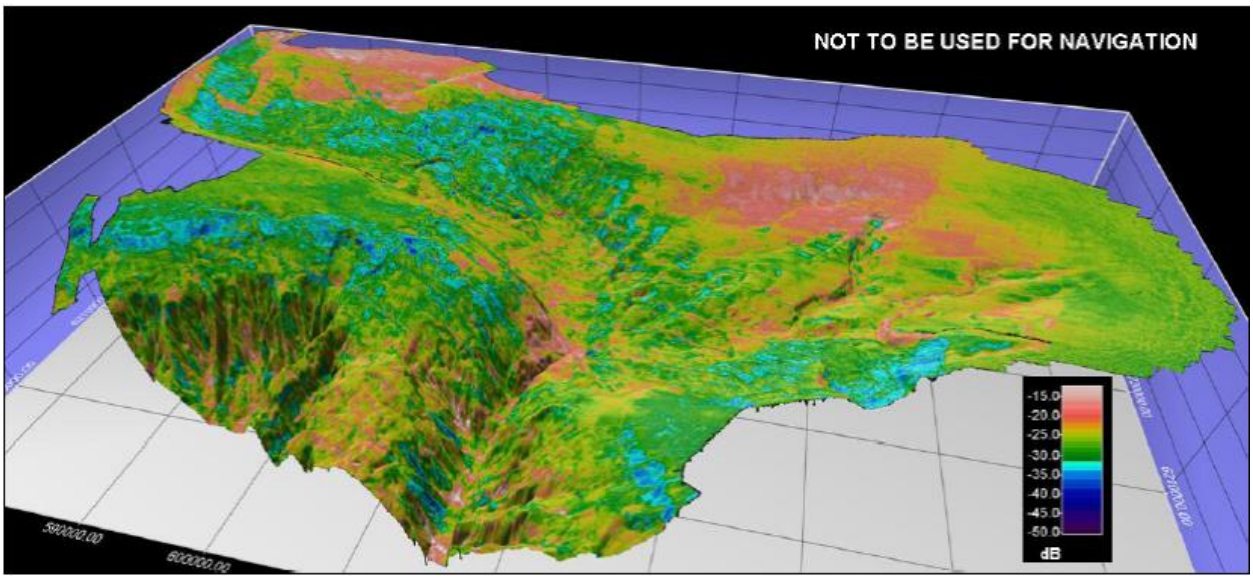
Agenda Item C9
APRIL 2014

Bering Sea Canyons:

Summary of public workshop and management measures for consideration by the North Pacific Fishery Management Council

April 2014[1]



Multibeam backscatter image of Pribilof Canyon. Reds indicate more backscatter and harder bottom; blues indicate less backscatter and softer bottom. Image courtesy of Marine Conservation Alliance.

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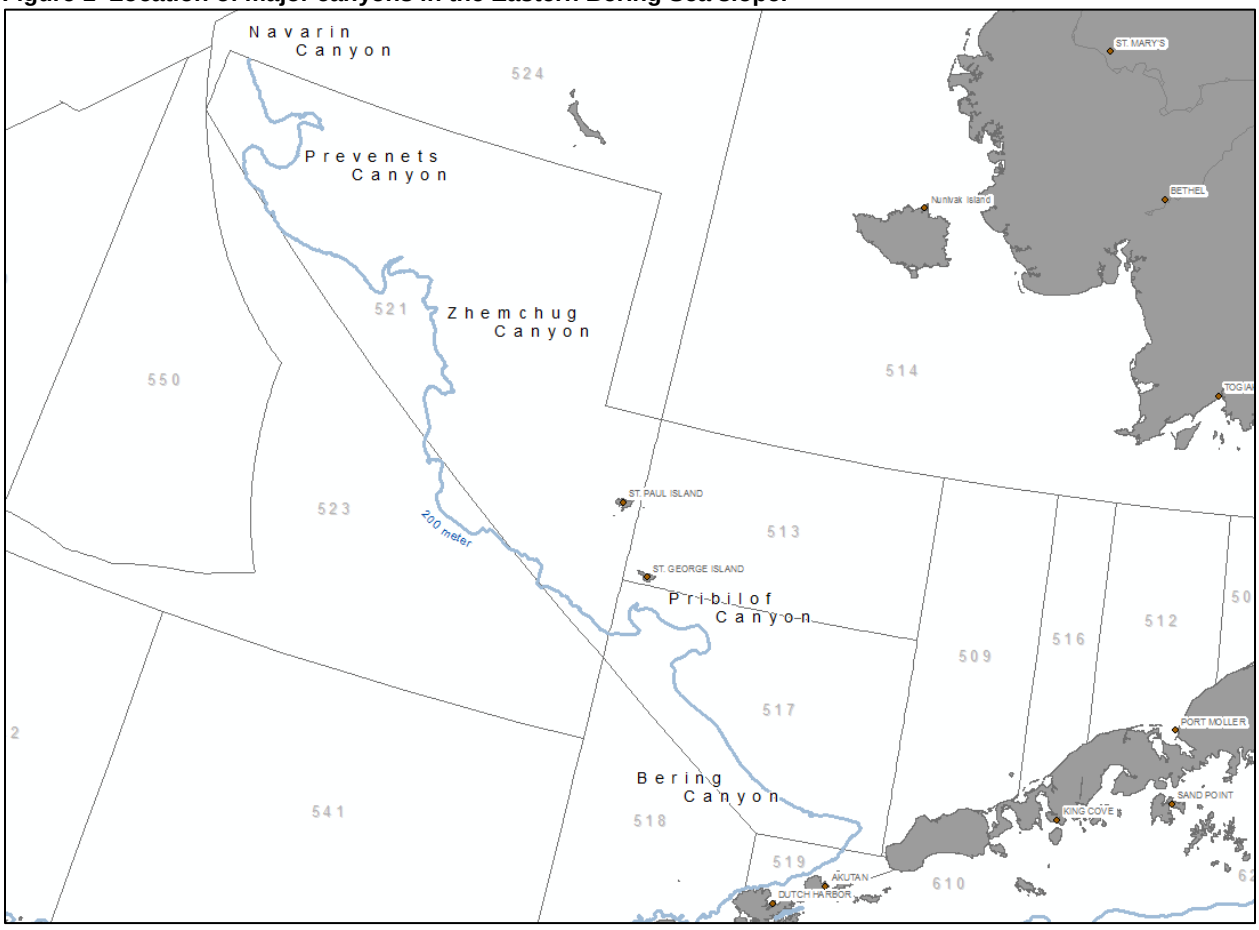
1 Introduction

In June 2013, the Council passed two motions (Appendix A) addressing habitat concerns in the Bering Sea slope and Pribilof and Zhemchug canyons (Figure 1). The first motion was a three part motion to identify and validate where necessary areas of coral concentrations for possible management measures for the conservation and management of deep sea corals in Pribilof and Zhemchug canyons. Part 2 of that motion tasked staff to initiate a discussion paper that addresses management measures to be considered for conserving areas of coral concentration and associated fish productivity. Staff were instructed to meet with the Alaska Fisheries Science Center (AFSC) and stakeholders to discuss possibilities for collaboration in order to survey areas of coral abundance as well as to identify and develop tools for coral impact reduction.

This discussion paper summarizes information about what is currently known about the abundance and diversity of corals on the Bering Sea slope and Pribilof and Zhemchug canyons, and reports the results of a public workshop that was held in February, 2014 to solicit information about planned and proposed collaborative research to survey areas of coral abundance and to identify potential tools for reducing impacts of fishing gear on deep-water corals.

