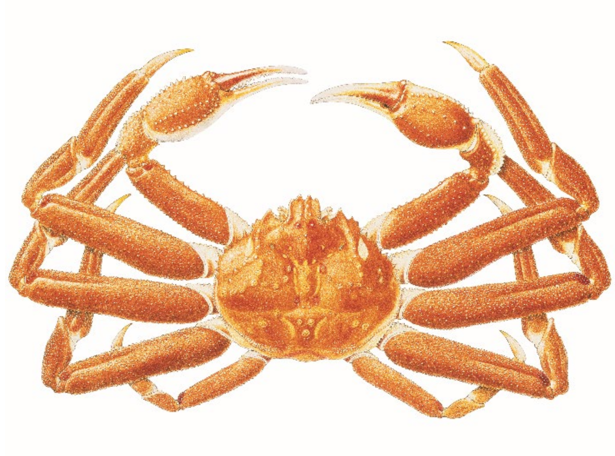
Draft Environmental Assessment for Proposed Amendment to the Fishery Management Plan for the Bering Sea and Aleutian Islands King and Tanner Crabs

Rebuilding Plan for Eastern Bering Sea Snow Crab Initial Review Analysis

November 10, 2022



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Abstract: This draft environmental assessment analyzes an amendment to the BSAI Crab FMP to rebuild the Eastern Bering Sea (EBS) snow crab (*Chionoecetes opilio*) stock in compliance with section 304(e)(3) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). A range of alternative rebuilding time frames is considered based on whether or not directed fishing is permitted during stock recovery. The impacts of the alternatives considered on crab resources, fishery participants, habitat, and other components of the human environment are discussed in the analysis.

1.1 List of Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
AAC	Alaska Administrative Code
ABC	Acceptable biological catch
ACL	Annual Catch Limit
ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
AIGKC	Aleutian Is. golden king crab
AKFIN	Alaska Fisheries Information Network
APICDA	Aleutian Pribilof Island Community Development Association
BBEDC	Bristol Bay Economic Development Corporation
BBRKC	Bristol Bay red king crab
BCAR	Bottom Contact Area ratio
B_{MSY}	Biomass corresponding to MSY
BSAI	Bering Sea and Aleutian Islands
CAS	Catch Accounting System
CBSFA	Central Bering Sea Fishermen's Association
CEQ	Council on Environmental Quality
CFEC	Commercial Fisheries Entry Commission
CFR	Code of Federal Regulations
CL	Carapace length
CMIP6	Coupled Model Intercomparison Project, Phase 6
Council	North Pacific Fishery Management Council
COBLZ	*C. opilio* Bycatch Limitation Zone
CP	Catcher/processor
CPUE	Catch per unit effort
CPT	Crab Plan Team
CSA	Catch survey analysis
CV	Catcher vessel
CVRF	Coastal Villages Region Fund
DPS	Distinct population segment
E.O.	Executive Order
EA	Environmental Assessment
EBS	Eastern Bering Sea
EEZ	Exclusive Economic Zone
EFH	Essential fish habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESB	Estimated Spawning Biomass
ESP	Ecosystem and Socio-economic Profile
ESU	Endangered species unit
F	Fishing mortality rate
FAR	Fraction of Attributable Risk
FAST	Fisheries, Aquatic Sciences & Technology
FE	Fishing Effects
FMA	Fisheries Monitoring and Analysis
FMP	Fishery management plan
FONSI	Finding of No Significant Impact
FR	Federal Register
FRFA	Final Regulatory Flexibility Analysis
ft	Foot or feet
GHL	Guideline harvest level
GOA	Gulf of Alaska
IRFA	Initial Regulatory Flexibility Analysis
IPA	Incentive Plan Agreement
lb(s)	Pound(s)
LLP	License limitation program
LOA	Length overall
m	Meter or meters
M	Natural mortality rate
MFMT	Maximum fishing mortality threshold
MMB	Mature male biomass
MSA	Magnuson Stevens Fishery Conservation and Management Act
MSST	Minimum stock size threshold
MSY	Maximum sustainable yield
t	Tonne, or metric ton
NAICS	North American Industry Classification System
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
NPPSD	North Pacific Pelagic Seabird Database
NS1	National Standard 1
NSEDC	North Sound Economic Development Corporation
NSRKC	Norton Sound red king crab
Observer Program	North Pacific Groundfish and Halibut Observer Program
OFL	Overfishing level
OMB	Office of Management and Budget
OY	Optimum yield
PBR	Potential biological removal
PIBKC	Pribilof Is. blue king crab
PIGKC	Pribilof Is. golden king crab
PIRKC	Pribilof Is. red king crab
PSC	Prohibited species catch
PRA	Paperwork Reduction Act
PSEIS	Programmatic Supplemental Environmental Impact Statement
RFA	Regulatory Flexibility Act
RFFA	Reasonably foreseeable future action
RIR	Regulatory Impact Review
RPA	Reasonable and prudent alternative
S-R	Stock-recruitment
SAFE	Stock Assessment and Fishery Evaluation
SAR	Swept area ratio
SBA	Small Business Act
Secretary	Secretary of Commerce
SHS	State Harvest Strategy
SMBKC	Saint Matthew Island blue king crab

SMIHCA	Saint Matthew Island Habitat Conservation Area
SSC	Scientific and Statistical Committee
SST	Sea surface temperature
TAC	Total allowable catch
T_{min}	Minimum time to rebuild
T_{max}	Maximum time to rebuild
U.S.	United States
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service
WAIRKC	Western Aleutian Is. red king crab
YDFDA	Yukon Delta Fisheries Development Assocation

Table of Contents

Executive Summary

This draft Environmental Assessment (EA) analyzes an amendment to the BSAI Crab FMP to rebuild the Eastern Bering Sea (EBS) snow crab (*Chionoecetes opilio*) stock in compliance with section 304(e)(3) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). A range of alternative rebuilding time frames is considered based on whether or not directed fishing is permitted during stock recovery. The impacts of the alternatives considered on crab resources, fishery participants, habitat, and other components of the human environment are discussed in the analysis.

Purpose and Need

Pursuant to the MSA section 304(e)(4)(A) and the National Standard Guidelines, the purpose of this proposed action is to develop a rebuilding plan to prevent overfishing and to rebuild the EBS snow crab stock. Rebuilding should take place in as short a time as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, and the interaction of the overfished stock of fish within the marine ecosystem. This action is necessary to facilitate compliance with the requirements of the MSA to end and prevent overfishing, rebuild overfished stocks, and achieve optimum yield. The Council approved the following purpose and need statement in June 2022.

> *The Eastern Bering Sea snow crab stock was determined to be overfished on October 19, 2021, because the estimated mature male biomass is below the minimum stock size threshold specified in the crab fishery management plan (FMP). To comply with provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), a rebuilding plan must be implemented prior to the start of the 2023/2024 fishing season. This action is necessary to facilitate compliance with MSA requirements to rebuild overfished stocks and achieve optimum yield.*

Alternatives

The Council's preliminary alternatives, selected at the June 2022 meeting, are below:

Alternative 1: No Action

Alternative 2: Adopt a rebuilding plan and specify a target rebuilding time not to exceed T_{MAX}, as recommended by the SSC. The stock will be considered "rebuilt" once it reaches B_{MSY}.

Option 1: No directed fishing until the stock is rebuilt, allow bycatch removals only

Option 2: Allow bycatch removals and a directed snow crab fishery under the current State of Alaska harvest strategy

Environmental Assessment

The proposed action is to establish a rebuilding plan for EBS Snow Crab. The environmental assessment provided in this analysis is a comprehensive review of five resource components that may be affected by the proposed alternatives for implementing a rebuilding plan for EBS snow crab. In accordance with National Standard 1 (NS1) guidelines, continued monitoring of the progress made during rebuilding will be conducted on a biennial basis. Additionally, the status of the EBS snow crab stock will continue to be monitored through annual stock assessments.

Impacts on the snow crab population

Alternative 2 is projected to allow EBS snow crab to rebuild within ten years, as required under the MSA. The analysis relies on a projection model that takes into account what is known about the EBS snow crab stock and environmental conditions affecting its recovery. The minimum estimated time for rebuilding (T_{MIN}), taking into account the biology of the species and current environmental conditions, is 6 years, which under the National Standard 1 guidelines dictates a maximum time for rebuilding (T_{MAX}) of ten years. The main driver in speed of rebuilding for this stock is not fishing mortality, rather it is likely related to recruitment and the conditions that allow for increased recruitment into the population, such as the Arctic Oscillation and physical indicators including, but not limited to temperature, sea ice extent, resource availability, and predator prey relationships. Ecosystem conditions (section 3.4.1) may improve, and improvements would result in reduced natural mortality and increased production and will be monitored during rebuilding through ecosystem indicators. The allowance, in the projections, for recruitment to eventually increase and contribute to stock growth assumes that existing ecosystem conditions or other constraints on production will not continue indefinitely. However, if recruitment remains at low levels, the population may take substantially longer to show rebuilding progress and may never reach B_{MSY}.

Alternative 2 includes two options, which either prohibit a directed snow crab fishery, with bycatch removals only (Option 1) or allow it to occur, subject to the current State of Alaska harvest strategy (Option 2). Because fishing mortality is not the primary driver of the current snow crab population status, either option does not substantively change the projection of T_{MIN}, and under both options it is assumed that the stock would rebuild within ten years.

Impacts of snow crab bycatch in other fisheries on rebuilding

Non-target bycatch of snow crab in other crab and groundfish fisheries will not substantially affect rebuilding time, based on model projections. In projections that apply average bycatch levels in all non-target fisheries (crab and groundfish) during rebuilding, the median time for stock recovery was not differentiable from the no fishing scenario. To account for unobserved mortality, the rebuilding projections also simulated scenarios with 5x and 100x the level of observed bycatch. Even in these projections, there was a minimal difference in median rebuilding time under each scenario. Therefore, analysts conclude that recovery of the EBS snow crab stock is likely to not be affected by current or predicted bycatch levels, based on average historical bycatch.

Under either option of Alternative 2, bycatch removals may continue, and all of the existing measures in other directed crab fisheries or groundfish fisheries that minimize non-target impacts on EBS snow crab, including a prohibited species catch (PSC) limit and closure area for the non-pelagic trawl groundfish fishery, are expected to be maintained throughout the rebuilding period. As a result, no measures to modify EBS snow crab bycatch management in the groundfish fisheries are included in this rebuilding analysis.

Impacts on other environmental components

Under either option of the rebuilding plan alternative, directed fishing for EBS snow crab will either continue at a similar or at a reduced level compared to status quo. When a fishery is allowed, it will be prosecuted in space and time within the footprint that the fishery has established over recent years. As a result, there are likely no negative effects on habitat as a direct result of implementing a rebuilding plan.

Minimal impacts on marine mammals would be observed as a result of implementing a rebuilding plan. However, there are potential implications for bearded seals as a result of the snow crab stock decline which may include: varying food web interactions and potential increased resource partitioning interspecifically. The larger trophic level effects for bearded seals and snow crab likely require future work especially given the unprecedented state of snow crab, and the current climate mediated changes in the phenology of arctic sea ice.

Socioeconomic Impacts

Overall, relative to the Alternative 2/Option 2, which would provide the opportunity for a directed EBS snow crab fishery, the guaranteed loss of the directed EBS snow crab fishery during the six-year rebuilding period under Alternative 2/Option 1 could result in severe impacts for those associated with the fishery. The assured loss of directed EBS snow crab for six years would represent substantial losses for vessel owners, crew, harvesting and processing quota shareholders, processors, CDQ groups, as well as the associated communities in addition to the communities where the shore-based processors are located. Under Alternative 2/Option 2, the socioeconomic impacts of the rebuilding plan could be somewhat less but still substantial. If, however, under Alternative 2/Option 2, the stock cannot support a directed fishery based on State of Alaska harvest strategy, then the socioeconomic impacts under Alternative 2/Option 2 could be similar or identical to the impacts under Alternative 2/Option 1.

Additional Council Request for Information on Bycatch Management Measures

The Council requested, in their June 2022 motion, that *additional information to help determine whether the following bycatch management measures would affect the rebuilding timeline:*

- *Remove the snow crab PSC floor*
- *Count all trawl PSC throughout the full range of the stock toward the PSC limit*
- *Limit on fixed gear PSC*

To address this request, analysts detailed historical PSC limits with and without the PSC floor, PSC (number of snow crab), and percent of PSC limit inside and outside the COBLZ in the BSAI non-pelagic trawl fisheries in section 3.3.2. Analysts concluded that none of the aforementioned bycatch management measures would have any measurable effect on the rebuilding time for EBS snow crab as fishing mortality is not the main driver in rebuilding under the proposed model projections.

1 Introduction

This draft EA analyzes an amendment to the Bering Sea and Aleutian Island (BSAI) Crab FMP to rebuild the Eastern Bering Sea snow crab (*Chionoecetes opilio*) stock in compliance with section 304(e)(3) of the MSA. A range of alternative rebuilding time frames is considered based on whether or not directed fishing is permitted during stock recovery. The impacts of the alternatives considered on crab resources, fishery participants, habitat, and other components of the human environment are discussed in the analysis.

1.1 Purpose and Need

Pursuant to the MSA section 304(e)(4)(A) and the National Standard Guidelines, the purpose of this proposed action is to develop a rebuilding plan to prevent overfishing and to rebuild the EBS snow crab stock. Rebuilding time should be as short a time as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, and the interaction of the overfished stock of fish within the marine ecosystem. This action is necessary to facilitate compliance with the requirements of the MSA to end and prevent overfishing, rebuild overfished stocks, and achieve optimum yield. The Council approved the following purpose and need statement in June 2022.

The Eastern Bering Sea snow crab stock was determined to be overfished on October 19, 2021, because the estimated mature male biomass is below the minimum stock size threshold specified in the crab FMP. To comply with provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), a rebuilding plan must be implemented prior to the start of the 2023/2024 fishing season. This action is necessary to facilitate compliance with MSA requirements to rebuild overfished stocks and achieve optimum yield.

1.2 Requirements of the Magnuson-Stevens Act and National Standard Guidelines

This EA addresses alternatives for rebuilding the EBS snow crab stock as required under the MSA. Additionally, this action must be consistent with the ten National Standards of the MSA section 301(a)(1); fishery management plan provisions 303(a)(10) and 303(a)(14); rebuilding overfished fisheries 304(e); and national standard guidelines 50 CFR 600.310.

The EBS snow crab stock was declared overfished on October 19, 2021, because estimated mature male biomass was below the minimum stock size threshold specified in the crab FMP. Section 304(e)(3) of the MSA requires the Council and Secretary of Commerce (Secretary) to develop and implement a rebuilding plan within two years of receiving notification from the Secretary that the stock is overfished, approaching an overfished condition, or has not made adequate progress towards rebuilding.

In order to comply with provisions of the MSA, the EBS snow crab rebuilding plan must be implemented prior to the start of the 2023/2024 fishing season.

1.2.1 Magnuson-Stevens Act Language on Rebuilding Overfished Stocks

Rebuilding of overfished stocks is required by the MSA section 304. The applicable section of the Act is provided below.

(e) REBUILDING OVERFISHED FISHERIES--

> (1) The Secretary shall report annually to the Congress and the Councils on the status of fisheries within each Council's geographical area of authority and identify those fisheries that are overfished or are approaching a condition of being overfished. For those fisheries

managed under a fishery management plan or international agreement, the status shall be determined using the criteria for overfishing specified in such plan or agreement. A fishery shall be classified as approaching a condition of being overfished if, based on trends in fishing effort, fishery resource size, and other appropriate factors, the Secretary estimates that the fishery will become overfished within two years.

(2) If the Secretary determines at any time that a fishery is overfished, the Secretary shall immediately notify the appropriate Council and request that action be taken to end overfishing in the fishery and to implement conservation and management measures to rebuild affected stocks of fish. The Secretary shall publish each notice under this paragraph in the Federal Register.

(3) Within two years of an identification under paragraph (1) or notification under paragraphs (2) or (7), the appropriate Council (or the Secretary, for fisheries under section 302(a)(3)) shall prepare a fishery management plan, plan amendment, or proposed regulations for the fishery to which the identification or notice applies--

> (A) to end overfishing in the fishery and to rebuild affected stocks of fish; or
>
> (B) to prevent overfishing from occurring in the fishery whenever such fishery is identified as approaching an overfished condition.

(4) For a fishery that is overfished, any fishery management plan, amendment, or proposed regulations prepared pursuant to paragraph (3) or paragraph (5) for such fishery shall--

> (A) specify a time period for ending overfishing and rebuilding the fishery that shall--
>
> > (i) be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystem; and
> >
> > (ii) not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise;
>
> (B) allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery; and
>
> (C) for fisheries managed under an international agreement, reflect traditional participation in the fishery, relative to other nations, by fishermen of the United States.

(5) If, within the 2-year period beginning on the date of identification or notification that a fishery is overfished, the Council does not submit to the Secretary a fishery management plan, plan amendment, or proposed regulations required by paragraph (3)(A), the Secretary shall prepare a fishery management plan or plan amendment and any accompanying regulations to stop overfishing and rebuild affected stocks of fish within 9 months under subsection (c).

(6) During the development of a fishery management plan, a plan amendment, or proposed regulations required by this subsection, the Council may request the Secretary to implement interim measures to reduce overfishing under section 305(c)) until such measures can be replaced by such plan, amendment, or regulations. Such measures, if otherwise in compliance with the provisions of this Act, may be implemented even though they are not sufficient by themselves to stop overfishing of a fishery.

(7) The Secretary shall review any fishery management plan, plan amendment, or regulations required by this subsection at routine intervals that may not exceed two years. If the Secretary finds as a result of the review that such plan, amendment, or regulations have not resulted in adequate progress toward ending overfishing and rebuilding affected fish stocks, the Secretary shall--

(A) in the case of a fishery to which section 302(a)(3) applies, immediately make revisions necessary to achieve adequate progress; or

(B) for all other fisheries, immediately notify the appropriate Council. Such notification shall recommend further conservation and management measures which the Council should consider under paragraph (3) to achieve adequate progress.

1.2.2 National Standard 1 Guidelines

Further clarification on stock rebuilding under the MSA for National Standard 1 (NS1) is provided in the excerpt below from the Final Rule on National Standard Guidelines published in the Federal Register on October 18, 2016 (81 FR 71858) and available on the NOAA Fisheries website: https://www.fisheries.noaa.gov/national/laws-and-policies/national-standard-guidelines

Sec. 600.310 National Standard 1— Optimum Yield.

(j) *Council actions to address overfishing and rebuilding for stocks and stock complexes—*

(1) *Notification.* The Secretary will immediately notify in writing a Regional Fishery Management Council whenever the Secretary determines that:

(i) Overfishing is occurring;

(ii) A stock or stock complex is overfished;

(iii) A stock or stock complex is approaching an overfished condition; or

(iv) Existing remedial action taken for the purpose of ending previously identified overfishing or rebuilding a previously identified overfished stock or stock complex has not resulted in adequate progress (*see* MSA section 304(e)).

(2) *Timing of actions—*

(i) *If a stock or stock complex is undergoing overfishing.* Upon notification that a stock or stock complex is undergoing overfishing, a Council should immediately begin working with its science and statistical committee (SSC) (or agency scientists or peer review processes in the case of Secretarially-managed fisheries) to ensure that the ABC is set appropriately to end overfishing. Councils should evaluate the cause of overfishing, address the issue that caused overfishing, and reevaluate their ACLs and AMs to make sure they are adequate.

(ii) *If a stock or stock complex is overfished or approaching an overfished condition.* Upon notification that a stock or stock complex is overfished or approaching an overfished condition, a Council must prepare and implement an FMP, FMP amendment, or proposed regulations within two years of notification, consistent with the requirements of section 304(e)(3) of the Magnuson-Stevens Act. Council actions should be submitted to NMFS within 15 months of notification to ensure sufficient time for the Secretary to implement the measures, if approved.

(3) *Overfished fishery.*—

(i) Where a stock or stock complex is overfished, a Council must specify a time period for rebuilding the stock or stock complex based on factors specified in Magnuson-Stevens Act section 304(e)(4). This target time for rebuilding (T_{target}) shall be as short as possible, taking into account: The status and biology of any overfished stock, the needs of fishing communities, recommendations by international organizations in which the U.S. participates, and interaction of the stock within the marine ecosystem. In addition, the time period shall not exceed 10 years, except where biology of the stock, other environmental conditions, or management measures under an international agreement to which the U.S. participates, dictate otherwise. SSCs (or agency scientists or peer review processes in the case of Secretarial actions) shall provide recommendations for achieving rebuilding targets (*see* Magnuson-Stevens Act section 302(g)(1)(B)). The above factors enter into the specification of T_{target} as follows:

(A) *The minimum time for rebuilding a stock (T_{min}).* T_{min} means the amount of time the stock or stock complex is expected to take to rebuild to its MSY biomass level in the absence of any fishing mortality. In this context, the term "expected" means to have at least a 50 percent probability of attaining the $B_{MSY}$where such probabilities can be calculated. The starting year for the T_{min} calculation should be the first year that the rebuilding plan is expected to be implemented.

(B) *The maximum time for rebuilding a stock or stock complex to its* B_{MSY} *(T_{max})*.

(*1*) If T_{min} for the stock or stock complex is 10 years or less, then T_{max} is 10 years.

(*2*) If T_{min} for the stock or stock complex exceeds 10 years, then one of the following methods can be used to determine T_{max}:

(*i*) T_{min} plus the length of time associated with one generation time for that stock or stock complex. "Generation time" is the average length of time between when an individual is born and the birth of its offspring,

(*ii*) The amount of time the stock or stock complex is expected to take to rebuild to B_{MSY} if fished at 75 percent of MFMT, or

(*iii*) T_{min} multiplied by two.

(*3*) In situations where T_{min} exceeds 10 years, T_{max} establishes a maximum time for rebuilding that is linked to the biology of the stock. When selecting a method for determining T_{max}, a Council, in consultation with its SSC, should consider the relevant biological data and scientific uncertainty of that data, and must provide a rationale for its decision based on the best scientific information available. One of the methods listed in subparagraphs (j)(3)(i)(B)(*2*)(*ii*) and (*iii*) may be appropriate, for example, if given data availability and the life history characteristics of the stock, there is high uncertainty in the estimate of generation time, or if generation time does not accurately reflect the productivity of the stock.

(C) *Target time to rebuilding a stock or stock complex (T_{target}).* T_{target} is the specified time period for rebuilding a stock that is considered to be as short a time as possible, taking into account the factors described in paragraph (j)(3)(i) of this section. T_{target} shall not exceed T_{max}, and the fishing mortality associated with achieving T_{target} is referred to as $F_{rebuild}$.

(ii) Council action addressing an overfished fishery must allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery.

(iii) For fisheries managed under an international agreement, Council action addressing an overfished fishery must reflect traditional participation in the fishery, relative to other nations, by fishermen of the United States.

(iv) *Adequate Progress.* The Secretary shall review rebuilding plans at routine intervals that may not exceed two years to determine whether the plans have resulted in adequate progress toward ending overfishing and rebuilding affected fish stocks (MSA section 304(e)(7)). Such reviews could include the review of recent stock assessments, comparisons of catches to the ACL, or other appropriate performance measures. The Secretary may find that adequate progress is not being made if $F_{rebuild}$ or the ACL associated with $F_{rebuild}$ is exceeded, and AMs are not correcting the operational issue that caused the overage, nor addressing any biological consequences to the stock or stock complex resulting from the overage when it is known (*see* paragraph (g)(3) of this section). A lack of adequate progress may also be found when the rebuilding expectations of a stock or stock complex are significantly changed due to new and unexpected information about the status of the stock. If a determination is made under this provision, the Secretary will notify the appropriate Council and recommend further conservation and management measures, and the Council must develop and implement a new or revised rebuilding plan within two years (*see* MSA sections 304(e)(3) and (e)(7)(B)). For Secretarially-managed fisheries, the Secretary would take immediate action necessary to achieve adequate progress toward rebuilding and ending overfishing.

(v) While a stock or stock complex is rebuilding, revising rebuilding timeframes (*i.e.,* T_{target} and T_{max}) or $F_{rebuild}$ is not necessary, unless the Secretary finds that adequate progress is not being made.

(vi) If a stock or stock complex has not rebuilt by T_{max}, then the fishing mortality rate should be maintained at its current $F_{rebuild}$ or 75 percent of the MFMT, whichever is less, until the stock or stock complex is rebuilt or the fishing mortality rate is changed as a result of the Secretary finding that adequate progress is not being made.

(4) *Emergency actions and interim measures.* If a Council is developing a rebuilding plan or revising an existing rebuilding plan due to a lack of adequate

progress (*see* MSA section 304(e)(7)), the Secretary may, in response to a Council request, implement interim measures that reduce, but do not necessarily end, overfishing (*see* MSA section 304(e)(6)) if all of the following criteria are met:

(i) The interim measures are needed to address an unanticipated and significantly changed understanding of the status of the stock or stock complex;

(ii) Ending overfishing immediately is expected to result in severe social and/or economic impacts to a fishery; and

(iii) The interim measures will ensure that the stock or stock complex will increase its current biomass through the duration of the interim measures.

(5) *Discontinuing a rebuilding plan based on new scientific information.* A Council may discontinue a rebuilding plan for a stock or stock complex before it reaches B_{MSY} if the Secretary determines that the stock was not overfished in the year that the overfished determination (*see* MSA section 304(e)(3)) was based on and has never been overfished in any subsequent year including the current year.

(k) *International overfishing.* If the Secretary determines that a fishery is overfished or approaching a condition of being overfished due to excessive international fishing pressure, and for which there are no management measures (or no effective measures) to end overfishing under an international agreement to which the United States is a party, then the Secretary and/or the appropriate Council shall take certain actions as provided under Magnuson-Stevens Act section 304(i). The Secretary, in cooperation with the Secretary of State, must immediately take appropriate action at the international level to end the overfishing. In addition, within one year after the determination, the Secretary and/or appropriate Council shall:

(1) Develop recommendations for domestic regulations to address the relative impact of the U.S. fishing vessels on the stock. Council recommendations should be submitted to the Secretary.

(2) Develop and submit recommendations to the Secretary of State, and to the Congress, for international actions that will end overfishing in the fishery and rebuild the affected stocks, taking into account the relative impact of vessels of other nations and vessels of the United States on the relevant stock. Councils should, in consultation with the Secretary, develop recommendations that take into consideration relevant provisions of the Magnuson-Stevens Act and NS1 guidelines, including section 304(e) of the Magnuson-Stevens Act and paragraph (j)(3)(iii) of this section, and other applicable laws. For highly migratory species in the Pacific, recommendations from the Western Pacific, North Pacific, or Pacific Councils must be developed and submitted consistent with Magnuson-Stevens Reauthorization Act section 503(f), as appropriate.

(3) *Considerations for assessing "relative impact."* "Relative impact" under paragraphs (k)(1) and (2) of this section may include consideration of factors that include, but are not limited to: Domestic and international management measures already in place, management history of a given nation, estimates of a nation's landings or catch (including bycatch) in a given fishery, and estimates of a nation's mortality contributions in a given fishery. Information used to determine relative impact must be based upon the best available scientific information.

(l) *Exceptions to requirements to prevent overfishing.* Exceptions to the requirement to prevent overfishing could apply under certain limited circumstances. Harvesting one stock at its optimum level may result in overfishing of another stock when the two stocks tend to be caught together (This can occur when the two stocks are part of the same fishery or if one is bycatch in the other's fishery). Before a

Council may decide to allow this type of overfishing, an analysis must be performed and the analysis must contain a justification in terms of overall benefits, including a comparison of benefits under alternative management measures, and an analysis of the risk of any stock or stock complex falling below its minimum stock size threshold (MSST). The Council may decide to allow this type of overfishing if the fishery is not overfished and the analysis demonstrates that all of the following conditions are satisfied:

(1) Such action will result in long-term net benefits to the Nation;

(2) Mitigating measures have been considered and it has been demonstrated that a similar level of long-term net benefits cannot be achieved by modifying fleet behavior, gear selection/configuration, or other technical characteristics in a manner such that no overfishing would occur; and

(3) The resulting rate of fishing mortality will not cause any stock or stock complex to fall below its MSST more than 50 percent of the time in the long term, although it is recognized that persistent overfishing is expected to cause the affected stock to fall below its B_{MSY} more than 50 percent of the time in the long term.

1.2.3 Process for Determining Status of BSAI Crab Stocks

Under the crab FMP, each crab stock is annually assessed by the CPT and SSCto determine its status regarding whether (1) overfishing is occurring or the rate or level of fishing mortality for the stock is approaching overfishing, (2) the stock is overfished, or the stock is approaching an overfished condition, and (3) the catch has exceeded the ACL. If overfishing occurred or the stock is overfished, the MSA requires the NPFMC to immediately end overfishing and/or develop a plan to rebuild affected stocks. Status determination criteria for crab stocks are calculated using a five-tier system described below (Table 1, Table 2) that accommodates varying levels of uncertainty of information. The five-tier system incorporates new scientific information and provides a mechanism to continually improve the status determination criteria as new information becomes available. Under the five-tier system, overfishing and overfished criteria and ABC levels for most stocks are annually formulated. The ACL for each stock equals the ABC for that stock. For crab stocks, the Overfishing Level (OFL) equals the maximum sustainable yield (MSY) and overfishing is determined by comparing the OFL with the catch estimates for that crab fishing year. Catch includes all fishery removals, including retained catch and discard mortality in the directed and non-directed fisheries. Discard mortality is determined by multiplying the appropriate handling mortality rate by observer-based estimates of discards.

To determine stock status, a stock is first assigned to one of the five tiers based on the availability of information for that stock and model parameter choices are made. Tier assignments and model parameter choices are recommended through the CPT process to the SSC. The SSC recommends tier assignments, stock assessment and model structure, and parameter choices, including whether the information is "reliable," for the assessment authors to use for calculating OFL and ABC.

For Tiers 1 through 4, once a stock is assigned to a tier (EBS snow crab is in Tier 3), the determination of stock status level is based on recent survey data and assessment models, as available. The stock status level determines the equation (Table 1) used in calculating the F_{OFL}. Three levels of stock status are specified and denoted by “a,” “b,” and “c” and the F_{MSY} control rule assigns F_{OFL} according to stock status level (Table 1). At stock status level “a,” current stock biomass exceeds the B_{MSY}. For stocks in status level “b,” current biomass is less than B_{MSY} but greater than a level specified as the “critical biomass threshold” (β). In stock status level “c,” the ratio of current biomass to B_{MSY} (or a proxy for B_{MSY}) is below β. At stock status level “c,” directed fishing is prohibited and an F_{OFL} at or below F_{MSY} would be determined for all other sources of fishing mortality in the development of the rebuilding plan.

1.2.4 Status Determination for Tier 3 Crab Stocks

As noted in Table 1 and Table 2, Tier 3 is for stocks like EBS snow crab for reliable estimates of the spawner/recruit relationship are not available, but proxies for F_{MSY} and B_{MSY} can be estimated For Tier 3, a designation of the form "F_X" refers to the fishing mortality rate associated with an equilibrium level of fertilized egg production (or its proxy such as mature male biomass at mating) per recruit equal to X% of the equilibrium level in the absence of any fishing. However, there exists sufficient information for modeling that captures the essential population dynamics of the stock as well as the performance of the fisheries.

The OFL and ABC calculation accounts for all losses to the stock not attributable to natural mortality. The OFL and ABC are total catch limits comprised of three catch components: (1) non-directed fishery discard losses; (2) directed fishery discard losses; and (3) directed fishery retained catch. To determine the discard losses, the handling mortality rate is multiplied by bycatch discards in each fishery. Calculations for OFLs and ABCs are done by the stock assessment author. OFLs are calculated by applying the F_{OFL} and using the most recent abundance estimates. The assessment authors calculate the proposed ABCs by applying the ABC control rule to the proposed OFL. Overfishing would occur if, in any year, the sum of all three catch components exceeds the OFL.

Table 1. Five-Tier System for setting overfishing limits (OFLs) and Acceptable Biological Catches (ABCs) for crab stocks. The tiers are listed in descending order of information availability.

Information available	Tier	Stock status level	F_{OFL}	ABC control rule
B, B_{MSY}, F_{MSY}, and pdf of F_{MSY}	1	a. $\frac{B}{B_{msy}} > 1$	$F_{OFL} = \mu_A$ =arithmetic mean of the pdf	
		b. $\beta < \frac{B}{B_{msy}} \le 1$	$F_{OFL} = \mu_A \frac{B/B_{msy} - \alpha}{1-\alpha}$	ABC≤(1-by) * OFL
		c. $\frac{B}{B_{msy}} \le \beta$	*Directed fishery F = 0* $F_{OFL} \le F_{MSY}$†	
B, B_{MSY}, F_{MSY}	2	a. $\frac{B}{B_{msy}} > 1$	$F_{OFL} = F_{msy}$	
		b. $\beta < \frac{B}{B_{msy}} \le 1$	$F_{OFL} = F_{msy} \frac{B/B_{msy} - \alpha}{1-\alpha}$	ABC≤(1-by) * OFL
		c. $\frac{B}{B_{msy}} \le \beta$	*Directed fishery F = 0* $F_{OFL} \le F_{MSY}$†	
B, $F_{35\%}$*, $B_{35\%}$*	3	a. $\frac{B}{B_{35\%*}} > 1$	$F_{OFL} = F_{35\%}*$	
		b. $\beta < \frac{B}{B_{35\%}*} \le 1$	$F_{OFL} = F^*_{35\%} \frac{\frac{B}{B^*_{35\%}} - \alpha}{1-\alpha}$	ABC≤(1-by) * OFL
		c. $\frac{B}{B_{35\%}*} \le \beta$	*Directed fishery F = 0* $F_{OFL} \le F_{MSY}$†	
B, M, $B_{msy^{prox}}$	4	a. $\frac{B}{B_{msy^{prox}}} > 1$	$F_{OFL} = \gamma M$	
		b. $\beta < \frac{B}{B_{msy^{prox}}} \le 1$	$F_{OFL} = \gamma M \frac{B/B_{msy^{prox}} - \alpha}{1-\alpha}$	ABC≤(1-by) * OFL
		c. $\frac{B}{B_{msy^{prox}}} \le \beta$	*Directed fishery F = 0* $F_{OFL} \le F_{MSY}$†	
Stocks with no reliable estimates of biomass or M.	5		OFL = average catch from a time period to be determined, unless the SSC recommends an alternative value based on the best available scientific information.	ABC≤0.90 * OFL

*35% is the default value unless the SSC recommends a different value based on the best available scientific information.
† An $F_{OFL} \le F_{MSY}$ will be determined in the development of the rebuilding plan for an overfished stock.

Table 2. A guide for understanding the five-tier system.

- F_{OFL} — the instantaneous fishing mortality (F) from the directed fishery that is used in the calculation of the overfishing limit (OFL). F_{OFL} is determined as a function of:
    - F_{MSY} — the instantaneous F that will produce MSY at the MSY-producing biomass
        - A proxy of F_{MSY} may be used; e.g., $F_{x\%}$, the instantaneous F that results in x% of the equilibrium spawning per recruit relative to the unfished value
    - B — a measure of the productive capacity of the stock, such as spawning biomass or fertilized egg production.
        - A proxy of B may be used; e.g., mature male biomass
    - B_{MSY} — the value of B at the MSY-producing level
        - A proxy of B_{MSY} may be used; e.g., mature male biomass at the MSY-producing level
    - β — a parameter with restriction that $0 \leq \beta < 1$.
    - α — a parameter with restriction that $0 \leq \alpha \leq \beta$.
- The maximum value of F_{OFL} is F_{MSY}. $F_{OFL} = F_{MSY}$ when $B > B_{MSY}$.
- F_{OFL} decreases linearly from F_{MSY} to $F_{MSY}\cdot(\beta-\alpha)/(1-\alpha)$ as B decreases from B_{MSY} to $\beta\cdot B_{MSY}$
- When $B \leq \beta\cdot B_{MSY}$, F = 0 for the directed fishery and $F_{OFL} \leq F_{MSY}$ for the non-directed fisheries, which will be determined in the development of the rebuilding plan.
- The parameter, β, determines the threshold level of B at or below which directed fishing is prohibited.
- The parameter, α, determines the value of F_{OFL} when B decreases to $\beta\cdot B_{MSY}$ and the rate at which F_{OFL} decreases with decreasing values of B when $\beta\cdot B_{MSY} < B \leq B_{MSY}$.
    - Larger values of α result in a smaller value of F_{OFL} when B decreases to $\beta\cdot B_{MSY}$.
    - Larger values of α result in F_{OFL} decreasing at a higher rate with decreasing values of B when $\beta\cdot B_{MSY} < B \leq B_{MSY}$.
- The parameter, b_y, is the value for the annual buffer calculated from a P* of 0.49 and a probability distribution for the OFL that accounts for scientific uncertainty in the estimate of OFL.
- P* is the probability that the estimate of ABC, which is calculated from the estimate of OFL, exceeds the “true” OFL (noted as OFL’) (P(ABC>OFL’).

1.3 Scope of the Analysis

This EA relies heavily on the information and analysis contained in previous NEPA documents and Stock Assessment and Fishery Evaluation (SAFE) Reports. The annual SAFE Reports contain the status of the EBS snow crab stock as well as annual stock assessments for all ten BSAI crab stocks.This EA also utilizes specific information and analysis contained in the Council’s the 2022 EBS snow crab SAFE Report (NPFMC 2022),

Relevant information from these documents are summarized in the appropriate chapters.

This EA also incorporates information from Amendment 40 to the BSAI groundfish FMP (NPFMC 2009), which established the current *C. opilio* Bycatch Limitation Zone (COBLZ) and set the formula for establishing the annual prohibited species catch (PSC) limit.

This analysis further incorporates information contained in the Bering Sea Aleutian Islands Crab Fisheries Final Environmental Impact Statement/Regulatory Impact Review/Initial Regulatory Flexibility Analysis/Social Impact Assessment (Crab EIS) (NMFS 2004) by reference and Ten-Year Program

Review for the Crab Rationalization Management Program in the Bering Sea/Aleutian Islands (NPFMC 2017).

The Council on Environmental Quality regulations encourage agencies preparing NEPA documents to, "tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review." Specifically, 40 CFR 1502.20 states the following:

> Whenever a broad environmental impact statement has been prepared (such as a program or policy statement) and a subsequent statement or environmental assessment is then prepared on an action included within the entire program or policy (such as a site specific action) the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action. (40 CFR 1502.20)

The preparation of a Regulatory Impact Review (RIR) is required under Presidential Executive Order (E.O.) 12866 (58 FR 51735, September 30, 1993). The requirements for all regulatory actions specified in E.O. 12866 are summarized in the following Statement from the E.O.:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and Benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

Because neither alternative would involve any changes to federal regulations, the preparation of an RIR is not necessary and is not a part of this analysis.

1.4 EBS Snow Crab Management

The analyses presented here consider the activities of directed EBS snow crab fisheries as well as other fisheries and non-fishing activities with the potential to impact the EBS snow crab stock. None of the actions to rebuild the EBS snow crab stock would redefine the fishery management unit in the FMP or introduce new or modified spatial management measures affecting EBS snow crab.

The Crab FMP in the BSAI was approved by the Secretary of Commerce on June 2, 1989. The FMP establishes a state/federal cooperative management regime that defers crab management to the State of Alaska with federal oversight. The Crab FMP divides management measures into three categories: (1) fixed in the Crab FMP and require an amendment to change, (2) frameworked in the Crab FMP which the state can change as outlined in the FMP, and (3) discretion of the State of Alaska (Table 3). State regulations are subject to the provisions of the FMP, including its goals and objectives, the Magnuson-Stevens Act National Standards, and other applicable federal laws.

Table 3.Crab FMP management measures by category.

Category 1 (Fixed in FMP)	Category 2 (Frameworked in FMP)	Category 3 (Discretion of State)
Legal Gear	Minimum Size Limits	Reporting Requirements
Permit Requirements	Guideline Harvest Levels	Gear Placement and Removal
Federal Observer Requirements	In-season Adjustments	Gear Storage
Limited Access	Districts, Subdistricts and Sections	Vessel Tank Inspections
Norton Sound Superexclusive Registration	Fishing Seasons	Gear Modifications
Essential Fish Habitat	Sex Restrictions	Bycatch Limits (in crab fisheries)
Habitat Areas of Particular Concern	Pot Limits	State Observer Requirements
	Registration Areas	Other
	Closed Waters	

The FMP authorizes the State of Alaska to define spatial management boundaries for crab stocks within the management unit. Under the State of Alaska's spatial management scheme, the EBS snow crab management area (Figure 1-1) is the Eastern Subdistrict (waters east of 173° W. long.) and the Western Subdistrict (waters west of 173° W. long. but west of 165° W. long.). As for season dates for the directed fisheries, Alaska department of fish and game (ADF&G) typically establishes the snow crab season start date for October 15 and, in general, the snow crab fishery ends on May 15 for the Eastern subdistrict and May 31 for the Western subdistrict. In contrast, Federal regulations specify the general groundfish seasons to begin January 1 and end December 31, and the total allowable catch (TAC)-setting and specifications process are designed around this schedule.

In 2005, the BSAI Crab Rationalization (CR) Program was implemented to ensure allocation of BSAI crab resources among harvesters, processors, and coastal communities. For further information detailing the CR program, please refer to section 3.6.1.

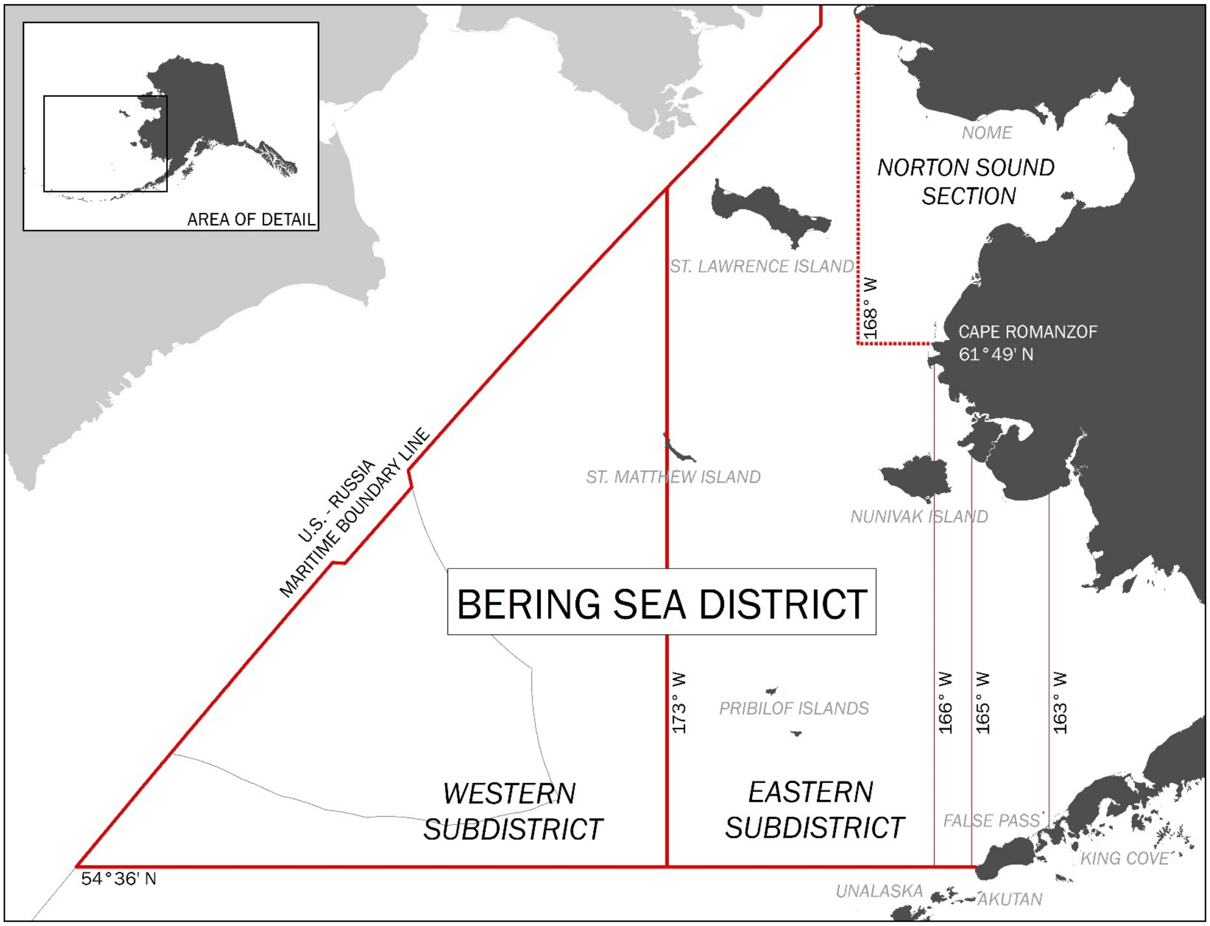


Figure 1-1 State of Alaska Bering Sea snow crab area which includes the Western Subdistrict and Eastern Subdistrict

2 Description of Alternatives

For all alternatives, the existing measures that minimize fishery impacts on EBS snow crab would be maintained throughout rebuilding. Additionally, since the alternatives propose to achieve rebuilding only by limiting direct harvest of EBS snow crab, no alternatives propose to create new management measures within the BSAI Crab FMP or any other FMP.

2.1 Alternative 1: No Action

Under Alternative 1, the Council would not develop a rebuilding plan, and no Federal management response to address an overfished stock would be undertaken. Importantly, taking no action to establish a rebuilding plan for an overfished stock is a violation of the MSA. Harvest under this alternative would continue to be defined by the State harvest strategy as in Alternative 2 / Option 2 below. However, without a rebuilding plan, there would not be a mechanism to necessarily address operational issues that may constrain rebuilding, if they are present. Importantly, fishery management operations are not expected to constrain rebuilding under the existing ecosystem regime, which is the dominant limiting factor on stock productivity under any alternative. Alternative 1 is not feasible in order for the Council follow MSA 304(e)(4)(A) guidelines in establishing a rebuilding plan for an overfished stock. Therefore, in accordance with MSA guidelines, the Council has the option of selecting either proposed Alternative 2/Option 1 or Alternative 2/Option 2. Therefore, for the purposes of this analysis, authors will only analyze the effects of Alternative 2/Option 1 and Alternative 2/Option 2, as these are the only proposed alternative/options that are in accordance with federal mandates.

2.2 Alternative 2: Establish a Rebuilding Plan

Under Alternative 2, a rebuilding plan would be established that would be consistent with the MSA and NS1 Guidelines on time for rebuilding, specifically rebuilding within a time (T_{target}) that is as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock of fish within the marine ecosystems. The fastest rebuilding time (T_{min}), is calculated based on no fishing mortality (F=0). Based on projections described in section 2.2.1, the time with a greater than 50% probability of rebuilding to B_{MSY} at F=0 **(T_{min}) is 6 years.** Because T_{min} < 10 years, **T_{max} =10 years,** based off of the guidelines outlined in NS1.

