King, Tanner, and Snow Crab

Lithodes aequispinus, Chionoecetes bairdi, Chionoecetes opilio

United States: Alaska

Pots

Report ID 27651

December 5, 2022

Seafood Watch Standard used in this assessment: Fisheries Standard v4

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About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report provides analysis and recommendations for the commercial fishery for U.S. wild golden king crab (*Lithodes aequispinus*) and Tanner crab (*Chionoecetes bairdi*) trap/pot fisheries in the Bering Sea and Aleutian Islands (BSAI) and in southeast (SE) Alaska. The Alaska Board of Fisheries and Alaska Department of Fish and Game manages the fisheries with federal oversight for BSAI fisheries through the North Pacific Fishery Management Council. Scores are provided for five Alaska fisheries that targeted either of the two species in 2021 and 2022, including: Pribilof Islands (PI) golden king crab (GKC), Aleutian Islands (AI) GKC, SE Alaska GKC, SE Alaska Tanner crab, and Eastern Bering Sea (EBS) Tanner crab.

Criterion 1 scored Red for the PI and SE Alaska GKC fisheries, Yellow for the SE Alaska Tanner crab fishery, and Green for the AI GKC and EBS Tanner crab fisheries. Concerns for fisheries that scored yellow or red included: low abundance relative to reference points/historic averages, overfished status, high or uncertain exploitation rates, and/or a lack of appropriate reference points to determine the stock status.

Criterion 2 scored Red for the SE Alaska Tanner crab and the EBS Tanner crab fisheries; all other fisheries scored Yellow. Fisheries that scored Yellow affect species or taxa including humpback whale and "corals and other biogenic habitats." The SE Alaska Tanner crab and EBS Tanner crab fisheries scored Red for Criterion 2 because they catch species of concern for abundance and/or fishing mortality.

Criterion 3 scored Red for the AI and SE Alaska GKC fisheries, as well as the SE Alaska Tanner crab fishery. The PI GKC and EBS Tanner crab fisheries scored Yellow. The SE Alaska GKC and Tanner crab fisheries had an ineffective management strategy because both catch golden king crab, which is at low abundance in SE Alaska, and there is a high probability that fishing is compounding the problem. The AI GKC had an ineffective bycatch strategy due to impacts on species of concern and limited measures to assess and control ghost fishing. Fisheries that scored Yellow had moderately effective management and bycatch strategies that were limited by several factors.

Criterion 4 scored Yellow for all fisheries. Crab pots have an impact on habitats by contact with the seafloor. The AI, PI, and SE Alaska fisheries present a moderately high impact because of the presence of deep-sea corals and other biogenic habitats, while the other assessed fisheries have a moderately low impact on the seafloor. Closure of some areas of vulnerable habitat (e.g., corals and sponges) reduces the likelihood of impacts, but most closures are for trawls, while most areas remain open to crab pot fishing. Although limited management measures are in place to protect ecosystem function and the target species' unique role, the harvest levels of target species are unlikely to cause large-scale impacts to the food web.

In summary, two fisheries received overall recommendations of Avoid (i.e., Red) and three fisheries received overall recommendations of Good Alternative (i.e., Yellow).

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Golden king crab | Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska	1.732	2.236	3.000	2.739	**Good Alternative (2.375)**	21 (MT) 2022
Golden king crab | Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska	4.284	2.236	1.000	2.449	**Good Alternative (2.201)**	1,475 (MT) 2022
Golden king crab | Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery	1.000	2.236	1.000	2.449	**Avoid (1.530)**	33 (MT) 2022
Southern tanner crab | Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery	3.413	1.732	3.000	3.000	**Good Alternative (2.701)**	449 (MT) 2022
Southern tanner crab | Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery	2.644	1.000	1.000	2.449	**Avoid (1.595)**	635 (MT) 2022

Eco-Certification Information

There are currently no Marine Stewardship Council (MSC) eco-certifications for the fisheries included in this report.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report includes U.S. wild golden king crab (*Lithodes aequispinus*) and Tanner crab (*Chionoecetes bairdi*) trap/pot fisheries in the Bering Sea and Aleutian Islands (BSAI) and Southeast (SE) Alaska. All the landed crabs of these species in Alaska are caught through directed crab pot (i.e., trap) or ring net fisheries, as no other fisheries are permitted to land them. Ring net fisheries (for Tanner crab in SE Alaska) are not covered by this report because commercial landings are negligible. Several fisheries that in the past targeted Alaska king crab and Tanner crab are currently closed to fishing, mainly due to stock declines (e.g., Bristol Bay and Norton Sound Red King Crab fishery, St. Matthews Island Blue King Crab fishery). This report provides recommendations for five regional fisheries that were open to fishing in 2021 and 2022: Pribilof Islands golden king crab, Aleutian Islands golden king crab, SE Alaska golden king crab, SE Alaska Tanner crab, and Eastern Bering Sea Tanner crab. Gulf of Alaska Tanner crab fisheries that were scheduled to open for the 2022 season were not covered by this report (e.g., Kodiak District Tanner crab) because these fisheries were not open in 2021. Management of some Alaska king and Tanner crab fisheries is further divided into smaller units. Fishery sustainability recommendations were only provided at the regional fishery level. The recommendations in this report cover the following regional fisheries and management units:

Pribilof Islands golden king crab: Registration Area Q1, Pribilof Islands District

Aleutian Islands golden king crab: Registration Area O with two management zones within: east of 174° W. longitude (EAG), west of 174° W. longitude (WAG)

SE Alaska golden king crab: Registration Area A (Northern, Icy Strait, North Stephens Passage, East Central, Mid-Chatham Strait, Lower Chatham Strait, Southern)

SE Alaska Tanner crab: Registration Area A

Eastern Bering Sea Tanner crab: Registration Area J with two management regions: east of 166° W. longitude, west of 166° W. longitude

Table 1. U.S. king, Tanner, and snow crab fisheries in Alaska, from north to south. Includes closed and open fisheries, typical seasons, recent catches, upcoming season quotas, and Seafood Watch ratings (if any). Sources: (ADFG 2016)(NOAA 2022f)(NOAA 2022g)

Species	Fishery	Season (approx.)	2021–22 Harvest (t)	2022–23 TAC or GHL (t)	SFW rating
BSAI					
Red King Crab	Norton Sound	Nov–May, Jun–Sept	132 mt	Closed in 2021 and no commercial fishing occurred during summer 2020 season. Opened for one month in June–July 2022.	None
Red King Crab	Bristol Bay Red King Crab	Oct–Jan	0	Closed since the 2021–22 season (TAC in 2020–21 season was 1,081 mt)	None

Red King Crab	Western Aleutian Islands		0	Closed since 1996	None
Red King Crab	Dutch Harbor		0	Closed since 1984	None
Red and Blue King Crab	Pribilof Islands King Crab	-	0	Closed since at least the 2015–16 season	None
Blue King Crab	Saint Matthew Island King Crab	Oct–Feb	0	Closed since 2016–17 season (TAC in 2015–16 season was 168 mt)	None
Tanner Crab	Bering Sea Tanner Crab	Oct–Mar	East: Closed West: 449 mt	East TAC: 475 mt West TAC: 385 mt	Yellow
Snow Crab	Bering Sea Snow Crab	Oct–May	2,262 mt	Closed in 2022–23 season (TAC in 2021–22 was 2,262 mt)	None
Red and Blue King Crab	Pribilof Islands King Crab		0	Closed since at least the 2015–16 season	None
Golden King Crab	Pribilof Islands Golden King Crab	Year-round	21	GHL: 59 mt	Yellow
Golden King Crab	Aleutian Islands Golden King Crab	Aug–April	East: 1,475 mt West: Conf.	East TAC: 1.355 mt West TAC: 706 mt	Yellow
Red King Crab	Adak		0	Closed since 1996	None

Species	**Fishery**	**Season (approx.)**	**2021–22 Harvest (t)**	**2022–23 TAC or GHL (t)**	**SFW rating**
Non-BSAI					
Tanner Crab	Alaska Peninsula Tanner Crab	Jan–Mar	226 mt	GHL: 499 mt	None
Tanner Crab	Kodiak Tanner Crab	Jan–Mar	499 mt	GHL: 2,630 mt	None
Tanner Crab	Chiknik Tanner crab		90 mt	GHL: 181 mt	None
Tanner Crab	Prince William Sound Tanner Crab			Closed since 1998, limited test fishery currently ongoing	None
Red King Crab	Prince William Sound		0	Closed since 1995	None
Tanner Crab	Cook Inlet Tanner Crab		0	Closed since 1995	None
Red King Crab	Cook Inlet Tanner Crab		0	Closed since 1984	None
Red/Blue King Crab	Yakutat King Crab	Oct–Dec	0	Closed since 2001	None
Golden King Crab	Southeast Alaska Golden King Crab	Feb–June	33 mt (2022)	Not yet announced	Red
Tanner Crab	Southeast Alaska Tanner Crab	Feb–Mar	635 mt (2022)	Not yet announced	Red

Red King Crab	Southeast Alaska King Crab	Nov–Jan	0	Closed since 2020–21 season	None

Species Overview

The distribution, basic life history traits, predator species, history of directed fisheries, and overall management framework for each of the two species included in this report are summarized below.

Golden King Crab

Golden king crab (GKC) occurs from the Sea of Japan to the northern Bering Sea, including the Aleutian Islands (AI), and as far south as northern British Columbia (Jewett et al. 1985). It is typically found at depths of 300–1,000 m in high-relief habitat, and frequently over coral substrate (NMFS 2004). Male size-at-maturity is about 130 mm carapace length (CL) in the AI and 107 mm in the Pribilof Islands (PI), whereas females mature at a slightly smaller size (approximately 100–110 mm) (Somerton and Otto 1986). GKC males in SE Alaska become mature at approximately 118–158 mm CL, depending on location (Olson et al. 2018). GKC in SE Alaska enter the fishery at approximately 150 mm CL and 10.5 years of age (Stratman et al. 2017). Males GKC mature at approximately 8 years of age (Stratman et al. 2017). The maximum observed size in the SE Alaska fishery is 215 mm CL, at approximately 18.5 years of age (Stratman et al. 2017). Fecundity is approximately 30,000 eggs (Jewett et al. 1985). The AI GKC commercial fishery began in 1981. AI GKC landings peaked in 1986, then declined steadily until the mid-1990s (Figure 1) (Siddeek et al. 2020). The AI GKC fishery was restructured beginning in 1996 to replace the Adak and Dutch Harbor areas with the AI Registration Area O. Since then, landings for the AI GKC fishery have been quite stable though 2018. Although most GKC harvest in Alaska currently occurs in the AI GKC fishery, there are two other small commercial GKC fisheries currently operating. The GKC fishery in SE Alaska started in 1972, with peak landings in 1986 (Figure 1) (Stratman et al. 2017). SE Alaska landings declined dramatically through the mid-1990s, then increased again until 2011 and have been declining steadily since. Another fishery has operated in some years in the PI since 1982, with peak landings in 1983 (Figure 1) (Daly and Jackson 2020). Since 1982, PI landings were generally low, except in the mid-1990s, with the fishery closed in some years and landings considered confidential in some years. In recent years, PI landings have reportedly been consistent, and in 2020 were approximately 50 t (pers. comm., M. Stichert, November 10, 2020).

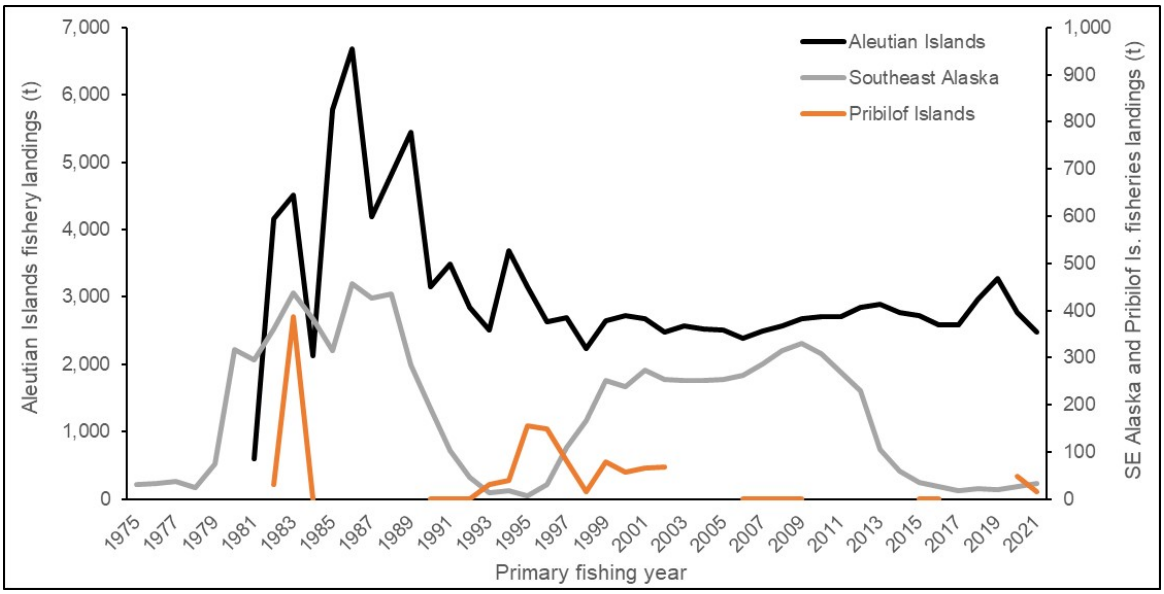

Figure 1: Landings of golden king crab in Aleutian Islands (left vertical axis), Pribilof Islands (right vertical axis) and SE Alaska (right vertical axis), 1975–2021 (Siddeek et al. 2020)(Daly and Jackson 2020)(ADFG 2022b)(NPFMC 2022). Note: Pribilof Islands GKC fishery landings were confidential and therefore not available for some of the time series.

Tanner Crab

The range of Tanner crab in the eastern North Pacific Ocean extends as far south as Oregon and as far north as the Bristol Bay (Stockhausen 2021). In the western North Pacific, its range extends as far south as Hokkaido, Japan and as far north as the Kamchatka Peninsula (Stockhausen 2021). Size-at-maturity is about 69 mm CW for females and 92 mm CW for males (Rugolo and Turnock 2012). Age of maturity for females is about 5 years, whereas males mature at about 6 years (Donaldson et al. 1981)(NPFMC 2021a). Maximum age is assumed to be 20 years, based on the snow crab lifespan (Rugolo and Turnock 2012). Mean fecundity for Tanner crab in the Eastern Bering Sea (EBS) was estimated at 138,127 (Gravel and Pengilly 2007) Pacific cod is the main predator on Tanner crab in terms of biomass; however, flathead sole, rock sole, halibut, skates, and yellowfin sole also prey on small Tanner crab (NPFMC 2021a). The EBS commercial Tanner crab fishery began in the late 1960s. Landings peaked in the late 1970s, then experienced dramatic fluctuations before closing for several years starting in the late 1990s (Figure 2) (Siddeek et al. 2020). NMFS declared Bering Sea Tanner crab overfished in 1999 and, although the stock was declared rebuilt in 2012, fishery landings remained at low levels through 2020 except for somewhat higher landings in 2014–15 (Stockhausen 2021). Although the EBS fishery is currently the primary commercial Tanner crab fishery in Alaska, a smaller commercial fishery in SE Alaska has also operated since the late 1960s. Landings for the SE Alaska fishery peaked in the early 1980s, then fluctuated before declining to low levels in the early 2000s (Figure 2) (Wood et al. 2017). Since 2003, SE Alaska fishery landings remained stable at low levels and increased slightly through 2020 (ADFG 2021a).

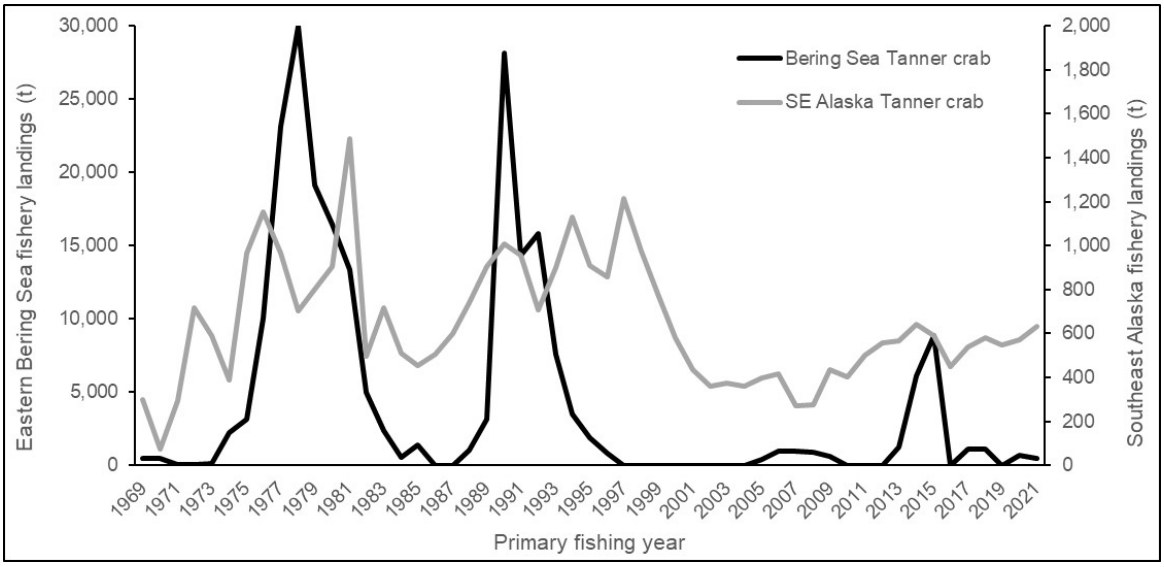

Figure 2: Landings of Tanner crab in the eastern Bering Sea (left vertical axis) and SE Alaska (right vertical axis), 1969–2021 (Stockhausen 2021){ADFG 2022}(NPFMC 2022).

The Fishery Management Plan (FMP) for Bering Sea and Aleutian Islands (BSAI) King and Tanner Crab establishes a state/federal cooperative that defers much of the management to the Alaska Department of Fish and Game (ADF&G) (NPFMC 2021a). But, federal management oversight is maintained through the North Pacific Fishery Management Council (NPFMC) and the National Oceanic and Atmospheric Administration (NOAA), and decisions are subject to review by the Secretary of the U.S. Department of Commerce. The State of Alaska divides the BSAI into three management registration areas to manage crab fisheries: Aleutian Islands, Bristol Bay, and Bering Sea. Under the FMP, management measures fall into three categories: 1) those that are fixed in the FMP under Council control; 2) those with a framework that allows the state to change them, following criteria outlined in the FMP; and 3) those measures under complete discretion of the state. Category 1 measures are fixed in the FMP, and include legal gear, permit requirements, federal observer requirements, limited access, and the Norton Sound Superexclusive Registration Area. Category 2 measures have a framework in the FMP but allow for flexibility, and include minimum size limits; guideline harvest levels (GHLs); in-season adjustments; districts, subdistricts, and sections; fishing seasons; sex restrictions; closed waters; pot limits; and other registration areas. Category 3 measures are at the discretion of the state of Alaska, and include reporting requirements, gear placement and removal, gear modifications, vessel tank inspections, state observer requirements, and bycatch limits (in crab fisheries). The FMP guides management of the following fisheries evaluated in this report: PI golden king crab, AI golden king crab, and EBS Tanner crab. These fisheries are grouped under multiple "Registration Areas" for management of permits, catch limits, and other parameters (Figures 3 and 4). The remaining fisheries in this report, SE Alaska Tanner crab and SE Alaska GKC (Figures 5 and 6), are managed by ADF&G with guiding decisions and regulations adopted through the Alaska Board of Fisheries (BOF) (ADFG 2020a). The Alaska BOF approves updates to management plans for the SE Alaska Tanner crab and GKC fisheries. Where data allow, federal management establishes overfishing levels (OFLs) and acceptable biological catches (ABCs) in accordance with the Magnuson-Stevens Fishery Conservation and Management Act. In addition, federal management through the BSAI Crab FMP and implementation of regulations create a catch share or limited access privilege program: the BSAI Crab Rationalization

Program. This program aims to control effort, improve safety, and reduce bycatch, among other goals. Retention of king and Tanner crab is prohibited in all other fisheries in Alaska. Several fisheries incidentally catch and discard king or Tanner crab; for the BSAI fisheries, these discards are monitored and mortalities are estimated as part of the respective stock assessments.

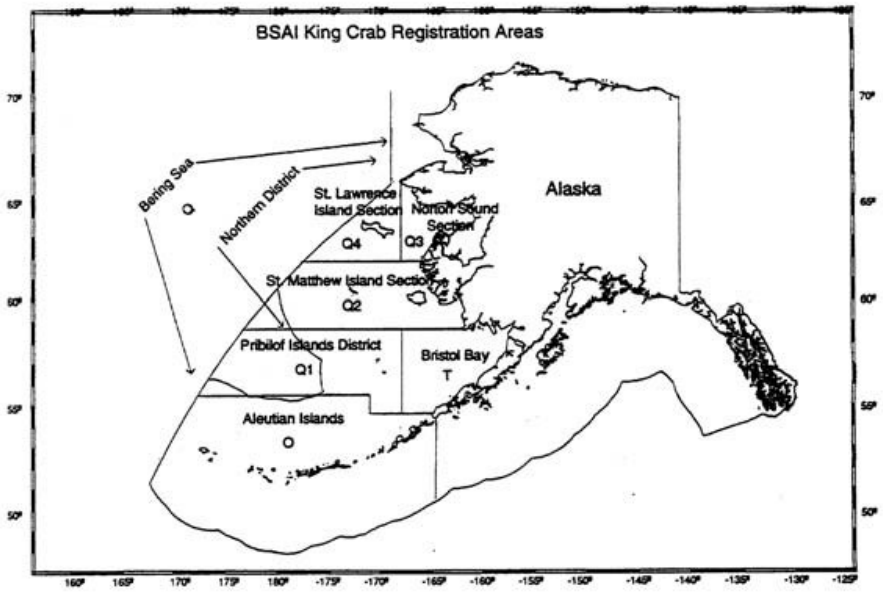

Figure 3: Map of Registration Areas for management of king crab species in the Bering Sea and Aleutian Islands (NPFMC 2021a). Letters/numbers below area names denote Registration Area codes. Registration Area O (Aleutian Islands) is further subdivided into east and west areas for management of golden king crab in that area. Registration Area J (BSAI Tanner and snow crab) is not depicted on this map.

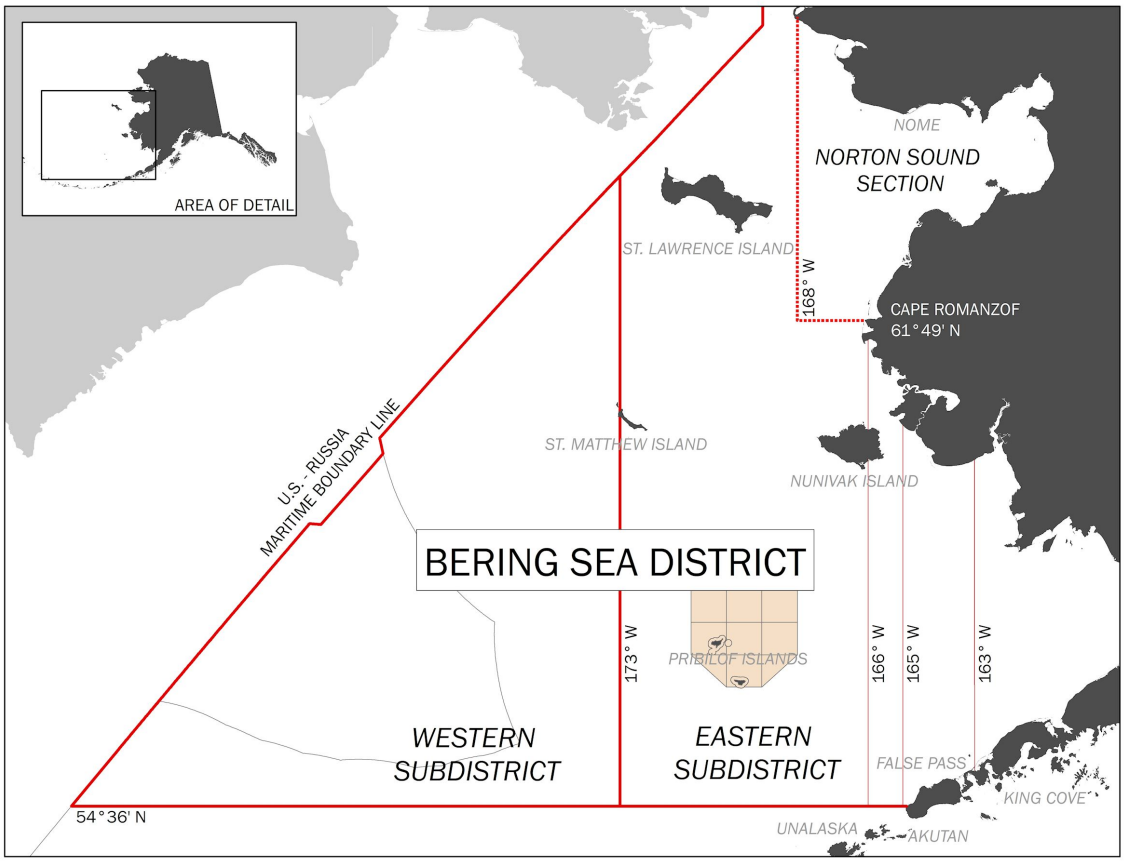

Figure 4: Eastern Bering Sea District of Tanner crab (Registration Area J) including sub-districts and the Pribilof Islands Blue King Crab Protection Area (tan colored polygon). Tanner crab management is further split into western and eastern regions (WAG and EAG) of the eastern subdistrict with separate TACs for each region; the 166° W. longitude line is the dividing line between these management areas. Map for the 2021–22 commercial crab fishery provided by ADF&G.

