Appendix A History of the Fishery Management Plan (Amendments)

Table A-1: Amendments to the BSAI King and Tanner crab FMP.

Amendments to the BSAI king and Tanner crab FMP.	
1.	Define overfishing
2.	Establish Norton Sound superexclusive area registration
3.	Establish a research plan
4.	Establish a moratorium on new vessels
5.	Establish a vessel License Limitation Program (LLP)
6.	Repeal the research plan
7.	Revise overfishing definitions
8.	Identify and describe Essential Fish Habitat (EFH)
9.	Extend the moratorium on new vessels established by AM 4
10.	Add a sunken vessel provision and other changes to the LLP
11.	Implement a rebuilding plan for Bering Sea Tanner crab
12.	Identify Habitat Areas of Particular Concern and protection measures
13.	Coordinate FMP with American Fisheries Act
14.	Implement a rebuilding plan for snow crab
15.	Implement a rebuilding plan for St. Matthew blue king crab
16.	Revise EFH descriptions and add measures to protect HAPC
17.	Implement a rebuilding plan for Pribilof Islands blue king crab
18.	Implement BSAI Crab rationalization program
19.	Implement BSAI Crab rationalization program
20.	Split eastern Bering Sea Tanner crab stock into two fisheries with separate harvester and processor QS
21.	Modify deadlines for IFQ/IPQ arbitration proceedings
22.	Modify CDQ eligibility for consistency with MSA (superseded by MSA change)
23.	Revise the Aleutian Islands Habitat Conservation Area boundaries near Agattu and Buldir Islands
24.	Establish a five tier system for crab stock status and OFL, and remove 12 crab stocks from the FMP
25.	Allow conversion of North Region CVO and PQS to CPO quota, and issue PQS
26.	Exempt C shares from processor share and regional landing requirements permanently
27.	Exempt custom processing from use caps on processing shares in some CR fisheries
28.	Allow post-delivery transfer of QS
29.	Coordinate BSAI Crab FMP with the new Arctic FMP
30.	Modify some administrative procedures within the arbitration system
31.	Modify some C-Share provisions and requirements.
32.	Extend the IPQ cooling off period and revise Right of First Refusal (ROFL) conditions for St. George (dropped)
33.	Reduce fees under CR Program
34.	Revise crab sideboard exemptions for the GOA Pacific cod and pollock fisheries
35.	Streamlined administrative aspects of CR Program (housekeeping)
36.	Allow collection of permit fees (dropped)
37.	Exempt Western Aleutian Islands golden king crab IFQ from regional delivery requirements under certain circumstances
38.	Establish Annual Catch Limits and Accountability Measures (ACL/AMs) for crab stocks
39.	Modify the snow crab rebuilding plan
40.	Revisions to essential fish habitat information (revised Amendment 16)
41.	Establish a process for emergency exemptions from regional delivery requirements
42.	Revise information requirements for Economic Data Reports (EDRs)
43.	Revise PIBKC rebuilding plan
44.	Modify ROFL provisions
45.	Modify freezer longline GOA Pacific cod sideboards
46.	Correct text around LLP vessel lengths
47.	Exempt custom processing from the Tanner crab IPQ use caps
48.	Revise ownership attribution model for AFA and crab excessive shares for CDQ Program
49.	Revisions to essential fish habitat information (revised Amendment 40)
50.	Implement a rebuilding plan for St. Matthew blue king crab
51.	Standardized Bycatch Reporting Methodology
52.	Revisions to EDR Requirements
53.	EBS snow crab Rebuilding

Appendix B Establishment of the Fishery Management Plan

Prior to implementation of the FMP, state laws and regulations are subject to mandatory review by the Secretary. Between the date the Secretary approves this FMP and the next regularly scheduled meeting of the Board concerning crab management, any member of the public may petition any existing regulation to the State and, if unsuccessful, to the Secretary, in accordance with the procedure set forth in Section 3.9 herein. If the Secretary finds, on the basis of an appeal, or as a result of mandatory review, that any existing State law or regulation is inconsistent with the Magnuson-Stevens Act, the FMP, or applicable Federal law, he/she will publish Federal rules in the *Federal Register* superseding the State laws or regulations in the EEZ.

The following document is the State/Federal Action Plan for the commercial king and Tanner crab fisheries. This Action Plan details the cooperative management system for BSAI crab fisheries between the North Pacific Fishery Management Council and the State of Alaska.

ALASKA DEPARTMENT OF
FISH & GAME
DIVISION OF COMMERCIAL FISHERIES
JUNEAU, ALASKA

NATIONAL MARINE FISHERIES
SERVICE
ALASKA REGION
JUNEAU, ALASKA

STATE/FEDERAL ACTION PLAN FOR MANAGEMENT OF COMMERCIAL KING AND TANNER CRAB FISHERIES OCTOBER, 1993

PURPOSE: To foster improved coordination and communication between National Marine Fisheries Service (NMFS) and Alaska Department of Fish & Game (ADF&G) with respect to crab management under the Fishery Management Plan for the Commercial King and Tanner Crab Fisheries in the Bering Sea and Aleutian Islands Area (FMP). Interagency action groups will implement this coordination.

BACKGROUND: The FMP approved in 1989 establishes a State/Federal cooperative management regime that defers crab management to the State of Alaska with Federal oversight. The Secretary of Commerce defers to the State's regulatory regime providing it is consistent with the FMP, the Magnuson Fishery Conservation and Management Act (Magnuson Act) and other Federal law.

A management goal and specific objectives are identified in the FMP. ADF&G, in consultation with NMFS, recommends to the Alaska Board of Fisheries (Board) appropriate management measure(s) for a given year and geographical area to accomplish the objectives. Three categories of management measures are available for consideration: (1) those that are specifically fixed and require an FMP amendment to change, (2) those that are framework-type measures which the State can change without an FMP amendment but following specified criteria, and (3) measures that are neither rigidly specified nor frameworked in the FMP. The measures in categories (2) and (3) may be adopted as State laws subject to the appeals process outlined in the FMP.

The State is not limited to the measures outlined above. Any other management measures must be justified based upon consistency with the FMP objectives, the Magnuson Act, and other applicable Federal law.

Overall, the FMP has efficiently managed the crab fisheries. The framework approach has worked well for the majority of crab management issues. However, Category 2 management measures have been appealed to the Secretary (specifically, pot limits and registration areas). Members of the industry also have criticized Board actions with respect to Category 2 measures (setting of guideline harvest levels). In order to avoid future contentious problems, NMFS and ADF&G will adopt this action plan to more formally implement State/Federal cooperation in crab management.

ACTION: Three action groups, described below, will facilitate this joint coordination.

a) Research Planning Group
b) Crab Plan Team
c) State/Federal Policy Group

Research Planning Group
The purpose of this group will be to consider long-term crab research priorities, current research activities, and each agency's particular research interests. The group will include NMFS, ADF&G and university crab biologists as well as other representatives from NMFS/Fisheries Management Division; Alaska Fisheries Science Center and ADF&G/Division of Commercial Fisheries. Some of these individuals also may be members of the Crab Plan Team.

This group will work on the development of a long-term plan for applied crab research which will help foster a healthy exchange of ideas among fishery biologists and managers on particular needs. The plan will focus on development of optimal long-term harvest policies. The plan will be updated annually and will function as a vehicle to coordinate the expenditure of crab funds between ADF&G and NMFS and to seek additional funding for critical research.

The group will meet annually for a one- or two-day period at a time and place convenient for the majority of group members.

Crab Plan Team
The annual development of the preseason guideline harvest levels (GHLs) is a dynamic process dependent on using the most current information available and applying this information via analysis and statistical modeling. Scientists from NMFS and ADF&G are currently involved in this process.

Though individual members of the Plan Team have always participated in the development of GHLs, public perception is that this is an ad hoc process. Due to the timing of the Bering Sea surveys and the openings of the early fall fisheries, only a limited amount of time exists to analyze, discuss, amend and release the GHLs to the public in a timely fashion. To release preseason GHLs that have been reviewed using a Council process, such as that used to establish annual groundfish harvest specifications under the groundfish FMPs, would require that current season opening dates for the fall fisheries be delayed and/or rescheduled, or the previous year's survey information would have to be used to set GHLs in the current year. The latter option could interfere with the FMP management objective of biological conservation. In addition, the Council would have to schedule a special meeting or allow time during the September meeting to address crab management after the survey information became available.

The purpose of a Plan Team review will be to formally incorporate its input in the GHL process. The FMP calls for Plan Team input in the preparation of an annual area management report to the Board. This report includes a discussion of the current status of GHLs and support for different management decisions. This report is reviewed by the State, NMFS, and the Council, and available for public comment on an annual basis.

The Plan Team will meet annually to review GHLs in a session that is open to the public.

<u>State/Federal Policy Group</u>
The purpose of the State/Federal Policy Group will be to review and discuss crab management issues prior to Board and/or Council review. This group will include senior staff and legal counsel and will meet annually, or more often if necessary. Many issues may be resolved through interagency agreement. For instance, prior to final Board action, this Policy Group could review whether crab management proposals and petitions are consistent with the FMP and reflect an appropriate and desired management strategy. Also, this group will review FMP amendment proposals. Their recommendations will be forwarded to the Board and the Council, providing guidance as the Board establishes management regulations.

<u>OTHER ACTION:</u>
In addition to the above action groups, NMFS and ADF&G will meet annually with crab industry representatives to discuss crab management issues such as, but not limited to, setting of GHLs, stock analysis, current research, and harvest strategies. The location of meetings will alternate between Washington and Alaska. These meetings will provide an opportunity for review of crab management issues and industry input to management agencies.

Council and Board members have agreed to form a Consultation Group composed of a subcommittee of Council and Board members that will meet publicly on an annual basis to focus on crab issues. (These meetings could occur at one of the regularly scheduled Council or Board meetings.) This joint subcommittee could review staff data on the status of crab stocks and fisheries and both public and staff information regarding crab management and then provide guidance to the respective Council and Board on pertinent crab issues. Council and Board representatives would benefit by meeting for the sole purpose of discussing crab-related issues.

Both NMFS and ADF&G agree to jointly request Council and Board concurrence on these action groups and their role in the cooperative management of the king and Tanner crab fisheries in the Bering Sea and Aleutian Islands.

This State/Federal Action Plan for Management of Commercial King and Tanner Crab Fisheries has been approved by:

Steven Pennoyer	Carl L. Rosier
Steven Pennoyer Director, Alaska Region National Marine Fisheries Service	Carl L. Rosier Commissioner Alaska Department of Fish & Game
10/12/93 Date	10/15/93 Date

Appendix C Community Profiles

Communities engaging in crab commercial fishing

The communities briefly summarized in this section are those most engaged in the federally managed BS/AI crab fisheries off of Alaska and, arguably, are the communities with the most potential to be affected by changes to those fisheries. Understanding how Alaskan fishing communities may be affected by changes in the federally managed fisheries begins with understanding how these communities are currently engaged in and dependent upon those fisheries, as well as the overall socioeconomic context of those communities. Impacts to Alaskan communities involved in these fisheries can occur as a result of changes to fishery management plans, fish stocks, the location of productive fishing grounds, or a combination of all of these factors.

Many of the Alaskan communities directly involved in the federally managed fisheries off Alaska are heavily dependent on these fisheries as a key component of a relatively small and undiversified local economy. Additionally, many of the communities heavily dependent on these fisheries are traditional villages with high proportions of Alaska Native residents, while others feature populations with relatively high proportions of non-Native minority residents drawn to the communities by opportunities in the commercial fishing sector. Understanding how Alaskan communities are reliant upon federally managed fisheries may be affected by changes in conservation and fishery management programs is prescribed by National Standard 8 of the Magnuson- Stevens Fishery Conservation and Management Act (MSA) and Executive Order (EO) 12898 on Environmental Justice. National Standard 8 states that conservation and management measures shall take into account the importance of fishery to fishing communities and, to the extent practicable minimize adverse economic impacts on such communities. EO 12898 states that federal agencies must identify and address disproportionately high and adverse environmental effects of their actions on minority populations and low-income populations.

Ten species of crabs are caught in Alaskan crab fisheries, and seven of these have commercial importance: red king crab, *Paralithodes camtschaticus*; blue king crab, *P. platypus*; golden king crab, *Lithodes aequispinus*; Tanner crab, *Chionoecetes bairdi*; snow crab, *C. opilio*; hair crab, *Erimacrus isenbeckii*; and Dungeness crab, *Cancer magister*. In addition to commercial fisheries, subsistence and personal use fisheries support local food security and cultural cohesion.

In 2021, the FMP BSAI crab fisheries had an active fleet of 67 catcher vessels and two catcher processors, and landed and processed at 15 processing facilities throughout the region.4 Commercial crab fisheries blossomed in the 1950s with the market of king crab fisheries in the Bering Sea, but today many of the stocks are in a depressed state. In 2021 and 2022, several crab stocks experienced unprecedented declines, resulting in closures and drops in total allowable catch (TAC) for a suite of crab fisheries. The declines in Bering Sea crab fisheries and the subsequent closures drastically affected fishermen as well as the social, cultural, and economic wellbeing of fishing communities, including economic dependence, social networks, food security, and identity.

Those communities with high engagement in the BS/AI crab fisheries will be detailed in the subsequent community profiles are: **Seattle, Kodiak, Akutan, Unalaska/Dutch Harbor, King Cove, Sand Point, Nome, St. Paul, Adak and Homer.** Seattle and Anchorage were rated as highly engaged[1]; however, as major cities, both are involved in multiple industries and are distinct from smaller, more remote fisheries-dependent communities. For that reason, Anchorage has been excluded from this iteration of community profiles. However, due to the large presence of Seattle communities in crab harvesting, a Seattle community profile can be found below.

[1] Community engagement ratings can be found in the 2023 ACEPO report on the April 2023 Council agenda.

Please note that the following community profiles are a snapshot in time given the most up-to-date information. These profiles are adapted from content produced by the community profiles (Fey et al. 2016), the 2023 Annual Community Engagement and Participation Overview (ACEPO; Wise et al. 2023), and recently updated community profiles on Akutan and Unalaska (Downs & Henry 2023). Given the instability in crab stocks in recent years, the likelihood that crab engagement will vary in subsequent years is high. For the most up-to-date information, readers can reference the ACEPO report, and npfmc.org for updated community profiles as information becomes available.

Seattle

The Seattle metropolitan statistical area (MSA) is an urban conglomeration in Washington state comprised of the three most populous counties—King, Pierce, Snohomish—and includes the Pacific Northwest's largest city, Seattle. Total population of the Seattle MSA was 737,015 in 2020. The area has long had a vital role in Alaska commercial fisheries, with 75% of Alaska's commercial fishing vessels mooring, docking, and conducting repairs in Seattle. Before Seattle and its suburbs became home to a technology industry, logging was its first major industry. Later in the 19th century, the city became the gateway to Alaska with newfound commercial and shipbuilding industries. For over 100 years, commercial fishers in Seattle have traveled to work and fish in Alaska waters. Commercial fishermen use the three core facilities in the Port of Seattle including Fishermen's Terminal, Maritime Industrial Center, and Terminal 91.

Seattle MSA plays an integral role in Alaska commercial fisheries. Seattle is the home port to 300 vessels with 226 of those involved in fishing Alaska waters for Pollock, Alaskan king crab, groundfish, and salmon. Alaskan fisheries account for an annual harvest greater than all other U.S. states combined, adding more than $4 billion dollars in sales annually to the U.S. economy. In 2017*, Seattle MSA's commercial fishing industry supplied 7,200 jobs. Of that, 5,100 individuals worked on fishing vessels, and 4,900 of those fished in Alaskan waters, supporting over $313 million in labor ($150 million in fishing employment; $163 million in onshore labor). In the same year, commercial fishing operations through the Port of Seattle generated $13.2 million in taxes in to Washington State.

In 2020, Seattle MSA had 11 crab processors, (including both at-sea and shore-based operations). These facilities processed 20.5 million pounds of crab worth $192 million4 across all fisheries. Seattle has a high engagement of crab harvesting (Figure 0-1). Seattle's resident vessels harvesting BSAI crab fisheries saw a dramatic decline in both harvest volume and associated value beginning in 2017 when harvest decreased by 17,441,359 pounds (46%) and $46.9 million (32%) from 2016 to 2018. However, the volume of crab harvested has increased by almost 10.6 million pounds or 51% between 2018 and 2021(Figure 0-1). There has been an increase of an ex-vessel value of $88.5 million (90%) between 2017 and 2021, with Seattle residents harvesting crab with an all time high ex-value of nearly $187 million in 2021.

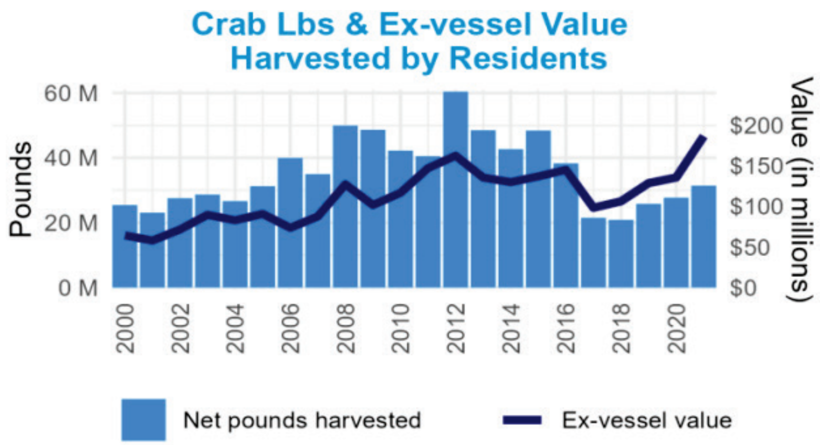

Figure 1 Crab harvested (in lbs.) and total ex-vessel value of crab harvested by Seattle residents

Source: 2023 ACEPO report

The number of crew residing in Seattle who engage in FMP crab fisheries has decreased sharply beginning in 2020, potentially due to the COVID-19 pandemic, with a decrease in 55 crewmembers harvesting BSAI or 41% between 2019 and 2020. This number rebounded slightly in 2021 to 101 crewmembers (down from 135 in 2019). Crab processing engagement in Seattle MSA is low, and there is not a substantial amount of crab processing activity in Seattle to report.

Kodiak

The largest island in the Gulf of Alaska, Kodiak Island is approximately 25 miles across the Shelikof Straight from the Katmai Coast and 90 miles southwest of the Kenai Peninsula, encompassing 6,559 square miles. The city of Kodiak is the largest community on the island, situated on the eastern tip about 219 nautical miles south of Anchorage. Kodiak has a long history and was originally inhabited by the Alutiiq for over 7,000 years. In the late 1800s, after the United States purchased of Alaska from Russia, large-scale fish processing plants were developed, establishing Kodiak as a cornerstone in American fisheries. The population of Kodiak in 2020 was 12,787 individuals. While the majority of the population of Kodiak Island live in Kodiak City, there are seven other island communities including Akhiok, Port Lions, Larsen Bay, Old Harbor, Karluk and Ouzinkie. Native Associations active in the area include the Natives of Kodiak, Inc., Koniag, Inc., and the Kodiak Area Native Association. Kodiak is located in Federal Statistical and Reporting Area 630, Pacific Halibut Fishery Regulatory Area 3A, and Central Gulf of Alaska Sablefish Regulatory Area.

The city of Kodiak is largely dependent upon commercial fishing and the seafood processing industry. Kodiak is home to most of the island's commercial fishing vessels and to the majority of the seafood processing plants. Commercial fishing, seafood processing, and commercial fishing support services are the major industries contributing to the local economy.

There are two main harbors in Kodiak, St. Paul Harbor and St. Herman Harbor, and together they possess a number of slips for commercial and recreational vessels. St. Herman Harbor is the larger of the two harbors and can accommodate vessels up to 150 feet in length. Kodiak's dependence on the fishing industry is apparent in the large number of commercial fishing permits and crewmember licenses issued to its residents. Kodiak Island has a diversified fisheries profile including engagement in both groundfish and crab fisheries. In this year, 526 commercial fishing permits were actively fished by Kodiak residents, with salmon permits representing the largest number at 233, 96 crab, 84 halibut permits, and 76 groundfish permits. In 2022, 604 Kodiak residents attained crewmember licenses, 42 of those were not permanent Alaskan residents.

In 2022, Kodiak residents owned 134 active federal fishing vessels. Two vessels had activity as catcher processors. Most of the vessels participated in multiple fisheries, switching their gear to adapt to different fisheries and seasons. The highest number of vessels participated in the Central Gulf halibut fishery (63). Of the vessels 20 carried trawl gear and 114 carried fixed gear. Groundfish made up the largest portion of all ex-vessel value at ($44M) followed by salmon at $38M, and halibut at $19M. On a species basis Pacific cod and pollock were the two most valuable federally managed species. Pacific cod is harvested by a variety of groups with the pot vessels as the largest user while pollock is mainly utilized by the trawl vessels.

Kodiak Island's resident vessels harvesting BSAI crab fisheries have seen drastic declines since 2012. However, both harvest volume and ex-vessel value have increased slightly each year since 2018 (**Figure 0-2**). In 2021, fishers harvested 3.2 million pounds of crab with an ex-vessel value of $16 million which, compared to 2018, showed a 1.2 million pounds (65%) increase in volume and $6.5 million (69%) increase in value.

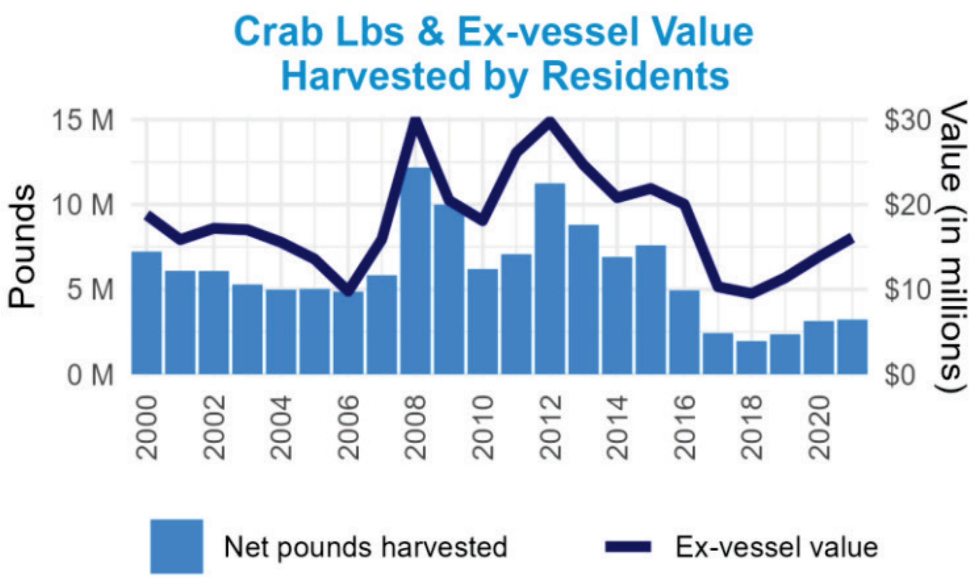

Figure 2 Crab harvested (in lbs.) and total ex-vessel value of crab harvested by Kodiak residents
Source: 2023 ACEPO report

Within the BSAI crab fisheries, the number of crew living in Kodiak Island communities declined from 55 in 2019 to 42 in 2021 (24%), despite a slight rebound from a 2020 low of 33. Having hit a peak in 2015 of 90 resident crew members, the number fell by 21% in 2016, and continues to decline. As of 2021, there were 45 quota share holders residing in Kodiak Island communities. This number has remained relatively constant over the past five years although there is a general downward trend since 2009, which had a high of 57 quota share holders.

In 2022, Kodiak had 7 active shore-based processors. Landings from the federal fishery accounted for 68% of the ex-vessel value received by Kodiak processors. The Central Gulf trawl fishery comprised 37% of the federal value with pollock accounting for $28M or 28% of the federal ex vessel value. Halibut and Sablefish deliveries followed Pollock at $22M and $17M respectively.

In order to show the general processing trends for crab FMP, the processing regional quotient (RQ) pounds and revenue landed in Kodiak show a steady decline over the past two decades, indicating a decrease in participating in the crab processing sector.

Subsistence hunting and fishing are an important part of people's recreation and livelihoods on Kodiak Island. All communities there are significantly reliant on groundfish and crab fisheries for subsistence purposes, with 18%-75% of households using at least one species of groundfish, and 15-90% of households using at least one species of crab.

Akutan

Akutan is located on Akutan Island in the eastern Aleutian Islands, one of the Krenitzin Islands of the Fox Island group. The community is approximately 35 miles east of Unalaska and 766 air miles southwest of Anchorage, the area occupies 14 square miles of land and 4.9 square miles of water. The broader area was historically occupied by the Unangan, and Akutan was used as a fur storage and trading facility starting in 1878. During World War II residents of the area were evacuated, and many former residents did not return after the reestablishment of the village in 1944.

In 1979, Akutan was incorporated as a 2nd Class City with a mayoral form of government and became a part of the Aleutians East Borough (AEB) when that was incorporated in 1987. The Akutan Corporation is the local Alaska Native Claims Settlement Act chartered village corporation, the Aleut Corporation is the regional ANCSA chartered corporation, and the federally recognized tribal entity in the community is the Native Village of Akutan. The population of Akutan in 2020 was 760 individuals.

Akutan is a unique community in terms of its relationship to the Bering Sea commercial fisheries. It has been the site of one of the largest shoreplants in North American, Trident Seafoods, but it is also the site of a village that is geographically, demographically, socially, and historically distinct from the locally operating shore plant. Akutan remains the only community in the region that is both a direct major/developed participant in multiple industrial scale fisheries of the Bering Sea and a CDQ community.

The vast majority of catch landed at the Trident Akutan plant comes from vessels based outside of the community. Most of those vessels focus primarily on pollock, Pacific cod, and crab. The shorebased processor is a multi-species plant. Given that the plant is an American Fisheries Act qualified plant with its own pollock co-op, pollock is the primary species in terms of labor requirements and economic value.

However, the shore plant has also accounted for a significant amount of the regional crab processing, which has historically provided for a significant amount of the processing value at the plant (EDAW 2005). As with plants in Dutch Harbor and King Cove, crab has been an important part of a diverse operation at the shore plant in Akutan, since implementation of CR Program. Closure of the BBR fishery in 2021/22 and closures of both the BBR and BSS fisheries in 2022/23 had substantial impact on this plant and associated tax revenue for the borough.

In 2022, Trident Seafoods announced plans to build a "next-generation processing plant" to replace its existing facility in Akutan[2]. According to company sources, Trident is working with third-party engineering firms to weigh the feasibility, costs, and design options for expanding its footprint in Akutan versus building a new plant on Unalaska's Captains Bay on property it recently acquired through its subsidiary LFS. This operational move would generate a major realignment of regional tax revenue and economic activity. Between fiscal year 2010 and fiscal year 2020 direct fishery revenue represented between 75% - 98% of all general fund revenue for Akutan (Downs & Henry 2023).

No vessels owned by Akutan residents have been active since 2021. In 2022, there were a small number of crew permits (4) and no commercial fishing permits issued.

[2] U.S. Department of Energy, 2023. Industrial Decarbonization and Emissions reduction Demonstration-to-deployment Funding Opportunity Announcement. https://www.documentcloud.org/documents/23809423-trident-makushin-concept-paper

Residents of Akutan regularly engage in subsistence fishing activities. The most popular species of groundfish harvested are cod and rockfish. Recorded numbers of halibut harvested fluctuated in recent years, but data from a subsistence harvesting study conducted in 2015 shows that halibut, salmon and cod are all staple subsistence foods in Akutan and comprise 76% of the major subsistence resources harvested by residents. Between 1991 and 2016, the estimated pounds of salmon harvested varied depending on availability, ranging from 1,000 to more than 18,000 pounds. Residents have also historically harvested a wide variety of species, but this has declined since 2008 as the species harvested and used have become more narrowed.

Unalaska/Dutch Harbor

The City of Unalaska and the port of Dutch Harbor are about 766 miles southwest of Anchorage, located on the Islands of Unalaska and Amaknak. The communities are connected by a bridge and are handled as a single community for this profile because of their socioeconomic interdependences. The City of Unalaska became incorporated in 1942 and it encompasses 111.0 square miles of land and 101.3 square miles of water. After World War II, the community evolved into the busy and prosperous commercial fishing and seafood processing port, and today it yields the nation’s largest volume of landings. The population of Unalaska in 2020 was 4,758 individuals.

The city owns six marine facilities, but fishing vessels are mainly moored at the Robert Storrs and Carl E. Moses boat harbors, or at Spit Dock. The Carl E. Moses and Robert Storrs facilities consist of 52 and 71 slips, respectively, whereas the Spit Dock has 2,400 linear feet of dock, along with multiple berths for long and short term moorage.

Commercial fishing and seafood processing play a significant role in the economic success of Unalaska. Major varieties of fish processed in Unalaska include king crab, Tanner crab, pollock, Pacific cod, salmon, herring, halibut, sablefish, turbot, Atka mackerel, and rockfish. As a result, commercial fishing and seafood processing provide a significant number of jobs and income to the community. For example, three of the largest employers in Unalaska are UniSea, Inc., Westward Seafoods, and Alyeska Seafoods, Inc. (EDAW, 2005).

