Western Aleutian Islands Red King Crab

– 2017 Tier 5 Assessment

2017 Crab SAFE Report Chapter (September 2017)

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Executive Summary

1. **Stock:**

Western Aleutian Islands (the Aleutian Islands, west of 171° W longitude) red king crab, *Paralithodes camtschaticus*

There are two districts for State management of commercial red king crab fisheries in waters of the Aleutian Islands west of 171º W longitude: the Adak District for waters east of 179º W longitude and the Petrel District for waters west of 179º W longitude. Although this stock has been referred to colloquially as the "Adak" stock, this report will refer to the stock as the "Western Aleutian Islands (WAI) red king crab" stock to avoid confusion with the Adak District.

2. **Catches:**

The domestic fishery has been prosecuted since 1960/61 and was opened every year through the 1995/96 crab fishing year. Peak retained catch occurred in 1964/65 at 9,613 t (21,193,000 lb). During the early years of the fishery through the late 1970s, most or all of the retained catch was harvested in the area between 172° W longitude and 179°15' W longitude. As the annual retained catch decreased into the mid-1970s and the early-1980s, the area west of 179°15' W longitude began to account for a larger portion of the retained catch. Retained catch during the 10-year period 1985/86–1994/95 averaged 428 t (942,940 lb), but the retained catch in 1995/96 was only 18 t (38,941 lb). The fishery has been opened only occasionally during 1996/97 to present. There was an exploratory fishery with a low guideline harvest level (GHL) in 1998/99, three commissioner's permit fisheries in limited areas during 2000/01–2002/03 to allow for ADF&G-Industry surveys, and two commercial fisheries with a GHL of 227 t (500,000 lb) in 2002/03 and 2003/04. Most of the retained catch since 1990/91 was harvested in the Petrel Bank area (between 179° W longitude and 179° E longitude); in 2002/03 and 2003/04 the commercial fishery was opened only in the Petrel Bank area. Retained catch in the last two years with commercial fishing was 229 t (505,642 lb) in 2002/03 and 217 t (479,113 lb) in 2003/04. The fishery has been closed during 2004/05–2016/17. Discarded (non-retained) catch of red king crab occurs in the directed red king crab fishery (when prosecuted), in the Aleutian Islands golden king crab fishery, and in groundfish fisheries. Estimated annual weight of bycatch mortality due

to crab fisheries during 1995/96–2016/17 averaged 1 t (1,902 lb). Estimated annual weight of bycatch mortality due to groundfish fisheries during 1993/94–2016/17 averaged 7 t (15,710 lb). Estimated weight of annual total fishery mortality during 1995/96–2016/17 averaged 34 t (74,890 lb); the average annual retained catch during that period was 26 t (57,278 lb). A cooperative red king crab survey was performed by the Aleutian Islands King Crab Foundation (an industry group) and ADF&G in the Petrel Bank area in November 2016 (Hilsinger and Siddon 2016b), which resulted in an estimated bycatch mortality of 0.03 t (59 lb). Estimated total fishery mortality in 2016/17 resulted from groundfish fisheries (0.13 t; 294 lb), the Aleutian Islands golden king crab fishery (0.05 t; 100 lb), and the cooperative survey (0.03 t; 59 lb).

3. Stock biomass:
Estimates of past or present stock biomass are not available for this Tier 5 assessment.

4. Recruitment:
Estimates of recruitment trends and current levels relative to virgin or historic levels are not available for this Tier 5 assessment.

5. Management performance:
Overfishing did not occur during 2016/17 because the estimated total catch (0.2 t; 454 lb) did not exceed the Tier 5 OFL established for 2016/17 (56 t; 123,867 lb). Additionally, the 2016/17 estimated total catch did not exceed the ABC established for 2016/17 (34 t; 74,320 lb). No determination has yet been made for a fishery opening or harvest level, if opened, for 2017/18. The OFL and ABC values for 2017/18 in the tables below are the author's status quo, Alternative 1 recommended values.

Management Performance Table (values in t)

Fishing Year	MSST	Biomass (MMB)	TAC[a]	Retained Catch	Total Catch	OFL	ABC
2012/13	N/A	N/A	Closed	0	<1	56	34
2013/14	N/A	N/A	Closed	0	<1	56	34
2014/15	N/A	N/A	Closed	0	<1	56	34
2015/16	N/A	N/A	Closed	0	1.3	56	34
2016/17	N/A	N/A	Closed	0	<1	56	34
2017/18	N/A	N/A				56	14

a. Pre-season harvest levels are established as total allowable catch for the rationalized fishery west of 179° W longitude and as a guideline harvest level for the non-rationalized fishery east of 179° W longitude.

Management Performance Table (values in lb)

Fishing Year	MSST	Biomass (MMB)	TAC[a]	Retained Catch	Total Catch	OFL	ABC
2012/13	N/A	N/A	Closed	0	624	123,867	74,320
2013/14	N/A	N/A	Closed	0	732	123,867	74,320
2014/15	N/A	N/A	Closed	0	474	123,867	74,320
2015/16	N/A	N/A	Closed	0	2,964	123,867	74,320
2016/17	N/A	N/A	Closed	0	454	123,867	74,320
2017/18	N/A	N/A				123,867	30,967

a. Pre-season harvest levels are established as total allowable catch for the rationalized fishery west of 179° W longitude and as a guideline harvest level for the non-rationalized fishery east of 179° W longitude.

6. **Basis for the OFL and ABC:** See table, below; values for 2017/18 are the author's recommended values.

Year	Tier	Years to define Average catch (OFL)	Natural Mortality	Buffer
2012/13	5	1995/96-2007/08[a]	0.18[b]	40%
2013/14	5	1995/96-2007/08[a]	0.18[b]	40%
2014/15	5	1995/96-2007/08[a]	0.18[b]	40%
2015/16	5	1995/96-2007/08[a]	0.18[b]	40%
2016/17	5	1995/96-2007/08[a]	0.18[b]	40%
2017/18	5	1995/96-2007/08[a]	0.18[b]	75%

a. OFL is for total catch and was determined by the average of the total catch for these years.
b. Assumed value for FMP king crab in NPFMC (2007); does not enter into OFL estimation for Tier 5 stock.

7. **PDF of the OFL:** Sampling distribution of the recommended (status quo Alternative 1) Tier 5 OFL was estimated by bootstrapping (see section G.1). The standard deviation of the estimated sampling distribution of the recommended OFL is 56 t (CV = 0.42). Note that generated sampling distribution and computed standard deviation are meaningful as measures in the uncertainty of the OFL only if assumptions on the choice of years used to compute the Tier 5 OFL are true (see Section E.4.f).

8. **Basis for the ABC recommendation:** The recommended ABC of 14 t is less than the ABC that was recommended by the SSC for 2012/13 – 2016/17. The recommended ABC is lowered because 1) the industry has not expressed interest in a small test fishery during 2017/18, and 2) because the stock is severely depressed as indicated by the 2016 Petrel survey (CPT minutes for May 2017).

At 14 t the ABC provides a 75% buffer on the OFL of 56 t; i.e., $(1.0-0.75) \cdot 56 \text{ t} = 14 \text{ t}$.

9. **A summary of the results of any rebuilding analyses:** Not applicable; stock is not under a rebuilding plan.

A. Summary of Major Changes

1. **Changes to the management of the fishery:** No changes have been made to management of the fishery (the fishery has remained closed) and no changes have been made to regulations pertaining to the fishery since those adopted by the Alaska Board of Fisheries in March 2014.

2. **Changes to the input data:**
   - Data on retained catch, discarded catch, and estimates of bycatch mortality in crab and groundfish fisheries during 2016/17 have been added, but were not entered into the calculation of the recommended 2017/18 total-catch OFL.

3. **Changes to the assessment methodology:** None: the computation of OFL in this assessment follows the methodology recommended by the SSC in June 2010.

4. **Changes to the assessment results, including projected biomass, TAC/GHL, total catch (including discard mortality in all fisheries and retained catch), and OFL:** None: the computation of OFL in this assessment follows the methodology recommended by the SSC in June 2010 applied to the same data and estimates with the same assumptions that were used for estimating the 2010/11–2016/17 OFLs.

B. Responses to SSC and CPT Comments

1. **Responses to the most recent two sets of SSC and CPT comments on assessments in general:**
   - CPT, May 2016: *None pertaining to a Tier 5 assessment*.
   - SSC, June 2016: *None pertaining to a Tier 5 assessment*.
   - CPT, September 2016 (via September 2015 SAFE Introduction chapter): *None pertaining to a Tier 5 assessment*.
   - SSC, October 2015: *None pertaining to a Tier 5 assessment*.

2. **Responses to the most recent two sets of SSC and CPT comments specific to the assessment:**
   - CPT, May 2016: *None.*
   - SSC, June 2015: *"The industry expressed no desire to pursue a red king crab fishery in the Adak area at this time. However, the Petrel Bank region will be surveyed during September 2016."*
     - Response: *The Petrel survey was conducted in November 2016 and showed very little RKC (ave CPUE=0.11).*
   - *"The SSC also appreciates the addition of size frequency data in Appendices A1-A4. The SSC requests plotting these data to enable visualization of progression of size modes in next year's assessment."*
     - Response: Done. See appendix A5.
   - CPT, September 2016: *None*.
   - SSC, October 2016: *None*.

C. Introduction

1. **Scientific name:** *Paralithodes camtschaticus*, Tilesius, 1815

2. <u>Description of general distribution</u>:

The general distribution of red king crab is summarized by NMFS (2004):

> Red king crab are widely distributed throughout the BSAI, GOA, Sea of Okhotsk, and along the Kamchatka shelf up to depths of 250 m. Red king crab are found from eastern Korea around the Pacific rim to northern British Columbia and as far north as Point Barrow (page 3-27).

> Most red and blue king crab fisheries occur at depths from 50-200 m, but red king crab fisheries in the Aleutian Islands sometimes extend to 300 m.

> Red king crab is native to waters of 300 m or less extending from eastern Korea, the northern coast of the Japan Sea, Hokkaido, the Sea of Okhotsk, through the eastern Kamchatkan Peninsula, the Aleutian Islands, the Bering Sea, the GOA, and the Pacific Coast of North America as far south as Alice Arm in British Columbia. They are not found north of the Kamchatkan Peninsula on the Asian Pacific Coast. In North America red king crab range includes commercial fisheries in Norton Sound and sparse populations extending through the Bering Straits as far east as Barrow on the northern coast of Alaska. Red king crab have been acclimated to Atlantic Ocean waters in Russia and northern Norway. In the Bering Sea, red king crab are found near the Pribilof Islands and east through Bristol Bay; but north of Bristol Bay (58 degrees 39 minutes) they are associated with the mainland of Alaska and do not extend to offshore islands such as St. Matthew or St. Laurence Islands.

Commercial fishing for WAI red king crab was opened only in the Petrel Bank area (i.e., between 179° W longitude and 179° E longitude; Baechler and Cook 2014) during the most recent two years that the fishery was prosecuted (2002/03 and 2003/04). Fishery effort during those two years typically occurred at depths of 60–90 fathoms (110–165 m); average depth of pots fished in the Aleutian Islands area during 2002/03 was 68 fathoms (124 m; Barnard and Burt 2004) and during 2003/04 was 82 fathoms (151 m; Burt and Barnard 2005). Depth was recorded for 578 pots out of the 580 pot lifts sampled by observers during the 1996/97–2006/07 Aleutian Islands golden king crab fishery that contained 1 or more red king crab (ADF&G observer database, Dutch Harbor, April 2008). Of those, the deepest recorded depth was 266 fathoms (486 m) and 90% of pot lifts had recorded depths of 100–200 fathoms (183–366 m); no red king crab were present in any of the 6,465 pot lifts sampled during the 1996/97–2006/07 Aleutian Islands golden king crab fishery with depths >266 fathoms (486 m).

In this chapter we will refer to the area west of 171° W longitude within the Aleutian Islands king crab Registration Area O as the "Western Aleutian Islands" (WAI). The Aleutian Islands king crab Registration Area O is described by Baechler and Cook (2014, page 7) as follows (see also Figure 1):

> "The Aleutian Islands king crab Registration Area O has as its eastern boundary the longitude of Scotch Cap Light (164° 44' W longitude), its northern boundary a

line from Cape Sarichef (54° 36' N latitude) to 171° W longitude, north to 55° 30' N latitude, and as its western boundary the Maritime Boundary Agreement Line as that line is described in the text of and depicted in the annex to the Maritime Boundary Agreement between the United States and the Union of Soviet Socialist Republics signed in Washington, June 1, 1990. Area O encompasses both the waters of the Territorial Sea (0-3 nautical miles) and waters of the Exclusive Economic Zone (3-200 nautical miles)."

From 1984/85 until the March 1996 Alaska Board of Fisheries meeting, the Aleutian Islands king crab Registration Area O as currently defined had been subdivided at 171° W longitude into the historic Adak Registration Area R and the Dutch Harbor Registration Area O. The geographic boundaries of the WAI red king crab stock are defined here by the boundaries of the historic Adak Registration Area R (i.e., the current Aleutian Islands king crab Registration Area O, west of 171° W longitude). Note that in March 2014 the Alaska Board of Fisheries established two districts for management of commercial fisheries for red king crab in the waters of the Aleutian Islands west of 171° W longitude: 1) the Adak District, 171º to 179º W longitude; and the Petrel District, west of 179º W longitude.