Under Alternative 2, a federal rebuilding plan for EBS snow crab will be incorporated into the BSAI King and Tanner Crab FMP by amending the FMP language to reflect the approved rebuilding alternative. The FMP authorizes the State to set preseason TACs and guideline harvest levels (GHLs) under State regulations, and seasons or areas are closed when the TAC is reached. The State must take into account the following factors, to the extent information is available, in developing harvest strategies or setting TACs (1) whether the ABC for that stock was exceeded in the previous year; (2) stock status relative to the OFL and ACL; (3) estimates of exploitable biomass; (4) estimates of recruitment; (5) estimates of thresholds; (6) market and other economic considerations; (7) additional uncertainty; and (8) any additional factors pertaining to the health and status of the stock or the marine ecosystem.

There are two options under Alternative 2 that consider alternative harvest scenarios during rebuilding:

Option 1: No directed fishing until the stock is rebuilt, allow bycatch removals only

Option 2 : Allow bycatch removals and a directed snow crab fishery under the current State of Alaska harvest strategy.

Under approval of Alternative 2/Option 1, the FMP language would be amended to reflect a prohibition on directed harvest of EBS snow crab until the stock is declared rebuilt. This would prohibit the State of

Alaska from setting a TAC under the State harvest strategy. Under Alternative 2/Option 2, the amended FMP language could also: 1) include the specific formulae for opening the EBS snow crab fishery provided in the current State harvest strategy or 2) state that no change in the harvest strategy should occur that would contribute to departure from the Council's intended rebuilding timeline.

For Option 2, the State of Alaska's EBS snow crab harvest strategy (referred to as the "State harvest strategy" or SHS) is provided in the Alaska Administrative Code at 5 AAC 34.917 (below). The minimum legal size limit for snow crab is 78 mm, however, the snow crab market generally only accepts crab greater than 101 mm

Since 2000, the state harvest strategy sets harvest rate based on estimated mature biomass. The harvest rate scales with the status of the population relative to B_{MSY}, which is calculated as the average total mature biomass at the time of the survey from 1983 to 1997 and MSST is one half B_{MSY}. As noted in Figure 2-1, the harvest rate begins at 0.10 when total mature biomass exceeds 50% MSST (230 million lbs) and increases linearly to 0.225 when biomass is equal to or greater than B_{MSY} (Zheng et al. 2002). Where total mature biomass (TMB) and TMB_{BMSY} is the TMB associated with maximum sustainable yield. The maximum retained catch is set as the product of the exploitation rate, u, calculated from the above control rule and survey mature male biomass. If the retained catch in numbers is greater than 58% of the estimated number of new shell crabs greater than 101 mm plus 25% of the old shell crab greater than 101 mm, the catch is capped at 58%. Currently, the biological reference point for biomass is calculated using a spawning biomass per recruit proxy, $B_{35\%}$ (Clark, 1993). B35% is the biomass at which spawning biomass per recruit is 35% of unfished levels and has been shown to provide close to maximum sustainable yield for a range of stock productivities (Clark, 1993). Consequently, it is an often used target when a stock recruit relationship is unknown or unreliable. The range of years of recruitment used to calculate biomass reference points is from 1982 to the present assessment year, minus 1.

As laid out under the BSAI Crab FMPs State/Federal cooperative management regime, the OFL and ABC for the Federal crab stocks are recommended to the Council by the Scientific and Statistical Committee (SSC).

The annual harvest levels and other management actions for the FMP crab stocks are determined by ADF&G according to State commercial fishery regulations. These regulations are established by the Alaska Board of Fisheries (BOF) and subject to the constraint that such harvest levels and management actions are consistent with provisions of the FMP, the National Standards of the MSA, and other applicable federal laws.

The FMP list out eight categories of factors the State of Alaska should take into account, to the extent information is available, in developing harvest strategies or setting TACs. This includes:

(1) whether the ABC for that stock was exceeded in the previous year;

(2) stock status relative to the OFL and ABC;

(3) estimates of exploitable biomass;

(4) estimates of recruitment;

(5) estimates of thresholds;

(6) market and other economic considerations;

(7) additional uncertainty; and

(8) any additional factors pertaining to the health and status of the stock or the marine ecosystem.

Additional uncertainty includes:

(1) management uncertainty (i.e., uncertainty in the ability of managers to constrain catch so the ABC is not exceeded, and uncertainty in quantifying the true catch amount) and

(2) scientific uncertainty identified and not already accounted for in the ABC (i.e., uncertainty in bycatch mortality, estimates of trends and absolute estimates of size composition, shell-condition, molt status, reproductive condition, spatial distribution, bycatch of non-target crab stocks, environmental conditions, fishery performance, fleet behavior, and the quality and amount of data available for these variables).

The FMP directs the State to establish an annual TAC for each crab stock at a level sufficiently below the ABC so that the sum of the total fishery removals and the State's assessment of additional uncertainty do not exceed the ABC. The State may establish the annual TACs below such a level to account for the other factors identified above. If an ABC is exceeded, the State will implement accountability measures in the fishing season following the overage to account for the overage through a downward adjustment to the TAC for that species by an amount sufficient to remedy the biological consequences of the overage.

Within these parameters laid out in the FMP, the State has further identified a process to establish annual harvest levels for each crab fishery. The process employed by the State begins with a review of stock status indicators derived from the recent assessments, including estimates of B_{MSY} (or its proxy), MSST, critical biomass threshold, and OFL (including a breakdown of the total OFL into subcomponents – estimates of future retained catch, discard mortality in directed fisheries, and non-target fishery bycatch). The State also relies on guidance provided in the annual NMFS stock status notification letter that is prepared for the Secretary of Commerce by the NMFS Alaska Region summarizing stock status relative to overfishing, OFLs for the 10 FMP crab stocks, and special concerns for stocks under rebuilding plans.

Annual biomass estimates of mature male biomass (MMB) provide a projection of stock status at the time of mating while the OFL estimate is a total catch level that may not be exceeded by the sum of all sources of fishing mortality. The OFL subcomponents provide additional information on the total catch OFL calculation for information relative to the directed fishing mortality estimate. The State has adopted harvest strategies for the crab fisheries which consist of rules in state regulation for computing TAC from survey and stock assessment data and identifying conditions under which the fishery would not open. Harvest strategy elements may include:

- a stock threshold for opening the fishery,
- rules for setting exploitation rate on abundance/biomass of mature-sized males,
- an exploitation rate dependent on stock index estimated from survey data,
- a cap on legal male exploitation rate, and
- a minimum TAC for fishery opening.

Both State harvest strategy thresholds and stock abundance or biomass estimates for computation of TACs reference stock biomass or abundance at the time of survey. State staff prepare annual assessments describing the requirements, process, and data needed to set TAC in manner that prevents overfishing. These assessments summarize stock status relative to OFL and document how the State sets TAC to account for uncertainty in stock biomass estimates and to ensure total removals remain below the ABC and OFL. The assessments are internal documents discussed with State, Federal, and Council staff during a series of teleconferences leading up to the announcement of TAC in early October. Details of the State TAC-setting process are publicly reviewed during an annual meeting with the BSAI crab industry after TACs are announced.

For EBS snow crab fishery to open, the preseason survey data must indicate that ESB snow crab is at least 25% of the B_{MSY}. The harvest strategy also includes thresholds for levels of exploitation based on different levels of estimated spawning biomass (ESB) relative to the B_{MSY}. The EBS snow crab harvest strategy was developed in 2002 (J. Zheng et al. 2002)and ADF&G uses the various abundance estimates available when implementing the the harvest strategy. The State of Alaska’s Bering Sea snow crab harvest strategy is provided in the Alaska Administrative Code at 5 AAC 35.517 (below).

5 AAC 35.517. Bering Sea *C. opilio* Tanner crab harvest strategy.

(a) In the Bering Sea District, the commercial *C. opilio* Tanner crab fishery may open only if the department's analysis of preseason survey data indicates the population of C. *opilio* Tanner crab

(1) contains an estimated spawning biomass of at least 25 percent of B_{MSY};

(2) repealed 6/10/2010.

(b) If the estimated spawning biomass of *C. opilio* Tanner crab is

(1) at least 25 percent of B_{MSY}, but less than B_{MSY}, the total allowable catch will be (Fmsy /3+(Bt-0.25 x B_{MSY}) x 0.417 x Fmsy /(0.75 x B_{MSY})) x 100 percent of the estimated mature male biomass or 58 percent of exploited legal males, whichever is less;

(2) at or above B_{MSY}, the total allowable catch will be (0.75 x Fmsy) x 100 percent of the estimated mature male biomass or 58 percent of the exploited legal males, whichever is less.

(c) In implementing this harvest strategy, the board directs the department to use the best scientific information available and to consider the reliability of estimates of *C. opilio* Tanner crab, the manageability of the fishery, and any other factors the department determines necessary to be consistent with the sustained yield principles.

(d) For the purposes of this section,

(1) " B_{MSY}" means the population biomass of mature male and female *C. opilio* Tanner crab that could produce maximum sustained yield under prevailing environmental conditions;

(2) "Bt" means the biomass of mature male and female *C. opilio* Tanner crab in a given year;

(3) "estimated mature male biomass" means the estimated biomass of all morphometrically mature male *C. opilio* Tanner crab;

(4) "estimated spawning biomass" means the estimated biomass of all morphometrically mature male *C. opilio* Tanner crab and all morphometrically mature female *C. opilio* Tanner crab;

(5) "exploited legal males" means 100 percent of the new-shell male *C. opilio* Tanner crab that are at least 102 millimeters (four inches) in width of shell, plus a percentage of

old-shell male *C. opilio* Tanner crab that are at least 102 millimeters in width of shell estimated at the time of the survey; the percentage of old-shell male *C. opilio* Tanner crab will be based on the expected fishery selectivity for old-shell verses new-shell male C. opilio Tanner crab;

(6) "Fmsy" means the fishing mortality of the mature male *C. opilio* Tanner crab stock that could produce maximum sustained yield under prevailing environmental conditions.

There are various abundance estimates available for TAC-setting including raw survey area-swept estimates, model-based survey estimates, and model-based population estimates that account for survey selectivity. Because these estimates can vary greatly, the resulting TAC can vary depending which estimates are used as harvest strategy inputs. In a given year, it may be difficult to know which estimate is closer to the true population size and factors, such as those outlined in the FMP, are used when setting the TAC.

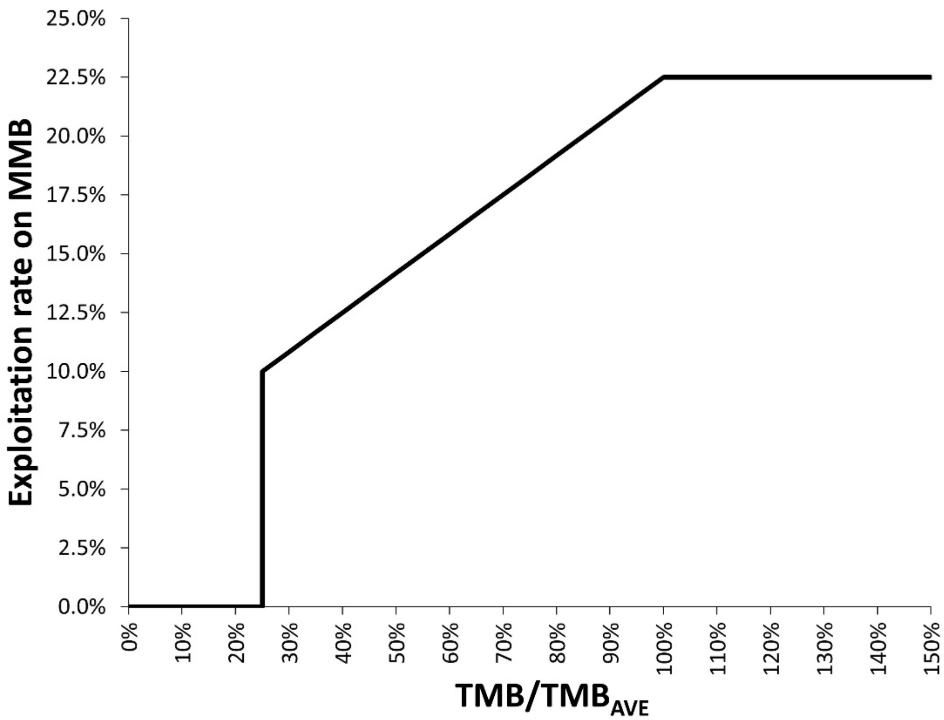


Figure 2-1. State harvest strategy for EBS snow crab.
Source: ADF&G

2.2.1 Rebuilding Projections

Quantitative estimation of rebuilding timelines under the alternatives was done through the SSC recommended modeled projections of population biomass. Each projection was identical in terms of starting population conditions, and multiple projection model parameterizations were explored to consider the range of stock productivity during rebuilding. The leading constraint on stock productivity is whether future ecosystem conditions will be conducive to the successful recruitment of crab to the population. The protracted timeline for rebuilding under any alternative is a reflection of sub-optimal ecosystem conditions (summarized in section 3.4.1) both presently and throughout the rebuilding process.

2.2.2 Starting Population Conditions

All of the projections to estimate rebuilding times are consistent with regard to starting population conditions and the measure of biomass that defines a rebuilt stock, i.e., the end point for rebuilding. Population quantities and parameter values were based on the accepted 2022 stock assessment for EBS snow crab. The stock assessment uses the GMACS framework in order to facilitate an evaluation of model assumptions.

The projection model used for rebuilding projections was based on the SSC selected model 22.1a from the 2022 SAFE document. The population dynamics in this model track the number of crab of sex, *s*, maturity state, *m*, during year, *y*, at length, *l* , $N_{s,m,y,l}$. A terminal molt occurs in which crab move from an immature to a mature state, after which no further molting occurs. The mid-points of the size bins tracked in the model span from 27.5 to 132.5 mm carapace width, with 5 mm size classes. For the author-preferred model, 431 parameters were estimated. Parameters estimated within the assessment included those associated with the population processes recruitment, growth, natural mortality (subject to an informative prior and two years of additional 'mortality events' estimated in 2018 and 2019), fishing mortality, selectivity (fishery, survey, and BSFRF experiments), catchability, and maturity. Weight at length, discard mortality, bycatch mortality, and parameters associated with the proportion of recruitment allocated to size bin were estimated outside of the model or specified. See the assessment for a detailed description of the population dynamics model (Szuwalski, 2022).

Projections were performed by starting at the maximum likelihood estimates (MLE) of parameters in the population dynamics model. The MLE was identified by performing a jittering analysis in which the assessment was fit to the data starting from 100 parameter vectors randomly chosen given the specified prior distributions for all parameters. These are often uniform over the bounds for a given parameter, but some parameters have normal priors imposed (see assessment for description). Recruitment and natural mortalities were sampled from the estimated recruitments and natural mortalities based on user input range of years. Four future productivity scenarios were analyzed by crossing the periods 1982-2017 and 2005-2019 for sampling recruitment and natural mortality. The model was projected to 2040 in each of 2000 projections performed for each combination of recruitment and natural mortality scenarios.

Importantly, no stochasticity exists in the initial conditions of the projection—all projections start from the MLE. Furthermore, the projections models assume that the OFLs and ABCs are set with perfect estimates of the scale of the population, which have been historically uncertain.

Five fishing scenarios were performed within the productivity scenarios based on the SSC requests: zero fishing mortality, only bycatch mortality, an approximation of the State of Alaska's harvest with no bycatch, an approximation of the State of Alaska's harvest including bycatch, and the federally set acceptable biological catch (ABC).

Bycatch mortality was specified in the model as the average of the estimated bycatch fishing mortality over the last ten years. The State of Alaska's harvest control rule was approximated by averaging the ratio of the total allowable catch (TAC) set by the State and the ABC over the last 10 years (Daly, pers.comms.). The ratio (equal to 0.40) was used to scale the ABC calculated in the projections; the ABC was based on a 25% buffer of the OFL calculated using the current B_{MSY} proxy and F_{MSY} proxy (B_{35}% and F_{35}%, respectively; see Szuwalski, 2022 for a detailed description of how these are calculated). Three proxies for B_{MSY} were calculated to evaluate rebuilding progress. These target biomasses correspond to the currently used B_{35}% (recruitment years 1982-2021), a target biomass calculated using expected recruitment based on the years 1982-2017, and a target based on the recruitment estimates for the years 2005-2019. All biomass targets were calculated without incorporating the potential for mortality events to occur (i.e. the base estimate of natural mortality was used in projections).

2.2.2.1 Constraints on rebuilding from recruitment and natural mortality

Future recruitment and natural mortality are primary drivers of the rebuilding trajectory (in addition to fishing mortality) and two different productivity scenarios were explored for snow crab projections. Both productivity scenarios sampled the estimated recruitment and natural mortality from the stock assessment model from a pre-defined period of time to represent future conditions. The SSC selected the periods 1982-2017 (Figure 2-2) (to represent something similar to the current assumptions in the stock assessment, but without the possibility of mortality events) and 2005-2019 (Figure 2-3) (to represent recent environmental conditions and allow for mortality events to occur in the future).

Different assumptions about future recruitment and natural mortality have strong impacts on projected rebuilding trajectories and associated time to rebuilding. The average estimated recruitments of the period 1982-2017 and 2005-2019 are fairly similar, but when any mortality events are allowed in the projections, the ability of the stock to rebuild is hampered (compare Figure 2-2 to Figure 2-3; Table 4). Under no mortality events in the projection period (i.e. the 1982-2017 scenario) the median projected stock rebuilt by 2029 with no fishing mortality. The rebuilding time was extended to 2034 under no fishing if mortality events were imposed during 1 in 7 years (on average).

The CPT and SSC preferred the projection scenarios that draw recruitment and mortality from 1982-2017 (Figure 2-2), based on two factors. First, snow crab recruitment is projected to be lower in the future than it has been historically as a result of decreased sea ice extent in the Bering Sea (Szuwalski et al., 2021). The 1982-2017 scenario had the lowest average recruitment of the scenarios considered. Although this scenario was the lowest of the scenarios considered, the assessment author, CPT, and SSC allow for the possibility that even the lower recruitment scenario of the two reported could be too optimistic. Second, the mortality event that occurred in 2018 and 2019 appears to have been related to the unprecedented number of snow crab in the eastern Bering Sea and high bottom temperatures (section 3.2.3 and Appendix A to the 2022 snow crab SAFE). Although bottom temperatures will likely be high at some point over the rebuilding period, crab densities will not be (and if they are high, the stock will have rebuilt).

Consequently, the CPT and SSC recommended 1982-2017 as the preferred rebuilding scenario of the available options(October 2022 SSC minutes). Based off of the SSC recommendations for the use of the recruitment and mortality scenarios from 1982-2017, T_{min}, under no fishing mortality=6, therefore T_{max}=10 (Table 4). Please note that under the 5 fishing mortality scenarios, the median projection times round to the same integer year (2029); however as shown in Table 4, there lies a difference between fishing mortality scenarios that is evidenced by the 5^{th} and 95^{th} inter-simulation quantiles for the uncertainty around biomass trajectories during the projection period. Thus, there is a slight difference in rebuilding projections influenced by different fishing mortality scenarios.

Table 4 Rebuilding time for scenarios described in the text. Median Tmin is calculated relative to the status quo B_{MSY} proxy that uses average recruitment from 1982-2021. The '5%' and 95%' columns represent the 5th and 95th inter-simulation quantiles for the uncertainty around biomass trajectories during the projection period. . "Inf" indicates that the stock never rebuilds to B_{MSY}.

Projection specifications			T_{min}		
Fishing Scenario	Recruitment	Mortality	Median	5%	95%
No fishing	1982-2017	1982-2017	2029	2027	2034
bycatch	1982-2017	1982-2017	2029	2027	2034
State + bycatch	1982-2017	1982-2017	2029	2027	Inf
State - bycatch	1982-2017	1982-2017	2029	2027	Inf
ABC	1982-2017	1982-2017	2030	2027	Inf
No fishing	2005-2019	2005-2019	2034	2027	Inf
bycatch	2005-2019	2005-2019	2034	2027	Inf
State + bycatch	2005-2019	2005-2019	Inf	2027	Inf
State - bycatch	2005-2019	2005-2019	Inf	2027	Inf
ABC	2005-2019	2005-2019	Inf	2027	Inf

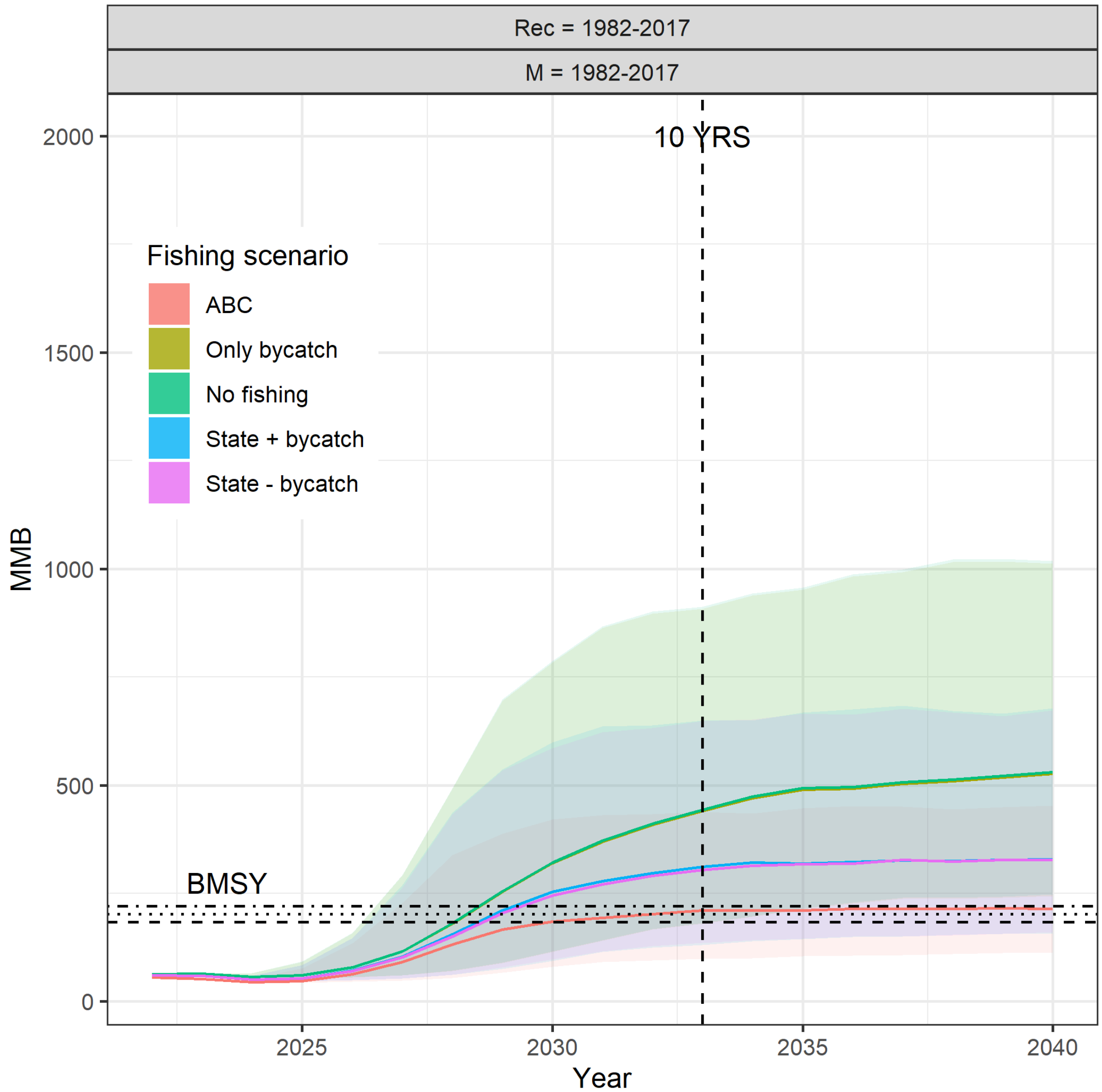


Figure 2-2 Rebuilding trajectories under different productivity assumptions associated with the years 1982-2017 and various fishing strategies. Shaded areas represent the 5th and 95th inter-simulation interval and the timing with which the median (solid line), upper, and lower intervals cross the line representing B_{MSY} are reported in table 1 as measures of uncertainty around the minimum time to rebuilding.

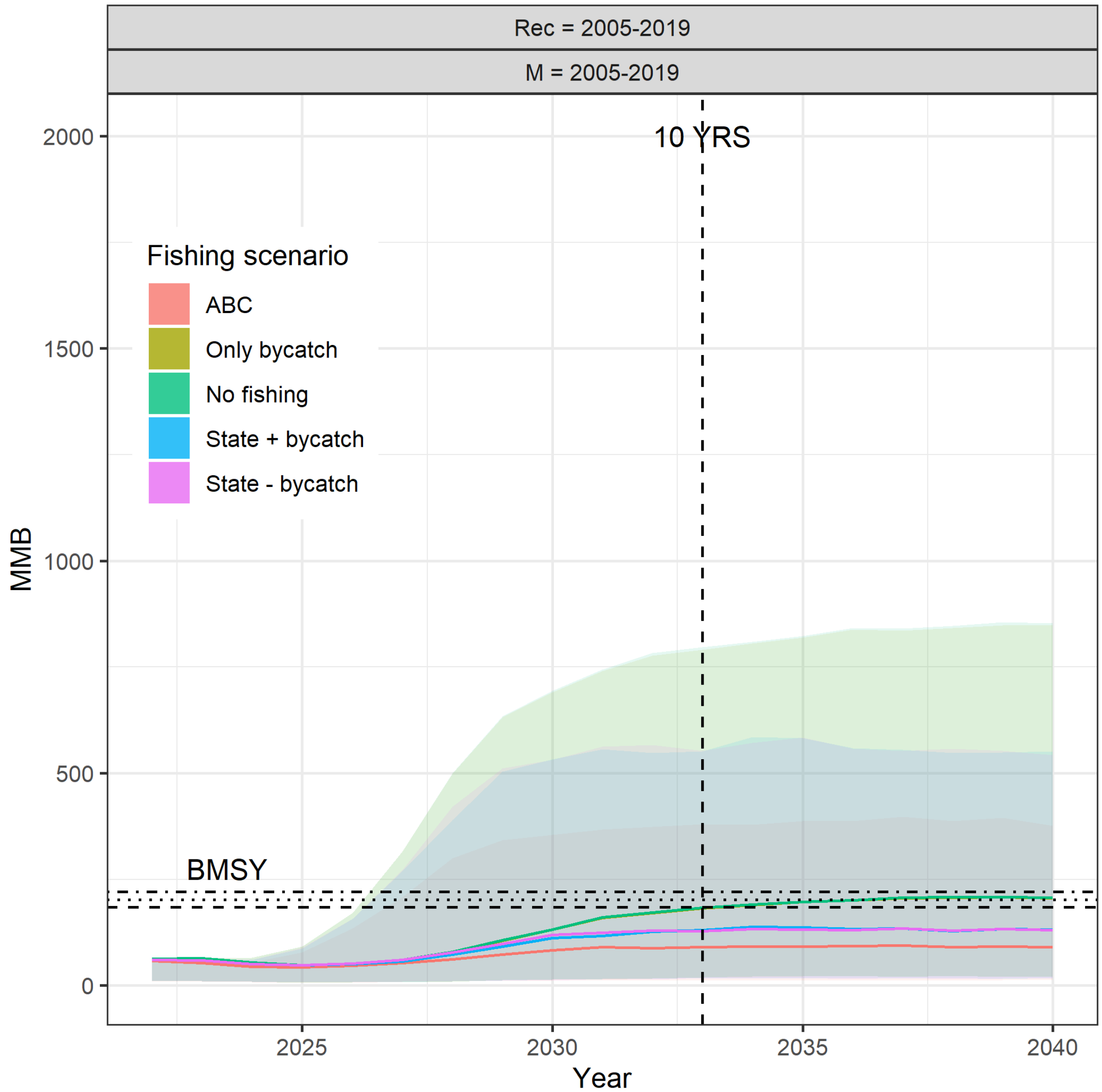


Figure 2-3 Rebuilding trajectories under productivity assumptions associated with the years 2005-2019 and various fishing strategies. Shaded areas represent the 5th and 95th inter-simulation interval and the timing with which the median (solid line), upper, and lower intervals cross the line representing B_{MSY} are reported in table 1 as measures of uncertainty around the minimum time to rebuilding.

3 Environmental Assessment

This chapter evaluates the potentially affected environment and the degree of the impacts of the alternatives and options on the various resource components, together with relevant past, present, and reasonably foreseeably actions (RFFA).

Recent and relevant information, necessary to understand the affected environment for each resource component, is summarized in the relevant section below. For each resource component, the analysis identifies the potential impacts of each alternative, and evaluates these impacts. If significant impacts are likely to occur, preparation of an EIS is required. Although an EA should evaluate economic and socioeconomic impacts that are interrelated with natural and physical environmental effects, economic and social impacts by themselves are not sufficient to require the preparation of an EIS (see 40 CFR 1508.14).

3.1 Methods

3.1.1 Resource Components Addressed in the Analysis

Table 5 shows the components of the environment and whether the proposed action and its alternatives have the potential to impact that resource component and thus require further analysis. Extensive environmental analysis on all resource components is not needed in this document because the proposed action is not anticipated to have environmental impacts on all resource components.

The proposed action is to establish a rebuilding plan for EBS Snow Crab. Table 5 identifies the components of the human environment that would be affected by establishing a rebuilding plan.

Table 5. Resources potentially affected by the proposed action and alternatives.

Potentially affected resource component					
Eastern Bering Sea Snow Crab	**Non-Target Species**	**Marine Mammals**	**Seabirds**	**Habitat**	**Social and Economic**
Y	Y	Y	N	Y	Y

N = no impact anticipated by each alternative on the component.
Y = an impact is possible if each alternative is implemented.

3.1.2 Effects of Aggregate Past, Present, and Reasonably Foreseeably Future Actions

This EA analyzes the effects of each alternative and the effects of past, present, and RFFA. Based on Table 5, the resources with potentially meaningful effects are EBS snow crab, non-target species, marine mammals, habitat, and social and economic components. The aggregate effects and the impacts of this proposed action and alternatives on seabirds is thought to be minimal, therefore there is no need to conduct an additional aggregate impacts analysis.

Each section below provides a review of the relevant past, present, and RFFA that may result in aggregate effects on the resource components analyzed in this document. A complete review of the past, present, and RFFAs are described in the prior NEPA documents incorporated by reference (section 1.3).

Actions are understood to be human actions (e.g., a designation of northern right whale critical habitat in the Pacific Ocean), as distinguished from natural events (e.g., an ecological regime shift). CEQ regulations require consideration of actions, whether taken by a government or by private persons, which are reasonably foreseeable. This requirement is interpreted to indicate actions that are more than merely possible or speculative. In addition to these actions, this aggregate effects analysis includes the effects of climate change.

Actions are considered reasonably foreseeable if some concrete step has been taken toward implementation, such as a Council recommendation or NMFS's publication of a proposed rule. Actions only "under consideration" have not generally been included, because they may change substantially or may not be adopted, and so cannot be reasonably described, predicted, or foreseen. Identification of actions likely to impact a resource component within this action's area and time frame will allow the public and Council to make a reasoned choice among alternatives.

3.2 Eastern Bering Sea Snow Crab

Snow crab (*Chionoecetes opilio*) are a circumpolar species. While commercial catches in Alaska are concentrated in the Bering Sea (Figure 3-1), the species is also found on the Chukchi Sea and Beaufort Sea continental shelves. The eastern Bering Sea population within U.S. waters is managed as a single stock; however, the distribution of the population may extend into Russian waters to an unknown degree. In the Bering Sea, snow crab are distributed widely over the shelf and are common at depths less than ~200 meters. Primiparous female snow crab appear to track near-bottom temperature during a northeast to southwest ontogenetic migration to warmer waters near the shelf break (Ernst et al., 2005; Parada et al., 2010). Shifts in centers of distribution of mature female snow crab relative to prevailing currents may affect larval supply to nursery areas (Zheng and Kruse, 2006) and thermal occupancy patterns of snow crab depend on the availability of cold water habitat (Fedewa et al., 2020).

Spatial patterns in juvenile and adult snow crab distribution are determined largely by ontogenetic migrations linked to size- and thermal requirements. Immature snow crab concentrate in colder, shallow waters of the northern Bering Sea (NBS) and EBS middle shelves. (Kolts et al., 2015). 2°C may represent a critical temperature threshold for immature snow crab (Murphy, 2020), negative effects on metabolic processes are not apparent in mature snow crab until temperatures exceed 7°C (Foyle et al., 1989). Temperature also influences molt timing (Dutil et al., 2010), growth rates (Yamamoto et al., 2015), energy stores (Hardy et al., 2000), and body condition (Dutil et al., 2010) of snow crab in the laboratory.

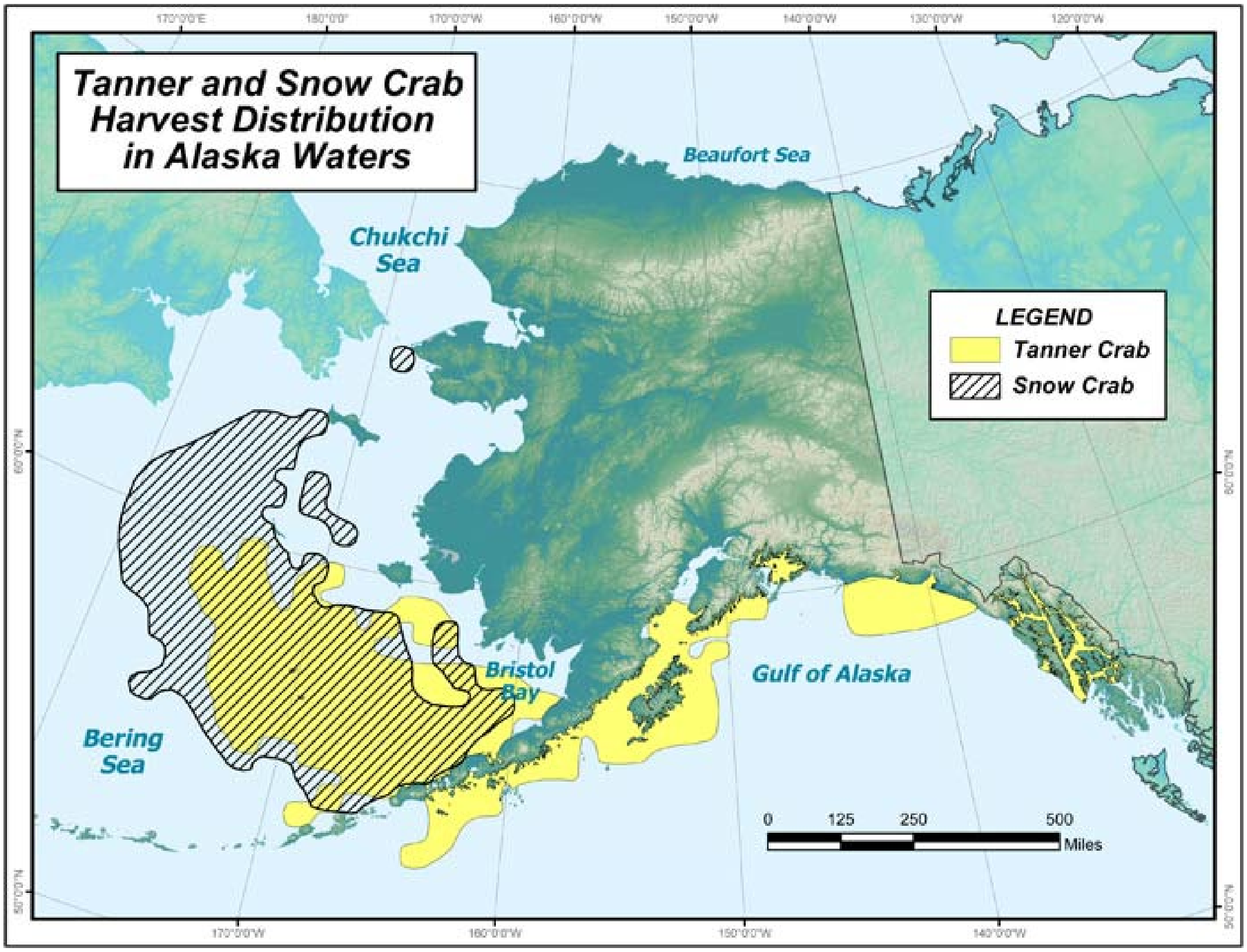


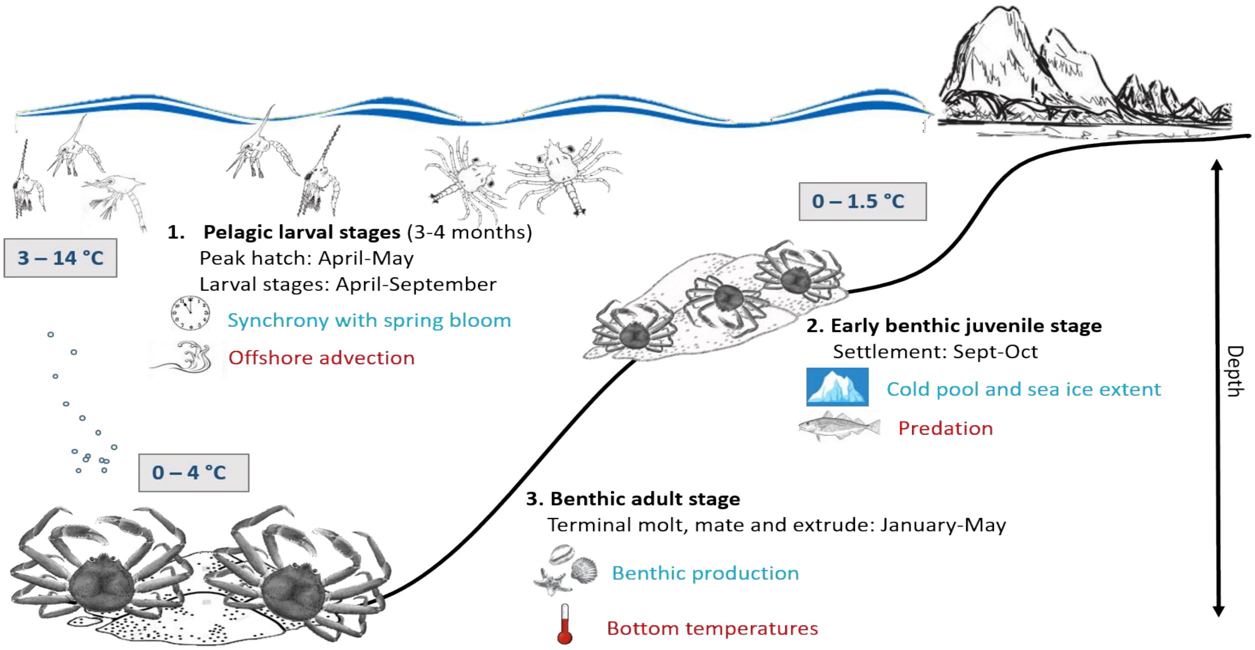
Figure 3-1 Snow crab and Tanner Crab distribution within the waters of Alaska.

3.2.1 Eastern Bering Sea Molting and Mating Cycle

As detailed in the 2022 Snow crab Ecosystem and socioeconomic profile, EBS snow crab undergo distinct life cycle stages (Figure 3-2,Table 6) associated with molting and mating cycles that correlate with spatial, environmental and temporal preferences. As mature females molt to maturity, female snow crab mate and extrude new egg clutches each spring, which remain attached to pleopods on the female's abdomen for a full year prior to hatching. Peak hatching of snow crab larvae occurs in April (Armstrong et al., 1981) and phyto-detritus may act as a chemical cue for larval release (Starr et al., 1994). Larval duration for each of the two zoeal stages is approximately 30 days (Incze et al., 1982). A longer larval stage associated with cooler temperatures may leave larvae more vulnerable to pelagic predators for a prolonged period. Furthermore, historical larval year-class failures have coincided with low zooplankton abundance over the middle shelf and low water column stability, suggesting that increased larval mortality is related to less favorable feeding conditions (Incze et al., 1987) and mismatches between larval release and the spring bloom (Somerton 1982).

Snow crab larvae settle from late August to the end of October (Conan et al., 1992). Early benthic instars are cryptic and concentrate in shallow, cold-water habitats (Lovrish et al., 1995; Murphy et al., 2010). Previous laboratory studies have shown that adequate energetic stores are prerequisites for molting, growth, and survival in snow crab early life history stages (e.g. Lovrich and Ouellet, 1994), indicating that variability in energetic reserves could represent a potential recruitment bottleneck in snow crab. Both settlement intensity and early benthic survival are likely critical determinants of year-class strength in snow crab (Sainte-Marie et al., 1996), and successful advection to areas of suitable temperature and muddy substrate are thought to be critical criteria for juvenile survival (Dionne et al., 2003). Density-dependence may also play a regulatory role due to high rates of cannibalism (Lovrich and Sainte-Marie 1997) and potential prey resource limitation in juvenile nurseries. Previous studies have shown that Pacific cod, sculpin, skates and halibut are major predators of juvenile snow crab (Livingston et al., 1993; Livingston and deReynier, 1996; Lang et al., 2003) and the cold pool may provide refuge from predators like Pacific cod that avoid waters less than 2°C (Ciannelli and Bailey, 2005). Juvenile snow crab are especially vulnerable to predation and cannibalism during and immediately following molting. Table 6 summarizes the ecological preferences and information utilized by EBS snow crab across ontogeny.

Generation time, or average age of spawning individuals within the EBS snow crab population, is estimated to be 7 years (E. Fedewa pers. Comm.). Minimum generation time is thought to be determined by primiparous females, rather than males as males undergo molt to maturity at a wider range of benthic instar stages. It is thought that females are 6-8 years post hatch when they terminally molt to maturity (Sainte-Marie et al., 1996), while quantitative assessment of instar composition and size frequency distribution similarly suggests approximately 7 years as the mean time lapsed between egg extrusion by females of a pseudocohort and terminal molt of primipara originating from those eggs (Ernst et.al., 2012).



Source: [2022 EBS snow crab ESP]

Figure 3-2 Life history conceptual model for EBS snow crab summarizing ecological information and key ecosystem processes affecting survival by life history stage. Red text means increases in process negatively affect survival, while blue text means increases in process positively affect survival.

Table 6 Ecological information by life history stage for EBS snow crab.

Stage	Habitat & Distribution	Phenology	Age, Length, Growth	Energetics	Diet	Predators/Competitors
Egg	Clutch of embryos brooded under the female's abdomen until hatching	240 days at 6°C to 353 days at -1°C; cold temperatures trigger a 2-year reproductive cycle(1)	Egg diameter: 644.4-772.1 μm(2)	Optimal: 0°C – 3°C(3)	Yolk	Nemertean worms and amphipods feed on egg clutches
Larvae	Pelagic; concentrated in the upper 20m over the middle shelf(4)	April-June hatch	Mean carapace length: 1.25mm	Optimal: 6.9°C – 9.1°C(5)	Diatoms, small copepods	Jellyfish, juvenile pollock and Pacific salmon
Juvenile	Benthic; found in mud and gravel habitat in 1°C bottom temperatures (50-100m depth)	Peak settlement in October, later benthic stages molt annually in the spring	10-12 benthic instar stages until final molt to maturity(6)	Growth indices highest at 5°C(7)	Crustaceans, bivalves, polychaetes(8)	Pacific cod, flatfish, sculpins, crab(9)
Adult	Benthic: sand and mud bottoms (70-200m depth)	6-7+ years, migration to shallow waters in spring to mate	Average size range at terminal molt: females 47-59 mm CW, males 73-101mm CW(10)	Growth is optimum at 4°C(11)	Polychaetes, crustaceans, echinoderms, mollusks(12)	Pacific cod, halibut, skates(13)

Source: 2022 EBS snow crab ESP
Note: Subscripts in table correspond to the following citations in sequential order 1. Webb et al., 2006, 2. Moriyasu and Lanteigne, 1998, 3. Webb et al., 2007, 4. Armstrong et al., 1981, 5. Yamamoto et al., 2017, 6. Sainte-Marie et al., 1995, 7. Yamamoto et al., 2015, 8. Kolts et al., 2013, 9. Lang et al., 2003, 10. Murphy 2021, 11. Foyle et al., 1989, 12. Divine et al., 2017, 13. Livingston et al., 1993

3.2.2 EBS Snow Crab Fishery Stock Biomass and Catches

This section is intended to detail historical snow crab biomass and catches throughout the duration of fishery operations. Snow crab were harvested in the Bering Sea (BS) by the Japanese from the 1960s until 1980 when the MSA prohibited foreign fishing. After the closure to foreign fleets, retained catches increased from relatively low levels in the early 1980s (e.g. retained catch of 11.85 kt during 1982) to historical highs in the early and mid-1990s (retained catches during 1991, 1992, and 1998 were 143.02, 104.68, and 88.09 kt, respectively; Table 7).

In 1999 the stock was declared overfished, at which time retained catches dropped to levels similar to the early 1980s (e.g. retained catch during 2000 was 11.46 kt). In 2000, under amendment 14, the EBS snow crab rebuilding plan contained three components to improve the status of the stock: (1) a harvest strategy, (2) bycatch control measures, and (3) habitat protection measures. The rebuilding plan was estimated to allow the BS snow crab stock to rebuild to the B_{MSY} level, with a 50 percent probability, in seven to ten years. The snow crab stock remained low for some time after the rebuilding plan was implemented.

In 2009, the NMFS Alaska Region notified the Council that the EBS snow crab stock would not be rebuilt by the end of the rebuilding time period, 2009/10, and that a revised rebuilding plan must be developed for that stock and implemented within two years of that notification. Amendment 39 passed in 2010 modifying the snow crab rebuilding plan to define the stock as rebuilt the first year the stock biomass is above the necessary level to produce maximum sustainable yield (MSY). The stock was declared rebuilt in 2011 and had expanded substantially, supporting some of the largest annual BSAI crab fisheries until the most recent decline in 2019/2020 prompting a new snow crab rebuilding plan when the stock was declared overfished in 2021.

