Blue king crab, Golden king crab, Red king crab

Paralithodes platypus, Lithodes aequispinus, Paralithodes camtschaticus

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Alaska

Pot

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About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological 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. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. 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.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

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.

Based on this principle, Seafood Watch had developed four sustainability **criteria** for evaluating wild-catch fisheries for consumers and businesses. These criteria are:

- How does fishing affect the species under assessment?
- How does the fishing affect other, target and non-target species?
- How effective is the fishery's management?
- How does the fishing affect habitats and the stability of the ecosystem?

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, we develop an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guide and the Safina Center's online guide:

Best Choice/Green: Are well managed and caught in ways that cause little harm to habitats or other wildlife.

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

Avoid/Red: Take a pass on these for now. These items are overfished or caught 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

Three species of king crab are found in Alaskan waters: red king crab (*Paralithodes camtschaticus*), golden (brown) king crab (*Lithodes aequispinus*), and blue king crab (*Paralithodes platypus*). King crab stocks in the U.S. have had a history of moderate susceptibility and vulnerability to fishing pressure. Alaskan king crab is caught using pot/trap gear. This report discusses the king crab fisheries that are responsible for the majority of landings in the United States: the Bristol Bay red king crab and the Aleutian Islands golden king crab. This report also reviews the recently rebuilt St. Matthew Island blue king crab fishery. The king crab fisheries of the Russian Barents Sea and Russian Pacific are discussed in separate Seafood Watch reports, because fishing activities, research, and management are not overseen by the U.S.

In 2015, the Bristol Bay red king crab underwent a stock assessment update, which indicated that the stock is not overfished, and overfishing did not occur, because biomass is above B_{MSY}. Although long-term trends show a continued increase in biomass, the stock status remains uncertain because recruitment has been low in recent years. The 2015 Aleutian Islands golden king crab stock assessment update indicated that overfishing did not occur for this stock. Because biomass estimates for this stock continue to be unknown, no overfished determination is possible for Aleutian Islands gold king crabs. Harvest trends have remained moderately stable since 2000, but the degree of uncertainty for this stock remains high because surveys are infrequent and recruitment trends are not readily available. Due to severe depletion, two blue king crab fisheries were closed in the late 1990s: the Pribilof Islands and St. Matthew Island fisheries. The 2015 Bering Sea Aleutian Islands (BSAI) blue king crab stock assessment report indicated that the Pribilof Islands stock is still classified as overfished, but because the fishery is closed, overfishing is not taking place. Abundance surveys remain infrequent, and the Pribilof Islands fishery has remained closed since 1999. But the St. Matthew blue king crab stock has continued to experience strong recruitment and biomass abundances since 2003. Although there is still a level of uncertainty around stock assessments, and survey data are limited, the most recent survey indicated that this stock is likely to be above the estimated B_{MSY}. In 2009, the fishery was considered rebuilt and was re-opened after a 10-year closure. The St. Matthew Island stock is not overfished and overfishing did not occur. Given this information, the Bristol Bay red king crab, Aleutian Islands golden king crab, and St. Matthew Island blue king crab stocks are considered to be healthy and at a sustainable level.

A variety of invertebrates and fish are incidentally caught in the crab pots of U.S. king crab fisheries. The majority of bycatch consists of males under the legal, commercial size; female crabs; and non-targeted crab species. Other non-target species include octopus, Pacific cod, Pacific halibut and other flatfish, sponges, coral, and sea stars. However, data collected by the Alaska Department of Fish and Game (ADF&G) observer program indicate that the bycatch of non-crab species is very low and these non-target species are not of conservation concern. Consequently, they are not included in this report. The only retained, non-target species analyzed in this assessment is the Tanner crab, because of the percentage of catch in the targeted king crab fishery. There is currently no way of estimating what percentage of discarded organisms die, but discard mortality rates for the directed pot fishery is estimated to be 20%. Nevertheless, it is unlikely that this bycatch affects the abundance of these

species, and current management requires fishers to adhere to specific gear types, techniques, and areas to reduce bycatch.

The National Marine Fisheries Service (NMFS) and North Pacific Fishery Management Council (NPFMC) have federal oversight of the state management of the Alaska king crab fisheries implemented by the ADF&G. Together, these management programs regularly conduct stock assessments, collect both fishery-dependent and -independent data, and implement and enforce harvest limits (guideline harvest levels, "GHLs") based on size, sex, and fishing season. Gear restrictions and observer coverage also compose part of the Alaska king crab management strategy. Since 2005, the Crab Rationalization Program sought to address economic, safety, and environmental issues in the Bering Sea-Aleutian Islands (BSAI) king and Tanner crab fisheries. The Bristol Bay red king crab, Aleutian Islands golden king crab, and St. Matthew Island blue king crab are all rationalized fisheries. Current management strategies take a precautionary and responsive approach, while also taking into account relative uncertainties. But implementation has varied because harvests do not always fall within GHL limitations and certain stock data are too infrequent and limited to be reliable. For this reason, management of these stocks is deemed moderate to highly effective. Bycatch species make up a low level of total catch due to well-implemented, precautionary management strategies such as highly selective gear and seasonal effort.

Pot fishing gear moderately affects the habitat, mostly during the setting and retrieval of the gear. The physical extent of habitat impacts depends on the type of bottom habitat fished and the spatial extent of that habitat type utilized by the fishery. Crab pots come into direct contact with a much smaller area of the seafloor than mobile gear; therefore, pots cause relatively less damage to the habitat than other gear types. Current management strategies that seek to reduce and mitigate the impacts of fishing gear are moderately effective.

Surveys, assessments, updates, and independent scientific research indicate that there is no significant impact of the king crab fisheries on the ecosystem, food web dynamics, or "exceptional species." But some important information (such as the alteration of genetic diversity) remains incomplete. For this reason, Seafood Watch deems the ecosystem effects of the U.S. Alaskan king crab fisheries to be of moderate conservation concern.

Table of Conservation Concerns and Overall Recommendations

Stock / Fishery	Impacts on the Stock	Impacts on other Spp.	Management	Habitat and Ecosystem	Overall Recommendation
Red King crab Alaska Bristol Bay - Pot	Green (3.83)	Green (5.00)	Green (5.00)	Green (3.74)	**Best Choice (4.351)**
Blue king crab Saint Matthew Island Bering Sea - Pot	Green (3.83)	Green (4.25)	Green (3.87)	Yellow (3.16)	**Best Choice (3.758)**
Golden king crab Aleutian Islands Bering Sea - Pot	Green (3.32)	Green (4.75)	Green (3.87)	Yellow (3.16)	**Best Choice (3.727)**

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 Concern[2], **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).

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Introduction

Scope of the analysis and ensuing recommendation

This report focuses on the U.S. Alaskan king crab species, which include the red king crab (*Paralithodes camtschaticus*), blue king crab (*Paralithodes platypus*), and golden king crab (*Lithodes aequispinus*).

King crab is caught in the waters of Alaska, the Barents Sea, and the waters of the Russian Pacific. This report discusses red, golden, and blue king crab that are commercially targeted using pot/trap gear in Alaskan waters. The king crab fisheries of the Russian Barents Sea and Russian Pacific are discussed in separate Seafood Watch reports because fishing activities, research, and management there are not overseen by the U.S.

Overview of the species and management bodies

Three commercially important king crab species in the U.S.—red, blue, and golden—are caught in Alaskan waters (Blue Ocean Institute 2012). Red king crab is the largest and most common species of the Alaskan king crabs. Golden king crab is the smallest and is found primarily in the Aleutian Islands (FishChoice 2013).

King crab distribution extends from the Gulf of Alaska, the Aleutian Islands, the Bering Sea, the Sea of Japan, and the Barents Sea. Red king crab is the most widely distributed of the three species (Figures 1 and 2) (Danner 2007). It ranges from eastern Korea to the northern coast of the Sea of Japan, into the Sea of Okhotsk along the eastern shores of the Kamchatkan Peninsula, and throughout the Bering Sea, Aleutian Islands, and Gulf of Alaska (NPFMC 1998) (NMFS 2004) (Danner 2007). It also has been found in the waters off British Columbia, Canada (Danner 2007) (FishWatch 2013a). During the 1960s, Russia intentionally introduced the red king crab into the Russian Barents Sea. Since then, the population has expanded into Norway (Jorgensen et al. 2005) (Danner 2007).

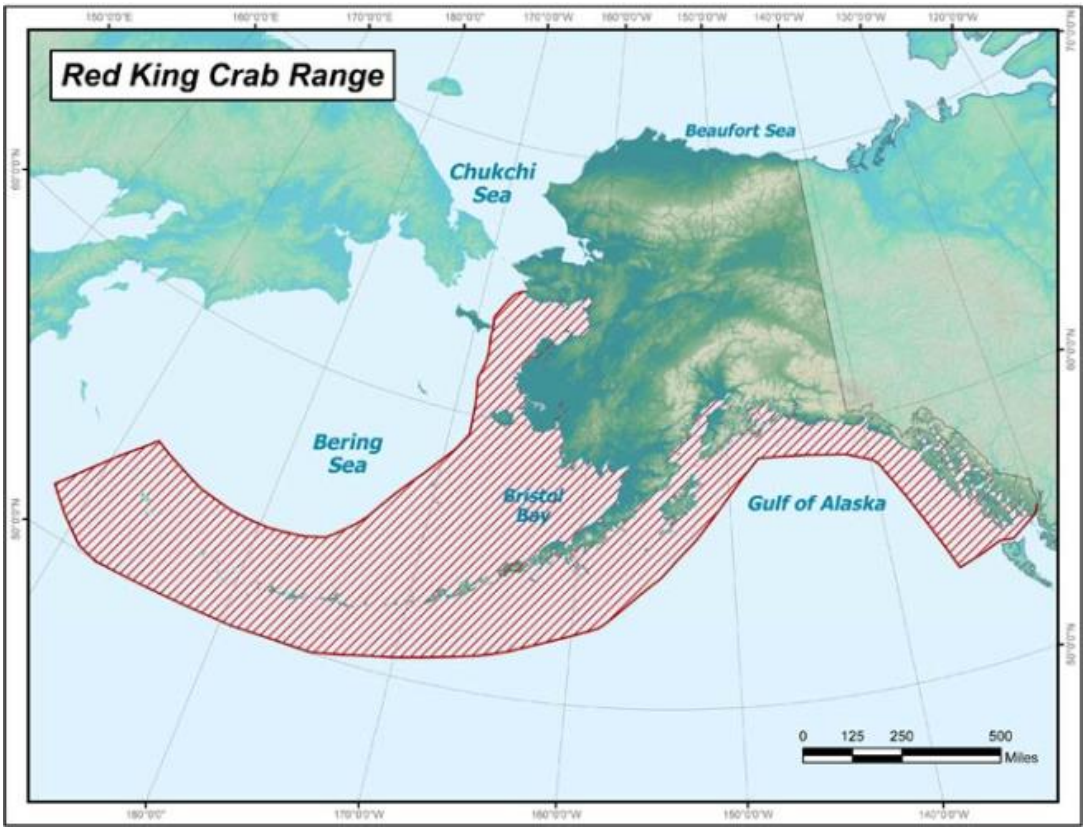

Figure 1. Distribution of U.S. Alaska red king crab (red shading) (figure source: ADF&G 2013a).

Figure 2. Global distribution of red king crab (orange shaded regions) (figure from Jorgensen et al. 2005).

Golden king crab distribution ranges from the Sea of Japan to the northern Bering Sea, around the Aleutian Islands, and southward to British Columbia (Figure 3) (NPFMC 1998) (NMFS 2004) (ADF&G 2013b).

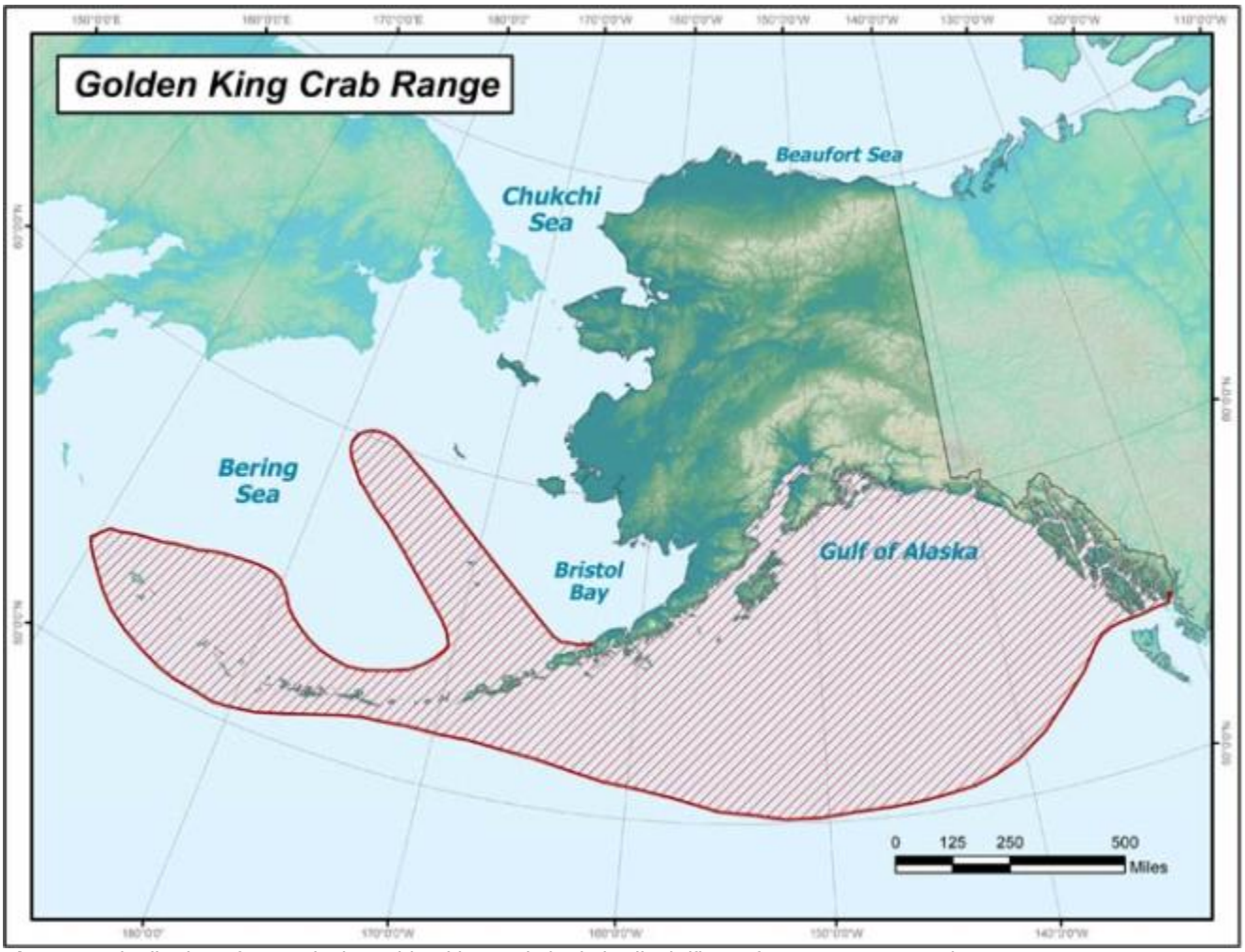

Figure 3. Distribution of U.S. Alaska golden king crab (red shading) (figure from ADF&G 2013c).

Blue king crab is unevenly distributed across the Bering Sea to the Gulf of Alaska. Alaskan blue king crab is found near King Island, St. Lawrence Island, St. Matthew Island, the Pribilof Islands, and occasionally around Nunivak Island (Figure 4). In the northwestern Pacific, it is found in the Sea of Okhotsk, Tartar Strait, and the northern part of the eastern Kamchatkan Peninsula, Cape Olyutorsky, the Koryak Coast, and Cape Navarin (NPFMC 1998) (NMFS 2004).

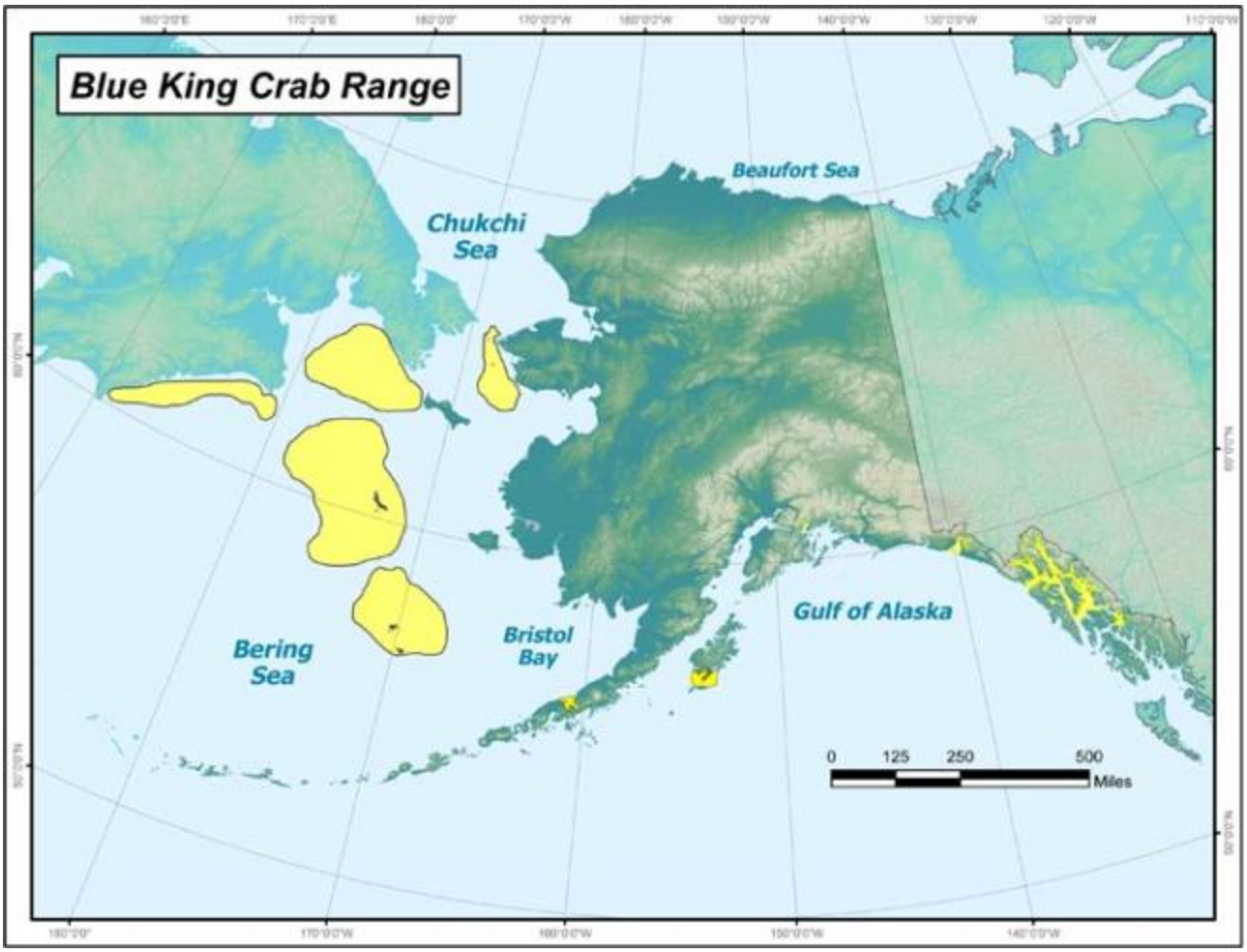

Figure 4. Distribution of U.S. Alaska blue king crab (yellow shading) (figure from ADF&G 2013b).