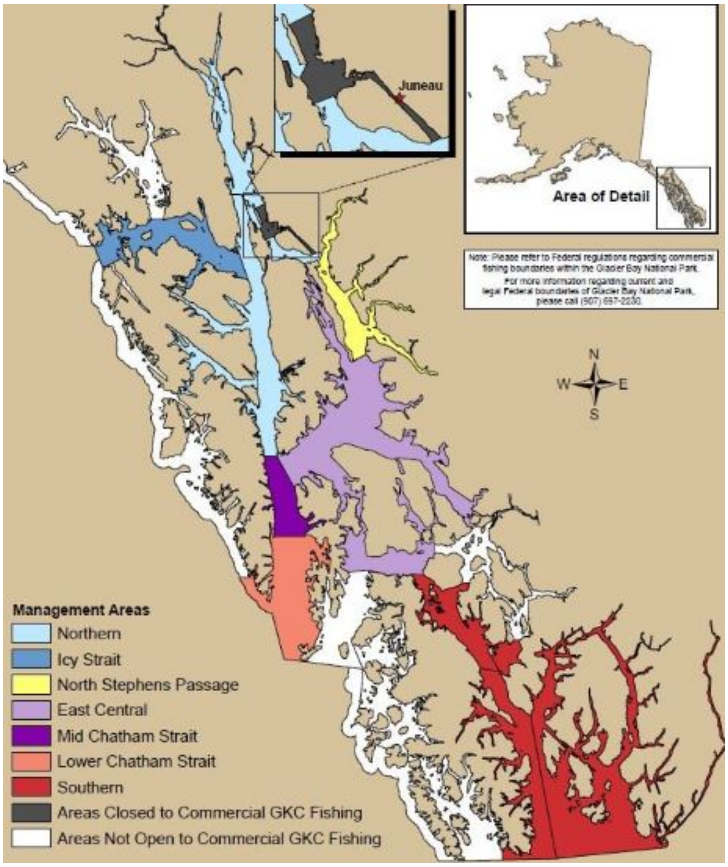

Figure 5: Map of golden king crab management areas within SE Alaska. Source: https://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryshellfish.shellfishmaps

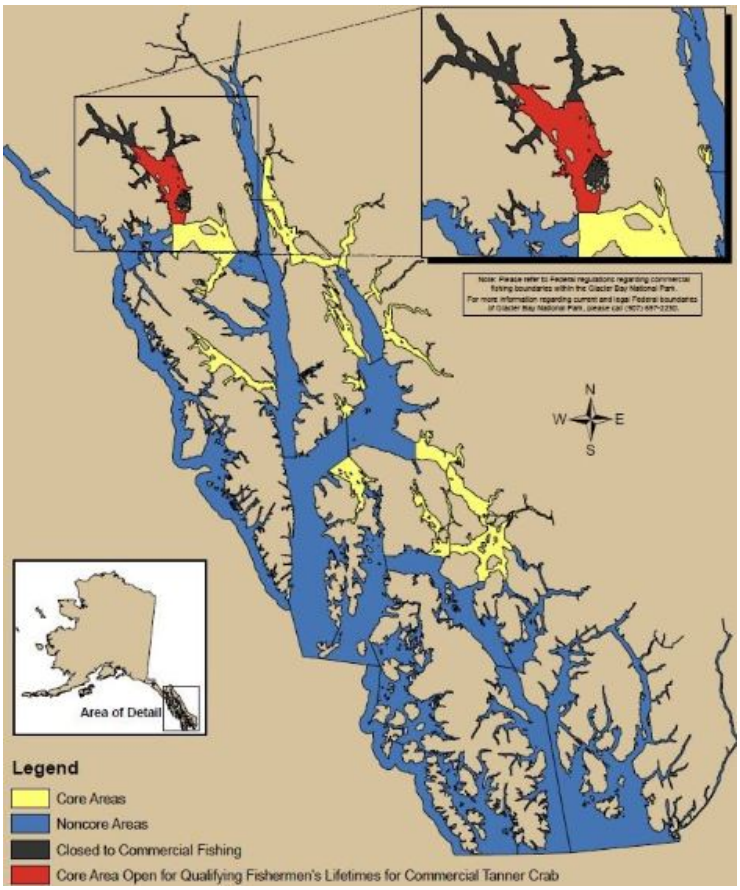

Figure 6: Map of Tanner crab management areas within SE Alaska. Source: https://www.adfg.alaska.gov/index.cfm?adfg=CommercialByFisheryshellfish.shellfishmaps

Production Statistics

King Crab

Global production of king crab (red king, blue king, and golden king) has experienced several large fluctuations since the fishery began in the 1950s, peaking at more than 100,000 t in 1966 (Figure 7). Because U.S. production as reported by FAO does not distinguish king crab by species, king crab are discussed as a group for most of this summary. Historically, Japan (and to a minor extent the Republic of Korea) produced large amounts of king crab but have not contributed to global production since 2001. The U.S. contributed the most to global production from the mid-1960s through 1987, but production declined greatly after 1980. In 1988–2018, Russia produced the most king crab of any country; production included all three king crab species but was dominated by red king crab. Landings data for king crab in Russia were not available before 1988. Global production increased from 2012 to 2018, because of production by the Russian Federation. FAO (2021) reports that the average contributions to global production in 2015–19 were approximately 80% from the Russian Federation, 15% from the United States, and 5% from Norway.

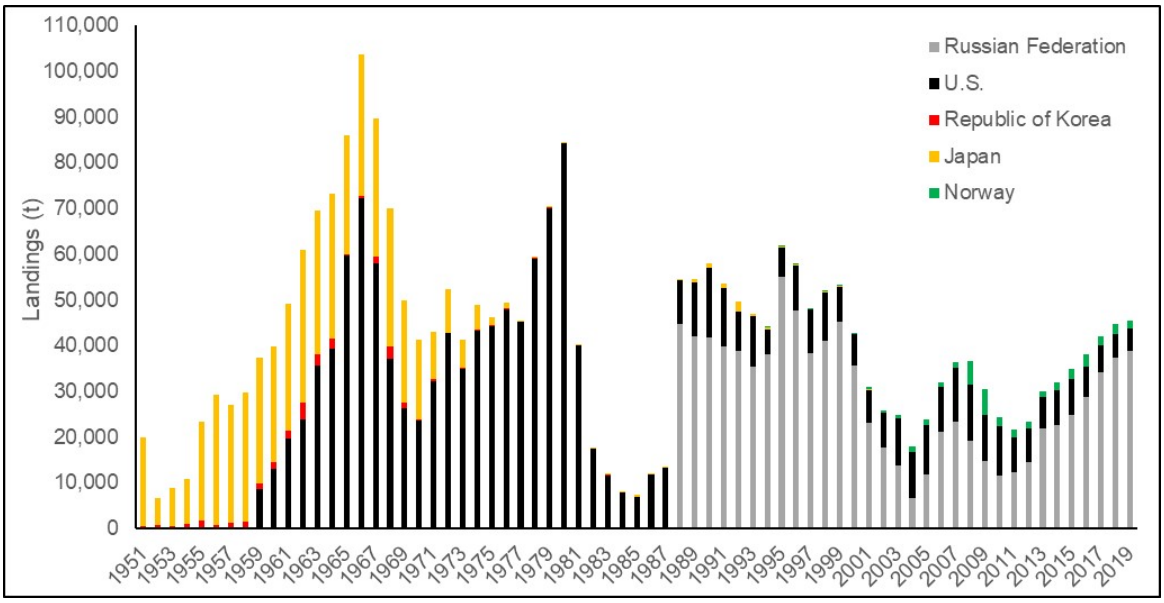

Figure 7: Worldwide landings of king crab by country, 1951–2019 (FAO 2021). Because the U.S. does not distinguish king crab species in reports to FAO, landings here include red, blue, and golden king crab for all countries. Note that historic U.S. king crab landings include several fisheries that are not open as of 2022, including the Bristol Bay fishery.

Tanner Crab

Global production of Tanner crab experienced dramatic increases and decreases untl the mid-1990s, peaking at more than 36,000 t in 1977. Production was dominated by Japan until 1975, when the United States became the major producer of Tanner crab. Russia contributed to production of Tanner crab before 1972 but has not reported landings of *O. bairdi* since then (Figure 8). Since 1980, 100% of Tanner crab production reported to the FAO has been from the United States (reported as *C. bairdi*), although it is likely that some Tanner crab is harvested in Russia and reported under the category *Chionoecetes* spp. (separate from *C. opilio*) (FAO 2021). Production dropped to quite low levels in the late 1990s; the U.S. stock was declared overfished in 1999, and then declared rebuilt as of 2012 (Stockhausen 2021). Despite being rebuilt, the stock has remained at a low level since 2012 and landings have been low.

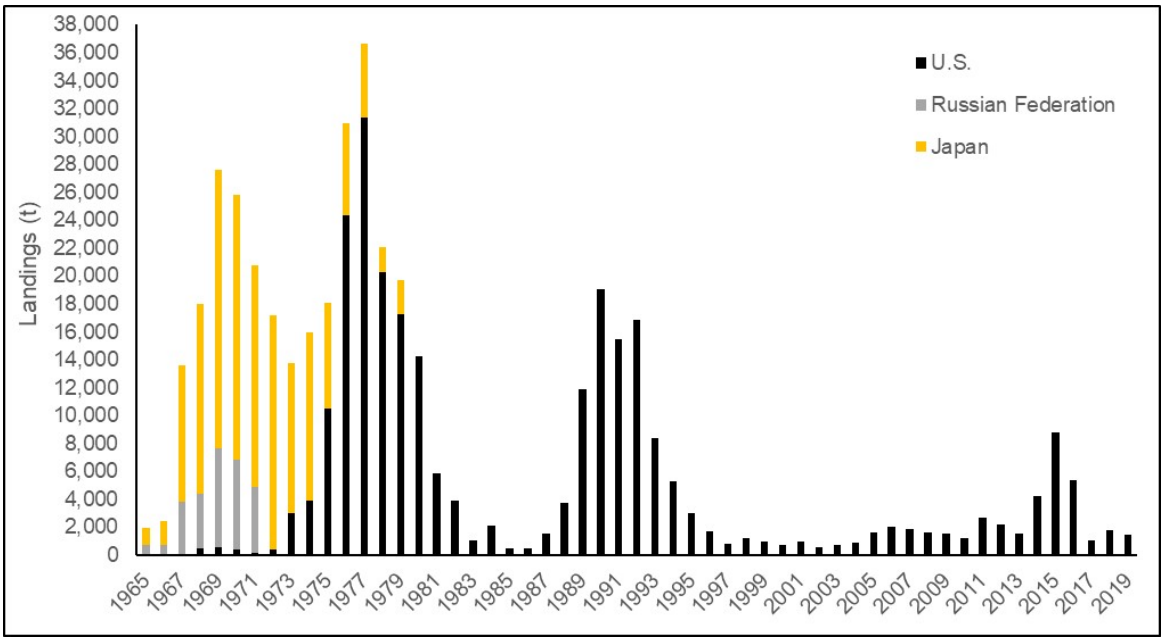

Figure 8: Worldwide landings of Tanner crab by country, 1965–2019 (FAO 2021).

Relative Production of Assessed Crab Species in Alaska

The proportion of landings of golden king crab and Tanner crab among Alaska crab pot fisheries has varied since these fisheries began. Of the fisheries included in this report, the Bering Sea Tanner crab fishery had the highest landings in the 1970s and some other years after, but the Aleutian Island golden king crab fishery most consistently had the highest landings since the 1980s, including in recent years (Figure 9).

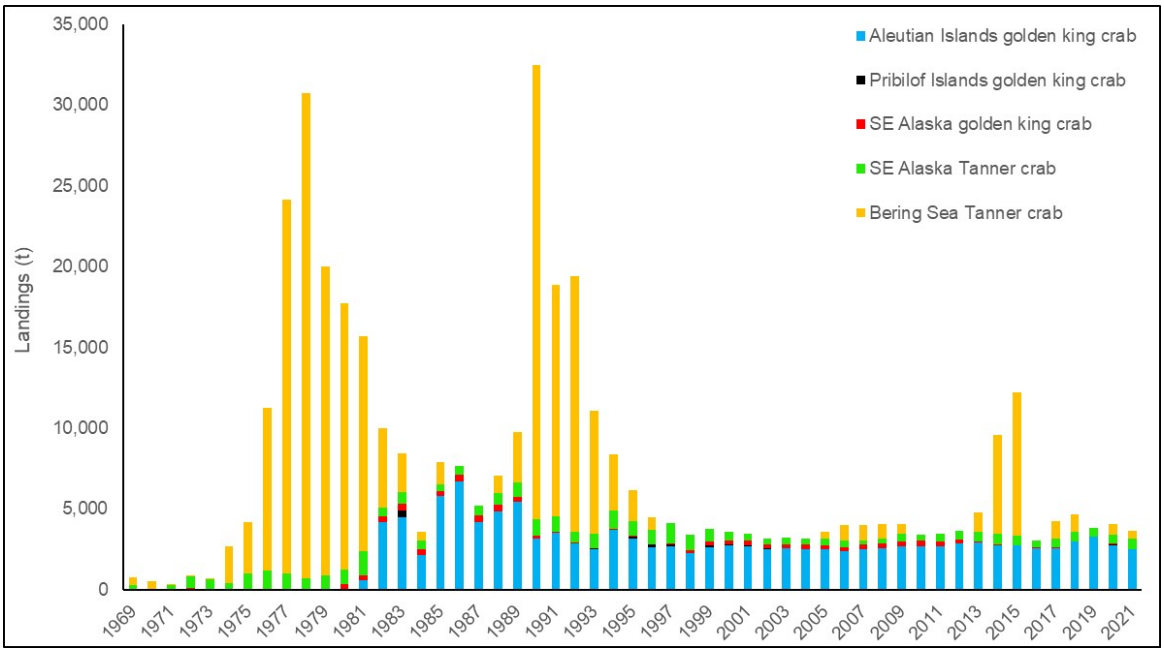

Figure 9: Landings of Alaska king crab and Tanner crab by fishery, 1969–2021. Includes only those fisheries open in BSAI and SE Alaska for the 2021 and 2022 seasons. Data were acquired from relevant ADF&G and NOAA stock assessments and the ADF&G website. Note that landings for the Pribilof Islands golden king crab fishery are confidential and therefore not available for most of the time series.

Importance to the US/North American market.

In 2022, U.S. production of red king crab and snow crab will be quite low due to fishery closures and reductions. In addition, in March 2022, the U.S. banned all seafood imports from the Russian Federation, including snow, king, and Tanner crab (SeafoodSource 2022). The most recent supply statistics available as of finalizing this report were from 2020, as summarized below.

The commercial Alaska king, Tanner, and snow crab fisheries have been among the most valuable in the U.S. in recent years. In 2020, these fisheries were worth roughly $160 million, approximately 27% of the total U.S. crab fishery value (NOAA 2022b).

Trade and supply statistics in the U.S. often include both *C. opilio* and *C. bairdi* (Tanner crab) as snow crab, so the two species' data are reported together in this section. The supply of snow and Tanner crab in the U.S. was approximately 217,920 t (round weight) in 2020, with roughly 93% of this supply being imported (NOAA 2022c). The 2020 U.S. supply was considerably higher than in 2019, and was the highest since 2013. Approximately 61% of U.S. imports of snow and Tanner crab in 2020 were from Canada, 33% from the Russian Federation, 2% from Norway, and the remainder from several other countries (NOAA 2022d). Approximately 30% of U.S. landings of snow and Tanner crab in 2019 were exported to China, 24% to Japan, 19% to Vietnam, and the remainder to several other countries (NOAA 2022c). Much of the snow crab exported to China is for meat extraction and subsequent export to Japan (DFO 2016).

Trade and supply statistics in the U.S. report all king crab species together (red, golden, blue), so all king crab species data are reported together in this section. The supply of king crab in the U.S. was

approximately 54,000 t (round weight) in 2020, with roughly 92% of this supply being imported (NOAA 2022c). This supply was slightly above the average U.S. supply for 2016–20. Approximately 90% of U.S. imports of king crab in 2020 were from the Russian Federation, 9% from Argentina (southern king crab, *Lithodes santolla*), and the remainder from several other countries (NOAA 2022d). Approximately 64% of U.S. landings of king crab in 2020 were exported to Japan, 26% to Canada, 2% to South Korea, and the remainder to several other countries (NOAA 2022c).

Common and market names.

Golden king crab: brown king crab. It is commonly sold as *kani* for sushi.

Tanner crab: southern Tanner crab, snow crab, spider crab.

Primary product forms

The most common product form of Tanner crab is frozen leg sections, mainly for export to Japan. Extracted meat is another common form of snow crab. The whole cooked crab (shelled and frozen) is another product form that makes up a small percentage of exports to Japan. Live crab is also sold in some locations.

King crab is sold as sections, claws, legs, and legs split down the middle. Most king crab is delivered live to shore-based processors, cooked, then brine-frozen (Blau 1997){Fishchoice 2020}. Fresh king crab is also sold for cooking at home (Blau 1997).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

GOLDEN KING CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery	1.000: High Concern	1.000: High Concern	Red (1.000)

SOUTHERN TANNER CRAB			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance

Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality

Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Golden king crab

Factor 1.1 - Abundance

Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska

Low Concern

Reference points for biomass were used to evaluate stock status in the most recent stock assessment of GKC in the Aleutian Islands (AI). An assessment model based only on fishery-dependent data was approved for use by the NPFMC Science and Statistical Committee in 2017. Stock assessment authors noted that the reliance on fisheries data was a source of uncertainty for estimates (Siddeek et al. 2020). BSAI crab stock assessments use mature male biomass (MMB) as a proxy for egg production {NPFMC 2008}. The target reference point for the AI stock is $MMB_{35\%}$ (a proxy for B_{MSY}). If the biomass is at or below the minimum stock size threshold (MSST; e.g., 0.5 B_{MSY}), the stock is considered overfished. Because the estimated MMB in 2019–20 (16,323 t) is above MSST (5,909 t) and $MMB_{35\%}$ (11,818 t), the stock was not considered overfished.

The level of uncertainty expressed in the most recent stock assessment regarding the biomass estimates was fairly high; however, the method was approved by the NPFMC, and the CPUE indices have been stable in recent years. MMB was above $MMB_{35\%}$, so abundance is considered a low concern.

Justification:

Fishery CPUE indices derived from onboard observers and from catch and size composition informed the abundance trends for the stock assessment (Siddeek et al. 2020). An ongoing abundance survey (5 years of data collected) has yet to be incorporated into the stock assessment process.

Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska

High Concern

Reference points for abundance were not available in the most recent ADF&G stock assessment of the Pribilof Islands (PI) GKC (Daly and Jackson 2020). A NOAA trawl survey was conducted biannually during 2002–16 for areas including the fished area near the Pribilof Islands; however, the NOAA survey has not occurred since 2016. PI GKC biomass estimates based on the NOAA surveys indicate stability in the stock, but changes since 2016 are unknown (Daly and Jackson 2020). A relevant biomass estimate is currently unavailable, so the assessment was considered data-limited. Indicators of abundance were lacking for this stock in recent years. Because of low confidence in the data-limited assessment results, a productivity–susceptibility analysis (PSA) was conducted. Results of the PSA (score = 3.33) suggested that the species in this area has a high vulnerability (Table 2).

Although abundance may be stable based on survey data through 2016, a current estimate of biomass and reference points for evaluating stock status were not available. Based on results of the PSA, abundance is considered a high concern.

Justification:
Table 2. PSA for GKC in the Pribilof Islands Commercial Pot Fishery (see Seafood Watch Fisheries Standard Version 4 for methodology details).

Productivity (P) attributes	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Average age at maturity	8 years; theoretical, based on laboratory experiments (Stratman et al. 2017)	2
Average maximum age	19 years, SE Alaska (Stratman et al. 2017)	2
Fecundity	30,000 eggs/year (northern B.C.) (Jewett et al. 1985)	1
Reproductive strategy	Brooder (Blau 1997)	2
Density dependence	None	2
Total	P = (2 + 2 + 1 + 2 + 2) ÷ 5	1.80

Susceptibility (S) attributes	Relevant information	Score (1 = low risk, 2 = medium risk, 3 = high risk)
Areal overlap	ADF&G estimates that roughly 50% of the Pribilof Island Registration Area is fishable by the commercial GKC fleet (pers. comm., Ethan Nichols, July 26, 2022). Therefore, overlap was considered to be high (i.e., >30% of the stock concentration is fished).	3
Vertical overlap	Overlap is unknown but likely high, so used default score (i.e., <33% of species depth range is unfished).	3
Seasonality	The fishing season is open year-round if GHL is not achieved early, so overlap with species is high (i.e., >6 months/year) (Daly and Jackson 2020).	3
Selectivity	Species is targeted and individuals below legal size limit may escape traps.	2
Post-capture mortality	The handling mortality rate was not provided in the most recent PI GKC stock assessment report, but was reportedly 20%. This rate was not based on empirical data but was assumed to be the same as in the RKC Bristol Bay fishery. Because the post-capture mortality rate is not known for this species and fishery, risk was assumed to be high.	3
Total	S = (3 + 3 + 3 + 2 + 3) ÷ 5	2.80

Vulnerability score (V) = $\sqrt{(P^2 + S^2)}$

V = $\sqrt{(3.24 + 7.84)}$

V = 3.33 = High vulnerability

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery

High Concern
The most recent ADF&G stock status update for GKC in SE Alaska included reference points based on commercial fishery catch per unit effort (CPUE), which currently cannot be used to assess whether the stock is overfished (Olson and Stratman 2022). Reference points are based on historical CPUE averages since the inception of logbook requirements (1999/2000) through the 2017–18

season. Reference points began to be used for the 2020–21 season. Fishery-independent monitoring to estimate abundance has not occurred for this stock; instead, ADF&G reviews commercial fishery logbook CPUE, fish tickets, and dockside sampling for each of the seven GKC management areas in SE Alaska to determine relative stock health {Stratman 2021}. Based on this review, the Northern, East Central, Mid-Chatham Strait, and Lower Chatham Strait management areas were closed for the 2019–20 season in response to continued and historically low fishery performance and concern for the long-term reproductive potential of GKC (Stratman 2020). But, for the 2020–21 season, all management areas were open to commercial fishing for GKC and the overall guideline harvest level (GHL) was increased, although commercial fishery logbook CPUE decreased in some areas and only increased notably in one area (North Stephens Passage) in 2019–2020 (Olson and Palof 2020)(ADFG 2021b). In the 2021–22 season, the GHLs for most management areas remained the same or increased, although one area was closed (Olson and Stratman 2022). Fishery CPUE in at least four management areas has declined since 2010, and a fifth area (Lower Chatham Strait) has not been fished in recent years (Olson and Stratman 2022). CPUE has been at levels similar to the 1990s, when a fishery collapse occurred (Stratman 2020)(Olson and Palof 2020). Because of uncertainty regarding the Olson and Stratman (2022) data-limited assessment results, a productivity-sensitivity analysis (PSA) was conducted for this Seafood Watch report. Results of the PSA (score = 3.33) suggested that GKC in this area has high vulnerability (Table 3).

The majority of management areas have declined to quite low CPUE in recent years. Some of the areas with low recent CPUE had the highest historical commercial harvests in SE Alaska. It is also unclear whether commercial fishery CPUE is a good indicator of stock health. Based on the apparent low stock size, combined with the PSA score of high vulnerability, abundance is considered a high concern.

Justification:
Table 3. PSA for GKC in the SE Alaska Commercial Pot Fishery (see Seafood Watch Fisheries Standard for methodology details).

Productivity (P) attributes	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	8 years; theoretical, based on laboratory experiments (Stratman et al. 2017)	2
Average maximum age	19 years, SE Alaska (Stratman et al. 2017)	2
Fecundity	30,000 eggs/year, northern B.C. (Jewett et al. 1985)	1
Reproductive strategy	Brooder (Blau 1997)	2
Density dependence	None	2
Total	P = (2 + 2 + 1 + 2 + 2) ÷ 5	1.80

Susceptibility (S) attributes	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap	Overlap is unknown but likely high (i.e., >30% of the species concentration is fished).	3
Vertical overlap	Overlap is unknown but likely high (i.e., <33% of species depth range is unfished).	3
Seasonality	The fishing season is February–November, thus overlap with the species is high (i.e., >6 months/year).	3

Selectivity	Species is targeted and individuals below legal size limit may escape traps.	2
Post-capture mortality	Because the post-capture mortality rate is not known for this species and fishery, risk was assumed to be high.	3
Total	S = (3 + 3 + 3 + 2 + 3) ÷ 5	2.80

Vulnerability score (V) = $\sqrt{(P^2 + S^2)}$

V = $\sqrt{(3.24 + 7.84)}$

V = 3.33 = High vulnerability

Factor 1.2 - Fishing Mortality

Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska

Low Concern

The overfishing limit (OFL)—the amount of catch above which overfishing is occurring—was defined for AI GKC in the most recent NOAA stock assessment (Siddeek et al. 2020). F_{OFL} is the limit fishing mortality rate (F) for the upcoming fishery year, F_{MSY} is the maximum possible value for F_{OFL}, and $F_{35\%}$ was used as the proxy for F_{MSY} (Siddeek et al. 2020). Total catch includes retained crabs as well as the estimated discard mortality for golden king crab. Because the 2019–20 total catch (3,693 t) was below the OFL (5,249 t), overfishing did not occur. The acceptable biological catch (ABC; 3,937 t) was set at 25% below the OFL in 2019 to account for uncertainty, and is treated as a target reference point for total fishing mortality on the stock (pers. comm., M. Stichert, October 29, 2020). ADF&G set the total allowable catch (TAC; 3,257 t) well below the ABC in 2019, because this serves as a target reference point for fishing mortality of the retained portion of the catch: legal-sized male crabs (pers. comm., M. Stichert, October 29, 2020). In 2016–19, retained catch exceeded the TAC by an average of 65 t per year; however, this overage was due to the ADFG cost-recovery program harvest, so it was not considered an overage for the commercial fishery.

Because total catch did not exceed the ABC and retained catch by the commercial fishery did not exceed the TAC, fishing mortality is considered a low concern.

Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska

Moderate Concern

Pribilof Islands (PI) GKC was considered a Tier 5 (i.e., data-poor) stock, and the OFL and ABC are defined in the 2020 NOAA stock assessment primarily based on historical catch from the 1990s (Daly and Jackson 2020). Total catch includes retained crabs as well as estimated discard mortality for golden king crab. Although retained and total catch were available to fisheries managers in recent years, these data were not publicly available due to confidentiality requirements of the state of Alaska (Daly and Jackson 2020). The ABC (70 t) was set at 25% below the OFL (93 t) in 2019 to account for uncertainty, and is treated as a target reference point for total fishing mortality on the stock (pers. comm., M. Stichert, October 29, 2020). The 2020 NOAA stock assessment states that overfishing did not occur in recent years because total catch did not exceed the OFL, although total

catch was not presented. ADF&G set the guideline harvest level (GHL; 59 t) below the ABC in 2019, because this serves as a target reference point for fishing mortality of the retained portion of the catch: legal-sized male crabs (pers. comm., M. Stichert, October 29, 2020). In recent years, PI landings have reportedly been consistent (pers. comm., M. Stichert, November 10, 2020). ADF&G reports that harvest of GKC in the PI fishery has not exceeded the GHL in recent years (pers. comm., M. Stichert, February 18, 2021). But, general uncertainty associated with the stock assessment was high due to the data-limited nature of the stock.

Uncertainty in the most recent stock assessment of PI GKC was high and data used to compute the OFL/ABC were not recent, but harvest did not exceed the GHL or ABC. Therefore, fishing mortality is considered a moderate concern.

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery

High Concern

Fishing mortality was not estimated for GKC in SE Alaska, and harvest levels corresponding to overfishing are not established. ADF&G evaluates stock status and establishes GHLs for seven GKC management areas based on fishery-dependent data. Beginning with the 2020–21 season, reference points for commercial fishery CPUE began to be used to determine GHLs, but these were based on historical CPUE and not designed to measure harvest levels relative to overfishing (Olson and Palof 2022). In recent years, commercial GKC fishery CPUE declined to historical lows for a longer duration than experienced during the 1990s fishery collapse (Stratman 2020). The fishery was closed in several management areas for the entire 2019–20 season due to low fishery logbook CPUE and other poor indicators. All areas were reopened for the 2020–21 season despite quite low fishery CPUE in the most recent years for nearly all areas {Olson and Palof 2020}(ADFG 2021b). Several areas closed early in 2020–21 due to poor fishery performance, and other areas had no fishing effort (Olson and Stratman 2022). For the 2021–22 season, all management areas were open with GHLs similar to the previous season or higher, except one area that was closed (Olson and Stratman 2022). Although GKC harvest had generally been below GHLs in most management areas in recent years, harvest exceeded the GHLs in 2018–21 in one area (North Stephens Passage) and in the last two seasons in at least three additional areas (ADFG 2022a)(ADFG 2022b). Harvest of SE Alaska GKC has been low in recent years relative to historical levels; however, a sustainable level of harvest that will prevent continued declines has yet to be defined for this fishery. Notably, GKC is vulnerable to overexploitation, given its slow growth and late maturation (Stratman 2020).

