# Adak Red King Crab

# 2008 Crab SAFE Report Chapter

Douglas Pengilly, ADF&G, Kodiak

## Executive Summary

Stock: Red king crab/Adak (Aleutian Islands, west of 171° W longitude)

Catches: The domestic fishery has been prosecuted since 1961 and was opened every season through the 1995/96 season. Peak harvest occurred during the 1964/65 season with a retained catch of 21-million pounds. 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 943-thousand pounds, but the retained catch during the 1995/96 season was only 39-thousand pounds. During the 1995/96 through 2007/08 seasons, the fishery was opened only occasionally. There was an exploratory fishery with a low GHL in 1998/99, three commissioner's permit fisheries in limited areas during 2001 and 2002 to allow for ADF&G-Industry surveys, and two commercial fisheries with a GHL of 0.5-million pounds 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 506-thousand pounds (2002/03) and 479-thousand pounds (2003/04). The fishery has been closed since the end of the 2003/04 season. Non-retained catch of red king crabs occurs in both the directed red king crab fishery and in the Aleutian Islands golden king crab fishery. Estimated non-retained catch during the 1996/97–2006/07 seasons has been low (<50-thousand pounds) and was <10% of the retained catch in the 2002/03 and 2003/04 seasons.

Data and assessment: There is no assessment model in use for this stock. Available data are from fish tickets (retained catch numbers, retained catch weight, and pot lifts by statistical area and landing date), size-frequency data from samples of landed crabs, at-sea observer data from pot lifts sampled during the directed fishery and the Aleutian Islands golden king crab fishery (including date, location, soak time, catch composition, size, sex, and reproductive condition of crabs), data from two ADF&G-Industry pot surveys during 2001 in the Petrel Bank area (north of 51° 45' N latitude and between 179° W longitude and 179° W longitude), data from an ADF&G-Industry survey in the vicinity of Adak, Atka, and Amlia Islands (between 172° W longitude and 179° W longitude), and data from an ADF&G pot survey during 2006 in the Petrel Bank area. These data are available through the 2006/07 fishery season and the 2006 pot survey.

Unresolved problems and major uncertainties: 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 Adak Area.

Reference points: This is stock is recommended for placement in Tier 5. For Tier 5 stocks $B_{MSY}$ and MSST are not estimated and OFL is defined as "the average retained catch from a time period determined to be representative of the production potential of the stock" (NPFMC 2007).

Stock biomass: Estimates of stock biomass are not available.

Recruitment: Estimates of recruitment trends and current levels relative to virgin or historic levels are not available. The fishery was closed at 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) provided no evidence of strong recruitment.

Exploitation status: The directed fishery has been closed since the 2004/05 season; there is some bycatch in the golden king crab fishery (average per year = 7,107 pounds for 1996-2007) and groundfish fisheries (average per year = 13,523 pounds for 1996-2007). Estimates of fishing mortality are not available.

Management performance: The fishery was only managed strictly towards a preseason GHL in the 2002/03 and 2003/04 seasons. The GHL for both of those seasons was set at 500,000 pounds and the retained catch was within 1% of the GHL in the 2002/03 season and was within 4% of the GHL in the 2003/04 season. Estimated weight of discarded bycatch of red king crabs during those two seasons (including that attributable to the Aleutian Islands golden king crab fishery) was less than 10% of the retained catch. Although the fishery has been closed since the end of the 2003/04 season, the fishery area west of 179° W longitude since 2005 has been regulated under the BSAI Crab Rationalization program.

Forecasts: No forecasts of catch and biomass are available.

Decision table: Not available.

Recommendations: This fishery has a long history, with the domestic fishery dating back to 1961. However, much of the data on this stock prior to the early-mid 1980s is difficult to retrieve and analyze. Changes in definitions of fishery statistical areas over the history of the fishery also make it difficult to assess geographic trends in effort and catch over much of the fishery's history. An effort to compile all written documentation on the stock and fishery, to enter all existing fishery, observer, survey, and tagging data into a database that allows for analyses of all data from the stock through the history of the fishery would be very valuable.

### *Summary of Major Changes*

Changes (if any) in the input data — N/A (= "not applicable" or "not available" or both)

Changes (if any) in the assessment methodology — N/A

Changes (if any) in the assessment results, including projected biomass, GHL, total catch (including discard mortality and retained catch), and FOFL (the full selection fishing mortality rate (F) that results in overfishing) — N/A

### *Responses to SSC Comments*

Responses to SSC comments specific to this assessment (for each comment that is addressed in the main text, list comment and give name of section where it is discussed; if the SSC did not make any comments specific to this assessment, say so) — N/A

Responses to SSC comments on assessments in general (for each comment that is addressed in the main text, list comment and give name of section where it is discussed; if the SSC did not make any comments on assessments in general, say so) — N/A

## Introduction

Scientific name: *Paralithodes camtschaticus*, Tilesius, 1815

Description of general distribution

General distribution of red king crabs 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 crabs 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; Table 1); 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 crabs 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).

<u>Description of management unit(s) (be sure to include any spatial and/or seasonal management measures)</u>:

From Failor-Rounds (2008, page 4; 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).

Prior to the March 1996 Alaska Board of Fisheries meeting, the Aleutian Islands king crab Registration Area O as currently defined had been subdivided into the historic Adak Registration Area R and the Dutch Harbor Registration Area O, which had been divided at 171° W longitude since the 1984/85 season (Figure 2). The geographic boundaries of the Adak red king crab stock are defined 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. Although the Adak Registration Area R is no longer defined in 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 Adak Area red king crab fishery west of 179° W longitude is managed 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 and remains open-access (Failor-Rounds 2008; but see below for restrictions on vessels in state waters between 172° W longitude and 179° W longitude).

The following area closures have been applied to the red king crab fishery in the Adak Area:

- The 1998/99 season for red king crab in the Adak Area was open east of 179° W longitude and west of 179° E longitude, but was closed between 179° W longitude and 179° E longitude.
- ADF&G-Industry pot surveys for red king crabs were conducted in January—March 2001 and November 2001 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; Failor-Rounds 2008, Bowers et al. 2002). 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 so-called "Petrel Bank area"; Failor-Rounds 2008). Additionally, an ADF&G-Industry pot survey for red king crabs 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"; Failor-Rounds 2008). The remaining area in the Adak Area was closed to commercial red king crab fishing during the 2003/04 season.

By State of Alaska regulation (5 AAC 34.610 (a)):

> The commissioner may open and close, by emergency order, a season for male red king crab [in the Aleutian Islands Registration Area O] beginning 12:00 noon, October 15 and ending no later than 11:59 p.m. February 15.

Additionally, by State of Alaska regulation (5 AAC 34.610 (d)):

> During a fishing season opened under (a) of this section in the waters of Alaska [in the Aleutian Islands Registration Area O] between 172° W. long. and 179° W. long., the commissioner may issue a permit only to a vessel 90 feet or less in overall length, to fish for red king crab.

<u>Evidence of stock structure, if any</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)."

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 crabs (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 crabs 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.

- <u>Description of life history characteristics relevant to stock assessments (e.g., special features of reproductive biology)</u>

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 crabs 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 crabs:

> 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.

Little data is available on the molting and mating period for red king crabs specifically in the Adak Area. Among the red king crabs 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 crabs 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, there is little data on reproductive condition of Adak red king crab females that has 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 October 2002/03 and October 2003/04 red king crab seasons in the Petrel Bank area, only 10 were scored as "hatching."

Data on mating pairs of red king crabs 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.

### *Fishery*

- Description of the directed fishery

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).

Red king crabs may be commercially fished only with king crab pots (as defined in 5 AAC 34.050). Pots used to fish for red king crabs 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 crabs and may not be longlined (5 AAC 34.625 (e)).

There is a pot limit of 250 pots per vessel for vessels fishing in the Petrel Bank red king crab fishery in king crab Registration Area O (5 AAC 34.625 (d)).

The following historical review of the red king crab fishery in the Adak Area is from Failor-Rounds (2008, pages 4–6):

> Historically, the red king crab *Paralithodes camtschaticus* resource in the Aleutian Islands was harvested in two registration areas. The Adak Registration Area (Area R) consisted of those waters in the Aleutian Islands west of 171° W long., while the Dutch Harbor Registration Area (Area O) encompassed waters east of 171° W long. In addition, as the fleet moved westward, a third Registration Area (Area S) was established for the waters around Amchitka Island and the Petrel Bank. Area S was created in 1967 and was merged into Area R in 1978. In March of 1996, the Alaska Board of Fisheries (BOF) established the Aleutian Islands king crab Registration Area (Area O) by combining the existing Dutch Harbor and Adak Registration areas. The BOF adopted this change to improve management of the increasingly important golden king crab *Lithodes aequispinus* resource in the Aleutian Islands. Combining the Adak and Dutch Harbor areas was not expected to impact management of red king crabs in the Aleutian Islands.
>
> Domestic fisheries for red king crabs in both the Adak and Dutch Harbor Registration areas began in 1961, with effort and harvest rapidly increasing in both areas. The Adak Area reached a peak harvest of 21 million pounds in 1964/65 [text concerning the Dutch Harbor Registration Area omitted. Note that 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 into the early-1980s, the area west of 179° 15' W longitude began to account for a larger portion of the retained catch (ADF&G 1978, 1983).].
>
> In the late 1970s, GHL ranges were established using a blend of pot survey results and fisheries data. Historic fishery GHLs set in the late 1970s ranged [text concerning the Dutch Harbor Registration Area omitted] from 0.5 million to 3.0 million pounds in Adak. GHLs were often modified inseason based on fishery performance.
>
> Fluctuating harvest levels from one year to the next characterized the fisheries in the Dutch Harbor and Adak areas [text concerning the Dutch Harbor Registration Area omitted]. The Adak fishery remained open through the 1995/96 season when only 39,000 pounds were harvested. After the 1995/96 season the fishery was closed for several years. Portions of the area were opened during the 1998/99, 2000/01, and 2001/02 seasons in

order to assess the status of red king crab stocks. In 2002 the Petrel Bank portion of Area O was reopened to commercial fishing with a guideline harvest level (GHL) of 500,000 pounds.

Observers have been required on all crab catcher-processor vessels since 1988 and on catcher vessels targeting red or golden king crabs in the Aleutian Islands since 1995. Observer coverage on golden king crab vessels provides red king crab incidental catch data from that fishery, although red king crab bycatch in golden king crab gear is minimal due to the limited overlap in distribution of the two species. Observer coverage also provides data on retained and non-retained crabs as well as information related to fishing patterns.