U.S. Alaskan king crab fisheries are managed cooperatively by the U.S. federal government (through the North Pacific Fishery Management Council (NPFMC) and National Marine Fisheries Service (NMFS)) and the State of Alaska (Alaska Department of Fish and Game, ADF&G) (ADF&G 2005) (NPFMC 2011a). The ADF&G has sole jurisdiction of red king crab in the Gulf of Alaska. The state divides the Aleutian Islands and eastern Bering Sea into three red king crab management registration areas: Aleutian Islands, Bristol Bay, and Bering Sea (ADF&G 2005). The Aleutian Islands area covers two stocks: Adak and Dutch Harbor. The Bering Sea area contains two other stocks: the Pribilof Islands and Norton Sound. Of all these, the largest stock is found in the Bristol Bay area (ADF&G 2005) (NPFMC 2011a). Additional red king crab stocks elsewhere are currently too small to support any commercial fishery. This report summarizes the stock assessment results for the Bristol Bay red king crab stock.

Golden king crab stocks are divided into several management areas within the Bering Sea and Aleutian Islands (BSAI). These include the Pribilof Islands and Aleutians Area O, also known as “East of 174°W longitude” and “West of 174°W longitude” and formerly known as the Adak District and Dutch Harbor BSAI golden king crab fisheries.

Two discrete stocks of blue king crab are managed in the BSAI region: the St. Matthews Island and Pribilof Islands blue king crab. Other, smaller populations are found within the Gulf of Alaska, St. Lawrence Island, and Nunivak Island, but these stocks are too small to support a commercial fishery (NPFMC 2011b).

The Bristol Bay red king crab, Aleutian Islands golden king crab, and St. Matthew Island blue king crab fisheries are responsible for the majority of the U.S. king crab landings (Danner 2007). The following remaining king crab stocks are either closed due to poor or overfished stock status: Pribilof Islands blue king crab, Pribilof Islands red king crab, Aleutian Islands red king crab, and Southeast red king crab. Specifically, the status of red king crab in the Adak region of the Aleutian Islands is unknown and undefined because surveys have been too limited and infrequent to provide reliable estimates of abundance in this area (FishWatch 2013b). The Pribilof Islands golden king crab fishery was closed from 2006–2009, and recent catch data for the directed fishery remain confidential. The Pribilof Islands and St. Matthew Island blue king crab fisheries were closed beginning with the 1998/1999 season due to low abundances. The St. Matthew Island blue king crab fishery reopened in 2009, but declines in abundance caused the fishery to close again in 2013/14 as a precautionary measure (NPFMC 2015). It reopened in 2014/15 after increases in abundance were detected (NPFMC 2015). The Pribilof Islands blue king crab fishery was declared overfished in September of 2002. The fishery was closed in 1999-2000 and has not yet reopened, (NPFMC 2015). For this reason, this report primarily focuses on the Bristol Bay fishery for red king crab, the Aleutian Islands fishery for golden king crab, and the St. Matthew Island fishery for blue king crab.

In 2005, federal fisheries managers implemented the Crab Rationalization Program to address economic, safety, and environmental issues in the Bering Sea/Aleutian Islands (BSAI) king and Tanner crab fisheries (NMFS 2013a). Under this program, the NPFMC seeks to improve conservation and management by limiting commercial access, thereby decreasing fishing capacity. Qualified participants are issued individual fishing quotas. Specifically, certain crab fisheries are "rationalized" by allocating BSAI crab resources among harvesters, processors, and coastal communities by including a "Community Development Quota," thereby protecting community interests by allocating 10 percent of the total allowable catch to CDQ groups. Groups are given the opportunity to purchase shares in the fishery before the shares are offered for sale outside the community.

Crab fisheries currently under the Crab Rationalization Program include the Bristol Bay red king crab, the Adak (western Aleutian Islands west of 179°W longitude) red king crab, the Pribilof Islands red and blue king crab, the St. Matthew blue king crab, the Aleutian Islands golden king crab, the Opilio (eastern Bering Sea) snow crab, and the *Bairdi* (eastern Bering Sea) Tanner crab (NPFMC 2015).

The NMFS calculates annual abundance estimates for the eastern Bering Sea crab fisheries using data collected by the NMFS summer bottom trawl surveys that employ an area-swept method (length of path x trawl width). Managers use these data to set harvest limits for the next fishing season (FishWatch 2013) (NMFS 2013a). The NMFS, in cooperation with the ADF&G, prepares and reviews an annual stock assessment and fishery evaluation report (SAFE) for each fishery management plan (NPFMC 2015). The annual SAFE reports summarize current and historic abundances, the economic status of the fisheries,

total allowable catch (TAC) or the guideline harvest limit (GHL), and other analytical information (*see a complete list of SAFE reports:* http://fakr.noaa.gov/npfmc/resources-publications/safe-reports.html; (NPFMC 2011a)). Each SAFE document is thoroughly reviewed by the NPFMC, a Scientific and Statistical Committee (SSC), and the Crab Plan Team. The report also generates harvest and stock status projections for the upcoming year (NPFMC 2015).

The Bering Sea Aleutian Islands crab fisheries are currently managed using a TAC. The TAC (calculated by the ADF&G) is set according to a specific harvest strategy specified by regulation, while the overfishing limit (OFL) and allowable biological catch (ABC) are developed from the summer survey and the results from stock assessments. Total catch and catch per unit effort (CPUE) are monitored in season. Generally, harvest rates are similar to projected values, and seasonal closures are determined based on the estimated time that the GHL will be fully harvested. However, if the CPUE and total catch indicate that resource abundance is below that projected in the fishery, the fishery might be closed early (prior to achieving the GHL) (NMFS 2004).

The State of Alaska enforces strict accountability measures. Regulations include individual fishing quotas and measures to ensure that individual fishing quotas are not exceeded; measures to minimize crab bycatch in directed crab fisheries; and monitoring and catch accounting measures. If limits are exceeded, managers will adjust the annual catch limit (ACL) and TAC within the fishing year (NPFMC 2015). Additional monitoring and catch measures include mandatory state vessel registrations, licenses, and permits; registration for each fishery and each area; observer coverage; and gear restrictions such as pot limits, degradable escape mechanisms, and web specifications. Season opening dates are set to maximize meat yield and minimize handling of soft shell crabs. Current minimum legal size limits vary by fishery (*see* Appendix A) (NOAA 2013a).

Biology and Life History Characteristics

King crabs are members of the order Decapoda and family Lithodidae, also known as stone crabs (Blau 1997). Although there are about 40 species within this family, only the red king crab (*Paralithodes camtschaticus*), blue king crab (*Paralithodes platypus*), and golden king crab (*Lithodes aequispinus*) are commercially important in the U.S. (Danner 2007).

Appearance. King crab is spiny in appearance, with five pairs of legs: one pair of claws in the front, three pairs of walking legs, and a fifth, specialized pair used to clean their gills and embryos (for females) or to transfer sperm to females during mating (Danner 2007). King crab has an abdomen, often known as a "tail," that is tucked beneath the rear of its shell (Alaska Bering Sea Crabbers 2012). Male red, blue, and golden king crabs have narrow, triangular-shaped tails, while females have distinctive fan-shaped tails that cover most of the underside of the abdomen (Blau 1997) (Danner 2007).

Red king crab appears dark red-to-burgundy in color. It can grow a very large carapace (shell covering), with leg spans that can extend to 5–6 ft (Blue Ocean Institute 2012) (ADF&G 2013a). Except for its color, blue king crab is similar in size and appearance to the more widespread red king crab (Alaska Bering Sea Crabbers 2012). Blue king crab gets its name from the distinct blue color of its shell (McCarty & Allee

2006). When compared to red and blue king crabs, golden king crab is smaller in size, averaging 5–8 lbs, with a golden-colored shell (ADF&G 2013b).

Reproduction and Development. Male red king crabs typically grow larger than females, and their sex is determined by examining their abdomen. Red king crab typically achieves sexual maturity at 7 years, although mating and reproduction usually does not occur until ages 8–9 (NMFS 2004). Blue king crab reaches sexual maturity between 5 and 6 years (NMFS 2004). The age of sexual maturity for golden king crab is unknown, but it typically becomes mature at carapace lengths of 92–130 mm (3.6–5.1 in) for males and 98–111 mm (3.9–4.4 in) for females (NMFS 2004) (Danner 2007). This roughly correlates to an age of 5–10 years, based on similar carapace length/age correlations for blue and red king crabs (Blue Ocean Institute 2012).

Adult crabs tend to segregate by sex outside of the mating and molting grounds. King crab species seldom co-occur, although there may be some overlap in depth and habitat (e.g., Pribilof Islands red and blue king crab). Distribution can vary; adult male red king crabs in the Kodiak area have been known to migrate up to 100 miles round-trip annually, moving as far as 1 mile in a day (ADF&G 2013a).

Red king crabs reproduce annually. They tend to mate in shallower waters (<50 m) from January to June. (NOAA 2013a). Adult females brood their embryos underneath their tail flap for up to a year. Golden king crab has a 20-month, asynchronous reproductive cycle. Golden king crab females molt and mate year-round and brood their eggs for 12 months (NOAA 2013b). Blue king crab has a biennial (2-year) ovarian cycle. In January-February of their spawning year, female crabs carry the developing fertilized embryos for approximately 14 months, hatching from February to May in the following year (NOAA 2013c).

King crabs hatch as swimming larvae, but are still subject to the movements of tides and currents. After feeding on plant and animal plankton for several months and undergoing several body changes with each molt, the larvae settle to the ocean bottom and molt into non-swimmers, looking for the first time like king crabs as we normally think of them, except they are smaller than the size of a dime (Blau 1997).

Migration. Red king crabs inhabit depths of 300 m or less (Danner 2007). Adults conduct annual round-trip migrations between nearshore (shallow) and offshore (deep) habitats. They come into shallow water in late winter, and by spring the females' embryos hatch. Adult females and some adult males molt and mate before they start their offshore feeding migration to deeper waters (ADF&G 2013a). Blue king crab is found at an average depth of 70 m, whereas golden king crab occurs at depths of 300 to 1,000 m on extremely rough bottoms, particularly coral bottoms (NPFMC 1998) (NMFS 2004).

Growth. Throughout growth, a king crab must molt. Although intrinsic rates of increase and growth rates are not known for any of the king crab species, juveniles molt many times in their first few years, then less frequently until they reach sexual maturity (≈5–10 years of age). Adult females must molt to mate but males do not. Adult males often skip a molt and keep the same shell for 1 or 2 years. Red king crab can grow very large, with the record female and male weighing 10.5 and 24 lbs, respectively. Overall king crab lifespan ranges from 10–20 years (SeaFood for the Future 2013). However, some of the large crabs were estimated to be 20 and 30 years old, with a leg span of nearly 5 ft (Blau 1997).

Mortality. Although fishery mortality rates vary, the default natural mortality rate (M) is assumed to be 0.18 for all king crab species (NPFMC 2008) (NPFMC 2011a).

Production Statistics

Production Statistics

King crab is the largest of the commercially harvested crabs in the United States (FishWatch 2013a). It is caught using large, wire pots that are 7 to 8 sq ft and baited with fish such as cod or herring. Each fishery is managed with restrictions on retained catch, including specifications for size and sex. Only male crabs can be caught and sold legally (Fishchoice 2013). Unless a surplus exists, female crabs cannot be harvested and sold commercially (NPFMC 2011b).

Commercial Landings

Historic landings for king crab were greatest in the mid-1960s and early 1980s (Figure 5). In the past few decades, landings have been much lower than the all-time highs, but have remained stable (Figure 5). In 2013, the U.S. Alaskan king crab commercial landings (all species combined) were 7,000.4 metric tons (mt), the equivalent of 15.43 million pounds. Given a 2013 market value of US $5.37 per pound, total U.S. Alaskan king crab landings were worth $82,869,602 (NMFS 2013b).

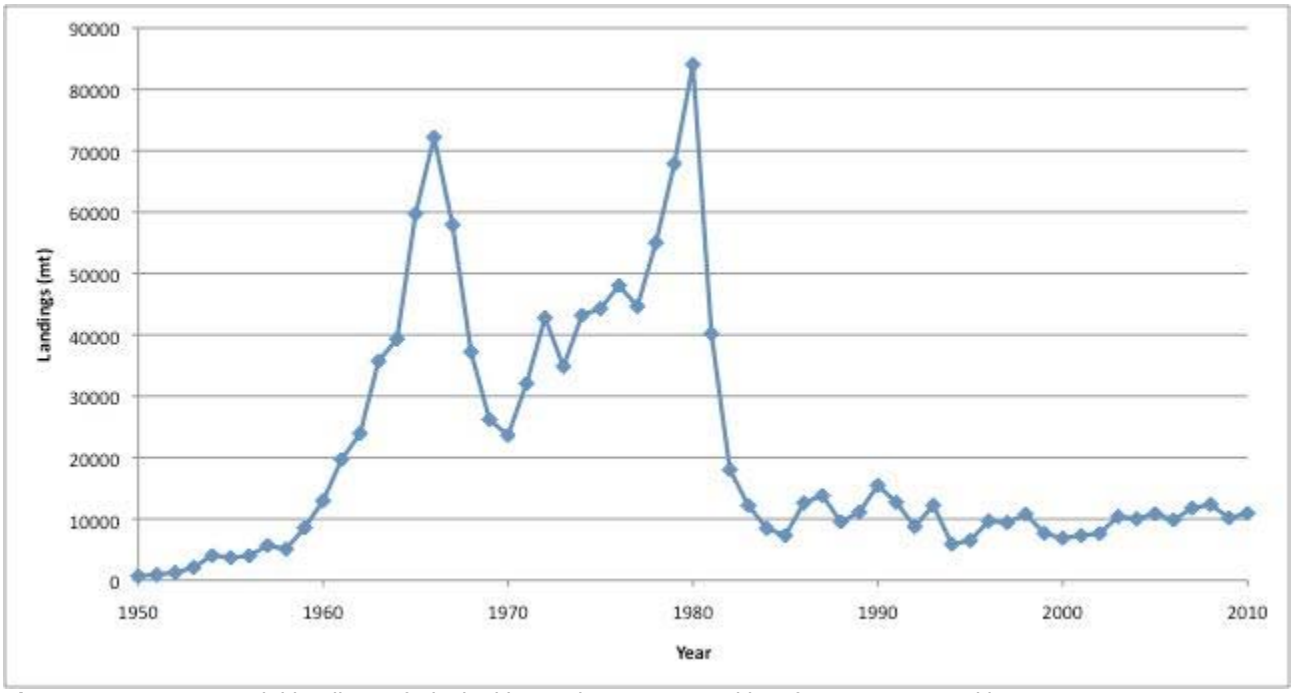

Figure 5. U.S. commercial landings of Alaska king crab, 1950–2011 (data from NMFS 2013b).

Production History

U.S. Red King Crab

Several red king crab fisheries exist in Alaska. These include the Gulf of Alaska (Southeast), the eastern Bering Sea (Norton Sound, Bristol Bay, and Pribilof Islands district), and the area west of the Aleutian

Islands (Adak and Dutch Harbor). The largest stock is found in Bristol Bay, located in the Eastern Bering Sea (Zheng & Siddeek, 2012). Contributions of the remaining fisheries have been minimal as a result of declining abundances, slow recoveries, and infrequent surveys that have provided limited data. The Pribilof Islands, Southeast, and Aleutian Islands red king crab fisheries are closed (NPFMC 2011a) (Zheng & Siddeek 2013) (NPFMC 2015).

The commercial harvest of Bristol Bay red king crab dates to the 1930s, and was initially prosecuted mostly by foreign fleets. The American pot fishery began in the 1960s, shifting to a largely domestic fishery in the early 1970s (NPFMC 2011a) (NOAA 2013a). By 1980, stocks had peaked at 129.9 million lbs. This was followed by a sharp collapse, as Bristol Bay red king crab fell to less than 4.2 million lbs in 1985 (NPFMC 2011a). Since then, catch has been relatively low but steady. The retained catch for the 2014/15 season was 10.01 million lbs (NPFMC 2015).