Figure 1 Location of major canyons in the Eastern Bering Sea slope.



2 Background

The continental slope and canyons of the Bering Sea have long been considered an important, productive area of the Bering Sea (Springer et al. 1996), and has been come to be known as the "green belt" of the Bering Sea. Although large areas of the Bering Sea and Aleutian Islands have been protected from the effects of FMP fisheries, none of those areas encompass the Bering Sea slope or canyon areas. This has prompted some conservation organizations to advocate for protections along the slope, particularly in Pribilof and Zhemchug canyons.

The Council has previously considered protections for the Bering Sea canyons. In December, 2006 the Council reviewed a discussion paper prepared by the AFSC that reviewed scientific information related to Bering Sea canyons and skate nursery areas in the context of Essential Fish Habitat (EFH) or Habitat Areas of Particular Concern (HAPC) in the Bering Sea (McConnaughey et al. 2006). That paper suggested that EFH/HAPC for skates could be established along the Bering Sea slope and canyons; that action was taken by the Council in February 2013 when they established HAPC for four skate nursery sites (NPFMC 2013). No fishery closures are associated with these sites. The Council, however, explicitly requested that NMFS monitor these sites to assess changes in egg density, and other potential effects of fishing, and that industry support data collection efforts at those sites.

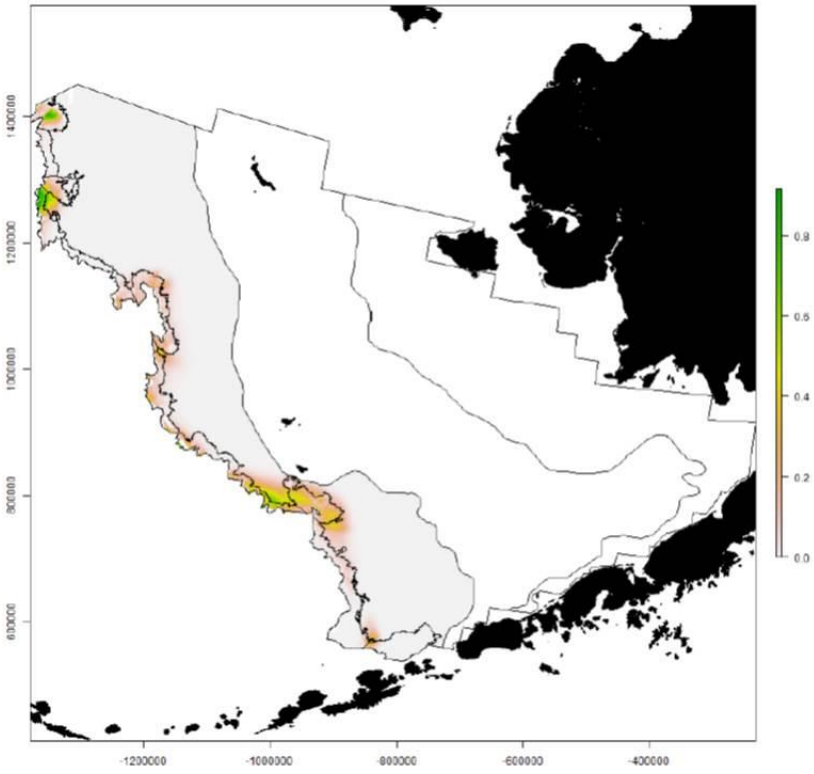
McConnaughey et al. (2006) also considered whether the information known at the time suggested that protections were necessary for Bering Sea canyons. The authors concluded that although there are extensive geological studies of submarine canyons in the EBS, very little biological information was available to assess the value of canyon habitat for specific species, and the available data did not suggest that EFH or HAPC designation was appropriate. The authors further concluded that a thorough assessment of EBS canyons habitats would require a dedicated study involving a systematic study of habitats and coordinated biological sampling before management decisions could be made based on the expected vulnerability of those habitats to anthropogenic disturbance.

Miller et al. (2012), partly in response to the recommendation for dedicated surveys, conducted video transects in Zhemchug and Pribilof canyons to evaluate the density of structure-forming corals and sponges and to evaluate the use of corals, sponges, and boulders as habitat by demersal fishes. Miller et al. (2012) concluded that the canyons are dominated by low relief soft substrate, which makes the corals an important habitat element that provides vertical relief, and further concluded that Pribilof and Zhemchug canyons harbor areas of "high densities of slow-growing corals that form the foundation of complex communities" and recommended that conservation of the canyons areas be given priority status in fisheries management decisions although specific recommendations for conservation were not provided.

In April 2012, the Council initiated two discussion papers in response to numerous proposals and public testimony regarding consideration of management measures to preserve representative portions of the highly productive slope and canyons habitats in the Bering Sea. Of particular interest to some members of the public were Pribilof and Zhemchug canyons, and their potential as important habitat for deep-sea corals and sponges, and for certain life stages of fish and crab species. The discussion papers were structured to better understand the importance of these canyons as unique coral and sponge habitats and habitats for FMP-managed species, and to understand the current fishing activities in the canyons. These discussion papers were presented to the Council in June, 2013.

The authors of the first paper (Sigler et al. 2013) compiled data from the eastern Bering Sea that included trawl survey data on fish and invertebrate distributions and observations of ocean conditions and benthic habitat and analyzed them using multivariate techniques to determine if the two canyons, Pribilof and Zhemchug, are distinguishable from the adjacent continental slope (Figure 2). Sigler et al. (2013) concluded that while Pribilof and Zhemchug canyons do show some distinguishing physical

Figure 2 Probability of coral presence along Bering Sea slope and canyons from original AFSC model.



characteristics from the adjacent slope areas (lower O_2 and pH, higher turbidity), they do not show distinguishing biological characteristics (fish, coral and sponge distribution). The major variables structuring the communities of fish and invertebrates on the eastern Bering Sea slope appear to be depth and latitude, rather than submarine canyons. However, although the canyons themselves were not good predictors for the presence of corals, about 30% of the coral habitat predicted for the eastern Bering Sea slope occurs in Pribilof Canyon (Figure 2), which comprises only about 10% of the total slope area. Sigler et al. (2013) note that although it appears that corals are concentrated in Pribilof Canyon, the average density of coral for Pribilof Canyon is only 0.28 colonies m^{-2}, which is much less than the density for the Aleutian Islands (1.23 colonies m^{-2}), suggesting that although the Bering Sea slope and canyons appear to be important coral habitat within the Eastern Bering Sea, other areas in the North Pacific may also be important. Sigler et al. (2013) also noted that the physical and biological features of Zhemchug and Pribilof Canyons are spatially heterogeneous, and that coral habitat was predicted more often in some sections of Pribilof Canyon than others.

In the second paper requested by the Council in April 2012 (NPFMC 2013), Council staff reported the observed fishing activity in the Bering Sea canyons. From 2004 – 2012 the observed catch was dominated by trawl gear, and catch in Pribilof Canyon dominated catch from the canyon areas (Table 1). However, NPFMC (20013) also shows that the observed catch from either Pribilof or Zhemchug canyon is small when compared to the total Bering Sea catch for each gear type (Table 2).