3. <u>**Evidence of stock structure:**</u>

Seeb and Smith (2005) analyzed microsatellite DNA variability in nearly 1,800 individual red king crab originating from the Sea of Okhotsk to Southeast Alaska, including a sample 75 specimens collected during 2002 from the vicinity of Adak Island in the Aleutian Islands (51° 51' N latitude, 176° 39' W longitude), to evaluate the degree to which the established geographic boundaries between stocks in the BSAI reflect genetic stock divisions. Seeb and Smith (2005) concluded that, "There is significant divergence of the Aleutian Islands population (Adak sample) and the Norton Sound population from the southeastern Bering Sea population (Bristol Bay, Port Moller, and Pribilof Islands samples)." Recent analysis of patterns of genetic diversity among red king crab stocks in the western north Pacific (Asia), eastern North Pacific, and Bering Sea by multiple techniques (SNPs, allozymes, and mtDNA) also showed that red king crab sampled near Adak Island had greater genetic similarity to stocks in Asia rather than other stocks in Alaskan waters including Bristol Bay and the Gulf of Alaska (reviewed in Grant et al. 2014).

To date, population genetic studies of red king crab within the WAI have only grouped samples from within this region as one site (i.e., Adak Island) (Grant et al. 2014). Given the complexity of currents throughout the WAI and that canyons deeper than the depth restrictions of red king crab (>1,000 m) separate several islands, the possibility of fine scale genetic structuring exists, but remains uninvestigated. A summary of total retained catch by 1-degree longitude groupings during 1985/86–1995/96 (years for which state statistical area definitions allow for grouping by 1-degree longitude and for which catch distribution was not affected by area closures and openings; see Section C.5) shows that catch and, presumably, distribution of legal-sized male red king crab is not evenly distributed across the Aleutian Islands. Most catch during that period was from Petrel Bank, followed by the vicinity of Adak, Atka, and Amlia Islands (Figure 2). Note that the 1-degree longitude grouping of catch does not portray the spatial gaps in catch that are apparent upon a closer inspection of the 1985/86–1995/96 catch data by state statistical areas. For example, no catch was reported during 1985/86–1995/96 from the two statistical areas

(795102 and 795132) that include Amchitka Pass (Amchitka Pass lies between Petrel Bank and the Delarof Islands; see Figure 2).

McMullen and Yoshihara (1971) reported the following on male red king crab that were tagged in February 1970 on the Bering Sea and Pacific Ocean sides of Atka Island and recovered in the subsequent fishery:

> "Fishermen landing tagged crabs were questioned carefully concerning the location of recapture. In no instance did crabs migrate through ocean passes between the Pacific Ocean and Bering Sea."

4. Description of life history characteristics relevant to stock assessments (e.g., special features of reproductive biology):

Red king crab eggs are fertilized externally and the clutch of fertilized eggs (embryos) are carried under the female's abdominal flap until hatching. Male king crab fertilize eggs by passing spermatophores from the fifth periopods to the gonopores and coxae of the female's third periopods; the eggs are fertilized during ovulation and attach to the female's pleopodal setae (Nyblade 1987, McMullen 1967). Females are generally mated within hours after molting (Powell and Nickerson 1965), but may mate up to 13 days after molting (McMullen 1969). Males must wait at least 10 days after completing a molt before mating (Powell et al. 1973), but, unlike females, do not need to molt prior to mating (Powell and Nickerson 1965).

Wallace et al. (1949, page 23) described the "egg laying frequency" of red king crab:

> "Egg laying normally takes place once a year and only rarely are mature females found to have missed an egg laying cycle. The eggs are laid in the spring immediately following shedding [i.e., molting] and mating and are incubated for a period of nearly a year. Hatching of the eggs does not occur until the following spring just prior to moulting [i.e., molting] season."

McMullen and Yoshihara (1971) reported that from 804 female red king crab (79–109-mm CL) collected during the 1969/70 commercial fishery in the western Aleutians, "Female king crab in the western Aleutians appeared to begin mating at 83 millimeters carapace length and virtually all females appeared to be mature at 102 millimeters length." Blau (1990) estimated size at maturity for WAI red king crab females as the estimated CL at which 50% of females are mature (SM50; as evidenced by presence of clutches of eggs or empty) according to a logistic regression: 89-mm CL (SD = 2.6 mm). Size at maturity has not been estimated for WAI male red king crab. However, because the estimated SM50 for WAI red king crab females is the same as that estimated for Bristol Bay red king crab females (Otto et al. 1990), the estimated maturity schedule used for Bristol Bay red king crab males (see SAFE chapter on Bristol Bay red king crab) could be applied to males in the WAI stock as a proxy.

Few data are available on the molting and mating period for red king crab specifically in the WAI. Among the red king crab captured by ADF&G staff for tagging on the south side of Amlia Island (173° W longitude to 174° W longitude) in the first half of April 1971, males and females were molting, females were hatching embryos, and mating was occurring (McMullen and

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Yoshihara 1971). The spring mating period for red king crab is known to last for several months, however. For example, although mating activity in the Kodiak area apparently peaks in April, mating pairs in the Kodiak area have been documented from January through May (Powell et al. 2002). Due to the timing of the commercial fishery within a year, little data on reproductive condition of WAI red king crab females have been collected by at-sea fishery observers that can be used for evaluating the mating period. Most recently, of the 3,211 mature females that were examined during the 2002/03 and 2003/04 red king crab fisheries in the Petrel Bank area, which were prosecuted in late October, only 10 were scored as "hatching" (ADF&G observer database, Dutch Harbor, April 2008).

Data on mating pairs of red king crab collected from the Kodiak area during March–May of 1968 and 1969 showed that size of the females in the pairs increased from March to May, indicating that females tend to release their larvae and mate later in the mating season with increasing body size (Powell et al. 2002). Size of the males in those mating pairs did not increase with later sampling periods, but did show a decreasing trend in estimated time since last molt. In all the data on mating pairs collected from the Kodiak area during 1960–1984, the proportion of males that were estimated to have not recently molted prior to mating decreased monthly over the mating period (Powell et al. 2002). Those data also suggest that, for males, not molting early in the mating period provides the advantage of mating when primiparous and small, multiparous females tend to ovulate. Alternatively, males that do molt early in the mating period likely participate in mating later, and with larger females.

Current knowledge of red king crab reproductive biology, including male and female maturation, migration, mating dynamics, and potential effects of exploitation on reproductive potential, is summarized by Webb (2014).

5. __Brief summary of management history__:

A complete summary of the management history through 2011/12 is provided by Baechler and Cook (2014, pages 7–13). The domestic fishery for red king crab in the WAI began in 1960/61. Retained catch of red king crab in the Aleutians west of 172° W longitude averaged 5,259 t (11,595,068 lb) during 1960/61–1975/76, with a peak retained catch of 9,613 t (21,193,000 lb) in 1964/65 (Tables 1a and 1b, Figure 3). Guideline harvest levels (GHL; sometimes expressed as ranges, with an upper and lower GHL) for the fishery were established in most years since 1973/74. The fishery was closed in 1976/77 in the area west of 172º W longitude, but was reopened for each year during 1977/78–1995/96. Average retained catch during 1977/78–1995/96 (for the area west of 172° W longitude prior to 1984/85 and for the area west of 171° W longitude since 1984/85) was 470 t (1,036,659 lb); the peak retained catch during that period occurred in 1983/84 at 899 t (1,981,579 lb). During the mid-to-late 1980s, significant portions of the catch during the WAI red king crab fishery occurred west of 179º E longitude or east of 179º W longitude, whereas most of the retained catch was harvested from the Petrel Bank area (179° W longitude to 179° W longitude) during 1990/91–1994/95 (Figure 4). Retained catch and fishery CPUE (retained crab per pot lift) declined from 1993/94 to 1994/95 and 1995/96; retained catch in 1994/95 and, especially, 1995/96 was far below the lower GHL established. Due to concerns about the low stock level and poor recruitment indicated by results of the fishery in 1994/95–1995/96, the fishery was closed in 1996/97–1997/98. During 1998/99–2003/04 the fishery was opened only in restricted areas, either as an open fishery managed under a GHL or as

an ADF&G-Industry survey conducted as a commissioner's permit fishery (Table 2); peak retained catch during that period was 229 t (505,642 lb) harvested from the Petrel Bank area in 2002/03. The fishery has been closed during 2004/05–2016/17.

Only males of a minimum legal size may be retained by the commercial red king crab fishery in the WAI. By State of Alaska regulation (**5 AAC 34.620 (a)**), the minimum legal size limit is 6.5-inches (165 mm) carapace width (CW), including spines. A carapace length (CL) ≥138 mm is used to identify legal-size males when CW measurements are not available (Table 3-5 in NPFMC 2007). Except for the years 1968–1970, the minimum size has been 6.5-inches CW since 1950; in 1968 there was a "first-season" minimum size of 6.5-inches CW and a "second-season" minimum size of 7.0-inches and in 1969–1970 the minimum size was 7.0-inches CW (Donaldson and Donaldson 1992).

Red king crab may be commercially fished only with king crab pots (as defined in **5 AAC 34.050**). Pots used to fish for red king crab in the WAI must, since 1996, have at least one-third of one vertical surface of the pot composed of not less than nine-inch stretched mesh webbing to permit escapement of undersized red king crab and may not be longlined (**5 AAC 34.625 (e)**). The sidewall of the pot "…must contain an opening equal to or exceeding 18 inches in length... The opening must be laced, sewn, or secured together by a single length of untreated, 100 percent cotton twine, no larger than 30 thread." (**5 AAC 39.145(1)**).

The WAI red king crab fishery west of 179° W longitude has been managed since 2005/06 under the Crab Rationalization program (50 CFR Parts 679 and 680). The WAI red king crab fishery in the area east of 179° W longitude was not included in the Crab Rationalization program (Baechler and Cook 2014). In March 2014 the Alaska Board of Fisheries established two red king crab management districts in state regulations for the Aleutian Islands west of 171° W longitude (the Adak District, 171° to 179° W longitude; and the Petrel District, west of 179° W longitude) and some notable differences in regulations exist between the two districts. The red king crab commercial fishing season in the Adak District is August 1 to February 15, unless closed by emergency order (**5 AAC 34.610 (a) (1)**); the red king crab commercial fishing season in the Petrel is October 15 to February 15, unless closed by emergency order (**5 AAC 34.610 (a) (2)**). Only vessels 60 feet or less in overall length may participate in the commercial red king crab fishery within the state waters of the Adak District (**5 AAC 34.610 (d)**); no vessel size limit is established for federal waters in the Adak District or for state or federal waters in the Petrel District. Federal waters in the Adak District are opened to commercial red king crab fishing only if the season harvest level established by ADF&G for the Adak District is 250,000 lb or more (**5 AAC 34.616 (a) (2)**); there is no comparable regulation for the Petrel District. In the Adak District, pots commercially fished for red king crab may only be deployed and retrieved between 8:00 AM and 5:59 PM each day (**5 AAC 34.625 (g) (2)**) and the following pot limits pertain: 10 pots per vessel for vessels fishing within state waters (**5 AAC 34.625 (g) (1) (A)**); and 15 pots per vessel for vessels fishing in federal waters (**5 AAC 34.625 (g) (1) (B)**). In the Petrel District there is no regulation pertaining to periods for operation of gear and a pot limit of 250 pots per vessel (**5 AAC 34.625 (d)**). See also "6. Brief description of the annual ADF&G harvest strategy," below.

6. Brief description of the annual ADF&G harvest strategy:

Prior to the March 2014 Alaska Board of Fisheries meeting, when the board adopted a harvest strategy for the Adak District only, there was no harvest strategy in state regulation for WAI red king crab. Following results of the January/February and November 2001 ADF&G-Industry pot surveys for red king crab in the Petrel Bank area, which produced high catch rates of legal males (CPUE = 28), but low catches of females and sublegal males, ADF&G opened the fishery in 2002/03 and 2003/04 with a GHL of 227 t (500,000 lb); that GHL was established as the minimum GHL that could be managed inseason, given expected participation and effort (Baechler and Cook 2014). The fishery was closed in 2004/05 due to continued uncertainty on the status of pre-recruit legal males, a reduction in legal male CPUE from 18 in 2002/03 to 10 in 2003/04, and a strategy adopted by ADF&G to close the fishery before the CPUE of legal crab dropped below 10.

The harvest strategy for red king crab in the Adak District adopted by the Alaska Board of Fisheries in March 2014 is as follows:

> **5 AAC 34.616. Adak District red king crab harvest strategy.** (a) In the Adak District, based on the best scientific information available, if the department determines that there is a harvestable surplus of
>> (1) red king crab available in the waters of Alaska in the Adak District, the commissioner may open, by emergency order, a commercial red king crab fishery only in the waters of Alaska in the Adak District under 5 AAC 34.610(a)(1);
>> (2) at least 250,000 pounds of red king crab in the Adak District, the commissioner may open, by emergency order, a commercial red king crab fishery in the entire Adak District under 5 AAC 34.610(a)(1).
>
> (b) In the Adak District, during a season opened under 5 AAC 34.610(a)(1), the operator of a validly registered king crab fishing vessel shall
>> (1) report each day to the department
>>> (A) the number of pot lifts;
>>> (B) the number of crab retained for the 24-hour fishing period preceding the report; and
>>> (C) any other information the commissioner determines is necessary for the management and conservation of the fishery, as specified in the vessel registration certificate issued under 5 AAC 34.020; and
>> (2) complete and submit a logbook as prescribed and provided by the department.

7. **Summary of the history of B_{MSY}:** Not applicable for this Tier 5 stock.