Unlike many of the crab ports in the region, Unalaska also has extensive support services for the BS fisheries. The support services in Unalaska can support all range of services for any vessel class in the pollock, crab, and other groundfish fisheries. As a result, the support services are heavily dependent upon the success of the groundfish and crab fisheries. To some extent, the fleet services also contribute to the diversification of the Unalaska economy, which helps insulate the community from negative changes in individual fisheries. Unalaska participates in a broad suit of fisheries. From 2017-2022, halibut accounted for an average of 40.6% of the community’s harvest, Pacific cod 29.7%, and other fish 29.7%. In 2021, Unalaska harvested 2.7 million pounds of groundfish with an associate value of $1 million.

Unalaska is highly engaged in the crab processing sector. Dutch Harbor based processors received a substantial share of the PQS allocation in most crab fisheries under the CR Program. These shares are subject to rights of first refusal of the Dutch Harbor community entity. These shares are unlikely to migrate out of the community because crab processing at most facilities plays an important part in an integrated operation that serves several fisheries. The number of processing facilities in the region has increased since 2019 from 7 to 12. In 2021, Unalaska processed 19.2 million pounds crab with an associated value of $136 million (**Figure 0-3**. This marks a 22% increase (3.5 million pounds) in volume landed since 2019, and a 57% increase in landed value (up $49.9 million). The amount of BSAI crab processed in the region reached a peak of 35.4 million pounds (with a value of $112 million) in 2015, then began a steep decline. However, it has begun increasing again since 2019.

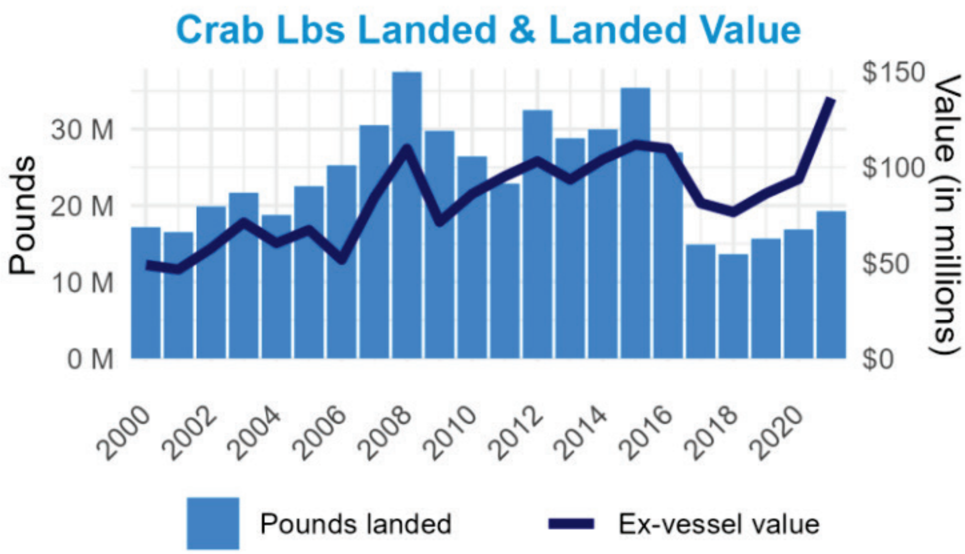

Figure 3 Crab landed (in lbs.) and total landed value of crab harvested by Unalaska/Dutch harbor residents
Source: 2023 ACEPO report

Residents own 3 federally permitted fishing vessels that were active in 2022. All of these commercial fishing vessels operated exclusively as catcher vessels, delivering to shoreside processors or motherships; were less than 60 feet in length; and utilized fixed gear (i.e., pots, hook and line). Due to confidentiality constraints, the specific activity of the Dutch Harbor/Unalaska fleet is withheld, as is shoreside processing. There were a substantial number of crew permits (68) and commercial fishing permits issued (28).

Residents of Unalaska are almost universally engaged in subsistence fishing, with 96.8% of all households utilizing fisheries resources (according to the most recent data available).12, The most common species include salmon, halibut, crabs (King crab, Tanner crab and Dungeness crab), cod, and rockfish. The high per capita harvest rates of both groundfish and crab indicate that residents of Unalaska rely on these species as key sources of nutrition in their diets.

King Cove

King Cove is located on the south side of the Alaska Peninsula and is about 605 miles southwest of Anchorage. The city was established in 1911, when Pacific American Fisheries constructed a salmon cannery. The city was incorporated in 1947 and encompasses 25.3 square miles of land and 4.5 square miles of water. The community lies on a sand spit, separated by King Cove Lagoon and King Cove, and is surrounded by rugged mountains. King Cove is an AEB community but not designed as a CDQ community. The population of King Cove in 2020 was 1,147 individuals.

King Cove's economy is solely dependent on commercial fishing and the seafood processing industry. There are two harbors that have moorage for 96 vessels with a maximum length of 165 feet, as well as a deep water pier for the state ferry, cruise ships, and cargo vessels. The community is home port to large crab vessels, and is also home to Peter Pan Seafoods, the only shore based processor located in the community. The plant processes salmon; crab; halibut; and groundfish.

Although the plant operates year- round, its peak seasons are in the winter and summer, when it employs up to 500 people (Himes-Cornell et al. 2013).

In 2022, King Cove residents owned 10 active federally permitted fishing vessels. All of these commercial fishing vessels operated exclusively as catcher vessels, delivering to shoreside processors or motherships. These catcher vessels were less than 60 feet in length and deployed fixed gear or trawl gear (three boats used both). The pot fleet of King Cove has 8 vessels, followed by halibut (3 vessels), and trawl (3 vessels). King Cove had 108 crewmember licenses issued. In 2022, 86 commercial fishing permits were issued to King Cove residents and actively fished, with salmon permits representing the largest number at 35, followed by 30 crab permits.

Residents of King Cove are moderately engaged in subsistence fishing activities within the groundfish and crab fisheries. Cod is the most utilized groundfish species by far, while King Crab and Tanner Crab are the most popular crab species. Compared to other communities, their harvested pounds per capita are on the lower end, however they have been highly stably engaged in halibut and salmon subsistence fishing. A study conducted by the Alaska Sustainable Salmon Fund in 2016 showed that the harvesting, processing, sharing and consumption of salmon, especially sockeye, was culturally essential for King Cove residents. While many residents still used traditional subsistence methods, many households had also begun meeting their subsistence needs by removing salmon for home use from their commercial harvests. In King Cove, nearly all households (91%) were found to use salmon, with 75% attempting to harvest and 59% receiving salmon from others. Overall, it was the most widely utilized wild resource by pounds. Changes and weather patterns, rising sea levels, and warming oceans were some of the environmental factors which had recently impacted residents' ability to harvest salmon. However, economic and social factors, such as access to funds to buy equipment and the influence of local canneries, also affected residents' harvest patterns.

Sand Point

Sand Point, also known as Qagun Tayagungin, is situated on Popof Island, off the southern coast of the Alaska Peninsula. The settlement of Sand Point was founded in 1898 as a cod fishing outpost and incorporated in 1946. Sand Point is home to one of the largest fishing fleets in the Aleutian Chain. Fisheries employs a number of seasonal workers each year. Included under the Alaska Native Claims Settlement Act (ANCSA), Sand Point was has three native tribes: The Qagan Tayagungin Tribe of Sand Point Village, the Native Village of Unga, and Pauloff Harbor Village. The population of King Cove in 2020 was 1,186 individuals.

Sand Point has marine facilities include a 25-acre boat harbor with four docks, 134 boat slips, a harbormaster office, barge off-loading area, and a 150-ton lift. Regular barge services supply the community. The state ferry operates between Sand Point and Unalaska, Akutan, False Pass, Cold Bay, and King Cove between May and October. Sand Points' economy is primarily based on commercial fishing and processing, with Trident Seafoods being a top employer.

The total number of resident owned fishing vessels decreased by 14 in 2021 (down 16% from 2019); this marks an upward trend from 2020 , which saw an all time low of 66. Ownership of groundfish vessels among residents also decreased since 2019, but increased slightly from a dip in 2020. These declines in 2020 are likely due to impacts from the COVID-19 pandemic

Commercial salmon harvest dominates the area's fisheries; however groundfish harvest accounted for an average of 18% of the total value landed over the past five years for these three communities.. In 2021, groundfish harvests were 26% of the total ex-vessel value landed in these communities, landing 12.2 million whole pounds, with an ex-vessel value of $3.1 million. Compared to 2019, this represents a 23% decline in pounds harvested and 32% in the associated value. Over the last five years, Pollock has on average accounted for 38.6% of the landed value within the processing sector in Akutan, King Cove, and Sand Point, while 14.7% is Pacific cod and 14.2% is salmon. The number of processing facilities has decreased by 1 since 2019 to just 5, processing 593 million pounds of groundfish with an ex-vessel value of $114 million in 2021.

Community engagement in the BSAI crab fisheries is varied. Due to the small number of participants, some data are Crab Harvesting Engagement LOW considered confidential. For this reason, data were aggregated to include adjacent communities within the Aleutians East Borough (AEB): Akutan, Sand Point, and King Cove communities. In 2021, 780,662 whole pounds of BSAI crab were harvested across Akutan, Sand Point, and King Cove, with an ex-vessel value of $3.1 million. A number of hired crew resides in these communities and residents continue to own crab licenses and quota shares, although participation has fluctuated. In 2021, there were 13 crew members working in the BSAI crab industry, and just 4 BSAI crab QS holders. This represents a slight increase of 2 crew members since 2019, but 1 fewer QS holder.

BSAI crab processing data has been aggregated for Akutan, King Cove, and Sand Point processing activities due to confidentiality reasons. These communities are highly engaged in the crab processing sector with seven processing facilities in the region. In 2021, these communities processed 7.5 million net pounds of crab with an associated exvessel value of $39 million. Compared to 2019, the volume decreased by 581,437 pounds (down 7%) and the value decreased by $5.7 million (down 12%). The amount of BSAI crab processed in the region reached a peak of 24.5 million pounds in 2015, quickly dropping to 16.3 million pounds the following year (down 33%) (**Figure 0-4**). Comparatively, the associated value dropped by $5.4 million or 7% during the same year. Both volume and landed value continued a steady decline since.

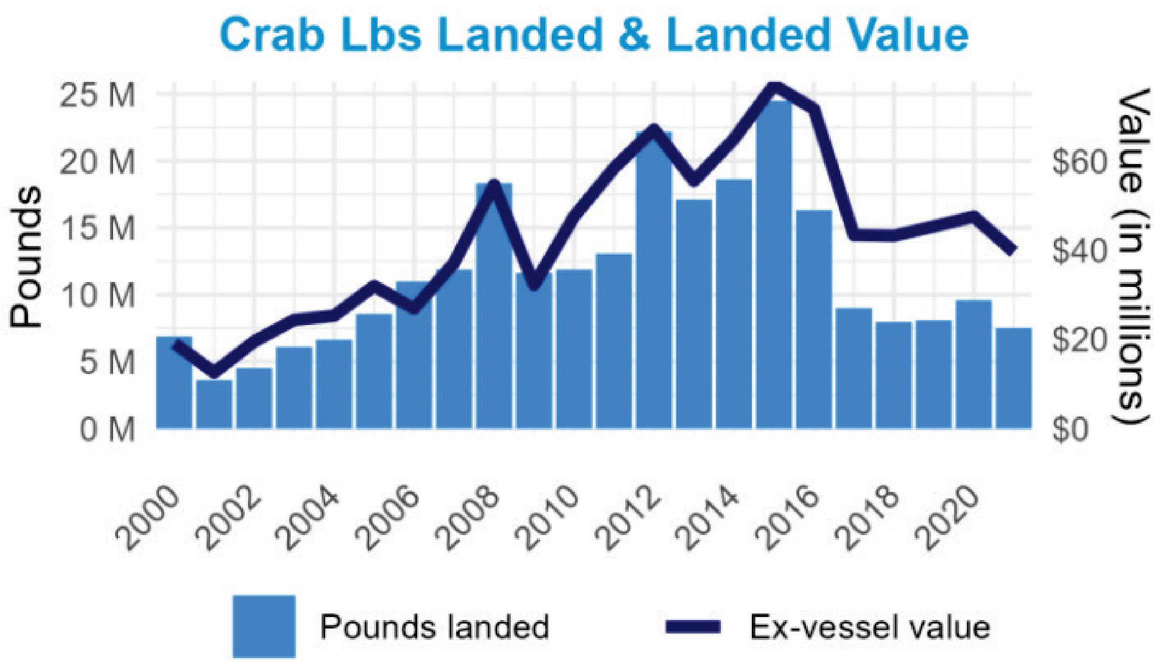

Figure 4 Crab landed (in lbs.) and total landed value of crab harvested by aggregated Sand point/King Cove/ Akutan residents
Source: 2023 ACEPO report

Residents of Sand Point rely heavily on certain species of groundfish for subsistence purposes, particularly cod and rockfish. They also rely heavily on crab species, including dungeness and king crab. According to Alaska Dept. of Fish and Game data, their subsistence harvests of halibut have increased since 2012, while their harvests of salmon have decreased. This is concerning, given that a study conducted by the Alaska Sustainable Salmon Fund in 2016 showed that the harvesting, processing, sharing and consumption of salmon, especially sockeye, was culturally essential for Sand Point residents. While many residents still used traditional subsistence methods, many households had also begun meeting their subsistence needs by removing salmon for home use from their commercial harvests. This study also showed that nearly every household in Sand Point (97%) used salmon, with 68% of households attempting to harvest and 66% receiving salmon from others.

Nome

Nome is located on the south coast of the Seward Peninsula. Historically, Malemiut, Kauweramiut, and Unalikmiut Iñupiat have occupied the area for thousands of years. Nome was a supply center for Russian whaling and trading in the mid 1800s; its population exploded during the Nome gold rush in 1898. Commercial exploitation of halibut and groundfish first extended into the Bering Sea region in 1928. King crab fisheries began in the 1950s, and Norton Sound is one of the fisheries historical centers. Nome is located in Pacific Halibut Fishery Regulatory Area 4E and the Bering Sea Sablefish Regulatory Area. The population of King Cove in 2020 was 9,865 individuals.

Nome's economy is based on public administration, fishing and other public-sector jobs. In recent years, 2017-2021, commercial harvest in Nome is predominantly focused on crab (59.2%), halibut (27.2%), and other groundfish species (13.6%). Among commercial fisheries in Nome, groundfish engagement has been low and primarily targeting Pacific cod. However, starting in 2020 and continuing in 2021, Pacific cod accounted for a much higher percentage of pounds harvested (74%) and harvest revenue (34%) than in previous years. During the same time period, both pounds harvested and harvest revenue fell significantly for crab and halibut. This was likely a consequence of the Red King Crab fishery closure in 2020. Today, Nome king crab fishermen hold both state-issued king crab permits, as well as permits in the Community Development Quota fishery. Norton Sound Seafood Products was established in 1995 and processes red king crab, salmon, and halibut.

Alaska FMP crab fisheries have struggled in recent years: hitting a peak in 2016 in both harvested volume and associated ex-vessel value, then beginning a steep decline. Bering Sea snow crab, Bristol Bay and Norton Sound Red King Crab have faced closures, late starts to the season, and reduced catch limits in recent years. In 2021, crab vessels registered in Nome harvested just 684 pounds of BSAI crab, a 98% decrease from 2019. The associated ex-vessel value in 2019 was $286,858, then down to $15,267 in 2021 (down 95%) (**Figure 0-5**) . Communities highly engaged in FMP crab fisheries, such as Nome, have undergone substantial economic and social challenges as a result of these declines, including loss of income, reduced opportunities, high levels of uncertainty, personal disruption, and increased food insecurity.

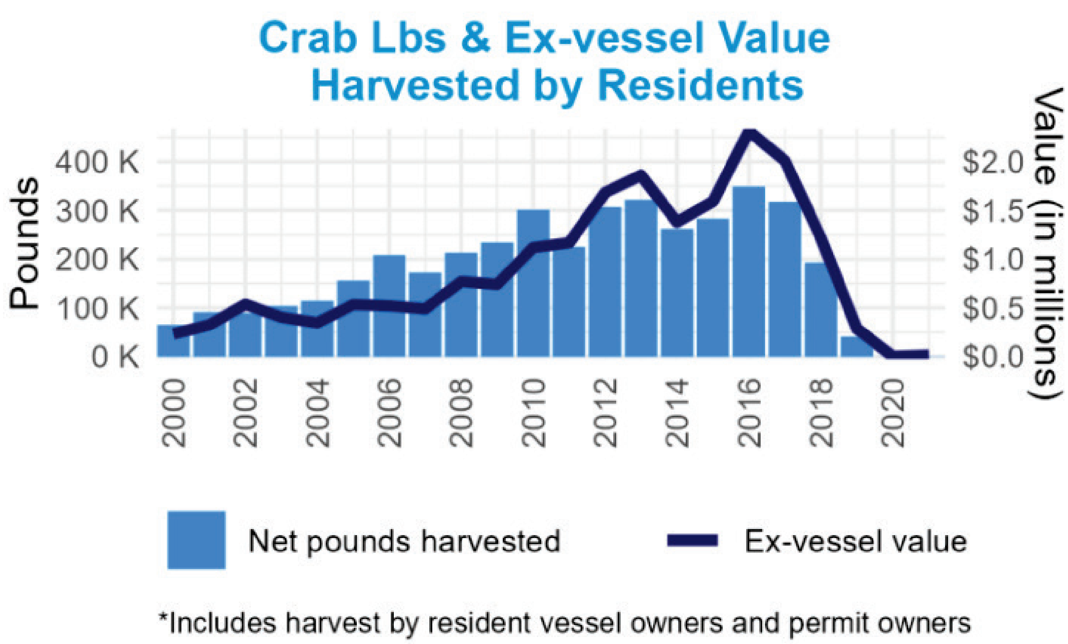

Figure 5 Crab harvested (in lbs.) and total ex-vessel value of crab harvested by Nome residents
Source: 2023 ACEPO report

In 2020, both the summer and winter Norton Sound red king crab (RKC) fisheries were closed due to low stock. To support rebuilding the stock, the Norton Sound Economic Development Corporation ceased purchasing RKC. This is reflected in the data which shows crab harvests and ex-vessel value decreased to zero in 2020, as well as lack of vessels and permits (**Figure 0-6**). Given simultaneous increases in harvests of Pacific cod during these two years, it is possible Nome fishermen attempted to compensate for the crab declines by engaging more in the groundfish fishery.

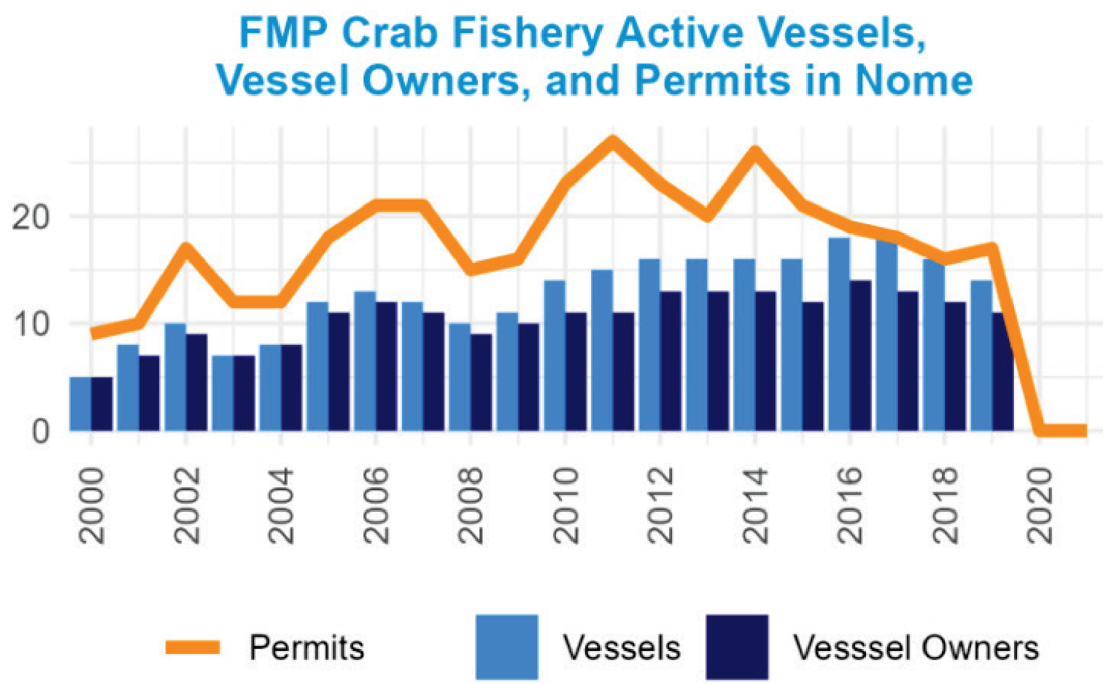

Figure 6 Number of Nome permits, vessels and vessel owners participating in the BSAI crab fisheries

The majority of the Alaska Native population in Nome depends heavily on local wild food resources such as salmon, tomcod, crab, and seal as important nutritional sources in their diets. According to Alaska Dept. of Fish and Game data, while subsistence harvests of halibut have fluctuated since 2012, 61 subsistence harvests of salmon have remained relatively constant and at a high level. Declines in salmon stocks have also been found to affect Nome residents, who have often turned to less regulated areas to subsistence fish when severe salmon fishing restrictions have been instituted. recent data from the Norton Sound overall show that from 2016-2020 there was an average of 2,873 pounds of red king crab caught for subsistence during the summer season and 8,844 pounds in the winter season. The summer saw an average of 40 subsistence harvesting permits issued, and the winter 121. These numbers decreased in 2021 to just 1,723 pounds harvested in the summer and 6,941 pounds in the winter. Winter permits also decreased to just 103, but summer permits increased to 42.1.

St. Paul

The community of St. Paul is located on a narrow peninsula on the southern tip of St. Paul Island, the largest of the five Pribilof Islands. It lies 47 miles north of St. George Island, 240 miles north of the Aleutian Islands, 300 miles west of the Alaska mainland, and 750 air miles west of Anchorage. St. Paul Island is located in the Aleutian Islands Recording District. The community encompasses 40.3 square miles of land and 255.2 square miles of water.

The population of St. Paul in 2020 was 399 individuals. The economy in St. Paul has focused on servicing the commercial fishing industry and the city is a port for the Central Bering Sea fishing fleet. Unlike King Cove, Akutan, or Unalaska, the majority of fisheries revenue for St. Paul depends almost entirely upon the processing of crab, with some halibut from local vessels typically processed in summer months as well. One shorebased processor exists on St. Paul Island, Trident Seafoods. Prior to the decline of the BS snow crab stock and closure of the fishery in 202/23, Trident Seafoods' processing operation in St. Paul existed as the largest crab production facility in the world (Himes-Cornell et al., 2013). In recent years on average, 96.5% of landed revenue by species came from crab for the city of St. Paul. With the majority of St. Paul's municipal tax revenue generated from fish tax, the closures of the Bristol Bay red king crab and BS snow crab fisheries have been particularly devastating to this community which is so dependent on crab.

St. Paul is a primary beneficiary of the North regional distribution of shares in the CR Program. This restriction on landings ensures that, when open, a substantial portion of the processing in the BS snow crab fishery is undertaken in St. Paul. The community of St. Paul also participates in the Western Alaska CDQ Program, under the Central Bering Sea Fishermen's Association (CBSFA), and receives an allocation of crab under that program.

In 2019, the island of St. Paul had six processing facilities, which landed 13.2 million pounds of crab with an associated value of $40.7 million. This marked an increase from the last two previous years; however compared to the previous five year average, there was an overall decreased in volume by 1.1 million pounds (8%) and increase of $39 million (4%) in landed ex-vessel value

St. Paul Island had also historically been the site of a number of mobile processing operations over the years either inside the harbor (with larger operations including UniSea and Icicle) or in the area but outside the harbor (including Norquest and a number of others) as the nature of the fishery and its economic incentives dictated, and by limitations imposed by weather.

No vessel owned by Saint Paul residents has been active since 2021. There were a small number of crew permits (3) and commercial fishing permits issued (6) to community residents. All commercial fishing permits were halibut permits.

Though subsistence was not historically practiced in local culture, today halibut and seal comprise many subsistence practiced on the island in exchange with other communities for salmon. St. Paul residents are also engaged heavily in subsistence harvesting of halibut. In 1994, 90.5% of households reported harvesting halibut, and according to more recent data, harvests of halibut, while fluctuating, have remained a constant activity for St. Paul residents.

Adak

The City of Adak is located on Kuluk Bay on the northeastern side of Adak Island, approximately 1,126 miles southwest of Anchorage. Adak Island is part of the Andreanof Islands group of the Aleutian Islands, and Adak is both the southernmost town in Alaska and the westernmost town in the United States. Adak covers 122 square miles of land and 4.9 square miles of water.

Historically, the island was inhabited by the Unangan people (Aleuts) but was abandoned in the early 1800s due to the eastward shifting fur trade and famine. During World War II, Adak was used as an army installation, and was later converted to a naval air station. The naval station officially closed in 1997. The Aleut Corporation acquired the majority of Adak's former military facilities in 2004. Since that time, the Aleut Corporation has continued its efforts to develop Adak as a civilian community with a private sector economy focused heavily on commercial fishing. According to the American Community Survey, there were 171 residents in Adak in 2021

Adak is home to one large shore-based processing plant, which is currently not operational. The Adak shoreplant has had numerous ownership changes since its establishment in 1999 as Adak Seafoods. Most recently, the City of Adak has been financially involved in the local seafood processing plant as it bought processing equipment from a former plant operator and then financed the sale of the gear to the most recent plant operator, which ceased operations in June 2020.

Adak is not eligible to participate in the CDQ program, but Adak Community Development Corporation (ACDC) is considered a Community Quota Entity on behalf of the community, which allows ACDC to purchase halibut catcher vessel quota share assigned to Area 4B and sablefish quota share assigned to the Aleutian Islands. In addition, as a result of Congressional action it receives a 10 percent allocation of WAG allocation to help foster the development and maintenance of sustained fisheries participation. Congressional action has also provided an allocation of AI pollock to the Aleut Corporation for the benefit of Adak, outside of the CDQ program.

Adak serves as a refueling point for boats, and provides access to an airport, ship repair and a grocery store. There is also one vessel owner that operates out of Adak.

Homer

Homer is located on the north shore of Kachemak Bay on the southwestern edge of the Kenai Peninsula. Homer is located in the traditional territory of the Kenaitze people, a branch of Athabascan Native Peoples. In 1895, the U.S. Geological Survey settled in the area to study coal and gold resources and named the community after Homer Pennock, a gold mining company promoter.2 Commercial fisheries began in the Cook Inlet in the mid 1800s with salmon and herring. Commercial exploitation of halibut and groundfish first extended into the Gulf of Alaska in the 1920s. The first year-round processing facility in Homer opened in 1954 specializing in frozen king crab and shrimp. The population of Homer in 2020 was 5,719 individuals.

The main economic contributors of Homer are commercial fishing, and tourism. Homer fishers are diversified in commercial fisheries, including salmon, halibut, crab, groundfish, and herring. Salmon remains the most abundant and valuable species; however, a wide range of fishing vessels use Homer as a base of fishing operations.

On average, from 2017-2021, the majority of harvest revenue came from salmon (66%), then halibut (15%). Fishing vessels owned by Homer residents continued a slight downward trend from a peak of 410 in 2015 to 390 in 2021 (5% decrease). Homer is one of the leading groundfish processing communities in Alaska. In 2021, Homer's processing sector processed 1.8 million pounds of groundfish with an associated value of $1.3 million. The number of processors fell slightly in 2020 to just 62, potentially due to the COVID-19 pandemic, but rose to 2019 levels in 2021 with 77 processors.

Homer's resident vessels harvesting BSAI crab fisheries saw a dramatic decline in both harvest volume and associated revenue beginning in 2016 when harvests decreased by 1.6 million pounds (44%), and $2.2 million (22%) from 2015. In 2017, harvests fell again by 1.4 million pounds (73%) and $5.5 million in associated revenue (70%). In 2021, Homer's resident vessels harvested 800 thousand pounds of BSAI crab with a value of $4 million (**Figure 0-7**). Quota shareholders have remained relatively constant in the last five years, ranging from 11 (2016) to 9 (2021). The number of crew residing in Homer participating in FMP crab fisheries decreased sharply in 2020, potentially due to the COVID-19 pandemic, but rebounded slightly in 2021 to 17. There is not a substantial amount of crab processing activity in Homer to report.