U.S. Golden King Crab

The remote waters of the Bering Sea Aleutian Islands (BSAI) contain a significant fishery for golden king crab, the smallest of the Alaska king crabs. BSAI golden king crab was initially taken as incidental harvest by the red king crab fishery. The first commercial landings of golden king crab in the Aleutian Islands were in 1975, but directed pot fishing did not occur until 1981. Between 1981 and 1995, the fishery was managed as two separate fisheries: the Adak and Dutch Harbor fisheries. Peak harvest occurred during the 1986/87 season, with a harvest of 14.74 million lbs. The Aleutian Islands golden king crab fishery was restructured in 1996 as two stocks, separately managed in the areas to the east and west of 174° longitude (NPFMC 2011a). As with the red king crab, the BSAI golden king crab fishery has been managed according to the 2005 Crab Rationalization program.

U.S. Blue King Crab

Blue king crab has been harvested in domestic pot fisheries since the 1970s. Historically, two discrete stocks of blue king crab were fished: the Pribilof Islands and the St. Matthew Island stocks (NPFMC 2011b). Other, smaller populations of blue king crab are found in the Gulf of Alaska and near St. Lawrence and Nunivak Islands. Both the Pribilof and St. Matthew Islands fisheries' landings peaked in the early 1980s.

The king crab fishery in the Pribilof District began in 1973 by targeting blue king crabs. Beginning in 1995, GHLs were established for blue and red king crabs combined. However, by the mid- to late 1990s, declines in red and blue king crab abundances resulted in poor fishery performance during those seasons, with annual harvests below the fishery GHL. From 1999 to 2011/12, the Pribilof blue king crab fishery was closed due to low abundance, high uncertainty, and concerns about blue king crab bycatch associated with a directed red king crab fishery. The Pribilof Islands blue king crab was declared overfished in September of 2002 and remains closed (Bowers et al. 2011) (Foy 2012).

The St. Matthew Island fishery was closed from 1988 to 1995 and reopened from 1995 to 1998. Harvests during this period ranged from 1.3 to 2.5 million lbs. The fishery closed again in 1999 due to declining stock abundance and was declared overfished in 2002 (NPFMC 2011a) (NOAA 2013b). The stock was officially deemed as rebuilt in 2009 and fishing resumed. Total allowable catch (TAC) was set at 1.17 million pounds and was increased to 1.60 million pounds for 2010/11. But in response to declining abundance, the fishery was closed for the 2013/14 season as a precautionary measure. Although both the St. Matthew Island and Pribilof Islands are within in the BSAI region, they are managed separately to accommodate different life histories and fishery characteristics (NPFMC 2011b). The St. Matthew Island fishery reopened in 2014/15 after abundance estimates indicated that biomass exceeded harvest strategy thresholds (ADF&G 2014).

Importance to the U.S./North American market

Importance to U.S. market. The majority (66%) of frozen king crab sold in the United States is imported from Russia, while 20% is from Alaska (Table 1) (WWF 2014). The United States imports the remainder from Argentina, Chile, China, Indonesia, Japan, Mexico, Norway, Peru, South Korea, or Thailand (NMFS 2013b).

Table 1. Percent of U.S. market supply of frozen king crab from Alaska and Russia, from WWF (2014).

Year	Percent from U.S. (Alaska)	Percent from Russia
2003	19.0%	79.5%
2004	21.1%	72.3%
2005	12.7%	82.3%
2006	5.6%	89.7%
2007	11.3%	83.6%
2008	16.9%	77.4%
2009	15.3%	80.8%
2010	23.5%	73.6%
2011	19.7%	78.0%
2012	21.4%	69.5%
2013*	19.8%	65.8%
11-yr avg.	16.9%	77.5%

*For 2013, Alaskan king crab TAC level used as a proxy for U.S. commercial landings due to lack of 2013 official catch data.

Data sources: NOAA (2014a, 2014b), Global Trade Atlas (2014)

In contrast, the U.S. exports the majority of its king crab harvest to Japan (54%) and, to a lesser extent, Canada, Belgium, China, Germany, Indonesia, and Mexico (Figure 6). The remainder is sold to 32 other countries.

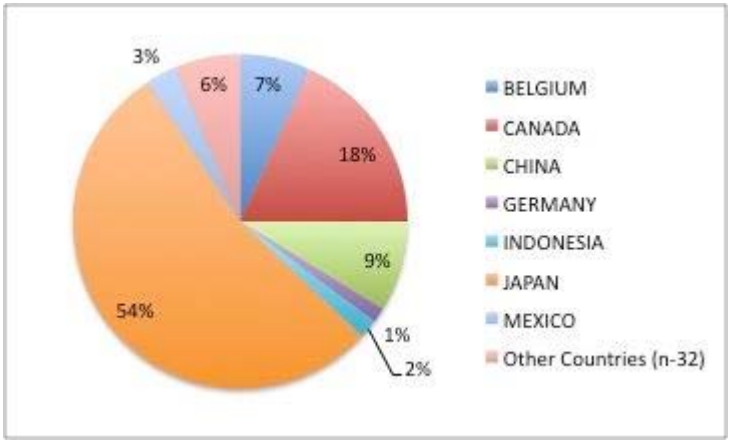

Figure 6. Sources of king crab exported from the U.S., 2012 (data from NMFS 2013b).

Common and market names

King crab is commercially known as the Alaska King Crab. It is also known by its common names: Red King Crab, Blue King Crab, and Golden King Crab. However, blue king crab also may be sold as red king crab, and golden king crab also may be sold as brown king crab. When used for sushi, the red, blue, and golden king crab are commonly sold as *kani* (Danner 2007). Russian king crab is sometimes mislabeled and sold in the U.S. as "Alaska king crab" (Fishchoice 2013).

Primary product forms

King crab is caught using large wire pots baited with fish such as cod or herring. King crabs are delivered live to shore-based processors and then cleaned, cooked while alive, and then brine frozen prior to shipping (Blau 1997) (Fishchoice 2013). King crab is primarily sold as frozen sections in the form of claws or legs (which can be split or whole). Frozen king crab is available year round (Fishchoice 2013).

Fresh king crab is available during the fishing seasons. The Bristol Bay red king crab fishing season occurs from mid-October (peak month) through mid-January. The Aleutian Islands golden king crab fishing season occurs from mid-August (peak month) through mid-May. Fresh king crabs can be sold and readily cooked in sections (NPFMC 2005) (Barnard & Pengilly 2006) (Danner 2007) (Fishchoice 2013). There are currently no reports of contaminant concerns (Fishchoice 2013).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Criteria for Fisheries, available at http://www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. The inherent vulnerability to fishing rating influences how abundance is scored, when abundance is unknown. 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.

Criterion 1 Summary

BLUE KING CRAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Saint Matthew Island Bering Sea Pot	2.00:Medium	4.00:Low Concern	3.67:Low Concern	**Green (3.831)**

GOLDEN KING CRAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Aleutian Islands Bering Sea Pot	2.00:Medium	3.00:Moderate Concern	3.67:Low Concern	**Green (3.318)**

RED KING CRAB				
Region / Method	**Inherent Vulnerability**	**Stock Status**	**Fishing Mortality**	**Subscore**
Alaska Bristol Bay Pot	1.00:High	4.00:Low Concern	3.67:Low Concern	**Green (3.831)**

Based on the PSA vulnerability scores, U.S. Alaska red king crab has a high vulnerability to fishing pressure while U.S. Alaska golden and blue king crabs have moderate vulnerabilities. The 2015 Bristol Bay red king crab stock assessment update (NPFMC 2015) indicated that the stock is not overfished, and overfishing did not occur. But poor recruitment and size distributions indicate a declining population trend (NPFMC 2015).

The 2013 Aleutian Islands golden king crab stock assessment (NPFMC 2013c) indicated that overfishing did not occur. Although abundance trends have remained moderately stable since 2000, the degree of uncertainty for this stock remains high because surveys are infrequent and recruitment trends are not readily available.

Recent Bering Sea Aleutian Islands (BSAI) blue king crab stock assessments (Gaeuman 2012a) (Gaeuman 2012b) (NPFMC 2013c) indicated that the Pribilof Islands stock is in an overfished state. Abundance surveys remain infrequent, and the Pribilof Islands fishery has remained closed since 1999. The St. Matthew blue king crab stock experienced strong recruitment and biomass abundances from 2003 to 2011. In 2009, the fishery was considered rebuilt after a 9-year closure, and was re-opened. Based on recent declines in abundance and stock assessments with very high uncertainty, the fishery was closed in 2013/14 as a precautionary measure (NPFMC 2014). However, the stock is not in an overfished condition (NPFMC 2014). Consequently, the fishery was re-opened in October 2014 with a cautiously low TAC (NPFMC 2014).

Criterion 1 Assessment

Factor 1.1 - Inherent Vulnerability

Scoring Guidelines

- *Low—The FishBase vulnerability score for species is 0-35, OR species exhibits life history characteristics that make it resilient to fishing, (e.g., early maturing (*
- *Medium—The FishBase vulnerability score for species is 36-55, OR species exhibits life history characteristics that make it neither particularly vulnerable nor resilient to fishing, (e.g., moderate age at sexual maturity (5-15 years), moderate maximum age (10-25 years), moderate maximum size, and middle of food chain).*
- *High—The FishBase vulnerability score for species is 56-100, OR species exhibits life history characteristics that make is particularly vulnerable to fishing, (e.g., long-lived (>25 years), late maturing (>15 years), low reproduction rate, large body size, and top-predator).*
  Note: The FishBase vulnerability scores is an index of the inherent vulnerability of marine fishes to fishing based on life history parameters: maximum length, age at first maturity, longevity, growth rate, natural mortality rate, fecundity, spatial behaviors (e.g., schooling, aggregating for breeding, or consistently returning to the same sites for feeding or reproduction) and geographic range.

Factor 1.2 - Stock Status

Scoring Guidelines

- *5 (Very Low Concern)—Strong evidence exists that the population is above target abundance level (e.g., biomass at maximum sustainable yield, BMSY) or near virgin biomass.*

- *4 (Low Concern)—Population may be below target abundance level, but it is considered not overfished*
- *3 (Moderate Concern) —Abundance level is unknown and the species has a low or medium inherent vulnerability to fishing.*
- *2 (High Concern)—Population is overfished, depleted, or a species of concern, OR abundance is unknown and the species has a high inherent vulnerability to fishing.*

1 (Very High Concern)—Population is listed as threatened or endangered.

Factor 1.3 - Fishing Mortality

Scoring Guidelines

- *5 (Very Low Concern)—Highly likely that fishing mortality is below a sustainable level (e.g., below fishing mortality at maximum sustainable yield, FMSY), OR fishery does not target species and its contribution to the mortality of species is negligible (≤ 5% of a sustainable level of fishing mortality).*
- *3.67 (Low Concern)—Probable (>50%) chance that fishing mortality is at or below a sustainable level, but some uncertainty exists, OR fishery does not target species and does not adversely affect species, but its contribution to mortality is not negligible, OR fishing mortality is unknown, but the population is healthy and the species has a low susceptibility to the fishery (low chance of being caught).*
- *2.33 (Moderate Concern)—Fishing mortality is fluctuating around sustainable levels, OR fishing mortality is unknown and species has a moderate-high susceptibility to the fishery and, if species is depleted, reasonable management is in place.*
- *1 (High Concern)—Overfishing is occurring, but management is in place to curtail overfishing, OR fishing mortality is unknown, species is depleted, and no management is in place.*

0 (Critical)—Overfishing is known to be occurring and no reasonable management is in place to curtail overfishing.

BLUE KING CRAB

Factor 1.1 - Inherent Vulnerability

Saint Matthew Island Bering Sea, Pot

Medium

The PSA vulnerability score for the Alaska blue king crab is 2.0, translating into a classification of "medium" inherent vulnerability by Seafood Watch Inherent Resilience classification scheme (Table 1) (MSC 2010) (Seafood Watch 2013b).

Rationale:
Table 1 shows PSA values for the Alaska blue king crab. However, it should be noted that the science around the life-history characteristics has some uncertainty, and life-history characteristics may vary from stock to stock.

Table 1. PSA Values for the Alaska Blue King Crab (NPFMC 2015) (NMFS 2005b)

Resilience attribute	Average age at maturity	Average maximum age	Fecundity	Average maximum size	Average size at maturity	Reproductive strategy	Trophic Level	Density Dependence	Score
Blue king crab	5-6 years	unknown	Average of 110,000 eggs, biennially	≈18 lbs for mature male	Unknown; size at 50% maturity: approx 77 mm CL (males); 81 mm CL (females)	Egg brooder; eggs hatch as swimming larvae; settle and molt on seafloor after several months	N/A	No depensatory or compensatory dynamics demonstrated or likely	**Moderate inherent vulnerability (2.0)**

Factor 1.2 - Stock Status

Saint Matthew Island Bering Sea, Pot

Low Concern

The abundance estimate of mature-male biomass (MMB_{MATING}) for 2014/15 is 5.47 million pounds, which is below the proxy for B_{MSY} (7.24 million lbs) (NPFMC 2015). The B_{MSY} proxy is the average estimated MMB_{MATING} between 1978 and 2014. But the mature male biomass estimate (5.47 million lbs) is above the minimum stock size threshold (4.1 million lbs), which indicates that the stock is not in an overfished condition (NPFMC 2015). Consequently, after a 1-year closure in 2013/14, the fishery was re-opened in October 2014 with a TAC of 0.655 million lbs, an acceptable biological catch (ABC) of 0.75 million lbs, and an overfishing limit (OFL) of 0.94 million lbs. The 2013/14 closure was precautionary, based on declining trends in abundance and stock assessments with very high uncertainty. The stock is not overfished and it is above the limit reference point (MSST), but below the target reference point B_{MSY} proxy). Thus, Seafood Watch currently deems the St. Matthews blue king crab stock to be of low conservation concern.

Rationale:
After a 9-year rebuilding period beginning in 2000, the St. Matthew Island Blue King Crab fishery reopened in 2009 (NPFMC 2014). Upon re-opening, mature male biomass (MMB) peaked at 14.77 million lbs (2010/11), before declining to 6.29 million lbs in 2012/13 (NPFMC 2013c). Recruitment declined between 2012 and 2013, and trawl surveys also revealed declines in abundance during that time (NPFMC 2014). The fishery was subsequently closed in 2013/14 (NPFMC 2014). Recruitment of the

St. Matthew Island blue king crab stock more than doubled between 2013 and 2014 and stayed roughly steady in 2015 (Figure 7 (Daly et al. 2015) (NPFMC 2014). The 2014/15 mature male (+105 mm CL) biomass was 5.47 million pounds. Estimates based only on NMFS trawl surveys are highly uncertain and are therefore supplemented by triennial pot surveys and pot-lift sampling by the ADF&G, retained-catch statistics from fish tickets and, to a limited extent, NMFS groundfish-observer bycatch biomass estimates (NPFMC 2014).

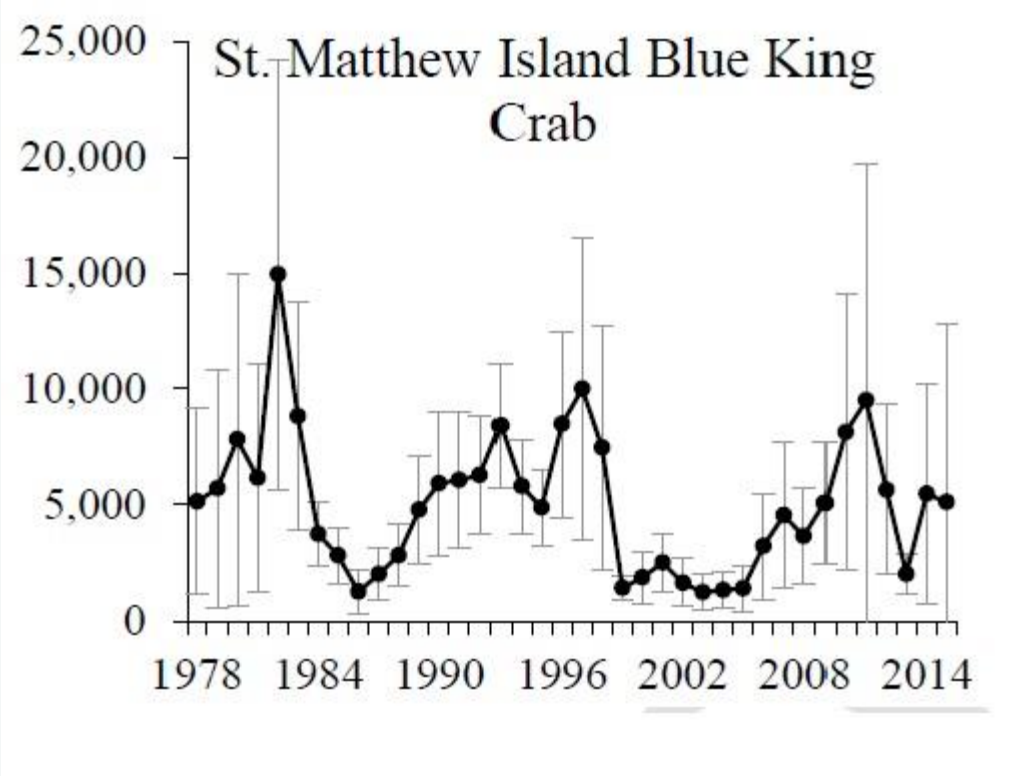

Figure 7. Mature male biomass of St. Matthew Island blue king crabs (1978–2015) caught on the National Marine Fisheries Service Eastern Bering Sea bottom trawl surveys.

Factor 1.3 - Fishing Mortality

Saint Matthew Island Bering Sea, Pot

Low Concern

Overfishing is not occurring, nor is the stock overfished (see Factor 1.2) (NPFMC 2014). Total catch (retained and discards) has been less than the overfishing limit (OFL) since 2010/11 and was less than the total allowable catch (TAC) from 2010–2012 (NPFMC 2014). “For crab stocks, the OFL equals the maximum sustainable yield (MSY) and is derived through the annual assessment process, under the framework of the tier system” (p. 3 (NPFMC 2015)). Blue king crab is classified as a Tier 4, and the OFL decreases linearly with declining biomass.