After reviewing Sigler et al. (2013) and NPFMC (2013) at the June, 2013 meeting, the Council tasked staff with a discussion paper that addresses management measures to be considered for conserving areas of coral concentration and associated fish productivity, and further instructed staff to meet with AFSC and stakeholders to discuss possibilities for collaboration in order to survey areas of coral abundance as well as to identify and develop tools for coral impact reduction. The meeting with AFSC and stakeholders took place in February, 2014 and informs this discussion paper.

Table 1 Observed catch by gear type from Pribilof and Zhemchug canyons, Bering Sea, Alaska from 2004 – 2012.

FMP Gear	Pribilof Canyon catch (mt)	Zhemchug Canyon catch (mt)
Hook & Line	3,079	14,185
Pot	164	5
Trawl	283,660	34,046

Includes retained catch and some discards
Canyon area as defined by AFSC
Source: NFS AFSC Observer Program sourced through NMFS AKR, data compiled by AKFIN in Comprehensive_OBS. *In* NPFMC (2013)

Table 2 Observed catch, as a percentage of total Bering Sea catch, by gear type from Pribilof and Zhemchug canyons, Bering Sea, Alaska from 2004 - 2012

FMP Gear	Pribilof Canyon catch (% of total Bering Sea catch)	Zhemchug Canyon catch (% of total Bering Sea catch)
Hook & Line	0.44	2.04
Pot	0.35	0.01
Trawl	2.42	0.30

Includes retained catch and some discards
Canyon area as defined by AFSC
Source: NFS AFSC Observer Program sourced through NMFS AKR, data compiled by AKFIN in Comprehensive_OBS. *In* NPFMC (2013)

2.1 Ecosystem Approach for the North Pacific Fishery Management Council

At the February, 2014 meeting the Council adopted, as Council policy, the ecosystem approach developed and revised by the Council's Ecosystem Committee and Science and Statistical Committee. The three-part policy statement adopted by the Council contains a Value Statement, Vision Statement, and Implementation Strategy. In summary, the Value Statement states that the Council has an important stewardship responsibility for the resources of the Gulf of Alaska, Bering Sea, Aleutian Islands, and Arctic, including their productivity and sustainability for future generations. The Vision Statement states that the Council envisions sustainable fisheries that provide benefits for multiple users that are maintained by healthy, productive, biodiverse, resilient ecosystems that support robust populations of marine species at all trophic levels, and are managed using a precautionary, transparent, and inclusive process. The Implementation Strategy states that the Council will explicitly address variability, uncertainty, changes in climate and ocean conditions, relationships between managed species and ecosystem components, including habitats, non-managed species, and the relationships between them. The vision statement "shall be given effect through all of the Council's work".

3 Public Workshop

In response to a motion made by the Council in June 2013, a workshop was hosted on February 3, 2014 in Seattle, WA to provide a public forum to review the outputs of the AFSC model to predict areas of likely coral abundance in Pribilof and Zhemchug canyons, to facilitate discussion between AFSC and stakeholders to discuss possibilities for collaboration in order to survey areas of coral abundance, and to identify and develop tools for coral impact reduction. The agenda for the workshop is attached as Appendix B. The workshop was attended by at least 71 people, with more people listening online. The list of attendees is attached as Appendix C.

3.1 AFSC Model Output

At the June 2013 meeting, the Council requested that the AFSC scientists overlap results of their coral habitat prediction model with existing data to better validate indication of modeled coral concentrations,

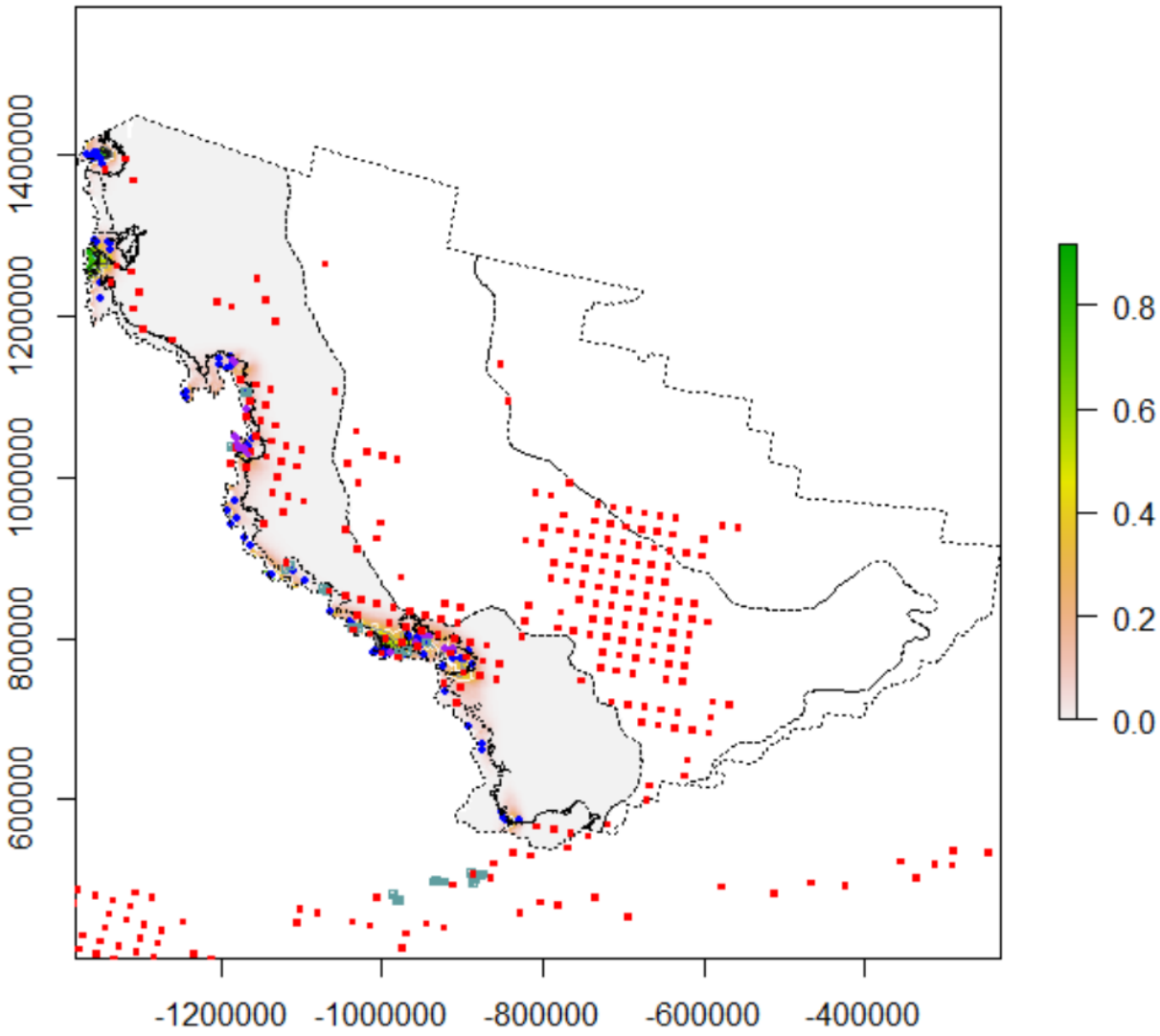
especially in Pribilof canyon where coral appeared common, as well as to incorporate a biodiversity index and rare species considerations into the model. The specific language of that motion was:

> *Identify and validate where necessary areas of coral concentrations for possible management measures for the conservation and management of deep sea corals in Pribilof and Zhemchug canyons.*
>
> - *Request AFSC expand upon the initial analysis to include an overlay of model results with existing data such as: visual survey data, observer data, longline survey data, multibeam sonar data and to incorporate a biodiversity index and rare species analysis.*

The results of the overlay and additional analyses were originally presented to the Council's Ecosystem Committee in October 2013 (Sigler et al. 2013b). The presentation to the Canyons Workshop was an encore of that presentation. In the initial analysis, Sigler et al. (2013) predicted coral abundance and presence using a statistical analysis of coral distributions from trawl surveys of the eastern Bering Sea shelf and slope and observations of ocean conditions and benthic habitat. Corals were predicted to occur along the eastern Bering Sea slope both inside and outside canyons. Within slope areas, 33% of the predicted coral habitat was within Pribilof canyon and only 1% was predicted within Zhemchug canyon. The rest was primarily in the inter-canyon areas and in Navarin canyon further north.