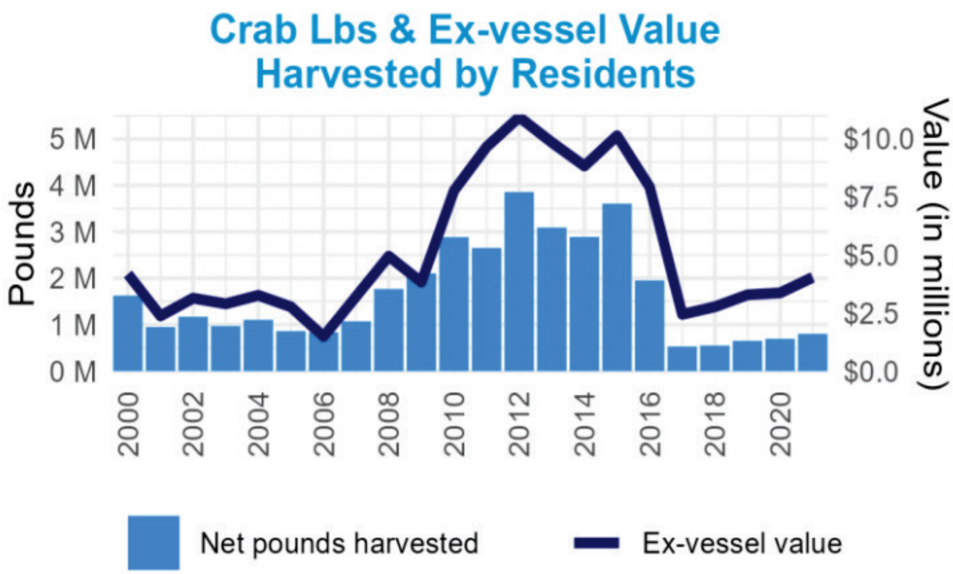

Figure 7 Crab harvested (in lbs.) and total ex-vessel value of crab harvested by Homer residents
Source: 2023 ACEPO report

The residents of Homer take part in a wide range of subsistence hunting and fishing activities. Historically, Homer residents have been highly engaged in subsistence uses of these two fisheries, particularly the crab fishery, and relied heavily on subsistence salmon.19 In 1998, a majority of residents were engaged in subsistence fishing activities which illustrates how ubiquitous subsistence fishing has been in the area.

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Appendix D Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC)

Table of Contents

List of Tables

List of Figures

1 Overview

Section 303(a)(7) of the Magnuson-Stevens Act requires that fisheries management plans (FMPs) describe and identify Essential Fish Habitat (EFH), minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to conserve and enhance EFH. FMPs must describe EFH in text, map EFH distributions, and provide information on habitat and biological requirements for each life history stage of the species. This appendix contains all of the required EFH provisions of the FMP, including the requirement in EFH regulations (50 Code of Federal Regulations [CFR] 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH.

In 2005 NMFS and the Council completed the Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska (EFH EIS, NMFS 2005). The EFH EIS provided a thorough analysis of alternatives and environmental consequences for amending the Council's FMPs to include EFH information pursuant to Section 303(a)(7) of the Magnuson-Stevens Act and 50 CFR 600.815(a). Specifically, the EFH EIS examined three actions: (1) describing and identifying EFH for Council managed fisheries, (2) adopting an approach to identify habitat areas of particular concern (HAPCs) within EFH, and (3) minimizing to the extent practicable the adverse effects of fishing on EFH. The Council's preferred alternatives from the EFH EIS were implemented through Amendment 16 to the BSAI King and Tanner Crab FMP and corresponding amendments to the Council's other FMPs.

The Council undertook the first five-year review of EFH in 2010 for the Council's managed species, which was documented in the Final EFH 5-year Review Summary Report (NPFMC and NMFS 2010). The review evaluated new information on EFH, including EFH descriptions and identification, and fishing and non-fishing activities that may adversely affect EFH. The review also assessed information gaps and research needs, and identified whether any revisions to EFH are needed or suggested. The Council identified various elements of the EFH descriptions meriting revision, and approved omnibus amendments 98/90/40/15/11 to the BSAI Groundfish FMP, the GOA Groundfish FMP, the BSAI King and Tanner Crab FMP, the Scallop FMP, and the Salmon FMP, respectively, in 2011. Amendment 11 to the Salmon FMP updated the description of EFH impacts from non-fishing activities, and EFH conservation recommendations for non-fishing activities; revised the timeline associated with the HAPC process to a 5-year timeline coinciding with the EFH 5-year review; and updated EFH research objectives in the FMP. While EFH identification and description for salmon species was considered as part of the 2010 EFH 5-year review, the implementation of changes was delayed because the methodology that has been proposed to revise EFH descriptions for salmon species was under peer review, and the Council determined to wait until the review process was complete before amendment this portion of the FMP.

From 2015 through 2017, the Council undertook a second five-year review of EFH for the Council's managed species, which was documented in the Final EFH 5-year Review Summary Report (Simpson et al. 2017). The review evaluated new information on EFH, including EFH descriptions and identification, and fishing and non-fishing activities that may adversely affect EFH. The review also assessed information gaps and research needs, and identified whether any revisions to EFH are needed or suggested. The Council identified various elements of the EFH descriptions meriting revision, and recommended omnibus amendments 115/105/49/13/2 to the BSAI Groundfish FMP, the GOA Groundfish FMP, the BSAI King and Tanner Crab FMP, the Salmon FMP, and the Arctic FMP, respectively, in 2017. Amendment 49 to the Crab FMP revised the EFH descriptions for crab species, and updated the analysis of fishing and non-fishing impacts to crab habitat in areas that are considered crab EFH.

2 Life History Features and Habitat Requirements of FMP Species

This section describes habitat requirements and life histories of the crab species managed by this FMP. Information contained in this appendix details life history information for federally managed crab species. Each species or species group is described individually. Habitat summary tables that denote habitat associations, biological associations, and predator and prey associations are also provided. In each section, a species-specific table summarizes habitat requirements.

2.1 Habitat Types

Bering Sea

The Bering Sea is a semi-enclosed, high-latitude sea. Of its total area of 2.3 million sq. km, 44 percent is continental shelf, 13 percent is continental slope, and 43 percent is deep-water basin. Its broad continental shelf is one of the most biologically productive areas of the world. The Eastern Bering Sea (EBS) contains approximately 300 species of fish, over 150 species of crustaceans and mollusks, 50 species of seabirds, and 26 species of marine mammals (Livingston and Tjelmeland 2000).

The dominant circulation of the water begins with the passage of North Pacific water (the Alaska Stream) into the EBS through the major passes in the Aleutian Islands (AI) (Favorite et al. 1976). The net current flows eastward along the north side of the AI and turns northward at the continental shelf break and at the eastern perimeter of Bristol Bay. Eventually EBS water exits northward through the Bering Strait, or westward and south along the Russian coast, entering the western North Pacific via the Kamchatka Strait. Some resident water joins new North Pacific water entering Near Strait, which sustains a permanent cyclonic gyre around the deep basin in the central Bering Sea (BS).

The EBS sediments are a mixture of the full range of potential grain sizes of mud (subgrades clay and silt), sand, and gravel. The proportion of each constituent determines the sediment type at any one location (Smith and McConnaughey 1999). Sand and silt are the primary components over most of the seafloor, with sand predominating in waters with a depth less than 60 m. In general, the fraction of finer-grade sediments increases (i.e. the average grain size decreases) with increasing depth and distance from shore. This grading is particularly noticeable on the southeastern BS continental shelf in Bristol Bay and immediately westward. The condition occurs because settling velocity of particles decreases with particle size (Stokes Law). Because the kinetic energy of sea waves reaching the bottom decreases with increasing depth, terrigenous grains entering coastal shallows drift with water movement until they are deposited at the depth at which water speed can no longer transport them. However, there is considerable fine-scale deviation from the graded pattern, especially in shallower coastal waters and offshore of major rivers, due to local variations in the effects of waves, currents, and river input (Johnson 1983).

The distribution of benthic sediment types in the EBS shelf is related to depth. Considerable local variability occurs in areas along the shore of Bristol Bay, the north coast of the Alaska Peninsula, and west and north of Bristol Bay, especially near the Pribilof Islands. In general, nearshore sediments in the east and southeast on the inner shelf (0 to 50 m depth) are sandy gravel and gravelly sand, transitioning to plain sand farther offshore and west. On the middle shelf (50 to 100 m), sand transitions to muddy sand and sandy mud, which continue over much of the outer shelf (100 to 200 m) to the the continental slope. Sediments on the central and northeastern shelf (including Norton Sound) have not been extensively sampled, but Sharma (1979) reports that, although sand is dominant in places, as it is in the southeast, there are deposits of silt both in shallow nearshore waters and in deep areas near the shelf slope. In addition, there are areas of exposed relic gravel, possibly deposited by glaciers. These departures from a classic seaward decrease in grain size are due to the large input of fluvial silt from the Yukon River and to flushing and scouring of sediment through the Bering Strait by the net northerly current.

McConnaughey and Smith (2000) and Smith and McConnaughey (1999) describe the available sediment data for the EBS shelf. These data were used to describe four habitat types. The first, situated around the shallow eastern and southern perimeter and near the Pribilof Islands, has primarily sand substrates with a little gravel. The second, across the central shelf out to the 100 m contour, has mixtures of sand and mud. A third, west of a line between St. Matthew and St. Lawrence islands, has primarily mud (silt) substrates, with some sand. Finally, the areas north and east of St. Lawrence Island, including Norton Sound, have a complex mixture of substrates.

Important water column properties in the EBS include temperature, salinity, and density. These properties remain constant with depth in the near-surface mixed layer, which varies from approximately 10 to 30 m in summer to approximately 30 to 60 m in winter (Reed 1984). The inner shelf (less than 50 m) is, therefore, one layer and is well mixed most of the time. On the middle shelf (50 to 100 m), a two-layer temperature and salinity structure exists because of downward mixing of wind and upward mixing due to relatively strong tidal currents (Kinder and Schumacher 1981). On the outer shelf (100 to 200 m), a three-layer temperature and salinity structure exists due to downward mixing by wind, horizontal mixing with oceanic water, and upward mixing from the bottom friction due to relatively strong tidal currents. Oceanic water structure is present year-round beyond the 200-m isobath.

Three fronts, the outer shelf, mid-shelf, and inner shelf, follow along the 200-, 100-, and 50-m bathymetric contours, respectively; thus, four separate oceanographic domains appear as bands along the broad EBS shelf. The oceanographic domains are the deep water (more than 200 m), the outer shelf (200 to 100 m), the mid-shelf (100 to 50 m), and the inner shelf (less than 50 m).

The vertical physical system regulates the biological processes leading to different cycles of nutrient regeneration. The source of nutrients for the outer shelf is the deep oceanic water; for the mid-shelf, it is the shelf-bottom water. In winter, surface waters across the shelf are high in nutrients. Spring surface heating stabilizes the water column, the spring bloom follows and consumes the nutrients. Steep seasonal thermoclines over the deep EBS (30 to 50 m), the outer shelf (20 to 50 m), and the mid-shelf (10 to 50 m) restrict vertical mixing of water between the upper and lower layers. Below these seasonal thermoclines, nutrient concentrations in the outer shelf water are higher than those in the deep EBS water with the same salinity. Winter values for nitrate-N/phosphate-P are similar to the summer ratios, which suggests that, even in winter, the mixing of water between the mid-shelf and the outer shelf domains is substantially restricted (Hattori and Goering 1986).

Effects of a global warming climate should be greater in the EBS than in the GOA. Located further north than the GOA, the seasonal ice cover of the EBS lowers albedo effects. Atmospheric attributes that are predicted to change ocean conditions include increased air temperature, pCO_2, storm intensity, storm frequency, southerly wind, humidity, and precipitation. Increased precipitation, plus snow and ice melt, would lead to increased freshwater runoff. The predicted decrease in sea level pressure is associated with the northward shift in the storm track. Although the location of the maximum in the mean wind stress curl will probably shift poleward, how the curl is likely to change is unknown. The net effect of the storms largely determines the curl, and there is likely to be compensation between changes in storm frequency and intensity.

Ocean circulation decreases are likely to occur in the major current systems: the Alaska Stream, Near Strait Inflow, Bering Slope Current, and Kamchatka Current. Competing effects make changes in the Unimak Pass inflow, the shelf coastal current, and the Bering Strait outflow difficult to predict. Changes in hydrography should include increases in sea level, sea surface temperature, shelf bottom temperature, pCO_2 (with an accompanying decrease in pH), and basin stratification. Decreases should occur in mixing energy and shelf break nutrient supply, while competing effects make changes in shelf stratification and eddy activity unknown. Ice extent, thickness, and brine rejection are all expected to decrease.

Temperature anomalies in the EBS illustrate a relatively warm period in the late 1950s, followed by cooling, especially in the early 1970s, and then by a rapid temperature increase in the latter part of that decade. For more information on the physical environment of the EBS, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

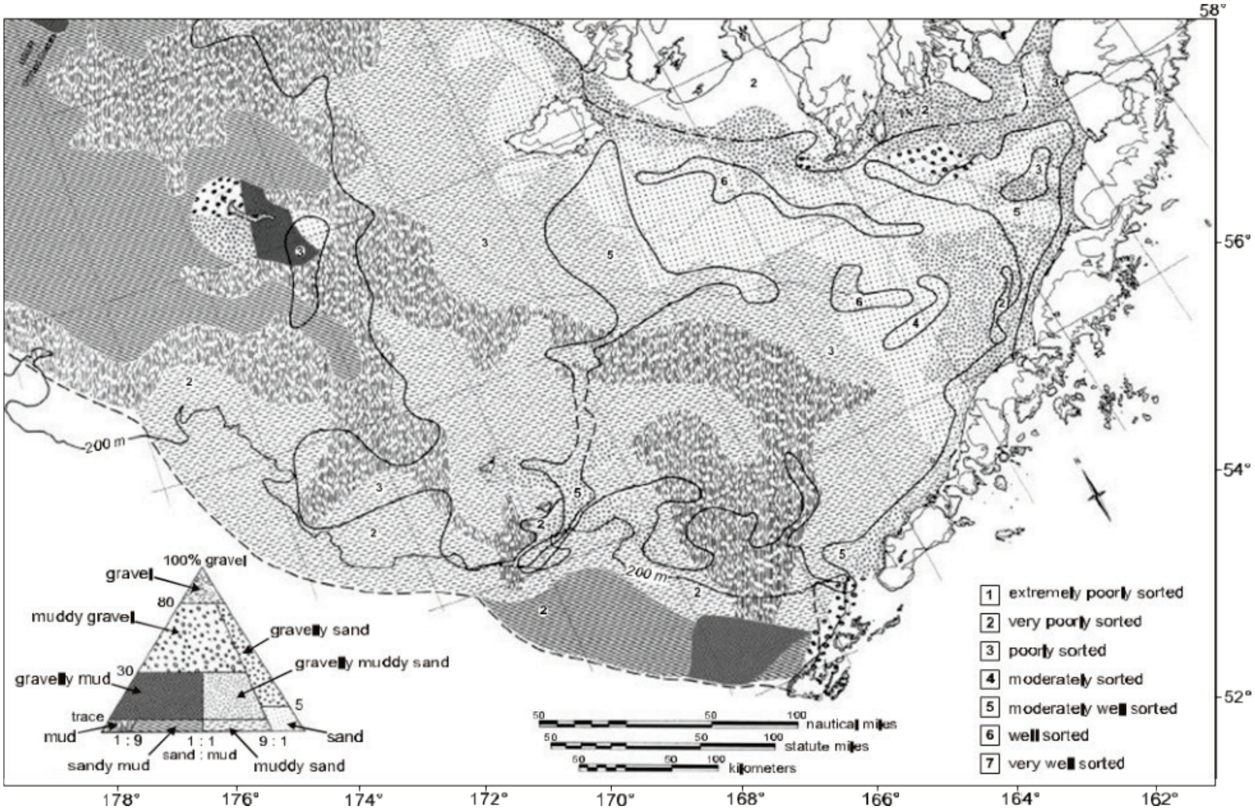

Figure 1 Distribution of Bering Sea Sediments. Source: Smith and McConnaughey 1999

Aleutian Islands

The Aleutian Islands lie in an arc that forms a partial geographic barrier to the exchange of northern Pacific marine waters with EBS waters. The AI continental shelf is narrow compared with the EBS shelf, ranging in width on the north and south sides of the islands from less than 4 km to 46 km; the shelf broadens in the eastern portion of the AI arc. The AI comprises approximately 150 islands and extends about 2,260 km in length.

Bowers Ridge in the AI is a submerged geographic structure forming a ridge arc off the west-central AI, approximately 550 km long and 75 to 110 km wide. The summit of the ridge is 150 to 200 m deep in the southern portion, deepening northward to about 800 to 1,000 m at its northern edge.

The AI region has complicated mixes of substrates, including a significant proportion of hard substrates (pebbles, cobbles, boulders, and rock), but data are not available to describe the spatial distribution of these bottom types. The patterns of water density, salinity, and temperature are similar to the GOA. Along the edge of the shelf in the Alaska Stream, a low salinity (less than 32.0 ppt) tongue-like feature protrudes westward. On the south side of the central AI, nearshore surface salinities can reach as high as 33.3 ppt, as the higher salinity EBS surface water occasionally mixes southward through the AI. Proceeding southward, a minimum of approximately 32.2 ppt is usually present over the slope in the Alaska Stream; values then rise to above 32.6 ppt in the oceanic water offshore. Whereas surface salinity increases toward the west as the source of fresh water from the land decreases, salinity values near 1,500 m decrease very slightly. Temperature values at all depths decrease toward the west.

Climate change effects on the AI area are similar to the effects described for climate change in the EBS. For more information on the physical environment of the AI, refer to the Alaska Groundfish Fisheries Programmatic Supplemental EIS (NMFS 2004).

2.2 General Life History Information for Crabs

Shallow inshore areas (less than 50 m depth) are very important to king crab reproduction as the adults move onshore to molt and mate. Tanner crabs also occupy shallower depths during molting and mating. All BSAI crab are highly vulnerable to predation and damage during molting when they shed their exoskeleton. Female king crab molt annually and must mate annually while Tanner and snow crab have a terminal molt to maturity and can store sperm internally for future clutch fertilization. The habitat occupied by molting and mating crab differs from that occupied by mature crabs during the remainder of the year. The EFH EIS crab technical team noted protection of crab in molting mating habitat during this sensitive life history stage as important.

Larval stages are planktonic for 2-3 months and their vertical distribution in the water column is determined by swimming behavior, currents, vertical mixing, or water column stratification. Generally, the larval stages are thought to occupy the upper 40 m of the water column, within the mixed layer. After molting through multiple larval stages, post-larvae settle on the ocean bottom. Habitat with adequate shelter, food, and temperature is imperative to survival of newly settling crabs. Young of the year red and blue king crabs require habitat with crevice spaces (e.g., structural invertebrates, macroalgae, shell hash, cobble, shale) that offers protection, which typically occurs in nearshore areas. Both species rely on cryptic behavior in complex habitat to reduce predation risk. Early juvenile stage Tanner and snow crab also occupy shallow waters and are found on mud habitat. Late juvenile stage crab are most active at night when they feed and molt.

Egg Stage
Female king and Tanner crabs extrude eggs, carry and nurture them outside the maternal body under their abdominal flap. Thus the habitat for eggs is the same as for egg-bearing females. The number of eggs produced by the female increases with body size.

Larval Stage
Successful hatch of king and Tanner crab larvae is a function of temperature and concentration of diatoms, so presence of larvae in the water column can vary accordingly. Crab larvae are planktonic: horizontal swimming is inconsequential compared to horizontal advection by oceanographic conditions. Larvae vertically migrate in the water column, which impacts the extent of horizontal transport as current direction and strength can vary with depth. Behaviors such as diel vertical migration may be a retention mechanism to transport larvae inshore.

Early Juvenile Stage
The early juvenile stage includes crabs first settling on the bottom as post-larvae (glaucothoe and megalopae) up to approximate size at age 2. Habitat complexity is obligatory for red and blue king crabs of this life stage and individuals less than 20 mm carapace length (CL) are typically distributed in nearshore waters among niches provided by sea star arms, anemones, shell hash, rocks and other complex habitat types. Early juvenile Tanner crab settle on mud, occur there during summer, but are not easily found in this habitat in winter.

Late Juvenile Stage
The late juvenile stage for crab is defined as the size at about age 2 to the first size of functional maturity. Late juvenile crabs are typically found further offshore in cooler water than early juvenile crabs. Smaller red king crabs of this life stage form pods during the day that break apart during the night when the crabs forage and molt. As these crabs increase in size, podding behavior declines and the animals forage throughout the day.

Mature Stage

Mature crabs are defined as those crabs of a size that is functionally mature. Functional maturity is based on size observed in mating pairs of crabs. This maturity definition differs from morphometric maturity based on chela height and physiological maturity when spermatophores or oocytes can be produced. The mature stage includes crabs from the first size of functional maturity to senescence.

Table 1 Summary of habitat associations for BSAI crab species

BSAI Crab Species	Life Stage	Nearshore				Shelf			Slope						Stratum Reference						
						Inner	Middle	Outer	Upper		Intermediate		Lower	Basin							
		Freshwater	Estuarine	Intertidal	Subtidal	1-50m	51-100m	101-200m	201-300m	301-500m	501-700m	701-1000m	1001-3000m	>3000m	Shallows	Island Pass	Bay/Fjord	Bank	Flat	Edge	Gully
Blue King Crab	M					x	x	x													
	LJ					x	x	x													
	EJ			x	x	x	x														
	L					x	x														
	E					x	x	x													
Golden King Crab	M							x	x	x	x	x				x		x			
	LJ												x	x				x			
	EJ												x	x							
	L																				
	E							x	x	x	x							x			
Red King Crab	M					x	x	x													
	LJ					x	x	x													
	EJ			x	x	x	x														
	L					x	x														
	E					x	x	x													
Snow Crab	M					x	x	x													
	LJ					x	x	x													
	EJ					x	x														
	L					x	x														
	E					x	x	x													
Tanner Crab	M					x	x	x	x	x	x						x	x			
	LJ			x	x	x	x	x	x	x								x			
	EJ			x	x	x	x	x	x	x								x			
	L		x	x	x	x	x														
	E				x	x	x	x	x	x	x	x									

BSAI Crab Species	Life Stage	Location							Physical Oceanography					Substrate												
						Pelagic																				
		Surafce	Near surface	Semi-demersal	Demersal	1-200m (epi)	201-1000m (meso)	>1000m (bathy)	Upwelling areas	Gyres	Thermo/pycnocline	Fronts	Edges (ice, bath)	Organic Debris	Mud	Sand	Gravel	Mud & sand	Mud & gravel	Sand & mud	Gravel & mud	Gravel & sand	Gravel & sand & mud	Gravel & mud & sand	Cobble	Rock
Blue King Crab	M				x											x	x								x	x
	LJ				x											x	x								x	x
	EJ				x																				x	x
	L					x																				
	E				x											x	x								x	x
Golden King Crab	M				x											x	x								x	x
	LJ				x											x	x								x	x
	EJ				x																					
	L																									
	E				x											x	x								x	x
Red King Crab	M				x									x	x	x	x	x	x	x	x	x	x	x		
	LJ				x									x	x	x	x	x	x	x	x	x	x	x		
	EJ				x												x								x	x
	L					x																				
	E				x									x	x	x	x	x	x	x	x	x	x	x		
Snow Crab	M				x									x	x	x	x	x	x	x	x	x	x	x		
	LJ				x									x	x	x	x	x	x	x	x	x	x	x		
	EJ				x									x	x	x	x	x	x	x	x	x	x	x		
	L					x																				
	E				x									x	x	x	x	x	x	x	x	x	x	x		
Tanner Crab	M				x							x		x	x	x	x	x	x	x	x	x	x	x	x	
	LJ				x						x	x		x	x	x	x	x	x	x	x	x	x	x	x	
	EJ				x									x	x	x	x	x	x	x	x	x	x	x	x	
	L					x						x	x													
	E				x							x		x	x	x	x	x	x	x	x	x	x	x	x	

BSAI Crab Species	Life Stage	Structure										Community Associations												Oceano-graphic Properties			
		Bars	Sinks	Slumps\Rockfalls\Debris	Channels	Ledges	Pinnacles	Seamounts	Reefs	Vertical Walls	Man-made	Algal Cover	Anenomes	Enchinoderms	Soft Coral	Hard Coral	Mollusca	Drift Algae\Kelp	Kelp	Polychaetes	Sea Grasses	Sea Onions	Tunicates	Temperature (Celsius)	Salinity (ppt)	Oxygen Conc (ppm)	Life Stage
Blue King Crab	M			x	x	x	x		x	x			x	x	x		x			x							M
	LJ			x	x	x	x		x	x			x	x	x		x			x							LJ
	EJ																x										EJ
	L																										L
	E			x	x	x	x		x	x			x	x	x		x			x							E
Golden King Crab	M			x	x	x	x	x	x	x			x	x	x		x			x				<5	>30		M
	LJ			x	x	x	x		x	x			x	x	x		x			x				<5	>30		LJ
	EJ																							<5	>30		EJ
	L																							<5	>30		L
	E			x	x	x	x		x	x			x	x	x		x			x				<5	>30		E
Red King Crab	M												x	x	x		x			x							M
	LJ												x	x	x		x			x							LJ
	EJ											x					x			x		x					EJ
	L																										L
	E												x	x	x		x			x							E
Snow Crab	M																										M
	LJ																										LJ
	EJ																										EJ
	L																										L
	E																										E
Tanner Crab	M	x	x	x	x			x			x		x	x	x	x	x	x	x	x		x	x	>4	>30		M
	LJ	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		LJ
	EJ	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		EJ
	L																							>4	>30		L
	E	x	x	x	x						x		x	x	x	x	x	x	x	x		x	x	>4	>30		E

Table 2 Summary of Reproductive Traits of BSAI Crab

BSAI Crab		Reproductive Traits																										
		Age at Maturity				Fertilization/Egg Development					Spawning Behavior						Spawning Season											
		Female		Male																								
Species	Life Stage	50%	100%	50%	100%	External	Internal	Oviparous	Ovoviviparous	Viviparous	Batch Spawner	Broadcast Spawner	Egg Case Deposition	Nest Builder	Egg/Young Guarder	Egg/Young Bearer	January	February	March	April	May	June	July	August	September	October	November	December
Blue King Crab	M	6+			6+	X		X								X	X	X	X	X	X	X	X					
	LJ																											
	EJ																											
	L																											
	E																											
Golden King Crab	M	6+			6+	X		X								X	X	X	X	X	X	X	X	X	X	X	X	X
	LJ																											
	EJ																											
	L																											
	E																											
Red King Crab	M	7 to 8		7 to 10		X		X								X	X	X	X	X	X	X	X					
	LJ																											
	EJ																											
	L																											
	E																											
Snow Crab	M	5 to 6		6 to 8		X	X	X								X	X	X	X	X	X	X						
	LJ																											
	EJ																											
	L																											
	E																											
Tanner Crab	M	5 to 6		6 to 8		X	X	X								X	X	X	X	X	X	X						
	LJ																											
	EJ																											
	L																											
	E																											

Table 3 Summary of predator and prey associations for BSAI crab species

Predator to

BSAI Crab Species	Life Stage	Algae	Plants	Plankton	Zooplankton	Diatoms	Sponges	Eusphausiid	Hydroids	Amphipoda	Copepods	Starfish	Polychaetes	Squid	Philodae (gunnels)	Bi-valves	Other - Mollusks	Crustaceans	Ophiuroids (brittle stars)	Shrimps, mysidacae	Sand lance	Osmerid (eulachon)	Herring	Myctophid (lantern fishes)	Cottidae (sculpins)	Arrowtooth	Salmon	Cod	Pollock	Halibut
Blue King Crab	M								x			x	x			x	x	x	x	x										
	LJ								x			x	x			x	x	x	x	x										
	EJ																													
	L			x	x																									
	E																													
Golden King Crab	M								x			x	x			x	x	x	x											
	LJ								x			x	x			x	x	x												
	EJ																													
	L																													
	E																													
Red King Crab	M								x			x	x			x	x	x	x	x										
	LJ								x			x	x			x	x	x	x	x										
	EJ	x				x	x			x	x		x																	
	L			x	x																									
	E																													
Snow Crab	M												x			x	x	x	x	x										
	LJ								x				x			x	x	x	x	x										
	EJ								x	x			x					x												
	L			x	x																									
	E																													
Tanner Crab	M								x			x	x			x	x	x		x										
	LJ								x			x	x			x	x	x		x										
	EJ																													
	L	x		x	x	x																								
	E																													

Prey of

BSAI Crab Species	Life Stage	Jellyfish	Starfish	Chaetognaths (arrowworms)	Crab	Herring	Salmon	Pollock	Pac fic Cod	Ling Cod	Rockfish	Rock Sole	Flathead Sole	Yellowfin sole	Arrowtooth flounder	Skate	Hailbut	Cottidae (sculpins)	Eel pouts	Salmon Shark	Northern Fur Seal	Harbor Seal	Steller sea lion	Dalls Porpoise	Beluga whale	Killer Whale	Minke whale	Eagles	Murres	Puffin	Kittiwake	Gull	Terrerstrial Mammals
Blue King Crab	M								x								x																
	LJ				x				x								x																
	EJ				x				x								x																
	L																																
	E																																
Golden King Crab	M								x								x																
	LJ								x								x																
	EJ								x								x																
	L																																
	E																																
Red King Crab	M							x	x								x																
	LJ				x			x	x			x	x	x	x	x	x																
	EJ				x			x	x			x	x	x	x	x	x	x															
	L																																
	E																																
Snow Crab	M				x				x									x															
	LJ				x				x			x	x		x	x	x	x	x														
	EJ				x				x									x	x														
	J																																
	L																																
Tanner Crab	M				x				x									x	x														
	LJ				x			x	x		x	x	x	x	x	x	x	x	x														
	EJ				x			x	x		x	x	x		x	x	x	x	x														
	L	x		x		x	x	x						x																			
	E																																

2.3 Habitat Description for Red King Crab (*Paralithodes camtschaticus*)

Abbreviations used in the habitat tables to specify location, position in the water column, bottom type, and other oceanographic features are provided in Table 4.