Current estimates of biomass and size frequency data are calculated based off the NMFS trawl survey, total catch data from the directed fishery, bycatch data from the trawl fishery, size frequency data for male-retained catch in the directed fishery, and male and female bycatch in the directed and non-target fisheries. Additional information of biomass estimates from the 2009/2010 BSFRF surveys are incorporated into the stock assessment model. It should be noted that the 2020 survey data is not included, as the survey season was cancelled due to the Covid-19 pandeminc. The current stock assessment of EBS snow crab is based on a size- and sex-structured model in which crabs are categorized as immature or mature, and account is taken of a terminal molt. The model takes into account all aforementioned estimates of biomass and size frequency to best update the stock assessment on an annual basis. Updated data in the 2022 assessment include retained catch, total catch and length frequencies from the 2021/22 directed fishery, discard catch and length frequencies from the 2021/22 groundfish fisheries, and biomass and length frequencies from the 2022 NMFS bottom trawl survey. Results from the 2022 NMFS bottom trawl survey indicated a decrease in biomass estimates for all size classes, with the exception of a slight increase in estimated industry preferred biomass (+9%) from the 2021 survey. 2022 observed EBS snow crab female mature and male mature biomass is the lowest value in history Table 8.

Based on the 2022 BSAI Crab SAFE, the model estimate of mature male biomass for the 2021/22 fishing season (41.2 kt) was below the MSST; 91.6 kt, and so the stock remains in an overfished status. The 2019/2020 season was the first time a mass mortality event appears to have occurred for snow crab since the survey began and the biomass of important size categories of crab are at historic lows. The observed biomass of males greater than 101mm carapace width was 13.36 kt in 2022, second lowest aside from 2021 (12.43 kt) (Table 8). The third lowest the biomass has ever been was 20,740 t in 2016. For context, when the stock was declared overfished in 1999, the observed biomass was 52,042 tons. Females are also currently at historic lows, observed at 23.89 kt in 2022. For the first time in history, the fishery will remain closed for the 2022/2023 fishing season.

Historical retained catch from the directed snow crab pot fishery from survey years 1982 to 2021 are presented in Table 7 and Table 9. Discards and bycatch mortality estimates are derived from at-sea observer data and assume a 30 percent handling mortality rate, 80 percent for trawl gear, and 50 percent in fixed gear groundfish fisheries. Figure 3-3 and Figure 3-4 illustrate the spatial distribution of the directed snow crab fisheries in the BSAI overlayed on the shaded COBLZ area. Figure 3-3 shows the statistical areas with retained catch from the 2021/22 season (with statistical areas that include at least three vessels) and Figure 3-4 demonstrates the weighted center of catch over time. The footprint of the directed snow crab fishery has remained fairly consistent over time. Snow crab fishing occurs over a wide distribution on and near the shelf edge and north toward Saint Matthew Island.

Table 7. EBS Snow crab directed pot fishery characteristics from 1990/91-2021/22 The Guideline Harvest Level and Total Allowable Catch (GHL/TAC) are equivalent and are in millions of pounds.

Year	GHL/TAC (lb)	Retained Catch (lb)	Retained Catch (crab)	Pot lifts	CPUE	avg_wt (lb)	avg CW (mm)
1990	315,000,000	328,648,169	265,124,637	1,382,908	191.7	1.24	110.1
1991	333,000,000	315,302,034	227,376,582	1,278,502	177.8	1.39	114.1
1992	207,200,000	230,754,145	169,531,168	969,209	174.9	1.36	113.4
1993	105,800,000	149,792,718	114,810,186	716,524	160.2	1.30	111.9
1994	55,700,000	75,309,187	60,591,399	507,603	119.4	1.24	110.2
1995	50,700,000	65,696,173	52,892,320	520,685	101.6	1.24	110.1
1996	117,000,000	119,589,339	100,013,816	754,140	132.6	1.20	108.8
1997	234,100,000	252,339,284	193,618,550	930,794	208.0	1.30	111.9
1998	196,000,000	194,363,869	151,183,798	945,533	159.9	1.29	111.4
1999	28,500,000	33,291,344	25,081,681	182,634	137.3	1.33	112.5
2000	27,300,000	25,256,384	18,612,605	191,200	97.3	1.36	113.3
2001	30,820,000	32,633,210	25,155,221	326,977	76.9	1.30	111.7
2002	25,610,000	28,316,923	23,252,904	153,862	151.1	1.22	109.4
2003	20,831,000	23,942,373	18,669,591	123,709	150.9	1.28	111.3
2004	20,932,000	24,892,128	17,985,745	75,095	239.5	1.38	114.0
2005	37,184,000	36,923,482	24,520,279	117,375	208.9	1.51	117.2
2006	36,566,000	36,243,989	29,536,398	86,328	342.1	1.23	109.7
2007	63,034,000	63,002,304	50,307,812	140,857	357.2	1.25	110.4
2008	58,550,000	58,547,849	45,945,092	163,537	280.9	1.27	111.0
2009	48,017,000	48,014,089	35,289,022	137,292	257.0	1.36	113.4
2010	54,281,000	54,263,200	37,758,496	147,478	256.0	1.44	115.4
2011	88,894,000	88,830,652	60,555,105	270,602	223.8	1.47	116.2
2012	66,350,000	66,254,528	47,455,883	225,627	210.3	1.40	114.4
2013	53,983,000	53,978,074	41,923,152	225,245	186.1	1.29	111.4
2014	67,950,000	67,939,253	55,027,927	279,183	197.1	1.23	109.9
2015	40,611,000	40,594,509	29,603,375	202,526	146.2	1.37	113.7
2016	21,570,000	21,570,915	16,412,386	118,548	138.4	1.31	112.2
2017	18,961,000	18,888,112	15,637,993	114,673	136.4	1.21	109.1
2018	27,581,000	27,501,780	22,408,836	119,484	187.5	1.23	109.7
2019	34,020,000	34,024,553	28,626,114	188,958	151.5	1.19	108.6
2020	45,000,000	45,001,190	37,492,237	171,678	218.4	1.20	108.9
2021	5,600,000	5,523,226	4,575,974	36,878	124.1	1.21	109.1

Table 8 Observed mature male and female biomass (1000 t) at the time of the survey and coefficients of variation.

Survey year	Female mature biomass	Female CV	Mature male biomass	Male CV	Males >101mm (kt)	Males >101mm (million)
1982	144.4	0.15	176.8	0.14	33.34	60.91
1983	90.13	0.2	161.6	0.13	38.09	70.09
1984	42.32	0.19	177.7	0.12	88.73	151.8
1985	6.12	0.2	71.84	0.11	43.39	72.84
1986	15.74	0.18	89.81	0.11	46.7	77.91
1987	122.6	0.16	194.6	0.11	74.44	128.6
1988	169.9	0.17	259.4	0.15	104.7	173.1
1989	264.2	0.25	299.2	0.11	92.31	158.9
1990	182.9	0.19	443.8	0.14	224.7	386.4
1991	214.9	0.19	466.6	0.15	292.2	452.9
1992	131.4	0.18	235.5	0.09	143.9	227.3
1993	132.1	0.16	183.9	0.1	78.11	126.7
1994	126.2	0.15	171.3	0.08	44.78	72.57
1995	168.7	0.14	220.5	0.13	37.75	65.18
1996	107.3	0.14	288.4	0.12	87.57	155.2
1997	103.8	0.2	326.8	0.1	168.7	280.6
1998	72.73	0.25	206.4	0.09	126.7	209.7
1999	30.89	0.21	95.85	0.09	52.53	85.2
2000	96.46	0.52	96.39	0.14	41.88	69.83
2001	77.24	0.28	136.5	0.12	41.51	70.69
2002	30.22	0.28	93.17	0.23	36.56	64.16
2003	41.71	0.31	79.07	0.12	32.57	55.61
2004	50.16	0.26	79.57	0.14	35.99	57.42
2005	64.85	0.17	123.5	0.11	40.67	63.26
2006	51.93	0.17	139.3	0.26	71.13	120.9
2007	55.89	0.22	153.1	0.15	73.62	127.5
2008	57.15	0.19	142	0.1	66.56	113.6
2009	52.16	0.21	148.2	0.13	78.92	129.9
2010	98.01	0.17	162.8	0.12	88.35	138.3
2011	175.8	0.18	167.1	0.11	94.67	147.6
2012	149.4	0.2	122.2	0.12	53.17	85.35
2013	131.4	0.17	97.46	0.12	42.93	71.79
2014	119.7	0.19	163.5	0.16	81.39	138.8
2015	85.13	0.17	80.04	0.12	35.77	56.11
2016	55.39	0.21	63.21	0.11	21.96	36.51
2017	106.8	0.21	83.96	0.13	20.52	35.02
2018	165.9	0.18	198.4	0.17	26.75	48.08
2019	110.4	0.2	169.1	0.17	28.12	51.27
2021	31.66	0.43	62.25	0.13	12.43	23.17
2022	22.44	0.31	37.5	0.15	13.36	23.89

Table 9 Observed retained catches, discarded catch, and bycatch. Discards and bycatch have assumed mortalities applied.

Survey year	Retained Catch (kt)	Discarded females (kt)	Discarded Males (kt)	Trawl bycatch (kt)
1982	11.85	0.02	1.47	0.37
1983	12.16	0.01	1.43	0.47
1984	29.94	0.01	3.2	0.5
1985	44.45	0.01	4.65	0.43
1986	46.22	0.02	4.92	0
1987	61.4	0.03	6.4	0
1988	67.79	0.04	6.74	0
1989	73.4	0.05	7.74	0.1
1990	149.1	0.05	17.62	0.71
1991	143	0.06	13.9	1.5
1992	104.7	0.12	17.06	2.28
1993	67.94	0.08	5.32	1.57
1994	34.13	0.06	4.03	2.67
1995	29.81	0.02	5.75	1.01
1996	54.22	0.07	7.44	0.66
1997	114.4	0.01	5.73	0.82
1998	88.09	0.01	4.67	0.54
1999	15.1	0	0.52	0.47
2000	11.46	0	0.62	0.41
2001	14.8	0	1.89	0.31
2002	12.84	0	1.47	0.17
2003	10.86	0	0.57	0.46
2004	11.29	0	0.51	0.63
2005	16.77	0	1.36	0.2
2006	16.49	0	1.78	0.42
2007	28.59	0.01	2.53	0.18
2008	26.56	0.01	2.06	0.18
2009	21.78	0.01	1.23	0.47
2010	24.61	0.01	0.62	0.14
2011	40.29	0.18	1.69	0.15
2012	30.05	0.03	2.32	0.22
2013	24.49	0.07	3.27	0.11
2014	30.82	0.17	3.52	0.13
2015	18.42	0.07	2.96	0.13
2016	9.67	0.02	1.31	0.06
2017	8.6	0.02	1.93	0.04
2018	12.51	0.02	2.86	0.23
2019	15.43	0.02	5.07	0.24
2020	20.41	0	5.8	0.07
2021	2.48	0	1.16	0.06

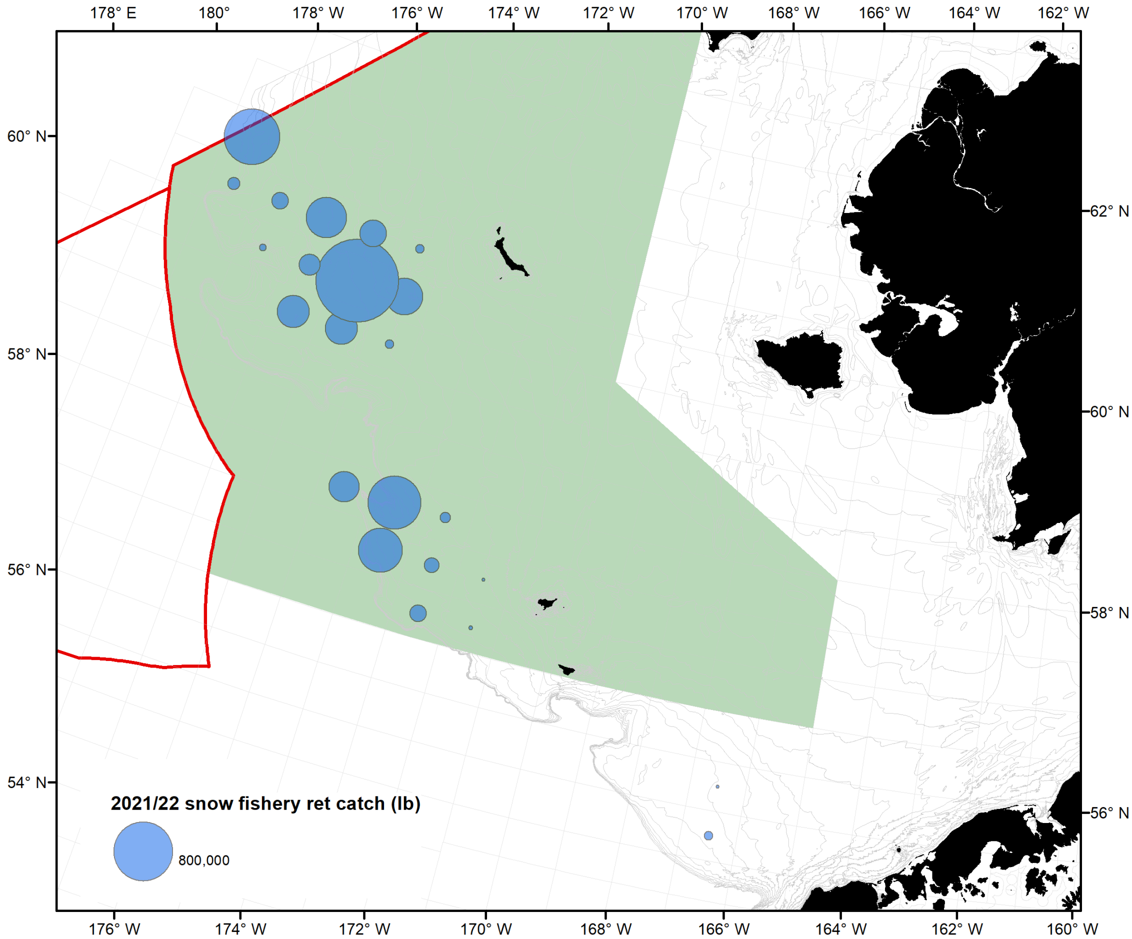


Figure 3-3 Retained catch of EBS snow crab in the directed fishery, 2021/22, where size of the blue dot corresponds to the magnitude of catch in each ADF&G statistical area (grid). Shaded area represents the COBLZ.

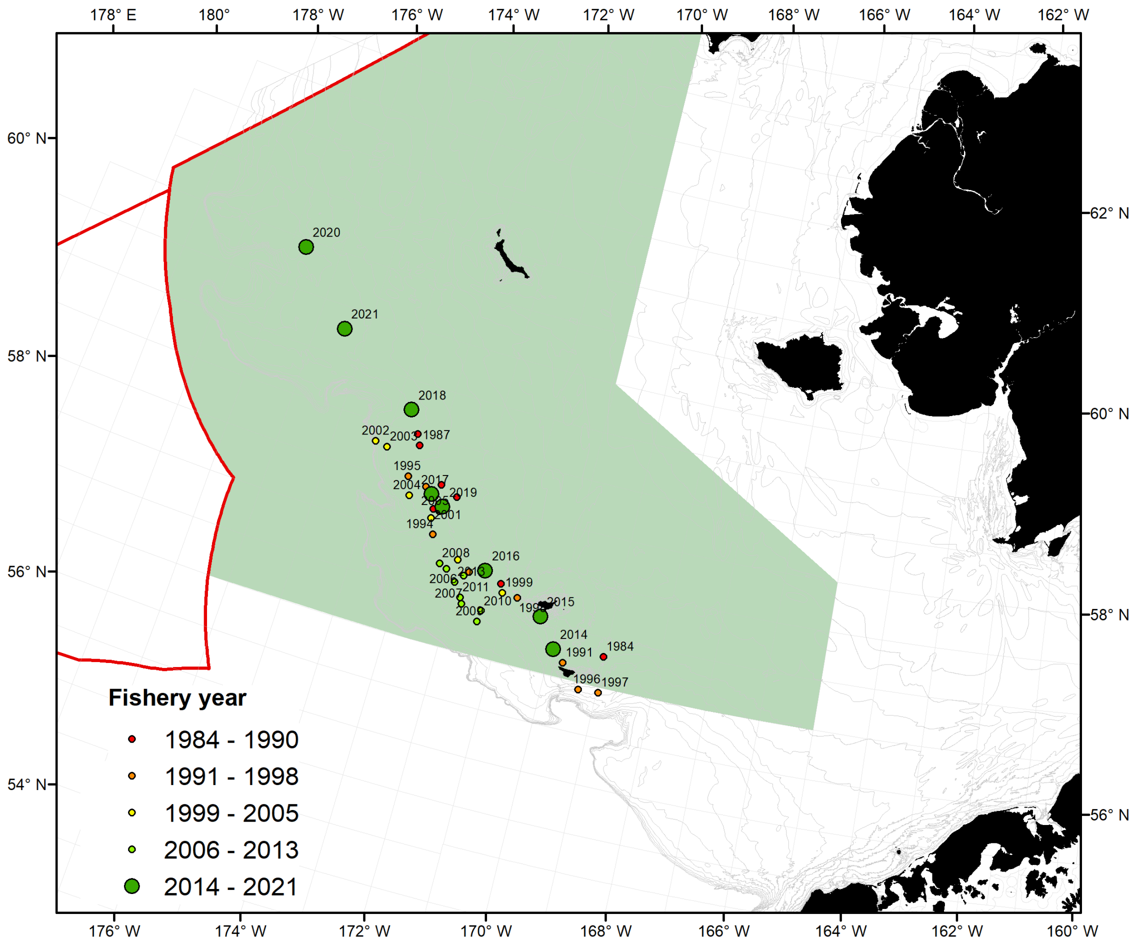
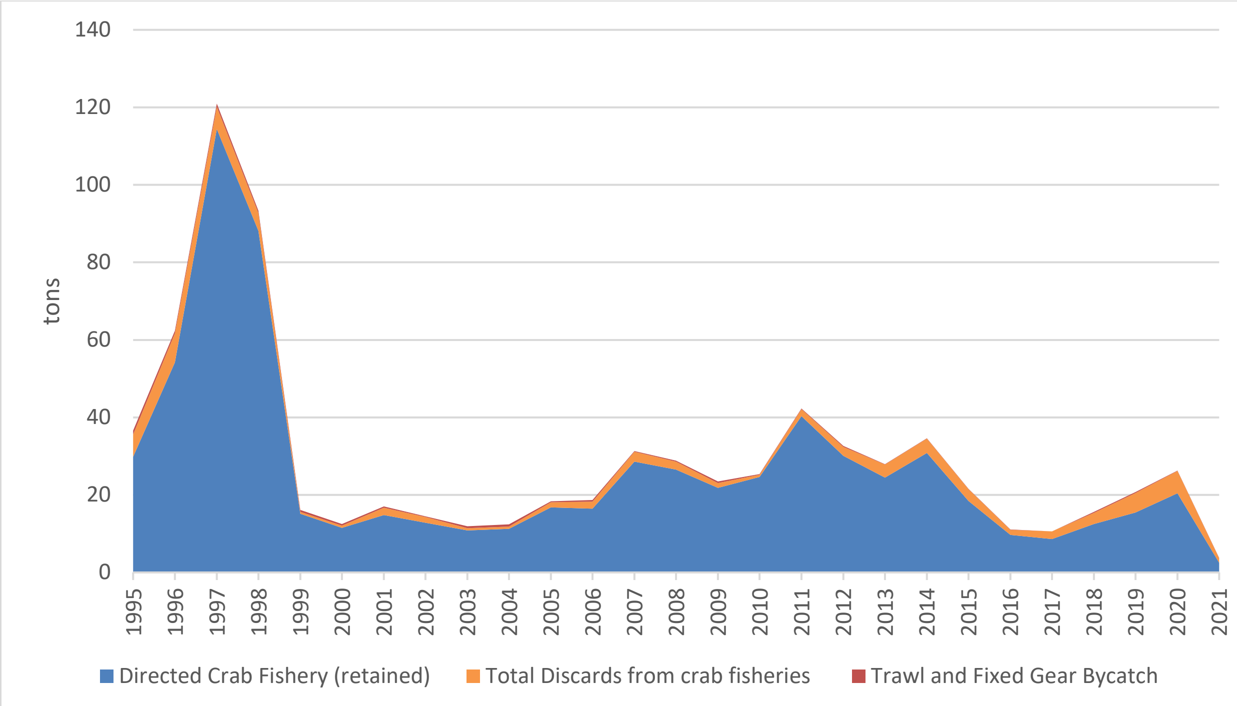


Figure 3-4 Weighted center of EBS snow crab catch in the directed fishery for 1984-2021. Shaded area represents the COBLZ.

Discard mortality in the directed fishery is the next largest source of mortality after retained catch. The highest estimated discard mortality occurred during 1992 at 17.06 kt, which was 16%of the retained catch. Discard from the directed pot fishery has been estimated from observer data since 1992 and has ranged from 11-100% of the magnitude of retained catch by numbers. In recent years, discards have reached 50-100% of the magnitude of retained catch because of the large year class entering the population. Regulatory female discard catch has been very low compared to male discard catch and has not been a substantial source of mortality.



Source: EBS Snow Crab SAFE, September 13, 2022 (Table 9)

Figure 3-5. Directed snow crab catch and other sources of mortality including discards from directed crab fisheries and trawl and fixed gear bycatch in groundfish fisheries, 1995 through 2020

3.2.3 EBS Snow Crab and Climate Change

As shown in the 2022 EBS snow crab ESP, ecosystem indicators prove beneficial when assessing snow crab populations. In the 2022 ESP, authors highlighted the potential loss of cold-water habitat available to snow crab, evidenced by record-low cold pool extent coinciding with dramatic increases in temperature in areas occupied by immature snow crab in recent years. Temperature has shown to be a primary ecosystem indicator when assessing snow crab populations. Fluctuations in temperature are shown to influence molt timing (Dutil et al., 2010), growth rates (Yamamoto et al., 2015), energy stores (Hardy et al., 2000), metabolic rate (Foyle et, al., 1998) and body condition (Dutil et al., 2010) of snow crab in the laboratory. Declines in sea ice extent also pose negative consequences for spring cold pool formation, carbon flux to the benthos and spatiotemporal mismatches between snow crab larvae and spring blooms.

The snow crab collapse coincided with rapid warming in the EBS during 2014-2020. The peak years of this warming event were 2016, 2018, and 2019, when annual mean sea surface temperature (SST) was well outside the range of previous observations and 1.9 - 2.3°C above the pre-1950 mean (Figure 3-6). The goals of this section are to: 1) review the evidence for warm temperatures as a cause of the snow crab collapse; 2) review the evidence for human-induced climate change as the mechanism leading to the warming event; and 3) evaluate the risk for similar warming events during snow crab rebuilding.

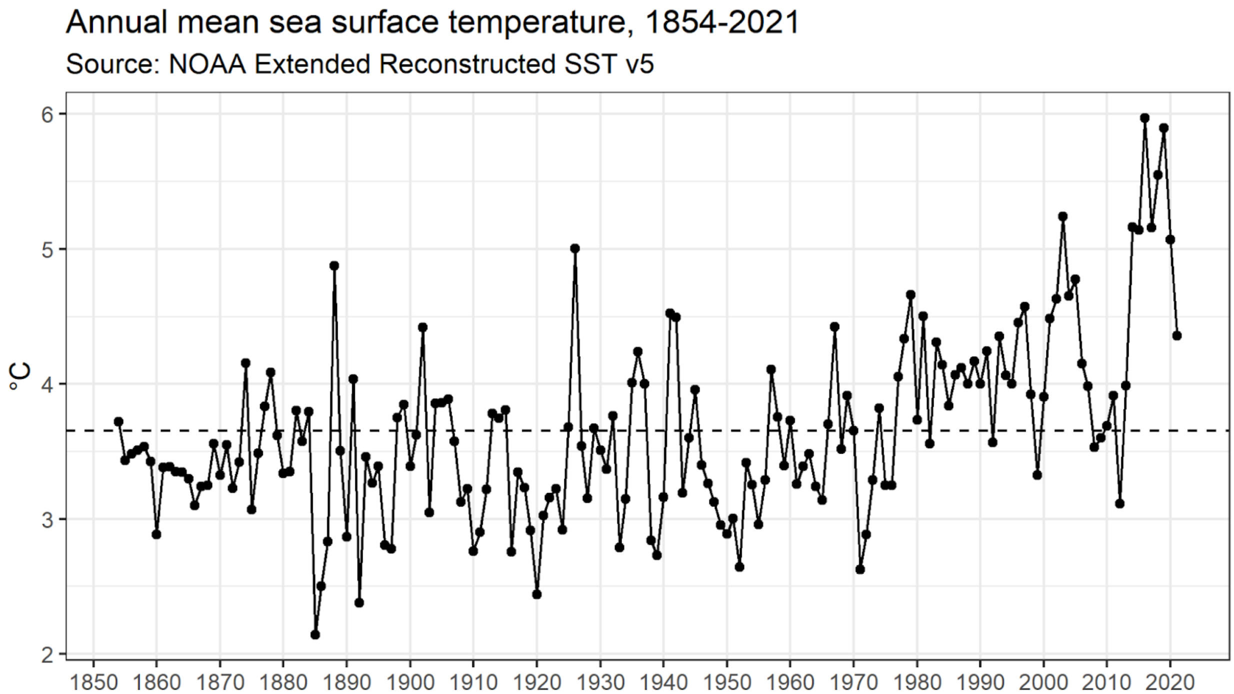


Figure 3-6 Annual mean sea surface temperature (SST) in the EBS. Dashed line indicates pre-1950 mean.

3.2.3.1 Warming as a cause of the snow crab collapse

Snow crab are a cold-water, Arctic species that is primarily found in seasonally ice-covered areas of the Bering sea (BS) with summer bottom water temperatures < 2°C. Because of this cold-water, ice-associated climate envelope, snow crab have long been proposed as a species that is likely to be negatively impacted by climate warming and the loss of sea ice in the BS (Mueter and Litzow 2008).

Two ongoing studies, not yet published, have investigated the causes of the post-2018 collapse of snow crab, and both have independently identified warming as a major contributor. Szuwalski et al. (in review) used annual mortality estimates from a population dynamics model run on males between 30 and 95 mm as the response variable for evaluating the role of a wide range of possible causes of the collapse. Candidate covariates included bycatch, directed fishing discard mortality, cannibalism, Pacific cod predation, the incidence of bitter crab syndrome, temperature, and population density. This model showed robust evidence for temperature and density-dependence as the causes of the collapse, with no evidence for an effect of the other covariates.

Borealization - the switch from an Arctic ecosystem state to a subarctic state - has long been proposed as the most important consequence of climate change for Arctic marine communities and fisheries (Mueter and Litzow 2008, Fossheim et al. 2015, Polyakov et al. 2020, Mueter et al. 2021, Emblemsvag et al. 2022). Litzow et al. (in prep.) evaluated the role that borealization of the southeast BS played in the snow crab collapse. This analysis used time series for thirteen physical and biological variables to create a borealization index that tracks the transition of the region from an Arctic, seasonally ice-covered state to a subarctic, ice-free state over the years 1972-2022 (Figure 3-7). This borealization index identifies 2018 and 2019 as the years when subarctic conditions were strongest in the southeast BS, and the analysts found a robust statistical relationship between the borealization index and the snow crab collapse.

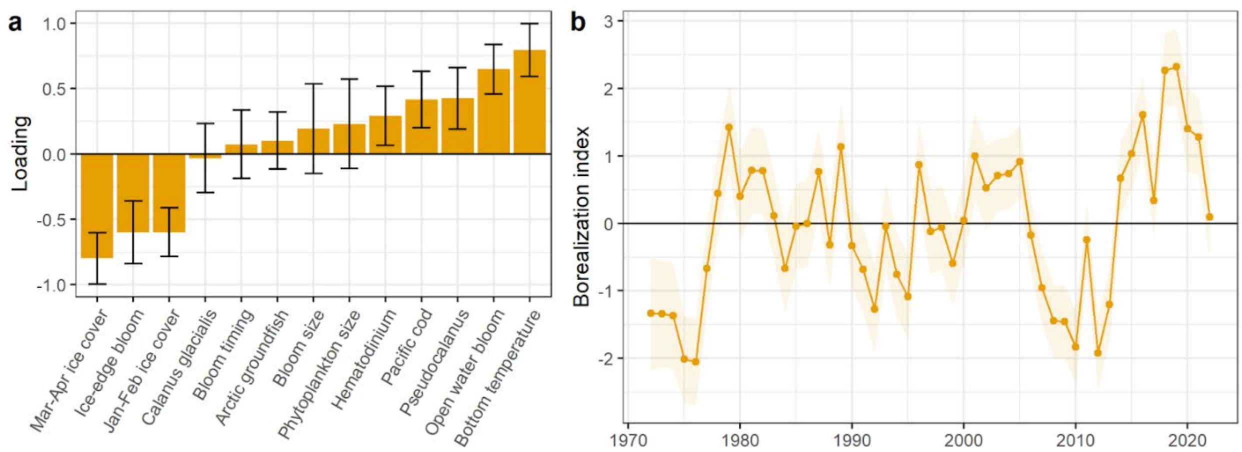


Figure 3-7 An index of borealization (the transition from Arctic to subarctic conditions) in the southeast BS, 1972-2022. a) Loadings for thirteen physical and biological time series onto a shared trend identified using Dynamic Factor Analysis (DFA). Time series with negative loadings are associated with more Arctic conditions, time series with positive loadings are associated with more subarctic conditions, and time series with 95% confidence intervals (error bars) that include 0 cannot be assigned to either state. b) Borealization index, defined as the shared trend from the DFA model (estimate with 95% confidence interval). Negative values indicate more Arctic conditions, positive values indicate more subarctic conditions.

3.2.3.2 The role of human-induced climate change

An important question regarding recent warming in the BS is the extent to which these events are the result of internal climate variability (e.g., Di Lorenzo and Mantua 2016), in which case the warming event could be understood as a one-off event, or the product of human-caused global warming (Broecker 1975), in which case the warming event could be understood as a part of a trend. Extreme event attribution is a branch of climate science that can address questions such as this, by quantifying the contribution of human-induced climate change to individual climate and weather events (Otto 2017).

Several attribution studies have identified a human role in recent North Pacific and BS climate extremes. Laufkötter et al. (2020) found that the 2013-2015 “Blob” marine heatwave that marked the onset of extreme BS temperatures could be attributed to human activities. Walsh et al. (2018) and Thoman et al. (2020) came to the same conclusion about 2016 BS sea surface temperature / ocean heat content and 2018 BS ice cover, respectively. In an unpublished study, Litzow et al. (in review) applied Extreme Event Attribution techniques to annual BS sea surface temperature observations for 1950-2021. Using outputs from 23 CMIP6 (Coupled Model Intercomparison Project, Phase 6) climate models, these authors calculate the Fraction of Attributable Risk (the proportion of risk for a given event that can be ascribed to human activities, FAR) and the Risk Ratio (how much more likely a given event is due to human activity). This analysis found FAR values ≥ 0.998 for 2018-2019 sea surface temperature values, and Risk Ratio values that indicated that 2018-2019 temperatures were ~500-1500 times more likely to occur due to human activities (Figure 3-8). These results provide compelling evidence that warming associated with the snow crab collapse was the result of human-caused climate change. This in turn indicates the likelihood that the Bering Sea will continue to warm, requiring the use of a forward-looking perspective for managing snow crab and other Bering Sea fisheries, based on the expectation that current trends will continue (Pershing et al. 2019).

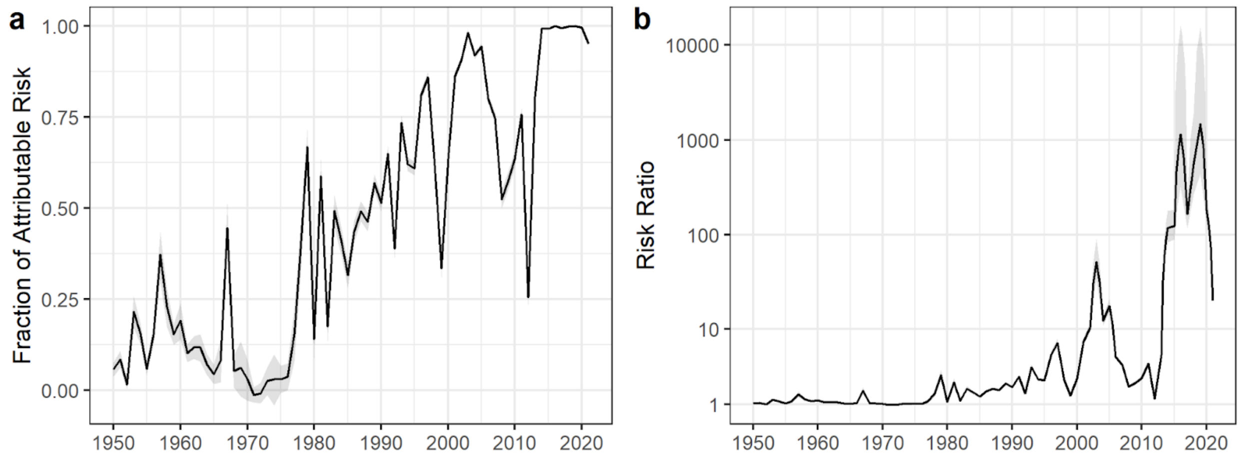


Figure 3-8 Attribution of change in BS sea surface temperature to human activities, 1950-2021. a) Fraction of Attributable Risk (proportion of risk for a given temperature that can be ascribed to human activities). b) Risk Ratio (how much more likely an observed temperature is due to human activities when compared with the preindustrial climate). Both time series are multi-model estimates from 23 climate models, plotted as posterior means and 95% credible intervals.

3.2.3.3 Risk for continued warming events during rebuilding

In order to make projections of the risk for extreme warming events during rebuilding, Litzow et al. (in prep.) identified the critical threshold in sea surface temperature that was associated with rapid borealization and the snow crab collapse, and then used outputs from the same 23 CMIP6 climate models to estimate the probability of temperatures as great as or greater than the critical threshold. This threshold was identified as the minimum SST value associated with the value of the borealization index observed to date (2016, 2018-2020; Figure 3-7b). Relative to preindustrial (pre-1950) temperatures, this critical threshold is a 3.85 standard deviation anomaly. (Anomalies are used rather than original units in order to ease comparison among observations and models; the 2019 anomaly was slightly higher at 4.9 standard deviations.)

The risk for temperatures exceeding this threshold was estimated for a range of different North Pacific warming levels (preindustrial to 0.5° warming, 0.5° - 1.0° warming, 1.0° - 1.5° warming [the current climate], and 1.5° - 2.0° warming). Multi-model estimates of the probability of temperatures as great as or greater than the critical threshold indicate that these temperatures were nearly unknown to rare historically (0% of years in the preindustrial climate, 0.1% from 1950 to 0.5° warming. 2.3% at 0.5° - 1.0° warming), can be expected as common events in the current climate (17% of years), and will become more common between 1.5° and 2.0° warming (32% of years; Figure 3-9a). Under the SSP2-4.5 emissions scenario (corresponding to ~3° global warming by 2100), the North Pacific is expected to exceed 1.5° warming some time in the 2040s (Figure 3-9b).

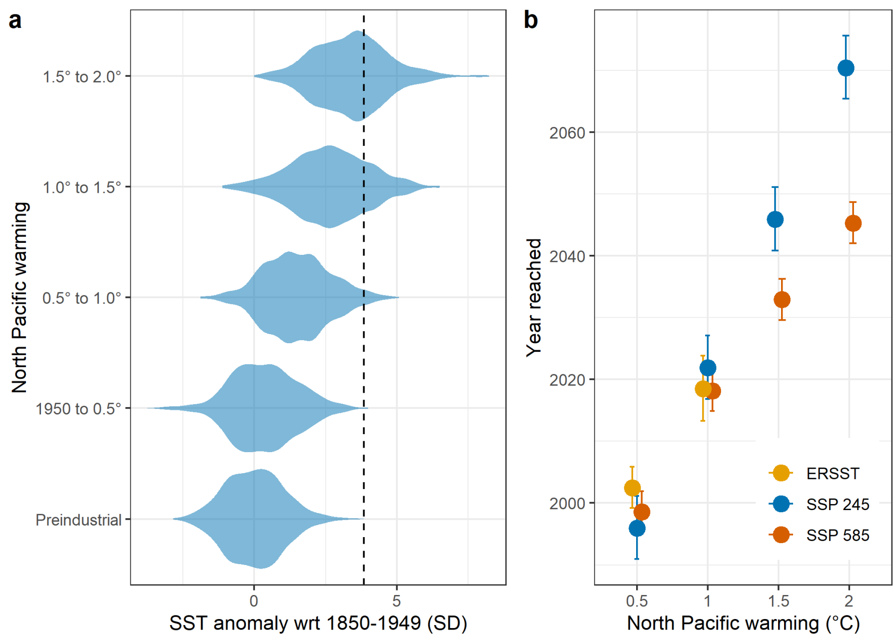


Figure 3-9 Global warming and climate risk for EBS snow crab. a) Bering Sea sea surface temperature probability densities projected for different levels of North Pacific warming. Dashed vertical line indicates critical threshold corresponding to observed borealization in 2020. b) Timing of observed and projected warming of the North Pacific warming from observations (ERSST) and two model scenarios (SSP5-8.5, corresponding to no mitigation, and SSP2-4.5, corresponding to ~3°C global warming by 2100). Plotted values are posterior means with 95% credible intervals.

3.2.4 Effects of the Alternatives on EBS snow crab

It is possible that rebuilding to B_{MSY} may not occur under any alternative, given that the predominant constraint on stock productivity is likely ecosystem conditions and recruitment. A complex suite of variables affects mortality of all life stages, but ecosystem conditions especially impact survival from age zero to approximately age 7, when male crab recruit to the mature male component of the population. As noted in section 3.2.3, the EBS snow crab mass mortality event is likely a result of the warming event associated with anthropogenic climate change. The warming event in the BS has been a contributor in the decline of snow crab stock.

The collapse of snow crab in the BS is thought to be one of the largest losses of marine macrofauna that can be attributed to the marine global heatwave (2022 BSAI Crab SAFE). Due to the uncertain nature of the snow crab stock in recent years; there are several possibilities that may influence the effectiveness of rebuilding the snow crab stock as detailed below:

- Highly specific thermal optimums and habitat requirements of EBS snow crab may alter physiological demands as a response to warmer than average bottom temperatures.
- Warmer temperatures may alter prey-predator relationships and predator distribution, resulting in a shift in predator-prey interactions, and food web dynamics.
- Constraints on recruitment will likely persist for an extended period of time despite the implementation of a rebuilding plan.

Alternative 1: No action, would not follow the federal mandates required per MSA, and would allow the fishery to operate at status quo. Whereby, an annual stock assessment is presented through the Council process, the council sets the specifications and delegates to the state to set the TAC per the state harvest strategy (section 2.2).

Alternative 2: Establish a rebuilding plan would implement a rebuilding plan under the parameters T_{min}=6 and T_{max}=10. The Council has yet to select a target time for rebuilding (T_{target}), but it will likely fall between 6 and 10 years.

Alternative 2/option 1 would designate no directed EBS snow crab fishery, with bycatch removals only, and implications to the stock will be similar to those seen as a result of the 2022/2023 fishery closure. The 2022/23 fishing season closure is the first closure in the history of the fishery; therefore, it is hard to determine at this time what the effects of no fishery would be on the EBS snow crab stock. However, given the current biomass and abundance estimates, it is likely that with no directed fishery and bycatch removals only there would be an increased opportunity for the stock to continue an upward tick in recruitment. However, there existed no difference in median rebuilding time under the bycatch-only fishing mortality scenario when compared to the state harvest strategy scenario.

Alternative 2/option 2 would allow for directed harvest if an opening is triggered by threshold survey catches under the State harvest strategy. The EBS snow crab stock is likely to have similar rebuilding trajectories under Alternative 1 and Alternative 2/Option 2, due to the nature of the current FMP delegation of TAC setting to the state of Alaska. Because a rebuilding plan would be in place, constraints on fishing mortality could be made more conservative by further restricting fishery operations if necessary to ensure adequate progress. For the EBS snow crab fishery to open under option 2, the model estimatemust indicate that ESB snow crab is at least 25% of the B_{MSY}.

Uncertainty in stock growth persists under all fishing mortality scenarios (Figure 2-2) and are likely related to delays in the onset of increases in recruitment. The mature male biomass (MMB) remains low in all fishing mortality projection scenarios for approximately the first 4 years, Figure 2-2 and Table 4 illustrate the average projected response of MMB under both Alt 2, Options 1 and 2, with the associated variability for each estimated MMB trend.

Given the variability in biomass in the last few years, the estimates in any given projection year indicates that future stock productivity is highly uncertain. The area where the 95% credible intervals overlap for all fishing mortality options illustrates the high variability associated with the biomass projections. The effects of stock productivity, a function of future ecosystem conditions, may overwhelm the effect of harvest under the Alternative 2 options. Nevertheless, this only serves to illustrate the uncertainty in future conditions. Under any productivity scenario, the median values suggest that rebuilding would be the same under Alternative 2/ option 1 and Alternative 2/option 2 (6 years).

Conclusions

If the speed of rebuilding is the primary metric for benefits to the EBS snow crab stock, Alternative 2 / Option 1 and Option 2 provide no difference in rebuilding timeframe metrics. The main driver in speed of rebuilding is likely related to recruitment and the conditions that allow for increased recruitment into the population. Ecosystem conditions (section 3.2.3) may improve, and improvements would result in reduced natural mortality and increased production and are addressed during rebuilding through continued monitoring of ecosystem indicators. The allowance, in the projections, for recruitment to eventually increase and contribute to stock growth assumes that existing ecosystem conditions or other constraints on production will not continue indefinitely. Alternatively, if current ecosystem conditions prevail, and recruitment remains at low levels, the population may take substantially longer to show rebuilding progress and may never reach the designated B_{MSY} level.

3.3 Impacts of snow crab bycatch in other fisheries on rebuilding

Under the proposed alternatives, all of the existing measures that minimize fishery impacts on EBS snow crab would be expected to be maintained throughout the rebuilding period. The rebuilding projections presented in 2.2 provide evidence that median rebuilding time does not greatly differ under the various fishing mortality scenarios. Below the analysts detail non-target fishery interactions with EBS snow crab.

3.3.1 Bycatch of EBS Snow Crab in other fisheries

Bycatch of snow crab occurs in the BBRKC and EBS Tanner crab fishery, and in the groundfish fisheries. Bycatch in fisheries other than the groundfish has historically been relatively low (Table 10). Bycatch mortality estimates in Table 10 are derived from at-sea observer data and assume a 30% handling mortality rate.

Table 10 Bycatch of snow crab in the Tanner and BBRKC fisheries from 2005/06 season to the 2021/22 season

Year	Tanner fishery (kilotons)		BBRKC (kilotons)	
	Bycatch	Bycatch mortality	Bycatch	Bycatch mortality
2005/06	49	15	9	3
2006/07	15	5	6	2
2007/08	76	23	12	4
2008/09	10	3	7	2
2009/10	0	0	11	3
2010/11	0	0	5	1
2011/12	0	0	4	1
2012/13	0	0	8	2
2013/14	275	82	1	0
2014/15	1,785	535	1	0
2015/16	3,214	964	1	0
2016/17	0	0	3	1
2017/18	201	60	6	2
2018/19	697	209	2	1
2019/20	0	0	1	0
2020/21	484	145	3	1
2021/22	230	69	0	0

Source: Ben Daly, ADF&G, Oct 25, 2022.
BBRKC = Bristol Bay Red King Crab

In the groundfish fisheries, crab bycatch management measures exist for the protection of BBRKC, EBS Tanner crab, and EBS snow crab stocks in the BSAI and include triggered area closures for BSAI groundfish trawl fisheries. Retention of crab bycatch is prohibited, so crab bycatch is also referred to as Prohibited Species Catch (PSC). For BBRKC, EBS snow crab, and EBS Tanner crab, triggered crab PSC limits exist for non-pelagic trawl fishing within specified areas. Non-pelagic trawl PSC accrues within these areas and these areas are closed to non-pelagic trawl directed fishing for groundfish in the fishery/sector that reaches its specified PSC limit. An area closure for EBS snow crab is triggered if the groundfish trawl fisheries by target/sector reach their allocated PSC limit for the COBLZ (Figure 3-10). PSC limits are based on a calendar year and not a crab year (July 1 – June 30). The limit accrues only for EBS snow crab PSC taken within the COBLZ. No measures limiting PSC are currently in place for any pelagic trawl and fixed gear fisheries, nor are there overall limits placed on bycatch of snow crab species outside of COBLZ.

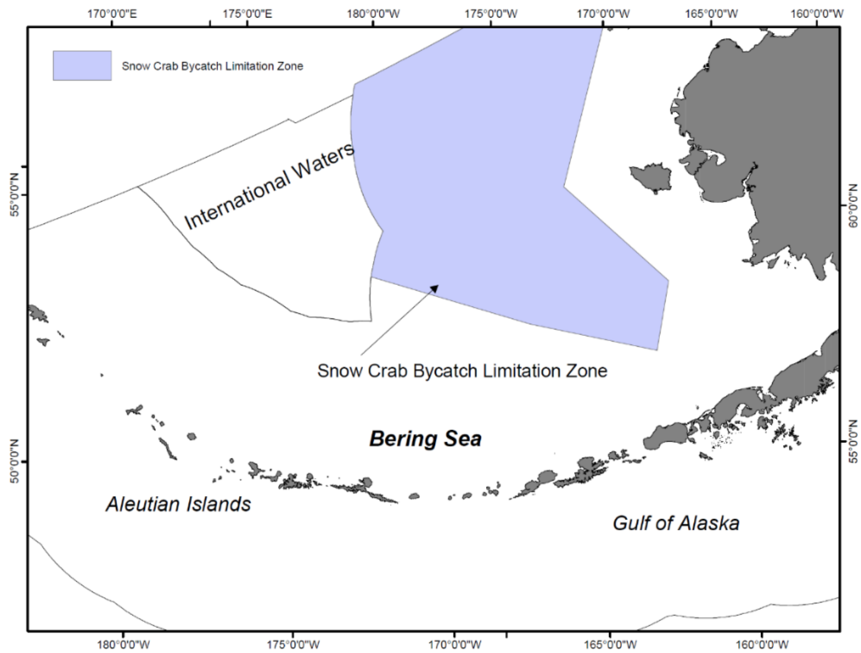


Figure 3-10 Map of COBLZ labeled as snow crab bycatch limitation zone in figure

The crab PSC limits are set each year in December during the groundfish harvest specifications process and apportioned across groundfish sectors. To determine PSC limits, crab stock assessment authors provide NMFS Inseason Management and/or Council staff with the abundance or biomass values necessary to compare to PSC thresholds established in Federal regulations.