To respond to the Council's request, Sigler et al. (2013b) overlaid visual survey, observer, and longline survey data on the coral model results for Pribilof and Zhemchug canyon, and on the eastern Bering Sea slope and outer shelf (Figure 3). The slope and outer shelf results are shown in Sigler et al. (2013), but are not summarized here. Corals were predicted to occur predominantly along the eastern Bering Sea slope, both inside and outside canyons (Figure 3). Within slope areas, the highest amount of coral habitat was predicted to be in Pribilof Canyon (33%). Only 1% of coral habitat for slope areas was predicted for Zhemchug Canyon, and the rest was primarily in the Pribilof-Zhemchug inter-canyon area (29%), the Zhemchug-Prevenets inter-canyon area (18%), and in Navarin Canyon (13%). Within Pribilof Canyon, there was some tendency for more coral presence inside or adjacent to the lateral wings of the canyon (Figure 4a). Except for observer data, observations of coral abundance generally matched the model predictions (Figure 4b). This suggests that the model reasonably represents areas where coral are more likely to be present within the resolution of the trawl and survey data (Sigler et al. 2013b). Observer data are less useful for validation because of the low resolution of the data, both taxanomic and spatial. Only start positions are recorded and distance and direction fished are not. Additionally, the 20 km x 20 km spatial scale of the observer data is substantially coarser than the 1 km x 1 km scale of the model. Because of these differences, the observer data were not considered useful for validation.

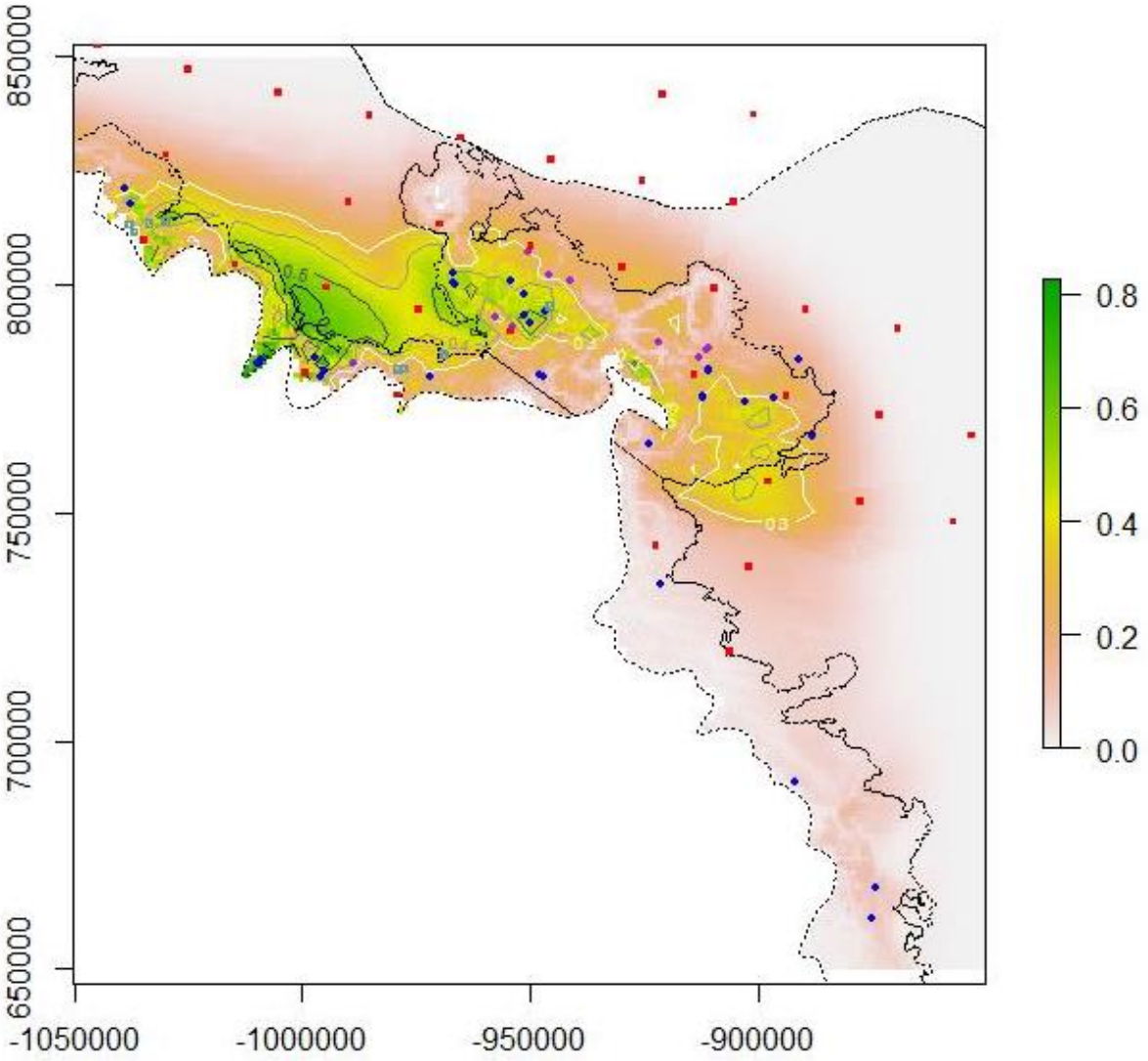
Figure 3 Probability of coral habitat along the Bering Sea shelf overlaid with survey and observer data.