Table 4 Abbreviations used in the EFH report tables to specify location, depth, bottom type, and other oceanographic features

Location

ICS =	inner continental shelf (1–50 m)	USP =	upper slope (200–1000 m)
MCS =	middle continental shelf (50–100 m)	LSP =	lower slope (1000–3000 m)
OCS =	outer continental shelf (100–200 m)	BSN=	basin (>3000 m)
BCH =	beach (intertidal)		
BAY =	nearshore bays, give depth if appropriate (e.g., fjords)		
IP =	island passes (areas of high current), give depth if appropriate		

Water column

D =	demersal (found on bottom)
SD/SP =	semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P =	pelagic (found off bottom, not necessarily associated with a particular bottom type)
N =	neustonic (found near surface)

Bottom Type

M = mud	S = sand	R = rock
SM = sandy mud	CB = cobble	C = coral
MS = muddy sand	G = gravel	K = kelp
SAV = subaquatic vegetation (e.g., eelgrass, not kelp)		

Oceanographic Features

UP = upwelling	G = gyres	F = fronts	E = edges
CL = thermocline or pycnocline			

General

U = Unknown	N/A = not applicable

Life History and General Distribution

Red king crab (*Paralithodes camtschaticus*) is widely distributed throughout the BS and AI, GOA, Sea of Okhotsk, and along the Kamchatka shelf, typically at depths less than 100 fathoms (fm). King crab molt multiple times per year through age 3 after which molting is annual. At larger sizes, king crab may skip molt as growth slows. Females grow more slowly than and do not get as large as males. In Bristol Bay, 50 percent maturity is attained by males at approximately 12 cm CL and 9 cm CL by females (about 7 years). Female red king crab in the Norton Sound area reach 50 percent maturity at approximately 7 cm and do not attain maximum sizes found in other areas. Size at 50 percent maturity for females in the western Aleutians is 8.9 cm CL. Natural mortality of adult red king crab is assumed to be about 18 percent per year (M=0.2), due to old age, disease, and predation.

The EFH EIS crab technical team emphasized the importance of shallow areas to all early juvenile stage crabs and in particular the importance to red and blue king crabs of high relief habitat nearshore with extensive biogenic assemblages. The area north and adjacent to the Alaska peninsula (Unimak Island to Port Moller), the eastern portion of Bristol Bay, and nearshore areas of the Pribilof and Saint Matthew Islands are locations known to be particularly important for king crab spawning and juveniles.

Relevant Trophic Information

Pacific cod is a known predator on adult red king crabs and likely primarily targets newly molted softshell crabs. Walleye pollock, yellowfin sole, and Pacific halibut are minor consumers of pelagic larvae, settling larvae, and larger crabs, respectively. Juvenile crab may be cannibalistic. Other known predators of juveniles in the GOA include hermit crabs, Alaskan ronquil, Arctic shanny, northern rock sole, sculpins, and kelp greenling. It is likely that other similar crustaceans and fish are predators but data is limited.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is approximately 7 and 9 cm CL for female and male red king crabs, respectively, from Norton Sound and St. Matthew and St. Lawrence Islands; it is approximately 9 cm for females and 12 cm for males in Bristol Bay and the Pribilof and Aleutian Islands.

Habitat and Biological Associations

Egg: In southeast Alaska egg hatch of larvae is synchronized with the spring phytoplankton bloom suggesting temporal sensitivity in the transition from benthic to planktonic habitat. Also see mature phase description; eggs are carried by adult female crab.

Larvae: Red king crabs spend 2 to 3 months in pelagic larval stages before settling to the benthic life stage. In the BS, larvae are thought to undergo diel vertical migration, which may serve to balance feeding opportunities and predator avoidance.

Early Juvenile: Early juvenile stage red king crabs are solitary and need complex habitat, consisting of coarse substrate (i.e., boulders, cobble, shell hash) or structural invertebrates (e.g., bryozoans, stalked ascidians). Young-of-the-year crabs occur at depths of 50 m or less.

Late Juvenile: Late juvenile stage red king crabs of 2 and 4 years exhibit decreasing reliance on complex habitat and a tendency for the crab to form pods consisting of hundreds to thousands of crabs. Late juvenile crab associate with deeper waters and migrate to shallower water for molting and mating in the spring. Aggregation behavior continues into adulthood.

Mature: Mature red king crabs exhibit seasonal migration to shallow waters for reproduction. The remainder of the year, red king crabs are found in deeper waters. In Bristol Bay, red king crabs mate when they enter shallower waters (less than 50 m). Timing of mating is variable, depending on water temperature, and can occur January through June. Males grasp females just prior to female molting, after which the eggs (43,000 to 500,000 eggs) are extruded and fertilized on the female's abdomen. The female red king crab carries the eggs for approximately 10 to 12 months before they hatch, generally in April.

Table 5 Red king crab, Paralithodes camtschaticus (abbreviations are in Table 4)

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs	10–12 mo	NA	Jan–April	NA	NA	NA	F	
Larvae	3–5 mo	Diatoms, Phytoplankton Copepod nauplii	April–August	MCS, JCS	P	NA	F	
Juveniles	1 to 5–6 yrs	Diatoms Hydroids	All year	ICS, MCS, BCH, BAY	D	(epifauna), R, CB, G	F	Found among biogenic assemblages (sea onions, tube worms, bryozoans, ascidians, sea stars)
Adults	5–6+ yrs	Mollusks, echinoderms, polychaetes, decapod, crustaceans, Algae, urchins, hydroids, sea stars	Spawning Jan– June	MCS, ICS, BAY, BCH	D	S, M, CB, G	F	

2.4 Habitat Description for Blue King Crab *(Paralithodes platypus)*

Life History and General Distribution

Blue king crab (*Paralithodes platypus*) has a discontinuous distribution throughout its range (Hokkaido, Japan to Southeast Alaska). In the BS, discrete populations exist in the cooler waters around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. Smaller populations have been found in Herendeen Bay and around Nunivak and King Island, as well as isolated populations in the GOA. Blue king crab molt multiple times as juveniles. In the Pribilof area, 50 percent maturity of females is attained at approximately 9.6 cm CL, which occurs at about 5 years of age. Blue king crab in the St. Matthew area mature at smaller sizes (50 percent maturity at approximately 8.1 cm CL for females) and do not get as large overall. Skip molting occurs with increasing probability for those males larger than 10 cm CL and is more prevalent for St. Matthew Island crab. Larger female blue king crab have a biennial ovarian cycle and a 14-month embryonic period. Adult male blue king migrate offshore to deeper waters and soft-bottomed habitats.

Relevant Trophic Information

Pacific cod is a predator on blue king crabs.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 10- and 12-cm CL for female and male crabs, respectively, from the Pribilof Islands, and 8- and 10.5-cm CL for St. Matthew Island female and male crabs, respectively.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Blue king crab larvae spend 3.5 to 4 months in pelagic larval stages before settling to the benthic life stage. Larvae are found in waters between 40 and 60 m deep. There is some evidence that blue king crab larvae exhibit diel vertical migration, but data is limited.

Early Juvenile: Early juvenile blue king crabs require ample crevice spaces for refuge from predators and foraging opportunities. Such substrates are typically characterized by gravel and cobble overlaid with shell hash and sponge, hydroid, and barnacle assemblages, which have been observed around the Pribilof Islands at 40 to 60 m depths. Early juveniles also occur in shallower water up to the intertidal in Herendeen Bay in rocky substrates and they may occur in similar habitats in other areas.

Late Juvenile: Late juvenile blue king crab are found in nearshore rocky habitat with shell hash.

Mature: Mature blue king crabs occur most often between 45 and 75 m deep on mud-sand substrate adjacent to gravel rocky bottom. Female crabs are found in a habitat with a high percentage of shell hash. Mating occurs in mid-spring. Larger older females reproduce biennially, while small females tend to reproduce annually. Fecundity of females range from 50,000 to 200,000 eggs per female. Spawning may depend on the availability of nearshore rocky-cobble substrate for protection of females. Larger older crabs disperse farther offshore and are thought to migrate inshore for molting and mating.

Table 6 Blue king crab, Paralithodes platypus (abbreviations are in Table 4)

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	14 mo.	NA	Starting April-May	NA	NA	NA	F	
Larvae	3.5 to 4 mo.		April-July	MCS, ICS	P	NA	F	
Juveniles	to about 5 years		All year	MCS, ICS, BAY, BCH	D	CB, G, R	F	
Adults	5+ years		Spawning Feb-Jun	MCS, ICS	D	S, M, CB, G, R	F	

2.5 Habitat Description for Golden King Crab (*Lithodes aequispina*)

Life History and General Distribution

Golden king crab (*Lithodes aequispina*), also called brown king crab, range from Japan to British Columbia. In the BS and AI, golden king crab are found at depths from 100 to 1,000 m, generally in high relief habitat such as inter-island passes, and they are usually slope-dwelling. Size at sexual maturity depends on latitude and ranges from 9.2 to 12.5 cm CL, with crabs in the northern areas maturing at smaller sizes. Females carry up to 20,000 eggs, depending on their size. Spawning appears to be non-synchronous and to occur throughout the year. Larvae are lecithotrophic and are pelagic for 3 to 5 months, but nothing is known about where they reside in the water column.

Relevant Trophic Information

Unknown

Approximate Upper Size Limit of Juvenile Crab (in cm): The size (CL) at 50 percent maturity for females and males, respectively: Aleutians 11 and 12.5 cm, Pribilofs 10 and 10.7 cm, Northern BS 9.8 and 9.2 cm.

Habitat and Biological Associations

Golden king crabs occur on hard bottom, over steep rocky slopes, and on narrow ledges. Strong currents are prevalent. Golden king crabs coexist with abundant quantities of epifauna: sponges, hydroids, coral, sea stars, bryozoans, and brittle stars.

Egg: Information is limited. See mature phase description; eggs are carried by adult female crab.

Larvae: Information is not available.

Early Juvenile: Information is not available.

Late Juvenile: Late juvenile golden king crabs are found throughout the depth range of the species. Abundance of late juvenile crab increases with depth, and these crab are most abundant at depths greater than 548 m.

Mature: Mature golden king crabs occur at all depths within their distribution. Males tend to congregate in somewhat shallower waters than females, and this segregation appears to be maintained throughout the year. Legal male crabs are most abundant between 274 and 639 m. Abundance of sub-legal males increases at depths greater than 364 m. Female abundance is greatest at intermediate depths between 274 and 364 m.

Table 7 Golden king crab, *Lithodes aequispina (abbreviations are in Table 4)*

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	15 mo.	n/a	all year	LSP	D	N/A		
Larvae	3–5 mo.	lecithotrophic	all year	U	P	N/A		
Juveniles		U	all year		D			
Adults		Ophiuroids, sponges, fish, plants, crustaceans	Spawning all year	LSP, BSN	D	R		

2.6 Habitat Description for Tanner Crab (*Chionoecetes bairdi*)

Life History and General Distribution

Tanner crab (*Chionoecetes bairdi*) are distributed on the continental shelf of the North Pacific Ocean and BS from Kamchatka to Oregon. Off Alaska, Tanner crab are concentrated around the Pribilof Islands and immediately north of the Alaska Peninsula. They occur in lower abundance in the GOA. Size at 50 percent maturity is variable, but approximately 11 cm for males and 9 cm carapace width (CW) for females in the BS. The age of maturity for male Tanner crab is estimated at 6 to 8 years. Mature male Tanner crabs may skip a year of molting as they attain maturity. Natural mortality of adult Tanner crab is assumed to be about 25 percent per year (M=0.3).

Relevant Trophic Information

Pacific cod is the main predator on Tanner crabs in terms of biomass. Predators consume primarily age 0 and 1 juvenile Tanner crab with a less than 7 cm CW. However, flathead sole, rock sole, halibut, skates, and yellowfin sole are important in terms of numbers of small crab. Larval predators include salmon, herring, jellyfish, and chaetognaths. Cannibalism is also common.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 9- and 11-cm CW for female and male crabs, respectively.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. bairdi* Tanner crabs are typically found in the BSAI water column from 0 to 100 m in early summer but mostly above 20m. They usually stay near the depth of the chlorophyll maximum, and in the BS there is no evidence of diel migration. The last larval stage settles onto the bottom mud.

Early Juvenile: Early juvenile *C. bairdi* Tanner crabs occur at depths of 10 to 70 m in mud habitat in summer and are known to burrow or associate with many types of cover. Early juvenile *C. bairdi* Tanner crabs are not easily found in winter.

Late Juvenile: The preferred habitat for late juvenile *C. bairdi* Tanner crabs is mud. Late juvenile Tanner crab migrate offshore of their early juvenile nursery habitat.

Mature: Mature *C. bairdi* Tanner crabs likely migrate inshore, and mating occurs from February through June. Mature female *C. bairdi* Tanner crabs can form high density mating aggregations, or pods, consisting of hundreds of crabs per mound. These mounds may provide protection from predators and also attract males for mating. Mating need not occur every year, as female *C. bairdi* Tanner crabs can retain viable sperm in spermathecae for at least 2 years. Females carry clutches of 24,000 to 400,000 eggs and brood the embryos for 1 year after fertilization (Hilsinger 1976). Primiparous females may carry the fertilized eggs for as long as 1.5 years. Brooding occurs in 100 to 150 m depths.

Table 8 Tanner crab, Chionoecetes bairdi (abbreviations are in Table 4)

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1 year	NA	Feb-March	NA	NA	NA	F	
Larvae	3 to 5 mo.	Diatoms Algae Zooplankton	Summer	MCS, ICS	P	NA	F	
Juveniles	1 to 6 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	MCS, ICS, BAY, BCH	D	M	F	
Adults	6+ years	Polychaetes crustaceans mollusks hydroids algae fish	Spawning Jan. to June (peak April-May)	MCS, ICS	D	M	F	

2.7 Habitat Description for Snow Crab (*Chionoecetes opilio*)

Life History and General Distribution

Snow crabs (*Chionoecetes opilio*) are distributed on the continental shelf of the BS, Chukchi Sea, and in the western Atlantic Ocean as far south as Maine. Snow crab are not present in the GOA. In the BS, snow crabs are common at depths less than 200 m. The EBS population within U.S. waters is managed as a single stock; however, the distribution of the population extends into Russian waters to an unknown degree. While 50 percent of the females are mature at 5-cm CW, the mean size of mature females varies from year to year over a range of 6.3- to 7.2-cm CW. Females cease growing with a terminal molt to maturity and rarely exceed 8 cm CW. The median size of maturity for males is about 8.5-cm CW (approximately 6 to 8 years old). Males larger than 6 cm grow at about 2 cm per molt, up to an estimated maximum size of 14.5-cm CW, but individual growth rates vary widely. Natural mortality of adult snow crab is assumed to be about 25 percent per year (M=0.3).

Relevant Trophic Information

Pacific cod, sculpins, skates, and halibut are the main predators on snow crabs in terms of biomass. Snow crabs less than 7-cm CW are most commonly consumed. Other predators include yellowfin sole, flathead sole, Alaska plaice, walleye pollock, rock sole, bearded seals, and walrus. Snow crabs are also cannibalistic.

Approximate Upper Size Limit of Juvenile Crab (in cm): The size at 50 percent maturity is 5- and 8.5-cm CW for female and male crabs, respectively.

Habitat and Biological Associations

Egg: See mature phase description; eggs are carried by adult female crab.

Larvae: Larvae of *C. opilio* snow crab are found in early summer primarily in the upper mixed layer (greater than 20 depth) and do not exhibit diel migration. The last of three larval stages settles onto bottom in nursery areas.

Early Juvenile: Shallow water areas of the EBS with muddy substrate are considered nursery areas for *C. opilio* snow crabs and are confined to the mid-shelf area due to the thermal limits of early and late juvenile life stages.

Late Juvenile: A geographic cline in size of *C. opilio* snow crabs indicates that a large number of morphometrically immature crabs occur in shallow waters less than 80 m.

Mature: Female *C. opilio* snow crabs have a terminal molt to maturity. Primiparous female snow crabs mate January through June and may exhibit longer egg development period and lower fecundity than multiparous female crabs. Multiparous female snow crabs can store spermatophores in seminal vesicles and fertilize subsequent egg clutches without mating. At least two clutches can be fertilized from stored spermatophores, but the frequency of this occurring in nature is not known. Females carry clutches of 10,000 to 70,000 eggs depending on size, and brood the embryos for either 1 or 2 years after fertilization depending on the water temperature. However, fecundity may decrease up to 50 percent between the time of egg extrusion and hatching, presumably due to predation, parasitism, abrasion, or decay of unfertilized eggs. Brooding probably occurs in depths greater than 50 m.

Table 9 Snow crab, *Chionoecetes opilio* (abbreviations are in Table 4)

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
Eggs	1 to 2 years	NA		NA	NA	NA	F	
Larvae	3 to 5 mo.	Diatoms algae zooplankton	Spring, summer	ICS, MCS	P	NA	F	
Juveniles	1 to 4 years	Crustaceans polychaetes mollusks diatoms algae hydroids	All year	ICS, MCS, OCS	D	M	F	
Adults	4+ years	Polychaetes brittle stars mollusks crustaceans	Spawning Jan. to June (peak	ICS, MCS, OCS	D	M	F	

Life Stage	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceano-graphic Features	Other
		hydroids algae diatoms	April to May)					

3 Essential Fish Habitat

EFH is determined to be the general distribution of a species described by life stage. General distribution is a subset of a species' total population distribution, and is identified as the distribution of 95 percent of the species population, for a particular life stage, if life history data are available for the species. Where information is insufficient and a suitable proxy cannot be inferred, EFH is not described. General distribution is used to describe EFH for all stock conditions whether or not higher levels of information exist, because the available higher level data are not sufficiently comprehensive to account for changes in stock distribution (and thus habitat use) over time.

EFH is described for FMP-managed species by life stage as general distribution using guidance from the EFH Final Rule (50 CFR 600.815), including the EFH Level of Information definitions. New analytical tools are used and recent scientific information is incorporated for each life history stage from updated scientific habitat assessment reports. EFH descriptions include both text (see 3.1) and maps (see 3.2), if information is available for a species' particular life stage.

EFH descriptions are interpretations of the best scientific information. In support of this information, a thorough review of FMP species is contained in the Environmental Impact Statement for Essential Fish Habitat Identification and Conservation (EFH EIS, NMFS 2005) in Section 3.2.1, Biology, Habitat Usage, and Status of Magnuson-Stevens Act Managed Species and detailed by life history stage in Appendix F: EFH Habitat Assessment Reports. This EIS was supplemented in 2010 and 2017 by the 5-year review cycle, which re-evaluated EFH descriptions and fishing and non-fishing impacts on EFH in light of new information (NPFMC and NMFS 2010, and Simpson et al. 2017). The EFH descriptions are risk averse, supported by scientific rationale, and account for changing oceanographic conditions and regime shifts.

3.1 Description of Essential Fish Habitat

EFH descriptions are based upon the best available scientific information. In support of this information, a thorough review of FMP species is contained in this Appendix and in the EFH EIS (NMFS 2005). A summary of the habitat information levels for each species, as described in the EFH regulations at 50 CFR 600.815(a)(1)(iii), is listed in Table 8.1. An "x" means that insufficient information is available to determine EFH for the life stage and a"1" means information is available to determine EFH.

Table 10 EFH information levels currently available for BSAI crab, by life history stage.

BSAI Crab Species	Egg	Larvae	Early Juvenile	Late Juvenile	Adult
Red king crab	inferred	x	1	1	1
Blue king crab	inferred	x	1	1	1
Golden king crab	inferred	x	x	1	1
Tanner crab	inferred	x	x	1	1
Snow crab	inferred	x	x	1	1

x indicates insufficient information is available to describe EFH
1 indicates general distribution data are available for some or all portions of the geographic range of the species
2 indicates quantitative data (density or habitat-related density) are available for the habitats occupied by a species or life stage

3.1.1 Red King Crab

Eggs
Essential fish habitat of the red king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined
Insufficient information is available.

Early Juveniles-
EFH for early juvenile red king crab is the general distribution area for this life stage, located in demersal habitat along the intertidal and subtidal zones, and inner and middle shelf (0 to 100 m). Early juveniles have specific habitat requirements based on their anti-predator strategy and can only occur in places where there is significant habitat structure either in the form of substrates such as rock, cobble, and gravel, or biogenic habitats such as bryozoans, ascidians, hydroids, or shell hash. In the BS, these habitats generally only occur in nearshore areas along the north side of the AI and the Alaskan Peninsula, around Bristol Bay, around the Pribilof Islands, and in nearshore areas of Norton Sound.

Late Juveniles
EFH for late juvenile red king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel and biogenic structures such as *Boltenia* spp., bryozoans, ascidians, and shell hash.

Adults
EFH for adult red king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore (spawning aggregations) and the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand, mud, cobble, and gravel.

3.1.2 Blue King Crab

Eggs
EFH of the blue king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined
Insufficient information is available.

Early Juveniles-
EFH for early juvenile blue king crab is the general distribution area for this life stage, located in demersal habitat along the intertidal and subtidal zones, and inner and middle shelf (0 to 100 m). Early juveniles require specific habitat types to avoid predation. In particular, they require either rock or cobble substrates or shell hash beds. Within the range of blue king crab, this only occurs in nearshore areas around the Pribilof Islands, St. Matthew Island, and St. Lawrence Island.

Late Juveniles
EFH for late juvenile blue king crab is the general distribution area for this life stage, located in bottom habitats along the nearshore where there are rocky areas with shell hash and the inner (0 to 50), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of rock, cobble, and gravel.

Adults
EFH for adult blue king crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting of sand and mud adjacent to rockier areas and areas of shell hash.

3.1.3 Golden King Crab

Eggs
EFH of golden king crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined
Insufficient information is available.

Early Juveniles-No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high-relief living habitats, such as coral, and vertical substrates, such as boulders, vertical walls, ledges, and deep water pinnacles.

Adults
EFH for adult golden king crab is the general distribution area for this life stage, located in bottom habitats along the along the outer shelf (100 to 200 m), upper slope (200 to 500 m), intermediate slope (500 to 1,000 m), lower slope (1,000 to 3,000 m), and basins (more than 3,000 m) of the BSAI where there are high relief living habitats, such as coral, and vertical substrates such as boulders, vertical walls, ledges, and deep water pinnacles.

3.1.4 Tanner Crab

Eggs
EFH of Tanner crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined
Insufficient information is available.

Early Juveniles-No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

Adults
EFH for adult Tanner crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

3.1.5 Snow Crab

Eggs
EFH of snow crab eggs is inferred from the general distribution of egg-bearing female crab. (See also Adults.)

Larvae-No EFH Description Determined
Insufficient information is available.

Early Juveniles-No EFH Description Determined
Insufficient information is available.

Late Juveniles
EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

Adults
EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m), middle (50 to 100 m), and outer shelf (100 to 200 m) throughout the BSAI wherever there are substrates consisting mainly of mud.

3.2 Maps of Essential Fish Habitat

Scientists at the Alaska Fisheries Science Center created species distribution models of EFH for all major crab species in the eastern Bering Sea (Laman et al. 2017) and in the Aleutian Islands (Turner et al. 2017). With Amendment 49, the Council adopted these new model-based maps for crab EFH that represent the 95th percentile by season for each species and life stage, as information is available.