After a closure in 2013/14, the fishery reopened in 2014/15 with a precautionary (low) TAC of 0.655 million lbs. Total male catch in 2014/15 was 0.329 million pounds, which was less than the TAC, and therefore also below the OFL (0.94 million lbs) and ABC (0.75 million lbs) (NPFMC 2015). The majority of incidental catch in the fishery are sub-legal and female blue king crabs. Closures were not a result of overfishing, but a precaution to prevent overfishing in light of possible stock declines and a highly uncertain but low stock abundance in 2012/13. The 2014 stock assessment showed much higher mature male biomass than expected. This may be an indication of uncertainty surrounding the stock assessments. For these reasons, Seafood Watch deems the mortality for the St. Matthew Island blue king crab fishery to be of “low” concern.

Rationale:

The National Marine Fisheries Service (NMFS) declared the St. Matthew Island stock rebuilt on Sept. 21, 2009, and the fishery was reopened after a 10-year closure with a TAC of 1.167 million pounds. Landings for the 2009/2010 season were 460,859 pounds (Figure 8), with a reported effort of 10,697 pot lifts and an estimated CPUE of 9.9 retained crab per pot lift (Bowers et al. 2011). Given the positive season, the ADF&G increased the TAC for the subsequent seasons. For the 2010/11 season, TAC was raised to 1.60 million pounds and increased to 2.54 million lbs for the 2011/12 season. The fishery was closed in 2013/14 as a result of a decline in biomass and recruitment detected during NMFS trawl surveys. The fishery was reopened for the 2014/15 season following increases in biomass to above harvest thresholds (NPFMC 2014).

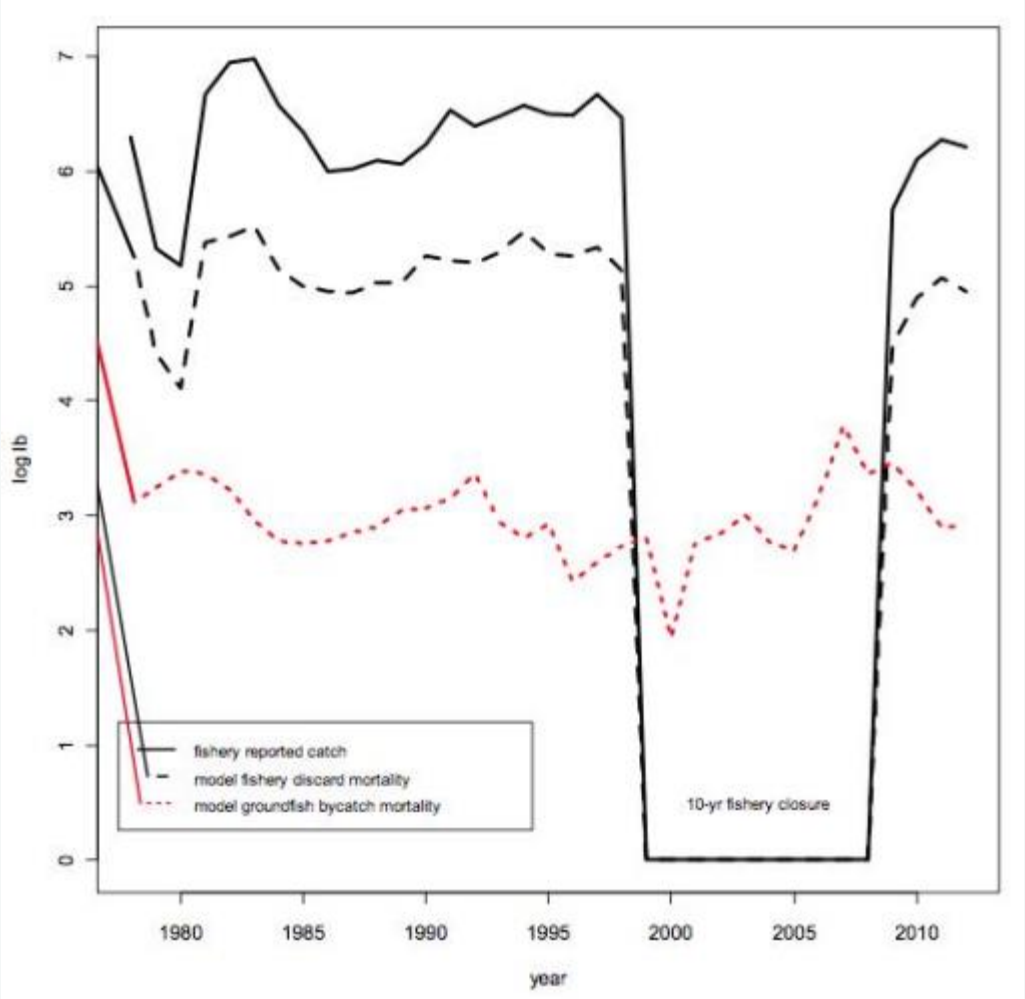

Figure 8. Fishing mortality biomass (1978/79 to 2012/13) for St. Matthew Island blue king crab (figure from BSAI Crab SAFE, NPFMC 2013).

Unretained mortality (bycatch and discards) of St. Matthew blue king crab occurs in the St. Matthew blue king crab fishery, the eastern Bering Sea snow crab fishery, and minimally in various groundfish fisheries. The majority of discards caught in the St. Matthew Island blue king crab fishery are sublegal males. Discards of females have declined in recent years, possibly as a result of shifts in timing of the contemporary fishery (NPFMC 2014). The 2014/15 ADF&G observer pot-lift sampling program estimated a discard rate of undersized males as 32% of sampled pots (NPFMC 2014). Assuming 20% handling mortality, the discard mortality rate of males in 2014/15 was approximately 6.4% of sampled landings (individuals) (NPFMC 2014). Model estimations of the overfishing limit (OFL) for 2012/13 partitioned 96% to retained mortality and 4% to bycatch plus discard mortality. Actual retained catch in 2014/15 was 94% of the total catch (0.309 million lbs out of 0.329 million lbs) (NPFMC 2015).

GOLDEN KING CRAB

Factor 1.1 - Inherent Vulnerability

Aleutian Islands Bering Sea, Pot

Medium

The PSA vulnerability score for the Aleutian Islands golden king crab is 2.0, translating into a classification of “medium” inherent vulnerability by Seafood Watch Inherent Resilience classification scheme (Table 2) (MSC 2010) (Seafood Watch 2013b).

Table 2. PSA Values for the Aleutian Islands Golden King Crab. Given the broad spatial distribution of this stock, assessment and monitoring are difficult. Note that there is some uncertainty surrounding life-history characteristics of the Aleutian Islands golden king crab (NPFMC 2015), (NMFS 2005b).

Resilience attribute	Average age at maturity	Average maximum age	Fecundity	Average maximum size	Average size at maturity	Reproductive strategy	Trophic Level	Density Dependence	Score
Golden king crab	Unknown; estimates of 5-10 years	unknown	10,000 and 30,000, annually	5-8 lbs	92-130 mm for males and 98-111 mm for females	Egg brooder; eggs hatch as swimming larvae and settle on seafloor rather quickly; males and females settle and molt on seafloor after several months	N/A	No depensatory or compensatory dynamics demonstrated or likely	**Moderate inherent vulnerability (2.0)**

Factor 1.2 - Stock Status

Aleutian Islands Bering Sea, Pot

Moderate Concern

Estimates of stock biomass and recruitment trends are not available for the Aleutian Islands golden king crab fishery (NPFMC 2014). Recent stock assessment updates from 2012 and 2013 (Pengilly 2012a), (NPFMC 2013c) did not indicate that the stock is depleted; however, there is a degree of uncertainty surrounding the susceptibility of this stock. Given this, and the fact that inherent vulnerability for the Aleutian Islands golden king crab is medium, the stock status is deemed to be of “moderate” concern.

Factor 1.3 - Fishing Mortality

Aleutian Islands Bering Sea, Pot

Low Concern

Overfishing is not occurring because the total catch (retained plus discards) consistently has been below both the overfishing limit (OFL) and Acceptable Biological Catch (ABC). For crab stocks, the OFL equals the maximum sustainable yield (MSY) and is derived through the annual assessment process, under the framework of the tier system (p. 3 (NPFMC 2015)). Golden king crab is classified as a Tier 5. The OFL is calculated as the average of the retained catch from 1985/6 to 1995/6 multiplied by an estimated average (annual bycatch mortality)/(retained catch) plus an estimated average annual bycatch mortality in groundfish fisheries (p. 835 (NPFMC 2015)).

As of this writing, data for the 2014/15 season are not available. For the 2013/14 season, the total catch (retained plus discards) was 7.04 million lbs, which was well below the OFL (12.54 million lbs) and the ABC (11.28 million lbs). The 2014/15 OFL is nearly the same at 12.53 million pounds, but the ABC for 2014/15 was decreased to 9.4 million pounds because the buffer was increased from 10% to 25% below the OFL (NPFMC 2015). The majority of non-target species in this fishery comprise female and sub-legal golden king crabs. It is probable that fishing mortality is at or below a sustainable level (OFL) that will allow the population to maintain its current level, but with some uncertainty. Therefore, Seafood Watch deems the mortality of the Aleutian Islands golden king crab as “low” concern.

Rationale:
Since the early 2000s, retained catch has remained steady (Figure 9).

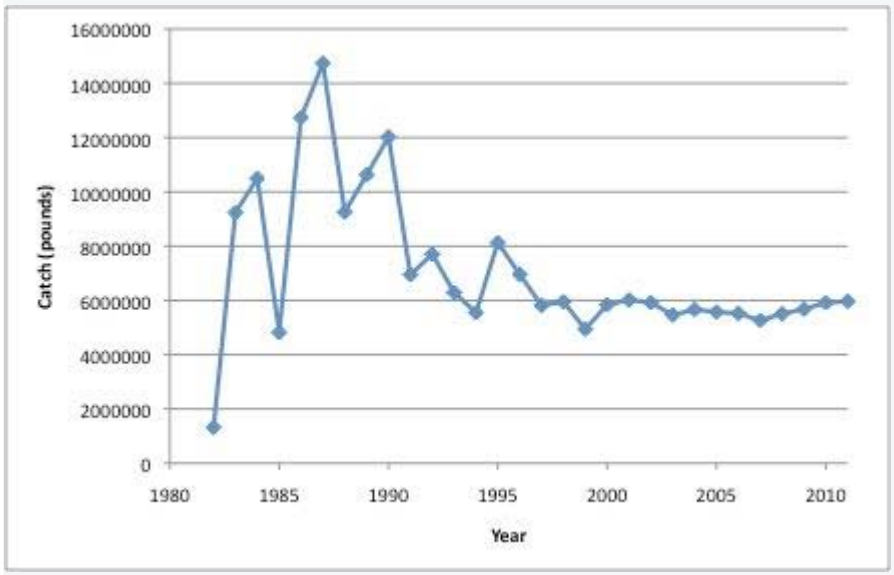

Figure 9. Retained catch (harvest in m lbs) for the Aleutian Islands golden king crab fishery, 1990–2011 (data from Siddeek et al. 2012).

East of 174°W Longitude
In 2013/14, estimated catches per unit effort (CPUEs) of legal retained, sublegal, and female eastern Aleutian Islands golden king crabs caught east of 174°W longitude (34.9 carbs/pot) were consistent with estimates since rationalization in 2005 (Gaeuman 2014). There was no notable bycatch of any other commercially important crab species in this fishery (NPFMC 2014) (Gaeuman 2014).

West of 174°W Longitude
In 2013/14, estimated legal retained CPUE in this fishery (west of 174°W longitude) was 15.5 crabs per pot in 1,233 pot lifts. This CPUE was substantially lower than the average CPUE range in the previous years (16.4–24), and the lowest estimated value in the rationalized fishery (Gaeuman 2014) (NPFMC 2014). CPUE estimates of discards (females and sublegal males) were consistent with those of previous years (Gaeuman 2014). There was no notable bycatch of any other commercially important crab species in this fishery (NPFMC 2014) (Gaeuman 2014).

RED KING CRAB

Factor 1.1 - Inherent Vulnerability

Alaska Bristol Bay, Pot

High

The PSA vulnerability score for the red king crab is 1.83, which is classified as a “high” inherent vulnerability by the Seafood Watch Inherent Resilience classification scheme (MSC 2010) (Seafood Watch 2013b).

Rationale:
Scoring for all species in this report was done through the Seafood Watch Inherent Vulnerability and Attribute Table (Seafood Watch 2013b). Red king crabs have a fairly high maximum age, averaging 20–30 years (Table 3). For this reason, the red king crab were assigned an attribute score of 1.5 for maximum age, giving an average PSA vulnerability score of 1.83.

Table 3. PSA Values for the Alaska Red King Crab from (NMFS 2005b), (NPFMC 2015).

Resilience attribute	Average age at maturity	Average maximum age	Fecundity	Average maximum size	Average size at maturity	Reproductive strategy	Trophic Level	Density Dependence	Score
Red king crab	7 years	20-30 years	43,000 to 500,000 eggs, annually	24 lbs (male); 10.5 lbs (female)	Unknown; size at 50% maturity: approximately 103 mm for males and	Egg brooder; eggs hatch as swimming larvae; settle and molt on	N/A	No depensatory or compensatory dynamics demonstrated or	**High inherent vulnerability (1.83)**

					79-102 mm females	seafloor after several months		likely	

Factor 1.2 - Stock Status

Alaska Bristol Bay, Pot

Low Concern

The Bristol Bay red king crab stock was not overfished in 2014/15 or in previous seasons (Zheng and Siddeek 2015). Mature male biomass for 2014/15 (MMB, 60.1 million lbs) was well above the minimum stock size threshold ($MSST_{2014/15}$ = 28.7 million lbs), as is the projected MMB for 2015/16 (54.4 million lbs) (NPFMC 2015). The $MMB_{2014/15}$ is 96% of B_{MSY} (Zheng and Siddeek 2015) (NPFMC 2015). Because biomass is above the limit reference point (> MSST) and may be below a target reference point (<B_{MSY}), the stock status of Bristol Bay red king crab is deemed "low" concern.

Rationale:
The estimated mature male biomass (MMB) increased dramatically in the mid-1970s, but decreased precipitously in the early 1980s (Figure 10). Although estimated mature abundance trends show a long-term increase over the past 25 years, short-term abundances have fluctuated since 2009 (Zheng & Siddeek 2012) (NPFMC 2014) (Daly et al. 2015).

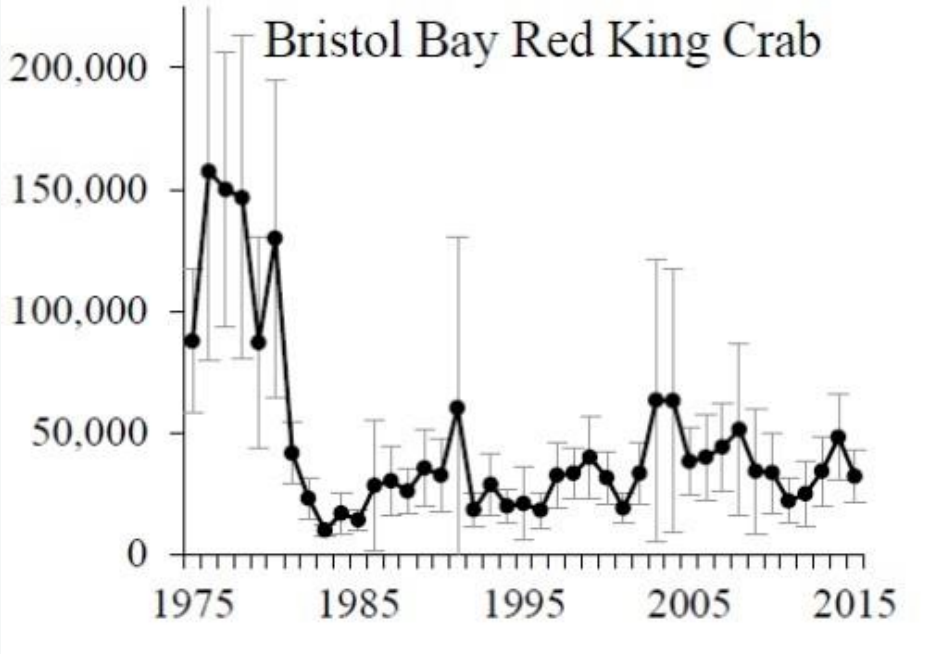

Figure 10. Mature male biomass of Bristol Bay red king crabs (1975–2015) caught on the National Marine Fisheries Service Eastern Bering Sea Bottom Trawl Surveys (Daly et al. 2015).

Factor 1.3 - Fishing Mortality

Alaska Bristol Bay, Pot

Low Concern

The Bristol Bay red king crab stock is not experiencing overfishing because the 2014/15 total catch (11.99 million lbs) was less than the 2014/15 overfishing limit (OFL, 15.04 million lbs) and the Acceptable Biological Catch (13.53 million lbs) (Zheng and Siddeek 2015) (NPFMC 2015). The retained catch (2014/15) was 10.01 million lbs (Zheng and Siddeek 2015) (NPFMC 2015).

“For crab stocks, the OFL equals the maximum sustainable yield (MSY) and is derived through the annual assessment process, under the framework of the tier system” (p. 3 (NPFMC 2015)). Red king crab is classified as a Tier 3. It is probable that fishing mortality is at or below a sustainable level that will allow the stock to maintain current abundance. Although there may be some uncertainty or disagreement among various models, mortality has been below the OFL since rationalization. Therefore, Seafood Watch deems fishing mortality as a “low” concern.

