiction; and

WHEREAS, the North Pacific Fishery Management Council is considering whether or not to establish and "open area" in the Bering Sea where bottom trawl fisheries may operate in the future;

WHEREAS, the Council is discussing where the boundaries for the "open area" should be based on past fishing activity; and

WHEREAS, our communities rely on halibut, herring, salmon and other fish for our local commercial fisheries and for traditional subsistence resources; and

WHEREAS, the Nelson Island villages are concerned about the impact of bottom trawl fisheries on waters and habitat nearby our communities; and

WHEREAS, bottom trawl fisheries have occurred in our waters in the past that we believe has had negative impact on our near shore resources.

NOW THEREFORE BE IT RESOLVED THAT, the Village of Chefornak supports the North Pacific Council's effort to limit bottom trawling;

BE IT FURTHER RESOLVED THAT, we recommend protecting areas important for our fishery resources including Etolin Strait and the waters south of Etolin Strait roughly between Nunivak Island and Cape Newenham (the southern end of Kuskokwim Bay);

BE IT FURTHER RESOLVED THAT, the Village of Chefornak offers to work with the North Pacific Fishery Management Council to define the boundaries necessary to protect our commercial and subsistence resources.

CERTIFICATION

Passed and approve on this 9th day of December 2006, at which a quorum of the Council members were in attendance. The Council vote taken was: 4 FOR and 0 AGAINST.

BY: [signature]
Chefornak Traditional Council Vice-President

ATTEST: [signature]
Chefornak Traditional Council Secretary

WWF

World Wildlife Fund
Kamchatka/Bering Sea Ecoregion
406 G. Street, Suite 303
Anchorage, AK 99501 USA

Tel: (907) 279-5504
Fax: (907) 279-5509

www.worldwildlife.org

May 29, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 West 4th Street, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 W. 9th Street
Juneau, AK 99802-1668

Dear Ms. Madsen and Mr. Mecum,

World Wildlife Fund (WWF) appreciates the opportunity to comment on the subject of Bering Sea Habitat Conservation. WWF is a global conservation organization with over 1.2 million members in the US and over 2,000 members in Alaska. WWF seeks science-based, non-partisan, collaborative, and creative solutions to conservation issues. We submit this letter in support of the Bering Sea Essential Fish Habitat (EFH) Conservation Alternative 2 for agenda items D-3(a) Bering Sea Essential Fish Habitat Conservation and D-3(b) for Habitat Areas of Particular Concern (HAPC) Priorities and Timing.

Agenda Item D-3(a) Final action on Bering Sea habitat conservation measures

Under agenda item D-3(a), Alternative 2 represents the most responsible and precautionary option to ensure that sensitive marine habitats are protected from adverse fishing impacts. Alternative 2 would also be a prudent step toward Ecosystem Based Management. The Bering Sea is home to numerous whale species, Pacific walrus, Steller sea lions, and seals. Eighty million seabirds of 30 different species, the largest convergence in the world, feed in the Bering Sea every year. These are all non-fish species that make up important components of the ecosystem that could be substantially affected by the encroachment of concentrated fishing effort by mobile bottom contact gear in these sensitive northern areas. The relationship between these non-fish species and the marine habitat, including all fish species, is poorly understood and must be carefully studied before significantly impacting the habitat in a way that could "cut the head off the goose that lays the golden eggs."

Additionally, the precautionary approach of establishing a northern boundary observes the complexities and uncertainties in the marine ecosystem associated with climate change. It is well-established the climate is changing, regardless of the source of that change. More importantly, climate change poses serious consequences for the North Pacific, particularly the Bering Sea. A precautionary northern boundary is a necessary step to further the efforts of addressing and mitigating these changes.

While WWF commends the attempt to incorporate a scientific program within Option 4, the existing option falls short of providing the appropriate vehicle for ensuring prudent scientific management in the northern area. WWF supports designation of the area beyond the open area footprint as a more expansive ecosystems research area, but not for the purpose of researching trawling effects alone. Lightly trawled and untrawled areas exist within the footprint defined by Alternative 2. The adaptive management plan currently envisioned in Option 4 could easily be achieved in the open area. Thus, we fully support a careful research design within the existing bottom trawl footprint to assess the impacts of trawling. However, untrawled habitat beyond the open area footprint, which forms the basis for the open area approach, need not be destroyed to support the trawling research considered under Option 4.

We support additional research beyond the open area footprint that includes long-term monitoring, habitat surveys, and baseline ecosystem research. Furthermore, we believe that long-term monitoring, habitat surveys, and baseline ecosystem research should constitute primary criteria for Exempted Fishing Permits under 50 C.F.R. §679.6 issued for the area beyond the footprint. Therefore, while we support research considered under Option 4, we believe it should incorporate the ecosystem concepts relative to the open area approach described above.

Agenda Item D-3(b) Review HAPC priorities and timing

WWF regrets that the Council failed to include the Bering Sea canyons in the EFH analysis. However, we strongly recommend that the Council address the unique habitat contained in the Bering Sea canyons under agenda item D-3(b) for HAPC Priorities and Timing. WWF remains concerned about the Zhemchug, Pribilof, and Pervenent Canyons and their importance to pelagic species such as squid, juvenile pollock, and deep-sea smelt. As we have stated previously, existing information demonstrates that the Bering Sea canyons contain distinct benthic habitats such as high relief structures like pinnacles, boulders, and steep walls as well as biogenic habitats including corals, sponges, and sea whips. These specific habitats are known, among other things, to provide important refugia for juvenile fish. Additionally, the unique hydrographic features of the canyons form one of the principal bases for productivity in the Bering Sea ecosystem through nutrient upwelling and deposition. The recent unusual capture of a 60 pound, 100 year old shortraker rockfish in a pelagic trawl operating in the canyon areas south of the Pribilof Islands underscores these facts.

WWF also wishes to again emphasize the importance of pelagic habitat, particularly as it relates to ecosystem management concepts and EFH. It is clearly understood that the presence of prey concentrated in pelagic habitat is in itself a characteristic of habitat suitability and can be "essential." Prey species are often concentrated by hydrographic features that define areas of pelagic habitat, such as the upwelling areas that occur in the Bering Sea canyon areas. Bering Sea squid represent an example of an important trophic species that aggregates in shelf edge pelagic habitat and canyons and, by their presence, define such habitat for other species. Concentration of squid bycatch in space and time presents a risk due to the unique life cycle of squid and raises concerns regarding forage availability of not only other managed fish species, but also of marine mammals such as the northern fur seal and Steller sea lion. The issue of forage availability remains particularly sensitive near the Pribilof Islands and the adjacent canyon areas.

Conclusion

WWF urges the Council to select Alternative 2, for agenda item D-3(a) Bering Sea EFH Conservation, as a first step in developing true ecosystem-based fishery management for the Bering Sea. Restricting the northward expansion of concentrated fishing effort by mobile bottom contact gear into the sensitive Arctic areas will help protect the resilience of Arctic ecosystems and prevent additional pressure on currently-stressed wildlife and important marine habitat areas. Furthermore, under agenda item D-3(b), WWF urges the Council to expedite the process for considering Zhemchug, Pribilof, and Pervenent canyons and associated pelagic habitat as HAPC.

Thank you for your time and consideration of these comments.

Respectfully,

Alfred Lee "Bubba" Cook Jr.
Kamchatka/Bering Sea Ecoregion Senior Fisheries Program Officer
World Wildlife Fund

OCEANA | Protecting The World's Oceans

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May 29, 2007

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Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

RE: Agenda item D3 – Bering Sea Habitat Conservation

Dear Madame Chair and Mr. Mecum:

After seven years of discussion, you now face a decision whether to protect habitat in the Bering Sea. We are writing now to urge you to take action to protect the northern Bering Sea and Arctic by preventing bottom trawling from expanding into the currently untrawled areas of this northern ecosystem. Alternative 2, with its concept of freezing the footprint of bottom trawling, would protect the seafloor habitat of Kuskowim Bay, Etolin Strait, Nunivak Island, St. Matthew Island, St. Lawrence Island, Norton Sound, and Kotzebue Sound. This is an entirely precautionary step, with almost no cost to the fishing industry, and will go a long way in mitigating cumulative impacts to a system already stressed from global warming[1].

There are many reasons why you must protect the northern Bering Sea from bottom trawling. First and foremost, the northern Bering Sea is an ecosystem reliant on benthic production from healthy seafloor habitat. The animals that have evolved there rely on food from the seafloor. There is a short and direct link from benthic production to the large populations of benthic-feeding marine mammals and seabirds[3]. It is well known that bottom trawling affects seafloor habitat and can have wide-ranging ecological consequences by reducing habitat complexity, benthic productivity and biodiversity[4]. Bottom trawling would be an additional stressor that could compromise the resilience of the northern Bering Sea ecosystem, at a time when the ecosystem cannot afford any additional stresses.

In the northern Bering Sea, Endangered Species Act-listed spectacled eiders congregate in ice-leads to feed on small clams. In fact, the entire world's population of these birds gather in one flock. This

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[1] Grebmeier, J.M., J.E. Overland, S.E. Moore, E.V. Farley, E.C. Carmack, L.W. Cooper, K.E. Frey, J. H. Helle, F.A. McLaughlin, and S. L. McNutt. 2006. A major ecosystem shift in the Northern Bering Sea. Science. Vol. 311: 1461-1464.

[3] Grebmeier, J.M. and K.H. Dunton. 2000. Benthic process in the northern Bering/Chukchi seas: status and global change, pp. 61-71. Impacts of Changes in Sea Ice and other Environmental parameters in the Arctic. Report of the Marine Mammal Commission Workshop, 15-17 February 2000, Girdwood, Alaska.

[4] National Research Council. 2002. Effects of Trawling and Dredging on Seafloor Habitat.

wildlife spectacle was unknown to science for 120 years, until being recently discovered in 1999[5]. What other secrets the northern Bering Sea holds we can only guess.

The National Marine Fisheries Service has stated that allowing bottom trawling to expand into new areas without identifying coral and sponge habitat would result in adverse impacts to such habitat[6]. Subsequently, NMFS developed a National Deep Sea Coral and Sponge Conservation and Management Strategy, which includes measures for NMFS to work with the Councils to prohibit expansion of bottom trawling into new areas[1]. Alternative 2, which prevents expansion of bottom trawling, is entirely consistent with this strategy. Alternative 2 is timely as well; recently, trawl surveys in the Canadian Arctic have reported red tree corals and bubblegum corals as bycatch.

We recognize the merits of research and will continue to encourage research, but it would be irresponsible to frame research within a mandate to open an unexploited ecosystem to industrial bottom trawling by factory trawlers, as is expressed by the Northern Bering Sea Trawl Research Area of Option 4. Instead of Option 4, we support a careful research design within the existing bottom trawl footprint to assess the impacts of trawling. Within the footprint defined by Alternative 2 are lightly trawled and untrawled areas which should be used in an adaptive management experiment to study the effects of trawling in previously untrawled areas. Further, we encourage ecosystem study of the northern Bering Sea, including long-term monitoring, habitat surveys, and establishing a baseline from which to track ecosystem changes. These research conditions should be fulfilled prior to any consideration of an Exempted Fishing Permit beyond the northern boundary line established by Alternative 2.

Throughout this long process we have participated actively, and have objected to the erroneous omissions of options such as shelf break protections, research closures, and consideration of effects of pollock trawling that would have helped comprehensively protect habitat in the Bering Sea. As a result, the options to protect Bering Sea habitat before you are quite limited. Therefore, in addition to adopting Alternative 2 to freeze the bottom trawl footprint of the Bering Sea, we also encourage the Council to establish a process to identify and protect the Important Ecological Areas of the Bering Sea such as submarine canyons and skate nurseries that are within the open trawl area. As we have stated before, unless and until the Council and NMFS implement regulations which minimize the adverse effects of fishing on essential fish habitat in the Bering Sea, federal fisheries will continue to be out of compliance with legal mandates.

Consideration of habitat protection in the Bering Sea has taken a long time, and has not been easy. We appreciate the time and effort that the Council and staff have devoted to the issue. We recognize that there may be concerns by the trawling industry over boundary lines, but this should not preclude you from taking action now to prevent expansion of bottom trawling and adopt Alternative 2. As we have seen before, boundary concerns can be addressed fairly quickly within the Council process, and we encourage you to address those concerns later. More importantly, we encourage you to regularly evaluate the impacts of commercial fishing on the subsistence needs of coastal communities and work with communities to adjust boundaries as necessary.

Thank you for allowing us this opportunity to comment. We urge the North Pacific Fishery Management Council to stop the expansion of bottom trawling into the northern Bering Sea by adopting Alternative 2.

Sincerely,

Jim Ayers
Vice President, Oceana

---

[5] Peterson, M.R., W.W. Larned, and D.C. Douglas. 1999. At-sea distribution of spectacled eiders: a 120 year old mystery resolved. The Auk, vol. 116, no. 4, pp. 1009-1020.
[6] 50 CFR Part 600, Federal Register, Vol. 70, No. 131, July 11, 2005.

**Groundfish Forum**

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Seattle, WA 98199
(206) 213-5270 Fax (206) 213 5272
www.groundfishforum.org

MAY 29 2007

N.P.F.M.C.

May 29, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. 4th Avenue
Anchorage, AK 99501-2252

Re: Agenda Item D-3: Bering Sea Habitat Conservation

Dear Madam Chair,

Groundfish Forum represents many of the non-AFA trawl catcher-processors that participate in Bering Sea flatfish fisheries – vessels that will be impacted by the Council's final action on Bering Sea habitat conservation at your upcoming meeting. We are writing you to offer our support and agreement with the letter you received from the 'H&G Workgroup' (John Gauvin) on this issue.

Specifically, we support continued work on the gear modification action (Alternative 3), inclusion of the 'wedge' between St. Matthews and Nunivak Islands in the area immediately available for fishing, and (should the Council choose to establish a Northern Research Area) a true research plan to compare areas impacted by commercial fishing to those which have not been fished.

**Gear modification**

Groundfish Forum supports gear modifications to minimize the impact of our gear while allowing continued viable fishing to occur. The elevating devices described in Alternative 3 should accomplish this. Having said that, we also recognize that there has not been enough field testing of the actual devices to confirm the optimum spacing and attachment techniques, or to be certain that the devices will work on vessels which use sweep winches. Gear regulations are notoriously difficult to write and it is extremely important to know that the specifications are realistic and effective. We need to be sure that the devices can be attached securely without compromising the strength of the sweep itself and, especially, that the devices will not pose a safety hazard on deck. If there is a gear failure due to the attachment technique or difficulty clearing a fair-lead, it is likely to occur on deck where the risk of injury to the crew is high. Further testing will ensure that the modifications work as intended, which will improve buy-in by the vessels using them.

**The 'wedge'**

The area between St. Matthews Island and Nunivak Island referred to as the 'wedge' is the area most likely to be needed by the non-AFA trawl CP sector in the near future, assuming the current pace of climate change continues. This is a relatively small area which has already experienced some fishing effort. Leaving this are open will buy time for the Council and NMFS to consider how to proceed in the Northern area without an immediate impact on the fishery. With so much uncertainty surrounding climate change and the movement of fish stocks, it is prudent to allow the fleet to operate in this area, if necessary.

**Northern Research Area**

Groundfish Forum supports science-based research to determine the impact of bottom fishing. The Northern Research Area could provide the opportunity to make clear comparisons between areas that are commercially fished and those that are not. However, for this to be accomplished there must be areas open for commercial-scale fisheries. If this becomes a default 'closed area' no knowledge is gained, and if it is only open for small-scale (EFP) experimental fishing it does not serve the intent either.

It's important to recognize that the Council does not need to take action to 'look green.' The NPFMC has a strong record of conservative management through harvest levels, gear restrictions and area closures. Taking the time to consider how fishing should occur in the northern area fits with this conservative approach; prohibiting it altogether (through a closed area or a 'research area' which is never open) does not, especially when the closure will only apply to one type of bottom contact fishing gear.

In summary, we support the comments offered by Mr. John Gauvin on behalf of the H&G Workgroup. We support sweep modifications and request that the final method for implementation be determined after more testing can be done. We ask that the Council leave the 'wedge' between St. Matthews and Nunivak Islands open to allow for possible short-term stock movements. Finally, we ask the Council to either leave the Northern area open, or to close it contingent on the development of a true research plan which includes opportunities for viable commercial fisheries along with protections for areas of concern.

Thank you for the opportunity to comment.

Sincerely,

Lori Swanson
Executive Director

**H&G WORKGROUP**
2104 SW 170TH STREET • BURIEN, WA 98166
PHONE (206) 660-0359 • FAX: (206) 243-

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MAY 29 2007
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Ms. Stephanie Madsen
Chairman, NPFMC
605 W. 4th Avenue
Anchorage, AK 99501-2252

May 29, 2007

RE: D-3- Bering Sea Habitat Conservation

Dear Madame Chair:

The H&G Workgroup was formed in early 2006 to represent the perspective of the head and gut (H&G) trawl sector on environmental issues affecting fisheries for flatfish and other demersal species. After reviewing the current Bering Sea Habitat Conservation EA "Draft for Final Action", we have the following comments on the alternatives for final action. Thanks in advance for considering our views on this important action.

**Alternative 3: Gear modifications and options for area closures:**
Gear modifications: The H&G sector remains solidly in support of an eventual requirement to use modified trawl sweeps for flatfish fishing. For this reason, we support the Council's conceptual approval of the Alternative 3 sweep modification at this time. We use the term "conceptual" approval for the following reason: the research on sweep modifications has demonstrated that modified sweeps reduce seafloor contact and effects on typical Bering Sea emergent epifauna. However, some important technical issues remain unresolved as to methods to attach the elevating devices to the sweeps and efficacy and safety of deployment/retrieval of the modified sweeps for deck crew. As the Council learned from its development of measures to reduce interactions with sea birds on longline vessels, gear modifications take time. Implementation must reflect the realities of the actual conditions in the field.

When the disc/bobbin height and spacing specifications from Dr. Rose's sweep mod research were presented to the Council late last fall, the H&G Workgroup and the Groundfish Forum reviewed these findings with flatfish captains at a Council workshop and a subsequent captains' meeting. These meetings covered the need for field testing in the flatfish fishery this winter/spring to confirm that the discs and bobbins can be safely deployed and remain attached under regular commercial fishing conditions. Another important implementation issue affects the six H&G vessels that are not equipped with net reels. Field testing for those vessels is needed to confirm deployment and retrieval where the discs/bobbins are rolled onto and off of the main winches which are equipped with level wind devices.

In truth, with the fast pace of the open access fishery for Bering Sea flatfish, our plan to have the captains conduct thorough field testing in the regular fishery proved overly ambitious. The limited testing that did occur however exposed some (hopefully small) problems. For this reason and in light of the fact that the Council intends to take final action on Bering Sea EFH this June, we recommend the Council approve the sweep modification in concept and allow the flatfish industry to continue to work with Dr. Rose and the NMFS Regional Administrator to conduct additional field testing and development of solutions to any remaining challenges for attachment and deployment of the modified sweeps.

Although some field trials of the modified sweeps are underway currently, given the high effort level in flatfish fisheries by all sectors this year and the small remaining amounts of flatfish TAC and PSC caps, we simply do not have sufficient fishing opportunity for resolving implementation issues this summer/fall. Assessment of the issue of wear rates for the elevating devices is of particular concern here. As we hope the Council recognizes, a great deal of work has gone into the research on sweep modification. For this reason, we feel that a slight modification to the implementation schedule is warranted given the substantial anticipated benefits from the sweep modification. Frankly, a successful overall outcome is more likely with this adjusted implementation timeline because missteps and implementation mistakes that could require much more extensive revision to the implementation schedule will hopefully be avoided.

To keep the flatfish industry's "feet to the fire" to resolve the remaining technical issues as expeditiously as possible, we suggest that the Council ask NMFS and the flatfish industry for a preliminary report on field testing and technical implementation issues in June of 2008. With Amendment 80 in place in January of 2008, the flatfish industry will have a viable opportunity to address remaining practical and safety issues early next year. Descriptions of the modified sweep testing activities can also be added to Amendment 80 cooperative reporting requirements for the first year of the H&G coops.

Options within Alternative 3 for area closures: The H&G Workgroup supports Option 4 "Northern Research Area" with the sub-option for removing from the closure the "wedge" east of St. Mathews (as described in the EA). A few significant changes to the intent language of the Northern Research Area are also needed as described below.

We support a Northern Research Area that is actually a research area and not just something that looks good on paper to non-fishing interests. So once the protection areas for marine mammals, opilio and king crab, ESA listed sea birds, and coastal communities are delineated from within the Northern Research Area, the alternative needs to allow viable commercial flatfish fishing to a portion of the remaining area. If climate change results in a significant northern shift of the flatfish biomass, then the future viability of the flatfish fishery may well depend on our ability to have sufficient access to this area. We think the current language fails to clearly express the intent that the fishing area portion of the Northern Research Area is for regular commercial fishing and not just for a few vessels to be allowed to fish under an EFP or other small-scale research.

Management information needs are for an evaluation of habitat and species diversity effects of full scale flatfish fishing so we can better understand how flatfish and other bottom contact fishing affects habitat in a controlled experiment.

The proposed timeline for development of the experimental plan for the Northern Research Area needs adjustment as well. The current language in the motion allows eighteen months from the date of publication in the FR of the EFH measures for development of an experimental design. We believe this is probably too short a timeframe and feel 36 months would better allow for development of a sound and informative experiment. At the same time, we feel strongly that the only way the experimental design will ever actually be developed and implemented is if the Council puts a sunset date on the Northern Research Area closures, (the portion of that Northern Research Area that are not part of the individual protection zones such as Etolin Strait/Nunivak/Kuskokwim Bay, and the St. Mathews and St. Lawrence crab protection zones). The sunset would allow the flatfish fishery to once again access the areas outside those individual protection zones if an experimental design is not developed within the 36 month timeframe.

**Alternative 2**: Advocates for Alternative 2 appear to believe that Alternative 2 captures the same intent and benefit of the Northern Research Area option in Alternative 3. We do not believe that this is the case. Alternative 2 is substantially different in two very important ways. First, Alternative 2 is plainly a permanent closure without a research component and hence it is purely aimed at setting aside large expanses of the Bering Sea rather than fishery management.

Additionally, Alternative 2 includes the creation of a no bottom trawl zone along the western extent of the deepwater basin. We do not support this approach for several reasons. One reason is that effect scores of the flatfish fishery on the slope were relatively low so there is no pressing need to pursue mitigations in this area. Another reason is that we do not know how the proposed closure lines would be drawn and how they would affect even our current fisheries. Like the SSC, during the development of this alternative, we have repeatedly asked for but have not been provided the detailed charts depicting the delineations of the western boundary lines along with bathymetric contours. These were needed while the captains were still in town last fall and winter to figure out how the lines would affect our current fishing opportunities. While we have been told that the lines would not really affect much of our current fishing, we have no way of confirming this.

As we learned during the development of coral protections in the Aleutian Islands, initial proposals that were also not supposed to affect our current fishing activities would have actually curtailed our access to many important fishing grounds. This is because while the haulback positions may have been included in the area where fishing would still be allowed, much of the fishing grounds fell outside. This was discovered once we were provided the detailed charts and had the opportunity to sit down with captains and review the proposed closure lines in the context of their plotter information. This is something we have not been able to do in this case (despite receiving tables with all the positions of the closures on May 15th) so we are actually not even able to evaluate how current fishing would be affected.

Finally, there is the equally important question of how Alternative 2 might affect future fishing opportunities in the Bering Sea. Experienced fishing captains have pointed out that the future development of an arrowtooth flounder fishery in the Bering Sea depends on access to the slope and in some cases deepwater basin. Arrowtooth flounder is a resource that competes with Bering Sea pollock and like pollock is of very significant biomass. It is also a fish for which developing markets hold exciting promise for economic development. We feel it would be irresponsible of the Council to approve a measure that could so radically affect potential for development of a fishery for this resource. For this reason, we prefer that the Council take the perspective of fishery managers here and focus on mitigating effects of a Bering Sea arrowtooth fishery on the slope (should one develop), instead of considering measures that might well make a significant portion of this resource inaccessible.

Thanks in advance for considering our comments and we look forward to further discussions of these matters in Sitka in June.

Sincerely,

John R. Gauvin

Date: May 22, 2007



Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Industrial scale bottom trawling is not a sustainable fishery management policy. Reign it in!

Sincerely,

Name: Steve Engel

Address: POB 4164

City: Portland State: OR Zip: 97208-4164

Email:

Date: May 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Please, please, please stop the destruction. We need the ocean!

~~Sincerely,~~ BEST FISHES!

Name: Mary Heeney
Address: 532 Mariposa Ave
City: Mtn. View State: CA Zip: 94041
Email: mary@malindi.com

Date: MAY 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

– ADDITIONALLY – PLEASE DO NOT HEED THOSE WHO CLAIM THAT DEEP SEA BOTTOM HABITAT IS DISPOSABLE – WHILE THERE MAY NOT BE "SCIENTIFIC EVIDENCE" PROVING THE IMPORTANCE OF THIS HABITAT, THERE IS NO SCIENTIFIC EVIDENCE PROVING ITS UN-IMPORTANCE – PRECAUTION

Sincerely,

Name: MICHAEL STOCKER
Address: P.O. BOX 559
City: LAGUNITAS State: CA Zip: 94938
Email: mstocker@msa-design.com

Date: 5/24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.** ONLY

Sincerely, D E Cooley

Name: DONALD E. COOLEY
Address: [illegible]
City: ...GHAM ROAD State: Zip:
Email: ...VILLE, CA 95076

D-3

Date: May 21, 2007

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N.P.F.M.C.

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Thank you so much for your careful consideration! Please do the right thing for this generation, and those that will follow us.

Sincerely,

Name: Cheryl Eldemar
Address: P.O. Box 32044
City: Juneau State: AK Zip: 9980?
Email:

Date: May 22, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Sincerely,

Name: Kent Benedict, MD
Address: 3283 Valencia Ave.
City: Aptos State: CA Zip: 95003
Email: skylax@cruzio.com

Date: 26 May, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Sincerely,

Name: Jud + Joyce Vandevere
Address: 93 Via Ventura
City: Monterey State: CA Zip: 93940
Email: jvan@mbay.net

Date: May 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

It is so important we protect our resources from distruction so future generations can enjoy them too!

Sincerely,

Name: Andrea Carvalho
[illegible]

Date: 05/25, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Sincerely,

Name: Scott Rainey
Address: 5514 SE Henderson Str
City: Portland State: OR Zip: 97206
Email:

Date: May 25, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Please!

Sincerely,

Name: Anita Bradley
Address: PO Box 2047
City: Carmel State: CA Zip: 93921
Email:

Date: May 25, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

We need to act now to protect this area.

Sincerely,

Name: Marlene Martin
Address: 26455 Via Mallorca
City: Carmel, CA 93923-9503 State: Zip:
Email: mlmaclen4@aol

Date: May 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

For long-term protection of this unique resource, we urge your adoption of measures that will ensure this future. Thank you for your stewardship of our nation's great marine resources.

Sincerely,

Name: Ann & Dobie Jenkins
Address: 35 LOMA PRIETA AV.
City: FREEDOM State: CA Zip: 95019
Email: ANN_DOBIE@YAHOO.COM

Date: MAY 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

THANK YOU FOR YOUR CONSIDERATION OF THIS REQUEST. ONCE THESE RESOURCES ARE GONE, THEY ARE LOST FOR OUR LIFETIMES AND MANY MORE AS WELL.

Sincerely,

Name: GARY GRIGGS
Address: 326 ALTA AVE
City: SANTA CRUZ State: CA Zip: 95060
Email: GRIGGS@PMC.UCSC.EDU

Date: MAY 25, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

please strongly consider the alternatives.

Sincerely,

Name: ROGER WOLFE
Address: 190 LAGUNITA DR.
City: soquel State: CA Zip: 95073
Email: rogwolfe@cruzio.com

Date: May 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Sincerely,

Name: Robin McGinnis
Address: 6835 SW Capitol Hill Rd #31
City: Portland State: OR Zip: 97219
Email:

Date: 5/24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Please help preserve the habitats, on which our ocean depends!

Sincerely,

Name: DAN HAIFLEY
Address: 2635 Fresno Street
City: Santa Cruz State: CA Zip: 95062
Email:

Date: May 24, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

please do everything you can to help preserve our wild oceans and fishes

Sincerely,

Name: E. Holmes
Address: 172 Emmanuel Ave
City: Atherton State: CA Zip: 94027
Email:

Date: 22 MAY, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

I'VE DEVOTED MY ENERGIES AND CAREER TO THE CAUSE OF SALMON AND STEELHEAD RECOVERY IN THE COLUMBIA BASIN. I WORK TO SPEND $600 MILLION / YEAR WISELY. PLEASE DO NOT UNDERMINE MY WORK; BUT TAKE ACTION TO PROTECT THIS ESSENTIAL HABITAT AND COMPLEMENT THIS REGION'S EFFORTS.

Sincerely, and with gratitude -

Name: André L'Heureux

Address: 13760 SWORDFERN CT

City: OREGON CITY State: OR Zip: 97045

Email:

---

Date: May 23, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

In addition research should be undertaken on (1) restoring habitat in trawled areas and (2) the design of trawling equipment that would be less injurious to the bottom where used. Trawling to date has been undertaken in the implicit belief that future trawling would be done elsewhere that is [illegible] imaginable

Sincerely,

Name: Steve Staloff

Address: PO Box 1711

City: Portland State: OR Zip: 97207

Email: [illegible]@aracnet.com

---

Date: 5/23, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

THANK YOU FOR YOUR EFFORTS TO PROTECT OCEAN HABITAT. DOING SO IS CRITICAL FOR A HEALTHY OCEAN ECOSYSTEM. THIS IS AN IMPORTANT STEP IN PRESERVING MARINE LIFE FOR THIS AND FUTURE GENERATIONS

Sincerely,

Name: CHRISTINA WEBER

Address: 7015 NE PACIFIC ST

City: POR ND State: OR Zip: 97213

Email:

---

Date: 24 May, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

the Time is overdue To stop excessively destructive fishing methods and manage fisheries in a sustainable way.

Sincerely, H Mitteldorf

Name:

Address:

City:

Email:

Ms. Harriet Mitteldorf
942 Coral Dr.
Pebble Beach, CA 93953

Date: May 22, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Thank - You!!

Sincerely,

Name: Had Walmer

Address: 4136 Old Gate Road

City: Lake Oswego State: OR Zip: 97034

Email: hwalm@gmail.com

Date: 5/23, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

PLEASE => Ban "Industrial" "Scraping" of sea floor!
=> Limited fishing season w/ sustainable fishing methods.

Sincerely,

Name: Kevin Blow

Address: PO Box 952

City: Lake Oswego State: OR Zip: 97034

Email: fabridesign@comcast.net

Date: 22 MAY, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

Sincerely, Gregor M. Cailliet

Name: GREGOR M. CAILLIET

Address: 712 GRACE STREET

City: MONTEREY State: CA Zip: 93940

Email: cailliet@mlml.calstate.edu

Date: May 23, 2007

Dear Ms. Madsen:

**We must protect ocean habitat in the northern Bering Sea and Arctic from destructive bottom trawling.**

**As you consider management alternatives for Bering Sea habitat conservation, please adopt Alternative 2 to freeze the current bottom trawl footprint in the Bering Sea and prevent industrial trawling vessels from moving North.**

If you truly care about generations to come, please consider this as a legacy for your children, grandchildren and beyond. In our Monterey, CA area we've been successful in preserving a major coastal area.

Sincerely, Clay Berling

Name: CLAYTON BERLING

Address: 2935 FRANCISCAN WAY

City: CARMEL State: CA Zip: 93923-9216

Email: [illegible]

PACIFIC ENVIRONMENT

*Protecting the living environment of the Pacific Rim*

May 29, 2007

Stephanie Madsen
Chair
North Pacific Fishery Management Council
605 W. 4th Ave, Suite 306
Anchorage, AK 99501

Doug Mecum
Regional Administrator
NOAA Fisheries
Alaska Region
709 W. 9th St.
Juneau, Alaska 99802-1668

Additional D-3 comments like this form letter can be reviewed at the secretary's desk

RE: Essential Fish Habitat in the Bering Sea

Dear Ms. Madsen and Mr. Mecum:

Pacific Environment appreciates this opportunity to comment on Essential Fish Habitat protections for the Bering Sea. As a non-governmental organization, PE works to protect the living environment of the Pacific Rim by strengthening democracy, supporting grassroots activism, empowering communities, and redefining international policies. A hard copy of these comments has also been sent via U.S. mail.

As you are aware, the Bering Sea is one of the most productive marine ecosystems on the planet and, we believe, worthy of protective measures that ensure ecosystem integrity and productive fisheries for generations to come. As such, it is imperative that Essential Fish Habitat protections are responsive to the growing body of scientific literature on the effects of trawling on seafloor habitat.[1] Based on a review of the literature and our extensive involvement in this process, we believe that freezing the footprint of bottom trawling in the northern Bering Sea by the adoption of Alternative 2 is the most practicable management measure currently in front of the NPFMC.

Only Alternative 2 would provide the necessary protection to seafloor habitat and the complex ecology of the Bering-Chukchi ecosystem. Walrus, seabirds, whales, and a multitude of fish species are dependent upon this relatively undisturbed ecosystem, and permitting the expansion of bottom trawling into this region would compromise the integrity of an area that has supported communities and wildlife for millennia. Considering the ongoing impacts that global warming is having on this area, it is simply not prudent to permit yet another stressor to impact this unique region.

---

[1] Steele et al., National Research Council Study on the Effects of Trawling and Dredging on Seafloor Habitat. 2005. Pages 91-99 *in* P.W. Barnes and J.P. Thomas, eds. Benthic Habitats and the Effects of Fishing. American Fisheries Society, Symposium 41, Bethesda, Maryland.

*308 G St. Suite 202 ▪ Anchorage, AK 99501*
*tel. 907.277.1029 ▪ fax. 907.929.1562 ▪ www.pacificenvironment.org*

As you are aware, our constituency has been engaged on this issue for many years, and has often weighed in on the need for further restrictions on bottom trawling, especially in areas that have as of yet seen any significant trawling. We sent out an update on the issue and provided the opportunity for members to weigh in on the alternatives. Attached is a sampling of the responses we received from people internationally, around the U.S., and in Alaska. Please give these comments due consideration.

Thank you for consideration of these comments. I look forward to continuing to work with the NPFMC and NMFS on this issue.

Sincerely,

Whit Sheard
Alaska Program Director
Pacific Environment

***308 G St. Suite 202 ▪ Anchorage, AK 99501***
***tel. 907.277.1029 ▪ fax. 907.929.1562 ▪ www.pacificenvironment.org***

Export PDF

North Pacific Fishery Management Council
Historic Old Federal Building
4th Avenue, 3rd Floor
Anchorage, Alaska

Dear members of the North Pacific Fishery Management Council:

I am writing to urge you to protect essential fish habitat in the Bering Sea by adopting Alternative 2, which would freeze the footprint of bottom trawling in the Bering Sea. Alternative 2 would provide the most reasonable protection from damage to the wildlife, communities and ocean habitats of the northern Bering Sea while having a minimal impact on the economic health of existing fisheries and fishing communities.

Bottom trawling is inappropriate in the northern Bering Sea for several reasons:

• There is little history of trawling in this region and it is well established that the first pass of a bottom trawler causes the most damage to the seafloor;
• The National Academy of Science has recommended restrictions on bottom trawling;
• The Arctic is already facing stress from the impacts of global warming;
• The northern Bering Sea and Chukchi Sea serve as essential habitats to a multitude of marine mammals, seabirds and fish vulnerable to the impacts of bottom trawling

Thank you for considering my comments,

Kristi Kroeger
4701 Shannonhouse Dr. Apt. 303
Raleigh, NC 27612

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Additional D-3 comments like this form letter can be reviewed at the secretary's desk

OCEANA

175 South Franklin Street, Suite 418 Juneau, Alaska 99801 907.586.4050 www.oceana.org

Ms. Stephanie Madsen
Chair
North Pacific Fishery Management Council
605 West 4th, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum
Regional Administrator
NOAA Fisheries, Alaska Region
709 W. 9th Street
Juneau, AK 99802-1668

Re: Agenda Item D3 — Bering Sea Habitat Conservation

Dear Ms. Madsen and Mr. Mecum:

I am writing to urge you to protect essential fish habitat in the Bering Sea by adopting Alternative 2 to freeze the footprint of bottom trawling in the Bering Sea. Alternative 2 would provide the most reasonable protection from damage to the wildlife, communities and ocean habitats of the northern Bering Sea while having a minimal impact on the economic health of existing fisheries and fishing communities.

Thank you for considering my comments.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Frank | Aaron | Frisco | TX | Corine | Landrieu | Seattle | WA |
| T | Abashian | Durham | NC | Rachael | Landry | Escondido | CA |
| Andrew | Abate | Lindenhurst | NY | Ron | Landskroner | Oakland | CA |
| Linda | Abbott | Torrance | CA | Mary | Lane | Fresno | CA |
| Anne | Abbott | New York | NY | Tomlo | Lane | Acworth | GA |
| Tonya | Abbott | Yorktown | VA | Kathleen | Lane | Columbia | MD |
| Tori | Abbott | Yorktown | VA | Johanna | Lang | Fremont | CA |
| Suzanne | A'Becket | Cupertino | CA | Scott | Lang | Cambridge | IA |
| Talya | Abel | Philomath | OR | Catherine | Langberg | Leonia | NJ |
| Mary | Able | Mcarthur | CA | Mark | Langley | Williamsburg | VA |
| Heather | Abney | Madison | WI | Joan | Langlois | Seward | CA |
| Kari | Abraham | Pinckney | MI | Keith | Langston | Toledo | OH |
| Yael | Abraham | Cedar Park | TX | Louise | Lanham | Pasadena | TX |
| Curl | Abrahamson | Rock Rapids | IA | Lynne | Lanier | Statesboro | GA |
| Natalie | Abram | Louisville | KY | Lynda | Lankford | Bakersfield | CA |
| Eric | Abrams | Bow | NH | Mary | Lannon | Hillsboro | NH |
| Jeffrey | Abramson | Short Hills | NJ | Gary | Lansinger | Barberton | OH |
| Wanda | Abunasser | Weatherford | TX | Giselle | Lantigua | Elmhurst | NY |
| Beverly | Ackerman | Santa Rosa | CA | L | Lantz | Fargo | ND |
| Janet | Ackerman | Apple Valley | MN | Jane | Lanzoni | Plymouth | MA |
| Andrea | Ackerman | New York | NY | Amber | Laplante | Port Orange | FL |
| Carolyn | Acuff | Duluth | GA | Sharon Lee | Laplante | Tolland | CT |

Dear Ms. Madsen

I am writing to urge you to protect essential fish habitat in the northern Bering Sea by adopting Alternative 2 to freeze the footprint of bottom trawling in the Bering Sea. Alternative 2 would provide the most reasonable protection from potentially devastating impacts to the wildlife, communities and ocean habitat of the northern Bering Sea from commercial bottom trawling, and is the most responsible and precautionary course of action for protecting this remarkable and fragile part of our world.

Thank you for considering my comments,

bonnie spromberg
827 peterson st.
Ketchikan, AK 99901

Additional D-3 comments like this form letter can be reviewed at the secretary's desk

May 15, 2007

Stephanie Madsen
605 W 4th Ave, Suite 306
Anchorage, AK 99501-2252

Dear Madsen,

As a concerned citizen, I am writing to urge the Council to protect the Northern Bering Sea from destructive bottom trawling.

Both people and animals, alike, depend on the Bering Sea for their survival. The Bering Sea is home to a wide array of marine life including numerous fish populations as well as a myriad of protected and endangered species including gray, beluga and bowhead whales, Pacific walrus, Steller sea lions, seals and seabirds. The Bering Sea is also home to communities of indigenous peoples who depend on a healthy and diverse ocean environment.

Bottom trawling poses a grave threat to all who rely on a healthy marine environment for survival. It is up to fishery managers to take the necessary steps to protect essential fish habitat in the Northern Bering Sea by banning bottom trawling in the region.

Specifically, I urge the Council to endorse Alternative 2 contained in the draft environmental assessment and establish procedures for continued research and monitoring. Alternative 2 would freeze the footprint of mobile bottom contact gear, limiting bottom trawls to where they currently operate and preventing them from moving northward.

This level of protection is critical and can be provided with minimal economic impact on fisheries. According to data from the National Marine Fisheries Service, Alternative 2 to freeze the bottom trawl footprint and establish a northern boundary will have a less than five percent economic impact on fisheries.

The Bering Sea is one of the most biologically diverse and productive marine environments. Keep bottom trawling out of the Arctic to ensure the area remains productive, resilient and diverse for future generations of ocean life and people.

Sincerely,

Mr. SEAN STEARMAN
780 Dickman Ave
Monterey, CA 93940-1831

Additional D-3 comments like this form letter can be reviewed at the secretary's desk

Scott Miller NMFS

**Bering Sea Habitat Conservation**
**Findings of the Regulatory Impact Review**

Analysis Conducted
by
Jeff June, Natural Resource Consultants and
Mike Downs, EDAW Inc.

