Adak Red King Crab

May 2012 Crab SAFE Report Chapter (10 May 2012)

Douglas Pengilly, ADF&G, Kodiak

Executive Summary

1. **Stock:** Adak/Western Aleutian Islands (the Aleutian Islands, west of 171° W longitude) golden king crab *Paralithodes camtschaticus*

2. Catches:

The domestic fishery has been prosecuted since 1960/61 and was opened every season through the 1995/96 season. Peak harvest occurred during the 1964/65 season with a retained catch of 21.193-million pounds (9,613 t). 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 0.943-million pounds (428 t), but the retained catch during the 1995/96 season was only 0.039-million pounds (18 t). During the 1995/96 through 2011/12 seasons, the fishery was opened only occasionally. 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 0.500-million pounds (227 t) during the 2002/03 and 2003/04 seasons. Most of the catch since the 1990/91 season was harvested in the Petrel Bank area (between 179° W longitude and 179° E longitude) and the last two commercial seasons (the 2002/03 and 2003/04 seasons) were opened only in the Petrel Bank area. Retained catch in the last two commercial fishery seasons was 0.506-million pounds (230 t) in 2002/03 and 0.479-milliion pounds (217 t) in 2003/04. The fishery has been closed through the 2011/12 season since the end of the 2003/04 season. 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 the groundfish fisheries. Estimated annual weight of bycatch mortality during the 1995/96–2009/10 seasons averaged 0.003-million pounds (1 t) in crab fisheries and 0.022-million pounds (10 t) during groundfish fisheries. Estimated weight of annual total fishery mortality during 1995/96–2009/10 averaged 0.109-million pounds (49 t); the average annual retained catch during that period was 0.084-million pounds (38 t). Estimated total fishery mortality for 2010/11 was 0.004-million pounds (2 t).

3. Stock biomass:

Estimates of past or present stock biomass are not available. There is no assessment model developed for this stock and standardized stock surveys have been too limited in geographic scope and too infrequent to provide a reliable index of abundance for the entire red king crab population in the Aleutian Islands west of 171° W longitude.

4. Recruitment:

Estimates of recruitment trends and current levels relative to virgin or historic levels are not available. The fishery has been closed since the end of the 2003/04 season due to apparent poor recruitment. A pot survey conducted by ADF&G in the Petrel Bank area (roughly, 179° W

longitude to 179° E longitude) in November 2006 provided no evidence of strong recruitment (Gish 2007). The overall survey CPUEs (catch per pot lift) of red king crab in the standard, systematic survey (170 stations with 4 pots per station resulting in 680 pot lifts) of the Petrel Bank area were 1.2 legal males, 0.2 sublegal males, and 0.2 females; 98% of all red king crab were captured at 30 stations within an area of approximately 185 nmi^2 (633 km^2). Additionally, concurrent with the November 2006 ADF&G survey, 165 pots were fished in "string" arrays, similar to the setting of pots during commercial fishing, between standard survey stations in areas with high CPUE during the standard survey and at locations where strings were fished during the November 2001 ADF&G-Industry survey (see Bowers et al. 2002). The CPUE of red king crab in those "niche fishing" pots in 2006 was 15.6 legal males, 4.1 sublegal males, and 3.1 females. Ninety-two pots fished in four strings during the November 2006 ADF&G survey at the locations where four strings were fished during the November 2001 ADF&G-Industry yielded CPUEs of 9.8 legal males, 2.5 sublegal males, and 2.1 females; during the November 2001 ADF&G-Industry survey the CPUEs for the 121 pots fished at those locations were 85.5 legal males, 5.5 sublegal males, and 9.7 females. Red king crab captured during the November 2009 pot survey conducted by ADF&G were predominately larger, matured-sized crab and the size distribution of captured males provided no expectations for near-term recruitment of legal males (Gish 2010). Only 117 4-pot stations (468 pot lifts) could be fished in the November 2009 ADF&G survey. The overall CPUEs of red king crab during the November 2009 ADF&G survey was 1.5 legal males, <0.1 sublegal males, and 0.1 females. Limited (18 pot lifts) exploratory catch-and-release fishing for red king crab was also conducted by a commercial fishing vessel during mid-October to mid-December 2009 under provisions of a commissioner's permit at depths ≤ 100 fathoms (183 m) using red king crab pot gear (i.e., fished as single-pots, not long-lined) with escape webbing closed to help retain sublegal and female crab in four areas west of Petrel Bank between 178°00' E longitude and 175°30' E longitude; that limited effort yielded a catch of one legal-sized male red king crab (J. Alas, ADF&G, 7 May 2010 ADF&G Memorandum).

Another ADF&G-Industry survey was conducted as a commissioner's permit fishery in the Adak-Atka-Amlia Islands area in November 2002 (Granath 2003). Although the survey design called for a possible 2,900 pot lifts to be performed, survey participants only completed 1,085 pot lifts before withdrawing from participation. Four legal male red king crabs were captured: three legal males and one sublegal male red king crab were captured around Adak Island; no red king crabs were captured in areas on the north side of Atka Island, but an estimated 520 sublegal males and females were captured in one pot on the north side of Atka Island; one legal male and no sublegal or female red king crabs were captured on the north side of Amlia Island; and no red king crabs were captured on the south side of Atka and Amlia Islands. By comparison, ADF&G conducted a pot survey in the Atka-Amlia Islands area in 1977 and captured 4,035 male and 1,088 female red king crabs in 360 pot lifts (ADF&G 1978), although from those results it was reported that "King crab stocks at Adak still seem to be depressed" (ADF&G 1978, page 167).

5. __Management performance:__
No overfished determination (i.e., MSST) is possible for this stock given the lack of biomass information. Overfishing did not occur during the 2010/11 fishing year; the 2011/12 fishing year is ongoing. No ABC was established for any season prior to the 2011/12 season; the ABC established for the ongoing 2011/12 season was 0.03 million pounds (12 t). OFL and ABC values for 2012/13 in the table below are the author's recommendations.

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a,b]	OFL[a,c]	ABC[a,c]
2008/09	N/A	N/A	Closed	0	0.014	0.46 R	N/A
2009/10	N/A	N/A	Closed	0	0.012	0.50 R	N/A
2010/11	N/A	N/A	Closed	0	0.004	0.12 T	N/A
2011/12	N/A	N/A	Closed	0	TBD	0.12 T	0.03 T
2012/13	N/A	N/A	TBD	TBD	TBD	[0.12 T]	[0.03 T]

a. Millions of pounds.
b. Includes bycatch mortality of discarded bycatch.
c. Noted as "R" for retained-catch OFL and "T" for total-catch OFL.

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a,b]	OFL[a,c]	ABC[a,c]
2008/09	N/A	N/A	Closed	0	<1	209 R	N/A
2009/10	N/A	N/A	Closed	0	<1	227 R	N/A
2010/11	N/A	N/A	Closed	0	2	56 T	N/A
2011/12	N/A	N/A	Closed	0	TBD	56 T	12 T
2012/13	N/A	N/A	TBD	TBD	TBD	[56 T]	[12 T]

a. Metric tons.
b. Includes bycatch mortality of discarded bycatch.
c. Noted as "R" for retained-catch OFL and "T" for total-catch OFL.