D. Data
1. **Summary of new information:**
    - Retained catch data from the 2016/17 directed fishery has been added; the fishery was closed and the retained catch was 0 t (0 lb).
    - Data on discarded catch in crab and groundfish fisheries has been updated with data from the 2016/17 Aleutian Islands golden king crab fishery and the 2016/17 groundfish fisheries in reporting areas 541, 542, and 543 (Figure 5).

- Discarded catch during the cooperative industry-ADF&G survey in 2016. Data was available as number of crab caught per size/sex group (males: legal, sub-lagal, and females). Assumptions were made on the representative size (width) of each group, which were converted to length then weight. A bycatch mortality rate of 0.2 (as applied to crab fisheries) was applied to the estimated total weight caught.

2. **Data presented as time series:**
a. *Total catch and b. Information on bycatch and discards:*
- Annual retained catch weight for 1960/61–2016/17 (Tables 1a and 1b, Figure 3).
- Annual retained catch weight and estimated weights of discarded legal males, discarded sublegal males, and discarded females captured by commercial crab fisheries during 1995/96–2016/17 (Table 3). Observer data on size distributions and estimated catch numbers of discarded catch were used to estimate the weight of discarded catch of red king crab by applying a weight-at-length estimator (see below). Estimates of discarded catch prior to 1995/96 are not given due to non-existence of data or to limitations on sampling for discarded catch during the crab fisheries: prior to 1988/89 there was no fishery observer program for Aleutian Islands crab fisheries and observers were required only on vessels processing king crab at sea (including catcher-processor vessels) during 1988/89–1994/95; observer data from the Aleutian Islands prior to 1990/91 is considered unreliable; and the observer data from the directed WAI red king crab fishery in 1990/91 and 1992/93–1994/95 and golden king crab fishery in the 1993/94–1994/95 are confidential due to the limited number of observed vessels. During 1995/96–2004/05, observers were required on all vessels fishing for king crab in the Aleutian Islands area at all times that a vessel was fishing. With the advent of the Crab Rationalization program in 2005/06, all vessels fishing for golden king crab in the Aleutian Islands area are now required to carry an observer for a period during which 50% of the vessel's retained catch was obtained during each trimester of the fishery; observers continue to be required at all times on a vessel fishing in the red king crab fishery west of 179° W longitude. All red king crab that were captured and discarded during the Aleutian Islands golden king crab fishery west of 174° W longitude by a vessel while an observer was on board during 2001/02–2002/03 and 2004/05–2016/17 were counted and recorded for capture location and biological data.
- Annual estimated weight of discarded catch and estimated bycatch mortality in the WAI (reporting areas 541, 542, and 543; i.e., Aleutian Islands west of 170° W longitude; Figure 5) during federal groundfish fisheries by gear type (fixed or trawl) for 1993/94–2016/17 (Table 4). Following Foy (2012a, 2012b), the bycatch mortality rate of king crab captured by fixed gear during groundfish fisheries was assumed to be 0.5 and of king crab captured by trawls during groundfish fisheries was assumed to be 0.8. Estimates of discarded catch by gear type for 1992/93 are available, but appear to be suspect because they are extremely low. Annual estimated weight of discarded catch during federal groundfish fisheries by reporting area (541, 542, and 543) for 1993/94–2016/17 is also presented in Table 5.
- Annual estimated weight of total fishery mortality for 1995/96–2016/17, partitioned into retained catch, estimated bycatch mortality during crab fisheries, and estimated bycatch mortality during federal groundfish fisheries (Table 6). Following Siddeek et al. (2011), the bycatch mortality rate of king crab captured and discarded during Aleutian Islands

king crab fisheries was assumed to be 0.2; bycatch mortality in crab fisheries was estimated for Table 6 by applying that assumed bycatch mortality rate to the estimates of discarded catch given in Table 3. The estimates of bycatch mortality in groundfish fisheries given in Table 6 are from Table 4.

- Table 7 summarizes the available data on retained catch weight and estimates of discarded catch weight.

c. *Catch-at-length:* Although not used in a Tier 5 assessment, available retained-catch size frequency sample data from 1960/61–2016/17 are summarized and presented (Appendices A1–A4).

d. *Survey biomass estimates:* Not available; there is no program for regular performance of standardized surveys sampling from the entirety of the stock range.

e. *Survey catch at length:* Not used in a Tier 5 assessment; none are presented.

f. *Other data time series:* Although not used in a Tier 5 assessment, available data on CPUE (retained crab per pot lift) from 1972/73–2016/17 directed fisheries are presented (Table 1, Figure 6).

3. Data which may be aggregated over time:
a. *Growth-per-molt; frequency of molting, etc. (by sex and perhaps maturity state)*:
Not used in a Tier 5 assessment. Growth per molt was estimated for WAI male red king crab by Vining et al. (2002) based on information received from recoveries during commercial fisheries of tagged red king crab released in the Adak Island to Amlia Island area during the 1970s (see Table 5 in Pengilly 2009). Vining et al. (2002) used a logit estimator to estimate the probability as a function of carapace length (CL, mm) at release that a male WAI red king tagged and released in new-shell condition would molt within 8–14 months after release (see Tables 6 and 7 in Pengilly 2009).

b. *Weight-at length or weight-at-age (by sex):*
Parameters (A and B) used for estimating weight (g) from carapace length (CL, mm) of male and female red king crab according to the equation, Weight = $A*CL^B$ (from Table 3-5, NPFMC 2007) are: A = 0.000361 and B = 3.16 for males and A = 0.022863 and B = 2.23382 for females; note that although the estimated parameters, A and B, are those estimated for ovigerous females, those parameters were used to estimate the weight of all females without regard to reproductive status. Estimated weights in grams were converted to lb by dividing by 453.6.

c. *Natural mortality rate:*
Not used in a Tier 5 assessment. NPFMC (2007) assumed a natural mortality rate of M = 0.18 for king crab species, but natural mortality rate has not been estimated specifically for red king crab in the WAI.

4. Information on any data sources that were available, but were excluded from the assessment:

- Distribution of effort and catch during the 2006 ADF&G Petrel Bank red king crab pot survey (Gish 2007) and the 2009 ADF&G Petrel Bank red king crab pot survey (Gish 2010).
- Sex-size distribution of catch and distribution of effort and catch during the January/February 2001 and November 2001 ADF&G-Industry red king crab survey of the Petrel Bank area (Bowers et al. 2002) and ADF&G-Industry red king crab pot survey conducted as a commissioner's permit fishery in November 2002 in the Adak Island and Atka-Amlia Islands areas (Granath 2003).
- Observer data on size distribution and geographic distribution of discarded catch of red king crab in the WAI red king crab fishery and the Aleutian Islands golden king crab fishery, 1988/89–2016/17 (ADF&G observer database).
- Summary of data collected by ADF&G WAI red king crab fishery observers or surveys during 1969–1987 (Blau 1993).

E. Analytic Approach

1. **History of modeling approaches for this stock:** This is a Tier 5 assessment.

2. **Model Description:** *Subsections a–i are not applicable to a Tier 5 assessment.*
There is no regular survey of this stock. No assessment model for the WAI red king crab stock exists and none is in development. The SSC in June 2010 recommended that: the WAI red king crab stock be managed as a Tier 5 stock; the OFL be specified as a total-catch OFL; the total-catch OFL be established as the estimated average annual weight of the retained catch and bycatch mortality in crab and groundfish fisheries over the period 1995/96–2007/08; and the period used for computing the Tier 5 total-catch OFL be fixed at 1995/96–2007/08.

Given the strong recommendations from the SSC in June 2010, Tier 5 total-catch OFLs would change only if retained catch data and estimates of discarded catch for the period 1995/96–2007/08 or assumed values of bycatch mortality rates used in the 2010 SAFE were revised. Given that no need has been shown to revise either the retained catch data or the discarded catch estimates for the period 1995/96–2007/08 or assumed values of bycatch mortality rates used in the 2010 SAFE, the recommended approach for establishing the 2017/18 OFL is the approach identified by the SSC in June 2010 and no alternative approaches are suggested by the author. Hence the recommended total-catch OFL for 2017/18 is computed according to the status quo "Alternative 1" approach as:

$$OFL_{2017/18} = RET_{95/96\text{-}07/08} + BM_{CF,\,95/96\text{-}07/08} + BM_{GF,\,95/96\text{-}07/08},$$

where,

- $RET_{95/96\text{-}07/08}$ is the average annual retained catch in the directed crab fishery during 1995/96–2007/08
- $BM_{CF,\,95/96\text{-}07/08}$ is the estimated average annual bycatch mortality in the directed and non-directed crab fisheries during 1995/96–2007/08, and
- $BM_{GF,\,95/96\text{-}07/08}$ is the estimated average annual bycatch mortality in the groundfish fisheries during 1995/96–2007/08.

Given the June 2010 SSC recommendations, items ***E.2 a–i*** are not applicable.

3. <u>**Model Selection and Evaluation**</u>**:**

a. *<u>Description of alternative model configurations</u>*
Not applicable; see section E.2.

b. ***<u>Show a progression of results from the previous assessment to the preferred base model by adding each new data source and each model modification in turn to enable the impacts of these changes to be assessed</u>*:** None; see section A.4.

c. ***<u>Evidence of search for balance between realistic (but possibly over-parameterized) and simpler (but not realistic) models</u>*:** None; see the section A.4.

d. ***<u>Convergence status and convergence criteria for the base-case model (or proposed base-case model)</u>*:** Not applicable.

e. *<u>Table (or plot) of the sample sizes assumed for the compositional data</u>*: Not applicable.

f. *<u>Do parameter estimates for all models make sense, are they credible?</u>*:
Use of the 1995/96–2007/08 time period for estimating annual total fishery mortality and computing a Tier 5 OFL was established by the SSC in 2010.

g. ***<u>Description of criteria used to evaluate the model or to choose among alternative models, including the role (if any) of uncertainty</u>*:** Use of the 1995/96–2007/08 time period for estimating annual total fishery mortality and computing a Tier 5 OFL was established by the SSC in 2010.

h. ***<u>Residual analysis (e.g. residual plots, time series plots of observed and predicted values or other approach)</u>*:** Not applicable.

i. *<u>Evaluation of the model, if only one model is presented; or evaluation of alternative models and selection of final model, if more than one model is presented</u>*: The model follows the June 2010 SSC recommendations to freeze the time period for estimation of the Tier 5 OFL.

4. <u>**Results (best model(s))**</u>**:**

a. *<u>List of effective sample sizes, the weighting factors applied when fitting the indices, and the weighting factors applied to any penalties</u>*: Not applicable to a Tier 5 assessment.

b. ***<u>Tables of estimates (all quantities should be accompanied by confidence intervals or other statistical measures of uncertainty, unless infeasible; include estimates from previous SAFEs for retrospective comparisons)</u>*:** See Table 6.

c. ***Graphs of estimates (all quantities should be accompanied by confidence intervals or other statistical measures of uncertainty, unless infeasible):*** Not applicable to a Tier 5 assessment.

d. ***Evaluation of the fit to the data:*** Not applicable to a Tier 5 assessment.

e. ***Retrospective and historic analyses (retrospective analyses involve taking the "best" model and truncating the time-series of data on which the assessment is based; a historic analysis involves plotting the results from previous assessments):*** Not applicable to a Tier 5 assessment.

f. ***Uncertainty and sensitivity analyses (this section should highlight unresolved problems and major uncertainties, along with any special issues that complicate scientific assessment, including questions about the best model, etc.):*** For a Tier 5 assessment, the major uncertainties are:

- Whether the time period is "representative of the production potential of the stock" and if it serves to "provide the required risk aversion for stock conservation and utilization goals." Or whether any such time period exists.
    - o In this regard, the CPT (May 2011 minutes) noted that the OFL (56 t; 0.12-million lb) that was established for this stock by the SSC in June 2010 "could be considered biased high because of years of high exploitation" and questioned "whether the time frame used to compute the OFL is meaningful as an estimate of the productivity potential of this stock."
- The bycatch mortality rates used in estimation of total catch. Being as most (78%) of the estimated total mortality during 1995/96–2007/08 is due to the retained catch component, the total catch estimate is not severely sensitive to the assumed bycatch mortality rates. Doubling the assumed bycatch mortality during crab fisheries from 0.2 to 0.4 would increase the OFL by a factor of 1.02; halving that assumed rate from 0.2 to 0.1 would decrease the OFL by a factor of 0.99. Increasing the assumed bycatch mortality rate for all groundfish fisheries (regardless of gear type) to 1.0, would increase the OFL by a factor of 1.07.

F. Calculation of the OFL

1. **Specification of the Tier level and stock status level for computing the OFL:**
   - Recommended as Tier 5, total-catch OFL computed as the estimated average annual total catch over a specified period.
   - Recommended time period for computing retained-catch portion of the OFL: 1995/96–2007/08.
   - Recommended time period for computing bycatch mortality due to crab fisheries: 1995/96–2007/08.
   - Recommended time period for computing bycatch mortality due to groundfish fisheries: 1995/96–2007/08.
   - Recommended bycatch mortality rates: 0.2 for crab fisheries; 0.5 for fixed-gear groundfish fisheries; 0.8 for trawl groundfish fisheries.