Rationale:
The Bristol Bay red king crab (BBRKC) commercial fishery peaked in 1980, with a retained catch of 129.95 million lbs (Figure 11) (NPFMC 2014). By the early 1990s, this decreased sharply and guideline harvest levels (GHL) were formally introduced. Retained catch has remained low over the past few decades (NPFMC 2014). With the implementation of the Crab Rationalization Program in 2005 ((ADF&G 2005)), the GHL was changed to a total allowable catch (TAC). The BBRKC TAC increased from 16.9 million lbs for the 2005/06 season to 23.4 million lbs for the 2007/08 season, but then declined (NPFMC 2014). The TAC has increased each year since 2011/12. The retained catch (retained and bycatch mortality) in the 2014/15 season of 10.01 million pounds was slightly higher than the TAC of 9.99 million pounds (Zheng and Siddeek 2015) (Zheng & Siddeek 2012) (NPFMC 2014).

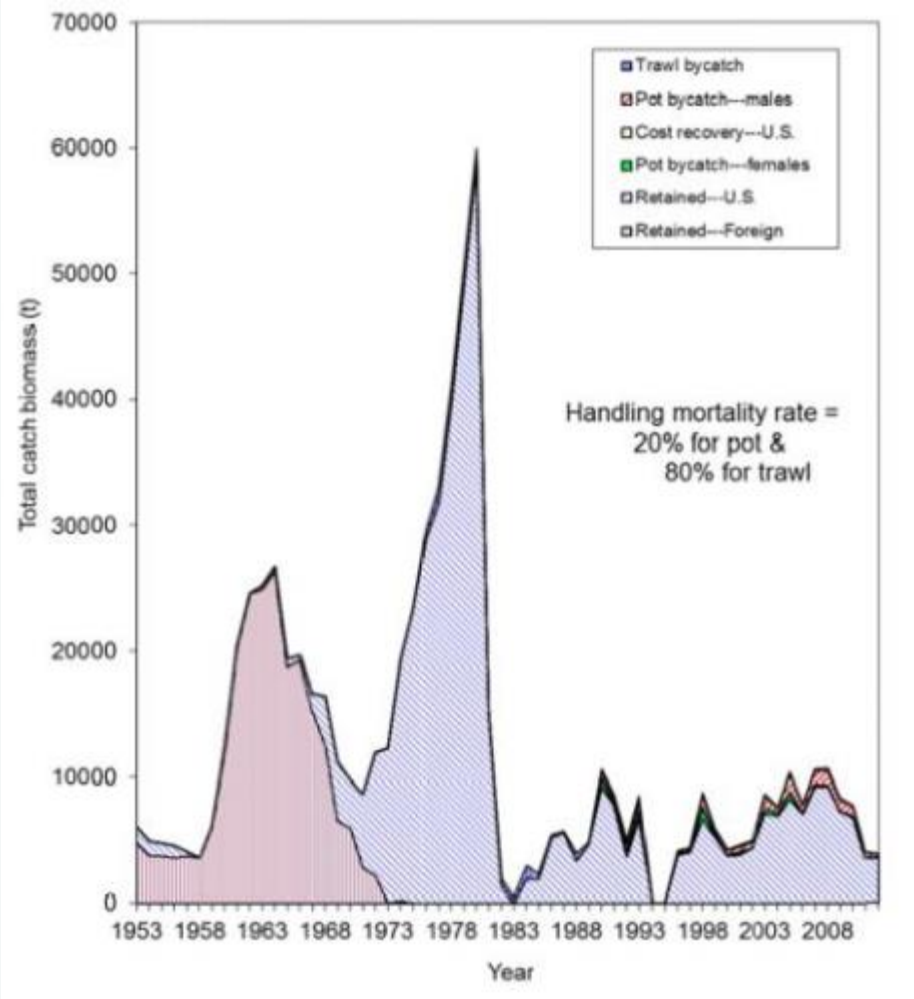

Figure 11. Retained catch biomass and bycatch mortality biomass (harvest in tonnes) in the Bristol Bay red king crab fishery, 1960–2012 (data from NPFMC 2013c).

The majority of incidental catch in the Bristol Bay red king crab fishery comprises sublegal male and female red king crabs. Since bycatch data collection began in the early 1990s, the annual non-retained catch of Bristol Bay female and sublegal male red king crab has averaged less than 3.9 million lbs. (Zheng & Siddeek 2012) (NPFMC 2014). With the implementation of the 2005 Crab Rationalization Program, fishers had more time to fish, allowing them to select the highest quality males. This practice, known as "highgrading," resulted in more discards of legal males as bycatch (NMFS 2004) (Barnard & Pengilly 2006) (Danner 2007). Due to this increase in handling mortality of legal-sized male red king crabs, the ADF&G responded in 2006 by lowering the 2006/2007 TAC by approximately 5% for each rationalized fishery (Barnard & Pengilly 2006) (ADF&G 2006). The discard mortality rate of red king crabs is approximately 20% (Zheng, J. and Siddeek, M.S.M. 2014). Observers sampled 657 pots in 2013/2014 (1.4% of total pot lifts) and documented 17,538 legal crabs (Gaeuman 2014). Catch per unit effort (CPUE) was estimated as 25.7 legal crabs per pot lift (1.18 million crabs) while actual total fishery estimates were a bit higher at 27.1 crabs per pot lift (1.24 million crabs). Estimated combined CPUE for

sublegal, female, and unretained crabs was 33.7 per pot lift (1.55 million crabs) (Gaeuman 2014). CPUE of legal males was slightly lower than the previous two seasons, but slightly higher for sublegal males and females (Gaeuman 2014).

The majority of incidental catch in the Bristol Bay red king crab fishery are sublegal male and female red king crabs. The discard mortality rate from handling is approximately 20% (Zheng, J. and Siddeek, M.S.M. 2014). In addition, some red king crabs are caught as bycatch in the Tanner crab fishery (0.08 million lbs) and the groundfish trawl fishery (0.37 million lbs). The discard mortality rate in the trawl fishery is much higher at 80%.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated in the same way as the species under assessment were evaluated in Criterion 1. 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 ghostfishing. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard rate score (ranges from 0-1), which evaluates the amount of non-retained catch (discards) and bait use relative to the retained catch. 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 Critical.

Criterion 2 Summary

Blue king crab: Saint Matthew Island Bering Sea, Pot

Subscore:: 5.000 **Discard Rate: 0.85** **C2 Rate: 4.250**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
BLUE KING CRAB	Medium	4.00: Low Concern	3.67: Low Concern	**3.831**

Golden king crab: Aleutian Islands Bering Sea, Pot

Subscore:: 5.000 **Discard Rate: 0.95** **C2 Rate: 4.750**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
GOLDEN KING CRAB	Medium	3.00: Moderate Concern	3.67: Low Concern	**3.318**

Red King crab: Alaska Bristol Bay, Pot

Subscore:: 5.000 **Discard Rate: 1.00** **C2 Rate: 5.000**

Species	Inherent Vulnerability	Stock Status	Fishing Mortality	Subscore
RED KING CRAB	High	4.00: Low Concern	3.67: Low Concern	**3.831**
TANNER CRAB: BERING SEA	Medium	5.00: Very Low Concern	5.00: Very Low Concern	**5.000**

U.S. king crab are commercially fished using crab pots. A variety of invertebrates and fish are incidentally caught in the crab pots of the Bristol Bay red king crab, Aleutian Islands golden king crab, and St. Matthews Island blue king crab fisheries. Bycatch species include female crabs, males under the commercial size, and non-targeted crab species, as well as small numbers of other species including octopus, Pacific cod, Pacific halibut, other flatfish, sponges, coral, and sea stars. Management requires fishers to adhere to specific gear types, techniques, and areas in order to reduce bycatch. Data collected by the ADF&G observer program indicate that the bycatch of non-crab species is low.

All bycatch is discarded at sea. There is currently no way of estimating what percentage of discarded organisms die; however, it is believed that even if mortality were 100%, it is not probable that this bycatch affects the population abundance of these species (NMFS 2004). Estimated mortalities are included in stock assessments where applicable.

Many of the non-target species caught in the king crab fisheries are not of conservation concern, so they are not further assessed or detailed in this report. Retained and bycatch species that are analyzed in this assessment have been chosen based on the percentage of catch they make up in the targeted king crab fishery.

The bulk of discards for the Bristol Bay red king crab, Aleutian Islands golden king crab, and the St. Matthew Islands blue king crab fisheries consist of non-retained king crabs (males and females) (Gaeuman 2014). Bycatch handling mortality rates of king crab are approximately 20% of the discarded catch for the directed pot fishery, with some scientific uncertainty (NPFMC 2013c).

Regarding bait use, crabbers catch and retain Pacific cod to use as bait, which equate to approximately 3% of total landings by weight for red king crabs (pers. comm., R. Christiansen and H. Fitch, August 2015). Fishers also purchase herring as bait. The volume of bait used within the fishery in relation to the volume of crabs landed is unknown. But based on expert opinion, bait use is as follows: fishers typically bait with one fresh codfish (about 10 lbs) and two bait jars of herring (another 10 lbs) for a total of about 20 lbs of bait for red and blue king crab (pers. comm., Poulsen). Crabbers use approximately 30 lbs of bait for golden king crabs (pers. comm., Poulsen).

Criterion 2 Assessment

TANNER CRAB: BERING SEA

Factor 2.1 - Inherent Vulnerability

Scoring Guidelines (same as Factor 1.1 above)

Alaska Bristol Bay, Pot

Medium

Based on the inherent vulnerability classification scheme listed in the Seafood Watch Guidelines, the

Tanner crab (*Chionocetes opilio* and *Chionocetes bairdi*) has a "medium" inherent vulnerability (MSC 2010) (Seafood Watch 2013b).

Table 1. PSA Values for the North Pacific Tanner Crab.

Resilience attribute	Score	Rationale	Source
Average age at maturity	2	6–8 years average age at maturity	(Zheng & Kruse 2003)
Average maximum age	2	Max age 12–20 years	(NPFMC 2011a)
Fecundity	N/A	Females carry clutches of 50,000-400,000 eggs	(Somerton and Meyers 198) (Rugolo & Turnock 2011) (Turnock & Rugolo 2011)
Reproductive strategy	2	Females brood eggs, then release larvae to water column; larval stage 2–7 months	(NPFMC 2011a)
Density dependence	2	Ricker-curve dynamics evident, suggesting decreased spawning at high and low sizes; Allee effects possible but not demonstrated	(Turnock 2012) (Zheng & Kruse 2003)
Total score	**2**	**Medium**	

Factor 2.2 - Stock Status

Scoring Guidelines (same as Factor 1.2 above)

Alaska Bristol Bay, Pot

Very Low Concern

In the 2015 SAFE stock assessment, MMB was estimated at 71.6 thousand t. The B_{MSY} for this stock was calculated to be 26.79 thousand t, so MSST is 13.40 thousand t. Because MMB > MSST (B/B_{MSY} = 1.97), the stock is not overfished (Stockhausen 2015). Thus, we have rated this factor as "very low" concern.

Rationale:
The most recent EBS trawl survey (2015) states that the abundance of legal male Tanner crab in the eastern area (east of 166°W) was 30.7 ± 7.8 million crabs, and biomass was 22,853 ± 6,247 t, which is substantially above the 20-year average biomass of 12,590 ± 3,204 t (Daly et al. 2015). West of 166°W, legal male Tanner crab abundance was 46.0 ± 14.1 million crabs, and biomass was 14,306 ± 5,040 t, which was above the 20-year average biomass of 13,940 ± 4,574 t (Daly et al. 2015).

Factor 2.3 - Fishing Mortality

Scoring Guidelines (same as Factor 1.3 above)

Alaska Bristol Bay, Pot

Very Low Concern

Eastern Bering Sea Tanner crabs are caught as bycatch in groundfish, scallop, and other crab fisheries, specifically the eastern Bering Sea snow crab fishery and, to a lesser extent, in the Bristol Bay red king crab fishery (NPFMC 2015). Total fishing mortality (retained catch plus bycatch) in 2014/15 was 20.19 million lbs, which was considerably less than the overfishing limit (OFL) of 69.4 million lbs, indicating that the impact of fisheries on this stock is at a sustainable level (NPFMC 2015). “For crab stocks, the OFL equals the maximum sustainable yield (MSY) and is derived through the annual assessment process, under the framework of the tier system” (p. 3 (NPFMC 2015)). Tanner crab is classified as a Tier 3 stock.

Provided that harvesters have an IFQ to retain Tanner crabs, they are allowed to retain some legal Tanner crabs that are caught as bycatch when targeting red king crab. This reduces mortality for Tanner crabs in general. Finally, the king crab fishery is a minor contributor to total Tanner crab mortality (<5%) and Tanner crab discard mortality (<10%) (NPFMC 2013c) (NPFMC 2015)) The impact is therefore considered negligible. Seafood Watch deems this as a “very low” conservation concern.

Factor 2.4 - Discard Rate

Alaska Bristol Bay, Pot

< 20%

Bristol Bay Red King Crabs

Bycatch of unretained Bristol Bay red king crabs (males and females) in 2014/15 was approximately 15% of the total landings (NPFMC 2015). Many of the additional discard species are identified only to the genus level. These include corals, sponges, and other invertebrates. For red king crab, the CPUE in 2014/15 was 26 crabs per pot (NPFMC 2015) and average weight is around 7 lbs per animal, for a total of about 182 lbs of crab per pot. Assuming bait weighs approximately 20 lbs (see Criterion 2 Summary above), this yields a bait:landings ratio of approximately 11% (20:182). Assuming a bycatch handling mortality rate of 20% of the discarded catch (see Criterion 2 Summary above), the bait+dead discards:landings ratio for Bristol Bay red king crabs = 14% (11% + 3%).

Aleutian Islands/Bering Sea, Pot

20-40%

Aleutian Islands Golden King Crabs

For golden king crabs east and west of 174°W longitude combined, CPUE in 2013/14 was 22.3 crabs per pot, with an average harvest weight of 4.5 lbs per crab (NMFMC 2015). This yields a total of about 100 lbs of crab per pot. At 30 lbs bait per pot (see Criterion 2 Summary above), the bait:landings ratio for

Aleutian Island golden king crabs is approximately 30%. Dead discards for 2012/13 were 9.9% of the total, retained catch (NPFMC 2014). Thus, for the Aleutian Islands golden king crabs, the bait+dead discards:landings ratio is approximately 40%.

Saint Matthew Island/Bering Sea, Pot

60-80%

St. Matthew Island Blue King Crabs

For blue king crabs, reported CPUE in 2014/15 was 7 crabs per pot (NPFMC 2015) with an average harvest weight of 4.5 lbs each (harvest weight/# harvested crabs), which yields an average of 31.5 lbs blue crab per pot (NPFMC 2015). Thus bait is approximately 63% of landings. The discard mortality rate of males (in 2012/13) was approximately 12% of total landings by weight (NPFMC 2014). Thus, for St. Matthew Island blue king crabs, the bait+dead discards:landings ratio equals approximately 75%.

Criterion 3: Management effectiveness

Management is separated into management of retained species (harvest strategy) and management of non-retained species (bycatch strategy).

The final score for this criterion is the geometric mean of the two scores. 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 or either the Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern = Red or High Concern*
  Rating is Critical if either or both of Harvest Strategy (Factor 3.1) and Bycatch Management Strategy (Factor 3.2) ratings are Critical.

Criterion 3 Summary

Region / Method	Management of Retained Species	Management of Non-Retained Species	Overall Recommendation
Alaska Bristol Bay Pot	5.000	5.000	Green(5.000)
Aleutian Islands Bering Sea Pot	3.000	5.000	Green(3.873)
Saint Matthew Island Bering Sea Pot	3.000	5.000	Green(3.873)

Factor 3.1: Harvest Strategy

Scoring Guidelines

Seven subfactors are evaluated: Management Strategy, Recovery of Species of Concern, Scientific Research/Monitoring, Following of Scientific Advice, Enforcement of Regulations, Management Track Record, and Inclusion of Stakeholders. Each is rated as 'ineffective,' 'moderately effective,' or 'highly effective.'

- *5 (Very Low Concern)—Rated as 'highly effective' for all seven subfactors considered.*
- *4 (Low Concern)—Management Strategy and Recovery of Species of Concern rated 'highly effective' and all other subfactors rated at least 'moderately effective.'*
- *3 (Moderate Concern)—All subfactors rated at least 'moderately effective.'*

- *2 (High Concern)—At minimum, meets standards for 'moderately effective' for Management Strategy and Recovery of Species of Concern, but at least one other subfactor rated 'ineffective.'*
- *1 (Very High Concern)—Management exists, but Management Strategy and/or Recovery of Species of Concern rated 'ineffective.'*
- *0 (Critical)—No management exists when there is a clear need for management (i.e., fishery catches threatened, endangered, or high concern species), OR there is a high level of Illegal, unregulated, and unreported fishing occurring.*

Factor 3.1 Summary

Factor 3.1: Management of fishing impacts on retained species							
Region / Method	**Strategy**	**Recovery**	**Research**	**Advice**	**Enforce**	**Track**	**Inclusion**
Alaska Bristol Bay Pot	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Aleutian Islands Bering Sea Pot	Moderately Effective	Highly Effective	Moderately Effective	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Saint Matthew Island Bering Sea Pot	Moderately Effective	Moderately Effective	Moderately Effective	Highly Effective	Highly Effective	Moderately Effective	Highly Effective

The Bristol Bay red king crab, Aleutian Islands golden king crab, and St. Matthew Island blue king crab fisheries are cooperatively managed by the NMFS and the State of Alaska through the North Pacific Fishery Management Council's (NPFMC) fisheries management plan (FMP) for Bering Sea/Aleutian Islands (BSAI) king and Tanner crabs. State regulations comply with the FMP and the national standards of the Magnuson-Stevens Act (NOAA 2013a). Each individual harvest strategy has specific thresholds and calculations for management of the species that are designed to minimize the effects of fishing pressure and mortality on the population unless key population thresholds are met. For all three fisheries, only male crabs of a certain size may be harvested, and fishing is not allowed during mating and molting periods. These measures help ensure that crabs are able to reproduce and replace the ones that are harvested (FishWatch 2013) (NOAA 2013b). Since 2005, the fisheries have been managed according to the Crab Rationalization program. The harvest strategy for each stock may result in a TAC that can be substantially lower than the established OFL/ABC, including seasonal closures.