GKC is also caught by fishers targeting SE Alaska Tanner crab (pers. comm., A. Olson, December 3, 2020). Estimates of GKC caught during SE Alaska Tanner crab fishery operations (including discards) were not available because at-sea observing has not occurred. GKC may be retained in the SE Alaska Tanner crab fishery, provided that the two fisheries occur concurrently and that fishers/permit holders are registered for the GKC fishery.

SE Alaska GKC fishery CPUE was at historically low levels in most management areas in recent years, although GHLs have been increased in most areas. The harvest relative to overfishing levels is currently not estimated for this fishery, but given the continuation of the fishery despite apparent quite low stock levels in most management areas, it is probable that fishing mortality is above a

sustainable level. Based on this information, fishing mortality is considered a high concern.

Southern tanner crab

Factor 1.1 - Abundance

Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery

Moderate Concern

The EBS Tanner crab stock east of 166° W. (EBT) and west of 166° W. (WBT) are managed separately by ADF&G; however, NOAA AFSC assesses the two areas together as a unit stock encompassing both regions (Stockhausen 2021). Reference points for biomass were used to evaluate stock status in the most recent stock assessment. The target reference point for the stock is $B_{35\%}$ (a proxy for B_{MSY}). If the MMB is at MSST or below (i.e., 0.5 B_{MSY}), the stock is considered overfished. B_{MSY} for this stock is 35,940 t and the MSST is 17,970 t. Because MMB in 2020–21 was 56,340 t, it was above MSST and the stock is not overfished. But, egg production is considered a better indicator for Tanner crab stock health than MMB (Stockhausen 2021)(Daly et al. 2020). In addition, the 2021 stock assessment found a notable divergence in modeled and survey estimated stock abundance, partly because of a lack of a trawl survey in 2020, so uncertainty is relatively high (Stockhausen 2021).

Although the stock is not overfished, EBS Tanner crab MMB has been declining since 2014 and remains at a quite low level in 2021 relative to historic levels, especially in the EBT area (Stockhausen 2021). MFB is also quite low, although it increased slightly in 2021. The WBT fishery was opened in 2020–21, but the EBT fishery remained closed because MMB was below the management threshold for opening. Likewise, in the 2021–22 season, the WBT will remain open but the EBT will remain closed (Stockhausen 2021). Explanations for the recent stock decline were not provided in the stock assessment, but there have been cycles of increasing and decreasing abundance levels since the 1970s, when the domestic fishery first expanded (Stockhausen 2021).

For the EBS Tanner crab stock, MMB is above MSST, so it is not considered overfished and is also above B_{MSY}. But, MMB and MFB were relatively low and declining in the WBT and EBT areas, causing fishing closures in some recent years in WBT and all recent years in EBT. Also, there was relatively high uncertainty associated with the 2021 stock assessment results. Therefore, abundance is considered a moderate concern.

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery

Moderate Concern

The biomass of mature male Tanner crab in Southeast Alaska was estimated using an annual ADF&G crab pot survey and a catch-survey model based on the survey data (Wood et al. 2017)(Rebert et al. 2019). Stock health across five categories was assessed by ADF&G relative to historical averages (1997–2010) of survey CPUE for females as well as pre-recruit and recruited

males in the surveyed areas (Wood et al. 2017). Results were mixed for 2020–2021: "Poor" in one area, "Below Average" in one area, "Moderate" in three areas, "Above Average" in three areas, and "Healthy" in four areas (ADFG 2020c). Because of these mixed results, a productivity-susceptibility analysis (PSA) was conducted for Tanner crab in SE Alaska. Results of the PSA (score = 2.69) suggested that the species in this area has medium vulnerability (Table 4). After a decline in the late 1990s, the overall SE Alaska Tanner crab stock biomass has been fairly stable from 2000 to 2020, but varies by area (ADFG 2020d). Standardized commercial CPUE for the 2014–15 through 2016–17 seasons was moderately stable (Wood et al. 2017). The stock biomass estimate in the 2016–17 season was 4.9 million lb of mature males and 2.6 million lb of legal male crab (Wood et al. 2017). A full assessment was not available since 2017; however, catch-survey modeling produced a regional biomass estimate of 5.81 million pounds of mature male Tanner crab for 2021/2022, continuing a general increasing trend in recent years (Palof et al. 2022).

Based on the mixed results from the most recent ADF&G data-limited assessment and the PSA, combined with a lack of evidence of a depressed stock, abundance for Tanner crab in SE Alaska is deemed a moderate concern.

Justification:
The overall stock health status for Tanner crab in each survey area is determined by comparing long-term and short-term trends in survey CPUE (Rebert et al. 2019). Mature male biomass is determined using a catch-survey model, and the exploitation or harvest rate is applied to mature male biomass to determine harvestable surplus. Stock health for
each area was determined through an examination of the following response variables:
mature female clutch fullness and CPUE; juvenile female CPUE; and pre-recruit, recruit, and post-recruit male CPUE. These response variables provide a range of indicators of the population over different time scales: from quite long (juvenile females; reproductive potential) and long (clutch fullness and mature abundance) to short (legal males). In assessing stock status, each size/sex class was scored independently and weighted equally.

Table 4. Productivity-Sensitivity Analysis for Tanner crab in the SE Alaska Commercial Pot Fishery (see Seafood Watch Fisheries Standard for methodology details).

Productivity (P) attributes	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Average age at maturity	6 years (NPFMC 2021a)	2
Average maximum age	20 years (Rugolo and Turnock 2012)	2
Fecundity	138,000 eggs/year (Gravel and Pengilly 2007)	1
Reproductive strategy	Brooder {Blau 1997]	2
Density dependence	None	2
Total	P = (2 + 2 + 1 + 2 + 2) ÷ 5	1.80

Susceptibility (S) attributes	**Relevant information**	**Score (1 = low risk, 2 = medium risk, 3 = high risk)**
Areal overlap	Overlap is unknown but likely high (i.e., >30% of the species concentration is fished).	3

Vertical overlap	Overlap is unknown but likely high (i.e., <33% of species depth range is unfished).	3
Seasonality	The fishing season is open only in February–March (ADFG 2020a). Therefore, fishery overlap with species is <3 months/year.	1
Selectivity	Species is targeted and individuals below legal size limit may escape traps.	2
Post-capture mortality	Although the post-capture handling mortality rate was estimated indirectly for Tanner crab in the Bering Sea (32%), there have not been studies of post-release mortality for Tanner crab in the SE Alaska fishery. Because the post-capture mortality rate is not known for this fishery, the default score was used.	3
Total	S= (3+3+1+2+3)/5	2.40

Vulnerability score (V) = $\sqrt{(P^2 + S^2)}$

V = $\sqrt{(3.24 + 5.76)}$

V = 3.00 = Medium vulnerability

Factor 1.2 - Fishing Mortality

Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery

Low Concern

The overfishing limit (OFL) was defined for EBS Tanner crab in the most recent NOAA stock assessment, using $F_{35\%}$ (a proxy for F_{MSY}) (Stockhausen 2021). Total catch includes retained crabs as well as the estimated discard mortality for Tanner crab. Total catch (960 t) in 2020–21 was less than the OFL (21,130 t), so overfishing did not occur (Stockhausen 2021). The allowable biological catch (ABC) (16,900 t) was set at 80% of the OFL to account for uncertainty, and is treated as a target reference point for total fishing mortality on the stock. ADF&G set the total allowable catch (TAC) well below the ABC in recent years, because this serves as a target reference point for fishing mortality of the retained portion of the catch: male crabs of the industry-preferred size (pers. comm., M. Stichert, October 29, 2020). Retained catch (660 t) did not exceed the TAC (1,070 t) for the 2020–21 Tanner crab season and total catch did not exceed the ABC (Stockhausen 2021).

The fishery was closed for the 2019–20 season (i.e., TAC = 0), primarily because MFB dropped below the harvest strategy threshold in both EBT and WBT. A new ADF&G harvest strategy in 2020 removed the MFB threshold because it was thought to be overly precautionary, but MFB is still considered when setting the TAC (Daly et al. 2020)(Heller-Shipley et al. 2021). In 2020, MMB was estimated to be below the threshold to open the EBT fishery, but high enough to open the WBT fishery. The stock was overfished in the late 1990s after high fishing pressure in previous decades. The fishery was closed for several years afterward, and the stock biomass increased steadily until abundance began dropping sharply around 2015. Fishing pressure increased greatly in 2014 and 2015 in response to the larger stock biomass. Although fishing mortality is a contributor to reductions in larger crabs in the stock, other factors are also involved in the stock decline (e.g., predation and environmental changes). Tanner crab productivity and distribution are negatively associated with Pacific cod biomass (through predation on Tanner crab) and sea surface temperature

{Szuwalski et al. 2021}. Pacific cod biomass declined from 1990 to 2008 (the time frame of a collapse in the Tanner crab stock), increased in 2008–18, and declined in 2019–21 (Thompson and Thorson 2019).

Because retained catch did not exceed the TAC and total catch did not exceed the ABC (or OFL), fishing mortality is considered a low concern.

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery

Moderate Concern

Fishing mortality estimates and reference points were not available for the SE Alaska Tanner crab stock. The harvest strategy includes a mature male abundance threshold (2.3 million lb) that is half of the long-term average abundance (1997–2007) (Wood et al. 2017). If abundance is below this level, the fishery remains closed. The mature male abundance estimate and the number of registered pots at the start of the fishery determine the commercial Tanner crab season length. Abundance was estimated to be above the threshold for the 2021–22 season (Palof et al. 2022).

The SE Alaska stock of Tanner crab is also caught by fishers targeting SE golden king crab, based on ADF&G at-sea observer data (Olson and Bishop 2012). Tanner crab may be retained in the GKC fishery, provided that the two fisheries occur concurrently and that fishers/permit holders are registered for the Tanner crab fishery.

Because of the unknown fishing mortality level and a lack of evidence suggesting stock declines, fishing mortality is considered a moderate concern.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

GOLDEN KING CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska	2.236	1.000: < 100%	Yellow (2.236)
Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska	2.236	1.000: < 100%	Yellow (2.236)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery	2.236	1.000: < 100%	Yellow (2.236)

SOUTHERN TANNER CRAB			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery	1.732	1.000: < 100%	Red (1.732)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

PACIFIC, NORTHEAST | POTS | UNITED STATES | ALASKA | ALEUTIAN ISLANDS			
SUB SCORE: 2.236	DISCARD RATE: 1.000		SCORE: 2.236
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Corals and other biogenic habitats	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Humpback whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Herrings	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Golden king crab	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Gray whale	3.670: Low Concern	5.000: Low Concern	Green (4.284)

PACIFIC, NORTHEAST | POTS | UNITED STATES | ALASKA | EASTERN BERING SEA | EASTERN BERING SEA TANNER CRAB FISHERY

SUB SCORE: 1.732 DISCARD RATE: 1.000 SCORE: 1.732

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Snow crab	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Herrings	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Southern tanner crab	2.330: Moderate Concern	5.000: Low Concern	Green (3.413)
Gray whale	3.670: Low Concern	5.000: Low Concern	Green (4.284)
Pacific cod	3.670: Low Concern	5.000: Low Concern	Green (4.284)

PACIFIC, NORTHEAST | POTS | UNITED STATES | ALASKA | PRIBILOF ISLANDS

SUB SCORE: 2.236 DISCARD RATE: 1.000 SCORE: 2.236

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Golden king crab	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Corals and other biogenic habitats	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Humpback whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Herrings	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Gray whale	3.670: Low Concern	5.000: Low Concern	Green (4.284)

PACIFIC, NORTHEAST | POTS | UNITED STATES | ALASKA | SOUTHEAST ALASKA | SOUTHEAST ALASKA GOLDEN KING CRAB FISHERY

SUB SCORE: 2.236 DISCARD RATE: 1.000 SCORE: 2.236

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Golden king crab	1.000: High Concern	1.000: High Concern	Red (1.000)
Corals and other biogenic habitats	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Gray whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Humpback whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Herrings	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pacific cod	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Pink salmon	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Southern tanner crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

PACIFIC, NORTHEAST | POTS | UNITED STATES | ALASKA | SOUTHEAST ALASKA | SOUTHEAST ALASKA TANNER CRAB FISHERY			
SUB SCORE: 1.000	DISCARD RATE: 1.000		SCORE: 1.000
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Golden king crab	1.000: High Concern	1.000: High Concern	Red (1.000)
Corals and other biogenic habitats	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Gray whale	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
Finfish	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Herrings	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Southern tanner crab	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)

Species were included in Criterion 2 if: 1) they represented 5% or more of the total catch from the relevant Alaska GKC or Tanner crab fisheries in 2015–19; 2) they were listed as endangered, threatened, or protected (ETP) species and were caught as bycatch in crab pots or there was evidence of crab fishing gear causing entanglements that resulted in mortality above 5% of a sustainable level during 2010–19 (or the fisheries impact is unknown); 3) there was evidence of non-ETP species being affected by the assessed fishery (e.g., caught in traps, entangled in gear), resulting in more than 20% of total fishing mortality during 2010–19 (or the fishing mortality rate was unknown); or 4) a species used as bait in the fishery meets 1, 2, or 3 above.

Non-ETP species

Bycatch species captured in crab pots were determined from fishery onboard observer data and fishery landings information provided by ADF&G. Recent onboard observer data summarizing all species captured in crab pots were available for the BSAI fisheries, but not for SE Alaska fisheries. In the directed Alaska crab fisheries, bycatch in pots includes female crabs of the target species, sublegal male crabs of the target species, and nontarget invertebrate and fish species. ADF&G observer data were available since 1990 for BSAI fisheries. Onboard observer data for 2017–19 were obtained from the ADF&G observer database for BSAI fisheries (ADFG 2020e).

Nontarget crab species

- Snow crab was included as a main species for the EBS Tanner crab fishery where it was not the target species but was still caught, and could be retained if the snow crab fishery was open. Reports indicate that catch of snow crab in the EBS Tanner crab fishery was well above 5% of retained Tanner crab volumes {Gaueman 2014}(ADFG 2020e).
- SE Alaska GKC and Tanner crab are evaluated as target species in Criterion 1, but were caught together in the two fisheries. Each species was estimated to make up more than 5% of landings when it was not the target species, based on ADF&G observer data for the GKC fishery (Olson and Bishop 2012) and personal communications with fisheries managers.

Mammals

- Eastern North Pacific (ENP) gray whale, a non-ETP species, is included in the NOAA list of fisheries LOF as affected by BSAI crab pot fisheries under Category III fisheries (NOAA 2021a). Fisheries that could affect gray whales based on fishery timing and location include all BSAI crab fisheries in this report. The estimated ENP gray whale annual mortality rate is less than one whale, and it is possible that any of these crab fisheries could make up over 20% of this estimate.

Noncrab species reported as bycatch in crab pots

- Pacific cod was included as a main species for some crab fisheries; catch volumes (retention and discards) of Pacific cod were above 5% of directed fishery catch in the EBS Tanner crab and SE Alaska GKC fisheries (Stichert, pers. comm. 2020d)(pers. comm., A. Olson, December 3, 2020) (ADFG 2020i).
- "Corals and Other Biogenic Habitats," including deepwater hard and soft corals as well as sponges and other species, was a main species for the AI and PI GKC fisheries because at-sea observer data showed catches of these species and research showed that bottom-contact fishing (including pots) has caused substantial damage to coral and sponge habitat in the Aleutian Islands (Heifetz et al. 2009). "Corals and Other Biogenic Habitats" was also included as a main species for the SE Alaska Tanner and GKC fisheries, based on limited observer data and on overlap between these habitats and the fisheries suggesting that catches could be occurring. "Corals and Other Biogenic Habitats" was considered a "species/taxa of concern" because: 1) trawling is prohibited in several large areas of the BSAI to protect deepwater coral habitats (Stone and Shotwell 2007); 2) harvest permits are not allowed for these species because of their vulnerability; and 3) Seafood Watch, NOAA, ADF&G, and other organizations consider deepwater corals to be vulnerable habitats as a result of slow growth and susceptibility to impacts from fishing and other seafloor disturbance.
- Many other invertebrate and fish species were recorded as bycatch, including some in high numbers (e.g., snails, sea stars, Pacific halibut, yellowfin sole) but none of these alone was believed to be more than 5% of the fishery catch volume or was considered a species of concern.

<u>ETP species</u>

ETP species were determined based on being designated as "Endangered" or "Threatened" under the U.S. Endangered Species Act (ESA) or the Canada Species At Risk Act (SARA), or categorized as "Critically Endangered," "Endangered," "Vulnerable," or "Near Threatened" by the International Union for the Conservation of Nature (IUCN). An ETP species was only included if there was evidence that the species, stock, or population was caught or entangled in relevant crab fisheries in Alaska or if the source of the entanglements was an unknown pot fishery operating in the same area. Three ETP marine mammal stocks were considered for inclusion in the report, but only two remained in the report:

- The NOAA list of fisheries (LOF) includes Central North Pacific (CNP) humpback whale under Category III for SE Alaska crab fisheries, which means that, although CNP humpback whale could be incidentally killed or injured in these fisheries, the likelihood is low (NOAA 2021a). Although CNP humpback whale is not listed under the ESA, it is considered endangered by NOAA for management because of overlap with the Western North Pacific humpback whale stock. Entanglements of humpback whale in BSAI and SE Alaska pot fisheries are reported in NOAA stock assessments and scientific literature {Muto et al. 2020}. Only the GKC fisheries in PI, AI, and SE Alaska overlap temporally and spatially with humpback migrations; therefore, humpback whale

was only included as a main species for these fisheries.

- The Gray Whale Pacific Coast Feeding Group (PCFG) is listed as an "Endangered" stock under SARA. PCFG migration can overlap with the timing and location of the SE Alaska GKC and Tanner crab fisheries, and entanglements have occurred with pot fisheries. Therefore, this stock was included as a main species for these fisheries.
- The Western Arctic bowhead whale stock is listed as "Endangered" under the ESA (USFWS 2021). The NOAA LOF includes this stock under Category III for impacts from BSAI fisheries, which means that, although bowhead whale could be incidentally killed or injured in these fisheries, the likelihood is low (NOAA 2021a). BSAI fisheries that could affect bowhead whale based on known stock distribution include the Pribilof Islands (PI) GKC and the Eastern Bering Sea (EBS) Tanner crab fisheries. There are no reports of entanglements attributed to these specific fisheries, but entanglements and mortalities have resulted due to unidentified Bering Sea commercial pot gear (Muto et al. 2020a). Gear marking may not be sufficient to identify BSAI crab fishery gear involved in entanglements. A study examined 514 of 904 harvested bowhead whales between 1990 and 2012, with approximately 12.2% of these showing entanglement scars (George et al. 2017). The cause of entanglements was determined to be most likely from fish/crab pot gear in the Bering Sea (George et al. 2017){George et al. 2019}. Four bowhead whale mortalities in recent years could have been due to crab gear entanglements from the Bering Sea. A mortality in northern Alaska in 2010 was entangled in crab pot gear similar to that used by commercial crabbers in the Bering Sea {Suydam et al. 2011}. A mortality in 2015 that was found entangled had an attached permit tag for the 2012–13 winter commercial blue king crab fishery located in Saint Matthew Island waters of the northern Bering Sea (Delean et al. 2020). The 2020 NOAA stock assessment of bowhead whale estimated the mortality from U.S. fisheries at 0.2 whales annually, with Native Alaskan subsistence harvest accounting for over 99% of known annual human-induced mortality (Muto et al. 2020a). Although research suggests that mortality due to entanglements is underestimated {George et al. 2019}, it is unlikely that mortality is above 5% of a sustainable level (i.e., potential biological removal, PBR), which would be over eight whales annually. Therefore, bowhead whale was not included as a main species in this assessment.

Bait use

Information on bait use in the Alaska crab fisheries relied on personal communications with ADF&G staff and crab fishing industry representatives.

- Pacific cod was included as a main species for some crab fisheries based on information provided by Alaska Bering Sea Crabbers (pers. comm., ABSC, July 2, 2021). Bait use of Pacific cod was above 5% of the directed fishery catch in the EBS Tanner crab fishery (Stichert, pers. comm. 2020d).
- Herring was included as a main species for some crab fisheries based on information from ABSC and other industry representatives (pers. comm., ABSC, July 2, 2021) (pers. comm., E. Paulsen, June 23, 2021). Bait use of herring from various stocks (including Pacific and Atlantic herring) was above 5% of the directed fishery catch in the AI GKC, PI GKC, and EBS Tanner crab fisheries.
- Pacific cod, Pacific herring, and pink salmon were each used as bait in quantities above 5% of landings in the SE Alaska GKC fishery, based on information provided by the Southeast Alaska Fishermen's Alliance industry group (pers. comm., K. Hansen, December 23, 2020).
- Other bait species were used at levels below 5% of landings for the relevant fishery.

- The "Unknown Finfish" category was also included for the SE Alaska Tanner crab fishery to account for uncertainty about stocks of pink salmon and Pacific herring used as bait and about unknown species/amounts of finfish bycatch.
- Although halibut and/or black cod heads were used as bait in large quantities in the BSAI GKC fisheries, this practice was considered to be making use of fish processing scraps, so halibut and black cod were not included as main species and these bait quantities were not included in overall bait totals for these fisheries (Factor 2.3). The AI GKC fishery has also started using invasive carp species from the U.S. Midwest as bait instead of halibut and black cod. Reports are that this technique has been successful and may expand to other boats in the fleet in the future (pers. comm., E. Poulsen, May 19, 2022).

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Corals and other biogenic habitats

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands

High Concern

Corals and other biogenic habitat-forming species (e.g., stony corals, soft corals, sponges, gorgonians, hydrozoans, tunicates) are present in ADF&G observer data at low levels for the AI and PI GKC fisheries (ADFG 2020e). Because corals and other biogenic habitat-forming species (e.g., stony corals, soft corals, sponges, gorgonians, hydrozoans, tunicates) in the AI, PI, and SE Alaska are typically found in quite deep water, the slower growth rates of corals and other biogenic habitats in these areas amplify the impacts from seafloor disturbance through fishing or other activities (NOAA 2021b)(Woodby et al. 2002). The vulnerability of deepwater corals to human-induced seafloor disturbances (e.g., trawling and crab pots) makes them a species (or taxa) of concern for Seafood Watch. The abundance of these species is unknown relative to sustainable levels in the AI, PI, and SE Alaska. Based on the unknown abundance of these taxa relative to sustainable levels, combined with their vulnerability, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands

Low Concern

Corals and other biogenic habitat-forming species (e.g., stony corals, soft corals, sponges, gorgonians, hydrozoans, tunicates) are present in ADF&G observer data at low levels for the AI and PI GKC fisheries (ADFG 2020e). Small numbers of corals and sponges were also observed in SE Alaska GKC fisheries before the observer program was discontinued in 2016, although observing rates were low and data are not available after 2010 (Olson and Bishop 2012). No observation data for bycatch occurred for the SE Alaska Tanner crab fishery. When crab pots shift or are dragged across the seafloor, corals and other biogenic habitat-forming species can be scraped away from the seafloor, and some are retained in pots. These species are also found in seafloor surveys of the AI fishing grounds, and were present in some areas of the PI and SE Alaska fishing areas (Stone and Shotwell 2007)(NMFS 2004). There is not a formal assessment of the impacts of the AI GKC, PI GKC, SE Alaska GKC, or SE Alaska Tanner crab fisheries on corals and other biogenic habitats. Based on available research on this subject, there is no clear evidence whether pot gear impacts are

sustainable or not (pers. comm., C. Rooper, August 23, 2021).

Although some coral and biogenic habitat species caught in the AI, PI, and SE Alaska GKC fisheries and the SE Alaska Tanner crab fishery are known through ADF&G observer data, the full array of affected species is incomplete. Therefore, the Unknown Bycatch Matrix (UBM) was used to evaluate fishing mortality. The UBM indicates that the impact of fisheries using pot gear on corals is a low concern.

Finfish

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderate Concern

The SE Alaska tanner crab fishery uses finfish as bait and also likely discards multiple finfish species as bycatch. Finfish used as bait include Pacific herring, Pacific cod, and pink salmon (peas comm., K. Hansen, December 23, 2020). The specific stocks of salmon and herring used as bait are unknown, and some stocks of these species in SE Alaska have an unknown status or are depleted (Conrad and Thynes 2020)(ADFG 2020h). Also, bait may be sourced from areas outside SE Alaska, where stock status is also mixed. At-sea observer data are not collected for this fishery, so it is unclear which finfish are discarded. A historical observer program for the SE Alaska GKC fishery, which operates in some of the same areas as the SE Alaska Tanner crab fishery, indicates that several finfish species are caught and discarded (Olson and Bishop 2012). The similarity in the catch composition between the two fisheries is unknown.

Because of uncertainty about the stocks and levels of finfish caught or used as bait, all finfish species were grouped into the Unknown Finfish category for this fishery. The Seafood Watch standard indicates that abundance of Unknown Finfish should be scored a moderate concern.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderate Concern

The SE Alaska Tanner crab fishery uses finfish as bait and also likely discards multiple finfish species as bycatch. Finfish used as bait include Pacific herring, Pacific cod, and pink salmon (pers. comm., K. Hansen, December 23, 2020). The specific stocks of salmon and herring used as bait are unknown, and some stocks of these bait species in SE Alaska have an unknown stock status or are depleted (Conrad and Thynes 2020)(ADFG 2020h). Bait may also be sourced from areas outside SE Alaska, where stock status of these species is also mixed. At-sea observer data are not collected for this fishery, so it is unclear which finfish are discarded. A historical observer program for the SE Alaska GKC fishery, which operates in some of the same areas as the SE Alaska Tanner crab fishery, indicates that several finfish species are caught and discarded (Olson and Bishop 2012). The

similarity in catch composition between the two fisheries is unknown.

Because of uncertainty about the stocks and levels of finfish caught or used as bait, all finfish species were grouped into the Unknown Finfish category for this fishery. The Seafood Watch standard indicates that fishing mortality of Unknown Finfish should be scored a moderate concern.

Golden king crab

Factor 2.1 - Abundance

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery

High Concern
See Explanation in Criterion 1.

Factor 2.2 - Fishing Mortality

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery

High Concern
See Explanation in Criterion 1.

Gray whale

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Low Concern
The Eastern North Pacific (ENP) gray whale stock feeds in the Chukchi, Beaufort, and northwestern Bering Seas, as well as from SE Alaska to California, during summer and fall {Carretta et al. 2021}. The ENP stock migration overlaps with the locations of several crab pot fisheries in the BSAI (Figure 10). But, the portion of the stock that feeds from SE Alaska to California is called the Pacific Coast Feeding Group (PCFG), and BSAI crab fisheries do not overlap with the PCFG migration. The ENP stock migrates to wintering lagoons in Baja California, Mexico in late fall, where they remain until early spring before migrating north to feed (Jones 1990). In 2015, the minimum population estimate (N_{min}) for the ENP stock was 25,849, which was the highest recorded in the 1967–2015 time series {Carretta et al. 2021}. The IUCN considers the status of the gray whale overall (not specific to the ENP population) to be "Least Concern" {Cooke et al. 2018}. In 1994, the ENP stock of gray whale was removed from the Endangered Species Act (ESA) (NMFS 1994). In 2011, the ENP

population was estimated at 85% of carrying capacity, 129% of the maximum net productivity level, and within the range of an optimum sustainable population (Punt and Wade 2010). An ongoing gray whale Unusual Mortality Event (UME) resulted in 502 gray whale mortalities in the United States, Canada, and Mexico in 2019–21 (117 mortalities in Alaska) (NOAA 2022e). Although the UME has not yet been incorporated into estimates of the population size, it is likely that the ENP gray whale stock remains at a sustainable level due to the large population size before the UME began.

Population trends were positive for ENP gray whale until the most recent estimate in 2015, and the stock is not ESA listed or strategic. Despite the ongoing UME, it is likely that abundance remains relatively high. Therefore, abundance of gray whale is considered a low concern.