EBS snow crab PSC limits are based on total abundance of snow crab as indicated by the model estimate of survey abundance. The limit in COBLZ is set annually at 0.1133% of the snow crab modeled abundance estimate from the NMFS standard summer trawl survey minus 150,000 crab, unless a minimum or maximum abundance threshold is reached.

- If 0.1133% multiplied by the total abundance is less than 4.5 million, then the minimum PSC limit will be 4.350 million animals.
- If 0.1133% multiplied by the total abundance is greater than 13 million, then the maximum PSC limit will be 12.850 million animals.[1]

Snow crab bycatch that occurs outside COBLZ does not accrue towards the COBLZ limit.

The total abundance or biomass values are calculated differently for each stock. Table 11 provides the estimates of abundance for snow crab and the historical snow crab COBLZ PSC limits from 2006 through 2023. Historically, these values were derived from area-swept estimates of the NMFS bottom trawl survey. Presently, they are derived from model-based survey estimates, whether population totals or survey abundance.

Prior to implementation of Amendment 40, snow crab PSC limits did not exist for BSAI groundfish trawl fisheries. The Final Rule for Amendment 40 (62 FR 66829) explains that bottom trawl survey data from 1996 was indicating an increasing abundance of adult males, but females and pre-recruits (males that have not reached legal commercial size) were becoming less abundant. This trend was troubling

[1] 50 CFR 679.21(e)(1)(iii)

because it could indicate declining abundance over a longer term. The Council relied on an industry work group to review proposed PSC limits for snow crab. The group met November 6–7, 1996, and came to a consensus on a PSC limit for snow crab. The group negotiated the PSC limit control rule based on the range included in Amendment 37 (0.005% to .25% of the total snow crab population) and past PSC use at different abundance levels.

Based on industry recommendations and Council and Secretary approval, Amendment 40 established a snow crab PSC limit as a rate that fluctuated with snow crab abundance and was applied within the newly defined area of the COBLZ. The PSC limit was established as 0.1133% of the total abundance under Amendment 40. However, the rule also included a lower bound (4.5 million animals) and an upper bound (13 million animals). Upon attainment of the snow crab bycatch limit as apportioned to a particular trawl fishery category, the COBLZ would be closed to directed fishing for species in that trawl fishing category, except for pollock with pelagic trawl gear. Snow crab PSC limits were later adjusted under Amendment 57, and are the numbers that exist in current regulations. The amendment package reduced snow crab PSC limits in COBLZ by 150,000 animals.

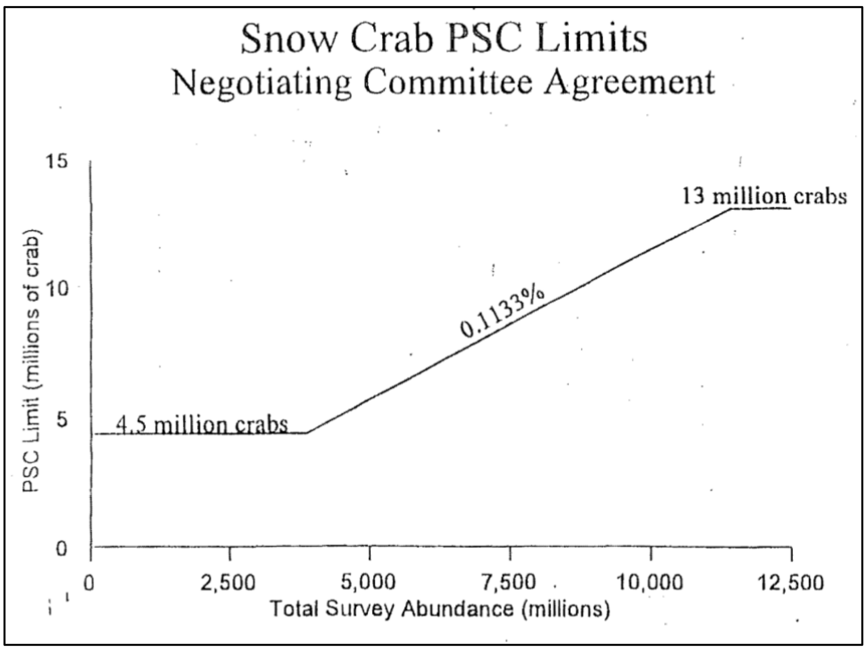


Figure 3-11 PSC limits for EBS snow crab within the COBLZ, as implemented under Amendment 40 (later amended to the current limits as described in this section)

The Council requested, in their June 2022 motion, that analysts include additional information surrounding the removal of the PSC floor. To address this request, analysts provide Table 11 detailing PSC limit with and a hypothetical scenario for PSC calculations without the PSC limit floor, PSC (number of snow crab), and percent of PSC limit inside and outside the COBLZ in the BSAI non-pelagic trawl fisheries from 2006 through 2023. The table also provides PSC for pelagic trawl, pot and hook-and-line gear inside and outside the COBLZ. PSC for pot and hook-and-line inside the COBLZ is not available prior to 2010. Table 12 provides PSC by gear in metric tons.

The EBS snow crab abundance estimate has been historically low enough to result in a PSC limit floor (4,350,000 crab) six times since 2006 for non-pelagic trawl gear (Table 11). The current regulations surrounding PSC limits have been traditionally non-constricting for non-pelagic trawl gear. Analyst detail a hypothetical scenario in which the PSC floor is removed in Table 11. For 2007-2010,2022, and 2023 the abundance estimates were low enough that if the PSC floor was removed, it would result in a PSC limit lower than 4,350,000 million animals. Thus, in recent years of low snow crab abundance, removing the PSC limit floor would still be non-constraining for non-pelagic trawl gear.

For snow crab, non-pelagic trawl PSC occurs primarily in the southeast portion of the COBLZ and extends northwest throughout the zone and to the north, east, and south of the zone (Figure 3-12). For pelagic trawl gear, snow crab PSC follows a similar spatial pattern but to a much smaller magnitude and does not spread as far around the southeast border of the COBLZ. PSC in pot gear is distributed throughout the southern two-thirds of the COBLZ and beyond the southeast border of the COBLZ along the Aleutian peninsula. Snow crab PSC in hook and line (HAL) gear seems to have the largest spatial distribution, which is likely due to the spatial distribution of effort in the HAL fisheries in these areas.

Table 11 Snow crab PSC limit with the PSC floor, a hypothetical scenario detailing PSC limits without the PSC floor, and PSC for BSAI non-pelagic trawl, and PSC for pelagic trawl, pot, and hook and line fisheries from 2006 through 2022 (# of crabs)

Year	Snow crab abundance estimate[1] (billions of animals)	Snow crab PSC limit	Snow crab PSC limit without floor	Nonpelagic trawl PSC (# of crabs)					Pelagic trawl PSC (# of crabs)*			Pot PSC (# of crabs)*			H&L PSC (# of crabs)*			Groundfish total (# of crabs)
				PSC inside COBLZ	PSC inside COBLZ as a % of PSC limit	PSC outside COBLZ	Total PSC (from both COBLZ and outside COBLZ)	Total PSC as a % of PSC limit without a floor	PSC inside COBLZ	Outside COBLZ	Total PSC	PSC inside COBLZ	Outside COBLZ	Total PSC	PSC inside COBLZ	Outside COBLZ	Total PSC	
2006	5.22	5,761,674	5,761,674	947,380	22%	63,343	1,010,723	29%	480	2,423	2,903	N/A	N/A	333,050	N/A	N/A	49,597	1,396,273
2007	**3.25**	**4,350,000**	**3,532,250**	1,821,672	42%	78,201	1,899,874	52%	357	2,580	2,936	N/A	N/A	1,536,818	N/A	N/A	48,545	3,488,173
2008	**3.33**	**4,350,000**	**3,622,890**	677,361	16%	112,455	789,816	28%	1,482	3,483	4,965	N/A	N/A	695,159	N/A	N/A	83,162	1,573,101
2009	**2.60**	**4,350,000**	**2,795,800**	436,051	10%	87,256	523,307	16%	162	3,048	3,209	N/A	N/A	605,631	N/A	N/A	54,638	1,186,785
2010	**3.06**	**4,350,000**	**3,316,980**	1,677,389	20%	25,164	1,702,552	20%	5,227	383	5,610	62,247	460,357	522,605	22,432	13,765	36,197	2,266,964
2011	7.47	8,310,480	8,310,480	741,568	11%	20,670	762,238	11%	4,444	670	5,113	16,647	85,029	101,676	27,602	20,764	48,366	917,394
2012	6.34	7,029,520	7,029,520	600,223	6%	22,767	622,990	6%	2,721	501	3,222	1	16,536	16,536	21,163	25,951	47,114	689,862
2013	9.40	10,501,333	10,501,333	673,966	6%	15,285	689,251	6%	3,670	395	4,065	0	14,784	14,784	17,660	11,552	29,212	737,312
2014	10.01	11,185,892	11,185,892	466,885	4%	14,280	481,165	4%	2,823	508	3,331	2,159	82,808	84,967	24,536	14,591	39,127	608,590
2015	9.85	11,011,976	11,011,976	484,297	10%	4,367	488,664	10%	2,906	55	2,961	20,390	101,171	121,561	19,956	7,347	27,303	640,489
2016	4.29	4,708,314	4,708,314	163,878	2%	2,211	166,090	2%	765	119	884	6,039	13,998	20,037	27,356	14,215	41,570	228,581
2017	8.17	9,105,477	9,105,477	153,101	2%	6,243	159,343	2%	253	81	334	2,567	142,891	145,457	18,658	18,501	37,158	342,293
2018	8.18	9,120,539	9,120,539	1,577,907	13%	4,242	1,582,149	13%	247	30	277	399	52,136	52,535	9,090	15,886	24,976	1,659,938
2019	10.65	11,916,450	11,916,450	936,578	11%	4,650	941,228	11%	48	21	69	19,726	52,447	72,174	11,231	14,699	25,930	1,039,401
2020	7.71	8,580,898	8,580,898	756,559	11%	22,296	778,855	11%	1,672	42	1,714	24,037	118,021	142,059	9,490	12,181	21,671	944,298
2021	6.48	7,191,840	7,191,840	234,590	5%	12,105	246,695	17%	451	71	522	15,903	51,549	67,452	10,948	10,238	21,186	335,855
2022	**1.42**	**4,350,000**	**1,458,860**	172,299	4%	3,036	175,336	6%	29	13	42	23,484	21,820	45,304	12,285	10,152	22,437	243,118
2023**	**2.58**	**4,350,000**	**2,777,672**															

Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN file name Crab_PSC_AREA(10-12-22)

Bold text indicates the PSC limit was set to its lowest limit

[1]Abundance estimate is based survey results from the previous year.

* Denotes sectors that do not have a PSC limit

**Denotes estimated PSC limit and PSC is not yet available for the 2023 groundfish fisheries.

N/A - PSC for pot and hook-and-line gears prior to 2010 was not broken out by inside/outside COBLZ.

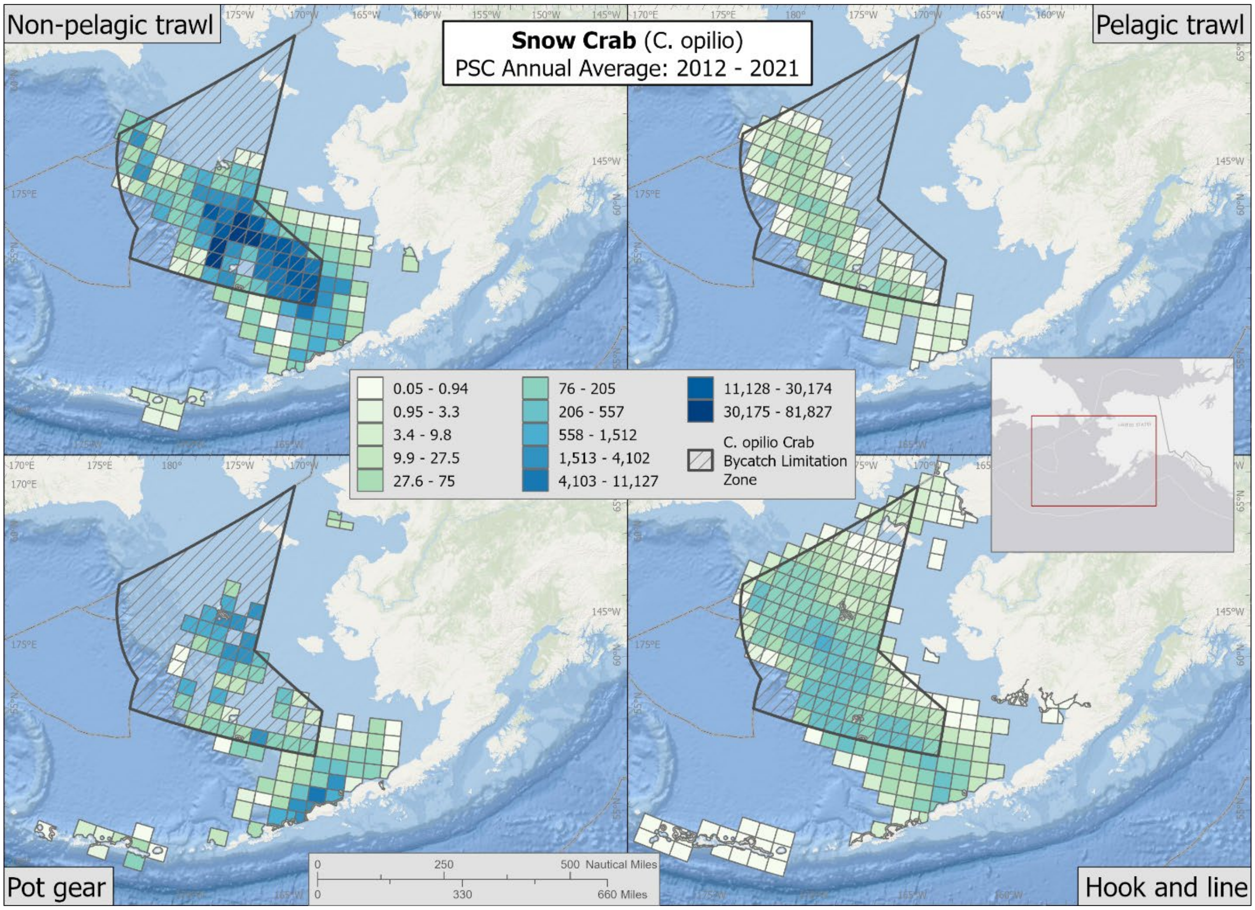
Table 12 Estimated PSC for non-pelagic trawl, pelagic trawl, pot, and hook and line fisheries from 2006 through 2022 (mt). The PSC limit only applies to non-pelagic trawl gear. All other gear types do not have a PSC limit in place.

Year	Nonpelagic trawl PSC (mt)			Pelagic trawl PSC (mt)*			Pot PSC (mt)*			H&L PSC (mt)*			Groundfish total (mt)
	PSC inside COBLZ	PSC outside COBLZ	Total PSC	PSC inside COBLZ	PSC outside COBLZ	Total PSC	PSC inside COBLZ	PSC outside COBLZ	Total PSC	PSC inside COBLZ	PSC outside COBLZ	Total PSC	
2006	351.33	23.52	374.85	0.19	0.95	1.13	N/A	N/A	127.38	N/A	N/A	19.00	522.36
2007	639.78	27.10	666.87	0.10	0.73	0.83	N/A	N/A	545.83	N/A	N/A	15.81	1,229.35
2008	187.37	30.48	217.85	0.43	0.99	1.42	N/A	N/A	190.75	N/A	N/A	23.30	433.31
2009	119.23	23.88	143.11	0.04	0.78	0.82	N/A	N/A	152.69	N/A	N/A	14.18	310.80
2010	310.38	4.66	315.03	1.38	0.10	1.49	26.58	196.58	223.16	12.28	7.53	19.81	559.49
2011	161.03	4.49	165.51	1.55	0.23	1.79	10.22	52.22	62.45	16.22	12.20	28.42	258.16
2012	133.56	5.07	138.62	0.84	0.15	0.99	0.00	10.59	10.59	13.08	16.04	29.11	179.32
2013	171.95	3.90	175.85	0.47	0.05	0.52	0.00	8.60	8.60	9.67	6.33	16.00	200.96
2014	102.00	3.12	105.12	0.60	0.11	0.71	1.23	47.04	48.26	11.20	6.66	17.86	171.94
2015	77.10	0.70	77.79	0.42	0.01	0.43	10.78	53.49	64.27	8.82	3.25	12.07	154.57
2016	28.58	0.39	28.96	0.15	0.02	0.17	2.56	5.94	8.50	11.91	6.19	18.09	55.73
2017	27.45	1.12	28.57	0.05	0.02	0.06	0.76	42.16	42.92	7.76	7.69	15.45	87.00
2018	343.48	0.92	344.40	0.05	0.01	0.05	0.16	20.67	20.83	3.47	6.07	9.54	374.82
2019	173.34	0.86	174.20	0.00	0.00	0.01	3.04	8.09	11.13	4.07	5.33	9.40	194.75
2020	135.19	3.98	139.18	0.24	0.01	0.25	6.12	30.04	36.16	3.37	4.33	7.70	183.29
2021	49.92	2.58	52.50	0.07	0.01	0.08	5.56	18.02	23.58	4.23	3.96	8.19	84.34
2022	43.88	0.77	44.65	0.01	0.00	0.01	9.48	8.81	18.29	5.12	4.23	9.36	72.30

Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN file name Crab_PSC_AREA(10-12-22)

* Denotes sectors that do not have a PSC limit

N/A - PSC for pot and hook-and-line gears prior to 2010 w as broken out by inside/outside COBLZ.

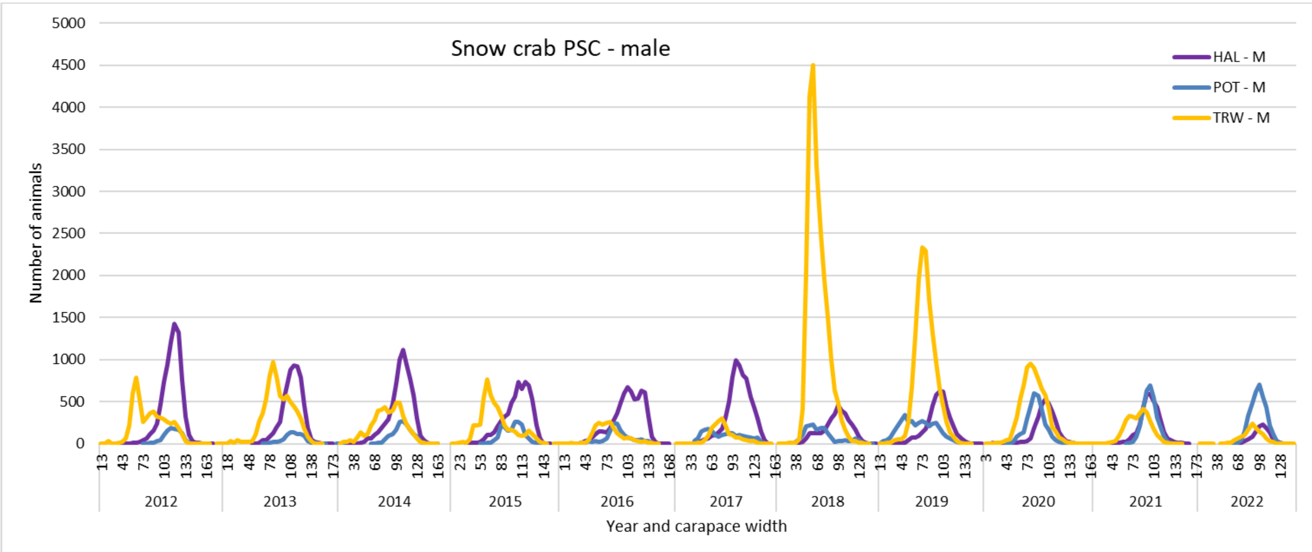


Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_PSC Maps produced by PSFMC.

Figure 3-12 EBS snow crab PSC (average annual #crab) by gear type, 2012-2021

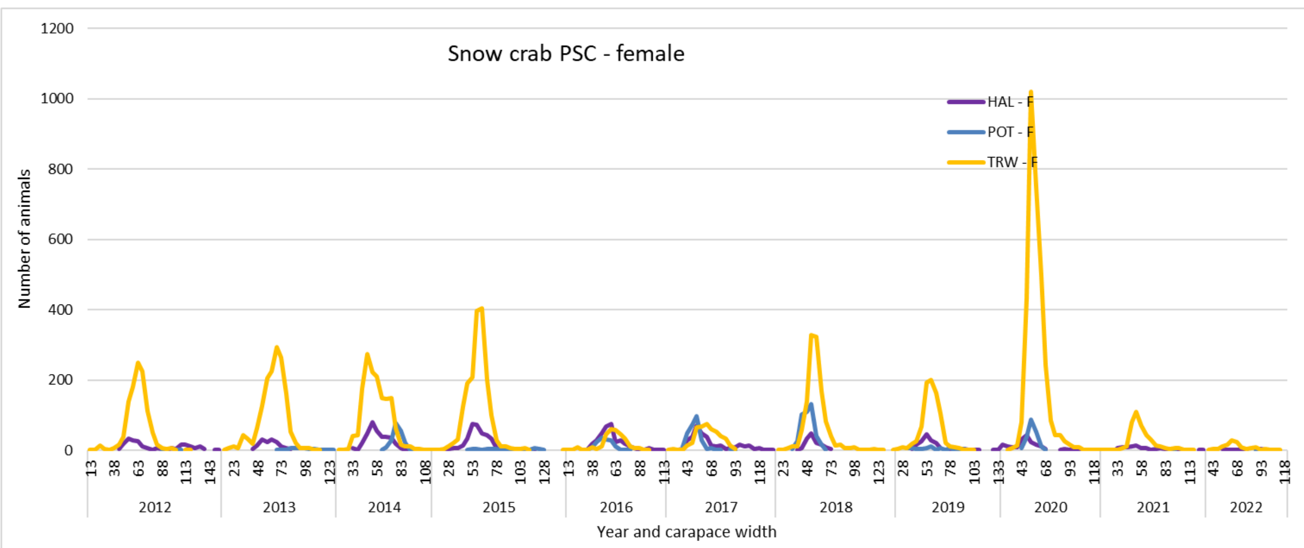
Figure 3-13 and Figure 3-14 provide data on size and sex composition of observed EBS snow crab PSC in the groundfish fisheries by gear from 2012 through 2022. Information in the figures shows that snow crab PSC in non-pelagic and pelagic trawl gear combined has been mostly males (Figure 3-13). Most of these male crabs have been between 50-99mm carapace width, though during the earlier part of this time series, male crab 75-124mm seemed to make up a larger proportion of the PSC. Male snow crab over 100mm make up a smaller proportion of the observed PSC over time. The majority of observed females in the snow crab PSC catch are between 50-74mm.

Table 13 demonstrate that non-pelagic trawl fisheries accounted for the greatest levels of snow crab in groundfish fisheries from 2012 through 2022. Bycatch of EBS snow crab in the groundfish fisheries has been highest in the yellowfin sole fishery, followed by the flathead sole fishery.



Source: Observer data, data compiled by AKFIN. Source file is Crab_PSC_Lengths(10-28-22)

Figure 3-13 Number of male snow crab PSC by gear, 2012-2022



Source: Observer data, data compiled by AKFIN. Source file is Crab_PSC_Lengths(10-28-22)

Figure 3-14 Number of female snow crab PSC by gear, 2012-2022

Table 13 Snow crab PSC in COBLZ by gear type and target species from 2012 through 2022 (# of crab)

Gear type	Target Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
HAL	Halibut	-	-	-	-	10	19	92	24	62	22	0
NPT	Alaska Plaice - BSAI	2,098	7,258	-	21,117	2,519	140	5,279	1,925	1,964	13,266	2
	Arrowtooth Flounder	2,518	8,892	6,440	3,786	2,761	33,442	465	6,205	30,646	1,557	27
	Flathead Sole	17,166	67,239	79,887	20,802	10,537	30,510	279,286	217,865	197,199	53,071	10,858
	Greenland Turbot - BSAI	-	-	-	-	117	2,002	78	38	3,008	162	0
	Kamchatka Flounder - BSAI	-	-	-	-		0	457	1,188	190	0	0
	Pacific Cod	415	6,170	6,657	4,464	1,869	900	6	45,175	1,567	115	82
	Pollock - bottom	C	1,888	15,301	5,296	190	3,058	4,866	6,006	38,288	3,944	1,539
	Rock Sole - BSAI	-	1,807	8,024	6,058	27,468	19,118	2,454	10,421	18,191	7,830	6,410
	Rockfish	-	C	-	-	17	0	14,408	652	92	487	0
	Yellowfin Sole - BSAI	559,559	550,261	329,488	420,528	115,127	61,049	1,268,997	644,006	460,446	151,531	101,047
Pot	Pacific Cod	1	-	-	-	-	1,396	25	-	47	1	-
	Sable	-	-	-	-	-	-	-	-	28	0	-
PTR	Pollock - bottom	67	135	-	C	51	C	-	-	-	-	-
	Pollock - midwater	2,453	3,380	2,811	2,887	682	202	247	48	1,647	449	0

Source: NMFS Alaska Region Catch Accounting System, data compiled by AKFIN in Comprehensive_PSC [Crab_PSC_AREA(11-13-20)]

C indicates confidential data, HAL = hook and line, NPT = non-pelegic trawl, pot = pot gear, PTR = pelagic trawl

3.3.1.1 Unobserved Mortality

Fishing activities lead to crab mortality in ways that are not directly observed. This includes both post-release mortality of discarded crab (which is estimated through a discard mortality rate) and crab that are never captured by fishing gear but die due to gear interactions or sustained damages that cause mortality. The potential for unobserved mortality of crabs that encounter bottom trawls but are not captured has long been a concern for the management of groundfish fisheries in the BS (Witherell and Pautzke, 1997; Witherell and Woodby, 2005). Unobserved mortality is not accounted for in crab stock assessments and is not accrued towards trawl PSC limits.

Published studies on the impacts of trawl gear on crab have generally focused on non-pelagic gear, including studies in the BS and in the shrimp fishery off the east coast of Canada. Studies have utilized bottom and wing recapture nets to collect impacted crab that would not have ended up in the trawl net, cameras to visualize crab that were avoiding the trawl net, and even submersible camera-equipped vehicle dives to compare damage to crabs before and after trawling in an area. Rose (1999) cites an earlier study (Donaldson 1990) as a “preliminary estimate” of the rate of unobserved crab injuries, wherein RKC were tethered to the seafloor, a trawl net was towed over the area, and divers attempted to recover the crab. Of 169 crab, 21 percent were captured in the net, 46 percent were recovered by the divers, and 33 percent could not be located. While only two of the 78 recovered crabs were injured, Rose noted the ambiguity posed by the fate of the unrecovered crabs relative to the sample size. An unpublished video study (Rose 1995) found that sweep diameter was the main factor in whether crab could escape over the sweep (note that sweeps were not elevated during this period). The study was not able to determine the frequency, nature, or severity of injuries to crabs that went under the sweep. The Rose (1999) study in Bristol Bay used a recapture net to assess injury rates to crab that pass under different types of footrope. Eight experimental tows yielded injury rates of between 5 percent and 10 percent of the recaptured crab.

Subsequent work by Rose et al. (2013) provided estimates of the unobserved mortality rates of crabs swept over by trawl gear common to bottom trawl fisheries in the BS. This study again recaptured crab after encountering trawl sweeps and footropes, but also used a reflex-assessment method[2], calibrated on mortalities of crabs held onboard the vessel, to predict the delayed mortality of recaptured crab impacted by, but not captured in, the trawl. This study also evaluated crab caught in a control net where they did not encounter the trawl gear to adjust observed mortality rates for the effects of capture and handling. This research demonstrated that mortality rates were higher for RKC than either snow or tanner crab and depended substantially on which part of the trawl system crabs encountered. Additionally, reduction of crab mortality rates by altering specific gear designs showed that gear modifications can mitigate unobserved mortality (Hammond et al. 2013). Raised sweeps essentially eliminated the 5% snow crab mortality rates measured using on-bottom sweeps, while not reducing flatfish herding (Rose et al 2010). This partly justified regulations requiring raised sweeps for flatfish fisheries (Amendment 94). Footrope modifications also reduced mortality rates for crabs encountering footropes. Relative to an older-style footrope, one with less weight and more clearance underneath reduced snow crab mortality rate from 10 to 5%. One supposition was that effective herding by sweeps can reduce overall crab mortality because it reduces the amount of footrope-swept area needed to catch the same number of flatfish.

Further follow-up research (Rose et al. 2014) used the same methods to estimate unobserved mortality rates, but also used recapture nets covering the full area behind the footrope, allowing assessment of the proportion of crabs captured to those passing under the net. It also included footrope designs better matching current fishery practice. While the final report graphically provided mortality rates and proportion-captured for snow and Tanner crabs, it did not combine these values to estimate a multiplier to estimate unobserved crab mortalities from observed crab bycatch. The primary author calculated such multipliers for snow crab from the original data and has provided them and a description of the

[2] Reflex Action Mortality Predictor (RAMP); see Davis and Ottmar (2006) and Stoner et al. (2008).

calculations as a comment to the October 2022 SSC meeting (Rose 2022). Multipliers for different footropes ranged from 0.5 to 3.9 unobserved snow crab mortalities per observed crab in the catch and multipliers were higher for males than for females.

The remote-video study of shrimp trawl interactions with snow crab off Saint Mary's Bay in southeastern Canada only assessed areas swept by the trawl footrope (Dawe et al. 2007). The study did not collect a large sample of direct post-trawl observations but did not report any dead crab in the trawl corridor or crab with carapace damage.The study did not find a reduced density of snow crab in the trawled bays after trawling occurred. However, the study concluded that intensive trawling could increase crab leg-loss by about 10 percent.

A trawl-mounted video study in the same part of Canada looked at how snow crab physically reacted to shrimp bottom trawls (Nguyen et al. 2014). This study was also limited to the footrope portion of the trawl and concluded that about 54 percent of observable crab interacted with the footgear (e.g., elevating discs, spacers, or chains). The majority of video-observed crabs actively responded to the approaching trawl and tried to escape. The study was unable to estimate the severity or likelihood of mortality after passing under footgear. This study, and references to herding in Rose et al. (2013), highlights the relevance of crab shell condition to susceptibility to unobserved trawl mortality. In a time/area where crab are likely to be in a soft-shell condition and less mobile, unobserved mortality rates could be higher than the ranges estimated in the studies available.

The topic of unobserved mortality was addressed in a Council analysis when crab PSC limits for trawl fisheries were reviewed in February 2021 prior to taking no action (see section 3.4.6 and Appendix 4 in NPFMC 2021a). The SSC's February 2021 report noted that including any future estimation of unobserved crab mortality (from both groundfish and directed crab fishing) in a stock assessment would require extensive evaluation to understand how the assessment's parameters for factors like catchability, natural mortality and reference points would be affected. The SSC noted that "unobserved mortality is a source of both assessed and unassessed uncertainty throughout the history of the assessments (e.g., currently attributed to natural mortality), and that the ABC/TAC buffers in place are an appropriate process to account for sources of uncertainty that cannot be explicitly described in the assessment." Finally, the at the October 2022 meeting, the SSC recommended a working group to develop a framework for how to estimate the magnitude of unobserved mortality for crab stocks and how these estimations may be utilized in BSAI crab stock assessments.

3.3.2 Effects of the alternatives on Non-Target Species

Under Alternative2/Option 1 or Alternative/Option 2, all of the existing measures that minimize fishery impacts on EBS snow crab would be expected to be maintained throughout rebuilding period. These measures include an established EBS snow crab PSC limit for non-pelagic trawl gear within COBLZ. No alternative proposes new management measures to reduce PSC of EBS snow crab in the groundfish fisheries.

The impacts of EBS snow crab bycatch were thoroughly evaluated as a potential factor in stock recovery and analyses of rebuilding times factoring in bycatch by groundfish fisheries at both average and 5x and 100x observed bycatch levels. Bycatch mortality was specified in the projection model as the average of the estimated bycatch fishing mortality over the last ten years. The State of Alaska's harvest control rule was approximated by averaging the ratio of the total allowable catch (TAC) set by the State and the ABC over the last 10 years (Daly, personal communication). The ratio (equal to 0.40) was used to scale the ABC calculated in the projections. In these projections, the time for stock recovery with average bycatch and with no bycatch are not differentiable (no effect). The reason for no discernible difference in the rebuilding time with or without bycatch is that EBS snow crab mortality due to bycatch is very small relative to total abundance of EBS snow crab and the effects of stock productivity, a function of future ecosystem conditions, overwhelms the effect of bycatch under the Alternative 2 options.

To better assess the impacts to non-target species, the Council requested, in their June 2022 motion, that analysts include additional information surrounding the removal of the PSC floor. To address this request, analysts detailed historical PSC limits with and without the PSC floor, PSC (number of snow crab), and percent of PSC limit inside the COBLZ and percent of PSC limit inside and outside the COBLZ in the BSAI non-pelagic trawl fisheries in Table 11. The table also provides the total PSC for pelagic trawl, pot, and hook-and-line fisheries inside and outside the COBLZ from 2006 through 2021 since these gear/fisheries are not limited by PSC. Overall, changing PSC management to remove the PSC limit floor and include PSC outside the COBLZ for the non-pelagic trawl gear, which has been non-constraining for the gear since 2006, would not have any measurable effect on the rebuilding time for EBS snow crab since the rebuilding projections with and without bycatch were indiscernible. This assessment also applies to changes in PSC management to include PSC limits for pelagic trawl, pot, and hook-in-line gears. The addition of PSC limits for pelagic trawl, pot, and hook-and-line gears would not change the rebuilding time for EBS snow crab since model projections indicate no discernible difference in the median rebuilding time with or without bycatch.

Additionally, sensitivities about the assumptions of unobserved mortality were explored in which the observed time series of bycatch was multiplied by 5 and 100 before the model was fit to the data. Model results of these assumptions using the selected recruitment and natural mortality parameters are provided in Figure 3-11 and Figure 3-12 and their associated projection specifications in Table 14 and Table 15. The general trends of the timing of rebuilding under a given productivity scenario and zero fishing mortality were similar to the results from modeling when no additional unobserved mortality was modeled. The lack of differences in the rebuilding time with and without unobserved mortality is again likely due to the effects of stock productivity overwhelming the effect of unobserved mortality.

As noted in the September 13, 2022, EBS snow crab SAFE, Appendix D by the stock author, there must be some unobserved mortality on snow crab in the BS by the groundfish fleets (see section 3.3.2). However, it is difficult to make a case for large impacts of non-directed fisheries on the recent population dynamics of snow crab. If the non-directed fisheries were a larger driver of population dynamics, it is hard to explain how the largest cohort ever observed would have occurred recently and developed through the size ranges that are impact by the non-directed fleets. Still, managers only have two levers for impacting the population dynamics of snow crab in the BS: adjusting fishing mortality in the directed fishery or adjusting fishing mortality in the non-directed fleets. The other apparent drivers of snow crab dynamics (e.g. sea ice) are outside of the control of managing bodies.

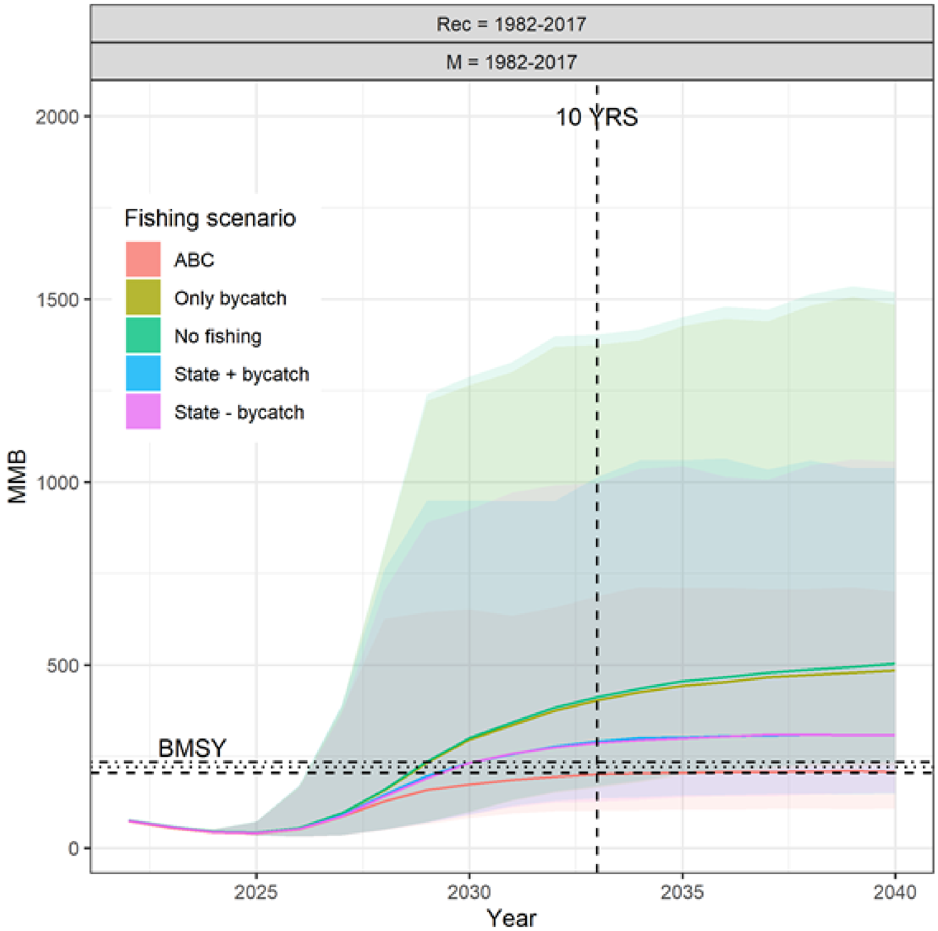


Figure 3-15 Projections of rebuilding trajectories under 1982-2017 productivity scenario (recruitment and mortality), fishing strategies, and target biomasses (three horizontal lines corresponding to 1982-2021, 1982-2017, and 2005-2019, in ascending order). Bycatch time series are 5x those used in the status quo assessment.

Table 14 Rebuilding time for the 1982-2017 productivity scenario. Median T_{min} is calculated relative to the status quo B_{MSY} proxy that uses average recruitment from 1982-2021. The '5%' and 95%' columns represent the 5th and 95th inter-simulation quantiles for the uncertainty around biomass trajectories during the projection period. Bycatch time series are 5x those used in the status quo assessment.

Projection specifications			T_{min}		
Fishing Scenario	**Recruitment**	**Mortality**	**Median**	**5%**	**95%**
No fishing	1982-2017	1982-2017	2029	2027	2035
bycatch	1982-2017	1982-2017	2029	2027	2036
State + bycatch	1982-2017	1982-2017	2030	2027	Inf
State - bycatch	1982-2017	1982-2017	2030	2027	Inf
ABC	1982-2017	1982-2017	2035	2027	Inf

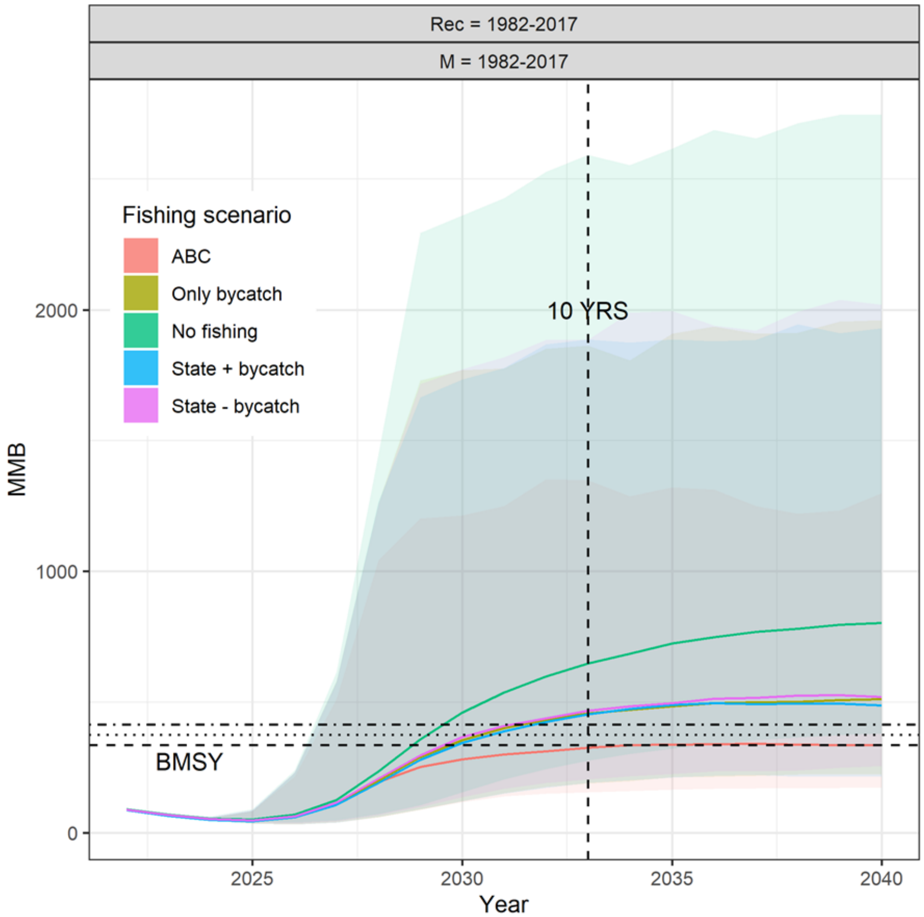


Figure 3-16 Projections of rebuilding trajectories under 1982-2017 productivity scenario (recruitment and mortality), fishing strategies, and target biomasses (three horizontal lines corresponding to 1982-2021, 1982-2017, and 2005-2019, in ascending order). Bycatch time series are 100x those used in the status quo assessment.

Table 15 Rebuilding time for the 1982-2017 productivity scenario. Median Tmin is calculated relative to the status quo B_{MSY} proxy that uses average recruitment from 1982-2021. The '5%' and 95%' columns represent the 5th and 95th inter-simulation quantiles for the uncertainty around biomass trajectories during the projection period. Bycatch time series are 100x those used in the status quo assessment.

Projection specifications			Tmin		
Fishing Scenario	**Recruitment**	**Mortality**	**Median**	**5%**	**95%**
No fishing	1982-2017	1982-2017	2029	2027	2036
bycatch	1982-2017	1982-2017	2030	2027	Inf
State + bycatch	1982-2017	1982-2017	2030	2027	Inf
State - bycatch	1982-2017	1982-2017	2030	2027	Inf
ABC	1982-2017	1982-2017	2035	2027	Inf

The NMFS trawl survey would continue throughout rebuilding, and the BSAI Crab Plan Team would continue to report stock status and progress towards the rebuilt level in the annual SAFE Report. Additionally, ADF&G and NMFS monitor catches and bycatch of EBS snow crab in other fisheries. ADF&G also requires observer coverage on catcher vessels and catcher processing vessels to monitor catch and landings. ADF&G reports harvest from the commercial fishery and those data are included annually in the SAFE.

State and federal observer programs monitor bycatch with State coverage of the crab fisheries and federal monitoring of the groundfish trawl, pot, and longline fisheries Estimates of crab bycatch from all fisheries will be reported annually in the SAFE. The BSAI Crab Plan Team will assess bycatch relative to the expectations and assumptions of the rebuilding plan. Additionally, if bycatch were to increase substantially, inseason actions could be taken to restrict harvest or area in the groundfish fisheries, if necessary, to reduce bycatch.

In conclusion, because fishing mortality is not the primary driver of the current snow crab population status, either option does not substantively change the projection of $T_{MIN,}$ and under both options it is assumed that the stock would rebuild within ten years. Bycatch rates in non-target fisheries showed no substantial effect on rebuilding time. In projections that apply average bycatch levels during rebuilding, the median time for stock recovery was not differentiable from the no fishing scenario. Additionally, the time for stock recovery was minimally affected in projections that used 5x and 100x level of observed bycatch as seen in the rebuilding projections. Therefore, analysts concluded that recovery of the EBS snow crab stock is likely to not be affected by current or predicted bycatch levels, based on average historical bycatch.

Additionally, Alternative2/Option 1 or Alternative/Option 2, would maintain all of the existing measures that minimize fishery impacts on EBS snow crab throughout the rebuilding period. No alternative proposes new management measures to reduce PSC of EBS snow crab in the groundfish fisheries. Therefore, bycatch in groundfish fisheries or other-directed crab fisheries are not expected to directly impact the success in rebuilding under any of the proposed alternatives.

3.4 Habitat

3.4.1 Prevailing Ecosystem Conditions

EBS Snow Crab rebuilding will occur within the context of prevailing ecosystem conditions, which are most recently characterized in the "Ecosystem and Socioeconomic Profile" (ESP) included in the 2022 BSAI Crab SAFE. The ESP uses data collected from a variety of sources to generate ecosystem and socioeconomic indicators that may help explain trends for a given stock.