6. **Basis for the OFL and ABC:** See table, below; values for 2012/13 are the author's recommendations

Year	Tier	Years to define Average catch (OFL)	Natural Mortality	Buffer
2009/10	5	1985/86-2007/08[a]	0.18[b]	N/A
2010/11	5	1995/96-2007/08[c]	0.18[b]	N/A
2011/12	5	1995/96-2007/08[c]	0.18[b]	75%
2012/13	5	[1995/96-2007/08[c]]	[0.18[b]]	[75%]

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

7. **PDF of the OFL:** Sampling distribution of the recommended Tier 5 OFL was estimated by bootstrapping; see section G.1. Estimated CV (sample standard error of mean divided by sample mean) of the annual total catch estimates for 1995/96–2007/08 is 0.43.

8. **Basis for the ABC recommendation:** The recommended ABC is the status quo; i.e., the ABC recommended by the CPT and SSC for 2011/12.

.

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:** None. (But Industry has expressed in an exploratory fishery in the area east of 179° W longitude).

2. **Changes to the input data:**
   - Data on non-retained bycatch and estimates of bycatch mortality in crab and groundfish fisheries during 2010/11 have been added to judge if overfishing occurred in 2010/11, but is not put into the calculation of the recommended 2012/13 total-catch OFL.

3. **Changes to the assessment methodology:** None.

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.

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 2011: None.
   - SSC, June 2011: None.
   - CPT, September 2011 (via Sept 2011 SAFE):
     - *"The team recommends that analysts provide a list of the parameters (e.g., natural mortality, Q, the appropriateness of F_{MSY} and B_{MSY} proxies), an indication of whether the estimates/assumptions used to compute the OFL is likely wrong in a systematic way (leading to under- or over-estimation of the OFL) and a range for the extent of error. The analysts should then calculate how the OFL would change for the extremes of the ranges."*
     - Response: This is addressed in Section **E**.**4**.*f*.
     - *"The team requests that, to the extent possible, assessments include a listing of the tables and figures in the assessment (i.e., Table of Tables, Table of Figures).*
     - Response: It is done.

SSC, October 2011: None.

2. **Responses to the most recent two sets of SSC and CPT comments specific to the assessment:**

CPT, May 2011 (May 2011 CPT minutes):
   1. *"The team struggled to establish an adequate means to recommend an ABC to appropriately reflect the uncertainty surrounding and conservation concerns regarding this stock."*
   Response: In this regard, the author has empathy for the team.

2. *"The time frame for establishing the OFL leads to a biased estimate of catch and using the maximum permissible ABC control rule would not be appropriate reflection of the bias imparted by the average catch calculation. To account for this bias a lower percentage of OFL is recommended." "…the team recommended an ABC based upon the maximum incidental catch (pot and groundfish fishery) over the time frame used to calculate the OFL."*

Response: The time period for calculating the OFL was established **and fixed** by the SSC in June 2010. The author recommends the status quo (2011/12) ABC, as recommended by the SSC in June 2011 and which is well below the maximum permissible ABC and less than half of what the CPT recommended in May 2011.

3. *"Further recommendations for the next assessment include evaluation of the bycatch for each of stat regions 541-543, as well as in total historically and to compile historical fishery information pre-1980."*

Response: Estimated bycatch by groundfish fisheries for each of the stat regions 541–543 during 1993/94–2010/11 is provided in Table 4. Aside from the information provided in Table 1, the author has not compiled historical fishery information pre-1980. The author agrees that compilation of historic fishery data would be valuable, but does not know where the historical fishery information pre-1980 could be found and has noted that, if found, it would be difficult to compile (see Section **I**. **Data Gaps and Research Priorities**). That compilation of information would be a good project for someone to do. Nonetheless, the author does not see the utility of that information from 30+ years ago in helping the CPT with its struggle *"to establish an adequate means to recommend an ABC to appropriately reflect the uncertainty surrounding and conservation concerns regarding this stock."*

SSC, June 2011:

1) *" Review of the time series of bycatch shows an allowance based on the mean bycatch for the period 1995/96-2007/08 should be sufficient"[to establish the 2011/12 ABC for this stock].*

Response: The author recommends the same ABC for 2012/13.

CPT, September 2011: [*None.*]

SSC, October 2011: [*None.*]

C. Introduction

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

2. **Description of general distribution:**

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 (page 3-41).

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 (pages 3-41–42)."

Commercial fishing for Adak red king crab during the last two prosecuted seasons (2002/03 and 2003/04) was opened only in the Petrel Bank area and effort during those two seasons typically occurred at depths of 60–90 fathoms (110–165 m); average depth of pots fished in the Aleutian Islands area during the 2002/03 season was 68 fathoms (124 m; Barnard and Burt 2004) and during the 2003/04 season was 82 fathoms (151 m; Burt and Barnard 2005).   In the 580 pot lifts sampled by observers during the 1996/97–2006/07 Aleutian Islands golden king crab fishery that contained one or more red king crab, depth was recorded for 578 pots. 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; ADF&G observer database, Dutch Harbor, April 2008).

Although the Adak Registration Area is no longer defined in State regulation, 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 "Adak Area". The Aleutian Islands king crab Registration Area O is described by Bowers et al (2011, page 8) 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 [Figure 1]. 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 the 1984/85 season 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 Adak 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.

3. Evidence of stock structure:

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)."

We know of no analyses of genetic relationships among red king crab from different locations within the Adak Area. However, given the expansiveness of the Adak Area and the canyons between some islands that are deep (>1,000 m) relative to the depth zone restrictions of red king crab (see above), at least some weak structuring within the Adak red king crab stock would be expected. 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 season:

> "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 Adak Area 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 Adak Area male red king crab. However, because the estimated SM50 for Adak Area 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 Adak stock as a proxy.

Little data is available on the molting and mating period for red king crab specifically in the Adak Area. 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 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 season timing for the commercial fishery, little data on reproductive condition of Adak red king crab females have been collected by at-sea fishery observers that can be used for evaluating the mating period. For example, of the 3,211 mature females that were examined during the 2002/03 and 2003/04 red king crab seasons in the Petrel Bank area, both of which seasons were restricted to late October, only 10 were scored as "hatching."

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 age (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 suggest that males that do not molt early in the mating period have an advantage in mating early in the mating period, when smaller, younger mature females and the primiparous females tend to ovulate, and that males that do molt early in the mating period participate in the later mating period, when the larger, older females tend to be mated.

5.   **Brief summary of management history:**
A complete summary of the management history through 2009/10 is provided in Bowers et al. (2011, pages 8–12). The domestic fishery for red king crab in the Adak Area began with the 1960/61 season. Retained catch of red king crab in the Aleutians west of 172° W longitude averaged 11.595-million pounds during the 1960/61–1975/76 seasons, with a peak harvest of 21.193-million pounds in the 1964/65 season (Table 1, Figure 2). Guideline harvest levels (GHL; sometimes expressed as ranges, with an upper and lower GHL) for the fishery have been established for most seasons since the 1970s. The fishery was closed for the 1976/77 season in the area west of 172° W longitude, but reopened for the 1977/78–1995/96 seasons. Average retained catch during the 1977/78–1995/96 seasons (for the area west of 172° W longitude prior to the 1984/85 season and for the area west of 171° W longitude since the 1984/85 season) was 1.044-million pounds; the peak harvest during that period was 1.982-million pounds for the 1983/84 season. During the mid-to-late 1980s, significant portions of the catch during the Adak

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 the 1990/91–1994/95 seasons (Figure 3). The Adak red king crab fishery was closed for the 1996/97 season following the diminishing harvests of the preceding two seasons that did not reach the lower GHL. Due to concerns about low stock levels and poor recruitment, the fishery has been opened only intermittently since 1996/97. The fishery was closed for the 1996/97–1997/98 seasons, closed in the Petrel Bank area for the 1998/99 season, closed for the 1999/2000 season, restricted to the Petrel Bank area for the 2000/01–2003/04 seasons (except for an ADF&G-Industry survey in the Adak, Atka, and Amlia Islands area conducted as a commissioner's permit fishery), and closed for the 2004/05–2011/12 seasons.   Management history since the 1996/97 closure is summarized in the table below. The peak harvest since the 1996/97 season was 0.506-million pounds, which occurred in the 2002/03 season.