Steve Lewis and Scott Miller,
NMFS Alaska Region Analytical Team

## Revenue at Risk Methodology

- Retained catch by species derived from Catch by Area Model, 2003-2005
- Round weight equivalent product prices applied to retained catch to produce gross first wholesale revenue by species
- Gross first wholesale revenue, all species, all areas, equals fleet sector status quo
- Closed area gross first wholesale revenue from NPT placed at risk

## Fleet Sectors Affected

Definitely Affected (revenue at risk)

- H&G Trawl Catcher Processors

Potentially Affected (no revenue at risk)

- AFA Trawl Catcher Processors
- AFA Trawl Catcher Vessels
- CDQ & local Alaska community NPT fisheries

## Alternative 2 Revenue At Risk ($ millions)

| Year | Sector or Species | Status Quo Revenue | Revenue at Risk | %Revenue at Risk |
|---|---|---|---|---|
| 2003 | H&G Trawl CP | $161.72 | $1.25 | 0.77% |
| 2004 | H&G Trawl CP | $195.51 | $3.53 | 1.81% |
| 2005 | H&G Trawl CP | $247.96 | $2.45 | 0.99% |
| | Average | $201.73 | $2.40 | 1.19% |

## Alternative 2 Revenue at Risk by Species Group ($ millions)

| Year | Sector or Species | Status Quo Revenue | Revenue at Risk | %Revenue at Risk |
|---|---|---|---|---|
| 2003 | Atka Mackerel | $21.87 | $0.00 | 0.00% |
| | Flatfish | $72.72 | $0.96 | 1.32% |
| | Pacific Cod | $35.91 | $0.25 | 0.69% |
| | Pollock | $10.68 | $0.03 | 0.32% |
| | Rockfish | $15.31 | $0.00 | 0.01% |
| | Sablefish | $4.18 | $0.00 | 0.00% |
| | Other | $1.06 | $0.00 | 0.00% |
| 2004 | Atka Mackerel | $29.08 | $0.00 | 0.00% |
| | Flatfish | $83.98 | $2.83 | 3.37% |
| | Pacific Cod | $46.39 | $0.57 | 1.23% |
| | Pollock | $14.36 | $0.11 | 0.73% |
| | Rockfish | $17.14 | $0.00 | 0.02% |
| | Sablefish | $4.03 | $0.02 | 0.48% |
| | Other | $0.53 | $0.00 | 0.00% |
| 2005 | Atka Mackerel | $36.52 | $0.00 | 0.00% |
| | Flatfish | $121.33 | $2.22 | 1.83% |
| | Pacific Cod | $44.30 | $0.19 | 0.43% |
| | Pollock | $15.22 | $0.04 | 0.27% |
| | Rockfish | $25.36 | $0.00 | 0.00% |
| | Sablefish | $4.89 | $0.00 | 0.00% |
| | Other | $0.34 | $0.00 | 0.00% |

## Potential Effects of Northward Fishery Movement

- TACs are below ABC
- Cost of harvesting TAC could increase if aggregations of fish move Northward and out of the open area of Alternative 2
- PSC catch rates could change and could result in fishery closure prior to attaining TAC
- This is all highly speculative; conclusive estimates of potential impacts to fishing operations are not possible at this time

## Potential Benefits of Alternative 2 and the Sub-option

- Provides habitat conservation in relatively unfished areas of the northernmost shelf and the deepwater basin of the Bering Sea
- Minimizes potential interactions between commercial activity and community use and subsistence fisheries
- Provides protections to nearshore habitats for community and subsistence use

## Alternative 3—Gear Modification

- 8 " bobbins attached on each side with a plate washer, 5 inch disk, and 1/2 inch rope
- sweeps replaced about once a year and vessels may carry two to three sets of sweeps
- Vessels using this gear may use 100 or 200 fathoms per side
- An approximate upper bound additional cost estimate would be 3 times the difference between the cost of the sweeps and the cost of the sweeps with the bobbins installed
- Gear manufacturers estimate this cost at just under $4,000, or about 33% more than the sweeps alone

## Alternative 3—Gear Modification Continued

- Vessels that put their sweeps on the main winches (i.e. do not have net reels) typically use much shorter bare wire sweeps
- Gear manufacturers indicate a 40 fathom assembly on each side would be needed for these vessels
- The additional cost is the cost of 8 inch disks and swaging stoppers onto the wire
- Estimates of the cost of these modifications are just under $500 per side ($1000 per pair), an increase of about 45% over the cost of the bare wire sweep alone

## Alternative 3—Gear Modification Continued

- Mudgear sweeps are made up of rubber disks, commonly 3 inches in diameter, strung over steel cables
- Mudgear sweeps would have to be retrofitted by replacing several of the 3 inch disks with larger disks at both ends and at 2 points in the middle span, dividing the 90 ft sweeps into 30 ft sections
- The cost difference for the addition of these larger disks is negligible over the cost of a regular 90 foot mudgear sweep, which is estimated to be approximately $1,100 for a 90 foot sweep

## Alternative 3—Gear Modification Continued

- Some vessels do not have net reels and currently wind their trawl sweeps onto the main deck winches
- The disks may create difficulty in passing the trawl sweep through the level wind on the deck winches and/or may exceed the holding capacity of the drum on the main deck winches
- It may be necessary for these vessels to modify the main trawl winch level-winds to allow passage of the disks
- The costs to modify trawl winches are vessel dependent and are not known at this time
- Initial indications are the vessels lacking net reels will likely be able to modify the level wind on their main trawl winches to accommodate the bobbins and that installation of net reels will not likely be necessary

## Potential Benefits of Gear Modifications (Alt. 3)

- Gear Modification would reduce trawl sweeps seabed contact by 90% - 95%
- Would conserve benthic habitat within the open area proposed in alternative 2 and/or within areas remaining open depending on selection of options to Alternative 3
- May lead to improved productivity, however, a quantitative link between fishery productivity and benthic habitat protection is not available

## Alternative 3, Options 1, 2, and 3 Revenue at Risk ($ millions).

| Year | Sector or Species Group | Status Quo Revenue | Option 1 | | Option 2 | | Option 3 | |
|---|---|---|---|---|---|---|---|---|
| | | | Revenue at Risk | %Revenue at Risk | Revenue at Risk | %Revenue at Risk | Revenue at Risk | %Revenue at Risk |
| 2003 | H&G Trawl CP | $161.72 | $0.21 | 0.13% | $0.57 | 0.35% | $1.03 | 0.64% |
| 2004 | H&G Trawl CP | $195.51 | $0.68 | 0.35% | $1.87 | 0.95% | $2.99 | 1.53% |
| 2005 | H&G Trawl CP | $247.96 | $0.05 | 0.02% | $0.06 | 0.02% | $1.00 | 0.40% |
| | Average | $201.73 | $0.31 | 0.15% | $0.83 | 0.41% | $1.67 | 0.83% |

North Pacific Fishery Management Council — NOAA Fisheries

## Alternative 3, Options 1, 2, and 3 Revenue at Risk by Species ($ millions)

| Year | Sector or Species Group | Status Quo Revenue | Option 1 | | Option 2 | | Option 3 | |
|---|---|---|---|---|---|---|---|---|
| | | | Revenue at Risk | %Revenue at Risk | Revenue at Risk | %Revenue at Risk | Revenue at Risk | %Revenue at Risk |
| 2003 | Atka Mackerel | $21.87 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Flatfish | $72.72 | $0.04 | 0.05% | $0.57 | 0.78% | $1.02 | 1.40% |
| | Pacific Cod | $35.91 | $0.16 | 0.43% | $0.00 | 0.00% | $0.00 | 0.01% |
| | Pollock | $10.68 | $0.02 | 0.16% | $0.00 | 0.01% | $0.00 | 0.02% |
| | Rockfish | $15.31 | $0.00 | 0.01% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Sablefish | $4.18 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Other | $1.06 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| 2004 | Atka Mackerel | $29.08 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Flatfish | $83.98 | $0.12 | 0.14% | $1.86 | 2.21% | $2.98 | 3.55% |
| | Pacific Cod | $46.39 | $0.47 | 1.02% | $0.01 | 0.01% | $0.01 | 0.02% |
| | Pollock | $14.36 | $0.08 | 0.58% | $0.00 | 0.03% | $0.01 | 0.05% |
| | Rockfish | $17.14 | $0.00 | 0.01% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Sablefish | $4.03 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Other | $0.53 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| 2005 | Atka Mackerel | $36.52 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Flatfish | $121.33 | $0.01 | 0.01% | $0.06 | 0.05% | $0.99 | 0.81% |
| | Pacific Cod | $44.30 | $0.04 | 0.08% | $0.00 | 0.00% | $0.01 | 0.01% |
| | Pollock | $15.22 | $0.00 | 0.02% | $0.00 | 0.00% | $0.01 | 0.04% |
| | Rockfish | $25.36 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Sablefish | $4.89 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |
| | Other | $0.34 | $0.00 | 0.00% | $0.00 | 0.00% | $0.00 | 0.00% |

North Pacific Fishery Management Council — NOAA Fisheries

## Summary of Average Revenue at Risk ($ millions)

| Alternative or Option | Average Revenue at Risk | % Revenue at Risk |
|---|---|---|
| Alternative 2 | $2.40 | 1.19% |
| Option 1 | $0.31 | 0.15% |
| Option 2 | $0.83 | 0.41% |
| Option 3 | $1.67 | 0.83% |
| Option 4 | $1.98 | 0.98% |
| Options 1+2 | $1.14 | 0.57% |
| Options 1+3 | $1.98 | 0.98% |
| Option 5 | $0.00 | 0.00% |

North Pacific Fishery Management Council — NOAA Fisheries

## Potential Benefits of Option 1

- Option 1: This option would provide some positive benefits to blue king crab habitat around Saint Matthew Island
- The area extends southwest to project juvenile, non-ovigerous female and male blue king crab habitat, and northeast to protect ovigerous females habitat
- This crab stock is severely depleted and designated overfished
- There may be long term economic benefits to crab fishermen associated with reduced impacts on crab; however, these effects are likely to be minor

North Pacific Fishery Management Council — NOAA Fisheries

## Potential Benefits of Options 2 and 3

- Minimize potential interactions between commercial activity and community use and subsistence fisheries
- Provides protections to nearshore habitats for community and subsistence use

## Potential Benefits of Option 4

- May be a precautionary measure in terms of habitat protection by preventing northward expansion of the bottom trawl fishery
- Research and an exempted fishing permit would still provide future access to the area
- The option would close roughly 188,157 sq. km of BS shelf (shelf area to 1,000 m depth) or 23.8% of the 791,731 sq. km

## Potential Benefits of Option 5

- Conserves blue king crab habitat around St. Lawrence Island by closing the area to NPT gear
- Minimizes potential interactions with community use and subsistence fisheries around St. Lawrence Island

## Direct Community Impacts

For All Alternatives:

- No impacts to sustained participation of fishing communities
- Community patterns of engagement and dependency would not change (Seattle; minor relative dependence, Dutch Harbor/Unalaska; highest relative dependence
- No significant community level impacts for any community

## Summary of Findings

- Benefits:
  - Alternative 2 would protect Bering Sea Shelf Fishing Habitat and all of the Bering Sea Basin and would minimize interactions between commercial and subsistence activities in nearshore areas.
  - Gear Modification would reduce trawl sweeps seabed contact by 90% - 95% providing associated habitat conservation
  - Options to Alternative 3 would provide blue king crab and Steller Eider habitat conservation and would minimize interactions between commercial and subsistence activities

- Impacts
  - Minimal Gear Modification Costs
  - Minimal Revenue at Risk
  - Revenue at Risk Easily Mitigated by Fishing in remaining open areas.
  - No finding of significant adverse economic impacts of the alternatives or options taken separately or cumulatively

U.S.C.C. *Healy*
6 June 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Douglas Mecum, Regional Adminstrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

Dear Ms. Madsen and Mr. Mecum:

We are writing to comment on the draft Environmental Assessment for amending the Fishery Management Plan for Groundfish of the Bering Sea, and regulatory amendments for Bering Sea Habitat Conservation. Our research group has over two decades of experience in scientific study of the ecosystem between St. Matthew Island and the Bering Strait. We are currently at sea on the USCGC *Healy*, conducting research on factors affecting food web structure and function that appear to be changing due to warming climate. Our work is focused on possible impacts on sea floor communities of predators that are expanding northward, and of a reduced ice-edge spring bloom due to shrinking ice cover. We note that the same warming effects that are motivating revised fishing regulations may also make bottom communities more vulnerable to effects of bottom trawling.

In processing our samples on deck, we are reminded daily of the extreme heterogeneity of bottom habitats and communities in this region. At stations 15 to 20 nmi apart, bottom communities are often completely different, with epibenthic trawl samples dominated in some areas by brittle stars with few clams or large invertebrate predators, to other areas with many small crabs and a few snails, to still other sites with abundant sea stars and whelks. Heterogeneity of community types makes it hard to delineate substantial blocks of coterminous habitat that contain more resilient or redundant species, and are thus amenable to industrial trawling or large-scale experiments to quantify its effects. We have also observed that bottom communities south of St. Lawrence Island are quite different from those north of the island, with a number of important species in the north being mostly absent from the south and vice versa. Thus, within and among these regions, it is likely that experimental results in one area would not be adequate to predict impacts in another area, even for sites rather close together.

By comparison to predators that move over the sediment surface, their prey base of animals living in the sediments is clustered into three to four major communities south of St. Lawrence Island, dominated by long-lived clams, amphipods, and worms. These animals are members of a short food chain that is directly tied to climate-forced variability that influences sea ice extent, primary production, and carbon export to bottom communities. Our 20-year time-series stations both south and north of St. Lawrence Island indicate a system under change, with declines in abundance and shifts in dominant species of animals living within the sediments during this period. We are observing similar declines in communities dominated by amphipods north of St. Lawrence Island. Responses to further increases in temperature and decreased ice extent may make this ecosystem more vulnerable to additional stresses such as large-scale bottom trawling.

Why is this heterogeneity of habitats and bottom communities so important? We focus here on three federally protected species that feed on bottom prey – spectacled eider, walrus, and bearded seal.

The world population of spectacled eiders winters south of St. Lawrence Island. This species was listed as Threatened in 1993, after a 96% decline on a major Alaskan breeding area from the 1970s to 1990s. Since their wintering site was discovered in 1995, these birds have occurred consistently in a relatively small area where clam populations are much higher than elsewhere in the region. Our simulation models suggest that this is currently the only area that will support profitable foraging by the eiders. Data for this region back to the 1950s suggest that the overall abundance and dominant species of clams in local areas can shift dramatically over decades, reflecting major pulses of recruitment and mortality at different times or places. Because this area is the only wintering site for these eiders, and because the location of key prey communities is spatially and temporally variable, the entire area between St. Matthew and St. Lawrence Islands has been designated critical habitat for eiders under the U.S. Endangered Species Act.

This area is also a key location for both wintering and pupping by Pacific walruses and bearded seals. In late winter and spring, large numbers of walruses occur south of St. Lawrence Island in a region that includes the wintering area of spectacled eiders. During aerial surveys by NOAA during the *Healy* cruise in March–April 2007, a striking result was the extent to which bearded seals also concentrate in the same region. The reason for these concentrations of walruses and bearded seals is the critical co-occurrence of abundant bottom foods and sea ice for hauling out and pupping. Even with adequate sea ice, degradation of feeding habitat would probably result in population declines of both species in this region, with loss of opportunities for subsistence hunters on St. Lawrence Island. Moreover, the extent of sea ice in spring is generally decreasing, and the co-occurrence of sea ice and abundant prey is diminishing in area and predictability. Thus, for both eiders and bottom-feeding marine mammals, potential impacts of bottom trawling on the abundance and dispersion of prey is a fundamental issue.

How might bottom trawling impact the heterogeneity of bottom communities on which these sensitive species depend? In the northern Bering Sea, bottom community types are related in part to sediment characteristics (grain size, porosity, organic matter content and quality). One of the best-documented effects of bottom trawling is alteration of the quality and distribution of sediments. Resuspension and erosion of fine particles can alter porosity and organic content, and thereby transform microbial communities that recycle nutrients and condition detrital foods for deposit-feeders. In addition to these trophic factors, severe disruptions of surface sediments can cause major physical displacement and mortality of animals living in the sediments. Deposit-feeders in fine sediments, and suspension-feeding amphipods north of the island in sandier sediments, are important prey of bottom-feeding fish, crabs, and marine birds and mammals in this region.

We have focused here on federally protected apex predators, which often subsume impacts throughout lower trophic levels. However, we emphasize that the overall strategy must be to maintain the integrity of entire food webs that support such predators. In much of the northern Bering Sea, bottom temperatures are consistently at or below 0°C; thus, growth rates of fish and invertebrates to sexual maturity, and development of eggs and larvae, can be quite slow. As a result, it may take many years for communities to recover after periodic major mortality due to bottom trawling. If trawling occurs too frequently in the same area, recovery may never occur. Without prudent and conservative site selection, large-scale experiments to determine effects of commercial-scale trawling might indicate serious consequences only after the impacts have occurred.

Based on the above points, we advocate closure of the Experimental Fishing Area to non-pelagic trawling until further research justifies opening this area to commercial fishing (Alternative 2 or Option 4 in the Environmental Assessment). Under Option 4, we urge that sites for any experiments exclude habitats critical to marine birds and mammals, or that harbor bottom species with very slow rates of growth and reproduction at low temperatures. We would be pleased to provide additional technical information as might be required by the Council.

Sincerely,

James R. Lovvorn
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**CHEVAK NATIVE VILLAGE**
P.O. Box 140
Chevak, Alaska 99563
Ph. (907) 858-7428/ Fx. (907) 858-7812

*QISSUNAMIUT TRIBAL GOVERNMENT*

RESOLUTION NO. 2007-08

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES

WHEREAS: the Chevak Native Village is a federally recognized tribe located on the Bering Sea Coast, and;

WHEREAS: the Kashunamiut tribe depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

WHEREAS: the Cu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and sea birds and small commercial fisheries for halibut, herring, and salmon, and;

WHEREAS: the Kashunamiut have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

WHEREAS: the warming ocean temperatures may result in ground fish moving northward into new areas of the Bering Sea, and;

WHEREAS: the movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

WHEREAS: the bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by the Kashunamiut for subsistence purposes, and;

WHEREAS: the expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

WHEREAS: the North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** the NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a Government-to-Government basis about how federal actions may affect them.

**NOW THEREFORE BE IT RESOLVED THAT:** the Chevak Traditional Council requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and

**BE IT FURTHER RESOLVED THAT:** the Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**BE IT FURTHER RESOLVED THAT:** the Chevak Traditional Council only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively.

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** no high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both and outside of the bottom trawl areas as well as subsistence resources the Kashunamiut relies on for its cultural and economic vitality.

**CERTIFCATION**

The Chevak Traditional Council passed this resolution during their duly convened meeting on May 30, 2007 in which a quorum was present. The Chevak Traditional Council passed this resolution with 4 in favor of, 0 against and 0 abstaining.

Roy J. Atchak, President

Leo Moses Jr., Vice-President

*Emmonak Tribal Council*

P.O. BOX 126
EMMONAK, ALASKA 99581
(907) 949-1720
FAX (907) 949-1384

**RESOLUTION NO. 07-26**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** Emmonak Traditional Council is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yup'ik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for herring, salmon, and crab, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and:

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past, and:

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and in by catch of fish and other marine life, including marine mammals; and

**WHEREAS:** An expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and:

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** the EMMONAK TRADITIONAL COULCIL requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling on our subsistence way of life are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources, and;

**NOW THEREFOR BE IT FURTHER RESOLVED THAT:** Emmonak Traditional Council only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

**Adopted by Emmonak Traditional Council on May 30th 2007 where a quorum of the Tribal Council was present.**

President

Secretary

# NATIVE VILLAGE OF KIPNUK
## KIPNUK TRADITIONAL COUNCIL

P.O. BOX 57 • KIPNUK, ALASKA 99614
(907) 896-5515 • FAX (907) 896-5240

**RESOLUTION NO.** 07-10

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** Kipnuk Traditional Council is a federally recognized tribe located on the Bering Sea Coast, and;

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Yu'pik way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** Kipnuk Traditional Council requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT**: The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT**: Kipnuk Traditional Council only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT**: No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by Kipnuk Traditional Council on May 31, 2007 where a quorum of the Tribal Council was present.**

David Paul
**President,**

**Secretary,**

NATIVE VILLAGE OF SAVOONGA · P.O. BOX 120, SAVOONGA, AK 99769 · PHONE 984-6414 · FAX 984-6027

**Resolution # 07-03**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

Whereas, the Native Village of Savoonga IRA Council(s) is a federally recognized governing body located on the Bering Sea coast; and

Whereas, the village depends on these waters and habitat for resources essential to our way of life; and

Whereas, our way of life includes subsistence use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for [halibut, herring, salmon and crab….]; and

Whereas, our people are observing substantial changes in sea ice and the environment due to global warming, and these changes are a concern for the future of marine life, and thus our subsistence traditions and commercial fisheries; and

Whereas, warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea; and

Whereas, the movement of fish populations may result in bottom trawl fleets also moving into new fishing grounds that have not been exposed to bottom trawling in the past; and

Whereas, bottom trawling is known to disturb seafloor habitats and result in significant bycatch of fish and other marine life, including marine mammals; and

Whereas, an expansion of bottom trawling into the northern Bering Sea would be an additional source of impact during this time of ecological change and uncertainty; and

Whereas, the North Pacific Fishery Management Council is considering management alternatives to control the impact of bottom trawling in the Bering Sea,

Therefore be it resolved that the Native Village of Savoonga IRA Council requests that the North Pacific Fishery Management Council adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment.

Be it further resolved that the Environmental Assessment is narrowly focused on fish habitat such that effects of bottom trawling on subsistence are not fully evaluated. Nonetheless, Alternative 2 is the choice that best protects local commercial fisheries and subsistence resources.

Be it further resolved that no high impact fishery should be introduced into the northern Bering Sea without sufficient consultation with communities who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic vitality.

Adopted by the Native Village of Savoonga IRA Council on May 29, 2007.

**NOW THEREFORE BE IT RESOLVED THAT:** Native Village of Savoonga IRA Council requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and:

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival for our survival, and;

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by Native Village of Savoonga IRA Council on May 29, 2007 where a quorum of the Tribal Council was present.**

Kenneth Kingeekuk For | Elizabeth Mokiyuk
Delbert Pungowiyi | Elizabeth Mokiyuk, Secretary

**TELLER TRADITIONAL COUNCIL**
**POB 567**
**TELLER, ALASKA 99778**
**(907) 642-3381 Telephone**
**(907) 642-2072 Fax**

**RESOLUTION NO. TR-07-05-31-01**

A RESOLUTION OF SUPPORT FOR ESTABLISHING A NORTHERN BOUNDARY FOR BOTTOM TRAWL FISHERIES TO PROTECT BERING SEA HABITAT, LOCAL FISHERIES AND SUBSISTENCE RESOURCES.

**WHEREAS:** Teller Traditional Council is a federally recognized tribe located on the Bering Sea Coast, and:

**WHEREAS:** The Tribal Members depend on lands and waters of the Bering Sea Coast for subsistence resources necessary for our survival, and;

**WHEREAS:** Our Inupiaq way of life includes use of marine and coastal resources such as fish, shellfish, marine mammals, and seabirds and small commercial fisheries for halibut, herring, and salmon, and;

**WHEREAS:** Our people have observed and are very concerned about substantial changes in sea ice and the environment due to global warming, and these changes are concern for the future of marine life and thus our subsistence way of life and our commercial fisheries, and;

**WHEREAS:** Warming ocean temperatures may result in groundfish moving northward into new areas of the Bering Sea, and;

**WHEREAS:** The movement of groundfish to new areas may result in bottom trawl fleets moving into new fishing grounds previously untouched by their trawls, and;

**WHEREAS:** Bottom trawl fishing is known to disturb important seafloor habitat and is known to result in significant bycatch of fish and other marine life, including marine mammals harvested by our people for subsistence purposes, and;

**WHEREAS:** Expansion of bottom trawl fishing into new areas will and has most certainly impacted the ecology and subsistence foods negatively, and;

**WHEREAS:** The North Pacific Fisheries Management Council (NPFMC) is considering management alternatives to control the impact of bottom trawling in the Bering Sea, and;

**WHEREAS:** The NPFMC is a federal agency and as such must adhere to a federal policy that requires the U.S. Government to consult with individual Tribes on a government-to-government basis about how federal actions may affect them, and;

**NOW THEREFORE BE IT RESOLVED THAT:** Teller Tradititonal Council requests that the NPFMC adopt a northern boundary for bottom trawl fisheries delineated in Alternative 2 of the Bering Sea Habitat Conservation Environmental Assessment, and;

**NOW THEREFORE BE FURTHER RESOLVED THAT:** The Environmental Assessment is narrowly focused on fish habitat such that the effects of bottom trawling in our subsistence way of life are not fully evaluated. Alternative 2 is the choice that best protects our local commercial fisheries and subsistence resources necessary for our survival, and;

**NOW THEREFORE BE IT FURTHER RESOLVED THAT:** Teller Tradititonal Council only agree to support Alternative 2 contingent on the NPFMC committing to a two (2) year review to address bottom trawl impacts to our subsistence way of life comprehensively

**NOW THEREFORE BE IT FINALLY RESOLVED THAT:** No high impact fishery should be introduced into the northern Bering Sea without consultation with individual Tribes located on the Bering Sea Coast who stand to be affected. Such fishing activities may lead to profound impacts to subsistence communities both in and outside of the bottom trawl areas as well as subsistence resources our Tribe relies on for its cultural and economic vitality.

**Adopted by Teller Tradititonal Council on May 31, 2007 where a quorum of the Tribal Council was present.**

Jenny M. Lee
President

Sig Elvin Anot
Secretary

# NATIVE VILLLAGE OF KWIGILLINGOK

Kwigillingok I.R.A. Council
P.O. Box 49
Kwigillingok, Alaska 99622-0049
(907) 588-8114/8212
(907) 588-8429-fax
kwkadmin@starband.net

June 1, 2007

Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 West 4th Avenue
Anchorage, Alaska 99501

RE: Bering Sea Habitat Conservation- Bottom Trawl Boundary

Dear Ms. Madsen:

The Native Village of Kwigillingok is deeply concerned about bottom trawl fishing that occurs near the Kuskokwim Bay and along the Bering Sea coast. The North Pacific Fishery Management Council (NPFMC) is considering establishing a northern boundary for bottom trawl fisheries at its June 4-8, 2007 meeting in Sitka, Alaska. In reviewing the alternatives or options proposed in your Environmental Assessment, we find that none provide adequate protection of the resources we depend on for our subsistence way of life. After careful review and in speaking with tribal members of our Tribe and that of other subsistence dependent communities, we find that Alternative 2 should be accepted temporarily with a stipulation that the NPFMC consider a revised boundary within the next two (2) years that addresses impacts of our subsistence resources, opportunities and our subsistence way of life.

The Native Village of Kwigillingok is a federally recognized Tribal Government in Alaska and is located on the western shore of the Kuskokwim Bay along the Bering Sea. Kwigillingok is a Yupik community that derives its sustenance from the land, water and air around us. We depend on the many species of anadromous fish such as salmon, burbot, pike, white fish that return annually to the Kuskokwim River and bottom feeders such as halibut, cod, and different flatfish. We also harvest walrus, seals and other marine mammals that depend on a vibrant, undisturbed sea floor for feeding. We are concerned about the negative effects of bottom trawling on the oceans various resources and the wasteful bycatch that result from bottom trawling. Our time tested subsistence practices do not disturb our environment and that of the resources we depend on for our survival as Yupik people. Any practice other than our own is not compatible with our traditional subsistence practices. We have a responsibility to promote, protect and perpetuate our Tribes' cultural and traditional values so that generations after us can continue to harvest fish, birds and marine mammals from undisturbed environment and habitat.

June 1, 2007
Stephanie Madsen, Chair

Page Two (2)

It is only within the last few decades that our people settled into villages from a nomadic way of life. Our people moved with the seasons and subsistence resource availability and in doing so our tribal elders taught us to leave our campsites, our hunting and fishing areas in a state that one's coming after us would not know that we had been there. Now today, we must be very careful to conserve our resources due to the many marine activities, such as bottom trawl fishing, increased land and air traffic. Until recently, we had not been required to reduce our subsistence harvest of birds, fish and marine mammals for conservation, even when our subsistence take was not necessarily the cause of declines. Yet bottom trawling has been going on year after year right outside Kuskokwim Bay and along the Bering Sea coast, without time for recovery of subsistence resources. This practice should not be allowed without understanding what impacts it has to the food web and to the habitat that supports the ocean and its subsistence resources that ensures the survival of Yupik people of this area.

The NPFMC makes decisions from far away that affect our communities and our ways of life yet you have not considered our subsistence needs and practices in your deliberations or decisions.

We urge you in the strongest way to create a two (2) year window for our people to propose a bottom trawl boundary that fully addresses subsistence. By accepting our request for a two (2) year window, the NPFMC and the National Marine Fisheries Service (NMFS) will fulfill its government-to-government relationship with Tribes located on the Kuskokwim Bay and Bering Sea coast. The government-to-government relationship is a Federal policy that requires the U.S. Government to consult with Tribes about how Federal actions may affect them. Creating this opportunity would also help the NPFMC meet goals stated in the "*Bering Sea Fishery Management Plan*" to "*Promote Sustainable Communities*" including "*(7) Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.*" Finally, the NPFMC included in its new "*Groundfish Workplan*" a general priority to "*Increase Alaska Native and community consultation.*"

We are committed to working with you and the NPFMC to resolve these complex and comprehensive issues. Toward that end, the Native Village of Kwigillingok invites you to visit the Kuskokwim Bay and Bering Sea coast so that we may have an opportunity to introduce you to our way of life, share with you the many subsistence resources we harvest from the land, water and air. The acceptance of our invitation would provide a unique opportunity to convey to you our concerns.

Respectfully Submitted:
**NATIVE VILLAGE OF KWIGILLINGOK**
**Tommy J. Andrew, President**

Arthur J. Lake
Tribal Administrator

**Emmonak Tribal Council**

P.O. BOX 126
EMMONAK, ALASKA 99581
(907) 949-1720
FAX (907) 949-1384

06/01/07

Stephanie Madsen, Chairmen (Chairperson)
North Pacific Management Council
605 West 4th Ave. Suite 306
Anchorage, AK 99501-2252

Re; Trawl fleet in the Northern Bering Sea

Dear North Pacific Management Council.

The Emmonak Tribal Council is strongly against the Trawl fleet moving into the Northern Bering Sea, even if the weather changes and brings warmer ocean temperatures. The Northern Bering Sea is our "bread basket"; we will oppose any attempt of the trawl fleet to expand into the Northern Bering Sea. The Emmonak Tribal Council was not even aware that our area of the Bering Sea was open to the trawl fleet, therefore we support closing and imposing a Northern Boundary to control the trawl fleets expansion. The Emmonak Tribal Council was not even aware that there was a possible rule change. Where is our Government-to-Government consultation?

Thank you very much,

Theodore Hamilton
Natural Resource Department
Emmonak Tribal Council

Cc; AMCC, file

March 28, 2007

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

RE: Agenda Item D-3, Bering Sea Habitat Conservation

Dear Madame Chair and Mr. Mecum:

The Eskimo Walrus Commission (EWC) at Kawerak, Inc. in Nome was formed in 1978. EWC is a recognized statewide entity working on resource co-management issues, specifically the Pacific walrus, on behalf of 19 Alaskan Yup'ik, St. Lawrence Island Yupik, and Inupiaq communities who rely on it as an essential cultural, natural, and subsistence resource. EWC works cooperatively with the U.S. Fish and Wildlife Service (FWS) to encourage subsistence hunters' participation in conserving and managing walrus in the coastal communities.

EWC is providing this letter to express concerns regarding potential detrimental long-term impacts of bottom trawling in waters critical to Pacific walrus and coastal subsistence communities. We therefore provide the following comments with respect to the draft EA for Bering Sea Habitat Conservation:

a. EWC only supports Alternative 2 as a minimum measure for precautionary management of Bering Sea habitat. The other proposed alternatives may result in significant impacts to walrus and subsistence hunting communities. We encourage the North Pacific Fishery Management Council to constrain high impact fishing techniques such as bottom trawling on the Bering and Chukchi Sea shelf areas until more is known about the impacts to critical ecological and subsistence resources. We further encourage the Council to close important walrus habitat and subsistence hunting areas to bottom trawling that are currently within the trawl footprint and we look forward to helping you identify those areas.

b. EWC endorses the comments of our co-management partner the U.S. Fish and Wildlife Service, with respect to their concerns about disturbance and impacts to the Pacific walrus population.

c. EWC believes that there has been inadequate official consultation with organizations such as ours in the production of this EA.

Although EWC's position is to not support bottom trawling on the Bering and Chukchi Sea shelf areas, we are also concerned with the preparation and content of the draft EA. We feel that the preparation did not involve significant consultation with communities that stand to be impacted from activities related to this EA, and the content of the EA is neither sufficient, nor precautionary in its approach when considering bottom trawling activities. These activities could

lead to profound impacts to subsistence communities both in and outside of the trawl area, as well as the resources on which they rely for cultural and economic sustenance.

Sincerely,

VMetcalf for Charles D.N. Brower

Charles D.N. Brower, Chair
Eskimo Walrus Commission

cc: Vera Metcalf, Director, Eskimo Walrus Commission
Loretta Bullard, President, Kawerak, Inc.
Rosa Meehan, Supervisory, USFWS

11

0550-258-406

Submitted by Oceana rep's Jon Warrenchuk + Susan Murray

Ms. Stephanie Madsen, Chair
North Pacific Fishery Management Council
605 W. Fourth Avenue, Suite 306
Anchorage, AK 99501-2252

Mr. Doug Mecum, Regional Administrator
NOAA Fisheries, Alaska Region
709 West Ninth Street
Juneau, AK 99802-1668

Dear Ms. Madsen and Mr. Mecum:

We are writing to urge you to take action to protect the northern Bering Sea and Arctic by preventing destructive bottom trawling from expanding into currently untrawled areas. Two years ago, the North Pacific Fishery Management Council and NOAA Fisheries took historic action to protect corals, sponges, and other living seafloor habitat of the Aleutians and Gulf of Alaska from destructive bottom trawling. At that time, the Council and the agency deferred action on the Bering Sea. As you now consider habitat protections for the Bering Sea, we hope you will complete the job you started so well in the Aleutians.

The northern Bering Sea ecosystem relies on healthy seafloor habitat and benthic production[1]. Large populations of benthic-feeding marine mammals and seabirds are linked to the benthic productivity in the northern Bering Sea in relatively short food chains[1]. Numerous species, such as gray whales, walrus, eiders, and commercially important crabs, rely on this rich benthic production.

Portions of the northern Bering Sea shelf are designated critical habitat for the ESA-listed spectacled eider and Steller's eider. These sea ducks dive to the seafloor to feed on clams and other invertebrates, sometimes diving over 60 m to reach the bottom. In the winter, spectacled eiders from Alaska and Russian congregate in the northern Bering Sea in huge flocks containing most of the world's population of this species[2]. Because of the tendency of the eiders to congregate in discrete areas and their reliance on benthic production from seafloor, it is noted that new trawl fisheries could have a major effect on the spectacled eider population[2].

The northern Bering Sea supports large populations of Pacific walrus, an important subsistence food resource for indigenous peoples from both Russia and Alaska. Walrus are extremely reliant on benthic production from a healthy seafloor, and may consume up to 6,000 clams per day[3].

Alaska's crab species, which include some of the world's most valuable crustacean species, are reliant on healthy and productive seafloor habitat and feed upon benthic organisms such as polychaete worms, bivalves, snails, brittlestars, starfish, anemones, crabs, and other crustaceans

---

[1] Grebmeier, J.M. and K.H. Dunton. 2000. Benthic process in the northern Bering/Chukchi seas: status and global change, pp. 61-71. Impacts of Changes in Sea Ice and other Environmental parameters in the Arctic. Report of the Marine Mammal Commission Workshop, 15-17 February 2000, Girdwood, Alaska.

[2] Peterson, M.R., W.W. Larned, and D.C. Douglas. 1999. At-sea distribution of spectacled eiders: a 120 year old mystery resolved. The Auk, vol. 116, no. 4, pp. 1009-1020.

[3] Fay, F.H. 1982. Ecology and biology of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. North American Fauna, vol. 74, U.S. Department of Interior, Fish and Wildlife Service.

the Bering Sea. Specifically, stocks of the St. Matthew blue king crab, snow crab and Norton Sound red king crab all rely on the habitat of the northern Bering Sea shelf which is currently experiencing little trawl effort.

The northern Bering Sea ecosystem is already experiencing stress from global warming[4]. We are beginning to see changes in the populations and behaviors of predators such as diving seabirds, walrus, and gray whales, which are reliant on benthic production[1]. The National Research Council concluded that bottom trawling changes the physical habitat and biological structure of ecosystems--with potentially wide-ranging consequences--by reducing habitat complexity, benthic productivity and biodiversity[5]. Bottom trawling would be an additional stressor that could compromise the resilience of the northern Bering Sea ecosystem, at a time when the ecosystem cannot afford any additional stresses.

Currently, factory trawlers in the southeastern Bering Sea target yellowfin sole, rock sole, and flathead sole. These factory trawlers, some more than 300 feet long, use bottom trawls which affect a 300 to 600 foot swath of seafloor over 4 to 18 miles with each trawl[6]. It would be exceedingly risky to allow these vessels, with their associated habitat degradation and high bycatch, into the northern Bering Sea.

We understand that the alternatives evaluated in the draft EA include allowing bottom trawling to expand into the northern Bering Sea, short-term research closures with a mandate to open the area to future bottom trawling, and a boundary to freeze the footprint and prevent the northern expansion of bottom trawling.

Within this suite of alternatives, Alternative 2, which would prevent major expansion of bottom trawl effort into the northern Bering Sea and untrawled areas along the coast, is a scientifically appropriate step to protect habitat that has experienced little trawling in the past. Alternative 2, by freezing the footprint of bottom trawling, would protect the seafloor habitat of Kuskokwim Bay, Etolin Strait, Nunivak Island, St. Matthew Island, St. Lawrence Island, Norton Sound, and Kotzebue Sound. It is particularly important to prevent expansion of trawling into habitat that supports resources needed by local communities in these areas. In addition, because NMFS has concluded that the effects of fishing on over a third of the life histories of commercially important species were 'unknown'[7], precautionary management of the habitat upon which these species rely is all the more imperative.

We urge the North Pacific Fishery Management Council to stop the expansion of bottom trawling into the northern Bering Sea by adopting Alternative 2. We thank you for your consideration.

---

[4] Grebmeier, J.M., J.E. Overland, S.E. Moore, E.V. Farley, E.C. Carmack, L.W. Cooper, K.E. Frey, J. H. Helle, F.A. McLaughlin, and S. L. McNutt. 2006. A major ecosystem shift in the Northern Bering Sea. Science. Vol. 311: 1461-1464.

[5] National Research Council. 2002. Effects of Trawling and Dredging on Seafloor Habitat.

[6] Bering Sea Habitat Conservation draft EA

[7] NMFS. 2005. Final EFH EIS: Appendix B. Table B.4.1. April 2005.

Very truly yours,

Dr. Thomas C. Shirley
Professor, Endowed Chair for Biodiversity and Conservation Science
Harte Research Institute
Texas A&M Univ.-Corpus Christi

Dr. George J. Divoky
Institute of Arctic Biology
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Dr. P. Dee Boersma
Wadsworth Endowed Chair in Conservation Science
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Dr. Daniel Pauly
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June 5, 2007

Stephanie Madsen, Chair
North Pacific Fishery Management Council
Anchorage, AK 99501

**Re: Agenda Item D3(a), Bering Sea Habitat Conservation**

Dear Ms. Madsen,

Alaska Marine Conservation Council strongly supports establishing a northern boundary for the bottom trawl fisheries in the Bering Sea (Alternative 2). A priority for Bering Sea habitat conservation should be to contain the bottom trawl footprint. Alternative 2 is an important conservation approach in light of ecological changes under way in the Bering Sea due to warming temperatures and associated loss of sea ice that is anticipated over the near-term in the northern region where fisheries have not concentrated in the past.

1. **Climate change and associated ecological uncertainty is an important reason for applying special precaution in the northern Bering Sea.**

   The northern Bering Sea supports sensitive marine species, such as the threatened spectacled eider, walrus and ice seals that are already under stress from climate change. Loss of sea ice is changing the ecosystem raising the degree of uncertainty about what the future holds. Warming combined with anticipated ocean acidification in Alaska's waters presents a daunting situation given potential effects on the entire food web and survivability for some species. Evaluating the effects of fisheries under such circumstances will be confounded by the many factors at play. The consequences of these changes are a critical area of research underway at the Alaska Fishery Science Center[1], National Science Foundation (Bering Sea Ecosystem Study) and North Pacific Research Board (Bering Sea Integrated Ecosystem Research Program) among other institutions. Preventing new sources of impact, such as bottom trawling in the northern Bering Sea, is important for preventing additional sources of stress to the system and communities as they face rapid change largely brought about by human-induced concentration of greenhouse gases in the atmosphere.[2]

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[1] Hollowed, A.B., R.P. Angliss, M.F. Sigler, B.A. Megrey and D.H. Ito. 2007. Implementation plan for the loss of sea ice (LOSI) program. AFSC Processed Report. 2007-05.

[2] The assertion of human-caused climate change is an international scientific consensus. "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to observed increase in anthropogenic greenhouse gas concentrations…Discernable human influence now extends to other aspects of climate including ocean warming…." International Panel on Climate Change, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Basis. Contribution of Working Group 1 to the Fourth Assessment of IPCC.http://ipcc-wg1.ucar.edu/wg1/wg1-report.html

2. **Coastal communities from the Kuskokwim Bay to Bering Strait have requested that the Council select Alternative 2.**

   The Council received at least 25 resolutions and letters describing traditional subsistence use of marine and coastal resources as fundamental to Yupik and Inupiaq cultures on the Bering Sea. Communities located along the Alternative 2 boundary (Nunivak Is., Etolin Strait and Kuskokwim Bay) have provided their support for Alternative 2 with the understanding that the Council would review it in two years to consider outstanding community concerns. This provides the Council with an avenue to explicitly address subsistence considerations and to meet goals of the Bering Sea/Aleutian Islands Fishery Management Plan and the Council's PSEIS work plan.[3]

3. **Other alternatives and options are not adequate.**

   - Options 1, 2, 3 and 5 – Bottom trawl closures around St. Matthew Is., Nunivak Is., Etolin Strait, Kuskokwim Bay and St. Lawrence Is.

     These options do not address the scope of sensitive areas in the northern region. They are inadequate from the perspective of subsistence-based communities who use resources, fishing and hunting grounds beyond the proposed boundaries. Island closures do not protect seafloor habitat associated with the St. Lawrence polynya or spectacled eider critical habitat. Leads and polynyas and the associated benthic environment are also important habitat for walrus and other marine mammals.

   - Option 4 – Experimental fishing area

     This option is not necessary because nothing precludes research from being done to gather the kind of information prescribed in the option. While we appreciate the benefits of more research, there are ways to conduct such research that should not require bottom trawling at a commercial scale in new frontiers.

     For example, intensive bottom trawling has occurred within the existing footprint. It would be prudent to compare trawled habitat within the Alternative 2 open area with untrawled habitat north of the boundary. Surely comparisons can be made as they have

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[3] BSAI Fishery Management Plan list of objectives includes:

Promote Sustainable Communities

(7) Promote management measures that, while meeting conservation objectives, are also designed to avoid significant disruption of existing social and economic structures.

Increase Alaska Native Consultation

(36) Continue to incorporate local and traditional knowledge in fisheries management.

(37) Consider ways to enhance collection of local and traditional knowledge from communities and incorporate such knowledge in fisheries management.

(38) Increase Alaska Native participation and consultation in fisheries management.

PSEIS Work Plan contains a general priority to "Increase Alaska Native and community consultation" but the NPFMC has not yet selected a management initiative to fulfill this commitment.

around Kodiak Is. where NMFS compared similar habitats inside and outside the red king crab no trawl zones[4] and elsewhere. Why would it be necessary to open unexploited grounds to bottom trawling when suitable areas already exist in the open area to conduct research? Option 4 appears to be more of a plan for opening the area for potentially large-scale bottom trawl activity than a plan for studying the effects of trawling.

We recommend that the Council select Alternative 2 now as a precautionary measure and engage in the effort of research institutions to increase understanding about the northern Bering Sea ecosystem. This would entail 1) expanded groundfish and crab surveys, 2) an evaluation of changes underway as a result of the loss of sea ice and other climate related effects, 3) an evaluation of sensitive physical, biological and cultural features of the northern Bering Sea, 4) outcomes from bottom trawl studies and 5) explicit consultation with Bering Sea tribes.

**4. Establishing a northern boundary does not unduly constrain fishing.**

- The boundary is the most liberal boundary considered by the NPFMC containing virtually all trawl tows that have occurred between 1990 and 2005. All other more conservative boundary options were eliminated from the analysis.
- The H& G fleet will soon be fishing under a cooperative system (Amendment 80) which provides additional tools to manage their halibut PSC cap and build other efficiencies into fishing operations. Part of the rationale for establishing coop systems was to provide new ways for the fleet to adapt to conservation measures such as the groundfish retention standard and halibut PSC.

Thank you for considering our recommendation.

Sincerely,

Dorothy Childers

Dorothy Childers
Program Director

---

[4] Stone, R., M.M. Masuda and P.W. Malecha. 2005. Effects of bottom trawling on soft sediments epibenthic communities in the Gulf of Alaska. In: P.W. Barnes and J.P. Thomas (editors), Benthic Habitat and the Effects of Fishing. Am. Fish. Soc. Symp.

AGENDA D-3 (a)
DECEMBER 2006

# A Review of Scientific Information Related to Bering Sea Canyons and Skate Nursery Areas

Prepared for the North Pacific Fishery Management Council
by the Alaska Fisheries Science Center

18 November 2006

# Table of Contents

Background ........................................ 3
AFSC Research on Skate Nursery Areas ........................................ 4
AFSC Research in Bering Sea Canyons ........................................ 6
Rockfish – sea whip associations ........................................ 6
Age and growth of sea whips ........................................ 8
Habitat associations of fish and crab ........................................ 9
Research summary and significant uncertainties ........................................ 10
AFSC Data Sources ........................................ 11
Bottom trawl surveys – EBS shelf and EBS slope ........................................ 11
Longline survey - EBS slope ........................................ 16
NORPAC fishery observer database ........................................ 18
Food habits database ........................................ 20
FOCI ocean moorings ........................................ 23
AFSC Underwater Video From Canyon Areas ........................................ 24
Pribilof Island / Canyon area ........................................ 24
Pribilof Island closure and skate nursery area ........................................ 25
Pribilof Island closure and skate nursery area ........................................ 26
External Data Sources ........................................ 27
U.S. Geological Survey – GLORIA mapping ........................................ 27
OCSEAP Data ........................................ 28
Summary and Recommendations ........................................ 29
Pertinent Scientific and Technical References ........................................ 31
Contributors ........................................ 43
Appendix 1 – Skate Nurseries ........................................ 43
Appendix 2 – Brodeur (2001) ........................................ 43
Appendix 3 – Wilson *et al.* (2002) ........................................ 43
Appendix 4 – Busby *et al.* (2005) ........................................ 43

## Background

The North Pacific Fishery Management Council ("Council") is one of eight regional councils overseeing management of the Nation's fishery resources. One of their specific responsibilities is compliance with provisions of the Magnuson-Stevens Fishery Management Act related to essential fish habitat (EFH). EFH is broadly defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". The mandate includes a requirement to "encourage the conservation and enhancement of such habitat". The Council is currently developing a list of alternatives to be analyzed in an Environmental Assessment for Bering Sea habitat conservation measures.

The Alaska Fisheries Science Center (AFSC) was contacted 25 October and asked to produce a white paper summarizing current scientific information on Pribilof, Middle (actually Pervenets)[1] and Zhemchug Canyons in the eastern Bering Sea (EBS), as well as skate nursery areas in the EBS. This document addresses the specific requests considered most relevant for the Council action:

1. Summarize AFSC research conducted in these areas and the principal findings;
2. Identify specific locations of AFSC sampling or dive surveys in these areas;
3. Document AFSC videos of these habitat features;
4. Summarize other available information regarding the ecology of these areas and their use by commercially important species;
5. Provide a qualitative assessment of the habitat value of these areas for managed species and their susceptibility to disturbance; and
6. Provide a list of pertinent scientific and technical references.

Because of time constraints, the document has been structured as an inventory of available data and information that are applicable to a thorough review and evaluation of the Proposal. Various database queries and GIS projects generated to produce these results have been archived.

[1] Close examination of Figure 6 in the OCEANA public testimony indicates the Middle Canyon closure boundary actually encompasses Pervenets Canyon, which is located due west of St Matthew Island and to the north of Middle Canyon (canyon head located at 58° 37' N, 176° 45' W). For clarity, Pervenets Canyon is used in this document to refer to this area.

## AFSC Research on Skate Nursery Areas

The goal of this research is to understand skate nursery dynamics and the physical and biological parameters that support successful skate reproduction. These nurseries are recent discoveries and it is presently unknown how many of these areas exist. To date six skate nursery sites have been identified in the eastern Bering Sea. All sites occur along the shelf-slope interface between 150 and 400 meters in depth and are associated with slope canyon areas and areas of significant upwelling. Three sites for the Alaska skate *Bathyraja parmifera*, two for the Bering skate *B. interrupta* and one for the Aleutian skate *B. aleutica* have been located and investigated in years 2004 and 2006.

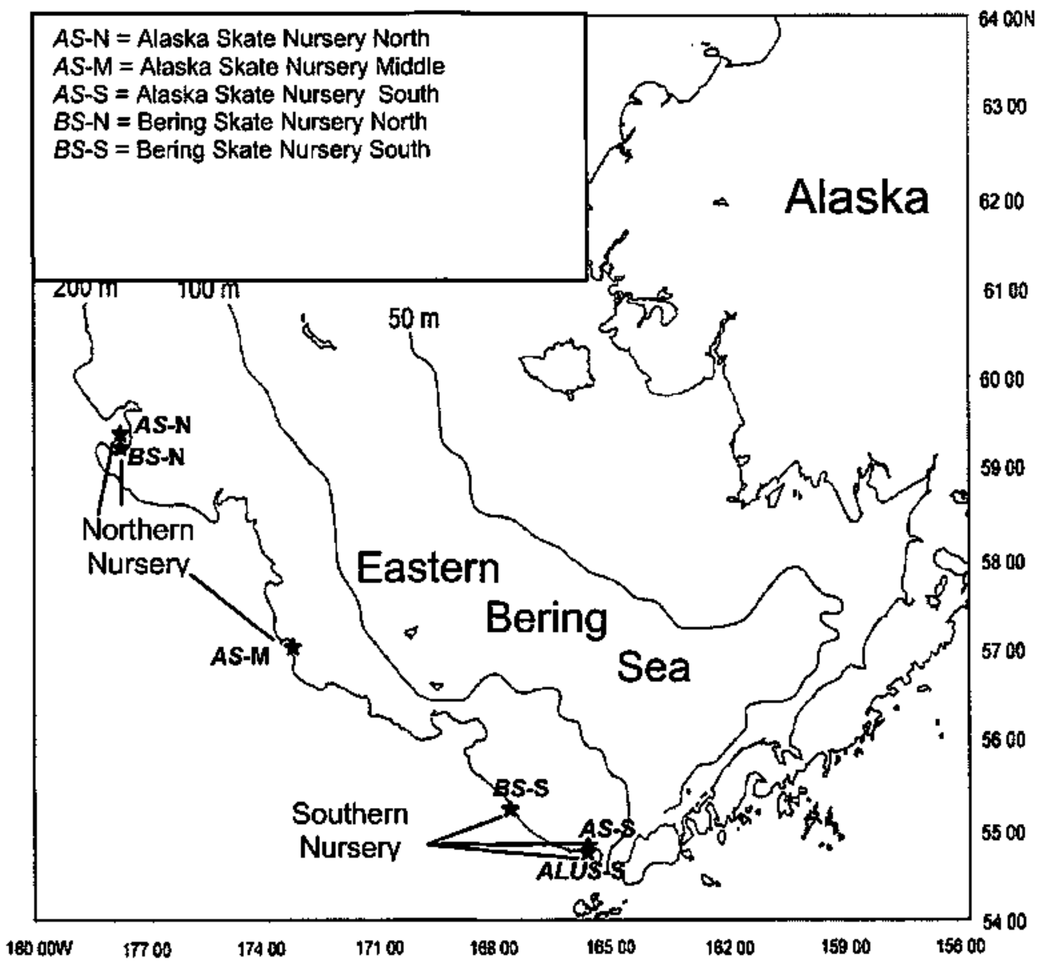
Each site has been explored using bottom trawls to determine the density of egg cases, the extent of the nursery sites, mortality sources to young skates and distinguishing abiotic features of the site that may define essential fish habitat. Two sites, that of the Alaska and Aleutian skates in the south EBS near Unimak Pass have been studied on a seasonal basis to determine timing of egg deposition and hatching as well as seasonal use of the nursery site by predator species.