Effects of climate change on EBS snow crab (section 3.2.3) was evident and likely contributed to the mass mortality event in snow crab. Increased warming and declines in sea ice are expected to decrease benthic juvenile snow crab prey resources supplied to the benthos through decreased benthic-pelagic flux (Copeman et al., 2021). Both settlement intensity and early benthic survival are likely critical determinants of year-class strength in snow crab (Sainte-Marie et al., 1996), and successful advection to areas of suitable temperature and muddy substrate are thought to be critical criteria for juvenile survival (Dionne et al., 2003)

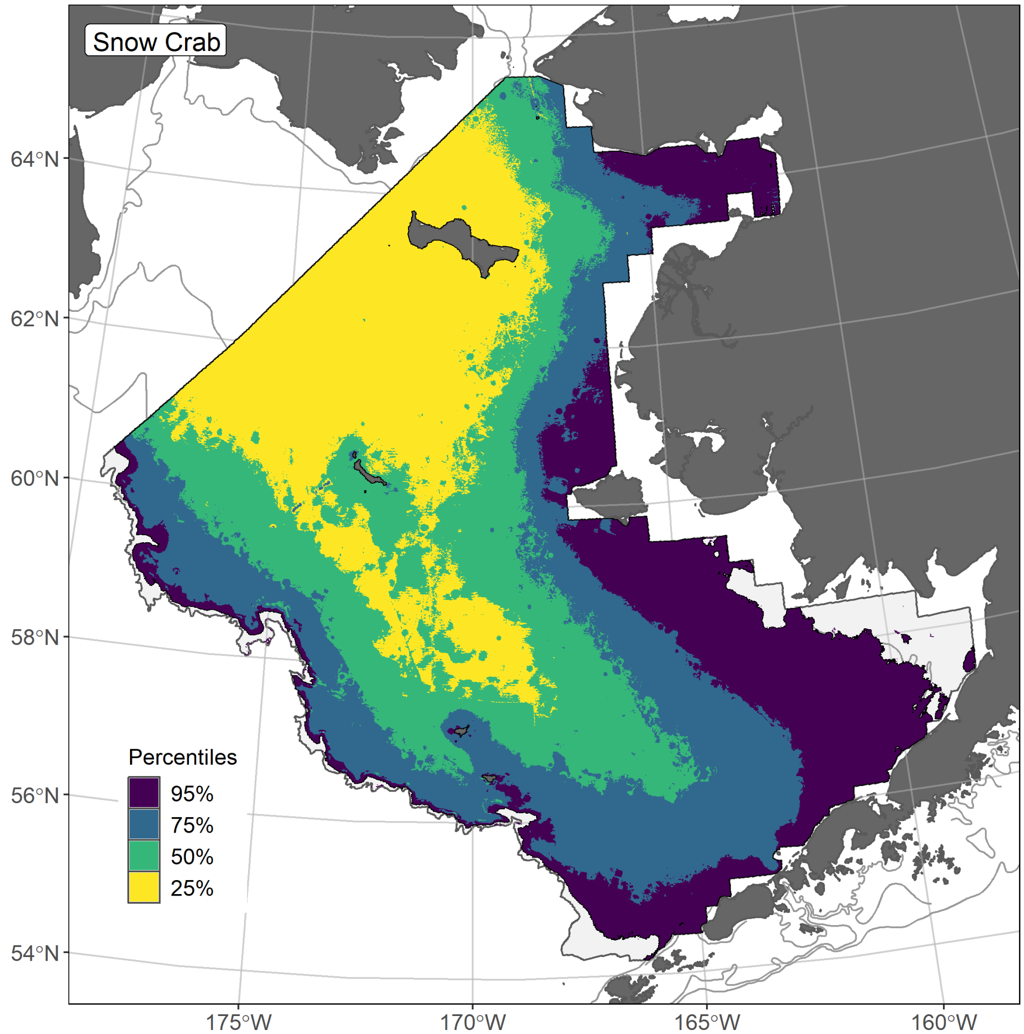
Physical indicators reveal much more favorable conditions for snow crab in 2022 following the 2018-2019 heat wave. Sub-0°C temperatures occupied by immature snow crab suggest that survival may be optimal for a new cohort of juveniles evident in the 2022 NOAA bottom trawl survey (Zacher et al., in review). Likewise, above-average chlorophyll-a biomass and benthic invertebrate density may be indicative of increased prey resources for larval and benthic stages of snow crab. Pacific cod consumption and bitter crab syndrome prevalence reached all-time highs in 2016 and may have been attributed to 2018-2019 mortality events, although both indices have returned to near-average in recent years. Northerly shifts in male snow crab centers of abundance in 2021-2022 have coincided with continued declines in mature male biomass, and may be a distributional response to recent warming in the BS.

Spatial patterns in juvenile and adult snow crab distribution are determined largely by ontogenetic migrations linked to size- and thermal requirements. Therefore, a better understanding of EBS snow crab physiological and biological response to the rapidly changing ecosystem conditions in the BS is necessary. Recent, dramatic population declines emphasize the importance of understanding proximate causes and mechanisms for mortality including predator-prey interactions, disease dynamics, shifts in benthic production, and responses to thermal stress.

3.4.2 Essential Fish Habitat

The Council and NMFS are currently evaluating updates to essential fish habitat (EFH) in the FMPs, including revisions to the model-based maps of EFH for BS, Aleutian Islands (AI), and Gulf of Alaska (GOA) groundfish and BSAI crab species, and updated output from the Fishing Effects (FE) model developed to assess the effects of fishing activities on EFH. The 2022 EFH preliminary results of the habitat mapping and fishing effects (FE) were presented to the Council in February and October 2022.

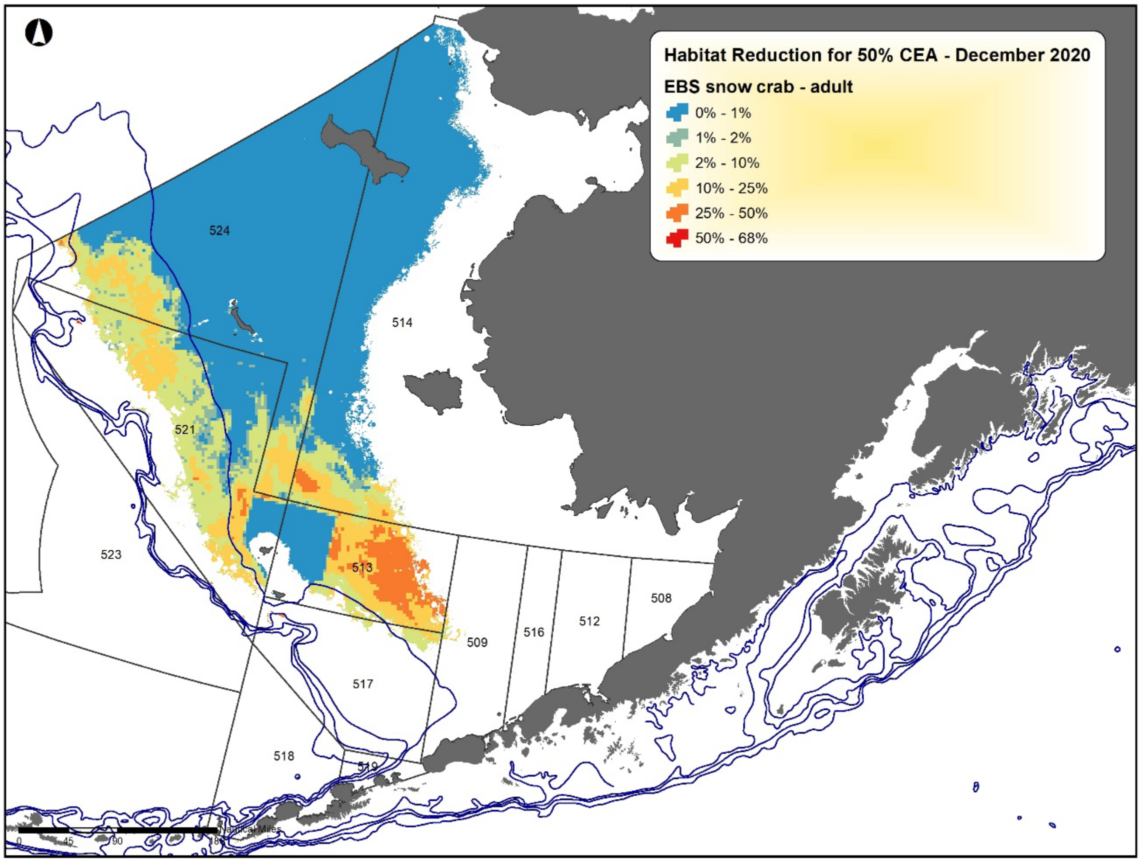
A level 2 habitat map for BS snow crab (**Figure 3-17**) whereby distribution data is available for the species as well as habitat-related densities or relative abundance of the species are available. The information provided is for all BS snow crab. **Figure 3-17** presented below exhibited the most up to date habitat map for EBS snow crab.



***Source:* [EFH Eastern Bering Sea FE species (NPFMC October 2022)]**

Figure 3-17 Habitat map for EBS snow crab. EFH is the area containing the top 95% of occupied habitat (defined as model estimated encounter probabilities greater than 5%) from a habitat-based ensemble fitted to EBS snow crab distribution and abundance in AFSC RACE-GAP summer bottom trawl surveys; within the EFH area map are the subareas of the top 25% (EFH hot spots), top 50% (core EFH area (CEA)), and top 75% (principal EFH area).

An additional component of EFH is assessing the FE on species. Assessing FE on habitat through the EFH process uses the FE model, developed by the Fisheries, Aquatic Sciences, & Technology (FAST) Lab at Alaska Pacific University (APU), and was recently published (Smeltz et. al, 2019). The FE model is a cumulative representation of the impact of all gears on benthic habitat, accounting for not only bottom contact but also the susceptibility of biological and geological habitats and recovery from fishery disturbance. The 2022 EFH 5 year review process is still underway; however, preliminary presentation of the FE results at the October 2022 SSC meeting indicated that snow crab in the EBS experienced 3.8% habitat disturbance (EFH FE Evaluation Discussion Paper) in 2020 **Figure 3-18**).



Source: [***EFH FE Evaluation Discussion Paper***]

Figure 3-18 Proportion of habitat disturbance, December 2020 - EBS Snow crab.

3.4.3 Fishing impacts to Snow crab habitat

The FE model acts as a unique tool outside of the EFH process. The primary output of the FE model is an estimate of cumulative habitat impacts. While these results are useful for assessing habitat impacts, they do not directly address the year-to-year pressure on seafloor habitat. However, an intermediate data product of the FE model workflow is the estimate of bottom contact explicit over time and space. The analysts collaborated with the APU FAST lab to detail the estimates of bottom contact areas by gear type in areas with high EBS snow crab distribution in the Bering sea (Figure 3-1), and historic areas that contain a high abundance of snow crab (2022 BSAI Crab SAFE). It is important to note that the estimated bottom contact area is not directly equivalent to EBS snow crab bycatch, mortality or impacts on the ability of EBS snow crab to reproduce and recruit into the fishery. It is the analysts' goal to present bottom contact area estimates to provide the historical fishing footprint and estimated bottom contact areas in areas with historically high snow crab abundance to estimate how fishing activity has historically influenced snow crab habitat.

The full results of the analysis are found in Appendix 1 and highlight bottom contact area by gear type. Analysts concluded that estimated bottom contact areas, and the historical fishing footprint has not drastically altered snow crab habitat in recent years. There are no proposed regulatory management measures under either of the alternatives; therefore, it is unlikely that fishing activity will vary from the historical average. In addition, the presence of fishing, and the current estimates of bottom contact are an unlikely cause of the EBS snow crab decline, which further emphasizes the lack of impact to snow crab habitat by fishing activity.

3.4.4 Effects of the alternatives on snow crab habitat

Given the current variability in climate, it is likely that snow crab habitat will undergo changes in the next decade (section 3.2.3). However, it is unlikely that under any of the proposed alternatives, there will be a negative effect on habitat as a direct result of implementing a rebuilding plan. Continuous monitoring of the environmental conditions detailed in the snow crab ESP, and summarized in section 3.4.1, should occur throughout the rebuilding plan. The snow crab ESP is brought forth on an annual basis and reviewed by the CPT. Monitoring ecosystem predictors for the duration of rebuilding may prove beneficial in monitoring snow crab habitat and using environmental indicators to aid in predicting stock status. Additionally, the EFH 5-year review process will act as a tool to monitor long-term effects on snow crab habitat in the BS. Additionally, The EFH review occurs on a 5-year basis, as defined in the FMP. The current EFH 5-year review cycle will likely be completed in 2023, thus the next 5-year review cycle would be up for review in 2028. The timing of the next 5-year review cycle will occur just before T_{min} (6 years) is predicted to be reached based off the rebuilding projections. The timing in the next iteration of the EFH 5-year review will provide a retrospective look on snow crab habitat and the EBS habitat fluctuated from 2023 to 2028.

In summary, there are likely no negative effects on habitat as a direct result of implementing a rebuilding plan under the proposed alternatives, and continued monitoring of habitat should occur throughout the duration of the rebuilding plan.

3.5 Marine Mammals

The bearded seal, *Erignathus barbatus*, is distributed among much of the BS, and is known to forage on invertebrates, specifically snow crab. Snow crab has been present in 54%-91% frequency of occurrence in biosampled stomachs (Lowry et.al, 1980, Antonelis et. al., 1994, Crawford et.al., 2015, Oxtoby et.al., 2017). Early stomach content analysis of bearded seal diet, indicated that crab consumed were smaller (mean carapace width of 57 mm) crab (Lowry et. al. 1980. The minimum legal size limit for snow crab is 78 mm, however, the snow crab market generally only accepts crab greater than 101 mm. It is likely that bearded seals are consuming snow crab prior to them reaching a maturity size class that is acceptable for commercial fishing. Given bearded seals' reliance on snow crab, it is possible that the food web dynamics between these species have shifted given the recent decline in snow crab abundance. With the decreased abundance, bearded seals are likely to have to switch food sources which may result in additional interspecific competition that did not exist prior to the collapse of snow crab.

3.5.1 Effects of the alternatives on Marine Mammals

Under the proposed alternatives, there are likely no negative effects on marine mammals. However, the foreseen impacts are dependent on the state of snow crab stock. Thus, under any alternative 2, implementing a rebuilding plan with intentions to rebuild the EBS snow crab stock will likley have positive implications for marine mammals, as some marine mammals are dependent on snow crab as a food source. Implications for bearded seals as a result of the snow crab stock decline may include: varying food web interactions and potential increased resource partitioning interspecifically. Interspecific resource competition may add additional strain to many species who are already mitigating the effects of loss of sea ice habitat (Oxtoby et. al., 2017). The bearded seal has a wide variety of prey items, so it is likely that the effects of a decreased in snow crab availability resulted in the bearded seal switching prey consumption to accommodate. It is unlikely that the decrease in snow crab abundance had substantial effects on bearded seal fitness, as they are reliant on additional benthic prey to subsidize their diet. The larger trophic level effects for bearded seals and snow crab likely require future work especially given the unprecedented state of the EBS snow crab population, and the current climate mediated changes in the phenology of arctic sea ice.

3.6 Economic and Social Effects

This section provides background information on the fishery as well as the economic and social impacts of the alternatives including identification of the individuals or groups that may be affected by the action, and the nature, direction and magnitude of impacts if possible. The objective of this amendment is to rebuild the EBS snow crab stock to B_{MSY}. The action alternative (Alternative 2) would either not allow a directed fishery during the rebuilding period (Option 1) or provide for the possibility of a directed fishery under the current State of Alaska harvest strategy (Option 2). The alternatives were discussed in section 2.

3.6.1 Description of the BSAI Crab Rationalization

The BSAI Crab Rationalization (CR) Program was implemented in 2005. The CR Program is a "voluntary three pie cooperative" program which allocates BSAI crab resources among harvesters, processors, and coastal communities. The CR Program was designed to address conservation, social, economic, and management issues associated with the previous over-capitalized derby fishery, as well as increased the safety of crab fishermen by ending the race for fish. The program issued harvest quota shares to vessel owners (License Limitation Program license holders) and captains and crew, as well as processor quota shares to processors based on historic participation to protect investment in and reliance on the program fisheries.

There are nine large crab fisheries in the BSAI rationalization under the program[3], specifically:

- BRR Bristol Bay red king crab
- BBS Bering Sea snow crab (C. opilio)
- EBT Eastern Bering Sea Tanner crab (C. bairdi) – East of 166° W
- WBT Western Bering Sea Tanner crab (C. bairdi) – West of 166° W
- PIK Pribilof Islands blue and red king crab
- SMB Saint Matthew Island blue king crab
- WAG Western Aleutian Islands (Adak) golden king crab – West of 174° W
- EAG Eastern Aleutian Islands (Dutch Harbor) golden king crab – East of 174° W
- WAI Western Aleutian Islands (Petrol Bank District) red king crab – West of 179° W

Each program fishery is managed with a TAC, which sets a specific catch limit. Once the TAC is set for the fishery, 10 percent of this amount is available for the Community Development Quota (CDQ) Program and 90 percent of the TAC is converted into individual fishing quota (IFQ) for harvest under the CR Program.

Provided is a brief description of CR Program to include harvester shares, processor shares, regional share designation, catcher processor shares, and crew shares that was included in the January 2017 Ten-Year Program Review for the Crab Rationalization Management Program in the Bering Sea/Aleutian Islands (NPFMC 2017). For further information about these elements and other elements of the CR Program, refer to the January 2017 Ten-Year CR Program Review (NPFMC 2017) for the Crab Rationalization Management Program in the Bering Sea/Aleutian Islands.

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[3] Some crab fisheries are considered one unit stock for assessment purposes but are managed as more than one fishery. For example, Eastern and Western Aleutian Islands golden king crab are assessed as one stock but are managed as distinct fisheries with separate TACs.

Harvesting shares

Harvesting quota shares (QS) were created in each crab fishery of the program (Figure 3-19). QS are a revocable privilege that allow the holder to harvest a specific percentage of the annual TAC in a program fishery. The corresponding annual allocations, which are expressed in pounds, are referred to as IFQ. The size of each annual IFQ allocation is based on the amount of QS held in relation to the QS pool in a program fishery – a person holding one percent of the QS pool receives IFQ to harvest one percent of the annual TAC in the fishery. IFQ TACs do not include pounds that have been set aside for the CDQ Program. All crab that is sold or kept for personal use, and all deadloss is debited against the IFQ amount of the allocation holder. Legal discards, however, are not counted against an IFQ holder's account, but are accounted for in total fishery removals.

QS is designated as either catch vessel QS or catcher processor QS, depending on whether the vessel that created the privilege processed the qualifying landings on board. Approximately 97 percent of the QS (referred to as "owner QS") in each program fishery was initially allocated to LLP license holders based on their catch histories in the fishery. The remaining 3 percent of the QS (referred to as "C shares" or "crew QS") were initially allocated to captains based on their catch histories in the fishery.

Catcher vessel owner IFQ are issued in two classes, Class A IFQ and Class B IFQ. Crab harvested using Class A IFQ must be delivered to a processor holding unused individual processing quota (IPQ). In addition, Class A IFQ are subject to regional share designations, whereby harvests are required to be delivered within an identified region. The delivery restrictions of Class A IFQ are intended to add stability to the processing sector by protecting processor investment in program fisheries and to preserve the historic distribution of landings and processing between regions.

Crab harvested using Class B IFQ can be delivered to any processor that is a registered crab receiver (except a catcher processor) regardless of whether the processor holds unused IPQ. In addition, Class B IFQ are not regionally designated. The absence of delivery restrictions on a portion of the catch is intended to provide harvesters with additional market leverage for negotiating prices for landings of crab.

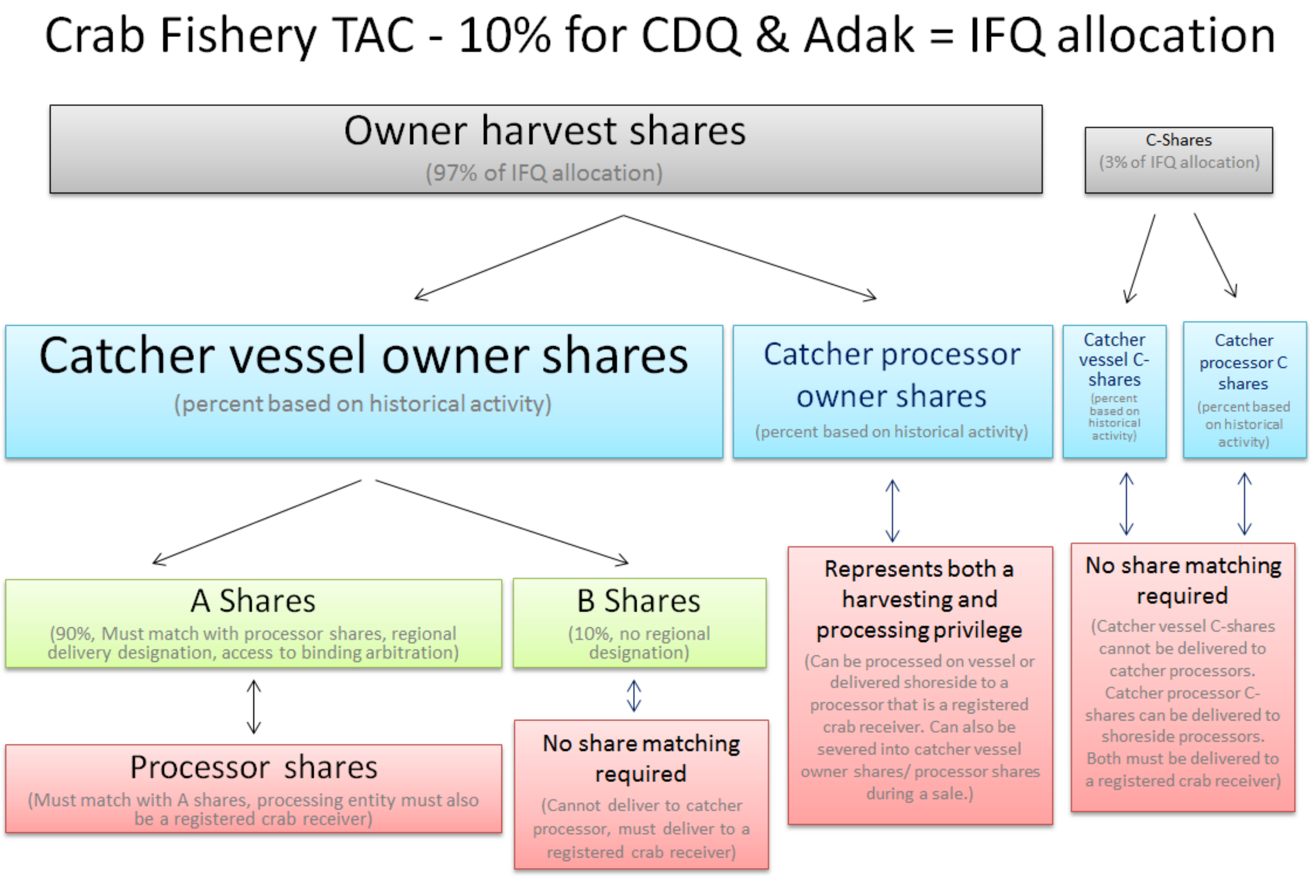

Figure 3-19 Diagram of quota shares in the CR Program

QS and IFQ are transferrable under the CR Program, subject to limits on the amounts of shares a person may own or use. Transferability of shares among eligible purchasers of QS and IFQ may promote production efficiency in the harvest sector and provides a means for compensated removal of excess harvesting capacity in the program fisheries. In addition, transferability may be used to avoid overages, in the event a harvester exceeds its available IFQ, and IFQ transfers post-delivery are also authorized to remedy a harvest overage. For further details on the limits of QS and IFQ transferability, see section 2.3.2 of the CR Program Review (NPFMC 2017).

Processing Shares

The CR Program also created processing quota shares (PQS), which all allocated to processors and are analogous to the QS allocated to harvesters. PQS are a revocable privilege to receive deliveries of a fixed percentage of the annual TAC from a program fishery. These annual allocations are referred to as individual processing quota (IPQ). IPQ is issued for 90 percent of the catcher vessel owner IFQ pool, corresponding to the 90 percent allocation for catcher vessel IFQ issued as Class A IFQ. As with Class A IFQ, PQS and IPQ are designated for processing by region.

IPQ landing requirements do not apply to the remaining 10 percent of the owner IFQ, corresponding to the 10 percent of the owner IFQ allocated as Class B IFQ, as these Class B IFQ are intended to provide harvesters with additional bargaining power. In addition, Class B IFQ may provide an opportunity for the entry of new processors in the program fisheries. Alternatively, new processors can enter a fishery by purchasing PQS or IPQ or by purchasing landings of CDQ crab. To ensure harvesters the latitude to use their Class B IFQ to pursue the best markets, processors are not permitted to leverage their IPQ to acquire crab harvested using Class B IFQ; the penalty is forfeiture of all of the processor's IPQ.

As in the harvester sector, processors received initial allocations of PQS based on processing history during a specified qualifying period for each fishery. A processor's PQS allocation, as a percentage of the pool, in a program fishery was equal to its share of qualified processing in the qualifying period (i.e., pounds processed by the processor divided by pounds processed by all qualified processors).

Processing shares are transferable, including leasing of PQS (or equivalently, the sale of IPQ) subject to use caps. As with harvesting shares, transferability of processing shares is intended to promote efficiency and facilitate compensated reduction of excess capacity. In addition, IPQ transfers may aid in the coordination of deliveries from the fisheries.

A right of first refusal was granted to community groups and CDQ groups from communities with substantial crab processing history on the sale of any processing share for use outside of the community of origin. The intention of the right of first refusal is to allow the community of origin the opportunity to keep PQS in a community under the same terms and condition the seller of PQS would have offered another buyer. For further details on the limits of PQS and IPQ transferability, see section 2.3.3 of the January 2017 Ten-Year Program Review for the Crab Rationalization Management Program in the Bering Sea/Aleutian Islands.

Regional Share Designation

The allocation to regions is accomplished by regionally designating all Class A (delivery restricted) harvest shares and all corresponding processing shares. In most CR Program fisheries including BS snow crab, regionalized shares are either North or South, with North shares designated for delivery in areas on the BS north of 56°20' north latitude and South shares designated for any other areas, including Kodiak and other areas on the Gulf of Alaska. In the Western Aleutian Islands (Adak) golden king crab fishery, the designation is based on an east/west line to accommodate a different distribution of activity in that fishery. Share designations are based on the history location of the landings and processing that gave rise to the shares.

Effective June 14, 2013, the Council approved an amendment that established a process whereby holders of regionally designated IFQ and IPQ in six CR Program fisheries, including BS snow crab, may receive an exemption from regional delivery requirements in the North or South Region. This regulatory action establishes a process that can mitigate disruptions in a CR Program fishery that prevent participants from complying with regional delivery requirements. For example, in the event of a strong ice pack around Saint Paul Island, North-designated harvested crab might be stranded if there is not flexibility to allow processing to occur elsewhere. A privately signed framework agreement stipulates the circumstance under which relief is granted from regional delivery requirements.

Catcher Process Shares

Catcher processors participate in both the harvest and processing sectors and therefor have a unique position in the program. Catcher processors are allocated catcher processor QS and issued corresponding catcher processor IFQ. These shares carry both a harvest privilege and an accompanying onboard processing privilege. To be eligible for the initial allocation of catcher processor QS, a person must have been eligible for a harvest allocation by holding a permanent, fully transferable catcher processor License Limitation Program (LLP) license. In addition, the catcher processor must have processed crab in either 1998 or 1999. These requirements parallel the harvester QS and processor PQS eligibility requirements, respectively. Persons meeting these eligibility requirements were allocated catcher processor QS in accordance with the allocation rules for harvest shares for all qualified catch that was processed onboard.

Since catcher processor IFQ provide both harvesting and on-board processing privileges, a person holding those shares may harvest and process crab onboard under the allocation. In addition, holders of catcher processor IFQ may choose not to process harvested crab, instead delivering their catch to any other processor. Use of catcher processor IFQ in this manner is akin to the use of Class B IFQ, which do not require the receiving processor to hold unused IPQ. Catcher/processor shares do not have regional designations.

Holders of catcher processor QS may also sever the harvesting and processing privileges, thereby creating separate QS and PQS. These newly severed interests create a privilege to annual IFQ allocations and IPQ allocations, which can be held by different persons. When severed, the resulting QS and PQS must be designated for a region with both shares taking the same regional designation. Allowing the conversion of shares permits a catcher processor shareholder to realize the maximum value of shares and provides greater flexibility in using the privileges.

Some catcher processors historically accepted delivery of crab from catcher vessels for processing. PQS are allocated based on this activity to the extent that processing vessels met processor eligibility requirements and had qualifying processing history. In addition, catcher processors are permitted to purchase and use additional IPQ. All processing of deliveries by catcher processors is required to take place within three miles of shore in the applicable region. The requirement of processing within three miles of shore is intended to ensure that the regional benefits of processing activity occur. Catcher processors may not purchase for processing crab harvested with Class B shares.

Crew Shares

To protect captains' historical interests in the program fisheries, 3 percent of the initial allocation of QS were issued to eligible captains. These "C shares" are to be held only by active captains and crew and are intended to provide additional leverage to those captains and crew when negotiating contracts with vessel owners. The Council chose to exempt C shares from all IPQ and regional landing requirements, as it recognized the logistical complications that would likely arise under the program as a result of the interaction of active participation requirements, fleet contraction, and the IPQ and regional landing requirements.

To be eligible for the initial allocation of C share QS, a captain was required to demonstrate both historical dependence on a program fishery and recent participation. Allocations to captains were based on participation in landings during the same qualifying years applicable to owner QS allocations. To ensure C shareholders are an integral part of the program, C shareholders are permitted to join cooperatives. IFQ attributable to C share QS of cooperative members are allocated directly to the cooperative and are harvested in accordance with the applicable cooperative agreement.

To ensure that C shares benefit active participants in the program fisheries, C share QS and IFQ may be acquired by transfer only by persons who are active in one of the program fisheries in the 365 days prior to the application for transfer. Under current rules, individuals who hold C share IFQ are required to be on board the vessel harvesting those IFQ. However, C shareholders who choose to join a cooperative are effectively exempted from the 'owner on board' rule, since the IFQ are held by the cooperative.

Under Amendment 31, annual C share IFQ are issued only to C share QS holders who meet an active participation requirement of being on board a vessel for one landing in the three years preceding the IFQ allocation. In addition, C share QS is revoked from persons who are not active in at least one of the crab fisheries for 4 consecutive years. The Council also included a transition period for persons who would be deprived of IFQ or QS by these active participation requirements. Under this transition period, no IFQ would be withheld until 3 years after implementation of the amendment and no QS would be revoked until 5 years after the implementation of the amendment. This amendment became effective May 1, 2015.

In 2022, an emergency rule to temporarily suspend the active participation requirement for captains and crew holding crew quota or C shares under the Bering Sea and Aleutian Islands Crab Rationalization Program (CR Program). The emergency rule is in effect from July 15,2022 through January 11, 2023 (87 FR 42390).

Individual C share holdings and use are capped at the same level as the vessel use caps applicable to owner IFQ (i.e., twice the owner QS cap level). A “grandfather” provision exempted initial allocations of Class C shares in excess of the cap. C share IFQ are not considered in determining a vessel’s compliance with the vessel use caps applicable to owner IFQ.

Catcher processor captains are allocated catcher processor C share QS that include both a harvesting and onboard processing privilege. Harvests with catcher processor C share IFQ may also be delivered to shoreside or stationary floating processors. Harvests with catcher vessel C share IFQ must be delivered to shoreside or stationary floating processors (i.e., they cannot be delivered to catcher processors)

3.6.2 Economic Status and Trends in the EBS Snow Crab Fishery

Table 16 provides general statistics on the harvest and processing of EBS snow crab fishery with corresponding Figure 3-20 through Figure 3-22 to visualize these trends. As seen in Table 16 and Figure 3-20, the number of vessels participating in the EBS snow crab fishery has generally trended downward between the 2005/2006 season and the 2020/2021 season. However, during the 2021/2022 EBS snow crab fishery, only 42 vessels were active in the fishery which was a substantial decline in the number of active vessels. As for retained catch of EBS snow crab, during the 2005/2006 through 2011/2012 period it generally trended upward from a low of 37 million pounds in 2005/2006 to high of 88 million pounds in 2011/2012 followed by an overall declined with temporary peaks during the 2014/2015 season at 68 million pounds and 2020/2021 season at 45 million pounds. Following the 2020/2021 retained catch of 45 million pounds, retained catch declined substantially the following year to record low of 5.5 million pounds due to the collapse of the population in 2021 (see Figure 3-21). Gross ex-vessel revenue also slowly increased from a low of $56 million in 2005/2006 season to a high of $224 million in 2011/2012 EBS snow crab season, followed by a downward trended for most years to a low of $76 million in 2016/2017 and 2017/2018 seasons. Following the decline in gross ex-vessel revenue in 2016/2017 and 2017/2018 seasons, gross ex-vessel revenue for the fishery trended upward to a high of $219 million during the 2020/2021 season (see Figure 3-22).

From the production perspective, the number of active shore plants that have received EBS snow crab deliveries has, in general, slowly trended downward from a high of 18 during the 2006/2007 season to a low of nine starting in the 2015/2016 season and continuing every season except during the 2016/2017 season when 11 shore processors received EBS snow crab deliveries (see Table 16). Gross first wholesale revenue shows a similar trend as the revenue gradually increased from a low $96 million during the 2005/2006 season to a high of $324 million during the 2011-2012 season followed by a gradual decline to $86 million during the 2017/2018 season (see Figure 3-22). Following the 2017/2018 season, gross first whole revenue for the EBS snow crab fishery recovered during the subsequent three seasons to a high of $286 million during the 2020/2021 season. Gross ex-vessel revenue and gross first wholesale revenue for is not yet available for the 2021/2022 season.

Table 16 EBS snow crab retained catch, gross ex-vessel value and price, and gross first wholesale revenue and price, 2005-2008 through 2021-2022

Snow crab year	TAC/GHL 1000t	TAC/GHL million lbs	Vessels	Retained catch 1000t	Retained catch million lbs	Gross ex-vessel revenue $ million	Ev-vessel price $/lb	Plants	Gross first wholesale revenue $ million	Gross first wholesale price $/lb
2005-2006	16.86	37.18	78	16.77	36.97	$55.79	$1.51	13	$96.27	$2.60
2006-2007	16.59	36.57	69	16.47	36.31	$72.67	$2.00	18	$118.89	$3.27
2007-2008	28.59	63.03	78	28.59	63.02	$133.69	$2.12	17	$209.31	$3.32
2008-2009	26.56	58.55	77	26.55	58.54	$101.24	$1.73	16	$163.64	$2.80
2009-2010	21.78	48.02	69	21.69	47.82	$76.48	$1.60	11	$125.92	$2.63
2010-2011	24.62	54.28	68	24.61	54.26	$164.80	$3.04	14	$231.51	$4.27
2011-2012	40.32	88.89	72	39.99	88.16	$224.00	$2.54	13	$323.57	$3.67
2012-2013	30.1	66.35	70	29.71	65.49	$173.96	$2.66	12	$259.17	$3.96
2013-2014	24.48	53.98	70	24.49	53.98	$144.25	$2.67	10	$222.86	$4.13
2014-2015	30.82	67.95	70	30.79	67.88	$157.49	$2.32	11	$227.73	$3.36
2015-2016	18.42	40.61	69	18.41	40.60	$119.89	$2.95	9	$174.12	$4.29
2016-2017	9.78	21.57	63	9.76	21.53	$75.82	$3.52	10	$127.00	$5.90
2017-2018	8.6	18.96	63	8.60	18.95	$76.25	$4.02	9	$86.39	$4.56
2018-2019	12.51	27.58	61	12.47	27.50	$109.49	$3.98	9	$154.02	$5.60
2019-2020	15.4	33.95	59	15.43	34.02	$133.53	$3.92	9	$177.81	$5.23
2020-2021	20.4	44.97	62	20.41	45.00	$219.16	$4.87	9	$286.37	$6.36
2021-2022	2.5	5.51	42	2.5	5.51	Not available	Not available	Not available	Not available	Not available

Source: AKFIN (ADF&G fish ticket data and ADF&G COAR data). 2021/2022 retained catch from 2021/2022 Snow Crab SAFE. Source for 2021/2022 vessel count from September 2022 Ecosystem & Socieconomic Profile for Eastern Bering Sea Snow Crab.
Data includes CDQ harvest
All price data is in real 2021 dollars
Note that value and price data is not yet available for the 2021/2022 snow crab season.

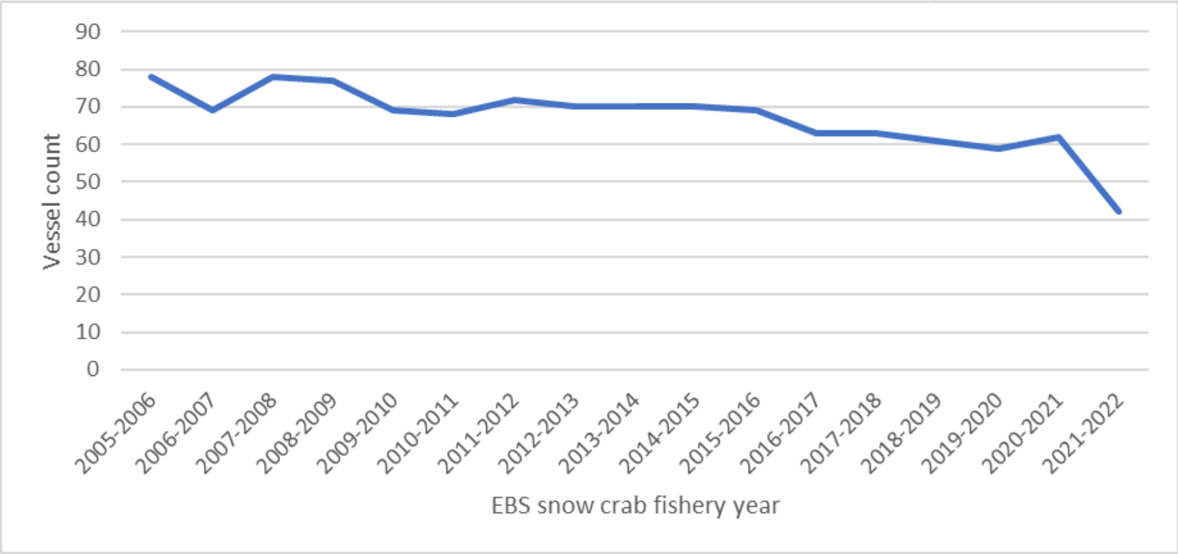

Figure 3-20 Annual number of vessels active in the EBS snow crab fishery, 2005/2006 through 2021/2022

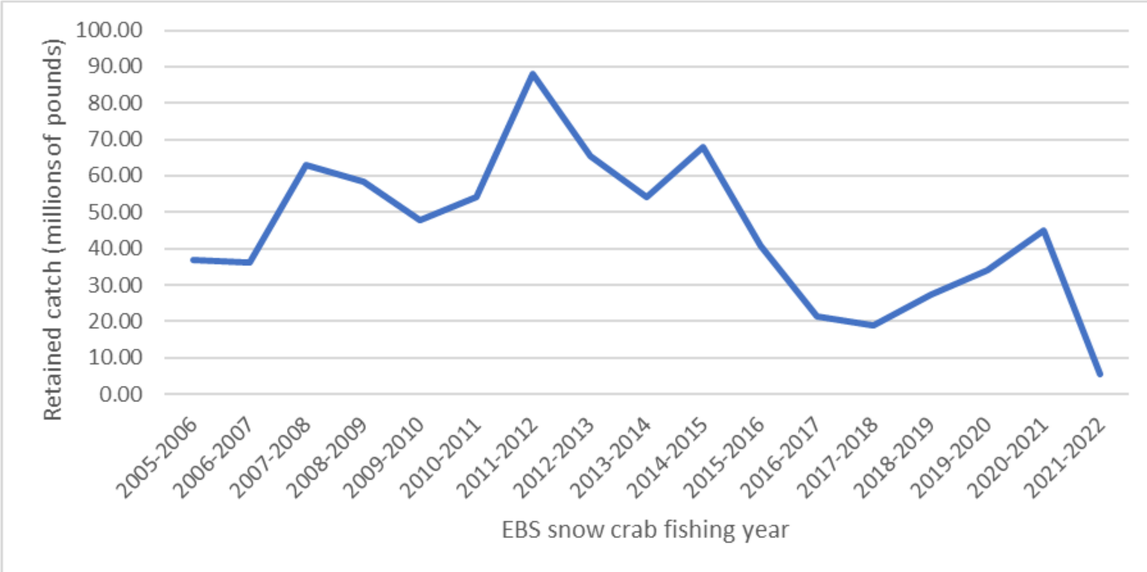

Figure 3-21 Annual retained catch (millions of lbs.) in the EBS snow crab fishery, 2005/2006 through 2021/2022

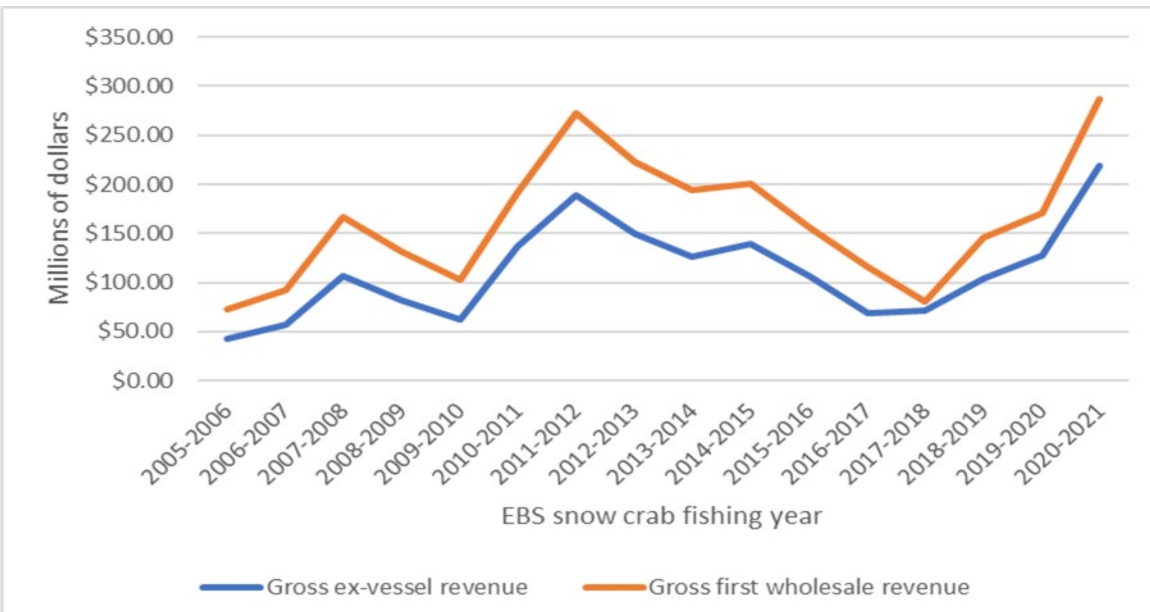

Figure 3-22 Annual gross ex-vessel and first whole revenue (millions of $) for the EBS snow crab fishery, 2005/2006 through 2020/2021

A summary of selected indicators from the most recent employment data available for the EBS snow crab fishery (up to 2019) is provided in Table 17. Data reported in Table 17 are by calendar year which is different than the data reported in Table 16 which is reported by EBS snow crab fishery season. As result, vessel and processor counts may differ between the tables. There were an estimated 428 total crew positions on 61 vessels in the EBS snow crab fishery for 2019 which is the third lowest number of crew positions since 2006 and 2007. Crew earnings for 2019 was $14.7 million up the previous year of $10.3 million, while captain earnings were $6.4 million up from $4.4 million the previous year. Crab processing employment in 2019, as measured by hours of processing labor input at plants that received EBS snow crab IFQ and CDQ landings, is estimated at 333 thousand labor hours, an increase of 44 percent from

2018. Aggregate wages paid to crab processing line employees in the EBS snow crab fishery was $4.6 million an increase of 58 percent than the previous year.

Table 17 EBS snow crab fisheries crew and processing sector employment and earnings

Year	Crew positions[a]			Crew share[b]		Captain share		Processor labor hours[c]			Processing labor payment[d]		
	Vessels	Total crew positions	Mean per vessel	Total $ million	Per vessel, median $1,000	Total $ million	Vessel median $1,000	Plants	Total 1,000 hrs	Plant median 1,000 hrs	Median $/hour	Total $ million	Plant median $1,000
2006	74	418	5.6	$6.58	$76.82	3.29	$40.00	10	445	49.45	$11.80	$5.14	$582
2007	65	377	5.8	$9.71	$128.01	4.62	$66.65	10	442	41.29	$12.22	$5.57	$512
2008	74	447	6.0	$17.86	$221.82	8.5	$113.19	12	712	30.52	$12.19	$9.94	$570
2009	77	536	7.0	$14.27	$162.90	6.32	$80.58	14	600	58.41	$11.69	$7.61	$349
2010	68	444	6.5	$10.29	$136.20	4.62	$65.16	11	534	50.9	$11.18	$6.22	$411
2011	68	453	6.7	$21.99	$310.21	9.84	$143.95	14	555	45.69	$11.64	$6.79	$393
2012	72	502	7.0	$29.73	$409.14	13.38	$192.10	13	1087	77.94	$11.41	$13.15	$671
2013	71	481	6.8	$24.10	$310.04	10.97	$154.69	12	774	63.55	$10.99	$8.74	$527
2014	70	480	6.9	$19.13	$255.64	8.58	$118.48	10	590	76.01	$11.47	$6.85	$495
2015	70	491	7.0	$18.12	$253.75	$8.20	$120.25	10	747	95.42	$11.56	$9.21	$857
2016	68	463	6.8	$15.46	$200.05	$6.91	$99.06	8	447	69.4	$12.62	$5.98	$567
2017	63	441	7.0	$12.84	$171.06	$5.45	$79.56	8	266	34.61	$12.34	$3.35	$218
2018	63	436	6.9	$10.25	$140.53	$4.39	$65.89	8	232	30.48	$12.23	$2.89	$166
2019	61	428	7.0	$14.67	$199.90	$6.35	$97.38	8	333	45.7	$12.92	$4.58	$306

Source: 2021 Crab Econ SAFE (ADF&G fish ticket data, eLandings, ADF&G COAR data, and EDR data)

Notes: Data show for snow crab fishery by calendar year. All dollar values are adjusted for inflation to 2019-equivalent value.

[a] Crew positions total and mean summary statics are calculated from vessel-level observations derived from eLandings crew size reporting, average over all landings in the respective fishery reported by each active vessel. Calculations do not include CPs numbers from 2006-2008 due to confidentiality.

[b] Crew and captain payments reflect amounts paid for labor during the crab fishery and include all post-season adjustments, bonuses, and deductions for shared expenses such as fuel, bait, and food and provisions; payments for IFQ royalties, labor outside of crab fishery, health/retirement or other benefits are excluded.

[c] Processing labor hours reflect hours w orked by processing-line employees w orking at shoreside and floating processor sectors only, excluding processing employees on catcher/processors and salaried w orks employed in the processing sectors.

[d] Pay per hour statistics reflect only the shoreside and floating processing sectors; all other processing labor pay statistics are reported inclusive of catcher/processor.

3.6.2.1 ESP Fishery Performance and Economic Indicators for EBS Snow Crab

This section provides the latest fishery performance and economic indicators from the 2022 Snow crab Ecosystem and socioeconomic profile. Fishery performance indicators are reported through calendar year 2022 (corresponding to the 2021-2022 crab season), with the exception of incidental catch in the (currently ongoing) EBS groundfish fisheries, reported through 2021. The active snow crab fleet during 2022 declined to 42 vessels, the lowest level since 1977 at the beginning of the time series, and approximately 68% of the average number of vessels participating during the previous five years. Relative to the substantially reduced TAC (less than 13% of the previous year and less than 20% of the previous five-year average), less consolidation of fishing activity occurred than would be expected based on economic efficiency, and it is unclear if other factors driving this level of vessel participation will persist if TAC levels remain comparably low. CPUE in the fishery declined from 218 the previous year to post- rationalization low of 124 legal crab per potlift, and total potlifts declined from 172 thousand in 2021 to 37 thousand, with both indicators approaching the lower bound of one standard deviation below the long term (1991-current) average, respectively. The latitude of the center of gravity of fishing activity during 2022 shifted somewhat south compared to the previous year but remained approximately two standard deviations greater than the long-term average. Incidental catch in EBS groundfish fisheries during 2021 declined for a fourth consecutive year to 77 thousand kg, approaching the lower bound of the long-term range of variation. TAC utilization reached 99% for the 2021-2022 snow crab fishery, however, fishing extended later than usual, with four vessels making landings later than May 15.