Justification:

Figure 10: Approximate distribution of the Eastern North Pacific stock of gray whale (shaded area) {Carretta et al. 2021}.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

High Concern

The Eastern North Pacific (ENP) gray whale stock feeds in the Chukchi, Beaufort, and northwestern Bering Seas, as well as from SE Alaska to California, during summer and fall (NOAA 2021c). The ENP stock migrates to wintering lagoons in Baja California, Mexico in late fall, where gray whales remain until early spring before migrating north to feed (Jones 1990). The portion of the ENP stock

that feeds from SE Alaska to California, called the PCFG, overlaps the SE Alaska GKC and Tanner crab fisheries in time and space. Because these whales are the most likely to be affected by the SE Alaska crab fisheries, only the PCFG was evaluated in relation to these fisheries. Although the United States does not consider the PCFG to be a stock subject to listing under the ESA, Canada does consider the PCFG to be a stock, based on recent genetic and tagging information, and it is listed as "Endangered" under the Canada Species at Risk Act (SARA) (Government of Canada 2021). The ENP stock has increased notably in recent years to a time-series high and was removed from the ESA in 1994 (NOAA 2021c); however, the number of whales in the PCFG has remained small in the most recent estimates (approximately 243 individuals as of 2017) (COSEWIC 2017). In addition, an ongoing gray whale Unusual Mortality Event (UME) resulted in 502 mortalities in the United States, Canada, and Mexico in 2019–21 (117 mortalities in Alaska) (NOAA 2022e). Although the ENP gray whale stock likely remains at a sustainable level, the results of the UME have not yet been incorporated into stock assessment estimates of the population size, and the effects of the UME on the PCFG is unknown. Because of the listing of the gray whale PCFG as "Endangered" in Canada, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Low Concern
The 2019 NOAA ENP gray whale stock assessment and the NOAA LOF indicate that crab pot fisheries in the Bering Sea may affect gray whale {NOAA 2019}(Carretta et al. 2021). ENP gray whale migrations overlap temporally and spatially with BSAI crab fisheries (Carretta et al. 2021) (see Figure 10 in Factor 2.1). In 2012, the International Whaling Commission (IWC) concluded that harvest levels and other human-caused mortality are sustainable, given the population abundance (Punt and Wade 2010). The potential biological removal (PBR) level for the ENP stock of gray whale is 801 animals per year. The total human-caused serious injury and mortality totals 62 ENP whales annually. Thus, the stock is not considered strategic under the Marine Mammal Protection Act (MMPA) (Carretta et al. 2021). Entanglement in commercial pot and trap fisheries along the U.S. West Coast is a source of gray whale mortality and serious injury (Carretta 2020). Although the stock assessment does not report any mortalities as a result of entanglement in BSAI crab fishery gear, 0.95 annual takes are attributed to unidentified pot gear and 3.65 takes are attributed to unidentified fishing gear. Because the estimated annual mortality rate for ENP gray whale from all fishing gears is less than 1% of the PBR, fishing mortality is considered a low concern.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Low Concern
The 2020 NOAA ENP gray whale stock assessment indicates that crab pot fisheries may affect grey whale through entanglements (Carretta et al. 2021). The gray whale PCFG migration overlaps

temporally and spatially with the SE Alaska GKC and Tanner crab fisheries {Carretta et al. 2021} (COSEWIC 2017) (see Figure 10 in Factor 2.1). The PBR level established in the most recent NOAA stock assessment for the PCFG gray whale is 3.5 animals per year. The total serious injury and mortality is 1.1 PCFG gray whales annually. Thus, the PBR has not been exceeded based on the most recent information {Carretta et al. 2021}. Entanglement in commercial pot and trap fisheries along the U.S. West Coast is a source of grey whale mortality and serious injury (Carretta 2020). Although the stock assessment does not report any mortalities as a result of entanglement in SE Alaska crab fishery gear, 0.3 annual mortalities of PCFG gray whale are attributed to unidentified pot gear and 0.4 were attributed to unidentified fisheries. Because the annual mortality rate for PCFG gray whale is approximately 31% of the PBR, fishing mortality is considered a low concern.

Herrings

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderate Concern
Multiple herring stocks are used as bait in the EBS snow crab and EBS Tanner crab fisheries according to the Alaska Bering Sea Crabbers industry group (pers. comm., ABSC, July 2, 2021), as well as in the PI and AI GKC fisheries (pers. comm., E. Paulsen, June 23, 2021). Based on estimates of bait use, herring quantities were over 5% of crab landings for the respective fisheries. Vessels primarily source herring for chopped bait locally in Alaska from the Dutch Harbor or the Kodiak bait fishery, if available (pers. comm., ABSC, July 2, 2021) (pers. comm., E. Paulsen, June 23, 2021). The Dutch Harbor herring fishery harvests from the Togiak District herring stock, which has been generally stable or slightly increasing in recent years (Whiteside 2020). Other sources of herring bait include Pacific herring from Russia or Canada or Atlantic herring from Norway, Canada, or the U.S. East Coast (pers. comm., ABSC, July 2, 2021). Some stocks of Pacific herring on the West Coasts of the United States and Canada are healthy, while others are depleted. Atlantic herring stocks are generally depleted, while some stocks have an unknown status.

Information provided by the Southeast Alaska Fishermen's Alliance indicates that Pacific herring harvested in SE Alaska is commonly used as bait in the SE Alaska GKC fishery (pers. comm., K. Hansen, December 23, 2020). Bait herring fisheries in SE Alaska include Sections 3-B (Craig/Klawock), 12-A (Tenakee Inlet), 13-C (Hoonah Sound), and District 7 (Ernest Sound) (Coonradt et al. 2019). The threshold level established by the state of Alaska for opening a fishery on the Craig/Klawock herring stock is 5,000 t (Coonradt et al. 2019). The 2019 spawn deposition estimate for the Craig/Klawock stock was 55,072 t, based on surveys conducted by ADF&G in 2019

(ADFG 2020h). Therefore, the stock is well above the threshold for opening a fishery. The other three sections/stocks in the SE Alaska herring bait fisheries were below management thresholds, which ranged from 2,000 to 3,000 t. There are no quantitative stock assessments for the SE Alaska herring stocks, and although stock biomass for one of the stocks is above the management threshold, it is unknown whether this is the appropriate measure for biomass of this important forage species.

Because of uncertainty about species and stocks of herring and the relative quantities of each used as bait in BSAI fisheries, combined with variable stock status, the abundance of stocks used in the BSAI was considered unknown. The most abundant stock of Pacific herring in SE Alaska is fairly healthy relative to management thresholds, but the other three stocks are depleted and it is uncertain whether thresholds are set to appropriate levels to avoid depletion of the last remaining healthy stock of this important forage species. Therefore, this factor is scored a moderate concern for herring stocks used as bait in the BSAI and SE Alaska fisheries.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderate Concern

Multiple herring stocks are used as bait in the Bering Sea crab fisheries (pers. comm., ABSC, July 2, 2021). One commonly reported source of herring is the Dutch Harbor food and bait herring fishery, which harvests from the Togiak District herring stock. The current harvest rate for the Togiak District stock is 20%, with the food and bait fishery harvesting 7% of that amount, but there are no fishing reference points identified to determine sustainable harvest levels (Whiteside 2020). Some Pacific herring on the West Coasts of the United States and Canada are healthy, while others are depleted relative to historical levels. Overfishing is occurring for some Atlantic herring stocks, while some stocks have unknown status.

Information provided by the Southeast Alaska Fishermen's Alliance indicates that Pacific herring harvested in SE Alaska is commonly used as bait in the SE Alaska GKC fishery (pers. comm., K. Hansen, December 23, 2020). Herring bait use exceeded 5% of crab landings in the GKC fishery, where herring bait use was roughly 13% of landings. This estimate was based on an average of 7,162 pot lifts per year (2015–19) in the GKC fishery and 1 lb of herring bait use per pot. Bait fisheries for herring include Sections 3-B (Craig/Klawock), 12-A (Tenakee Inlet), 13-C (Hoonah Sound), and District 7 (Ernest Sound) (Coonradt et al. 2019). Quantitative stock assessments were not available to estimate fishing mortality or define reference points for these stocks. In 2020, only the Section 3-B fishery was open, with the other areas closed due to minimal herring spawning observed (ADFG 2020h). In 2020, the Section 3-B fishery landed the highest amount of herring ever recorded for that fishery (over 250 t); however, this was still well below the guideline harvest level

(GHL) (ADFG 2020j). The threshold level established by the State of Alaska for opening a fishery on the Craig/Klawock herring stock is 5,000 t (Coonradt et al. 2019). The 2019 spawn deposition estimate for the Craig/Klawock stock was 55,072 t, based on surveys conducted by ADF&G in 2019 (ADFG 2020h). Therefore, the stock is well above the threshold for conducting a fishery. The other three sections/stocks involved in the SE Alaska herring bait fisheries have thresholds ranging from 2,000 to 3,000 t for opening fisheries in those areas.

Fishing mortality was considered unknown for stocks used as bait in BSAI fisheries, because fishing mortality reference points were lacking for the Togiak Stock and there is uncertainty about other species and stocks of herring and the relative quantities of each used as bait. Fishing mortality is unknown and reference points are not available for Pacific herring stocks used as bait in SE Alaska fisheries, but harvest may be at a sustainable level for at least one of the stocks and fisheries for the other stocks are closed. Therefore, fishing mortalityias considered a moderate concern for herring used as bait in the BSAI and SE Alaska fisheries.

Humpback whale

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

High Concern
The Central North Pacific (CNP) stock of humpback whale consists of individuals spending winter/spring near the Hawaiian Islands and migrating in summer/fall for feeding primarily in northern British Columbia (B.C.), SE Alaska, and the BSAI (Figure 11) (Calambokidis et al. 1997). This range overlaps with some crab pot fisheries in the BSAI and SE Alaska.

Based on surveys from 2004 to 2006, the N_{MIN} for the CNP humpback whale stock was estimated at 7,891 (Muto et al. 2020b). NMFS typically recommends that N_{MIN} be considered unknown if the abundance estimate is more than 8 years old, unless there is compelling evidence that the stock has not declined since the last estimate. This population is increasing in areas of Alaska (Teerlink et al. 2015); therefore, NOAA considers the most recent N_{MIN} to be a valid minimum population estimate. The N_{MIN} for the SE Alaska/B.C. feeding aggregation is 2,252, although it is not formally considered a stock.

The stock structure of humpback whale is under consideration and revisions may be proposed within the next few years. But, NOAA currently considers the stock depleted and endangered for management purposes, and also strategic. This is because the Western North Pacific stock as defined by the ESA covers a portion of the CNP stock as defined under the MMPA. Because of the endangered status of the CNP stock, abundance is considered a high concern.

Justification:

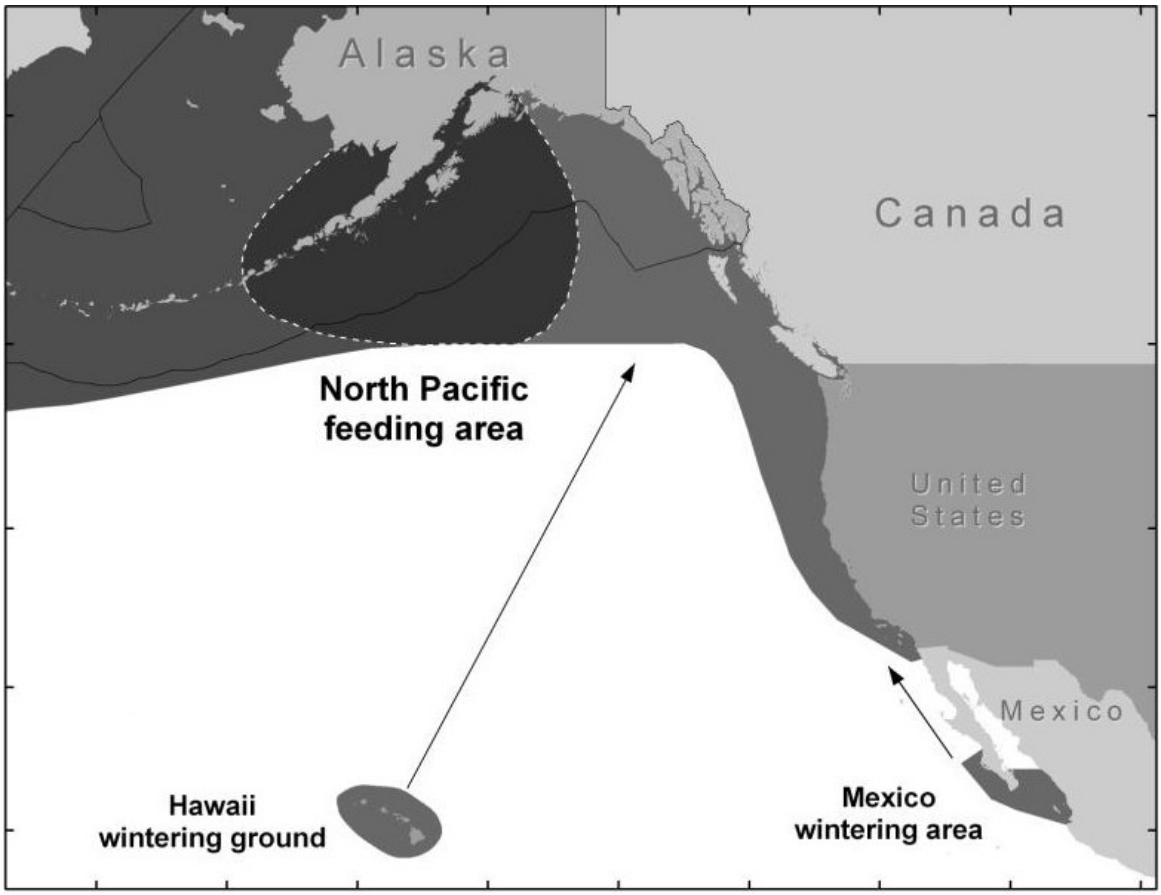

Figure 11: Approximate distribution of humpback whale in the eastern North Pacific (dark shaded areas). Central North Pacific and Western North Pacific stocks overlap within the dotted line area. (Muto et al. 2020b)

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Low Concern

The CNP stock of humpback whale is known to become entangled in crab pot gear in BSAI and SE Alaska, infrequently resulting in mortalities (Neilson et al. 2009)(Muto et al. 2020b){NOAA 2020c}. The AI, PI, and SE Alaska GKC fisheries can extend through the summer and fall months, and humpback whales may encounter pot gear from these fisheries during migrations in the area in late spring through fall. In addition, SE Alaska crab pot fisheries were included in the NOAA LOF under Category III fisheries affecting CNP humpback whale (NOAA 2021a).

Using abundance estimates derived from surveys in 2004–06, the annual potential biological removal (PBR) for CNP humpback whale is 83 whales. The PBR for the SE Alaska/B.C. feeding

aggregation is 24 and for BSAI is 7.9. The minimum mean annual level of human-caused mortality and serious injury for CNP humpback whale between 2013 and 2017 was 25 whales, including 9.5 in U.S. commercial fisheries as well as 7.7 in unknown fisheries (other mortalities were from ship strikes, etc.). This estimate is considered a minimum because no observers have been assigned to several fisheries that are known to interact with this stock, including SE Alaska pot fisheries and B.C. commercial fisheries. A portion of mortalities was due to Alaska fisheries, but only 0.2 whales were estimated to be killed due to entanglement in BSAI pot fisheries and another 0.2 due to SE Alaska pot fisheries; another 0.2 were due to entanglement in Alaska crab pot fisheries in general, 0.3 were due to entanglement in unidentified SE Alaska fisheries, and 5.5 due to entanglement in unidentified fishing gear. Even added together and assuming that all are due to the SE Alaska crab pot fishery, these are less than 10% of the PBR for CNP humpback whale, and approximately 25% of the SE Alaska/B.C. feeding aggregation, although they nearly equal the PBR for BSAI. Neilson et al. (2009) found that roughly 71% of humpback whales in SE Alaska showed scars from entanglements. This study also indicated that, of the 54 entanglements of humpback whales in Alaska in 1997–2004, 32% were due to crab pot gear and 48% of all entanglements were due to fishing gear in Alaska.

Although entanglements are likely occurring, potentially at high rates, mortality is low based on available information. Therefore, fishing mortality is considered a low concern.

Pacific cod

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Low Concern

Pacific cod is caught and often retained for use as bait in the Bering Sea Tanner crab and snow crab fisheries, as well as the Bristol Bay RKC fishery (Stichert, pers. comm. 2020d). In the most recent stock assessment for Pacific cod in the EBS, female spawning biomass in 2020 (259,509 t) was projected to be below $B_{MSY40\%}$ (266,602 t), but above $B_{MSY35\%}$ (233,277 t) and MSST (0.5 $B_{MSY35\%}$) (Thompson and Thorson 2019). Therefore, the stock was not overfished.

Because biomass was above the limit reference point (MSST) and greater than 75% of the target ($B_{MSY40\%}$), abundance is considered a low concern.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Moderate Concern

Based on information from ADF&G, Pacific cod can be retained in the SE Alaska crab fisheries for use as bait, although it is not known how much is retained annually (pers. comm., A. Olson, December 3, 2020) (ADFG 2020i). Information provided by the Southeast Alaska Fishermen's Alliance indicates that Pacific cod is regularly used as bait in the SE Alaska Tanner crab and GKC fisheries (pers. comm., Kathy Hansen, December 23, 2020); however, only the GKC fishery is likely to use cod as bait in quantities greater than 5% of the crab fishery landings. There is no current

stock assessment for Pacific cod in SE Alaska, so stock status is unknown (pers. comm., Forrest Bowers, July 27, 2021). Because of the unknown stock status, the abundance of Pacific cod in SE Alaska is considered a moderate concern.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Low Concern

ADF&G data indicate that Pacific cod was retained or used as bait at just over 5% of harvest for each fishery (Bering Sea RKC, EBS Tanner crab, and EBS snow crab) in 2016–19 {Stichert pers. comm. 2020d}. Observer data also show that Pacific cod is also regularly discarded from these fisheries (ADFG 2020e). In the most recent stock assessment for Pacific cod in the EBS, harvest of Pacific cod was below the allowable biological catch (ABC). Therefore, overfishing is not occurring. In recent years, the ABC was set at roughly 85% of the overfishing limit (OFL) for the EBS Pacific cod stock, and the total allowable catch (TAC) was set below the ABC. Although federal plus state catch exceeded the federal TAC in 2016–18, the total catch did not exceed the federal TAC plus state guideline harvest level (GHL) in recent years (Thompson and Thorson 2019). The state GHL is based on a percentage of the ABC, and fishery managers' intention is to keep the state plus federal fishing under the ABC, because the TAC is set for federal fishing only (pers. comm., K. Milani, May 13, 2022). Because overfishing is not occurring for Pacific cod in the EBS, harvest was below the TAC in 2019, and catch in this fishery is a small component of overall fishing mortality, fishing mortality is considered a low concern.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Moderate Concern

ADF&G at-sea observer data indicate that Pacific cod is caught in the SE Alaska GKC fishery (Olson and Bishop 2012). Pacific cod may also be retained for use as bait in this fishery, but this amount was not available. Bait use was estimated for this report based on the average number of pot lifts in these fisheries in 2015–19 and information provided by the Southeast Alaska Fishermen's Alliance (pers. comm., K. Hansen, December 23, 2020). Although this method is highly uncertain, it did suggest that cod may be used as bait above 5% of GKC landings on average. There is not a stock assessment for Pacific cod in SE Alaska, so fishing mortality is unknown (pers. comm., Forrest Bowers, July 27, 2021). Because fishing mortality is unknown but there are no obvious signs of overfishing, fishing mortality is considered a moderate concern.

Pink salmon

Factor 2.1 - Abundance

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Moderate Concern

Information provided by the Southeast Alaska Fishermen's Alliance indicates that pink salmon is regularly used as bait in the SE Alaska GKC fishery (pers. comm., K. Hansen, December 23, 2020). Based on information provided, the fishery likely uses pink salmon in quantities above 5% of the GKC fishery landings. It was unknown which stocks of pink salmon were used as bait, and many stocks with varying status exist in Alaska. If the pink salmon used is from SE Alaska, the status of stocks is also mixed. The 2019 Southeast Alaska pink salmon escapement index was 8.81 million fish (Thynes et al. 2020). Biological escapement goals were met in two of the three subregions of SE Alaska. Management targets for pink salmon were met or exceeded for 9 of 15 districts with management targets and for 27 of the 46 pink salmon stock groups (Thynes et al. 2020). Because stock status (based on escapement relative to management goals) was mixed for pink salmon in Alaska (including SE Alaska) in 2019, and stocks used as bait were not known, abundance is considered a moderate concern.

Factor 2.2 - Fishing Mortality

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Moderate Concern

Crab fishing industry representatives report that pink salmon is commonly used as bait in the SE Alaska GKC fishery (pers. comm., K. Hansen, December 23, 2020). The amount of salmon used as bait in this fishery was not available. Bait use was estimated for this report based on the average number of pot lifts in these fisheries in 2015–19 and information provided by the Southeast Alaska Fishermen's Alliance (pers. comm., K. Hansen, December 23, 2020). Although this method is highly uncertain, it did suggest that pink salmon may be used as bait above 5% of GKC landings on average. It is not clear that pink salmon used as bait was sourced from SE Alaska stocks, but these stocks had mixed status (as do pink salmon stocks throughout Alaska). Fishing for pink salmon in SE Alaska occurs in several areas, mainly using purse seines and drift gillnets. In 2019, some areas had escapement estimates within management ranges, while some were below these ranges (Thynes et al. 2020). Because fishing mortality is unknown, the health of Alaska pink salmon stocks (including SE Alaska) is mixed, but the overall contribution to fishing mortality of pink salmon in Alaska from this fishery is low, it is considered a moderate concern.

Snow crab

Factor 2.1 - Abundance

Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

High Concern

The 2021 NOAA AFSC stock assessment of EBS snow crab used reference points to evaluate biomass (Szuwalski 2021). Abundance estimates of EBS snow crab were derived from the annual NOAA Eastern Bering Sea Continental Shelf Trawl Survey. Results from the 2021 NOAA trawl survey indicated that abundance of mature male and female snow crab declined 55% and 70%,

respectively, and immature snow crab abundance declined even further, compared to 2019 estimates (the survey did not occur in 2020 due to the COVID-19 pandemic) {Zacher et al. 2021}. The current mature male biomass (MMB) is the lowest in the time series that began in 1980, and mature female abundance is also near a time-series low (Szuwalski 2021). The target biomass reference point is B_{MSY}, for which $B_{35\%}$ is used as a proxy, where $B_{35\%}$ is 35% of the estimated unfished biomass, and the minimum stock size threshold (MSST) is 0.5 $B_{35\%}$. The MMB was 26,700 t in 2020–21, well below MSST (76,700) (Szuwalski 2021). Because of the current MMB level, the stock was declared overfished in 2021 by NOAA Fisheries (NOAA 2022a). The 2022 NOAA AFSC stock assessment of EBS snow crab was still in draft form as this report was being finalized, but a summary of the stock assessment confirmed that the stock remained overfished (MMB was well below MSST) (NPFMC 2022). Because MMB is below MSST and the stock is considered overfished, abundance is considered a high concern.

Factor 2.2 - Fishing Mortality

Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Moderate Concern

The EBS stock of snow crab is mostly caught in a targeted fishery that was closed as of the publication of this report. But, snow crab is also caught and can be retained in the EBS Tanner crab fishery if the snow crab fishery is open. ADF&G observer data from 2017–18 indicate that catches of snow crab (landings plus discards) made up a quite large percentage of overall catch in the EBS Tanner crab fishery (ADFG 2020e). Although snow crab cannot be retained in the 2022–23 Tanner crab fishery due to closure of the snow crab fishery, snow crab will be discarded at an unknown rate. Bycatch of snow crab in the EBS Tanner crab fishery in 2021 was notably lower than in previous years and is expected to remain so in the near future, as a result of the depleted snow crab stock and the shift of adult snow crab abundance farther north, thus reducing the overlap with EBS Tanner crab (pers. comm., M. Stichert, November 11, 2022). Because not all snow crab will survive post-release from the Tanner crab fishery, fishing mortality will occur. Handling mortality in recent NOAA snow crab stock assessments was estimated at 30%, but this is not based on post-release field studies. Although mortality of snow crab in the EBS Tanner crab fishery may effect the EBS snow crab stock's recovery, the fishing mortality for snow crab is currently unknown.

Based on the unknown fishing mortality of depleted EBS snow crab in the EBS Tanner crab fishery, combined with the expectation of relatively lower bycatch in the upcoming Tanner crab fishing seasons, fishing mortality is considered a moderate concern.

Justification:

The OFL was defined for EBS snow crab in the 2021 NOAA stock assessment, using $F_{35\%}$ (a proxy for F_{MSY}) (Szuwalski 2021). The total catch includes retained crabs as well as the estimated discard mortality for snow crab. The total catch in 2020–21 (26,200 t) was well below the OFL (95,400 t, fishing at F_{OFL} = 0.37). The ABC (71,550 t) was set at 75% of the OFL to account for uncertainty, and is treated as a target reference point for total fishing mortality on the stock. ADF&G set the TAC (20,400 t) well below the ABC in the 2020–21 season; the TAC serves as a target reference point

for fishing mortality of the retained portion of the catch: male crabs at the industry-preferred size (pers. comm., M. Stichert, October 29, 2020). The total catch (26,200 t) did not exceed the OFL, and the retained catch (20,400 t) did not exceed the TAC in 2020–21.

Because of a sharp drop in MMB in 2021 to historically low levels below MSST, the stock was declared overfished. The 2021–22 fishing season remained open, with the TAC (2,540 t) reduced by over 85% relative to the prior season (ADFG 2021d). There is not a minimum threshold for female crab abundance for the snow crab fishery to occur. Instead, total mature biomass (TMB) is estimated for male and female snow crabs, and if TMB is less than 25% of B_{MSY}, the fishery is closed based on this threshold as determined by ADF&G. In 2021, TMB was 27% of B_{MSY}, so the fishery remained open for the 2021–22 season (ADFG 2021d). The fishery was closed for the 2022–23 season because TMB fell below the threshold for opening a fishery—the first time this has occurred (ADFG 2022c). Based on the 2022 NOAA stock assessment, which was in draft form as this report was being published, the retained catch was equal to the TAC in the 2021–22 season, with approximately 1.1 t of additional mortality for snow crab due to discard mortality (NPFMC 2022). Overfishing did not occur in the 2021–22 season.

Retained catch of snow crab in the 2020–21 fishing season was at the highest level since 2014. This level of harvest was allowed due to the relatively high MMB estimated the previous year. Removals of snow crab through retention of legal-sized male crab and bycatch mortality of females and undersized males were likely a contributing factor in the decline of the stock. Although snow crab likely experienced high mortality in the past few years, the relative contributions of natural mortality (environmental processes, predation, etc.) and fishing mortality remain highly uncertain (NPFMC 2022). Research into the snow crab stock decline is ongoing.

Southern tanner crab

Factor 2.1 - Abundance

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery

Moderate Concern

See Explanation in Criterion 1.