- Recommended OFL for 2017/18 is estimated by,

$$OFL_{2017/18} = RET_{95/96\text{-}07/08} + BM_{CF,\,95/96\text{-}07/08} + BM_{GF,\,95/96\text{-}07/08},$$

where,

- $RET_{95/96\text{-}07/08}$ is the average annual retained catch in the directed crab fishery during 1995/96–2007/08
- $BM_{CF,\,95/96\text{-}07/08}$ is the estimated average annual bycatch mortality in the directed and non-directed crab fisheries during 1995/96–2007/08, and
- $BM_{GF,\,95/96\text{-}07/08}$ is the estimated average annual bycatch mortality in the groundfish fisheries during 1995/96–2007/08.

Statistics on the data and estimates used to calculate $RET_{95/96\text{-}07/08}$, $BM_{CF,\,95/96\text{-}07/08}$, and $BM_{GF,95/96\text{-}07/08}$ are provided in the "Mean, 1995/96–2007/08" row of Table 6. Using the calculated values of $RET_{95/96\text{-}07/08}$, $BM_{CF,\,95/96\text{-}07/08}$, and $BM_{GF,95/96\text{-}07/08}$, OFL $_{2016/17}$ is,

$$OFL_{2017/18} = 43.97 \text{ t} + 1.36 \text{ t} + 10.86 \text{ t} = 56 \text{ t} \ (123,867 \text{ lb}).$$

2. **List of parameter and stock size estimates (or best available proxies thereof) required by limit and target control rules specified in the fishery management plan:** Not applicable to Tier 5 assessment.

3. **Specification of the OFL:**
a. ***Provide the equations (from Amendment 24) on which the OFL is to be based:***
From **Federal Register** / Vol. 73, No. 116, page 33926, "For stocks in Tier 5, the overfishing level is specified in terms of an average catch value over an historical time period, unless the Scientific and Statistical Committee recommends an alternative value based on the best available scientific information." Additionally, "For stocks where nontarget fishery removal data are available, catch includes all fishery removals, including retained catch and discard losses. Discard losses will be determined by multiplying the appropriate handling mortality rate by observer estimates of bycatch discards. For stocks where only retained catch information is available, the overfishing level is set for and compared to the retained catch" (FR/Vol. 73, No. 116, 33926). That compares with the specification of NPFMC (2007) that the OFL "represent[s] the average retained catch from a time period determined to be representative of the production potential of the stock."

b. ***Basis for projecting MMB to the time of mating:*** Not applicable to Tier 5 assessment.

c. ***Specification of F_{OFL}, OFL, and other applicable measures (if any) relevant to determining whether the stock is overfished or if overfishing is occurring:*** See Management Performance tables, below. No vessels participated in the 2016/17 directed fishery and but some bycatch was observed in the Aleutian Islands golden king crab fishery in 2016/17. Total catch mortality in 2016/17 consists of what occurred during the Aleutian Islands golden king crab fishery and groundfish fisheries (0.18 t) and the cooperative industry-ADF&G survey (0.03 t). Overfishing did not occur in 2016/17. The OFL and ABC values for 2017/18

in the table below are the author's recommended values. The 2017/18 TAC has not yet been established.

Management Performance Table (values in t)

Fishing Year	MSST	Biomass (MMB)	TAC[a]	Retained Catch	Total Catch	OFL	ABC
2012/13	N/A	N/A	Closed	0	<1	56	34
2013/14	N/A	N/A	Closed	0	<1	56	34
2014/15	N/A	N/A	Closed	0	<1	56	34
2015/16	N/A	N/A	Closed	0	1.3	56	34
2016/17	N/A	N/A	Closed	0	<1	56	34
2017/18	N/A	N/A				56	14

a. Pre-season harvest levels are established as total allowable catch for the rationalized fishery west of 179° W longitude and as a guideline harvest level for the non-rationalized fishery east of 179° W longitude.

Management Performance Table (values in lb)

Fishing Year	MSST	Biomass (MMB)	TAC[a]	Retained Catch	Total Catch	OFL	ABC
2012/13	N/A	N/A	Closed	0	624	123,867	74,320
2013/14	N/A	N/A	Closed	0	732	123,867	74,320
2014/15	N/A	N/A	Closed	0	474	123,867	74,320
2015/16	N/A	N/A	Closed	0	2,964	123,867	74,320
2016/17	N/A	N/A	Closed	0	454	123,867	74,320
2017/18	N/A	N/A				123,867	30,967

a. Pre-season harvest levels are established as total allowable catch for the rationalized fishery west of 179° W longitude and as a guideline harvest level for the non-rationalized fishery east of 179° W longitude.

4. **Specification of the recommended retained-catch portion of the total-catch OFL:**
   - *a.* Equation for recommended retained portion of the total-catch OFL,
     Retained-catch portion = average retained catch during 1995/96–2007/08
     = 44 t (96,932 lb).

5. **Recommended F_{OFL}, OFL total catch and the retained portion for the coming year:**
   See sections *F.3* and *F.4*, above; no F_{OFL} is recommended for a Tier 5 assessment.

G. Calculation of ABC

1. PDF of OFL. A bootstrap estimate of the sampling distribution (assuming no error in estimation of the discarded catch) of the OFL is shown in Figure 7 (the sample means of 1,000 samples drawn with replacement from the 1995/96–2007/08 estimates of total fishery mortality in Table 6). The mean (56 t) and CV (0.42) computed from the 1,000 replicates are essentially the same as for the mean and CV of the 1995/96–2007/08 total catch estimates given in Table 6. Note that generated sampling distribution is meaningful as a measure in the uncertainty of the OFL only if assumptions on the choice of years used to compute the Tier 5 OFL are true (see Section E.4.f).

2. List of variables related to scientific uncertainty.
- The time period to compute the average catch relative to the assumption that it represents "a time period determined to be representative of the production potential of the stock."
- Bycatch mortality rate in each fishery that bycatch occurs. Note that for a Tier 5 assessment, an increase in an assumed bycatch mortality rate will increase the OFL (and hence the ABC), but has no effect on the retained catch portion of the OFL or the retained catch portion of the ABC.
- Estimated discarded catch and bycatch mortality during each fishery that bycatch occurred in during 1995/96–2007/08.

3. List of additional uncertainties for alternative sigma-b. Not applicable to this Tier 5 assessment.

4. Author recommended ABC: 14 t (30,967 lb). This is lower than the ABC that has been recommended by the author since the SSC recommended a 34 t (74,320 lb) ABC for 2012/13. The SSC's recommended ABC of 34 t for 2012/13 was determined as a value "sufficient to cover bycatch and the proposed test fishery catch" (June 2012 SSC meeting minutes, page 10). It provides a 40% buffer on the OFL of 56 t (123,867 lb). However, the industry has not expressed interest in conducting a test fishery for 2017/18. Further, the 2016 Petrel survey indicated the stock is severely depressed. Thus, the author and CPT recommend increasing the buffer to 75%.

H. Rebuilding Analyses

Entire section is not applicable; this stock has not been declared overfished.
I. Data Gaps and Research Priorities
This fishery has a long history, with the domestic fishery dating back to 1960/61. However, much of the data on this stock prior to the early-mid 1980s is difficult to retrieve for analysis. Fishery data summarized to the level of statistical area are presently not available prior to 1980/81. Changes in definitions of fishery statistical areas between 1984/85 and 1985/86 also make it difficult to assess geographic trends in effort and catch over much of the fishery's history. An effort to compile all fishery data and other written documentation on the stock and fishery and to enter all existing fishery, observer, survey, and tagging data into a database that allows for analysis of all data from the fishery and stock through the history of the fishery would be time-consuming, challenging, and – perhaps – disappointing, but could provide valuable information if successful.

The SSC in October 2008, June 2011, and June 2013 noted the need for systematic surveys to obtain the data to estimate the biomass of this stock. Surveys on this stock have, however, been few and the geographic scope of the surveyed area is limited. Aside from the pot surveys performed in the Adak-Atka area during the mid-1970s (ADF&G 1978, Blau 1993), the only standardized surveys for red king crab performed by ADF&G were performed in November 2006 and November 2009 and those were limited to the Petrel Bank area (Gish 2007, 2010). ADF&G-Industry surveys, conducted as limited fisheries that allowed retention of captured legal males under provisions of a commissioner's permit, have been performed in limited areas of the WAI: during January–February 2001 and November 2001 in the Petrel Bank area (Bowers et al. 2002) and during November 2002 in the Adak-Atka-Amlia area (Granath 2003). A very limited

(18 pot lifts) Industry exploratory survey without any retention of crab was performed during mid-October to mid-December 2009 between 178°00' E longitude and 175°30' E longitude produced a catch of one red king crab, a legal-sized male (Baechler and Cook 2014). Based on requests from Industry in 2012, ADF&G designed a state-waters red king crab pot survey for the Adak Island group. Twenty-five stations were designated with 20 pot lifts in each station. To defray cost of the survey, participants would be allowed to sell up to 14 t (31,417 lb) of red king crab. In addition, bycatch mortality during the proposed survey was assumed not to exceed 9 t based on assumed maximum discarded catch weight and an assumed bycatch mortality rate of 0.2. In 2012 the CPT and SSC recommended an ABC of 34 t (0.74-million lb) for 2012/13 to accommodate total fishery mortality due the proposed red king crab survey in addition to estimated bycatch mortality due to non-directed fisheries (12 t). In late summer 2012, Industry advocates decided to forgo the fall 2012 survey.

Trawl surveys are preferable relative to pot surveys for providing density estimates, but crab pots may be the only practical gear for sampling king crab in the Aleutians. Standardized pot surveys are a prohibitively expensive approach to surveying the entire WAI. Surveys or exploratory fishing performed by industry in cooperation with ADF&G, with or without allowing retention of captured legal males, reduce the costs to agencies. Agency-Industry cooperation can provide a means to obtain some information on distribution and density during periods of fishery closures. However, there can be difficulties in assuring standardization of procedures during ADF&G-Industry surveys (Bowers et al. 2002). Moreover, costs of performing a survey have resulted in incompletion of ADF&G-Industry surveys (Granath 2003). Hence surveys performed by Industry in cooperation with ADF&G cannot be expected to provide sampling over the entire WAI during periods of limited stock distribution and overall low density, as apparently currently exists.

A cooperative survey between industry and ADF&G was performed in the Adak area in September 2015 (Hilsinger et al. 2016a). A total of 442 red king crab (23 legal males, 74 pre recruit males, 140 juvenile males, and 204 females) were captured in Sitkin Sound and Expedition Harbor from 730 pots. Since RKC were highly aggregated (most were in inner Sitkin Sound) and few crab were legal males, further surveys of RKC in this area are a low priority. A cooperative survey between industry and ADF&G was also performed in the Petrel area in November 2016 (Hilsinger et al. 2016b). A total of 40 red king crab (39 legal males, 1 sub-legal male, and 0 females) were captured.

J. Literature Cited

Alaska Department of Fish and Game (ADF&G). 1978. Westward Region shellfish report to the Alaska Board of Fisheries, April 1978. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak.

Baechler, B., and C. Cook 2014. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, 2011/12. Pages 3–71 *in* Fitch, H., M. Schwenzfeier, B. Baechler, C. Trebesch, M. Salmon, M. Good, E. Aus, C. Cook, E. Evans, E. Henry, L. Wald, J. Shaishnikoff, and K. Herring. 2014. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands,

Bering Sea and the Westward Region's Shellfish Observer Program, 2011/12. Alaska Department of Fish and Game, Fishery Management Report No. 14-54, Anchorage.

Barnard, D. R., and R. Burt. 2004. Alaska Department of Fish and Game summary of the 2002 mandatory shellfish observer program database for the general and CDQ crab fisheries. Alaska Department of Fish and Game, Regional Information Report No. 4K04-27, Kodiak.

Blau, S. F. 1990. Size at maturity of female red king crabs (*Paralithodes camtschatica*) in the Adak Management Area, Alaska. Pages 105–116 *in* Proceedings of the International Symposium on King and Tanner Crabs, Anchorage, Alaska, USA, November 28–30, 1989. Alaska Sea Grant College Program Report No. 90-04, Fairbanks.

Blau, S. F. 1993. Overview of the red king crab surveys conducted in the Adak management area (R), Alaska 1969–1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K93-10, Kodiak.

Bowers, F. R., W. Donaldson, and D. Pengilly. 2002. Analysis of the January-February and November 2001 Petrel bank red king crab commissioner's permit surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K02-11, Kodiak.

Burt, R. and D. R. Barnard. 2005. Alaska Department of Fish and Game summary of the 2003 mandatory shellfish observer program database for the general and CDQ fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 05-05, Anchorage. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Research Bulletin No. 92-02. Juneau.

Donaldson, W. E., and W. K. Donaldson. 1992. A review of the history and justification for size limits in Alaskan king, Tanner, and snow crab fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Research Bulletin No. 20-02, Juneau.

Foy, R. J., 2012a. 2012 Stock Assessment and Fishery Evaluation Report for the Pribilof Islands Blue King Crab Fisheries of the Bering Sea and Aleutian Islands Regions. *in*: Stock Assessment and fishery Evaluation report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions: 2012 Crab SAFE. NPFMC, Anchorage, September 2012.

Foy, R. J., 2012b. 2012 Stock Assessment and Fishery Evaluation Report for the Pribilof Islands Red King Crab Fisheries of the Bering Sea and Aleutian Islands Regions. *in*: Stock Assessment and fishery Evaluation report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions: 2012 Crab SAFE. NPFMC, Anchorage, September 2012.

Gish, R. K. 2007. The 2006 Petrel Bank red king crab survey. Alaska Department of Fish and Game, Fishery Management Report No. 07-44, Anchorage.