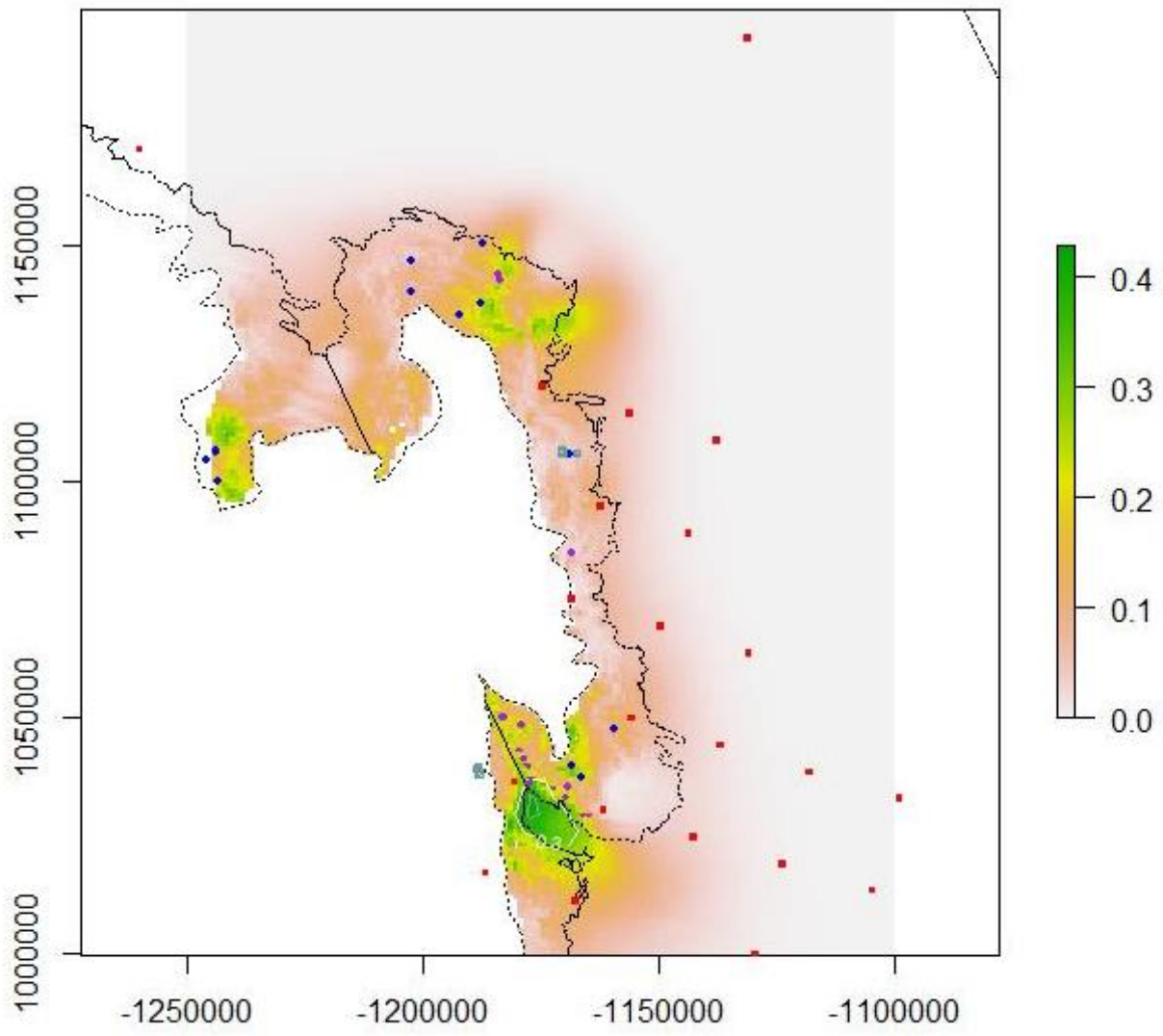
Dots represent coral presence. Dark blue = trawl survey, light blue = longline survey, purple = video survey, red = observer data.

Figure 4 **Probability of coral habitat in Pribilof Canyon (a) and Zhemchug Canyon (b) overlaid with survey data.**

(a)



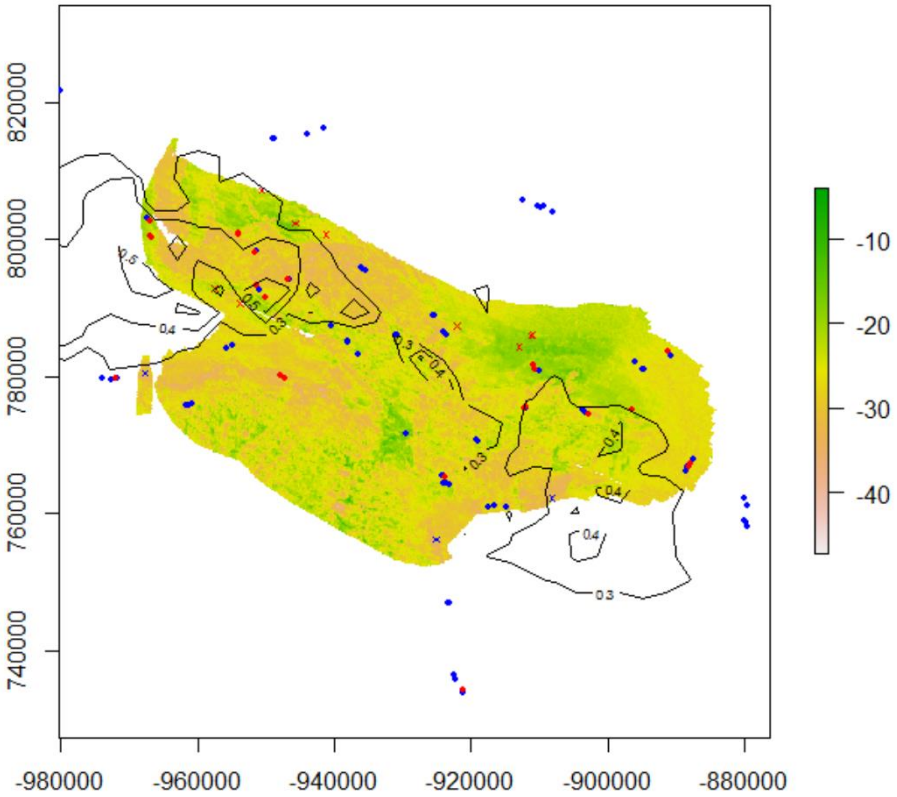
(b)



Dots represent coral presence. Dark blue = trawl survey, light blue = longline survey, purple = video survey, red = observer data.

Pribilof canyon is the only area of the eastern Bering Sea slope with multibeam backscatter data, which indexes bottom hardness. During visual surveys, nearly all corals were found on harder seafloors, but a review of visual survey photos showed that many of the corals in Pribilof canyon were attached to individual, small rocks that were surrounded by soft sediment (Figure 5). Additionally, trawl surveys sometimes found corals in areas of soft bottom. As a result, the area of predicted coral habitat, which is based on trawl survey results, is larger than the area where corals were found during visual surveys. This suggests that additional visual surveys, focused on areas where the current model predicts likely coral habitat, would be useful for understanding habitat relationship and the spatial scale of the coral habitat.

Figure 5 Coral probability in Pribilof Canyon overlaid with multibeam data, visual and trawl surveys.



Contours represent probability of coral presence, colored symbols represent coral presence (red) and absence (blue) and sampling gear of trawl survey (dots) and video survey (x). Color scale represents multibeam backscatter: green = harder seafloor, tan = softer seafloor.

Results of the biodiversity index show that while diversity could be distinguished between canyons and other areas of the slope, this differentiation was due to latitude rather than a canyon effect; diversity indices decreased northward indicating a decline in species richness and a decline in species evenness along the Bering Sea slope. Species rarity was examined by assessing endemics or species that only occurred in one area. Only a single species of coral (undescribed) and a single species of sponge (*Aaptos kanuxx*) was found only in Pribilof canyon. Other methods of assessing rarity were considered, but the approach originally used in Sigler et al. (2013) was considered to be of most utility.