Factor 2.2 - Fishing Mortality

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery

Moderate Concern

The EBS stock of snow crab is mostly caught in a targeted fishery that was closed as of the publication of this report. But, snow crab is also caught and can be retained in the EBS Tanner crab fishery if the snow crab fishery is open. ADF&G observer data from 2017–18 indicate that catches of snow crab (landings plus discards) made up a quite large percentage of overall catch in the EBS

Tanner crab fishery (ADFG 2020e). Although snow crab cannot be retained in the 2022–23 Tanner crab fishery due to closure of the snow crab fishery, snow crab will be discarded at an unknown rate. Bycatch of snow crab in the EBS Tanner crab fishery in 2021 was notably lower than in previous years and is expected to remain so in the near future, as a result of the depleted snow crab stock and the shift of adult snow crab abundance farther north, thus reducing the overlap with EBS Tanner crab (pers. comm., M. Stichert, November 11, 2022). Because not all snow crab will survive post-release from the Tanner crab fishery, fishing mortality will occur. Handling mortality in recent NOAA snow crab stock assessments was estimated at 30%, but this is not based on post-release field studies. Although mortality of snow crab in the EBS Tanner crab fishery may effect the EBS snow crab stock's recovery, the fishing mortality for snow crab is currently unknown.

Based on the unknown fishing mortality of depleted EBS snow crab in the EBS Tanner crab fishery, combined with the expectation of relatively lower bycatch in the upcoming Tanner crab fishing seasons, fishing mortality is considered a moderate concern.

Justification:
The OFL was defined for EBS snow crab in the 2021 NOAA stock assessment, using $F_{35\%}$ (a proxy for F_{MSY}) (Szuwalski 2021). The total catch includes retained crabs as well as the estimated discard mortality for snow crab. The total catch in 2020–21 (26,200 t) was well below the OFL (95,400 t, fishing at F_{OFL} = 0.37). The ABC (71,550 t) was set at 75% of the OFL to account for uncertainty, and is treated as a target reference point for total fishing mortality on the stock. ADF&G set the TAC (20,400 t) well below the ABC in the 2020–21 season; the TAC serves as a target reference point for fishing mortality of the retained portion of the catch: male crabs at the industry-preferred size (pers. comm., M. Stichert, October 29, 2020). The total catch (26,200 t) did not exceed the OFL, and the retained catch (20,400 t) did not exceed the TAC in 2020–21.

Because of a sharp drop in MMB in 2021 to historically low levels below MSST, the stock was declared overfished. The 2021–22 fishing season remained open, with the TAC (2,540 t) reduced by over 85% relative to the prior season (ADFG 2021d). There is not a minimum threshold for female crab abundance for the snow crab fishery to occur. Instead, total mature biomass (TMB) is estimated for male and female snow crabs, and if TMB is less than 25% of B_{MSY}, the fishery is closed based on this threshold as determined by ADF&G. In 2021, TMB was 27% of B_{MSY}, so the fishery remained open for the 2021–22 season (ADFG 2021d). The fishery was closed for the 2022–23 season because TMB fell below the threshold for opening a fishery—the first time this has occurred (ADFG 2022c). Based on the 2022 NOAA stock assessment, which was in draft form as this report was being published, the retained catch was equal to the TAC in the 2021–22 season, with approximately 1.1 t of additional mortality for snow crab due to discard mortality (NPFMC 2022). Overfishing did not occur in the 2021–22 season.

Retained catch of snow crab in the 2020–21 fishing season was at the highest level since 2014. This level of harvest was allowed due to the relatively high MMB estimated the previous year. Removals of snow crab through retention of legal-sized male crab and bycatch mortality of females and undersized males were likely a contributing factor in the decline of the stock. Although snow crab likely experienced high mortality in the past few years, the relative contributions of natural mortality (environmental processes, predation, etc.) and fishing mortality remain highly uncertain (NPFMC 2022). Research into the snow crab stock decline is ongoing.

Factor 2.3 - Discard Rate/Landings

Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska

< 100%

Information on bait use and discards was limited for the AI GKC fishery. Based on reports from the GKC commercial fishing industry, bait use is as follows: 5 lb herring and 10 lb halibut or black cod heads for each pot set (pers. comm., E. Paulsen, June 23, 2021). Assuming 15 lb of bait on average (5 lb herring and 10 lb Pacific halibut or black cod) per pot set and using average pot lifts (60,857) from 2016 to 2019, 414 t of bait is used per year. But, because halibut and black cod heads are scraps from processing rather than whole fish, this portion of bait was subtracted from the bait total. Based on this information, bait use was estimated for this report to be 138 t or 7.3% of AI GKC landings in 2016–19.

An annual average of 366 t of dead discards of GKC were estimated for 2016–17 to 2019–20. A 20% handling mortality rate was assumed for this fishery in the stock assessment, but that rate is from the red king crab stock assessment, with no studies to support use in the GKC fisheries (Siddeek 2002). Dead discards were approximately 12.8% of GKC landings, although the total catch volume of the fishery (including discards) was unknown. Other nontarget species are also caught and discarded in this fishery, based on ADF&G onboard observer data, but volumes of discards are not available. Discard rates in BSAI crab fisheries have been estimated at 40% of total catch weight, based on independent studies, although discard rates specific to the AI GKC fishery were not available (Kelleher 2005). Because of uncertainties about discards, an estimate of 40% was used for the AI GKC fishery in this report.

The estimated ratio of bait and dead discards to landings is 47.3% (7.3% + 40%). Although this may be underestimated, it is unlikely that the bait and dead discards to landings ratio is above 100%. Therefore, the score for this factor is 1, which is the best score possible.

Justification:

Additional information regarding bait use. The AIGKC industry has started experimenting with ways to reduce bait usage through lights or artificial bait (no improvements yet) as well as utilizing invasive asian carp from the U.S. midwest instead of halibut and black cod heads. Reports are that use of carp as bait has been successful and may expand to other boats in the fleet in the future (E. Poulsen, Personal Communication, May 19, 2022).

Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery

< 100%

Limited data were available to estimate bait use and discards in the EBS Tanner crab fishery. Based on reports from the Alaska Bering Sea Crabbers industry group, bait use is as follows: 5–12 lb herring and 5–15 lb Pacific cod for each pot set (pers. comm., ABSC, July 2, 2021). Bait use was

assumed to be 18.5 lb on average (8.5 lb herring and 10 lb Pacific cod) per pot set. Average pot lifts for 2015, 2017, and 2018 (the three open seasons in 2015–19) were 88,120 (Stockhausen 2020). Based on this information, annual bait use for this report was estimated to be 733 t, which is 20.0% of EBS Tanner crab landings for 2015–19.

In 2015, 2017, and 2018, discard mortalities of Tanner crab in the fishery averaged 1,413 t, which is 38.3% of the Tanner crab fishery landings for those years. A handling mortality rate of 32.1% was used for discarded Tanner crabs in the most recent EBS Tanner crab stock assessment (Stockhausen 2020). Snow crab is the most common bycatch species in the EBS Tanner crab fishery, and can be retained if the EBS snow crab fishery is open. A handling mortality rate of 30% was used for discarded snow crab catch in the most recent stock assessment of EBS snow crab (Szuwalski 2021). According to ADF&G staff (pers. comm., M. Stichert, November 6, 2020), these handling mortality rates were estimated indirectly using a reflex action mortality predictor (RAMP) methodology (Stoner 2012). Other nontarget species are caught and discarded in this fishery, based on ADF&G onboard observer data (ADFG 2020e), but overall volumes of nontarget species discards and survival rates were not available for recent years. Based on estimates from 2014 to 2015, the bycatch ratio for the EBS Tanner crab fishery was roughly 47% of the total catch weight (NMFS 2019). With the closure of the snow crab fishery, it is possible that the bycatch ratio in the EBS Tanner crab fishery may now be higher than 47%, because all snow crab caught in the fishery are now being discarded. The survival rates for discards other than Tanner crab and snow crab were unknown, so it was assumed to be 100% (per Seafood Watch policy).

The bait and Tanner crab dead discards are estimated at 67% (20% + 47%). Although this could be underestimated, and the bycatch ratio is based on older data, it is unlikely that the bait and dead discards to landings ratio is above 100%. Therefore, the score for this factor is 1, which is the best score possible.

Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska

< 100%

Bait use and discard information for the PI GKC fishery was limited. Based on reports from the GKC commercial fishing industry, bait use is as follows: 5 lb herring and 10 lb halibut or black cod heads for each pot set (pers. comm., E. Paulsen, June 23, 2021). The GHL in the early 2000s was 68 t, slightly higher than the current GHL (59 t), but the ratio of pot lifts to landings was assumed to be similar to recent years (Daly and Jackson 2020). Bait use was assumed to be 15 lb on average (5 lb herring and 10 lb Pacific halibut or black cod) per pot set. The average annual pot lifts from 2000 to 2002 (the last years of nonconfidential data) were approximately 5,000. Because halibut and black cod heads are scraps from processing rather than whole fish, this portion of bait was subtracted from the bait total. Based on this information, annual bait use was estimated for this report to be 11.3 t or 17.6% of PI GKC landings.

Since 2002, the discards in the GKC pot fishery were considered confidential. In 2001–02, an average of 18.4 t of GKC were discarded in the fishery. Assuming a 20% handling mortality rate (used in the stock assessment), this yields a discard rate of 5.5% of landings in 2001–02, although the total catch volume of the fishery (including discards) was not available. The handling mortality rate of 20% was not based on empirical data, so this could be underestimated. Regulations since

2002 for this fishery (size limit, etc.) have been fairly similar, so discard percentages may be similar in recent years, depending on fishery practices and size frequencies in the population. Other nontarget species are also caught and discarded in this fishery, based on ADF&G onboard observer data, but volumes of discards are not available. Discard rates in BSAI crab fisheries have been estimated at 40% of the total catch weight, based on independent studies, but discard rates specific to the PI GKC fishery were not available (Kelleher 2005). Because of uncertainties about discards, an estimate of 40% was used for the PI GKC fishery in this report.

The bait and dead discards are estimated at 57.6% (17.6% + 40%). Although this may be underestimated, it is unlikely that the bait and dead discards to landings ratio is above 100%. Therefore, the score for this factor is 1, which is the best score possible.

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery

< 100%

Limited data were available to estimate bait use and discards for the SE Alaska GKC fishery. The Southeast Alaska Fishermen's Alliance industry group reports that bait for most fishers includes roughly 2 pounds of either Pacific cod or pink salmon and 1 pound of herring per pot deployed (pers. comm., K. Hansen, December 23, 2020). Some fishers only use herring; it was assumed that 75% of pot lifts only used herring. There were approximately 5,946 annual pot lifts in this fishery on average in 2015–21 {ADFG 2021}. Based on this information, bait use was estimated for this report to be 6.7 t annually, which is roughly 28% of SE Alaska GKC fishery landings in 2015–21.

Discard estimates were not available for this fishery. Based on historic ADFG onboard observer data for the SE Alaska GKC fishery, there are many species caught as bycatch in this fishery, but volumes of these species were not available. Deadloss, or legal-size crab discarded at the dock due to quality issues, was roughly 0.2 t annually in 2018–20, according to ADF&G, which is less than 1% of landings (pers. comm., A. Olson, December 29, 2020). Discards can be substantial in Alaska crab pot fisheries based on information from BSAI crab pot fisheries (although they operate differently) (Kelleher 2005). Because the SE Alaska GKC fishery extends throughout much of the year, discards could be relatively high.

Despite uncertainty about discards and the large amount of bait used relative to the size of the fishery, the available information suggests that discards plus bait use does not exceed landings, and a score of 1 is given.

Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery

< 100%

Data on bait use and discards for the SE Alaska tanner crab fishery were limited. The Southeast Alaska Fishermen's Alliance industry group reports that bait for most fishers includes roughly 2 pounds of either Pacific cod or pink salmon and 1 pound of herring per pot deployed (pers. comm., K. Hansen, December 23, 2020). Some fishers only use herring; it was assumed that 75% of pot lifts only used herring. There were approximately 33,607 annual pot lifts in this fishery on average

in 2015–21 {ADFG 2021}. Based on this information, bait use was estimated for this report to be 83.5 t annually, which is roughly 7% of SE Alaska Tanner crab fishery landings in 2015–21.

Numbers and species of discards are unknown for this fishery. There are likely large numbers of female and sublegal male Tanner crab discards, but estimates were not available. Deadloss, or legal-size crab discarded before landing due to quality issues, was roughly 3.5 t annually in 2018–20, according to ADF&G, which is less than 1% of landings (pers. comm., A. Olson, December 29, 2020). Discard rates can be substantial in these types of fisheries, based on information from BSAI crab pot fisheries (Kelleher 2005).

Given the small amount of bait use relative to landings and the short duration of the fishery, it is unlikely that bait plus discards exceed landings. Therefore, the score for this factor is 1, which is the best score possible.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	DATA COLLECTION AND ANALYSIS	ENFORCEMENT	INCLUSION	SCORE
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands	Highly effective	Ineffective	Moderately Effective	Highly effective	Highly effective	Red (1.000)
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Yellow (3.000)

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	Yellow (3.000)
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery	Ineffective	Moderately Effective	N/A	N/A	N/A	Red (1.000)
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery	Ineffective	Moderately Effective	N/A	N/A	N/A	Red (1.000)

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands

Highly effective

Recent harvest strategies and management measures have been proactive in limiting fishing pressure for AI GKC. Management has set the total allowable catch (TAC) well below the allowable biological catch (ABC), and provided a large buffer between the ABC and TAC, to prevent stock declines. Stock abundance has been stable in recent years, demonstrating that the management strategy is successful. Therefore, this factor is considered highly effective.

Justification:

The AI GKC stock is assessed annually by ADF&G. The NPFMC adopted an observer CPUE-based stock assessment model for AI GKC in recent years (Siddeek et al. 2020). GKC in the AI is managed as two stocks in the areas east (EAG) and west (WAG) of 174° W. longitude. Abundance and fishing mortality are evaluated relative to MSY-proxy reference points. The annual ABC is set at 75% of the overfishing limit (OFL), resulting in a buffer to account for scientific uncertainty. Harvest is also constrained by a TAC that is adjusted annually by the state of Alaska based on their current harvest rate strategy. In 2016–19, the TAC was set at just above 65% of the ABC on average, in an attempt to account for uncertainty and the impacts of a fishery that only harvests male crabs (Siddeek et al. 2020). The TAC (historically a guideline harvest limit [GHL]) has generally declined since the late 1990s, but was stable in recent years and increased in 2019. Mature male biomass (MMB) has also been stable in recent years, and increased slightly in 2018 and 2019.

Aside from the TAC, other measures are in place to limit harvest and effort in this fishery. The ADF&G harvest strategy for this stock was updated in 2019 and includes the following components (Siddeek et al. 2020): 1) if mature male abundance (MMA) is estimated for the EAG or the WAG at less than 25 percent of average MMA in 1985–2017 (in the EAG or WAG), then the fishery will not open in that area; 2) increases in harvest rate are allowed as estimates of MMA increase; 3) the fishery may only retain male GKC at least 6.0 in (152.5 mm) carapace width (CW), which is larger than the 50% maturity length of 120.8 mm CW for males; and 4) the fishing season is set at August 1 through April 30 (although it may be shortened based on harvest relative to the TAC or other factors).

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Moderately Effective

The EBS Tanner crab stock MMB and MFB have declined in recent years; however, managers responded by reducing the TAC substantially, and in some years the fishery was closed (Daly et al. 2020). The TAC has not been exceeded in recent years, but it is not clear whether the stock is improving. Because of uncertainty about the impacts of fishing and the current low level of harvestable male crab, the management strategy is considered moderately effective.

Justification:
The EBS Tanner crab stock is assessed annually by AFSC. Abundance and fishing mortality of Tanner crab are evaluated relative to MSY-proxy reference points for both management areas within the EBS District (EBT and WBT) (Daly et al. 2020). In recent years, the ABC was set 20% lower than the OFL, resulting in a buffer to incorporate concerns regarding model uncertainty for this stock. Harvest is also constrained by a TAC that is adjusted annually by the state of Alaska based on the current harvest rate strategy. The TAC is intended to limit the harvest of male crabs above the size preferred by the fishery (equal or greater than 5 in. CW), unlike the OFL, which applies to all Tanner crab sizes and sexes. Reducing the harvest of males is likely appropriate when the mature female biomass (MFB) is at relatively low levels, thus ensuring
optimal mating opportunities for incoming female recruits (Daly et al. 2020). The stock assessment model consistently results in a retrospective bias (i.e., it overestimates biomass); therefore, uncertainty is considered to be high (pers. comm., M. Stichert, November 6, 2020). In 2016–17 through 2019–20, the TAC was set at zero for EBT, and likewise in 2016–17 and 2019–20 for WBT; in 2017–18 and 2018–19, the TAC was approximately 6% of the ABC in WBT on average. The low TAC setting relative to the ABC was intended to account for uncertainty in modeling and the impacts of a fishery that harvests only male crabs in a certain size range. Recent fishing closures were primarily the result of the MFB dropping below a threshold level established within the ADF&G harvest strategy.

In addition to the TAC, other measures are in place to limit harvest and effort for this fishery. The harvest strategy was updated in 2020, and some of the components are: 1) if MMB is estimated for the EBT or the WBT at less than 25% of average MMB in 1982–2018 (for the relevant management area), then the fishery will not open in that area, as determined by ADF&G; 2) a sliding scale for exploitation rates as a function of the ratios of MMB and MFB to 1982–2018 averages; 3) the ADF&G threshold for opening the fisheries based on MFB was eliminated in 2020; and 4) the minimum size limit is 4.8 in. CW for EBT and 4.4 in. CW for WBT. The Bering Sea Tanner crab fishery season is typically mid-November through March unless the TAC is achieved before the scheduled end date (ADFG 2020l).

Limits have been established in some other (noncrab-directed) Bering Sea fisheries to reduce the impacts on discarded Tanner crab (NPFMC 2021b). When bycatch limits are reached, fisheries responsible for the bycatch are closed for the rest of the season, or are prohibited from fishing in areas with historically high bycatch rates due to high release mortality rates (NPFMC 2021b). In 2011, a modification was implemented to raise the trawl sweep off the seafloor, which research has demonstrated reduces unobserved mortality of Tanner crab in the Bering Sea and the Gulf of Alaska. Although these measures are not directly related to management of the EBS Tanner crab fishery—and are therefore not considered in the scoring for this section—they are worth noting for their likely positive impact on the resource.

Managers believe that the MFB threshold used for determining whether the fishery could open before the 2020–21 season was overly precautionary (pers. comm., M. Stichert, November 6, 2020) (Heller-Shipley et al. 2021). But, using the new harvest strategy, the TAC for WBT was set quite low for the 2020–21 season (1,065 t; approximately 6% of the ABC) and the fishery was closed in EBT. Biomass of Tanner crab is low relative to historic levels. The current low abundance level may be related to environmental factors (pers. comm., M. Stichert, November 6, 2020), but fishing levels in the 1970s and 80s were quite high and contributed to stock depletion, from which the stock may still be recovering to some degree.

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands

Moderately Effective

Determining the effectiveness of management for the PI GKC stock is challenging because biomass is currently unknown and it is not clear when abundance trends might be better understood. The GHL and ABC have not been exceeded, but the appropriateness of these reference points is difficult to evaluate, given the uncertainties about the current biomass size. The fishing season runs year-round, which may affect spawning aggregations or recently molted crabs, thus possibly increasing discard mortalities (survival rates are currently unknown). Despite these uncertainties and deficiencies, there is not a clear indication that the stock is declining or that fishing pressure is too high. Therefore, the management strategy is considered moderately effective.

Justification:

The PI GKC stock is assessed tri-annually by ADF&G, most recently in 2020, and overfishing is determined annually based on reference points determined at 3-year intervals. Abundance surveys were not conducted in recent years; however, biomass estimates from biennual NOAA trawl surveys in 2008–16 suggest that the stock was fairly stable during that period (Daly and Jackson 2020). Fishing mortality was evaluated by comparing harvest with an OFL and ABC set in 2020. The ABC was set at 75% of the OFL, resulting in a buffer to account for scientific uncertainty. The fishery is not rationalized and is managed in-season using a GHL, with low and sporadic effort in recent years (Daly and Jackson 2020). The state of Alaska adjusts the annual GHL based on their current harvest rate strategy. In 2017–20, the GHL was set at roughly 84% of the ABC, in an attempt to account for uncertainty and the impacts of a fishery that harvests only male crabs. The GHL has generally been reduced since the late 1990s, but was consistent in recent years. Although landings are confidential for this fishery, ADF&G reports that the GHL has reportedly not been exceeded (pers. comm., M. Stichert, February 16, 2021). The total catch—retained plus discard mortalities from this and other fisheries—has not exceeded the ABC in recent years (Daly and Jackson 2020).

Aside from the GHL, other measures are in place to limit harvest and effort in this fishery. Only males of a minimum legal size may be harvested; the minimum legal size limit for Pribilof District GKC is 5.5 in. CW (Daly and Jackson 2020). Pots must have at least four escape rings of no less than 5-½ in. on at least one vertical surface of the pot that are composed of not less than 9-in. stretched mesh webbing to permit escapement of undersized GKC (ADFG 2020a). Vessels ≤125 ft long are limited to 40 pots, and vessels >125 ft are limited to 50 pots (ADFG 2020a). GKC can be harvested from January 1 through December 31 only under conditions of a permit issued by the commissioner of ADF&G (ADFG 2020a).

ADF&G reports that an industry-supported survey is currently being planned for this stock, and an observer CPUE-based stock assessment model is being developed, similar to the AI GKC stock assessment (pers. comm., M. Stichert, November 10, 2020). Until the stock assessment incorporates these new ideas, it is not possible to evaluate their effectiveness.

Ineffective

GKC and Tanner crab are caught together in pots in some areas during SE Alaska GKC crab fishery operations (Olson and Bishop 2012) (pers. comm., A. Olson, July 2, 2022). Because the GKC and Tanner crab fisheries occur concurrently, it is difficult to differentiate between GKC that is harvested as bycatch or directly targeted (Olson and Stratman 2022). Fishers with permits for harvesting both species may do so if both fisheries are open. In this situation, Seafood Watch methodology requires considering management of the Tanner crab fishery in scoring the management strategy for the SE Alaska GKC fishery. An evaluation of the management strategy for the SE Alaska Tannery crab fishery can be found under Factor 3.1 for that fishery within this report.

Before the new harvest strategy implementation in 2020–21, managers closed several of the SE Alaska GKC management areas to fishing, based on fishery-dependent information. But, GHLs were increased for the 2020–21 season and again for the 2021–22 season, despite the stock in most management areas being at historically low levels, based on commercial fishery CPUE. Although reference points were introduced in 2020–21 for managing the stock, these are based on historical fishery CPUE data, and managers currently do not make a determination of whether the stock is overfished or overfishing is occurring (Olson and Palof 2020). Given the recent implementation of the new harvest strategy, and the quite low level of the stock overall, effectiveness is uncertain. Managers expect to more clearly ascertain the effectiveness of the new harvest strategy in upcoming years (pers. comm., A. Olson, July 8, 2022). Without fishery-independent surveys of abundance, determining the appropriateness of current and past harvest levels for this fishery will remain challenging. Also, GKC harvest in several management areas exceeded the respective GHLs in the recent fishing seasons. Management strategy effectiveness is unknown, and it is likely that fishing pressure has contributed to the low level of the stock in most management areas. Therefore, the management strategy is considered ineffective.

Justification:

The SE Alaska GKC stock is assessed annually using fishery-dependent data. Managers conduct annual reviews of landings, logbooks, and port sampling data to adjust guideline harvest ranges (GHRs) for each of seven management areas (Stratman et al. 2017). A new harvest strategy was implemented for the 2020–21 season, which utilized commercial fishery CPUE-based reference points, biological data, and local ecological knowledge in determining preseason GHLs and managing the fishery in season (Stratman et al. 2021). Reference points, which were used for the first time in 2020–21 for managing the stock, compared the latest CPUE with historic averages to determine stock health. The 2021–22 GHRs would allow for a harvest of 675,000 lb (306 t) if all management areas were open and stocks were healthy enough to support the maximum GHL (Table 5) (ADFG 2022a). All management areas were open for the 2020–21 season, and all but one area were open in 2021–22, with GHLs set at varying levels within the GHRs (ADFG 2021b)(ADFG 2022a). The last two seasons allowed for a large increase in GHLs from the 2019–20 season, when the overall GHL was 41,500 lb and four management areas were closed (ADFG 2020k). The expansion of the fishing season occurred despite the apparent lack of evidence that stock biomass increased. CPUE is reviewed biweekly by ADF&G for each management area, and if it is below a threshold reference point, management action may be taken to shorten the season in that area (ADFG 2021b).

Measures are in place to limit harvest and effort in this fishery. The annual fishery typically starts in early February, concurrent with the start of the SE Alaska Tanner crab fishery, and continues until the season is closed due to resource conservation concerns or the attainment of established GHLs. But, it is not clear whether current in-season data collections are sufficient to determine the level of conservation concern to inform managers of the need for season closure. Although GKC harvest had generally been below GHLs in most management areas in recent years, harvests exceeded the GHLs in one area (North Stephens Passage) from 2018 to 2021 and in at least three additional areas in the last two seasons (ADFG 2022a)(ADFG 2022b). The fishing season ends December 1, although fishery areas have closed between March and November in recent years (pers. comm., A. Olson, December 3, 2020). The fishery is restricted to harvesting only male crab with a minimum legal size of 7 in. CW. The fishery is "limited-entry," with the number of fishers allowed to participate capped in 1984.

Table 5. GHRs and GHLs for each Management Area within the SE Alaska GKC fishery for the 2021–22 season (ADFG 2022a).

Management Area	GHR	2021/2022 GHL
Northern	0–145,000	Closed
Icy Strait	0–55,000	8,250
North Stephens Passage	0–25,000	18,000
East Central	0–225,000	12,050
Mid-Chatham Strait	0–150,000	7,500
Lower Chatham Strait	0–50,000	7,500
Southern	0–25,000	22,000
Registration Area A total	0–675,000	75,300

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Ineffective

Tanner crab and GKC are caught together in pots in some areas during SE Alaska Tanner crab fishery operations (pers. comm., A. Olson, July 2, 2022). Because the GKC and Tanner crab fisheries occur concurrently, it is difficult to differentiate between GKC that is harvested as bycatch or directly targeted (Olson and Stratman 2022). Fishers with permits for harvesting both species may do so if both fisheries are open. In this situation, Seafood Watch methodology requires considering management of the GKC fishery in scoring the management strategy for the SE Alaska Tanner crab fishery. An evaluation of the management strategy for the SE Alaska GKC fishery can be found under Factor 3.1 for that fishery within this report.

Reference points are not used in management of the SE Alaska Tanner crab stock, and the effectiveness of management measures is uncertain. Some potentially effective regulations are in place for the Tanner crab fishery, and stock abundance data suggest that fishing is unlikely to be causing a serious negative impact on SE Alaska Tanner crab stock health. But, because of concerns regarding the management strategy of the SE Alaska GKC fishery and the allowance for harvest of GKC in this fishery, the management strategy for the SE Alaska Tanner crab fishery is considered ineffective.

Justification:
Annual ADF&G stock assessments of SE Alaska Tanner crab do not use reference points to determine stock status and harvest rates. The harvest strategy for this stock includes an MMA threshold (2.3 million lb) that is half the long-term average abundance (1997–2007) (Wood et al. 2017). Tanner crab biomass, both mature and legal, is estimated annually for each of the surveyed areas using a model that relies on inputs from an ADF&G biomass survey and the fishery (Rebert et al. 2019). Tiered harvest rates, with a maximum of 50% of legal males, are determined based on the biomass estimate. Available data related to stock abundance suggest a fairly stable biomass overall, although trends vary by survey area (Wood et al. 2017).