Gish, R. K. 2010. The 2009 Petrel Bank red king crab pot survey: Results for red king crab. Alaska Department of Fish and Game, Regional Information Report No. 4K10-06, Kodiak.

Granath, K. 2003. Analysis of the November 2002 Adak, Atka, and Amlia Islands red king crab commissioner's permit survey. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 4K03-33, Kodiak.

Grant, W.S., D.A. Zelinina, and N.S. Mugue. 2014. Phylogeography of red king crab: implications for management and stock enhancement. Pages 47-72 *in* B.G. Stevens (ed.): King Crabs of the World: Biology and Fisheries Management. CRC Press, Taylor & Francis Group, New York.

Hilsinger, J., C. Siddon and L. Hulbert. 2016a. Cooperative red king crab survey in the Adak area, 2015. Anchorage., Alaska Department of Fish and Game, Fishery Data Series No. 16-18.

Hilsinger, J., and C. Siddon. 2016b. Cooperative red king crab survey in the Petrel Bank area, 2016. Alaska Department of Fish and Game, Regional Operational Plan ROP.CF.5J.2016.01, Juneau.

McMullen, J. 1967. Breeding king crabs *Paralithodes camtschatica* located in ocean environment. J. Fish. Res. Board. Can. 24(12): 2627–2628.

McMullen, J. 1969. Effects of delayed mating in the reproduction of king crab *Paralithodes camtschatica*. J. Fish. Res. Board. Can. 26(10): 2737–2740.

McMullen, J., and H. Yoshihara. 1971. King crab research: Alaska Peninsula-Aleutian Islands Area. *In*: ADF&G. 1971. King crab management report to the Board of Fish and Game, April 1971 meeting. Kodiak.

Moore, H., L.C. Byrne, and D. Connolly. 2000. Summary of the 1998 mandatory shellfish observer program database. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 4K00-21, Kodiak.

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

North Pacific Fishery Management Council (NPFMC). 2007. Public Review Draft: Environmental Assessment for proposed Amendment 24 to the Fishery Management Plan for Bering Sea and Aleutian Islands King and Tanner Crabs to Revise Overfishing Definitions. 14 November 2007. North Pacific Fishery Management Council, Anchorage.

Nyblade, C.F. 1987. Phylum or subphylum Crustacea, class Malacostraca, order Decopoda, Anomura. In: M.F. Strathman (ed), Reproduction and development of marine invertebrates on the northern Pacific Coast. Univ. Wash. Press, Seattle.

Otto, R. S., R. A. MacIntosh, and P. A. Cummiskey. 1990. Fecundity and other reproductive parameters of female red king crab (*Paralithodes camtschatica*) in Bristol Bay and Norton Sound, Alaska. Pages 65–90 *in* Proceedings of the International Symposium on King and Tanner Crabs, Anchorage, Alaska, USA, November 28–30, 1989. Alaska Sea Grant College Program Report No. 90-04, Fairbanks.

Pengilly, D. 2009. Adak red king crab: September 2009 Crab SAFE Report Chapter. Pages 605–644 *in*: Stock Assessment and Fishery Evaluation Report for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands Regions (2009 Crab SAFE), September 2009. North Pacific Fishery Management Council, Anchorage, AK.

Powell, G. C., and R. B. Nickerson. 1965. Reproduction of king crabs *Paralithodes camtschatica* (Tilesius). J. Fish. Res. Board Can. 22(1):101–111.

Powell, G. C., D. Pengilly, and S. F. Blau. 2002. Mating pairs of red king crabs (*Paralithodes camtschaticus*) in the Kodiak Archipelago, Alaska, 1960–1984. Pages 225–245 *in* Crabs in cold-water regions: Biology, management, and economics. University of Alaska Sea Grant, AK-SG-02-01, Fairbanks.

Powell, G. C., B. Shafford, and M. Jones. 1973. Reproductive biology of young adult king crabs *Paralithodes camtschaticus* (Tilesius) at Kodiak, Alaska. Proc. Natl. Shellfish. Assoc. 63:77–87.

Seeb, L., and C. Smith. 2005. Red king crab and snow-Tanner crab genetics. Bering Sea Crab Research II, Project 2. Final Comprehensive Performance Report for NOAA Award NA16FN2621. October 2005. ADF&G, Juneau.

Siddeek, M.S.M., D. Pengilly, and J. Zheng. 2011. Aleutian Islands golden king crab (*Lithodes aequispinus*) model based stock assessment. http://www.fakr.noaa.gov/npfmc/PDFdocuments/membership/PlanTeam/Crab/GKCModelBasedAssessWorkShopJan2012.pdf

Wallace, M. M., C. J. Pertuit, and A. R. Hvatum. 1949. Contribution to the biology of the king crab (*Paralithodes camtschatica* Tilesius). U. S. Fish Wildl. Serv. Fish. Leafl. 340.

Webb. J. 2014. Reproductive ecology of commercially important Lithodid crabs. Pages 285-314 In B.G. Stevens (ed.): King Crabs of the World: Biology and Fisheries Management. CRC Press, Taylor & Francis Group, New York.

Vining, I., S. F. Blau, and D. Pengilly. 2002. Growth of red king crabs from the central Aleutian Islands, Alaska. Pages 39–50 *in* Crabs in cold-water regions: Biology, management, and economics. University of Alaska Sea Grant, AK-SG-02-01, Fairbanks.

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Appendix A5. Page 49. Plot of available retained catch size frequency sample data 1961/62–2003/04 western Aleutian Islands directed red king crab fishery (data listed in Appendices A2-A4).

Table 1a. Commercial fishery history for the western Aleutian Islands red king crab commercial fishery, 1960/61–2016/17: number of vessels, guideline harvest level (GHL; established in lb, **converted to t**) for 1973/74–2004/05, total allowable catch (TAC; established in lb, **converted to t**) in the area west of 179° W longitude combined with GHL (established in lb, **converted to t**) in the area east of 179° W longitude for 2005/06–2016/17, weight of retained catch (Harvest; **t**), number of retained crab, pot lifts, fishery catch per unit effort (CPUE; retained crab per pot lift), and average weight (**kg**) of retained crab.

Crab fishing year	Area	Vessels	GHL/TAC	Harvest[a]	Crab[a]	Pots lifted	CPUE	Weight
1960/61	West of 172° W	4	-	941	NA	NA	NA	NA
1961/62	West of 172° W	8	-	2,773	NA	NA	NA	NA
1962/63	West of 172° W	9	-	3,631	NA	NA	NA	NA
1963/64	West of 172° W	11	-	8,121	NA	NA	NA	NA
1964/65	West of 172° W	18	-	9,613	NA	NA	NA	NA
1965/66	West of 172° W	10	-	5,858	NA	NA	NA	NA
1966/67	West of 172° W	10	-	2,668	NA	NA	NA	NA
1967/68	West of 172° W	22	-	6,410	NA	NA	NA	NA
1968/69	West of 172° W	30	-	7,303	NA	NA	NA	NA
1969/70	West of 172° W	33	-	8,172	NA	115,929	NA	2.5
1970/71	West of 172° W	35	-	7,283	NA	124,235	NA	NA
1971/72	West of 172° W	40	-	7,020	NA	46,011	NA	NA
1972/73	West of 172° W	43	-	8,493	3,461,025	81,133	43	2.5
1973/74	West of 172° W	41	9,072[b]	4,419	1,844,974	70,059	26	2.4
1974/75	West of 172° W	36	9,072[b]	1,259	532,298	32,620	16	2.4
1975/76	West of 172° W	20	6,804[b]	187	79,977	8,331	10	2.3
1976/77	West of 172° W	FC	FC	FC	FC	FC	FC	FC
1977/78	West of 172° W	12	113–1,134	411	160,343	7,269	22	2.6
1978/79	West of 172° W	13	227–1,361	366	149,491	13,948	11	2.4
1979/80	West of 172° W	18	227–1,361	212	82,250	9,757	8	2.6
1980/81	West of 172° W	17	227–1,361	644	254,390	20,914	12	2.5
1981/82	West of 172° W	46	227–1,361	748	291,311	40,697	7	2.6
1982/83	West of 172° W	72	227–1,361	772	284,787	66,893	4	2.7
1983/84	West of 172° W	106	227–1,361	899	298,958	60,840	5	3.0
1984/85	West of 171° W	64	680–1,361	588	196,276	48,642	4	3.0
1985/86	West of 171° W	35	227–907	394	156,097	29,095	5	2.5
1986/87	West of 171° W	33	227–680	323	126,204	29,189	4	2.6
1987/88	West of 171° W	71	227–680	551	211,692	43,433	5	2.6
1988/89	West of 171° W	73	454	711	266,053	64,334	4	2.7
1989/90	West of 171° W	56	771	502	193,177	54,213	4	2.6
1990/91	West of 171° W	7	NA	376	146,903	10,674	14	2.6
1991/92	West of 171° W	10	NA	431	165,356	16,636	10	2.6
1992/93	West of 171° W	12	NA	584	218,049	16,129	14	2.7
1993/94	West of 171° W	12	NA	317	119,330	13,575	9	2.7
1994/95	West of 171° W	20	454–680	89	30,337	18,146	2	2.9
1995/96	West of 171° W	4	454–680	18	6,880	1,986	3	2.6
1996/97–1997/98	West of 171° W	FC	FC	FC	FC	FC	FC	FC
1998/99	174°–179° W; west of 179° E	1	7	CF	CF	CF	CF	CF
1999/00	West of 171° W	FC	FC	FC	FC	FC	FC	FC
2000/01[c]	179° W–179° E	1	(Permit/Survey)	35	11,299	496	23	3.1
2001/02[d]	179° W–179° E	4	(Permit/Survey)	70	22,080	564	39	3.2
2002/03	179° W–179° E	33	227	229	68,300	3,786	18	3.4
2003/04	179° W–179° E	30	227	217	59,828	5,774	10	3.6
2004/05–2016/17	West of 171° W	FC	FC	FC	FC	FC	FC	FC

Note: NA = Not available, FC = fishery closed, CF = confidential.

[a] Deadloss included.
[b] GHL includes all king crab species. Golden king crab incidental to red king crab.
[c] January/February 2001 Petrel Bank survey.
[d] November 2001 Petrel Bank survey.

Table 1b. Commercial fishery history for the western Aleutian Islands red king crab commercial fishery, 1960/61–2016/17 number of vessels, guideline harvest level (GHL; **lb**) for 1973/74–2004/05, total allowable catch (TAC; **lb**) in the area west of 179° W longitude combined with GHL (**lb**) in the area east of 179° W longitude for 2005/06–2016/17, weight of retained catch (Harvest; **lb**), number of retained crab, pot lifts, fishery catch per unit effort (CPUE; retained crab per pot lift), and average weight (**lb**) of retained crab.

Crab fishing year	Area	Vessels	GHL/TAC	Harvest[a]	Crab[a]	Pots lifted	CPUE	Weight
1960/61	West of 172° W	4	-	2,074,000	NA	NA	NA	NA
1961/62	West of 172° W	8	-	6,114,000	NA	NA	NA	NA
1962/63	West of 172° W	9	-	8,006,000	NA	NA	NA	NA
1963/64	West of 172° W	11	-	17,904,000	NA	NA	NA	NA
1964/65	West of 172° W	18	-	21,193,000	NA	NA	NA	NA
1965/66	West of 172° W	10	-	12,915,000	NA	NA	NA	NA
1966/67	West of 172° W	10	-	5,883,000	NA	NA	NA	NA
1967/68	West of 172° W	22	-	14,131,000	NA	NA	NA	NA
1968/69	West of 172° W	30	-	16,100,000	NA	NA	NA	NA
1969/70	West of 172° W	33	-	18,016,000	NA	115,929	NA	6.5
1970/71	West of 172° W	35	-	16,057,000	NA	124,235	NA	NA
1971/72	West of 172° W	40	-	15,475,940	NA	46,011	NA	NA
1972/73	West of 172° W	43	-	18,724,140	3,461,025	81,133	43	5.4
1973/74	West of 172° W	41	20,000,000[b]	9,741,464	1,844,974	70,059	26	5.3
1974/75	West of 172° W	36	20,000,000[b]	2,774,963	532,298	32,620	16	5.2
1975/76	West of 172° W	20	15,000,000[b]	411,583	79,977	8,331	10	5.2
1976/77	West of 172° W	FC	FC	FC	FC	FC	FC	FC
1977/78	West of 172° W	12	0.25 - 2.5 million	905,527	160,343	7,269	22	5.7
1978/79	West of 172° W	13	0.5 - 3.0 million	807,195	149,491	13,948	11	5.4
1979/80	West of 172° W	18	0.5 - 3.0 million	467,229	82,250	9,757	8	5.7
1980/81	West of 172° W	17	0.5 - 3.0 million	1,419,513	254,390	20,914	12	5.6
1981/82	West of 172° W	46	0.5 - 3.0 million	1,648,926	291,311	40,697	7	5.7
1982/83	West of 172° W	72	0.5 - 3.0 million	1,701,818	284,787	66,893	4	6.0
1983/84	West of 172° W	106	0.5 - 3.0 million	1,981,579	298,958	60,840	5	6.6
1984/85	West of 171° W	64	1.5 - 3.0 million	1,296,385	196,276	48,642	4	6.6
1985/86	West of 171° W	35	0.5 - 2.0 million	868,828	156,097	29,095	5	5.6
1986/87	West of 171° W	33	0.5 - 1.5 million	712,543	126,204	29,189	4	5.7
1987/88	West of 171° W	71	0.5 - 1.5 million	1,213,892	211,692	43,433	5	5.7
1988/89	West of 171° W	73	1.0 million	1,567,314	266,053	64,334	4	5.9
1989/90	West of 171° W	56	1.7 million	1,105,971	193,177	54,213	4	5.7
1990/91	West of 171° W	7	NA	828,105	146,903	10,674	14	5.6
1991/92	West of 171° W	10	NA	951,278	165,356	16,636	10	5.8
1992/93	West of 171° W	12	NA	1,286,424	218,049	16,129	14	6.0
1993/94	West of 171° W	12	NA	698,077	119,330	13,575	9	5.9
1994/95	West of 171° W	20	1.0 - 1.5 million	196,967	30,337	18,146	2	6.5
1995/96	West of 171° W	4	1.0 - 1.5 million	38,941	6,880	1,986	3	5.7
1996/97–1997/98	West of 171° W	FC	FC	FC	FC	FC	FC	FC
1998/99	174°–179° W; west of 179° E	1	15,000	CF	CF	CF	CF	CF
1999/00	West of 171° W	FC	FC	FC	FC	FC	FC	FC
2000/01[c]	179° W–179° E	1	(Permit/Survey)	76,562	11,299	496	23	6.8
2001/02[d]	179° W–179° E	4	(Permit/Survey)	153,961	22,080	564	39	7.0
2002/03	179° W–179° E	33	500,000	505,642	68,300	3,786	18	7.4
2003/04	179° W–179° E	30	500,000	479,113	59,828	5,774	10	8.0
2004/05–2016/17	West of 171° W	FC	FC	FC	FC	FC	FC	FC

Note: NA = Not available, FC = fishery closed, CF = confidential.
[a] Deadloss included.
[b] GHL includes all king crab species. Golden king crab incidental to red king crab.