Bristol Bay Red King Crab

The Bristol Bay red king crab fishery is well managed. Qualified participants are issued individual fishing quotas (ITQs), are required to adhere to gear restrictions and area closures, and have limits on the size and sex of the catch (NOAA 2013b).

Abundance estimates for the Bristol Bay red king crab stock are obtained through annual NMFS bottom trawl surveys that employ an area-swept method (NMFS 2004, NPFMC 2011b). The ADF&G uses this information to determine the status of stocks and set the harvest levels for the upcoming year. Bristol Bay red king crab are managed as a Tier 3 stock, meaning that there are reliable estimates of B, B_{MSY}, and

F_{MSY}, or their respective proxy values. Overfishing did not occur during 2014/15, the most recently completed season; the estimated total catch (11.99 million lbs) was less than the total catch OFL established for that season (15.04 million pounds) (NPFMC 2014).

The implementation and enforcement of these management strategies are highly effective; they take a precautionary and scientific approach that includes stakeholder participation while also taking into account relative uncertainties. Overall, harvest strategy of the Bristol Bay red king crab fishery is deemed "low concern."

Aleutian Islands Golden King Crab

Like the Bristol Bay red king crab fishery, abundance estimates for the Aleutian Islands golden king crab (AIGKC) stocks are obtained through annual NMFS bottom trawl surveys, which the ADF&G uses to determine the upcoming harvest (NMFS 2004) (NPFMC 2011b). Every 3 years, the ADF&G surveys a relatively small portion of the Aleutian Islands golden king crab fishery through pot surveys. (Other golden king crab stocks, such as the Pribilof Islands golden king crab fishery, are surveyed irregularly.) In general, assessments of golden king crab are infrequent and fishery-independent data have high uncertainty. The AIGKC stocks are considered a Tier 5, meaning the "stocks have no reliable estimates of biomass and only historical catch data are available" (NPFMC 2014, p. 8).

No overfished determination (i.e., MSST) is possible for this Tier 5 stock. However, overfishing did not occur during 2014/15; the estimated total catch (6.79 million lbs) was less than the total catch OFL established for 2014/15 (12.53 million pounds) (NPFMC 2014).

Implementation of the management strategies and scientific research are moderately effective, while scientific advice, enforcement, and track record are highly effective. Management takes a precautionary and scientific approach that includes stakeholder participation, and takes into account relative uncertainties. But due to the high uncertainty and limited data available for this stock, the harvest strategy of the Aleutian Island Alaskan golden king crab fishery is deemed "moderate concern."

St. Matthew Island Blue King Crab

Since 2005, the St. Matthew Island blue king crab fishery has been managed according to the Crab Rationalization program. As with the Bristol Bay red king crab fishery, qualified participants are issued individual fishing quotas (ITQs), are required to adhere to gear restrictions and area closures, and have limits on the size and sex of the catch (NOAA 2013b).

Stock assessments are conducted using the same methodology used to assess the red and golden king crab stocks: through annual NMFS bottom trawl surveys with an area-swept method, which the ADF&G uses to set the harvest levels for the upcoming year (NMFS 2004) (NPFMC 2011b). The ADF&G also conducts a triennial pot survey for St. Matthew stocks, to sample abundance (especially females) in

areas that the annual trawl surveys are unable to adequately sample due to the species' preference for rocky, un-trawlable habitat (NPFMC 2011a) (NOAA 2013b).

The Pribilof Islands stock was closed with the 1998/99 season, and has remained closed since. The St. Matthew stock was also closed in 1998/99 due to low stock abundance, but was reopened to fishing for the 2009/10 season. Based on low abundance estimates with high uncertainty, managers again closed the fishery in 2013/14. Updated stock assessments showed that abundances were higher than originally thought. Consequently, the fishery was re-opened in 2014/15 with a low TAC.

Implementation of the management strategies, recovery of the stock, scientific research, and track record are moderately effective, while scientific advice and enforcement
are highly effective. Management takes a precautionary and scientific approach that includes stakeholder participation and takes into account relative uncertainties. But due to the fluctuations in stock abundance and its associated uncertainties, the harvest strategy of the St. Matthew Island/Bering Sea blue king crab fishery is deemed "moderate concern."

Subfactor 3.1.1 – 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? To achieve a highly effective rating, there must be appropriate management goals, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab Red king crab stocks in the Bering Sea/Aleutian Islands (BSAI) region are managed according to specific harvest strategies contained in ADF&G King and Tanner Crab Commercial Fishing Regulations. Red king crab stocks found within the BSAI are managed as four separate fisheries: Bristol Bay, Pribilof Islands, Aleutian Islands, and Norton Sound. Three of these stocks (Bristol Bay, Norton Sound, and Aleutian Islands) are managed separately to accommodate different life histories and fishery characteristics. The largest stock is found in the Bristol Bay area. The Pribilof Islands stock is managed in conjunction with the blue king crab fishery, and has not been open since 1999 due to incidental harvest of blue king crabs. Elsewhere in the Aleutian Islands, the eastern Bering Sea, and the Gulf of Alaska, red king crab populations are currently too small to support a commercial fishery (Zheng & Siddeek 2012) (NOAA 2013a). Under the Crab Rationalization Program (2005), the Bristol Bay red king crab fishery is currently managed according to specific harvest strategies contained in ADF&G King and Tanner Crab Commercial Fishing Regulations. Each individual harvest strategy has specific thresholds and calculations for management of the species by implementing a Total Allowable Catch (TAC). Only male crabs of a certain size may be harvested, and fishing is not allowed during mating and molting periods. These measures help ensure that crabs are able to reproduce and replace the ones that are

harvested (FishWatch 2013) (NPFMC 2014). These management strategies take a precautionary and scientific approach, while also taking into account relative uncertainties. Given the measures implemented by the Crab Rationalization Program, management is considered highly appropriate for this stock, and is deemed “highly effective.”

Aleutian Islands Bering Sea, Pot

Moderately Effective

Aleutian Islands Golden King Crab

Golden king crab stocks in the Bering Sea/Aleutian Islands (BSAI) region are managed according to specific harvest strategies contained in ADF&G King and Tanner Crab Commercial Fishing Regulations. At present, the two Aleutian Islands stocks within Registration Area O (east and west of 174°W longitude) and the Pribilof Island stock are actively managed. The 2005 Crab Rationalization program applies to the BSAI golden king crab fisheries. The State of Alaska institutes minimum size and sex restrictions, vessel registration, licenses and permits, observer coverage, and gear requirements. The ADF&G annually estimates the commercial catch. However, surveys for the Aleutian Islands golden king crab have been sporadic. Triennial pot surveys for a portion of this stock were not performed in 2009 or in 2012. There are no current biomass estimates for this stock, so proxies are required, and the bycatch mortality rate in the directed fishery is unknown (Siddeek et al. 2012). For these reasons, management effectiveness may be only moderately successful.

Rationale:

Golden king crab were initially taken as an incidental harvest by the red king crab fishery, but since 1981 a directed pot fishery has harvested the stock. In 1996, the Aleutian Islands golden king crab fishery was restructured to replace the Adak and Dutch Harbor areas with the newly created Registration Areas R and O, respectively. The golden king crab in the Aleutian Islands east and west of 174°W longitude have since been managed separately as two stocks (Siddeek et al. 2012).

Saint Matthew Island Bering Sea, Pot

Moderately Effective

Blue king crab stocks in the Bering Sea are managed according to specific harvest strategies contained in ADF&G King and Tanner Crab Commercial Fishing Regulations. At present, two discrete stocks of blue king crab are actively managed in the Bering Sea/Aleutian Islands (BSAI) region: the Pribilof Islands and St. Matthew Island. Smaller populations of this species are found within the Bering Sea and in isolated locations in the Gulf of Alaska; however, they are not substantial enough to sustain a directed fishery. Actively fished stocks are managed separately to accommodate different life histories and fishery characteristics. The State of Alaska institutes minimum size and sex restrictions, vessel registration,

licenses and permits, observer coverage, and gear requirements. The ADF&G estimates commercial catch data annually. Coupled with annual trawl and triennial pot survey data, catch-survey analyses are used to estimate stock abundances and management effectiveness. Area closures, such as the one implemented for the St. Matthew Island blue king crab fishery in 1999, can be a useful management strategy. The blue king crab fishery around St. Matthew Island was closed from 1999 to 2009 to allow the stock to rebuild. Stock abundance continued to increase after the re-opening of the fishery; however, the 2013 stock assessment showed declining trends in biomass and recruitment, so in 2014 the fishery was closed as a precautionary measure. Using new stock assessment information, the fishery was reopened in 2014/15. The closure of the fishery demonstrates a precautionary management system, but the failure to maintain the stock at a rebuilt level suggests that there are problems that need to be understood and resolved. If abundance continues to decline, the stock may be deemed "depleted" in the future (NPFMC 2015). Seafood Watch therefore considers the management strategy and implementation for the St. Matthew Island blue king crab fishery to be "moderately effective."

Subfactor 3.1.2 – Recovery of Species of Concern

Considerations: When needed, are recovery strategies/management measures in place to rebuild overfished/threatened/ endangered species or to limit fishery's impact on these species and what is their likelihood of success? To achieve a rating of Highly Effective, rebuilding strategies that have a high likelihood of success in an appropriate timeframe must be in place when needed, as well as measures to minimize mortality for any overfished/threatened/endangered species.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab

Abundance estimates for the red king crab populations in Bristol Bay are deemed to be at healthy levels (NPFMC 2014). There are currently no overfished, depleted, endangered, or threatened species targeted or retained in the fishery. Although this report focuses on the largest red king crab fishery (Bristol Bay), the status of other red king crab stocks is less well known. The BSAI SAFE report (NPFMC 2011a) indicated that the Norton Sound red king crab stock also is healthy. But in the Adak area of the Aleutian Islands, surveys have been too infrequent to provide a reliable abundance estimate. This fishery has been periodically closed since the end of the 1995/96 season due to poor growth and reproductive rates, illustrating that management is responsive to changes in abundance.

Aleutian Islands Bering Sea, Pot

Highly Effective

There are currently no overfished, depleted, endangered, or threatened species targeted or retained in the Aleutian Islands golden king crab fishery.

Saint Matthew Island Bering Sea, Pot

Moderately Effective

St. Matthew Island Blue King Crab
In 1999, the St. Matthew Island blue king crab fishery was declared overfished because stock size estimates were below MSST. Shortly thereafter, an amendment was added to the Fisheries Management Plan to include harvest regulations, area closures to reduce bycatch, and gear modifications. The fishery was considered rebuilt and it reopened for the 2009/2010 season. Although stock biomass reached a 36-year high in 2011 (21.07 million pounds) and total catch between 2010 and 2012 remained below TAC quotas, biomass dropped significantly by 2013 to 4.46 million pounds. Even though the 2012/13 retained catch was below the TAC, the biomass estimate from trawl surveys indicated that the stock was declining (NPFMC 2014). This estimate may have been overly pessimistic because surveys conducted in 2014 indicated that mature male biomass increased to above the harvest strategy threshold, and the fishery was re-opened for 2014/15. It appears that recovery of the St. Matthew blue king crab is weak but that the management strategy of periodically closing the fishery has been effective (NPFMC 2011a) (NPFMC 2013c). Seafood Watch therefore deems the recovery of the stock as moderately successful.

Subfactor 3.1.3 – Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the health of the population and the fishery's impact on the species? To achieve a Highly Effective rating, population assessments must be conducted regularly and they must be robust enough to reliably determine the population status.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab
Stock assessment models for several BSAI crab stocks combine data from the following sources: 1) fishery-independent monitoring (e.g., abundance) from the NMFS eastern Bering Sea trawl and the Bering Sea Fisheries Research Foundation (BSFRF) annual surveys, which collect information on

several BSAI crab stocks (including the Bristol Bay red king crab); and 2) observer data on landings, bycatch, and CPUE collected by the ADF&G. Observers are required to be on 20% of the vessels in the fishery.

The NMFS and the State of Alaska collectively use this information to determine the status of the stocks and to set the harvest levels. The State of Alaska also conducts research to collect and evaluate basic life-history information, characterize stock distribution, and develop methods to improve the fisheries and reduce bycatch (ADF&G 2005) (NPFMC 2013b). The NPFMC's Crab Plan Team works with the NMFS and ADF&G to develop amendments to FMPs and annual stock assessments (NPFMC 1998) (Danner 2007). Because the Bristol Bay red king crab stock is included in the Crab Rationalization Program, the stock is surveyed by the NMFS and assessed on an annual basis (Danner 2007). Outside of the program, the eastern Aleutian Islands, the Norton Sound, and the Gulf of Alaska are surveyed by the ADF&G. The remaining red crab stocks are surveyed on a more limited basis. Updates may be more infrequent for these stocks. Bristol Bay red king crab is managed as a Tier 3 stock, meaning that reliable estimates are available of B, B_{MSY}, and F_{MSY}, or their respective proxy values. Tier 3 status for stocks is used when reliable estimates of the spawner/recruit relationship may not be available, but proxies for F_{MSY} and B_{MSY} can be estimated (NPFMC 2011a). Given that the management process uses independent and up-to-date scientific stock assessments and analyses to obtain regular and frequent stock information, the scientific research and monitoring of the Bristol Bay red king crab fishery is deemed "highly effective."

Aleutian Islands Bering Sea, Pot

Moderately Effective

Aleutian Islands Golden King Crab

The 2005 Crab Rationalization program applies to the BSAI golden king crab fisheries. The State of Alaska institutes minimum size and sex restrictions, vessel registration, licenses and permits, observer coverage, and gear requirements. The ADF&G annually estimates commercial catch data. But the triennial surveys are too limited in geographic scope and too infrequent to provide a reliable index of abundance for the Aleutian Islands area (NPFMC 2013c). As with the 2011 Crab SAFE report, the 2013 SAFE recommended that the Aleutian Islands golden king crab be managed as a Tier 5 stock, meaning that estimates of life history and recruitment are not available. Given the large geographic range of the commercial fishery and limited survey efforts, data collection by ship-based surveys may be sparse. Model-based stock assessments are being developed but they are not part of current management practices. For this reason, estimates of stock biomass are poor (Siddeek et al. 2012) (NPFMC 2013c). Consequently, there are no estimates for B_{MSY}, MSST, recruitment, or recruitment trends. Observer data on bycatch from the directed fishery and groundfish fisheries provide an estimate of total bycatch mortality (NPFMC 2011a). Given the moderate collection of data related to the stocks and the high uncertainty, Seafood Watch considers scientific research and monitoring of the Aleutian Islands golden king crab fisheries as "moderately effective."

Saint Matthew Island Bering Sea, Pot

Moderately Effective

St. Matthew Island Blue King Crab

The 2015 SAFE recommended that the St. Matthew Island blue king crab be managed as a Tier 4 stock, meaning that information on life history and recruitment were insufficient to fully estimate the spawner-recruit relationship. However, there are reliable enough estimates of recent survey biomass and instantaneous mortality to calculate the proxy B_{MSY} as the average biomass over a specified period (NPFMC 2011a) (NPFMC 2015).

The ADF&G and NMFS monitor harvests, and the Plan Team for the BSAI King and Tanner Crab Fisheries set the annual TACs for the St. Matthew Island blue king crab fishery. The TAC is calculated from abundance estimates derived from the NMFS eastern Bering Sea crab and groundfish trawl abundance index surveys. There is some uncertainty associated with the annual trawl surveys, which may underestimate abundance because the trawl cannot survey the rocky areas where these animals typically live.

State and federal researchers are able to collect some data related to stock abundance and health, but these data may be insufficient, temporally limited, and/or too uncertain to effectively manage the stock with high certainty. For this reason, research and monitoring of the St. Matthew Island blue king crab fishery is considered to be “moderately effective.”

Subfactor 3.1.4 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g. do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab

Stock status determination for BSAI crab fisheries, including the Bristol Bay red king crab fishery, is calculated annually using a five-tier system that incorporates newly acquired scientific information. The stock assessment is based on a sex- and size-structured population dynamics model that incorporates

data from the NMFS eastern Bering Sea trawl survey, commercial catch, the Bering Sea Fisheries Research Foundation (BSFRF) trawl survey, and at-sea observer data program ((NPFMC 2013c)). The tiered system accommodates for levels of uncertainty surrounding information, and whether proxies need to be used for certain information such as MSST, B_{MSY}, and F_{MSY}. Under this system, each crab stock is annually assessed to determine 1) its status and 2) whether overfishing is occurring or the rate or level of fishing mortality for the stock is approaching overfishing; the stock is overfished or the stock is approaching an overfished condition; and the catch has exceeded the Annual Catch Limit (ACL) (NPFMC 2011a). Since the inception of the 2005 rationalization, the Bristol Bay red king crab fishery has regularly followed scientific advice. For this reason, the scientific advice for this fishery is considered to be "highly effective."

Aleutian Islands Bering Sea, Pot

Highly Effective

Aleutian Islands Golden King Crab

From 1996/97 to 2010/11, retained catch fluctuated above and below the TAC, but since rationalized in 2005, the fishery has not exceeded advised TACs. The retained catch for the 2012/13 season was 6.27 million pounds, just below the TAC of 6.29 million pounds.

In March 2012 the Alaska Board of Fisheries (BOF) approved a change in the Aleutian Islands golden king crab SAFE that increases the TAC for the fishery by 5%, until a stock assessment model and state regulatory harvest strategy are more clearly established. For example, for the 2008/09 to 2011/2012 seasons, the TAC was 6.0 million pounds. In 2012/2013, the TAC was raised to 6.3 million pounds (NPFMC 2013c). In addition to this increase, the BOF added language to the existing regulation that allows ADF&G to reduce the TAC from the specified levels for stock conservation purposes (Siddeek et al. 2012). The 2014 SAFE also recommended that the Aleutian Islands golden king crab stock continue be managed as a Tier 5, given that no reliable estimates of biomass are available, so information is insufficient to reliably estimate abundance (NPFMC 2013c). Given that management nearly always follows scientific advice, as shown by the current retained catch to TAC record, the Aleutian Islands golden king crab fishery adherence to scientific advice is deemed "highly effective."