Some measures are in place to limit harvest and effort in the SE Alaska Tanner crab fishery. Only male Tanner crab of legal size may be harvested; the minimum size limit is 5½ inches CW (ADFG 2020a). Current pot limits for the fishery are set at 80 pots per vessel. In-season management is not used due to the short duration of the fishery (several weeks). The annual season starts in early February, consistent with the start of the SE Alaska GKC fishery. The MMA estimate and the number of registered pots at the start of the fishery determine the commercial Tanner crab season length. The season length is dictated by biomass threshold levels and the number of pots registered for the fishery. When the mature male biomass of Tanner crab is above the lower or upper threshold (that allows for a fishery to be prosecuted), the number of days for a season length is decreased as the number of pots registered for the fishery increases (pers. comm., A. Olson, June 01, 2022).

Factor 3.2 - Bycatch Strategy

Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands

Ineffective
Evaluation of the bycatch strategy for the AI GKC fishery includes species caught in crab pots and those affected by entanglements in the gear (ropes, buoys, and traps). Some measures are in place to reduce impacts to bycatch species in the AI GKC fishery; however, it is not clear that these are sufficient, given the vulnerability of deep-sea coral and other biogenic habitats to crab pot gear. Ghost gear (lost pots) is a consistent issue for this fishery, with potentially serious impacts to deep-sea coral and other biogenic habitats occurring annually. The entanglement of marine mammals and the mortality of crabs and other biota trapped in lost pot gear are also concerns, but these impacts are not the primary driver of the score for this factor. Additional measures are needed to evaluate, track, and reduce impacts from ghost gear to coral and other biogenic habitats, as well as to other marine life, including crabs and marine mammals. As a result, the bycatch strategy is considered ineffective.

Justification:
Gear restrictions have been implemented to reduce bycatch in crab pots and the potential for ghost gear, including the following (ADFG 2020a): 1) pots must be attached to a shellfish longline to minimize gear loss; 2) pots must have at least four circular escape rings of 5½ in. inside diameter, or have no less than one-third of a vertical surface covered with at least 9 in. of stretched mesh webbing to permit the escapement of undersize crab; 3) pots must have a minimum 18-in. opening within 6 in. of the pot bottom secured by untreated cotton twine no larger than 60 thread, to reduce the effects of ghost fishing if gear is lost.

ADF&G observers deployed on fishing vessels in the BSAI crab fisheries record the species composition of retained catch and discards (Gaeuman 2014)(ADFG 2020e). Bycatch within pots used for the AI GKC fishery consists of a variety of species, mostly at low frequencies. The only known species of concern caught in traps are deep-sea corals and other biogenic habitats (e.g., sponges), which are prevalent and diverse in the AI. Although much of the AI GKC fishing area is closed to trawling to protect deep-sea corals and other biogenic habitats, most of it is open to crab pot fishing. Fishing gear that contacts the bottom, including crab pot gear, can affect these fragile habitats greatly (Stone and Shotwell 2007)(NPRB 2008). There are large areas of seafloor with the potential to support coral gardens outside of the areas closed to crab pot fishing {Woodby et al. 2009}. Once damaged, these slow-growing habitats may never recover (NMFS 2004). GKC and other invertebrates and fish are known to be closely associated with coral and biogenic habitats in the AI (NMFS 2004). Without additional assessments of the condition of these habitats and impacts from crab pots, it is not clear if sufficient measures are in place for the AI GKC fishery to protect corals and other biogenic habitats.

Ghost gear is a concern for this fishery. There were 138 lost crab pots reported to ADF&G by AI GKC fishers in the 2020–21 season, and an average of 119 lost pots per season were reported since 2018–19 (Table 6) (ADFG 2021e). Lost pots were voluntarily reported by fishers to ADF&G, and because this is not mandatory, it is not clear how many lost pots were not reported. In 2008–09 and 2009–10, 120 lost pots during 777 days of fishing in two seasons (an average of 60 lost per season) were reported by ADF&G onboard observers and dockside samplers in the AI GKC fishery (Gaeuman 2011). It is likely that Gaeuman (2011) only includes a portion of lost traps because many fishing trips were not observed; however, there were more than twice as many lost pots reported in 2020–21 for a single season. Although the voluntary reporting system and observer counts represent different methods of recording lost pots, the likelihood of more lost pots compared to a decade ago is also supported by increased effort in the AI GKC fishery in recent years. The impacts from BSAI crab fishery ghost gear (i.e., lost pot gear) likely include entanglement of endangered bowhead whale {Citta et al. 2013}{George et al. 2019} (pers. comm., C. George, June 13, 2021). Other problematic impacts could include damage to vulnerable deep-sea coral and other biogenic habitats, and mortality of crab and fish species trapped in lost pots (pers. comm., C. Rooper, August 23, 2021). Regulations are in place to reduce the impacts to animals caught in the pots if gear is lost; however, the required biodegradable twine that is intended to disable lost crab pots takes up to 125 days to degrade enough for animals to escape pots. This rate of degradation is likely too long to ensure that trapped biota can escape, because survival of crabs (and likely other species) begins to decline greatly after being trapped in a pot for 28 days (Barnard 2008); further, the trap could also continue to cause damage to vulnerable deep-sea habitats before it degrades and detaches from buoy lines. Ghost fishing impacts on king crab species have been demonstrated in other Alaska crab pot fisheries (Long et al. 2014). Pots must be attached to longlines, which should reduce the chances for losing individual pots; however, if an entire pot longline is lost, this may cause more impacts than a single lost trap (e.g., entanglements, dragging across the seafloor). Also, there are no known measures to assess and remove the impacts of derelict gear from the fishery, or a requirement for timely reporting of lost fishing gear (reporting is voluntary). Research has concluded that bottom-contact fishing, especially with bottom trawls but also including pots, causes substantial damage to coral and sponge habitat in the Aleutian Islands (Heifetz et al. 2009). These impacts from pots dragging through deep-sea habitats or causing entanglements can continue after the gear is no longer actively fishing, until the gear degrades sufficiently, which may take years even

if the trap is disabled {NOAA 2015}(Arthur et al. 2014).

Entanglements of marine mammals due to gear used in the BSAI crab fishery have been reported. Recent observed entanglements in suspected Bering Sea pot gear that likely led to mortalities of bowhead whale, an ETP species, occurred in 2015 and 2017 (George et al. 2017). Entanglement of bowhead whale was estimated to occur at the rate of ≈12% of whales annually, with most of these resulting from Bering Sea crab/fish pot fisheries (George et al. 2017). Based on the most recent NOAA stock assessment of the Western Arctic stock of bowhead whale, mortalities of bowhead whale from entanglements are low, but difficulties in observing and recovering mortalities in the Bering Sea in winter months likely result in underestimates of these events. As noted above, many of these entanglements are likely the result of ghost gear. Gray whale may also be affected by entanglement in crab pot gear from this fishery. The most recent stock assessment of the ETP stock of gray whale indicates that impacts from entanglements are low relative to the annual PBR. No known regulations are in place to reduce or prevent these entanglements. Although gear marking of buoys is required, it may be insufficient to identify the gear responsible for entanglements (e.g., trap lines).

Table 6. Numbers of crab pots voluntarily reported as lost in BSAI crab fisheries, based on fishing vessel logbooks (ADFG 2021d). AI = Aleutian Islands, BB = Bristol Bay, BSS = Bering Sea Snow Crab, BST = Bering Sea Tanner crab.

Season	AIGKC	BBRKC	BSS	BST
2018–19	76	27	243	41
2019–20	142	45	339	Closed
2020–21	138	17	750	72
3-yr average	119	30	444	57

In 2020, the NPFMC initiated a review to ensure that the federal king and Tanner crab FMP is in compliance with Standardized Bycatch Reporting Methodology (SBRM) guidance. Specifically, the review focused on how bycatch information is collected and reported for the BSAI king and Tanner crab fisheries. The review was completed in February 2021, and the NPFMC determined that bycatch reporting is consistent with SBRM requirements; however, the language in the FMP will need to be modified to identify a SBRM and explain how it meets the purpose of collecting, recording, and reporting bycatch (NPFMC 2021c). This change is necessary to increase transparency about how the SBRM in each fishery is consistent with national guidance.

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Moderately Effective

Evaluation of the bycatch strategy for the EBS Tanner fishery includes species caught in crab traps and those affected by entanglements in the gear (ropes, buoys, and traps). Impacts to bycatch species, such as EBS snow crab, are likely occurring at moderate levels. Proactive measures to reduce impacts to marine mammals are lacking, and additional measures are needed to reduce impacts from ghost gear. Based on these factors, the bycatch strategy for this fishery is considered moderately effective.

Justification:
To reduce bycatch, measures are in place, including the following (ADFG 2020a)(Szuwalski 2020): 1) Tanner crab pots must have at least four circular escape rings of 5-in. diameter or no less than one-third of a vertical surface covered with at least 7 in. of stretched mesh webbing, to permit the escapement of undersize crab; 2) a 3-in. maximum tunnel height opening for Tanner crab pots, to inhibit the bycatch of red king crab; and 3) Tanner crab pots must also be fitted with a degradable escape mechanism consisting of cotton thread no larger than 30 thread.

ADF&G observers deployed on fishing vessels in the BSAI crab fisheries record species composition of retained catch and discards (Gaeuman 2014). Based on observer data from 2015, 2017, and 2018, snow crab is the primary species of concern caught in pots used in the Bering Sea Tanner crab fishery (ADFG 2020e). Observer data indicate that large numbers of legal and sublegal snow crab were caught in the EBS Tanner crab fishery in these years. The EBS snow crab stock is currently overfished and the directed snow crab fishery is closed because stock biomass declined below the ADF&G management threshold. Before the snow crab fishery closure, legal-sized snow crab could be retained in the targeted Tanner crab fishery if both fisheries were open. With the snow crab fishery closure, all snow crab must be discarded, which will result in handling mortality. A handling mortality rate of 30% was used for discarded snow crab catch in the most recent stock assessment of EBS snow crab (Szuwalski 2021). According to ADF&G staff (pers. comm., M. Stichert, November 6, 2020), this handling mortality rate was predicted using an indirect reflex action mortality predictor (RAMP) study rather than a post-release field study (Stoner 2012). Because snow crab will not be retained when the snow crab fishery is closed, the mortality of snow crab caused by the Tanner crab fishery will be reduced but will still occur due to post-release discard mortality. Bycatch of snow crab in the EBS Tanner Crab fishery in 2021 was notably lower than previous years and is expected to remain at a lower level in the near future, as a result of the depleted snow crab stock and the current shift of adult snow crab abundance farther north, thus reducing overlap with EBS Tanner crab (pers. comm., M. Stichert, November 11, 2022).

Marine mammal species have also been reported to be affected by the crab fishery in the Bering Sea through entanglements. Bowhead whale, an ETP species, has been reported entangled, and mortalities have occurred. Observed entanglements in suspected Bering Sea pot gear that likely led to mortalities occurred in 2015 and 2017. Entanglement of bowhead whale was estimated to occur at the rate of ≈12% of whales annually, with most of these thought to result from Bering Sea pot fisheries (George et al. 2017). Based on the most recent NOAA stock assessment of the Western Arctic stock of bowhead whale, mortalities of bowhead whale from entanglements are low, but difficulties in observing and recovering mortalities in the Bering Sea in winter months likely result in underestimates of these events. Gray whale may also be affected by entanglement in crab pot gear from this fishery. The most recent stock assessment of the ETP stock of gray whale indicates that impacts from entanglements are low relative to the annual PBR. No known regulations are in place to reduce or prevent these entanglements. Although gear marking of buoys is required, it may be insufficient to identify gear responsible for entanglements (e.g., trap lines). The Alaska crab industry reports that it is tracking marine mammal interactions with fishing gear (pers. comm., J. Goen, June 25, 2021). The industry has also reportedly discussed options with researchers for additional monitoring of marine mammals to better understand if and when they are in the areas being fished. Although these are positive steps, it is unlikely that tracking interactions alone will reduce

entanglements, so further action is needed.

Ghost gear is a concern for this fishery. In 2020–21, 72 lost pots were reported in the EBS Tanner crab fishery, and an average of 57 lost pots in the 2018–19 through 2020–21 seasons (see Table 6) (ADFG 2021e). Lost pots were voluntarily reported by fishers to ADF&G, and it is not clear how many lost pots were not reported. Fishing effort has been relatively low in the Tanner crab fishery in recent years as a result of low annual TACs, but it is expected to increase in the upcoming season because the TAC is the highest in several years. This likely increase in effort may also lead to more lost pots in the fishery. The impacts from BSAI crab fishery ghost gear (i.e., lost pot gear) likely include entanglement of endangered bowhead whale {Citta et al. 2013}{George et al. 2019} (pers. comm., C. George, June 13, 2021). Other problematic impacts could include damage to vulnerable deep-sea coral and other biogenic habitats, and mortality of crab and fish species trapped in lost pots (pers. comm., C. Rooper, August 23, 2021). Regulations are in place to reduce impacts to animals caught in the pots if gear is lost. But, the required biodegradable twine that is intended to disable lost traps needs up to 105 days to degrade enough for animals to escape, and survival of crabs begins to decline greatly after being trapped 28 days (Barnard 2008). Ghost fishing impacts on king crab species have been demonstrated in other Alaska crab pot fisheries (Long et al. 2014). Also, there are no known measures to assess and remove the impacts of derelict gear from the fishery, or a requirement for timely reporting of lost fishing gear. Although annual lost pot numbers are substantial, and understanding the scale and impacts of ghost gear from these fisheries is an important management issue, there is currently not a demonstrated concern for vulnerable species (e.g., deep-sea corals and other biogenic habitats).

In 2020, the NPFMC initiated a review to ensure that the federal king and Tanner crab FMP is in compliance with Standardized Bycatch Reporting Methodology (SBRM) guidance. Specifically, the review focused on how bycatch information is collected and reported for the BSAI king and Tanner crab fisheries. The review was completed in February 2021, and the NPFMC determined that bycatch reporting is consistent with SBRM requirements; however, the language in the FMP will need to be modified to identify a SBRM and explain how it meets the purpose of collecting, recording, and reporting bycatch (NPFMC 2021c). This change is necessary to increase transparency about how the SBRM in each fishery is consistent with national guidance.

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands

Moderately Effective

Evaluation of the bycatch strategy for the PI GKC fishery includes species caught in crab pots and those affected by entanglements in the gear (ropes, buoys, and traps). Based on low known impacts to bycatch species, but a lack of proactive measures to reduce impacts to marine mammals and corals and other biogenic habitats, and the potential for impacts to many species through ghost gear, the bycatch strategy is considered moderately effective.

Justification:

ADF&G observers deployed on fishing vessels in the BSAI crab fisheries record the species composition of retained catch and discards (Gaeuman 2014)(ADFG 2020e). Gear restrictions have been implemented to reduce bycatch of crab and other small marine animals. Pots must have a minimum size of 9 in. stretched mesh on one vertical panel, to allow for escapement of undersize

crabs. Although this likely reduces bycatch, there are still considerable amounts of undersized crab and nontarget species discarded. The only known species of concern caught in traps are deep-sea corals and other biogenic habitats (e.g., sponges), which are found in certain areas of the PI GKC fishing area. Although some of the PI GKC fishing area is closed to trawling, most of it is open to crab pot fishing. Fishing gear that contacts the bottom, including crab pot gear, can affect these habitats greatly (Stone and Shotwell 2007)(NPRB 2008). Without additional assessments of the condition of these habitats and the impacts from crab pots, it is not clear if sufficient measures are in place for the PI GKC fishery to protect corals and other biogenic habitats; however, the frequency of observations in pot bycatch is low.

Marine mammal species have also been reported to be affected by the crab fishery in the Bering Sea through entanglements. Bowhead whale, an ETP species, has been reported entangled, and mortalities have occurred. Observed entanglements in suspected Bering Sea pot gear that likely led to mortalities occurred in 2015 and 2017. Entanglement of bowhead whale was estimated to occur at the rate of ≈12% of whales annually, with most of these thought to result from Bering Sea pot fisheries (George et al. 2017). Based on the most recent NOAA stock assessment of the Western Arctic stock of bowhead whale, mortalities of bowhead whale from entanglements are low, but difficulties in observing and recovering mortalities in the Bering Sea in winter months likely result in underestimates of these events. Gray whale of the Eastern North Pacific (ENP) stock can be present in the Bering Sea during operations of these fisheries, and may be affected by entanglement in crab pot gear {NOAA 2019}. The most recent stock assessment of the ENP gray whale indicates that impacts from entanglements are low relative to the annual PBR. No known regulations are in place to reduce or prevent these entanglements. Although gear marking of buoys is required, it may be insufficient to identify the gear responsible for entanglements (e.g., trap lines).

Ghost gear is a concern for this fishery. Although recent annual numbers of lost pots for the PI GKC fishery were not available, recent reported lost pots from other BSAI crab fisheries were in the dozens to hundreds annually (see Table 6). Because of the current low effort in the PI GKC fishery, it is likely that lost pots are relatively rare. The impacts from BSAI crab fishery ghost gear (i.e., lost pot gear) likely include entanglement of endangered bowhead whale {Citta et al. 2013}{George et al. 2019} (pers. comm., C. George, June 13, 2021). Other problematic impacts could include damage to vulnerable deep-sea coral and other biogenic habitats, and mortality of crab and fish species trapped in lost pots (pers. comm., C. Rooper, August 23, 2021). To reduce the impacts from lost pots on target and bycatch species, pots in this fishery must contain an opening at least 18 in. long, secured by biodegradable cotton twine no larger than 60 thread, to allow for trapped animals to escape if the pot were lost (ADFG 2020a). But, up to 125 days may be required to degrade the twine enough for animals to escape from lost traps, and the survival of crabs begins to decline greatly after being trapped 28 days (Barnard 2008). Ghost fishing impacts on king crab species have been demonstrated in other Alaska crab pot fisheries (Long et al. 2014). There are no known measures to assess and remove the impacts of lost gear from the fishery, or a requirement for timely reporting of lost gear. Although understanding the scale and impacts of ghost gear from this fishery is an important management issue, there is not a demonstrated concern for species of concern.

In 2020, the NPFMC initiated a review to ensure that the federal king and Tanner crab FMP is in compliance with Standardized Bycatch Reporting Methodology (SBRM) guidance. Specifically, the

review focused on how bycatch information is collected and reported for the BSAI king and Tanner crab fisheries. The review was completed in February 2021, and the NPFMC determined that bycatch reporting is consistent with SBRM requirements; however, the language in the FMP will need to be modified to identify an SBRM and explain how it meets the purpose of collecting, recording, and reporting bycatch (NPFMC 2021c). This change is necessary to increase transparency about how the SBRM in each fishery is consistent with national guidance.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Moderately Effective

Evaluation of the bycatch strategy for the SE Alaska GKC fishery includes species caught in crab pots and those affected by entanglements in the gear (ropes, buoys, and traps). Observed impacts to bycatch species from this fishery were low; however, current bycatch data (since 2010) were not available. Monitoring for impacts to marine mammals, as well as assessing, tracking, and removing ghost gear are needed, given the potential impacts to corals and other biogenic habitats and other species. Therefore, the bycatch strategy is considered moderately effective.

Justification:

Regulations to reduce bycatch include a requirement for escape rings to allow escapement of small crabs {ADF&G 2020a}. Biodegradable twine no larger than 60 thread is required to hold pots together, thus reducing impacts from ghost fishing because lost pots will eventually open {ADF&G 2020a}. There is also a prohibition on "side-loading" pots, to reduce halibut bycatch (Wood et al. 2017).

An at-sea observer program for this fishery was in place from 1998 to 2004 and 2007 to 2016 (it was discontinued after 2016). Data were only available through 2010, with 4.3% of commercial landings on average observed annually {Olson et al. 2012}. Based on this information, there were many species caught in the pots in small numbers, including species of corals and other biogenic habitats. Pacific cod was observed in moderate numbers and Tanner crab was observed in relatively large numbers.

The potential impacts of the fishery on endangered humpback whale in the area due to entanglements are not mitigated through any management measures. The available literature indicates that the fishing gear most often associated with entanglement of humpback whale in SE Alaska is pot gear (Neilson et al. 2009). In addition, marking of gear used in the fishery may be insufficient to identify the source of entanglements.

Ghost gear from this fishery could affect multiple species, including endangered humpback whale and deep-sea corals and other biogenic habitats. Regulations are in place to reduce impacts to animals caught in the pots if gear is lost. But, the required biodegradable twine that is intended to disable lost traps may need up to 125 days to degrade enough for animals to escape, and survival of crabs begins to decline greatly after being trapped 28 days (Barnard 2008). Ghost fishing impacts on king crab species have been demonstrated in other Alaska crab pot fisheries (Long et al. 2014). Also, there are no known measures to assess and remove the impacts of derelict gear from the fishery, or a requirement for timely reporting of lost fishing gear. Impacts from ghost gear in this

fishery could include entanglements of marine mammals and damage to deep-sea corals and other biogenic habitats. Although impacts could occur due to ghost gear from this fishery, there is not a demonstrated concern for this fishery regarding impacts to species of concern.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderately Effective

Evaluation of the bycatch strategy for the SE Alaska Tanner crab fishery includes species caught in crab pots and those affected by entanglements in the gear (ropes, buoys, and traps). Impacts to corals and other biogenic habitats, as well as other species caught in pots as bycatch, are likely occurring but data are not available for confirmation. Also, evidence to indicate success of the few measures currently in place to reduce bycatch in pots is lacking, and measures are needed to assess, track, and reduce the impacts from ghost gear. Despite these deficiencies, serious impacts to nonretained bycatch have not been demonstrated. Therefore, the bycatch strategy is considered moderately effective.

Justification:

Regulations to reduce bycatch include a requirement for escape rings to allow escapement of sublegal crabs and nontarget species (ADFG 2020a). To reduce ghost fishing, biodegradable twine no larger than 30 thread is also required to hold pots together, because lost pots will eventually open {ADF&G 2020a}. There is also a prohibition on "side-loading" pots, to reduce halibut bycatch (Wood et al. 2017).

At-sea observers have not been deployed by ADF&G in the SE Alaska Tanner crab fishery, so bycatch in crab pots is unknown. Although the SE Alaska GKC fishery likely operates in somewhat different areas and depths, it begins at the same time of year as the Tanner crab fishery and uses similar pots. Historical bycatch data from observers for the GKC fishery found various species caught at low frequencies, Pacific cod caught at moderate levels, and Tanner crab caught regularly. Corals and other biogenic habitats were also caught in small amounts. Assuming a similar bycatch composition for the Tanner crab fishery, species of concern would include GKC and corals and other biogenic habitats. Impacts to GKC by this fishery were evaluated in Factor 3.1 because that species can be retained in the Tanner crab fishery. The lack of observer data, and the expectation that it will not be available in the future, is a concern because impacts cannot be accurately evaluated.

Ghost gear from this fishery could affect multiple species, including GKC and other animals caught in traps, endangered humpback whale, and vulnerable deepsea corals and other biogenic habitats. Regulations are in place to reduce impacts to animals caught in the pots if gear is lost. But, the required biodegradable twine that is intended to disable lost traps may require up to 125 days to degrade enough for animals to escape, and survival of crabs begins to decline greatly after being trapped 28 days (Barnard 2008). Ghost fishing impacts on king crab species have been demonstrated in other Alaska crab pot fisheries (Long et al. 2014). Endangered humpback whale is found in the area where the fishery occurs, but the timing of its migrations (typically late spring through early fall) likely does not overlap with fishery operations because of their short duration (generally mid-February through mid-March). But, ghost gear could cause impacts to marine mammals beyond the end of the fishery. There are no known measures to assess and remove the

impacts of lost gear from the fishery, or a requirement for timely reporting of lost gear. But, the short duration of the fishery may limit the amount of ghost gear generated.

Factor 3.3 - Scientific Data Collection and Analysis

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Moderately Effective
Data to support stock assessments for target species in the PI GKC, AI GKC, and EBS Tanner crab fisheries are collected, allowing for estimates of stock abundance, except in the PI GKC fishery. Bycatch within crab pots is monitored by at-sea observers, with the observing level and methods likely adequate. Data on entanglements of marine mammals were available through NOAA stock assessments, but more extensive monitoring is needed to help prevent these incidents and assess the scope of the problem. Data collection on ghost gear and its impacts to marine life from these fisheries is insufficient, and more effort is needed to understand and mitigate for this issue. Based on this information, the scientific research and monitoring of this fishery is considered moderately effective.

Justification:
The 2021 ADF&G stock assessments of the PI GKC, AI GKC, and EBS Tanner crab were all peer-reviewed and approved through the NPFMC process (NPFMC 2021e). AI GKC and EBS Tanner crab stocks are managed as Tier 3 stocks, meaning that reliable estimates of the spawner-recruit relationship are available, but proxies for F_{MSY} and B_{MSY} can be estimated (NPFMC 2021d). The PI GKC is managed as a Tier 5 stock, meaning that it is data-poor and F_{MSY} and B_{MSY} cannot be estimated because only retained catch information is available, but an OFL and ABC are calculated (NPFMC 2021d).

Data collection to support stock assessments for target stocks in the Alaska BSAI crab fisheries is a priority for managers. A NOAA trawl survey is conducted annually in the eastern Bering Sea, including Bristol Bay, from which estimates of biomass and other key stock assessment inputs are derived for stocks in those areas. Although NOAA does conduct a trawl survey in the AI, the survey primarily targets fish and does not cover much of the habitat of GKC in the region. Instead, recent stock assessments of AI GKC have used a model with data derived from onboard observers, including CPUE and tag-recapture growth, which has proved sufficient for informing stock assessment models. In addition to data collection by NMFS and ADF&G for target stocks, the Bering Sea Fisheries Research Foundation (BSFRF) (http://www.bsfrf.org/) conducts cooperative research with industry, ADF&G, and NMFS to improve the science used in Bering Sea crab fisheries management. The BSFRF is funded by the Bering Sea crab fishing industry and coordinates project design, field research, analyses, and reporting. Also, in the AI, a cooperative GKC pot-based survey was conducted by the Aleutian Islands King Crab Foundation (an industry group) and ADF&G for the past few seasons, with the goal of eventually using this survey to inform stock assessments.

Biannual NOAA trawl surveys had been conducted in the vicinity of the PI, which allowed for estimates of biomass and collection of other key stock assessment inputs. Since 2016, surveys that included the PI area have not occurred, and ADF&G reports that they likely will not occur in the future, although a collaborative, industry-based trawl survey is currently in development (pers. comm., M. Stichert, November 10, 2020). Without biomass/abundance data to include in a quantitative stock assessment, or development of a data-limited analysis, it is not possible to determine if the PI GKC stock is overfished. Confidential harvest data are collected for the PI fishery, and harvest data from the 1990s were used to compute the OFL/ABC; given the age of the data used to compute the OFL and ABC, it is even more important to restart surveys to estimate PI GKC stock abundance.

ADF&G operates an onboard observer program annually to monitor bycatch in the fishery, with data available through 2019. ADF&G observers deployed on catcher-processors and catcher vessels in the BSAI crab fisheries record the gear and location information for a random sample of pot lifts, the species composition of catch, and the sex and legal status of commercially important captured crabs (Gaeuman 2014). ADF&G onboard observers and dockside samplers document overall vessel catch and effort, and size-frequencies of catch species. Observing coverage goals have been defined for rationalized BSAI fisheries based on either the percent of randomly selected catcher vessels observed or the percent of landings observed. These goals were met on average for BSAI fisheries in 2017–19 (Table 7) (pers. comm., M. Stichert, October 28, 2020). In addition, observers try to sample 100% of catcher-processor vessels. These goals are high enough that most of the key bycatch species are likely well characterized, because most species caught in BSAI crab pots as bycatch are fairly consistent at low levels. The observing target is higher for AI GKC (50% of landings), which is helpful given the presence of corals and other biogenic habitats (a taxa of concern) in catches. In the PI GKC fishery, an observing coverage goal of 100% of catch was set for this fishery and this goal was achieved in 2016–19 (pers. comm., M. Stichert, December 18, 2020).