[c] January/February 2001 Petrel Bank survey.
[d] November 2001 Petrel Bank survey.

Table 2. A summary of relevant fishery activities and management measures pertaining to the Western Aleutian Islands red king crab fishery since 1996/97.

Crab fishing year	Fishery Activities and Management Measures
1996/97–1997/98	• Fishery closed.
1998/99	• GHL of 7 t (15,000 lb) for exploratory fishing with fishery closed in the Petrel Bank area (i.e., between 179° W longitude and 179° E longitude) ○ 1 vessel
1999/00	• Fishery closed
2000/01	• Fishery closed • Catch retained during ADF&G-Industry survey of Petrel Bank area (i.e., between 179° W longitude and 179° E longitude) conducted as commissioner's permit fishery, Jan–Feb 2001 ○ 1 vessel ○ Retained catch weight = 35 t (76,562 lb) ○ CPUE = 23 retained crab per pot lift
2001/02	• Fishery closed • Catch retained ADF&G-Industry survey of Petrel Bank area (i.e., between 179° W longitude and 179° E longitude) conducted as commissioner's permit fishery, November 2001 ○ 4 vessels ○ Retained catch weight = 70 t (153,961 lb) ○ CPUE = 39 retained crab per pot lift
2002/03	• Fishery opened with GHL of 227 t (500,000 lb) restricted to Petrel Bank area (i.e., between 179° W longitude and 179° E longitude) ○ 33 vessels ○ Retained catch weight = 229 t (505,642 lb) ○ CPUE = 18 retained crab per pot lift • ADF&G-Industry survey of the Adak, Atka, and Amlia Islands area conducted as a commissioner's permit fishery ○ 4 legal males captured in 1,085 pot lifts
2003/04	• Fishery opened with GHL of 227 t (500,000 lb) restricted to Petrel Bank area (i.e., between 179° W longitude and 179° E longitude) ○ 30 vessels ○ Retained catch weight = 217 t (479,113) lb ○ 10 retained crab per pot lift
2004/05–2016/17	• Fishery closed ○ 2006 and 2009 ADF&G pot surveys on Petrel Bank ○ 2015 exploratory/reconnaissance survey in Adak Island area. ○ 2016 exploratory/reconnaissance survey in the Petrel Bank area.

Table 3. Annual retained catch (**t**) of Western Aleutian Islands red king crab, with the estimated annual discarded catch (**t**; <u>not</u> discounted for an assumed bycatch mortality rate) and components of discarded catch (legal males, sublegal males, and females) during commercial crab fisheries, 1995/96–2016/17.

Crab fishing year		WAI red king crab fishery			AI golden king crab fishery			Total
		Discarded						
	Retained	Legal male	Sublegal male	Female	Legal male	Sublegal male	Female	Discarded
1995/96	17.66	0.00	9.38	12.53	0.00	0.93	0.14	22.98
1996/97	0.00	0.00	0.00	0.00	1.49	0.92	0.30	2.71
1997/98	0.00	0.00	0.00	0.00	0.08	0.26	0.08	0.42
1998/99[a]	2.68	–[a]	–[a]	–[a]	0.34	0.06	0.08	–[a]
1999/00	0.00	0.00	0.00	0.00	0.07	0.34	0.04	0.46
2000/01	34.73	0.00	0.35	0.17	0.17	0.12	0.02	0.83
2001/02	69.84	0.08	2.98	3.80	9.07	0.00	0.17	16.09
2002/03	229.36	0.75	2.73	7.91	9.86	0.16	0.23	21.65
2003/04	217.32	0.29	2.99	3.61	4.28	2.88	3.03	17.08
2004/05	0.00	0.00	0.00	0.00	0.97	0.10	0.00	1.07
2005/06	0.00	0.00	0.00	0.00	0.09	0.00	0.02	0.11
2006/07	0.00	0.00	0.00	0.00	0.15	0.05	0.02	0.22
2007/08	0.00	0.00	0.00	0.00	0.28	0.83	0.25	1.36
2008/09	0.00	0.00	0.00	0.00	0.10	0.01	0.04	0.15
2009/10	0.00	0.00	0.00	0.00	0.26	0.11	0.02	0.39
2010/11	0.00	0.00	0.00	0.00	1.96	0.08	0.04	2.07
2011/12	0.00	0.00	0.00	0.00	0.43	0.01	0.04	0.49
2012/13	0.00	0.00	0.00	0.00	0.40	0.03	0.02	0.44
2013/14	0.00	0.00	0.00	0.00	1.34	0.05	0.08	1.46
2014/15	0.00	0.00	0.00	0.00	0.24	0.01	0.03	0.28
2015/16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2016/17	0.00	0.00	0.00	0.00	0.15	0.01	0.07	0.23
Average	25.98	0.05	0.88	1.33	1.49	0.33	0.22	4.31

[a] Data on discarded catch of red king crab during the red king crab fishery not available (see Moore et al. 2000).

Table 4. Estimated annual weight (**t**) of discarded catch of red king crab (all sizes, males and females) and estimated annual bycatch mortality (**t**) during federal groundfish fisheries by gear type (fixed or trawl) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude), 1993/94–2016/17 (assumes bycatch mortality rate of 0.5 for fixed-gear fisheries and 0.8 for trawl fisheries).

Crab fishing	Discarded catch		Bycatch Mortality		
year	Fixed Gear	Trawl Gear	Fixed Gear	Trawl Gear	Total
1993/94	0.60	40.09	0.30	32.07	32.37
1994/95	1.36	10.34	0.68	8.27	8.95
1995/96	2.63	6.93	1.32	5.55	6.86
1996/97	1.30	20.26	0.65	16.21	16.86
1997/98	1.73	5.31	0.87	4.25	5.12
1998/99	4.60	20.65	2.30	16.52	18.82
1999/00	17.13	12.69	8.57	10.15	18.72
2000/01	1.22	6.30	0.61	5.04	5.65
2001/02	2.42	27.01	1.21	21.61	22.82
2002/03	5.12	33.12	2.56	26.50	29.06
2003/04	1.62	4.15	0.81	3.32	4.13
2004/05	0.36	5.86	0.18	4.69	4.87
2005/06	1.61	1.07	0.80	0.86	1.66
2006/07	3.08	0.28	1.54	0.22	1.76
2007/08	7.70	1.19	3.85	0.95	4.80
2008/09	4.89	4.67	2.44	3.73	6.18
2009/10	0.14	6.40	0.07	5.12	5.19
2010/11	0.04	1.99	0.02	1.59	1.61
2011/12	1.19	0.82	0.60	0.41	1.01
2012/13	0.01	0.24	0.00	0.19	0.19
2013/14	0.01	0.04	0.01	0.03	0.04
2014/15	0.00	0.11	0.00	0.09	0.09
2015/16	0.03	1.46	0.02	1.17	1.19
2016/17	0.00	0.17	0.00	0.13	0.13
Average	2.45	8.80	1.23	7.03	8.25

Table 5. Estimated annual weight of discarded catch (**t**; <u>not</u> discounted by an assumed bycatch mortality rate) of red king crab in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude) during federal groundfish fisheries (all gear types combined) by reporting area, 1993/94–2016/17.

Crab fishing	Reporting Area			
year	541	542	543	Total
1993/94	37.9893	2.6590	0.0372	40.6855
1994/95	10.7216	0.8718	0.1025	11.6959
1995/96	5.9520	1.8398	1.7763	9.5681
1996/97	1.9477	3.0890	16.5258	21.5624
1997/98	1.0061	3.9639	2.0770	7.0470
1998/99	6.7549	7.1659	11.3335	25.2542
1999/00	16.3416	8.0535	5.4227	29.8183
2000/01	1.7686	3.6541	2.0961	7.5192
2001/02	3.4750	24.0341	1.9250	29.4341
2002/03	10.9996	21.3098	5.9384	38.2483
2003/04	2.2294	3.5280	0.0163	5.7733
2004/05	0.5280	5.6803	0.0154	6.2237
2005/06	1.6057	0.0395	1.0333	2.6785
2006/07	2.9688	0.3869	0.0000	3.3557
2007/08	5.1233	3.0427	0.7248	8.8909
2008/09	1.1440	7.5455	0.8668	9.5563
2009/10	1.6719	3.7548	1.1136	6.5404
2010/11	0.2123	1.8162	0.0005	2.0289
2011/12	0.8768	1.1335	0.0000	2.0108
2012/13	0.1560	0.0903	0.0000	0.2463
2013/14	0.0000	0.0435	0.0118	0.0553
2014/15	0.0000	0.1148	0.0005	0.1152
2015/16	0.0000	0.8864	0.6102	1.4966
2016/17	0.0000	0.0718	0.0950	0.1669
Average	4.7280	4.3656	2.1551	11.2488

Table 6. Estimated annual weight (**t**) of total fishery mortality to Western Aleutian Islands red king crab, 1995/96–2016/17, partitioned by source of mortality: retained catch, estimated bycatch mortality during crab fisheries, and estimated bycatch mortality during groundfish fisheries.

Crab fishing year	Retained Catch	Bycatch Mortality by Fishery Type Crab	Groundfish	Total Estimated Fishery mortality
1995/96	17.66	4.60	6.86	29.12
1996/97	0.00	0.54	16.86	17.40
1997/98	0.00	0.08	5.12	5.20
1998/99[a]	2.68	0.70	18.82	22.19
1999/00	0.00	0.09	18.72	18.81
2000/01	34.73	0.17	5.65	40.54
2001/02	69.84	3.22	22.82	95.88
2002/03	229.36	4.33	29.06	262.75
2003/04	217.32	3.42	4.13	224.87
2004/05	0.00	0.21	4.87	5.08
2005/06	0.00	0.02	1.66	1.68
2006/07	0.00	0.04	1.76	1.81
2007/08	0.00	0.27	4.80	5.08
2008/09	0.00	0.03	6.18	6.21
2009/10	0.00	0.08	5.19	5.27
2010/11	0.00	0.41	1.61	2.02
2011/12	0.00	0.10	1.01	1.10
2012/13	0.00	0.09	0.19	0.28
2013/14	0.00	0.29	0.04	0.33
2014/15	0.00	0.06	0.09	0.15
2015/16	0.00	0.16	1.19	1.34
2016/17	0.00	0.07	0.13	0.21
Mean, 1995/96–2007/08	43.97	1.36	10.86	56.19
CV of mean	0.52	0.37	0.23	0.43
Mean, 1995/96–2016/17	25.98	0.86	7.13	33.97
CV of mean	0.54	0.37	0.25	0.45

a. No discarded catch data was available from the 1998/99 directed fishery for red king crab (see Table 2); bycatch mortality due to the 1998/99 crab fisheries was estimated by multiplying the retained catch for the 1998/99 directed red king crab fishery by the ratio of the 1995/96 bycatch mortality in crab fisheries to the 1995/96 retained catch.

Table 7. Annual retained catch weight (**t**) and estimates of annual discarded catch weight (**t**; <u>not</u> discounted for an assumed bycatch mortality rate) of Western Aleutian Islands red king crab available for a Tier 5 assessment; shaded, bold values are used in computation of the recommended (status quo) 2017/18 Tier 5 OFL.