3.2.1 Aleutian Islands crab EFH maps

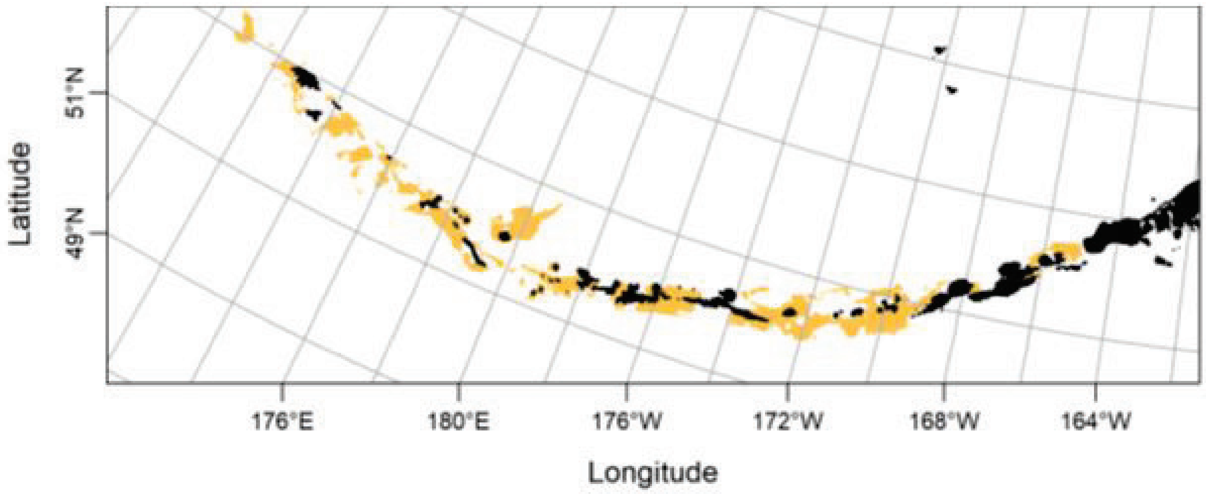

Figure 2 AI adult Golden king crab fall EFH

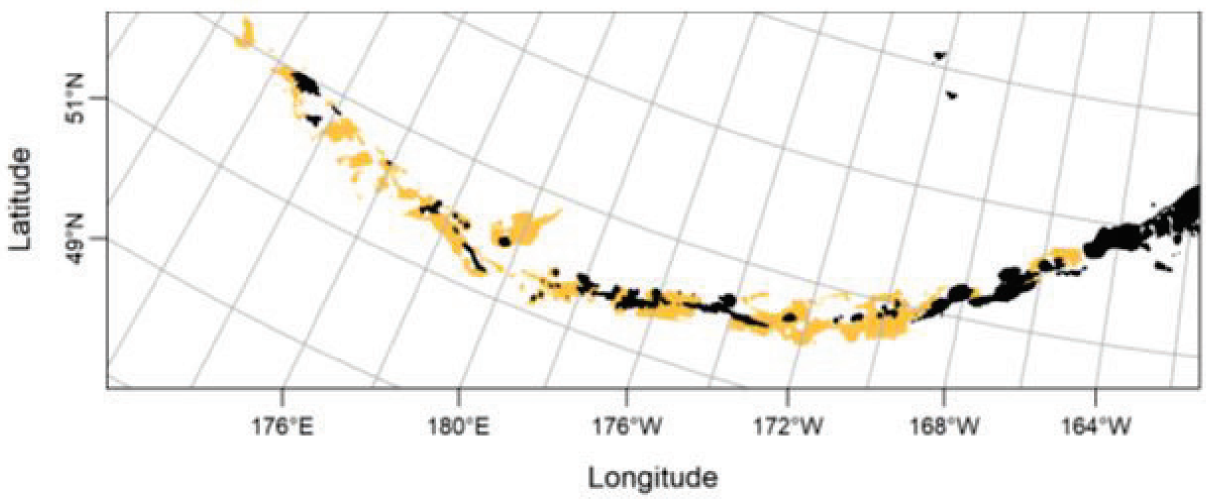

Figure 3 AI adult Golden king crab spring EFH

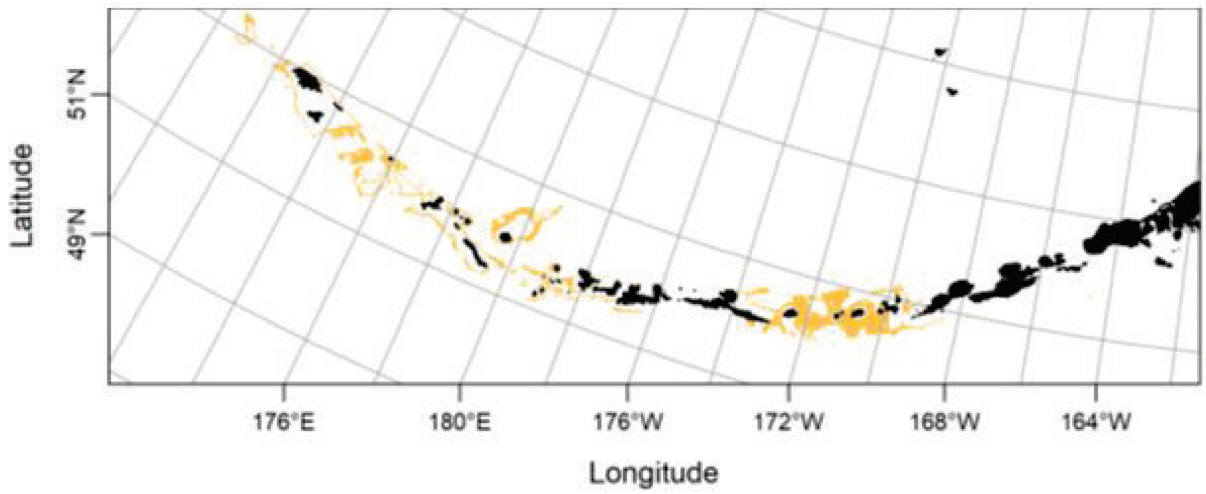

Figure 4 AI adult Golden king crab summer EFH

3.2.2 Bering Sea crab EFH maps

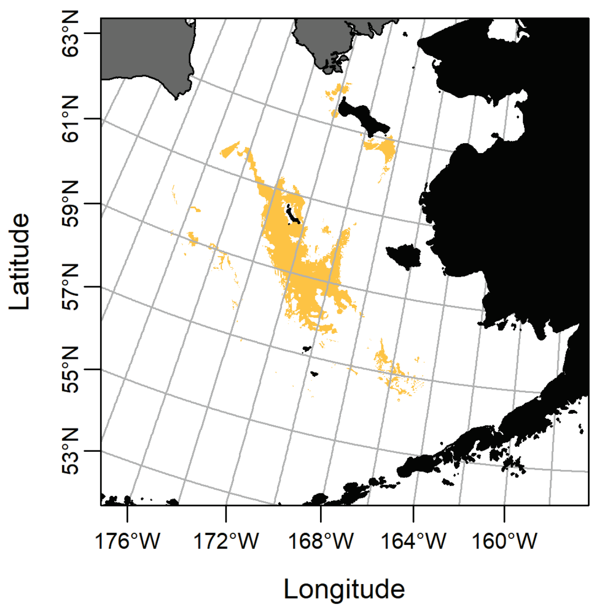

Figure 5 EBS adult Blue king crab fall EFH

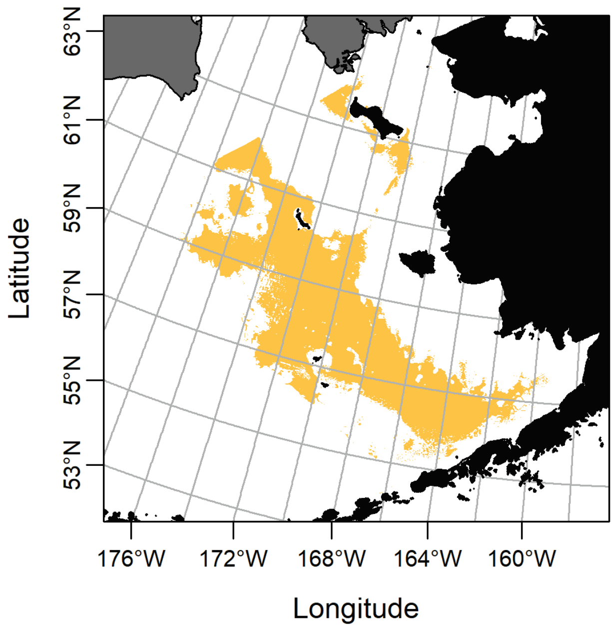

Figure 6 EBS adult Blue king crab spring EFH

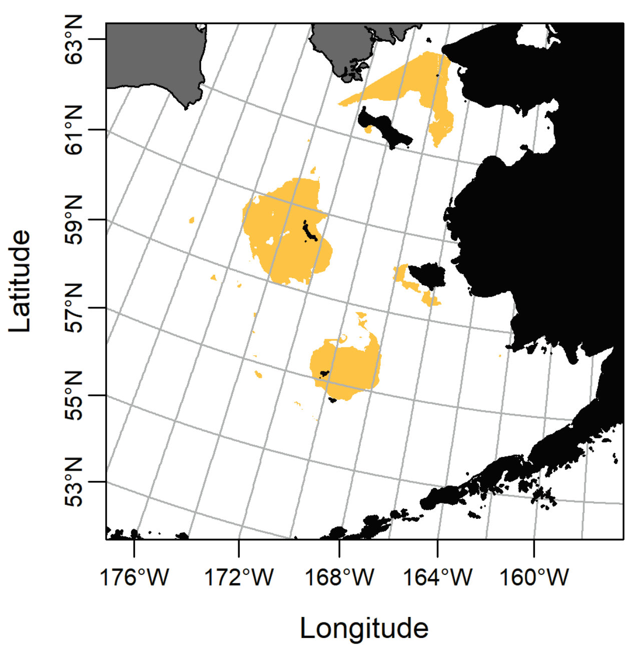

Figure 7 EBS adult Blue king crab winter EFH

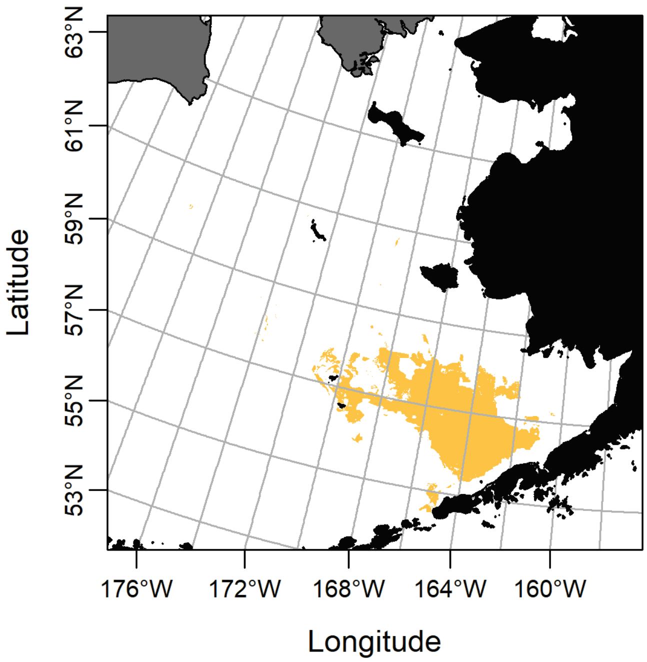

Figure 8 **EBS adult Red king crab fall EFH**

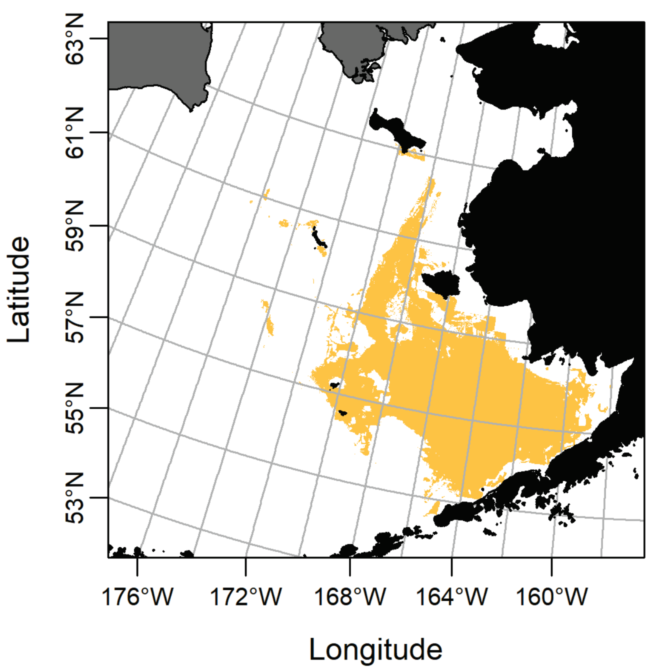

Figure 9 **EBS adult Red king crab spring EFH**

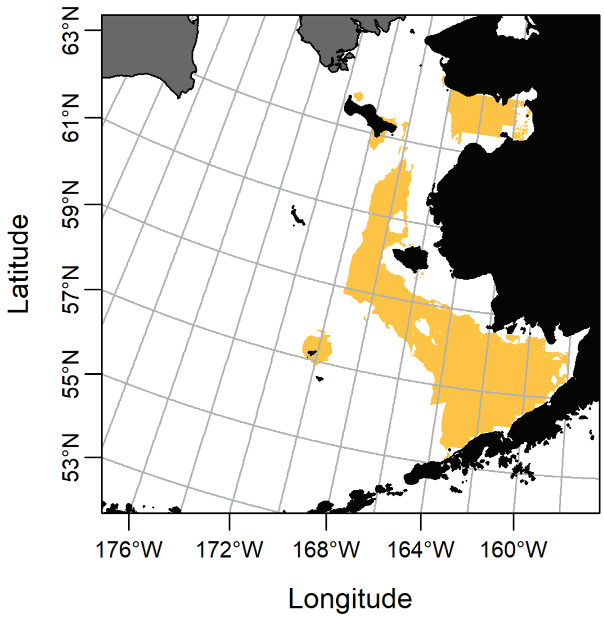

Figure 10 EBS adult Red king crab summer EFH

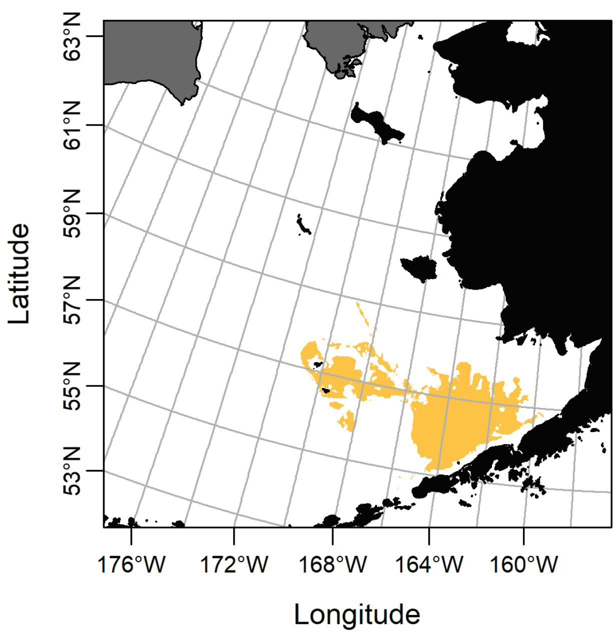

Figure 11 EBS adult Red king crab winter EFH

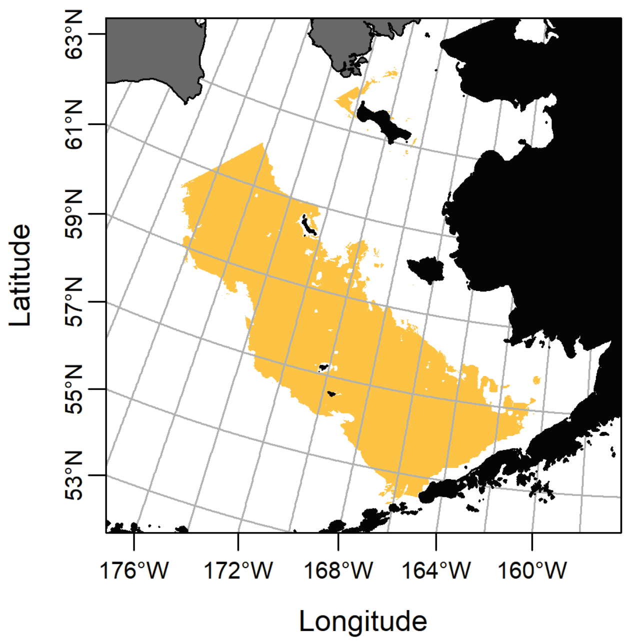

Figure 12 EBS adult Snow crab fall EFH

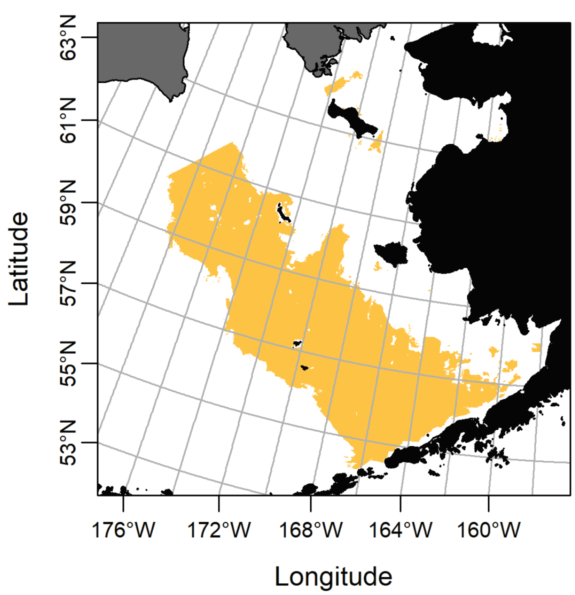

Figure 13 EBS adult Snow crab spring EFH

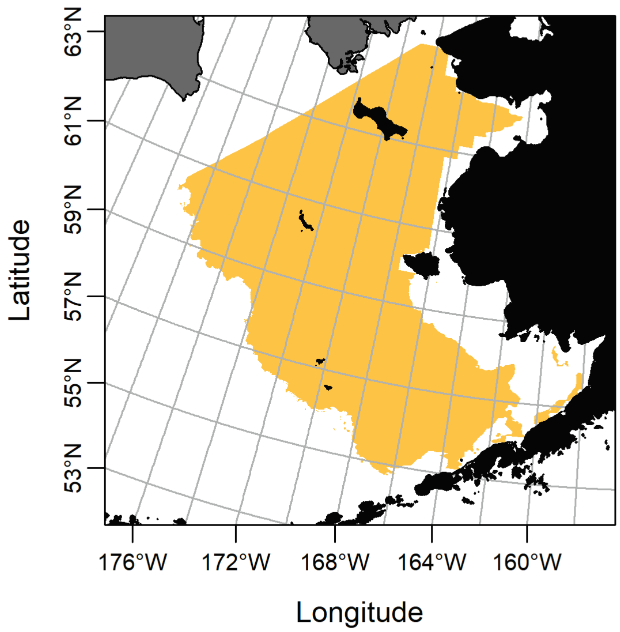

Figure 14 **EBS adult Snow crab summer EFH**

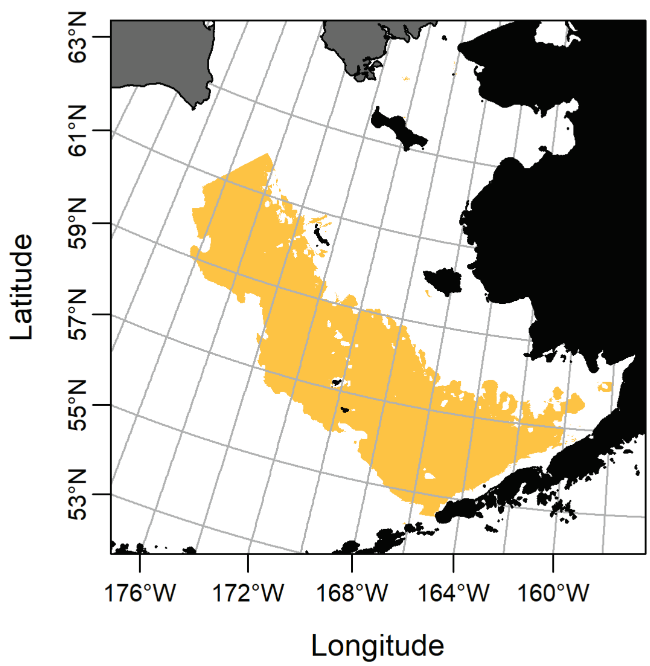

Figure 15 **EBS adult Snow crab winter EFH**

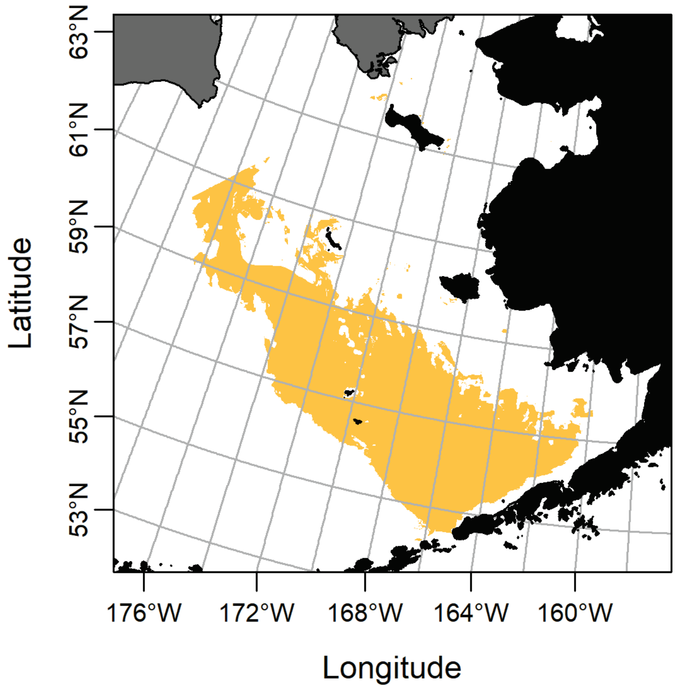

Figure 16 EBS adult Tanner crab fall EFH

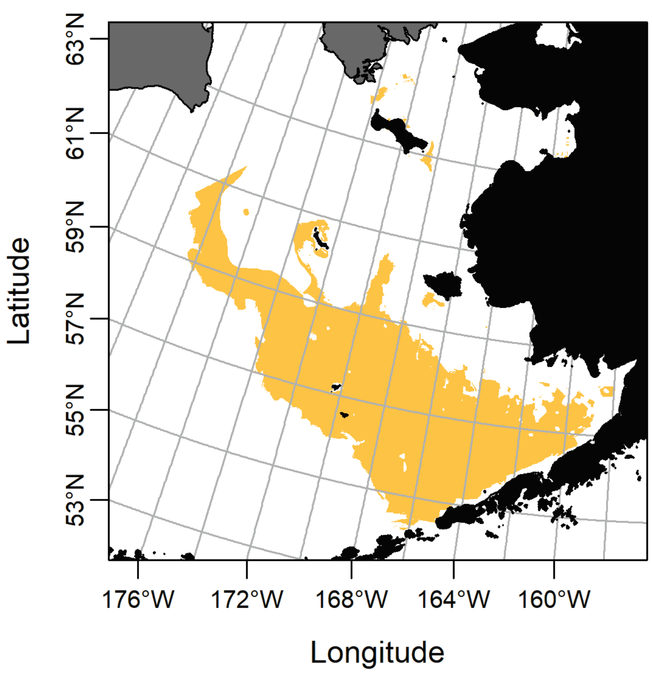

Figure 17 EBS adult Tanner crab spring EFH

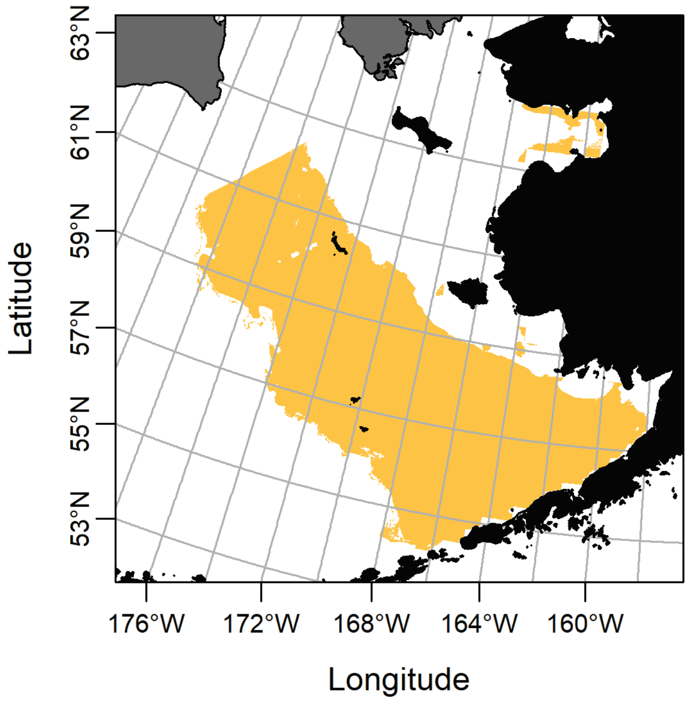

Figure 18 **EBS adult Tanner crab summer EFH**

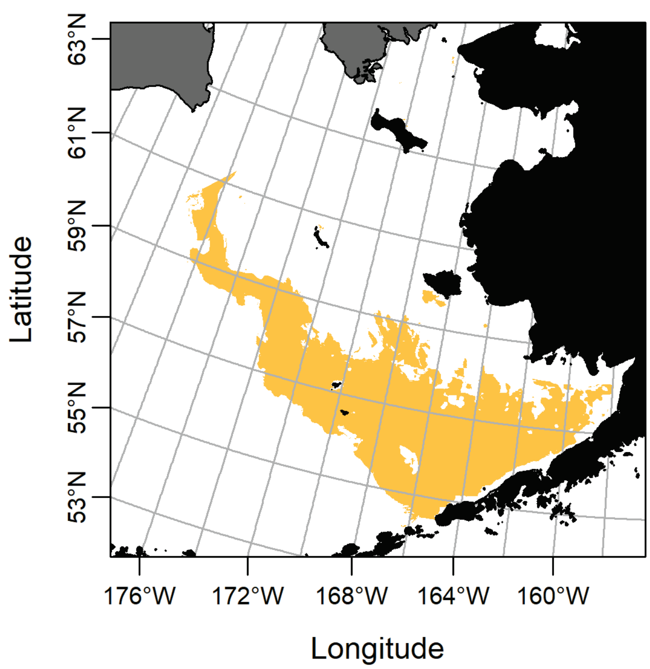

Figure 19 **EBS adult Tanner crab winter EFH**

3.3 Essential Fish Habitat Conservation and Habitat Areas of Particular Concern

The Council established the Aleutian Islands Habitat Conservation Area and the Aleutian Islands Coral Habitat Protection Areas to protect EFH from fishing threats. The Council also established two Habitat Areas of Particular Concern (HAPCs) within crab EFH to protect those areas from fishing threats: the Alaska Seamount Protection Area and the Bowers Ridge Habitat Conservation Zone. Maps of these areas, as well at the coordinates, are provided below.

HAPCs are specific sites within EFH that are of particular ecological importance to the long-term sustainability of managed species, are of a rare type, or are especially susceptible to degradation or development. HAPCs are meant to provide greater focus to conservation and management efforts and may require additional protection from adverse effects.

3.3.1 Aleutian Islands Coral Habitat Protection Areas

The use of bottom contact gear, including pot gear, as described in 50 CFR part 679, is prohibited year-round in the Aleutian Islands Coral Habitat Protection Areas, see Figure 20. Anchoring by a federally permitted fishing vessel, as described in 50 CFR part 679, is also prohibited. The coordinates for the areas are listed in the table below.

Table 11 Aleutian Islands Coral Habitat Protection Areas

Area Number	Name	Latitude			Longitude		
1	Great Sitkin Is	52	9.56	N	176	6.14	W
	Great Sitkin Is	52	9.56	N	176	12.44	W
	Great Sitkin Is	52	4.69	N	176	12.44	W
	Great Sitkin Is	52	6.59	N	176	6.12	W
2	Cape Moffett Is	52	0.11	N	176	46.65	W
	Cape Moffett Is	52	0.10	N	176	53.00	W
	Cape Moffett Is	51	55.69	N	176	53.00	W
	Cape Moffett Is	51	55.69	N	176	48.59	W
	Cape Moffett Is	51	57.96	N	176	46.52	W
3	Adak Canyon	51	39.00	N	177	0.00	W
	Adak Canyon	51	39.00	N	177	3.00	W
	Adak Canyon	51	30.00	N	177	3.00	W
	Adak Canyon	51	30.00	N	177	0.00	W
4	Bobrof Is	51	57.35	N	177	19.94	W
	Bobrof Is	51	57.36	N	177	29.11	W
	Bobrof Is	51	51.65	N	177	29.11	W
	Bobrof Is	51	51.71	N	177	19.93	W
5	Ulak Is	51	25.85	N	178	59.00	W
	Ulak Is	51	25.69	N	179	6.00	W
	Ulak Is	51	22.28	N	179	6.00	W
	Ulak Is	51	22.28	N	178	58.95	W
6	Semisopochnoi Is	51	53.10	N	179	53.11	E
	Semisopochnoi Is	51	53.10	N	179	46.55	E
	Semisopochnoi Is	51	48.84	N	179	46.55	E
	Semisopochnoi Is	51	48.89	N	179	53.11	E

Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. The projected coordinate system is North American Datum 1983, Albers.

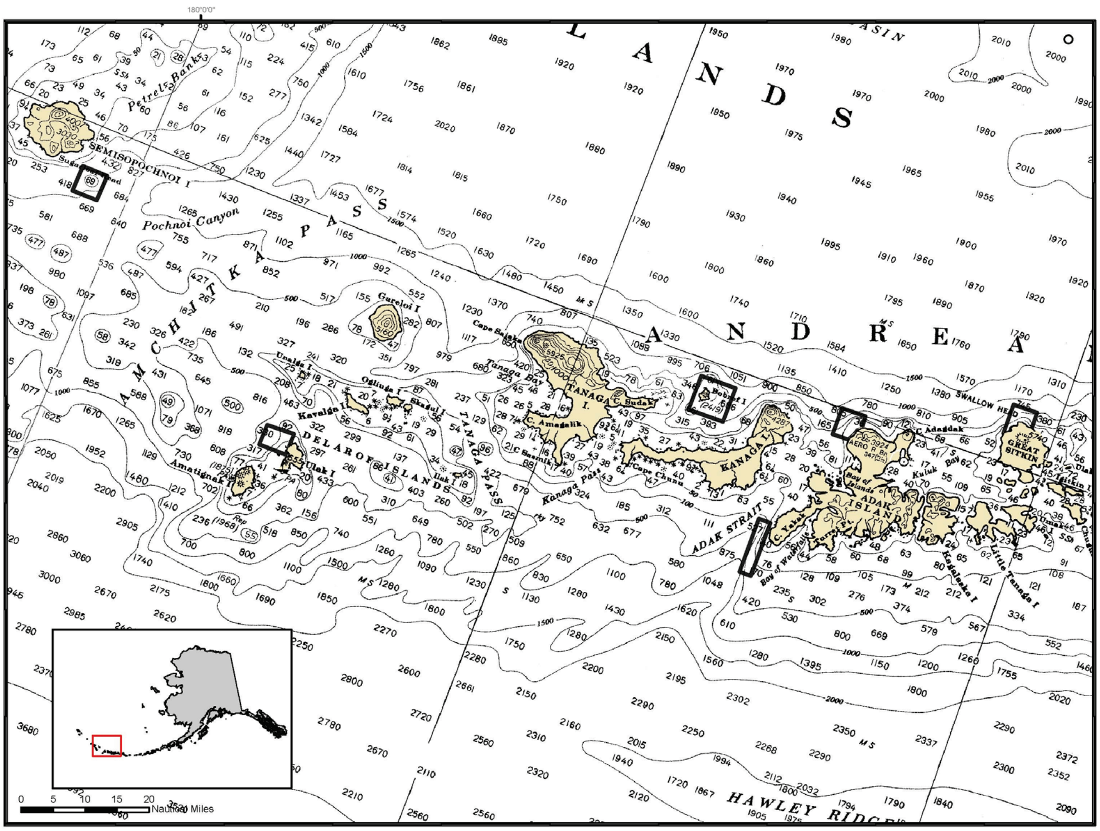

Figure 20 Aleutian Islands Coral Habitat Protection Areas

3.3.2 Aleutian Islands Habitat Conservation Areas

Nonpelagic trawl gear fishing is prohibited year-round in the Aleutian Islands Habitat Conservation Area, except for designated areas open to nonpelagic trawl gear. The Aleutian Islands Habitat Conservation Area is defined as the entire Aleutian Islands groundfish management subarea, as described in 50 CFR 679. Areas open to nonpelagic trawl gear fishing in the Aleutian Islands shown in Figure 21; however, the use of trawl gear is prohibited in the BSAI King and Tanner crab fisheries.

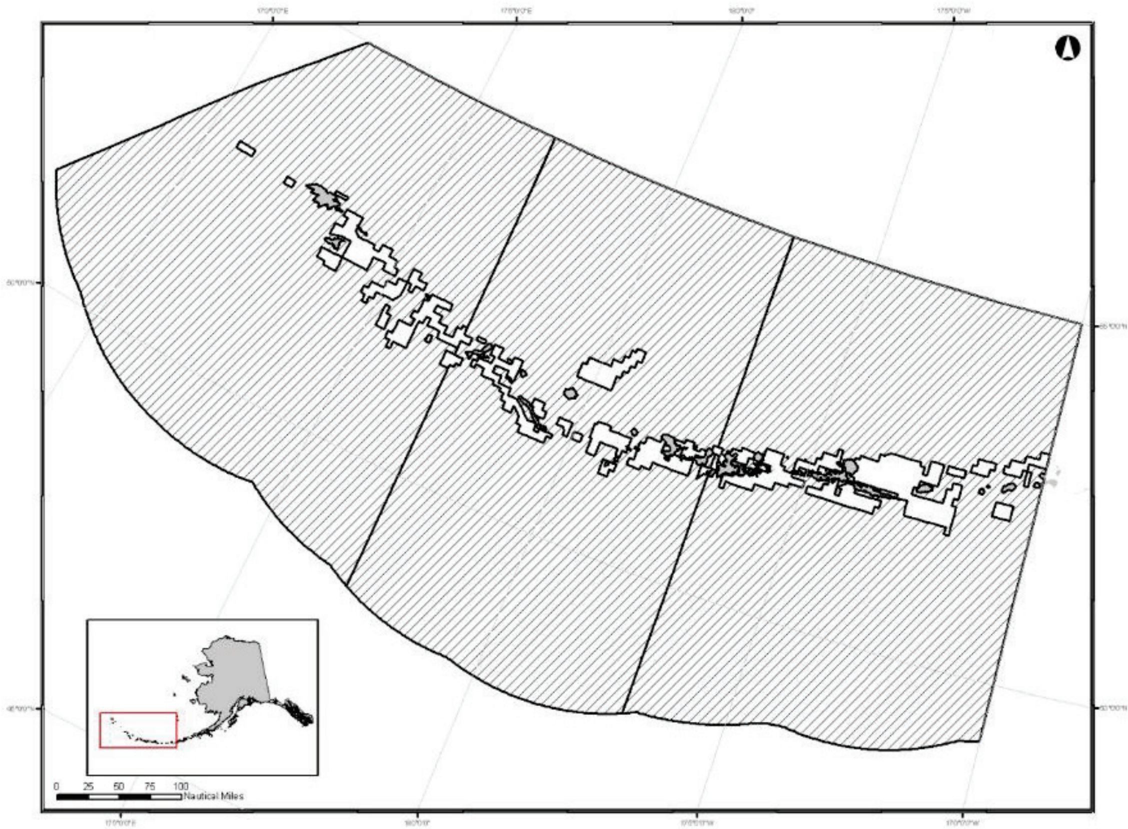

Figure 21 Aleutian Islands Habitat Conservation Area. Polygons are areas open to nonpelagic trawl gear.