Season	Change in management measure
1996/97– 1997/98	• Fishery closed
1998/99	• GHL of 15,000 pounds (for exploratory fishing) with fishery closed in the Petrel Bank area (i.e., between 179° W longitude and 179° E longitude)
1999/00	• Fishery closed
2000/01	• Fishery closed • Catch retained during ADF&G-Industry survey of Petrel Bank area conducted as commissioner's permit fishery, Jan–Feb 2001
2001/02	• Fishery closed • Catch retained ADF&G-Industry survey of Petrel Bank area conducted as commissioner's permit fishery, November 2001
2002/03	• Fishery opened with GHL of 500,000 pounds restricted to Petrel Bank area • 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 500,000 pounds restricted to Petrel Bank area
2004/05– 2011/12	• Fishery closed

A summary of relevant fishery regulations and management actions pertaining to the Adak red king crab fishery is provided below.

Only males of a minimum legal size may be retained by the commercial red king crab fishery in the Adak Area. 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 Adak Area 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)**).

By State of Alaska regulation (**5 AAC 34.610 (a)**) the Adak red king crab commercial fishing season is from October 15 to February 15, unless closed by emergency order.

The Adak Area red king crab fishery west of 179° W longitude has been managed since the 2005/06 season under the Crab Rationalization program (50 CFR Parts 679 and 6805). The Adak Area red king crab fishery in the area east of 179° W longitude was not included in the Crab Rationalization program (Bowers et al. 2011). Fishing for red king crab in the area between 172° W longitude and 179° W longitude in the Aleutian Islands is limited to vessels 90 feet or less in overall length (**5 AAC 34.610 (d)**). Additionally, there is a pot limit of 250 pots per vessel for vessels fishing for red king crab in the Petrel Bank area (**5 AAC 34.625 (d)**).

The Adak red king crab fishery was closed for the 1996/97–1997/98 seasons. The following area closures and harvest restrictions have been applied to the red king crab fishery, when opened, in the Adak Area since the 1998/99 season:

- The 1998/99 season for red king crab in the Adak Area was open east of 179° W longitude with a guideline harvest level (GHL) of 0.005-million pounds and west of 179° E longitude with a GHL of 0.010-million pounds, but was closed between 179° W longitude and 179° E longitude.
- ADF&G-Industry pot surveys for red king crab were conducted in January—February 2001 (the 2000/01 season) and November 2001 (the 2001/02 season) under the restrictions of a commissioner's permit fishery in the Petrel Bank area (north of 51° 45' N latitude and between 179° W longitude and 179° E longitude; Bowers et al. 2002, Bowers et al. 2011). The Adak Area was closed to commercial red king crab fishing outside of the designated survey area.
- The 2002/03 season opened in those waters of king crab Registration Area O between 179° W longitude and 179° E longitude and north of 51° 45' N latitude (the Petrel Bank area; Bowers et al. 2011) with a GHL of 0.500-million pounds. Additionally, an ADF&G-Industry pot survey for red king crab was conducted in November 2002 under the restrictions of a commissioner's permit fishery in the vicinity of Adak, Atka, and Amlia Islands to assess the Adak red king crab stock in the area between 172° W longitude and 179° W longitude (Granath 2003). The remaining area outside of the Petrel Bank area and the designated survey area in the Adak Area was closed to commercial red king crab fishing during the 2002/03 season.
- The 2003/04 season opened in those waters of king crab Registration Area O between 179° W longitude and 179° E longitude and north of 51° 45' N latitude (the so-called "Petrel Bank area"; Bowers et al. 2011). The remaining area in the

Adak Area was closed to commercial red king crab fishing during the 2003/04 season.

D. Data

1. <u>**Summary of new information:**</u>
   - Retained catch data from the closed 2011/12 directed fishery season has been added; the retained catch was 0 pounds.
   - Data on non-retained bycatch in crab and groundfish fisheries has been updated with data from the 2010/11 Aleutian Islands golden king crab fishery and the 2010/11 groundfish fisheries in reporting areas 541, 542, and 543 (Figure 4).

2. <u>**Data presented as time series:**</u>
a. ***Total catch* and b. *Information on bycatch and discards:***
   - The 1960/61–2011/12 time series of retained catch (number and pounds of crab harvested, including deadloss), effort (vessels, landings, and pot lifts), average weight of landed crab, average carapace length of landed crab, and CPUE (number of landed crab captured per pot lift) is presented in Table 1.
   - The 1960/61–20011/12 time series of retained catch (pounds of landed crab) is presented graphically in Figure 2.
   - The 1995/96–2010/11 times series of weight of retained legal males and estimated weight of non-retained legal male, non-retained sublegal male, and non-retained female red king crab in the Adak Area during commercial crab fisheries is given in Table 2. Observer data on size distributions and estimated catch numbers of non-retained catch were used to estimate the weight of non-retained catch of red king crab by applying a weight-at-length estimator (see below). Estimates of bycatch prior to the 1995/96 season are not given due to non-existence of data or to limitations on bycatch sampling during the crab fisheries. Prior to 1988/89 there was no fishery observer program for Aleutian Islands crab fisheries and during the 1988/89–1994/95 seasons observers were required only on vessels processing king crab at sea, including catcher-processor vessels. Observer data from the Aleutian Islands prior to 1990/91 is considered unreliable and the observer data from the directed Adak red king crab fishery in the 1990/91 and 1992/93–1994/95 seasons and golden king crab fishery in the 1993/94 and 1994/95 seasons are confidential due to the limited number of observed vessels. During the 1995/96–2004/05 seasons, 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 the 2005/06 season, 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 harvest was obtained during each trimester of the fishery; observers continue to be required at all times a vessel is fishing in the red king crab fishery west of 179° W longitude. All king crab that were captured as bycatch during the Aleutian Islands golden king crab fishery west of 174° W longitude by a vessel while an observer was on board during the 2001/02–2002/03 and 2004/05–2010/11 seasons were counted and recorded for capture location and biological data.
   - The 1993/94–2010/11 time series of estimated weight of bycatch and estimated bycatch mortality of red king crab in the Adak Area (reporting areas 541, 542, and 543; i.e., Aleutian Islands west of 170° W longitude; Figure 4) during federal groundfish fisheries

by gear type (fixed or trawl) is provided in Table 3. Estimated weight of bycatch during the 1993/94–2010/11 groundfish fisheries by reporting area (541, 542, or 543) is provided in Table 4. Bycatch estimates for 1992/93 are available, but appear to be suspect because they are extremely low. Following Foy (2011 a, b), 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.

- The 1995/96–2008/09 time series of estimated weight of total fishery mortality of red king crab in the Adak Area, partitioned into retained catch, bycatch mortality during crab fisheries, and bycatch mortality during federal groundfish fisheries, is provided in Table 5. 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 5 by applying that assumed bycatch mortality rate to the estimates of non-retained catch given in Tables 2. The estimates of bycatch mortality in groundfish fisheries given in Table 5 are from Table 3.

c. *Catch-at-length:* Not used in a Tier 5 assessment; none are presented here.