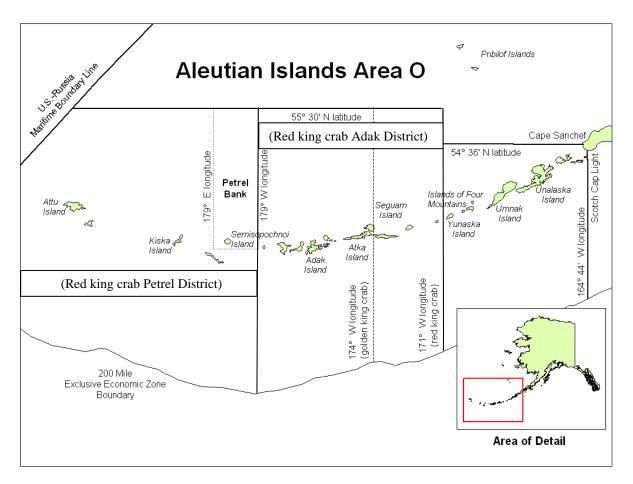| Crab Fishing Year | Retained catch weight | Discarded catch weight (estimated) | | |
| | Fish tickets | Observer data: lengths, catch per sampled pot | Blend method; Catch Accounting System | |
	Directed fishery	Crab fisheries	Fixed gear, groundfish	Trawl gear, groundfish
1960/61	940.75	—	—	—
1961/62	2773.27	—	—	—
1962/63	3631.46	—	—	—
1963/64	8121.13	—	—	—
1964/65	9612.99	—	—	—
1965/66	5858.15	—	—	—
1966/67	2668.49	—	—	—
1967/68	6409.72	—	—	—
1968/69	7302.85	—	—	—
1969/70	8171.93	—	—	—
1970/71	7283.34	—	—	—
1971/72	7019.78	—	—	—
1972/73	8493.14	—	—	—
1973/74	4418.66	—	—	—
1974/75	1258.70	—	—	—
1975/76	186.69	—	—	—
1976/77	0.00	—	—	—
1977/78	410.74	—	—	—
1978/79	366.14	—	—	—
1979/80	211.93	—	—	—
1980/81	643.88	—	—	—
1981/82	747.94	—	—	—
1982/83	771.93	—	—	—
1983/84	898.83	—	—	—
1984/85	588.03	—	—	—
1985/86	394.09	—	—	—
1986/87	323.20	—	—	—
1987/88	550.61	—	—	—
1988/89	710.92	—	—	—
1989/90	501.66	—	—	—
1990/91	375.62	Confidential	—	—
1991/92	431.49	Confidential	—	—
1992/93	583.51	Confidential	—	—
1993/94	316.64	Confidential	0.60	40.09
1994/95	89.34	Confidential	1.36	10.34
1995/96	**17.66**	**22.98**	**2.63**	**6.93**
1996/97	**0.00**	**2.71**	**1.30**	**20.26**
1997/98	**0.00**	**0.42**	**1.73**	**5.31**
1998/99	**2.68**	**3.48**	**4.60**	**20.65**
1999/00	**0.00**	**0.46**	**17.13**	**12.69**
2000/01	**34.73**	**0.83**	**1.22**	**6.30**
2001/02	**69.84**	**16.09**	**2.42**	**27.01**
2002/03	**229.36**	**21.65**	**5.12**	**33.12**
2003/04	**217.32**	**17.08**	**1.62**	**4.15**
2004/05	**0.00**	**1.07**	**0.36**	**5.86**
2005/06	**0.00**	**0.11**	**1.61**	**1.07**
2006/07	**0.00**	**0.22**	**3.08**	**0.28**
2007/08	**0.00**	**1.36**	**7.70**	**1.19**
2008/09	0.00	0.15	4.89	4.67
2009/10	0.00	0.39	0.14	6.40
2010/11	0.00	2.07	0.04	1.99
2011/12	0.00	0.49	1.19	0.82
2012/13	0.00	0.44	0.01	0.24
2013/14	0.00	1.46	0.01	0.04
2014/15	0.00	0.28	0.00	0.11
2015/16	0.00	0.00	0.03	1.46
2016/17	0.00	0.23	0.00	0.17

Figure 1. Aleutian Islands, Area O, red and golden king crab management area (from Baechler and Cook 2014, updated to show boundaries of the Adak and Petrel Districts for red king crab as established by the Alaska Board of Fisheries in March 2014).
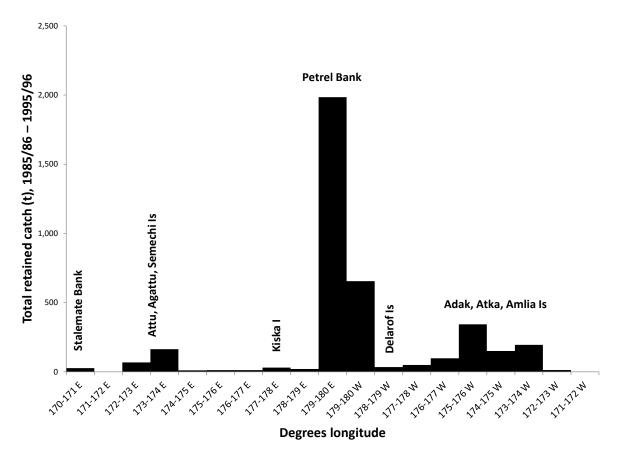
Figure 2. Retained catch (**t**) in the Western Aleutian Islands red king crab fishery, 1985/86–1995/96 by 1-degree longitude grouping, summarized from fish ticket catch by state statistical area landing data.
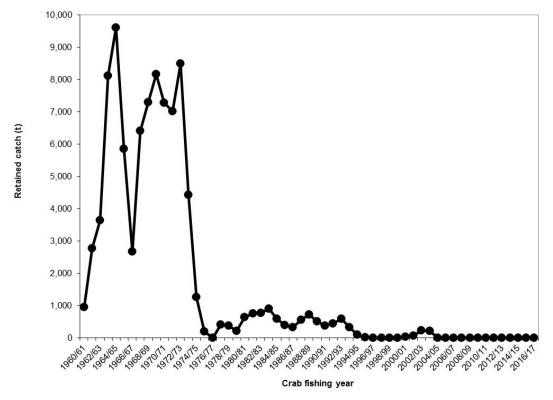
Figure 3. Retained catch (**t**) in the Western Aleutian Islands red king crab fishery, 1960/61–2016/17 (catch is for the area west of 172° W longitude during 1960/61–1983/84 and for the area west of 171° W longitude during 1984/85–2016/17; see Table 1a).
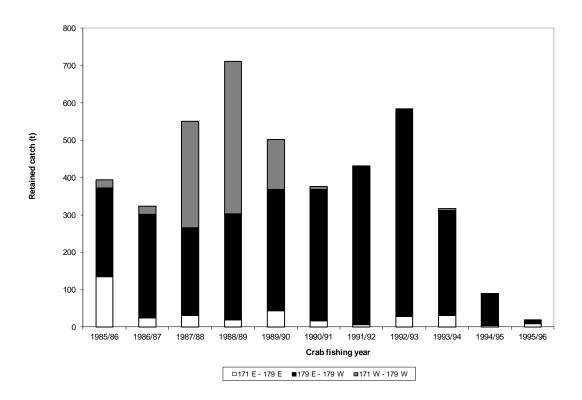
Figure 4. Annual retained catch (**t**) in the Western Aleutian Islands red king crab fishery during 1985/86–1995/96, partitioned into three longitudinal zones: 171º W longitude to 179º W longitude (white bars); 179º W longitude to 179º E longitude (black bars); and 179º E longitude to 171º E longitude.
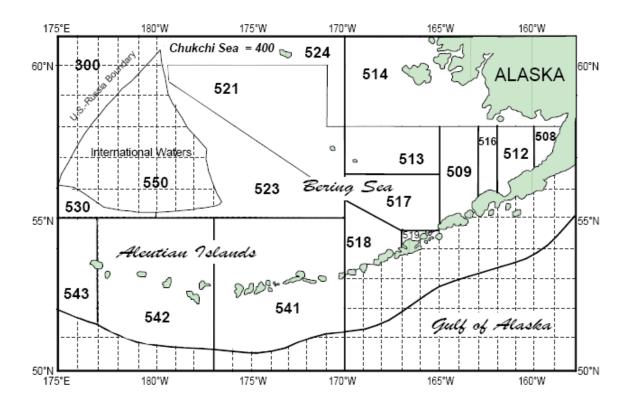

Figure 5. Map of federal groundfish fishery reporting areas for the Bering Sea and Aleutian Islands. Areas 541, 542, and 543 are used to obtain data on discarded catch of Western Aleutian Islands red king crab during groundfish fisheries (from http://www.alaskafisheries.noaa.gov/rr/figures/fig1.pdf).
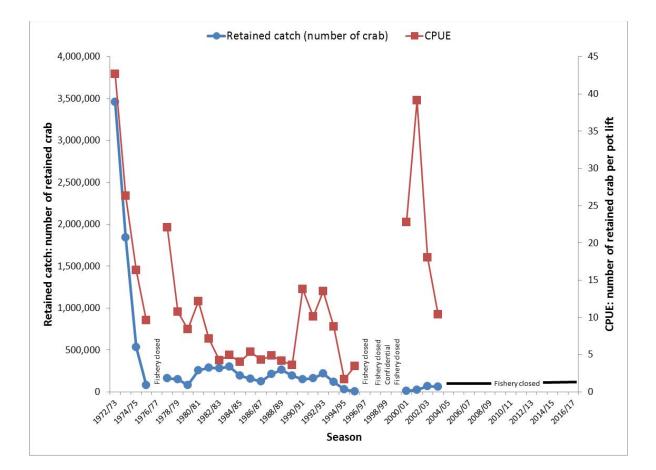
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Figure 6. Retained catch (number of crab) and CPUE (number of retained crab per pot lift) in the western Aleutian Islands red king crab fishery, 1972/73–2016/17 (from Table 1a). Data for 1972/73–1983/84 are for the area west of 172° W longitude; data for 1984/85–1997/98, 1999/00, and 2004/05–2016/17 are for the area west of 171° W longitude; data for 1998/99 are for the area west of 174° W longitude; and data for 2000/01–2003/04 are for the area between 179° W longitude and 179° E longitude.
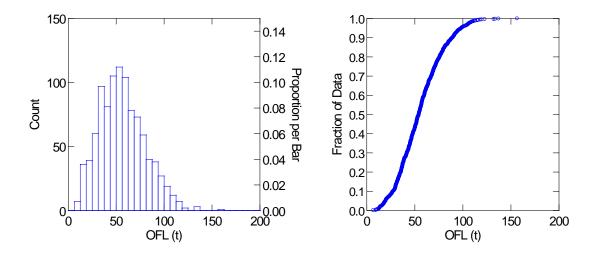
Figure 7. Bootstrapped estimate of the sampling distribution of the recommended 2016/2017 Tier 5 OFL (total-catch, t) for the Western Aleutian Islands red king crab stock; histogram in left column, cumulative distribution in right column.

Appendix A1. Summary of retained catch size frequency data available from Western Aleutian Islands directed red king crab fishery, 1960/61–2015/16.

Crab fishing year	N
1960/61	0
1961/62	386
1962/63	661
1963/64	0
1964/65	1,285
1965/66	423
1966/67	0
1967/68	0
1968/69	0
1969/70	0
1970/71	0
1971/72	0
1972/73	10,043
1973/74	9,789
1974/75	2,609
1975/76	680
1976/77	0
1977/78	666
1978/79	1,485
1979/80	963
1980/81	2,537
1981/82	2,175
1982/83	6,287
1983/84	3,806
1984/85	1,805
1985/86	1,217
1986/87	422
1987/88	441
1988/89	4,860
1989/90	12,405
1990/91	9,406
1991/92	8,306
1992/93	5,195
1993/94	4,426
1994/95	1,037
1995/96	978
1996/97−1997/98	Closed
1998/99	0
1999/00	Closed
2000/01	460
2001/02	589
2002/03	2,056
2003/04	2,381
2004/05−2016/17	Closed

Appendix A2. Available retained catch size frequency sample data 1961/62–1979/80 western Aleutian Islands directed red king crab fishery. Page 1 of 3.