Pot surveys in the western Aleutian Islands conducted from 1975 to 1977 provided catch per unit of effort (CPUE), fecundity, and relative abundance information of red king crabs. [see ADF&G 1978; text concerning the Dutch Harbor Registration Area omitted].

In 1996 and 1997, a catcher-processor vessel was permitted to target red king crabs on the Petrel Bank in conjunction with their directed golden king crab fishing. The goals of this project were to enumerate, tag, and collect biological data from all red king crabs captured and to recapture tagged individuals. During this two-year period, a total of 926 crabs were tagged along the north side of Amchitka Island and along the south side of Semisopochnoi Island. Of the tagged crabs, 440 were legal males and 160 were females; 89% of legal crabs were new shell. Recovery efforts yielded 15 tagged crabs, six of which were legal males. While the tagging was too limited to provide quantitative stock assessment data, it did provide some information related to migration, molting cycle, and seasonal distribution [see Byersdorfer 1998].

In order to assess the status of red king crab stocks in two areas of the Aleutian Islands without recent abundance information, a limited commercial fishery was opened on November 1, 1998 with the provision that crabs not harvested be tagged and released. In addition, vessel operators were required to document all red king crab fishing activities in a pilothouse logbook. East of 179° W long., a GHL of 5,000 pounds was established and west of 179° E long., a GHL of 10,000 pounds was set; these GHLs were set using historic catch information. Closed waters included the Petrel Bank (the area between 179° E long. and 179° W long.). The Alaska Department of Fish and Game (ADF&G) did not open the Petrel Bank area in 1998/99 since prior efforts had provided some population data from that area.

Three vessels registered to harvest red king crabs in the Aleutian Islands during the 1998/99 season, but only one recorded landings. The GHL was not reached in either open area and the fishery was closed by emergency order on July 31, 1999. Observers were required on all vessels participating in the 1998/99 fishery.

In order to gain information on red king crab abundance in the Petrel Bank area, two surveys were conducted in January/February and November, 2001. Due to budget constraints, the surveys were designed so fishers could retain and sell all legal male red king crabs captured to cover survey expenses. The commissioner's permit specified stations to be fished, soak times and effort levels.

Capture of red king crabs from both 2001 surveys in the Petrel Bank area indicated healthy levels of legal males. CPUE for the combined surveys was 28. Survey CPUEs are not directly comparable to previous commercial fishery CPUEs because pot lifts in prior commercial fisheries were not conducted in a systematic manner and may have occurred

in different fishing locations. Sublegal male and female CPUE for the combined surveys was two and three, respectively.

Size composition data from the 2001 surveys were comparable to the size composition of catches prior to the 1995/96 fishery closure. The size composition and shell condition data indicated that approximately 61% of the sampled legal-size crabs were post recruits. Of the crabs sampled 77% were new-shell. Similar to the surveys conducted in the mid-1990s, very few sublegal crabs were captured during the 2001 surveys.

The surveys conducted in 2001 indicated that legal male abundance increased since the fishery was closed, however, red king crab female and sublegal abundance remained low. Given the legal male abundance, a limited commercial fishery on the Petrel Bank was opened during the 2002 and 2003 seasons with a GHL of 500,000 pounds. Based on expected effort, this was considered the minimum GHL that could be managed inseason. Because of the uncertainty in the status of sublegal and female red king crabs and to provide for overall stock protection, ADF&G adopted a management strategy that would close the fishery prior to achieving the GHL if legal male CPUE drops below 10 crabs/pot. Establishing a low GHL with a moderate CPUE threshold level should help prevent the stock from declining to levels seen in the mid-90s. Trends in fishery performance were used to evaluate GHLs and having a defined threshold for closing the fishery permitted clearer understanding of the management strategy.

Thirty-three vessels participated in the 2002 Petrel Bank red king crab fishery. The fleet pulled 3,786 pots, an average of 115 pots per vessel. CPUE for the Petrel Bank was 18 legal crabs per pot lift and the fleet harvested a total of 505,642 pounds. Exvessel price averaged $6.51 per pound and the 2002 Petrel Bank fishery had a total value of over $3.29 million.

During the 2003 Petrel Bank red king crab fishery a total of 479,113 pounds were harvested by 30 vessels in 91 hours. The fleet pulled 5,774 pots and average CPUE was 10 legal crabs per pot lift. Exvessel price averaged $5.14 per pound and the 2003 Petrel Bank fishery had a total value of nearly $2.45 million.

The Petrel Bank red king crab fishery was closed in 2004 and 2005 due to low levels of sublegal crab and females seen in the 2002 and 2003 fisheries, along with the low legal male CPUE seen toward the end of the 2003 fishery.

In 2005 Crab Rationalization was implemented for the major Bering Sea and Aleutian Islands crab fisheries. Western Aleutian Islands red king crab (west of 179° W long.) is included in this program and will have both Individual Fishing Quota (IFQ) and Community Development Quota (CDQ) fisheries when the stock is again open to commercial harvest.

The red king crab fishery in the Adak Area has continued to be closed to commercial fishing through the 2007/08 season since the end of the 2003/04 season.

Failor-Rounds (2008, pages 8–9) reviewed fishery management of red king crab in the Adak Area:

***Fishery Management and Stock Status 171° W Longitude to 179° W Longitude***

A vessel may not be registered to fish in the commercial red king crab and golden king crab fisheries concurrently between 171° W long. and 179° W long. This red king crab fishery remains open access and was not included in crab rationalization. Regulations do not allow vessels to retain IFQ and non-IFQ species concurrently.

In November of 2002 ADF&G conducted a survey similar in design to the Petrel Bank surveys of 2001 in the area between 172° W long. and 179° W long. The survey area was developed in consultation with industry and focused on areas of historic red king crab abundance in the Adak, Atka, and Amlia Islands areas that have been closed to commercial red king crab fishing since the 1998/99 season and had not been previously surveyed. The survey had a total of 116 stations that were divided between state-waters (56 stations) and federal-waters (60 stations).

Ten vessels conducted 1,085 pot lifts in a total of 61 stations. Survey catches were poor and only four legal males were captured during the entire survey. Due to poor survey catches and high operation costs, many vessels were unable to fulfill their survey commitment and only 34% of the survey was completed. The portion of the survey that was completed indicates that the red king crab stocks around Adak, Atka, and Amlia Islands continue to be severely depressed [see Granath 2003]. Therefore, the department does not expect a commercial red king crab fishery to open in this area in the near future.

***Fishery Management and Stock Status West of 179° W Longitude (Petrel Bank)***

West of 179° W longitude a vessel may be registered to fish in the commercial red king crab and golden king crab fisheries concurrently; however, only single-line pots may be operated in areas open to red king crab fishing and only longline pots may be operated in areas open to golden king crab fishing. Likewise, red king crab may only be retained from single-line pots and golden king crab may only be retained from longline pots. Golden king crab fisheries in the Aleutian Islands are not restricted by pot limits. In the Petrel Bank red king crab fishery each vessel is restricted to a pot limit of 250 pots.

Shell-condition and size composition data from the 2001, 2002 and 2003 fisheries in the Petrel Bank area indicate that primarily older, post-recruit crabs supported these fisheries. Proportions of sublegal and female red king crabs did not change significantly from the 2001 surveys to the 2002 or 2003 commercial fisheries. Average weight and carapace length (CL) of legal male red king crabs increased from 2001 to 2003. Average weight and CL of legal male red king crabs increased from the surveys to 7.4 pounds and 162 mm in 2002 and up to 8.0 pounds and 168 mm in 2003. A mode of sublegal crab seen in 2003 (centered at 86 – 90 mm CL) is approximately three molts from attaining legal size.

Cumulative fishery CPUE did not drop below the benchmark of 10 during the 2003 fishery, although fish ticket data indicate that the fishery CPUE was 10 crabs per pot. Fishery CPUE climbed during the first 36 hours from 8.5 to 15.0 crabs per pot and steadily dropped for the remainder of the fishery with the exception of the morning of October 28, when most pots had soaked for an additional 12 hours. Compared to the combined survey CPUE of 28 and 2002 fishery CPUE of 18, performance during the 2003 fishery was not promising.

The harvest based approach using only legal-male CPUE as a threshold was developed to help maintain multiple size and age classes on the grounds to promote rebuilding. Using a threshold of legal male CPUE alone does not protect the stock. Because survey catch of sublegal and female crab was low, thresholds were not developed for those stock components. After the 2001 surveys, staff expressed concern about overall stock status. While legal male catch was encouraging, the lack of sublegal and female crab was disappointing. ADF&G now has two additional years of fishery information that have failed to indicate healthy levels of those stock components. Based on fishery performance and the lack of recruitment of legal-sized crabs, it was likely that the fishery would fail to stay above the threshold criteria of 10 crabs per pot if a fishery were

prosecuted in 2004. Following the 2003 fishery, ADF&G made the decision to close the Petrel Bank red king crab fishery until the next survey was conducted in the fall of 2006.

A survey was conducted on the Petrel Bank area red king crab stock in November of 2006 [see Gish 2007]. This information was compared to the 2001 industry survey and the 2002 and 2003 commercial fisheries to evaluate current stock status. Because of differences in fishing practices between the 2001 survey, the 2002 and 2003 commercial fisheries, and the 2006 survey, a direct CPUE comparison could not be made. However, legal male red king crab catch rate during the 2006 survey was lower than during the 2001 survey and recent commercial fisheries. The 2006 survey CPUE of legal males was 1.2 crabs per pot from 170 stations fished. Red king crabs captured during the survey were predominately larger, mature-sized male crabs, and the size distribution of surveyed crabs provides no expectation for significant recruitment of legal males in the immediate future. Although males that were estimated to be new recruits to legal size accounted for 36% of the 2006 survey catch of legal crabs, recruitment occurring since the 2001 survey has been insufficient to rebuild legal male abundance to levels of the early 2000s. Spatial distribution of legal males during the 2006 survey decreased from the 2001 survey distribution and was limited to the northwestern portion of the Petrel Bank. Distribution of red king crabs was also restricted relative to harvest location during the last two commercial fisheries. Given the limited distribution and low relative abundance of legal male red king crab on Petrel Bank and the lack of projected recruitment to the legal size class in the near future, a harvestable surplus of red king crab is not currently available.