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 here.

f. *Other data time series:*
Data on CPUE (number of retained crab per pot lift) during the red king crab in the Adak Area are available for the 1972/73–2010/11 seasons (see Table 1).

3. **Data which may be aggregated over time:**
a. *Growth-per-molt; frequency of molting, etc. (by sex and perhaps maturity state):*
Growth per molt was estimated for Adak Area 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 Adak Area 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 pounds by dividing by 453.6.

c. *Natural mortality rate:* Natural mortality rate has not been estimated specifically for red king crab in the Adak Area. NPFMC (2007) assumed a natural mortality rate of M =0.18 for king crab species.

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 bycatch of red king crab in the Adak red king crab fishery and the Adak/Aleutian Islands golden king crab fishery, 1988/89–2009/10 (ADF&G observer database).
   - Summary of data collected by ADF&G Adak red king crab fishery observers or surveys during 1969–1987 (Blau 1993).
   - Retained catch-at-length data for the red king crab fishery in the Adak Area for the 1984/85–1995/96, 1999/00, 2000/01–2001/02, and 2002/03–2003/04 seasons (data from the 1999/2000 season and the 2000/01–2001/02 seasons collected made during either restricted exploratory fishing or during ADFG-Industry surveys).

E. Analytic Approach

1. **History of modeling approaches for this stock:** This is a Tier 5 stock; there is no assessment model and no history of assessment modelling approaches for this stock.

2. **Model Description:** There is no regular survey of this stock. No assessment model for the Adak Area red king crab stock exists and none is in development. The SSC in June 2010 recommended that: the Adak Area 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 bycatch estimates 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 retained catch data and bycatch 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 2012/13 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 2012/13 is

   $$OFL_{2012/13} = RET_{95/96-07/08} + BM_{CF, 95/96-07/08} + BM_{GF, 95/96-07/08},$$

   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. **Model Selection and Evaluation:** Not applicable; see section *E.2*.

4. **Results (best model(s)):**
a. *List of effective sample sizes, the weighting factors applied when fitting the indices, and the weighting factors applied to any penalties:* Not applicable.

b. *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):* See Table 4.

c. *Graphs of estimates (all quantities should be accompanied by confidence intervals or other statistical measures of uncertainty, unless infeasible):* Information requested for this subsection is not applicable to a Tier 5 stock.

d. *Evaluation of the fit to the data:* Not applicable for Tier 5 stock.

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 for Tier 5 stock.

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 (0.12 million pounds) 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." Additionally, the CPT registered its concern with a fishery mortality equivalent to 90% of that OFL: "Discussion further noted to what extent removing 110,000 lbs in perpetuity is reasonable rate of sustainable catch for this stock given its current size."
- 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 specified as the estimated average annual total-catch during the period 1995/96–2007/08; i.e.,

$$OFL_{2012/13} = RET_{95/96\text{-}07/08} + BM_{CF,\ 95/96\text{-}07/08} + BM_{GF,\ 95/96\text{-}07/08},$$

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 5. Using the calculated values of $RET_{95/96\text{-}07/08}$, $BM_{CF,\ 95/96\text{-}07/08}$, and $BM_{GF,95/96\text{-}07/08}$, $OFL_{2012/13}$ is,

$$OFL_{2012/13} = 96{,}932 + 3{,}000 + 23{,}935 = 123{,}867 \text{ lbs } (0.12\text{-million lbs}).$$

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 for Tier 5 stock.

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 for Tier 5 stock.

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 table, below; OFL and ABC values for 2012/13 are the author's recommendations.

Year	MSST	Biomass (MMB)	TAC	Retained Catch[a]	Total Catch[a,b]	OFL[a,c]	ABC[a,c]
2008/09	N/A	N/A	Closed	0	0.014	0.46 R	N/A
2009/10	N/A	N/A	Closed	0	0.012	0.50 R	N/A
2010/11	N/A	N/A	Closed	0	0.004	0.12 T	N/A
2011/12	N/A	N/A	Closed	0	TBD	0.12 T	0.03 T
2012/13	N/A	N/A	TBD	TBD	TBD	[0.12 T]	[0.03 T]

a. Millions of pounds.
b. Includes bycatch mortality of discarded bycatch.
c. Noted as "R" for retained-catch OFL and "T" for total-catch OFL.

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
                              = 96,932 pounds (0.10-million pounds).

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 stock.

G. Calculation of ABC

1. PDF of OFL. A bootstrap estimate of the sampling distribution (assuming no error in estimation of bycatch) of the OFL is shown in Figure 5 (the sample means of 1,000 samples drawn with replacement from the 1995/96–2007/08 estimates of total fishery mortality in Table 5). The mean and CV 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 5.

2. List of variables related to scientific uncertainty.
   - Bycatch mortality rate in each fishery that bycatch occurs. Note that for Tier 5 stocks, an increase in an assumed bycatch 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 bycatch mortality for each fishery that bycatch occurred in during 1995/96–2007/08.
   - The time period to compute the average catch relative to assumption that it represents "a time period determined to be representative of the production potential of the stock."

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

4. Author recommended ABC. 0.03 million pounds = the SSC's June 2011 estimate of the average bycatch mortality due to groundfish and the non-directed crab fisheries during 1995/96–2007/08.

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 stock through the history of the fishery would be very valuable.

The SSC in October 2008 and June 2011 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 Adak Area: 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, but only produced a catch of one red king crab (J. Alas, ADF&G, 7 May 2010 ADF&G Memorandum).

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 Adak Area. 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 Adak Area during periods of limited stock distribution and overall low density, as apparently currently exists.

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.

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.

Bowers, F. R., K. Herring, J. Shaisnikoff, J. Alas, B. Baechler, and I. Fo. 2011. Annual management report for the commercial shellfish fisheries of the Bering Sea, 2009/10. Pages 78–182 *in* Bowers, F. R., M. Schwenzfeier, K. Herring, M. Salmon, J. Shaishnikoff, H. Fitch, J. Alas, and B. Baechler. 2011. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's Shellfish Observer Program, 2009/10. Alaska Department of Fish and Game, Fishery Management Report No. 11-05, Anchorage.

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 Comercial 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., 2011a. 2011 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: 2011 Final Crab SAFE. NPFMC, Anchorage, September 2011.

Foy, R. J., 2011b. 2011 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: 2011 Final Crab SAFE. NPFMC, Anchorage, September 2011.

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.

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.

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.

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.

Table of tables.

Table 1: page 23. Aleutian Islands, Area O, red king crab commercial fishery data, 1960/61–2011/12, partitioned into the Adak area (west of 172º W longitude prior to 1984/85 and west of 171º W longitude since 1984/85) and the Dutch Harbor area (from Bowers et al. 2011, updated for the 2010/11–2011/12 seasons).

Table 2: page 26. Weight (in pounds) of retained legal males and estimated weight of non-retained legal male, non-retained sublegal male, and non-retained female red king crab in the Adak Area during commercial crab fisheries by season for the 1995/96–2010/11 seasons (from 2011 SAFE).

Table 3: page 27. Estimated annual weight (pounds) of discarded bycatch of red king crab (all sizes, males and females) and bycatch mortality during federal groundfish fisheries by gear type (fixed or trawl) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude), 1993/94–2010/11 (assumes bycatch mortality rate of 0.5 for fixed-gear fisheries and 0.8 for trawl fisheries; from 2011 SAFE).

Table 4: page 28. Estimated pounds of bycatch (not discounted by an assumed bycatch mortality) during federal groundfish fisheries (all gear types combined) by NMFS Reporting Area, 1993/94–2010/11.