3.3.3 Alaska Seamount Habitat Protection Area

The use of bottom contact gear by a federally permitted fishing vessel, as described in 50 CFR part 679, is prohibited year-round in the Alaska Seamount Habitat Protection Area, see Figure 22. Anchoring by a federally permitted fishing vessel, as described in 50 CFR part 679, is also prohibited. Coordinates for the Alaska Seamount Habitat Protection Area are listed in the table below.

Table 12 Alaska Seamount Habitat Protection Area

Area Number	Name	Latitude	Longitude
15	Bowers Seamount	54 9.00 N	174 52.20 E
	Bowers Seamount	54 9.00 N	174 42.00 E
	Bowers Seamount	54 4.20 N	174 42.00 E
	Bowers Seamount	54 4.20 N	174 52.20 E

Note: The area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates is connected to the first set of coordinates by a straight line. The projected coordinate system is North American Datum 1983, Albers.

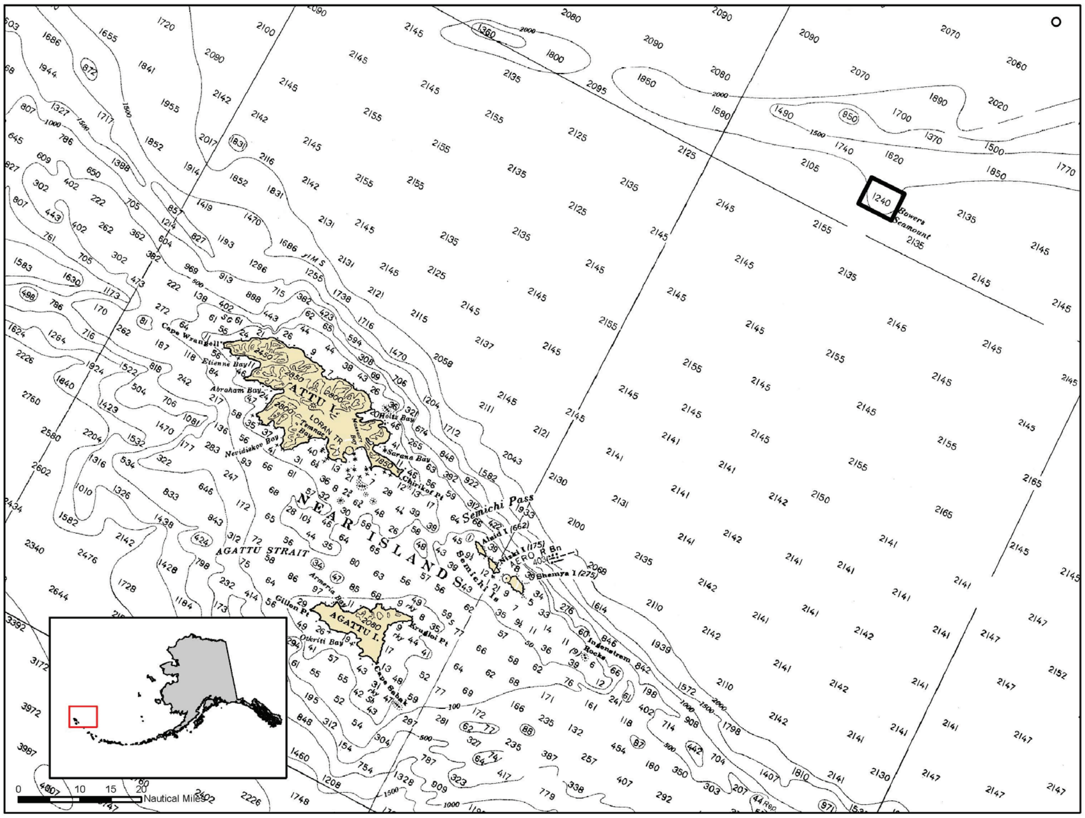

Figure 22 Alaska Seamount Habitat Protection Area in the Aleutian Islands

3.3.4 Bowers Ridge Habitat Conservation Zone

The use of mobile bottom contact gear, as described in 50 CFR part 679, is prohibited year-round in the Bowers Ridge Habitat Conservation Zone, see Figure 23. The areas are described in the table below.

Table 13 Bowers Ridge Habitat Conservation Zone

Area Number	Name	Latitude			Longitude		
1	Bowers Ridge	55	10.50	N	178	27.25	E
	Bowers Ridge	54	54.50	N	177	55.75	E
	Bowers Ridge	54	5.83	N	179	20.75	E
	Bowers Ridge	52	40.50	N	179	55.00	W
	Bowers Ridge	52	44.50	N	179	26.50	W
	Bowers Ridge	54	15.50	N	179	54.00	W
2	Ulm Plateau	55	5.00	N	177	15.00	E
	Ulm Plateau	55	5.00	N	175	60.00	E
	Ulm Plateau	54	34.00	N	175	60.00	E
	Ulm Plateau	54	34.00	N	177	15.00	E

Note: Each area is delineated by connecting the coordinates in the order listed by straight lines. The last set of coordinates for each area is connected to the first set of coordinates for the area by a straight line. The projected coordinate system is North American Datum 1983, Albers.

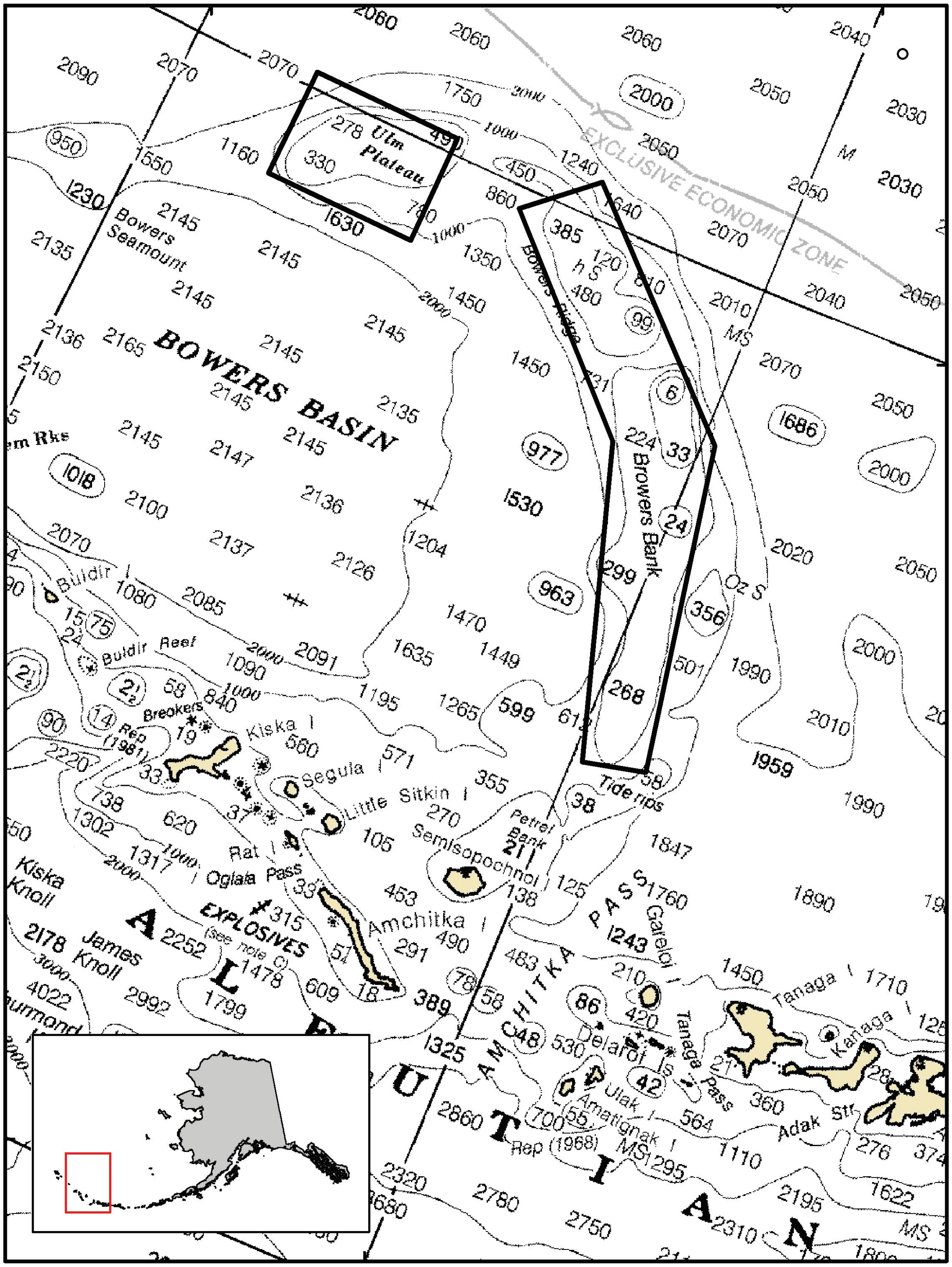

Figure 23 Bowers Ridge Habitat Conservation Zone

3.3.5 HAPC Process

The Council may designate specific sites as HAPCs and may develop management measures to protect habitat features within HAPCs.

50 CFR 600.815(a)(8) provides guidance to the Councils in identifying HAPCs. FMPs should identify specific types or areas of habitat within EFH as habitat areas of particular concern based on one or more of the following considerations:

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

Proposed HAPCs, identified on a map, must meet at least two of the four considerations established in 50 CFR 600.815(a)(8), and rarity of the habitat is a mandatory criterion. HAPCs may be developed to address identified problems for FMP species, and they must meet clear, specific, adaptive management objectives.

The Council will initiate the HAPC process by setting priorities and issuing a request for HAPC proposals. Any member of the public may submit a HAPC proposal. HAPC proposals may be solicited every 5 years, to coincide with the EFH 5-year review, or may be initiated at any time by the Council. The Council will establish a process to review the proposals. The Council may periodically review existing HAPCs for efficacy and considerations based on new scientific research.

4 Effects of Fishing on Essential Fish Habitat

This section addresses the requirement in EFH regulations (50 Code of Federal Regulations [CFR] 600.815(a)(2)(i)) that each FMP must contain an evaluation of the potential adverse effects of all regulated fishing activities on EFH. This evaluation must 1) describe each fishing activity, 2) review and discuss all available relevant information, and 3) provide conclusions regarding whether and how each fishing activity adversely affects EFH. Relevant information includes the intensity, extent, and frequency of any adverse effect on EFH; the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed.

In addition, the evaluation should 1) consider the cumulative effects of multiple fishing activities on EFH, 2) list and describe the benefits of any past management actions that minimize potential adverse effects on EFH, 3) give special attention to adverse effects on habitat areas of particular concern (HAPCs) and identify any EFH that is particularly vulnerable to fishing activities for possible designation as HAPCs, 4) consider the establishment of research closure areas or other measures to evaluate the impacts of fishing activities on EFH, and use the best scientific information available, as well as other appropriate information sources.

This evaluation assesses whether fishing adversely affects EFH in a manner that is more than minimal and not temporary in nature (50 CFR 600.815(a)(2)(ii)). This standard determines whether Councils are required to act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable. Although methods used in the EFH Environmental Impact Statement of 2005 are different from those described in this FMP, Appendix B of the EFH EIS (2005) also contains a comprehensive, peer-reviewed analysis of fishing effects on EFH and detailed results for managed species.

Fishing operations change the abundance or availability of certain habitat features (e.g., prey availability or the presence of living or non-living habitat structure) used by managed fish species to accomplish spawning, breeding, feeding, and growth to maturity. These changes can reduce or alter the abundance, distribution, or productivity of that species, which in turn can affect the species' ability to "support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR 600.10). The outcome of this chain of effects depends on characteristics of the fishing activities, the habitat, fish use of the habitat, and fish population dynamics. The duration and degree of fishing's effects on habitat features depend on the intensity of fishing, the distribution of fishing with different gears across habitats, and the sensitivity and recovery rates of habitat features.

4.1 Effects of Fishing Analysis

The 2005 EFH FEIS and 2010 EFH Review effects of fishing on EFH analyses included application of a numerical model that provided spatial distributions of an index of the effects of fishing on several classes of habitat features, such as infauna prey and shelter created by living organisms. The Long-term Effect Index (LEI) estimated the eventual proportional reduction of habitat features from a theoretical unaffected habitat state, should the recent pattern of fishing intensities be continued indefinitely (Fujioka 2006). For the 2005 and 2010 analyses, the LEI generated represented a 5-year time period.

During the 2015 EFH Review, the Council requested several updates to the LEI model to make the input parameters more intuitive and to draw on the best available data. In response to their requests, the Fishing Effects (FE) model was developed (Harris et al. 2017). Like the LEI model, it is run on 25 km^2 grid cells throughout the North Pacific and is based on interaction between habitat impact and recovery, which depend on the amount of fishing effort, the types of gear used, habitat sensitivity, and substrate. The FE model updates the LEI model in the following ways:

1. The FE model is cast in a discrete time framework. This means rates such as impact or recovery are defined over a specific time interval, compared to the LEI model which used continuous time. Using discrete time makes fishing impacts and habitat recovery more intuitive to interpret compared to continuous time.
2. The FE model implements sub-annual (monthly) tracking of fishing impacts and habitat disturbance. While this was theoretically possible in the LEI model, the LEI model was developed primarily to estimate long term habitat disturbance given a constant rate of fishing and recovery. The FE model allows for queries of habitat disturbance for any month from the start of the model run (January 2003). This aids in the implications of variable fishing effort within season and among years.
3. The FE model draws on the spatially explicit Catch-In-Areas (CIA) database to use the best available spatial data of fishing locations. The CIA database provides line segments representing the locations of individual tows or other bottom contact fishing activities. This provides a more accurate allocation of fishing effort among grid cells. In comparison, the LEI model used haulback locations summarized to the 25 km^2 grids to represent fishing activity. The description of fishing gears that may contact benthic habitat was also greatly improved with significant input from fishing industry representatives.
4. The FE model incorporates an extensive, global literature review from Grabowski et al. (2014) to estimate habitat susceptibility and recovery dynamics. The FE model identifies 27 unique biological and geological habitat features and incorporates impact and recovery rates to predict habitat reduction and recovery over time. The FE model is also designed to be flexible to produce output based on any single habitat feature or unique combination of features.

Once the FE model has been run and a surface of predicted habitat reduction is produced, the 95% species descriptions for each species can be used as a mask and the cumulative fishing effect on that species can be calculated. It is important to note that because the FE model incorporates both impact to and recovery of benthic structures, the calculated habitat reduction for any grid is the cumulative value at that point in time.

4.1.1 Habitat Categorization

The FE and LEI model both consider habitat impacts and recovery at the level of habitat features, where habitat is the sum total of all habitat features. Aside from structural differences between models (i.e. continuous vs discrete time), both LEI and FE treat habitat features in the same way, just define them differently. The 2005 EFH FEIS analyzed approximately 2,000 sediment point data and divided Bering Sea habitat types into 4 sediment types – sand, mixed sand and mud, and mud. Additional categories were added for the slope below 200 m depth and the northern shelf. The ability to classify habitats in the Aleutian Islands and Gulf of Alaska was highly constrained due to the lack of comprehensive sediment distribution data, so the RACE survey strata, split into shallow, deep, and slope were used. The LEI model defined four broad habitat features: infaunal prey, epifaunal prey, biological structure, and physical structure. The FE model, in contrast, defines 27 habitat features which can be grouped into biological or geological features. These 27 habitat features were drawn from the literature review described above. The FE model, however, is flexible to produce results over any combination of habitat features, if for example a specific subset of habitat features was important for a specific species.

For the 2015 EFH Review, sediment data were compiled from various surveys collected across the North Pacific, and now includes over 240,000 individual points. The data consist of spatially explicit points attributed with sediment descriptions although the various surveys varied widely in methodology, sediment descriptions, and point density. Sediment points in the Eastern Bering Sea are separated on average by ~10.5 km, while some localized sampling efforts, especially near shore, collected data at much greater densities. Very few points were located deeper than 500 meters or in areas of boulder or hard rock habitat.

Initial processing of the data consisted of parsing through the various sediment descriptions to map them to a sediment category used in the FE model (mud, sand, granule/pebble, cobble, or boulder). The mapping was not one-to-one, however, such that more than one sediment category could be described by a single sediment description. Each point was attributed as present or absent for each sediment category. An indicator Kriging algorithm was used (Geostatistical Wizard, ArcMap v10.2) to interpolate a probability surface for each sediment category over a 2.5 km grid aligned to the 5 km grid used for the FE model. A probability threshold of 0.5 to indicate presence/absence of each sediment category was set, so four sediment grid cells were located within each 5 km grid cell, providing a pseudo-area weighted measured of each sediment type within each 5 km grid cell. For each 5 km grid cell, the proportion of each sediment type was calculated as the sum of all 2.5 km grid cells with sediment present (up to four for each sediment class) divided by the sum of all present cells across all sediments (up to 20 possible, 4 cells X 5 sediment classes). In ~10% of the 5 km grid cells, no sediment class was predicted present. In these cases, sediment proportions from the nearest 5 km grid cell were used.

4.1.2 General Fishing Gear Impacts

The following sections summarize pertinent research on the effects of fishing on seafloor habitats.

4.1.2.1 Bottom Trawls

The EFH EIS evaluates the effects of bottom trawls on several categories of habitats: infaunal prey, epifaunal prey, living structure, hard corals, and nonliving structure.

4.1.2.2 Infaunal Prey

Infaunal organisms, such as polychaetes, other worms, and bivalves, are significant sources of prey for Alaska groundfish species. Studies of the effects of representative trawl gear on infauna included Kenchington et al. (2001), Bergman and Santbrink (2000), Brown (2003), Brylinsky et al. (1994), and Gilkinson et al. (1998).

Kenchington et al. (2001) examined the effects on over 200 species of infauna from trawl gear that closely resembled the gear used off of Alaska. Three separate trawling events were conducted at intervals approximating 1 year. Each event included 12 tows through an experimental corridor, resulting in an average estimate of three to six contacts with the seafloor per event. Of the approximately 600 tests for species effects conducted, only 12 had statistically significant results. The statistical methods were biased toward a Type 1 error of incorrectly concluding an impact. Ten of the significant results are from a year when experimental trawling was more concentrated in the center of the corridors where the samples of infauna were taken. It is likely that more trawl contacts occurred at these sampled sites than the 4.5 estimate (average of three to six contacts) used to adjust the multiple contact results. As such, the results that were available from the study (non-significant values were not provided) represent a sample biased toward larger reductions when used to assess median reductions of infauna.

Bergman and Santbrink (2000) studied effects on infauna (mostly bivalves) from an otter trawl equipped with 20-centimeter (cm) rollers in the North Sea. Because the study was conducted on fishing grounds with a long history of trawling, the infaunal community may already have been affected by fishing. Experimental trawling was conducted to achieve average coverage of 1.5 contacts within the experimental area over the course of the study. Results were provided for two substrate types: coarse sand with 1 to 5 percent of the area contacted, and silt and fine sand with 3 to 10 percent of the area contacted. The five infauna biomass reductions in the first area had a median of 8 percent. The ten infauna biomass reductions from the second area had a median of 5 percent.

Brown (2003) studied the effects of experimental trawling in an area of the nearshore EBS with sandy sediments. Trawling covered 57 percent of the experimental area. Several bivalves had lower abundance after trawling, while polychaetes were less affected. The median of the reduction in percentages for each species, after adjusting for coverage, was a 17 percent reduction in biomass per gear contact.

Brylinsky et al. (1994) investigated effects of trawling on infauna, mainly in trawl door tracks, at an intertidal estuary. Eight results on the effects of trawl doors on species biomass were available for polychaetes and nemerteans. These results had a median of 31 percent reduction in biomass and a 75th percentile of 42 percent reduction in biomass. Gilkinson et al. (1998) used a model trawl door on a prepared substrate to estimate that 64 percent of clams in the door’s path were exposed after one pass, but only 5 percent were injured.

4.1.2.3 Epifaunal Prey

Epifaunal organisms, such as crustaceans, echinoderms, and gastropods, are significant prey of Alaska groundfish species. However, one of the most common classes of echinoderms, asteroids, are rarely found in fish stomachs. While some crustaceans may be infauna, an inability to consistently identify these species resulted in all crustaceans being categorized as epifaunal prey. Studies of the effects of representative trawl gear on epifauna included Prena et al. (1999), Brown (2003), Freese et al. (1999), McConnaughey et al. (2000), and Bergman and Santbrink (2000).

Prena et al. (1999), as a component of the Kenchington et al. (2001) study, measured the effects of trawling on seven species of epifauna. The median of these results was a 4 percent biomass reduction per gear contact. There appeared to be in-migration of scavenging crabs and snails in this and other studies. Removing crab and snails left only two measurements, 6 and 7 percent reductions in biomass. Bergman and Santbrink (2000) measured effects on four epifaunal species in the experimental coarse sand area (median reduction in biomass was 12 percent) and five epifaunal species in the experimental fine sand area (median reduction in biomass was 16 percent). When crabs and snails were removed, the coarse sand area was unchanged, and the median value for the fine sand area was 15 percent biomass reduction. Brown (2003) studied six epifaunal species, resulting in a median reduction in biomass per gear contact of 5 percent. Combining results from Prena et al. (1999), Brown (2003), and Bergman and Santbrink (2000), and removing crabs and snails, gives a median reduction in biomass of epifaunal species of 10 percent, and 25th and 75th percentiles of 4 and 17 percent, respectively.

The study of McConnaughey et al. (2000) compared the effects of fishing on an area that received heavy fishing pressure between 4 and 8 years previously, using an adjacent unfished area as a control.

Therefore, results included a combination of species reductions and recovery, were not adjusted for multiple contacts, and were not directly comparable to the results of the studies above.

Freese et al. (1999) studied the effects of tire gear on the epifauna of a pebble and boulder substrate. Eight epifaunal species gave a median response of 17 percent reduction in biomass and a 75th percentile of 43 percent reduction in biomass. The authors noted a strong transition to apparently smaller effects outside of the direct path of the tire gear.

4.1.2.4 Living Structure

Organisms that create habitat structure in Alaska waters include sponges, bryozoans, sea pens, soft and stony corals, anemones, and stalked tunicates. Studies of the effects of representative trawls on these groups include Van Dolah et al. (1987), Freese et al. (1999), Moran and Stephenson (2000), Prena et al. (1999), and McConnaughey et al. (2000). The first three studies examined the effects on epifauna on substrates such as pebble, cobble, and rock that support attached erect organisms, while the last two studies were located on sandy substrates. Effect estimates were available for only one type of structure-providing organism, the soft coral *Gersemia*, from Prena et al. (1999).

Both the Van Dolah et al. (1987) and Freese et al. (1999) studies identified removal rates and rates of damage to organisms remaining after contact, raising the question of how damage incurred from contact with gear reduces the structural function of organisms. In Freese et al. (1999), sponges were indicated as damaged if they had more than 10 percent of the colony removed, or if tears were present through more than 10 percent of the colony length. Van Dolah et al. (1987) classified organisms as heavily damaged (more than 50 percent damage or loss) or lightly damaged (less than 50 percent damage or loss).

4.1.2.5 Hard Corals

While numerous studies have documented damage to hard corals from trawls (e.g., Fossa 2002, Clark and O'Driscoll 2003), only one (Krieger 2001) was found that related damage to a known number of trawl encounters. Fortunately, this study occurred in the GOA with a common species of gorgonian coral (Primnoa rubi) and with gear not unlike that used in Alaska commercial fisheries. Krieger used a submersible to observe a site where large amounts of Primnoa were caught during a survey trawl. An estimated 27 percent of the original volume of coral was removed by the single trawl effort. The site was in an area closed to commercial trawling, so other trawling effects were absent.

In the 2005 EFH FEIS, the effects of fishing analysis noted that the LEI results required separate consideration for particularly long-lived and slow-growing living structures, exemplified by corals in hard bottom areas. Even relatively low fishing intensities still eventually reduced corals to very low levels in exposed areas. As a result, this class of living structure is treated separately from those with faster recovery rates. Research on coral distribution and fishing impacts moved forward, with studies by Stone (2006), expanded in Heifitz et al. (2009). Areas of highest coral density in the central Aleutian Islands were found to be deeper than most trawling effort. These studies found coral ubiquitous throughout transects across the central Aleutian Islands and damage to these correlated to the intensity of bottom trawling effort. Damage was also noted in depths with little trawling effort, where longline and pot fisheries were the only fishing effort contacting the seafloor. Damage from those gears was harder to identify and attribute due to the less continuous pattern of their effects.

These studies are consistent with the effects of fishing analysis of the 2005 EFH FEIS in that bottom trawling damages corals and that the slow growth rates of coral make them particularly vulnerable. In the development of the 2005 EFH FEIS, a suggestion was made to evaluate the effects of fishing on EFH by identifying areas of high coral bycatch, or "hotspots". In response, NMFS analysts utilized the observer and survey databases to plot observed catch of corals and assess the capability of the data to support area closures based on high coral observed catch. The results of this analysis were that observer and survey data are not useful for "hotspot" analysis of coral catch.

NMFS and the Council continue to track coral & sponge observed catch through both observer and survey programs. This information is reported yearly in several publications, including the SAFE reports, and those data are made available to the public. Recently, species distribution models have been developed for coral and sponge species in the Eastern Bering Sea, Gulf of Alaska, and Aleutian Islands (Rooper et al. 2014, Sigler et al. 2015). NMFS's Deep Sea Coral Research and Technology Program (DSCRTP) funds research in Alaska to examine the location, distribution, ecosystem role, and status of deep-sea coral and sponge habitats based upon research priorities identified by the DSCRTP, the Council, and the EFH 5-year review process. Research priorities include:

- Determine the distribution, abundance, and diversity of sponge and deep-sea coral in Alaska (and their distribution relative to fishing activity);
- Compile and interpret habitat and substrate maps for the Alaska region;
- Determine deep-sea coral and sponge associations with species regulated by fishery management plans (especially juveniles) and the contribution of deep-sea coral and sponge ecosystems to fisheries production;
- Determine impacts of fishing by gear type and test gear modifications to reduce impacts;
- Determine recovery rates of deep-sea coral and sponge communities in Alaska from disturbance or mortality; and
- Establish a long-term monitoring program to determine the impacts of climate change and ocean acidification on deep-coral and sponge ecosystems.

At the October 2016 Council meeting, the SSC supported the use of the FE model as a tool for assessing the effects of fishing on EFH. In response to public comment, however, the SSC raised concern that the longest recovery time incorporated into the model (10 years) may not capture the recovery needed for long-lived species like some hard corals that live on rocky substrate at deep depths. The authors of the model explained that recovery is addressed in the model as an exponential decay function and that 10 years is a recovery to 50% of original coral biomass; a site would recover to 80% of the original biomass after 34 years in the absence of further damage or removals. However, to further address these concerns, a deep and rocky substrate habitat category was added using published information from Stone (2014).

This study was focused on the central Aleutian Islands, but is the most comprehensive source of information on corals in Alaska. Results indicate that corals have the highest density and depths of 400-700m, on bedrock or cobbles, with moderate to very high roughness, and slopes greater than 10 percent.

To account for long-lived species expected to be found in these habitats, a new "Long-Lived Species" habitat feature was added with a new recovery score of "4", corresponding to a recovery time of 10-50 years. The 50-year upper limit of recovery time was calculated with the expectation that 5% of the long-lived species would require 150 years to recover. Inclusion of this new category resulted in an average increase of 0.03% more habitat in a disturbed state compared to the original model predictions. Predicted habitat reduction was about 70% less in grid cells that contained Deep/Rocky substrate compared to the entire domain, reflecting the reduced fishing effort in those areas.

At the April 2017 Council meeting, the SSC mentioned that techniques are emerging that would allow future assessment of corals as an ecosystem component, as opposed to a living structure. The SSC encouraged FE analysts to consider this in future assessments.

4.1.2.6 Non-living Structure

A variety of forms of the physical substrates in Alaska waters can provide structure to managed species, particularly juveniles. These physical structures range from boulder piles that provide crevices for hiding to sand ripples that may provide a resting area for organisms swimming against currents. Unfortunately, few of these interactions are understood well enough to assess the effects of substrate changes on habitat functions. A number of studies describe changes to the physical substrates resulting from the passage of trawls. However, there is no consistent metric available to relate the use of such structures by managed species to their abundance or condition. This lack of relationship effectively precludes a quantitative description of the effects of trawling on non-living structure. The following discussion describes such effects qualitatively.