The implementation of Crab Rationalization designated a portion of the western Aleutian Islands (west of 179° W long.) red king crab fishery as an IFQ fishery. Individual fishing quota shares will allow harvesters to prosecute this fishery at any time during the biological season opening. Prior to rationalization, the overall pot limit in the Western Aleutian Islands red king crab fishery was 1,250 pots to be divided evenly among participants. Currently, regulations stipulate a pot limit of 250 pots per vessel. Observer coverage requirements remain at 100% of fishing activity.

- <u>Information on bycatch and discards</u>

Information on bycatch and discards during the Adak Area red king crab fishery is obtained by observers deployed on fishing vessels by the State of Alaska shellfish observer program (Schwenzfeier et al. 2008). Bycatch of red king crabs is also recorded by observers from randomly-sampled pot lifts during the Aleutian Islands golden king crab fishery. Additionally, during the 2001/02–2002/03 and 2004/05–2007/08 golden king crab fishery seasons, observers documented the catch and catch location of all red king crabs incidentally captured during the Aleutian Islands golden king crab fishery at all times that observers were present on the fishing vessels. During the 1988/89–1994/95 seasons observers were required only on vessels processing king crabs at sea, including catcher-processor vessels. Since the 1995/96–2004/05 seasons, observers were required on all vessels fishing for king crabs in the Aleutian Islands area at all times that a vessel was fishing. With the advent of the Crab Rationalization program, all vessels fishing for golden king crabs 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.

A summary of the information obtained by observers on bycatch and discards during the Aleutian Islands crab fisheries is provided in annual reports (e.g., Barnard and Burt 2007). The Adak Area red king crab fishery and the Aleutian Islands golden king crab fishery are the only crab fisheries in which non-retained Adak Area red king crab are captured. Estimates of the weight of bycatch (discarded non-retained) of red king crabs during the Adak Area red king crab fishery and the Aleutian Islands golden king crab fishery

are reported under the section "DATA: Total catch, partitioned by strata used in the assessment model, if any," below.

- Summary of historical catch distributions

Table 2 provides the time series of GHLs/TACs, retained catch, estimated discard, and estimated total catch (estimated discard mortality and retained catch). The handling mortality rate for red king crabs during the red king crab fishery in the Adak Area and during the Aleutian Islands golden king crab fishery was not discussed by the Crab Plan Team during development of Amendment 24. However, as handling mortality rates of 10%, 20%, 30% were discussed for the Bristol Bay red king fishery (NPFMC 2007), we provide total catch estimates for assumptions of handling mortality rates of 10%, 20%, and 30%.

### *Data (Items in this section should be presented in tabular form.)*

Data which should be presented as time series:

- Total catch, partitioned by strata used in the assessment model, if any

Harvest (retained catch) history for the red king crab fishery in the Adak Area (number of crabs and pounds of crabs landed, pot lifts, fishery catch per unit effort, and average weight of landed crabs) by fishery season from the 1984/85 season (the first season that the 171° W longitude line was used to divide the historic Adak and Dutch Harbor king crab Registration Areas) through the 2007/08 season is provided in Table 3a; data are from fish ticket database summaries produced by ADF&G Dutch Harbor during March 2008. A fishery data summary over the full history of the fishery (including years when the area was defined as west of 172° W longitude) is provided in Table 3b.

Observer data collected since the 1996/97 season on size distributions and estimated catch numbers of non-retained catch were used to estimate the weight of non-retained catch of legal male, sublegal male, red king crabs during commercial fisheries for red king crabs in the Adak Area and for Aleutian Islands golden king crabs by season through the 2005/06 season according to the methods and parameters provided in Section 3.4 of NPFMC 2007. Estimates of the weight of non-retained catch of red king crabs during the king crab fisheries by sex-size class and season, 1996/97–2006/07, are provided and compared with weight of retained catch in Table 4a.

Estimated annual weight of red king crab captured as bycatch during groundfish fisheries, 1996-2007, in reporting areas 541, 542, 543 (Aleutian Islands west of 170° W longitude) is provided in Table 4b.

Table 4c provides a summary of the estimated average annual bycatch weight of Adak red king crab during crab and groundfish fisheries, 1996–2007.

- Catch at age or catch at length, as appropriate

The size (carapace length, CL, mm) distribution of retained legal male red king crabs from the Adak Area red crab fishery sampled prior to processing at-sea and dockside by observers and ADF&G catch samplers by each opened season are provided in Table 5 and Table 6.

- Survey biomass estimates and variances, and/or confidence intervals — N/A

- Survey numbers at age or numbers at length, as appropriate

Surveys have 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), the only standardized

survey for red king crabs performed by ADF&G was performed in November 2006 and was limited to the Petrel Bank area (Gish 2007). The area surveyed in 2006 by ADF&G and the survey grid used was based on that of the November 2001 ADF&G-Industry survey (Figure 3). The November 2001 ADF&G-Industry survey was conducted as a commissioner's permit fishery (Bowers et al. 2002). Participants were allowed to fish 25 pot lifts anywhere within each of the 28 designated stations (see Figure 3, upper panel), with restrictions that included a pot spacing of no less than 1/8 nm apart, and they were allowed to retain any legal male red king crabs captured by those pots. During the 2006 ADF&G pot survey a survey station grid was established with station centers spaced by 2.50' latitude (2.50 nmi) north-to-south and 3.75' longitude (approximately 2.29 nmi) west-to-east. Four pots were fished at the centers of each station. Additionally, during the ADF&G survey several strings of pots were fished off the survey grid at locations based on the locations of strings of pots fished during the November 2001 ADF&G-Industry survey. A comparison of the effort and catch of red king crabs between the November 2001 ADF&G-Industry survey and the November 2006 ADF&G survey is provided in Table 7. A comparison of the catch of red king crabs captured in pots fished as off-survey-grid strings during the November 2006 ADF&G pot survey with the catch at strings in the same location during the November 2001 ADF&G-Industry survey is provided in Table 8.

Another ADF&G-Industry survey was conducted as a commissioner's permit fishery in the Adak-Atka-Amlia Islands area in November 2002 (see Figure 4 and 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).

- Other time series data (e.g., predator abundance, fishing effort)

The 1984/95–2007/08 time series of fishing effort (pot lifts) is provided in Table 3.

- Sample sizes (e.g., numbers of age or length samples by year, gear, and area)

Sample sizes for length samples from the Adak Area commercial fishery by season are provided in Table 5. Those from the three AD&G-Industry red king crab pot surveys in the Adak Area that were conducted as a commissioner's permit fishery are provided in Table 6.

Data which may be aggregated over time:

- Length at age

There is no length-at-age relationship established for Adak Area red king crabs.

- Growth per molt

Growth per molt was estimated for Adak Area male red king crabs by Vining et al. (2002) based on information received from recoveries during commercial fisheries of tagged red king crabs released in the Adak Island to Amlia Island area during the 1970s (Table 9).

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 (Tables 10 and 11).

- Weight at length or weight at age

Parameters for estimating weight (g) from carapace length (CL, mm) of BSAI red king crabs are provided in Table 12.

## Analytic Approach

### *Model Structure — N/A*

Description of overall modeling approach (e.g., age/size structured versus biomass dynamic, maximum likelihood versus Bayesian) — N/A

Reference for software used (e.g., Synthesis, AD Model Builder) — N/A

Description of, or reference for, population dynamic representations used in the model (e.g., Baranov catch equation, Brody length-at-age equation) — N/A

List and description of all likelihood components in the model — N/A

Discussion of changes in any of the above since the previous assessment — N/A

### *Parameters Estimated Independently*

List of parameters that are estimated independently of others (e.g., the natural mortality rate, parameters governing the maturity schedule)

- 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 crabs species.

- Parameters governing maturity schedule:

McMullen and Yoshihara (1971) reported that from 804 female red king crabs (79–109-mm CL) collected during the 1969/70 commercial fishery in the western Aleutians, "Female king crabs 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 red king crabs. 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.

### *Parameters Estimated Conditionally — N/A*

List of parameters that are estimated conditionally on those described above (e.g., full-selection fishing mortality rates, parameters governing the survey and fishery selectivity schedules, recruitments) — N/A

Description of how these parameters are estimated (e.g., error structures assumed, list of likelihood components, constraints on parameters) — N/A

Critical assumptions and consequences of assumption failures — N/A

### Model Evaluation — N/A

Description of alternative models, if any (e.g., alternative M values or likelihood weights) — N/A

Evidence of search for balance between realistic (but possible over-parameterized) and simpler (but not realistic) models — N/A

Use hierarchical approach where possible (e.g. asymptotic vs domed selectivities, constant vs time varying selectivities) — N/A

Do parameter estimates make sense, are they credible? — N/A

Description of criteria used to evaluate the model or to choose between alternative models, including the role (if any) of uncertainty — N/A

Residual analysis (e.g. residual plots, time series plots of observed and predicted values or other approach) — N/A

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 — N/A

List of final parameter estimates, with confidence intervals or other statistical measures of uncertainty if possible (if the set of parameters includes quantities listed in the "Results" section below, the values of these quantities should be presented in the "Results" section rather than here) — N/A

Schedules, if any, defined by final parameter estimates — N/A

## TIER 5 OFL BACKGROUND ANALYSIS

There is no regular survey of this stock and no assessment model for the Adak Area red king crab stock exists and none is in development; hence the Adak Area red king crab stock should be considered a Tier 5 stock. For Tier 5 stocks only an OFL is estimated, because it is not possible to estimate MSST without an estimate of biomass, and "the OFL represent the average retained catch from a time period determined to be representative of the production potential of the stock" (NPFMC 2007). Additionally, NPFMC (2007) states that for estimating the OFL of Tier 5 stocks, "The time period selected for computing the average catch, hence the OFL, should be based on the best scientific information available and provide the required risk aversion for stock conservation and utilization goals." This section provides background for considering the appropriate time period for estimating OFL.

Time periods for averaging the retained catch. NPFMC (2007) suggested using the average retained catch over the years 1985 to 1994 as the estimated OFL for Adak Area red king crab. Years post-1984 were chosen based on an assumed 8-year lag between hatching during the 1976/77 "regime shift" and growth to legal size. With regard to excluding data from years after 1995, NPFMC (2007) states, "The excluded years are from 1995 to 2005 for Adak red king crab when the fishery was closed, fishing effort was less than 10% of the average, or fishing was allowed only in a small part of the fishing ground."