Table 5: page 29. Estimates of total fishery mortality (pounds) for red king crab in the Adak Area, 1995/96–2010/11, partitioned into retained catch, bycatch mortality during crab fisheries, and bycatch mortality during federal groundfish fisheries (from Table 2 with assumed bycatch mortality rate of 0.2 applied to total non-retained bycatch and Table 3).

Table of Figures.

Table 1. Aleutian Islands, Area O, red king crab commercial fishery data, 1960/61–2011/12, partitioned into the Adak area (west of 172º W longitude prior to 1984/85 and west of 171º W longitude since 1984/85) and the Dutch Harbor area (from Bowers et al. 2011, updated for the 2010/11–2011/12 seasons).

Season	Locale	Number of				Harvest[b,c]	Average			Deadloss[c]
		Vessels[a]	Landings	Crabs[b]	Pots Lifted		Weight[c]	CPUE[d]	Length[e]	
1960/61	East of 172° W	NA	NA	NA	NA	NA	NA	NA	NA	NA
	West of 172° W	4	41	NA	NA	2,074,000	NA	NA	NA	NA
	TOTAL									
1961/62	East of 172° W	4	69	NA	NA	533,000	NA	NA	NA	NA
	West of 172° W	8	218	NA	NA	6,114,000	NA	NA	NA	NA
	TOTAL		**287**			**6,647,000**				
1962/63	East of 172° W	6	102	NA	NA	1,536,000	NA	NA	NA	NA
	West of 172° W	9	248	NA	NA	8,006,000	NA	NA	NA	NA
	TOTAL		**350**			**9,542,000**				
1963/64	East of 172° W	4	242	NA	NA	3,893,000	NA	NA	NA	NA
	West of 172° W	11	527	NA	NA	17,904,000	NA	NA	NA	NA
	TOTAL		**769**			**21,797,000**				
1964/65	East of 172° W	12	336	NA	NA	13,761,000	NA	NA	NA	NA
	West of 172° W	18	442	NA	NA	21,193,000	NA	NA	NA	NA
	TOTAL		**778**			**34,954,000**				
1965/66	East of 172° W	21	555	NA	NA	19,196,000	NA	NA	NA	NA
	West of 172° W	10	431	NA	NA	12,915,000	NA	NA	NA	NA
	TOTAL		**986**			**32,111,000**				
1966/67	East of 172° W	27	893	NA	NA	32,852,000	NA	NA	NA	NA
	West of 172° W	10	90	NA	NA	5,883,000	NA	NA	NA	NA
	TOTAL		**983**			**38,735,000**				
1967/68	East of 172° W	34	747	NA	NA	22,709,000	NA	NA	NA	NA
	West of 172° W	22	505	NA	NA	14,131,000	NA	NA	NA	NA
	TOTAL		**1,252**			**36,840,000**				
1968/69	East of 172° W	NA	NA	NA	NA	11,300,000	NA	NA	NA	NA
	West of 172° W	30	NA	NA	NA	16,100,000	NA	NA	NA	NA
	TOTAL					**27,400,000**				
1969/70	East of 172° W	41	375	NA	72,683	8,950,000	NA	NA	NA	NA
	West of 172° W	33	435	NA	115,929	18,016,000	6.5	NA	NA	NA
	TOTAL		**810**		**188,612**	**26,966,000**				
1970/71	East of 172° W	32	268	NA	56,198	9,652,000	NA	NA	NA	NA
	West of 172° W	35	378	NA	124,235	16,057,000	NA	NA	NA	NA
	TOTAL		**646**		**180,433**	**25,709,000**				
1971/72	East of 172° W	32	210	1,447,692	31,531	9,391,615	7	46	NA	NA
	West of 172° W	40	166	NA	46,011	15,475,940	NA	NA	NA	NA
	TOTAL		**376**		**77,542**	**24,867,555**				
1972/73	East of 172° W	51	291	1,500,904	34,037	10,450,380	7	44		
	West of 172° W	43	313	3,461,025	81,133	18,724,140	5.4	43	NA	NA
	TOTAL		**604**	**4,961,929**	**115,170**	**29,174,520**	**5.9**	**43**		
1973/74	East of 172° W	56	290	1,780,673	41,840	12,722,660	7.1	43	NA	NA
	West of 172° W	41	239	1,844,974	70,059	9,741,464	5.3	26	148.6	NA
	TOTAL		**529**	**3,625,647**	**111,899**	**22,464,124**	**6.2**	**32**		

(Continued)

Table 1. page 2 of 3.

Season	Locale	Number of				Harvest[b,c]	Average			Deadloss[c]
		Vessels[a]	Landings	Crabs[b]	Pots Lifted		Weight[c]	CPUE[d]	Length[e]	
1974/75	East of 172° W	87	372	1,812,647	71,821	13,991,190	7.7	25		
	West of 172° W	36	97	532,298	32,620	2,774,963	5.2	16	148.6	NA
	TOTAL		**469**	**2,344,945**	**104,441**	**16,766,153**	**7.1**	**22**		
1975/76	East of 172° W	79	369	2,147,350	86,874	15,906,660	7.4	25		
	West of 172° W	20	25	79,977	8,331	411,583	5.2	10	147.2	NA
	TOTAL		**394**	**2,227,327**	**95,205**	**16,318,243**	**7.3**	**23**		
1976/77	East of 172° W	72	226	1,273,298	65,796	9,367,965 [f]	7.4	19		
	East of 172° W	38	61	86,619	17,298	830,458 [g]	9.6	5	NA	NA
	West of 172° W	F I S H E R Y C L O S E D								
	TOTAL		**287**	**1,359,917**	**83,094**	**10,198,423**	**7.5**	**16**		
1977/78	East of 172° W	33	227	539,656	46,617	3,658,860 [f]	6.8	12		
	East of 172° W	6	7	3,096	812	25,557 [h]	8.3	4	NA	NA
	West of 172° W	12	18	160,343	7,269	905,527	5.7	22	152.2	NA
	TOTAL		**252**	**703,095**	**54,698**	**4,589,944**	**6.5**	**13**		
1978/79	East of 172° W	60	300	1,233,758	51,783	6,824,793	5.5	24	NA	NA
	West of 172° W	13	27	149,491	13,948	807,195	5.4	11	NA	1,170
	TOTAL		**327**	**1,383,249**	**65,731**	**7,631,988**	**5.5**	**21**		
1979/80	East of 172° W	104	542	2,551,116	120,554	15,010,840	5.9	21	NA	NA
	West of 172° W	18	23	82,250	9,757	467,229	5.7	8	152	24,850
	TOTAL		**565**	**2,633,366**	**130,311**	**15,478,069**	**5.9**	**20**		
1980/81	East of 172° W	114	830	2,772,287	231,607	17,660,620 [f]	6.4	12	NA	NA
	East of 172° W	54	120	182,349	30,000	1,392,923 [h]	7.6	6		
	West of 172° W	17	52	254,390	20,914	1,419,513	5.6	12	149	54,360
	TOTAL		**1,002**	**3,209,026**	**282,521**	**20,473,056**	**6.4**	**11**		
1981/82	East of 172° W	92	683	741,966	220,087	5,155,345	6.9	3	NA	NA
	West of 172° W	46	106	291,311	40,697	1,648,926	5.7	7	148.3	8,759
	TOTAL		**789**	**1,033,277**	**260,784**	**6,804,271**	**6.6**	**4**		
1982/83	East of 172° W	81	278	64,380	72,924	431,179	6.7	1		
	West of 172° W	72	191	284,787	66,893	1,701,818	6.0	4	150.8	7,855
	TOTAL		**469**	**349,167**	**139,817**	**2,132,997**	**6.1**	**3**		
1983/84	East of 172° W	F I S H E R Y C L O S E D								
	West of 172° W	106	248	298,958	60,840	1,981,579	6.6	5	157.3	3,833
1984/85	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	64	106	196,276	48,642	1,296,385	6.6	4	155.1	0
1985/86	East of 171° W					F I S H E R Y C L O S E D				
	West of 171° W	35	82	156,097	29,095	868,828	5.6	5	152.2	0
1986/87	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	33	69	126,204	29,189	712,543	5.7	4	NA	800
1987/88	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	71	103	211,692	43,433	1,213,892	5.7	5	148.5	6,900