CL (mm)	1961/62	1962/63	1964/65	1965/66	1972/73	1973/74	1974/75	1975/76	1977/78	1978/79	1979/80
98	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0	0
108	0	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0	0
117	0	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0
122	0	0	0	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0	0
124	0	2	0	0	0	0	0	0	0	0	0
125	0	1	0	0	0	0	0	0	0	0	0
126	0	2	0	0	0	0	0	0	0	0	0
127	0	3	0	0	0	0	0	0	0	0	0
128	0	2	0	0	0	0	0	0	0	0	0
129	0	1	0	0	0	0	0	0	0	1	0
130	0	7	0	0	3	1	0	0	0	3	0
131	0	2	0	0	1	0	0	0	0	1	0
132	0	1	0	0	1	7	6	1	0	1	1
133	0	3	0	0	13	15	9	1	0	7	4
134	0	3	2	0	22	24	15	0	1	4	1
135	0	5	0	0	52	58	31	7	0	12	9
136	0	4	0	1	91	107	30	7	5	13	3
137	0	3	2	0	179	174	52	17	11	37	8

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CL (mm)	1961/62	1962/63	1964/65	1965/66	1972/73	1973/74	1974/75	1975/76	1977/78	1978/79	1979/80
138	0	3	4	0	313	281	114	20	16	40	9
139	0	6	3	1	267	295	103	22	15	38	15
140	0	9	1	2	434	362	119	37	19	45	28
141	0	11	2	1	384	403	102	31	17	53	15
142	0	9	3	0	476	445	150	46	29	65	33
143	0	8	3	2	532	462	136	44	35	71	32
144	0	6	7	1	473	497	112	49	35	52	32
145	2	7	14	1	547	549	109	37	30	82	49
146	2	15	10	4	508	514	119	31	16	63	39
147	0	5	9	7	552	488	114	25	35	80	43
148	2	3	11	4	589	478	101	46	41	101	36
149	2	10	17	4	477	488	79	29	15	64	50
150	8	9	23	5	524	490	84	28	24	59	38
151	4	12	10	1	393	432	65	21	17	58	46
152	10	16	20	7	436	409	93	21	21	69	40
153	0	13	29	9	439	367	69	13	12	45	32
154	10	11	33	6	324	318	76	17	17	53	37
155	2	13	42	8	330	337	67	14	27	56	49
156	2	19	32	9	272	285	60	10	24	37	35
157	4	22	28	6	203	229	63	11	12	43	36
158	12	10	39	16	226	234	62	17	17	31	36
159	10	17	34	14	147	174	51	6	11	24	22
160	18	13	38	15	180	146	53	5	20	25	30
161	18	12	30	10	127	129	40	7	6	23	21
162	8	16	32	17	120	145	45	8	17	14	21
163	8	7	44	15	99	93	39	10	15	17	12
164	4	13	34	9	74	70	33	5	11	13	15
165	6	16	54	17	46	56	31	5	6	15	16
166	16	18	39	13	51	43	25	6	6	12	14
167	10	13	55	24	40	37	21	4	7	16	5
168	24	13	47	19	24	30	19	5	15	7	8
169	10	20	36	12	14	29	10	3	12	9	13
170	22	20	28	23	16	18	16	2	7	2	10
171	18	14	43	16	9	15	6	2	8	6	3
172	16	15	36	18	10	9	13	2	5	5	4
173	8	9	42	12	6	7	7	0	8	4	1
174	8	12	25	8	5	7	5	2	3	0	1
175	22	27	30	14	4	6	7	3	7	1	3
176	14	19	30	11	1	3	3	0	1	3	3
177	12	10	22	9	4	5	1	0	1	0	1
178	14	17	23	12	2	6	4	1	4	1	0

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CL (mm)	1961/62	1962/63	1964/65	1965/66	1972/73	1973/74	1974/75	1975/76	1977/78	1978/79	1979/80
179	0	11	21	10	2	2	4	1	2	0	0
180	10	13	20	9	0	3	4	1	0	2	1
181	2	14	13	3	0	1	1	0	0	0	2
182	4	11	23	6	0	2	2	0	1	0	0
183	8	8	13	3	0	1	2	0	1	1	0
184	4	7	16	1	1	0	3	0	0	1	1
185	6	2	10	3	0	1	1	0	1	0	0
186	2	4	15	1	0	0	5	0	0	0	0
187	8	8	11	1	0	0	4	0	0	0	0
188	6	4	10	2	0	0	2	0	0	0	0
189	0	5	11	1	0	0	0	0	0	0	0
190	2	4	12	0	0	0	2	0	0	0	0
191	0	3	8	0	0	0	1	0	0	0	0
192	0	2	8	0	0	1	3	0	0	0	0
193	0	1	5	0	0	0	1	0	0	0	0
194	0	1	5	0	0	1	1	0	0	0	0
195	0	0	2	0	0	0	0	0	0	0	0
196	0	1	3	0	0	0	0	0	0	0	0
197	0	1	5	0	0	0	0	0	0	0	0
198	0	0	3	0	0	0	2	0	0	0	0
199	2	1	3	0	0	0	2	0	0	0	0
200	2	3	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0	0
202	0	0	1	0	0	0	0	0	0	0	0
203	4	0	0	0	0	0	0	0	0	0	0
204	0	0	1	0	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0
207	0	0	0	0	0	0	0	0	0	0	0
208	0	0	0	0	0	0	0	0	0	0	0
209	0	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0
Total	386	661	1,285	423	10,043	9,789	2,609	680	666	1,485	963

Appendix A3. Available retained catch size frequency sample data 1980/81–1989/90 Western Aleutian Islands directed red king crab fishery. Page 1 of 3.

CL (mm)	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
98	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0
108	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	1
110	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0
117	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0
122	0	0	0	1	0	0	1	0	0	1
123	0	0	0	0	0	0	0	0	0	0
124	0	0	0	0	1	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	1
126	0	0	0	0	0	1	0	0	0	0
127	1	1	1	0	0	3	0	0	0	2
128	0	0	1	0	1	0	0	0	1	0
129	2	1	0	0	0	1	0	0	3	1
130	3	4	2	3	1	2	1	1	5	8
131	4	3	8	2	3	7	0	3	7	29
132	6	6	23	8	6	9	2	2	5	51
133	15	11	34	10	6	19	2	5	18	88
134	25	11	55	17	9	10	5	8	19	161
135	34	25	70	25	19	27	3	10	38	280
136	53	51	92	27	21	18	8	8	55	276
137	72	45	145	32	33	23	12	11	92	370

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CL (mm)	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
138	89	76	187	49	39	29	10	10	108	497
139	106	55	184	49	30	39	10	11	121	532
140	119	76	221	74	30	48	16	17	134	631
141	99	78	224	58	46	48	16	13	118	529
142	128	104	256	97	41	59	16	20	157	562
143	127	110	323	94	57	38	13	18	161	514
144	96	100	226	73	39	33	14	21	139	494
145	115	105	224	94	56	28	25	21	179	559
146	95	112	208	107	49	21	14	25	164	460
147	103	97	250	99	47	36	14	17	186	460
148	98	93	269	128	55	36	11	10	158	483
149	94	79	186	94	36	28	14	17	170	399
150	85	100	249	122	61	42	16	21	177	451
151	76	82	172	87	47	27	13	18	146	283
152	59	98	215	121	48	24	13	5	191	371
153	66	75	234	134	58	27	8	17	170	361
154	59	72	184	104	40	30	14	16	152	292
155	45	73	176	104	58	39	12	13	147	370
156	53	63	152	99	44	24	15	12	129	265
157	59	59	164	111	41	31	6	7	132	244
158	32	54	162	117	42	35	10	17	132	256
159	41	27	131	70	30	36	14	6	105	232
160	40	34	126	100	62	31	7	5	128	233
161	30	33	99	93	30	17	6	9	105	190
162	42	37	89	83	53	34	6	7	98	178
163	31	21	106	94	52	23	6	4	97	185
164	40	24	87	77	26	34	7	9	108	134
165	43	18	86	88	50	24	5	8	92	153
166	27	7	69	161	38	18	5	5	72	92
167	32	11	90	80	41	17	3	2	71	92
168	29	5	86	73	45	19	2	3	70	76
169	21	1	46	51	32	18	5	2	57	85
170	20	11	45	69	39	12	5	2	65	85
171	18	3	37	47	22	3	3	1	45	65
172	19	9	42	59	30	12	1	1	50	51
173	15	1	45	57	24	7	2	1	32	48
174	13	3	41	44	30	10	3	0	48	32
175	12	3	28	36	24	5	1	0	48	35
176	7	1	20	40	17	7	3	0	28	23
177	9	2	20	39	17	2	0	0	19	26
178	6	0	19	34	18	7	1	0	21	18

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CL (mm)	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
179	8	1	13	33	12	1	6	0	14	19
180	2	2	14	28	8	4	2	0	13	16
181	3	0	10	15	7	1	0	0	15	9
182	2	0	12	23	4	5	1	1	5	4
183	2	0	4	22	6	2	2	0	7	12
184	1	0	8	27	3	5	3	0	6	4
185	1	0	6	21	5	1	2	0	5	5
186	2	1	2	14	3	0	0	0	5	2
187	0	0	1	14	1	2	2	1	4	2
188	0	1	4	10	2	2	1	0	7	3
189	1	0	2	11	2	3	0	0	2	4
190	1	0	0	13	4	1	0	0	1	4
191	0	0	1	10	1	1	0	0	1	2
192	0	0	0	2	0	3	0	0	1	0
193	1	0	0	10	0	2	1	0	0	2
194	0	0	1	4	0	2	1	0	1	0
195	0	0	0	6	2	0	1	0	0	1
196	0	0	0	4	0	0	0	0	0	0
197	0	0	0	1	0	0	0	0	0	0
198	0	0	0	1	1	2	0	0	0	1
199	0	0	0	0	0	0	0	0	0	0
200	0	0	0	1	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0
202	0	0	0	0	0	0	1	0	0	0
203	0	0	0	0	0	1	0	0	0	0
204	0	0	0	0	0	1	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0
207	0	0	0	0	0	0	0	0	0	0
208	0	0	0	0	0	0	0	0	0	0
209	0	0	0	0	0	0	0	0	0	0
210	0	0	0	1	0	0	0	0	0	0
Total	2,537	2,175	6,287	3,806	1,805	1,217	422	441	4,860	12,405

Appendix A4. Available retained catch size frequency sample data 1990/91–2003/04 Western Aleutian Islands directed red king crab fishery. Page 1 of 3.

CL (mm)	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	2000/01	2001/02	2002/03	2003/04
98	1	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0
103	1	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0
108	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0
117	1	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0
122	0	0	0	1	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0
127	2	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0
129	2	0	0	0	0	0	0	0	0	1
130	4	0	1	1	0	1	0	0	0	0
131	9	0	1	2	0	0	0	0	0	0
132	12	3	6	1	2	4	0	0	0	0
133	22	13	6	4	1	3	0	0	0	0
134	46	47	19	9	5	8	0	0	0	0
135	108	65	47	15	8	9	0	0	1	0
136	152	115	59	15	10	11	0	3	1	1
137	223	173	76	32	15	17	0	2	5	1

Appendix A4. Page 2 of 3.

CL (mm)	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	2000/01	2001/02	2002/03	2003/04
138	310	211	118	35	11	27	0	3	6	1
139	381	255	101	41	18	24	1	2	2	0
140	391	289	186	63	12	24	0	4	7	3
141	455	315	156	89	16	31	1	5	14	4
142	467	341	184	92	24	32	1	9	10	3
143	449	392	216	102	20	23	2	8	13	6
144	521	342	206	114	23	32	2	11	15	5
145	483	359	220	148	16	32	3	7	18	11
146	456	356	229	162	27	38	4	7	30	8
147	469	390	244	155	29	24	3	7	18	12
148	408	304	221	183	31	27	6	16	18	9
149	428	319	160	136	20	30	7	10	30	8
150	386	364	251	177	39	24	12	13	26	19
151	315	288	145	186	29	25	15	16	35	22
152	333	344	233	169	31	29	19	25	43	17
153	292	369	170	180	38	18	20	22	41	27
154	288	320	145	180	19	33	12	28	63	36
155	311	295	164	174	28	34	14	18	58	39
156	223	280	165	182	30	18	22	14	74	46
157	203	294	148	154	25	30	17	24	74	33
158	169	211	158	167	30	37	12	23	81	52
159	167	199	86	154	25	23	20	20	97	56
160	136	149	142	154	43	23	26	19	81	78
161	106	121	88	149	28	21	16	15	69	64
162	103	115	92	114	33	27	22	25	84	72
163	77	118	96	115	34	16	15	30	78	57
164	78	80	76	117	30	23	26	25	100	98
165	78	66	79	95	21	22	20	13	75	115
166	48	51	52	85	33	17	22	17	91	95
167	59	56	74	77	24	29	21	24	82	105
168	34	47	69	68	24	33	13	18	80	99
169	33	43	29	70	16	13	20	13	53	99
170	25	33	52	39	22	15	9	13	71	126
171	29	33	33	47	13	10	16	6	58	87
172	24	20	37	30	14	16	12	13	60	119
173	14	19	23	19	17	10	4	18	41	99
174	17	15	20	27	13	6	7	5	44	86
175	18	12	19	23	8	11	6	9	49	92
176	11	11	19	12	13	4	3	4	35	62
177	4	5	12	19	13	2	5	4	27	68
178	6	3	12	7	4	5	0	2	20	50

Appendix A4. Page 3 of 3.

CL (mm)	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	2000/01	2001/02	2002/03	2003/04
179	7	7	11	9	3	1	1	6	20	53
180	1	8	9	5	6	1	2	2	20	45
181	1	13	6	5	7	1	0	2	9	44
182	2	5	5	6	3	1	0	3	12	37
183	0	8	3	2	3	1	0	2	3	22
184	2	2	2	4	4	0	1	1	2	26
185	1	1	3	0	6	0	0	0	0	11
186	2	0	3	2	2	0	0	0	7	14
187	1	2	0	1	4	1	0	1	1	13
188	0	3	1	0	0	1	0	1	1	1
189	1	1	1	1	5	0	0	0	0	6
190	0	1	1	1	3	0	0	0	3	6
191	0	1	1	0	1	0	0	1	0	2
192	0	1	1	0	2	0	0	0	0	4
193	0	0	1	0	0	0	0	0	0	3
194	0	1	1	0	2	0	0	0	0	3
195	0	0	1	0	1	0	0	0	0	0
196	0	2	0	0	0	0	0	0	0	0
197	0	0	0	0	0	0	0	0	0	0
198	0	0	0	0	0	0	0	0	0	0
199	0	0	0	0	0	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0
201	0	0	0	0	0	0	0	0	0	0
202	0	0	0	0	0	0	0	0	0	0
203	0	0	0	0	0	0	0	0	0	0
204	0	0	0	0	0	0	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0
207	0	0	0	0	0	0	0	0	0	0
208	0	0	0	0	0	0	0	0	0	0
209	0	0	0	0	0	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0
Total	9,406	8,306	5,195	4,426	1,037	978	460	589	2,056	2,381

Appendix A5. Page 1 of 1. Plot of available retained catch size frequency sample data 1961/62–2003/04 western Aleutian Islands directed red king crab fishery (data listed in Appendices A2-A4).

Western Aleutian Islands Red King C

Carapace length (mm)