The 1985/86–1994/95 period. There are several features about the fishery during the period 1985 to 1994 (which we take to be the 1985/86–1994/95 seasons) to note when considering the average harvest over this period as providing a measure of the "production potential of the stock" that provides "the required risk aversion for stock conservation and utilization goals." Although there were no area closures in effect for any of those seasons, 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 5). Earlier during the

1985/86–1994/95 period, significant portions of the harvest were attributable to areas east of the Petrel Bank area (the 1987/88-1989/90 seasons) or west of the Petrel Bank area (the 1985/86 season). Additionally, it is notable that both retained catch and the catch per pot lift (CPUE) of retained legal males declined during 1990/91–1994/95, the period when the majority of catch was harvested from the Petrel Bank area; the average annual retained catch was slightly over 1-million pounds and CPUE was 10–14 crabs per pot lift during the 1990/91–1992/93 seasons, whereas approximately 200-thousand pounds were harvested during the 1994/95 season at a CPUE of 2 crabs per pot lift (Table 3, Figure 6). Concurrent with the decline in catch and CPUE during the 1990/91–1994/95 seasons, the size frequency distribution in samples of the retained catch showed a clear progression of increasing size for 1990/91 through 1994/95, indicative of poor recruitment to legal size (Table 5, Figure 7). Finally, during the next season following the 1994/95 season (i.e., the 1995/96 season), less than 40,000 pounds were harvested (only half of that from the Petrel Bank area; Figure 5), although the entire area west of 171° W longitude remained open for red king crab fishing through the entire season (11/1/1995–02/15/1996; Failor-Rounds 2008).

The post-1994/95 period. Less than 40-thousand pounds were harvested during the 1995/96 season (see above) and the fishery in the Adak Area was closed for the next two seasons due to apparent low abundance and lack of recruitment.

The Adak Area east of 179° west longitude and west of 179° E longitude (i.e., outside of the Petrel Bank area was opened for limited exploratory fishing with a GHL of 15,000 pounds during the 1998/99 season. The GHL was not attained (Tables 2 and 3), but due to low participation in that season, the results of that exploratory fishing were inconclusive in providing information on the level of the stock outside of the Petrel Bank area at that time.

Results of two ADF&G-Industry surveys for red king crabs in the Petrel Bank area conducted as commissioner's permit fisheries in 2001 (Bowers et al. 2002; Table 3) and the two fisheries opened for red king crabs in the Petrel Bank area in 2002/03 and 2003/04 (Bush et al. 2005; Table 7) showed that legal males were present at least initially in high densities in the Petrel Bank area, although relatively few sublegal males or females were captured. However, CPUE declined from the 2001 surveys through the 2003/04 fishery season and fishery performance and observer data from those two seasons suggested that the harvests were supported largely by a single aging cohort of crabs and that prospects for new recruitment of legal males were poor (Bush et al. 2005). Based on those trends the fishery remained closed for the 2004/05–2006/07 seasons. The survey performed by ADF&G in the Petrel Bank area in November 2006 showed no indications of recovery of the stock there (Gish 2007; see also "Data-Survey numbers" in this chapter) and the fishery has remained closed through the 2007/08 season.

The ADF&G-Industry survey performed in the Adak, Atka, and Amlia Islands area in November 2002 provided no indication that red king crabs were at an abundance that could support a commercial fishery season in that area at that time (Granath 2002; see also "Data-Survey numbers" in this chapter).

In addition to documenting the presence of red king crabs that occur in randomly-sampled pots during the Aleutian Islands golden king crab fishery, observers on fishing vessels during the 2001/02, 2002/03, 2004/05, 2005/06, and 2006/07 Aleutian Islands golden king crab seasons have been instructed to document each red king crab that is captured while the observer is on the vessel. Data on the catch of red king crabs during the 2001/02-2006/07 Aleutian Islands golden king crab seasons are summarized in Table 13. The trend in catch of red king crabs during the 2001/02-2006/07 Aleutian Islands golden king crab seasons (Table 13) is graphed as documented catch (number) per observed effort (numbers of pot lifts) in Figure 8. Except for the catch of legal males during the 2001/02-2003/04 seasons and of sublegal males and females during the 2003/04 season (which is based on only random pot samples), the documented catch of red king crabs per observed effort was been low during the 2001/02-2006/07

Aleutian Islands golden king crab seasons. Nearly two-thirds of the red king crabs documented to have been captured as bycatch during the 2001/02–2006/07 Aleutian Islands golden king crab seasons were captured between 179° W longitude and 179° E longitude (Table 14), with most of those being captured on the margins of Petrel Bank and Petrel Spur. However, during the 2003/04 season the majority of the documented catch of red king crabs occurred between 178° W longitude and 179° W longitude (Table 14), in the vicinity of the Delarof Islands. A relatively large portion of the red king crab bycatch has also occurred in the area between 176° E longitude and 177° E longitude (i.e., between Kiska and Buldir Islands) in some seasons.

The following changes in management measures by season after the 1995/96 season are also important if considering any seasons after the 1994/95 season to include in the estimation of the OFL from the average retained catch:

| Season | Change in management measure |
|---|---|
| 1996/97–1997/98 | • Fishery closed |
| 1998/99 | • GHL of 15,000 pounds (for exploratory fishing) with fishery closed between 179° W longitude and 179° E longitude (i.e., the Petrel Bank area) |
| 1999/00 | • Fishery closed |
| 2000/01 | • Harvests during ADF&G-Industry survey of Petrel Bank area conducted as commissioner's permit fishery, Jan–Feb 2001 |
| 2001/02 | • Harvests during 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<br>• 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 |
| 2004/05–2007/08 | • Fishery closed |

## Results

Definition of biomass measures used (e.g., biomass at length 50 and above):

- weight of retained catch during the commercial fishery for estimation of OFL

Definition of recruitment measures used (e.g., numbers at length 40-70) – N/A

Definition of fishing mortality measures used (e.g., full-recruitment F multiplied by selectivity for lengths 80 and above):

- weight of retained catch during the commercial fishery

Table of estimated abundance and biomass time series, including spawning biomass as one measure, with confidence bounds or other statistical measure of uncertainty if possible. Include estimates from previous SAFE for retrospective comparisons:

- Tables 2 and 3 provide the annual weight of retained catch in a variety of formats and contexts.

Table of estimated recruitment time series, including average, with confidence bounds or other statistical measure of uncertainty if possible. Include estimates from previous SAFE for retrospective comparisons — N/A

Table of estimated catch/biomass time series, with confidence bounds or other statistical measure of uncertainty if possible:

- Tables 2 and 3 provide the annual weight of retained catch and annual estimated weight of non-retained catch in a variety of formats and contexts.

Graphs of fishery and survey selectivities, molting probabilities, and other schedules depending on parameter estimates

- Tables 9–11 provide estimated molting probabilities for males.
- Otherwise — N/A

Graph of estimated male, female, total and effective mature biomass time series, with confidence bounds if possible — N/A

Include a graph of the estimated fishing morality versus estimated spawning stock biomass, including applicable OFL and maximum $F_{target}$ definitions for the stock. The rationale is that graphs of this type are useful to evaluate management performance:

- The actual retained catch and GHL/TAC for the Adak Area red king crab fishery during 1996/97–2007/08 seasons are provided in Table 2 and are compared graphically in Figure 9. The retained catch in the 2002/03 season was 1% above the 500,000-pound GHL and the 2003/04 retained catch was 4% below the 500,000-pound GHL.

Graph of estimated full selection F over time. — N/A

Graphs of model fits to survey numbers or proportions by age or length. — N/A

Graphs of model fits to catch numbers or proportions by age or length. — N/A

Uncertainty and sensitivity analyses. — N/A

1. The best approach for describing uncertainty and range of probable biomass estimates in stock assessments may depend on the situation. Approaches used previously are:
   a) Sensitivity analyses (tables or figures) that show ending biomass levels or likelihood component values obtained while systematically varying emphasis factors for each type of data in the model. — N/A
   b) Likelihood profiles for parameters or biomass levels may also be used. — N/A
   c) CVs for biomass estimated by bootstrap, implicit autodifferentiation, or the delta method; — N/A
   d) Subjective appraisal of magnitude and sources of uncertainty; — N/A
   e) Comparison of alternate models; — N/A
   f) Comparison of alternate assumptions about recent recruitment. — N/A

2. If a range of model runs (e.g.; based on CV's or alternate assumptions about model structure or recruitment) is used to depict uncertainty, then it is important that some qualitative or quantitative information about relative probability be included. If no statements about relative probability can be made, then it is important to state that all scenarios (or all scenarios between the bounds depicted by the runs) are equally likely. — N/A

3. if possible, ranges depicting uncertainty should include at least three runs: (a) one judged most probable; (b) at least one that depicts the range of uncertainty in the direction of lower current biomass levels; and (c) one that depicts the range of uncertainty in the direction of

higher current biomass levels. The entire range of uncertainty should be carried through stock projections and decision table analyses. — N/A

4. retrospective analysis (retrospective bias in base model or models for each area). — N/A

5. historic analysis (plot of actual estimates from current and previous assessments for each area). — N/A

6. Simulation results (if available). — N/A

### Projections and Harvest Alternatives

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:

- OFL = "The average retained catch from a time period determined to be representative of the production potential of the stock"

Specification of FOFL , OFL, the upper bound on Ftarget, and other applicable measures (if any) relevant to determining whether the stock is overfished or if overfishing is occurring:

- Due to the apparent current low level of the stock and the lack retained catch data from unconstrained fisheries in the last 12 seasons, the assessment author could not recommend a time period for averaging retained catch to estimate OFL. However, estimated OFLs estimated as average retained catch for four different candidate time periods from within 1985/86–2007/08 are provide below:

| Time period | Number of seasons | OFL ( = average retained catch) |
|---|---|---|
| 1985/86–2007/08 | 23 | 464,762 |
| 1985/86–1995/96, 2002/03, 2003/04 | 13 | 804,084 |
| 1985/86–1994/95, 2002/03, 2003/04 | 12 | 867,846 |
| 1985/86–1994/95 | 10 | 942,940 |

- Recommend that OFL be set as the estimated average annual bycatch for the period 1996-2007, **26,287 pounds** (see Tables 4a-4c).

List of standard harvest scenarios and description of projection methodology

- Standard harvest scenario is that: 1) retained catch will be ≤TAC under the rationalized fishery in the area west of 179° W longitude; and retained catch in the area between 171° W longitude and 179° W longitude, where the fishery is not rationalized would be within 10% of the GHL for GHLs ≥500,000 pounds.