Economic performance indicators included in this ESP are reported through calendar year 2021, the most recent year for which data are available. With a TAC of 18.37 thousand metric tons, the highest since the 2014-2015 crab season, combined with historically high market values for snow crab driven by high consumer demand during the first two years of the covid-19 pandemic, estimated ex-vessel revenue in the snow crab fishery during 2021 exceeded $219 million, approaching the upper bound of one standard deviation above the long-term (1991-2021) average. Average ex-vessel price per pound reached a historical high in 2021, increasing by 25% from 2020, to $4.97 per pound, greater than two standard deviations higher than the historical average since 1991 (adjusted for inflation). As a result of the historically high ex-vessel value of the snow crab fishery during 2021, combined with the closure or reduced TAC levels in most crab and other fisheries targeted by the snow crab fleet, ex-vessel revenue share increased to an unprecedented 85% of total annual ex-vessel landings revenue, summed across all fisheries in which snow crab vessel landed catch during the 2021 calendar year. Although 2022 data is not yet available for economic performance indicators, news reports and other information indicate that market demand for crab and other premium seafood products contracted sharply in 2022, suggesting that economic returns for most or all of the fleet active during the 2021-2022 snow crab season were poor and many vessels likely operated at a loss.

All of the socioeconomic indicators associated with the snow crab target fishery included in the ESP exhibited substantial deviation from historical patterns during the most recent period for which data are available. During 2022, the number of active vessels in the fishery fell to 42, the lowest level since 1977, but, with the historically low TAC set for the 2021-2022 season and early evidence of sharply reduced market value, likely exceeding the number of vessels that could be financially sustained at similarly reduced production levels. Results from an industry skipper survey highlight concerns with perceived low abundance on the fishing grounds and changes in fishing behavior attributed to reductions in the 2021/2022 snow crab TAC. Historically low CPUE in 2022, and the continued spatial shift of fishing activity far to the north of historical fishing grounds, reflected adverse fishing conditions. A historically high ex-vessel price during 2021, combined with a relatively high TAC level, contributed to strong economic performance in the snow crab fishery during 2021. However, the ex-vessel revenue share indicator increased for 2021 to an unprecedented 85% share of the fleet's total gross landings revenue for the year, reflecting increased dependence on the snow crab fishery. The continued limited availability of alternative fishing targets for the fleet, combined with high operating costs associated with adverse fishery performance indicators noted above, without the mitigating (though limited) effect of high ex-vessel price observed for the previous year, is evidence of severe economic stress on the snow crab fleet and dependent stakeholders and communities during 2022.

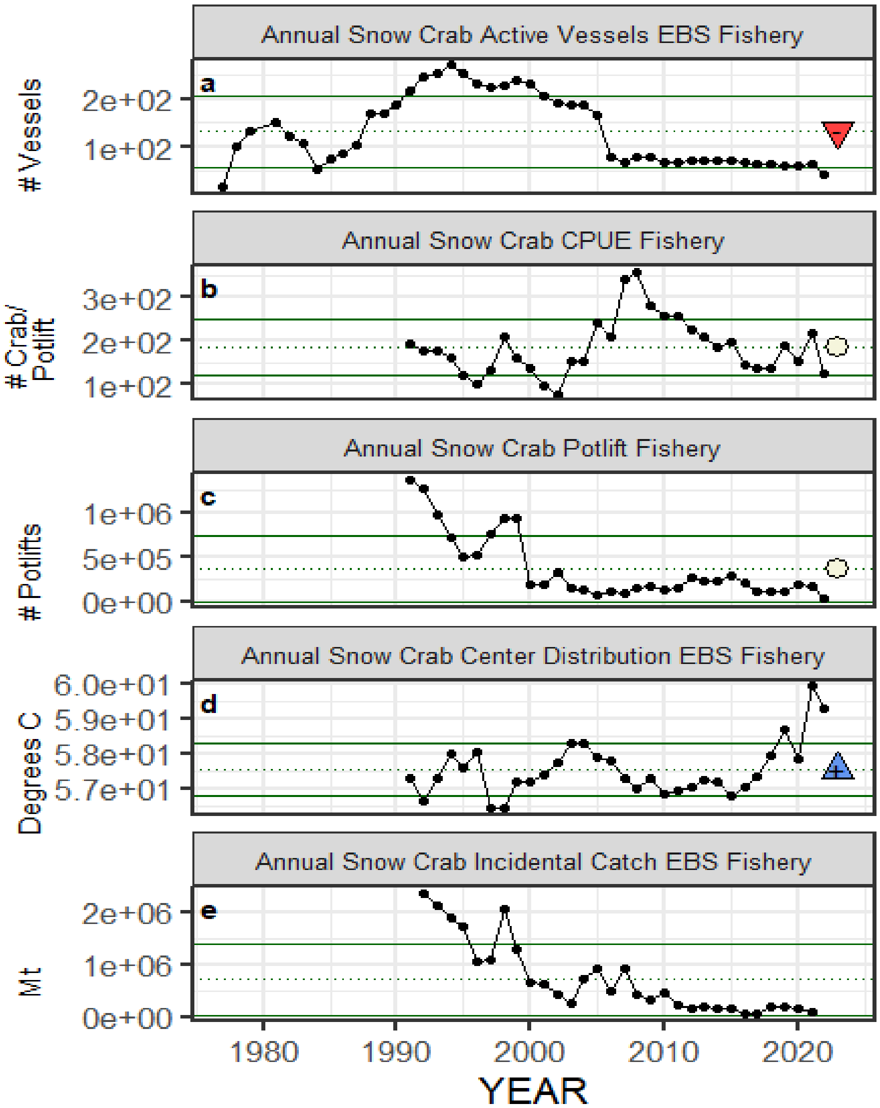

Figure 3-23 Selected socioeconomic indicators for EBS snow crab with time series ranging from 1977 – present. Upper and lower solid green horizontal lines represent 1 standard deviation of the time series mean. Dotted green horizontal line is the mean of the time series. A symbol appears when current year data are available and follows the traffic light status table designations (triangle direction represents if above or below 1 standard deviation from the time series mean, color represents proposed relationship for stock, white circle for neutral).

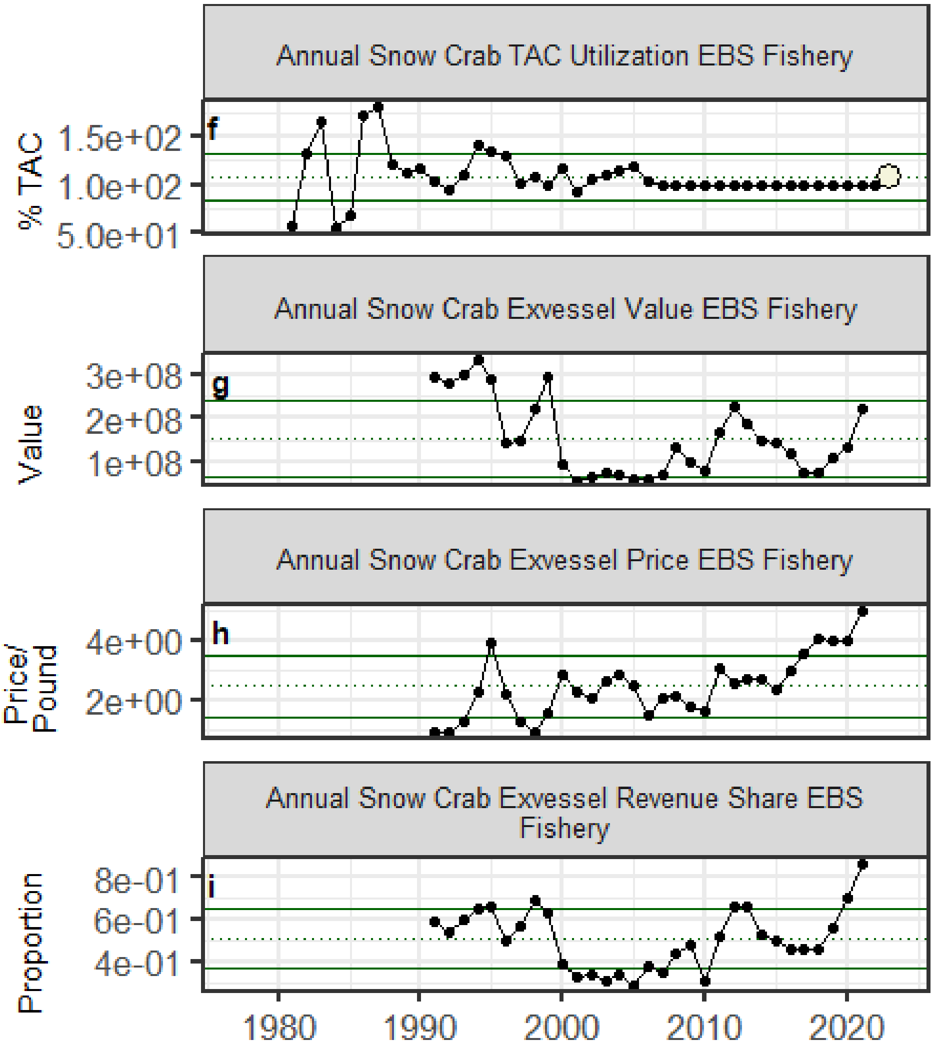

Figure 3-25 (cont.). Selected socioeconomic indicators for EBS snow crab with time series ranging from 1977 – present. Upper and lower solid green horizontal lines represent 1 standard deviation of the time series mean. Dotted green horizontal line is the mean of the time series. A symbol appears when current year data are available and follows the traffic light status table designations (triangle direction represents if above or below 1 standard deviation from the time series mean, color represents proposed relationship for stock, white circle for neutral).

3.6.2.2 Local and Traditional Knowledge and Subsistence Specific to BS Snow Crab

When preparing this analysis, staff used the Local Knowledge (LK), Traditional Knowledge (TK), and Subsistence search engine to look for sources of information containing LK and TK specific to Bering Sea snow crab. The search engine contains scientific articles in peer-reviewed journals, white papers, archival references, and other sources of information related to LK, TK, the social science of LK and TK, and subsistence information. No results based on LK from the Bering Sea snow crab fleet or communities substantially engaged in, or dependent on, snow crab were returned. Likewise, no results were based on TK were returned.

LK is based on the observations and experience of local people in a region with significant in-situ expertise related to particular species, environments, and practices (Martin et al., 2007). LK holders, such as long-term crab skippers or crew members, may be some of the earliest observers of environmental and/or fishery changes because of their long-term experience working and harvesting specific areas

(Johannes & Nies 2007). For these reasons, the authors reached out to the Alaska Bering Sea Crabber's Association (ABSC) regarding their new skipper survey.

ABSC's survey was administered online to all Bering Sea snow crab skippers that participated in the 2020/2021 and 2021/2022 seasons. The results reported in the analysis draw from the 2022 skipper survey administered at the close of the 2021/2022 season. Forty-two vessels participated in 021, of which 13 skippers fully completed the survey in 2022, yielding a 31%response rate. Mailed or online surveys can collect data from larger numbers of people that can be extrapolated to a sample population (i.e., the entire fleet of snow crab skippers during the 2020/2021 and 2021/2022 fishing seasons) and minimize response effects based on direct interviewer/surveyor interactions (Bernhard 2006; Salant & Dillman 1994). However, it is important to apply some level of caution when extrapolating the results yield from the surveyed population to the sample population. The skipper survey results do not reflect the full observations of the Bering Sea snow crab fleet as only 31% of the active 2021/2022 skippers completed the most recent survey. Fishermen make different operational choices, work under different business plans, and therefore are likely to have diverse observations about the fishery.

A subset of survey questions compared observations between the 2021/2022 and 2020/2021 snow crab fishing seasons. This approach provides ABSC an opportunity to establish a time-series of observations that can be compared to the prior year, each year the survey is administered. Specifically, the survey collects skipper's observations of changes in the amount of industry preferred males, sub-legal males, immature males and females, changes in fishing behavior (e.g., fishing deeper waters, longer pot soak times), factors that motivated changes in fishing behavior (e.g., weather, empty pots, etc.), and more.

The 2022 skipper survey results show participating skippers reported a decrease in their encounters with commercial sized male crab, as did their encounters with sub-commercial sized males. Participating skippers also reported they fished deeper compared to the prior fishing season while others reported no significant changes in fishing behavior. Those skippers that did change their fishing behavior attributed it to smaller TACs in the 2021/2022 snow crab season.

Results from the skipper survey also highlight skipper's concerns about low abundance on the snow crab fishing grounds, and the subsequent changes in fishing behavior were attributed to reductions in the 2021/2022 snow crab TAC and that there was greater sea ice extent southward in the Bering Sea. Historically low CPUE in 2022, and the continued spatial shift of fishing activity far to the north of historical fishing grounds, reflected adverse fishing conditions. Despite a relatively low Bering Sea snow crab TAC in the 2021/2022 fishing season, the fishery had a strong economic performance because of the higher ex-vessel price for the fishery (see Table 16). However, the continued limited availability of alternative fishing targets for the fleet, combined with higher operating costs (e.g., increased fuel costs, fishing further north, etc.), suggest the fleet, and communities that are substantially engaged in or dependent on snow crab for shoreside processing, are experiencing overall negative economic impacts, despite a higher ex-vessel price in 2021 (2021 Bering Sea Snow Crab ESP; C. Lescher).

Finally, it is the author's understanding that snow crab is not a historically important species for subsistence uses among Bering Sea communities because the fishing grounds are far offshore as compared to other subsistence species, such as Red King Crab. However, it is possible that Alternative 2 could negatively impact indirect personal use harvest of snow crab by reducing the opportunities for home pack.

3.6.3 Social Impact Assessment of the EBS Snow Crab Fishery

A two-part approach was used in characterizing the communities engaged in or dependent on the EBS snow crab fishery in ways that may be affected by the proposed action. First, tables based on existing quantitative fishery information were developed and are presented in section 3.6.3.1 to identify patterns of engagement in and dependency on the EBS snow crab fishery based on the distribution across communities of the sector most likely to be directly affected by one or more of the proposed alternatives. This is consistent with the portion of the National Standard 8 guidelines.

To address the sustained participation of fishing communities that will be affected by management measures, the analysis should first identify affected fishing communities and then access their differing levels of dependence on and engagement in the fishery being regulated (50 CFRF 600.345).

The second approach involved selecting a subset of communities that, based on the results of the first approach, appear to be substantially engaged in or substantially dependent on the EBS snow crab fishery and providing a more qualitative description of the community and it's relationship with the EBS snow crab fishery for characterization of the specific community context of the fishery. This is consistent with the portion of the National Standard 8 guidelines.

> The best available data on the history, extent, and type of participation in these fishing communities in the fishery should be incorporated into the social and economic information presented in the FMP. The analysis does not have to contain an exhaustive listing of all communities that might fit the definition; a judgment can be made as to which are primarily affected (50 CFR 600.345).

This two-part approach provides a more wholistic context for the subsequent analysis of potential community impacts that may occur due to the rebuilding alternative selected by the Council (section 3.6.4). The characterization of the relevant communities, appearing in section 3.6.3 incorporates existing and easily accessible community descriptive information by reference to the extent feasible, which has been supplemented with limited phone and email contacts with individuals and entities to update existing information where needed.

3.6.3.1 Quantitative Indicators of Community Fishery Engagement and Dependency

The sections below provide quantitative participation information, within the bounds of confidentiality restrictions, for the communities most directly engaged in and dependent on the relevant sectors of the EBS snow crab fishery. Specifically, the individual sections include a series of tables containing a range of quantitative information describing the distribution of sector-specific community engagement (or participation) in and dependency (or reliance) on the EBS snow crab fishery for the following sectors:

- EBS snow crab CVs and CPs owners
- EBS snow crab vessel crew
- CV and CP EBS snow crab quota share owners
- Shore-based processors operating in Alaska accepting EBS snow crab deliveries

Within this quantitative characterization of fishery participation, several simplifying assumptions were made. First, assignment of vessels to a region or community has been made based upon ownership address information as listed in the CFEC vessel registration files. Thus, some caution in the interpretation of this information is warranted. It is not unusual for vessels to have complex ownership structures involving more than one entity in more than one region. Further, the community of ownership address does not directly indicate where a vessel spends most of its time, purchases services, or hires its crew as, for example, some of the vessels with ownership addresses in the Pacific Northwest spend a great deal of time in Alaska ports and hire at least some crew members from these ports. The region or community of ownership address does, however, provide a rough indicator of the direction or nature of ownership ties (and a proxy for associated economic activity, as no existing datasets provide consistently collected time-series information on where CV expenditures on support services are made), especially when patterns are viewed at the sector or vessel class level. The vessel discussion includes the crew data that is available for this sector, which is useful in understanding the geographic footprint of sector employment and earnings (and potentially where earnings are at least in part spent).

Vessel ownership location has been chosen for this analysis as the link of vessels to communities rather than other indicators, such as vessel homeport information. Previous Council FMP SIA experience (e.g., AECOM 2010) that has highlighted the problematic nature of existing homeport data, i.e., that it does not have a consistent meaning across vessels. Vessel ownership address that is reported in CFEC data is the primary link of vessels to communities used in this analysis.

Community designation for EBS snow crab quota shareholders has been made based on ownership address from NMFS, Restricted Access Management (RAM) data and for crew of EBS snow crab vessels ownership addresses is based on ADF&G crew licenses linked with crab Economic Data Report (EDR) data.

For shore-based processors, community designation was based on the operating location of the plant (rather than ownership address) to provide a relative indicator of the local volume of fishery-related economic activity, which can also serve as a rough proxy for the relative level of associated employment, income, and local government revenues. There are, however, considerable limitations on the data that can be utilized for these purposes, based on confidentiality restrictions. A prime example of this is where a community is the site of one or two shore-based processors active in a community in a given year. No information can be disclosed about the volume and/or value of landings in those communities.

3.6.3.1.1 EBS Snow Crab Vessels

The following tables provide a series of quantitative indicators of sector engagement in and dependency on the EBS snow crab fishery, by community and/or regional geography depending on data confidentiality restrictions, for EBS snow crab CVs and one CP with local ownership addresses, as noted in the following paragraphs. Overall community vessel fleet dependency is also shown to the extent possible within data confidentiality restrictions. Where appropriate, ex-vessel gross revenue and first wholesale gross revenue from harvesting and processing of CDQ EBS snow crab allocations are included in the vessel harvesting tables and shore-based processor tables.

Table 18 provides a count, by community of historical ownership address and year (2006-2021), of EBS snow crab for all Alaska communities with any vessels active in the fishery in any given year during this time, as well as for the Seattle metropolitan area, as defined by the Seattle Metropolitan Statistical Area (Seattle MSA[4]); Washington communities outside of the Seattle MSA combined; and Oregon/other states combined. For each geography, annual average counts and percentages of the grand total are also provided, along with a count of unique vessels, which may be indicative of continuity of participation (or lack thereof) at the vessel level. As shown, vessel ownership among states is concentrated in Washington, specifically within the Seattle MSA, Alaska, concentrated within Kodiak, Anchorage and Homer/Seldovia, and Oregon/other states.

[4] The Seattle MSA encompasses all communities in King, Pierce, and Snohomish counties, Washington.

Table 18 Vessels harvesting EBS snow crab by community of vessel historic ownership address, 2006-2021 (number of vessels)

Community	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021 (number)	Annual Average 2006-2021 (percent)	Unique Vessels 2006-2021 (number)
Homer	3	2	3	4	5	4	5	5	4	4	4	3	3	3	3	3	3.6	5.48%	7
Seldovia	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0.9	1.42%	1
Homer/Seldovia	4	3	4	4	6	5	6	6	5	5	5	4	4	4	4	4	4.6	6.90%	8
Kodiak	10	8	10	11	9	8	8	8	8	8	8	8	7	7	7	7	8.3	12.48%	18
Anchorage	5	7	9	8	8	9	9	8	8	9	7	7	6	6	6	10	7.6	11.53%	17
Unalaska	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.09%	1
Ketchikan	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.19%	1
Wasilla	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0.5	0.76%	2
Other AK	6	8	10	9	8	9	9	8	8	10	8	8	7	7	7	11	8.3	12.57%	21
Alaska	20	19	24	24	23	22	23	22	21	23	21	20	18	18	18	22	21.1	31.95%	44
Seattle MSA**	39	34	37	38	34	35	36	34	33	33	35	29	31	30	31	27	33.5	50.66%	64
Other WA	4	2	4	3	2	3	3	4	4	4	4	4	4	4	2	3	3.4	5.10%	11
Washington	43	36	41	41	36	38	39	38	37	37	39	33	35	34	33	30	36.9	55.77%	72
Oregon	9	8	8	8	6	6	6	7	8	7	6	7	7	7	6	6	7.0	10.59%	13
Other States	2	1	1	1	1	1	1	1	2	1	1	1	1	0	1	2	1.1	1.70%	4
Oregon/Other States	11	9	9	9	7	7	7	8	10	8	7	8	8	7	7	8	8.1	12.29%	17
Grand Total	74	64	74	74	66	67	69	68	68	68	67	61	61	59	58	60	66.1	100.00%	111

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 19 provides EBS snow crab ex-vessel gross revenue by ownership address at the community and year (2006-2021) level to the extent possible within data confidentiality restrictions, along with annual averages in terms of inflation-adjusted dollars and percentages of the grand total for all geographies combined. Given the few vessels with historical ownership addresses outside of Kodiak, Homer/Seldovia, and Seattle MSA, little can be shown at the community level. The overall pattern of distribution of revenue is clear with Alaska ownership address vessels accounting for about 32 percent of the total of annual average ex-vessel gross revenue, Washington at 57 percent, and Oregon\other states at 11 percent, respectively.

Table 19 Vessels harvesting EBS snow crab by community of vessel historic ownership address, 2006-2021 (thousands of real 2021 dollars)

Community	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021 (thousands)	Annual Average 2006-2021 (percent)	Unique Vessels 2006-2021 (number)
Homer/Seldovia	$1,149	$1,206	$2,923	$3,027	$3,902	$7,727	$9,155	$7,449	$6,058	$6,010	$4,374	$1,667	$1,514	$2,377	$2,841	$4,630	$4,126	3.39%	8
Kodiak	$3,657	$6,934	$18,607	$13,042	$6,997	$18,357	$25,922	$19,047	$15,203	$16,134	$11,701	$6,041	$5,510	$7,943	$11,535	$16,003	$12,665	10.42%	18
Other AK	$5,171	$15,886	$24,623	$16,669	$13,063	$27,823	$36,638	$26,489	$23,250	$30,687	$18,757	$13,466	$12,927	$18,660	$25,042	$44,097	$22,078	18.16%	21
Alaska	$9,977	$24,026	$46,152	$32,738	$23,963	$53,907	$71,714	$52,985	$44,511	$52,832	$34,832	$21,175	$19,951	$28,980	$39,418	$64,730	$38,868	31.97%	44
Seattle MSA**	$28,010	$30,356	$56,529	$48,335	$40,932	$81,716	$111,563	$85,458	$66,789	$72,710	$61,878	$38,670	$40,867	$58,014	$73,531	$105,750	$62,569	51.47%	64
Other WA	$3,610	$2,382	$5,832	$3,427	$2,959	$7,419	$9,567	$10,760	$9,822	$9,739	$7,090	$6,654	$5,130	$7,296	$5,142	$12,764	$6,850	5.63%	11
Washington	$31,620	$32,738	$62,361	$51,762	$43,891	$89,135	$121,130	$96,219	$76,611	$82,448	$68,968	$45,324	$45,997	$65,310	$78,673	$118,514	$69,419	57.10%	72
Oregon/Other States	$8,947	$9,485	$12,863	$8,046	$6,294	$14,740	$23,333	$18,107	$16,910	$17,027	$10,043	$7,112	$7,576	$11,222	$14,303	$26,479	$13,280	10.92%	17
Grand Total	$50,544	$66,249	$121,376	$92,546	$74,149	$157,782	$216,178	$167,310	$138,032	$152,307	$113,843	$73,611	$73,523	$105,512	$132,393	$209,723	$121,567	100.00%	111

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA(10-12-22_1)).

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 20 provides information on EBS snow crab vessel dependency on EBS snow crab compared to all other areas, gear types, and species fished by those same vessels, as measured by percentage contribution to annual average ex-vessel gross revenue. As shown, dependency on EBS snow crab is relatively important for Alaska address vessels as well as vessels with address in Washington and Oregon/other states with EBS snow crab contributing between 53 percent to 50 percent of the annual average total ex-vessel gross revenue from all areas, gear types, and species fished.

Table 20 Revenue diversification for vessels harvesting EBS snow crab by ex-vessel gross revenue diversification, 2006-2021

Geography	Annual Average Number of Vessels	Annual Average Ex-Vessel Gross Revenues from Bering Sea Snow Crab Only (millions 2021 real $)	Annual Average Total Ex-Vessel Gross Revenues from All Area, Gear, and Species Fisheries	Ex-Vessel Value as a Percentage of Total Ex-Vessel Gross Revenue Annual Average
Homer/Seldovia	4.6	$4.1	$8.2	50.4%
Kodiak	8.3	$12.7	$25.0	50.8%
Other AK	8.3	$22.1	$40.4	54.6%
Alaska	21.1	$38.9	$73.5	52.9%
Seattle MSA**	**33.5**	$62.6	$127.3	**49.2%**
Other WA	**3.4**	$6.8	$11.7	**58.3%**
Washington	36.9	$69.4	$139.0	49.9%
Oregon/Other States	8.1	$13.3	$29.2	45.4%
Grand Total	66.1	$121.6	$241.8	50.3%

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA(10-12-22_1)).

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 21 provides information on overall community vessel dependency on EBS snow crab. This table includes all commercial fishing vessels, not just vessels that participate in the EBS snow crab fishery for those communities that had at least local ownership address EBS snow crab vessel participating in the fishery in any year 2006-2021. It compares the ex-vessel revenue from vessel caught EBS snow crab to ex-vessel revenue from all other areas, gear types, and species fished by all commercial fishing vessels with ownership addresses in that same community. As shown, Seattle MSA ownership address community fleet is relatively more dependent on the EBS snow crab fishery, as measured by contribution to total ex-vessel gross revenues, than the other communities or aggregation of communities other than Oregon/other states. In addition, Kodiak, Alaska ownership address community fleet is also more dependent on the EBS snow crab fishery than other Alaska communities.

Table 21 Revenue diversification for communities with vessels harvesting EBS snow crab by ex-vessel gross revenue diversification, 2006-2021

Geography	Annual Average Number of Vessels	Annual Average Number of All Commercial Fishing Vessels in those Same Communities	Annual Average Ex-Vessel Gross Revenues from Bering Sea Snow Crab Only (millions 2021 real $)	Annual Average Total Ex-Vessel Gross Revenues from All Areas, Gears, and Species Fisheries for the Community Fleet (millions 2021 real $)	Ex-Vessel Gross Revenue as a Percentage of Total Community Ex-Vessel Gross Revenue Annual Average
Homer/Seldovia	4.6	377.4	$4.1	$96.9	4.3%
Kodiak	8.3	247.8	$12.7	$128.3	9.9%
Other AK	8.3	1149.9	$22.1	$216.6	10.2%
Alaska	21.1	1775.2	$38.9	$441.8	8.8%
Seattle MSA**	33.5	332.3	$62.6	$443.5	14.1%
Other WA	3.4	250.9	$6.8	$76.1	9.0%
Washington	36.9	583.2	$69.4	$519.6	13.4%
Oregon/Other States	8.1	63.1	$13.3	$67.5	19.7%
Grand Total	66.1	2421.4	$121.6	$1,029.0	11.8%

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA(10-12-22_1)).

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 22 provides information on EBS snow crab vessel dependency on EBS snow crab fishery, BBRKC fishery, and aggregated groundfish fisheries by comparing annual average ex-vessel gross revenue from these fisheries to annual average total ex-vessel gross revenue from all other areas, gear types, and species from 2006-2021. The largest share of annual average gross ex-vessel revenue for EBS snow crab vessels is from the EBS snow crab fishery followed by the BBRKC fishery, while annual average gross ex-vessel revenue from aggregate groundfish fisheries contributed a relatively small portion of the annual average total ex-vessel revenue from all areas, gears, and species fished.

Table 22 Revenue sources for vessels harvesting EBS snow crab by ex-vessel revenue, 2006-2021

Geography	Annual Average Ex-Vessel Gross Revenues from Bering Sea Snow Crab (millions 2021 real $)	Annual Average Ex-Vessel Revenues from Bristol Bay Red King Crab (millions 2021 real $)	Annual Average Ex-Vessel Revenues from All Crab (millions 2021 real $)	Annual Average Ex-Vessel Revenues from Groundfish (millions 2021 real $)	Annual Average Total Ex-Vessel Revenues from All Areas, Gears, and Species Fisheries (millions 2021 real $)
Homer/Seldovia	$4.1	$2.9	$7.4	$0.6	$8.2
Kodiak	$12.7	$8.5	$22.0	$1.3	$25.0
Other AK	$22.1	$12.4	$39.0	$1.3	$40.4
Alaska	$38.9	$23.7	$68.4	$3.1	$73.5
Seattle MSA**	$62.6	$38.4	$99.0	$9.1	$127.3
Other WA	$6.8	$3.4	$10.8	$0.3	$11.7
Washington	$69.4	$41.9	$109.7	$9.3	$139.0
Oregon/Other States	$13.3	$1.0	$23.3	$2.3	$29.2
Grand Total	$121.6	$66.5	$201.4	$14.8	$241.8

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA(10-12-22_1)).

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 23 provides information on annual EBS snow crab vessel dependency on the EBS snow crab fishery relative to the total gross ex-vessel revenue from all other areas, gear types, and species fished by these vessels. In general, during 2006 to 2010, largest number of vessels received between 10 percent to 50 percent of their total revenue from the EBS snow crab fishery but starting in 2011 there was a slight shift in EBS snow crab dependency where the largest group of EBS snow crab vessels received between 30 percent to 70 percent of their total revenue from this fishery. In 2021, the majority of the EBS snow crab vessels' total gross ex-vessel revenue was from the EBS snow crab fishery, which is likely due primarily to the closure of the directed BBRKC fishery.

Table 23 EBS snow crab revenue as a percent of total revenue for vessels harvesting EBS snow crab, 2006-2021 (number of vessels)

BSS Crab Rev as a % of Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021
0-10%	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0.31
10-20%	9	7	2	2	5	1	0	0	0	0	1	1	1	1	0	0	1.88
20-30%	16	15	5	1	21	0	1	1	2	2	2	2	2	0	0	0	4.38
30-40%	13	10	14	14	13	4	1	1	5	9	12	10	11	4	1	0	7.63
40-50%	12	14	19	19	10	12	4	0	12	10	22	14	17	7	0	0	10.75
50-60%	2	3	14	14	1	19	8	14	20	21	12	14	12	11	6	2	10.81
60-70%	2	1	2	1	1	14	16	20	13	9	6	7	6	16	9	0	7.69
70-80%	1	0	1	1	0	1	16	13	2	3	0	0	1	6	18	5	4.25
80-90%	0	2	0	1	0	0	6	2	0	1	0	0	0	1	6	8	1.69
90-100%	5	1	4	7	3	3	3	5	2	3	2	4	3	3	7	32	5.44
Grand Total	74	64	74	74	66	67	69	68	68	68	67	61	61	59	58	60	66.13

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA(10-12-22_1)).

3.6.3.1.2 Crew Licenses Harvesting EBS Snow Crab

Table 24 provides information on the number of crew licenses harvesting EBS snow crab by community for the years 2012 through 2020[5]. As shown, the largest number of crew licenses harvesting EBS snow crab were from Washington state with an annual average of 242 licenses, of which 91 on average originate from Seattle and the other 151 remaining licenses originate from other Washington communities. Of the Alaska communities, Kodiak had the largest number of annual average crew licenses harvesting EBS snow crab at 61 licenses. Crab CVs harvesting EBS snow crab typically employ six to seven crew members including the captain (Garber-Yonts & Lee 2021). On average in the given time period, this represented 668 people employed annually harvesting EBS snow crab.

[5] EDR crew license data was redesigned in 2012 that included improvements to determine crew license location, so data was limited to 2012-2020.

Table 24 Crew licenses harvesting EBS snow crab by community, 2012-2020

Community	2012	2013	2014	2015	2016	2017	2018	2019	2020	Annual Average 2012-2020 (number)	Annual Average 2012-2021 (percent)
Akutan	1	2	2	2	3	0	1	0	0	1.2	0.18%
Anchorage/Palmer/Wasill	45	49	46	55	41	35	37	44	33	42.8	6.41%
Dutch Harbor/Unalaska	23	22	22	28	20	12	18	19	3	18.6	2.78%
Homer/Seldovia	37	29	31	39	27	22	24	26	18	28.1	4.21%
King Cove	4	2	4	8	9	6	9	6	3	5.7	0.85%
Kodiak	70	70	76	83	60	62	54	50	24	61.0	9.14%
Other Ak	52	42	45	50	39	40	32	35	151	54.0	8.09%
Saint Paul	0	0	3	2	1	1	2	1	0	1.1	0.17%
Alaska	232	216	229	267	200	178	177	181	232	211.2	31.64%
Seattle MSA*	57	49	47	185	43	145	121	107	48	89.1	13.35%
Other Washington	224	214	208	120	219	84	92	88	96	149.4	22.39%
Washington	281	263	255	305	262	229	213	195	144	238.6	35.74%
Oregon	63	61	65	80	71	52	53	55	21	57.9	8.67%
Other States	143	136	134	196	201	148	139	167	175	159.9	23.95%
Grand Total	719	676	683	848	734	607	582	598	572	667.6	100.00%

Source: Economic Data Reports, data compiled by AKFIN source file BSS_SIA_Crew(9-15-22)

*Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

3.6.3.1.3 EBS Snow Crab Harvest Shareholders

Table 25 provides information on EBS snow crab quota share by community from 2012-2022. The state with largest concentration of EBS snow crab quota shares is Washington at an annual average of 569 quota shares followed by Alaska at 321 quota shares. Of the quota shares with a Washington address, Seattle MSA accounts for the largest portion with 427 annual average quota shares. For Alaska, Anchorage/Wasilla/Palmer has the largest concentration of quota shares at annual average of 145 shares followed by Kodiak at 81shares. Shares by community have remained relatively stable over the 2012-2022 period.

The majority of EBS snow crab IFQ is leased. Between 2012 and 2021, 81-89 percent of the total EBS snow crab IFQ was leased, with a slightly increasing trend (Garber-Yonts & Lee 2021). Table 26 provides information on EBS snow crab IFQ lease prices and total value of those leases. During the 2012 through 2021 period, lease prices were highest in 2021 at $2.28 per pound of quota share for a total value of $90 million for that year. Quota lease rates (i.e., the per-pound lease cost as a percentage of ex-vessel value) have remained quite stable overtime. The median lease rate for arms-length transactions of EBS snow crab have been about 46 percent, which tends to be lower than IFQ lease rates for BBRKC (about 63 percent) but higher than Tanner crab (about 29 percent). Further information about EBS snow crab IFQ leasing by quota share type is available from Garber-Yonts & Lee (2021).

Table 25 EBS snow crab quota shareholders by community, 2012-2022 excluding 2020 (millions of shares)

Community	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Annual Average 2012-2022
Anchorage/Palmer/Wasilla	116.47	140.75	138.92	168.88	139.88	138.80	138.69	141.02	169.71	162.92	163.36	147.22
Dillingham	*	*	*	*	*	*	*	*	*	47.92	54.26	51.09
Homer/Seldovia	30.52	29.91	24.87	24.17	24.17	18.22	18.22	18.22	18.24	18.24	18.00	22.07
Kodiak	89.61	86.59	80.31	76.35	81.62	87.90	82.78	75.99	76.74	75.25	76.63	80.89
Petersburg	12.10	12.07	*	12.24	12.24	*	12.32	12.32	6.16	12.32	12.32	11.57
Other AK*	41.76	34.28	75.39	33.65	62.76	74.60	62.89	62.89	0.00	41.03	36.58	52.58
Alaska	290.45	303.60	319.48	315.29	320.68	319.52	314.90	310.45	355.34	357.68	361.16	324.41
Seattle MSA**	489.86	480.09	455.68	442.45	441.10	444.84	419.40	408.97	320.24	340.48	347.05	417.29
Other Washington	118.55	112.58	120.57	137.13	125.60	131.36	152.97	167.90	204.96	184.72	168.24	147.69
Washington	608.41	592.67	576.25	579.58	566.70	576.20	572.37	576.87	525.20	525.20	515.28	564.98
Oregon	77.76	81.15	77.08	78.00	78.24	77.91	78.62	79.00	76.40	76.40	76.40	77.91
Other States	29.33	29.50	33.40	34.13	39.90	31.10	36.99	40.73	43.94	43.94	54.20	37.92
Grand Total	1005.95	1006.92	1006.22	1007.00	1005.53	1004.73	1002.88	1007.04	1000.88	1003.22	1007.05	1005.22

Source: NMFS Restricted Access Management (RAM) division sourced through AKFIN source file BSS_SIA_QS(11-10-22)

*Includes listed communities when data is confidential

**Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 26 EBS snow crab IFQ leasing, 2012-2021 (2021 real dollars)

Crab Fishery	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2012-2021
Price Per Pound	$1.05	$1.15	$1.13	$0.96	$1.30	$1.90	$1.80	$2.09	$1.80	$2.28	$1.55
Total Value	$62,062,982	$58,600,842	$49,165,576	$43,836,861	$38,370,276	$33,569,980	$27,948,171	$48,525,660	$50,724,828	$89,947,222	$50,275,240
Total QS Leased	70,074,652	59,237,504	49,679,334	51,695,480	33,011,671	19,426,419	16,666,954	24,465,746	29,435,361	39,366,169	39,305,929

Source: Economic Data Reports, data compiled by AKFIN source file BSS_SIA_QS_Leasing(10-7-22)

3.6.3.1.4 Shore-based Processors Accepting EBS Snow Crab

The following tables provide a series of quantitative indicators of sector engagement in and dependency on the EBS snow crab fishery. Engagement is shown through participation by community and/or regional geography depending on data confidentiality constraints, for shore-based processors operating in Alaska and Washington, as noted in the following paragraphs. Overall community shore-based processor dependency (as measured in percentage of total ex-vessel value paid for all deliveries from all fisheries made to the relevant processors) is also shown to the extent possible within confidentiality constraints.

Table 27 provides information on the distribution of relevant shore-based processors in Alaska and Washington communities active in the period 2006-2021. For the purpose of this portion of the analysis, relevant shore-based processors are defined as those shore-based entities accepting EBS snow crab deliveries. As shown, five Alaska communities and Seattle MSA were the locations of relevant shore-based processing over this period accepting EBS snow crab deliveries in each year included in the data (Alaska communities were Unalaska/Dutch Harbor, Akutan, King Cove, Kodiak, Saint Paul), with one community (Unalaska/Dutch Harbor) having multiple processors accepting EBS snow crab deliveries in each year.

Table 27 Processors accepting EBS snow crab by community of operation, 2006-2021 (number of processors)

Community	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021 (number)	Annual Average number of processors 2006-2021 (percent)	Unique Processors 2006-2021 (number)
Akutan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	8.29%	1
King Cove	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.1	8.81%	3
Kodiak	2	2	3	2	1	3	2	2	1	2	1	1	1	1	1	1	1.6	13.47%	4
St Paul	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.0	8.29%	1
Akutan/King Cove/Kodiak/St Paul	5	6	6	5	4	6	5	5	4	5	4	4	4	4	4	4	4.7	38.86%	9
Dutch Harbor	3	4	4	5	3	3	3	3	3	3	3	4	3	3	3	3	3.3	27.46%	6
Anchorage	0	0	0	1	1	2	3	3	2	1	1	1	1	2	2	2	1.4	11.40%	4
Edmonds	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	0.52%	1
Juneau	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0.8	6.22%	1
King Salmon	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	1.04%	1
Savoonga	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.1	0.52%	1
Seattle MSA*	2	4	3	2	2	2	2	1	1	2	1	1	1	1	1	1	1.7	13.99%	6
Other	2	5	4	4	4	5	6	5	4	4	3	4	3	4	4	4	4.1	33.68%	14
Grand Total	10	15	14	14	11	14	14	13	11	12	10	12	10	11	11	11	12.1	100.00%	29

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT source file BSS_SIA_Proc(10-13-22).
*Seattle MSA includes all communities in King, Pierce, and Snohomish counties.

Table 28 provides information on the first wholesale gross revenue for EBS snow crab by shore-based processors associated with EBS snow crab deliveries by community and year (2006-2021) to the extent possible within data confidentiality constraints. The decision to group Akutan with King Cove, Kodiak, and Saint Paul was due to confidentiality constraints. As shown, Akutan, King Cove, Kodiak, and Saint Paul combined account for approximately 46 percent of the average annual first wholesale gross revenue of EBS snow crab delivered to shore-based processors from 2006 through 2021, while Unalaska/Dutch Harbor accounts for 30 percent of the average annual first wholesale gross revenue for EBS snow crab. The remaining 26 percent of the average annual first wholesale gross revenue from EBS snow is included in other communities.

Table 28 EBS snow crab first wholesale gross revenue for shored-based processors accepting EBS snow crab by community of operation, 2006-2021 (thousands of 2021 real dollars)

Community	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021 (thousands)	Annual Average 2006-2021 (percent)	Unique Processors 2006-2021 (number)
Akutan/King Cove/Kodiak/St Paul	$35,584	$35,188	$73,080	$65,074	$45,211	$93,798	$139,523	$109,355	$103,892	$105,757	$78,598	$60,019	$41,010	$71,294	$79,118	$134,199	$79,419	45.56%	9
Dutch Harbor	*	*	$58,268	$55,082	$41,156	$64,178	$83,849	$71,699	$61,369	$58,497	$47,487	$31,675	$21,672	$32,773	$37,999	$66,203	$50,439	28.94%	6
Other	*	*	$34,726	$29,816	$28,981	$63,589	$89,752	$68,518	$48,164	$53,833	$39,364	$30,938	$20,740	$35,863	$43,761	$73,911	$44,449	25.50%	14
Grand Total	$88,682	$106,442	$166,073	$149,972	$115,348	$221,564	$313,124	$249,573	$213,425	$218,088	$165,449	$122,631	$83,422	$139,930	$160,879	$274,314	$174,307	100.00%	25

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT source file BSS_SIA_Proc(10-13-22).

Table 29 provides information on average annual shore-based processor dependency on deliveries of EBS snow crab compared to all area and species fisheries landings processed by those same processors for the years 2006-2021, as measured in percentage of first wholesale gross revenue associated with deliveries made to these processors. As shown, of the deliveries made to the combined Akutan, King Cove, Kodiak, and Saint Paul shore-based processors, approximately 13 percent of total first wholesale gross revenue of landings of all species were associated with EBS snow crab deliveries over the period. Some individual communities in this group represent a much greater dependency than the mean, which cannot be shown due to confidentiality restrictions; however, this community-level context is qualitatively described more in section 3.6.4. For the processors in Unalaska/Dutch Harbor, that figure was also approximately 13 percent.

Table 29 Revenue diversification for shore-based processors accepting EBS snow crab by first wholesale gross revenue, 2006-2021

Geography	Annual Average Number of Processors	Annual Average First Wholesale Revenues from Bering Sea Snow Crab Only (millions 2021 real $)	Annual Average Total First Wholesale Revenues from All Area, Gear, and Species Fisheries	Bering Sea Snow Crab First Wholesale as a Percentage of Total Ex-Vessel Gross Revenue Annual Average
Akutan/King Cove/Kodiak/St Paul	9	$79.4	$630.4	12.60%
Dutch Harbor	6	$50.4	$400.1	12.61%
Other	14	$44.4	$97.7	45.51%
Grand Total	25	$174.3	$1,128.1	15.45%

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT source file BSS_SIA_Proc(10-13-22).

Table 30 provides information on average annual total shore-based processor dependency on EBS snow crab (all shore-based processors in the communities that had at least one shore-based processor that accepted EBS snow crab deliveries, not just the shore-based processors that participate in that fishery) compared to all area and species fishery landings processed by all processors in the community(ies) for the years 2006-2021, within the constraints of confidentiality restrictions, as measured by first wholesale gross revenue associated with those landings. As shown, for the span of years provided, EBS snow crab first wholesale gross revenue of landings accounted for about 7 percent of all shore-based processor first wholesale gross revenue of landings for Akutan, King Cove, Kodiak, and Saint Paul combined, while for Unalaska/Dutch Harbor that figure was 8 percent for all shore-based processor first wholesale gross revenue.

Table 30 Revenue diversification for communities with shore-based processors that processed EBS snow crab by first wholesale gross revenue by these shore-based processors, 2006-2021

Geography	Annual Average Number of Processors	Annual Average Number of All Commercial Fishing Processors in those Same Communities	Annual Average First Wholesale Revenues from Bering Sea Snow Crab Only (millions 2021 real $)	Annual Average Total First Wholesale Revenues from All Areas, Gears, and Species Fisheries for the Community Fleet (millions 2021 real $)	First Wholesale Revenue as a Percentage of Total Community First Wholesale Gross Revenue Annual Average
Akutan/King Cove/Kodiak/St Paul	9	23.8	$70.9	$947.2	7.48%
Dutch Harbor	6	7.4	$49.2	$582.4	8.45%
Other	14	310.6	$37.4	$585.2	6.39%
Grand Total	25	341.8	$157.5	$2,114.7	7.45%

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT (BSS_SIA_Proc(9-21-22))

Table 31 provides information on EBS snow crab processor dependency on the EBS snow crab fishery, BBRKC fishery, and aggregated groundfish fisheries by comparing annual average first wholesale gross revenue from these fisheries to annual average total first wholesale gross revenue from all other areas, gear types, and species from 2006-2021. As shown, the largest share of annual average first wholesale gross revenue for EBS snow crab processors is from the aggregated groundfish fisheries followed by the EBS snow crab fishery.