Details of the Alaska Skate nursery site in the southern EBS have been synthesized in a final report to the North Pacific Research Board (Appendix 1) and are the focus of Gerald Hoff's PhD dissertation, which is currently in draft form. The final dissertation will be available for distribution in late January of 2007. A synthesis of the six nursery sites will be presented in a manuscript that will be available in February of 2007.

All nursery sites show similar characteristics and at this point Hoff feels that many biological and physical processes can be generalized for the six known EBS skate nursery sites:

1. Nursery sites are single species and used over multiple years.
2. Nursery sites are small in area (<2 $km^2$) with high densities of eggs.
3. Nurseries occur along the shelf-slope environment which may provide many physical and biological features that maximize skate production.
4. Nurseries are used exclusively by mature and developing embryos with other life stages rarely found in nurseries.
5. Embryo development time is long (>3 years) with multiple cohorts developing within the nursery at the same time.

6. Embryos and newly hatched juveniles are susceptible to mortality due to snail and fish predators.
7. Nursery sites may be vulnerable to disturbances from trawling due to the protracted embryo development time, limited habitat area, and low annual productivity of the species.




Map of the six skate nursery sites in the eastern Bering Sea.

# AFSC Research in Bering Sea Canyons

Scientific research in the Bering Sea canyon areas by the Alaska Fisheries Science Center is limited to three opportunistic studies in and around the Pribilof Island Area. Two of the studies use data from a pair of cruises aboard NOAA ship *Miller Freeman* which was engaged in a multidisciplinary study of the frontal region near the Pribilof Islands. Summary statements for each of these studies follow.

### *Rockfish – sea whip associations*

Brodeur (2001; Appendix 2) reported on one aspect of a larger multidisciplinary study of fish - zooplankton interactions in and around Pribilof Canyon, a large canyon with depths ranging from 130 – 3200 m. Sampling with a variety of devices was concentrated at the head of the canyon.

| Sampler | Deployments | Maximum Depths (m) |
|---|---|---|
| CTD[2] | 3 | 246, 256 |
| Light levels[3] | unspecified | unspecified |
| ROV with color video[4] | 7 | 184-243 |
| Bottom trawl[5] | 5 | 200-248 |
| Acoustic transect[6] | 4 | 230-264 |
| Methot midwater trawl[7] | 2 | 214, 234 |

Bottom water temperatures in the study area were generally 4-5° C. Illumination levels at 200 m were 4.3 x $10^{-6}$ $\mu Es^{-1}$ $m^{-2}$ (day) and 6.2 x $10^{-7}$ $\mu Es^{-1}$ $m^{-2}$ (night) and were considered very low however suitable for feeding by planktivorous fish.

The ROV revealed a seabed of compacted mud and silt with little geological relief, except for occasional rocks and small boulders. Five of seven ROV dives encountered dense, evenly spaced

[2] Sea-Bird model SEE-9
[3] In situ light levels recorded at several stations using an International Light IL-1700 Research Radiometer.
[4] Super Phantom II ROV on a 300 m umbilical, with a color CCD video camera recorded on Hi-8 tapes.
[5] Nylon Nor-eastern bottom trawl with roller gear and 1.5 m x 2.1 m steel doors.
[6] Simrad EK-500 calibrated echosounder at 38kHz and 120 kHz (7° beam width)
[7] 5 $m^2$ opening with 13cm – 8.9 cm mesh sizes, and a 3.2 cm liner in the codend.

1-2 m high stands of sea whips (*Halipteris willemoesi*) along the central and western flank of the canyon. Hundreds of mature adult rockfish were observed in these "forests" at night, or just above them during the day. Other species of groundfish were also observed but with no apparent affinity for the sea whips. Lower densities of rockfish were observed in large sea whip beds with some non-upright specimens. Neither rockfish nor sea whips were observed during the two easternmost and shallowest (181-224 m) ROV dives.

The bottom trawl captured 16 species of groundfish, with Pacific ocean perch, arrowtooth flounder and Pacific cod most abundant. Invertebrate catches were probably small due to the roller gear and, although taxa such as sea whips were collected, invertebrates were not quantitatively assessed due to anticipated losses through the trawl meshes. King crabs (*Paralithodes* spp.), large anemones (*Metridium giganteum*, *Urticinal* spp.), and large basket stars (*Gorgonocephaluseucremis*) were observed during ROV dives.

Acoustic transects along the shelf break and across the axis of the upper canyon detected substantial aggregations of large scatterers within 10 m of the seabed with smaller scatterers above and occasionally overlapping them. Based on theoretical scattering models, the large scatters were thought to be rockfish (or cod), while the smaller scatters could have been either euphausiids or gelatinous zooplankton.

Macrozooplankton and micronekton in the Methot trawls were dominated by euphausiids (primarily *Thyanoessa inermis*), which accounted for 87% (1995) and 98% (1996) of the total catch.

Taken together, the findings are interpreted that rockfish rest in sea whips at night and reside above them during daylight hours possibly feeding on euphausiids. The paper concludes the following:

1. "This study is the first to show the importance of the Pribilof Canyon in general and the sea whip 'forest' in particular as a distinctive habitat for adult Pacific ocean perch in the Bering Sea".
2. The sea whips in this region may provide important structural habitat for Pacific ocean perch in an otherwise featureless environment."

3. Because sea whips may be slow-growing and long-lived, "...fishing operations that disturb the bottom and uproot the sea whips may have a lasting effect on the rockfish population inhabiting this region."

### *Age and growth of sea whips*

Wilson *et al.* (2002; Appendix 3) examined age and growth of the sea whip, *Halipteris willemoesi*, using measurements obtained from the axial rod endoskeleton of 12 colonies. The colonies were selected from two trawl samples in the EBS. The colonies were divided for analysis into three size classes (four colonies each), based on length of the axial rod. The largest colonies came from the northwestern head of Pribilof Canyon (56°16.8' N, 169°25.8' W; 248 m depth; 3.5° bottom temperature), while the "small" and "intermediate" classes were collected on the shelf to the northwest (56°16.8' N, 169°25.8' W; 248 m; 2.0° C.). Age and growth rates were estimated based on an assumption that growth ring couplets visible in thin cross-sections of the axial rod represented annuli. Annuli were counted, and axial rod lengths and diameters were measured to estimate colony ages and annual growth rates.

| Group | Size (cm) | Mean ± Standard Error | |
|---|---|---|---|
| | | Age (yr) | Growth Rate (cm $yr^{-1}$) |
| Small | 25–29 | 7.1 ± 0.7 | 3.9 ± 0.2 |
| Medium | 98-130 | 19.3 ± 0.5 | 6.1 ± 0.3 |
| Large | 153-167 | 44.3 ± 2.0 | 3.6 ± 0.1 |

A predictive age model was developed using the average annual increase in maximum diameter of the axial rod ($R^2 = 0.99$). However, growth rates and corresponding ages could not be validated using two different radiometric methods and alternative methods were suggested for future studies. The authors conclude that:

1. "Growth in total rod length is slow at first, fastest at medium size, and slows toward maximum size, with an estimated longevity approaching 50 years."
2. "...the longevity of these organisms and the biogenic habitat they may provide to other species makes it essential that fishing-related impacts be studied in detail."

### *Habitat associations of fish and crab*

Busby *et al.* (2005; Appendix 4) analyzed 45 ROV dives conducted in the Pribilof Island area of the eastern Bering. Seven of the dives were in Pribilof Canyon and were the basis for the Pacific ocean perch – sea pen analysis by Brodeur (2001).

| ROV Dive | Date | Time (GMT) | N. Latitude | W. Longitude | Depth (m) | |
|---|---|---|---|---|---|---|
| | | | | | ROV | Bottom |
| 12 | 9/17/1995 | 4:06 | 56.30 | -169.44 | 203 | 203 |
| 13 | 9/17/1995 | 11:44 | 56.29 | -169.46 | 211 | 211 |
| 25 | 9/24/1995 | 3:47 | 56.31 | -169.68 | 209 | 209 |
| 26 | 9/24/1995 | 10:41 | 56.28 | -169.60 | 184 | 184 |
| 27 | 9/24/1995 | 22:16 | 56.29 | -169.30 | 197 | 197 |
| 3 | 9/10/1997 | 23:22 | 56.28 | -169.43 | 243 | 243 |
| 4 | 9/11/1997 | 5:41 | 56.28 | -169.43 | 234 | 234 |

These two studies are based on sampling from NOAA ship *Miller Freeman* during 9-26 September 1995 and 8-18 September 1997. The primary objective of the Busby *et al.* analysis was to describe small-scale habitat associations of demersal fish and crabs using underwater video collected with an ROV. Secondarily, the study evaluated video as a survey tool by comparing observed species compositions with those obtained in coordinated bottom trawl samples. Similar to Brodeur (2001), sampling sites were chosen to represent different hydrographic regimes that supported the primary mission focus on frontal regions in the area. Contrary to Brodeur's emphasis on rockfish and canyon locations with sea whips, pleuronectid flatfish (primarily the northern rock sole *Lepidopsetta polyxystra*) were the most frequently observed taxa, and the majority of Busby's observations occurred on silt bottoms with no cover.

Overall, 42 taxa representing 16 families of fish and 8 taxa from 3 families of crabs were observed. Statistical analyses with six habitat classes revealed some species showed clear substrate preferences (e.g. yellowfin sole *Limanda aspera*; snow crab *Chionoecetes opilio*), while other taxa associated with multiple habitat types (e.g. walleye pollock *Theragra chalcogramma*; Korean horsehair crab *Erimacrus isenbeckii*). Most rockfish were associated with rocky outcrops or biogenic structure, and rock sole were frequently observed swimming along troughs in seabed waves. Eight color plates included in the paper show species in their common habitats.

Statistical analyses also indicated significant differences in species composition among habitats and depth intervals. Finally, there was significant correlation between species composition and ranked abundances of taxa from the ROV observations and bottom trawl pairs. Several dives at the head of Pribilof Canyon showed "silt throughout the center with large fields of gravel-cobble and rocks-near the edges of the canyon."

### *Research summary and significant uncertainties*

Relatively few biological studies have been conducted in the three submarine canyons. The three AFSC studies conducted to date were confined to the uppermost head of the Pribilof canyon and adjoining continental shelf. No AFSC research has occurred in Zhemchug or Pervenets Canyons. In all cases, video and trawl sampling was limited to less than 10% of the maximum canyon depth. Sampling for the two habitat studies was further constrained by the primary scientific mission of the research vessel (Brodeur 2001; Busby *et al.* 2005). Although mature POP are reported to associate with sea whips in canyon head areas, the relative importance of this habitat compared to deeper habitats in the canyon is unknown. In fact, Brodeur (p. 219) reports that Krieger[8] "found that adult Pacific ocean perch were more likely to inhabit flat, pebble substrate based on submersible observations off Southeast Alaska." Apparent preference for upright sea pen beds based on high abundance in sea whips, substantially lower numbers in "perturbed" beds, and absence in other shallower areas without whips (Brodeur 2001) could perhaps be related to other environmental factors not being considered. It also is difficult to compare the POP densities observed inside and outside the sea whip beds relative to other areas not being considered for closure. This is due to the inherent difficulty of determining the physical area being observed with video (i.e., the width of the video camera's field of view and the distances traveled by the ROV are frequently unknown and variable; Busby *et al.* 2005). Similarly, significant habitat function in the canyon areas is not demonstrated by Busby *et al.*'s research. The substrates described in this study are rather typical of those found elsewhere in the Bering Sea[9] and inordinately large concentrations of fish or invertebrates were not reported. It would perhaps be

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[8] Krieger, K.J. 1992. Distribution and abundance of rockfish determined from a submersible and by bottom trawling. Fishery Bulletin 91: 87-96.

[9] The authors cite Smith, K.R. and R.A. McConnaughey. 1999. Surficial sediments of the eastern Bering Sea continental shelf: EBSSED database documentation. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-104. 41 p.

useful to compare the relationships between bottom type and fish distribution reported from their study with those for the full EBS shelf [10].

The studies each express concern about possible consequences of destructive fishing practices and losses of important habitat. For example, Brodeur reported that perturbed sea whip beds contained substantially fewer rockfish and "fishing operations that disturb the bottom and uproot the sea whips may have a lasting effect on the rockfish populations inhabiting this region". However, it is unknown whether uprooted sea whips are truly lost as a result, given a propensity in certain whip species to detach, drift and re-attach (Wilson *et al.* 2005). First and foremost in the context of EFH, it is unknown whether there exists an essential functional dependency between rockfish and sea whips that is affected by the disturbance. Concerns about disturbance by fishing are particularly warranted for slow-growing and long-lived species, as reported for the sea whip, *Halipteris willemoesi*. There are however acknowledged uncertainties about the age and growth determinations for this species, including the existence of true annuli and the inability to validate the reported ages (Wilson *et al.* 2005).

## AFSC Data Sources

The AFSC is responsible for research on living marine resources in the coastal oceans off Alaska (http://www.afsc.noaa.gov). Its mission is to plan, develop, and manage scientific research programs, which generate the best scientific data available. These data are used to understand, manage and conserve the region's living marine resources, as well as the environmental quality essential for their existence. This section provides information on data holdings from various AFSC monitoring and assessment activities in the conservation areas of interest. These data collectively provide the most comprehensive set of biological and ecological information that is currently available.

### *Bottom trawl surveys – EBS shelf and EBS slope*

The RACE Division of the Alaska Fisheries Science Center conducts annual bottom trawl surveys of the EBS continental shelf. These surveys provide data for stock assessments and management of the fishery resources. Each June–August, the EBS shelf (approximately 463,400

[10] 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.

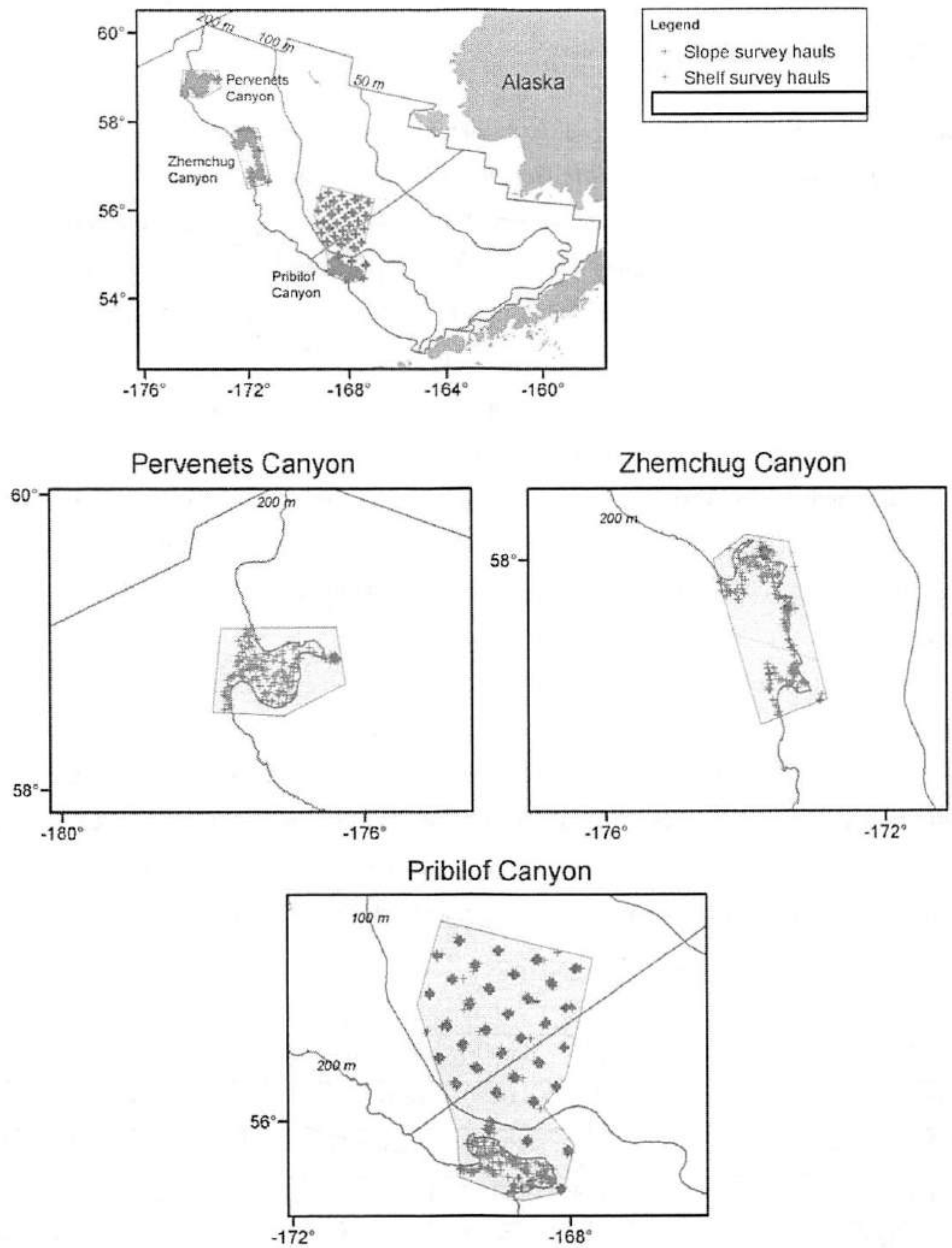
km$^2$) is systematically surveyed at depths ranging from 20 to 200 m. An 83-112 eastern otter trawl is deployed from chartered vessels at 356 standard stations in a sampling grid with 20 × 20 nautical mile cells. Each sample consists of a 30-min tow at 3 kn. The catch is processed to determine total weight and numbers by species and sex, and a variety of biological measurements and samples are collected from individual specimens. Acoustic net mensuration data and a global positioning system are used to standardize catches (CPUEs) according to area swept.

The RACE Division also conducts bottom trawl surveys along the upper slope of the EBS in order to produce standardized estimates of groundfish and invertebrate abundance. Compared to the shelf survey, the time series is less complete and standard protocols have been implemented only recently. The slope survey was conducted during the period 1975-1991 using a variety of nets, vessels, methods, and sampling locations. A pilot study in year 2000 compared performance of two versions of a Poly Nor'eastern bottom trawl and concluded that the net with mud-sweep roller gear was more efficient and should thereafter be used exclusively. The first standardized biennial survey using this gear occurred in 2002. It should be noted that comparability of data before and after the year 2000 has not been examined and caution is therefore required when examining time series of catches. The standardized survey extends from Unalaska and Akutan Island to the U.S. Russian border near the International Date Line, at depths from 200 to 1,200 m. The survey area encompasses several geologically distinct bathymetric types described as broad low slope areas, canyon areas (including Pribilof and Zhemchug), and steep-slope inter-canyon faces. Trawl sampling occurs at pre-selected locations where depth changes less than 50 m over a distance of 2 nm and the bottom is judged to be free of obstructions that would impede completion of the tow or negatively affect performance of the gear. A standard sample at all depths on the slope consists of a 30-minute tow at 2.5 knots. Available shelf and slope survey data from the three Bering Sea Canyons:

| Year | Number of Hauls (Shelf Survey) | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| 1982 | 32 | 2 | 1 | 35 |
| 1983 | 34 | 3 | 1 | 38 |
| 1984 | 34 | 3 | 1 | 38 |
| 1985 | 34 | 2 | 1 | 37 |
| 1986 | 34 | 2 | 1 | 37 |

| Year | Number of Hauls (Shelf Survey) | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| 1987 | 34 | 2 | 1 | 37 |
| 1988 | 36 | 2 | 1 | 39 |
| 1989 | 35 | 2 | 1 | 38 |
| 1990 | 34 | 3 | 1 | 38 |
| 1991 | 34 | 3 | 1 | 38 |
| 1992 | 33 | 2 | 1 | 36 |
| 1993 | 33 | 2 | 1 | 36 |
| 1994 | 34 | 2 | 1 | 37 |
| 1995 | 34 | 2 | 1 | 37 |
| 1996 | 34 | 3 | 1 | 38 |
| 1997 | 34 | 2 | 1 | 37 |
| 1998 | 33 | 3 | 1 | 37 |
| 1999 | 34 | 3 | 1 | 38 |
| 2000 | 33 | 2 | 1 | 36 |
| 2001 | 34 | 2 | 1 | 37 |
| 2002 | 34 | 2 | 1 | 37 |
| 2003 | 34 | 2 | 1 | 37 |
| 2004 | 33 | 2 | 1 | 36 |
| 2005 | 33 | 2 | 1 | 36 |
| 2006 | 34 | 2 | 1 | 37 |
| Total | 845 | 57 | 25 | 927 |
| | | | | |
| **Year** | **Number of Hauls (Slope Survey)** | | | |
| | **Pribilof** | **Zhemchug** | **Pervenets** | **Total** |
| 1975 | 0 | 2 | 2 | 4 |
| 1976 | 2 | 4 | 0 | 6 |
| 1979 | 10 | 19 | 13 | 42 |
| 1981 | 27 | 24 | 15 | 66 |
| 1982 | 19 | 29 | 32 | 80 |
| 1985 | 28 | 32 | 32 | 92 |
| 1988 | 10 | 4 | 8 | 22 |

| Year | Number of Hauls (Shelf Survey) | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| 1991 | 6 | 5 | 9 | 20 |
| 2000 | 14 | 18 | 14 | 46 |
| 2002 | 10 | 14 | 12 | 36 |
| 2004 | 19 | 19 | 14 | 52 |
| Total | 145 | 170 | 151 | 466 |




Distribution of standard eastern Bering Sea bottom trawl survey hauls conducted by the Alaska Fisheries Science Center within the three canyon areas.

### *Longline survey - EBS slope*

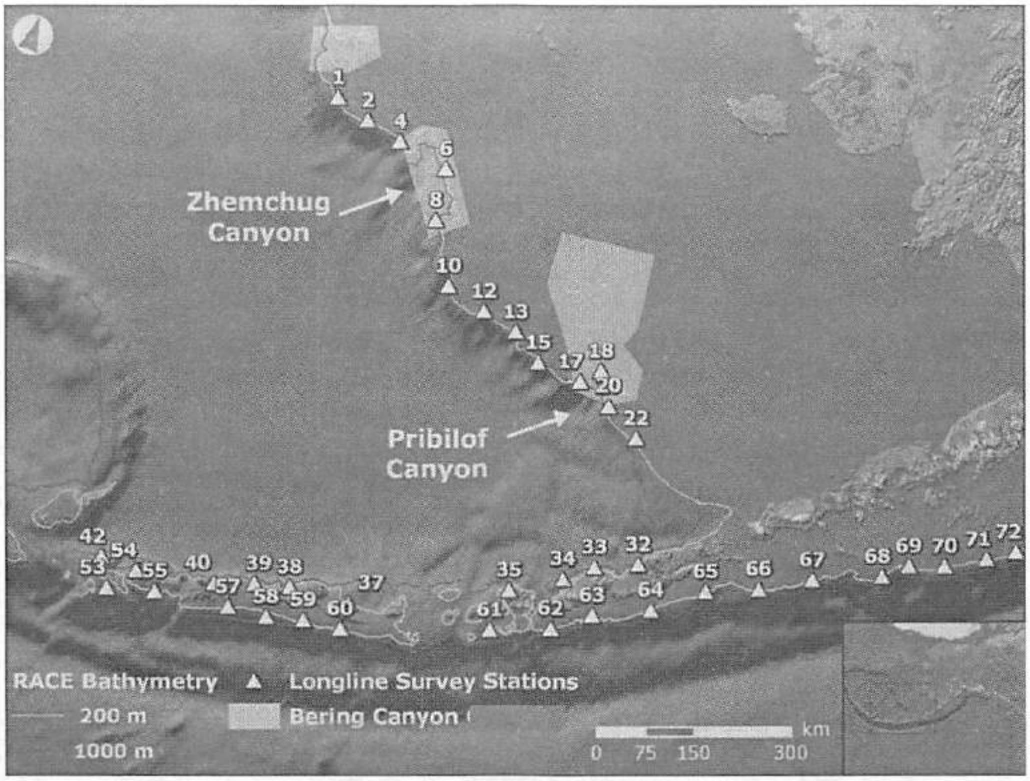
Since 1995, the Auke Bay Laboratory of the Alaska Fisheries Science Center has conducted annual longline surveys of sablefish (*Anoplopoma fimbria*) resources in Alaskan waters. These surveys were designed to continue the time series (1979-94) of the Japan-U.S. cooperative longline survey that was discontinued after 1994. The EBS was sampled annually as part of the cooperative survey between 1982 and 1993 and then biennially since 1997 (Table below).

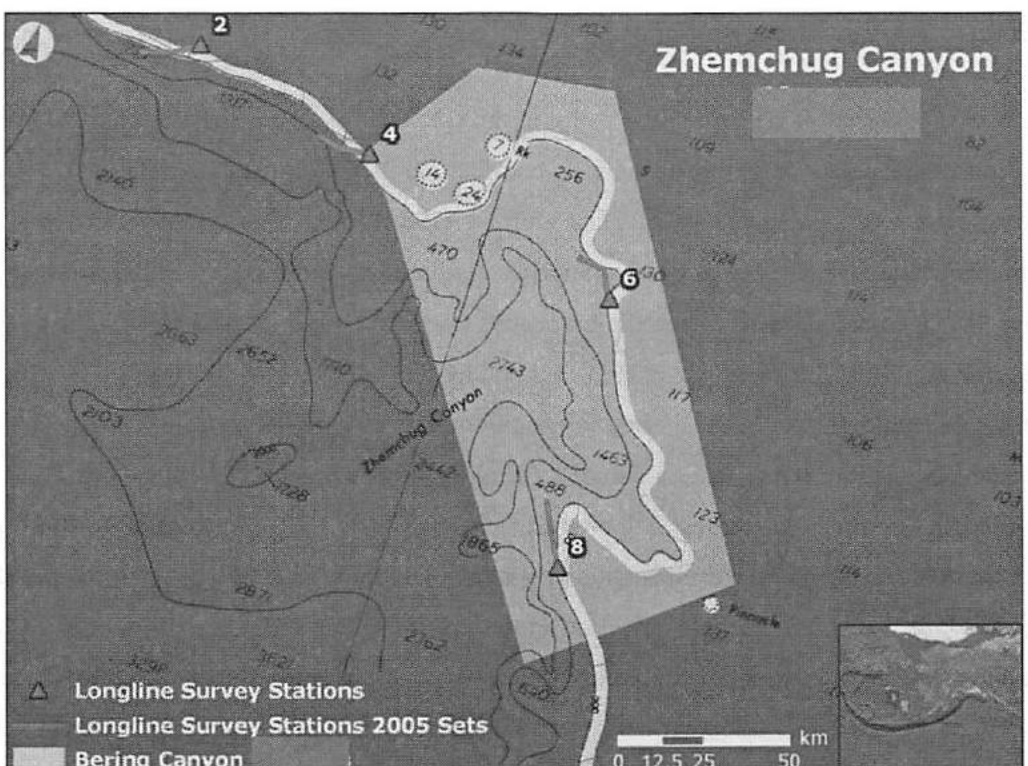
Sixteen stations along the upper continental slope of the EBS are surveyed (Figure below). Surveyed depths range from approximately 200 to 1000 m, although slightly shallower or deeper depths are fished at some stations. Units of gear (skates) are 100 m long and contain 45 size-13/0 Mustad circle hooks. Hooks are attached to 38 cm gangions that are secured to beckets tied into the groundline at 2 m intervals. Total groundline at each station consists of 180 skates with 8100 hooks.

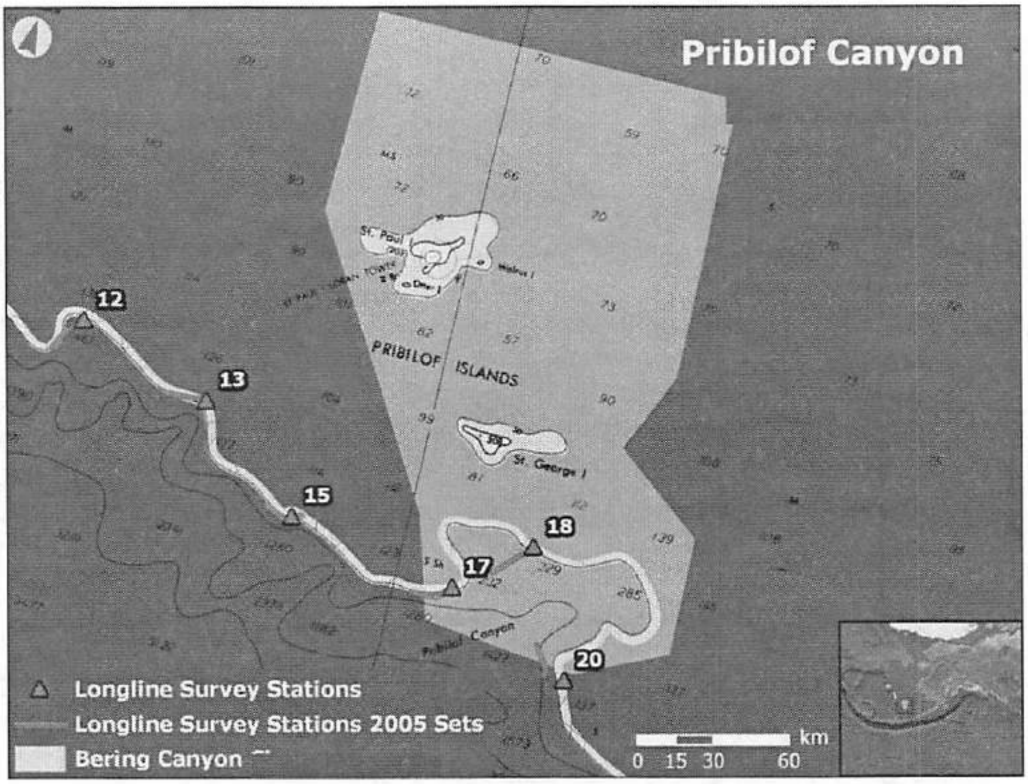
Catch data are recorded on hand-held electronic data loggers. A scientist records the species of each hooked fish during gear retrieval and the depth strata (100 m intervals) of each gear set. In addition to fish and crab species, coral and sponge catch was generically recorded beginning in 1997. In 2005, coral catch was recorded to higher taxonomic categories (i.e. gorgonians, *Primnoa* sp., *Paragorgia* sp., bamboo corals, scleractinians, black corals, pennatulaceans, and hydrocorals).

| Region | Station # | Latitude/Longitude | Survey Years |
|---|---|---|---|
| Pribilof Canyon | 17 | 56.04° N, 169.62° W | 82-93,97,99,01,03,05 |
| Pribilof Canyon | 18 | 56.24° N, 169.17° W | 82-93,97,99,01,03,05 |
| Pribilof Canyon | 20 | 55.81° N, 168.93° W | 82-93,97,99,01,03,05 |
| Zhemchug Canyon | 4 | 58.50° N, 175.68° W | 82-93,97,99,01,03,05 |
| Zhemchug Canyon | 6 | 58.33° N, 174.32° W | 82-93,97,99,01,03,05 |
| Zhemchug Canyon | 8 | 57.63° N, 174.16° W | 82-93,97,99,01,03,05 |

Stations from AFSC longline survey in submarine canyons of the eastern Bering Sea (see Figures below). Note that the survey does not extend as far north as Pervenets Canyon and consequently no survey data are available for that region.


Zhemchug Canyon
Pribilof Canyon
RACE Bathymetry
200 m
1000 m
Longline Survey Stations
Bering Canyon
km
0 75 150 300


Zhemchug Canyon
Zhemchug Canyon
Longline Survey Stations
Longline Survey Stations 2005 Sets
Bering Canyon
km
0 12.5 25 50




### *NORPAC fishery observer database*

As part of a comprehensive data-gathering program for North Pacific fisheries, certified fishery observers are placed on larger vessels during commercial fishing operations. These observers collect a variety of data, including total catch, effort, catch composition and occurrence of prohibited species. These data are transmitted at regular intervals and are used for in-season fishery management and other scientific purposes. Historical observer data reside in the NORPAC relational database, which is maintained by the Fisheries Monitoring and Analysis (FMA) Division at the Alaska Fisheries Science Center. These data cover three distinct periods in the development of North Pacific fisheries (foreign, joint-venture or j/v, domestic). Commercial bottom trawls during the domestic period are easily identified from gear information recorded in the field. This gear information is not available for hauls during the foreign and j/v period and it was therefore necessary to use a judicious combination of vessel type, processor type and presence of benthic invertebrates in the catch to identify bottom trawl activity. Because observers did not process all catches prior to 1988, roughly half of all hauls during the period are not included by this method (J. Berger, FMA Division, pers. comm.). Furthermore, the estimates of fishing effort do not account for variable and incomplete coverage of vessels over all years so, in general, the counts should be considered conservative. In general, in all three canyon areas commercial trawl hauls were made near or above the 1000m contour.

The following table summarizes the number of commercial bottom trawls observed in the three canyon areas.

| Year | Number of Commercial Bottom Trawls | | |
|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets |
| 1977 | 104 | 13 | 11 |
| 1978 | 82 | 159 | 86 |
| 1979 | 128 | 251 | 88 |
| 1980 | 122 | 96 | 29 |
| 1981 | 164 | 119 | 137 |
| 1982 | 432 | 407 | 569 |
| 1983 | 436 | 966 | 1,380 |
| 1984 | 616 | 941 | 971 |
| 1985 | 564 | 413 | 788 |
| 1986 | 627 | 149 | 335 |
| 1987 | 446 | 126 | 314 |
| 1988 | 445 | 12 | 0 |
| 1989 | 591 | 30 | 0 |
| 1990 | 2,298 | 1,388 | 23 |
| 1991 | 1,989 | 1,204 | 449 |
| 1992 | 2,830 | 467 | 242 |
| 1993 | 2,205 | 489 | 289 |
| 1994 | 1,763 | 335 | 455 |
| 1995 | 83 | 104 | 169 |
| 1996 | 96 | 122 | 9 |
| 1997 | 212 | 72 | 102 |
| 1998 | 82 | 91 | 95 |
| 1999 | 93 | 48 | 30 |
| 2000 | 433 | 84 | 135 |
| 2001 | 256 | 11 | 222 |

| Year | Number of Commercial Bottom Trawls | | |
|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets |
| 2002 | 367 | 13 | 202 |
| 2003 | 316 | 18 | 16 |
| 2004 | 229 | 7 | 92 |
| 2005 | 107 | 67 | 21 |
| 2006 | 257 | 276 | 7 |
| Totals | 18,373 | 8,478 | 7,266 |

### *Food habits database*

The Resource Ecology Fisheries Management (REFM) Division of the Alaska Fisheries Science Center conducts food habits studies during bottom trawl surveys in the EBS. These data are used to estimate the total biomass and numbers of commercially important crab and groundfish consumed by major groundfish species, as well as describe the diet composition of groundfish species in the region. In most years, stomachs are removed at sea and preserved for laboratory analysis. Beginning in 2005 and 2006, food habits data are based primarily on at-sea scans of stomachs. The capture location, as well as fork length, sex and spawning condition of the source animal are recorded. In the laboratory, prey organisms are identified to the lowest practical taxon, enumerated and wet weights determined. Measurements of standard length (fish prey) and carapace length/width (crab prey) may also be determined. The following tables summarizes the number of predator stomachs collected in the canyon areas, and the corresponding list of predators sampled:

| Year | Number of Stomachs Collected | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| 1982 | 72 | 58 | 7 | 137 |
| 1983 | 200 | 67 | 268 | 535 |
| 1984 | 425 | 95 | 177 | 697 |
| 1985 | 635 | 99 | 266 | 1,000 |
| 1986 | 637 | 90 | 201 | 928 |
| 1987 | 953 | 347 | 360 | 1,660 |
| 1988 | 821 | 76 | 59 | 956 |
| 1989 | 811 | 86 | 20 | 917 |

| Year | Number of Stomachs Collected | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| 1990 | 689 | 188 | 55 | 932 |
| 1991 | 824 | 172 | 142 | 1,138 |
| 1992 | 991 | 53 | 112 | 1,156 |
| 1993 | 1,213 | 43 | 83 | 1,339 |
| 1994 | 1,183 | 109 | 126 | 1,418 |
| 1995 | 1,740 | 52 | 30 | 1,822 |
| 1996 | 1,396 | 11 | 19 | 1,426 |
| 1997 | 860 | 59 | 39 | 958 |
| 1998 | 832 | 41 | 4 | 877 |
| 1999 | 929 | 174 | 23 | 1,126 |
| 2000 | 769 | 230 | 157 | 1,156 |
| 2001 | 111 | 0 | 492 | 603 |
| 2002 | 733 | 270 | 195 | 1,198 |
| 2003 | 483 | 1 | 24 | 508 |
| 2004 | 393 | 163 | 82 | 638 |
| 2005 | 146 | 0 | 10 | 156 |
| 2006 | 134 | 0 | 5 | 139 |
| Total | 17,980 | 2,484 | 2,956 | 23,420 |

| Predator Name | Number of Stomachs Collected | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| *Albatrosia pectoralis* (giant grenadier) | 43 | 82 | 87 | 212 |
| *Anoplopoma fimbria* (sablefish) | 66 | 58 | 78 | 202 |
| *Aptocyclus ventricosus* (smooth lumpsucker) | 0 | 0 | 3 | 3 |
| *Aspidophoroides bartoni* (Aleutian alligatorfish) | 0 | 0 | 10 | 10 |
| *Atheresthes evermanni* (Kamchatka flounder) | 165 | 44 | 156 | 365 |
| *Atheresthes sp.* | 41 | 9 | 188 | 238 |
| *Atheresthes stomias* (arrowtooth flounder) | 1,168 | 215 | 1,374 | 2,757 |
| *Bathyagonus nigripinnis* | 0 | 0 | 12 | 12 |
| *Bathyraja aleutica* (Aleutian skate) | 36 | 37 | 45 | 118 |

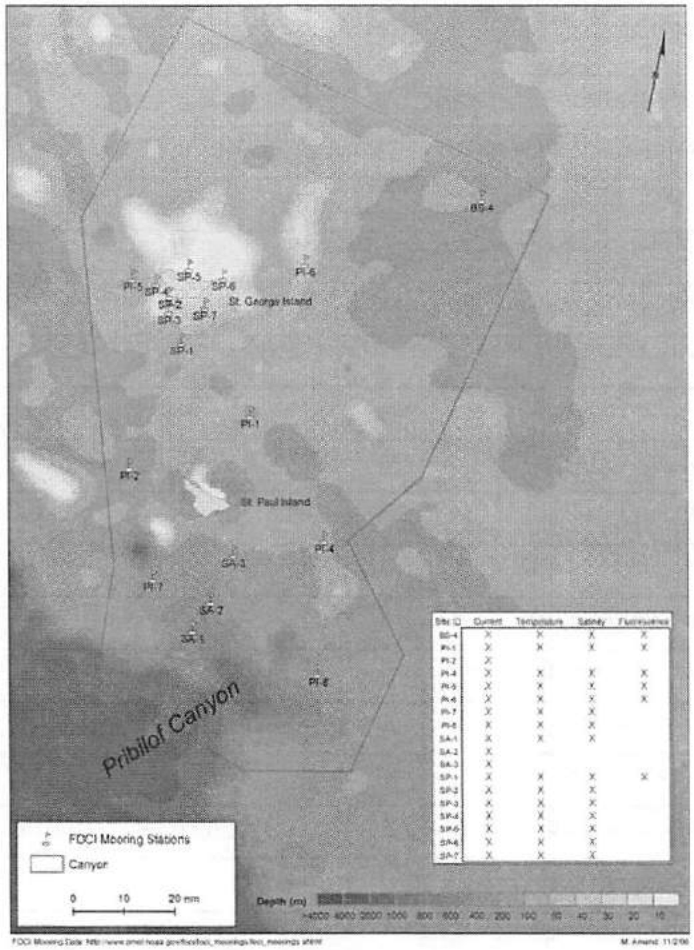
| Predator Name | Number of Stomachs Collected | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| *Bathyraja binoculata* (big skate) | 0 | 0 | 2 | 2 |
| *Bathyraja interrupta* (Bering skate) | 3 | 0 | 38 | 41 |
| *Bathyraja lindbergi* (commander skate) | 21 | 10 | 32 | 63 |
| *Bathyraja maculata* (white blotched skate) | 10 | 0 | 23 | 33 |
| *Bathyraja parmifera* (Alaska skate) | 68 | 1 | 408 | 477 |
| *Bathyraja sp.* (skate) | 2 | 0 | 63 | 65 |
| *Bathyraja tarantetzi* (mud skate) | 12 | 3 | 17 | 32 |
| *Bathyraja trachura* (black skate) | 3 | 0 | 3 | 6 |
| *Bothrocara spp.* (two-line eelpouts (fat and skinny)) | 0 | 0 | 15 | 15 |
| *Clupea pallasi* (Pacific herring) | 0 | 0 | 27 | 27 |
| *Coryphaenoides acrolepis* (Pacific rattail) | 0 | 0 | 64 | 64 |
| *Coryphaenoides cinereus* (popeye grenadier) | 92 | 25 | 20 | 137 |
| *Embassichthys bathybius* (deepsea sole) | 0 | 0 | 48 | 48 |
| *Errex zachirus* (rex sole) | 0 | 11 | 36 | 47 |
| *Gadus macrocephalus* (Pacific cod) | 2,785 | 271 | 1,574 | 4,630 |
| *Hemilepidotus hemilepidotus* (red Irish lord) | 0 | 0 | 50 | 50 |
| *Hemilepidotus jordani* (yellow Irish lord) | 15 | 0 | 211 | 226 |
| *Hemitripterus bolini* (bigmouth sculpin) | 10 | 0 | 1 | 11 |
| *Hippoglossoides elassodon* (flathead sole) | 320 | 86 | 856 | 1,262 |
| *Hippoglossoides robustus* (Bering flounder) | 0 | 0 | 13 | 13 |
| *Hippoglossus stenolepis* (Pacific halibut) | 255 | 20 | 484 | 759 |
| *Icelus canaliculatus* (sculpin) | 0 | 0 | 1 | 1 |
| *Icelus spiniger* (thorny sculpin) | 0 | 0 | 3 | 3 |
| *Lepidopsetta polyxystra* (northern rock sole) | 172 | 4 | 349 | 525 |
| *Leuroglossus schmidti* (northern smoothtongue) | 0 | 0 | 3 | 3 |
| *Leuroglossus stilbius* (California smoothtongue) | 0 | 0 | 4 | 4 |
| *Limanda aspera* (yellowfin sole) | 0 | 0 | 1,019 | 1,019 |
| *Lycodes brevipes* (shortfin eelpout) | 0 | 0 | 11 | 11 |
| *Lycodes concolor* (ebony eelpout) | 0 | 0 | 5 | 5 |
| *Lycodes diapterus* (black eelpout) | 0 | 0 | 19 | 19 |
| *Lycodes palearis* (wattled eelpout) | 0 | 0 | 12 | 12 |

| Predator Name | Number of Stomachs Collected | | | |
|---|---|---|---|---|
| | Pribilof | Zhemchug | Pervenets | Total |
| *Myoxocephalus jaok* (plain sculpin) | 0 | 0 | 5 | 5 |
| *Myoxocephalus polyacanthocephalus* (great sculpin) | 0 | 0 | 20 | 20 |
| *Oncorhynchus tshawytscha* (chinook salmon) | 0 | 0 | 4 | 4 |
| *Pleurogrammus monopterygius* (Atka mackerel) | 0 | 0 | 8 | 8 |
| *Pleuronectes quadrituberculatus* (Alaska plaice) | 0 | 0 | 168 | 168 |
| *Pleuronectidae* (flatfish) | 0 | 0 | 4 | 4 |
| *Rajidae* (skate) | 62 | 0 | 83 | 145 |
| *Reinhardtius hippoglossoides* (Greenland turbot) | 117 | 69 | 163 | 349 |
| *Sarritor frenatus* (sawback poacher) | 0 | 0 | 44 | 44 |
| *Sebastes alutus* (Pacific ocean perch) | 95 | 45 | 53 | 193 |
| *Sebastes polyspinis* (northern rockfish) | 0 | 0 | 20 | 20 |
| *Sebastolobus alascanus* (shortspine thornyhead) | 29 | 0 | 15 | 44 |
| *Somniosus pacificus* (Pacific sleeper shark) | 0 | 0 | 11 | 11 |
| *Thaleichthys pacificus* (eulachon) | 0 | 0 | 8 | 8 |
| *Theragra chalcogramma* (walleye pollock) | 5,510 | 780 | 2,621 | 8,911 |
| *Zaprora silenus* (prowfish) | 0 | 0 | 6 | 6 |
| Total | 11,100 | 1,770 | 10,597 | 23,467 |

### *FOCI ocean moorings*

The Alaska Fisheries Science Center's and Pacific Marine Environmental Laboratory's FOCI Program has maintained a number of ocean moorings in the eastern Bering Sea over the period 1994 to the present. 18 of these moorings are located within the Pribilof Island and Pribilof canyon area. The moorings support a number of meteorological and oceanographic instruments, with most data available online at http://www.pmel.noaa.gov/foci/foci_moorings/foci_moorings.shtml. The following figure indicates the location of the moorings relative to the Pribilof Island and Pribilof canyon area, as well as the data types available from the onboard instrument pack.