Table of 12-year projected catches corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios) — N/A

Table of 12-year 5-year (or 10-year, if the stock is overfished) projected spawning biomass corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios) — N/A

Table of 12-year projected fishing mortality rates corresponding to the alternative harvest scenarios, using stochastic methods if possible (mean values or other statistics may be shown in the case of stochastic recruitment scenarios) — N/A

Discussion of information, if any, that might warrant setting the GHL or total catch below the upper bound:

- The State of Alaska intends to manage the rationalized portion of the Adak area red king crab fishery in a precautionary manner, including keeping the fishery closed in the absence of stock assessment data that would indicated rebuilding of the population.

Recommendation of $F_{OFL}$ , OFL total catch, OFL retained catch for coming year: TBA

Include a subsection titled "Area Allocation of Harvests" and provide results and details of any apportionment schemes that are used. — N/A

### *Data gaps and research priorities*

The process of development and annual use of an assessment model to estimate spawning biomass will identify data gaps and research priorities.

### Summary

Table showing M, Tier (previous year or recommended), projected total biomass (give age or length range), female spawning biomass, male spawning biomass and total spawning biomass for current year and for next year. Male spawning biomass values at the time of mating for B0 and Bmsy and Fmsy (if available from stock-recruit relationship) or proxy values, FOFL , the maximum allowable value for Ftarget , the recommended value of OFL, the maximum allowable total catch.

| Parameter | Value |
|---|---|
| M | Default=0.18 |
| Tier | 5 |
| Projected total biomass | N/A |
| Female spawning biomass, current year (2007/08) | N/A |
| Male spawning biomass, current year (2007/08) | N/A |
| Total spawning biomass, current year (2007/08) | N/A |
| Female spawning biomass, next year (2008/09) | N/A |
| Male spawning biomass, next year (2008/09) | N/A |
| Total spawning biomass, next year (2008/09) | N/A |
| Male spawning biomass values at the time of mating for B0 and Bmsy and Fmsy, or proxy values | N/A |
| Maximum allowable value for Ftarget | N/A |
| Recommended value of OFL | 26,287 pounds (bycatch only) |
| Maximum allowable total catch | N/A |

## 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.

Alaska Department of Fish and Game (ADF&G). 1983. Westward Region shellfish report to the Alaska Board of Fisheries, March 1983. 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 2005 2006 mandatory shellfish observer program database for the rationalized crab fisheries. Alaska Department of Fish and Game, Fishery Data Series No. 07-02, Anchorage.

Barnard, D. R. and R. Burt. 2007. Alaska Department of Fish and Game summary of the 2002 mandatory shellfish observer program database for the general and CDQ 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.

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.

Bush, K. L., M. Bon, and M. E. Calvin, Jr. 2005. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, 2004/05. [*In*]: Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's shellfish observer program, 2004. Alaska Department of Fish and Game, Fishery Management Report No. 05-51, Anchorage.

Byersdorer, S. 1998. A summary of tagging data collected by observers on board the *F/V Patricia Lee* during the Aleutians brown king crab fishery from November 1996 to February 1997. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information report 4K98-22, Kodiak.

Failor-Rounds, B. 2008. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, 2006/07. Pages 3–71 *in* Bowers, F. R., M. Schwenzfeier, S. Coleman, B. Failor-rounds, K. Milani, K. Herring, M. Salmon, and M. Albert. 2008. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's Shellfish Observer Program, 2006/07. Alaska Department of Fish and Game, Fishery Management Report No. 08-02, Anchorage.

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.

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 Fishieries, 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, pp.441-450.

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.

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. 876 pp.

Schwenzfeier, M., S. Coleman, and M. Salmon. 2008. Annual report of the onboard observer program for the Westward Region crab fisheries, 2006/07. Pages 195–230 *in* Bowers, F. R., M. Schwenzfeier, S. Coleman, B. Failor-rounds, K. Milani, K. Herring, M. Salmon, and M. Albert. 2008. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's Shellfish Observer Program, 2006/07.

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.

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. 55 pp.

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. 876 pp.

NOTE: Perhaps in the future, dependent on the availability of time and information, a section on "ecosystem considerations" pertaining to red king crabs in the Adak Area will be included in this chapter.

Table 1. Relative frequency distribution (percentage) of depths (fathoms) of pot lifts sampled with catch per sampled pot by depth zone of red king crabs during the 2002/2003 Adak (Petrel Bank) red king crab fishery (top panel; from Barnard and Burt 2004) and the 2003/2004 Adak (Petrel Bank) red king crab fishery (bottom panel; from Burt and Barnard 2005).

Appendix C.31. CPUE by depth for 592 pot lifts sampled during the 2002 Petrel Bank red king crab fishery.

| Depth[a] | Percent of Sampled Pot lifts | Catch per sampled pot lift | | | |
|---|---|---|---|---|---|
| | | Legal | Sublegal | Female | Total |
| 41-45 | 0.5 | 0 | 0 | 0 | 0 |
| 46-50 | 1.0 | 0 | 0 | 0 | 0 |
| 51-55 | 2.9 | 0.2 | 0 | 0.1 | 0.3 |
| 56-60 | 3.7 | 11.7 | 0 | 5.0 | 16.8 |
| 61-65 | 24.8 | 17.4 | 0.7 | 5.1 | 23.1 |
| 66-70 | 40.4 | 15.0 | 0.9 | 0.6 | 16.5 |
| 71-75 | 19.8 | 11.7 | 0.1 | 0.1 | 11.8 |
| 76-80 | 4.7 | 13.4 | 1.1 | 0.4 | 14.9 |
| 81-85 | 2.0 | 12.4 | 0.2 | 0 | 12.6 |
| 86-90 | -- | -- | -- | -- | -- |
| 91-95 | 0.2 | 1.0 | 0 | 0 | 1.0 |

[a] Mean depth = 67.6 fathoms.

**Appendix C31.**-CPUE by depth for 929 pot lifts sampled during the 2003 Petrel Bank red king crab fishery.

| Depth[a] (fathoms) | Percent of Sampled Pots | Catch Per Sampled Pot | | | |
|---|---|---|---|---|---|
| | | Legal | Sublegal | Female | Total |
| 21-30 | 0.1 | 5.0 | 0 | 0 | 5.0 |
| 41-50 | 0.1 | 0 | 0 | 0 | 0 |
| 51-60 | 1.4 | 2.0 | 0.1 | 12.1 | 14.2 |
| 61-70 | 26.8 | 7.7 | 0.9 | 5.3 | 13.8 |
| 71-80 | 28.1 | 10.4 | 0.6 | 1.4 | 12.4 |
| 81-90 | 18.9 | 12.4 | 1.5 | 1.3 | 15.2 |
| 91-100 | 10.1 | 11.5 | 0.6 | 0.5 | 12.6 |
| 101-110 | 6.2 | 11.6 | 1.6 | 1.2 | 14.3 |
| 111-120 | 4.3 | 8.6 | 0.2 | 0.2 | 9.1 |
| 121-130 | 3.0 | 8.0 | 0 | 0 | 8.0 |
| 131-140 | 0.6 | 17.8 | 0 | 0 | 17.8 |
| 141-150 | 0.2 | 25.0 | 0 | 0 | 25.0 |

[a] Mean depth = 82.4 fathoms.

Table 2. Annual guideline harvest level (GHL, 1996/97–2004/05) or total allowable catch (TAC, 2005/06–2006/07) for retained catch (pounds), actual retained catch (pounds), estimated non-retained discards (pounds), and estimates of total catch (retained catch plus discard mortality; pounds) for the red king crabs in the Adak Area.

| Season | Retained GHL/TAC | Retained Catch | Non-retained discards | Total Catch[a] | | |
|---|---|---|---|---|---|---|
| | | | | *hm*=10% | *hm*=20% | *hm*=30% |
| 1996/97 | 0 | 0 | 5,982 | 598 | 1,196 | 1,795 |
| 1997/98 | 0 | 0 | 936 | 94 | 187 | 281 |
| 1998/99[b] | 15,000 | 5,900 | 1,071 | 6,007 | 6,114 | 6,221 |
| 1999/00 | 0 | 0 | 1,010 | 101 | 202 | 303 |
| 2000/01[c] | - | 76,562 | 1,819 | 76,744 | 76,926 | 77,108 |
| 2001/02[c] | - | 153,961 | 35,476 | 157,509 | 161,056 | 164,604 |
| 2002/03 | 500,000 | 505,642 | 47,722 | 510,414 | 515,186 | 519,959 |
| 2003/04 | 500,000 | 479,113 | 37,653 | 482,878 | 486,644 | 490,409 |
| 2004/05 | 0 | 0 | 2,353 | 235 | 471 | 706 |
| 2005/06 | 0 | 0 | 242 | 24 | 48 | 73 |
| 2006/07 | 0 | 0 | 478 | 48 | 96 | 143 |

a. Total catch is the retained catch plus estimated discard mortality with assumed handling mortality rate,*hm* .
b. Estimated weight of non-retained discards is only from that attributable to the Aleutian Islands golden king crab fishery; estimated weight of non-retained discards from the directed red king crab fishery are not available.
c. Fishery was prosecuted as a commissioner's permit fishery with no GHL for purposes of conducting ADF&G-Industry survey for red king crab in the Petrel bank area.