Discussion at the workshop following the presentation was broad, and focused on three main themes: data used to inform the model, verification of model results, and physical and biological forces that may be contributing to coral abundance. Several questions concerned whether multiple or single survey results, or single year or multiple year surveys data were used. Presenters noted that the bottom trawl survey, which was the major data source for coral abundance, contains many survey points, some of which are surveyed more often than others. The purpose of the bottom trawl surveys is not to survey for coral, but rather for commercially important fish species, and the surveys may sample areas of known fishery abundance more often than areas where those fishes may not occur. The surveys used, however, represent the best available data. Other questions centered around the verification of high-probability vs. low-probability coral areas, and the difficulty of verifying coral absence as opposed to coral presence. Presenters noted that this is always a challenge with presence/absence surveys. Surveys are planned in cooperation with industry that will use stereo cameras (Section 3.5) to survey approximately 300 sites to further verify model results. Additional questions suggested that physical or biological forces, other than fishing activity, may be contributing to coral abundance. Those other forces could include upwelling in the

canyons and current mediated nutrient transfer. Presenters acknowledged that these are likely taking place, but were outside the scope of the paper requested by the Council.

3.2 Fishing activity in Bering Sea canyons

Staff from NMFS Alaska Region provided a brief summary of the fishing activity that occurs within Pribilof and Zhemchug canyon area to focus discussion on those fisheries that have the greatest potential to impact benthic habitats (NPFMC 2013). Trawl gear dominates fishing effort in both Pribilof and Zhemchug canyons, 98% of catch in Pribilof canyon and 71% of all catch in Zhemchug canyon came from trawl gear. Pollock (pelagic trawl) also dominated catch in both canyons; 96% of catch in Pribilof canyon and 68% of catch in Zhemchug canyon was trawl-caught pollock. Discussion after the presentation included questions about whether there are other ways to evaluate effort in the canyons area, which gear groups were most active in the canyon areas and how likely those gear groups were to affect benthic habitat, and whether the canyons and their associated biota could be considered Essential Fish Habitat for some species in the Bering Sea. There was considerable discussion about the potential impacts of pelagic trawling on the benthic habitat, including the accuracy of current estimates of the extent to which pelagic gear contacts the bottom. The current assumptions based on input from industry, is that pelagic gear contacts the seafloor approximately 44% of the time the gear is being towed. While there was no consensus about the potential impacts of pelagic gear, it was recommended that those estimates be revisited and any management measures should consider the potential impacts of pelagic gear.

3.3 Deep-Sea Coral Research Program

Staff from NMFS, AFSC provided an update on the NMFS Deep-Sea Corals Research and Technology Program, summarizing work done to date and planned for summer 2014. Fieldwork, to date, has focused on the Aleutian Islands, but fieldwork is planned for the Bering Sea slope where stereo cameras will be dropped to survey areas of likely coral habitat.

3.4 Previous research to reduce trawl gear impact

Staff, recently retired and current, from NMFS, AFSC, Resource Assessment and Conservation Engineering (RACE) Division provided a presentation on research to reduce the effects of trawl gear on the seafloor and associated habitat features. Although there is not currently any program to develop a tool or gear modification to directly address issues in the Bering Sea canyons, the results of studies to reduce the effects of flatfish trawls on the Bering Sea shelf may be a model for similar efforts to address potential impacts in the Bering Sea canyons. Concepts investigated to reduce the potential impact of gear include reducing the area of bottom contact, raising sections of the gear higher off the bottom, and reducing the weight of gear which reduces contact pressure. Previous work has raised trawl seeps and footropes off the seafloor with the use of bobbins which reduced the seafloor contact while still effectively catching the targeted flatfish. The bobbins on the sweeps and footropes also replaced some of the steel components on that part of the gear, reducing the weight of the gear and further reducing the potential impacts. However, the presenters also emphasized the importance of catch effectiveness for any gear modification. Reducing target effectiveness could result in increased length of tows, thereby increasing the potential impacts of gear, or potentially impacting more area with the gear. Considering application of gear impact reduction research in the Bering Sea canyons, the presenters noted that while their research concentrated on flatfish trawling, there was relatively little flatfish trawling in the canyons and most effort was pelagic, pollock trawls. The presenters highlighted that pelagic trawls have a very different configuration than flatfish trawls, which would require new gear development and testing. The presenter summarized five elements that illustrate the concepts and methods that could be applied to research to reduce the potential impacts of gear in the Bering Sea canyons:

1. Industry collaboration,
2. Address seafloor effects,
3. Address effects on target capture,
4. Address bycatch (crab, halibut, etc.),
5. Address practical implementation.

Previous trials to reduce impacts of trawls have focused on impacts to sessile epifauna (breaks, knock-down, etc.), and mortality of crabs after encountering bottom trawls. Survival of sea whips (upright and undamaged) was significantly greater for modified gear than for conventional gear, and mortality to crabs was reduced 70-100% compared to conventional gear. Target catch was largely unchanged during the tests of modified gear. Results of these practical tests suggest that the same methods could be useful for tests in the Bering Sea canyons, although the applicability in the canyons depends on a better understanding of the benthic habitat and fauna, and how the gear currently used in the canyons interacts with benthic habitats and fauna.

3.5 Collaborative research

The second part of the workshop was focused on planned and potential collaborative (Industry, NMFS, NGO) research to understand the distribution and abundance of corals in the canyons, and to develop tools to mitigate potential impacts of fishing gear on those corals. The presentation was made by Dr. Mike Sigler of AFSC, and Mr. Merrick Burden of the Marine Conservation Alliance. Dr. Sigler and Mr. Burden were asked to answer the following questions in their presentation:

1. What are the objectives? What information does this provide to help manage habitat along the Bering Sea slope and canyons?
2. How does this project build upon what is already known about the Bering Sea slope and canyons?

The proposed research (tentatively funded) is intended to gather information from fishermen on locations of hard-bottom areas, and to determine the presence or absence and density for major coral taxa at approximately 300 transects on the EBS slope using a stereo drop camera. The stereo drop camera will allow the Principal Investigators to ground truth the existing AFSC coral presence/absence model for the region, and measure the size and height of a subsample of the major coral taxa at each site. The data will improve the understanding of Bering Sea coral presence, density, and their attributes, and will help to inform types of management measures for fisheries (e.g., gear modification and area closures) that interact with these corals, should protection be necessary. Secondarily, the proposed project will determine the presence/absence and abundance of major sponge taxa at the sampled transects, measure the fine-scale association of fish and crab with coral and sponge, and record evidence of fishing gear impacts.

The Marine Conservation Alliance will conduct formal workshops, in cooperation with AFSC, with Bering Sea fishermen to gather their knowledge of specific locations where hard-bottom areas are found. That information will be evaluated alongside the results of the visual survey and will complement the proposed fieldwork and model validation.

Some attendees of the workshop had concerns that the data from fishermen would be challenging to incorporate into existing models to predict coral density in the Bering Sea. Mr. Burden reiterated that the data from fishermen would be complementary to the modeled predictions, rather than informing the model. Other concerns of the attendees included whether the model results could influence where fishermen choose to fish, the dichotomous nature of data that can be obtained from fishermen (e.g., objective data from equipment such as depth readings from sounders, and subjective data such as “the best place to catch X”), and the utility of the transects to address questions about the absence of corals.

3.6 Attendee concerns

After formal presentations, workshop attendees were asked to provide their insights and concerns about corals in the Bering Sea canyons, research, and management. Some organizations (TDX, Greenpeace) submitted written comments before the workshop. Topics from attendees included the contribution of the drop camera data to estimates of species evenness and richness, the contribution of the Bering Sea canyons to the health of subsistence species, whether the Bering Sea canyon habitats could be considered Essential Fish Habitat for some life stages of the fish in the Bering Sea, life history characteristics of deep-water corals, a database about the types of fishing gear used in the Bering Sea canyons, the necessity of scientific control areas in the Bering Sea to understand anthropogenic impacts, the need for trends across time to understand the importance of habitats to fisheries production, the utility of observer data and the need for additional data sources to fully understand the levels of fishing in the canyons, the need for information on the rates of colonization and recovery of Bering Sea corals to understand acceptable levels of take and whether the current levels of take are acceptable on both a small scale and population level.