AFSC FOCI Oceanographic Mooring Locations - Pribilof Islands Region

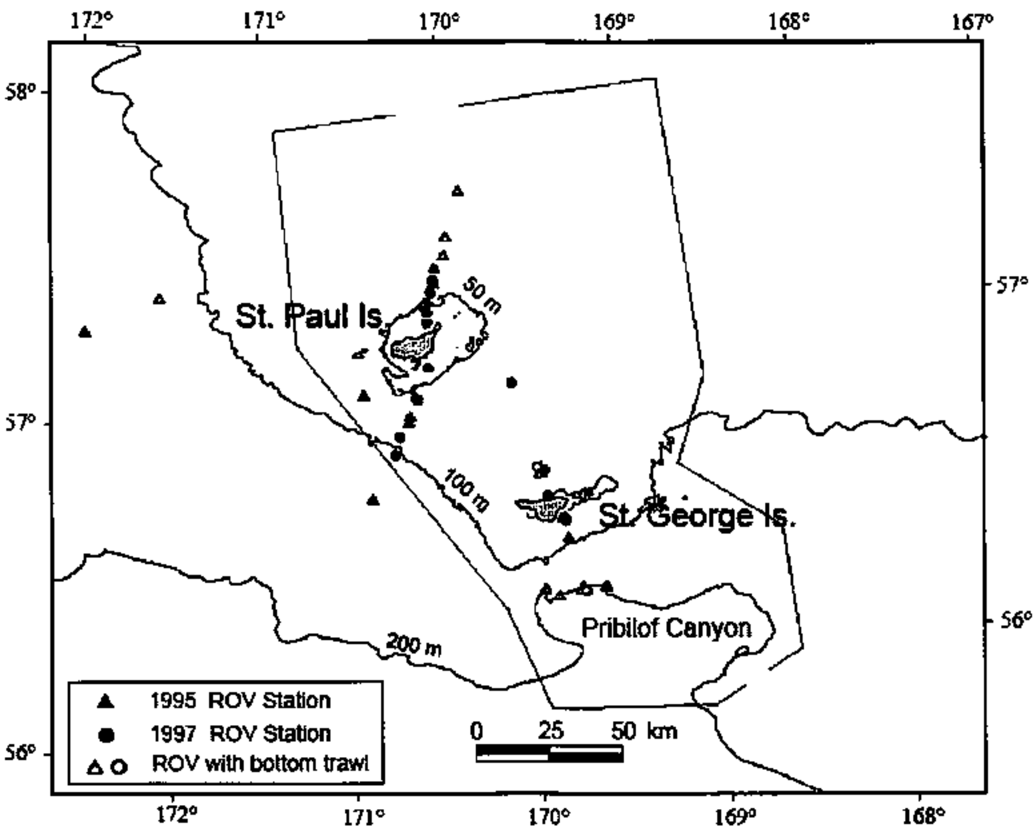



## AFSC Underwater Video from Canyon Areas

### *Pribilof Island / Canyon areas*

Seven of the 45 ROV video camera dives conducted in the EBS during the 1995 and 1997 *Miller Freeman* cruises were in Pribilof Canyon (Brodeur 2001; Busby *et al.* 2005). All of this footage and notes of observations are available for additional study if needed. The following table lists the amount and type of video footage recorded at the dive locations indicated in the figure. (Also see additional information included in the Busby *et al.* research summary above.)

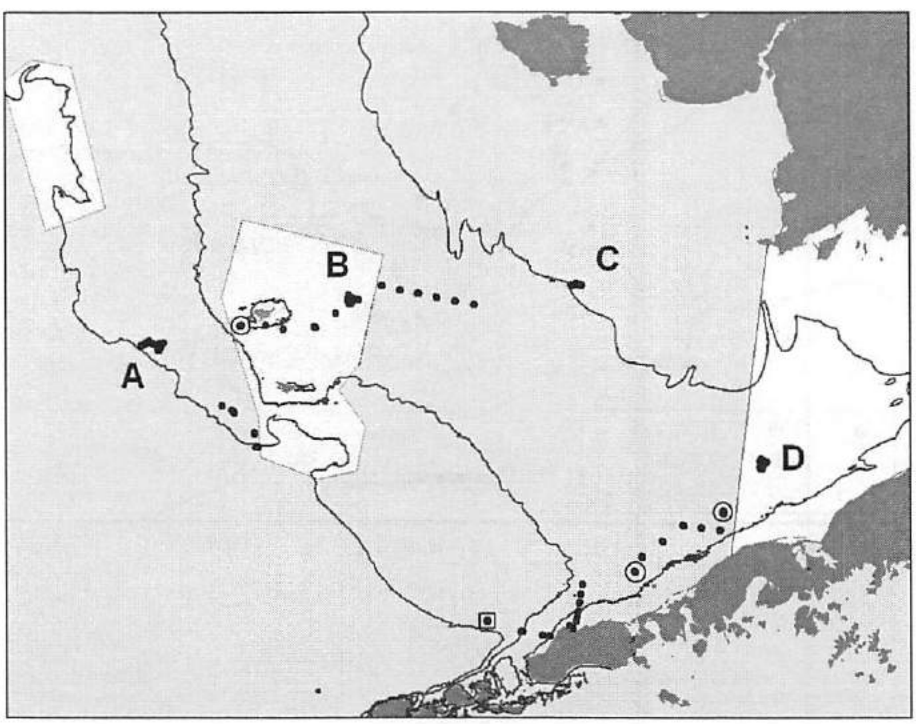
| ROV Dive | Elapsed Recording Time (min.) | |
|---|---|---|
| | Midwater | On-Bottom |
| 12 | 30 | 60 |
| 13 | 35 | 15 |
| 25 | 60 | 15 |
| 26 | 20 | 15 |
| 27 | 25 | 50 |
| 3 | 30 | 65 |
| 4 | 25 | 60 |



*Pribilof Island closure and skate nursery area*

From 23 May to 7 June 2006, RACE scientists conducted research to compare the effects of conventional and modified trawl sweeps on sessile invertebrates at four study sites on the EBS shelf. Included were sites 45 nm east of St. Paul Island (area B in the figure), which were primarily characterized by colonial ascidians (*Halocynthia*, *Boltenia* and *Styela*). At each site, experimental trawling created parallel tracks with the four types of gear being investigated. A seafloor sled outfitted with both a Didson imaging sonar and video sensors was then towed across the tracks at several points to compare the condition of seafloor animals in areas affected by these different gears. The imagery from these sensors has not been analyzed, but will be used to estimate the relative effects of the different sweep designs on the structure-forming invertebrates.

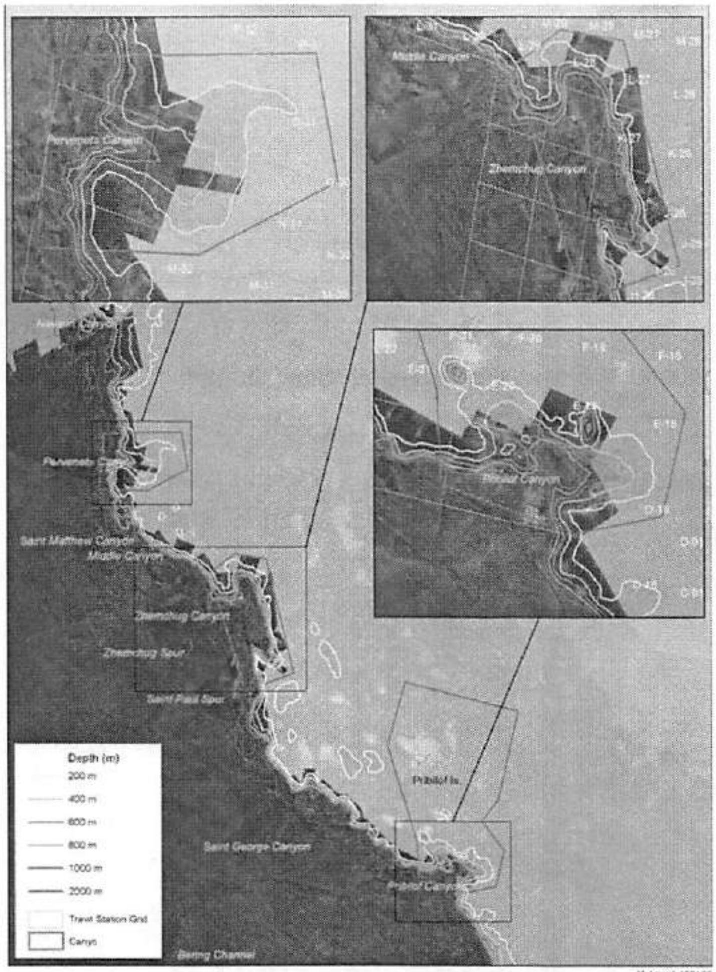
One of the EBS skate nursery areas was also examined with the sled, and very high densities of skate egg cases were observed, confirming prior trawl observations and also providing finer-scale distribution information.



## External Data Sources

### *U.S. Geological Survey – GLORIA mapping*

The U.S. Geological Survey conducted a 1986-1987 survey of the Bering Sea, as part of a national program to map the U.S. EEZ. The survey encompassed all of the Aleutian Basin and Bowers Basin deeper than 200 m that is east of the U.S. – U.S.S.R. Convention Line of 1867. This coverage includes many of the canyons located along the shelf margin. The primary mapping tool was GLORIA, a 6.5 kHz long-range sidescan sonar producing digital backscatter data with each pixel representing ~125 m by 45 m of seabed. Additionally, bathymetry data and both acoustic and air-gun seismic reflection data were collected over 40,000 line km of geophysical transects. An atlas summarizing data from this effort is included in the section "Pertinent Scientific and Technical References".




**USGS Gloria Sonar Imagery: Bering Sea AFSC Trawl Stations near canyons**

## *OCSEAP Data*

NOAA initiated the Outer Continental Shelf Environmental Assessment (OCSEAP) program in 1975, at the request of the Bureau of Land Management. Its purpose was to assess the environmental impact of outer continental shelf oil and gas development in designated large environmental regions or lease areas in Alaska. These areas include the three Bering Sea canyons. Hundreds of biological, chemical, physical and geological/geophysical studies were conducted, many of them in the EBS. A large number of documents including bibliographies[11] and data inventories[12] exist to facilitate identification of studies and data applicable to review of

[11] Anonymous. 1981. Environmental assessment of the Alaskan continental shelf – comprehensive bibliography. Office of Marine Pollution Assessment, National Oceanic and Atmospheric Administration, Washington, D.C. Distributed by the U.S. Government Printing Office, Washington, D.C. 177 pp.

[12] Anonymous. 1979. NODC catalog of OCSEAP data. Part 2. Inventory of digital data by lease area for the Alaska Outer Continental Shelf Environmental Assessment Program. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Information Service.iv + 84 pp.

the Proposal. Hood and Calder (1981)[13], for example, produced a two-volume publication based on a 1979 OCSEAP-sponsored symposium held to review and evaluate the available data for the EBS. Formatted digital data, referenced to the original OCSEAP research study by the Research Unit (RU) number, are archived by NOAA at the National Oceanographic Data Center (NODC) and the National Geophysical Data Center (NGDC).

## Summary and Recommendations

The EFH mandate, in very simple terms, is intended to identify, conserve and enhance "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity".

Skate populations are characterized by low fecundity and slow growth rates, suggesting a bottleneck during early life history stages. As such, areas supporting large numbers of egg cases are extremely important and warrant special consideration. This is especially true in this case given evidence of extended embryonic development (> 3 years) and expected vulnerability of egg cases to removal or disturbance by bottom fishing activity. It is admittedly unknown how many of these nursery areas exist in the EBS. Nevertheless, it seems prudent to consider protecting these nursery areas until such time as the extent of their contribution to the skate populations in the EBS (and perhaps elsewhere) is better understood. Such protective action would fall squarely within the scope of the EFH mandate. Furthermore, the aggregate size of the six closures is quite small suggesting impacts on other fisheries would be minor.

Submarine canyons are significant geological features that cut the continental slope and function as conduits for organic and inorganic matter moving between deep basins and the continental shelf.[14,15] The resulting fluxes can support diverse communities with high biomass, as compared to non-canyon regions at similar depths. Canyons are rare habitats, occupying <4% of the world sea floor and commonly contain unique species assemblages.

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[13] Hood, D.W. and J.A. Calder (eds.). 1981. The eastern Bering Sea shelf: oceanography and resources. Volumes I and II. Office of Marine Pollution Assessment, National Oceanic and Atmospheric Administration, Washington, D.C. Distributed by University of Washington Press, Seattle, WA. xviii + 1339 p.

[14] Glover, A.G. and C.R. Smith. 2003. The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. Environmental Conservation 30(3): 219-241.

[15] Vetter, E.W. and P.K. Dayton. 1998. Macrofaunal communities within and adjacent to a detritus rich submarine canyon system. Deep-Sea Research II 45: 25-54.

There are at least 15 distinct canyon systems along the EBS continental shelf, including the three largest submarine canyons in the world.[16] Zhemchug is the largest of these; each of its two main branches is larger than typical continental shelf canyons (e.g. Monterey). Pervenets and Pribilof Canyon are substantially smaller. Two of these canyons (Middle, St. Matthew) were discovered as recently as 1982.[17]

Despite rather extensive geological studies of submarine canyons in the EBS, very little biological information is available to assess the value of canyon habitat. Although these canyons, including the three evaluated in this paper, are likely to be important at the ecosystem level, the EFH guideline is much more restrictive and a direct link to commercial fish production has not been established. Unfortunately, fisheries research is limited to two AFSC studies in the upper head of a single canyon. These studies indicate the presence of commercially important groundfish and crabs, characterize different benthic habitats, and describe some common fish-habitat associations (Brodeur 2001; Busby *et al.* 2005). One of these associations is between mature rockfish and sea whips, which provide vertical structure in an otherwise featureless area. A third study suggests that sea whips grow slowly with 50 yr longevity (Wilson *et al.* (2002), and it has been argued that rockfish populations could be negatively affected if sea whips are disturbed by fishing (Brodeur 2001). Although insightful for the areas and times sampled, these studies provide no information about the biology and habitat characteristics found in the majority of this canyon system. Taken together, the information from these three studies do not support any proposals for closures based on the existence of unique and/or essential habitat, nor do they make the case for inordinately sensitive habitat in need of immediate protection. Clearly, additional research is required to evaluate the significance of habitat in the proposed canyon areas. A detailed analysis using other data sources identified in this document would likely address the deficiencies at depth and in other canyons and thereby improve an analysis based on existing data.

Ultimately, a thorough assessment of EBS canyon habitats will require a dedicated study. Although it is relatively straightforward to designate EFH in areas with obvious and significant ecological value, such as the skate nursery sites, it is much more difficult to judge habitat quality and discern true habitat dependencies based solely on patterns of biological abundance. This

[16] Normark, W.R and P.R. Carlson. 2003. Giant submarine canyons: is size any clue to their importance in the rock record? Geological Society of America Special Paper 370. 15 p.
[17] Carlson, P.R. J.M. Fischer, and H.A. Karl. 1983. Two newly discovered submarine canyons on Alaskan continental margin of Bering Sea. U.S. Geological Survey Open-File Report 83-24. 37 pp + 1 plate.

requires a systematic survey of habitats and coordinated biological sampling over *the full range* of a species' abundance. Having done this, the relative importance of different habitat characteristics can be compared and the essential elements identified. Management decisions can then be made based on the expected vulnerability of these habitats to anthropogenic disturbance.

## Pertinent Scientific and Technical References

Baldauf, J.G. 1984. Diatom analysis of surface samples recovered from Pervenets Canyon. *In* Carlson, P.R. and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons: U.S. Geological Survey Open-File Report 84-0089, p. 100-112.

Belykh, I.N., S.L. Klemperer, D.W. Scholl, J.R. Childs and H. Gnibidenko. 1995. New deep seismic profiles across the Bering Sea shelf margin, EOS, Transactions, American Geophysical Union, 76(46 suppl.): 590.

**Abstract.** As part of the NSF-CD Bering Shelf-Chukchi Sea continental transect, in 1994 we recorded two crustal (17 s) marine seismic- reflection profiles across the Beringian margin. One profile runs from the Navarin Basin across the shelf edge at St. Matthew Canyon; the other crosses the shelf edge near Zhemchug Canyon and the epicenter of a 1991 Ms=6.8 earthquake. Although a tilted sedimentary basin sequence is seen in this area, no clear fault-plane reflections are visible. On both profiles the top of oceanic crust can be seen at 8 s travel-time beneath about 4 s of Tertiary sediments of the Aleutian Basin. Oceanic crust and Moho can only reliably be traced beneath the smooth sedimentary pile of the basin to the foot of the rough slope on our (currently) unmigrated profiles. On the Zhemchug Canyon profile, NE-dipping reflections can be traced from the top of oceanic crust near the base of the slope to > 12 s, probably equivalent to reflections identified by Marlow & Cooper (1985) as possibly representing the too of oceanic crust subducted into an early Tertiary trench. Complex layered reflections at 12 s at or beneath the base of oceanic crust are also present in this area. Reflection Moho is intermittently visible beneath the outer Bering Shelf at 10 to 12 s (30 to 38 km?) beneath 1 to 2 s carapace sedimentary deposits, but shallows to <10 s, thinning significantly to c. 10 km basement thickness beneath the >6 s (c. 10 km) Navarin Basin.

Bering Sea EEZ-SCAN Scientific Staff. 1991. Atlas of the U.S. Exclusive Economic Zone, Bering Sea. U.S. Geological Survey, Miscellaneous Investigations Series I-2053. 145 pp.

**Summary.** This atlas compiles results from a 1986-1987 survey of the Bering Sea by the U.S. Geological Survey as part of a national program to map the U.S. EEZ. The survey encompassed all of the Aleutian Basin and Bowers Basin deeper than 200 m that is east of the U.S. – U.S.S.R. Convention Line of 1867. This coverage includes canyons located along the shelf margin. The primary mapping tool was GLORIA, a 6.5 kHz long-range sidescan sonar producing digital backscatter data with each pixel representing ~125 m by 45 m of seabed. Additionally, bathymetry data and both acoustic and air-gun seismic reflection data were collected over 40,000 line km of geophysical transects. Data summaries in the atlas consist of (1) sonar imagery mosaics with geologic interpretations and bathymetry, and (2) seismic reflection, magnetic, and gravity profiles.

Blueford, J. R. 1983. Distribution of Quaternary Radiolaria in the Navarin Basin geologic province, Bering Sea. Deep-Sea Research. 30(7A): 763-781.

**Abstract.** Radiolarians from the surface sediments of the Navarin Basin geologic province in the western part of the Bering Sea are more diverse and abundant than previous reports indicate. The shelf is dominated by two spongy radiolarian species groups (Stylochlamydium venustum and Spongotrochus glacialis groups), while the slope has more diversity. The distributions can in part, be explained by present oceanographic conditions. Studies of five cores along the slope show that there is a faunal change within the top 5 m of sediment. The spongy radiolarians are more abundant in recent sediments but gradually decrease downcore as Cycladophora davisiana becomes the dominant species, which probably reflects an environmental change. The disappearance of Lychnocanoma grande in the area occurred around 17,000 to 34,000 y BP, but more research is needed to confirm whether the extinction is a useful biostratigraphic marker.

Blunt, D.J., and K.A. Kvenvolden. 1984. Aspartic acid geochronology of mollusks. *In* Carlson, P.R. and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons: U.S. Geological Survey Open-File Report 84-0089, p. 113-118.

Brodeur, R.D. 2001. Habitat-specific distribution of Pacific ocean perch (*Sebastes alutus*) in Pribilof Canyon, Bering Sea. Continental Shelf Research 21(3): 207-224.

**Abstract.** Shelf edge canyons are well-known sites of enhanced biomass due to on-shore transport and concentration of zooplankton along their axes, both of which contribute to the high densities of nekton frequently found in these canyons. Using a combination of acoustics, trawling, and in situ observations with a remotely operated vehicle (ROV), the distribution of pelagic and demersal biota within Pribilof Canyon in the Bering Sea was examined in September of 1995 and 1997. Near-bottom acoustic scattering patterns in the 38 kHz data showed high concentrations of biomass beginning around the 180m bottom depth contour and continuing to about 220m, which were presumed to be adult fish based on their target strength distributions. The 120 kHz data also showed very strong scattering in the water column between 150 and 175 m, which was absent from the 38 kHz data, and therefore attributed mainly to zooplankton. The dominant taxa collected in bottom trawls and mid-water plankton tows were adult rockfishes (Pacific ocean perch, *Sebastes alutus*) and euphausiids (*Thysanoessa* spp.), respectively. In situ videos revealed dense aggregations of these rockfishes inhabiting a ``forest" of attached sea whips, *Halipteris willemoesi*, during night deployments of the ROV, while areas with damaged sea whips had far fewer rockfish, and areas without this biotic habitat structure had no rockfish. During the day, the rockfishes were seen above the ``forest", where they were apparently feeding on dense swarms of euphausiids. It appears that these rockfish utilize this predictable and abundant food resource in the canyon during the day and are associated with the sea whip habitat at night during periods of inactivity. More research is needed on these slow-growing biotic habitats and how fishing activities in the Bering Sea and elsewhere may impact these habitats.

Busby, M.S., K.L. Mier and R.D. Brodeur. 2005. Habitat associations of demersal fishes and crabs in the
Pribilof Islands region of the Bering Sea. Fisheries Research 75: 15–28.

**Abstract.** Habitat associations of demersal fishes and crabs were determined from observations of videotapes recorded by a camera equipped remotely operated vehicle (ROV) in the Bering Sea near the Pribilof Islands in September 1995 and 1997.We identified 42 taxa

representing 16 families of fishes and 8 taxa from 3 families of crabs. Families Pleuronectidae (righteye flounders) and Cottidae (sculpins) were represented by the greatest number of taxa. *Lepidopsetta polyxystra* and *Chionoecetes opilio* were the most frequently observed fish and crab species. Other fish species in the families Pleuronectidae, Gadidae, Scorpaenidae, Agonidae, and Bathymasteridae were also encountered frequently. Six classifications based on substrate and cover were used to describe the habitat where each fish and crab was observed. Agonids and pleuronectids were typically observed on silt, mud, or sand substrate with no cover while other taxa, particularly cottids and bathymasterids, were encountered in more varieties of habitat including areas covered with rocks and boulders. Significant differences in species composition were found among habitats and stratified depth ranges. Similarity analyses showed that different taxa were responsible for these differences, but within each habitat type and depth range, two to five species contributed to 90% of the average similarity. Some ROV dives were paired with bottom trawls in the same general locations. Species compositions of the ROV observations were significantly correlated with that of the corresponding bottom trawl catch compositions. Overall, we believe that in situ observations provide useful information on fish habitats and behaviors not readily available from conventional trawling surveys.

Carlson, P.R., H.A. Karl and K.A. Johnson. 1981. Morphology, sedimentology, and genesis of three large submarine canyons adjacent to Navarin Basin, Bering Sea. American Association of Petroleum Geologists Bulletin, 65(5): 909-909.

Carlson, P.R., H.A. Karl and B.D. Edwards. 1982. Puzzling mass movement features in the Navarinsky Canyon head, Bering Sea. Geo-Marine Letters 2(3-4): 123-127.

**Abstract**. Two types of morphologic features in the head of Navarinsky Canyon are attributed to mass movement of near-surface sediment. A series of pull-aparts is located downslope of large sand waves. These pull-aparts, possibly induced by liquefaction, affect the upper 5 to 10 m of sandy sediment (water depths 350 to 600 m) on a $1^\circ$ slope. A hummocky elongate mound of muddy sand (water depths 550 to 800 m) contains chaotic internal reflectors to a subbottom depth of 30 to 40 m and possibly is the product of a shallow slide. We speculate that Holocene seismicity is the likely triggering mechanism.

Carlson, P.R., H.A. Karl and P.J. Quinterno. 1982. Sedimentologic processes in world's largest submarine canyons, Bering Sea, Alaska. *In* Braunstein, Jules, and A.F. Thomson, chairperson, 95th annual meeting, The Geological Society of America: Geological Society of America Abstracts with Programs, 14(7): 459-460.

Carlson, P.R., J.M. Fischer and H.A. Karl. 1983. Two newly discovered submarine canyons on the Alaskan continental margin of Bering Sea. U.S. Geological Survey Open-File Report 83-0024, 38 pp.

Carlson, P.R. and H.A. Karl. 1984. Discovery of two new large submarine canyons in the Bering Sea. Marine Geology 56(1-4): 59-179.

**Abstract:** The Beringian continental margin is incised by some of the world's largest submarine canyons. Two newly discovered canyons, St. Matthew and Middle, are hereby added to the roster of Bering Sea canyons. Although these canyons are smaller and not cut back into the Bering shelf like the five very large canyons, they are nonetheless comparable in size to most of the canyons that have been cut into the U.S. eastern continental margin and much larger than the well-known southern California canyons. Both igneous and sedimentary

rocks of Eocene to Pliocene age have been dredged from the walls of St. Matthew and Middle Canyons as well as from the walls of several of the other Beringian margin canyons, thus suggesting a late Tertiary to Quaternary genesis of the canyons. We speculate that the ancestral Yukon and possibly Anadyr Rivers were instrumental in initiating the canyon-cutting processes, but that, due to restrictions imposed by island and subsea bedrock barriers, cutting of the two newly discovered canyons may have begun later and been slower than for the other five canyons.

Carlson, P.R., and H.A. Karl. 1984. Rates of sediment accumulation. *In* Carlson, P.R., and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons: U.S. Geological Survey Open-File Report 84-0089, p. 21-27.

Carlson, P.R., M. Golan-Bac, H.A. Karl and K.A. Kvenvolden. 1985. Seismic and geochemical evidence for shallow gas in sediment on Navarin continental margin, Bering Sea: American Association of Petroleum Geologists Bulletin 69(3): 422-436.

**Abstract.** Marine seismic studies coupled with geochemical investigations demonstrate that hydrocarbon gases are ubiquitous in the near-surface ( less than or approximate to 250 m or 820 ft depth) sediment of the Navarin continental margin in the northern Bering Sea. Three types of acoustic anomalies appear to be related to the presence of gas in the sediment. These anomalies are most prevalent in the northern half of the Navarin Basin. Acoustic anomalies attributed to gas hydrates and to diagenetic boundaries are present on seismic records of the lower slope between Navarinsky and Zhemchug canyons.

Carlson, Paul R., and H.A. Karl. 1988. Development of large submarine canyons in the Bering Sea, indicated by morphologic, seismic, and sedimentologic characteristics. Geological Society of America Bulletin, 100(10): 1594-1615.

**Abstract.** Seven large submarine canyons cut the Beringian continental margin. Three of these are among the world's largest submarine canyons. Bering is 400 km long, Navarinsky and Zhemchug are each 100 km wide at the shelf break, and volumes of sediment removed from these three canyons range from 4,300 to 5,800 km super(3), an order of magnitude larger than any submarine canyons incised in the margin of the lower 48 states. Two major events set the stage for the development of the Beringian margin and the dissection of these canyons: (1) the jump of the subduction zone to the Aleutian trench in Late Cretaceous-early Tertiary time that changed the margin from active to passive and (2) the low stands of sea level during the Cenozoic glacial stages.

Carlson, Paul R., H.A. Karl and B.D. Edwards. 1991. Mass sediment failure and transport features revealed by acoustic techniques, Beringian margin, Bering Sea, Alaska. Marine Geotechnology, 10(1-2): 33-51.

**Abstract:** GLORIA sidescan sonar imagery and seismic-reflection profiles show pervasive evidence for a wide variety of slides and slumps associated with the large canyons of the 1400-km-long Beringian margin. Styles of failure include mud and debris flows, slumps, and massive block slides. A 100-km-long shelf-edge segment on the northern margin is characterized by a series of scalloped slide scars and incipient scars associated with sedimentary blocks, 1-2 km across, that seem to be the initiators of a series of small canyons. Some of the largest single slide masses, including huge blocks tens of kilometers wide, occur on the rise of the central margin. Sliding of these blocks may have initiated the incision of some of the world's largest submarine canyons, a prime example of which is the massive

Zhemchug Canyon. Mass movement along the southern margin is widespread at the edges of Umnak Plateau. One mass failure, particularly well defined by GLORIA, is 55 km long. This slide and others along the plateau are associated with diapiric-like structures indicative of relatively recent tectonism.

Carlson, P.R., H.A. Karl, B.D. Edwards, J.V. Gardner and R. Hall. 1993. Mass movement related to large submarine canyons along the Beringian margin, Alaska. *In* Schwab, W.C., H.J. Lee and D.C.Twichell, eds., Submarine landslides; selected studies in the U.S. Exclusive Economic Zone: U.S. Geological Survey Bulletin 2002, p. 104-116.

Edwards, B.D., and H.J. Lee. 1984. Summary of Navarin Basin geotechnical characteristics. *In* Carlson, P.R. and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons: U.S. Geological Survey Open-File Report 84-0089, p. 39-54.

Evsyukov, Y.D., and L.P. Volokitina. 1985. Main results of geomorphological studies in the Navarin Canyon area (the northwestern Bering Sea). Okeanologiya 25(2): 254-257. Moscow.

**Abstract.** On the basis of a 2000 mile echo-survey performed in the polygon of about 44,300 km super(2), during the 29th cruise of the R/V "Dmitrij Mendeleev" in 1982, bathymetric and geomorphological charts were constructed. The Navarin Canyon was found to be the main morphological element of the area. The shelf zone was characterized by a smooth relief. The continental slope was of a complicated structure due to erosive and tectonic processes.

Feder, H.M., R.H Day, S.C. Jewett, S.G. McGee and S.V. Schonberg. 1981. Analysis of van Veen grab samples collected during 1979 and 1980 in the northern Bering Sea and southeastern Chukchi Sea. NOAA/OMPA, BOULDER, CO (USA). NOAA/OMPA, BOULDER, CO (USA).

**Abstract.** The van Veen grab survey for the investigation of infaunal invertebrates was effective, and excellent spatial coverage of most of the study areas was obtained. To date 24 stations from the Navarin Basin lease area, 5 from the vicinity of the Hope Basin lease area, and 1 from the St. Matthew Basin lease area have been sorted and the organisms identified and quantified. Stations from the central Navarin Basin, were dominated by polychaetous annelids, especially maldanids, capitellids, cirratulids, and lumbrinerids. Mollusks were present but not abundant. The stations from the Chukchi Sea (Hope Basin area) appear to be considerably different from those further south in the Bering Sea (Navarin Basin area). In general, mollusks and amphipods were more prevalent in this area.

Field, M.E., P.R. Carlson, and R.K. Hall. 1983. Seismic facies of shelf edge deposits, U.S. Pacific continental margin. *In* Stanley, Daniel Jean and George T. Moore, eds., The shelf break; critical interface on continental margins: Society of Economic Paleontologists and Mineralogists Special Publication 33: 299-313.

**Abstract:** Pacific-style continental margins, such as that of western N America, are marked by large contrasts in the type of shelf edge sedimentary deposits and the processes that form them. Many of the sediment sources of the NW US and S Alaska feed directly onto swell- and storm-dominated shelves. On such narrow unprotected shelves, sediment has a short residence time in submarine deltaic deposits before being remobilized and dispersed to outer-shelf and upper-slope environments. Through study of high-resolution seismic-reflection profiles, we have identified four principal types of shelfedge deposits: 1) starved, 2) draped, 3) prograded, and 4) upbuilt and outbuilt. Each type of shelfedge deposit results from a characteristic balance between sedimentation rate and distributive energy (waves and currents) and is, therefore, characterized by distinctive seismic facies and bedding patterns.

Fischer, J.M., P.R. Carlson and H.A. Karl. 1982. Bathymetric map of Navarin Basin Province, northern Bering Sea. U.S. Geological Survey Open-File Report 82-1038. 11 pp.

Galloway, B. K., S.L. Klemperer and J.R. Childs. 1994. New seismic coverage of the continental crust and moho, Bering and Chukchi Seas Transect, Alaska. EOS, Transactions, American Geophysical Union 75 (44 suppl.): 642.

**Abstract.** Stanford University, in conjunction with the USGS, conducted deep seismic investigations of the continental crust beneath the Bering and Chuckchi Seas, Alaska, during the month of August, 1994. The data was recorded to two-way travel-times of 15 to 23 seconds, with 50 to 75 meter shot spacing. Two north-south transects were profiled. The eastern transect extended from 58d 50m N, 169d 32m W, well within the continental shelf of the Bering Sea, north of the Pribilof Islands, to just south of the shelf edge north of Barrow, Alaska, at 71d 49m N, 154d 33m W. Ice prevented continuation of the line beyond the shelf edge. The western transect extended from the central Chukchi Sea, within the shelf at 71d 30m N, 163d 00m W, into the Aleutian basin at 58d 00m N, 178d 30m W, near the Navarinsky Canyon. An additional short line crossing over the Beringian margin a second time was recorded near Zemchug Canyon east of the western transect. Constant-offset sections were plotted on board the ship during acquisition. These plots exhibit large differences in lower crustal reflectivity across the breadth of the continental crust. The profiles cross important strike-slip faults, possible terrane boundaries, two continental margins, and several Cretaceous/Tertiary sedimentary basins (Norton, Hope, Chuckchi, Navarin Basins). Together with the preceding cruise EW94-09, led by Sue McGeary, the profiles provide a continuous transect across the North American continent, from the Pacific to the Arctic Ocean. Most of the multi-channel seismic data is generally of high quality. Gravity, magnetic, and sonobuoy data were also recorded along the profiles. Wide-angle recording was done in conjunction with the seismic profiling, at recording sites located along the central west coast of Alaska and the Chukchi Peninsula, as well as on islands in the Bering Strait and Bering Sea.

Gardner J.V. and T.L Vallier. 1977. Areas of faulting and potentially unstable sediments in the St. George Basin Region, Southern Bering Sea. *In* Environmental assessment of the Alaskan continental shelf: Principal investigators' reports 17(hazards): 230-241.

**Abstract.** Preliminary analyses of seismic and sediment data collected during the 1976 field year in the St. George Basin region of the southern Bering Sea continental margin, indicate that the large submarine canyons in the region, the Pribilof and Bering Canyons, exert a profound influence on the sediment distribution and dynamics of the adjacent outer continental shelf region including St. George and Amak Basins. In addition data show that the upper continental slope and shelf break are areas of mass movement of sediment (creeping, slumping, and catastrophic movement as shown by steep scarps). The effects of the canyons on the distribution of sediment and the near-bottom dynamics must be known before man-made structures, whether they be offshore rigs, underwater completion systems, storage facilities, or pipelines, are placed in this area. An investigation of slumping along the continental margin should allow an estimate of the present rate of sediment flux over the outer continental shelf region and what it has been in the past. This study focuses on faulting and potential sediment instability by describing the types and distribution of faults and by outlining areas where potentially unstable sediment masses occur.

Gardner, J.V., H.A. Karl and Q. Huggett. 1986. Origin and development of Zhemchung Canyon (Bering Sea), adjacent continental margin, and abyssal plain as revealed by GLORIA (long-range side-scan sonar) and seismic data. EOS, Transactions, American Geophysical Union 67(44): 1229.

Kaplan I.R., W.E. Reed, M.W. Sandstrom and M.I. Venkatesan. 1977. Characterization of organic matter in sediments from Gulf of Alaska, Bering and Beaufort Seas. *In* Environmental assessment of the Alaskan continental shelf: Principal investigators' reports 13; contaminant baselines: p. 751-838.

**Abstract.** The paraffin fraction of the high molcular weight hydrocarbons have been identified from sediment samples from the Eastern Gulf of Alaska and the Eastern Bering Sea. In general it has been shown that: The concentrations of total hydrocarbons in surface sediments from both areas, with the exception of one sample near Pribilof Canyon, is low compared to recent marine sediments from other environments; the hydrocarbons in the sediments appear to be derived from a mixture of terrigenous and marine sources. In the Bering Sea, a terrigenous source predominates, while in the Gulf of Alaska, contribution from marine and terrigenous sources is approximately equal; a series of n-alkanes and unresolved hydrocarbons in the n-C21 to n-C23 molecular weight range occurs in some samples from the Bering Sea and many of the sediments of the Gulf of Alaska. The source of these hydrocarbons may be either from petroleum or from unidentified marine organisms; and sediments near the head of Pribilof Canyon appear to contain petroleum derived hydrocarbons. This is in contrast to most other samples of the Bering Sea which have no indications of petroleum addition. Several of the Gulf of Alaska sediments analyzed seem to indicate some petroleum contribution.

Karl, H.A., P.R. Carlson and D.A. Cacchione. 1981. Factors influencing sediment transport at shelf break. American Association of Petroleum Geologists Bulletin, 65(5): 943-943.

Karl, H.A., and P.R. Carlson. 1982. Location and description of sediment samples: Navarin Basin Province, Bering Sea, 1980-81. U.S. Geological Survey Open-File Report 82-0958. 6 pp.

Karl, H.A., and P.R. Carlson. 1982. Large sand waves in Navarinsky Canyon head, Bering Sea. Seafloor stability of continental margins research conference: Geo-Marine Letters 2(3-4): 157-162.

Karl, H.A., P.R. Carlson and David A. Cacchione. 1983. Factors that influence sediment transport at the shelfbreak. *In* Stanley, Daniel Jean and George T. Moore, eds., The shelfbreak; critical interface on continental margins: Society of Economic Paleontologists and Mineralogists Special Publication 33: 219-231.

**Abstract:** Because the shelf edge bridges shallow and deep ocean environments, sedimentary processes characteristic of each of these provinces interact at the shelfbreak to influence sediment transport in the benthic boundary layer. Sophisticated instruments deployed for long periods of time are necessary to acquire data adequate for an assessment of the forcing mechanisms that control sediment transport. The few existing measurements of this type support the concept that shelfedge processes differ with place and time among continental margins and on any given continental margin.

Karl, H.A., and P.R. Carlson. 1984. Geologic hazards. *In* Carlson, P.R. and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons. U.S. Geological Survey Open-File Report 84-0089, p. 11-14.

Karl, H.A. and P.R. Carlson. 1984. Textural variations of surficial bottom sediment. *In* Carlson, P.R., and H.A. Karl, eds., Surface and near-surface geology, Navarin Basin province; results of the 1980-81 field seasons: U.S. Geological Survey Open-File Report 84-0089, p. 15-20.

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Karl, H.A., D.A. Cacchione and P.R. Carlson. 1986. Internal-wave currents as a mechanism to account for large sand waves in Navarinsky Canyon head, Bering Sea. Journal of Sedimentary Petrology 56(5): 706-714.

**Abstract.** Sand waves average 5m in height and about 650m in wavelength, with crests oriented subparallel to isobaths and almost perpendicular to the axes of the 2 main branches of the canyon. Speculates that inter-wave currents are responsible for the sand waves. However, the sand waves could have originated in the Pleistocene when Navarinsky Canyon headed in a shallow embayment that was receiving large quantities of sediment discharged by glacial meltwater streams.

Karl, H.A., and P.R. Carlson. 1987. Surface current patterns suggested by suspended sediment distribution over the outer continental margin, Bering Sea. Marine Geology 74(3-4): 301-308.

**Abstract.** Samples of total suspended matter (TSM) were collected at the surface over the northern outer continental margin of the Bering Sea during the summers of 1980 and 1981. Volume concentrations of surface TSM averaged 0.6 and 1.1 mgl super(-1) for 1980 and 1981, respectively. Organic matter, largely plankton, made up about 65% of the near-surface TSM for both years. Distributions of TSM suggested that shelf circulation patterns were characterized either by meso- and large- scale eddies or by cross-shelf components of flow superimposed on a general northwesterly net drift. These patterns may be caused by large submarine canyons which dominate the physiography of this part of the Bering Sea continental margin.

Karl, H.A., P.R. Carlson, K.H. Johnson and D.M. Rearic. 1987. Grain-size parameters and constituent grain composition of surface sediment in Navarin Basin Province, Bering Sea. U.S. Geological Survey Open-File Report 87-0064, 26 pp.

Kotenev, B. N. 1964. Sea valleys in the continental slope of the Bering Sea. Pages 23-32 *in* P. A. Moiseev (ed.). Soviet fisheries investigations in the Northeast Pacific. Part IV. Sovetskie rybokhozyaistvennye issledovaniya v severo-vostochnoi chasti Tikhogo okeana. Translated from Russian by Israel Program for Scientific Translations, Jerusalem.

**Summary.** Geomorphology of the continental slope "seavalleys" of the Bering Sea is described, including the northwest continental slope, northeast continental slope (Navarin, Pervenets, Zhemchug, and Pribilof canyons), and Commander-Aleution slope regions. The large seavalleys of the northeast continental slope are 5-25 miles wide, 50-200 miles long, and begin at 100-150 m depth. The vertical transitions that mark the edges of the upper slope become most dramatic at depths of 500-700 m. The author states that this zone represents a major demarcation that has a profound influence on water mass circulation and likely causes fronts. This characteristic of the upper slope also influences the success of trawling in these areas, as shallow as 300 m. Zhemchug and Pribilof seavalleys are described as being more complex than Navarin or Pervenets, with continental slope sections having "northwestern and sublatitudinal trends". All seavalleys of the northeast slope are troughlike in shape at their heads and resemble canyons in the middle part of the slope.

Kowalik, Z., and P. Stabeno. 1999. Trapped motion around the Pribilof Islands in the Bering Sea. Journal of Geophysical Research 104(C11): 25667-25684.

**Abstract.** Observations in the region of the Pribilof Islands and Canyon (PIC) reveal a clockwise circulation around the group of islands and around each of the two largest islands, St. Paul and St. George. Six current meters deployed around St. Paul Island revealed a steady clockwise flow around the island, which was strongest south of the island and weakest to the east. We use a high-resolution tidal model in the PIC region to show that this flow pattern results from tidal rectification over the shallow topography tides. Tidal residual currents of 10-15 cm s[-1] were predicted by the model, compared to mean currents of 5-20 cm s[-1] observed at the mooring sites. Both diurnal and semidiurnal tidal oscillations contribute to the clockwise circulation around the islands. In the diurnal band the enhanced currents occur also at the shelf slope where a tidal wave generates a shelf wave due to resonance with topography. In the PIC region the main shelf wave occurs in the Pribilof Canyon where both observations and measurements show enhancement of the diurnal tidal currents.

Lus, V. Y. 1970. Quantitative distribution of benthos on the continental slope of the eastern part of the Bering Sea. Pages 116-124 *in* P. A. Moiseev (ed.). Soviet fisheries investigations in the Northeast Pacific. Part V. Sovetskie rybokhozyaistvennye issledovaniya v severo-vostochnoi chasti Tikhogo okeana. Translated from Russian by Israel Program for Scientific Translations, Jerusalem.

**Summary.** As part of the USSR Bering Sea Expedition from 1958-60, benthic grab samples were collected across the continental slope. Samples were collected at 102 stations using 0.25 m2 grabs covering depths of 150 - 3045 m. Cruise transects were perpendicular to isobaths, placed at even along the eastern continental slope, with one additional transect extending north from Island of Four Mountains. Dominant taxa from all eastern slope stations combined (average biomass 27 g / m2) were from four groups: polychaetes (26 %), echinoderms (primarily ophiuroids), sponges (23 %), and mollusks (16 % mostly bivalves). The southern slope transect differed markedly from those on the eastern slope (average biomass 626 g / m2) and was primarily composed of sponges (84 %, 527 g / m2) and soft corals (12 %, 76 g / m2). Vertical zonation of overall biomass was observed, decreasing with increasing depth, on all transects. The northern transects contained a zone of high biomass at shallow depths, with the zone expanding and descending to deeper depths at southern transects. In certain transects, biomass was "markedly depleted" over extents as much as 1000 m.

McLean, H. 1979. Pribilof segment of the Bering Sea continental margin: A reinterpretation of Upper Cretaceous dredge samples. Geology 7(6): 307–310.

**Abstract.** Samples of an Upper Cretaceous sandstone dredged from Pribilof Canyon, Bering Shelf margin, do not compare well with rocks of the Shumagin Formation of presumed Late Cretaceous age on Sanak Island. Contrary to repeated published inferences, the rocks from Pribilof Canyon do not appear to be strongly deformed. They show no evidence of slaty

cleavage or penetrative deformation and were probably deposited in a shelf environment at neritic or possibly upper bathyal depth rather than in a trench or deep continental slope basin. The presence of shelf-facies rocks in Pribilof Canyon at the edge of the Bering Shelf leaves little room for a subduction-related accretionary terrane such as exists along the Shumagin shelf near Sanak Island. The concept of strongly folded deep-water trench-facies rocks in Pribilof Canyon has led to the development of Late Cretaceous subduction-related scenarios that include magmatic arcs parallel to the hypothetical subduction zone. Alternative hypotheses include a strike-slip plate boundary along the Pribilof segment of the Bering margin, which is consistent with the petrographic character of the Pribilof Canyon rocks, or a transitional trench-transform boundary--for example, the modern central to western Aleutian Trench.

Normark, W.R., and P.R. Carlson. 2003. Giant submarine canyons: Is size any clue to their importance in the rock record? Geological Society of America Special Paper 370. 16 pp.

**Abstract.** Submarine canyons are the most important conduits for funneling sediment from continents to oceans. Submarine canyons, however, are zones of sediment bypassing, and little sediment accumulates in the canyon until it ceases to be an active conduit. To understand the potential importance in the rock record of any given submarine canyon, it is necessary to understand sediment-transport processes in, as well as knowledge of, deep-sea turbidite and related deposits that moved through the canyons. There is no straightforward correlation between the final volume of the sedimentary deposits and size of the associated submarine canyons. Comparison of selected modern submarine canyons together with their deposits emphasizes the wide range of scale differences between canyons and their impact on the rock record. Three of the largest submarine canyons in the world are incised into the Beringian (North American) margin of the Bering Sea. Zhemchug Canyon has the largest cross-section at the shelf break and greatest volume of incision of slope and shelf. The Bering Canyon, which is farther south in the Bering Sea, is first in length and total area. In contrast, the largest submarine fans—e.g., Bengal, Indus, and Amazon—have substantially smaller, delta-front submarine canyons that feed them; their submarine drainage areas are one-third to less than one-tenth the area of Bering Canyon. Some very large deep-sea channels and turbidite deposits are not even associated with a significant submarine canyon; examples include Horizon Channel in the northeast Pacific and Laurentian Fan Valley in the North Atlantic. Available data suggest that the size of turbidity currents (as determined by volume of sediment transported to the basins) is also not a reliable indicator of submarine canyon size.

Palacios, R. 1987. Community structure of the macro epifauna of the Pribilof Islands. Ph.D. Dissertation, University of Washington, School of Fisheries, Seattle, WA. 112 p.

**Abstract.** The macrobenthos of the Pribilof Islands was surveyed on three cruises of the R/V MILLER FREEMAN in May and August 1983 and April 1984. Information on the dominant species as numbers per hectare was used to perform cluster analyses to investigate the community structure. Using the Bray-Curtis coefficient and flexible sorting strategy (B = -0.5) 3 groups of stations were defined throughout the cruises. Cluster Group 1composed stations located nearshore, around St. Paul Island and east of St. George Island. Characteristics of these stations were rocky bottoms with large deposits of shellhash. Dominant species included sea urchins (*Strongylocentrotus droebachiensis*), several bivalves (*Chlamysl* sp., *Pododesmus macrochisma*, and Mytillid mussels), the gastropod *Fusitriton oregonensis*, starfish *Henricia* sp., sea cucumber *Cucumaria* sp., barnacles, hermit crab *Elassochirus cavimanus*, *Cancer oregonensis* crab and juvenile blue king crab (*Paralithodes platypus*). Stations in Cluster Group 3 were found in the basin between the two main islands over sand-mud bottoms. Dominant species were Tanner crab (*Chionoecetes* sp.)hermit crabs (*Labidochirus splendescens* and *Pagurus ochotensis*), adult blue king crab (*P. platypus*), gastropods of the genus *Neptunea* sp. and the flatfishes *Lepidopseta bilineata* and *Hippoglossoides elassodon*. Stations in Cluster Group 2 were intermediate between the other two groups both in their geographic location, substrate characteristics, and dominant species.

Reed, R.K. 1991. Circulation and Water Properties in the Central Bering Sea During OCSEAP Studies, Fall 1989-Fall 1990. NOAA Technical Report ERL 446.