(Continued)

Table 1. page 3 of 3.

| Season | Locale | Number of | | | | Harvest[b,c] | Average | | | Deadloss[c] |
		Vessels[a]	Landings	Crabs[b]	Pots Lifted		Weight[c]	CPUE[d]	Length[e]	
1988/89	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	73	156	266,053	64,334	1,567,314	5.9	4	153.1	557
1989/90	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	56	123	193,177	54,213	1,105,971	5.7	4	151.5	759
1990/91	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	7	34	146,903	10,674	828,105	5.6	14	148.1	0
1991/92	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	10	35	165,356	16,636	951,278	5.8	10	149.8	0
1992/93	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	12	30	218,049	16,129	1,286,424	6.0	14	151.5	5,000
1993/94	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	12	21	119,330	13,575	698,077	5.9	9	154.6	7,402
1994/95	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	20	31	30,337	18,146	196,967	6.5	2	157.5	1,430
1995/96	East of 171° W	F I S H E R Y C L O S E D								
	West of 171° W	4	12	6,880	1,986	38,941	5.7	3	153.6	235
1996/97		F I S H E R Y C L O S E D								
1997/98		F I S H E R Y C L O S E D								
1998/99	West of 174° W	1	CF	CF	CF	0.015	CF	CF	CF	CF
1999/2000		FC	FC	FC	FC	FC	FC	FC	FC	FC
2000/01[k]	Petrel Bank[l]	1	3	11,299	496	FC	76,562	6.8	23	161.0	0
2001/02[m]	Petrel Bank[l]	4	5	22,080	564	FC	153,961	7.0	39	159.5	82
2002/03	Petrel Bank[l]	33	35	68,300	3,786	0.5	505,642	7.4	18	162.4	1,311
2003/04	Petrel Bank[l]	30	31	59,828	5,774	0.5	479,113	8.0	10	167.9	2,617
2004/05 - 2009/10		FC	FC	FC	FC	FC	FC	FC	FC	FC
2010/11–2011/12		FC	FC	FC	FC	FC	FC	FC	FC	FC

Note: NA = Not available.

[a] Many vessels fished both east and west of 171° W long., thus total number of vessels reflects registrations for entire Aleutian Islands.

[b] Deadloss included.

[c] In pounds.

[d] Number of legal crab per pot lift.

[e] Carapace length in millimeters.

[f] Split season based on 6.5 inch minimum legal size.

[g] Split season based on 8 inch minimum legal size.

[h] Split season based on 7.5 inch minimum legal size.

[i] January/February 2001 Petrel Bank survey (fish ticket harvest code 15).

[j] Those waters of king crab Registration Area O between 179° E long., 179° W long., and north of 51° 45' N lat.

[k] November 2001 Petrel Bank survey (fish ticket harvest code 15).

[m] November Petrel Bank survey (fish ticket harvest code 15, exploratory shellfish harvest).

Table 2. Weight (in pounds) of retained legal males and estimated weight of non-retained legal male, non-retained sublegal male, and non-retained female red king crab in the Adak Area during commercial crab fisheries by season for the 1995/96–2010/11 seasons (from 2011 SAFE).

| | Adak red king crab fishery | | | | AI golden king crab fishery | | | Total |
| | Retained | Non-retained | | | | | | |
Season	legal male	Legal male	Sublegal male	Female	Legal male	Sublegal male	Female	non-retained
1995/96	38,941	0	20,669	27,624	0	2,047	314	50,654
1996/97	0	0	0	0	3,292	2,024	666	5,982
1997/98	0	0	0	0	178	579	179	936
1998/99[a]	5,900	-	-	-	747	138	186	-
1999/00	0	0	0	0	161	756	93	1,010
2000/01	76,562	0	771	374	365	274	35	1,819
2001/02	153,961	174	6,574	8,369	19,995	0	364	35,476
2002/03	505,642	1,658	6,027	17,432	21,738	355	512	47,722
2003/04	479,113	631	6,597	7,962	9,425	6,352	6,686	37,653
2004/05	0	0	0	0	2,143	210	0	2,353
2005/06	0	0	0	0	189	0	49	239
2006/07	0	0	0	0	323	117	50	491
2007/08	0	0	0	0	615	1,819	561	2,995
2008/09	0	0	0	0	220	20	97	337
2009/10	0	0	0	0	574	249	43	866
2010/11	0	0	0	0	4,312	167	82	4,561
Average, through 2010/11	78,757	164	2,709	4,117	4,117	944	620	12,873

[a]. Data on non-retained bycatch of red king crab during the red king crab fishery not available (see Moore et al. 2000).

Table 3. Estimated annual weight (pounds) of discarded bycatch of red king crab (all sizes, males and females) and bycatch mortality during federal groundfish fisheries by gear type (fixed or trawl) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude), 1993/94–2010/11 (assumes bycatch mortality rate of 0.5 for fixed-gear fisheries and 0.8 for trawl fisheries; from 2011 SAFE).

| Season | Bycatch | | Bycatch Mortality | | |
	Fixed Gear	Trawl Gear	Fixed Gear	Trawl Gear	Total
1993/94	1,312	88,384	656	70,707	71,363
1994/95	2,993	22,792	1,497	18,234	19,730
1995/96	5,804	15,289	2,902	12,231	15,133
1996/97	2,874	44,662	1,437	35,730	37,167
1997/98	3,819	11,717	1,910	9,374	11,283
1998/99	10,143	45,532	5,072	36,426	41,497
1999/00	37,765	27,973	18,883	22,378	41,261
2000/01	2,697	13,879	1,349	11,103	12,452
2001/02	5,340	59,552	2,670	47,642	50,312
2002/03	11,295	73,027	5,648	58,422	64,069
2003/04	3,577	9,151	1,789	7,321	9,109
2004/05	791	12,930	396	10,344	10,740
2005/06	3,546	2,359	1,773	1,887	3,660
2006/07	6,781	617	3,391	494	3,884
2007/08	16,971	2,630	8,486	2,104	10,590
2008/09	10,778	10,290	5,389	8,232	13,621
2009/10	315	14,104	158	11,283	11,441
2010/11	92	4,381	46	3,504	3,551
Average, through 2010/11	7,050	25,515	3,525	20,412	23,937

Table 4. Estimated pounds of bycatch (not discounted by an assumed bycatch mortality) during federal groundfish fisheries (all gear types combined) by NMFS Reporting Area, 1993/94–2010/11.