Written comments from the Tanadgusix Corporation (TDX) stated that as the Council considers protection measures for corals in the Bering Sea canyons, it should also take into account the impacts that those actions could have on the northern fur seal populations of the Pribilof Islands, and female fur seals foraging in and around the canyons in particular. TDX stated concern that closures in part of the canyons could displace fishing effort into areas where vessels would complete with foraging female fur seals. TDX highlighted concerns about the potential impacts to northern fur seals as a research priority, and encouraged the Council to consider impacts on northern fur seals as it contemplates protections for the canyons.

Greenpeace, on behalf of five conservation organizations, presented comments advocating for sustainable management of the Bering Sea canyon-slope habitat. Greenpeace commented that conservation management over a portion of the shelf habitat would achieve at least 9 ecosystem benefits, including conservation of coral and sponge habitat, providing refugia in the Bering Sea, bycatch mitigation, spawning and foraging habitat, reference areas, conserving rare or vulnerable habitat, promoting research, and protecting ecosystem processes. The comments from conservation organizations also included a list of specific tools or management measures that should be considered by the Council. Those include:

1. Fully protected closures
2. Exclusion of bottom-contact gear
3. Designated exclusive zones for limited access for Pribilof Islands-based fisheries
4. Net monitors to ensure pelagic trawls avoid contact with bottom
5. Including net depth and distance-to-bottom data in Observer reports
6. Coral and sponge bycatch limits with move-on protocols, temporary closures, and research protocols
7. Geographic boundaries, including buffer zones
8. Expanding the Pribilof Islands Habitat Protection Area to include shelf break and slope habitat.

4 Potential Management Measures for Bering Sea Canyons

The discussion around protections for the Bering Sea canyons has taken multiple turns. Initial discussions in 2006 concerned EFH or HAPC for various commercially important fish species. Later, Miller et al. (2012) proposed protections in Pribilof and Zhemchug canyons to protect deep-sea corals and sponges and their associated fish assemblages. Recently, the Council requested discussion papers considering the canyons as coral habitat, and management measures to conserve corals while other discussion by

conservation organizations has focused on conserving representative slope habitats, ecosystem services, and creation of scientific control areas[2].

The difference in discussion topics is subtle, but important. The objective will strongly affect the management measures that would be considered. A taxon-specific conservation objective has very different goals and management tools than a habitat and ecosystem process conservation objective. In its motion from June 2013, the Council clearly stated its objective was to address management measures to conserve areas of coral concentration and associated fish productivity. Should the Council wish to address conservation of representative slope/canyon habitat and ecosystem services, then that objective should be clearly stated. Until that time, the focus remains on conservation of coral concentrations on the Bering Sea slope and canyons.

4.1 Management tools

There are several types of management tools that the Council has used in other areas that could be implemented in the Bering Sea slope and canyons. Those management tools, and others raised at the public workshop are discussed below.

In addition to conserving corals as Essential Fish Habitat (EFH) for managed fish species, the Council may consider measures for deep sea coral areas under MSA section 408. Under the deep sea coral authority, any coral areas identified for management measures must have a connection to a fishery managed by the Council under an FMP. Provided that nexus exists, the Council's may:

- designate deep sea coral zones to protect deep sea corals from physical damage or to prevent loss or damage of gear
- limit the location and time during which fishing may occur within zones
- limit fishing within zones to certain types of vessels
- limit fishing within zones to specified types and quantities of gear
- close deep sea coral zones to all fishing

Under the MSA, any closure area must include criteria to assess the conservation benefit of the closed area and a timetable for review. This again reiterates the necessity of clear management objectives for any action related to Bering Sea canyons and deep sea corals

4.1.1 Area Closures

Area closures have been used for a number of different purposes in the Bering Sea. There are a number of closures around the Bering Sea canyons area. The closures around the Bering Sea canyons area that have the potential to affect fishing effort around the canyons were summarized in NPFMC (2013), and include Steller sea lion closures, EFH and HAPC in the Bering Sea and Aleutian Islands, the Pribilof Island Habitat Conservation Zone (PIHCZ), crab closures, and rolling hot spot closures for salmon PSC. Closures can be initiated to preclude or limit all gear, some gear types, specific target species catch, or PSC. Full closures could be necessary if full habitat protection or scientific research control areas were the objective. If the objective was to protect corals and other benthic fauna, then modified gear or non-bottom contact gear may be allowable while still meeting conservation objectives.

Area closures have been enacted specifically to protect areas of coral concentration in the Aleutian Islands and Gulf of Alaska. In February 2005, the Council prohibited all bottom trawling in the Aleutian

[2] Scientific control areas in this context are areas set aside to provide a contrast between an unfished (control) area and a fished (treatment) area in order to understand the impacts of fishing activity and potential for recovery from impacts.

Islands, except in small discrete "open areas" where trawling had occurred previously. Over 95% of the Aleutian Islands management area is closed to bottom trawling. Additionally, six areas with especially high density coral and sponge habitat, based on submersible observations, are closed to all bottom contact (total area = 112 nm^2). These "coral gardens" are essentially marine reserves. In the Gulf of Alaska, the Council prohibited bottom trawling for all groundfish species in 10 designated areas along the continental slope break, thought to contain high relief bottom and coral communities (total area = 1,892 nm^2). The Council also designated 20 areas consisting of seamounts and high density coral areas in the EEZ off Alaska as HAPC and prohibited all bottom-contact gear. The Council included all 16 seamounts named on NOAA charts, several aggregations of *Primnoa* corals in Southeast Alaska (total area = 14 nm^2), and Bowers Ridge in the Aleutian Islands region.

Existing area closures were created where coral abundance was directly observed by submersible surveys (coral gardens and *Primnoa* closures), or where corals were thought to be present based on input from scientists and fishermen. The precedent, therefore, exists for the Council to create closures based on either direct observation of coral abundance or predicted abundance of corals, and the Council could take either route should they decide to move forward with alternatives to preserve corals in the eastern Bering Sea.

As noted in Sigler et al. (2013) and Sigler et al. (2013b), Pribilof Canyon contains 33% of the coral habitat modeled for the Bering Sea slope, and visual and trawl surveys have found corals in the northwestern arm of Pribilof Canyon, where coral presence was predicted from the model. Based on previous actions, the Council could consider establishing complete closures for these areas, similar to the "coral gardens" in the Aleutian Islands, establish certain gear closures as was done for the seamounts, or take no action to preserve these areas. Naturally, complete closures would preclude any incidental catch of corals from these conservation areas. There is limited understanding of the relative impacts of different bottom-contact gear to corals and coral habitat, but all gear types are thought to impact corals.

One of the suggestions from the conservation organizations at the workshop was to expand the Pribilof Islands Habitat Conservation Area (PIHCA) to include the shelf break and slope habitat. The PIHCA was established in 1995 by Amendment 21a to the BSAI FMP (NPFMC 1994). One of the alternatives considered (Alternative 4) would have established closures within 25 nm zones around St. Paul Island and St. George Island. That alternative was rejected in favor of Alternative 8, which was selected to allow trawl access to the edge of the 100 m contour and the groundfish resources to the east and north of the Pribilof Islands. The 25 nm buffers around the islands would have included the shelf break west of the Pribilof Islands, and the northwest corner of Pribilof Canyon, where Sigler et al. (2013) identified high probability coral habitat (Figure 4). However, if the objective is to protect corals, this option may have higher economic impacts to fisheries than more discrete closures in areas of coral concentration.