4.1.2.7 Sand and Silt Substrates:

Schwinghamer et al. (1998) described physical changes to the fine sand habitats caused by trawling as part of the same study that produced Prena et al. (1999) and Kenchington et al. (2001). Door tracks, approximately 1 m wide and 5 cm deep, were detected with sidescan sonar, adding to the surface relief of the relatively featureless seafloor. Finer scale observations, made with video cameras, indicated that trawling replaced small hummocky features a few cm tall with linear alignments of organisms and shell hash. A dark organic floc that was present before trawling was absent afterwards. While no changes in sediment composition were detected, measurements of the internal structure of the top 4.5 cm of sediment were interpreted to indicate loss of small biogenic sediment structures such as mounds, tubes, and burrows. Brylinsky et al. (1994) describe trawl tracks as the most apparent effect of trawls on a silty substrate and the tracks of rollers as resulting in much shallower lines of compressed sediment than tracks of trawls without rollers. A wide variety of papers describes trawl marks; these papers include Gilkinson et al. (1998), who describe the scouring process in detail as part of a model door study.

For effects on sedimentary forms, the action of roller gear trawls replaces one set of cm-scale forms, such as hummocks and sand ripples, with door and roller tracks of similar scales. In habitats with an abundance of such structures, this can represent a decrease in seabed complexity, while in relatively smooth areas, an increase in complexity will result (Smith et al. 2000). The effects on internal sediment structure are considered too small in scale to provide shelter directly to the juveniles of managed species. The extent to which they affect the availability of prey for managed species is better measured by directly considering the abundance or those prey species.

4.1.2.8 Pebble to Boulder Substrates:

In substrates composed of larger particles (large pebbles to boulders), the interstitial structure of the substrate has a greater ability to provide shelter to juveniles and adults of managed species. The association of species aggregations with such substrates provides evidence of their function as structure (Krieger 1992, 1993). Freese et al. (1999) documented that the tire gear section of a trawl disturbed an average of 19 percent of the large boulders (more than 0.75-m longest axis) in its path. They noted that displaced boulders can still provide cover, while breaking up boulder piles can reduce the number and complexity of crevices.

In areas of smaller substrate particles (pebble to cobble), the track of the tire gear was distinguishable from the rest of the trawl path due to the removal of overlying silt from substrates with more cobble or the presence of a series of parallel furrows 1 to 8 cm deep from substrates with more pebble. Of the above effects, only breaking up boulder piles was hypothesized to decrease the amount of non-living functional structure for managed species. A key unknown is the proportional difference in functional structure between boulder piles and the same boulders, if separated. If that difference comprised 20 percent of the functional structure, and 19 percent of such piles were disturbed over one-third of the trawl paths (tire gear section), a single trawl pass would reduce non-living structure by only about 1 percent. Even if piles in the remaining trawl path were disturbed at half the rate of those in the path of the tire gear (likely an overestimate from descriptions in Freese et al. 1999).

4.1.2.9 Pelagic Trawls

Studies using gear directly comparable to Alaska pelagic trawls, and thus identifying the resulting effect of such gear contact with the seafloor, are lacking. By regulation, these trawls must not use bobbins or other protective devices, so footropes are small in diameter (typically chain or sometimes cable or wrapped cable). Thus, their effects may be similar to other footropes with small diameters (i.e., shrimp or Nephrops trawls). However, these nets have a large enough mesh size in the forward sections that few, if any, benthic organisms that actively swim upward would be retained in the net. Thus, benthic animals that were found in other studies to be separated from the bottom and removed by trawls with small-diameter footropes would be returned to the seafloor immediately by the Alaska pelagic trawls. Pelagic trawls are fished with doors that do not contact the seafloor, so any door effects are eliminated. Finally, because the pelagic trawl's unprotected footrope effectively precludes the use of these nets on rough or hard substrates, they do not affect the more complex habitats that occur on those substrates.

Sessile organisms that create structural habitat may be uprooted or pass under pelagic trawl footropes, while those that are more mobile or attached to light substrates may pass over the footrope, with less resulting damage. Non-living structures may be more affected by pelagic trawl footropes than by bottom trawl footropes because of the continuous contact and smaller, more concentrated, surfaces over which weight and towing force are applied. In contrast, bottom trawls may capture and remove more of the large organisms that provide structural habitat than pelagic trawls because of their smaller mesh sizes. The bottom trawl doors and footropes could add complexity to sedimentary bedforms as mentioned previously, while pelagic trawls have an almost entirely smoothing effect.

4.1.2.10 Longlines

The light weight of the lines used with longline gear, effects on either infaunal or epifaunal prey organisms are considered to be limited to anchors and weights. Since these components make up less than 1/500th of the length of the gear, their effects are considered very limited (0.05 percent reduction per contact was the value used). Similarly, effects on the non-living structure of soft bottoms are also likely to be very limited.

Organisms providing structure may be hooked or otherwise affected by contact with the line. Observers have recorded anemones, corals, sea pens, sea whips, and sponges being brought to the surface hooked on longline gear (Stellar sea lion protection measures SEIS, 2001), indicating that the lines move some distance across the seafloor and can affect some of the benthic organisms. The effects on non-living structure in hard-bottom areas due to hang-ups on smaller boulder piles and other emergent structures are limited to what may occur at forces below those necessary to break the line. Similar arguments to those used for bottom trawl effects on hard non-living structure would justify an even lower effect than the value generated for bottom-trawling (1 percent). Unfortunately, there are no data to indicate what proportion the retained organisms represent of those contacted on the seafloor or the level of damage to any of the affected organisms.

4.1.2.11 Pots

The only studies on pots (Eno et al. 2001) have examined gear much smaller and lighter than that used in Alaska waters and are, thus, not directly applicable in estimating effects of pots on habitat. Alaska pots are approximately 110 times as heavy and cover 19 times the area as those used by Eno et al. (2001) (2.6 kilograms [kg], 0.25^2 m). The Eno et al. (2001) study did show that most sea pens recovered after being pressed flat against the bottom by a pot. Most Alaska pots have their mesh bottoms suspended 2.5 to 5 cm above their weight rails (lower perimeter and cross pieces that contact the substrate first); hence, the spatial extent to which the greater weight of those pots is applied to organisms located underneath the pots is limited, but more intense.

The area of seafloor disturbed by the weight rails is of the greatest concern, particularly to the extent that the pot is dragged across the seafloor by bad weather, currents, or during hauling. Based on the estimated weight of the pots in water, and the surface area of the bottom of these rails, the average pressure applied to the seafloor along the weight rails (about 1 pound per square inch [lb/in^2] [0.7 kilogram per square centimeter (kg/cm^2)]) is sufficient to penetrate into most substrates during lateral movement. The effects of pots as they move across the bottom were speculated to be most similar to those of pelagic trawls with smaller contact diameter and more weight concentrated on the contact surface.

4.1.2.12 Dinglebar

Dinglebar troll gear (Figure 3-9 of the HAPC EA) consists of a single line that is retrieved and set with a power or hand troll gurdy, with a terminally attached weight (cannon ball -12 lbs. or iron bar), from which one or more leaders with one or more lures or baited hooks are pulled through the water while a vessels is underway (NPFMC 2003). Dinglebar troll gear is essentially the same as power or hand troll gear, the difference lies in the species targeted and the permit required. For example, dinglebar troll gear can be used in the directed fisheries for groundfish (e.g. cod) or halibut. These species may only be taken incidentally while fishing for salmon with power or hand troll gear. There is a directed fishery for ling cod in Southeast Alaska using dinglebar troll gear. Trolling can occur over any bottom type and at almost any depths. Trollers work in shallower coastal waters, but may also fish off the coast, such as on the Fairweather Grounds. The dinglebar is usually made of a heavy metal, such as iron, is used in nearly continuous contact with the bottom, and therefore, is likely to disturb bottom habitat.

4.1.2.13 Dredge Gear

Dredging for scallops may affect groundfish habitat by causing unobserved mortality to marine life and modification of the benthic community and sediments. Similar to trawling, dredging places fine sediments into suspension, buries gravel below the surface and overturns large rocks that are embedded in the substrate (NEFMC 1982, Caddy 1973). Dredging can also result in dislodgement of buried shell material, burying of gravel under re-suspended sand, and overturning of larger rocks with an appreciable roughening of the sediment surface (Caddy 1968). A study of scallop dredging in Scotland showed that dredging caused significant physical disturbance to the sediments, as indicated by furrows and dislodgement of shell fragments and small stones (Eleftheriou and Robertson 1992). The authors note, however, that these changes in bottom topography did not change sediment disposition, sediment size, organic carbon content, or chlorophyll content. Observations of the Icelandic scallop fishery off Norway indicated that dredging changed the bottom substrate from shell-sand to clay with large stones within a 3-year period (Aschan 1991). Mayer et al. (1991), investigating the effects of a New Bedford scallop dredge on sedimentology at a site in coastal Maine, found that vertical redistribution of bottom sediments had greater implications than the horizontal translocation associated with scraping and plowing the bottom. The scallop dredge tended to bury surficial metabolizable organic matter below the surface, causing a shift in sediment metabolism away from aerobic respiration that occurred at the sediment-water interface and instead toward subsurface anaerobic respiration by bacteria (Mayer et al. 1991). Dredge marks on the sea floor tend to be short-lived in areas of strong bottom currents, but may persist in low energy environments (Messieh et al. 1991).

Two studies have indicated that intensive scallop dredging may have some direct effects on the benthic community. Eleftheriou and Robertson (1992), conducted an experimental scallop dredging in a small sandy bay in Scotland to assess the effects of scallop dredging on the benthic fauna. They concluded that while dredging on sandy bottom has a limited effect on the physical environment and the smaller infauna, large numbers of the larger infauna (molluscs) and some epifaunal organisms (echinoderms and crustaceans) were killed or damaged after only a few hauls of the dredge. Long-term and cumulative effects were not examined, however. Achan (1991) examined the effects of dredging for islandic scallops on macrobenthos off Norway. Achan found that the faunal biomass declined over a four-year period of heavy dredging. Several species, including urchins, shrimp, seastars, and polychaetes showed an increase in abundance over the time period. In summary, scallop gear, like other gear used to harvest living aquatic resources, may affect the benthic community and physical environment relative to the intensity of the fishery.

4.1.3 Fishing Effects Vulnerability Assessment

A goal of the vulnerability assessment is to base estimates of susceptibility and recovery of features to gear impacts on the scientific literature to the extent possible. In previous EFH fishing effects analyses (2005 and 2010), an overview of new and existing research on the effects of fishing on habitat was included in this document. Each of the inputs to the fishing effects model were evaluated, including the distribution of fishing intensity for each gear type, spatial habitat classifications, classification of habitat features, habitat- and feature-specific recovery rates, and gear- and habitat- specific sensitivity of habitat features. Many of these estimates were best professional judgement by fisheries managers and scientists.

For the 2015 EFH Review, a more empirical literature review method was incorporated to assess the effects of fishing on habitat. A vulnerability assessment and associated global literature review was developed by members of the New England Fishery Management Council's Habitat Plan Development Team while developing the Swept Areas Seabed Impacts model, which was in part based on the LEI model. Studies were selected for evaluation based on their broad relevance to Northeast Region habitats and fishing gears, but have been adapted for use in the North Pacific. Synthesis papers and modeling studies are excluded from the review, but the research underlying these publications is included when relevant. Most of the studies reviewed are published as peer-reviewed journal articles, but conference proceedings, reports, and these are considered as well.

A Microsoft Access database was developed to organize the review and to identify in detail the gear types and habitat features evaluated in each study. In addition to identifying gear types and features, the database included field codes for basic information about study location and related research; study design, relevance and appropriateness to the vulnerability assessment; depth; whether recovery of features is addressed; and substrate types found in the study area. Analysts interacted with the database via an Access form.

Over 115 studies are evaluated, although additional literature referenced in the previous section on feature descriptions was used in some cases to inform recovery scores, and not all of the studies are used equally to inform the matrix-based vulnerability assessment. The long-term intention is to create new records in the database as additional gear impacts studies are published. This database is published as Grabowski et al (2014).

As a model parameterization tool, the vulnerability assessment quantifies both the magnitude of the impacts that result from the physical interaction of fish habitats and fishing gears, and the duration of recovery following those interactions. This vulnerability information from this database has been modified to condition area swept (i.e. fishing effort) in the FE model via a series of susceptibility and recovery parameters.

A critical point about the vulnerability assessment and accompanying FE model is that they consider EFH and impacts to EFH in a holistic manner, rather than separately identifying impacts to EFH designated for individual species and life stages. This is consistent with the EFH final rule, which indicates "adverse effects to EFH may result from actions occurring within EFH or outside of [designated] EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (§600.810). To the extent that key features of species' EFH can be related to the features in the vulnerability assessment, post-hoc analysis of model outputs can be conducted to better evaluate the vulnerability of a particular species' essential habitat components to fishing gear effects.

4.1.4 Impact Assessment Methods

In 2005, distribution of LEI values for each class of habitat feature were provided to experts on each managed species, to use in their assessment of whether such effects were likely to impact life history processes in a way that indicated an adverse change to EFH. Experts were asked to assess connections between the life history functions of their species at different life stages and the classes of habitat features used in the LEI model. Then, considering the distribution of LEIs for each of those features, they were asked whether such effects raised concerns for their species. Experts also considered the history of the status of species stocks in their assessments. While this process provided the first information available of the effects of fishing on stocks, it was not overly analytical.

In December 2016, the Council approved a three-tiered method to evaluate whether there are adverse effects of fishing on EFH (Figure 24). This analysis considers impacts of commercial fishing first at the population level, then uses objective criteria to determine whether additional analysis is warranted to evaluate if habitat impacts caused by fishing are adverse and more than minimal or not temporary.

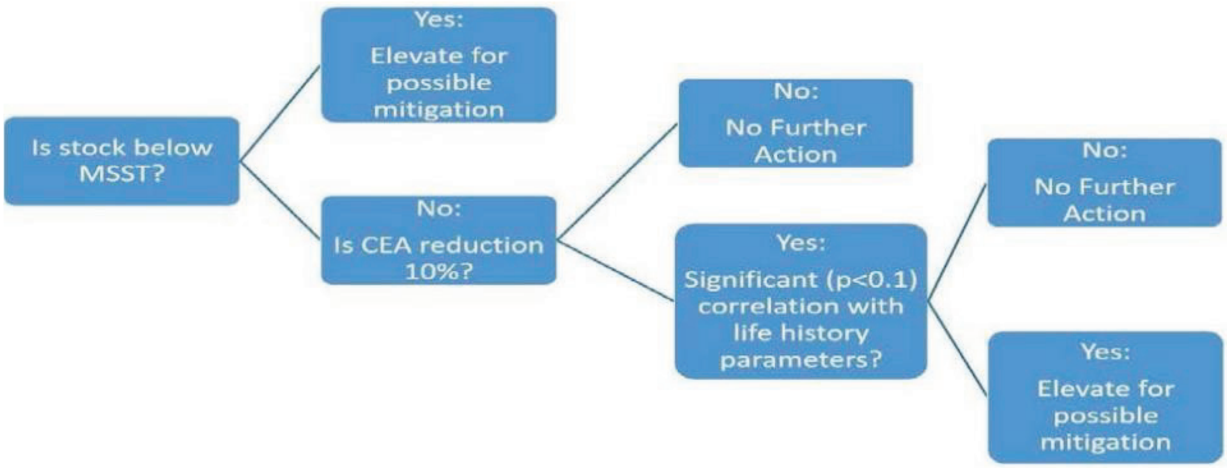

Figure 24 Three tiered method to evaluate effects of fishing on Essential Fish Habitat in Alaska

Because EFH is defined for populations managed by Council FMPs, stock authors first considered whether the population is above or below the Minimum Stock Size Threshold (MSST), defined as 0.5*MSY stock size, or the minimum stock size at which rebuilding to MSY would be expected to occur within 10 years if the stock were exploited at the Maximum Fishing Mortality Threshold (MFMT). Stock authors were asked to identify any stock that is below MSST for review by the Plan Teams. Mitigation measures may be recommended by the Plan Team if they concur that there is a plausible connection to reductions of EFH as the cause.

To investigate the potential relationships between fishing effects and stock production, the stock assessment authors examined trends in life history parameters and the amount of disturbed habitat in the “core EFH Area” (CEA) for each species. The CEA is identified as the predicted 50 percent quantile threshold of suitable habitat or summer abundance (Laman et al., 2017, Turner et al. 2017, Rooney et al., In Press). Stock assessment authors evaluated whether 10 percent or more of the CEA was impacted by commercial fishing in November 2016 (the end of the time series). The 10 percent threshold was selected based on the assumption that impacts to less than 10 percent of the CEA means than more than 90 percent of the CEA (top 50 percent of suitable habitat or summer abundance) was undisturbed, and therefore represented minimal disturbance. If 10 percent or more of the CEA was impacted, the stock assessment authors examined indices of growth-to-maturity, spawning success, breeding success, and feeding success to determine whether there are correlations between those parameters and the trends in the proportion of the CEA impacted by fishing. If a correlation exists, positive or negative, stock assessment authors determined whether the correlation is significant at a p-value of 0.1. If a significant correlation was found, stock assessment authors used their expert judgement to determine whether there is a plausible connection to reductions in EFH as the cause. Stock assessment authors identified the correlation, and the significance in their reports.

Reports from the stock assessment authors were collated and presented to representatives of the GOA and BSAI Groundfish Plan Teams and the Crab Plan Team. Plan Team representatives reviewed the reports in March, 2017. Representatives concurred with the stock assessment authors determinations in all cases. None of the stock assessment authors concluded that habitat reduction within the CEA for their species was affecting their stocks in ways that were more than minimal or not temporary. None of the authors recommended any change in management with regard to fishing within EFH.

4.1.5 Evaluation of Effects on EFH of BSAI Crab Species

This section evaluates whether the fisheries, as they are currently conducted off Alaska, will affect habitat that is essential to the welfare of the managed fish populations in a way that is more than minimal and not temporary. The previous statement describes the standard set in the EFH regulations which, if met, requires Councils to act to minimize such effects. Habitat features were selected as those which a) can be affected by fishing, and b) may be important to fish in spawning, breeding, feeding, and growth to maturity. This section evaluates the extent that these changes related to the EFH of each managed species and whether they constitute an effect to EFH that is more than minimal.

Two conclusions are necessary for this evaluation: (1) the definition of EFH draws a distinction between the amount of habitat necessary for a species to support a sustainable fishery and the managed species contribution to a healthy ecosystem (40 CFR 600.10) and all habitat features used by any individuals of a species; (2) this distinction applies to both the designation of EFH and the evaluation of fishing effects on EFH. If these conclusions are valid, the more than minimal standard relates to impacts that potentially affect the ability of the species to fulfill its fishery and ecosystem roles, not just impacts on a local scale. The following text summarizes the results of the analysis for each managed species.

4.1.5.1 Red King Crab

The first step in the three-tiered approach is to determine whether or not the stock is below MSST. There are three red king crab stocks in the eastern Bering Sea: Bristol Bay, Norton Sound, and Pribilof Islands. In the 2016 assessments (Hamazaki and Zheng, 2016; Turnock, Szuwalski and Foy, 2016; Zheng and Siddeek, 2016), all three stocks were determined to be above MSST.

The next step in the three-tiered approach, having determined that the stock is above MSST, is to determine whether or not the amount of habitat disturbed by commercial fishing withing the stock's 50 percent quantile Core Essential Area is greater than 10 percent. As shown in Figure 25, the percent habitat reduction with the red king crab Core Essential Area during the 2003-2016 time period has always been less than 10 percent. Because the habitat reduction within the Core Essential Area is less than 10 percent, professional judgement indicates that fisheries do not adversely affect the EFH of the red king crab stocks, and the remaining tiers are not addressed.

A concern was raised regarding the use of the 50 percent Core Essntial Area for red king crab stocks. Some habitat is much more important for red king crab spawning success than others. Even though the habitat reduction for all red king crab habitat areas is less than ten percent, the most critical area for Bristol Bay red king crab spawning is southern Bristol Bay, where the habitat reduction is over ten percent (Figure 26). Additional analysis may be beneficial for understanding fishery impacts on Bristol Bay red king crab beyond Figures 25 and 26.

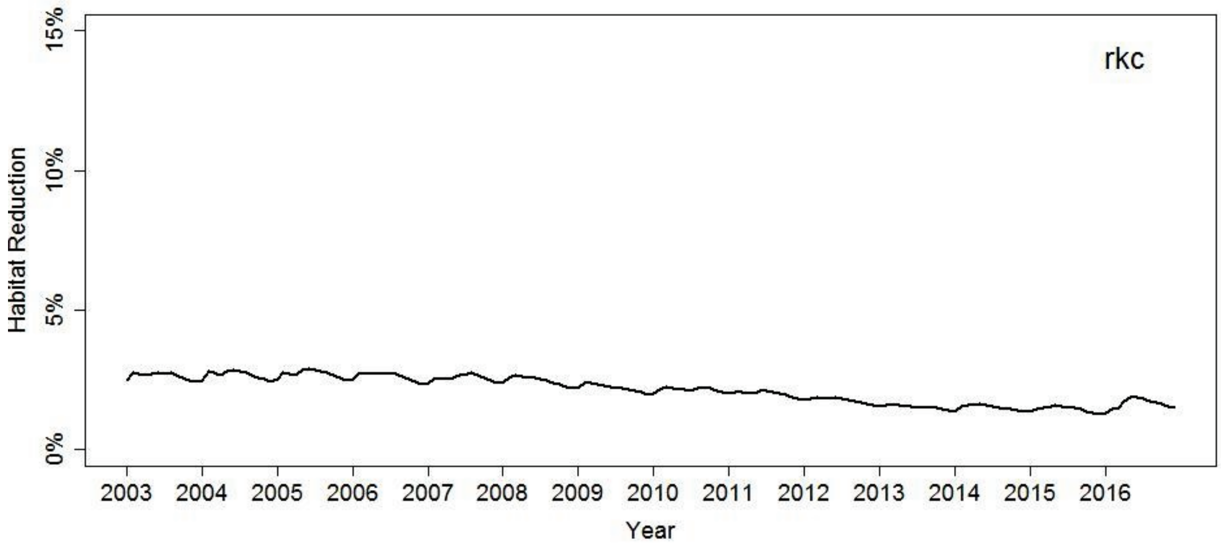

Figure 25 Estimated time series for the percent habitat reduction in the Core Essential Area for red king crab in the Bering Sea

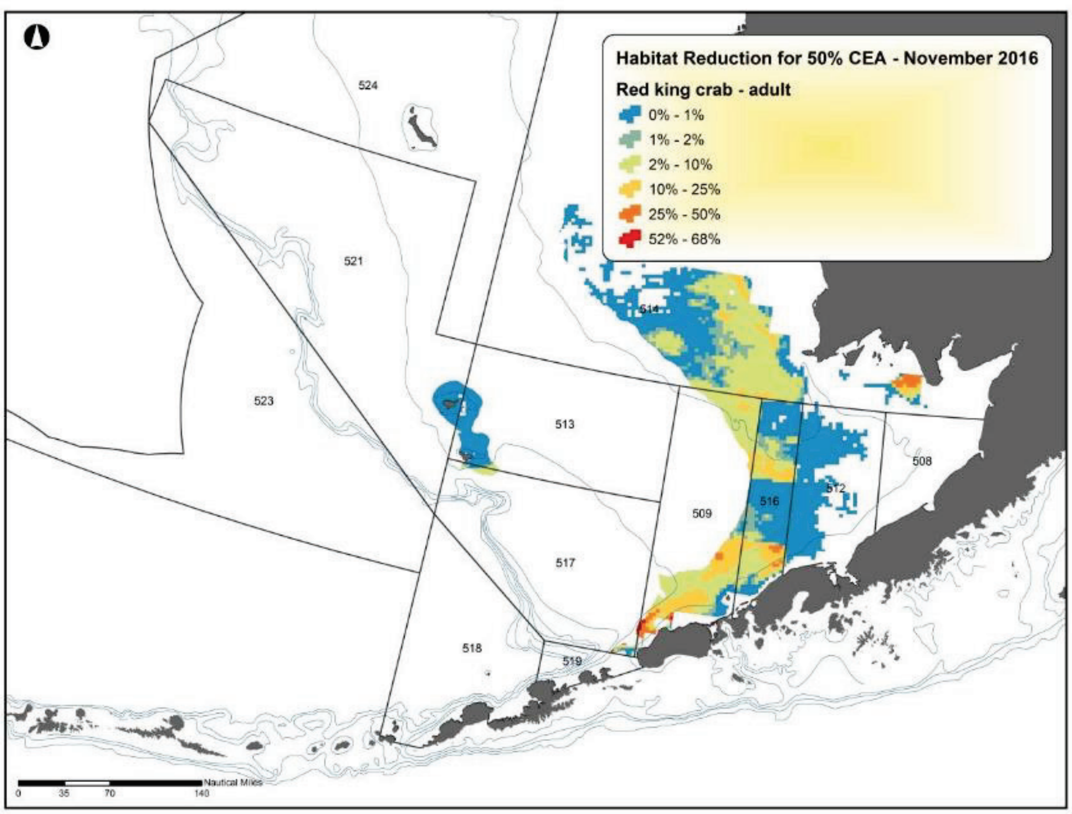

Figure 26 Estimated habitat reduction in the Core Essential Area for red king crab in the Bering Sea

4.1.5.2 Blue King Crab

4.1.5.2.1 Pribilof Islands stock

The first step in the three-tiered approach is to determine whether or not the stock is below MSST. In the 2016 assessment (Stockhausen, 2016), the Pribilof Islands blue king crab (PIBKC) stock was determined to be below MSST. The three-tiered approach is consequently terminated, and the stock should be elevated for possible mitigation. However, habitat reduction in the total Core Essential Area, as well as directly around the Pribilof Islands, appears to be (and have been) less than 1 percent (Figure 27). Thus, it is unlikely that habitat reduction due to commercial fishing plays a role in the decline of the PIBKC stock. Additionally, the Pribilof Islands Habitat Conservation Zone is closed to fishing with either non-pelagic trawl gear or Pacific cod pot gear.

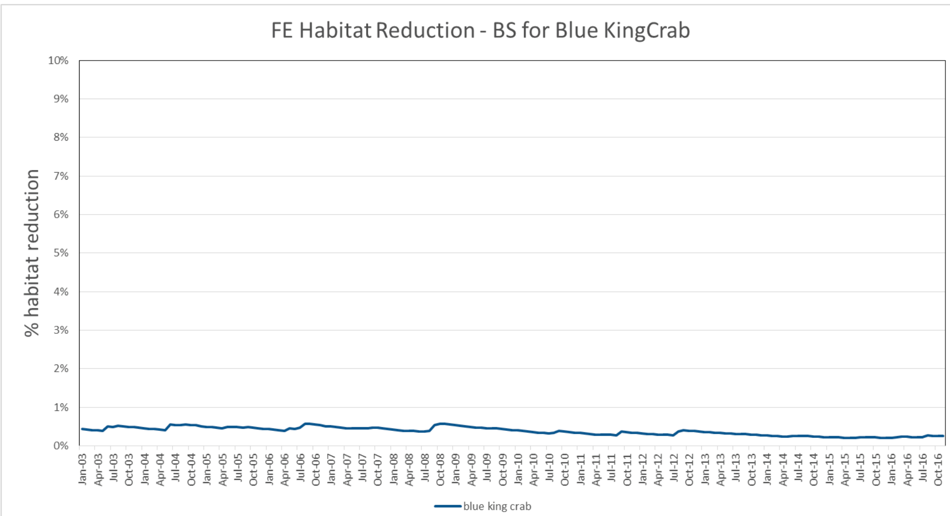

Figure 27 Estimated time series for the percent habitat reduction in the total Core Essential Area for blue king crab in the Bering Sea (of which the Pribilof Islands is one of three areas)

4.1.5.2.2 St. Matthew Island stock

The first step in the three-tiered approach is to determine whether or not the stock is below MSST. In the 2016 assessment (Webber et al., 2016), the St. Matthew Pribilof Island blue king crab (SMBKC) stock was determined to be above MSST.

The next step in the three-tiered approach, having determined that the stock is not below MSST, is to determine whether or not the amount of habitat disturbed by commercial fishing within the stock's 50 percent quantile Core Essential Area is greater than 10 percent. As shown in Figure 28, the percent habitat reduction with the SMBKC Core Essential Area during the 2003-2016 time period has always been less than 10 percent. Because the habitat reduction within its Core Essential Area is less than 10 percent, professional judgement indicates that fisheries do not adversely affect the EFH of the SMBKC stock, and the remaining tiers are not addressed.