Table 31 Revenue sources for processors accepting EBS snow crab for shore-based processors accepting EBS snow crab by gross first wholesale revenue, 2006-2021

Geography	Annual Average First Wholesale Revenues from Bering Sea Snow Crab (millions 2021 real $)	Annual Average First Wholesale Revenues from Bristol Bay Red King Crab (millions 2021 real $)	Annual Average First Wholesale Revenues from All Crab (millions 2021 real $)	Annual Average First Wholesale Revenues from Groundfish (millions 2021 real $)	Annual Average Total First Wholesale Revenues from All Areas, Gears, and Species Fisheries (millions 2021 real $)
Akutan/King Cove/Kodiak/St Paul	$79.4	$34.2	$115.9	$332.0	$630.4
Dutch Harbor	$50.4	$37.5	$116.8	$257.5	$400.1
Other	$44.4	$13.3	$62.7	$4.6	$97.7
Grand Total	$174.3	$85.0	$295.4	$594.1	$1,128.1

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT source file BSS_SIA_Proc(10-13-22).

Table 32 provides information on annual EBS snow crab processor dependency on the EBS snow crab fishery relative to the total first wholesale gross revenue from all other areas, gear types, and species processed by those same processors. In general, during 2006 to 2021, largest number of processors received up to 20 percent of their total first wholesale gross revenue from EBS snow crab. The table also indicates that a few EBS snow crab processors routinely received between 70 percent to 100 percent of their annual total first wholesale gross revenue from EBS crab.

Table 32 Annual average EBS snow crab first wholesale gross revenue as a percentage of annual average total first wholesale gross revenue, 2006-2021 (number of processors)

BSS Crab Revenue as a % of Total	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Annual Average 2006-2021
0-10%	6	8	6	6	4	6	2	3	3	4	4	6	5	4	4	3	4.63
10-20%	0	0	2	1	1	1	3	4	2	2	1	0	1	1	0	2	1.31
20-30%	0	2	1	0	0	0	2	1	0	0	0	0	0	1	2	1	0.63
30-40%	1	3	1	0	3	0	0	0	1	2	1	1	2	1	0	0	1.00
40-50%	0	0	0	2	1	2	1	0	2	0	1	1	1	0	1	0	0.75
50-60%	1	1	1	2	1	2	0	2	1	2	2	1	1	1	0	2	1.25
60-70%	1	0	1	0	0	2	2	2	1	0	0	2	0	1	0	0	0.75
70-80%	0	0	1	1	1	0	2	0	0	0	1	1	1	1	2	0	0.69
80-90%	1	0	0	1	0	1	1	1	0	1	0	0	0	1	0	1	0.50
90-100%	0	1	1	1	0	0	1	0	1	1	0	0	0	0	2	2	0.63
Grand Total	10	15	14	14	11	14	14	13	11	12	10	12	10	11	11	11	12.06

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT source file BSS_SIA_Proc(10-13-22).

3.6.3.2 Overview of EBS Snow Crab Communities

The information included in this section originates from four sources: 1) Community Profiles for North Pacific Fisheries[6]; 2) Appendix A BSAI Crab Rationalization Ten-Year Program Review, Social Impact Assessment; 3) Annual Community Engagement and Participation Overview (ACEPO), March 19, 2021, and 4) Regulatory Impact Review/Environmental Assessment for Proposed Amendment 122 to the Fishery Management Plan for Groundfish of the BS and Aleutian Islands Management Area, BSAI Pacific Cod Trawl Cooperative Program.

6 https://www.fisheries.noaa.gov/resource/document/profiles-fishing-communities-alaska

3.6.3.2.1 Unalaska/Dutch Harbor

Unalaska is located within the Aleutians West Census Area and is not under the jurisdiction of a borough. In 2010, there were 4,376 residents in Unalaska, making it the 26th largest of 352 total Alaskan communities with recorded populations that year. In a survey conducted by NOAA's Alaska Fisheries Science Center in 2011, community leaders estimated that approximately 2,500 seasonal or transient workers come to Unalaska each year. Community leaders also noted that the population of Unalaska reaches its annual peak between January 15th and April 1st each year (during Pollock "A" Season), and that the annual peak in population is "entirely" driven by employment in the fishing sectors.

Unalaska, traditionally an Aleut community, has become a relatively large, plural community with population growth that has accompanied port and fisheries-related development. Despite being an ANCSA village and having a federally recognized tribe, Unalaska did not qualify for CDQ membership based in part on having previously developed harvesting or processing capability sufficient to support substantial groundfish participation in the BSAI. It is, however, an *ex-officio* member of the Aleutian Pribilof Island Community Development Association (APICDA) CDQ group, a status that facilitates the participation of Unalaska residents in a range of APICDA programs. While the Unalaska/Dutch Harbor local commercial fishing fleet is typically represented in the Council and other regulatory processes by the Unalaska Native Fishermen's Association which, according to tribal leadership has a close working relationship with the Qawalangin Tribe of Unalaska, membership is not limited to those residents of Alaska Native descent. The demographics of the owners and crew of the specific <60' HAL/pot vessels that would potentially experience adverse impacts under one or more of the proposed alternatives are unknown, but a general knowledge of the fleet would suggest that its demographics are largely reflective of the general/residential population of the community.

Unalaska's economy is based on commercial fishing, fish processing, and fleet services, such as fuel, repairs, maintenance, trade, and transportation. The community enjoys a strategic position as the center of a rich fishing area and is used for transferring cargo between Pacific Rim trading partners. The Great Circle shipping route from major U.S. west coast ports to the Pacific Rim passes within 50 mi of Unalaska, and Dutch Harbor provides natural protection for fishing vessels. Onshore and offshore processors provide some local employment. However, non-resident workers are usually brought in during the peak season. In 2010, 31 residents held commercial fishing permits. Westward Seafoods, Unisea, Alyeska Seafoods, Icicle Seafoods, Trident Seafoods, and Royal Aleutian Seafoods process the commercial catch.

With respect to local economies, the importance of commercial fishing for Unalaska/Dutch Harbor cannot be overstated, as Unalaska/Dutch Harbor has ranked as the number one U.S. port in volume of landings since 1992 and has ranked second in value of landings (behind New Bedford, Massachusetts) since 2000. In recent years, employment statistics for Unalaska/Dutch Harbor have shown that the top three employers in the community were seafood processing companies, and that their employees accounted for over half of all employment in the city. The support service sector for the commercial fishing fleet is by far the most developed in the BSAI region, and Unalaska and firms dependent on the fisheries, such as stevedoring and shipping, regularly rank as some of the largest employers. There is no other community in the region with the level of development or the range of support services provided to the various fishery sectors operating in the BSAI region, which include accounting and bookkeeping, banking, construction and engineering, diesel sales and service, electrical and electronics services, freight forwarding, hydraulic services, logistical support, marine pilots/tugs, maritime agencies, gear replacement and repair, vessel repair, stevedoring, vehicle rentals, warehousing, and welding, among others (AECOM 2010; NOAA 2014).

As noted in the ACEPO document, Unalaska has a total of 12 seafood processing plants, five of which process groundfish. The vast majority of landings in Unalaska is pollock at 90 percent, Pacific cod at 7 percent, and crab at 2 percent. Although the percent of crab processing in Unalaska is only 2 percent, the community nevertheless is highly engaged in the crab processing sector, as noted in the ACEPO document. During 2019, Unalaska processed 15.7 million pounds of crab with an associated value of $66.9 million. This marks a 15 percent increase (2 million pounds) in volume landed since 2018, and a 10 percent decreased in landed value (down $7.8 million). Compared to the previous five-year average both volume processed and landed value in 2019 has decreased. 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.

The first wholesale gross revenue for processors accepting EBS snow crab has ranged from $22 million in 2018 to $84 million in 2012, with an average annual first wholesale gross revenue of $50 million from 2006 through 2021 (see Table 28). Relatively to the annual average gross revenues of only EBS snow crab deliveries to shore-based processors, Unalaska accounted for 29 percent of this value. Relatively to the average annual total first wholesale gross revenue of all fisheries processed by these Unalaska EBS snow crab processors from 2006 through 2021, EBS snow crab accounted for 13 percent of that total (see Table 29). Expanding to include all shore-based processors in Unalaska, the average annual EBS snow crab first wholesale gross revenue from 2006 through 2021 accounted for 8 percent (see Table 30).

Unalaska/Dutch Harbor EBS snow crab crew employment has been variable. As demonstrated in Table 24, between 2012 through 2020, EDR data indicate that between 3 (2020) and 28 (2015) crew from EBS snow crab vessels provided Unalaska/Dutch Harbor addresses on their ADFG commercial fishing crew licenses.

Table 33 provides information on City of Unalaska tax revenue deriving from sources directly related to fishing activities (the city raw seafood tax, the state shared fisheries business tax, and the state shared fisheries resource landing tax) compared to all general fund revenues received by the city for fiscal years 2010-2019. As shown, for the City of Unalaska, between roughly 37 percent and 50 percent of all general fund revenues in any given year derive from direct fishery revenue sources. These figures do not include revenue from other taxes and fees from activities in the community that are fishing related (e.g., property taxes paid by fisheries businesses, fuel transfer tax revenue, and harbor fee revenue, among others).

Table 33 City of Unalaska selected fisheries-related general fund revenues, fiscal years 2010-2019

Fiscal Year	Revenue (dollars) by Direct Fishery Revenue Source				All General Fund Revenue	Direct Fishery Revenue Source Total as a Percent of All General Fund Revenue
	Direct Fishery Revenue Source			Direct Fishery Revenue Source Total		
	City Raw Seafood Tax	Shared State Fisheries Business Tax	Shared State Fisheries Resource Landing Tax			
FY 2010	$3,594,173	$4,547,084	$4,676,603	$12,817,860	$29,604,371	43.3%
FY 2011	$5,371,768	$3,199,290	$3,531,739	$12,102,797	$29,152,912	41.5%
FY 2012	$5,260,999	$4,143,777	$3,469,263	$12,874,039	$31,634,417	40.7%
FY 2013	$4,784,198	$4,398,441	$4,898,543	$14,081,182	$32,609,892	43.2%
FY 2014	$4,449,921	$4,377,934	$6,974,887	$15,802,742	$34,376,971	46.0%
FY 2015	$4,981,770	$3,639,448	$5,014,309	$13,635,527	$34,525,170	39.5%
FY 2016	$5,123,372	$4,099,315	$3,034,438	$12,257,125	$30,723,626	39.9%
FY 2017	$4,657,385	$4,276,287	$8,272,661	$17,206,333	$34,371,441	50.1%
FY 2018	$4,475,150	$4,014,323	$4,532,106	$13,021,579	$30,300,957	43.0%
FY 2019	$4,761,506	$3,528,499	$5,220,958	$13,510,963	$36,419,248	37.1%

Source: City of Unalaska, Alaska. Comprehensive Annual Financial Reports, Fiscal Years 2010-2019. https://www.commerce.alaska.gov/dcra/dcrarepoext/Pages/FinancialDocumentsLibrary.aspx. Accessed 4/25/2020.

3.6.3.2.2 Akutan

Akutan is located on Akutan Island in the eastern Aleutians, one of the Krenitzin Islands of the Fox Island group. It is 35 mi east of Unalaska and 766 mi southwest of Anchorage. The area occupies 14.0 sq mi of land and 4.9 sq mi of water. The community was incorporated as a Second-class city in 1979 and is under the jurisdiction of the Aleutians East Borough.

Akutan, a community within the Aleutians East Borough, is somewhat unique demographically since it is the home of a large shore-based processor and the population size of the processing workforce residing in company housing at the plant site[7] is larger than the predominately Alaska Native population residing within the traditional community footprint. The dual nature of the community demographics and socioeconomic attributes is reflected in the history of the community involvement in the CDQ program. Initially (in 1992), Akutan was deemed not eligible for participation in the CDQ program as the community was home to "previously developed harvesting or processing capability sufficient to support substantial groundfish participation in the BSAI…" though the community met other qualifying criteria. The Akutan Traditional Council subsequently initiated action to show that large industrial enclave-style development of the locally operating shore-based processor was essentially socially and economically separate and distinct from the traditional community of Akutan. With the support of APICDA and others, Akutan was successful in obtaining CDQ community status in 1996 and became a member community of APICDA.

As of 2010, there were 1,027 residents, ranking Akutan 64th of 352 Alaskan communities in terms of population size (this population count captured a large number of non-permanent residents).
In a survey conducted by NOAA's Alaska Fisheries Science Center (AFSC) in 2011, community leaders reported that there were an estimated 85 permanent and 900 seasonal residents living in Akutan in 2010. Seasonal workers typically live in Akutan from January through April with the population peaking in May. Peaks in Akutan's population are mostly driven by seasonal employment in fisheries sectors.

Akutan has seen little in the way of fishery support service development, but the local processing operation accounts for a large percentage of local private sector employment and income opportunities.

Akutan is home to a large processing operation (Trident Seafoods) that was a major crab processing plant prior to rationalization and has remained so post-rationalization. Confidentiality restrictions do not allow disclosure of processing volumes or values.[8] Given the lack of processor quota movement from the community, however, it is assumed that net processing volumes as a percentage of total fishery processing volumes have not decreased substantially, and it can be assumed with an increase in custom

processing since the time of the 5-year program review that it is likely that locally processed percentage of overall fishery volume has increased. According to 2008 interviews with Akutan community leaders, no long-term residents of the community work at the plant other than a few individuals who came to the community for employment at the plant, a situation that existed prior to rationalization. According to

local leadership, at present (2016) there is one local individual who has worked at the plant "for the last couple of years."

[7] According to the owner/operator's website, the Akutan shoreplant has become the largest seafood production facility in North America with more than 1,400 company-housed employees present during peak seasons (accessed 6/30/2021).
[8] In terms of processing quota shares held, at the time of initial allocation, Trident held processor quota shares with Akutan as the designated boundary for right of first refusal and the Aleutians East Borough designated as the cooling off boundary under the community protection measures built into the program for the Bristol Bay red king crab, Bering Sea snow crab, EAI golden king crab, Saint Matthew blue king crab, and Pribilof Islands blue and red king crab fisheries. At the time of the 5-year program review, these share holdings were unchanged from initial allocations and right of first refusal provisions are unchanged as well; the same holds true at present (2016).

As noted in the ACEPO document, Akutan, King Cove, and Sand Point crab processing activity which were aggregated due to confidentiality concerns, are highly engaged in the crab processing sector with six processing facilities in the region. In 2019, these communities processed 8.1 million net pounds of crab with an associated value of $35.8 million. Compared to the previous five-year average, the volume decreased by 5 million pounds (down 39 percent) and the value decreased by $17.6 million (down 33 percent). 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 percent). Comparatively, the associated value dropped by $5.4 million or 7 percent during the same year. Both volume and landed value continued a steady decline since. In addition to crab processing, these communities are also highly engaged in the groundfish processing sector. Walleye pollock accounts for 76 percent of the landed value within the processing sector in Akutan, King Cove, and Sand Point. Other processing activity include Pacific cod at 13 percent and salmon at 8 percent.

As demonstrated in Table 24, EDR data indicated that one to three EBS snow crab crew members who provided Akutan addresses on their ADFG commercial fishing crew licenses between the period of 2012 through 2016, in addition to one crew member in 2018.

Table 34 provides information on City of Akutan tax revenues deriving from direct fishery revenue sources (the city raw seafood tax, the state shared fisheries business tax, and the state shared fisheries resource landing tax) compared to all general fund revenues received by the city for fiscal years 2010-2019. As shown, for the City of Akutan, between roughly 75 percent and 99 percent of all general fund revenues in any given year derive from direct fishery revenue sources.

Table 34 City of Akutan selected fisheries-related general fund revenues, fiscal years 2010-2019

	Revenue (dollars) by Direct Fishery Revenue Source					
	Direct Fishery Revenue Source					
Fiscal Year	City Raw Seafood Tax	Shared State Fisheries Business Tax	Shared State Fisheries Resource Landing Tax	Direct Fishery Revenue Source Total	All General Fund Revenue	Direct Fishery Revenue Source Total as a Percent of All General Fund Revenue
FY2010	$753,127	$1,088,369	$307,561	$2,149,057	$2,588,527	83.0%
FY 2011	$1,222,653	$827,408	$154,758	$2,204,819	$2,926,637	75.3%
FY 2012	$1,385,057	$853,570	$244,134	$2,482,761	$3,077,710	80.7%
FY 2013	$1,663,209	$1,186,396	$178,611	$3,028,216	$3,831,293	79.0%
FY 2014	$1,715,128	$1,217,118	$157,540	$3,089,786	$3,602,184	85.8%
FY 2015	$1,774,963	$1,029,663	$69,412	$2,874,038	$3,418,630	84.1%
FY 2016	$2,098,763	$943,814	$173,049	$3,215,626	$3,253,634	98.8%
FY 2017	$2,044,698	$1,082,206	$210,114	$3,337,018	$3,784,609	88.2%
FY 2018	$1,985,328	$1,358,949	$4,916	$3,349,193	$3,796,184	88.2%
FY 2019	$2,101,784	$1,097,955	$163,372	$3,363,111	$3,887,032	86.5%

Note: in 2013, the City of Akutan raised is local fish tax from 1.0 to 1.5 percent.
Source: City of Akutan, Alaska Basic Financial Statements, Required Supplementary Information, Additional Supplementary Information, and Compliance Reports, fiscal years 2010-2013 and 2015-2019; Certified Financial Statement, fiscal year 2014. https://www.commerce.alaska.gov/dcra/dcrarepoext/Pages/FinancialDocumentsLibrary.aspx. Accessed 9/15/2020.

3.6.3.2.3 King Cove

King Cove is located on the south side of the Alaska Peninsula, on a sand spit fronting Deer Passage and Deer Island. It is 18 miles southeast of Cold Bay and 625 miles southwest of Anchorage. King Cove is in the AEB and the Aleutian Islands Recording District. King Cove's area encompasses 25.3 square miles of land and 4.5 square miles of water.

In 2010, there were 938 residents in King Cove, making it the 70th largest of 352 total Alaskan communities with recorded populations that year. Overall, between 1990 and 2010, the population increased by 108 percent. Between 2000 and 2010, there was an average annual growth rate of 18.4 percent, which was substantially above the statewide average of 0.75 percent. It is important to note that, in a survey conducted by AFSC in 2011, community leaders reported that the 2010 Decennial Census population count may have been inflated, including approximately 400 individuals that do not reside in the community permanently. Community leaders estimated 450 permanent residents in 2010.

In the 2011 AFSC survey, community leaders indicated that 75 percent of economic activity in King Cove is based on direct and indirect fishing activity. Between 2000 and 2010, the number of commercial fishery permit holders, crew license holders, and vessel owners residing in King Cove all declined, but all of these numbers represented a large percentage of the population. On average over the 2000-2010 period, the number of state permit holders was equivalent to 7.8 percent of the local population, the number of vessel owners was equivalent to 10.2 percent, and the number of crew license holders was equivalent to 19.2 percent.

King Cove is one of the leading processing communities in Alaska, ranking 7th in landings and 11th in ex-vessel revenue out of 67 Alaskan ports that received landings in 2010. As noted in the Akutan community profile of the ACEPO document, when combined with King Cove and Sand Point, these communities are highly engaged in the crab processing sector with six processing facilities in the region.[9]

In the 2011, AFSC survey, community leaders indicated that vessels homeporting in King Cove range in size from 35 feet to over 125 feet in length, and utilize gear types including trawl, pots, longline, gillnet, purse seine, and troll gear. They also indicated that most of the decline in fishing vessels in recent years has been a loss of the larger fleet – those vessels ranging from 60 to more than 125 feet in length. Specifically, they reported that one source of this decline is fewer BS crab boats coming to King Cove as a result of crab rationalization.

King Cove is home to a large processing operation (Peter Pan Seafoods) that was a major crab processing plant prior to rationalization and has remained so post-rationalization. Confidentiality restrictions do not allow disclosure of processing volumes or values, but city officials on multiple occasions, have noted that local fish taxes, while varying from year-to-year are often a rough balance between crab, salmon, and groundfish.[10] Given the lack of processor quota movement from the community, however, it is assumed that net processing volumes as a percentage of total fishery quota processed have not changed substantially. Additionally, as reported in the 5-year program review (and confirmed with subsequent correspondence with Peter Pan Seafoods management), the plant has benefited from a consolidation of processor history within the AEB (and within the same firm) that was originally associated with processing activity during the qualification period that took place in both False Pass and Port Moller.[11] This consolidated processing has continued to take place in King Cove through the present

[9] Akutan, King Cove, and Sand Point processing activity was aggregated due to confidentiality concerns.
[10] Percentage dependency for major species groups ranged widely on an annual basis between FY 2000 and FY 2015, based on relative fishing success and variable market (price) conditions. During this time span, crab ranged between roughly 30 and 50 percent, salmon accounted for between roughly 15 and 40 percent, and groundfish between roughly 25 and 50 percent of total local landing taxes in any given year.
[11] Qualifying crab processing history associated both False Pass and Port Moller resulted exclusively from floating processors operating within those communities. All False Pass associated processing history was derived from Peter Pan Seafoods operations. In the case of Port Moller, Peter Pan Seafoods was one of three firms with qualifying history associated with that community (with the other two being Snopac and Icicle Seafoods). According to Peter Pan Seafoods management, the Peter Pan Seafoods processor quota associated with False Pass and Port Moller have been processed annually in the Peter Pan Seafoods plant in King Cove; the Port Moller associated processing quota shares owned by the other two firms (or the successor owners of the processor quota originally owned by those other firms, APICDA and CBSFA/57 Degrees North, respectively), has not been custom processed at the Peter Pan Seafoods King Cove plant.

(2016). Further, according to interviews with plant management conducted for the 5-year program review, employment levels and the annual activity fluctuations at the plant have remained consistent with the patterns seen before rationalization was implemented.

Also, as reported in the 5-year program review, according to interviews, no long-term residents of the community work at the plant other than a few individuals who originally came to the community for employment at the plant, a situation that existed prior to rationalization; according to more recent (2016) interview information, this situation remains unchanged, although it is reported also that there have always been a few local teenagers who take the opportunity provided by the summer break to work at the plant.

As noted previously reported in the 5-year program review, changing processor ownership patterns have required divestiture, and resulted in the transfer (through sale) of some King Cove-based processor quota from Peter Pan Seafoods to Aleutia, a regional-based (Aleutian East Borough-based) entity. These shares have continued to be processed in King Cove under a series of annual custom processing agreements.[12] According to city staff, this situation has remained unchanged in more recent years, with the city and the borough continuing to support Aleutia's efforts through a favored tax status.

As demonstrated in Table 24, EDR data indicated that two to nine Alaska residents who provided King Cove addresses on their ADFG commercial fishing crew licenses have crewed on EBS snow crab vessels each year from 2012 through 2020, with an average during this period of 6 crew licenses.

In 2020, King Cove total tax revenue was $1,319,017 of which $695,368 was from the 2 percent raw fish tax and $623,649 was from a 6 percent sales tax. King Cove also received $12,844.87 in shared fisheries business tax for that year. In 2021, King Cove received $2,152,507 in total tax revenue of which $743,413 originated from a 2 percent raw fish tax and $1,409,094 was from a 6 percent sales tax. The community also received $7,237 in shared fisheries business tax for that year. Community leaders reported that a variety of public services are at least partially funded by fisheries-related taxes and fees, including harbor maintenance, the health clinic, roads, the police force and fire protection, the recreation center, social services such as libraries, and general city administration. King Cove has local fishing-related fee programs that charge the fishing industry specifically to support public services and infrastructure.

3.6.3.2.4 Saint Paul Island

The community of Saint Paul Island is located on a narrow peninsula on the southern tip of Saint Paul Island, the largest of the five Pribilof Islands. It lies 47 miles north of Saint George Island, 240 miles north of the Aleutian Islands, 300 miles west of the Alaska mainland, and 750 air miles west of Anchorage. Saint 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.

In 2010, the U.S. Census determined that there were 479 residents in Saint Paul Island, making it the 122nd largest of 352 total Alaskan communities with recorded populations that year. However, the 2006-2010 American Community Survey (ACS) estimated that Saint Paul Island had 1,065 residents in 2010.

[12] At the time of initial allocation, Peter Pan Seafoods held processor quota shares with King Cove designated as the right of first refusal boundary and the Aleutians East Borough designated as the cooling off boundary under the community protection measures built into the program for the Bristol Bay red king crab, Bering Sea snow crab, Pribilof blue and red king crab, and Saint Matthew blue king crab fisheries. At the time of the 5-year program review (2010), Peter Pan Seafoods retained ownership of all of these shares, except for a portion of the Bristol Bay red king crab shares that had been acquired by Aleutia. For the shares owned by Aleutia (including EBS Tanner and WBS Tanner crab, in addition to the Bristol Bay red king crab quota obtained from Peter Pan Seafoods), no right of first refusal provisions existed; for all other shares, right of first refusal provisions were unchanged. At the time of 2015/2016 IPQ allocation, Aleutia's holdings were unchanged from the time of the 5-year program review. For Peter Pan Seafoods, all remained the same as at the time of the 5-year program review except for their Saint Matthew blue king crab processor quota shares which, according to the dataset, were listed under a different holder (B&N Fisheries Company) and had no right of first refusal provisions attached.

Another census by the city reports there were 344 full time residents as of October 2022. In a survey conducted by AFSC in 2011, community leaders reported that an estimated 300 seasonal workers or transients live in Saint Paul Island for part of the year, mostly working in the construction, tour guide, and fishing industries (e.g., snow crab, halibut, and king crab). They also indicated that the population of Saint Paul Island reaches an annual peak in January when transient processors are present, and that the population peak is entirely driven by fisheries-related employment.

Saint Paul Island is home to one large onshore processing operation (Trident Seafoods), which was a major crab processing plant prior to rationalization and has remained so post-rationalization. As noted in the ACEPO document, most processing activity in Saint Paul Island is for crab (94 percent of landed revenue). Halibut accounts for 6 percent of landed revenue. As noted in Table 27 in section 3.6.3.1.4, only one facility in Saint Paul has received EBS snow crab deliveries since 2006. In addition, as noted in Table 9 of the ACEPO document, Saint Paul Island has the second highest commercial crab processing engagement score since 2008, second only to Unalaska/Dutch Harbor. This index is an indicator of the degree of crab processing participation in a community relative to the crab processing participation of other communities.

Saint 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. While the floating processors did not typically employ any Saint Paul Island residents, a handful of long-term residents were employed at the Trident Seafoods shore plant, mostly as dock workers or crane operators. These employees typically worked the entire year, which includes the BSAI crab season in the fall and winter months, and the halibut season in the spring and summer months.

According to CBSFA staff, in each year since the 5-year program review, the Icicle Seafoods floating processor R.M. Thorstenson processed BSAI crab within the municipal boundaries but outside of the harbor up through the 2014/2015 season. It did not do so in the 2015/2016 season and, with the sale of Icicle Seafoods crab assets consisting of both IFQ and IPQ to 57 Degrees North, it is not expected to return to the community as a crab processor in the future. The Trident Seafoods shoreplant has continued to provide employment to a number of residents, mostly in dock crew and crane operator positions, but CBSFA staff report that a few local residents have worked line and other inside jobs at the plant as well in recent years. With the local presence of a major processing operation, CBSFA staff also point out that indirect employment is generated across a range of businesses, including at the fuel dock, the grocery store, and the air carriers, among others, not to mention administrative positions at the CBSFA as well as 57 Degrees North, Saint Paul Fish Company, and other CBSFA subsidiaries.

In terms of direct participation, local fishermen are almost exclusively engaged in the halibut fishery. With CBSFA investments in multiple crab vessels, Saint Paul residents interested in obtaining a crew position on a crab vessel have ready access though the CBSFA. At the time of the 5-year program review, officials from the CBSFA report, however, that this is not common because of (1) the relative ability of halibut fishermen to receive income throughout the year due to a phased payment for the halibut harvest that continues through the fall and winter, (2) relatively ample alternate employment opportunities on-island during typical crabbing months, and (3) the less attractive nature of the BSAI crab fishery when compared to the halibut fishery.

More recently, however, CBSFA leadership reported that this situation has changed somewhat. While there is still a strong local focus on the halibut fishery, the vitality of which is largely attributable to the CDQ program, a number of residents have reportedly crewed on CBSFA's 58-foot cod vessels, and at least a few individuals in the most recent seasons have worked on crab vessels in which CBSFA or its subsidiaries have an ownership interest. Local officials are optimistic that continuing opportunities for experience in the other two fisheries will, in turn, provide others the opportunity to take similar routes into the crab fishery, should they choose to do so.

As noted in Table 24, EDR data indicated that between one to three Alaska residents with Saint Paul Island addresses on their ADFG commercial fishing crew license crewed on EBS snow crab vessels from 2013 to 2019; none did so in 2012 and 2020.

In 2021, Saint Paul Island total tax revenue was $4,188,257 of which $3,347,430 was from the local fish tax on the sale of seafood which is composed of 3.5 percent on rationalize shares and species of crab and 2 percent on non-rationalized shares and species of crab. Saint Paul Island also received $840,827 in shared state fish tax for that year. In 2022, Saint Paul Island received $2,049,748 in total tax revenue of which $503,856 originated from fish tax on the sale of seafood and $1,545,892 from shared state fish tax. The city is now facing a decline in fisheries related revenue, due to a sharp decline in EBS snow crab TAC in 2021/2022 season and no directed fishing for EBS snow crab in the 2022/2023 season, by far the most economically important fishery overall to the community, combined with the closure of the BBRKC fishery, and an ongoing decline in halibut exploitable biomass available to the directed halibut fishery, the most substantial fishery pursued by the local fleet. Slowdowns in these fisheries are also felt throughout the range of support services provided in the community, such as fuel sales and marine usage, which also underpin the local economy.

3.6.3.2.5 Kodiak

Kodiak is located near the northwestern tip of Kodiak Island in the Gulf of Alaska. Kodiak Island (aka: “the emerald isle”) is the largest island in Alaska and is the second largest island in the United States. Kodiak National Wildlife Refuge (KNWR) encompasses nearly 1.9 million acres on Kodiak and Afognak Islands. It is 252 mi south of Anchorage (a 45-minute flight) and is a 4-hour flight from Seattle. Kodiak was first incorporated in 1940 and is now a Home Rule City and the seat of the Kodiak Island Borough.

In 2010, there were 6,130 residents in Kodiak, ranking it the 16th largest of 352 total Alaskan communities with recorded populations that year. Between 1990 and 2010, the population declined by 3.7%. Between 2000 and 2009, the population increased by 4.6% with an average annual growth rate of 0.51%, which was similar to statewide average of 0.75% and indicative of modest growth. In a survey conducted by the AFSC in 2011, community leaders reported that there were an estimated 6,000 permanent residents, and 600 transient residents living in Kodiak in 2010. According to community leaders, seasonal workers live in Kodiak from July through September, with annual population peaks typically occurring in July and August. Peaks in population are mostly driven by employment in fisheries sectors.

Commercial fishing, seafood processing, and commercial fishing support services are the major industries contributing to the local economy in Kodiak. The U.S. Coast Guard station is also a substantial employer. Other industries include retail services and government. Tourism is growing, and recreational fishing, hiking, and kayaking are increasing in popularity. In a survey conducted by the AFSC in 2011, community leaders reported that Kodiak’s economy is reliant on logging, fishing, ecotourism, and sport hunting and fishing.

As noted in the ACEPO document, Kodiak has a diversified fisheries profile, with groundfish making up about 40 percent of total fisheries harvest by weight. Pacific cod has shown a consistent decline in recent years, as has halibut, crab, and to some degree pollock. In 2019, the volume of groundfish harvest was 241.6 million pounds with an associated value of $44.1 million. Compared to the previous five-year average, both the harvest volume and associated value showed declines of 18 million pounds (down 7 percent) and $3.8 million (down 8 percent) respectively.

For EBS snow crab fishery, eight Kodiak-owned vessels participated in the fishery from 2011 through 2017 while the remaining years through 2021 had seven vessels participating in the fishery (see Table 18). The annual average ex-vessel revenue from EBS snow crab fishery by the Kodiak-owned EBS snow crab vessels was $12.7 million, which accounts for 10.4 percent of the total of annual average EBS snow crab ex-vessel gross revenue for the fishery (see Table 19). Relatively to annual average total ex-vessel gross revenues from all areas, gear, and species for these Kodiak-owned EBS snow crab vessels, the annual average EBS snow crab ex-vessel gross revenue accounted for 50.8 percent (see Table 20). From the perspective of the annual average total EBS snow crab ex-vessel gross revenue from 2006 through 2021 for these Kodiak-owned vessels as a percentage of total community ex-vessel gross revenue from all areas, gears, and species from the Kodiak-owned fleet during the same years, Kodiak-owned EBS snow crab vessels accounted for 9.9 percent of that community total (see Table 21).

Kodiak is also home to several crab processing plants. As noted in the BSAI Crab Rationalization Ten-Year Program Review, during the second five years of the rationalization program (2010/2011 through 2014/2015) there were between three and five Kodiak plants that processed BBRKC and between one and three Kodiak plants that processed EBS snow crab in any given year. This trend has continued through 2021 for EBS snow crab with only one shorebased processor accepting deliveries of EBS snow crab since 2015 (Table 27). The annual average number of plants processing BBRKC was the same during the first five and the second five years of the rationalization program (3.6 plants), while the annual average number of Kodiak plants processing EBS snow crab declined slightly (from 2.0 to 1.8 plants).

As noted in Table 24, EDR data, for years 2012 through 2020, indicate that between 24 in 2020 and 83 in 2015 crew provided Kodiak addresses on their ADFG commercial fishing crew licenses crewed on EBS snow crab vessels each year.

3.6.3.2.6 Seattle MSA

As described in the Seattle community profile in the *BSAI Crab Fisheries Final Environmental Impact Statement Social Impact Assessment* (NOAA 2004, Appendix 3), Seattle is the community most engaged in the BSAI crab fisheries, if gauged by the sheer number of locally owned vessels participating in the fisheries as a whole. Seattle is also the location of regional if not company headquarters for a number of the processing firms engaged in the BSAI crab fisheries. It is also a major support service center for the fleet, both in terms of providing services directly and as the headquarters for a number of firms that provide support services out of Alaskan ports. As described in the in section 3.6.3.1, crab fishery support activity takes a variety of forms and does not appear to be heavily concentrated in any one area of Seattle.

For EBS snow crab fishery, the number of vessels harvesting EBS snow crab from 2006 to 2021 with ownership address of Seattle MSA ranged from a low of 27 in 2021 to a high of 39 in 2006 (see Table 18). The annual average ex-vessel revenue from EBS snow crab fishery by the Seattle MSA-owned EBS snow crab vessels was $63 million, which accounts for 51 percent of the total of annual average EBS snow crab ex-vessel gross revenue for the fishery (see Table 19). Relatively to annual average total ex-vessel gross revenues from all areas, gear, and species for these Seattle MSA-owned EBS snow crab vessels, the annual average EBS snow crab ex-vessel gross revenue accounted for 49 percent (see Table 20). From the perspective of the annual average total EBS snow crab ex-vessel gross revenue from 2006 through 2021 for these Seattle MSA-owned vessels as a percentage of total community ex-vessel gross revenue from all areas, gears, and species from the Seattle MSA-owned fleet during the same years, Seattle MSA-owned EBS snow crab vessels accounted for 14.1 percent of that community total (see Table 21).

EDR data for years 2012 through 2020 indicate that between 43 (2016) and 185 (2015) EBS snow crab crew members provided Seattle MSA addresses on their ADFG commercial fishing crew licenses (Table

24). This represents on average 13.35 percent of the EBS snow crab crew and the community with the largest share of crew employment.

3.6.3.3 Community Development Quota

Regulations establishing the CDQ Program were first implemented in 1992. The CDQ Program was incorporated into the MSA in 1996, through the Sustainable Fisheries Act (Pub. L. 104–297). Since the inception of the program, CDQ fisheries management regulations have continued to be developed and amended.

Particularly in fitting with National Standard 8,[13] MSA §305(i)(1) describes the intent of the CDQ Program:

> (i) to provide eligible western Alaska villages with the opportunity to participate and invest in fisheries in the Bering Sea and Aleutian Islands Management Area;
> (ii) to support economic development in western Alaska;
> (iii) to alleviate poverty and provide economic and social benefits for residents of western Alaska;
> (iv) to achieve sustainable and diversified local economies in western Alaska.

The CDQ is an economic development program associated with federally managed fisheries in the BSAI. The purpose of the program is to provide these 65 western Alaska communities the opportunity to participate and invest in BSAI fisheries, to support economic development in western Alaska, to alleviate poverty, and provide economic and social benefits for residents of western Alaska, and to achieve sustainable and diversified local economies in western Alaska.

The MSA allocates a portion of the annual catch limit for each directed fishery of the BS and Aleutian Islands management area among six entities representing 65 western Alaska villages. The six entities (CDQ groups) and the villages associated with each of those entities are specifically named in in the MSA. The CDQ groups include the Aleutian Pribilof Island Community Development Association (APICDA), the Bristol Bay Economic Development Corporation (BBEDC), the Central BS Fishermen's Association (CBSFA), the Coastal Villages Region Fund (CVRF), the Norton Sound Economic Development Corporation (NSEDC), and the Yukon Delta Fisheries Development Association (YDFDA). The CDQ groups are nonprofit corporations whose board of directors and staff manage and administer CDQ allocations, investments, and economic development projects. CDQ groups use the revenue derived from the harvest of their fisheries allocations to fund economic development activities and provide employment opportunities.

Prior to the implementation of the CR Program, the CDQ groups received an allocation of 7.5 percent of the GHL in the BPRKC, Pribilof red and blue king crab, Norton Sound red king crab, EBS snow crab, and BS Tanner crab fisheries. The CR Program increased the program allocation up to 10 percent and was expanded to all crab fisheries included under the CR Program. In a similar design to the CDQ Program, all allocation of 10 percent of the Aleutian Islands golden king crab TAC was granted to the community of Adak at the onset of the CR Program. The CDQ and Adak community allocation, are exempt from the CR Program management, but are subject to separate CDQ/Adak community allocation regulations.

Table 35 illustrates the breakout of the 10 percent CR Program allocation by CDQ group as a percentage of program allocation. The CDQ group makes internal management decisions about how to harvest their program allocations. Some of the allocations under the CDQ groups are focused towards providing

[13] Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meet the requirements of paragraph (2), in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities. (MSA §301(a)(8)).

directed harvest opportunities for members of the CDQ communities. For example, some fisheries are relatively easier and safer to access with smaller vessels and have represented historical sources of employment and income for residents. Other allocations under the CDQ program, particularly in those fisheries that are more industrialized like EBS snow crab require greater access to capital and specialized gear, and/or prosecuted in remote areas of the BSAI, are often harvested on larger, more efficient vessels. The revenues from these types of operations can aid in funding other types of economic development opportunities.

Table 35 CDQ and Adak community allocations by fishery and group

Fishery	Group Allocation (as a % of program allocation)						Adak allocation	Program allocation (% of TAC)
	APICDA	BBEDC	CBSFA	CVRF	NSEDC	YDFA		
BBR	17%	19%	10%	18%	18%	18%	-	10%
BSS	8%	20%	20%	17%	18%	17%	-	10%
EBT	10%	19%	19%	17%	18%	17%	-	10%
WBT	10%	19%	19%	17%	18%	17%	-	10%
WAG	-	-	-	-	-	-	100%	10%
EAG	8%	18%	21%	18%	21%	14%	-	10%
WAI	8%	18%	21%	18%	21%	14%	-	10%
STB	50%	12%		12%	14%	12%	-	10%
PIK	-	-	100%	-	-	-		10%

Both before and after implementation of the CR Program, CDQ groups made substantial investments in the BSAI crab fisheries. While these entities do not meet the requirements to hold C shares, community groups may, and have, invested in both catcher vessel owner (CVO) and catcher processor owner (CPO) QS. Some CDQ groups and wholly owned subsidiaries were granted CR Program QS at initial allocation; however, much of holdings have been acquired since program implementation. In some cases, QS is purchased outright, and in some cases groups may acquire a company or equity in a company that might include QS, vessels, or other assets. Allowing for QS and PQS acquisition by CDQ groups was in line with the Program's intention to:

(4) [Promote] economic stability for harvesters, processors, and coastal communities;

(6) Address the social and economic concerns of communities;

Provided below is a summary of the CDQ groups. The information provided in this section originates from the most current annual report available for each group and where available additional information from the CDQ group.

APICDA (2020 Annual Report)

APICDA represents 6 communities: Akutan, Atka, False Pass, Nelson Lagoon, Nikolski, Saint George, and Unalaska. The region APICDA encompasses is along the remote Aleutian Chain and Saint George Island of the Pribilof Islands. The total population represented by APICDA is 1,257, which represents 15% of the region's population. APICDA's for-profit subsidiary is APICDA Joint Ventures, which manages the majority of their partnerships and assets. APICDA owns three processing companies, Atka Pride Seafoods, Bering Pacific Seafoods, and Cannon Fish Company. The pollock trawl catcher/processor Starbound was lengthened in 2016 to install a fish meal plant in its factory. The Starbound harvests and processes 80% of APICDA's CDQ quota. As noted in their 2021 Annual report, in late 2021, APICDA sold its interest in Starbound, which at the time was a 20 percent interest. APICDA still has a strong and successful relationship with Aleutian Spray Fisheries. The Aleutian Longling Company, a fleet of cod freezer longliners that includes the F/V Arctic Prowler, F/V Ocean Prowler, F/V Siberian Sea, and the

F/V U.S. Liberator, is jointly owned by Prowler Fisheries (a subsidiary of APICDA Joint Ventures) and Aleutian Spray Fisheries.

BBEDC (2020 Annual Report)

BBEDC represents 17 communities in the Bristol Bay watershed: Aleknagik, Clark's Point, Dillingham, Egegik, Ekuk, Ekwok, King Salmon, Levelock, Manokotak, Naknek, Pilot Point, Port Heiden, Portage Creek, South Naknek, Togiak, Twin Hills, and Ugashik. The major hub is Dillingham. The total population represented by BBEDC is 5,380, which represents 72% of the region's population.

The region is known for its sockeye salmon runs in its expansive watershed and BBEDC uses its royalties to provide several finance programs to their fishing fleet, including a vessel upgrade grant and refrigerated sea water support. BBEDC had 20 fishermen participate in its small boat halibut fishery in 2016, harvesting 77,306 lbs. Bristol Bay Science and Research Institute is a non-profit research entity and subsidiary of BBEDC that conducts fisheries research and monitoring for the region. BBEDC engages in several partnerships to harvest and process its CDQ quota. The Defender, a 195' American Fisheries Act (AFA) vessel, was converted and upgraded in 2016 and began fishing in 2016. BBEDC owns 50% of Ocean Beauty Seafoods, one of the largest seafood buyers in Alaska. In 2016, BBEDC-contracted vessels harvested 87 million lbs. of CDQ allocations. They received $15.0 million in CDQ allocation royalties in 2016 and an additional $3.1 million in IFQ program royalties.

As noted in the BBEDC 2020 Annual Report, in 2020, 15 communities from BBEDC and 15 communities from CVRF, along with their CDQ groups acquired all the sellers' partnership interests in the Mariner Companies. The buy-out provides participating communities with snow and red king crab quota, equaling 3 percent of the total crab fishery. The BBEDC acquired full ownership of four crabbing vessels which it will operate under a new company called Bristol Group. The boats acquired are the Aleutian Mariner, Bristol Mariner, Nordic Mariner, and Pacific Mariner.

CBSFA (2021 Annual Report combined with updated information from the group)

CBSFA's fleet of BS catcher vessels includes the 165' F/V Fierce Allegiance (crab/pollock), 124' F/V Starward and F/V Starlite (pollock/cod), 108' F/V Early Dawn (crab), 100' F/V Adventure (crab/tendering, through 2021), 58' F/V Saint Paul and F/V Saint Peter (halibut, cod, sablefish, tendering). Saint Paul Fishing Company (SPFC), a wholly owned subsidiary of CBSFA, owns 9.9% of Bering Sea Partners, LLC, in partnership with Unisea Seafoods. SPFC also holds crab, cod, and pollock permits, as well as sablefish and crab Individual Fishing Quota for CBSFA. CBSFA has two longtime business partners, Unisea and Rick and Mary Mezich.

CBSFA is heavily invested in all BS crab fisheries and has used its revenue from crab investments as well as CDQ crab to help benefit the community of Saint Paul. In 2021, two of CBSFA's crab vessels, the Fierce Allegiance and Adventure landed 2.8 million pounds and received $5.00 per pound on average. Unexpectedly, in late 2021, the annual crab stock assessment indicated a near-total collapse of snow crab stocks. As a result, the F/V Fierce Allegiance and F/V Early Dawn had only 492,000 pounds of EBS snow crab to harvest in 2022 – an 82% reduction. Closure of the BBRKC fishery and severely reduced snow crab quotas in 2021 necessitated consolidation within CBSFA's crab fleet. CBSFA sold the F/V Adventure in early 2022. Only CBSFA's smallest crab vessel, the F/V Early Dawn, will remain in operation, harvesting Eastern Aleutian Islands Golden king crab and a small amount of Tanner crab.

CVRF (2021 Annual Report)

CVRF represents 20 communities: Chefornak, Chevak, Eek, Goodnews Bay, Hooper Bay, Kipnuk, Kongiganak, Kwigillingok, Mekoryuk, Napakiak, Napaskiak, Newtok, Nightmute, Oscarville, Platinum, Quinhagak, Scammon Bay, Toksook Bay, Tuntutuliak, and Tununak. CVRF communities are in the Kuskokwim River Delta and on Nelson Island. The total population represented by CVRF is 9,429 in

2016, which represents 51% of the region's population. The for-profit subsidiary, Coastal Alaska Premier Seafoods, owns 6 vessels and harvested and processed 126 million pounds of seafood in 2016. In a combined single platform since 2014, the fleet harvests pollock, crab, and cod with vessels that are wholly-owned by CVRF. CVRF was the first CDQ group to catch its pollock, crab, and cod CDQ allocation aboard vessels that they own and operate. In 2001, CVRF entered into a partnership with NSEDC and Maruha Nichiro Corporation to form BSAI Partners to manage five in-shore pollock catcher vessels and their quota. As noted in the Coastal Villages Region Fund 2021 Annual Report, in 2021, the CVRF Bering Sea fleet caught more than 126 million pounds of pollock, Pacific cod, and crab and generated more than $100 million in revenue from sales of these fish products of which 60.09 percent was from pollock, 14.41 percent was from Pacific cod, and 20.50 percent was from crab.