Beyond observers onboard fishing vessels, data were not available regarding air or sea surveys for entangled marine mammals in BSAI fisheries. The main source of information about these interactions is reports of entanglements to marine mammal stranding networks, which are summarized in annual NOAA marine mammal stock assessments. In these reports, entangling gear is often not traced to a particular fishery, likely due to insufficient gear marking protocols. NOAA marine mammal stock assessments do contain estimates of mortalities from entanglements, but these are uncertain, given the lack of consistent surveys to report incidents (Muto et al. 2020a). Available research on bowhead whale suggests that entanglements and mortalities of these animals in BSAI crab gear may be underestimated in stock assessments (George et al. 2017){George et al. 2019}.

Lost crab fishing gear that may affect species caught in pots, vulnerable habitats, or entanglements with marine mammals (i.e., ghost gear) are voluntarily reported to ADF&G by commercial BSAI crab fishers. Annual numbers of lost gear are high for some of these fisheries. This is helpful information for understanding the scope of the issue, although reporting is not mandatory, so it is unclear whether all lost gear is reported. The fate of these lost pots is unknown and data on any retrieved gear were not available. Impacts from ghost gear are not regularly evaluated aside from voluntary reports of entanglements in marine mammal stock assessments, where gear is often not assigned to a specific fishery. Given the potential risks from ghost gear to multiple species in these fisheries,

including deep sea corals and other biogenic habitats in some areas, this lack of evaluation of impacts needs to be addressed.

Table 7. 2017–19 ADF&G onboard observer program percent coverage goals and actual coverage for BSAI fisheries {Stichert 2020c}. Note that the Bristol Bay RKC fishery is currently closed.

Fishery	Actual Observer Coverage	Observer Coverage Goal	Goal Met?
Bristol Bay RKC	23.6%	20% of vessels	Yes
Bering Sea Snow Crab	29.5%	30–100% of vessels	Yes
Bering Sea Tanner Crab	44.0%	30–100% of vessels	Yes
Aleutian Is. GKC EAG	70.7%	50% of landings	Yes
Aleutian Is. GKC WAG	61.0%	50% of landings	Yes

In 2020, the NPFMC initiated a review to ensure that the federal king and Tanner crab FMP is in compliance with Standardized Bycatch Reporting Methodology (SBRM) guidance. Specifically, the review focused on how bycatch information is collected and reported for the BSAI king and Tanner crab fisheries. The review was completed in February 2021, and the NPFMC determined that bycatch reporting is consistent with SBRM requirements; however, the language in the FMP will need to be modified to identify a SBRM and explain how it meets the purpose of collecting, recording, and reporting bycatch (NPFMC 2021c). This change is necessary to increase transparency about how the SBRM in each fishery is consistent with national guidance.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

N/A
Per Seafood Watch policy, when Factor 3.1 (Management Strategy) or Factor 3.2 (Bycatch Strategy) is scored "Ineffective," the score for Criterion 3 will always be 1.0 (i.e., Red). Although management of this fishery may include components relevant for Factor 3.3 (Scientific Data Collection and Analysis), Factor 3.4 (Enforcement of and Compliance with Management Regulations), and Factor 3.5 (Stakeholder Inclusion), scores for these factors would not affect the overall fishery score, so answers and scores were not provided.

Factor 3.4 - Enforcement of and Compliance with Management Regulations

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Highly effective
Although compliance to regulations by BSAI commercial crab fisheries is uncertain, enforcement is in place and TACs or GHLs have not been exceeded in recent years by commercial fisheries.

Therefore, enforcement and compliance is considered highly effective.

Justification:
ADF&G reports that an active vessel monitoring system (VMS) is required for all current BSAI crab fisheries, except PI GKC and Norton Sound RKC fisheries (pers. comm., M. Westphal, December 16, 2020). The enforcement of VMS and all other regulations in these fisheries is the shared responsibility of Alaska Wildlife Troopers (AWT) and the NOAA Office of Law Enforcement (OLE). ADF&G fishery managers monitor VMS for malfunctions during the fishing seasons, notify a vessel's captain if there are issues, then notify NOAA OLE if the issue is not corrected (pers. comm., M. Westphal, December 16, 2020). AWT and NOAA OLE did not respond to requests for summaries of fishery compliance information, so it is unclear how often regulations are broken and what impacts may result for target and nontarget stocks. According to 2020 stock assessments, fishery landings have not exceeded TACs or GHLs in recent years for any of the BSAI crab fisheries (note that overall harvest above the TAC in BBRKC and AIGKC fisheries was due to an ADF&G cost-recovery program rather than commercial fisheries).

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

N/A
Per Seafood Watch policy, when Factor 3.1 (Management Strategy) or Factor 3.2 (Bycatch Strategy) is scored "Ineffective," the score for Criterion 3 will always be 1.0 (i.e., Red). Although management of this fishery may include components relevant for Factor 3.3 (Scientific Data Collection and Analysis), Factor 3.4 (Enforcement of and Compliance with Management Regulations), and Factor 3.5 (Stakeholder Inclusion), scores for these factors would not affect the overall fishery score, so answers and scores were not provided.

Factor 3.5 - Stakeholder Inclusion

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Highly effective
Stakeholders can participate in management processes for Alaska BSAI crab fisheries through the NPFMC as well as the state of Alaska. Based on the transparency of the management process and multiple avenues for stakeholders to participate in management, along with well-organized conflict resolution, stakeholder involvement was considered highly effective.

Justification:
The Alaska Board of Fisheries (BOF) determines regulations governing access to fisheries, harvest plans for each stock, and how fisheries are allocated. Stakeholders, ADF&G, and the general public

can make a proposal to the BOF to change existing regulations or propose new regulations (pers. comm., M. Westphal, December 16, 2020). The public can give testimony about fishery management to the BOF through submitted written comments or verbally at BOF meetings. In addition, the BOF takes input from Advisory Committees (ACs) inside and outside of BOF meetings. ACs comprise stakeholders in communities across Alaska, with positions on the AC filled through requests by local stakeholders that are subject to AC approval. ACs typically attempt to maintain a balance between commercial, sport, and subsistence stakeholders and focus on all regional fisheries, including BSAI crab fisheries. ADF&G staff members attend AC meetings to explain regulations and proposals or to provide data and fishery updates. Stakeholders are also encouraged to speak with their local ADF&G staff concerning regulations, fisheries, or ideas for BOF proposals. Local ADF&G personnel may assist members of the public in writing and submitting proposals to the BOF. ADF&G holds an annual public TAC setting meeting for all BSAI fisheries, which provides a venue for stakeholders to ask questions about the data ADF&G used to make decisions regarding TACs (pers. comm., M. Westphal, December 16, 2020).

Management decisions by the NPFMC that affect BSAI fisheries are made through public meetings, where stakeholders can provide input on decisions and issues of concern. The NPFMC process involves multiple committees that hold meetings open for public comment. The BSAI Crab Plan Team was formed primarily to provide the NPFMC with the best available scientific information regarding appropriate measures for the conservation and management of the BSAI crab fisheries (NPFMC 2021e). BSAI crab stock assessments and other topics are discussed at these meetings. The BSAI Crab FMP also established a Pacific Northwest Crab Industry Advisory Committee to provide the Alaska BOF with advice on preseason and in-season management measures for BSAI crab fisheries, including advice from nonresidents of Alaska (NPFMC 2021a). The Community Engagement Committee was recently formed to identify and recommend strategies for the NPFMC to provide effective community engagement with rural and Alaska Native communities. The NPFMC's Ecosystem Committee considers North Pacific management in the light of national ecosystem discussions, and suggests new ways for the NPFMC to engage in ecosystem-based management.

Conflicts between user groups are handled in several ways. If conflicts cannot be resolved by dialog between group representatives, then ADF&G or the enforcement agencies will be asked to mediate (pers. comm., M. Westphal, December 16, 2020). For cases of gear conflicts or gear interference, there may be regulatory guidance to guide resolution. For conflicts where there is no regulatory guidance, issues are taken before the Alaska BOF or the NPFMC, depending on where the conflict is located and which parties are involved. Enforcement agencies typically handle gear-related conflicts. All allocation issues are dealt with by the BOF if there is no clear regulatory guidance (pers. comm., M. Westphal, December 16, 2020).

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

N/A

Per Seafood Watch policy, when Factor 3.1 (Management Strategy) or Factor 3.2 (Bycatch Strategy) is scored "Ineffective," the score for Criterion 3 will always be 1.0 (i.e., Red). Although management of this fishery may include components relevant for Factor 3.3 (Scientific Data Collection and Analysis), Factor 3.4 (Enforcement of and Compliance with Management Regulations), and Factor 3.5 (Stakeholder Inclusion), scores for these factors would not affect the overall fishery score, so answers and scores were not provided.

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	FORAGE SPECIES?	SCORE
Aleutian Islands Stock | Pacific, Northeast | Pots | United States | Alaska	Score: 2	Score: 0	Moderate Concern		Yellow (2.449)
Eastern Bering Sea Stock | Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea Tanner Crab Fishery	Score: 3	Score: 0	Moderate Concern		Yellow (3.000)
Pribilof Islands Stock | Pacific, Northeast | Pots | United States | Alaska	Score: 2	+.5	Moderate Concern		Yellow (2.739)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Golden King Crab Fishery	Score: 2	Score: 0	Moderate Concern		Yellow (2.449)
Southeast Alaska Stock | Pacific, Northeast | Pots | United States | Southeast Alaska Tanner Crab Fishery	Score: 2	Score: 0	Moderate Concern		Yellow (2.449)

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management
Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at*

sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.

- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Score: 3

Crab pots contact the seafloor but have a low likelihood of contacting vulnerable habitats in the EBS Tanner crab fishery, so a score of 3 is given.

Justification:

No studies have been undertaken to specifically examine the effects of pot fishing on seafloor habitat in Alaska. Crab pot fisheries in the eastern Bering Sea and SE Alaska likely have a minimal effect on coral habitat, because they generally occur in soft-sediment areas with minimal coral habitat, and a relatively small area of the seafloor is contacted with the gear (Stone and Shotwell 2007). The Bering Sea contains low densities of hard corals, although soft corals are fairly widespread. A directed inventory study of sponges in the EBS during 2013–15 found a much more diverse assemblage than previously believed, with over 75 species—roughly half as many as in the AI region [Stone et al. 2019}.

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Score: 2

Crab fishing areas in AI, PI, and SE Alaska contain deepsea corals and other biogenic habitats. Because crab fisheries can and have caused damage to these vulnerable habitats through contact with and potentially dragging across the seafloor, a score of 2 is given for these fisheries.

Justification:

Few studies have been undertaken to study the effects of pot fishing on seafloor habitat in Alaska. Pot longlines used in the AI GKC fishery have the potential to cause extensive damage to coral habitat because the spatial distribution of fishing is extensive in some areas of high coral abundance (Stone and Shotwell 2007)(Heifetz et al. 2009). During pot retrieval, or if dragging occurs while pots are deployed in rough seas or strong currents, the area of seafloor contacted may be relatively large and the forces on the seafloor may be substantial. The Aleutian Islands (AI) contain a high density and diversity of deepsea corals, often forming unique "coral garden" habitats that are similar in structural complexity to shallow tropical reefs, with a rigid framework, high topographic relief, and high taxonomic diversity (Stone 2006)(Stone and Shotwell 2007). Impacts from crab pot gear in the AI have been observed, where the seafloor was scoured to bare substrate (Stone 2006). AI corals are at high risk to disturbance from the GKC fishery (Heifetz et al. 2009). The Pribilof Islands (PI) also have corals and other vulnerable habitats, albeit at a lower density than the AI, and fine-scale associations between GKC and corals have been observed (Stone and Shotwell 2007). SE Alaska also contains corals and other biogenic habitats, and overlap between these habitats and the fisheries is

possible (Stone and Shotwell 2007).

In addition, ADF&G onboard observer data indicate that hard and soft corals, as well as sponges, tunicates, and hydroids, are regularly caught by the AI GKC fishery (ADFG 2020e). Data show that soft corals, sponges, and hydroids are also caught in the PI and SE Alaska GKC fisheries, but at lower frequency than in the AI (ADFG 2020e)(Olson and Bishop 2012). Observer data were not collected for the SE Alaska Tanner crab fishery.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands

Score: 0

Points are awarded for this factor only if the seafloor (including any vulnerable habitats) is protected from the fishery under assessment. Even if vulnerable habitats do not exist in the fishing area, closing areas to crab pot fishing would still be needed to be awarded points. But, points are not deducted from the overall assessment score if no such protections exist. The available information indicated that areas closed to crab pot fishing in AI represent less than 20% of representative habitat, so zero points are awarded for this factor.

Justification:

Within most of the Aleutian Islands Habitat Conservation Area, which encompasses a large portion of the AI GKC fishing registration area, no federally permitted vessel may fish with nonpelagic trawl gear (Figure 12). This area was developed to reduce the effects of bottom trawling on coral, sponges, and hard-bottom habitat in the AI (pers. comm., K. Milani, October 29, 2020). A portion of the Bowers Ridge Habitat Conservation Zone is within the AI GKC fishing registration area; in this area, no federally permitted vessel may fish with mobile bottom contact gear (including crab pots). NOAA staff report that this area was designated a habitat area of particular concern and closed to most fishing to help protect hard coral areas (pers. comm., K. Milani, October 29, 2020). A small portion of the Bering Sea Habitat Conservation Area also falls within the AI GKC fishing registration area. In this area, no federally permitted vessel may fish with nonpelagic trawl gear. NOAA staff report that this area closure was intended to prevent expansion of nonpelagic trawl gear to areas not historically fished (pers. comm., K. Milani, October 29, 2020). Lastly, several relatively small areas are closed to all fishing in the western AI to protect fragile and unique coral garden habitats (Figure 13) (Beder 2019). Although the various closures in the AI likely greatly reduce impacts from trawls on seafloor habitats, the closure does not greatly limit the GKC fishery in this area. There are large areas of seafloor with the potential to support coral gardens outside of the coral garden closure area where no bottom contact gear is allowed {Woodby et al. 2009}. Although the areas closed to trawling in the AI are substantial, areas closed to all fishing (including crab pots) likely comprise less than 20% of vulnerable deepsea coral and other biogenic habitats within the Aleutian Island GKC fishing area (Registration Area O).

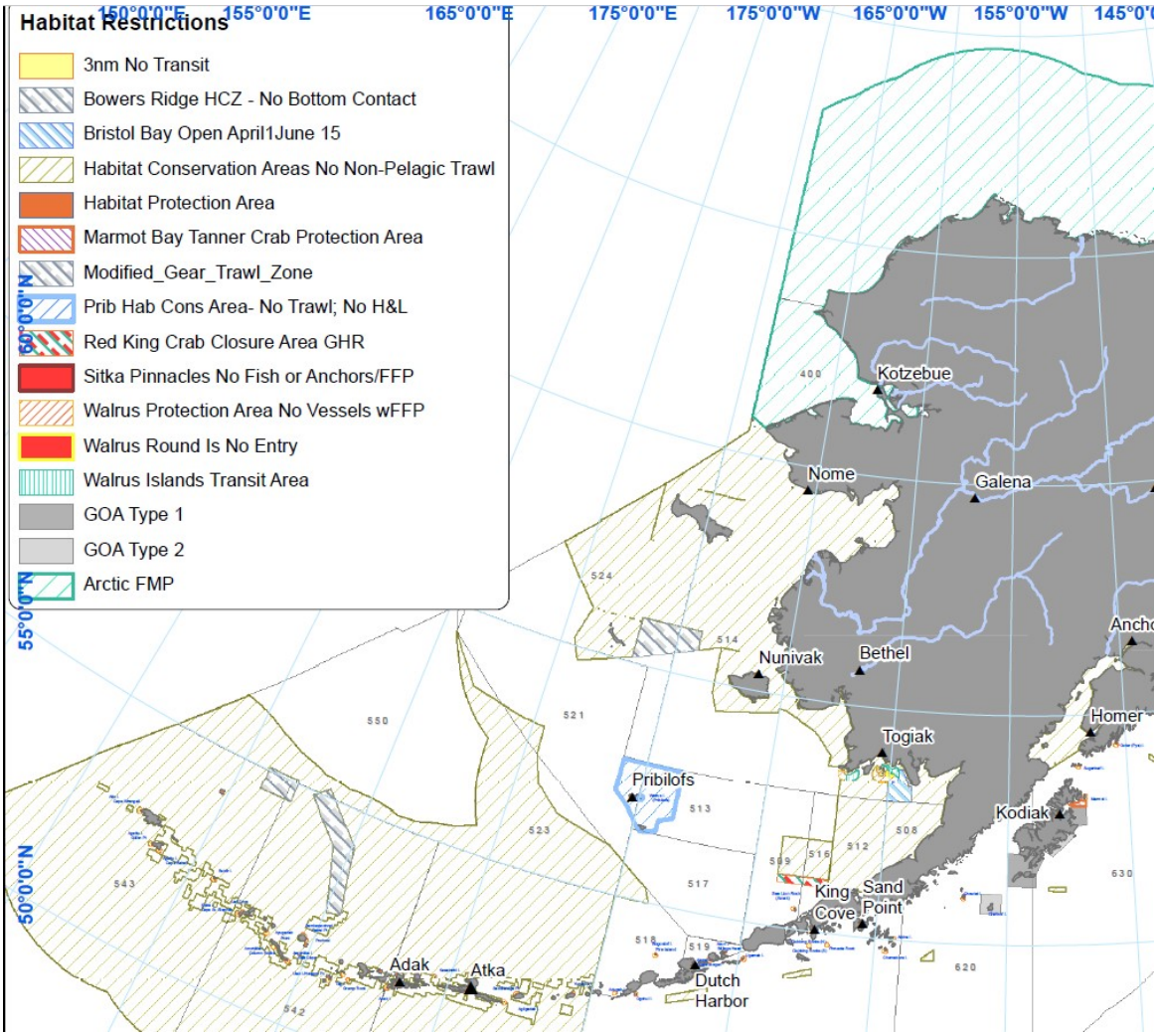

Figure 12: Marine waters around Alaska with reduced or prohibited fishing. Map provided by NOAA Fisheries (https://media.fisheries.noaa.gov/dam-migration/habitat-restrictions-map.pdf).

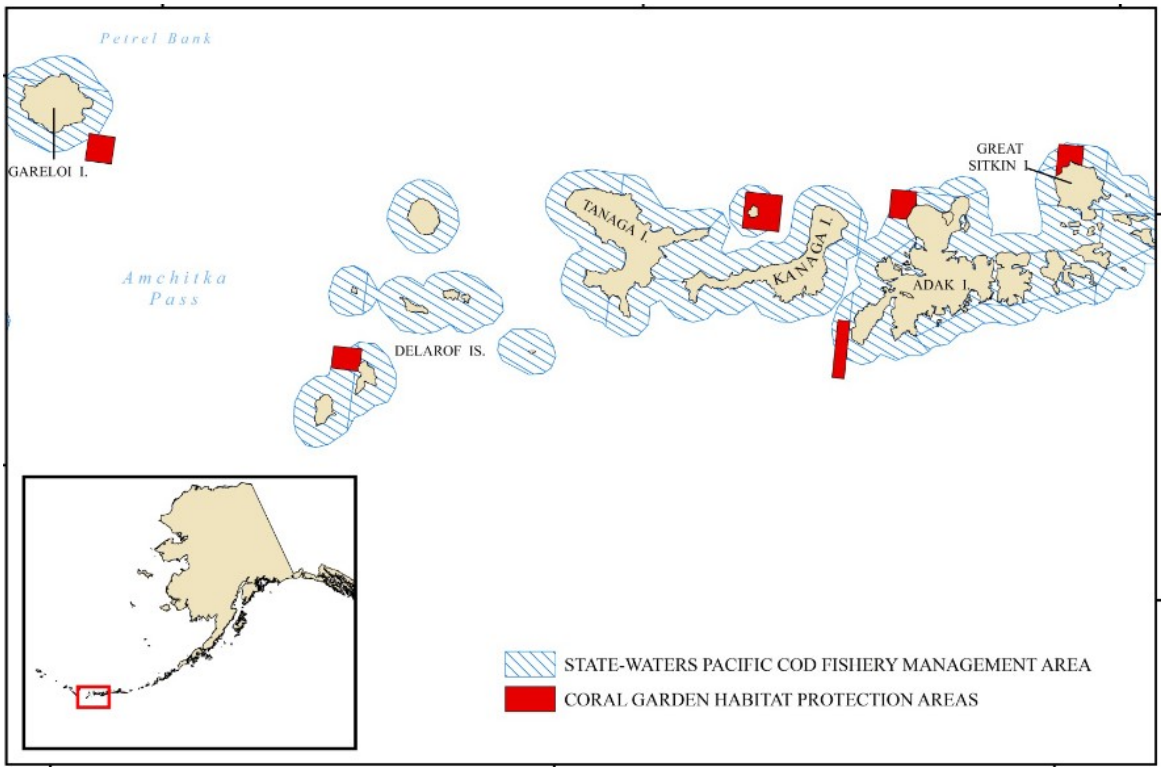

Figure 13: Areas closed to all fishing (red shaded polygons) in the western Aleutian Islands to protect coral garden habitats (Beder 2019).

Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery

Score: 0

Points are awarded for this factor only if the seafloor (including any vulnerable habitats) is protected from the fisheries under assessment. Even if vulnerable habitats do not exist in the fishing area, closing areas to crab pot fishing would still be needed to be awarded points. But, points are not deducted from the overall assessment score if no such protections exist. The available information indicated that less than 20% of representative habitats in the EBS Tanner crab fishing area were closed to crab pot fishing, so zero points were awarded for this factor.

Justification:

Several areas are closed to some or all fishing gears in the Bering Sea district Tanner crab registration area (see Figure 14). The Bering Sea Habitat Conservation Area prohibits federally permitted vessels to fish with non-pelagic trawl gear. NOAA staff report that this Conservation Area was intended to prevent expansion of nonpelagic trawl gear to areas not historically fished (pers. comm., K. Milani, October 29, 2020). In the Pribilof Island Habitat Conservation Area, directed fishing for groundfish using trawl gear, or fishing for halibut or groundfish using pot gear, is prohibited. This Conservation Area was part of the Pribilof Islands blue king crab rebuilding plan and was implemented to protect blue king crab habitat. The Pribilof Blue King Crab Protection Area (PBKCPA), an area managed by the state of Alaska to protect blue king crab, is closed to fishing by commercial king, Tanner, and groundfish pot gears. Although it can be modified each year by

ADF&G based on available blue king crab data, in 2017–22 the PBKCPA was the same location and size (see Figure 14). The PBKCPA is roughly 3% of Tanner Crab Registration Area J west of 166° W. and roughly 5% of the fishable waters within Area J (pers. comm., Ethan Nichols, July 26, 2022). The Red King Crab Savings Area has been closed year-round to nonpelagic trawling since 1996 to increase protection of adult red king crab and its habitat (NPFMC 2020b). The Nearshore Bristol Bay Closure is also closed to all trawling, except for a small area that is open during April 1 to June 15, to protect juvenile red king crab and critical rearing habitat (NPFMC 2021a). Within the Nunivak Island, Etolin Strait, and Kuskokwim Bay Habitat Conservation Area, no federally permitted vessel may fish with nonpelagic trawl gear. NOAA staff report that this Conservation Area was put into place to protect bottom habitat that supports subsistence marine resources, including marine mammals, fish, and birds (pers. comm., K. Milani, October 29, 2020). In the St. Lawrence Island Habitat Conservation Area, no federally permitted vessel may fish with nonpelagic trawl gear. NOAA staff report that this Conservation Area was put into place to conserve blue king crab habitat and minimize potential interactions with community use and subsistence fisheries taking place in nearshore areas (pers. comm., K. Milani, October 29, 2020). In the St. Matthew Island Habitat Conservation Area, no federally permitted vessel may fish with nonpelagic trawl gear. NOAA staff report that this Conservation Area was established to protect blue king crab habitat (pers. comm., K. Milani, October 29, 2020). In the Northern Bering Sea Research Area, no federally permitted vessel may fish with nonpelagic trawls. NOAA staff report that the Research Area was established to provide a location with little to no nonpelagic trawling, for the purpose of studying the effects of nonpelagic trawl on bottom habitat (pers. comm., K. Milani, October 29, 2020). Aside from the PBKCPA, these spatial regulations do not limit pot fishing, and pot fishing can occur throughout most of the Bering Sea. Because pot gear contacts the seafloor, sensitive habitats such as corals may be affected. Vulnerable habitats such as deepsea corals do occur in some areas of the Bering Sea, but spatial closures were not designed to protect those areas.

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands

+.5

Points are awarded for this factor only if the seafloor (including any vulnerable habitats) is protected from the fishery under assessment. Even if vulnerable habitats do not exist in the fishing area, closing areas to crab pot fishing would still be needed to be awarded points. But, points are not deducted from the overall assessment score if no such protections exist. The available information indicated that areas closed to crab pot fishing in PI represent a substantial portion (but less than 50%) of representative habitat, so 0.5 points are awarded for this factor.

Justification:

Two fishery closures to protect blue king crab are relevant to the PI GKC fishing area. The Pribilof Island Habitat Conservation Area makes up a portion of the PI RKC fishery registration area (Figure 14). In this Conservation Area, directed fishing for groundfish using trawl gear, or fishing for halibut or groundfish using pot gear, is prohibited. This closure was part of the PI blue king crab rebuilding plan, and NOAA staff report that it was implemented to protect blue king crab habitat (pers. comm., K. Milani, October 29, 2020). Although this likely greatly reduces impacts from these gears on seafloor habitats, the closure does not limit crab pot fishing. But, the Pribilof Blue King Crab Protection Area (PBKCPA), implemented by the state of Alaska to protect blue king crab and its habitat, currently encompasses an area roughly the same size and shape as the PI Habitat

Conservation area (Figure 14). The PBKCPA is closed to fishing using commercial king, Tanner, and groundfish pot gears {ADFG 2021f}. Although it can be modified each year by ADF&G based on available blue king crab data, in 2017–22 the PBKCPA was the same location and size as shown in Figure 12. ADF&G estimates that the Protection Area comprises approximately 7% of the Pribilof District king crab fishing area but is roughly 15% of the fishable area (pers. comm., Ethan Nichols, July 26, 2022). The seafloor within the PBKCPA contains corals and other deepsea biogenic habitats, and may represent 20% or more of this habitat type in the Pribilof District fishing area (Stone and Shotwell 2007).