**Abstract.** Data from three CTD surveys conducted during Outer Continental Shelf Environmental Assessment Program (OCSEAP) cruises in the central Bering Sea during fall 1989, spring 1990, and fall 1990 are used to examine circulation and property distributions. Geostrophic flow was quite variable, except in Pribilof and Zemchug Canyons where it was consistently westward. The variability of flow and small transports are difficult to reconcile with any permanent current system. The relatively cold temperatures near the temperature maximum suggest the absence of inflow through Amukta Pass near 172 degree W. The distributions of nutrients in fall 1989 and spring 1990 are also presented and discussed.

Schumacher, J. D. and R. K. Reed. 1992. Characteristics of currents over the continental slope of the eastern Bering Sea. Journal of Geophysical Research- C Oceans 97(6): 9423-9433.

**Abstract.** Between September 1989 and 1990, twenty-six current records were collected by instruments on eight moorings located in Pribilof and Zhemchug canyons, and at a site midway between these features. These records provide the first long-term Eulerian measurements from the slope and mid-slope of the eastern Bering Sea. Results from the current records, together with water property observations, permit a characterization of the Bering Slope Current. Moderate flow ( similar to 2 to 18 cm/s) followed the bathymetry toward the northwest and existed primarily in the upper 300 m. Wind and current energy increased in winter, but vector mean current did not increase at all sites. Wind forcing accounted for only a small fraction of the current fluctuations. At one mid-slope location in Pribilof Canyon, bathymetry resulted in rectification of the strong daily tidal current. Estimates of heat and salt fluxes indicate some significant shoreward transport; however, this flux did not occur preferentially in the canyons.

Starratt, S. W. 1993. Late Quaternary paleoceanography of the Pervenets Canyon area of the Bering Sea: evidence from the diatom flora. Diatom Research 8(1): 159-170.

**Abstract.** Sediments from three gravity cores from an east-west shelf-to-slope transect along the axis of Pervenets Canyon in the northern Navarin basin, Bering Sea were analyzed for diatoms. The diatom floras present in the cores were divided into four assemblages following Sancetta (1981). The Bering Basin (deep water open ocean) and Sea Ice (ice cover at least six months per year) Assemblages were dominant in each core. The taxa that comprise the Bering Shelf Assemblage (continental shelf) indicate that downslope transport plays only a minor part in the development of the thanatocenoses. The presence (up to 10% of the total valve count) of the Productivity Assemblage, which consists mainly of poorly silicified, easily dissolved taxa, indicates that nutrient flux is relatively high in the region

Starratt, S. W. 1995. Latest Quaternary foraminifers and sediment transport in Pervenets Canyon, Bering Sea. Marine Micropaleontology 26(1-4): 233-243.

**Abstract.** A combination of microfossil and sediment analysis has been used in an attempt to

understand oceanographic processes and the late Quaternary history of the Pervenets Canyon region. The primary sedimentation process in Pervenets Canyon is downslope transport. Near the shelfbreak, there is evidence of turbidite and debris-flow activity, but at the distal end of the upper canyon and on the continental slope there is nomacroscopic evidence for these processes. Analysis of the foraminiferal assemblages shows that the fauna is 97.6% from the Suborder Rotaliina and about 2.0% from the Suborder Textulariina. The Suborder Miliolina accounts for approximately 0.4% of the fauna. The Pervenets Canyon fauna is most similar to other faunas from the Bering Sea, indicating a North Pacific Ocean influence on the fauna. Foraminiferal abundance and species diversity vary widely in the samples studied. The major factors controlling these values are downslope transport of sediment, disintegration of arenaceous taxa, dissolution of calcareous taxa, and diversity limited by low-oxygen bottom waters. Downslope transport of shelf species is indicated by the presence of Elphidium clavatum and E. Excavatum. Shallow-shelf and low-oxygen foraminiferal faunas are often intermixed in the samples. The distribution of these low-oxygen faunas in Core 81-65 suggests that the oxygen-minimum zone fluctuated with sea level.

Shin, K.-H., and N. Tanaka. 2004. Distribution of dissolved organic matter in the eastern Bering Sea, Chukchi Sea (Barrow Canyon) and Beaufort Sea. Geophysical Research Letters 31(24).

**Abstract.** The distribution of dissolved organic carbon (DOC) in the western Arctic Ocean is greatly influenced by conservative riverine DOC flux into the northern Bering Sea, Bering Strait and Beaufort Sea, as indicated by an inverse correlation with salinity. Based on the relations between DOC, salinity and seawater temperature, several water masses could be identified. These included riverine water, ice-melt water, surface mixed water, cold and saline shelf water, and Atlantic Ocean water. High concentrations of chlorophyll *a* and DOC were found in some parcels of dense shelf water in Barrow Canyon. In addition, labile DOC compounds, such as polyunsaturated fatty acids (PUFA), were found in the dense shelf water, suggesting the dense shelf water contains a product (marine organic matter) of the biological $CO_2$ pump.

Swartzman, G., J. Napp, R. Brodeur, A. Winter, and L. Ciannelli. 2002. Spatial patterns of pollock and zooplankton distribution in the Pribilof Islands, Alaska nursery area and their relationship to pollock recruitment. ICES Journal of Marine Science 59(6): 1167-1186.

**Abstract.** Data from six years, September 1994-1999, of bio-acoustic surveys near the Pribilof Islands, Alaska, (AK), from which age-0 walleye pollock (Theragra chalcogramma) school and zooplankton patch locations have been extracted, were analysed using image-processing methods. Multiple passes along four transects in this major pollock nursery area were examined. The data showed high year-to-year variability in overall abundance of both fish and plankton, but consistent abundance differences between the transects. Juvenile pollock abundance was generally highest in the shallow shelf region to the north of the Pribilof Islands and lowest in the mouth of the Pribilof Canyon to the south. Plankton biomass patterns tended to be the reverse. Fronts and regions within the transects were identified based on changes in hydrography (e.g. vertical stratification) and bathymetry. Diel migration patterns of pollock and zooplankton within these regions appear to depend on the degree of stratification, the depth, the size of the pollock and the relative abundance of the pollock and zooplankton. Several hypotheses are also discussed concerning the relationship of pollock recruitment year-class strength to large year classes including differences in the environmental conditions, the pervasiveness of the pollock, the size of juvenile pollock and the density of predators.

Wilson, M.T., A.H. Andrews, A.L. Brown and E.E. Cordes. 2002. Axial rod growth and age estimation of the sea pen, *Halipteris willemoesi* Kölliker. Hydrobiologia 471: 133–142.

**Abstract.** *Halipteris willemoesi* is a large octocoral commonly found in the Bering Sea. It is a member of a ubiquitous group of benthic cnidarians called sea pens (Octocorallia: Pennatulacea). Sea pens have a skeletal structure, the axial rod, that in cross section exhibits growth rings. Pairs of adjacent rings, or ring couplets, were assumed to be annuli and were used to estimate the age and growth of *H. willemoesi*. Twelve axial rods, extracted from *H. willemoesi* collected in the Bering Sea, were selected to represent small (25–29 cm total length), medium (97–130 cm TL) and large (152–167 cm TL) colonies. Each rod resembled a tapered dowel; the thickest part (0.90–6.75 mm in diameter) was at about 5–10% of total length from the base tip, the distal part was more gradually tapered than was the base. The number of ring couplets increased with rod size indicating their utility in estimating age and growth. Estimated age among rods was based on couplet counts at the thickest part of each rod; the average estimated age (±SE) was 7.1 ±0.7, 19.3 ±0.5, and 44.3 ±2.0 yr for small, medium and large-size rods, respectively. Based on these estimated ages, average growth rate in total length was 3.9 ± 0.2, 6.1 ± 0.3, and 3.6 ± 0.1 cm yr−1 for small, medium, and large-size colonies. The average annual increase in maximum rod diameter among all colonies was 0.145 ± 0.003 SE mm yr−1; therefore, age prediction from maximum rod diameter was calculated (estimated age (yr) = 7.0 • (maximum rod diameter, mm) −0.2; *R*2 = 0.99). At maximum diameter, the average couplet width was relatively constant among the three colony sizes (0.072 ± 0.05 mm). X-ray diffraction and electron microprobe analyses revealed that the inorganic portion of the rod is composed of a high-magnesium calcite. Radiometric validation of these age and growth rate estimates was attempted, but high amounts of exogenous 210Pb precluded using the disequilibria of 210Pb:226Ra. Instead, 210Pb activities were measured in a series of cores extracted along the axial rod. These activities ranged from 0.691 ± 0.036 (SE) to 2.76 ± 0.13 dpm g−1, but there was no pattern of decay along the length of the rod; therefore, the growth rates and corresponding ages could not be validated. Based on estimated age from ring couplet counts, growth in total rod length is slow at first, fastest at medium size, and slows toward maximum size, with an estimated longevity approaching 50 yr.

## Contributors

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Appendices attached as follows:

**Appendix 1 – Skate Nurseries**
**Appendix 2 – Brodeur (2001)**
**Appendix 3 – Wilson *et al.* (2002)**
**Appendix 4 – Busby *et al.* (2005)**

# NORTH PACIFIC RESEARCH BOARD PROJECT FINAL REPORT

## Investigations of a Skate Nursery Area in the Eastern Bering Sea

NPRB Project 415 Final Report

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## ABSTRACT

The dynamics of a nursery area for the Alaska skate was investigated in the southeastern Bering Sea. The nursery is located in 149 meters of water near the shelf-slope interface in a highly productive area of the eastern Bering Sea. The nursery is small in area (>2 nm), persistent, and highly productive. Density estimates from trawling showed the most active part of the nursery contained >100,000 eggs/km$^2$ Seasonal sampling suggested that reproduction occurs throughout the year but peaks occurred during spring and summer months. Hatching events likewise were throughout the year but peaked in fall and winter months. Embryo development was slow taking >3.5 years from deposition to hatching. The developing embryos and newly hatched juveniles suffered natural mortality due to gastropod snails and piscivory by the Pacific cod and the Pacific halibut. The Oregon trition *Fusitrion oregonensis* was the most likely predator on newly deposited egg cases and mortality was estimated at 3.64%. The nursery is located in a highly fished area and vulnerable to disturbances due to continuous use of the nursery grounds by skates throughout the year.

## KEY WORDS

Skate, *Bathyraja parmifera*, nursery, skate reproduction, eastern Bering Sea, skate egg case

## INTRODUCTION

Skate species (Family Rajidae) are of growing concern worldwide as they are threatened by increased fishing or habitat disturbances (Musick et al. 2000a, 2000b, Stevens et al. 2000, Jennings et al. 1998). In general they are characterized as slow-growing, late maturing, long-lived, and have small brood size (Jennings et al. 1998, Musick et al. 2000a, 2000b, Dulvy 2000, Stevens et al. 2000, Frisk et al. 2002). Elasmobranch life history strategies are unlike many teleost fishes and complete understanding of habitat requirements and reproduction dynamics are lacking for most species, yet they may be the most critical aspects of population survival and success.

Most elasmobranchs are known to utilize dedicated nursery grounds as a critical part of their reproductive strategy. For many viviparous sharks and rays nursery grounds become pupping areas where live young are birthed in mass. skate nurseries are used as areas for egg deposition and embryo development.

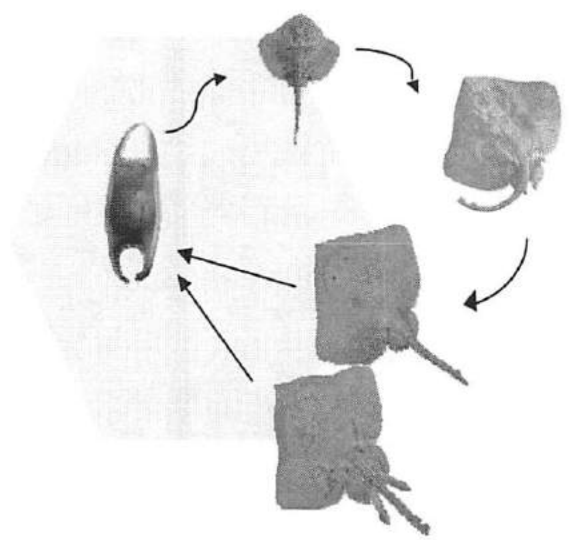

**Figure 1. Life history stages of the Alaska Skate *Bathyraja parmifera*. Gray area represents amount of time spent in the nursery. Clockwise: egg case, newly hatched juvenile, sub-adult, adult female and male.**

Skates are oviparous species that produce relatively large chitinous egg cases that are deposited directly onto the sea floor. In general the case contains a single embryo that develops independent of maternal input and hatches fully developed appearing similar to adults. The embryo developmental period is poorly known for most species of skate s but evidence suggests periods >1 year are not uncommon in temperate and deepwater species (Berestovskii 1994). Reproductive cycles and annual fecundity are likewise poorly known for many species. Those that have been studied show low production (<100) of estimated annual offspring and protracted reproductive cycles that vary in length and timing. Species show reproductive cycles of semi-annual, annual, or continuous reproduction throughout the year (Sulikowski et al 2004, Templeman 1982). Combining the reproductive cycles with long developmental periods for the embryos suggests that nurseries are in continuous use throughout the year and an important habitat for successful reproduction. Reproductive adults and offspring are two of the most critical life stages dictating successful skate populations (Simpfendorfer 2004, Stevens et. al. 2000). Understanding the dynamics of skate reproduction and nursery habitat is essential for successful management and conservation for skates.

For eastern Bering Sea shelf waters (20-200 m) the Alaska skate *Bathyraja parmifera* comprises >95% of the abundance of skate species (Acuna and Kotwicki 2004). All life stages are encountered in the shelf environment and the species depth range is limited to approximately 20-400 m. The species reaches a large size (122 cm) and locally can be very abundant (Hoff & Britt 2003, 2005). Life history characteristics and their accessibility in relatively shallow waters make the Alaska skate vulnerable to as a targeted fishery or as bycatch.

## OBJECTIVES

This proposal addressed the hypothesis that there exists a distinct nursery habitat in a heavily fished area of the southeastern Bering Sea that could be characterized and defined using trawl and video camera. The main objectives of this project were: to determine the species utilizing the habitat; determine the timing of egg deposition; track the development and hatching time of cohorts; and determine mortality sources to young skate s in the nursery.

### Achievements of Objectives

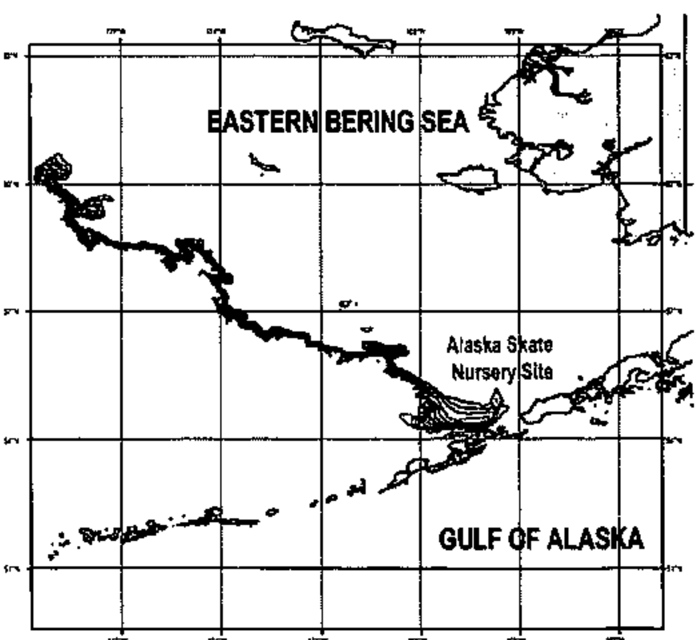


**Figure 1. Location of the study area and nursery site for the Alaska skate in the eastern Bering Sea.**

The initial hypothesis was supported in that a nursery site for the Alaska skate exists and persists in the southeastern Bering Sea (Figure 1) and was successfully studied using bottom trawl and seasonal sampling to determine timing and seasonality processes of reproduction. The preliminary results and conclusions of this study are reported here. Much more data was collected during the course of this study and will be reported in manuscripts to be submitted for publication. These will be made available as they are prepared.

Nursery sites for the Alaska skate *Bathyraja parmifera*, the Aleutian skate, *B. aleutica*, and the Bering skate, *B. interrupta* were found during this study. Although three nursery sites were investigated only the results for the Alaska skate are reported here due to a more complete understanding of the reproduction processes and timing resulting from an increased effort at this study site. One aspect of the original objective that was not met during this study was using video cameras to assess the nursery habitat. This was attempted during the summer of 2004 but due to video camera failure, increased cost of vessel charter time which limited survey time, video recording was not successful. Recent developments may allow me to successfully obtain video footage of this nursery in the near future and if successful, will be incorporated into subsequent reports from this study.

# METHODS

## Initial Investigation

The Alaska skate nursery site was sampled using bottom trawl gear similar to that used by the AFSC standard eastern Bering Sea bottom trawl survey (see Acuna and Kotwicki 2004). The initial trawl survey for this study was conducted in July-August of 2004 employing the *F/V Ocean Explorer*. During this investigation the extent and spatial density of egg cases was determined utilizing an adaptive sampling trawling approach. An index site was chosen during the initial investigation which was sampled subsequently during each seasonal sampling period. The criteria used to select the index site included an area of high density live skate eggs in early stage of development and constituted a circle of approximately 1 $km^2$ over the highest density area. The nursery index site was then sampled over the next 14 months at a rate of approximately once every 60 days (Figure 2). The sampling dates and associated designated Julian calendar dates are presented in Table 1.

**Table 1. Sampling dates and associated Julian Date assignments for each sample at the index site at the Alaska skate nursery.**

| Sampling Period | Julian Date |
|---|---|
| June 3 2004 | 155 |
| July 27 2004 | 209 |
| September 11 2004 | 255 |
| November 17 2004 | 322 |
| January 16 2005 | 382 |
| April 18 2005 | 474 |
| June 1 2005 | 519 |
| July 7 2005 | 554 |

## Haul Data

Haul data was collected from each tow using Scanmar net mensuration gear from the bridge and attached to the trawl net. During each tow starting and ending latitude, longitude, bottom depth, time, vessel speed, net height and width, and bottom temperatures were recorded. Area swept was estimated from average net width and distance fished during each tow. Egg case and fish and invertebrate densities were calculated from area swept estimate and the estimated numbers from each trawl.

## Species Composition

Species composition of the sample catches was collected from each trawl. All species were weighed and enumerated or a weighed numerical subsample was used to estimate total numbers from weighed samples. All species of fish and invertebrate were identified to the lowest taxonomic level possible by the onboard fish and invertebrate taxonomist during the July 2004 sampling. At all subsequent sampling all fish and only selected invertebrates were identified to species due to time limitations. Species diversity estimates were calculated from the July 2004

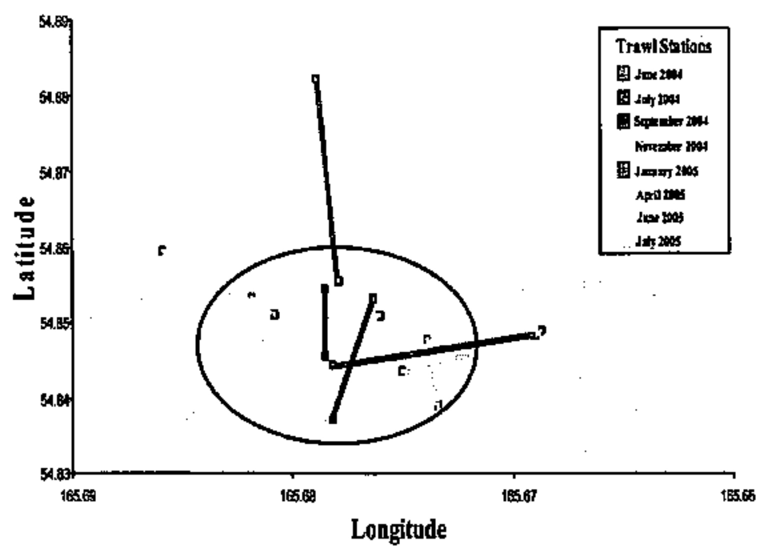


**Figure 2. Index site trawl locations conducted in the Alaska Skate nursery during the eight seasonal sampling periods. Circle indicates the area targeted as the index site for seasonal sampling.**

sampling only. Biological specimens of interest or importance were either frozen in the onboard ships freezer or preserved in 10% formalin for later study. All egg cases were identified to species and categorized as empty (post hatching), full (pre hatching, including eggs which may have been damaged by the trawl), or predated egg cases (empty and contain a bore hole). Each category of egg case was enumerated and weighed separately and recorded.

**Stomach Scans of Predatory Fish Species**

Stomachs of selected predatory fish species were scanned for evidence of predation on newly hatched skate s. Only fish species that could consume newly hatched skate s were included in this analysis. Species that were targeted included; Pacific halibut *Hippoglossus stenolepis*, Pacific cod *Gadus macrocephalus*, Arrowtooth flounder *Atheresthes stomias*, great sculpin *Myoxocephalus polyacanthocephalus*, Greenland turbot *Reinhardtius hippoglossoides*, Alaska skate *Bathyraja parmifera*, and the Bering skate *Bathyraja interrupta*. In most cases all individuals of each species were scanned during each sampling period, however when large numbers of any of these species were encountered subsamples were taken. A random length frequency sample was collected for each scanned species in cases where not all individuals were scanned. During stomach scanning, the species, sex, fork length or total length, total weight, stomach content weight, general diet composition, and presence of skate s consumed were recorded. In the cases where skate embryos were detected in the stomach the entire stomach contents were preserved in 10% formalin for later species identification. In the course of stomach scanning of the skate species both gonads were also removed and weighed to the nearest 0.1g and recorded for subsequent Gonadal Somatic Index (GSI) estimates.

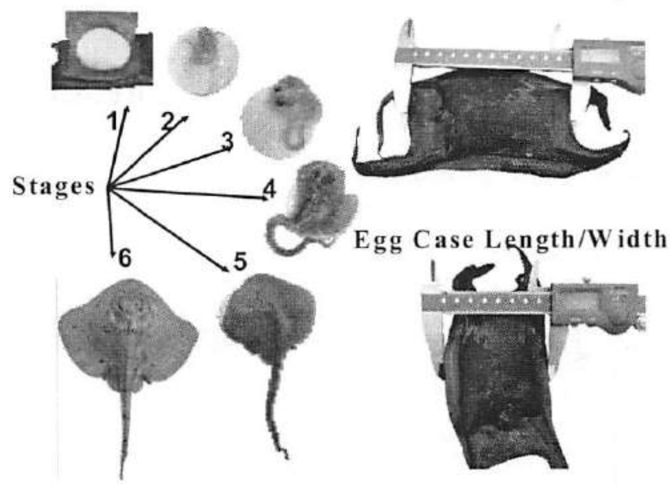


**Figure 3. Development of the Alaska Skate embryo and the numbers assigned to each developmental stage (Left). Egg case measurements of Length and width were taken for each egg case staged during this study (Right).**

**Embryo Staging and Length Frequency Measurements**

During each sampling period approximately 100 Alaska skate embryos were staged at sea and an additional 100 were preserved in 10% formalin for detailed study in the laboratory. Stage determination roughly followed that of Hitz (1964) determined for *Raja binoculata* with an additional stages of 1 for undeveloped newly deposited egg cases and stage 6 for embryos with the yolk sac completely absorbed (last stage before hatching Figure 3). Egg case length (excluding horns) and width (including keels at mid case) (Figure 3) were recorded to the nearest millimeter as well as embryo stage. In the laboratory identical data was recorded from preserved eggs as well as embryo total length (TL). All embryo stage data were pooled from each sampling period.

## Seasonal Monitoring

The index site at the Alaska skate nursery was visited a total of eight times over the 14 month period during June, July, September and November 2004, and January, April, June and July of 2005 (Table 1). During each two-day sampling period a single 5-10 minute bottom trawl was completed at the index site targeting the designated index sampling area (Figure 2). The biological and catch workup was similar to that previously described for the initial 2004 trawl survey. However, species composition was limited to fish and gastropod snail species and net mensuration and trawl data was limited to bottom depth, temperature, and distance fished and start and end latitude and longitude during seasonal sampling.

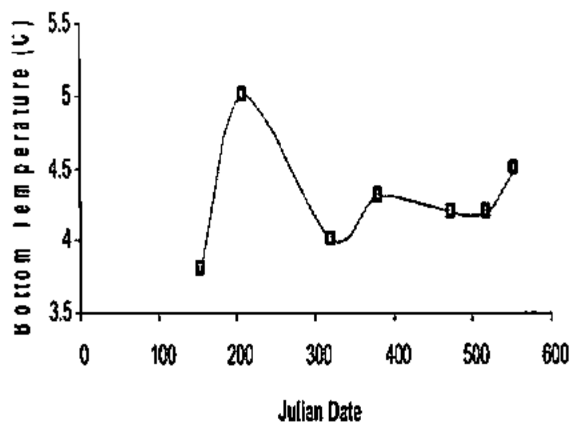


**Figure 5. Bottom temperatures recorded at the index site in the Alaska skate nursery at each sampling period from June 2004 through July 2005.**

# RESULTS

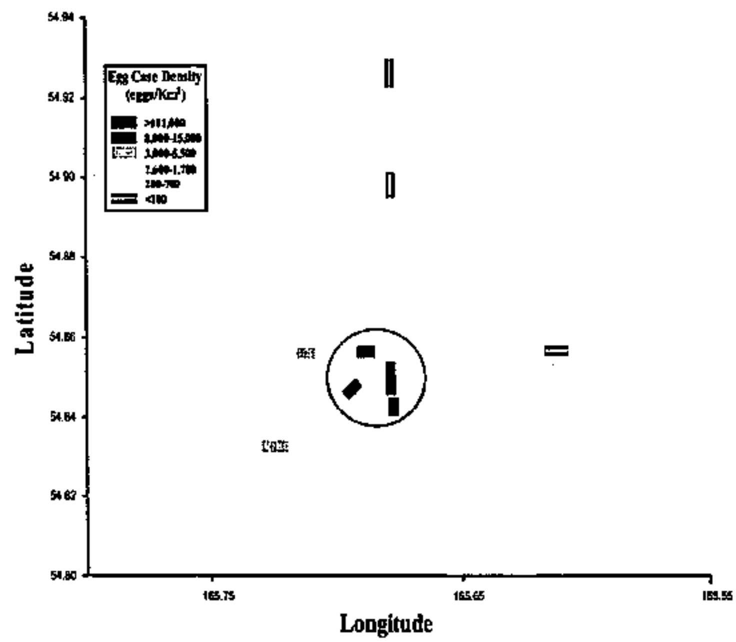


**Figure 4. Trawl locations and egg case density estimates in the Alaska skate nursery site during the July 2004 investigation. Circle indicates the index site location used for seasonal sampling**

## Nursery Site Location and Habitat

The nursery site for the Alaska skate was relatively small in area. Results from trawl samples taken in July 2004 suggest that the most active nursery area was only from 1-2 kilometers across (Figure 4). Analysis of the trawl catch data showed the nursery site had little benthic structure or habitat diversity from trawl analysis. The bottom was relatively flat sandy muddy bottom with no detectable abiotic or biotic structure. Bottom depths varied by only several meters throughout the nursery site for the highest density areas (145-150 meters) with the average bottom depth, weighted by egg case density, being 149 meters. Bottom temperatures varied between 3.8-5.0°C throughout the year with a low in June of 2004 at 3.8 C and a high temperature of 5.0 C in July of 2004 (Figure 5). Both these temperatures appear extreme for this area of the eastern Bering Sea as temperatures recorded for the subsequent sampling period (after July 2004) showed between 4.0-4.5 C from November 2004 through July of 2005.

**Species Composition**

Results from species composition sampling showed that within the nursery site areas of higher egg densities there was higher species diversity. Figure 6 shows that although species diversity varied in low egg case density areas (17-29 species), diversity was consistently high where egg case densities were high with 30-31 species. The two highest diversity stations consisted of 13 fish species and the remainder were invertebrate species. The most abundant fish species encountered in the nursery site throughout the sampling period included walleye pollock *Theragra chalcogramma*, arrowtooth flounder, flathead sole *Hippoglossoides elassodon,* rex sole *Glyptocephalus zachirus*, Alaska skate and Pacific cod . The most abundant invertebrate species (from initial summer 2004 investigations) were the Tanner crab *Chionoecetes bairdi*, tentacle-shedding anemone *Liponema brevicornis*, and Oregon triton *Fusitriton oregonensis*.

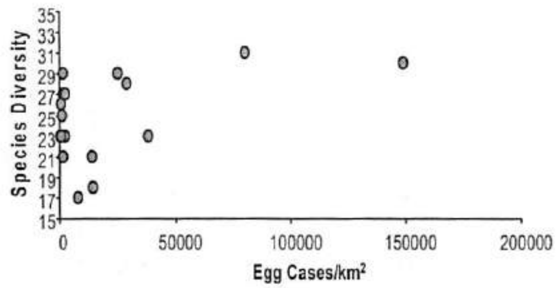


**Figure 6. The relationship between species diversity and egg case density at the Alaska Skate nursery site.**

The Alaska skate and the Bering skate were both found at the index site during most sampling periods. The Alaska skate predominated in number of skate s (96%) and in egg case composition (99.6%). Although the Bering skate accounted for about 4% of the skate s found at the site, their egg cases only contributed about 0.4% of the egg cases found at the site and this site proved to be predominately at single species nursery site for the Alaska skate.

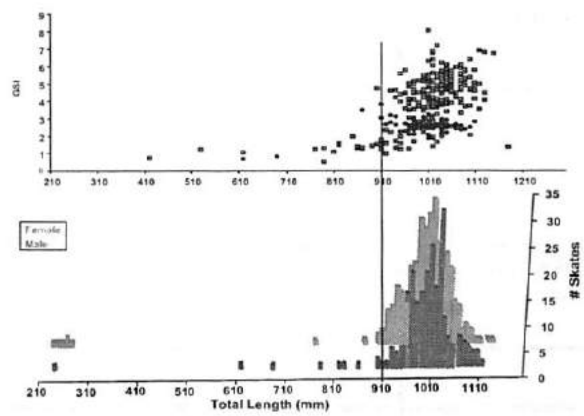


**Figure 7. Gonadal somatic index (GSI) for males (blue) and females (red) Alaska skates collected from the nursery site (top). Length frequency of male and female skates found in the nursery throughout the study (bottom). Vertical line indicates size at first maturity.**

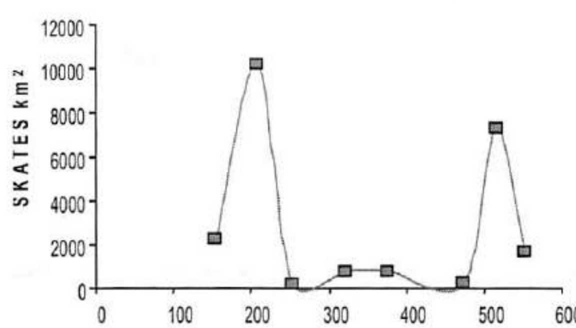


**Figure 8. Density estimates for the Alaska skate from each sampling period at the nursery index site.**

The length frequency of the Alaska skate from all sampling periods combined suggested that the nursery site was used primarily by mature reproductively active adult male and female skates (Figure 7). Data from gonadal somatic index showed that nearly all Alaska skates found in the nursery were adults and gonadal examination showed that developed ovaries and the presence of egg cases in the uterus were found during all sampling periods. Although present during all sampling periods, the Alaska skate showed seasonal trends of increased abundance in the nursery during summer months. suggesting increased reproductive activity during these months (Figure 8). Increased abundance of newly deposited egg cases during summer sampling periods coincided with the increase in skate abundance confirming that the summer was a period of high reproductive activity.

**Predatory Fish Species**

Seven species of predatory fish were examined for stomach contents during this study (Table 2). The most common prey items of all species combined included the walleye pollock, *Chionoecetes* sp. Crabs, and euphasid shrimps. Pacific cod and The Pacific halibut consumed newly hatched Alaska skate juveniles as part of their diet. The Pacific cod consumed skate s at a rate of 0.06 skates/cod and the Pacific halibut at 0.13 skate s/Halibut. Although predation rates were low for both species, they showed a seasonal preference for consuming skate s during the winter (January 2005) and early summer (June 2005) months based on the index site samples (Figure 9). Pacific cod and Pacific halibut were found in higher abundance at the index site during winter months and possibly in summer months suggesting they move into the nursery area during these periods (Figure 9).

**Table 2. Sample sizes and length range by sex of all predatory species scanned for evidence of predation on newly hatched Alaska skates. Of the seven species scanned only the Pacific cod and the Pacific halibut showed evidence of predation on skates.**

| | Males | | Females | | | | |
|---|---|---|---|---|---|---|---|
| Species | Stomachs scanned | length range (cm SL) | Stomachs scanned | length range (cm SL) | Total scanned | Total Skates consumed | Predominant prey item |
| Arrowtooth Flounder | 31 | 25-54 | 109 | 20-81 | 140 | 0 | euphausid shrimp / pollock |
| Pacific Cod | 79 | 42-99 | 83 | 35-102 | 162 | 10 | crab / pollock |
| Pacific Halibut | 35 | 33-84 | 17 | 46-92 | 52 | 7 | crab / pollock |
| Great Sculpin | 2 | 47-49 | 1 | 63 | 3 | 0 | pollock / tanner crab |
| Greenland Turbot | 0 | NA | 1 | 83 | 1 | 0 | empty |
| Bering Skate | 25 | 56-79 | 11 | 55-82 | 36 | 0 | euphasid shrimp |
| Alaska Skate | 72 | 62-111 | 106 | 79-115 | 178 | 0 | pollock |

The Alaska skate and the Bering skate stomachs were also scanned for cannibalism of newly hatched skates. A total of 178 Alaska and 36 Bering skates were scanned over the 14 month study with no instances of predation on juvenile skate s observed. The Alaska skate consumed almost exclusively walleye pollock and the Bering skate consumed euphausid shrimp in the size range scanned (Table 2).

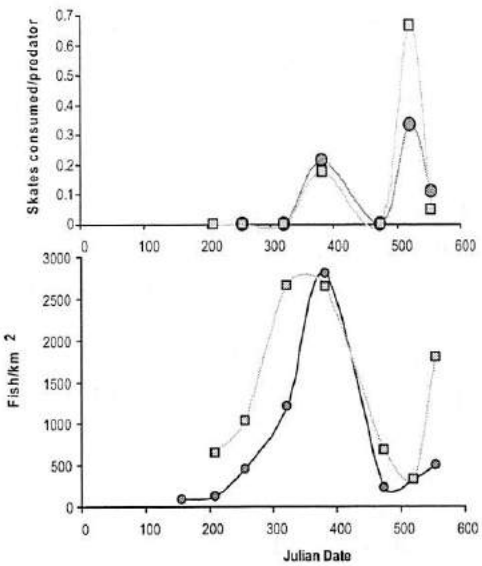


**Figure 9. Predation rates of Pacific cod (Blue) and Pacific halibut (Yellow) on newly hatched Alaska skates found during the nursery study (Top) Density estimates of Pacific cod (Blue) and Pacific halibut (Yellow) found at the Alaska skate nursery site throughout the sampling period (Bottom). Peak predation occurred during winter and summer months coinciding with peak predator estimates.**

## Predation on Egg Cases By Snails

Gastropods have been reported in multiple cases of consuming skate egg cases by drilling a hole in the newly deposited egg, inserting its proboscis and sucking out the large yolky egg mass (Lucifora and Garcia 2004, Cox et al. 1999). skate egg cases preyed upon by gastropod snails were evident from the presence of gastropod holes penetrating into the inside chamber in the main case area, and the cases was empty of all contents. Predation rates by snails were estimated in each trawl from egg cases containing bore holes. A predation rate of 3.64% was estimated from the 8 sample periods at the Alaska skate nursery index site. Approximately 24,885 Alaska skate egg cases were examined throughout this study and a total of 906 egg cases were encountered which contained bore holes. The most likely candidate preying upon egg cases is believed to be the Oregon triton (Figure 10). The Oregon triton was the most common snail species found throughout the study period and showed a positive relationship between snail density and predated egg case densities (Figure 11).

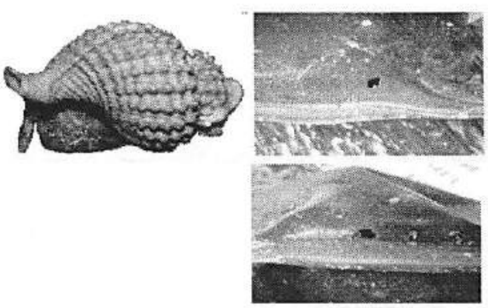

**Figure 10. Left-The snail *Fusitriton oregonensis* is the most likely predator on newly deposited egg cases of the Alaska Skate. Right-holes left in Alaska skate egg cases by snail predators.**

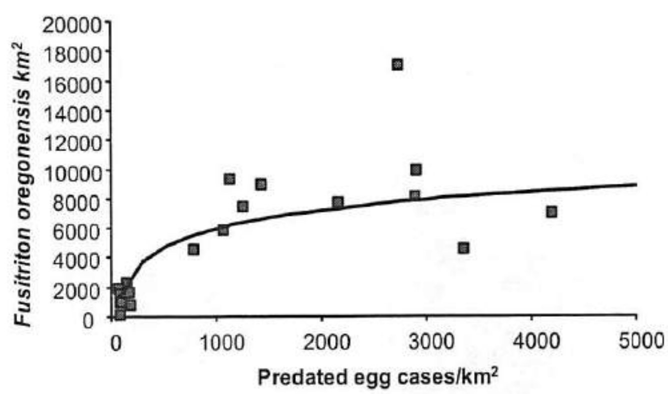


**Figure 11. Relationship between *Fusitriton* density and predated egg case density in the Alaska skate nursery site.**

In a simple experiment conducted at sea during this study, the Oregon triton was held in small buckets with egg cases of the Alaska skate for up to three weeks. The buckets were constantly flushed with fresh seawater and submitted to very low natural light levels. After three weeks time the egg cases were examined and only in a single instance was an egg case containing a single hole found. This suggests that the Oregon triton is at least one of the gastropod species that may prey on the Alaska skate egg cases.

### Embryo Staging and Length Frequency Measurements

A sample of Alaska skate embryos were staged at each sampling period while at sea. Approximately 100 random egg cases were staged at the time of collection and the remainder of the random sample were staged up to 1.5 years after preservation in 10% formalin. Figure 12 shows the distribution of stage frequencies encountered during the initial July 2004 trawling study. The largest modes found in the nursery during the summertime were in stage 1, 2 and 5. This distribution differed from the index site during the same period in that there were a larger portion of stage 5 embryos at the index site (Figure 13, top Box).

Figure 13 shows the distribution of stage frequencies for all sampling periods collected at the index site combining both the preserved and live staged samples. In all sampling periods the highest proportion of egg cases were in early

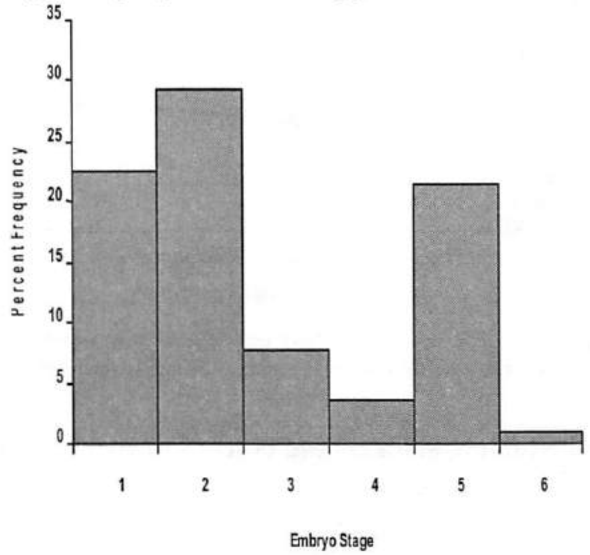


**Figure 12. Developmental stages of embryos from the Alaska skate nursery site during the July 2004 study. Frequency is all egg cases staged for each trawl combined extrapolated to nursery wide density estimates.**

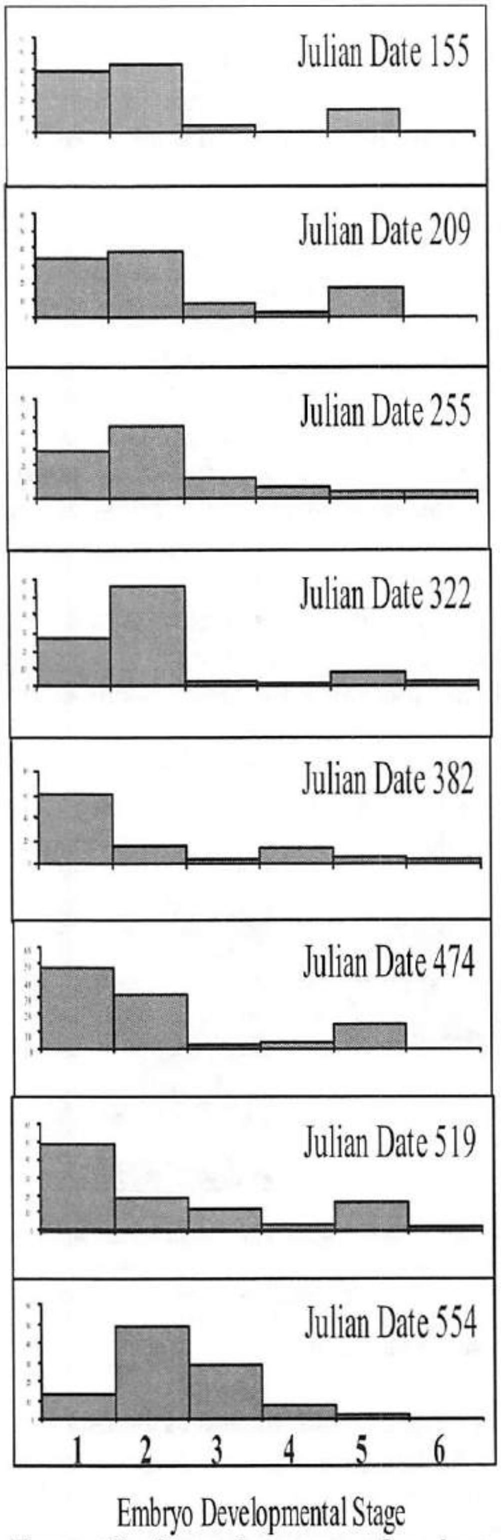


**Figure 13. Stage frequency of embryo development from the Alaska skate nursery site over the 14 month study period. Stage 1 is newly deposited egg cases and 6 is fully developed.**

stages (1 and 2) of development and all other stages were less frequent with embryos in stage 6 being rare. The distribution of embryo stages at the index site did not mimic the overall nursery stage frequency indicating that there was high heterogeneity of nursery use by egg laying skate s. Tracking stage frequency changes throughout the 14 months of sampling period was difficult from this data and stage frequency alone proved to be of limited use to track embryo development and timing.

Preserved egg cases containing embryos were examined in the laboratory. In addition to embryo development stage frequencies, embryo length measurements were obtained from preserved samples taken during each sampling period. Each egg case was measured to length and width, the egg case opened and the embryo stage recorded, the total length including accessory tail filament recorded and additional embryonic developmental parameters such as disc width, the state of the egg gel, yolk diameter, accessory tail filament length and sex of the embryo were documented.

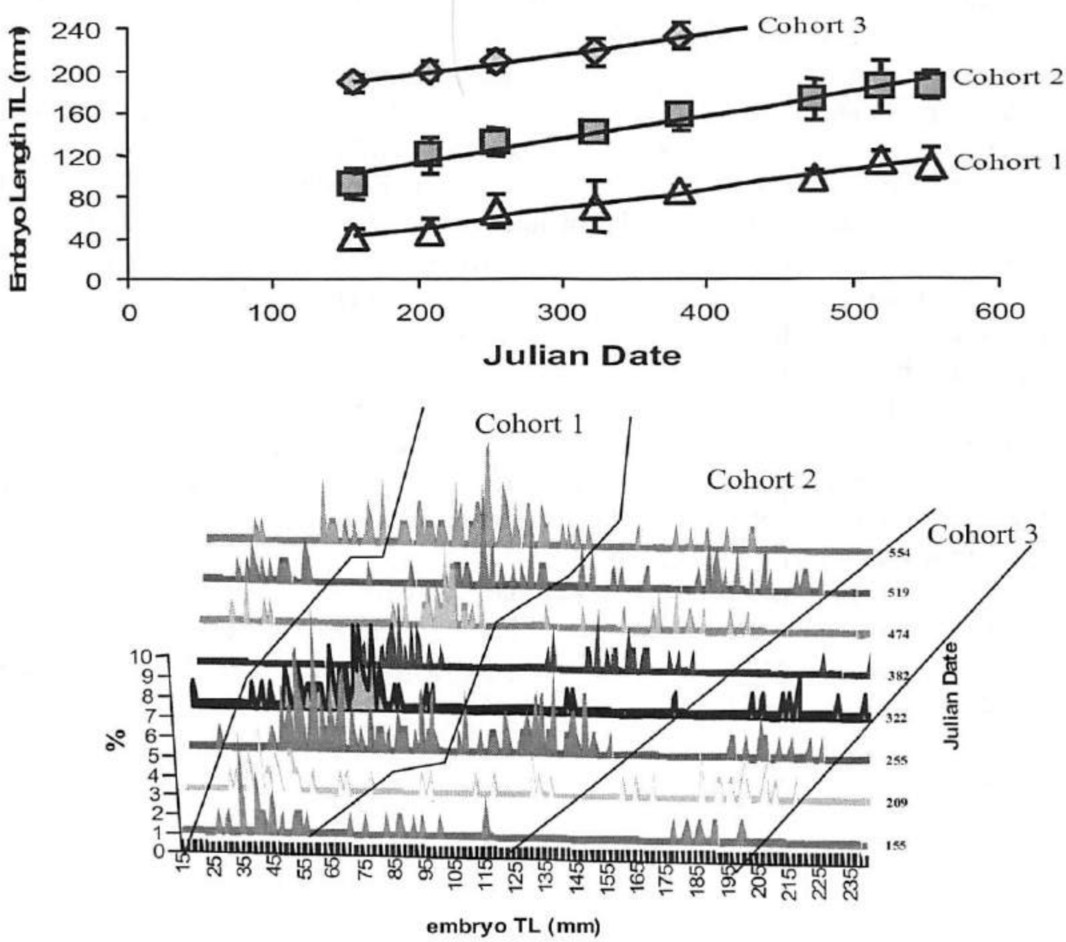


**Figure 14. Mean and standard deviation of three cohorts based on embryo length frequencies from the seasonal sampling at the Alaska skate nursery site.**

Figure 14 (bottom) is the result of the length frequency measurements taken from preserved samples. Each sampling period suggested a minimal of three cohorts developing simultaneously based on the length frequency modes. Each cohorts length mode shifted at each subsequent sampling and showed there was a natural progression of development from sampling period to sampling period.