Table 3a. Harvest history for the Adak Area red king crab fishery (number of crabs and pounds of crabs landed, pot lifts, fishery catch per unit effort, and average weight of landed crabs) by fishery season from the 1984/85 season through the 2007/08 season.

| Season | Harvest Number[a] | Harvest Pounds[a] | Pot lifts | CPUE[b] | Average Weight[c] |
|---|---|---|---|---|---|
| 1984/85 | 196,276 | 1,296,385 | 48,642 | 4.0 | 6.60 |
| 1985/86 | 156,097 | 868,828 | 29,095 | 5.4 | 5.58 |
| 1986/87 | 126,204 | 712,543 | 29,189 | 4.3 | 5.65 |
| 1987/88 | 211,692 | 1,213,892 | 43,433 | 4.9 | 5.73 |
| 1988/89 | 266,053 | 1,567,314 | 64,334 | 4.1 | 5.89 |
| 1989/90 | 193,177 | 1,105,971 | 54,213 | 3.6 | 5.73 |
| 1990/91 | 146,903 | 828,105 | 10,674 | 13.8 | 5.64 |
| 1991/92 | 165,356 | 951,278 | 16,636 | 9.9 | 5.75 |
| 1992/93 | 218,049 | 1,286,424 | 16,129 | 13.5 | 5.90 |
| 1993/94 | 119,330 | 698,077 | 13,575 | 8.8 | 5.85 |
| 1994/95 | 30,337 | 196,967 | 18,146 | 1.7 | 6.49 |
| 1995/96 | 6,880 | 38,941 | 1,986 | 3.5 | 5.66 |
| 1996/97 | | | Fishery closed | | |
| 1997/98 | | | Fishery closed | | |
| 1998/99[d] | 749 | 5,900 | 102 | 7.3 | 7.88 |
| 1999/00 | | | Fishery closed | | |
| 2000/01[e] | 11,299 | 76,562 | 496 | 22.8 | 6.78 |
| 2001/02[f] | 22,080 | 153,961 | 564 | 39.1 | 6.97 |
| 2002/03[g] | 68,300 | 505,642 | 3,786 | 18.0 | 7.40 |
| 2003/04 | 59,828 | 479,113 | 5,774 | 10.4 | 8.01 |
| 2004/05 | | | Fishery closed | | |
| 2005/06 | | | Fishery closed | | |
| 2006/07 | | | Fishery closed | | |
| 2007/08 | | | Fishery closed | | |

a. Includes deadloss.

b. Catch (number of crabs) per pot lift.

c. Average weight (pounds) of landed crabs, including deadloss.

d. Fishery closed between 179° W longitude and 179° E longitude.

e. ADF&G-Industry pot survey of red kings in the Adak Area conducted as commissioner's permit fishery, January–February 2001 between 179° W longitude and 179° E longitude and north of 51° 45' N latitude (Petrel Bank area).

f. ADF&G-Industry pot survey of red kings in the Adak Area conducted as commissioner's permit fishery, November2001 between 179° W longitude and 179° E longitude and north of 51° 45' N latitude (Petrel Bank area).

g. Does not include catch of legal males (4 in number) and effort (1,085 pot lifts) from ADF&G-Industry pot survey of red kings in the Adak Area conducted as commissioner's permit fishery during November 2002 in the vicinity of Adak, Atka, and Amlia Islands (Granath 2003).

Table3b. Aleutian Islands, Area O, red king crab commercial fishery data, 1960/61 - 2006/07 (from Bowers et al. 2008).

| | | Number of | | | | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | Locale | Vessels[a] | Landings | Crabs[b] | Pots Lifted | Harvest[b,c] | Weight[c] | CPUE[d] | Length[e] | Deadloss[c] |
| 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** | | | | |

| | | Number of | | | | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season | Locale | Vessels[a] | Landings | Crabs[b] | Pots Lifted | Harvest[b,c] | Weight[c] | CPUE[d] | Length[e] | Deadloss[c] |
| 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 3b. page 2 of 3.

| Season | Locale | Number of Vessels[a] | Number of Landings | Number of Crabs[b] | Number of Pots Lifted | Harvest[b,c] | Average Weight[c] | Average CPUE[d] | Average Length[e] | Deadloss[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| 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** | | |

| Season | Locale | Number of Vessels[a] | Number of Landings | Number of Crabs[b] | Number of Pots Lifted | Harvest[b,c] | Average Weight[c] | Average CPUE[d] | Average Length[e] | Deadloss[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 3b. Page 3 of 3.

| Season | Locale | Number of Vessels[a] | Number of Landings | Number of Crabs[b] | Number of Pots Lifted | Harvest[b,c] | Average Weight[c] | Average CPUE[d] | Average Length[e] | Deadloss[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | | | |

| Season | Locale | Number of Vessels[a] | Number of Landings | Number of Crabs[b] | Number of Pots Lifted | Harvest[b,c] | Average Weight[c] | Average CPUE[d] | Average Length[e] | Deadloss[c] |
|---|---|---|---|---|---|---|---|---|---|---|
| 1998/99 | West of 174° W | 3 | 6 | 749 | 102 | 5,900 | 7.9 | 7 | NA | 0 |
| 1999/2000 | | F I S H E R Y C L O S E D | | | | | | | | |
| 2000/01[i] | Petrel Bank[j] | 1 | 3 | 11,299 | 496 | 76,562 | 6.8 | 23 | 161.0 | 0 |
| 2001/02[k] | Petrel Bank[j] | 4 | 5 | 22,080 | 564 | 153,961 | 7.0 | 39 | 159.5 | 82 |
| 2002/03 | Petrel Bank[j] | 33 | 35 | 68,300 | 3,786 | 505,642 | 7.4 | 18 | 162.4 | 1,311 |
| 2003/04 | Petrel Bank[j] | 30 | 31 | 59,828 | 5,774 | 479,113 | 8.0 | 10 | 167.9 | 2,617 |
| 2004/05 | | F I S H E R Y C L O S E D | | | | | | | | |
| 2005/06 | | F I S H E R Y C L O S E D | | | | | | | | |
| 2006/07 | | F I S H E R Y C L O S E D | | | | | | | | |

Table 4a. 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 crabs in the Adak Area during commercial crab fisheries by season for the 1996/97–2006/07 seasons. (Bycatch weight estimates for 1996/97–2005/06 were provided by D. Barnard, ADF&G, 20 July 2007; bycatch weight estimates for 2006/07 were provided by D. Pengilly using data from the ADF&G crab observer database, Dutch Harbor, 7 April 2007).

| | Adak red king crab fishery | | | | AI golden king crab fishery | | | |
|---|---|---|---|---|---|---|---|---|
| | Retained | Non-retained | | | | | | Total |
| Season | legal male | Legal male | Sublegal male | Female | Legal male | Sublegal male | Female | non-retained |
| 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 | 1,071 |
| 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 | 192 | 0 | 50 | 242 |
| 2006/07 | 0 | 0 | 0 | 0 | 315 | 114 | 49 | 478 |
| Average | 111,016 | 246 | 1,997 | 3,414 | 5,323 | 982 | 802 | 12,249 |

a. Data on bycatch of red king crabs during the red king crab fishery not available (see Moore et al. 2000).

(continued, with Table 4b, 4c on next page)

Table 4b. Estimated annual weight (pounds) of discarded bycatch of red king crabs (all sizes, males and females) during groundfish fisheries (all gear types and fisheries pooled) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude), 1996–2007 (summary of the data provided by J. Mondragon, NMFS-Alaska Region Office, 31 March 2008).

| Year | 541 | 542 | 543 | Total |
|---|---|---|---|---|
| 1996 | 1,379 | 359 | 25,374 | 27,113 |
| 1997 | 5 | 34 | 0 | 39 |
| 1998 | 16 | 2,854 | 570 | 3,440 |
| 1999 | 885 | 23 | 0 | 908 |
| 2000 | 3,013 | 5,373 | 1,449 | 9,835 |
| 2001 | 165 | 3,525 | 120 | 3,810 |
| 2002 | 0 | 39,068 | 0 | 39,068 |
| 2003 | 2,849 | 39,428 | 213 | 42,490 |
| 2004 | 15 | 4,541 | 16 | 4,572 |
| 2005 | 172 | 14,230 | 3,101 | 17,503 |
| 2006 | 3,386 | 121 | 2 | 3,510 |
| 2007 | 7,032 | 2,334 | 622 | 9,989 |
| Average | 1,577 | 9,324 | 2,622 | 13,523 |

Table 4c. Estimated average annual weight (pounds) of discarded bycatch of red king crabs (all sizes, males and females) during crab and groundfish fisheries (all gear types and fisheries pooled) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude, 1996–2007). Crab fishery average bycatch weight is the average for the 1996/97–2006/07 seasons; groundfish fishery average is from summary of the 1996–2007 data provided by J. Mondragon, NMFS-Alaska Region Office, 31 March 2008.

| Fishery | | | |
|---|---|---|---|
| Red king crab | Golden king crab | Groundfish - all gears | Total |
| 5,657 | 7,107 | 13,523 | 26,287 |

Table 5. Carapace length (CL, mm) frequency distribution from biological measurements of retained red king crabs sampled by season during the 1984/85–1995/96 and 2002/03–2003/04 red king crab seasons in the Adak Area. The commercial fishery was not opened for the 1996/97–1997/98, 1999/2000, 2004/05–2007/08 seasons. No data is available from the 1998/99 season. For data from the ADF&G-Industry pot surveys in 2001 and 2002 that were conducted as a commissioner's permit fishery, see Table 15. Data from ADF&G shellfish observer database, Dutch Harbor, 16 April 2008.