	Reporting Area			
Season	541	542	543	Total
1993/94	83,752	5,862	82	89,696
1994/95	23,637	1,922	226	25,785
1995/96	13,122	4,056	3,916	21,094
1996/97	4,294	6,810	36,433	47,537
1997/98	2,218	8,739	4,579	15,536
1998/99	14,892	15,798	24,986	55,676
1999/00	36,027	17,755	11,955	65,738
2000/01	3,899	8,056	4,621	16,577
2001/02	7,661	52,986	4,244	64,891
2002/03	24,250	46,980	13,092	84,323
2003/04	4,915	7,778	36	12,728
2004/05	1,164	12,523	34	13,721
2005/06	3,540	87	2,278	5,905
2006/07	6,545	853	0	7,398
2007/08	11,295	6,708	1,598	19,601
2008/09	2,522	16,635	1,911	21,068
2009/10	3,686	8,278	2,455	14,419
2010/11	468	4,004	1	4,473
Average	13,772	12,546	6,247	32,565

Table 5. Estimates of total fishery mortality (pounds) for red king crab in the Adak Area, 1995/96–2010/11, partitioned into retained catch, bycatch mortality during crab fisheries, and bycatch mortality during federal groundfish fisheries (from Table 2 with assumed bycatch mortality rate of 0.2 applied to total non-retained bycatch and Table 3).

| Season | Retained Catch | Bycatch mortality | | Total |
		Crab Fisheries	Groundfish Fisheries	
1995/96	38,941	10,131	15,133	64,205
1996/97	0	1,196	37,167	38,363
1997/98	0	187	11,283	11,470
1998/99[a]	5,900	1,535	41,497	48,931
1999/00	0	202	41,261	41,463
2000/01	76,562	364	12,452	89,378
2001/02	153,961	7,095	50,312	211,368
2002/03	505,642	9,544	64,069	579,256
2003/04	479,113	7,531	9,109	495,753
2004/05	0	471	10,740	11,210
2005/06	0	48	3,660	3,708
2006/07	0	98	3,884	3,982
2007/08	0	599	10,590	11,189
2008/09	0	67	13,621	13,688
2009/10	0	173	11,441	11,614
2010/11	0	912	3,551	4,463
Mean, 1995/96–2007/08	96,932	3,000	23,935	123,867
CV of mean	52%	37%	23%	43%
Mean, 1995/96–2010/11	78,757	2,510	21,236	102,503
CV of mean	53%	37%	22%	43%

a. No bycatch 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.
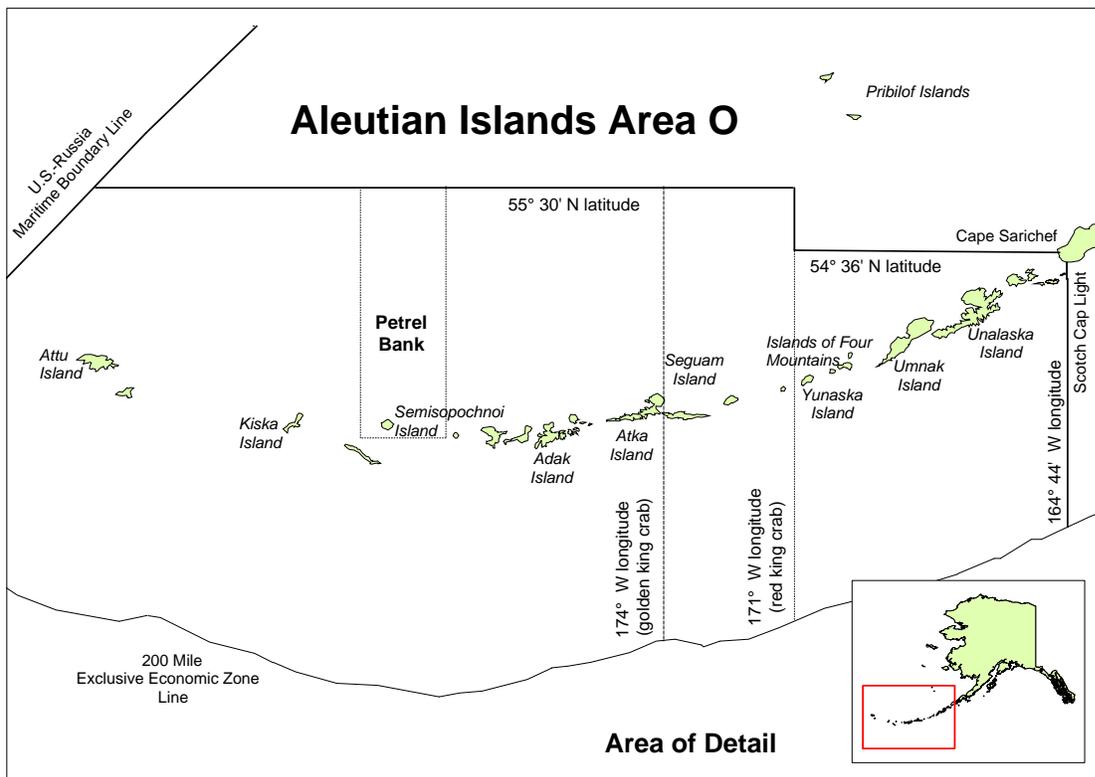
Figure 1. Aleutian Islands, Area O, red and golden king crab management area (from Bowers et al 2011).
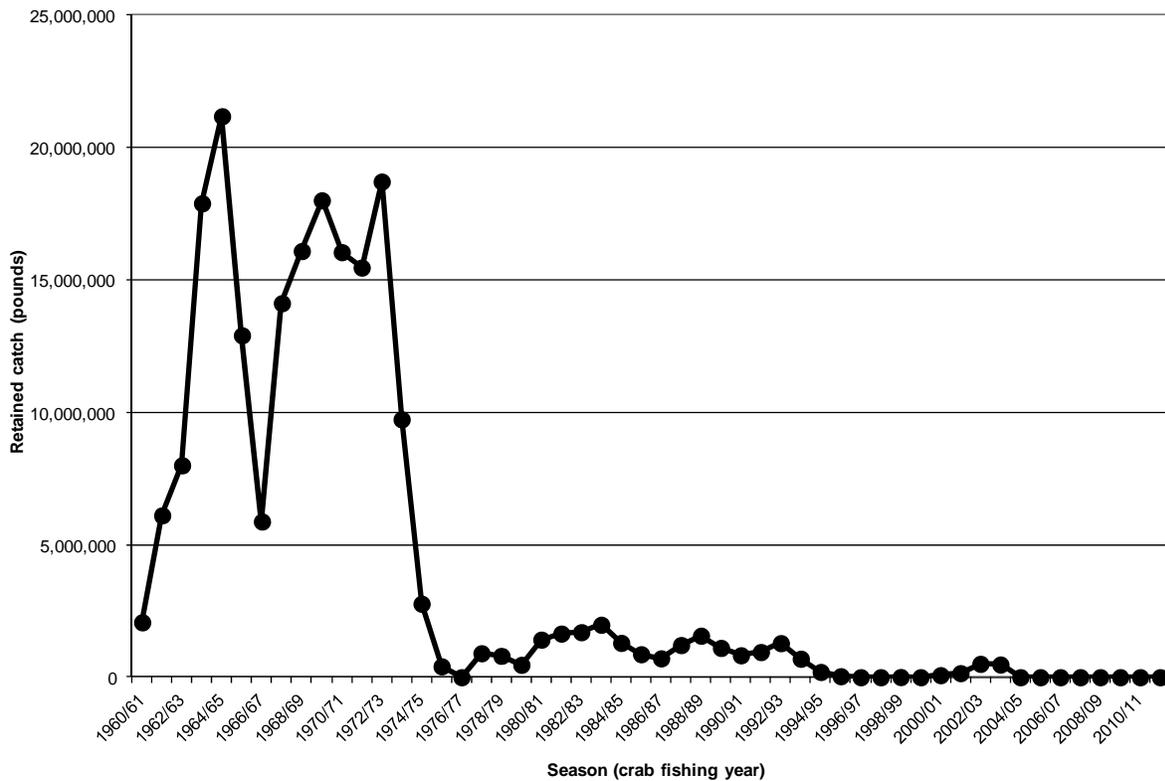