**Cohort Analysis**

Growth rates were estimated for each cohort by calculating the mean total length for the cohort at each sampling period. Subjective criteria were used to determine inclusion for each cohort from natural mode breaks of embryo lengths (Figure 14 bottom). Figure 14 shows the entire data set of length frequencies and the frequencies included in each cohort. The mean lengths for each cohort at each time period was plotted and a linear equation obtained for each cohorts growth throughout the study period (Figure 14 top). Each cohort showed similar linear growth rates throughout their size ranges. An average growth rate of 0.1977 mm/day was calculated from the three cohorts and this estimate was used for embryo developmental timing, hatching and egg case depositional events (Table 3).

Birthdates and egg case deposition dates were estimated for each individual embryo that was sampled. Approximate hatching date was estimated by using a mean hatching size of 224 mm TL (mean of all stage 6 embryos (n=39) from fresh and preserved samples) and estimating the time required to reach hatching size at a constant growth rate of 0.1977 mm/day. The deposition dates were obtained in a similar manner by determining the time required to reach the measured size and subtracting the number of days from the collection date. For deposition dates, an additional 180 days were added based on the stage data (Figure 13) which suggested that it took approximately 6 months from the time of deposition until visible embryo development (> 10 mm TL) could be detected.

Figure 15 shows the distribution of expected birthdates and deposition dates from the embryo length frequencies. The frequency distributions shows that although there is continuous hatching and egg case deposition throughout the year, the peak hatching event happens during fall and winter months (September-February) and egg case depositional events peak during spring and summer months (May-August).

Average growth rates of 0.1977 mm/day provide an estimate of embryo gestation duration to be approximately 3.5 years to reach 224 mm TL. Cohorts also averaged a difference of approximately one year growth between groups (lag time mean of 379 days, Table 3) at any single period suggesting a single depositional event each year.

## DISCUSSION

Skate Nursery habitat mapped for the Alaska skate appears to be the first recorded for detailed information of a skate nursery in the Northeastern Pacific. The location of nursery sites along the shelf-slope interface appears common in the eastern Bering Sea as 4 additional skate nursery sites have been located at depths between 150 and 360 meters (Authors unpublished data). All sites are located in highly productive upwelling areas near canyons or otherwise show high species diversity. Site selection criteria for skate nurseries are as of yet unknown. Areas of high production may be critical as nursery sites due to the protracted reproductive activity and high energy expenditure of egg production. Having a ready supply of food would allow for skate s to remain within the nursery site and minimize foraging excursions during reproductive cycles. In addition adequate current flows such as those encountered in the slope area of the eastern Bering Sea may be critical for the successful hatching and embryo development. Development within the egg cases is dependent on a current of seawater to supply oxygen to the embryo and remove metabolic wastes from the egg case which the slope region may supply. A steady current would also ensure the egg cases would not become buried in areas of soft bottom types, undoubtedly fatal to the fragile embryos. The shelf-slope interface may provide the delicate balance of all these elements to ensure the highest production and survival of adult and developing offspring.

**Table 3. Sampling periods and embryo length means and standard deviations of each cohort from the Alaska Skate nursery site. Included are the linear equations of growth for each cohort and the estimated growth rate for the embryo period of development. The time lag between cohorts was estimated as the difference in mean lengths divided by average growth rates. Estimated time between each cohort was around 1 year suggesting an annual depositional event at this nursery site.**

| Sampling Period | Julian Date | Cohort 1 | Cohort 2 | Cohort 3 |
|---|---|---|---|---|
| June 3 2004 | 155 | 41.6 +- 8.09 | 91.5 +- 15.12 | 187.89 +- 7.88 |
| July 27 2004 | 209 | 46.96 +- 10.43 | 118.13 +-16.76 | 199.53 +- 8.86 |
| September 11 2004 | 255 | 57.44 +- 8.13 | 131.89 +- 12.97 | 207.82 +- 9.57 |
| November 17 2004 | 322 | 65.24 +- 10.33 | 141 +- 1.41 | 217 +- 12.28 |
| January 16 2005 | 382 | 84.17 +- 6.19 | 156.38 +-13.31 | 233 +- 11.31 |
| April 18 2005 | 474 | 97.11 +- 7.25 | 171.85 +-18.75 | |
| June 1 2005 | 519 | 113.83 +- 10.25 | 193.27 +- 7.92 | |
| July 7 2005 | 554 | 116.07 +- 11.45 | 200.5 +- 0.71 | |
| | | | | |
| linear equation | | y=0.1819x + 13.401 | y=0.2214x + 68.17 | y=0.1899x + 158.8 |
| $R^2$ of equation | | 0.9771 | 0.9688 | 0.9890 |
| Growth Rate of Cohort | | 0.1819 mm/day | 0.2214 mm/day | 0.1899 mm/day |
| | | | | |
| Average growth rate | | 0.1977 +- 0.0208 mm/day | | |
| time lag between cohort 1 & 2 | | 348.79 +- 41.27 days | | |
| time lag between cohort 2 & 3 | | 411.07 +- 44.28 days | | |

This study suggests that specific requirements for newly hatched juveniles may not be a criteria for nursery habitat selection as very few hatchlings were ever found at the nursery site. The most likely explanation is that quickly after emerging from the eggcase the skate moves out of the nursery area. Trawl studies done adjacent to the Alaska skate nursery study found newly hatched juvenile Alaska skate s in great abundance using similar trawl methods (Kotwicki and

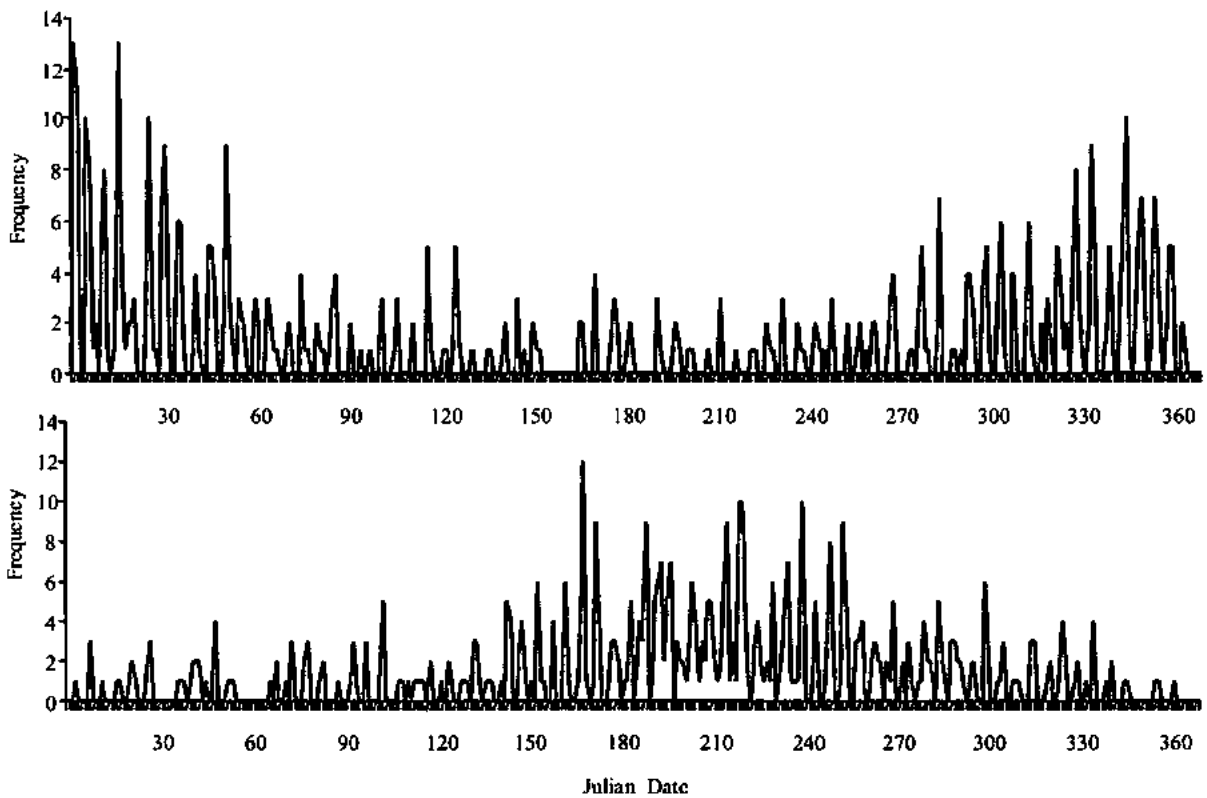


**Figure 15. Estimated frequency of hatching dates (top) and deposition dates (bottom) from all embryos measured from the Alaska skate nursery site.**

Weinberg 2006). This study suggested an exodus from the nursery area soon after emerging from the egg case.

The Alaska skate nursery site was utilized by the Bering skate and the Alaska skate for egg case deposition. The Bering skate was found in low abundance throughout the sampling period and egg cases were always found at this site. The egg case density of the Alaska skate and seasonal abundance indicate this site is primarily a single species nursery area with the Bering skate sharing the habitat to some extent. The Alaska skate s use of the nursery site is limited for reproduction as only reproductive adult males and females were found at the site throughout the year. Reproductive cycles in temperate to arctic and deepwater skate species is poorly known. Due to their inherent low fecundity and slow growth rates it is speculated that skate s may reproduce over long protracted periods or in some cases continuously throughout the year (Sulikowski et al 2004, Templeman 1982). For the Alaska skate it appears that in general there is reproduction throughout the year with peak egg laying events in the summer months. However this timing is at the population level and the reproductive cycle at the individual level is still unknown.

Embryo development progressed slowly based on length frequency cohort analysis and estimated growth rates. A single cohort was estimated to take >3.5 years from deposition until hatching with multiple cohorts developing simultaneously within the nursery due to continued annual reproduction. Embryo developmental rates are most likely coupled with environmental temperatures. The bottom temperature recorded during this study shows that there was little change over the study period and therefore probably little growth rate change. Cohort analysis confirmed that during the study period growth rates were linear and similar between cohorts.

Predation sources to newly hatched skate s included gastropod snails and piscivorous fishes. Gastropod snails have been shown to predate on skate egg cases worldwide with predation rates between 14-42% (Lucifora and Garcia 2004, Cox et al. 1999). Predation rates for the Alaska skate were on the lower than this range at 3.64% from the nursery site. For the Alaska skate this may be a very reasonable predation rate that is averaged over multiple cohorts since egg cases take many years to hatch. These estimates based on a nursery site are novel since most estimates come from marginally valid samples. Samples collected from beach collections, random trawl hauls and museum collections are included in literature cited estimates. All samples have obvious biases due to low sample sizes and collection methods and the nonrandom distribution of predated egg cases. Predation rates from widely distributed egg cases outside the nursery area show higher predation rates for the Alaska skate . Random collections from trawl hauls during 3 years of bottom trawl surveys in the eastern Bering Sea resulted in a collection of 149 Alaska skate egg cases. This entire collection was not associated with a nursery site and were widely collected across the shelf and slope area of the eastern Bering Sea. Predation rates from this collection showed that 38% had evidence of snail predation by containing bore holes in the case. This rate is an order of magnitude greater than that within the nursery site and demonstrates how widely distributed collections show much higher predation rates. Whether egg cases widely distributed have increased vulnerabilities to predation due to the limited resource to snail predators or are the result of increased vulnerability to the trawl is unknown. Clearly predation rates from large samples collected from nurseries are more meaningful to embryo mortality and should be considered as more reasonable values of pre-hatching predation on pre-recruitment mortality. Lucifora (Lucifora and Garcia 2004) estimated the effect of high snail predation on skate fecundity and mortality for four skate species from the Atlantic. The conclusion suggested that even given the high estimates of around 15-42% predation on eggs, oviparous skate s can be more productive than their counterpart viviparous shark cousins due to the increased advantage of oviparity. The results of this study suggest an even much lower predation rate for the Alaska skate allowing for even greater production success.

Predation by Pacific cod and Pacific Halibut were at low levels and appeared to have a seasonal component to piscivory. Pacific cod are known to migrate along the shelf adjacent to the Aluetian Islands in the area of Unimak Pass seasonally for spawning. The increased abundance of Pacific cod during the winter months may be indirectly related to skate predation due to these reproductive migrations, however the increased abundance during peak hatching periods increases the likelihood of juvenile predation by Pacific cod . Pacific Halibut followed a similar pattern of increasing in the nursery area during winter months during peak hatching events and like Pacific cod may utilize the nursery area as a food resource during other behavioral activity.

## CONCLUSIONS

It is clear that a nursery habitat exists in the southeastern Bering Sea for the Alaska skate . The nursery is persistent, small in area, and highly productive. Reproduction occurs throughout the year at low levels with a peak in egg deposition in summer months and peak hatching in winter months. Embryo development is extremely slow with an estimated 3.5 years from deposition to hatching. Natural mortality sources include gastropod snail predation and piscivory from large predator species. Both showed moderate to low levels of mortality suggesting high survivability of newly hatched skate s. The nursery for the Alaska skate is highly vulnerable to perturbation due to its location in a highly fished area in the eastern Bering Sea. The low reproductive potential and long life cycles of the Alaska skate should warrant measures to conserve this critical habitat.

### Aknowledgments

I thank the skipper and crews of the FV *Ocean Explorer*, *Sea Storm*, *Nordic Fury*, *Arcturus*, *Aldebaran*, and *Great Pacific*. Thanks to the scientists at the Alaska Fisheries Science Center (NMFS) that helped with this study. I especially thank D. Stevenson, S. Kotwicki, and E. Acuna with the seasonal sampling. This project was supported by North Pacific Research Board (NPRB grant #415) and Essential Fish Habitat (EFH) funding.

## OUTREACH

**WebPage developed: none**
Exhibits/Demonstration Project Developed: none
**Conference Presentations**: American Fisheries Society Meeting September 2005; Alaska Marine Science Symposium, January 2006

**Community Meetings:** none
**Presentations at Festivals/Events:** none
**WorkShop Participation:** none
**Presentations in Schools:** none
**Other Presentations:** Alaska Fisheries Science Center January 2005, September 2005, University of Washington May 2005, March 2006
**Press Articles:** NOAA Press Release in September 2005
**Factsheets Produced:** none
**Video Produced:** none
**Radio Television Interviews:** none
**Other:** Information gathered from this study is included in a new forthcoming publication "A Field Guide to the Chondrichthyans of Alaska".

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# Habitat-specific distribution of Pacific ocean perch (*Sebastes alutus*) in Pribilof Canyon, Bering Sea

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**Abstract**

Shelf edge canyons are well-known sites of enhanced biomass due to on-shore transport and concentration of zooplankton along their axes, both of which contribute to the high densities of nekton frequently found in these canyons. Using a combination of acoustics, trawling, and in situ observations with a remotely operated vehicle (ROV), the distribution of pelagic and demersal biota within Pribilof Canyon in the Bering Sea was examined in September of 1995 and 1997. Near-bottom acoustic scattering patterns in the 38 kHz data showed high concentrations of biomass beginning around the 180 m bottom depth contour and continuing to about 220 m, which were presumed to be adult fish based on their target strength distributions. The 120 kHz data also showed very strong scattering in the water column between 150 and 175 m, which was absent from the 38 kHz data, and therefore attributed mainly to zooplankton. The dominant taxa collected in bottom trawls and mid-water plankton tows were adult rockfishes (Pacific ocean perch, *Sebastes alutus*) and euphausiids (*Thysanoessa* spp.), respectively. In situ videos revealed dense aggregations of these rockfishes inhabiting a "forest" of attached sea whips, *Halipteris willemoesi*, during night deployments of the ROV, while areas with damaged sea whips had far fewer rockfish, and areas without this biotic habitat structure had no rockfish. During the day, the rockfishes were seen above the "forest", where they were apparently feeding on dense swarms of euphausiids. It appears that these rockfish utilize this predictable and abundant food resource in the canyon during the day and are associated with the sea whip habitat at night during periods of inactivity. More research is needed on these slow-growing biotic habitats and how fishing activities in the Bering Sea and elsewhere may impact these habitats. 

*Keywords:* Habitat; Acoustics; Demersal fishes; Zooplankton; Bering Sea; Pribilof Canyon

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## 1. Introduction

Submarine canyons are a common feature of many of the world's continental shelf breaks. Owing to their abrupt and steep topography, these canyons often modify the downstream circulation and increase shelf-slope exchange of water masses and nutrients (Klinck, 1996; Hickey, 1997). They are known to be areas of enhanced productivity due to topographically induced upwelling along their axes (Freeland and Denman, 1982). Canyons also transport large quantities of organic matter offshore through sediment flushing (Okey, 1997; Granata et al., 1999), thus enriching the deep ocean (Rowe, 1971). These physical processes enrich canyon regions (Denman and Powell, 1984), which may show enhanced concentrations of macrobenthos (Haedrich et al., 1980; Sardà et al., 1994; Vetter and Dayton, 1998), micronekton (Cartes et al., 1994; Macquart-Moulin and Patriti, 1996), demersal fishes (Stefanescu et al., 1994), and cetaceans (Kenney and Winn, 1987; Schoenherr, 1991) relative to the slope as a whole.

Another mechanism by which accumulations of planktonic organisms occur in canyons involves the interaction of diel vertical migration and onshore transport. In the case of large offshore euphausiids normally found over deeper water, onshore advection of individuals near the surface at night deposits them over bottom depths shallower than their normal daytime depths (Isaacs and Schwartzlose, 1965; Koslow and Ota, 1981; Genin et al., 1988). This process may deposit large aggregations of euphausiids near bottom at the upstream end of canyons (Koslow and Ota, 1981; Greene et al., 1988), where they become easy prey for planktivorous fishes (Mackas et al., 1997). In the North Pacific Ocean, rockfishes in the genus *Sebastes* often inhabit the offshore edges of banks or canyons and are known to capitalize on these advected prey resources (Isaacs and Schwartzlose, 1965; Pereyra et al., 1969; Brodeur and Pearcy, 1984; Chess et al., 1988; Genin et al., 1988).

In 1994, a dense acoustic scattering of near-bottom fish was detected at the upstream end of the Pribilof Canyon in the Bering Sea. Trawling through this acoustic sign revealed that it was comprised almost entirely (>92% of total catch) of Pacific Ocean perch (*Sebastes alutus*). In this paper, acoustic and trawl data collected from 1995 and 1997 are presented along with in situ observations using remotely operated vehicle (ROV) videos that revealed a biogenic habitat association between Pacific Ocean perch and pennatulaceans in Pribilof Canyon.

## 2. Methods

### 2.1. Study site

Surveys were conducted at the head of Pribilof Canyon, a large canyon situated at the outer edge of the Bering Sea continental shelf some 370 km from the Aleutian Island Chain and approximately 40 km south of St. George Island, the southernmost of the Pribilof Islands (Fig. 1). The Pribilof sea valley begins at a depth of 130 m and drops off to a maximum depth of 3200 m (Carlson and Karl, 1988), with the main incision of the canyon cutting from 100 to 1000 m into the slope (Kotenov, 1965). The upper part of the canyon is bifurcated (Fig. 1), forming a trough 90 km long and 30 km wide parallel to the continental margin (Scholl et al., 1970). The total canyon volume is 1300 $km^3$, which classifies it among the largest canyons in the world (Carlson and Karl, 1988).

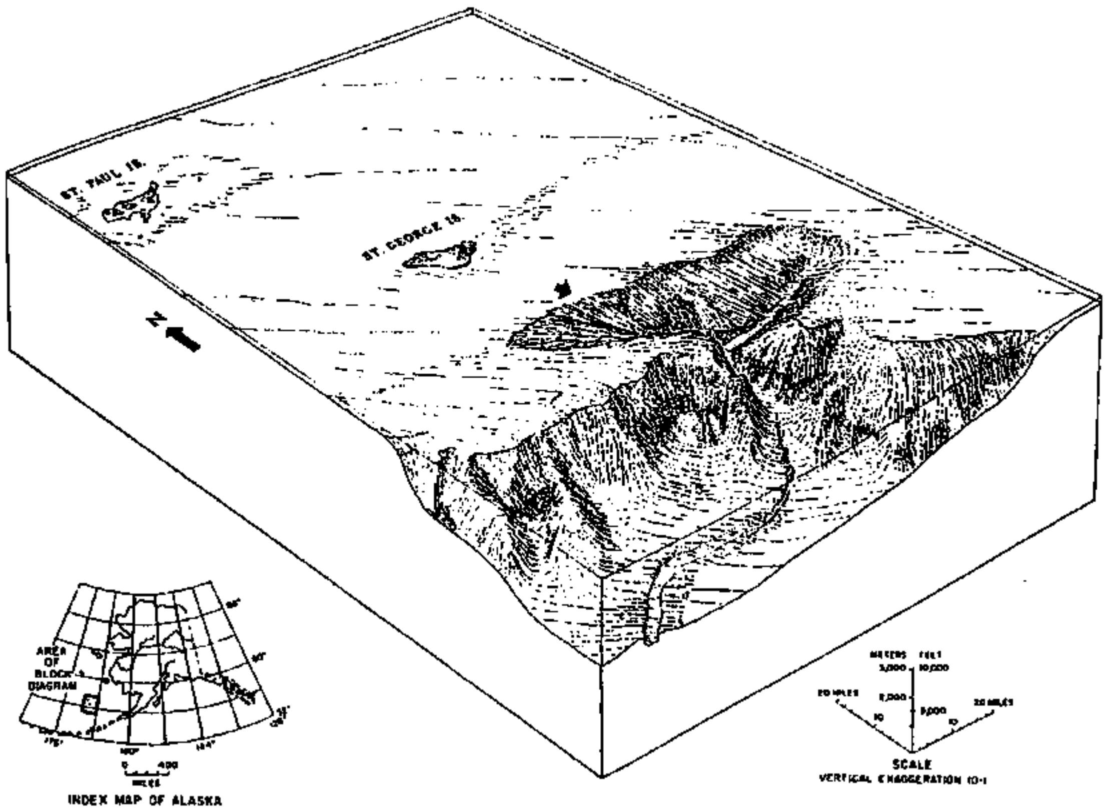


Fig. 1. Physiographic plot of Pribilof Canyon looking onto the shelf showing the study area (arrow) relative to the Pribilof Islands (modified from Scholl et al., 1970).

Results from hydrographic surveys, satellite track buoys and moored current meters in the vicinity of Pribilof Canyon suggest the presence of two circulation features: the Bering Slope Current (Schumacher and Reed, 1992) and a flow over the outer continental shelf (Schumacher and Stabeno, 1998). The Bering Slope Current is most marked in the upper 300 m of the water column, flowing along isobaths generally toward the northwest at speeds of $0.1$–$0.2\,m\,s^{-1}$. The increased speed of the outer shelf current apparently results from the marked decrease in width of the outer shelf (from ~160 km to less than 30 km) in the canyon area. Satellite-tracked buoy trajectories support the existence of this stronger flow. Exchange of slope water onto the shelf occurs in the vicinity of Pribilof Canyon. Interaction of tidal currents with canyon topography results in rectified onshore flow, and the acceleration of the outer slope current appears to draw deeper nutrient-rich water up onto the outer shelf (Stabeno et al., 1999).

### 2.2. Field sampling

The observations reported here were part of a multi-disciplinary study of biophysical interactions between fish and zooplankton in the area of the Pribilof Islands (Brodeur et al., 1997).

Cruises were conducted during 9–26 September, 1995, and 8–18 September, 1997 and a broad suite of physical and biological measurements were made in the Pribilof Canyon area (Table 1; Fig. 2) from the NOAA vessels *Miller Freeman* and *Surveyor* working in tandem.

In situ water temperatures and light levels were recorded at several stations within the canyon (Table 1). Conductivity-temperature-depth (CTD) casts were taken using a Sea-Bird SEE-9 system and light and light measurements were made with an IL1700 Research Radiometer (International Light, Newburyport, MA).

### 2.3. ROV deployments

Underwater observations in the Pribilof Canyon were made using video cameras mounted on a Deep Ocean Engineering Super Phantom II ROV deployed from the *Miller Freeman*. Most surveys were done with a color CCD video camera (Hitachi Model HV-C20) with the viewing area illuminated by two confocal 250 W tungsten–halogen lights mounted externally on the vehicle. These lights were dimmed to about 75% of full power to minimize the backscatter from biogenic

Table 1
Operations carried out in Pribilof Canyon region in 1995 and 1997. The first station conducted in 1995 (S80) was done by the ship Surveyor. All other stations were done by the Miller Freeman. Bottom depth is the maximum depth encountered during the operation

| Station No. | Haul No. | Date | Time (ADT) | Latitude °N | Longitude °W | Bottom depth (m) | Operation |
|---|---|---|---|---|---|---|---|
| *1995* | | | | | | | |
| S80 | 1 | 16-September | 19:17 | 56.28 | 169.44 | 246 | CTD |
| 29 | 1 | 16-September | 20:06 | 56.30 | 169.44 | 203 | ROV |
| 29 | 2 | 16-September | 22:41 | 56.29 | 169.47 | 215 | Bottom trawl |
| 29 | 4 | 17-September | 0:58 | 56.29 | 169.45 | 214 | Methot trawl |
| 29 | 6 | 17-September | 3:44 | 56.29 | 169.46 | 211 | ROV |
| 30 | 1 | 17-September | 5:06 | 56.28 | 169.44 | 240 | Acoustic transect |
| 56 | 1 | 23-September | 8:02 | 56.28 | 169.43 | 236 | Bottom trawl |
| 57 | 1 | 23-September | 9:14 | 56.28 | 169.44 | 230 | Acoustic transect |
| 59 | 1 | 23-September | 19:47 | 56.31 | 169.68 | 209 | ROV |
| 59 | 2 | 23-September | 21:59 | 56.31 | 169.68 | 200 | Bottom trawl |
| 60 | 1 | 24-September | 2:41 | 56.28 | 169.60 | 184 | ROV |
| 60 | 3 | 24-September | 5:40 | 56.28 | 169.60 | 205 | Bottom trawl |
| 61 | 2 | 24-September | 14:16 | 56.29 | 169.30 | 197 | ROV |
| *1997* | | | | | | | |
| 1 | 1 | 9-September | 13:31 | 56.28 | 169.44 | 256 | CTD |
| 1 | 2 | 9-September | 14:23 | 56.28 | 169.44 | 246 | CTD |
| 10 | 2 | 10-September | 3:59 | 56.28 | 169.44 | 264 | Acoustic transect |
| 14 | 1 | 10-September | 13:46 | 56.28 | 169.44 | 257 | Acoustic transect |
| 15 | 1 | 10-September | 15:22 | 56.28 | 169.43 | 243 | ROV |
| 15 | 2 | 10-September | 17:47 | 56.28 | 169.43 | 248 | Bottom trawl |
| 15 | 3 | 10-September | 21:41 | 56.28 | 169.43 | 234 | ROV |
| 16 | 1 | 11-September | 0:41 | 56.28 | 169.47 | 234 | Methot trawl |

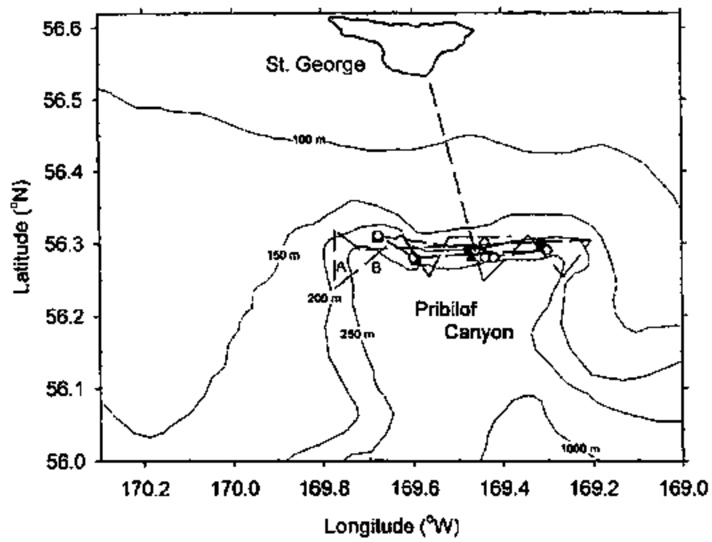


Fig. 2. Locations of ROV deployments (circles), bottom trawls (squares), Methot trawls (triangles) and acoustic transects (dashed lines) in Priblilof Canyon during September 1995 and 1997. Also shown are acoustic transect lines A and B shown in Figs. 4a and b, respectively.

particulate matter in the water column. A silicon intensifier target low-light level black and white camera (Osprey OE1323), which provided a 110° field of view, was used to initially survey each site. In addition, still photos were taken in 1997 using a submersible camera (Benthos Model 3782) and strobe on the ROV.

The ROV was lowered from the vessel using a 300 m umbilical cord while the vessel maintained a constant heading using its bow thrusters. A 108 kg down weight was attached 25 m from the end of the umbilical cord to provide stability and reduce the angle of drift of the ROV away from the vessel. The ROV was generally propelled at slow speed to keep it in front of the down weight and the speed over ground was less than 1 knot ($<1.6\,\mathrm{km\,h^{-1}}$) for all deployments in the canyon. Video images were viewed in real time at an on-deck console that allowed the operator to maneuver the vehicle and control the cameras and lights. The depth of ROV was annotated onto the tape by observers throughout the deployment. Recordings were made on two Hi-8 VHS tape decks and identification of organisms and characterization of habitats were made during playback.

## 2.4. *Acoustic transects*

Acoustic backscatter data were collected along transects radiating from the Pribilof Islands, including one transect south of St. George Island which bisected the canyon, to quantify midwater and bottom acoustic sign (see Swartzman et al., 1999a, b, for detailed collection and analytical methodology). A Simrad EK-500 echosounder, equipped with calibrated split-beam 38 and 120 kHz transducers (7° beam width), provided estimates of echo integration and target strength, which is indicative of the approximate size of the scatterers. The transducers were mounted in the centerboard of the ship at a depth of 10 m. The system was calibrated before the survey using a copper ball of known acoustic properties suspended below the ship. Shorter acoustic transects were also conducted across the axis of the canyon to determine the east-west extent of the echosign (Fig. 2). The position at the start and end of each transect was recorded using GPS.

Mean backscattering area per square nautical mile (nm) of sea surface ($S_A$) was calculated for each 5 m depth interval [units in $m^2\,nm^{-2}$] as follows:

$$S_A = 4\pi r_0^2 1852^2 \int_{z=r_1}^{z=r_2} S_v \, dz,$$

where $z$ is the depth, $r_0$ is the reference range for backscattering strength (1 m), $r_1$ and $r_2$ are the top and bottom of the 5 m depth intervals which ranged from 10 to 250 m, and $S_v$ is the volume backscattering strength.

### 2.5. Net tows

Short (< 1 h) bottom tows were made in areas of substantial near-bottom acoustic backscatter and along several of the ROV transects using a nylon Nor'eastern bottom trawl with 1.5 m × 2.1 m steel doors fished with roller gear. The mesh size varied from 13 cm in the forward part of the net to 8.9 cm in the codend, which was also equipped with a 3.2 cm liner. The mean effective path width of this trawl was estimated to be 13.4 m with a mean vertical opening of 9.2 m. The entire catch was processed aboard deck and numbers and weights of all taxa were recorded. Length measurements were made to the nearest centimeter on all fish species. Subsamples of rockfish were frozen and transported to shore for later laboratory processing. Number and biomass per $km^2$ were then estimated for all taxa using the area-swept method.

Macrozooplankton and micronekton were collected in 1995 and 1997 using a 5 $m^2$ Methot mid-water trawl with 3 mm × 2 mm oval mesh in the body and 1 mm mesh in the codend. The net was fished obliquely to within 10 m of the bottom to obtain depth-integrated abundance estimates of zooplankton and fish (Brodeur et al., 1997). The depth of tow was monitored using a SCANMAR acoustic sensor on the frame of the trawl and volume filtered was estimated by mounting flowmeters in the center of the frame. Since euphausiids and other micronekton are known to exhibit significantly lower daytime densities with this gear (e.g., Sugisaki et al., 1998), I examined only the night samples collected in the Pribilof Canyon area in this analysis.

### 2.6. Laboratory analysis

Methot collections were sorted into major taxonomic categories in the laboratory and fish, euphausiids and chaetognaths were identified to species. Raw counts were converted to numbers per 1000 $m^3$. Stomach contents of Pacific Ocean perch were analyzed in the laboratory. Because of the closed nature of rockfish swimbladder and the great depth from which they were collected, many of the stomachs that were brought back to the lab were empty and believed to be regurgitated. The stomachs containing food were examined under a dissecting microscope and the contents were identified to the lowest possible taxon. Otoliths of a representative subsample of Pacific Ocean perch were removed at sea for age determination in the laboratory by two experienced readers at the Alaska Fisheries Science Center using the break and burn technique.

## 3. Results

### 3.1. ROV deployments

ROV deployments were made in the vicinity of the canyon in both years and at different times of the day (Table 1). Transects were made both perpendicular and parallel to isobaths. On several descents to the bottom, the ROV passed through layers of squid (*Berryteuthis* sp.) and dense aggregations of euphausiids. The bottom generally was composed of compacted mud and silt. Occasionally rocks and small boulders were present but the bottom generally contained little geologic relief. However, in five out of seven of the deployments in the canyon, the ROV passed through areas containing dense aggregations of 1–2 m high sea whips (*Halipteris willemoesi*) evenly spaced about 2 m apart. During nighttime observations, hundreds of rockfishes (mainly Pacific Ocean perch) were seen inside the sea whip "forest" (Fig. 3). These rockfish were all oriented in the same direction (generally facing into the current) and were also evenly dispersed with approximately 3–4 m between adjacent fish. The rockfish appeared to be in a resting state and did not move until the ROV approached within a few meters. The sea whips and associated rockfish were observed over the depth interval of 185–240 m, but the highest densities ($>30$ fish min$^{-1}$) were recorded around 198 m. Other fishes were occasionally seen within the sea whip habitat, including arrowtooth flounders (*Atheresthes stomias*), sawback poachers (*Leptagonus frenatus*), and big skates (*Raja binoculata*), but none seemed to be consistently associated with this habitat as the rockfish. Several large areas contained numerous sea whips that were no longer upright and had much lower rockfish densities ($<2$ fish min$^{-1}$).

During the day, the Pacific Ocean perch were more active and in some cases were seen milling above the forest, presumably feeding on the euphausiids. In the two canyon deployments in which

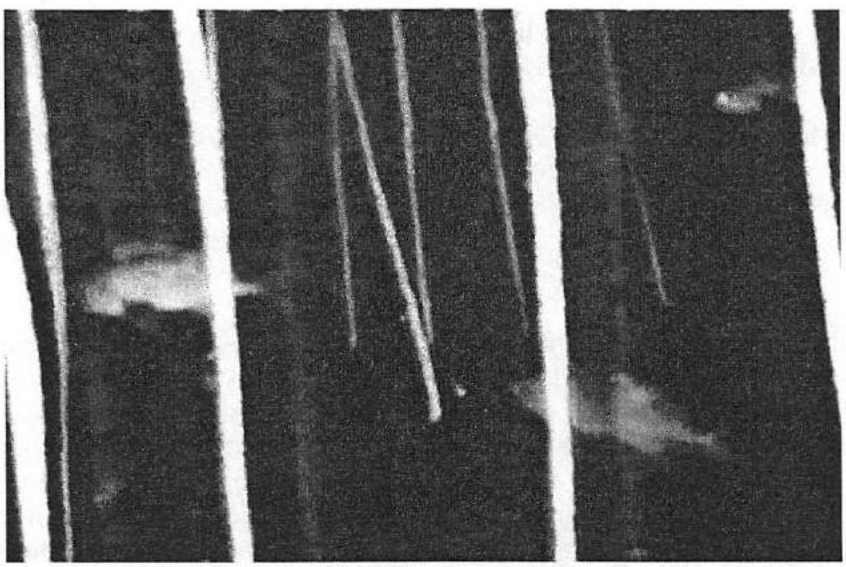

Fig. 3. Photograph of several adult Pacific Ocean perch inside sea whip "forest". The slanting vertical lines are the center portions of sea whips which are around 2 m high.

no sea whips were observed (depth range 181–224 m), there were also no Pacific Ocean perch observed, although many other bottom fishes such as Pacific cod (*Gadus macrocephalus*), arrowtooth flounders, and sawback poachers were observed. These were the easternmost and shallowest of the deployments, and apparently missed the main sea whip habitat, which appeared to be mainly in the central and western flank of the canyon. In addition to the sea whips, the most obvious invertebrate macrofauna observed in the canyon were king crabs (*Paralithodes* spp.), large anenomes (*Metridium giganteum* and *Urticina* spp.) and large basket stars (*Gorgonocephalus eucremis*). Most of the basket stars had their arms extended indicating that they were actively feeding.

### 3.2. Acoustic transects

Transects along the shelf break (ca. 210 m) and those that crossed the axis of the canyon both showed substantial near-bottom aggregations of large scatterers at the upper edge of the canyon (Fig. 4). These large scatterers extended generally less than 10 m off bottom and were present in both the 38 and 120 kHz images. In addition, the 120 kHz echograms contained a dense layer of smaller scatterers above the larger ones that at times extended down to and overlapped the vertical distribution of the large scatterers (Fig. 4a), but was restricted to mid-water when it crossed the canyon axis (Fig. 4b).

Based on the mean acoustic backscatter from 4 inshore-offshore transects (2 each year) in the central and western part of the canyon for the 10 m above the bottom (38 kHz) and the layer between 150 and 175 m (120 kHz), these aggregations mainly occurred over a very narrow bottom

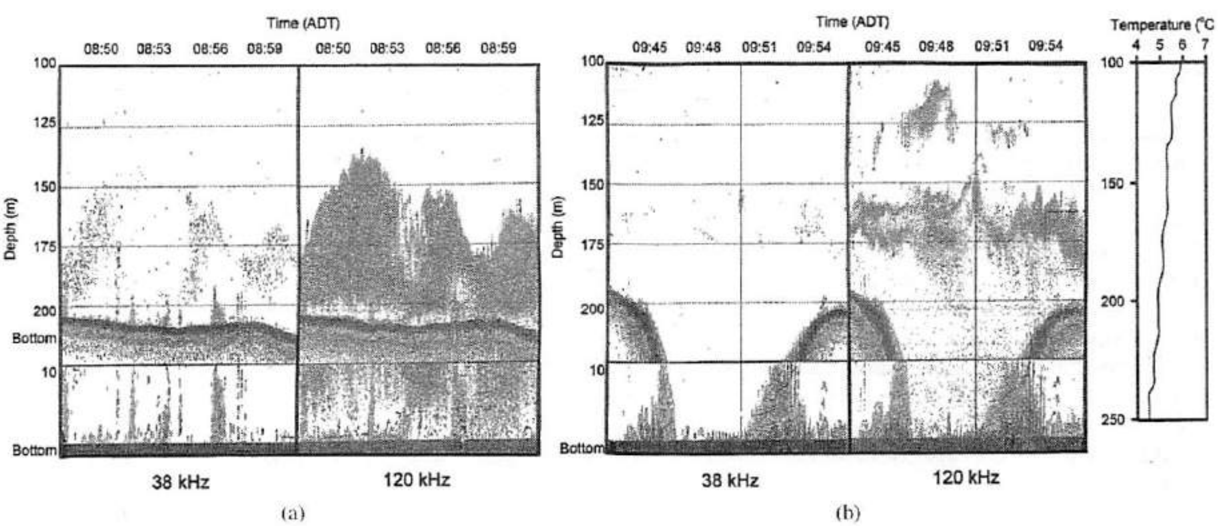


Fig. 4. Acoustic transect showing backscatter signals (a) along the 210–220 m isobath and (b) across the northwest end (Fig. 2) of Pribilof Canyon on 23 September 1995 for 38 kHz (left panel) and 120 kHz (right panel). The top part of each panel shows the water column from 100 m to the bottom or 250 m. The bottom part of each panel is an expanded view of the 10 m of the water column right above bottom. The time of day is shown at the top of the panel. To the right is the distribution of temperature with depth measured from a nearby CTD cast.

depth range. High acoustic backscatter first became apparent around 180 m depth, peaked around 200 m, and declined after 220 m at both frequencies (Fig. 5). The mean areal backscatter at the 200 m isobath was 2233 and 59,443 $m^2 nm^{-2}$ for these depth strata using 38 and 120 kHz data,

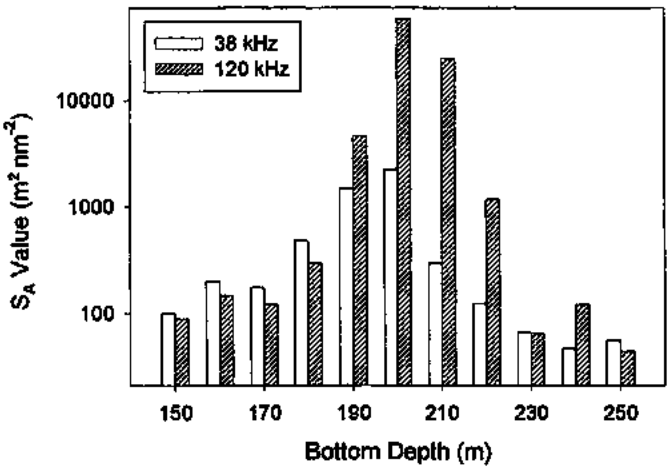


Fig. 5. Acoustical backscatter ($S_A$) from the EK-500 for the 10 m directly above bottom (38 kHz) and the layer between 150 and 175 m in the water column (120 kHz) by 10 m bottom depth intervals. Data are averaged by depth bin for four transects (two each in 1995 and 1997) in the northwest part of the canyon. Note that the ordinate scale is logarithmic.

Table 2
Fish catches (density and biomass) from bottom trawls ranked in order of decreasing mean density for 1995 and 1997. Shown only are the species which made up greater than 0.1 of the numerical catch. The 1995 data represent the mean of four tows

| Common name | Scientific name | 1995 ($n$=4) | | | | 1997 ($n$=1) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No./km² (%) | | Kg/km² (%) | | No./km² (%) | | Kg/km² (%) | |
| | | No./km² | (%) | Kg/km² | (%) | No./km² | (%) | Kg/km² | (%) |
| Pacific Ocean perch | *Sebastes alutus* | 1106.2 | 87.7 | 793.5 | 71.8 | 366.7 | 34.6 | 288.1 | 43.0 |
| Arrowtooth flounder | *Atheresthes stomias* | 100.0 | 7.9 | 152.1 | 13.8 | 126.4 | 11.9 | 178.7 | 26.7 |
| Pacific cod | *Gadus macrocephalus* | 17.4 | 1.4 | 67.0 | 6.1 | 46.8 | 4.4 | 141.2 | 21.1 |
| Darkfin sculpin | *Malacocottus zonurus* | 10.3 | 0.8 | 4.5 | 0.4 | — | — | — | — |
| Sturgeon poacher | *Podothecus acipenserinus* | 8.7 | 0.7 | 0.2 | <0.1 | — | — | — | — |
| Spectacled sculpin | *Triglops scepticus* | 3.3 | 0.3 | 0.3 | <0.1 | — | — | — | — |
| Sawback poacher | *Leptagonus frenatus* | 2.3 | 0.2 | 0.1 | <0.1 | 449.2 | 42.3 | 18.9 | 2.8 |
| Alaska ronquil | *Bathymaster caeruleofasciatus* | 2.3 | 0.2 | 0.5 | <0.1 | — | — | — | — |
| Big skate | *Raja binoculata* | 1.8 | 0.1 | 19.5 | 1.8 | — | — | — | — |
| Sablefish | *Anoplopoma fimbria* | 1.3 | 0.1 | 2.5 | 0.2 | — | — | — | — |
| Flathead sole | *Hippoglossoides elassodon* | 1.0 | 0.1 | 0.5 | <0.1 | 51.4 | 4.8 | 23.4 | 3.5 |
| Prowfish | *Zaprora silenus* | 1.0 | 0.1 | 5.7 | 0.5 | — | — | — | — |
| Rex sole | *Errex zachirus* | 1.0 | 0.1 | 0.4 | <0.1 | 19.2 | 1.8 | 17.2 | 2.6 |
| Pacific sleeper shark | *Somniosus pacificus* | 0.8 | 0.1 | 42.7 | 3.9 | — | — | — | — |
| Dusky rockfish | *Sebastes ciliatus* | 0.8 | 0.1 | 1.2 | 0.1 | — | — | — | — |
| Sharpchin rockfish | *Sebastes zacentrus* | — | — | — | — | 1.1 | 0.1 | 2.2 | 0.3 |
| | Total catch | 1229.5 | 100.0 | 1104.6 | 100.0 | 1060.8 | 100.0 | 669.7 | 100.0 |

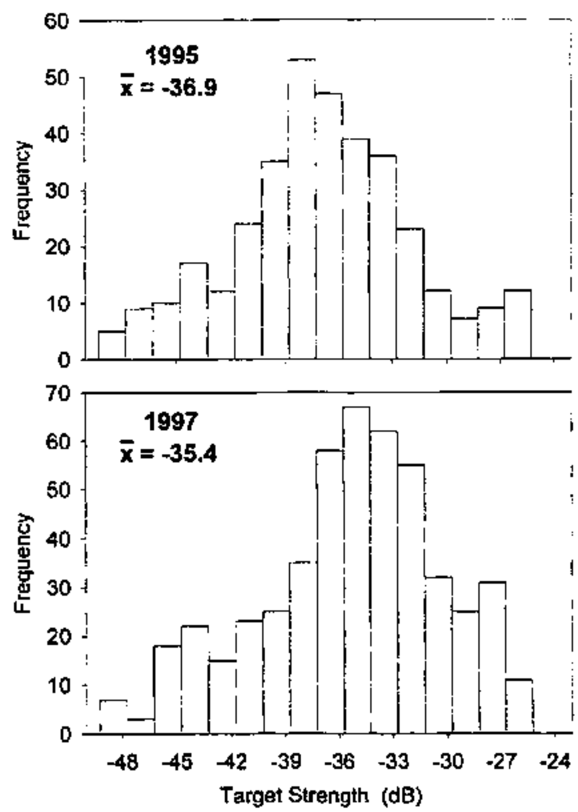


Fig. 6. Distribution of 38 kHz target strengths in the 10 m directly above bottom for 1995 (top) and 1997 (bottom). Shown also is the mean overall target strength by year.

respectively. Mean backscatter for two transects over similar bottom depth ranges in the easternmost head of Pribilof Canyon (Fig. 2) was 63.6 ($\pm$ 11.3 SE) and 79.3 ($\pm$ 10.4) $m^2\,nm^{-2}$ for these two frequencies, respectively.

The target strength (TS) distributions for 38 kHz were similar for both years, although the values were about 1.5 dB higher in 1997, indicating larger scatterers were present that year (Fig. 6). The target strengths obtained with the 120 kHz were similar in both years (mean TS = −75.1 and −76.0 dB for 1995 and 1997, respectively), but were substantially lower than those seen with the 38 kHz, suggesting that these scatterers were predominantly zooplankton.