| CL (mm) | 84/85 | 85/86 | 86/87 | 87/88 | 88/89 | 89/90 | 90/91 | 91/92 | 92/93 | 93/94 | 94/95 | 95/96 | 02/03 | 03/04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <130 | 2 | 5 | 1 | 0 | 4 | 6 | 7 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 130 | 1 | 2 | 1 | 1 | 5 | 8 | 4 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 131 | 3 | 7 | 0 | 3 | 7 | 29 | 9 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 132 | 6 | 9 | 2 | 2 | 5 | 51 | 12 | 3 | 6 | 1 | 2 | 4 | 0 | 0 |
| 133 | 6 | 19 | 2 | 5 | 18 | 88 | 22 | 13 | 6 | 4 | 1 | 3 | 0 | 0 |
| 134 | 9 | 10 | 5 | 8 | 19 | 161 | 46 | 47 | 19 | 9 | 5 | 8 | 0 | 0 |
| 135 | 19 | 27 | 3 | 10 | 38 | 280 | 108 | 65 | 47 | 15 | 8 | 9 | 1 | 0 |
| 136 | 21 | 18 | 8 | 8 | 55 | 276 | 152 | 115 | 59 | 15 | 10 | 11 | 1 | 1 |
| 137 | 33 | 23 | 12 | 11 | 92 | 370 | 223 | 173 | 76 | 32 | 15 | 17 | 5 | 1 |
| 138 | 39 | 29 | 10 | 10 | 108 | 497 | 310 | 211 | 118 | 35 | 11 | 27 | 6 | 1 |
| 139 | 30 | 39 | 10 | 11 | 121 | 532 | 381 | 255 | 101 | 41 | 18 | 24 | 2 | 0 |
| 140 | 30 | 48 | 16 | 17 | 134 | 631 | 391 | 289 | 186 | 63 | 12 | 24 | 7 | 3 |
| 141 | 46 | 48 | 16 | 13 | 118 | 529 | 455 | 315 | 156 | 89 | 16 | 31 | 14 | 4 |
| 142 | 41 | 59 | 16 | 20 | 157 | 562 | 467 | 341 | 184 | 92 | 24 | 32 | 10 | 3 |
| 143 | 57 | 38 | 13 | 18 | 161 | 514 | 449 | 392 | 216 | 102 | 20 | 23 | 13 | 6 |
| 144 | 39 | 33 | 14 | 21 | 139 | 494 | 521 | 342 | 206 | 114 | 23 | 32 | 15 | 5 |
| 145 | 56 | 28 | 25 | 21 | 179 | 559 | 483 | 359 | 220 | 148 | 16 | 32 | 18 | 11 |
| 146 | 49 | 21 | 14 | 25 | 164 | 460 | 456 | 356 | 229 | 162 | 27 | 38 | 30 | 8 |
| 147 | 47 | 36 | 14 | 17 | 186 | 460 | 469 | 390 | 244 | 155 | 29 | 24 | 18 | 12 |
| 148 | 55 | 36 | 11 | 10 | 158 | 483 | 408 | 304 | 221 | 183 | 31 | 27 | 18 | 9 |
| 149 | 36 | 28 | 14 | 17 | 170 | 399 | 428 | 319 | 160 | 136 | 20 | 30 | 30 | 8 |
| 150 | 61 | 42 | 16 | 21 | 177 | 451 | 386 | 364 | 251 | 177 | 39 | 24 | 26 | 19 |
| 151 | 47 | 27 | 13 | 18 | 146 | 283 | 315 | 288 | 145 | 186 | 29 | 25 | 35 | 22 |
| 152 | 48 | 24 | 13 | 5 | 191 | 371 | 333 | 344 | 233 | 169 | 31 | 29 | 43 | 17 |
| 153 | 58 | 27 | 8 | 17 | 170 | 361 | 292 | 369 | 170 | 180 | 38 | 18 | 41 | 27 |
| 154 | 40 | 30 | 14 | 16 | 152 | 292 | 288 | 320 | 145 | 180 | 19 | 33 | 63 | 36 |
| 155 | 58 | 39 | 12 | 13 | 147 | 370 | 311 | 295 | 164 | 174 | 28 | 34 | 58 | 39 |
| 156 | 44 | 24 | 15 | 12 | 129 | 265 | 223 | 280 | 165 | 182 | 30 | 18 | 74 | 46 |
| 157 | 41 | 31 | 6 | 7 | 132 | 244 | 203 | 294 | 148 | 154 | 25 | 30 | 74 | 33 |
| 158 | 42 | 35 | 10 | 17 | 132 | 256 | 169 | 211 | 158 | 167 | 30 | 37 | 81 | 52 |
| 159 | 30 | 36 | 14 | 6 | 105 | 232 | 167 | 199 | 86 | 154 | 25 | 23 | 97 | 56 |

(continued)

Table 5. page 2 of 2.

| CL (mm) | 84/85 | 85/86 | 86/87 | 87/88 | 88/89 | 89/90 | 90/91 | 91/92 | 92/93 | 93/94 | 94/95 | 95/96 | 02/03 | 03/04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 160 | 62 | 31 | 7 | 5 | 128 | 233 | 136 | 149 | 142 | 154 | 43 | 23 | 81 | 78 |
| 161 | 30 | 17 | 6 | 9 | 105 | 190 | 106 | 121 | 88 | 149 | 28 | 21 | 69 | 64 |
| 162 | 53 | 34 | 6 | 7 | 98 | 178 | 103 | 115 | 92 | 114 | 33 | 27 | 84 | 72 |
| 163 | 52 | 23 | 6 | 4 | 97 | 185 | 77 | 118 | 96 | 115 | 34 | 16 | 78 | 57 |
| 164 | 26 | 34 | 7 | 9 | 108 | 134 | 78 | 80 | 76 | 117 | 30 | 23 | 100 | 98 |
| 165 | 50 | 24 | 5 | 8 | 92 | 153 | 78 | 66 | 79 | 95 | 21 | 22 | 75 | 115 |
| 166 | 38 | 18 | 5 | 5 | 72 | 92 | 48 | 51 | 52 | 85 | 33 | 17 | 91 | 95 |
| 167 | 41 | 17 | 3 | 2 | 71 | 92 | 59 | 56 | 74 | 77 | 24 | 29 | 82 | 105 |
| 168 | 45 | 19 | 2 | 3 | 70 | 76 | 34 | 47 | 69 | 68 | 24 | 33 | 80 | 99 |
| 169 | 32 | 18 | 5 | 2 | 57 | 85 | 33 | 43 | 29 | 70 | 16 | 13 | 53 | 99 |
| 170 | 39 | 12 | 5 | 2 | 65 | 85 | 25 | 33 | 52 | 39 | 22 | 15 | 71 | 126 |
| 171 | 22 | 3 | 3 | 1 | 45 | 65 | 29 | 33 | 33 | 47 | 13 | 10 | 58 | 87 |
| 172 | 30 | 12 | 1 | 1 | 50 | 51 | 24 | 20 | 37 | 30 | 14 | 16 | 60 | 119 |
| 173 | 24 | 7 | 2 | 1 | 32 | 48 | 14 | 19 | 23 | 19 | 17 | 10 | 41 | 99 |
| 174 | 30 | 10 | 3 | 0 | 48 | 32 | 17 | 15 | 20 | 27 | 13 | 6 | 44 | 86 |
| 175 | 24 | 5 | 1 | 0 | 48 | 35 | 18 | 12 | 19 | 23 | 8 | 11 | 49 | 92 |
| 176 | 17 | 7 | 3 | 0 | 28 | 23 | 11 | 11 | 19 | 12 | 13 | 4 | 35 | 62 |
| 177 | 17 | 2 | 0 | 0 | 19 | 26 | 4 | 5 | 12 | 19 | 13 | 2 | 27 | 68 |
| 178 | 18 | 7 | 1 | 0 | 21 | 18 | 6 | 3 | 12 | 7 | 4 | 5 | 20 | 50 |
| 179 | 12 | 1 | 6 | 0 | 14 | 19 | 7 | 7 | 11 | 9 | 3 | 1 | 20 | 53 |
| 180 | 8 | 4 | 2 | 0 | 13 | 16 | 1 | 8 | 9 | 5 | 6 | 1 | 20 | 45 |
| >180 | 41 | 34 | 15 | 2 | 60 | 55 | 10 | 41 | 30 | 22 | 43 | 5 | 38 | 192 |
| Total | 1,805 | 1,217 | 422 | 441 | 4,860 | 12,405 | 9,406 | 8,306 | 5,195 | 4,426 | 1,037 | 978 | 2,056 | 2,381 |

Table 6. Carapace length (CL, mm) frequency distribution from biological measurements of retained red king crabs sampled during ADF&G-Industry pot surveys of red kings in the Adak Area conducted as commissioner's permit fisheries: January–February 2001, between 179° W longitude and 179° E longitude and north of 51° 45' N latitude (Petrel Bank area); November 2001 in the Petrel Bank area; and November 2002 in the vicinity of Adak, Atka, and Amlia Islands (Adak–Amlia). Data from ADF&G shellfish observer database, Dutch Harbor, 16 April 2008.

| CL (mm) | Petrel Bank Jan–Feb 2001 | Petrel Bank Nov 2001 | Adak–Amlia Nov 2002 |
|---|---|---|---|
| <130 | 0 | 0 | 0 |
| 130 | 0 | 0 | 0 |
| 131 | 0 | 0 | 0 |
| 132 | 0 | 0 | 0 |
| 133 | 0 | 0 | 0 |
| 134 | 0 | 0 | 0 |
| 135 | 0 | 0 | 0 |
| 136 | 0 | 3 | 0 |
| 137 | 0 | 2 | 0 |
| 138 | 0 | 3 | 0 |
| 139 | 1 | 2 | 0 |
| 140 | 0 | 4 | 0 |
| 141 | 1 | 5 | 0 |
| 142 | 1 | 9 | 0 |
| 143 | 2 | 8 | 0 |
| 144 | 2 | 11 | 0 |
| 145 | 3 | 7 | 0 |
| 146 | 4 | 7 | 0 |
| 147 | 3 | 7 | 0 |
| 148 | 6 | 16 | 0 |
| 149 | 7 | 10 | 0 |
| 150 | 12 | 13 | 0 |
| 151 | 15 | 16 | 0 |
| 152 | 19 | 25 | 0 |
| 153 | 20 | 22 | 0 |
| 154 | 12 | 28 | 0 |
| 155 | 14 | 18 | 0 |
| 156 | 22 | 14 | 0 |
| 157 | 17 | 24 | 0 |
| 158 | 12 | 23 | 0 |
| 159 | 20 | 20 | 0 |

(continued)

Table 6. page 2 of 2.

| CL (mm) | Petrel Bank Jan–Feb 2001 | Petrel Bank Nov 2001 | Adak–Amlia Nov 2002 |
|---|---|---|---|
| 160 | 26 | 19 | 0 |
| 161 | 16 | 15 | 0 |
| 162 | 22 | 25 | 0 |
| 163 | 15 | 30 | 0 |
| 164 | 26 | 25 | 0 |
| 165 | 20 | 13 | 0 |
| 166 | 22 | 17 | 0 |
| 167 | 21 | 24 | 0 |
| 168 | 13 | 18 | 0 |
| 169 | 20 | 13 | 0 |
| 170 | 9 | 13 | 0 |
| 171 | 16 | 6 | 0 |
| 172 | 12 | 13 | 0 |
| 173 | 4 | 18 | 0 |
| 174 | 7 | 5 | 0 |
| 175 | 6 | 9 | 0 |
| 176 | 3 | 4 | 0 |
| 177 | 5 | 4 | 0 |
| 178 | 0 | 2 | 0 |
| 179 | 1 | 6 | 0 |
| 180 | 2 | 2 | 0 |
| >180 | 1 | 11 | 2[a] |
| Total | 460 | 589 | 2[b] |

a. One at 193-mm CL and one at 194-mm CL.
b. Only four legal males were captured (Granath 2003).