4.1.2 Gear Modifications

Gear modifications to reduce impacts of gear on benthic habitat and reduce mortality of PSC species have already been implemented for sectors of the Bering Sea fishing fleet. Information on existing modifications to gear can be found at http://www.npfmc.org/habitat-protections/gear-modifications. Modifications to trawl sweeps in the Bering Sea were enacted in 2009 specifically to reduce impacts to bottom habitats and fauna following the research described in Section 3.4.

Based on the presentations given at the Bering Sea Canyons Workshop (Section 3.4), it is important that any program to modify gear used in the Bering Sea canyons address the gear that is most commonly used in the canyons: pelagic trawls. Questions about the proportion of pelagic trawls that contact the bottom, and the proportion of time that pelagic trawls are on the bottom remain. The current assumptions, based on prior input from the fishing industry, is that pelagic gear contacts the seafloor approximately 44% of the time the gear is being towed on the Bering Sea shelf. However, it is likely that pelagic gear contacts the bottom less often than that while operating in the steeper areas of the canyon. In order to devise a

program to modify gear to reduce the amount of time that the gear contacts the bottom, it is necessary to understand which part of the gear contacts the bottom, and the fishing and environmental conditions that contribute to bottom contact. Additionally, any gear modification program should be guided by the elements presented at the workshop to inform concepts and methods for gear modification research. It is likely that any gear modification program would take several years to devise modifications that meet all objectives. As noted above, gear modifications may be a condition for fishing within a closure area.

Conservation organizations also suggested development of net monitors to ensure that pelagic trawls avoid contact with the seafloor and including net depth and distance-to-bottom data in observer reports. These monitors are not yet available, and development of these monitors could take several years, if they are feasible.

4.1.3 Exclusive Fishing Areas

Conservation groups suggested during the workshop that some areas in the Bering Sea slope and canyon areas could be designated as exclusive zones for limited access for Pribilof Islands-based fisheries. The assumption behind this suggestion is, presumably, that limiting access would reduce fishing pressure in the area and provide economic opportunity for the residents of the Pribilof Islands. However, it is likely that such action would run afoul of National Standard 4 of the Magnuson-Stevens Act which prohibits discrimination between residents of different states.

5 Next steps for Council consideration

There are questions that should be answered before the Council considers moving forward with developing options for conserving areas of coral concentration in the Bering Sea. Sigler et al. (2013b) noted that Pribilof Canyon contains approximately 33% of the coral habitat along the Bering Sea shelf. However, coral habitat was also modeled to occur in the inter-canyon areas and in Navarin Canyon, farther north. To date, the discussion has focused on Pribilof and Zhemchug canyons. Given the fishing history in these areas, the Council could consider whether their conservation efforts should also consider inter-canyon areas or other canyons in the Eastern Bering Sea.

As was discussed in the Bering Sea Canyons Workshop (Section 3), there are also substantive questions about the ecology of the Bering Sea canyons, contributors to their productivity, and their contribution to productivity of species managed by the Council. In 2006, McConnaughey et al. suggested that to assess the value of canyon habitat as EFH or HAPC for specific species would require a dedicated study involving systematic surveys of habitats and coordinated biological sampling. To date, although some studies have been conducted (Miller et al. 2012), are planned (DSCRT Bering Sea surveys in 2014), or proposed (AFSC/MCA camera drop and fishermen surveys) a full dedicated study has not been completed, and it is uncertain, given current budget scenarios, that a full dedicated survey will be completed in the near future. While it is not entirely necessary that those studies be completed before the Council begins the process to evaluate potential management actions, the planned and proposed studies will likely provide data that will inform the Council's decisions.

If the Council chooses to move forward and begin considering alternatives for conserving corals in the Bering Sea slope and canyon habitat, the Council would need to decide how to develop areas for consideration. Previously, the Council has used the committee process to design closures, solicited closure proposals from the public, initiated development of options by staff, and a negotiation process to design area closures. Because any process is likely to be iterative and take considerable time, the Council may wish to identify the process by which alternatives will be developed early in the process.

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7 Appendices

7.1 Appendix A

C-7 Bering Sea Canyons Motion
6/10/2013

Motion 1: Identify and validate where necessary areas of coral concentrations for possible management measures for the conservation and management of deep sea corals in Pribilof and Zhemchug canyons.

- Request AFSC expand upon the initial analysis to include an overlay of model results with existing data such as: visual survey data, observer data, longline survey data, multibeam sonar data and to incorporate a biodiversity index and rare species analysis.

- Task staff to initiate a discussion paper that addresses management measures to be considered for conserving areas of coral concentrations and associated fish productivity. Staff should meet with AFSC and stakeholders to discuss possibilities for collaboration in order to survey areas of coral abundance as well as to identify and develop tools for coral impact reduction and to bring a report of that meeting back to the council at the October or December meeting.

- Draft a letter to the Deep Sea Coral Research and Technology Program (DSCRTP) requesting that further research be done to identify and characterize areas of relatively high coral abundance in the Pribilof canyon using camera drops or similar techniques capable of gathering empirical data. Request that this research be used to inform longer term research priorities including: refining predictions of coral presence, acquiring information on the characteristics of coral in this area such as height and density, the role of these coral as habitat for fish, and documenting presence and degree of fishing gear effects.

Motion 2: Task staff with a discussion paper regarding the development of a Bering Sea Fishery Ecosystem Plan.

7.2 Appendix B

BERING SEA CANYONS PUBLIC WORKSHOP
FEBRUARY 3, 2014
12:30 PM – 5:30 PM
RENAISSANCE HOTEL, NORTHWEST ROOM
SEATTLE, WA

AGENDA

This workshop is intended to meet the objectives of the North Pacific Fishery Management Council, as identified in their June 10, 2013 motion. Specifically the objectives of this workshop are to review output of the AFSC model run with additional data, facilitate discussion between AFSC and stakeholders to discuss possibilities for collaboration in order to survey areas of coral abundance, and to identify and develop tools for coral impact reduction. The results of this workshop will be presented to the Council in a discussion paper at a future Council meeting.

12:30	**Introduction** – Objectives of workshop	
12:45	**Bering Sea Canyons** – AFSC Response to Council's June, 2013 motion	*Mike Sigler & Chris Rooper*
1:45	**Deep Sea Corals Update** – Update on ongoing fieldwork	*Chris Rooper*
2:00	**Previous impact reduction research**	*Carwyn Hammond & Craig Rose*
2:45	**Break**	
3:00	**Collaborative Research and tools**	
	Questions: 1. What are objectives? What information does this provide to help manage habitat along the Bering Sea slope and canyons? 2. How does project build upon what is already known about Bering Sea slope and canyons?	
	Proposed collaborative research in BS Canyons	*Mike Sigler & Merrick Burden*
	Discussion on additional opportunities for collaboration and tools to reduce impact to corals	*Attendees*
5:30	**Adjourn**	

7.3 Appendix C

BERING SEA CANYONS WORKSHOP
FEBRUARY 3, 2014
LIST OF ATTENDEES

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