NSEDC (2021 Annual Report)

The most northern CDQ group, NSEDC, represents 15 communities: Brevig Mission, Diomede, Elim, Gambell, Golovin, Koyuk, Nome, Savoonga, Shaktoolik, Saint Michael, Stebbins, Teller, Unalakleet, Wales, and White Mountain. Communities in NSEDC stretch as far north as Diomede Island and as far south as Stebbins in the Norton Sound region. The major hub is Nome. The 2016 total population represented by NSEDC is 9,310, which represents 98% of the region's population. NSEDC receives 50% of the Norton Sound Red King Crab CDQ allocation and opens the fishery to its residents. NSEDC provides a loan program to residents of Norton Sound. Norton Sound Seafood Products, a processing subsidiary with plants in Nome, Unalakleet, and Savoonga, purchases salmon, crab, halibut, and herring from the resident fleet. Crab and salmon were worth $5.7 million in 2016 for local residents. NSEDC created Siu Alaska Corporation in 2009 to manage its fishing-related ventures and fishing partnerships. NSEDC owns a 37.5% stake in BSAI Partners, a fishing company venture jointly owned with CVRF and Maruha. NSEDC owns outright or has a stake in 14 vessels. With the revenues received from their CDQ and IFQ royalties, NSEDC received $17.7 million in CDQ revenues in 2016 and an additional $6.9 million in IFQ fishing revenues.

YDFDA (2020 Annual Report)

YDFDA represents six communities located along the Yukon River delta: Alakanuk, Emmonak, Grayling, Kotlik, Mountain Village, and Nunam Iqua. The total population represented by YDFDA is 3,434, which represents 26% of the region's population. As noted in their 2020 Annual Report, YDFDA's crab portfolio consists of all the major species, including BBRKC, snow and Tanner crab, and Golden King crab. YDFDA's crab investments are substantial as it generates nearly 1/3 of the YDFDA's total royalty revenue. YDFDA receives annual allocation of crab CDQ and has purchases substantial amounts of crab IFQs that have brought YDFDA closer to meeting the maximum allocation allocations cap under the Crab Rationalization Program. To date, YDFDA owns up to the cap in both the eastern and western Tanner crab fisheries. YDFDA's other crab caps are BBRKC at 80.40 percent, snow crab at 97.45 percent, and Western golden crab at 59.94 percent. To harvest it's crab quota, YDFDA engages with vessels, the C/P Baranof, and the F/V Kiska Sea, as well as 3rd party harvesters. Yukon Delta Fisheries, Inc. (YDFI), YDFDA's for-profit subsidiary, owns 45% of the F/V Kiska Sea, a crab catcher vessel. YDFDA, in coordination with the harvesting vessels, enters into profit/margin sharing agreements with various shoreside processors to boost royalties off of the unrestricted crab shares to maximize crab revenues

3.6.4 Expected Effects of the Alternatives

This section provides an overview of the potential socioeconomic effects of EBS snow crab rebuilding alternatives. This section will provide qualitative discussion of the likely impacts of the two rebuilding alternatives on vessel owners, crew, quota shareholders and the communities associated with these EBS snow crab participants separate from the impacts of the alternatives on processors and the communities where the processing activity is located. Additionally, since both EBS snow crab rebuilding Alternative 2/Option 1 and Alternative 2/Option 2 allow for bycatch of EBS snow crab while targeting other crab fisheries or groundfish fisheries and does not adjust PSC limits or change the management of the COLBZ, this socioeconomic effect section focuses solely on impacts to the directed EBS snow crab fishery participants and communities from a directed fishery closure perspective. For impacts on bycatch of EBS snow crab, see section 3.3.1.

The rebuilding plan alternatives affect the TAC to be set and thereby the opportunity for any directed catch of EBS snow crab. Since allocation of directed catch is determined by quota share holdings, the action alternatives would directly affect holders of all classes of quota share (A, B, and C), processor shares, as well as CDQ organizations and those whose fish the CDQ allocations. There are also identifiable indirect effects. For example, changes in payments to labor or diminished revenue for vessel owners or quota shareholders would then affect expenditures by labor, crew, vessel owners, or quota shareholders in landing ports and in their place of residence. Finally, there are also induced impacts from direct and indirect expenditures in a community. Induced impacts are money recirculated through the household spending patterns causing further local economic activity. Diminished direct and indirect expenditures in community would negatively impact the induced effects in the community. These impacts will be highlighted throughout this section where appropriate.

3.6.4.1 Impacts to vessel owners, crew, quota shareholders and associated communities

Looking first at EBS snow crab vessel owners and the communities of historical ownership address, Table 18 shows the count of EBS snow crab vessels by community from 2006-2021, vessel ownership among states is concentrated in Washington at 56 percent and Alaska at 32 percent. The largest share of Washington ownership address is in the Seattle MSA at 51 percent, while the largest share of Alaska vessel ownership is concentrated in the communities of Kodiak (12 percent), Anchorage (12 percent), Homer (5 percent) and Seldovia (1 percent). From the perspective vessel owner information, these communities represent those most likely directly impacted by the action alternatives due to diminished or loss of EBS snow crab ex-vessel gross revenue. For example, Table 19 shows the overall pattern of distribution of EBS snow crab average annual ex-vessel gross revenue from 2006-2021 of $122 million by vessel ownership address is Washington at 57 percent, Alaska at 30 percent, and Oregon/other states at 12 percent. Of the Washington communities, Seattle MSA has the highest portion of the average annual ex-vessel revenue from the EBS snow crab at 51 percent, whole for Alaska communities, the annual average ex-vessel gross revenue from the EBS snow crab fishery is concentrated in Kodiak at 12 percent followed by Homer/Seldovia at 4 percent. All other Alaska communities combined captured the remaining 15 percent of annual average ex-vessel gross revenue.

Table 20 shows the dependency on the EBS snow crab fishery for vessel owners by community. For Alaska, the annual 2006-2021 average ex-vessel gross revenues from EBS snow crab fishery was $33.4 million, while the annual average total ex-vessel gross revenue from all areas, gears, and fisheries for these same vessels and same period was $73.5 million. As a percent of the total ex-vessel gross revenue, the EBS snow crab fishery on average contributed 45.4 percent of the ex-vessel gross revenue for vessel owners with an Alaska address. Of the Alaska communities with EBS snow crab ownership address, the eight vessels with a Kodiak address appear to be highly dependent on the EBS snow crab fishery with 50.6 percent of the total ex-vessel revenue coming from the EBS snow crab fishery. Vessel owners with Homer/Seldovia and other Alaska addresses also appear to be highly dependent on the EBS snow crab fishery with 50.4 percent and 41.2 percent of the total ex-vessel total ex-vessel gross revenue coming from the EBS snow crab fishery, respectively. For EBS snow crab vessel owners with Washington and Oregon/other states address, dependency on the EBS snow crab fishery is also substantial. For vessel owners with Washington address, 45.3 percent of their annual average total ex-vessel gross revenues from all areas, gears, and fisheries was from the EBS snow crab fishery, while vessel owners with

Oregon/other states address the EBS snow crab contributed 45.3 percent of the annual average total ex-vessel gross revenue from all other fisheries (Table 20).

Looking at crew license address (Table 24) for crew of EBS snow crab vessels, the largest number of crew licenses for these EBS snow crab vessels were from Washington with an annual average of 242 licenses, while Alaska reported 211 annual average licenses. Of the Alaska communities, Kodiak had the largest number of crew licenses at an annual average of 211 followed by Anchorage/Palmer/Wasilla at 43 licenses, Homer/Seldovia at 28 licenses, and Dutch Harbor/Unalaska at 19 licenses.

From the perspective of EBS snow crab quota shareholders by address (Table 25) and their associated quota share revenues (Table 26) in communities of address, Washington followed by Alaska reported the highest annual average shares at 569 million shares and 321 million shares, respectively. As a community, Seattle MSA had the highest annual average shares at 427 million, while of the Alaska communities, Anchorage/Palmer/Wasilla had an annual average of 145 million shares, Kodiak as an annual average of 81 million shares, and Dillingham had 51 million shares.

Shifting to the impacts of the action alternatives from the perspective of vessel owners, crew, and quota shareholders, the loss of the EBS snow crab fishery under Alternative 2/Option 1 relative to the Alternative 2/Option 2 will likely be substantial. Clearly, the closure of the EBS snow crab fishery for 6 years under Alternative 2, Option 1 would mean that the exvessel revenue for vessel owners and quota shareholder, crew positions and their associated payments to crew would be foregone during the six-year rebuilding period. When compared to the average annual exvessel revenue from the EBS snow crab reported in the above tables, this loss represents a substantial economic impact for vessel owners, crew, quota shareholders, and the communities where these participants reside. As noted in Table 23, in 2021, 32 of the 60 vessels that participated in the EBS snow crab received 90 to 100 percent of their ex-vessel gross revenue from this fishery. The high recent high dependence on the EBS snow crab fishery for vessels is likely due to the closure of the directed BBRKC fishery last year. With the closure of EBS snow crab under Alternative 2/Option 1 and roughly 50 percent of exvessel revenue originating from the EBS snow crab fishery (Table 20) and with little fishing opportunities from other crab fisheries with the closure of the BBRKC and groundfish fisheries (Table 22), many of the EBS snow crab vessel owners, crew, and quota shareholders will likely see substantial declines in payments to vessel owners, crew, and quota shareholders which could lead to consolidation of the snow crab fleet and result in substantial losses in crew opportunities in a future directed EBS snow crab fishery.

Most businesses that must invest in highly valued capital operate under credit instruments that provided needed cash flow and may have substantial loan financed debt. A complete closure of the EBS snow crab fishery for six-years would eliminate operating revenue from snow crab. As noted in Table 23, many harvesting operations are highly dependent on snow crab revenue and thus these operations may have difficulty maintaining their credit and debt instruments and could be forced to refinance, which may not be possible for some entities and such a situation could lead to business sale and/or bankruptcy. The extent to which such impacts on business operations may be realized is impossible to evaluate given the proprietary nature of business finance information.

In comparing the impacts of Alternative 2/Option 2 relative to Alternative 2/Option 1, the socioeconomic impacts could be improved for vessel owners, crew, and quota shareholders since a directed EBS snow crab fishery would be allowed during the rebuilding period. Vessel owners, crew, and quota shareholders would receive critical exvessel payments from the harvesting of EBS snow crab that would keep the vessel and its crew active in the EBS snow crab fishery which would also provide benefits downstream for vessel owners, crew, quota shareholders, and the communities these participants reside. However, this assessment depends on the stock being sufficient to support a directed fishery based on the State's harvest strategy. Under Alternative 2/Option 2, allows for the opportunity for a directed snow crab fishery under the current State of Alaska harvest strategy. If the stock is insufficient to support a directed fishery based on the harvest control rule, the fishery will be closed for that year. If the fishery is closed for several years during the rebuilding period, then the socioeconomic impacts of Alternative 2/Option 2 will be similar to the socioeconomic impacts of Alternative 2/Option 1.

Additionally, the importance of a fishery to the operations of vessels is not just a function of percentage contribution to overall gross revenues as, for example, a fishery may contribute revenue during what would otherwise be a slow time of year, which could be important for covering fixed cost, maintaining existing snow crab markets, helping to make or keep the vessel ready for future fishery operations, assist in employment/retention of crew, and/or maintaining favorable business relationships with processors, among other factors.

Communities with historical EBS snow crab vessel ownership address, crew license address, and quota shareholder address, will likely experience negative impacts from Alternative 1/Option 1 relative to Alternative 2/Option 2. In general, the impacts to the communities under Alternative 2/Option 1 would likely reduce indirect and induced expenditures by vessel owners, crew, and quota shareholders in the communities of residence. The severity of these impacts will likely depend on the economic diversity of the community. Communities that are highly dependent on the expenditures of EBS snow crab vessel owners, crew, and quota shareholders will be substantially impacted under Alternative 2/Option 1. As indicated in Table 21, Table 22, Table 24, and Table 25, the Washington and Alaska communities most affected by the loss of expenditures in communities from payments to crew, and expenditures of snow crab fishing revenue from vessel owners and quota shareholders during the rebuilding period are likely Seattle MSA, Kodiak, Homer/Seldovia, and Anchorage/Palmer/Wasilla. For Seattle MSA and Anchorage/Palmer/Wasilla communities, these large economies with substantial diversity in a wide array of economic activities will help absorb the loss of EBS snow crab revenue expenditures due to the closure of the EBS snow crab fishery during rebuilding. For Kodiak, only 10 percent of the total annual average ex-vessel gross revenue was from EBS snow crab, while four percent of the total annual average ex-vessel gross revenue for Homer/Seldovia was from EBS snow crab fishery (Table 21). These communities, which have some crew, vessel owner, and quota shareholder dependency on the EBS snow crab fishery, do have economic diversity in other fisheries or other industries that may enable them to weather the loss of EBS snow crab expenditures under Alternative 2/Option 1. In contrast, the ability to have a directed EBS snow crab fishery each year during the six-year rebuilding period under Alternative 2/Option 2 would likely provide greater benefits to communities of vessel owners, crew, and quota shareholders through expenditures in these communities relative to Alternative 2/Option 1.

3.6.4.2 Impacts to processors and the communities where they are located

Overall, since 2006 the number of processors that have received EBS snow crab deliveries has ranged from a high of 15 in 2007 to a low of 10 in 2006 and 2018 (Table 27). In 2021, there were 11 processors that received EBS snow crab deliveries. The total first wholesale gross revenue for these 11 processors from processing EBS snow crab was $274 million in 2021 (Table 28). Of that $274 million first wholesale gross revenue from EBS snow crab, processors located in Akutan/King Cove/Kodiak/Saint Paul captured $134 million or 46 percent of the total, processors located in Dutch Harbor garnered $66 million or 29 percent of the total, and the remaining $44 million or 26 percent was received by other processors.

In general, most of the processors that received EBS snow crab deliveries also process other crab, groundfish, as well as IFQ halibut and sablefish. As noted in Table 29, for processors located in Unalaska/Dutch Harbor, EBS snow crab contributed 12 percent of the total annual average first wholesale gross revenue, while for the combined Akutan/King Cove/Kodiak/Saint Paul processors the EBS snow crab fishery contributed 11 percent of the total annual average first wholesale gross revenue. Other revenue sources for Unalaska/Dutch Harbor processors and Akutan/King Cove/Kodiak/Saint Paul processors included other crab fisheries and groundfish fisheries. As noted in Table 31, annual average first wholesale gross revenue sources included BBRKC at $34 million and groundfish at $332 million for Akutan/King Cove/Kodiak/Saint Paul processors, while for Unalaska/Dutch Harbor processors, the BBRKC fishery contributed $38 million and the groundfish fishery contributed $258 million. Note that the BBRKC fishery was closed during the 2021/2022 season and will be closed during the 2022/2023 season, so first wholesale gross revenue from this fishery will be zero.

The importance of the EBS snow crab fishery for processors relative to other fisheries revenue sources is reflected in Table 32, which shows the annual average EBS snow crab first wholesale gross revenue as a percentage of annual average total first wholesale gross revenue from 2006 through 2021. Nearly half of the processors received less than 20 percent of their annual average total first wholesale gross revenue from the EBS snow crab fishery which could represent a substantial impact for these processors, but the diversity of other processing activity by these processors helps reduces the impact of a closed EBS snow crab fishery for six-years under Alterative 2/Option 1. On the other end of the processor dependency spectrum, in 2020 and 2021, two processors were 90 percent to 100 percent dependent on the EBS snow crab fishery. Of these two processors, one is a shorebased processor that may be severely impacted due to the loss of EBS snow crab processing. Unfortunately, given the need to combine processor operating revenue to prevent disclosing confidential information, the above description of processor dependency on the EBS snow crab fishery masks the level of dependency for this one shorebased processor and even more importantly masks the impacts on the community where that processor is located.

Changes in the quantity of EBS snow crab delivered for processing can have both direct and indirect effect. The numbers of processor workers hired during the first several months of the year with associated implications for processor worker wages, local expenditures by processor workers in the community where the plant is located, as well as remittances of wages to primary residences supported by processing workers who are working away from home are examples of direct and indirect effects. Impacts to processors and the communities where the processors are based likely depend on the revenue diversity of the processor and/or the community. As noted above, for many of the processors, the EBS snow crab fishery is one of several fisheries the processor receives deliveries.

From the perspective of direct effects, Alternative 2/Option 1, relative to the Alternative 2/Option 2, would result in no EBS snow crab deliveries during the six-year rebuilding period which could range from minor impacts on total operating revenue to substantial impacts on operating revenue. The impacts to a processor from the closure of the EBS snow crab fishery during the six-year rebuilding period depends on how dependent the processor is on EBS snow crab deliveries, as well as its ability to adapt or diversify. As noted in Table 32, dependency is varied from little reliance on the EBS snow crab fishery to at least two processors in recent years that are highly dependent on EBS snow crab deliveries. Given the varied dependency on the EBS snow crab, impacts to the processors and the communities where the processors reside will also likely vary. For processors with little reliance on the EBS snow crab fishery, it would be expected that processors in this category would see reduce operating revenue from the loss of EBS snow crab deliveries which could result in reduced processor workers and/or reduced worker wages and the subsequent expenditures in the local communities where the processors reside and reduced remittance to worker's resident communities. Loss of processor operating revenue due to the closure of the EBS snow crab fishery could also reduce processor expenditures of goods and services in the community where the processor resides. In addition, like harvesters, processors likely operate under credit instruments that provided required cash flow and may also have substantial loan financed debt.

For at least one shorebased processor, Trident Seafoods, and the community the plant resides in, Saint Paul, the magnitude of impacts under Alternative 2/Option 1 are likely severe since the processor and the community are highly dependent on EBS snow crab deliveries. As noted on Trident's website, the plant is the largest crab processing plant in the world. The plant can process and freeze more than 500,000 pounds of snow crab per day. The plant has processed snow crab, king crab, and Tanner crab in the past. During the peak of the snow crab season in February, the plant employs as many as 400 workers. Given the processor's focus on crab processing and the loss of EBS snow crab operating revenue and the potential continued loss of BBRKC operating revenue due to the continued closure of the fishery, it is likely the processor will be severely impacted by this loss of operating revenue under Alternative 2/Option 1, which could have severe impacts on the community of Saint Paul as well. A substantial reduction or temporary loss of processing operations during part or all of the six-year rebuilding period could indirectly reduce or eliminate processor wages earned in the community, reduce or eliminate processor operating purchases of local goods and services, and reduce or eliminate processor worker expenditures in the community.

The loss of the processor would also likely impact processing of local halibut IFQ landings by the local community residents since they would no longer have a local processor for their IFQ halibut landings. Additionally, the community's CDQ fishing group (CBSFA) would also be impacted by the closure of the EBS snow crab fishery due to the loss of EBS snow crab revenue through CDQ snow crab quota and investments in CR Program harvesting and processing quota. As noted in a personal communication with a Trident representative, in general, it is more costly to operate at low TAC levels than to have the shoreplants shuttered and pay for annual maintenance. However, long-term implications of doing so, for the community and regional delivery requirements, make the cost of not operating in St. Paul severe. If the plant is shuttered for a prolonged period, there would be additional costs related to the replacement non-stainless steel parts (e.g., drive changes and some bearings).

Saint Paul also receives tax revenue from a local sales tax on the sale of seafood that would be at risk if the processor reduced processing activity or shut down during the rebuilding period. As an example of the risk to the community of Saint Paul, the City of Saint Paul's October 2022 Disaster Request indicates that the community is expecting a 100 percent drop in local sales tax on the sale of seafood and a 90 percent drop in state shared fish tax revenue due to the closure of the EBS snow crab fishery and the BBRKC fishery for the 2022/2023 season. The loss of revenue from seafood sales tax due to fishery related purchases and the loss of moorage, wharfage, and tariff collections for the 2022/2023 season would also impact provision of port services. Thus, by extension, an EBS snow crab fishery closure under Alternative 2/Option 1 for six years, would place a considerable burden on the community Saint Paul and could likely result in severe reductions of services in the community. Based on information in the City of Saint Paul's October 2022 Disaster Request, the City of Saint Paul would likely be evaluating plans to reduce expenditures, reduce services provided by the community, seek new sources of revenue, lift current tax exemptions, and increase utility rates, adjust dockage, and wharfage fees due to a closure of the EBS snow crab fishery for six years under Alternative 2/Option 1. In addition, Tanadgusix Corporation, the Alaska Native Village Corporation for Saint Paul, which also supports the crab fishery on Saint Paul Island would also be impacted by the loss of the directed fishing opportunity for EBS snow crab under Alternative 2/Option 1. Examples of services and sales impacted would be moving and storage of crab pots, fuel sales to Trident Seafoods, fishing boats, and electricity generation specific to fisheries, and lodging of itinerant workers. As noted in the City of Saint Paul's October 2022 Disaster Request, Tanadguisix Corporation estimates for the 2022/2023 season as a complete loss from its 2020 to 2022 average revenue of $2,369,792. This loss of revenue associated with the current economic conditions is likely an example of the economic conditions during the six-year rebuilding period under Alternative 2/Option 1, which would likely impact city sales taxes, revenue for the corporation, and likely result in staffing changes that would result in diminished economic activity.

Alternative 2/Option 2 would provide an opportunity for a directed EBS snow crab under State harvest strategy during a projected six-year rebuilding period. The benefit of a directed snow crab fishery for processors and communities would provide valuable operating revenue to allow for paying processor wages, processor expenditures of goods and services in the local community, expenditures by processor workers in the communities, as well as remittances of wages to primary residences supported by processing workers who are working away from home. In addition, the operating revenue from processing EBS snow crab would allow processors to make payments toward financed credit and/or debt instruments. Of course, processor benefits from a directed EBS snow crab fishery during the rebuilding period is dependent on the annual stock of EBS snow crab being sufficient to support a directed fishery. Based on the Alaska State harvest strategy, if the stock cannot support a directed fishery for that year, the directed fishery would be closed. In years when the fishery is closed to directed fishing, there would be no processor operating revenue from the processing of EBS snow crab, which would likely impact processors and the residing communities.

3.6.4.3 Impacts to CDQ groups

Impacts of Alternative 2/Option 1 relative to Alternative 2/Option 2 could be substantiable for some CDQ groups. The absence of a directed EBS snow crab fishery for six years under Alternative 2/Option 1 from the perspective of the CDQ allocation will likely have an impact on each of the CDQ groups due to loss of revenue from those allocations. For BBEDC and CBSFA, the impact will be slightly greater for these two CDQ groups since they receive 20 percent of the 10 percent CDQ group allocation of EBS snow crab. Slightly less of an impact would be NSEDC, YDFA, and CVRF given their slightly smaller allocation of the 10 percent EBS snow crab. APICDA, receiving 8 percent of the 10 EBS snow crab CDQ allocation would receive slightly less revenue from the loss of this fishery. CDQ groups would also be impacted based on their investments in the EBS snow crab harvester and processor quota. For those CDQ groups that are heavily invested in the EBS snow crab quota, for example CBSFA, CVRF, APICDA, NSEDC, and BBEDC, would be severely impacted due to this loss of revenue due the closure of the directed EBS snow crab fishery. The loss of EBS snow crab CDQ earnings due to no directed fishing during the rebuilding period could reduce funding for CDQ programs. For example, CBSFA's Elders Residential Assistance Program, Unangam Tunuu Revitalization, and Bycatch Reduction Engineering Program, or APIDCA's Community Development Grant Program, large-scale multi-year infrastructure projects, and post-secondary and vocational education training scholarships are just a few of the programs that could be at risk. Reduced funding for these and other CDQ programs due to the loss of the directed EBS snow crab fishery could also diminish induced expenditures in the community. Money spent in the community by recipients of these CDQ programs helps support additional economic activity in the community.

From the perspective of Alternative 2/Option 2, the socioeconomic impacts to the CDQ groups would likely improve given the potential of a directed EBS snow crab fishery during the rebuilding period. CDQ groups would receive earnings from their CDQ allocations of EBS snow crab in addition to earnings from their EBS snow crab investments. CDQ earnings under this rebuilding option could allow for continued funding of CDQ programs which in turn would continue the socioeconomic benefits to the communities impacted. However, this assessment depends on the stock being sufficient to support a directed fishery. If the stock is insufficient to support a directed fishery based on the State's harvest control rule, the fishery will be closed for that year. If, however, under Alternative 2/Option 2, the stock cannot support a directed fishery based on State of Alaska harvest strategy, then the socioeconomics impacts under Alternative 2/Option 2 could be similar or identical to the impacts under Alternative 2/Option 1.

3.6.4.4 Summary of Impacts

Overall, relative to the Alternative 2/Option 2, which would provide the possibility of a directed EBS snow crab fishery, the guaranteed loss of the directed EBS snow crab fishery during the six-year rebuilding period under Alternative 2/Option 1 could result in severe impacts for those associated with the fishery. The assured loss of directed EBS snow crab for six years would represent substantial losses for vessel owners, crew, harvesting and processing quota shareholders, processors, CDQ groups, as well as the associated communities in addition to the communities where the shorebased processors are located. When combined with the potential of annual directed fishery closures of the BBRKC fishery, the socioeconomic impacts to the participants of the EBS snow crab fishery could be accentuated even further under Alternative 2/Option 1. Under Alternative 2/Option 2, the socioeconomic impacts of the rebuilding plan could be somewhat less but still substantial which allows for a directed fishing during the six-year rebuilding period. If, however, under Alternative 2/Option 2, the stock cannot support a directed fishery based on State of Alaska harvest strategy, then the socioeconomics impacts under Alternative 2/Option 2 could be similar or identical to the impacts under Alternative 2/Option 1.

3.7 Monitoring Progress of the Rebuilding Plan

As required under NS1 Guidelines, the Secretary must ensure that progress made under a rebuilding plan is adequate. Throughout the rebuilding plan for EBS snow crab (Alternative 2), assessment surveys and biological data collection would be continued and help to facilitate the determination of adequate progress.

The NMFS eastern Bering Sea bottom-trawl survey provides data for annual assessment of the status of crab stocks in the BSAI, including EBS snow crab, and would continue throughout rebuilding. The BSAI Crab Plan Team would report stock status and progress towards the rebuilt level in the Stock Assessment and Fishery Evaluation (SAFE) Report for the king and Tanner crab fisheries of the BSAI.

Additionally, ADF&G and NMFS will monitor directed fishery catch (allowable only under Alternative 2/Option 2) and bycatch of snow crab in other fisheries (under any alternative). ADF&G requires full observer coverage (100%) for catcher processors and partial coverage (30%) for catcher vessels participating in the fishery. Observers monitor harvest at sea and landings by catcher vessels shoreside processors. ADF&G reports the total harvest from the commercial fishery and that report will be included annually in the SAFE.

State and federal observer programs monitor bycatch with State coverage of the crab fisheries and federal monitoring of the groundfish trawl, pot and longline fisheries. Estimates of crab bycatch from all commercial fisheries will be reported annually in the SAFE and the CPT will assess that bycatch relative to the expectations and assumptions of the rebuilding plan.

3.7.1 Expectations for Recruitment during Rebuilding

One of the primary drivers for future stock health for most shellfish stocks is recruitment, which can be highly variable and driven by environmental conditions. As noted in section 2.2.2.1, varying assumptions about future recruitment and natural mortality have heavily influence projected rebuilding trajectories and associated time to rebuilding.

The average estimated recruitments of the period 1982-2017 and 2005-2019 are fairly similar, but when any mortality events are allowed in the projections, the ability of the stock to rebuild is hampered (compare Figure 2-2 to Figure 2-3; Table 4). Under no mortality events in the projection period (i.e. the 1982-2017 scenario) the median projected stock rebuilt by 2029 with no fishing mortality. The rebuilding time was extended to 2034 under no fishing if mortality events were imposed during 1 in 7 years (on average).

It is the analysts goal in restating this to emphasize the expectation that uncertainty surrounding recruitment and mortality under the current ecosystem conditions may heavily influence the rate at which the stock is able to rebuild under the proposed projection parameters, regardless of the fishing mortality.

4 Magnuson-Stevens Act and FMP Considerations

This section will be completed prior to Council final action.

4.1 Magnuson-Stevens Act National Standards

Below are the 10 National Standards as contained in the MSA and a brief discussion of how each alternative is consistent with the National Standards, where applicable. In recommending a preferred alternative, the Council must consider how to balance the national standards.

National Standard 1 — Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

National Standard 2 — Conservation and management measures shall be based upon the best scientific information available.

National Standard 3 — To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

National Standard 4 — Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be; (A) fair and equitable to all such fishermen, (B) reasonably calculated to promote conservation, and (C) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

National Standard 5 — Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources, except that no such measure shall have economic allocation as its sole purpose.

National Standard 6 — Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

National Standard 7 — Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

National Standard 8 — Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meet the requirements of National Standard 2, in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

National Standard 9 — Conservation and management measures shall, to the extent practicable, (A) minimize bycatch, and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

National Standard 10 — Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

4.2 Section 303(a)(9) Fisheries Impact Statement

Section 303(a)(9) of the MSA requires that a fishery impact statement be prepared for each FMP or FMP amendment. A fishery impact statement is required to assess, specify, and analyze the likely effects, if any, including the cumulative conservation, economic, and social impacts, of the conservation and management measures on, and possible mitigation measures for (a) participants in the fisheries and fishing communities affected by the plan amendment; (b) participants in the fisheries conducted in adjacent areas under the authority of another Council; and (c) the safety of human life at sea, including whether and to what extent such measures may affect the safety of participants in the fishery.

The EA prepared for this plan amendment constitutes the fishery impact statement. The likely effects of the proposed action are analyzed and described throughout the EA. The effects on participants in the fisheries and fishing communities are analyzed in section 3.6.2. No effects of the proposed action on safety of human life at sea are anticipated since no changes in fishery management measures are proposed. Based on the information reported in this section, there is no need to update the Fishery Impact Statement included in the FMP.

The proposed action affects the EBS snow crab fishery crab fishery in the EEZ off Alaska, which is under the jurisdiction of the North Pacific Fishery Management Council and the State of Alaska. Impacts on participants in fisheries conducted in adjacent areas under the jurisdiction of other Councils are not anticipated as a result of this action.

4.3 Council's Ecosystem Vision Statement

In February 2014, the Council adopted, as Council policy, the following:

Ecosystem Approach for the North Pacific Fishery Management Council

Value Statement

The Gulf of Alaska, Bering Sea, and Aleutian Islands are some of the most biologically productive and unique marine ecosystems in the world, supporting globally significant populations of marine mammals, seabirds, fish, and shellfish. This region produces over half the nation's seafood and supports robust fishing communities, recreational fisheries, and a subsistence way of life. The Arctic ecosystem is a dynamic environment that is experiencing an unprecedented rate of loss of sea ice and other effects of climate change, resulting in elevated levels of risk and uncertainty. The North Pacific Fishery Management Council has an important stewardship responsibility for these resources, their productivity, and their sustainability for future generations.

Vision Statement

The Council envisions sustainable fisheries that provide benefits for harvesters, processors, recreational and subsistence users, and fishing communities, which (1) are maintained by healthy, productive, biodiverse, resilient marine ecosystems that support a range of services; (2) support robust populations of marine species at all trophic levels, including marine mammals and seabirds; and (3) are managed using a precautionary, transparent, and inclusive process that allows for analyses of tradeoffs, accounts for changing conditions, and mitigates threats.

Implementation Strategy

The Council intends that fishery management explicitly take into account environmental variability and uncertainty, changes and trends in climate and oceanographic conditions, fluctuations in productivity for managed species and associated ecosystem components, such as habitats and non-managed species, and relationships between marine species. Implementation will be responsive to changes in the ecosystem and our understanding of those dynamics, incorporate the best available science (including local and traditional knowledge), and engage scientists, managers, and the public.

> The vision statement shall be given effect through all of the Council's work, including long-term planning initiatives, fishery management actions, and science planning to support ecosystem-based fishery management.

In considering this action, the Council is being consistent with its ecosystem approach policy. This action establishes a plan for rebuilding the EBS snow crab stock, taking into account the biology of the stock and prevailing ecosystem conditions. This is supportive of the Council's intention to prevent overfishing and to adjust catch levels as necessary to account for uncertainty and ecosystem factors.

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6 References

Antonelis, G.A., Melin, S.R., Bukhtiyarov, Y.A., 1994. Early spring feeding habits of bearded seals (Erignathus barbatus) in the Central Bering Sea, 1981. Arctic 47 (1), 74–79.

Armstrong, D., Incze, L., Wencker, D., and Armstrong, J. 1981. Distribution and abundance of decapod crustacean larvae in the southeastern Bering Sea with emphasis on commercial species. 53. 479-878 pp.

Bernard, H.R. 2006. Research methods in anthropology: qualitative and quantitative approaches. Lanham, MD: AltaMira Press.

Broecker, W. S. 1975. Climatic Change: Are We on the Brink of a Pronounced Global Warming? Science 189:460–463.

City of Saint Paul Alaska (2022, October 18) *Bering Sea Community Faces Uncertain Future.* https://www.pacificfishing.com/St-Paul-Island-Press-Release-Crab-Closures.pdf

Copeman, L. A., Ryer, C. H., Eisner, L. B., Nielsen, J. M., Spencer, M. L., Iseri, P. J., and Ottmar, M. L. 2021. Decreased lipid storage in juvenile Bering Sea crabs (Chionoecetes spp.) in a warm (2014) compared to a cold (2012) year on the southeastern Bering Sea. Polar Biology, 44: 1883-1901.

Crawford JA, Quakenbush LT, Citta JJ (2015) A comparison of ringed and bearded seal diet, condition and productivity between historical (1975–1984) and recent (2003–2012) periods in the Alaskan Bering and Chukchi seas. Prog Oceanogr 136:133–150. doi:10.1016/j.pocean.2015.05.011

Dawe, E.G., K.D. Gilkinson, S.J. Walsh, W. Hickey, D.R. Mullowney, D.C. Orr, and R.N. Forward. 2007. A Study of the Effect of Trawling in the Newfoundland and Labrador Northern Shrimp (Pandalus borealis) Fishery on Mortality and Damage to Snow Crab (Chionoecetes opilio). Canadian Technical Report of Fisheries and Aquatic Sciences No. 2752. Science Branch. Department of Fisheries and Oceans Canada.

Di Lorenzo, E., and N. Mantua. 2016. Multi-year persistence of the 2014/15 North Pacific marine heatwave. Nature Climate Change 6:1042–1047.

Dionne, M., Sainte-Marie, B., Bourget, E., and Gilbert, D. 2003. Distribution and habitat selection of early benthic stages of snow crab Chionoecetes opilio. Marine Ecology Progress Series, 259: 117 128.

Doherty, B., Johnson, S., and Cox, S.P. 2017. Using autonomous video to estimate the bottom-contact area of longline trap gear and presence–absence of sensitive benthic habitat. Collaborative fisheries research: The Canadian Fisheries Research Network Experience, 2017, 01:797-812, https://doi.org/10.1139/cjfas-2016-0483@cjfas-cfr/issue01.

Emblemsvag, M., K. M. Werner, I. Nunez-Riboni, R. Frelat, H. Torp Christensen, H. O. Fock, and R. Primicerio. 2022. Deep demersal fish communities respond rapidly to warming in a frontal region between Arctic and Atlantic waters. GLOBAL CHANGE BIOLOGY 28:2979–2990.

Fedewa, E., Garber-Yonts, B., Shotwell, K., and Tyrell, A. 2022. Ecosystem and Socioeconomic Profile of the snow crab stock in the Eastern Bering Sea 2022.

Fossheim, M., R. Primicerio, E. Johannesen, R. B. Ingvaldsen, M. M. Aschan, and A. V Dolgov. 2015. Recent warming leads to a rapid borealization of fish communities in the Arctic. NATURE CLIMATE CHANGE 5:673+.

Garber-Yonts, B., and J. Lee., 2021. Stock Assessment and Fishery Evaluation Report for King and Tanner Crab Fisheries of the Gulf of Alaska and Bering Sea and Aleutian Islands Area: Economic Status of the Bering Sea and Aleutian Islands Crab Fisheries off Alaska, 2021.

Hammond, C.F., Conquest, L.L., and Rose, C.S**.** 2013.Using reflex action mortality predictors (RAMP) to evaluate if trawl gear modifications reduce the unobserved mortality of Tanner crab (*Chionoecetes bairdi*) and snow crab (*C. opilio*). ICES Journal of Marine Science 70: 1308-1318

Incze, L. S., Armstrong, D. A., and Wencker, D. L. 1982. Rates of development and growth of larvae of Chionoecetes bairdi and C. opilio in the southeastern Bering Sea. In Proceedings of the International Symposium on the Genus Chionoecetes, 3rd edn, pp. 191-218. Ed. by A. J. Paul, F. Gaffney, D. Haapa, J. Reeves, R. Baglin, and S. K. Davis. Alaska Sea Grant College Program, University of Alaska Fairbanks, Anchorage, AK.

Incze, L. S., Armstrong, D. A., and Smith, S. L. 1987. Abundance of larval Tanner crabs (Chionoecetes spp.) in relation to adult females and regional oceanography of the southeastern Bering Sea. Canadian Journal of Fisheries and Aquatic Sciences, 44: 1143-1156.

Johannes, R.E., & Neis, B. (2007). *The value of anecdote.* Fishers' knowledge in fisheries science and management. Paris: UNESCO Publishing.

Lowry, L.F., Frost, K.J., Burns, J.J., 1980a. Feeding of bearded seals in the Bering and Chukchi Seas and trophic interaction with pacific walruses. Arctic 33 (2), 330–342.

Litzow, M., Fedewa, E., Connors, B., Elsner, L., Kimmel, D., Malick, M., Nielsen, J. 2022. Human-induced borealization and the collapse of the Bering Sea snow crab fishery. In prep.

Litzow, M., Malick, M., Kristiansen, T., Connors, B., Ruggerone,G.T. 2022. Attribution time series track the growing human influence on North Pacific sea surface temperature. In review

Martin, K. S., McCay, B. J., Murray, G. D., Johnson, T. R., & O. les, B. (2007). Communities, knowledge and fisheries of the future. International Journal of Global Environmental Issues*,* 7(2-3), 221-239.

Mueter, F. J. F. J., and M. A. M. A. Litzow. 2008. Sea ice retreat alters the biogeography of the Bering Sea continental shelf. Ecological Applications 18:309–320.

Mueter, F. J., B. Planque, G. L. J. J. Hunt, I. D. Alabia, T. Hirawake, L. Eisner, P. Dalpadado, M. Chierici, K. F. Drinkwater, N. Harada, P. Arneberg, and S.-I. Saitoh. 2021. Possible future scenarios in the gateways to the Arctic for Subarctic and Arctic marine systems: II. prey resources, food webs, fish, and fisheries. ICES JOURNAL OF MARINE SCIENCE 78:3017–3045.

Nguyen, TX, PD Winger, G Legge, EG Dawe, DR Mullowney. 2014. Underwater observations of the behaviour of snow crab (Chionoecetes opilio) encountering a shrimp trawl off northeast Newfoundland. Fisheries Research, Vol. 156, pp. 9-13.

NMFS. 2004. Final Environmental Impact Statement/Regulatory Impact Review/Initial Regulatory Flexibility Analysis/Social Impact Assessment for Bering Sea and Aleutian Islands Crab Fisheries. NMFS, Juneau, AK.

NOAA (2004) *BSAI Crab Fisheries Final Environmental Impact Statement Social Impact Assessment.*

NOAA (2022). *Profiles of fishing communities of Alaska*. NOAA. Retrieved from https://www.fisheries.noaa.gov/resource/document/profiles-fishing-communities-alaska

NPFMC. 2000. Environmental assessment/regulatory impact review/initial regulatory flexibility analysis for proposed Amendment 15 to the Fishery Management Plan for king and Tanner crab fisheries in the Bering Sea/Aleutian Islands and regulatory amendment to the Fishery Management Plan for the groundfish fishery of the Bering Sea and Aleutian Islands area: A rebuilding plan for the Pacific Fishery Management Council, Anchorage. Draft report.

NPFMC. 2009. Amendment 94 to the Fishery Management Plan (FMP) for Groundfish of the Bering Sea and Aleutian Islands to Require Trawl Sweep Modification in the Bering Sea Flatfish Fishery, Establish a Modified Gear Trawl Zone, and Revise Boundaries of the Northern Bering Sea Research Area and Saint Matthew Island Habitat Conservation Area. North Pacific Fishery Management Council, 605 West 4th Ave, Anchorage, AK. 99501.

NPFMC. 2011. Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs. NPFMC, Anchorage, AK.

NPFMC. 2017. Ten-Year Program Review for the Crab Rationalization Management Program in the Bering Sea/Aleutian Islands. NPFMC, Anchorage, AK.

NPFMC, 2021. Regulatory Impact Review/Environmental Assessment for Proposed Amendment 122 to the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area, BSAI Pacific Cod Trawl Cooperative Program. NPFMC, Anchorage, AK

NPFMC. 2021a. Crab PSC Limits in the BSAI Groundfish Trawl Fisheries. Prepared for the February 2021 Council Meeting. NPFMC, Anchorage, AK.

NPFMC. 2022. Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. NPFMC, Anchorage, AK.

Otto, F. E. L. 2017. Attribution of Weather and Climate Events. Annual Review of Environment and Resources 42:627–646.

Oxtoby, L.E., Horstmann, L., Budge, S.M. *et al.* Resource partitioning between Pacific walruses and bearded seals in the Alaska Arctic and sub-Arctic. *Oecologia* **184**, 385–398 (2017). https://doi.org/10.1007/s00442-017-3883-7

Pershing, A. J., N. R. Record, B. S. Franklin, B. T. Kennedy, L. McClenachan, K. E. Mills, J. D. Scott, A. C. Thomas, and N. H. Wolff. 2019. Challenges to natural and human communities from surprising ocean temperatures. Proceedings of the national academy of sciences of the United States of America, 116:18378-18383.

Polyakov V, I., M. B. Alkire, B. A. Bluhm, K. A. Brown, E. C. Carmack, M. Chierici, S. L. Danielson, I. Ellingsen, E. A. Ershova, K. Gardfeldt, R. B. Ingvaldsen, A. Pnyushkov V, D. Slagstad, and P. Wassmann. 2020. Borealization of the Arctic Ocean in Response to Anomalous Advection From Sub-Arctic Seas. FRONTIERS IN MARINE SCIENCE 7.

Rose, C. S. 1995. Behavior of Bering Sea crabs encountering trawl groundgear. Unpubl. video

tape presented at N. Pac. Fish. Manage. Counc. meeting Dec. 1995. Avail. from Alaska Fisheries Science Center, NMFS, 7600 Sand Point Way N.E., Seattle, WA 98115.

Rose, CS. 1999. Injury Rates of Red King Crab, Paralithodes camtschaticus, Passing Under Bottom-trawl Footropes. United Nations Food and Agriculture Organization, available at: https://agris.fao.org/agris-search/search.do?recordID=AV2012094812.

Rose, CS, JR Gauvin, and CF Hammond. 2010. Effective herding of flatfish by cables with minimal seafloor contact. Fishery Bulletin, Volume 108:136–144.

Rose, CS, CF Hammond, AW Stoner, E Munk and J Gauvin. 2013. Quantification and reduction of unobserved mortality rates for snow, southern tanner, and red king crabs (Chionoecetes opilio, C. bairdi, and Paralithodes camtschaticus) after encounters with trawls on the seafloor. Fishery Bulletin, Volume 111:42-53.

Sainte-Marie, B., Sévigny, J., Smith, B. D., and Lovrich, G. A. 1996. Recruitment variability in snow crab (Chionoecetes opilio): Pattern, possible causes, and implications for fishery management. In High Latitude Crabs: Biology, Management and Economics 13th edn, pp. 454-478. Ed. by B. Baxter, W. E. Donaldson, A. J. Paul, R. S. Otto, and D. B. Witherell. Alaska Sea Grant College Program, University of Alaska Fairbanks, Anchorage, AK.

Salant, P., Dillman, D.A. 1994. How to conduct your own survey. New York: Wiley.

Schwinghamer, P., Gordon, D., Rowell, T., Prena, J., McKeown, D., Sonnichsen, G., and Guigne, J.,2008. Effects of Experimental Otter Trawling on Surficial Sediment Properties of a Sandy-Bottom Ecosystem on the Grand Banks of Newfoundlan. Society for Conservation Biology, Volume 12, Issue 6.

Smeltz, T.S., Harris, B., Olson, J., and Sethi, S. 2019. A seascape-scale habitat model to support management of fishing impacts on benthic ecosystems. Canadian Journal of Fisheries and Aquatic Sciences, 2019, 76(10): 1836-1844, https://doi.org/10.1139/cjfas-2018-0243

Somerton, D. A. 1982. Effects of sea ice on the distribution and population fluctuations of C. opilio in the eastern Bering Sea. In Proceedings of the International Symposium on the Genus Chionoecetes, 3rd edn, pp. 157-172. Ed. by A. J. Paul, F. Gaffney, D. Haapa, J. Reeves, R. Baglin, and S. K. Davis. Alaska Sea Grant College Program, University of Alaska Fairbanks, Anchorage, AK.

Starr, M., Therriault, J.-C., Conan, G. r. Y., Comeau, M., and Robichaud, G. 1994. Larval release in a sub-euphotic zone invertebrate triggered by sinking phytoplankton particles. Journal of Plankton Research, 16: 1137-1147.

Szuwalski, C., Aydin, K,. Fedewa, E., Garber-Yonts, B., Litzow, M., Canaries of the Arctic; the collapse of eastern Bering Sea snow crab. In review

Thoman Jr., R. L., U. S. Bhatt, P. A. Bieniek, B. R. Brettschneider, M. Brubaker, S. L. Danielson, Z. Labe, R. Lader, W. N. Meier, G. Sheffield, and J. E. Walsh. 2020. The record low bering sea ice extent in 2018: context, impacts, and an assessment of the role of anthropogenic climate change. Bulletin of the American meteorological society, 101:S53-S57.

Walsh, J. E., R. L. Thoman, U. S. Bhatt, P. A. Bieniek, B. Brettschneider, M. Brubaker, S. Danielson, R. Lader, F. Fetterer, K. Holderied, K. Iken, A. Mahoney, M. McCammon, and J. Partain. 2018. The high latitude heat wave of 2016 and its impacts on Alaska. Bulletin of the American Meteorological Society 99:S39--S43.

Welsford, D., Ewing, G., Constable, A., Hibberd, T., and Kilpatrick, R. 2014. Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: an assessment of the vulnerability of benthic habitats to impact by demersal gears. Australian Antarctic Division. FRDC project 2006/042.

Wise, S., Sparks, K., Lee, J., (2021) Annual Community Engagement and Participation Overview (ACEPO)

Witherell, D., and C. Pautzke. 1997. A brief history of bycatch management measuresfor eastern Bering Sea groundfish fisheries. Mar. Fish. Rev. 59:15–22.

Witherell, D., and D. Woodby. 2005. Application of marine protected areas for sustainable production and marine biodiversity off Alaska. Mar. Fish. Rev. 67:1–27.

Zaleski, M., Smeltz, S., Rheinsmith, S., Pirtle, J., Harrington, G. 2022 Evaluation of Fishing Effects on Essential Fish Habitat.

Zheng, J., and G.H. Kruse. 2002. Assessment and management of crab stocks under uncertainty of massive die-offs and rapid changes in survey catchability. Pages 367-384 [In] A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby (eds.). Crabs in Cold Water Regions: Biology, University of Alaska Fairbanks, Alaska Sea Grant Report 02-01, Fairbanks.