Saint Matthew Island Bering Sea, Pot

Highly Effective

Similar to the Bristol Bay red king crab, stock status determination for the St. Matthew blue king crab fishery is based on a sex- and size-structured population dynamics model that incorporates data from the NMFS eastern Bering Sea trawl survey, commercial catch, the Bering Sea Fisheries Research Foundation (BSFRF) trawl survey, and at-sea observer data program (NPFMC 2013c).

Since the rebuilding plan outlined by the FMP in 2000 and the inception of the 2005 rationalization, the St. Matthew Island blue king crab fishery has followed scientific advice, maintaining a track record of falling within advised TACs. The fishery reopened in 2009/2010 with a retained catch 60% below advised TAC (0.461 million lbs and 1.167 million lbs, respectively). Retained catch was higher for 2010/11 and 2011/12, but still fell ≈25% below advised TAC levels for those years (Figure 12). The 2012/13 retained catch has decreased to 1.62 million pounds, just shy of the season's TAC of 1.63 million pounds (NPFMC 2013c). The fishery was closed in 2013/14 as a precautionary measure based on draft information from scientific modeling, but reopened in 2014/15 (NPFMC 2014) (ADF&G 2014). Given the initial successful implementation of rebuilding strategies and the precautionary closure of the fishery due to concerns for this stock, managers closely follow scientific advice for the St. Matthew Island blue king crab fishery. Thus, this factor is deemed to be "highly effective."

Rationale:

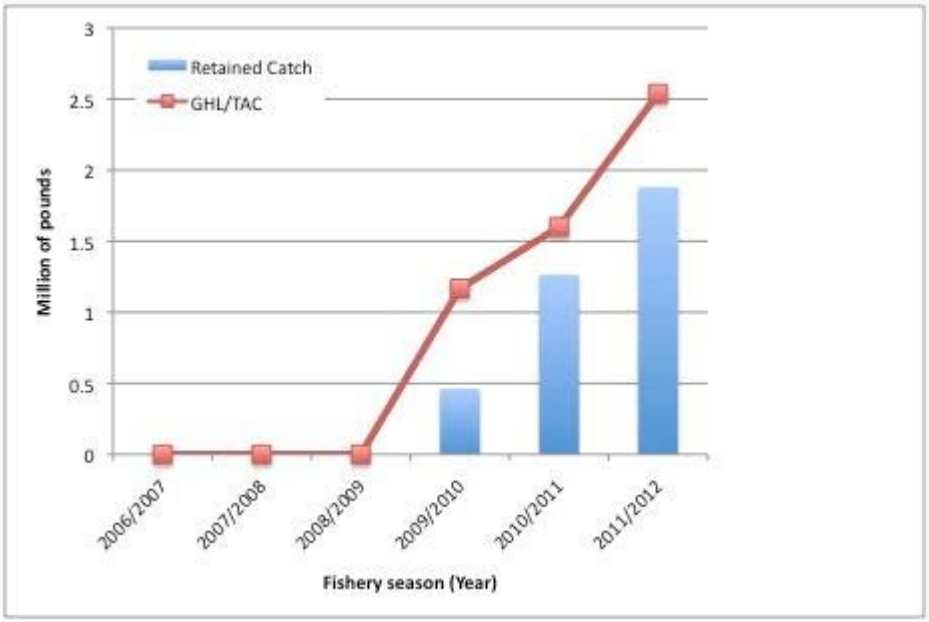

Figure 12. Retained catch (harvest in m lbs) vs. Total Allowable Catch (TAC) for the St. Matthew Island blue king crab fishery, since the implementation of the Crab Rationalization Program, 2005–2012 (data from Gaeuman 2012b).

Subfactor 3.1.5 – 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.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab

There are various forms of enforcement on the Bristol Bay red king crab fishery. Regulations are enforced by the ADF&G and U.S. Coast Guard. Vessel monitoring systems must be used onboard all fishing vessels. Fishers also must report their landings electronically so that managers can monitor the fishery in real time and anticipate any issues. If a fishery is projected to reach the harvest limit before the end of the fishing season, the fishery will be closed (FishWatch 2013). However, this has not occurred for the Bristol Bay red king crab fishery.

Because the Bristol Bay red king crab is one of the fisheries under the Crab Rationalization Program, only certain locations that qualify as a "Registered Crab Receiver" (RCR) are able to offload this stock. RCR permits are issued by NMFS. In other words, if crab is retained and it comes off the boat, it will have to come off the boat at an RCR. Specific enforcements and requirements are listed on the BSAI Crab Rationalization Program Overview website (*see* http://www.fakr.noaa.gov/sustainablefisheries/crab/rat/progfaq.htm#mae). For these reasons, the regulations and voluntary arrangements that are set in place by the Crab Rationalization Program ensure that the Bristol Bay red king crab fishery remains regularly enforced and adequately monitored. Thus, enforcement is deemed "highly effective."

Aleutian Islands Bering Sea, Pot

Highly Effective

Aleutian Islands Golden King Crab

Because it is a rationalized fishery, the monitoring and enforcement of the Aleutian Islands golden king crab fishery is identical to that of the Bristol Bay red king crab fishery, as previously noted in this report. Enforcement strategies include onboard observers, VMS monitoring systems, reporting protocols, Registered Crab Receiver restrictions, and voluntary buyback programs. For these reasons, the regulations and voluntary arrangements that are set in place by the Crab Rationalization Program ensure that the Aleutian Islands golden king crab fishery remains regularly enforced and adequately monitored. For this reason, management enforcement is considered to be "highly effective."

Saint Matthew Island Bering Sea, Pot

Highly Effective

St. Matthew Island Blue King Crab

Because it is a rationalized fishery, the monitoring and enforcement of the St. Matthew Island blue king crab fishery is identical to that of the Bristol Bay red king crab fishery, as previously noted in this report. Enforcement strategies include onboard observers, VMS monitoring systems, reporting protocols, Registered Crab Receiver restrictions, and voluntary buyback programs. For these reasons, the regulations and voluntary arrangements that are set in place by the Crab Rationalization Program

ensure that the St. Matthew Island blue king crab fishery remains regularly enforced and adequately monitored. Thus, enforcement is deemed “highly effective.”

Subfactor 3.1.6 – Management Track Record

Considerations: Does management have a history of successfully maintaining populations at sustainable levels or a history of failing to maintain populations at sustainable levels? A Highly Effective rating is given if measures enacted by management have been shown to result in the long-term maintenance of species overtime.

Alaska Bristol Bay, Pot

Highly Effective

Bristol Bay Red King Crab

Before 2005, the Bristol Bay red king crab fishery operated as a “derby”: in effect, opening the fishery to anyone, and closing as soon as the catch limit was exceeded. This proved to be both ineffective and unsustainable. As a result, the red king crab stock collapsed in the early 1980s, forcing managers to cut harvest levels for the next two decades to rebuild the stock. Since the 2005 Crab Rationalization Program, managers implemented an individual fishing quota (IFQ), replacing the previous derby-style fishery. Under the IFQ system, individual fishers are given a share of the harvest and can catch their share at any time during the fishing season. This has resulted in a safer and more efficient fishery with a longer season, because fishers can take weather and economic factors into account when deciding when to fish (FishWatch 2013b). Although this management strategy has worked well for the Bristol Bay red king crab fishery, red king crab populations in other areas of Alaska have not been as responsive. Despite closure since 1995, red king crab stocks in the Aleutian Islands and Gulf of Alaska remain low. Scientists are uncertain about the abundance of red king crab in the Bering Sea. In the Pribilof Islands, the red king crab fishery has been closed since 1999 due to population uncertainty and concerns over bycatch of the similarly depressed blue king crab stock. Although monitoring of these populations is infrequent, it occurs through periodic surveys and observations (FishWatch 2013b). With respect to the fishery of interest, measures enacted by management have resulted in the long-term maintenance of Bristol Bay red king crab stock abundance, productivity, and ecosystem integrity. For this reason, the management track record is considered “highly effective.”

Aleutian Islands Bering Sea, Pot

Highly Effective

Despite the infrequency of abundance surveys and the resultant challenges for the management of the fishery, stable catches and increasing trends in catch per unit effort (CPUE) suggest that current management is effective at maintaining a stable population. Seafood Watch therefore considers the

track record for management of the Aleutian Island golden king crab fishery to be “highly effective.”

Saint Matthew Island Bering Sea, Pot

Moderately Effective

Closure of the blue king crab fishery around St. Matthew Island between 1999 and 2009 allowed the stock to rebuild from a depleted state. After continued increases in abundance, TACs for the fishery were increased; however, the stock exhibited declines in abundance and recruitment and in 2013/14 the fishery was again closed for one season. The recent fluctuations and uncertainty in abundance estimates after rebuilding (which may result from the trawl survey sampling methodology) lead Seafood Watch to consider the track record of the St. Matthew Island blue crab fishery as “moderately effective.”

Subfactor 3.1.7 – 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 and includes stakeholder input.

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Highly Effective

Federal and state management of all BSAI king and Tanner crab fisheries allows for public input and ensures that stock assessments are updated annually. Specifically, the public is solicited for comments on proposed regulatory changes on all FMP amendments affecting all crab fisheries (NMFS 2013c). For stocks that are surveyed annually, such as the Bristol Bay red king crab, St. Matthew Island blue king crab, and Aleutian Islands golden king crab, the NPFMC’s Crab Plan Team (CPT) gathers information from the ADF&G and NMFS, and assembles an annual SAFE report. These reports are available to the public at: http://fakr.noaa.gov/npfmc. The Crab Plan Team meets in May and September of each year to provide recommendations and finalize overfishing levels (OFL), acceptable biological catch (ABC), and stock status determinations (NPFMC 2011a). Unfortunately, the technical and procedural complexities of the CPT render the BSAI stock assessments accessible primarily only to individuals with specialized knowledge, time, and interest. But comments and suggested revisions are documented and included

within the final publication of the SAFE report. In addition, the Bering Sea Fisheries Research Foundation (BSFRF) provides a forum for fishers, scientific researchers, and members of government agencies (NMFS and the ADF&G) to conduct collaborative scientific research on fisheries in the Bering Sea, primarily focusing on commercially important crab resources (http://www.bsfrf.org/). The BSFRF establishes cooperative research priorities and coordinates project design, planning, field research, analyses, and reporting among multiple research partners. Funding to support the BSFRF is voluntarily provided by Bering Sea crab processors, crab vessel owners, and fishery communities and organizations. Research grants from the North Pacific Research Board have supplemented funding for some research projects and in many cases projects have resulted from collaboration between fishers and federal and state scientists (http://www.bsfrf.org/). Given the availability and inclusivity for comments and revisions in conjunction with collaborative research through the BSFRF, the management process for the Bristol Bay red king crab, St. Matthew blue king crab, and Aleutian Islands golden king crab fisheries is considered transparent and stakeholder input is deemed "highly effective."

Bycatch Strategy

Factor 3.2: Management of fishing impacts on bycatch species						
Region / Method	**All Kept**	**Critical**	**Strategy**	**Research**	**Advice**	**Enforce**
Alaska Bristol Bay Pot	No	No	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Aleutian Islands Bering Sea Pot	No	No	Highly Effective	Highly Effective	Highly Effective	Highly Effective
Saint Matthew Island Bering Sea Pot	No	No	Highly Effective	Highly Effective	Highly Effective	Highly Effective

In the directed crab fisheries, the majority of bycatch consists of females of target species, sublegal males of target species, and non-target crab species (NPFMC 2013a). The impact of the fishery on non-target components of the target stock are included in the stock assessments and considered in the management of the target species, and are therefore covered by previous discussions in this report. This section discusses the measures in place to reduce and monitor bycatch impacts and the enforcement of these measures. Based on the assessment, Seafood Watch considers the management of bycatch species within the king crab fisheries to be "highly effective."

Subfactor 3.2.1 – Management Strategy and Implementation

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and how successful are these management measures? To achieve a Highly Effective rating, the primary bycatch species must be known and there must be clear goals and measures in place to minimize the impacts on bycatch species (e.g., catch limits, use of proven mitigation measures, etc.).

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Highly Effective

The Alaska king crab stocks are cooperatively managed by NMFS and the State of Alaska through the North Pacific Fishery Management Council's (NPFMC) fisheries management plan (FMP) for Bering Sea/Aleutian Islands (BSAI) king and Tanner crabs. State regulations comply with the FMP and the national standards of the Magnuson-Stevens Act (NOAA 2013c). Bycatch in the king crab fisheries consists mainly of females and undersized males of the target species, along with minor catches of Tanner and hair crabs. Stock assessments of each of these species consider the impacts of all fisheries, both when targeted and when caught as bycatch. As a result, negative impacts on any given stock are minimized to the extent possible. The 2005 Crab Rationalization Plan allows for adjustments to management to avoid overharvest in a particular area, and change in size limits and/or fishing seasons (NPFMC 2011a).

Mitigation of bycatch in the king crab fisheries is deferred to the state through the FMP, and measures that have been introduced include seasonal closures, gear modifications such as escape rings and/or mesh panels, the use of biodegradable twine to reduce the impacts of lost gear through ghost fishing, and the use of observers to monitor the level of bycatch, all of which reduce uncertainty in the modeling process (NPFMC 2011b).

For these reasons, the management strategy and implementation for bycatch in the Alaska king crab fisheries are deemed to be "highly effective."

Subfactor 3.2.2 – Scientific Research and Monitoring

Considerations: Is bycatch in the fishery recorded/documented and is there adequate monitoring of bycatch to measure fishery's impact on bycatch species? To achieve a Highly Effective rating, assessments must be conducted to determine the impact of the fishery on species of concern, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are being met.

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Highly Effective

Measures to monitor crab bycatch in directed crab fisheries include observers deployed on floating processor vessels and catcher/processor vessels, and on all vessels participating in the Bering Sea Aleutian Islands. But observer deployment on catcher/processor vessels may vary by fishery (NPFMC 2011a) (NPFMC 2011b). Observers may be required in other king crab fisheries (e.g., Norton Sound or Pribilof Islands) as the State deems necessary (Gaeuman 2011) (NPFMC 2011b). Gaeuman (2014) published estimates of BSAI fisheries bycatch, which included catch and catch per unit effort (CPUE) and information about size and shell condition of both discarded and retained crab. This report also provides information on bycatch rates by soak time and depth, female reproductive condition, sampled pot lift locations, species composition of sampled pot lifts, and total legal tally results. Consequently, the scientific research and monitoring for bycatch in the Alaska king crab fisheries are deemed to be "highly effective."

Subfactor 3.2.3 – Management Record of Following Scientific Advice

Considerations: How often (always, sometimes, rarely) do managers of the fishery follow scientific recommendations/advice (e.g., do they set catch limits at recommended levels)? A Highly Effective rating is given if managers nearly always follow scientific advice.

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Highly Effective

Harvest strategies and abundance models for Alaska king crab fisheries are required to incorporate estimates of bycatch mortality in determining the stock abundance and TACs. This ensures that bycatch does not negatively impact stock abundance. As stated in the 2014 SAFE, discard losses are determined by multiplying the handling mortality rate by the bycatch discards in each fishery (NPFMC 2013c). Stock assessment models rely on catch information collected by observers. Such models provide crucial information to the comprehensive management of Alaska's BSAI crab stocks (Gaeuman 2011). Evidence suggests that management of the fishery incorporates scientific advice regarding bycatch of non-target species or non-target components of the target species, and a number of mechanisms are in place to reduce bycatch and discard mortality. As a result, Seafood Watch considers this sub-factor to be "highly effective."

Subfactor 3.2.4 – Enforcement of Management Regulations

Considerations: Is there a monitoring/enforcement system in place to ensure fishermen follow management regulations and what is the level of fishermen's compliance with regulations? To achieve a Highly Effective rating, there must be consistent enforcement of regulations and verification of compliance.

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Highly Effective

Enforcement strategies for rationalized fisheries include onboard observers, VMS monitoring systems, reporting protocols, Registered Crab Receiver restrictions, and voluntary buyback programs. In addition to bycatch, onboard observers must document vessel catch and fishing effort, monitor vessel activities for regulatory compliance, collect data on size-frequencies of the catch, conduct legal tallies, and estimate the average weight of delivered catch (Gaeuman 2011). Along with gear type, location, depth, and soak time of each sampled pot lift, observers collect data describing pot contents, including species composition and the sex and legal status of all commercially important captured crab (Gaeuman 2011). The regulations and voluntary arrangements that are set in place by the Crab Rationalization Program ensure that the Alaska king crab fisheries remain adequately monitored and regularly enforced. For this reason, management enforcement is considered to be "highly effective."

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 (plus the mitigation of gear impacts score) and the ecosystem-based fishery management 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 cannot be Critical for Criterion 4.

Criterion 4 Summary

Region / Method	Gear Type and Substrate	Mitigation of Gear Impacts	EBFM	Overall Recomm.
Alaska Bristol Bay Pot	3.00:Low Concern	0.50:Moderate Mitigation	4.00:Low Concern	**Green (3.742)**
Aleutian Islands Bering Sea Pot	2.00:Moderate Concern	0.50:Moderate Mitigation	4.00:Low Concern	**Yellow (3.162)**
Saint Matthew Island Bering Sea Pot	2.00:Moderate Concern	0.50:Moderate Mitigation	4.00:Low Concern	**Yellow (3.162)**

The crab fisheries may affect bottom habitat through the setting and retrieval of pots. The extent of habitat impacts depends on the gear used, the type of bottom habitat fished, and the portion of that habitat type utilized by the fishery (NMFS 2004). The Magnuson-Stevens Act, amended in 1996 by the Sustainable Fisheries Act, mandated that any Fisheries Management Plan must include a provision to describe and identify Essential Fish Habitat (EFH) for the fishery, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat (NMFS 2004).