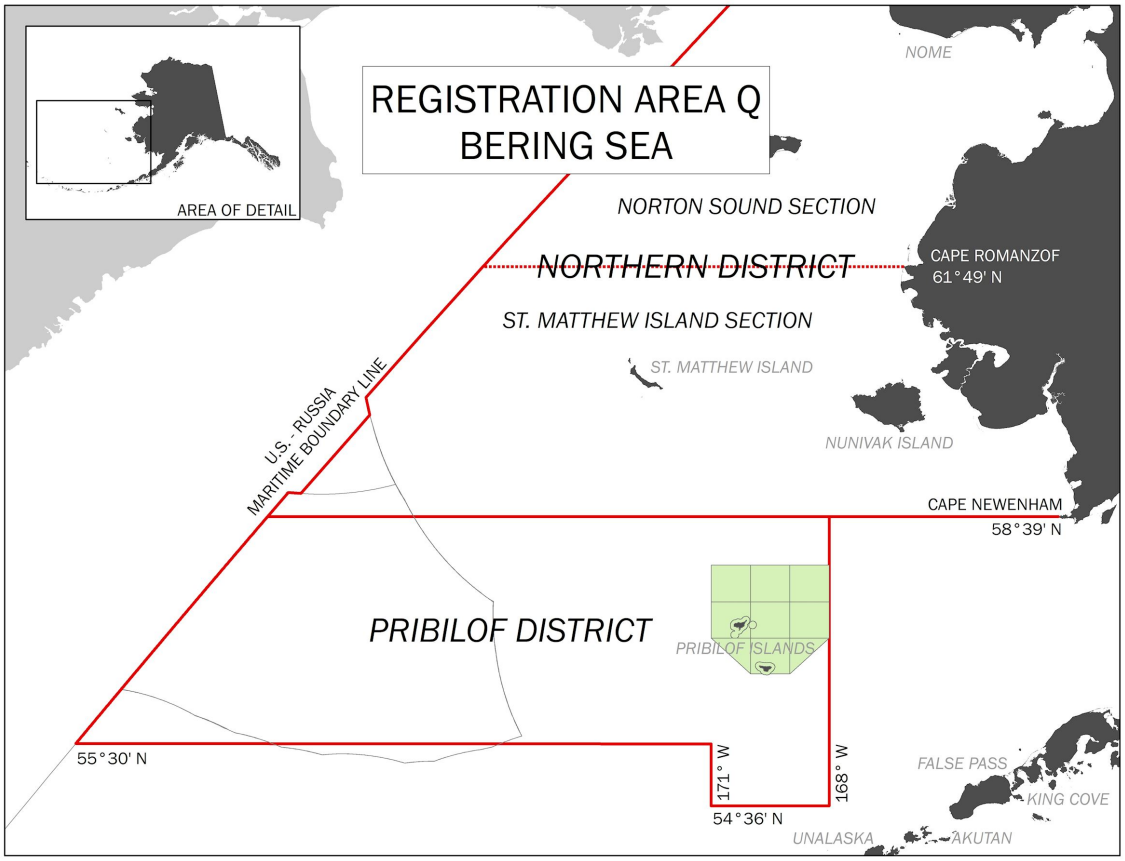

Figure 14: Map of Registration Area Q, including the Pribilof District fishing area and the Pribilof Blue King Crab Protection Area (green polygon) as defined for the 2021–22 commercial crab fishing season. Map provided by ADF&G.

Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Score: 0

Points are awarded for this factor only if the seafloor (including any vulnerable habitats) is protected from the fishery under assessment. Even if vulnerable habitats do not exist in the fishing area, closing areas to crab pot fishing would still be needed to be awarded points. But, points are not

deducted from the overall assessment score if no such protections exist. The available information indicated that less than 20% of seafloor habitat is protected from crab pot fishing in SE Alaska, so zero points are awarded for this factor.

Justification:
Glacier Bay is closed to commercial fishing for GKC and most other species because it is a National Park; commercial Tanner crab fishing can occur there only by special permit (see Figures 7 and 8 in the Introduction). An additional area near Juneau is also closed to GKC fishing. All other waters within the SE Alaska GKC and Tanner crab registration area are open to commercial fishing unless stock health is poor enough to warrant closures. Trawling is prohibited in the SE Alaska commercial crab fishing registration area.

Factor 4.3 - Ecosystem-based Fisheries Management

Pacific, Northeast | Pots | United States | Alaska | Pribilof Islands
Pacific, Northeast | Pots | United States | Alaska | Aleutian Islands
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Golden King Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Eastern Bering Sea | Eastern Bering Sea Tanner Crab Fishery
Pacific, Northeast | Pots | United States | Alaska | Southeast Alaska | Southeast Alaska Tanner Crab Fishery

Moderate Concern
Although there is some spatial and temporal management for BSAI and SE Alaska crab fisheries, as well as some protections of vulnerable habitats, measures designed to protect the ecosystem function and the ecological role of harvested crab stocks have not yet been implemented in management plans or other key processes. But, detrimental food web impacts are not likely, given the intermediate trophic role of the target species in these fisheries (Divine 2016). Therefore, ecosystem-based management is considered a moderate concern.

Justification:
Management plans are in place for all fisheries in this report. BSAI fisheries are covered by the NPFMC FMP (NPFMC 2021a), while the SE Alaska fisheries are covered by state of Alaska management plans (Stratman 2020)(Wood et al. 2017). Managers of the BSAI and SE Alaska king and Tanner crab fisheries have implemented limited temporal and spatial management or other policies to protect ecosystem functioning and account for capture species' ecological role. A few areas within BSAI are closed to all fishing (including crab pots), but most areas remain open to crab pot gears (see Factor 4.2). Spatial management in SE Alaska crab fishing areas is quite limited, and mostly focused in Glacier Bay National Park. Temporal management in BSAI and SE Alaska varies considerably among species, but is mostly linked to prevent TACs or GHLs from being exceeded or the harvest of crabs during periods of mating or molting, rather than for ecosystem-related concerns. Some fisheries may be open year-round, depending on harvest levels and other factors. According to the FMP for BSAI crab fisheries, the state of Alaska establishes TACs to maximize harvest and associated economic and social benefits, when biological and ecological conditions allow

(NPFMC 2021a). In addition, ADF&G staff report that ecosystem indicators are currently used to qualitatively inform environmental uncertainty in management of BSAI fisheries and can be used to: 1) reduce or "buffer" TACs; or 2) temper confidence in assessment model-based population estimates (pers. comm., M. Stichert, August 23, 2021). Management plans for SE Alaska GKC and Tanner crab fisheries do not mention ecosystem-based management strategies.

The NPFMC adopted the Bering Sea Fishery Ecosystem Plan (BSFEP) in December 2018 (NPFMC 2018). The BSFEP establishes a framework for NPFMC in moving toward ecosystem-based management (EBM) of the Bering Sea fisheries, and describes research project to address NPFMC priorities. The NPFMC views the FEP as a tool to promote ecosystem science, provide a systematic approach to identifying ecosystem considerations and priorities, enhance ecosystem considerations as they are incorporated into Council decisions, and provide a flexible, adaptive platform to address management and conservation needs in the face of climate and ecosystem change. Any output of the FEP and associated research is intended to be informative but not prescriptive, and recommendations are reviewed through the normal NPFMC process. This is a helpful process for prioritizing research related to the Bering Sea ecosystem; however, quantitative translation of tools like the BSFEP into the BSAI crab management process is still in the developmental stage (pers. comm., M. Stichert, August 23, 2021).

Acknowledgements

Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

Seafood Watch would like to thank the consulting researcher and author of this report, Tom Wadworth (gmail) from None for graciously reviewing this report for scientific accuracy.

References

ADF&G. 2020a. 2020–2021 Statewide King and Tanner Crab Commercial Fishing Regulations. Alaska Department of Fish and Game.

ADF&G. 2020c. Alaska Department of Fish and Game Memorandum: 2020/21 Southeast Alaska Tanner Crab status

ADF&G. 2020d. 2020 Tanner Crab Survey Results. King and Tanner Task Force Meeting. December 11, 2020.

ADF&G. 2020e. ADF&G Bering Sea and Aleutian Islands Onboard Observer Dataset, 2017-2019. Unpublished data provided by Mark Stichert, Alaska Department of Fish and Game.

ADF&G. 2020h. 2020 Alaska Department of Fish and Game Advisory Announcement: Southeast Alaska Herring Summary.

ADF&G. 2020i. 2020–2021 Statewide Commercial Groundfish Fishing Regulations

ADF&G. 2020j. Alaska Department of Fish and Game Advisory Announcement: 2020 Southeast Alaska Herring Spawn-On-Kelp Pound Fisheries.

ADF&G. 2020k. 2020 Alaska Department of Fish and Game Advisory Announcement: 2019/2020 Southeast Alaska Golden King Crab Commercial Fishery Announcement

ADF&G. 2020l. Alaska Department of Fish and Game Advisory Announcement: Bering Sea Tanner Crab Season and Total Allowable Catch Announced

ADF&G. 2021a. Tanner Crab Harvest - Registration Area A (Southeast Alaska). Alaska Department of Fish and Game. Available at: https://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.shellfish_harvest_tannera [Accessed November 3, 2021]

ADF&G. 2021b. Alaska Department of Fish and Game Announcement: 2020/2021 Southeast Alaska commercial golden king crab fishery.

ADF&G. 2021d. Review of TACs: Bering Sea Crab: 2020/21 Season. ADF&G presentation to BSAI crab industry, 19 Oct 2021.

ADF&G. 2022a. Alaska Department of Fish and Game Announcement: 2021/2022 Southeast Alaska commercial golden king crab fishery.

ADF&G. 2022b. Commercial Shellfish Fisheries, Southeast Alaska & Yakutat, Golden King Crab Harvest. Available at: http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.shellfish_harvest_goldenking

ADF&G. 2022c. 2022/23 Bering Sea Snow Crab Season Closed. Advisory Announcement. October 10,

2022.

ADFG 2016. Commercial Fishing Seasons in Alaska. October 2016. Accessed 11/16/2022 at https://www.adfg.alaska.gov/static/fishing/pdfs/commercial/commercial_season_2.pdf

ADFG. 2021e. Westward Region Shellfish Database, Alaska Department of Fish and Game, Division of Commercial Fisheries. (Accessed June 15, 2021).

Arthur, C., Sutton-Grier, A. E., Murphy, P. & Bamford, H. 2014. Out of sight but not out of mind: harmful effects of derelict traps in selected U.S. coastal waters. Mar. Pollut. Bull. 86, 19–28

Barnard, D. R. 2008. Biodegradable twine report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 08-05, Anchorage.

Beder, A. 2019. Fishery Management Plan for the Aleutian Islands Subdistrict State-Waters and Parallel Pacific Cod Seasons, 2020. Alaska Department of Fish and Game, Fishery Management Report No. 19-31

Blau, S.F. 1997. Alaska Department of Fish and Game Wildlife Notebook Series: Alaska King Crabs. Accessed on February 13, 2013

Calambokidis, J., G. H. Steiger, J. M. Straley, T. Quinn, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. Urban R., J. Jacobson, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara, S. A. Mizroch, L. Schlender, and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037. 72 p.

Carretta, J.V., Erin M. Oleson, Karin. A. Forney, Marcia M. Muto, David W. Weller, Aimee R. Lang, Jason Baker, Brad Hanson, Anthony J. Orr, Jay Barlow, Jeffrey E. Moore, and Robert L. Brownell Jr. 2021. Gray Whale (Eschrichtius robustus): Eastern North Pacific Stock, in: U.S. Pacific Marine Mammal Stock Assessments: 2020, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-646.

Carretta, J.V.. 2020. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery:1990-2018. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-632.

Conrad S. and T. Thynes. 2020. Overview of the 2019 SE Alaska and Yakutat Salmon Fisheries. Alaska Department of Fish and Game, Fishery Management Report No. No. 20-18

Coonradt E., D. Harris, T. Thynes and S. Walker. 2019. 2019 Southeast Alaska Herring Spawn-On-Kelp Pound Fishery Management Plan. Alaska Department of Fish and Game, Regional Information Report No. 1J19-02.

COSEWIC. 2017. COSEWIC assessment and status report on the Grey Whale Eschrichtius robustus, Northern Pacific Migratory population, Pacific Coast Feeding Group population and the Western Pacific population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxi + 74 pp.

(http://www.registrelepsararegistry.gc.ca/default.asp?lang=en&n=24F7211B-1).

Daly, B. and T. Jackson. 2020. Pribilof Islands Golden King Crab SAFE Report. Alaska Department of Fish and Game.

Daly, B., M. Heller-Shipley, M. Stichert, W. Stockhausen, A. Punt, and S. Goodman. 2020. Recommended Harvest Strategy for Bering Sea Tanner Crab. Alaska Department of Fish and Game Fishery Manuscript No. 20-03.

Delean, B. J., V. T. Helker, M. M. Muto, K. Savage, S. Teerlink, L. A. Jemison, K. Wilkinson, J. Jannot, and N. C. Young. 2020. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2013-2017. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-401, 86 p.

DFO. 2016. Eastern Nova Scotia and 4X Snow Crab Integrated Fisheries Management Plan. Effective as of 2013, Updated February 2016. Retrieved from: https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/snow-crab-neige/snow-crab-neiges2013-eng.html. [Accessed November 18, 2019]

Divine, L.M.. 2016. Trophic dynamics and stock characteristics of snow crabs, Chionoecetes opilio, in the Alaskan Arctic. Master's thesis. University of Alaska, Fairbanks.

Donaldson, W. E., R. T. Cooney, and J. R. Hilsinger. 1981. Growth, age and size at maturity of Tanner crab, Chionoecetes bairdi M.J. Rathbun, in the Northern Gulf of Alaska (Decapoda, Brachyura). Crustaceana 40(3):286–302.

FAO. 2021. Global Production Statistics 1950-2019. Retrieved from: http://www.fao.org/fishery/statistics/global-production/query/en [Accessed November 16, 2021]

Gaeuman, W. B. 2014. Summary of the 2013/2014 mandatory crab observer program database for the Bering Sea/Aleutian Islands commercial crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 14-49, Anchorage.

Gaeuman. 2011. Biodegradable twine report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 11-03

George, J. C., G. Sheffield, D.J. Reed, B. Tudor, R. Stimmelmayr, B.T. Person, T. Sformo, R. Suydam. 2017. Frequency of Injuries from Line Entanglements, Killer Whales, and Ship Strikes on Bering-Chukchi-Beaufort Seas Bowhead Whales. Arctic Vol. 70, No. 1: 1–120

Government of Canada. 2021. Grey Whale (Eschrichtius robustus), Pacific Coast Feeding Group population. Available at: https://species-registry.canada.ca/index-en.html#/species/1373-1008 [Accessed March 3, 2021].

Gravel, K. A. and D. Pengilly. 2007. Investigations on Reproductive Potential of Snow and Tanner Crab Females from the Eastern Bering Sea in 2005. Alaska Department of Fish and Game. Fishery Data Series No. 07-23

Heifetz, J., R. P. Stone, S. K. Shotwell. 2009. Damage and disturbance to coral and sponge habitat of the Aleutian Archipelago. Marine Ecology Progress Series 397: 295–303.

Heller-Shipley M.A., W. T. Stockhausen, B. J. Daly, A. E. Punt, S. E. Goodman. 2021. Should harvest control rules for male-only fisheries include reproductive buffers? A Bering Sea Tanner crab (Chionoecetes bairdi) case study. Fisheries Research, 243. https://doi.org/10.1016/j.fishres.2021.106049

Jewett, S.C., N.A. Sloan, and D.A. Somerton. 1985. Size at sexual maturity and fecundity of the fjord-dwelling golden king crab Lithodes aequispina from northern British Columbia. Journal of Crustacean Biology 5: 377–385.

Jones, M.L. 1990. Reproductive cycle in gray whales based on photographic resightings of females on the breeding grounds from 1977-1982. Report of the International Whaling Commission (Special Issue 12): SC/A88/ID38.

Kelleher, K. 2005. Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper. No. 470. Rome, FAO. 131p. Available at: http://www.fao.org/3/y5936e/y5936e02.htm#TopOfPage

Long, W.C., P. A. Cummiskey, and J.E. Munk. 2014. Effects of ghost fishing on the population of red king crab (Paralithodes camtschaticus) in Womens Bay, Kodiak Island, Alaska. Fishery Bulletin 112:101–111

Muto, M.M.,V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2020a. Bowhead Whale (Balaena mysticetus): Western Arctic Stock. In: Alaska Marine Mammal Stock Assessments, 2019. NOAA Technical Memorandum NMFS-AFSC-404.

Muto, M.M.,V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2020b. Humpback Whale (Megaptera novaeangliae): Central North Pacific Stock, In: Alaska Marine Mammal Stock Assessments, 2019. NOAA Technical Memorandum NMFS-AFSC-404.

Neilson J.L., J. M. Straley, C. M. Gabriele and S. Hills. 2009. Non-lethal entanglement of humpback whales (Megaptera novaeangliae) in fishing gear in northern Southeast Alaska. Journal of Biogeography 36: 452–464

NMFS. 1994. Endangered and Threatened Wildlife and Plants; Remove the Eastern North Pacific Population of the Gray Whale From the List of Endangered Wildlife; Final Rule. Federal Register Volume 59, Number 115

NMFS. 2004. Bering Sea Aleutian Islands Crab Fisheries Final Environmental Impact Statement. DOC, NOAA, National Marine Fisheries Service, AK Region, P.O. Box 21668, Juneau, AK 99802-1668.

NMFS. 2019. U.S. National Bycatch Report First Edition Update 3 [L. R. Benaka, D. Bullock, A. L. Hoover, and N. A. Olsen, Editors]. U.S. Dep. Commer., 105 p.

NOAA 2022f. Alaska Fisheries Management Reports: Seasons and TAC. Accessed 11/16/22 from https://www.fisheries.noaa.gov/alaska/sustainable-fisheries/alaska-fisheries-management-reports#bsai-crab

NOAA 2022g. Fisheries Catch and Landings Reports in Alaska. Accessed 11/16/22 at https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports-alaska

NOAA. 2021a. "2021 List of Fisheries Summary Tables." Retrieved from: https://www.fisheries.noaa.gov/national/marine-mammal-protection/list-fisheries-summary-tables [accessed on January 21, 2021].

NOAA. 2021b. "Deep-Sea Corals." Available at: https://deepseacoraldata.noaa.gov/about-us [Accessed January 20, 2021]

NOAA. 2021c. Gray Whale (Eschrichtius robustus): Eastern North Pacific Stock. Stock Assessment Report

NOAA. 2022a. Alaska Snow Crab: Overview. Available at: https://www.fisheries.noaa.gov/species/alaska-snow-crab#overview [Accessed January 20, 2022]

NOAA. 2022c. Supply of fisheries products. Available at: https://www.fisheries.noaa.gov/foss/f?p=215:23:17412412085451::NO::: [Accessed August 8, 2022].

NOAA. 2022d. Foreign Trade Data. Available at: : https://www.fisheries.noaa.gov/foss/f?p=215:2:17412412085451::NO::: [Accessed August 8, 2022].

NOAA. 2022e. 2019-2022 Gray Whale Unusual Mortality Event along the West Coast and Alaska. Available at: https://www.fisheries.noaa.gov/national/marine-life-distress/2019-2022-gray-whale-unusual-mortality-event-along-west-coast-and [Accessed January 26 , 2022].

NOAA. 2022b. Fisheries of the United States. Available at: https://www.fisheries.noaa.gov/foss/f?p=215:26:17412412085451::NO:::

North Pacific Research Board (NPRB). 2008. Coral Gardens Deep in the Aleutians. North Pacific Research Board Project Synopsis, Project 304.

NPFMC. 2018. Draft Bering Sea Fishery Ecosystem Plan. 152 p.

NPFMC. 2020b. "Habitat Protections." Available at: https://www.npfmc.org/habitat-protections/ [Accessed December 3, 2020]

NPFMC. 2021a. Fishery Management Plan for Bering Sea and Aleutian Islands King and Tanner Crabs

NPFMC. 2021b."Crab Bycatch Overview." Available at: https://www.npfmc.org/crab-bycatch-overview/ [Accessed January 13, 2021]

NPFMC. 2021c. "Standard Bycatch Reporting Methodologies." Available at: https://www.npfmc.org/sbrm-feb2021 [Accessed on August 15, 2021].

NPFMC. 2021d. BSAI Crab SAFE Introduction. Compiled by The Plan Team for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands. Available at: https://meetings.npfmc.org/CommentReview/DownloadFile?p=01dc4c33-94a5-47ac-a756-7cf3af9c16cc.pdf&fileName=BSAI%20Crab%20SAFE%20Intro.pdf

NPFMC. 2021e. "BSAI Crab Plan Team." Available at: https://www.npfmc.org/fishery-management-plan-team/bsai-crab-plan-team/ [Accessed on January 20, 2021].

NPFMC. 2022. Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. 2022 Final Crab SAFE. Compiled byThe Plan Team for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands. With Contributions by JB. Bechtol, B. Daly, M. Dorn, G. Eckert,E. Fedewa, B. Garber-Yonts, T. Hamazaki, M. Litzow, K. Milani, K. Palof, A.E. Punt, S. Rheinsmith, , M.S.M. Siddeek, W. Stockhausen, , C. Szuwalski, and M. Westphal. October 2022. Downloaded from: https://www.npfmc.org/about-the-council/plan-teams/bsai-crab-planning-team/

Olson A. and K. Palof. 2020. Recommended Harvest Strategy for Southeast Alaska Golden King Crab (Lithodes aequispinus). Draft. Alaska Department of Fish and Game.

Olson A. and K. Palof. 2022. Recommended Harvest Strategy for Southeast Alaska Golden King Crab (Lithodes aequispinus). Draft. Alaska Department of Fish and Game.

Olson, A. and G. Bishop. 2012. Southeast Alaska Golden King Crab Onboard Observer Program Report for 1998 through 2010 Seasons. Alaska Department of Fish and Game Regional Information Report No. 1J12-11

Olson, A., and J. Stratman. 2022. 2021 Golden king crab stock status and management plan for the 2022 season. Alaska Department of Fish and Game, Regional Information Report No. 1J22-14, Douglas, Alaska. Available at: http://www.adfg.alaska.gov/FedAidPDFs/RIR.1J.2022.14.pdf

Olson, A.P., C.E. Siddon, and G.L. Eckert. 2018. Spatial variability in size at maturity of golden king crab (Lithodes aequispinus) and implications for fisheries management. Royal Society Open Science 5: 171802. http://dx.doi.org/10.1098/rsos.171802

Palof, K., A. Olson, and J. Stratman. 2022. 2021 Southeast Alaska Tanner crab stock health assessment and management plan for the 2022 season. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 1J22-11, Douglas.

Punt, A. E. and Wade, P.R. 2010. Population status of the eastern North Pacific stock of gray whales in 2009. Journal of Cetacean Research and Management 12(1): 15-28

Rebert, A., K. Palof, and A. Messmer. 2019. Operational plan: Southeast Alaska Tanner crab survey. Alaska Department of Fish and Game, Regional Operational Plan ROP.CF.1J.2019.12, Douglas.

Rugolo, L.J., and B.J. Turnock. 2012. 2012 Stock Assessment and Fishery Evaluation Report for the Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. In: Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands: 2012 Crab SAFE. North Pacific Fishery Management Council. Anchorage, AK, pp. 267-416

SeafoodSource. 2022. Biden bans Russian seafood imports in latest economic response to Ukraine invasion. https://www.seafoodsource.com/news/supply-trade/biden-bans-russian-seafood-imports-in-latest-economic-response-to-ukraine-invasion. Published March 11, 2022 [Accessed Aug 24, 2022].

Siddeek, M.S.M. 2002. Review of biological reference points used in Bering Sea and Aleutian Islands (king and Tanner) crab management. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J02-06, Juneau, Alaska.

Siddeek, M.S.M., J. Zheng, C. Siddon, B. Daly, M.J. Westphal, and L. Hulbert. 2020. Aleutian Islands Golden King Crab Stock Assessment. May 2020 Crab SAFE Draft Report. Alaska Department of Fish and Game.

Somerton, D.A., and R.S. Otto. 1986. Distribution and reproductive biology of the golden king crab, Lithodes aequispina, in the Eastern Bering Sea. Fishery Bulletin 84(3): 571-584. https://www.semanticscholar.org/paper/DISTRIBUTION-AND-REPRODUCTIVE-BIOWGY-OF-THE-GOLDEN-SOMERTONl-Otto/f5dc5155e740eff51e356d875bfdd0e83e2112ca#extracted

Stichert, Mark. November 2, 2020. ADF&G. Personal communication. Note that Pacific cod bait estimates in the attached document were generated for this report using pot lifts in the document (supplied by ADF&G) as well as information about average bait use per crab pot supplied by Alaska Bering Sea Crabbers.

Stockhausen, W.T. 2020. 2020 Stock Assessment and Fishery Evaluation Report for the Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. NOAA Alaska Fisheries Science Center.

Stockhausen, W.T. 2021. 2021 Stock Assessment and Fishery Evaluation Report for the Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions. NOAA Alaska Fisheries Science Center.

Stone R.P. 2006. Coral habitat in the Aleutian Islands of Alaska: depth distribution, fine-scale species associations, and fisheries interactions. Coral Reefs 25:229-238

Stone R.P. 2006. Coral habitat in the Aleutian Islands of Alaska: depth distribution, fine-scale species associations, and fisheries interactions. Coral Reefs 25:229-238

Stone R.P. and S.K. Shotwell. 2007. State of deep coral ecosystems in Alaska region: Gulf of Alaska, Bering Sea and Aleutian Islands. In: Lumsden SE, Hourigan TF, Bruckner AW, Dorr G, editors, The State of Deep Coral Ecosystems of the United States, NOAA Technical Memorandum CRCP-3. Silver Spring MD. pp. 65–108.

Stoner, A.W. 2012. Assessing Stress and Predicting Mortality in Economically Significant Crustaceans. Reviews in Fisheries Science, 20(3):111–135. DOI: 10.1080/10641262.2012.689025

Stratman, J. 2020. 2019 Golden King Crab Stock Status and Management Plan for the 2019/2020 Season. Alaska Department of Fish and Game, Regional Information Report No. 1J20-11, Douglas, Alaska.

Stratman, J., A. Olson, and K. Palof. 2021. 2020 Golden king crab stock status and management plan for the 2020/2021 season. Alaska Department of Fish and Game, Regional Information Report No. 1J21-10, Douglas, Alaska. Available at: https://www.adfg.alaska.gov/FedAidPDFs/RIR.1J.2021.10.pdf

Stratman, J., T. Bergmann, K. Wood, and A. Messmer. 2017. Annual management report for the 2016/2017 Southeast Alaska/Yakutat golden king crab fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 17-57, Anchorage.

Szuwalski, C. 2020. A stock assessment for eastern Bering Sea (EBS) snow crab. NOAA Alaska Fisheries Science Center.

Szuwalski, C. 2021. A stock assessment for eastern Bering Sea (EBS) snow crab. NOAA Alaska Fisheries Science Center.

Teerlink, S. F., O. von Ziegesar, J. M. Straley, T. J. Quinn II, C. O. Matkin, and E. L. Saulitis. 2015. First time series of estimated humpback whale (Megaptera novaeangliae) abundance in Prince William Sound. Environ. Ecol. Stat. 22:345. DOI: dx.doi.org/10.1007/s10651-014-0301-8 .

Thompson, G.G., and J.T. Thorson. 2019. Assessment of the Pacific Cod Stock in the Eastern Bering Sea. NPFMC Bering Sea and Aleutian Islands SAFE.

Thynes, T., J. Bednarski, S. Conrad, E. Coonradt, D. Harris, B. Meredith, A. Piston, P. Salomone, and N. Zeiser. 2020. Annual Management Report of the 2019 Southeast Alaska Commercial Purse Seine and Drift Gillnet Fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 20-19.

USFWS. 2021. Bowhead whale (Balaena mysticetus). Available at: https://ecos.fws.gov/ecp/species/4615 [Accessed January 11, 2021]

Whiteside, C. J. 2020. Alaska Peninsula–Aleutian Islands Management Area commercial herring fishery management strategy, 2020. Alaska Department of Fish and Game, Regional Information Report 4K20-06, Kodiak.

Wood, K., J. Stratman, K. Palof, and A. Messmer. 2017. Annual Management Report for the 2016/2017 Southeast Alaska/Yakutat Tanner Crab Fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 17-60, Anchorage.

Woodby D., S. Meyer, K. Mabry, V. O'Connell, C. Trowbridge, J. Hall Schempf, E. Krygier, and D. Lloyd. 2002. Marine Protected Areas in Alaska: Recommendations for a Public Process, Report to the Alaska Board of Fisheries.

Appendix A: ADF&G BSAI Crab Fisheries Onboard Observer Data

ADF&G provided onboard observer data for 2017–2019 for the red king crab, golden king crab, Tanner crab, and snow crab fisheries in the BSAI, and these data were used in this report.