### 3.3. Net tows

A diverse group of shelf and deepwater teleost and elasmobranch species were collected in the five bottom trawls (Table 2). In 1995, Pacific Ocean perch was the dominant species both in terms of number and biomass caught. The only other species comprising at least 5% of either the number or biomass were arrowtooth flounder and Pacific cod. In the one tow taken in 1997, Pacific Ocean perch was again the dominant species by weight but the smaller sawback poachers

Table 3
Densities (number per 1000 m$^3$) of macrozooplankton and micronekton collected in Methot tows in the Pribilof Canyon region by year

| Taxa | 1995 | | 1997 | |
|---|---|---|---|---|
| | Density | % of total | Density | % of total |
| Cnidaria | 13.0 | 3.7 | 25.9 | 1.5 |
| Chaetognatha | | | | |
| *Sagitta elegans* | 2.0 | 0.6 | 0.3 | 0.0 |
| *Eukrohnia hamata* | 1.3 | 0.4 | — | — |
| Hyperiidea | 0.2 | 0.1 | — | — |
| Gammaridea | 2.5 | 0.7 | — | — |
| Euphausiacea | | | | |
| *Thysanoessa inermis* | 194.6 | 56.0 | 1124.1 | 63.5 |
| *Thysanoessa longipes* | 85.4 | 24.6 | 490.5 | 27.7 |
| *Thysanoessa raschii* | — | — | 51.1 | 2.9 |
| *Thysanoessa spinifera* | 22.1 | 6.4 | 61.3 | 3.5 |
| Decapoda Natantia | 1.0 | 0.3 | — | — |
| Osteichthyes | | | | |
| *Theragra chalcogramma* | 22.7 | 6.5 | 16.3 | 0.9 |
| *Anoplopoma fimbria* | 0.9 | 0.3 | — | — |
| *Hexagrammos decagrammus* | 0.8 | 0.2 | 0.2 | 0.0 |
| *Lumpenus maculatus* | — | — | 0.2 | 0.0 |
| *Atheresthes stomias* | 0.9 | 0.3 | — | — |
| *Lepidopsetta bilineata* | — | — | 0.2 | 0.0 |
| Total | 347.3 | 100.0 | 1770.0 | 100.0 |

were more important numerically (Table 2). Other rockfish species (*Sebastes* spp.) were caught in both years, but these made up a minor component of the total biomass. Many sea whips were also collected in the trawls during both years, but these could not be quantitatively assessed due to loss through the trawl meshes.

The catch of the Methot tows was dominated by euphausiids, which comprised 87.0 and 97.6% of the total densities in 1995 and 1997, respectively (Table 3). *Thysanoessa inermis* was more than twice as abundant as the next most important species, *T. longipes*. Small cnidarian jellyfish were the only other invertebrate taxa collected in moderate densities. Several juvenile fishes were collected but, other than walleye pollock (*Theragra chalcogramma*), they were of negligible importance.

The size distributions of Pacific Ocean perch caught in the bottom trawls were similar in both years, although in 1997 slightly larger fish were caught (Fig. 7). These fish ranged in age from 8 to 15 yr (median = 11 yr) and were all classified as mature adults. Out of the 306 fish examined for stomach contents in both years, only 26 were found to contain food. Of these, 25 contained mainly euphausiids, most of which were *Thysanoessa inermis*. The remaining stomach contained a juvenile squid, *Berryteuthis magister*. A few other stomachs contained well-digested squid and fish remains and could not be formally analyzed.

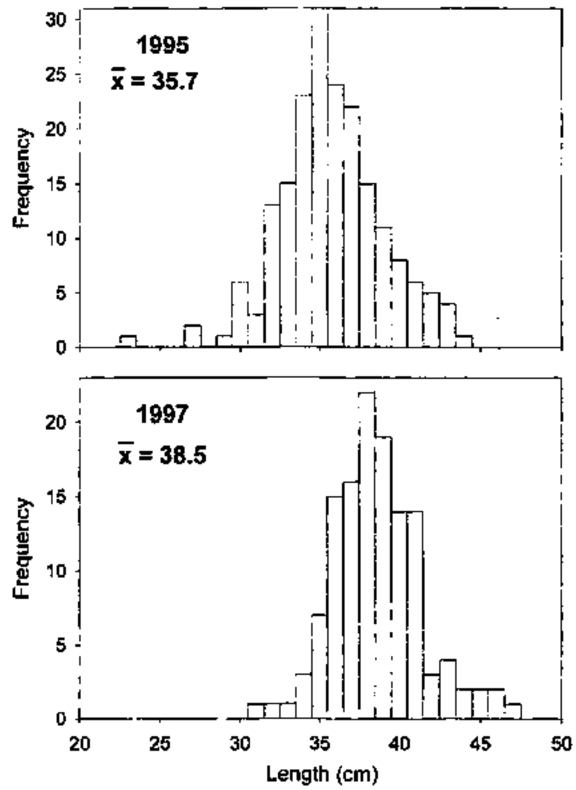


Fig. 7. Size distribution of Pacific Ocean perch collected in four bottom trawls in 1995 (top) and one bottom trawl in 1997 (bottom). Shown also is the mean size by year.

### *3.4. Environmental conditions*

Temperatures at the bottom generally varied between 4 and 5°C on all CTD deployments (Fig. 4), which is typical of the offshelf waters at these depths (Stabeno et al., 1999). Ambient light levels measured around 200 m in the canyon were very low both day and night ($4.3 \times 10^{-6}$ and $6.2 \times 10^{-7}\,\mu E\,s^{-1}\,m^{-2}$, respectively), but were at or above threshold feeding levels of typical planktivorous fishes (Ryer and Olla, 1999).

## 4. Discussion

Many in situ studies examining the habitat preferences of demersal fishes show that these fishes are not randomly distributed but are often generally aggregated near some structure on the bottom (Auster et al., 1995). In some instances, these structures can be of biogenic origin, such as depressions or holes dug into the substrate (Able et al., 1982). In rockfishes of the genus *Sebastes*, however, the majority of studies have revealed a dependence on hard bottom substrates, often with substantial vertical relief (Richards, 1986, 1987; Pearcy et al., 1989; O'Connell and Carlile, 1993; Krieger and Ito, 1999). Krieger (1992), however, found that adult Pacific Ocean perch were more likely to inhabit flat, pebble substrate based on submersible observations off Southeast Alaska. In ROV observations in other shelf and slope areas of the Bering Sea, Pacific Ocean perch were occasionally found in other deepwater deployments outside the canyon, but these were for the most part solitary individuals associated with large boulders (Busby and Brodeur, in prep.).

In this study, the highest densities of Pacific Ocean perch were found at the northwest edge of the canyon based on both ROV observations and trawl collections, and were clearly associated with the sea whip 'forest'. Krieger (1992), in a photograph taken by submersible, also shows an aggregation of adult Pacific Ocean perch near several sea whips in the Gulf of Alaska. Similar to the present study, he found these fish to be evenly spaced and oriented into the current. This utilization of the sea whip 'forest' by Pacific Ocean perch apparently satisfies some need by this species to associate with a high-profile substrate in the absence of high relief rock substrates.

The high densities of vertebrate and invertebrate macrofauna in the canyon attest to the high productivity in this area. In addition to the sea whips, the high densities of other filter-feeding organisms such as anenomes and basket starfish suggest the presence of a substantial near-bottom flow containing high concentrations of zooplankton. This flow is apparently quite consistent over time to develop such a complex assemblage of sessile or slow-moving organisms. A cross section of a calcareous axial rod in several sea whip specimens revealed up to 130 circulli (M. Wilson, AFSC, personal communication). Presently, it is unknown whether these growth rings represent annual growth rings, but other related deep-sea sessile invertebrates are known to have extended life spans (Druffel et al., 1995).

It seems likely that the high densities of euphausiids found in the water column at the western head of the canyon originate from deeper areas of the Bering Sea Basin and are advected up the canyon by the prevailing currents. Most of the specimens found in the Methot mid-water tows and stomach contents of Pacific Ocean perch were *Thysanoessa inermis*, a characteristic euphausiid species of the outer shelf and basin of the Bering Sea (Smith, 1991; Sugisaki et al., 1998; Stockwell et al., in press). These euphausiids then impinge on the bottom at the head of the canyon as they attempt to migrate down to their normal daytime depths, similar to that observed in other canyons (Mackas et al., 1997). Although no depth-discrete plankton tows were conducted in this study area, other studies in the outer shelf region of the Pribilof Islands show higher concentrations of euphausiids in the epibenthic layer than in the water column, especially during the day (Coyle and Cooney, 1993; J. Napp, AFSC, unpublished data). An intense acoustic player layer of the type shown here has been consistently observed at the head of the Pribilof Canyon, but nowehere else, every year (1994–1999) that fall acoustic surveys have been conducted in this area (G. Swartzman, University of Washington, personal communication).

The foraging behavior of most shelf rockfish appears to be highly opportunistic and they are known to take advantage of oceanic mesopelagic prey that are advected onto the shelf near canyons or offshore banks (Pereyra et al., 1969; Brodeur and Pearcy, 1984; Chess et al., 1988; Genin et al., 1988). Information on the diet of Pacific Ocean perch in the Bering Sea is fragmentary, perhaps due in part to the difficulty in obtaining non-inverted stomachs from deep-water tows. Brodeur and Livingston (1988) found that of the 50 stomachs of this species examined, only 19 contained food, with euphausiids and caridean shrimp dominating the diet. Poltev (1999) found *S. alutus* on a seamount off the Kuril Islands were feeding mainly on euphausiids (86.3% by volume) with smaller contributions by fish (4.6%) and squid (3.2%) during

September 1997. These fish were not observed to undergo pronounced diel vertical migrations but did feed exclusively during the daytime. Although the number of stomach samples available in the present study was insufficient to elucidate the diel feeding cycle of Pacific Ocean perch in Pribilof Canyon, it seems likely that they are feeding mainly during the day when their activity level is higher and they are swimming above the 'forest'. This was also the time when high densities of euphausiids were seen in the ROV videos swarming in a layer just above the bottom.

It is not presently known what the predation impact of these large aggregations of rockfishes is on the euphausiid biomass advected over them on a daily basis. Demersal rockfishes have been shown to deplete populations of euphausiids advected over shallow banks off Southern California during the day such that 'gaps' appear in the acoustic echograms (Genin et al., 1988, 1994). Estimation of this predation impact by Pribilof Canyon rockfish on euphausiids will require more precise abundance estimates of both predator and prey as well as daily ration estimates of Pacific Ocean perch.

Although trawling and ROV deployments took place in a relatively small subarea of the canyon, it appeared to be one of the main aggregation areas based on the densities of near-bottom acoustic scatterers. It is highly probable that most of the acoustic sign observed near-bottom around 200 m was due to rockfish. The only other species with a swimbladder that was collected in any abundance in the trawls was Pacific cod, although their abundances were relatively low compared to Pacific Ocean perch. Although no in situ target strength measurements exist for Pacific Ocean perch, I applied Foote's (1987) generic target strength (TS) to length ($L$) relationship for physoclist fishes ($\mathrm{TS} = 20 \log L - 67.5\,\mathrm{dB}$), which appears to be appropriate for rockfishes in general (R. Kieser, Pacific Biological Station, DFO, Nanaimo, B.C. Canada, personal communication), to the mean size of Pacific Ocean perch caught in the trawls. The predicted TS from this relationship would be −36.88 and −35.42 dB for 1995 and 1997, respectively, reasonably close to the observed mean TS of −36.44 and −35.77 dB for these two years. More systematic acoustic surveys of the entire canyon region could yield more precise estimates of the total rockfish population inhabiting this area.

Similarly, no target strength measurements exist for the dominant euphausiid species (*Thysanoessa inermis*) collected in the Methot trawls, but the values taken with the 120 kHz echosounder are within the range expected for similar-sized euphausiids, based on theoretical scattering models (Stanton, 1989; Miyashita et al., 1997; Simard and Lavoie, 1999). However, other organisms that were caught in the Methot trawls, such as gelatinous zooplankton, could also fall within this range of target strengths.

This study is the first to show the importance of the Pribilof Canyon in general and the sea whip 'forest' in particular as a distinctive habitat for adult Pacific Ocean perch in the Bering Sea. Past attempts to define marine habitats of this species have relied on physical variables such as temperature and depth (Scott, 1995). Although this may narrow the range of possible habitats that could be occupied, the utilization of species such as Pacific Ocean perch of highly predictable but dynamic food sources and relatively static physical features renders such simple classifications inadequate.

The sea whips in this region may provide important structural habitat for Pacific Ocean perch in an otherwise featureless environment. An important consideration in this habitat is the slow growth rates and potential longevity of the sea whips providing this habitat. If they do indeed live for extended periods of time, fishing operations that disturb the bottom and uproot the sea whips may have a lasting effect on the rockfish populations inhabiting this region that could be potentially more detrimental than the direct effects of removing fish. The similar orientation of the sea whips observed in the ROV videos that had been apparently knocked down and were lying on the seabed suggests that fishing operations, including possibly some of my own trawl sampling, could have uprooted them. The substantially lower densities of Pacific Ocean perch observed in this perturbed habitat suggests that it is less preferred by this species compared to the undisturbed "forest". Destructive fishing methods have been widely observed to have major and long-lasting effects on sessile benthic megafauna (Jennings and Kaiser, 1998; Freese et al., 1999). More research needs to be done to determine the importance of areas such as Pribilof Canyon to Pacific Ocean perch production in the Bering Sea, so that we may protect and allow restoration of these utilized habitats for commercially and ecologically important species such as rockfishes.

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# Axial rod growth and age estimation of the sea pen, *Halipteris willemoesi* Kölliker

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*Key words:* Pennatulacea, age, growth, axial rod, lead-210, radium-226

**Abstract**

*Halipteris willemoesi* is a large octocoral commonly found in the Bering Sea. It is a member of a ubiquitous group of benthic cnidarians called sea pens (Octocorallia: Pennatulacea). Sea pens have a skeletal structure, the axial rod, that in cross section exhibits growth rings. Pairs of adjacent rings, or ring couplets, were assumed to be annuli and were used to estimate the age and growth of *H. willemoesi*. Twelve axial rods, extracted from *H. willemoesi* collected in the Bering Sea, were selected to represent small (25–29 cm total length), medium (97–130 cm TL) and large (152–167 cm TL) colonies. Each rod resembled a tapered dowel; the thickest part (0.90–6.75 mm in diameter) was at about 5–10% of total length from the base tip, the distal part was more gradually tapered than was the base. The number of ring couplets increased with rod size indicating their utility in estimating age and growth. Estimated age among rods was based on couplet counts at the thickest part of each rod; the average estimated age (±SE) was 7.1 ±0.7, 19.3 ±0.5, and 44.3 ±2.0 yr for small, medium and large-size rods, respectively. Based on these estimated ages, average growth rate in total length was 3.9 ± 0.2, 6.1 ± 0.3, and 3.6 ± 0.1 cm $yr^{-1}$ for small, medium, and large-size colonies. The average annual increase in maximum rod diameter among all colonies was 0.145 ± 0.003 SE mm $yr^{-1}$; therefore, age prediction from maximum rod diameter was calculated (estimated age (yr) = 7.0 ∗ (maximum rod diameter, mm) −0.2; $R^2 = 0.99$). At maximum diameter, the average couplet width was relatively constant among the three colony sizes (0.072 ± 0.05 mm). X-ray diffraction and electron microprobe analyses revealed that the inorganic portion of the rod is composed of a high-magnesium calcite. Radiometric validation of these age and growth rate estimates was attempted, but high amounts of exogenous $^{210}Pb$ precluded using the disequilibria of $^{210}Pb$:$^{226}Ra$. Instead, $^{210}Pb$ activities were measured in a series of cores extracted along the axial rod. These activities ranged from 0.691 ± 0.036 (SE) to 2.76 ± 0.13 dpm $g^{-1}$, but there was no pattern of decay along the length of the rod; therefore, the growth rates and corresponding ages could not be validated. Based on estimated age from ring couplet counts, growth in total rod length is slow at first, fastest at medium size, and slows toward maximum size, with an estimated longevity approaching 50 yr.

## Introduction

Sea pens and whips (Octocorallia: Pennatulacea) are colonial organisms that inhabit soft-bottom areas over a broad range of depths (intertidal – 6200 m) in all oceans (Williams, 1995, 1999). They can form vast forest-like patches of biogenic habitat that may play an important role as fish habitat (Krieger, 1993). Each colony stands erect and is secured to the sea floor by peristaltic burrowing of the peduncle, a slightly swollen basal (proximal) part of the fleshy tissue. The upper or distal part, the rachis, is populated with feeding polyps (autozooids). Sea pens are considered to be sessile (Williams, 1999), but movement by detaching, drifting, and re-attaching has been noted in the shallow-water species *Ptilosarcus gurneyi* (Birkeland, 1974) and *Renilla kollikeri* (Kastendiek, 1976), and the deep-water sea pen *Umbellula lindahli* (Flores, 1999). Despite this potential for movement, sea pens may contain useful records of environmental conditions stored in the skeletal tissues.

The endoskeleton of sea pens is a simple unbranched structure called an axial rod. The axial rod of the sea pen *Veretillum cynomorium* consists of a matrix of longitudinally oriented collagen fibrils embedded in columns of calcite that radiate out from a nodular core (Franc & Chassagne, 1974; Ledger & Franc, 1978). At the base (inferior) end, a calcification gradient exists between the non-calcified tip and the rest of the rod. The autoradiography ($^3$H-proline labeling) results of Franc et al. (1985) indicate that deposits are made onto the rod exterior; the interior is closed to deposition. Chia & Crawford (1977) found evidence of initial axial rod formation in *P. gurneyi* primary polyps soon after settlement of the planula. Birkeland (1974) found that growth rings in the axial rods of young sea pens (*P. gurneyi*) were formed annually, based on observed growth, and averaged 0.1 mm in width. Some colonies were estimated to be 15 years old based on rod diameter but, because of core degeneration, these estimates remain unvalidated. Linear extension rates and radiometric age determination provide evidence that skeletal growth rings in other octocorals are formed annually (Grigg, 1974; Szmant-Froelich, 1974; Andrews et al., 2002).

In September 1997, numerous large sea pens (*Halipteris willemoesi*) were collected as bycatch during bottom-trawl sampling in the Bering Sea prompting an investigation of the structure of the axial rod as a tool for determining age. Transverse sections revealed many growth rings in the axial rods indicating that *H. willemoesi* colonies may be slow growing and long lived; therefore, anthropogenic disturbance or removal of sea pen 'forests' could have a lasting effect on the structure of soft-bottom communities. In addition, chronologically ordered sequences of ring widths may be useful for constructing a history of variation in the surrounding environment. This concept is supported by studies on other organisms that indicate skeletal microstructure can be used as a record of age and environmental variability; for example trees (Stokes & Smiley, 1996), fish (Woodbury, 1999), bivalves (Cerrato, 2000), and other colonial anthozoans (Druffel et al., 1995; Cole et al., 2000; Andrews et al., 2002; Risk et al., 2002). Despite the cosmopolitan distribution and large size of *H. willemoesi* (Williams, 1995), we found no literature describing colony age or the growth of its axial rod. Therefore, the focus of this study was to: (1) describe the structure of different-size axial rods; (2) estimate colony age from axial rod ring counts; (3) create growth models from estimated ages; and 4) attempt to validate colony age and growth estimates using radiometric age validation.

## Material and methods

Twelve *H. willemoesi* colonies were selected from two trawl samples collected in the eastern Bering Sea (Fig. 1). Species identification was based on the recent revision of the order Pennatulacea (Williams, 1995). Colonies were selected by total rod length to form three size groups (small, 25–29 cm; medium, 98–130 cm; large, 153–167 cm) consisting of four colonies each (Table 1). The largest colonies were from Pribilof Canyon (11 September 1997, 56°16.8′ N, 169°25.8′ W, 248 m depth, 3.5°C bottom temp.), the others were collected farther northwest (28 July 1998, 60°0.6 N, 177°56.4′ W, 142 m, 2.0°C). Soft tissue surrounding the axial rod was easily removed because it was securely attached only to the rod base.

Each rod was allowed to dry for 1 month at room temperature before measuring and sectioning. Rod diameter along the full length of each rod was measured with a micrometer to the nearest 0.05 mm. Cross sections were cut at set distances from the base tip with a diamond blade saw and mounted onto slides with LR White resin. Each mounted section was ground down to a thickness of approximately 0.3 mm using 320 and 600 grit wet/dry sand paper and coated with immersion oil for viewing. Sections were viewed through a dissecting microscope with transmitted light to make all counts and measurements at a magnification of 16 times. Although higher magnification revealed rings nested within rings, these finer rings were often hard to distinguish. Growth rings were evident as couplets, each consisting of one translucent and one adjacent opaque band.

For each cross section, the number of couplets was counted three non-consecutive times. In addition, radial measurements of cross sections of the rod base were made to quantify and construct a longitudinal view of the thickness of a core of smooth rings and the overlaying layer of rough material. These measure-

*Table 1.* Axial rod measurements and age estimates at maximum rod diameter for twelve *Halipteris willemoesi* colonies collected in the eastern Bering Sea, with calculated total length and diameter growth rates

| Size-group and colony | Total length (cm) | Maximum diameter (mm) | Average increment width (mm)[a] | Estimated age (yr ± SD)[b] | Length growth rate (cm $yr^{-1}$)[c] | Diameter growth rate (mm $yr^{-1}$)[d] |
|---|---|---|---|---|---|---|
| **Small** | | | | | | |
| BS-G | 25.3 | 0.90 | 0.075 | 6.0 ± 1.0 | 4.21 | 0.150 |
| BS-E | 26.2 | 0.95 | 0.079 | 6.0 ± 1.7 | 4.36 | 0.158 |
| BS-F | 29.0 | 1.15 | 0.075 | 7.7 ± 1.2 | 3.78 | 0.150 |
| BS-H | 29.3 | 1.05 | 0.060 | 8.7 ± 0.6 | 3.38 | 0.121 |
| **Medium** | | | | | | |
| BS-D | 97.8 | 2.55 | 0.070 | 18.3 ± 0.6 | 5.33 | 0.139 |
| BS-B | 118.4 | 2.80 | 0.074 | 19.0 ± 1.0 | 6.23 | 0.147 |
| BS-A | 124.4 | 2.85 | 0.075 | 19.0 ± 2.6 | 6.54 | 0.150 |
| BS-C | 130.3 | 3.05 | 0.074 | 20.7 ± 2.1 | 6.30 | 0.148 |
| **Large** | | | | | | |
| PC-C | 152.6 | 5.85 | 0.073 | 40.0 ± 5.3 | 3.81 | 0.146 |
| PC-D | 156.9 | 6.35 | 0.076 | 41.7 ± 2.1 | 3.76 | 0.152 |
| PC-B | 162.6 | 6.75 | 0.072 | 47.0 ± 1.7 | 3.45 | 0.144 |
| PC-A | 166.7 | 6.40 | 0.066 | 48.3 ± 1.5 | 3.44 | 0.132 |

[a]Calculated as half the diameter divided by increment count.
[b]Triplicate count of the growth increments resulting in an average age at the maximum rod diameter.
[c]Total length divided by the estimated age.
[d]Maximum diameter divided by the estimated age.

ments were also repeated three non-consecutive times. Triplicate counts and measurements were averaged before calculating the average and standard error (SE) for each rod size group and cross-section position. Cross-section positions were constant within each size group and were determined by distance from the base tip. Average couplet width was calculated as one-half rod diameter divided by couplet count.

Rod length and diameter measurements and growth increment counts (estimated age) were used to estimate growth rates. In addition, growth rates were calculated for the change in colony size, from small to medium and from medium to large, by dividing the difference of the average rod lengths by the difference of the average estimated age.

To gain a better understanding of the composition and structure of the carbonate matrix, X-ray diffraction was performed at the Department of Geology and Geophysics at the University of Alaska, Fairbanks.

To attempt a validation of age and growth estimates, a radiometric age-validation technique was applied to the calcified axial rod among and within colonies. Skeletal material from three sea pen colonies was used in these analyses. Whole and core skeletal material from one colony was used in a preliminary analysis to determine the levels of $^{210}Pb$ and $^{226}Ra$. Core material at the center of the rod was exposed when the rod exterior was removed using a milling machine. The result was a 1-mm diameter, 3-cm long core estimated to be the first few years of growth. Extracted samples were cleaned and processed for $^{210}Pb$ and $^{226}Ra$ using well established protocol as described by Andrews et al. (1999 a, b). Two approaches were utilized to attempt to validate age and growth. First, to determine radiometric age using the disequilibria of $^{210}Pb$ and $^{226}Ra$, core material from the thickest, and presumably oldest, part of the axial rod in two colonies was analyzed. The aim of this approach was to age individual cores using the disequilibria of $^{210}Pb$ and $^{226}Ra$. Second, core material at locations along the axial rod (base to tip) was analyzed for $^{210}Pb$ only. The aim of this approach was to measure the decay of $^{210}Pb$ activity along the rod from the apical tip to near the base tip that presumably corresponds with a young-to-old gradient.

## Results

The axial rods of *H. willemoesi* resembled a thin tapered dowel, and extended the length of the colony (Fig. 1). The upper part of the rod was white, well

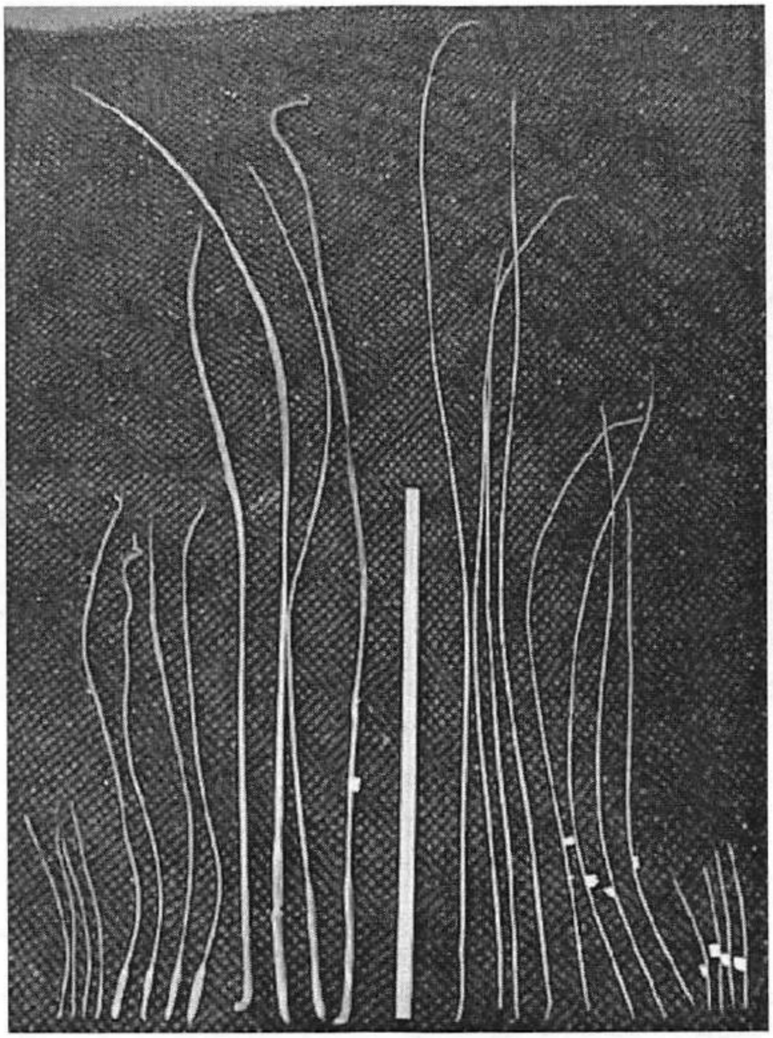

*Figure 1.* Twelve intact *Halipteris willemoesi* colonies from the Bering Sea (left of meter stick) next to the twelve axial rods from similar-size colonies. The cleaned rods on the right were used to describe rod structure, and to estimate colony age and growth rate.

calcified, and smooth and circular in cross section (Fig. 2A). Soft tissue easily sloughed off this part. The lower part, hereafter referred to as the base, comprised about 10% of the total rod length and differed from the upper part by having a rough exterior and by being irregular in cross section (Fig. 2B). Except at its very tip, which was brown and pliable when wet, the base was also white and well calcified. Soft tissue was securely attached to the base, particularly the tip.

Transverse sections of the rod base revealed that the rough material overlays a core of smooth, concentric growth rings that are similar in cross-section appearance to the rings in the upper part of the rod (Fig. 2). Series of radial measurements of this core were used to construct longitudinal views to show how core thickness decreases toward the base tip (Fig. 3). Comparing core thickness among different size rods helps to illustrate how the rod base may grow. Assuming no structural variation after deposition, the core of small rods corresponds in thickness to the lower part of the core in large rods indicating that the youngest part of large rods is probably close to the base tip.

Rod shape was similar among the different size groups (Fig. 4A). From the point of maximum diameter, rod thickness decreased sharply before assuming a more gradual taper to the apical tip. The distance from the base tip to the point of maximum rod diameter increased with rod size. As a percent of total length, however, this distance was about 5–10% regardless of size group. Maximum rod diameter was similar among the four rods in each size group (Table 1). The average maximum thickness for small,

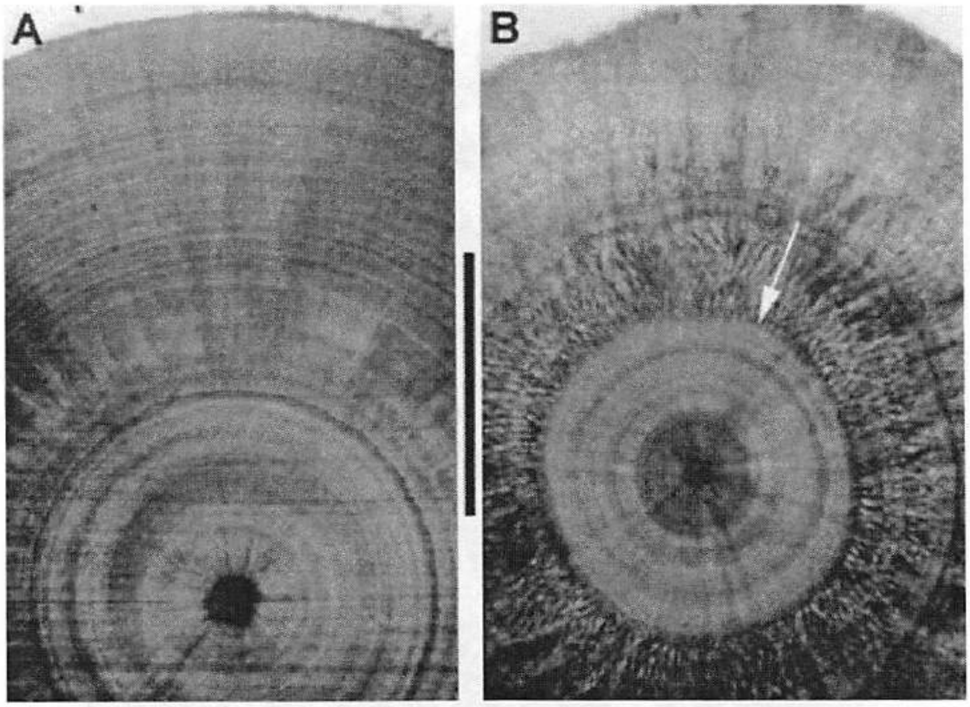


*Figure 2.* Photographs (32×) of transverse sections of an axial rod taken in the distal part at 25 cm from the basal tip (A), and in the basal part at 5 cm (B) from the basal tip. The axial rod, 167 cm total length, was from a *Halipteris willemoesi* colony collected in the Bering Sea. The arrow points to the interface within the rod base between the inner core of smooth, concentric increments, and the outer rough material (scale bar = 1 mm).

medium, and large rods was 1.01 mm ±0.06 (SE), 2.81 mm ±0.10, and 6.34 mm ±0.19, respectively.

The number of couplets per cross section changed with rod diameter (Fig. 4A, B). For each rod, maximum couplet count occurred at the maximum rod diameter. Among the rods examined, the average count at maximum diameter increased with rod size (Table 1): small, 7.1 ±0.7 (SE); medium, 19.3 ±0.5; and large, 44.3 ±2.0. These counts are assumed to indicate colony age in years; thus, the maximum estimated age for the largest colony, 167 cm total length, was 48.3 ± 1.5 SD yr.

Assuming an annual rate of couplet formation, the estimated annual growth rate in colony length varied with rod size, whereas change in diameter was near constant (Table 1). Total colony length divided by the average estimated age resulted in average annual growth rates of 3.9 ± 0.2 (SE), 6.1 ± 0.3, and 3.6 ± 0.1 cm $yr^{-1}$ for small, medium, and large-size colonies, respectively. Estimated growth rates calculated for change in size, from small to medium and medium to large, also varied as the rod increased in length. Growth estimates from small to medium colony size was 7.42 cm $yr^{-1}$ and 1.68 cm $yr^{-1}$ from medium to large. Estimated annual increase in rod maximum diameter varied little among colonies (small, 0.145 ±0.008 (SE); medium, 0.146 ±0.002; and large, 0.144 ±0.004 mm $yr^{-1}$) reflecting low among-group variability in mean couplet width. The average annual increase in rod maximum diameter among all colonies was estimated to be 0.145 ± 0.003 SE mm $yr^{-1}$. This relationship was used to estimate an age prediction model using maximum rod diameter (estimated age (yr) = 7.0*(maximum rod diameter, mm) - 0.2; $R^2$ = 0.99). The average width of each couplet was somewhat variable along the rod for all sizes (0.128 ± 0.013 mm; Fig. 4C), particularly at the base and apex which reflects our observation that the innermost couplets tend to be relatively wide. At maximum diameter, the average increment width was near constant among the three colony sizes (0.072 ± 0.050 mm; Table 1).

The X-ray diffraction analysis of the axial rod indicated the carbonate structure is a high-magnesium calcite. Magnesium comprised 3–4 weight percent of the carbonate. Sodium was present at 1–1.5 weight percent.

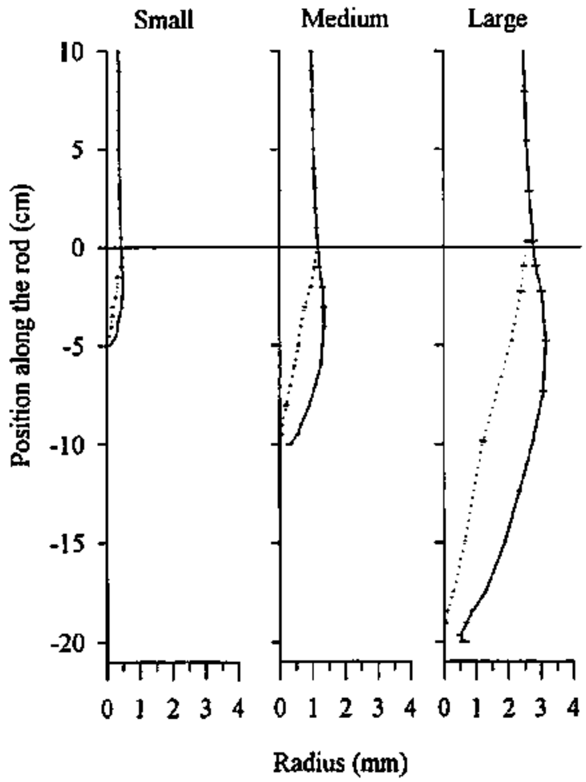


*Figure 3.* Measurements from cross sections taken throughout the base of twelve axial rods of *Halipteris willemoesi* were used to calculate the average (±SE) radius of the inner core (dotted line, Fig 2B) and the average (±SE) total rod radius (solid line) for each size group (four rods per group, Table 1). For each size group, superimposed plots of these two measurements *versus* cross section position along the rod (distance from the base tip) illustrate how core radius and thickness of the rough outer material varies longitudinally, and that the core extends to the basal tip regardless of rod size. Position along the rod is scaled so that zero (solid horizontal bar) corresponds with the probable relative position of the seafloor surface.

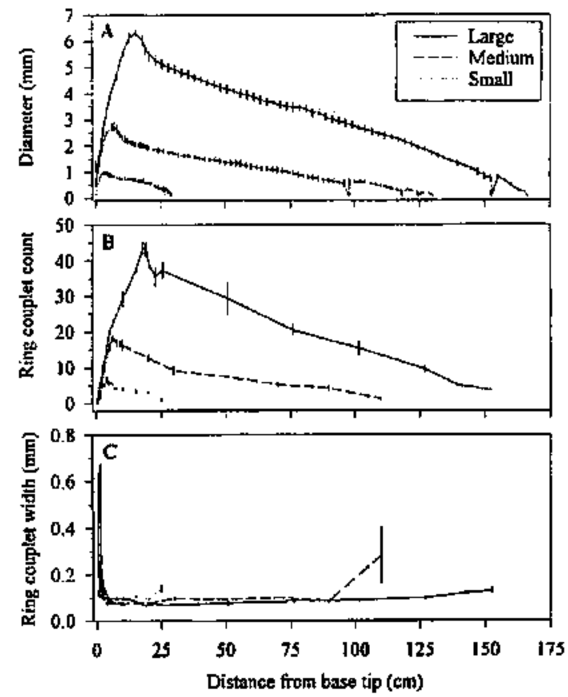


*Figure 4.* Average diameter (A) and growth increment count (B) from along the axial rods of small ($n$=4), medium ($n$=4), and large ($n$=4) *Halipteris willemoesi* colonies collected in the Bering Sea. Average increment width (C) was calculated as one-half diameter divided by increment count. Vertical bars indicate the standard error of the mean.

Radiometric results indicated that $^{210}Pb$ activities were relatively high and that exogenous $^{210}Pb$ was present in all samples except one (Table 2). Whole and cored samples had $^{210}Pb$ activities that exceeded the activity of $^{226}Ra$ in 7 out of 8 samples. The one sample that had a $^{210}Pb$ activity (0.0229 ± 0.0022 dpm/g) that was lower than $^{226}Ra$ activity (0.121 ± 0.0013 dpm/g) allowed for the calculation of an age from the disequilibrium of $^{210}Pb$:$^{226}Ra$. The result was 5.7 yr (1.7–10.2 yr range) for that colony. The next set of 5 samples from colonies 2 and 3, all of which were cores, had $^{210}Pb$:$^{226}Ra$ ratios that exceeded 1.0. Therefore, the ageable sample was thought to be anomalous and the method of disequilibria dating was dropped.

The alternate approach to determining a growth rate was to pursue the decay of $^{210}Pb$ over the length of the colony (Andrews et al., 2002). In general, $^{210}Pb$ activity in cores taken from near the basal and apical tips was high relative to activity in the middle of the rod. The range of activities for the 8 core samples taken from colony 3 ranged from 0.692 ± 0.036 to 2.76 ± 0.13 dpm/g. No growth rate or age was determined because the $^{210}Pb$ activities did not follow a consistent pattern over the length of the colony.

## Discussion

Knowledge of structural and temporal growth are important factors in understanding the life history of organisms like coral whose structure provides habitat for other species (i.e., biogenic habitat), and in understanding how skeletal structures may record environmental variability. *In situ* observations indicate that *H. willemoesi*, or similar species, stand erect on the sea floor with the peduncle, which corresponds to the base of the axial rod (Fig. 1), embedded in sed-

*Table 2.* Results from the radiometric analysis of axial rod sections (whole or core) taken from three *H. willemoesi* colonies collected in the eastern Bering Sea.

| Colony | Distance (cm)[a] | Sample type (whole/core) | Sample weight (g) | Activity of $^{210}Pb$ (dpm/g) | Sigma (1 SE) | Activity of $^{226}Ra$ (dpm/g) | Sigma (1 SE) | $^{210}Pb$:$^{226}Ra$ activity ratio |
|---|---|---|---|---|---|---|---|---|
| 1 | 11.6 | Whole | 0.699[b] | 1.79 | 0.12 | 0.125 | 0.001 | 14.3 |
| | 11.6 | Whole | 0.699[b] | 1.92 | 0.10 | 0.125 | 0.001 | 15.4 |
| | 16.7 | Whole[c] | 0.7244 | 0.0229 | 0.0022 | 0.121 | 0.001 | 0.19 |
| 2 (PC-C) | 13.1[d] | Core | 0.1543 | 0.875 | 0.033 | 0.147 | 0.002 | 5.95 |
| | 18.2[d] | Core | 0.1711 | 0.728 | 0.028 | 0.132 | 0.002 | 5.52 |
| 3 (PC-B) | 11.6 | Core | 0.0691 | 0.917 | 0.050 | 0.157 | 0.001 | 5.84 |
| | 16.7 | Core | 0.0700 | 0.773 | 0.045 | 0.149 | 0.006 | 5.19 |
| | 24.4 | Core | 0.0313 | 0.715 | 0.055 | 0.178 | 0.044 | 4.02 |
| | 52.3 | Core | 0.0633 | 0.727 | 0.041 | N.P. | – | – |
| | 77.7 | Core | 0.0415 | 0.774 | 0.046 | N.P. | – | – |
| | 103.1 | Core | 0.0702 | 0.692 | 0.036 | N.P. | – | – |
| | 128.5 | Core | 0.0600 | 1.03 | 0.050 | N.P. | – | – |
| | 156.4 | Core | 0.0200 | 2.76 | 0.13 | N.P. | – | – |

N.P. Not processed
[a] Distance from basal end to the center of each section.
[b] Same sample for $^{226}Ra$ analysis, split for $^{210}Pb$ analysis.
[c] Small amount of exterior removed by grinding.
[d] Sample length was 6 cm.

iments (Krieger, 1993). The rough part of the base corresponds to secure attachments between the rod and the surrounding soft tissue. In contrast, the upper part of the rod may be smooth so that the soft tissue better slides along it as the colony flexes in near-bottom currents. Based on cross sections through the base, the rough material overlays a core of well defined rings resembling the distal, above-sediment, part of the colony (Fig. 2).

As with *P. guerneyi* (Chia & Crawford, 1973), *H. willemoesi* probably begin to burrow into the sediment as newly settled planula larvae. The axial rod probably forms early after settlement (Chia & Crawford, 1977), but exactly when is unclear. With development, each colony probably burrows deeper to better anchor and support itself. We believe that depositions onto the rod above the seafloor surface result in smooth concentric rings and that lower depositions result in the rough material. Thus, the two layers of the base (Fig. 3) can be explained by rough material being deposited onto the rod as burrowing by the colony draws the rod farther into the sediment. The core of smooth rings at the base tip is difficult to explain unless the tip is the first-formed part of the rod. The relatively thin covering of rough material over this core at the tip probably results from relatively little material being deposited onto the tip during subsequent growth. Deposits onto the remaining parts of the rod must therefore cause it to thicken and elongate. This is relevant to ring-count age estimates because our couplet counts at the maximum diameter of axial rods from large colonies (ca. 160 cm total length) probably did not include the youngest part of the rod, perhaps the first couple of growth rings were missed.

Average width of growth-ring couplets was nearly constant in cross sections of the axial rod. This was especially true for determinations made at the maximum diameter of the rod (Table 1). The calculated average width of the couplets (0.072 ± 0.005 mm) was similar to the result from a study on the axial rod of the sea pen *Ptilosarcus gurneyi* (0.1 mm), a shallow-water species (Birkland, 1974).

Age, estimated from counts of ring couplets, was similar within size groups and was used to determine growth rates (Table 1). The average growth rate for each colony indicated that growth was fastest for the medium sized colonies (97.8–130.3 cm), slower in the small size class (25.3–29.3 cm), and slowest for largest sizes (152.6–166.7 cm). Calculated interval growth, small to medium size and medium to large size, clearly indicated that growth was rapid (7.42 cm $yr^{-1}$) from an average length of 27.5 cm to 117.7 cm. Interval growth from 117.7 cm to 159.7 cm was slower at 1.68 cm $yr^{-1}$.

The growth pattern in length indicates slow initial growth followed by rapid growth at intermediate rod size progressing towards an asymptotic length. This is similar to growth models used in other studies of octocoral growth. Velimirov (1975) used a sigmoidal function to describe the growth of the Mediterranean gorgonian *Eunicella cavolinii*, which approached asymptotic size at approximately 15 years. Cordes et al. (2001) used a Gompertz function to model the growth of the deep-sea alcyonacean *Anthomastus ritteri*, which reached an asymptotic size between 30 and 35 years. Although neither study formed conclusions about the maximum age for these colonies, the ages estimated for asymptotic size for *A. ritteri* were similar to the maximum ages reported in this study. No growth model was applied to the data for *H. willemoesi* because few length intervals were sampled.

In contrast to the rate of growth in length, the rate of growth in diameter was nearly constant despite differences in rod size. An age prediction equation was developed based on maximum rod diameter (estimated age (yr) = 7.0*(maximum rod diameter, mm) – 0.2, $R^2 = 0.99$). This relationship needs to be further reinforced, however, because of the low number of samples (n = 12). Assuming the age estimates are valid, this relationship could be used in age composition monitoring of trawl bycatch.

Radiometric age determination using the disequilibria of $^{210}$Pb:$^{226}$Ra and the decay of $^{210}$Pb was unsuccessful in establishing a validation of age or growth rate estimates for *H. willemoesi*. In one sample, an age estimate of 5.7 yr (1.7–10.2 yr range) was determined for a colony (Table 2). This estimate, however, is suspect because subsequent samples had $^{210}$Pb and $^{210}$Pb:$^{226}$Ra activity ratios that exceeded 1.0 (Table 2). These high activity ratios indicate an accumulation of $^{210}$Pb from an exogenous source. Because all $^{210}$Pb must result from the decay of $^{226}$Ra for the technique to work (Burton et al. 1999), the presence of exogenous $^{210}$Pb in these samples precluded the use of measured $^{210}$Pb:$^{226}$Ra activity ratios as an indicator of age.

An alternate approach using the decay of $^{210}$Pb over the length of a coral colony was successfully applied to red tree coral (*Primnoa resedaeformis*; Andrews et al., 2002). The approach was successful for *P. resedaeformis* because the activities of $^{210}$Pb in a series of core samples (material from the inner part of the skeleton when viewed in cross section) from near the apical tip to near the base followed the expected decay pattern and allowed for growth rate estimation and validation of annual growth rings. This approach was applied to one sea pen colony (PC-B), but was unsuccessful because the activity of $^{210}$Pb from near the apical tip to near the basal tip did not follow a consistent reduction in activity (Table 2). This may indicate that $^{210}$Pb was taken up by the colony unequally throughout life, which may be a reflection of either environmental variability or a violation of the closed system assumption (Burton et al., 1999).