Justification of Ranking

Factor 4.1 – Impact of Fishing Gear on the Habitat/Substrate

Scoring Guidelines

- *5 (None)—Fishing gear does not contact the bottom*

- *4 (Very Low)—Vertical line gear*
- *3 (Low)—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. Bottom seine on resilient mud/sand habitats. Midwater trawl that is known to contact bottom occasionally (*
- *2 (Moderate)—Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Bottom seine except on mud/sand*
- *1 (High)—Hydraulic clam dredge. Dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 (Very High)—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.

Alaska Bristol Bay, Pot

Low Concern

Setting and retrieval of pots likely affect the habitat, but little research exists. The physical damage from pots greatly depends on habitat type. Chuenpagdee et al. (Chuenpagdee 2003) noted that pots tend to have a moderate or “medium impact” on physical substrates and a “low impact” on seafloor organisms. The majority of the crab pot fishing in the eastern Bering Sea (EBS) occurs in sand and soft sediments. These substrates are more resilient and less vulnerable to the impacts of crab pots (Danner 2007). As a result, NMFS (2004) reported that the total portion of the EBS affected by commercial pot fishing may be less than 1% of the shelf. This was supported by a more recent assessment (Fitch 2012), which concluded that the BSAI crab fisheries have an insignificant effect on benthic habitat. Seafood Watch considers the impact on marine habitats from the red king crab fishery to be a “low” concern.

Rationale:
Alaska king crab is only caught in pot fishing gear. King crab pots are larger than those used in other crab fisheries, and are made of a 7–8 sq ft steel wire frame that is covered with nylon mesh and baited with squid, clams, or fish (e.g., cod or herring) (Danner 2007) (NPFMC 2011b). The majority of the crab fisheries occur on sandy and sand/silt bottom types in waters greater than 100 ft deep. Specifically, red king crabs are mostly harvested in areas consisting of sandy and silty bottoms, where depths range from 120 to 480 ft.

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Moderate Concern

Setting and retrieving crab pots likely affect bottom habitats, but little research has been done. The physical damage from pots is highly dependent on habitat type. Chuenpagdee et al. (Chuenpagdee 2003) noted that pots tend to have a moderate or "medium impact" on physical substrates and a "low impact" on seafloor organisms . Fishing for blue and golden king crab occurs over rougher ground than fishing for red king crab, and there is a greater potential for damage to the seabed and the organisms living there, such as cold-water corals. Thus, Seafood Watch considers the impact of fisheries for golden and blue king crab on the marine habitat to be of "moderate" concern.

Rationale:
Alaska king crab are only caught in pot fishing gear. King crab pots are larger than those used in other crab fisheries, and are made of a 7–8 sq ft steel wire frame that is covered with nylon mesh and baited with squid, clams, or fish (e.g., cod or herring) (Danner 2007) (NPFMC 2011b). Golden and blue king crabs are taken in areas of rough, uneven bottom and in compacted, sand-cobble sediments at depths of 600 to 2,400 ft. Fishing effort is generally concentrated at the entrances to passes between islands, particularly in the district east of 174°W longitude. West of 174°W longitude, fishing occurs in steep rocky terrain, near passes between islands, and on moderately sloping mud/sand sediments in basins.

Blue king crabs are taken at depths of 90 to 360 ft on hard bottom, including cobble, gravel, and occasional rock ledges near shore, and softer bottom offshore (NMFS 2004). Sand and soft sediments tend to be less affected than hard, rocky bottom substrates (Quandt 1999). It is assumed that these sessile organisms are not able to reattach to the substrate when returned to the water and thus will die. Destruction of such sponge and coral species may be detrimental to the ecosystem. Recovery of corals may take several decades (Roberts & Hirshfield 2004) (Danner 2007). Substrate damage also may affect small benthic organisms, including newly settled crabs, because substrates provide valuable habitat structure and protection from predation (NMFS 2004). Stationary fishing gear such as crab pots are considered to be less damaging than mobile gear because they directly contact a much smaller area of the seafloor (Stewart 1999) (Eno et al. 2001). But when there is insufficient line, strong currents, or large swells, pots can damage bottom habitats by bouncing around the seafloor. Recovery of pots also can damage the seabed through dragging. Lost pots can impact benthic species by continuing to capture and kill them, which is known as ghost fishing. It is difficult to assess the extent of these impacts when little evidence is brought on deck; no current studies have been conducted on the effects of these activities.

Factor 4.2 – Mitigation of Gear Impacts

Scoring Guidelines

- *+1 (Strong Mitigation)—Examples include large proportion of habitat protected from fishing (>50%) with gear, fishing intensity low/limited, gear specifically modified to reduce damage*

to seafloor and modifications shown to be effective at reducing damage, or an effective combination of 'moderate' mitigation measures.

- *+0.5 (Moderate Mitigation)—20% of habitat protected from fishing with gear or other measures in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing.*
- *+0.25 (Low Mitigation)—A few measures are in place (e.g., vulnerable habitats protected but other habitats not protected); there are some limits on fishing effort/intensity, but not actively being reduced.*
- *0 (No Mitigation)—No effective measures are in place to limit gear impacts on habitats.*

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Moderate Mitigation

Despite the potential impacts previously mentioned, current management efforts actively seek to reduce and mitigate the impacts of fishing gear. Effective strategies include measures to reduce fishing effort, intensity, and spatial footprint. Consequently, Seafood Watch deems the mitigation of fishing gear impacts on U.S. Alaskan king crab fisheries as "moderate."

Rationale:

When IFQs were implemented in 2005, the fleet consolidated, which reduced the number of pots being fished. In addition, vessels soak their gear longer, which results in higher CPUE. This means that fewer pots can catch the same amount of crab. Gear modifications also limit adverse impacts. For example, the steep, deep, bottom topography in the inter-island passes inhabited by the Aleutian Islands golden king crab necessitates the use of longlined rather than single pot gear. There are no other major king crab fisheries in Alaska where longlined pot gear is the only legal gear type (NMFS 2004). Other mitigation measures include biodegradable escape mechanisms and various other bycatch minimization devices, and gear restrictions implemented through limitations in pot and vessel registration areas.

The NPFMC protects Essential Fishing Habitats (EFH) from fishing and gear impacts (Figure 13). Areas protected from fishing include the Aleutian Islands Habitat Conservation Area, the Aleutian Islands Coral Habitat Protection Areas, and the Habitat Areas of Particular Concern (HAPCs). These areas prohibit the use of any bottom contact gear (e.g., trawl and pot gear) year-round (NPFMC 2011b). Additional measures protect managed or rare species, and ensure the sustainability of sensitive habitats (Figure 14). Moreover, NOAA Fisheries runs a voluntary buyback program to reduce excess participation in crab fisheries. The agency pays participants for withdrawing their vessels from the fishery, yielding their fishing licenses, and surrendering fishing histories. Reducing overcapitalization helps conserve the resource and increases the productivity and value of the fishery for remaining participants.

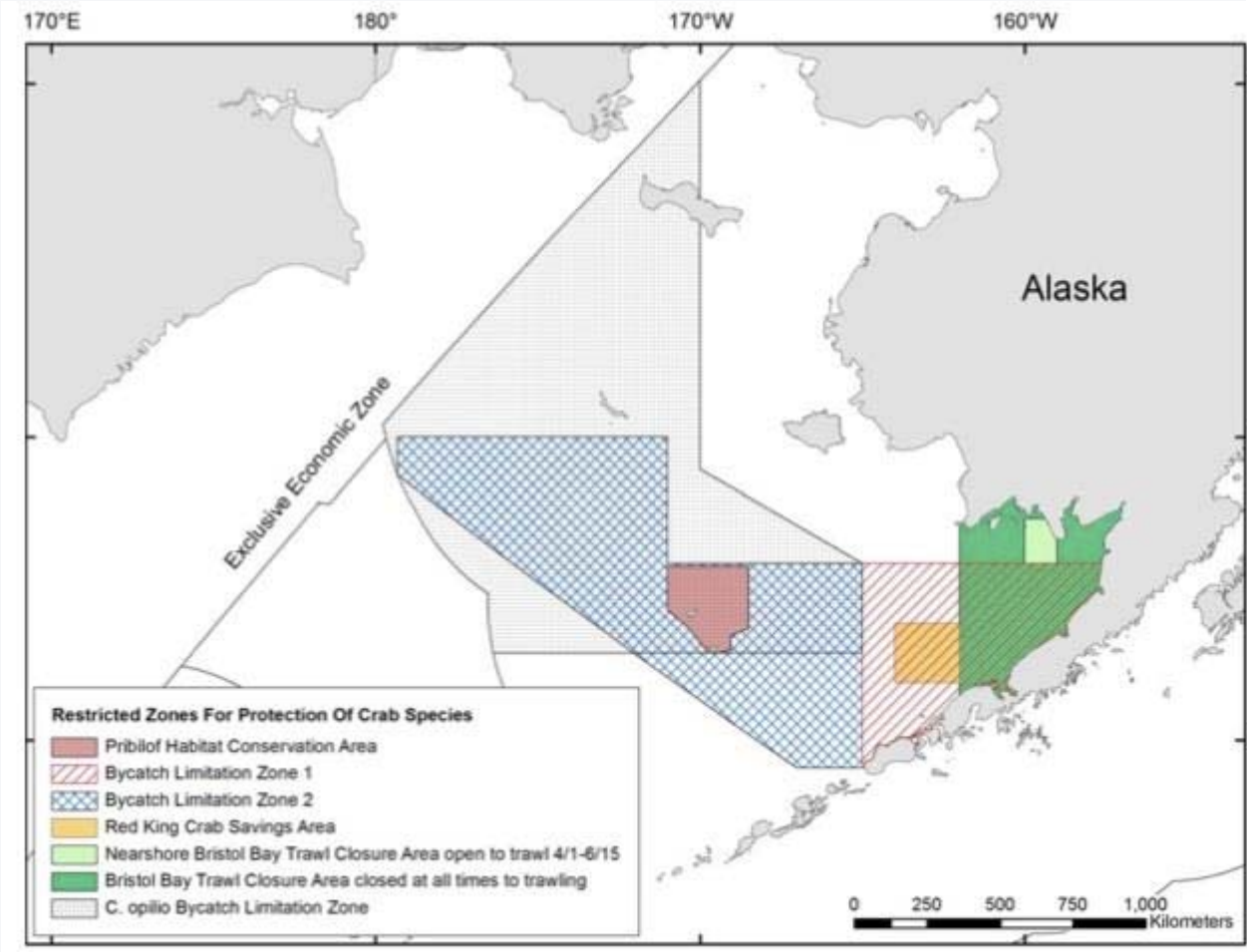

Figure 13. Restricted areas within the eastern Bering Sea that serve as protective management for commercial crab species in the U.S. (figure from Chilton et al. 2011).

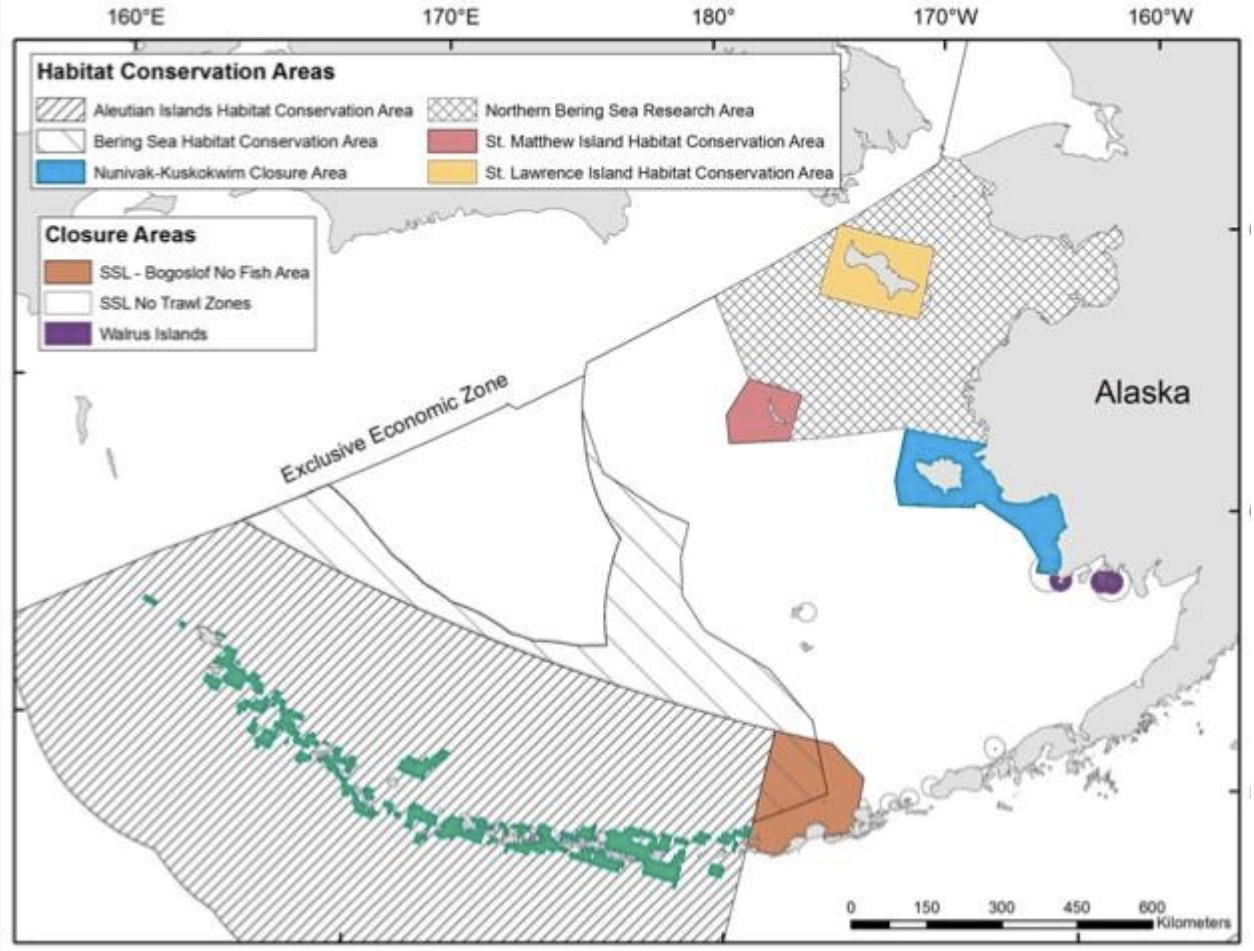

Figure 14. Habitat conservation areas and areas closed to bottom trawling in the eastern Bering Sea and Aleutian Islands (figure from Chilton et al. 2011).

Factor 4.3 – Ecosystem-Based Fisheries Management

Scoring Guidelines

- *5 (Very Low Concern)—Substantial efforts have been made to protect species' ecological roles and ensure fishing practices do not have negative ecological effects (e.g., large proportion of fishery area is protected with marine reserves, and abundance is maintained at sufficient levels to provide food to predators).*
- *4 (Low Concern)—Studies are underway to assess the ecological role of species and measures are in place to protect the ecological role of any species that plays an exceptionally large role in the ecosystem. Measures are in place to minimize potentially negative ecological effect if hatchery supplementation or fish aggregating devices (FADs) are used.*
- *3 (Moderate Concern)—Fishery does not catch species that play an exceptionally large role in the ecosystem, or if it does, studies are underway to determine how to protect the*

ecological role of these species, OR negative ecological effects from hatchery supplementation or FADs are possible and management is not place to mitigate these impacts.

- *2 (High Concern)—Fishery catches species that play an exceptionally large role in the ecosystem and no efforts are being made to incorporate their ecological role into management.*
- *1 (Very High Concern)—Use of hatchery supplementation or fish aggregating devices (FADs) in the fishery is having serious negative ecological or genetic consequences, OR fishery has resulted in trophic cascades or other detrimental impacts to the food web.*

Alaska Bristol Bay, Pot

Aleutian Islands Bering Sea, Pot

Saint Matthew Island Bering Sea, Pot

Low Concern

Although the last ecosystem assessment was completed in 2004, recent stock assessments (NPFMC 2011a) indicate that the Alaska king crab pot fishery does not affect "exceptional species." Moreover, surveys, assessments, updates, and independent scientific research indicate that the king crab fisheries do not significantly affect the ecosystem or food web dynamics (NPFMC 2011a). But some important information (such as the alteration of genetic diversity) remains incomplete. In Alaska, management regulations already include ecosystem-based fishery management measures, such as control of directed and incidental catches; prohibition on fishing of forage species (on which other fish, seabirds, and marine mammals depend); protection of habitat for fish, crabs, and marine mammals; and temporal and spatial controls on fishing (Witherell and Woodby 2005) (Pikitch et al. 2004). As a result, we have rated this factor "low" concern. Scientific assessment and management efforts to account for the ecological role of king crab fisheries are underway (NPFMC 2011a). Therefore, Seafood Watch considers ecosystem based fisheries management in the king crab fisheries to be a low concern.

Rationale:
The amount of energy/biomass removed by the crab fisheries is insignificant (Trites et al. 1999) (NMFS 2004). As noted in the Endangered Species Act (ESA) Environmental Impact Statement (EIS) report, crab fisheries do not adversely affect ESA-listed species, destroy or modify their habitat, or compose a measurable portion of their diet (NMFS 2004) (NPFMC 2011a). Bycatch levels of all non-target species within the crab fisheries are minimal and gear effects on benthic habitats are relatively minor. For this reason, there is no demonstrated evidence that removal of king crabs disrupts the food web (Danner 2007).

In addition, crab fisheries may alter the genetic diversity of the stock by only removing the largest males. Genetic studies on BSAI king crab populations are incomplete. Ongoing research seeks to further understand and identify genetic variation and stock structure of Alaska king crab species, because the

potential effects on overall genetic diversity remain unknown (NMFS 2004) (Danner 2007) (Alaska Sea Grant 2013).

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.

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