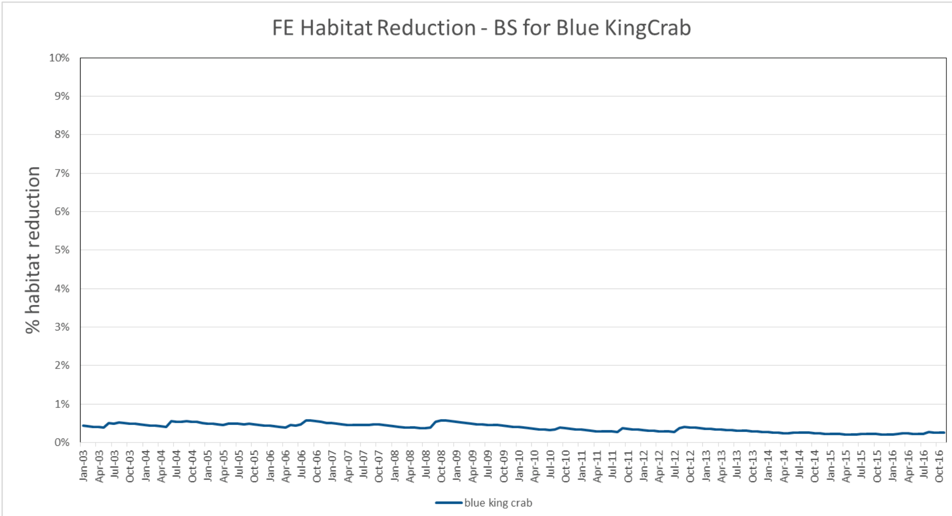

Figure 28 Estimated time series for the percent habitat reduction in the total Core Essential Area for blue king crab in the Bering Sea (of which the St. Matthew Island is one of three areas)

4.1.5.3 Golden King Crab

Issue	Evaluation
Spawning/breeding	MT (Minimal, temporary, or no effect)
Feeding	U (Unkown effect)
Growth to maturity	U (Unknown effect)

Information was insufficient to conduct the three-tiered approach for golden king crab. However, based on the analysis in the 2005 EFH EIS, fishing activities are considered to have overall minimal and temporary effects on the EFH for golden king crab. Groundfish trawl fishing in the EBS slope is of some concern; however, any effects are thought to be minimal. Professional judgement indicates that fisheries do not adversely affect the EFH of golden king crab.

4.1.5.4 Tanner Crab

The first step in the three-tiered approach is to determine whether or not the stock is below MSST. In the 2016 assessment (Stockhausen 2016a), the Tanner crab stock was determined to be above MSST.

The next step in the three-tiered approach, having determined that the stock is above MSST, is to determine whether or not the amount of habitat disturbed by commercial fishing within the stock's 50 percent quantile Core Essential Area is greater than 10 percent. As shown in Figure 29, the percent habitat reduction with the Tanner crab Core Essential Area during the 2003-2016 time period has always been less than 10 percent. Because the habitat reduction within its Core Essential Area is less than 10 percent, professional judgement indicates that fisheries do not adversely affect the EFH of the Tanner crab stock, and the remaining tiers are not addressed.

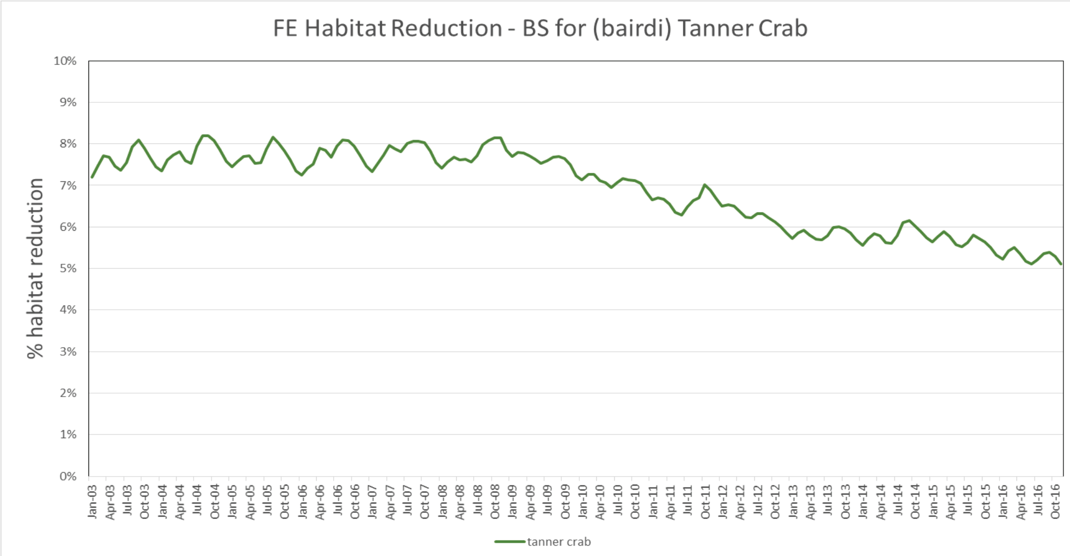

Figure 29 Estimated time series for the percent habitat reduction in the Core Essential Area for Tanner crab in the Bering Sea

4.1.5.5 Snow Crab

The first step in the three-tiered approach is to determine whether or not the stock is below MSST. In the 2016 assessment (Szuwalski and Turnock 2016), the snow crab stock was determined to be above MSST.

The next step in the three-tiered approach, having determined that the stock is above MSST, is to determine whether or not the amount of habitat disturbed by commercial fishing withing the stock's 50 percent quantile Core Essential Area is greater than 10 percent. As shown in Figure 30, the percent habitat reduction with the snow crab Core Essential Area during the 2003-2016 time period has always been less than 10 percent. Because the habitat reduction within its Core Essential Area is less than 10 percent, professional judgement indicates that fisheries do not adversely affect the EFH of the snow crab stock, and the remaining tiers are not addressed.

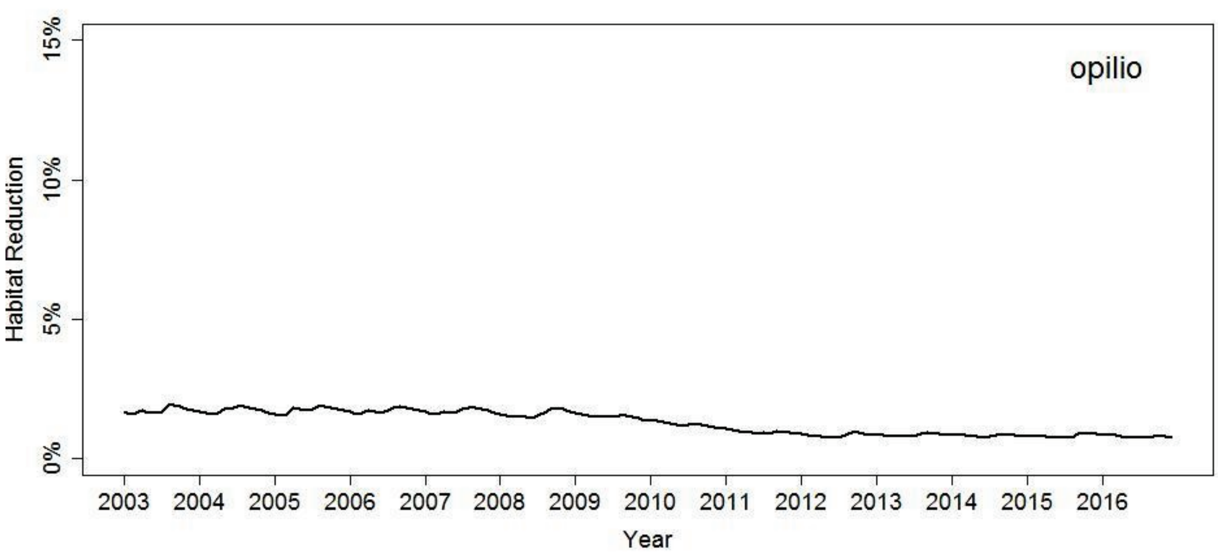

Figure 30 Estimated time series for the percent habitat reduction in the Core Essential Area for snow crab in the Bering Sea

4.1.6 Cumulative Effects of Fishing on Essential Fish Habitat

The 2005 EFH FEIS, 2010 EFH Review, and 2015 EFH Review concluded that fisheries do have long term effects on habitat, and these impacts were determined to be minimal and not detrimental to fish populations or their habitats. While the 2010 EFH Review provided incremental improvements to our understanding of habitat types, sensitivity and recovery of seafloor habitat features, these new results were consistent with the sensitivity and recovery parameters and distributions of habitat types used in the prior analysis of fishing effects for the 2005 EFH EIS. None of this new information revealed significant errors in the parameters used in that analysis; rather, it marginally increased support for their validity.

This still left the LEI model well short of a rigorously validated, predictive structure.

The previous EFH analyses, as well as the CIE review, indicated the need for improved fishing effects model parameters. With the FE model, our ability to analyze fishing effects on habitat has grown exponentially. Vessel Monitoring System data provides a much more detailed treatment of fishing intensity, allowing better assessments of the effects of overlapping effort and distribution of effort between and within grid cells. The development of literature-derived fishing effects database has increased our ability to estimate gear-specific susceptibility and recovery parameters. The distribution of habitat types, derived from increased sediment data availability, has improved. The combination of these parameters has greatly enhanced our ability to estimate fishing impacts.

In April 2016, the SSC recommended that new methods and criteria be developed to evaluate whether the effects of fishing on EFH are more than minimal and not temporary. Criteria were developed by NMFS and researchers at Alaska Pacific University, and reviewed by the Council and its advisory committees in 2016, and the stock assessment authors in 2017. In April 2017, based on the analysis with the FE model, the Council concurred with the Plan Team consensus that the effects of fishing on EFH do not currently meet the threshold of more than minimal and not temporary, and mitigation action is not needed at this time.

While these analyses found no indication that continued fishing activities at the current rate and intensity would alter the capacity of EFH to support healthy populations of managed species over the long term, the Council acknowledges that scientific uncertainty remains regarding the consequences of habitat alteration for the sustained productivity of managed species. Consequently, the Council has adopted, and NMFS has implemented, a number of management measures designed to reduce adverse impacts to habitat.

5 Non-fishing Activities that may Adversely Affect Essential Fish Habitat

The waters, substrates and ecosystem processes that provide EFH and support sustainable fisheries are susceptible to a wide array of human activities and climate related influences completely unrelated to the act of fishing. These activities range from easily identified point source anthropogenic discharges in watersheds or nearshore coastal zones to less visible influences of changing ocean conditions or increased variability in regional temperature or weather patterns. Broad categories of such activities include, but are not limited to, mining, dredging, fill, impoundment, discharge, water diversions, thermal additions, actions that contribute to nonpoint source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. For Alaska, these categories of non-fishing impacts are presented and discussed in the non-fishing impacts report, which NMFS updates every five years with the 5-year EFH review.

The most recent report is *Impacts to EFH from Non-Fishing Activities in Alaska* (Limpinsel et al. 2017). This report addresses non-fishing activities requiring EFH consultations and that may adversely affect EFH. The report offers general conservation measures for a wide variety of non-fishing activities grouped into four broad categories of ecotones: (1) wetlands and woodlands; (2) headwaters, streams, rivers, and lakes; (3) marine estuaries and nearshore zones; and (4) open water marine and offshore zones. The report emphasizes the recognition that water quality and quantity are the most important EFH attributes for sustainable fisheries. It also recognizes that in Alaska, water contributes to ecosystems processes supporting EFH under the influence of three climate zones, through eight terrestrial ecoregions, and water eventually influences the character of seventeen coastal zones and four Large Marine Ecosystems (LMEs). The report also provides: (1) descriptions of ecosystem processes and functions that support EFH through freshwater and marine systems; (2) the current observations and influence of climate change and ocean acidification to our federally managed fisheries in Alaska; and (3) discussions oil spill response technologies and increasing vessel traffic in the Bering Sea and Arctic Ocean.

The purpose of this report is to assist in the identification of activities that may adversely impact EFH and provide general EFH conservation recommendations to avoid or minimize adverse impacts. Section 305(b) of the MSA requires each Federal agency to consult with NMFS on any action that agency authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake, that may adversely affect EFH. Each Council shall comment on and make recommendations to the Secretary and any Federal or State agency concerning any such activity that, in the view of the Council, is likely to substantially affect the habitat, including essential fish habitat, of an anadromous fishery resource under its authority. If NMFS or the Council determines that an action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by any State or Federal agency would adversely affect any EFH, NMFS shall recommend to the agency measures that can be taken to conserve EFH. Within 30 days after receiving EFH conservation recommendations from NMFS, a Federal agency shall provide a detailed response in writing to NMFS regarding the matter. If the response is inconsistent with NMFS's recommendations, the Federal agency shall explain its reasons for not following the recommendations.

EFH conservation recommendations are non-binding to Federal and state agencies. EFH consultations do not supersede regulations or jurisdictions of Federal or state agencies. NMFS has no authority to issue permits for projects or require measures to minimize impacts of non-fishing activities. Most non-fishing activities identified in this report are already subject to numerous Federal, state, and local environmental laws and regulations designed to minimize and mitigate impacts. Listing all applicable laws and management practices is beyond the scope of this FMP or the non-fishing impacts report. Environmentally sound engineering and management practices are strongly encouraged to mitigate impacts from all actions.

Table 14 identifies activities other than fishing that may adversely affect EFH and identifies known and potential adverse effects to EFH. More information on these activities and the potential adverse effects is provided in the non-fishing impacts report (Limpinsel et al. 2017).

Table 14 Summary on Non-Fishing Effects on Habitat

Threats	HABITAT ALTERATION	Alternation of original or normal habitat	Loss of offshore habitat	Loss of pelagic habitat	Loss of nearshore habitat	Loss of benthic habitat	Loss of aquatic vegetaion	Loss of wetland value	Loss of original sediment type	Detrital matter introduction	TOPOGRAPHIC ALTERATION	Change in original feature or structure	Accretion \ Overburden of original feature	Erosion \ Dispersal of feature	ORGANISM ALTERATION	Physical damage to organism	Mortality	Spatial alteration	Gene pool deterioration	Introduction of exotic species	Introduction of pathogens\disease	Change in photosynthetic regime	OCEANOGRAPHIC ALTERATION	Change in temperture regime	Change in salinity	Change in circulation pattern	WATER QUALITY ALTERATION	Change in dissolved oxygen content	Eutrophication, nutrient loading	Water contamination	Suspended sediments, turbidity	Atmospheric deposition
Excavation																																
Dredging		X			X	X	X	X	X			X	X	X		X	X					X		*	*	*		*	X	X	X	
Dredge Material Disposal		X	X		X	X	X	X	X	X		X	X			X	X	X			X	X		*	*	*		*	X	X	X	
Marine Mining		X	X			X			X	X		X	X	X		X	X				X	X		X	X	X		*	X	X	X	
Nearshore Mining		X			X	X	X		X	X		X	X	X		X	X				X	X		*	*	*		*	X	X	X	
Recreational Uses																																
Boating				X	X	X	X			X						X	X			X	X			*	*	*		*	*	X	X	X
Stream Bank Over-usage		X						X	X	X		X	X	X		X	X				X	X							X	X	X	
Fish Waste Processing																																
Shoreside Discharge		X			X	X	X		X	X		X	X								X	X		X	X			*	X	X	X	
Vessel Discharge				X		X				X											X	X						*	X		X	
Aquaculture					X		X			X								X	X	X	X	X		X	X	X		*	X	X	X	
Petroleum Production																																
Production Facility		X	X		X	X	X	X	X	X		X	X	X			X	X			X	X		X	X	X				X	X	X
Exploration		X	X		X	X	X	X				X	X	X		X	X				X	X				X				X	X	X
Oil Spill		X	X		X	X	X	X	X	X						X	X		X		X	X			*			X		X	X	X
Hydrological																																
Hydroelectric Dams									X								X				X	X						X			X	
Impoundments		X					X	X	X			X	X	X		X	X				X	X						X	X		X	
Flood Erosion/Control		X			X		X	X	X			X	X	X		X	X					X						X	X			
Agricultural																																
Agriclutural/Farming		X			X		X	X	X	X		X	X	X				X			X			*	*			X	X	X	X	
Insect Control					X		X	X								X	X				X	X								X		X
Forestry		X			X		X	X	X	X		X	X	X		X		X				X		X	*					X	X	
Water Diversion/Withdraw l		X			X		X	X				X	X	X								X		*		X		X	X	X	X	
Harbors/Ports/Marinas																																
Port Construction		X			X	X	X	X	X	X		X	X	X		X	X	X				X		*	*	X		*		X	X	
Port Development		X			X	X	X	X	X	X		X	X	X		X	X	X			X	X				*		*		X	X	
Artifical Reefs		X			X	X						X	X	X				X				X		X	X	X						
Municipal and Industrial																																
Non-point Source				X	X	X	X	X	X	X			X			X	X	X	X		X	X		X	X			X		X		X
Coastal Urbanization		X			X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X		X	X	X		X	X	X	X	X
Sew age Treatment		X			X	X				X			X			X	X		X	X	X	X		X	X			X	X	X		
Storm Water Runoff					X					X						X	X		X	X	X	X		X	X			X	X	X	X	
Environmental																																
Climatic Changes/Shifts				X	X		X						X	X								X		X	X	X						X
Toxic Algal Bloom																X	X		X		X	X			*			X				
Introduction of Exotic Species																X	X	X	X	X	X								X			
Marine Transportation																																
Vessel Groundings		X			X	X	X		X	X		X		X		X	X			X	X									X		
Ballast Water				X		X										X	X		X	X	X	X		X	X					X		
Marine Debris		X		X	X	X	X		X	X			X			X	X	X			X	X								X		

* - short term impact

6 Cumulative Effects of Fishing and Non-fishing Activities on EFH

This section summarizes the cumulative effects of fishing and non-fishing activities on EFH. The cumulative effects of fishing and non-fishing activities on EFH were considered in the 2005 EFH EIS, but insufficient information existed to accurately assess how the cumulative effects of fishing and non-fishing activities influence ecosystem processes and EFH. The 2015 5-year review has reevaluated potential impacts of fishing and non-fishing activities on EFH using recent technologies and literature, and the current understanding of marine and freshwater fisheries science, ecosystem processes, and population dynamics (Simpson et al. 2017).

As previously identified in Section 4.4 EFH-EIS (NMFS 2005), historical fishing practices may have had effects on EFH that have led to declining trends in some of the criteria examined (Table 4.4-1). For fishing impacts to EFH, the FE model calculates habitat reductions at a monthly time step since 2003 and incorporates susceptibility and recovery dynamics, allowing for an assessment of cumulative effects from fishing activities for the first time. As identified in Section 5, the effects of current fishing activities on EFH are considered as minimal and temporary or unknown using the new methods.

The cumulative effects from multiple non-fishing anthropogenic sources are increasingly recognized as having synergistic effects that may degrade EFH and associated ecosystem processes that support sustainable fisheries. Non-fishing activities may have potential long term cumulative impacts due to the long term additive and chronic nature of the activities combined with climate change (Limpinsel et al. 2017). However, the magnitude of the effects of non-fishing activities cannot currently be quantified with available information. NMFS does not have regulatory authority over non-fishing activities, but frequently provides recommendations to other agencies to avoid, minimize, or otherwise mitigate the effects of these activities.

Fishing and each activity identified in the analysis of non-fishing activities may not significantly affect the function of EFH. However, the synergistic effect of the combination of all of these activities may be a cause for concern. Unfortunately, available information is not sufficient to assess how the cumulative effects of fishing and non-fishing activities influence the function of EFH on an ecosystem or watershed scale. The magnitude of the combined effect of all of these activities cannot be quantified, so the cumulative level of concern is not known at this point.

7 Research Approach for EFH

The EFH EIS (NMFS 2005) identified a research approach for EFH regarding minimizing fishing impacts. The research approach was revised in 2010 following the Council's EFH 5-year Review for 2010, documented in a Final Summary Report (NPFMC and NMFS 2010).

7.1.1.1 Objectives

Establish a scientific research and monitoring program to understand the degree to which impacts have been reduced within habitat closure areas, and to understand how benthic habitat recovery of key species is occurring.

Benthic habitat recovery. Allow recovery of habitat in a large area with relatively low historic effort.

7.1.1.2 Research Questions

Reduce impacts. Does the closure effectively restrict higher-impact trawl fisheries from a portion of the GOA slope? Is there increased use of alternative gears in the GOA closed areas? Does total bottom trawl effort in adjacent open areas increase as a result of effort displaced from closed areas? Do bottom trawls affect these benthic habitats more than the alternative gear types? What are the research priorities? Are fragile habitats in the AI affected by any fisheries that are not covered by the new EFH closures? Are sponge and coral essential components of the habitat supporting FMP species?

Benthic habitat recovery. Did the habitat within closed areas recover or remain unfished because of these closures? Do recovered habitats support more abundant and healthier FMP species? If FMP species are more abundant in the EFH protection areas, is there any benefit in yield for areas that are still fished without EFH protection?

7.1.1.3 Research Activities

- Fishing effort data from observers and remote sensing would be used to study changes in bottom trawl and other fishing gear activity in the closed (and open) areas. Effects of displaced fishing effort would have to be considered. The basis of comparison would be changes in the structure and function of benthic communities and populations, as well as important physical features of the seabed, after comparable harvests of target species are taken with each gear type.

- Monitor the structure and function of benthic communities and populations in the newly closed areas, as well as important physical features of the seabed, for changes that may indicate recovery of benthic habitat. Whether these changes constitute recovery from fishing or just natural variability/shifts requires comparison with an area that is undisturbed by fishing and otherwise comparable.

- Validate the LEI model and improve estimates of recovery rates, particularly for the more sensitive habitats, including coral and sponge habitats in the Aleutian Islands region, possibly addressed through comparisons of benthic communities in trawled and untrawled areas.

- Obtain high resolution mapping of benthic habitats, particularly in the on-shelf regions of the Aleutian Islands.

- Time series of maturity at age should be collected to facilitate the assessment of whether habitat conditions are suitable for growth to maturity.

- In the case of red king crab spawning habitat in southern Bristol Bay, research the current impacts of trawling on habitat in spawning areas and the relationship of female crab distribution with respect to bottom temperature.

7.1.1.4 Research Time Frame

Changes in fishing effort and gear types should be readily detectable. Biological recovery monitoring may require an extended period if undisturbed habitats of this type typically include large or long-lived organisms and/or high species diversity. Recovery of smaller, shorter-lived components should be apparent much sooner.

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Appendix E Areas Described in the Fishery Management Plan

The following descriptions of the registration areas are adopted from Alaska State regulations. In the case of the Bering Sea king crab Registration Area (Registration Area Q) and some of its districts, the boundary descriptions extend into the Chukchi Sea to Point Hope. The FMP's jurisdiction ends at the southern boundary of the Chukchi Sea. Updated information surrounding shellfish management can be found in the Annual management report for shellfish of the BS/AI management area.

Current Registration Areas

King Crab

Bering Sea Registration Area (Area Q): The southern boundary is a line from 54°36′ N lat., 168° W long., to 54°36′ N lat., 171° W long., to 55°30′ N lat., 171° W long., to 55°30′ N lat., 173°30′ E long. The northern boundary is the latitude of Point Hope (68°21′ N lat.). The eastern boundary is a line from 54°36′ N lat., 168° W long., to 58°39′ N lat., 168° W long., to Cape Newenham (58°39′ N lat.). The western boundary is the United States–Russia Maritime Boundary Agreement Line of 1990. Area Q is divided into 2 districts:

1. Pribilof District Q_1: waters of Registration Area Q south of the latitude of Cape Newenham (58°39' N lat.).
2. Northern District: waters of Registration Area Q north of latitude of Cape Newenham (58°39' N lat.). The Northern District is subdivided into three sections:

    Saint Matthew Island Section Q_2: waters north of the latitude of Cape Newenham (58°39' N lat.) and south of the latitude of Cape Romanzof (61°49' N lat.);

    Norton Sound Section Q_3: waters north of latitude of Cape Romanzof (61°49' N lat.) and south of the latitude of Cape Prince of Wales (66° N lat.); and

    Kotzebue Sound Section Q_4: all remaining waters of the district.

Bristol Bay Registration Area (Area T): has as its northern boundary the latitude of Cape Newenham (58°39'N lat), as its southern boundary the latitude of Cape Sarichef (54°36' N lat.), as its western boundary 168° W long. and includes all waters of Bristol Bay.

Aleutian Islands Registration Area (Area O): has as its eastern boundary the longitude of Scotch Cap Light (164°44.72' W long.), its western boundary the U.S.–Russia Maritime Boundary Agreement Line of 1990, and its northern boundary a line from the latitude of Cape Sarichef (54°36' N lat.) to 171° W long., north to 55°30' N lat., and west to the U.S.–Russia Maritime Boundary Agreement Line of 1990. The Aleutian Islands golden king crab (AIGKC) stock is managed as two separate fisheries, east and west of 174° W long., with a separate TAC set for each fishery.

Tanner Crab

Bering Sea District of the Westward Registration Area (Bering Sea District of Area J): all Bering Sea waters east of the U.S.–Russia Maritime Boundary Agreement Line of 1990 and north of 54°36' N lat.

Western Subdistrict: all waters of the Bering Sea District west of 173° W long.

Eastern Subdistrict: all waters of the Bering Sea District east of 173° W long., including the waters of Bristol Bay. The Eastern Subdistrict is further divided into two sections:

1. Norton Sound Section: all waters of the Eastern Subdistrict north of the latitude of Cape Romanzof (61°49′ N lat.) and east of 168° W long., and
2. General Section: all waters of the Eastern Subdistrict not included in the Norton Sound Section.

Historic Registration Areas

King Crab

Historic Adak Registration Area (Area R): has as its eastern boundary 171° W long., as its western boundary the U.S.–Russia Maritime Boundary Line of 1990, and as its northern boundary 55°30’ N lat.
Historic Dutch Harbor Registration Area (Area O): has as its northern boundary the latitude of Cape Sarichef (54°36’ N lat.), and its eastern boundary the longitude of Scotch Cap Light (166°44.72’ W long.), and as its western boundary 171° W long.

Appendix F Research Needs

Although research needs are expressed in this appendix to the Fishery Management Plan (FMP), ongoing research and research needs are constantly being updated. It may therefore be useful to the reader to access other sources in order to obtain the North Pacific Fishery Management Council (Council)'s most current description of research and research needs on BS/AI crab fisheries. A complete discussion of up-to-date sources is included in Section 6 of the FMP. In particular, the Council's Science and Statistical Committee regularly updates the Council research needs, and these can be found on the Council's website. Additionally, ongoing research by National Marine Fisheries Service (NMFS)'s Alaska Fisheries Science Center (AFSC) is also accessible through their website. Website addresses are in Section 6.

The FMP management policy identifies several research programs that the Council would like to encourage. The Council relies on its Scientific and Statistical Committee (SSC) to assist the Council in interpreting biological, sociological, and economic information. The SSC also plays an important role in providing the Council with recommendations regarding research direction and priorities based on identified data gaps and research needs.

Management Policy Research Programs

The management objectives of the FMP (see Section 2.2) include several objectives that provide overarching guidance as to research programs that the Council would like to encourage.

1. Biological Conservation Objective. Ensure the long-term reproductive viability of king and Tanner crab populations.
2. Economic and Social Objective. Maximize economic and social benefits to the nation over time.
3. Gear Conflict Objective. Minimize gear conflict among fisheries.
4. Habitat Objective. Preserve the quality and extent of suitable habitat.
5. Vessel Safety Objective. Provide public access to the regulatory process for vessel safety considerations.
6. Due Process Objective. Ensure that access to the regulatory process and opportunity for redress are available to interested parties.
7. Research and Management Objective. Provide fisheries research, data collection, and analysis to ensure a sound information base for management decisions.

Other objectives in the management policy also contain research elements without which they cannot be achieved. Research initiatives that would support other FMP management objectives are discussed in Section H.1.2 below.

Council Research Priorities

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires that regional fishery management councils develop "multi-year research priorities for fisheries, fisheries interactions, habitats, and other areas of research that are necessary for management purposes" (16 U.S.C. 1852(h)(7)). This includes research to support fishery management plans and associated regulations for fisheries requiring conservation and management to prevent overfishing, rebuild depleted fish stocks, and ensure sustainable fishing practices. Research priorities should be established and updated as necessary.

At its April 2021 meeting, the SSC reviewed the list of research priorities as developed by the Council's BS/AI Crab Plan Team, and contributed to the ongoing research priorities for crabs in the BS/AI. The regional database is frequently updated based on plan team/SSC and Council input. Research projects are classified among four priority categories. Projects classified as "Critical Ongoing Monitoring" either (1) provide an essential management function; (2) cannot be achieved through other means; or (3) are required by regulation. These essential projects include the surveys that provide fishery independent data to stock assessments, among other things. Urgent projects are similarly essential to the fulfillment of the Council's mission and obligations but are time-limited in duration. Important and Strategic projects are associated with less pressing Council concerns. Research priorities designated as Critical Ongoing Monitoring are of the highest priority level for the Council. These monitoring activities create and maintain indispensable data that substantially contribute to the understanding and management of fish populations, fisheries, and the communities dependent upon those fisheries.

The Council's Top Ten List for 2022-2024 is given below and is also provided in the attached table along with the Council's rationale for selecting these projects. Projects in the table are listed in chronological order – the Council did not assign differential ranks to projects within the top ten. NPFMC Top Ten Research Priorities for 2022-2024

1. Spatial distribution and movement of crabs relative to life history events and fishing.
2. Conduct routine fish, crab, and oceanographic surveys in the Arctic Ocean.
3. Develop a framework and collect economic information.
4. Develop stock-specific ecosystem indicators and incorporate into stock assessments.
5. Cooperative research efforts to supplement existing at-sea surveys that provide seasonal, species specific information on upper trophic levels.
6. Develop tools for analyzing coastal community vulnerability to fisheries management changes.
7. Maturity estimates for Bering Sea and Aleutian Island crab stocks.
8. Collection of socio-economic information.
9. Gap Analyses on loss of biological samples due to implementation of Electronic Monitoring.
10. Norton Sound Red King Crab case study.

Curation of Council research priorities is done within a publicly accessible online database (https://research.psmfc.org/) that includes a query tool and report generating functional.