It is increasingly common to find that deep-sea organisms can attain ages that are on the order of decades to hundreds of years (Andrews et al., 1999a; Kastelle et al., 2000; Andrews et al., 2001; Cailliet et al., 2001). The patterns of growth in their skeletal tissues may therefore reflect long histories of environmental variability such as the seasonal flux of particulate matter. This flux has been linked to reproductive cycles in some deep-sea organisms (Valiela, 1984), but not deep-sea pennatulids (Rice et al., 1992; Tyler et al., 1995; Eckelbarger, 1998). Furthermore, the longevity of these organisms and the biogenic habitat they may provide to other species makes it essential that fishing-related impacts be studied in detail (Krieger, 1993; Auster & Langton, 1999; Freese et al., 1999), particularly as fishing activities reach greater depths and fish stocks decline. This perspective on fishing-related impacts has been mandated in management practices in 1996 with the Sustainable Fisheries Act, where understanding and protection of essential fish habitat has become paramount (Rosenburg et al., 2000).

Future efforts using other methods, such as fluorochemical marking and linear extension rates may provide validated estimates of age and growth rates for *H. willemoesi*. It remains to be seen if the growth rates and age estimates determined in this study are accurate; however, in light of their importance as biogenic habitat, it is prudent to take heed of the high estimated longevity of *H. willemoesi*, which may approach or exceed 50 years.

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# Habitat associations of demersal fishes and crabs in the Pribilof Islands region of the Bering Sea

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**Abstract**

Habitat associations of demersal fishes and crabs were determined from observations of videotapes recorded by a camera-equipped remotely operated vehicle (ROV) in the Bering Sea near the Pribilof Islands in September 1995 and 1997. We identified 42 taxa representing 16 families of fishes and 8 taxa from 3 families of crabs. Families Pleuronectidae (righteye flounders) and Cottidae (sculpins) were represented by the greatest number of taxa. *Lepidopsetta polyxystra* and *Chionoecetes opilio* were the most frequently observed fish and crab species. Other fish species in the families Pleuronectidae, Gadidae, Scorpaenidae, Agonidae, and Bathymasteridae were also encountered frequently. Six classifications based on substrate and cover were used to describe the habitat where each fish and crab was observed. Agonids and pleuronectids were typically observed on silt, mud, or sand substrate with no cover while other taxa, particularly cottids and bathymasterids, were encountered in more varieties of habitat including areas covered with rocks and boulders. Significant differences in species composition were found among habitats and stratified depth ranges. Similarity analyses showed that different taxa were responsible for these differences, but within each habitat type and depth range, two to five species contributed to 90% of the average similarity. Some ROV dives were paired with bottom trawls in the same general locations. Species compositions of the ROV observations were significantly correlated with that of the corresponding bottom trawl catch compositions. Overall, we believe that in situ observations provide useful information on fish habitats and behaviors not readily available from conventional trawling surveys.
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*Keywords:* Fishes; Crabs; Habitat; ROV; Bering Sea; Pribilof Islands

## 1. Introduction

There has been a recent surge of interest in ecosystem-based management of marine resources. Regulatory agencies are now mandated to identify,

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describe and protect essential fish habitats in order to sustain the long-term viability of these resources. Managers are often faced with the dilemma of defining and preserving critical fish-habitat associations without supporting scientific data, which renders any decisions made toward this objective tenuous at best. Anthropogenic effects on demersal habitats attributable to various sources but particularly mobile bottom fishing gear have been shown to have adverse and long-lived effects on biogenic structure and sediment quality (Auster et al., 1996; Collie et al., 1997, 2000; Jennings and Kaiser, 1998; Schwinghamer et al., 1998; Auster and Langton, 1999; Freese et al., 1999). The extent of habitat disturbance can be related to the size and type of gear used and the frequency and severity of impact, but the type and structure of the habitat itself is also an important consideration. There is increasing concern that fishing effort in many shelf systems has reached a level that it is negatively affecting the productivity and diversity of these ecosystems (Boehlert, 1996). Despite these concerns, we have little baseline data on the habitat requirements and utilization of most continental shelf regions of the world. This is particularly true in much of the North Pacific Ocean and Bering Sea.

Manned submersibles, underwater cameras carried by remotely operated vehicles (ROVs), and towed platforms have become widely used tools for conducting fishery research. These devices have provided the ability to observe fishes and invertebrates in their natural environment and have added a new dimension to fishery surveys beyond traditional net and hydroacoustic sampling (Gunderson, 1993). A majority of the studies utilizing these technologies has focused on characterizing the habitat utilized by a particular species or community (Carlson and Straty, 1981; Richards, 1986; Pearcy et al., 1989; Stein et al., 1992; Krieger, 1992, 1993; Felley and Veccionne, 1995; Auster et al., 1995; Norcross and Mueter, 1999; Johnson et al., 2003). In most of these studies, the behavior of individuals or groups of a particular species was observed and noted, and the characteristics of their habitat evaluated in terms of depth and substrate composition, size, or texture.

The National Marine Fisheries Service (NMFS) has been conducting fishery-independent bottom trawl surveys in the Eastern Bering Sea since the 1960s (Conners et al., 2002). These surveys have yielded important information on the distribution and ecology of Bering Sea fishes and invertebrates. However, little effort has been expended on examining smaller-scale association of the biota with the substrates they inhabit. With the exception of McConnaughey and Smith (2000) and Brodeur (2001), no studies have examined the relationship between bottom type and fish distribution in the Bering Sea. In this study, we describe small-scale habitat associations of demersal fishes and crabs in the southeastern Bering Sea using underwater video cameras mounted on a ROV. Seafloor habitat characteristics are described and substrate associations of several fish and commercially important crustacean species determined. In addition, we compare species composition observed using ROV-mounted video cameras to that determined from bottom trawl collections at the same general locations.

## 2. Materials and methods

### 2.1. Field operations

Cruises were conducted in the vicinity of the Pribilof Islands, a group of islands situated at the outer edge of the Bering Sea continental shelf some 370 km north of the Aleutian Islands Archipelago during 9–26 September 1995 and 8–18 September 1997 (Fig. 1). This research was conducted as part of an intensive multidisciplinary study of the frontal regions around the Pribilof Islands and a substantial amount of ancillary physical and biological data were collected at each deployment site (Brodeur et al., 2002). Most of the sites were chosen to represent the different hydrographic habitats (inner shelf, fronts, outer shelf) around the Pribilof Islands that were being studied. Other sites were added based on acoustic signals detecting high biomass near the bottom (e.g. Pribilof Canyon sites).

Underwater observations were made with video cameras mounted on a Deep Ocean Engineering Super Phantom II ROV deployed from the NOAA R/V *Miller Freeman*. ROV surveys were performed with a color CCD video camera (Hitachi Model HV-C20). The viewing area was illuminated by two 250 W tungsten–halogen lights mounted externally on the vehicle. We generally dimmed these lights to about 75% of full power to minimize the backscatter from biogenic particulate matter (organisms and marine snow) in the water column. In 1997, the ROV was also

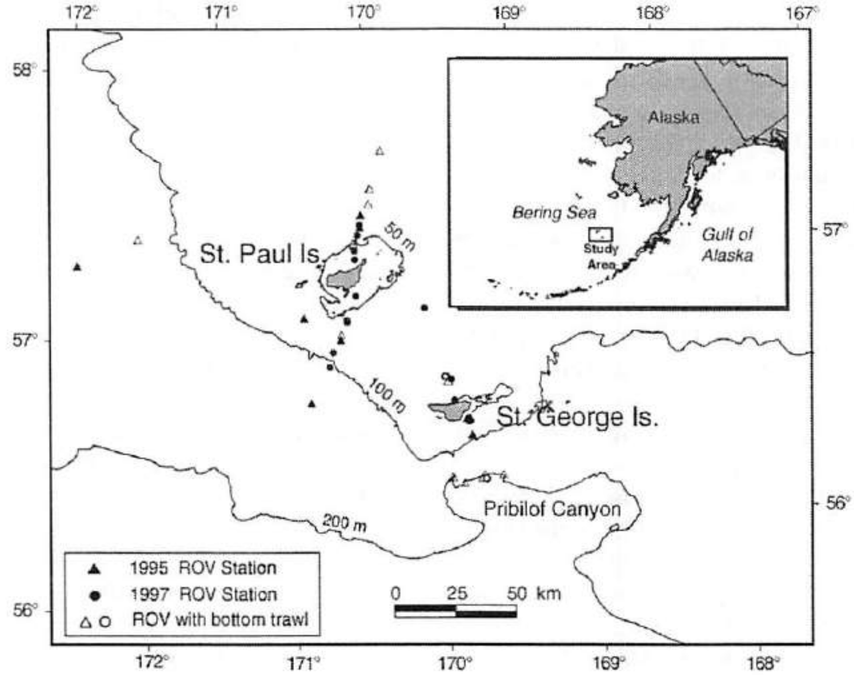


Fig. 1. Pribilof Island study area in the Southeast Bering Sea and station locations of 1995 and 1997 ROV deployments and bottom trawls. Multiple deployments were conducted at some stations.

fitted with a 35 mm still minicamera (Benthos Model 3782) and strobe. The ROV was deployed 25 times in 1995 and 16 times in 1997 (Fig. 1). Mean deployment time was 35.8 min (range 10–78 min).

During each deployment, the vessel drifted with the currents while maintaining a constant heading using its bow thruster. A 108-kg weight was attached 25 m from the end of the ROV umbilical cord to provide stability and reduce the angle of drift of the ROV away from the vessel. The ROV had the capability of moving in all directions within a 25 m radius sphere, but was generally propelled in a linear trajectory at a slow speed to keep it away from the weight. The bottom depth range over which observations were made was from 33 to 248 m. Video images were viewed in real-time using an on deck console that allowed the ROV operator to maneuver the vehicle and control the cameras and lights and provide the depth of the ROV which was annotated throughout the deployment. The video camera had zoom capability but was used only when necessary to identify organisms on transects. Continuous video recordings were made on two Hi-8 mm tape decks.

Following 13 ROV deployments in 1995 and 3 in 1997, a short tow was made along the ROV transect using a nylon northeastern bottom trawl with 1.5 m × 2.1 m steel doors fished without roller gear (Feldman and Rose, 1981). These sites were selected for having bottom types suitable for fishing with a bottom trawl (Fig. 1). The mesh size decreased from 13 cm in the forward part of the net to 8.9 cm in the codend which was also equipped with a 3.2-cm liner. The mean effective path width of the trawl was estimated to be 13.4 m with a mean vertical opening of 9.2 m. The entire catch was processed on deck and the number and weights of all taxa were recorded.

### 2.2. *Laboratory procedures*

Videotape footage for each ROV transect was reviewed by two observers in the laboratory. Methods for data collection from videotape footage were similar to those used by Felley and Veccionne (1995) with some modifications. Observations of videotape footage were divided into 1-min intervals. Within each interval, all fishes and crabs were identified to the lowest possible taxa. Depth was recorded and substrate was characterized into categories of silt, mud or sand. Silt was categorized as very fine and could be disturbed into visible plumes by the ROV thrust propellers and moving organisms. Mud was notably more compact, had a slick appearance with a visible sheen on the surface, and could not be disturbed by ROV movements. Sand was notably coarser with no visible sheen and usually appeared as wavy bedforms. Substrate cover was categorized as absent or comprised of broken shell hash, gravel-cobble, or rocks-boulders.

### 2.3. Analytical methods

Habitat types are modified after Norcross and Mueter (1999). Six habitat classifications were identified from the video footage based on observations of substrate and cover (Table 2A). These habitats were: silt (1); mud (2); sand with no cover (3); silt, mud, or sand with broken shell hash (4); silt, mud, or sand with gravel and/or cobble (5); silt, mud, or sand with rocks and/or boulders (6). Habitats were distributed over similar depth intervals with minimum depths from 33 to 55 m and maximum depths from 207 to 248 m. Observations were stratified into depth intervals of ≤100, 101–150, 151–200, and >200 m. Because of the large number of gelatinous zooplankton encountered in midwater during most of the deployments (Brodeur, 1998), we were not able to use any external calibration scale on the ROV to measure the field of view. We estimated this to be about 1 m (wide) × 1 m (tall) for the Hitachi video camera based upon measurements made aboard the research vessel with a typical drifting altitude of about 1 m off bottom.

To examine fish assemblages and relate these to habitat classification, we used presence/absence data within 1-min time intervals as our sampling unit (Felley and Veccionne, 1995). This was found to be necessary as observations were often affected by water clarity. Species with less than 1% occurrence in all intervals were eliminated. To test if differences in species composition occurred among habitat classifications and depth intervals, we performed two analysis of similarity (ANOSIMs), using a Bray–Curtis similarity matrix of samples (1-min intervals). ANOSIM is a nonparametric, multivariate permutation test, analogous to the parametric, univariate ANOVA that is particularly applicable when analyzing multiple species data that do not meet the assumptions required for multivariate ANOVA (MANOVA) (Clarke and Green, 1988). Beginning with a matrix of Bray–Curtis similarity indices, which measures how similar the species composition is for each pair of samples, the matrix is ranked, and then reordered so that all samples within each habitat group are grouped together. An $R$-statistic is then calculated, which is defined as a measure of how the between-group variance compares to the within-group variance, as does an ANOVA. The formula is,

$$R = \frac{\bar{r}_B - \bar{r}_W}{\frac{1}{2}M}$$

where $\bar{r}_B$ and $\bar{r}_W$ are the average rank similarities for each pair of intervals for between- and within-groups, respectively, $M = n(n-1)/2$, and $n$ is the sample size. Sample sizes for the different habitats do not need to be equal for an ANOSIM, as only the average rank similarities between- and within-groups are compared. We first tested for significant differences between habitats, and then between depth intervals. Whenever a significant difference was found, we followed this with pairwise ANOSIM tests between-groups using a Bonferroni correction. When significant differences were found by the ANOSIM, we then wanted to determine the discriminating species behind the differences. This was done with a SIMPER (similarity percentages) analysis that determines: (1) how much each species contributes to the dissimilarity between two groups and (2) how much each species contributes to the average similarity within a particular group (Clarke, 1993).

In order to compare the ROV data with the trawl data, a separate analysis was used. Instead of presence/absence data, densities per square kilometer were estimated for taxa collected with the bottom trawl using the area swept method as follows:

$$D = \frac{N \times 10^6 \mathrm{m}^2\,\mathrm{km}^{-2}}{L \times W}$$

where $D$ is the density of fish per square kilimeter, $N$ the number of fish observed, $L$ the length of transect (m), and $W$ is the width of transect (m). Sixteen stations where both ROV (standardized to numbers seen per 1 min) and bottom trawl data (standardized to catch per square kilimeter) occurred were selected and a separate Bray–Curtis similarity matrix of the fourth root transformed data was created for both the ROV and trawl data. A fourth root transformation was necessary so that rare taxa were not overwhelmed by the most common taxa. Although the ROV data could not be standardized by area sampled, we assumed that the speed of the ROV was constant, and therefore standardizing by the total number of intervals within each dive should yield comparable rank correlations between the two matrices. A nonparametric Mantel-type test using Spearman correlation coefficients between the two similarity matrices (RELATE procedure in PRIMER software) was used to determine if there was a relationship between the species compositions in the ROV and trawl data (Clarke and Gorley, 2001).

## 3. Results

### 3.1. Observations of fishes and crabs

Overall, 42 taxa representing 16 families of fishes were observed with the ROV with a total of 35 taxa identified in 1995 and 31 in 1997 (Table 1). The family Pleuronectidae was represented by the greatest number of taxa ($n = 8$) followed by Cottidae ($n = 7$). Identifications of fishes only to the family level (Cottidae or Pleuronectidae) were usually the consequence of rapid escape movement, the subject being visually obscured by suspended sediments or other particulate matter, or were based on smaller individuals (juveniles) for which we could not discern specific characteristics. Seven taxa of crabs representing three families were observed in 1995 and six in 1997. Table 1 also lists the number of observations in each habitat for each taxon of fishes and crabs identified and how each ranks if within the top 10 in the number of observations.

### 3.2. Habitat

Overall, a total of 1013 1-min intervals of videotape was examined for the presence of fishes and crabs and for determination of habitat type (Table 2). In 1995, the greatest number ($n = 260$) of ROV observation time intervals was conducted on silt substrate with no cover (habitat 1) followed by mud with no cover (habitat 2) ($n = 138$)(Table 2B). Habitats 3–6 were occupied for substantially lesser amounts of time (Table 2B). Fish or crabs were observed in 67% of the intervals overall. Habitats 2 and 6 had the highest percentage of intervals with fish or crabs observed (77%), followed closely by habitat 3 (76%), while habitat 4 had the lowest (42%).

In 1997, habitat 1 was again the most frequently encountered habitat type ($n = 157$) but was instead followed by habitat 4 ($n = 121$). Habitats 2 ($n = 54$), 5 ($n = 48$), and 6 ($n = 41$) were occupied for similar but substantially lesser amounts of time, and habitat 3 was only encountered once. Fishes or crabs were observed in 61% of the intervals overall and excluding habitat 3, habitat 6 had the highest percentage of intervals with fish or crabs observed (73%) and habitat 2 had the lowest (50%).

### 3.3. Habitat—species associations

*Lepidopsetta polyxystra* (Fig. 2A) was the most frequently observed fish ranking first overall in 1995 and second in 1997 (Table 1) and was most commonly encountered on habitat 2 at depths <100 m. *Leptagonus frenatus* (Fig. 2B) ranked second in number of observations overall and was found most often (76.9%) on habitat 1. *Bathymaster signatus* (Fig. 2C and D) ranked third and were usually observed in habitat 6 (68.6%) and sometimes in areas covered with gravel and cobble (habitat 5). *B. signatus* were typically encountered at depths <100 m but some observations were made at depths >200 m. *Sebastes alutus* (Fig. 2E) were most frequently observed (73.8%) on habitat 1 which was often covered with "forests" of the sea whip *Halipterus willemoesi* at depths near 200 m. More detailed descriptions of the habitat of *S. alutus* based on these and other observations can be found in Brodeur (2001). *Theragra chalcogramma* (juveniles and adults) ranked seventh in overall number of observations and were most frequently encountered over habitat 2 (34%) or habitat 4 (34%). *Limanda aspera* (Fig. 2F) were seen mostly on habitat 1 (71.5%) at depths <100 m. *Chionoecetes opilio* (Fig. 2G), the only crab species ranking in the top 10 for number of overall observations, was also encountered most frequently on habitat 1 (81.1%) at depths <100 m and sometimes at depths 101–150 m. Another crab species, *Paralithodes camtschaticus*, ranked fifth in 1997 but did not rank within the top 10 for both years combined. *Gadus macrocephalus* (Fig. 2H) ranked 10th in number of observations overall and was usually observed on habitat 1 (61.1%) at depths both <100 and >200 m. Observations of less frequently encountered taxa in specified habitats are summarized in Table 1.

Some individual taxa displayed associations with or were dominant in single or multiple habitats (Fig. 3).

Table 1
List of fish and crab taxa observed from video tapes recorded during 1995 and 1997 ROV deployments with number of observations in each habitat type and total number of observations

| Family | Scientific name | Common name | Presence/absence | | Numbers of observations Habitat type | | | | | | Total no. of observations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1995 | 1997 | 1 | 2 | 3 | 4 | 5 | 6 | |
| Fishes | | | | | | | | | | | |
| Rajidae | Rajidae | Unidentified skates | × | × | 3 | 1 | | | | | 4 |
| | *Bathyraja aleutica* | Aleutian skate | × | | 1 | | | | | | 1 |
| | *Bathyraja interrupta* | Bering skate | | × | 1 | | | | | | 1 |
| | *Bathyraja taranetzi* | Mud skate | | × | 3 | | | | | | 3 |
| | *Raja binoculata* | Big skate | × | | 1 | | | | 1 | | 2 |
| Gadidae | | Unidentified cods | × | × | 5 | 1 | | | 5 | 1 | 12 |
| | *Gadus macrocephalus* | Pacific cod | × | × | 22 | 4 | | | 7 | 3 | 36 |
| | *Theragra chalcogramma* | Walleye pollock (juveniles and adults) | × | × | 13 | 20 | | 20 | | 6 | 59 |
| Scorpaenidae | *Sebastes* spp. | Unidentified rockfishes | × | × | | 1 | | | 2 | 3 | 6 |
| | *S. alutus* | Pacific ocean perch | × | × | 48 | | 1 | | 2 | 14 | 65 |
| | *S. ciliatus* | Dusky rockfish | | × | | | | | | 1 | 1 |
| Hexagrammidae | *Hexagrammos* spp. | Unidentified greenlings | | × | | | | 3 | | | 3 |
| Cottidae | | Unidentified sculpins | × | × | 15 | 17 | 11 | 11 | 5 | 3 | 62 |
| | *Hemilepidotus jordani* | Yellow Irish Lord | × | × | 3 | 6 | | 1 | 4 | 8 | 22 |
| | *Malacocottus* spp. | Unidentified *Malacocottus* | × | | | | | | 1 | | 1 |
| | *Malacocottus zonurus* | Darkfin sculpin | | × | 1 | | | | | 2 | 3 |
| | *Myoxocephalus* spp. | Unidentified *Myoxocephalus* | × | | | 1 | | | | | 1 |
| | *Triglops* spp. | Unidentified *Triglops* | × | × | 4 | | | 3 | 4 | 2 | 13 |
| | *Triglops scepticus* | Spectacled sculpin | × | × | 3 | | | | | | 3 |
| Psychrolutidae | *Dasycottus setiger* | Spinyhead sculpin | | × | 1 | | | | | 1 | 2 |
| | *Psychrolutes paradoxus* | Tadpole sculpin | × | | | 4 | | | | | 4 |
| | *Psychrolutes sigalutes* | Soft sculpin | × | | | 2 | | | | | 2 |
| Hemitripteridae | *Hemitripterus bolini* | Bigmouth sculpin | × | × | 3 | 1 | | | | | 4 |
| Agonidae | | Unidentified poachers | × | × | 19 | 6 | | 2 | 2 | 2 | 31 |
| | *Leptagonus frenatus* | Sawback poacher | × | × | 70 | 5 | | 10 | 3 | 3 | 91 |
| | *Podothecus acipenserinus* | Sturgeon poacher | × | × | 4 | | | 2 | | | 6 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cyclopteridae | *Aptocyclus ventricosus* | Smooth lumpsucker | × | | 1 | | | | | | 1 |
| Liparidae | *Careproctus* spp. | Unidentified snailfishes | × | | 1 | | | | | | 1 |
| Bathymasteridae | *Bathymaster signatus* | Searcher | × | × | | 1 | | | 21 | 48 | 70 |
| Zoarcidae | | Unidentified eelpouts | × | × | 13 | 3 | | 2 | | | 18 |
| Stichaeidae | | Unidentified pricklebacks | × | × | 11 | | | | | | 11 |
| | *Lumpenus* spp. | Unidentified *Lumpenus* | × | × | 13 | 1 | | | | | 14 |
| Trichodontidae | *Trichodon trichodon* | Pacific sandfish | × | | 1 | | | | | | 1 |
| Zaproridae | *Zaprora Silenus* | Prowfish | × | | | 1 | | | 1 | | 2 |
| Pleuronectidae | | Unidentified flatfish | × | × | 21 | 24 | | 12 | 1 | 2 | 60 |
| | *Atheresthes* spp. | Arrowtooth or Kamchatka flounder | × | × | 8 | 5 | | 2 | 12 | | 27 |
| | *Glyptocephalus zachirus* | Rex sole | | × | 3 | | | | | | 3 |
| | *Hippoglossus stenolepis* | Pacific halibut | × | × | 8 | 3 | | | | 2 | 13 |
| | *Hippoglossoides elassodon* | Flathead sole | × | | 1 | | | | | | 1 |
| | *Lepidopsetta polyxystra* | Northern rock sole | 1 | × | 32 | 106 | 28 | 67 | 7 | 6 | 246 |
| | *Limanda aspera* | Yellowfin sole | × | × | 35 | 6 | | 8 | | | 49 |
| | *Pleuronectes quadrituberculatus* | Alaska plaice | × | × | 1 | | | 1 | | | 2 |
| Total number of taxa | | 42 | 35 | 31 | | | | | | | |
| Crabs | | | | | | | | | | | |
| Majidae | *Brachyura* | Unidentified crab | × | × | 10 | 4 | | 1 | | | 15 |
| | *Chionoecetes* sp. | Unidentified Tanner crab | × | | 4 | | | | | | 4 |
| | *C. bairdi* | Tanner crab | × | × | 7 | 5 | | 4 | | | 16 |
| | *C. opilio* | Snow crab | 8 | × | 30 | 3 | | 4 | | | 37 |
| Lithodidae | *Paralithodes* spp. | Unidentified king crab | | × | | 2 | | | | | 2 |
| | *Paralithodes camtschaticus* | Red king crab | × | 5 | 1 | 3 | | 18 | 2 | 1 | 25 |
| | *P. platypus* | Blue king crab | × | | | 1 | | | | | 1 |
| Atelecyclidae | *Erimacrus isenbeckii* | Korean horsehair crab | × | × | 1 | 9 | | 5 | 2 | 3 | 20 |
| Total number of taxa | | 8 | 7 | 6 | | | | | | | |

Table 2
(A) List of habitat types, characteristics, depth ranges, and percentage of observations in selected depth intervals and (B) number of 1 min video observation intervals in each habitat with number and percentage of intervals where fish and/or crabs were observed for 1995, 1997, and combined ROV deployments

| Habitat | Characteristics | Depth range (m) | Depth interval (m) (% of observations) | | | |
|---|---|---|---|---|---|---|
| | | | <100 m | 101–150 m | 151–200 m | >200 m |
| (A) | | | | | | |
| 1 | Silt, no cover | 55–248 | 32 | 16 | 8 | 44 |
| 2 | Mud, no cover | 50–207 | 96 | | | 4 |
| 3 | Sand, no cover | 50–247 | 97 | | | 3 |
| 4 | Silt, mud, or sand covered with broken shell hash | 33–208 | 95 | | | 5 |
| 5 | Silt, mud, or sand covered with gravel-cobble | 36–208 | 58 | | 35 | 7 |
| 6 | Silt, mud, or sand covered with rocks-boulders | 36–222 | 74 | | 6 | 20 |

| Habitat | 1995 | | | 1997 | | | 1995, 1997 combined | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total 1 min intervals | # w fish/crabs | % w fish/crabs | Total 1 min intervals | # w fish/crabs | % w fish/crabs | Total 1 min intervals | # w fish/crabs | % w fish/crabs |
| (B) | | | | | | | | | |
| 1 | 260 | 169 | 65 | 157 | 99 | 63 | 417 | 268 | 64 |
| 2 | 138 | 106 | 77 | 54 | 27 | 50 | 192 | 133 | 69 |
| 3 | 37 | 28 | 76 | 1 | 1 | 100 | 38 | 29 | 76 |
| 4 | 50 | 33 | 66 | 121 | 71 | 59 | 171 | 104 | 61 |
| 5 | 67 | 28 | 42 | 48 | 29 | 60 | 115 | 57 | 50 |
| 6 | 39 | 30 | 77 | 41 | 30 | 73 | 80 | 60 | 75 |
| Total | 591 | 394 | 67 | 422 | 257 | 61 | 1013 | 651 | 64 |

For example, although dominant in habitats 2–4, *L. polyxystra* was present in all habitats, and had a wide range of substrate utilization. Cottidae (unidentified sculpins) was the only other taxon identified in all habitats. *L. frenatus* was dominant in habitat 1 but was also present in all other habitats except 3. *B. signatus* was the dominant taxon in habitats covered with cobble-gravel (5) and rocks-boulders (6). One noteworthy observation was the relatively high number of encounters of the pleuronectid flatfishes *Atheresthes* spp. and *L. polyxystra* on cobble-gravel (habitat 5). *L. aspera* were most frequently encountered on silt substrate (habitat 1) and at depths always less than 100 m. Crabs were most frequently observed on habitats 1 and 4 and were completely absent on habitat 3.

There were significant differences in species composition among habitats ($P < 0.01$, ANOSIM). Pairwise tests showed that (a) species assemblages on habitats 1–4 were all different from habitats 5 and 6 and (b) species composition of habitat 1 was different from habitats 2 and 4. The subsequent SIMPER analysis, corresponding to result (a) above, showed that in order of highest to lowest importance, *L. polyxystra*, *B. signatus*, *L. frenatus*, Cottidae, *Hemilepidotus jordani*, *Atheresthes* spp., *S. alutus*, Pleuronectidae, *T. chalcogramma*, *G. macrocephalus*, and Agonidae contributed to 75% of the average dissimilarity between combined habitats 1–4 and combined habitats 5 and 6, therefore making these the primary discriminating species for this difference. The second SIMPER analysis, corresponding to result (b) above, showed that, in order of highest to lowest importance, *L. polyxystra*, *L. frenatus*, Pleuronectidae, *T. chalcogramma*, Cottidae, *C. opilio*, *L. aspera*, *S. alutus*, Agonidae, and *G. macrocephalus* contributed to 75% of the average dissimilarity between habitat 1 and combined habitats 2 and 4, therefore making these species the primary taxa responsible for the observed difference.

Species composition was also significantly different among all four depth intervals ($P < 0.01$, ANOSIM). Subsequent SIMPER analysis showed that different sets of taxa were responsible for these differences, but within each depth interval, there were 2–5 taxa unique to that interval contributing to 90% of the aver-

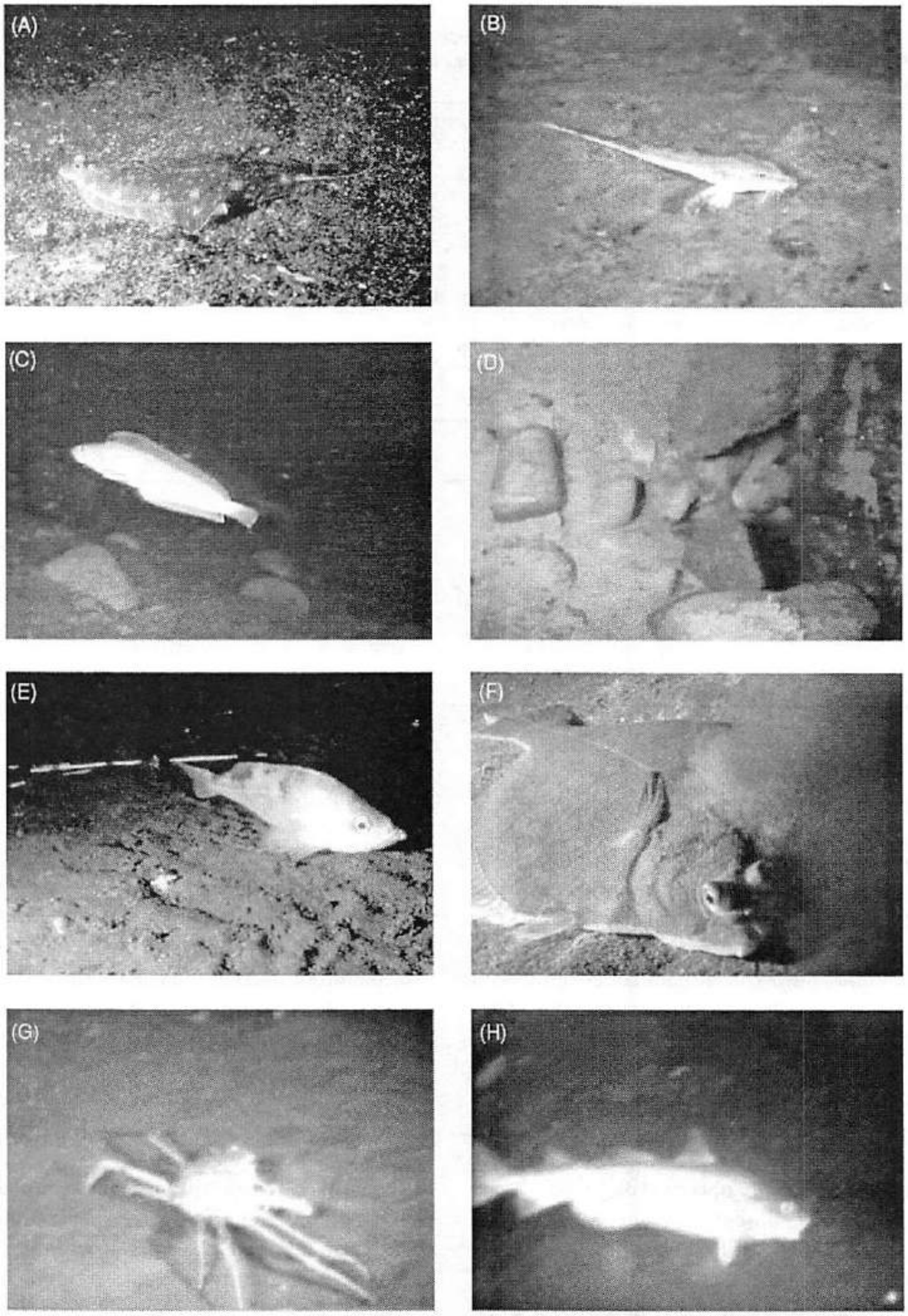


Fig. 2. Photographs and digitized video taped images of some of the most frequently observed fish and crab species. (A) *Lepidopsetta polyxystra* on sand with broken shell hash (habitat 4) depth 57 m. (B) *Leptagonus frenatus* on silt with no cover (habitat 1) depth 208 m. (C) *Bathymaster signatus* over silt with rocks and boulders (habitat 6) depth 175 m. (D) *Bathymaster signatus* hiding in hole in silt with rocks and boulders (habitat 6) depth 207 m. (E) *Sebastes alutus* on silt with no cover (habitat 1) depth 248 m; note downed sea whip *Halipterus willemoesi* in background. (F) *Limanda aspera* on silt with no cover (habitat 1) depth 62 m. (G) *Chionoecetes opilio* on silt with no cover (habitat 1) depth 114 m. (H) *Gadus macrocephalus* feeding in silt with no cover (habitat 1) depth 204 m.

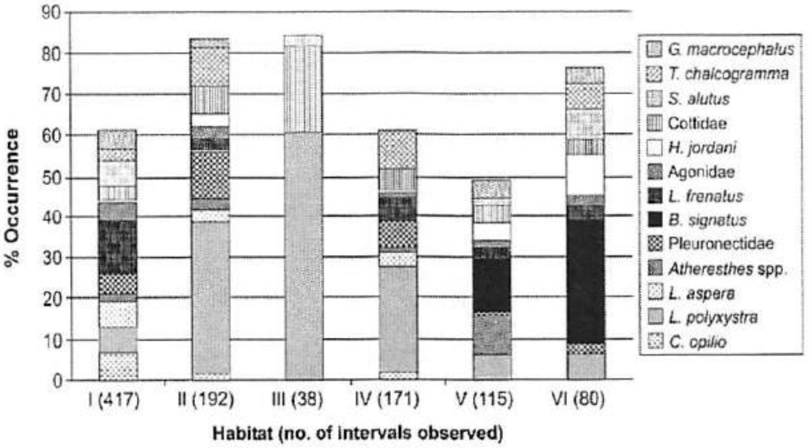


Fig. 3. Percent occurrence in each habitat type for some of the most frequently observed taxa.

age similarity. Listed by depth interval, the unique species were (<100 m) *L. polyxystra*, Pleuronectidae, *T. chalcogramma*, Cottidae, and *B. signatus*; (101–150 m) *C. opilio*, *Lumpenus* spp., Stichaeidae; (151–200 m) *S. alutus* and *Atheresthes* spp.; (>200 m) *L. frenatus*, *G. macrocephalus*, and Agonidae.

### 3.4. Comparisons of ROV observations with bottom trawl catches

Overall, 46 taxa of fishes and 8 taxa of crabs were collected in bottom trawls paired with ROV deployments in 1995 and 1997. Although we observed nine fish taxa on the tapes recorded from the ROV deployments that were not collected in bottom trawls, there were 21 taxa of fish and crabs identified in bottom trawls that were not seen in the video footage (Table 3). Among these was *Somniosus pacificus*, the only shark encountered in the study. Species composition and ranked abundances of taxa of the ROV observation data from dives paired with bottom trawls was significantly correlated with those of the bottom trawl data ($P < 0.01$, Mantel).

## 4. Discussion

### 4.1. Habitat observation

Video observations provided us with a wealth of information on microhabitat usage and behavior of fishes and crabs in the Eastern Bering Sea that would not be discernable from trawling. For example, *B. signatus* individuals were seen darting into crevices or burrows often in close proximity to rockpiles upon the approach of the ROV, and thus would likely not be caught by bottom trawls in these habitats. It is unknown whether they excavate these burrows themselves, similar to tilefishes (*Lopholatilus chamaeleonticeps*) in the Atlantic (Able et al., 1982, Grimes et al., 1986), or whether they occupy previously excavated holes. Most rockfishes (*Sebastes* spp.) were associated with rocky outcrops or with some sort of biogenic structure such as the sea whip 'forest' in Pribilof Canyon (Brodeur, 2001), anenomes or sponges. Although most of the habitats we surveyed lacked substantial vertical relief, many other fish and invertebrate taxa showed apparently thigmotactic responses to natural or biogenic features such as excavated pits, anemones and sponges, basket stars, and sand waves, as has been observed in other continental shelf habitats (Auster et al., 1991). We also observed large depressions in sand and mud that were occupied and apparently excavated by skates. *Lepidopsetta polyxtstra* were frequently seen swimming along troughs between sand waves. This behavior likely reduces their vulnerability to capture in bottom trawls. Several flatfish species including *Atheresthes* spp. and *L. polyxystra* were seen in small pockets of silt, sand, or mud surrounded by cobble-gravel (habitat 5) or rocks and boulders (habitat 6) (Fig. 3). In these untrawlable habitats, the ROV could be used as a means to enhance or "fine tune" trawl surveys.

Table 3
List of fish and crab taxa observed from video tapes recorded during 1995 and 1997 ROV deployments that were not collected in bottom trawls and fish and crab taxa collected in bottom trawls that were not observed on video tapes in paired ROV and bottom trawl deployments

| ROV | Bottom trawl | |
|---|---|---|
| *Bathyraja aleutica* | *Somniosus pacificus* | Pacific sleeper shark |
| *Bathyraja taranetzi* | *Bathyraja parmifera* | Alaska skate |
| *Hexagrammos* spp. | *Clupea pallasi* | Pacific herring |
| *Psychrolutes sigalutes* | *Mallotus villosus* | Capelin |
| *P. paradoxus* | *Oncorhynchus keta* | Chum salmon |
| *Aptocyclus ventricosus* | *Sebastes aleutianus* | Rougheye rockfish |
| Stichaeidae | *S. zacentrus* | Sharpchin rockfish |
| *Lumpenus* spp. | *Anoplopoma fimbria* | Sablefish |
| *Trichodon trichodon* | *Artediellus pacificus* | Hookhorn sculpin |
| | *Gymnocanthus galeatus* | Armorhead sculpin |
| | *Icelus spiniger* | Thorny sculpin |
| | *Myoxocephalus jaok* | Plain sculpin |
| | *M. polyacanthocephalus* | Great sculpin |
| | *Triglops forficata* | Scissortail sculpin |
| | *Triglops macellus* | Roughspine sculpin |
| | *Triglops pingelli* | Ribbed sculpin |
| | *Lycodes palearis* | Wattled eelpout |
| | *Atheresthes evermanni* | Kamchatka flounder |
| | *Reinhardtius hippoglossoides* | Greenland halibut |
| | *Hyas* spp. | Lyre crabs |
| | *Telmessus cheiragonus* | Helmet crab |

Common names of ROV taxa are given in Table 1.

This study provides the first descriptive community-wide account of demersal fishes and crabs and their habitat associations in the Bering Sea based on in situ observations. Video observation is a useful tool in many habitats, particularly where trawling is difficult, and it readily provides valuable information on habitat associations and behavior. However, this sampling gear does have its own drawbacks and difficulties in both collecting and analyzing data that are discussed here.

### 4.2. Species identifications

Identification of fish species images recorded on videotape is somewhat problematic because of viewing angles, flight responses, and cryptic behavior. In particular for this region of the Bering Sea near the Pribilof Islands, several congeners are similar in appearance and often require detailed examination to differentiate. Consequently, a large number of identifications were made to family and genus in the families Cottidae and Pleuronectidae in all habitats and depths. Among the Cottidae, *Myoxocephalus jaok* and *M. polyacanthocephalus* were identified in bottom trawls, but such distinctions could not be made from the video recordings, though it is highly likely both species were encountered. The same can be said for *Triglops forficata*, *T. macellus*, and *T. pingeli*.

In the family Pleuronectidae, we could not distinguish *Atheresthes evermanni* from *A. stomias* in video footage although both species were caught in bottom trawls. Although *L. polyxystra* is the only species of rock sole known from the Pribilof Island region, it would be extremely difficult to distinguish this species from *L. bilineata* in the Gulf of Alaska where the two species occur sympatrically (Orr and Matarese, 2000). The best characters for distinguishing *L. bilineata* from *L. polyxystra* require close examination of the lateral line, blind side of the fish, and gill rakers which would be impossible with a video camera. Similar detailed examinations are necessary to distinguish species within other pleuronectid genera such as *Hippoglossoides* and *Limanda*, and may limit the utility of the ROV as a survey tool for flatfishes in the Bering Sea. Perhaps with higher resolution cameras and increased zoom capabilities, these identifications can be accomplished.

### 4.3. Habitat distribution and human impacts

Although we did not collect and analyze sediment samples as part of this study, large areas of the eastern Bering Sea continental shelf, particularly around the Pribilof Islands, have been surveyed for surficial sediment particle sizes, degree of sorting, and composition (Smith and McConnaughey, 1999) and associated flatfish abundances (McConnaughey and Smith, 2000). Some generalized comparisons of our habitat observations and their sediment maps can be made. Our apparently finest unconsolidated substrate that we called silt (habitat 1) would be most similar to their mud while mud (habitat 2) and sand (habitat 3) approximate their sandy mud and muddy sand. Our remaining habitat types use these three categories for underlying substrate with cover of varying composition (broken shell hash—habitat 4) and size classes (gravel-cobble—habitat 5; rocks-boulders—habitat 6). We conducted several dives in Pribilof Canyon, south of St. George Island (Fig. 1), and observed silt (habitat 1) throughout the center with large fields of gravel-cobble (habitat 5) and rocks-boulders (habitat 6) near the edges of the canyon. Moving north from Pribilof Canyon to the south end of St. George Island, we encountered habitats 2 and 3 that were covered with gravel-cobble (habitat 5) and rocks-boulders (habitat 6) in dives closest to the island. All dives in the area between St. George and St. Paul Islands were either on habitats 1 or 2 suggesting that this large area has rather uniform and consistent substrate composition. This observation is consistent with those of Smith and McConnaughey (1999) who reported numerous collections of sandy mud and muddy sand in this area. Immediately north of St. Paul Island we encountered predominantly mud (habitat 2) and mud covered with broken shell hash (habitat 4). The northern and western most dives were on silt substrate (habitat 1).

On several occasions, we encountered evidence of human influence on the sea floor. This was usually in the form of "ghost" crab pots. Some of these had obviously been present for long periods of time and had been colonized by large anemones, sea stars, and barnacles. *Sebastes* spp. were usually seen in the vicinity of these objects. On one occasion, a clothes washer/dryer combination was collected in a bottom trawl and the drums found to be full of juvenile crabs (*C. opilio*). However, we observed few examples of bottom trawl tracks in our study region despite substantial trawling that has occurred here. This may be due in part, to the substantial near bottom tidal currents (>2 kts) that likely "erase" trawl tracks or naturally compacted sediments which resist scouring.

### 4.4. ROV-bottom trawl comparisons

We compared two methods of assessing fish distribution and habitats in our study. Trawling has some obvious advantages in that the specimens are captured so that positive identification, size, sex, age, and other biological variables can be determined. In addition, the effort tends to be more standardized and does not suffer from variability with respect to visibility and viewing angle as an ROV does. For purposes of habitat definition, trawling provides few details about the small-scale distribution patterns since it integrates the sample over the entire length of the trawl and provides almost no information on bottom type or topographic relief. Trawling also does not work well in rocky or high-relief environments. Even in flatter terrain, some flatfish are known to escape under the trawl footrope or through the meshes (Adams et al., 1995; Munro and Somerton, 2002). Finally, trawling provides little information about small-scale animal/substrate interactions that were readily apparent in our ROV observations (e.g. fishes that occupy burrows in the sediments).

Although the bottom trawl collected four more fish taxa than were identified on the videotapes, there are a few problems with this comparison that should be addressed. Firstly, three of these taxa collected in the bottom trawl (*Clupea pallasi*, *Mallotus villosus*, *Oncorhynchus keta*) are considered pelagic species and were most likely caught during deployment or retrieval of the bottom trawl and were unlikely to have been observed with an epibenthic video camera. With these three taxa removed from the trawl species list, the number of fish taxa nearly equals that observed on videotape (43 taxa versus 42 taxa). With these taxa excluded, a significant correlation in species composition and ranked abundance of taxa occurred between ROV observations and bottom trawls.

Although we were able to calculate densities of fish and crab taxa from bottom trawls, estimating densities from the video observations was more difficult. This is due to variations in altitude, pitch and roll of the ROV that affect the area of each view. Had we been able to measure the width of the video camera's field of view and distance traveled by the ROV accurately, a more meaningful comparison of the ROV and bottom trawl as sampling devices could have been made (e.g. Adams et al., 1995). Also, we have little information on how the presence of the ROV (e.g. lights, vibrations, and thruster noise) may have impacted the behavior of the fish in the path of the deployment. Previous studies have shown attraction, repulsion, and no apparent response to ROVs and submersibles (Carlson and Straty, 1981; Pearcy et al., 1989; Krieger, 1993; Adams et al., 1995; Norcross and Mueter, 1999). We were not able to directly address the effects of lights on the behavior of fishes although on several occasions, we turned off the lights for short periods of time and then turned them on and found no apparent 'startle' behavior for fish, although this reaction could still be occurring outside our visual range.

Another complicating factor encountered during the video survey was reduced and variable visibility levels. Reduced visibility was most frequently caused by large amounts of suspended sediment and other particulate matter mostly on unconsolidated substrate (e.g. silt). On several occasions, visibility was dramatically reduced by large swarms of euphausiids and other zooplankton in close proximity to the bottom during daylight hours. Moreover, in 1997, there was a pervasive bloom of the coccolithophore, *Emiliania huxleyi*, in the Eastern Bering Sea (Napp and Hunt, 2001) and at several locations, this bloom of highly-reflective particles extended to the bottom severely restricting visibility (Stockwell et al., 2001).

Our use of ROV video analysis of demersal fishes and crabs provided new and important information on the types of habitats utilized by these important taxa in the Bering Sea. Although the cost and logistic difficulties in using ROVs may prohibit their use for large-scale surveys, we feel that their potential advantages may someday make their widespread use more desirable in fishery surveys. Towed vehicles supporting underwater video cameras show promise as a lower cost alternative for habitat surveys (Barker et al., 1999). Future ROV video and manned submersible studies in the Bering Sea should be equipped with the necessary instrumentation to collect quantitative data (e.g. width of camera field of view and distance traveled) for estimating fish and crab abundance and to quantify the environment in which they occur.

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