Figure 2. Retained catch in the Adak red king crab fishery, 1960/61–2011/12 (catch is for the area west of 172º W longitude during 1960/61–1983/84 and for the area west of 171º W longitude during 1984/85–2011/12; see Table 1).
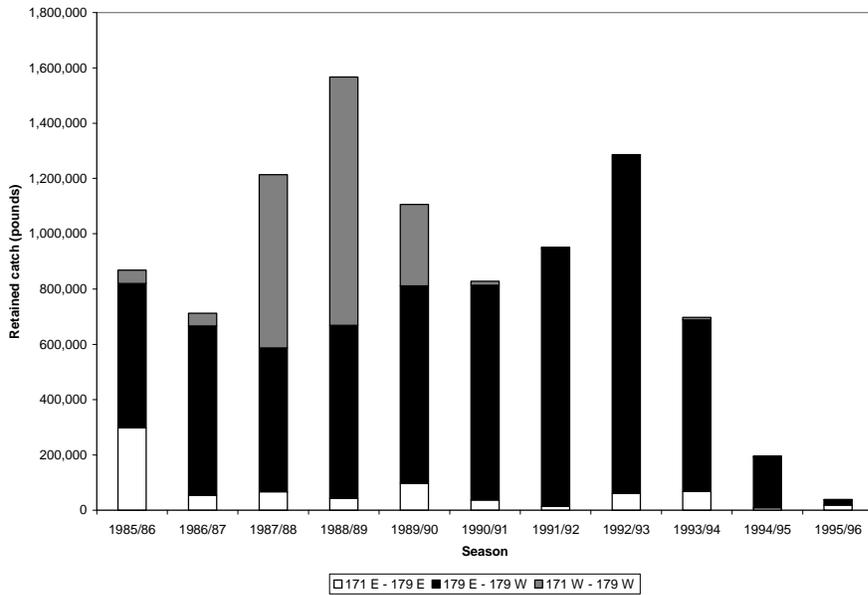
Figure 3. Retained catch (pounds) in the Adak red king crab fishery for the 1985/86–1995/96 seasons, partitioned into three longitudinal zones (171º W longitude to 179º W longitude, 179º W longitude to 179º E longitude, and 179º E longitude to 171º E longitude; from ADF&G fish ticket summary provided by F. Bowers, ADF&G, March 2008).
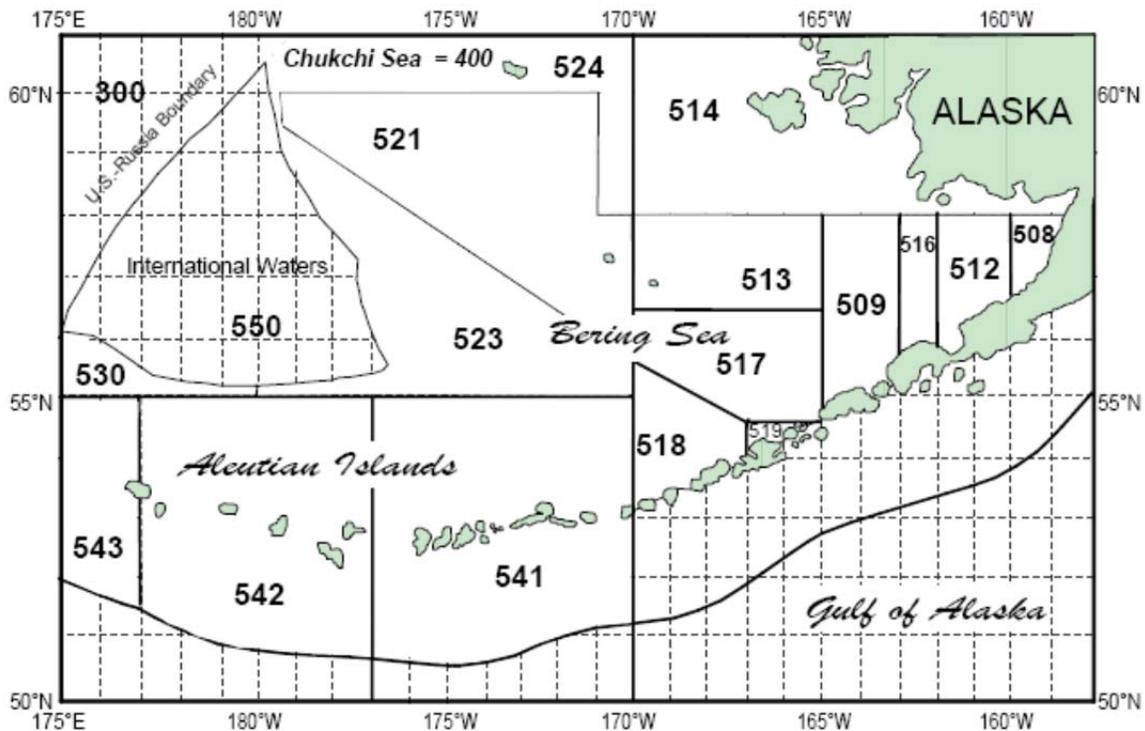

Figure 4. Map of federal groundfish fishery reporting areas for the Bering Sea and Aleutian Islands showing reporting areas 541, 542, and 543 that are used to obtain data on bycatch of Adak red king crab during groundfish fisheries (from http://www.fakr.noaa.gov/rr/figures/fig1.pdf).
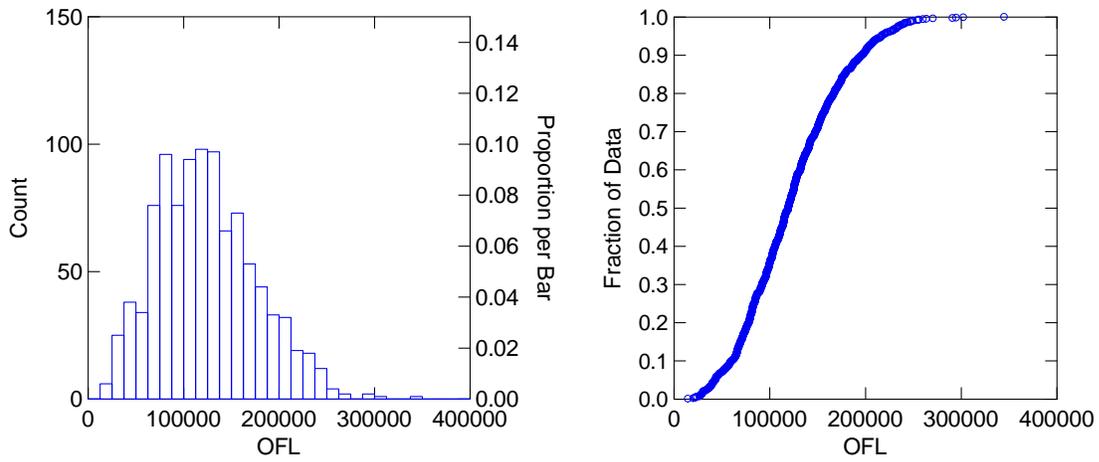
Figure 5. Bootstrapped estimate of the sampling distribution of the recommended 2012/2013 Tier 5 OFL (pounds of total catch) for the Adak red king crab stock; histogram in left column, quantile plot in right column (from 2011 SAFE).