Table 7. Number of pots fished within station areas designated for the November 2001 ADF&G-Industry survey for red king crabs on Petrel Bank and number of legal male, sublegal male, and female red king crabs captured within station areas during the 2006 ADF&G Petrel Bank red king crab survey and the November 2001 ADF&G-Industry survey for red king crabs on Petrel Bank (from Gish 2007).

| Station Area[a] | 2006 Survey | | | | November 2001 Industry Survey | | | |
|---|---|---|---|---|---|---|---|---|
| | Pots Fished | Legal Males | Sublegal Males | Females | Pots Fished | Legal Males | Sublegal Males | Females |
| 1 | 16 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| 2 | 8 | 0 | 0 | 0 | 25 | 271 | 0 | 0 |
| 3 | 12 | 0 | 0 | 0 | 25 | 75 | 1 | 2 |
| 4 | 24 | 0 | 0 | 1 | 25 | 320 | 0 | 1 |
| 5 | 16 | 0 | 0 | 0 | 25 | 1,765 | 5 | 1 |
| 6 | 20 | 0 | 0 | 0 | 25 | 1,424 | 25 | 0 |
| 7 | 16 | 0 | 0 | 0 | 24 | 0 | 0 | 0 |
| 8 | 24 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| 9 | 16 | 0 | 0 | 0 | 25 | 419 | 2 | 2 |
| 10 | 16 | 0 | 0 | 0 | 25 | 1,723 | 135 | 9 |
| 11 | 16 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| 12 | 16 | 0 | 0 | 0 | 25 | 0 | 0 | 1 |
| 13 | 24 | 7 | 6 | 3 | 25 | 49 | 0 | 0 |
| 14 | 8 | 62 | 76 | 31 | 25 | 1,312 | 30 | 6 |
| 15 | 15 | 0 | 0 | 0 | 25 | 2,648 | 106 | 207 |
| 16 | 16 | 0 | 0 | 0 | 25 | 275 | 10 | 149 |
| 17 | 16 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| 18 | 16 | 0 | 0 | 0 | 25 | 0 | 0 | 0 |
| 19 | 12 | 0 | 0 | 0 | 25 | 38 | 0 | 0 |
| 20 | 12 | 67 | 4 | 9 | 25 | 3,227 | 189 | 197 |
| 21 | 16 | 154 | 35 | 33 | 26 | 2,674 | 216 | 353 |
| 22 | 16 | 5 | 0 | 49 | 25 | 2,541 | 451 | 1,040 |
| 23 | 16 | 0 | 0 | 0 | 25 | 22 | 0 | 0 |
| 24 | 8 | 0 | 0 | 0 | 25 | 54 | 0 | 0 |
| 25 | 24 | 80 | 2 | 4 | 25 | 1,147 | 13 | 3 |
| 26 | 20 | 187 | 20 | 7 | 25 | 1,198 | 206 | 403 |
| 27 | 8 | 0 | 0 | 0 | 25 | 1,340 | 19 | 17 |
| 28 | 24 | 0 | 0 | 0 | 25 | 39 | 1 | 1 |
| Total | 451 | 562 | 143 | 137 | 700 | 22,561 | 1,409 | 2,392 |

[a] Station areas are illustrated in Figure 3 and are described in Appendix B of Bowers et al. (2002).

Table 8. Number of pots fished within four off-survey-grid strings during the 2006 ADF&G Petrel Bank red king crab survey charter and catch of legal male, sublegal male, and female red king crabs compared with number of pots corresponding to those strings that were fished during the November 2001 industry survey for red king crabs on Petrel Bank and catch of legal male, sublegal male, and female red king crabs (from Gish 2007).

| String | 2006 Survey Charter | | | | November 2001 Industry Survey | | | |
|---|---|---|---|---|---|---|---|---|
| | Pots Fished | Legal Males | Sublegal Males | Females | Pots Fished | Legal Males | Sublegal Males | Females |
| 3 | 33 | 344 | 159 | 117 | 34 | 1,739 | 150 | 307 |
| 4 | 16 | 60 | 3 | 11 | 18 | 2,021 | 188 | 84 |
| 5 | 25 | 382 | 48 | 58 | 44 | 3,937 | 222 | 570 |
| 6 | 18 | 111 | 18 | 4 | 25 | 2,648 | 106 | 207 |
| Total | 92 | 897 | 228 | 190 | 121 | 10,345 | 666 | 1,168 |

Table 9. Mixture model parameter estimates (Est.) and standard errors (SE) of proportion molting and mean and standard deviation of growth (mm carapace length, CL) for male red king crabs tagged during 1970, 1971, and 1973-1977 in the Adak Island to Amlia Island area of the Adak Area (from Vining et al. 2002).

| Release Period | Feb-Mar 1970 | | Apr, Dec 1971 | | Feb 1973 | | 1974-1977 | | 1971,1973-1974 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Shell Age at Release | New | | New | | New | | New | | Old | |
| Recovery Period | Oct 1970 – Mar 1971[1] | | Nov-Dec 1971-1973[2] | | Nov-Dec 1973, Jan-Mar 1975[3] | | 1975, 1978-1979 | | 1972, 1973, 1975 | |
| Sample Size | 239 | | 297 | | 497 | | 53 | | 70 | |
| | Est. | SE | Est. | SE | Est. | SE | Est. | SE | Est. | SE |
| **No Molts:** | | | | | | | | | | |
| Proportion | 0.84 | 0.024 | 0.19 | 0.024 | 0.39 | 0.023 | 0.69 | 0.065 | 0.34 | 0.063 |
| Mean[4] | -0.01 | 0.044 | 0.08 | 0.112 | -0.07 | 0.033 | 0.13 | 0.151 | 0.03 | 0.134 |
| Standard Deviation[5] | 0.62 | 0.032 | 0.78 | 0.082 | 0.41 | 0.030 | 0.90 | 0.107 | 0.58 | 0.108 |
| **Single Molt:** | | | | | | | | | | |
| Proportion | 0.16 | 0.024 | 0.77 | 0.026 | 0.55 | 0.025 | 0.31 | 0.065 | 0.66 | 0.063 |
| Mean | 10.56 | 0.514 | 15.70 | 0.202 | 10.83 | 0.382 | 8.29 | 0.807 | 8.81 | 0.781 |
| Standard Deviation | 3.13 | 0.386 | 2.85 | 0.147 | 5.35 | 0.337 | 2.99 | 0.628 | 4.69 | 0.542 |
| **Double Molt:** | | | | | | | | | | |
| Proportion | NA | NA | 0.04 | 0.049 | 0.06 | 0.047 | NA | NA | NA | NA |
| Mean | NA | NA | 26.72 | 0.354 | 28.04 | 0.893 | NA | NA | NA | NA |
| Standard Deviation | NA | NA | 1.09 | 0.248 | 3.41 | 0.592 | NA | NA | NA | NA |

1. Also includes one recovery in February 1970 and one recovery in January 1973.
2. Also includes one recovery in February 1973, two recoveries in January 1975, and one recovery in March 1975.
3. Also includes one recovery in February 1974, one recovery in September 1974, one recovery in November 1977, and one recovery in March 1978.
4. Mean of measurement error.
5. Standard deviation of measurement error.

Table 10. Logit parameter estimates, slope ( ) and intercept ( ), and their standard errors (SE) for estimating probability of molting within 8–14 months from carapace length (CL) of new-shell male red king crabs tagged and released in the Adak Area during 1970, 1971, 1973, and 1974–1977, and old-shell male red king crabs tagged and released in the Adak Area during 1970, 1971, and 1973–1977 (from Vining et al. 2002).

| Year | Shell Condition | Slope ( ) Estimate | Slope ( ) SE | Intercept ( ) Estimate | Intercept ( ) SE |
|---|---|---|---|---|---|
| 1970 | New | -0.205 | 0.0327 | 26.66 | 4.433 |
| 1971 | New | -0.234 | 0.0373 | 33.54 | 5.202 |
| 1973 | New | -0.202 | 0.0186 | 27.67 | 2.583 |
| 1974–1977 | New | -0.124 | 0.0464 | 16.82 | 6.619 |
| 1970, 1971, 1973–1977 | Old | -0.180 | 0.0555 | 25.59 | 7.908 |

Table 11. Logit estimates of carapace lengths (CL; mm) at which 10%, 50% and 90% of the crabs would molt within 8–14 months for new-shell male red king crabs tagged and released in the Adak Area during 1970, 1971, 1973, and 1974–1977, and old-shell male red king crabs tagged and released in the Adak Area during 1970, 1971, and 1973–1977 (from Vining et al. 2002).

| Year | Shell Condition | CL (mm) for 90% probability of molting | CL (mm) for 50% probability of molting | CL (mm) for 10% probability of molting |
|---|---|---|---|---|
| 1970 | New | 119 | 130 | 140 |
| 1971 | New | 134 | 143 | 152 |
| 1973 | New | 126 | 137 | 148 |
| 1974–1977 | New | 118 | 136 | 154 |
| 1970, 1971, 1973–1977 | Old | 130 | 142 | 154 |

Table 12. Estimated parameters (A and B) for estimating weight (g) from carapace length (CL, mm) of male and ovigerous female red king crabs according to the equation, Weight = $A*CL^B$ (from Table 3-5, NPFMC 2007).

| Parameter | Males | Ovigerous females |
|---|---|---|
| A | 0.000361 | 0.022863 |
| B | 3.16 | 2.23382 |

Table 13. Number of pot lifts (fishery effort), number of pot lifts performed with an observer on the vessel (observed effort), and number of red king crabs by sex-size class documented as captured during the Aleutian Islands golden king crab fishery, 2001/02-2006/07 seasons.

| Season | Fishery effort[a] | Observed effort[b] | Number of red king crabs | | |
|---|---|---|---|---|---|
| | | | Legal | Sublegal | Female |
| 2001/02[c] | 168,151 | 168,151 | 457 | 36 | 47 |
| 2002/03[c] | 131,021 | 131,021 | 772 | 26 | 30 |
| 2003/04[d] | 125,119 | 7,294 | 61 | 102 | 120 |
| 2004/05[c] | 91,694 | 91,694 | 115 | 57 | 37 |
| 2005/06[e] | 54,685 | 41,323 | 6 | 16 | 14 |
| 2006/07[e] | 53,065 | 38,388 | 37 | 35 | 24 |

a. Number of pot lifts performed during the Aleutian Islands golden king crab season.
b. Number of pot lifts performed during the Aleutian Islands golden king crab season while an observer was present on the vessel. For the 2003/04 season "Observed effort" is the number of pot lifts randomly sampled by observers during the season.
c. Observers present on all vessels at all times when fishing during the Aleutian Islands golden king crab fishery season.
d. Program for documenting catch of all red king crabs during the Aleutian Islands golden king crab fishery not implemented in the 2003/04 season.
e. Partial-time observer presence on catcher-only vessels during the Aleutian Islands golden king crab fishery season (full-time observer presence on catcher-processor vessels).

Table 14. Number of red king crabs documented as captured during the, 2001/02-2006/07 Aleutian Islands golden king crab fishery seasons by 1-degree zones of longitude.

| Longitude zone | 2001/02 | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | Total |
|---|---|---|---|---|---|---|---|
| 169°–170° W[a] | 4 | 0 | 1 | 0 | 0 | 0 | 5 |
| 170°–171° W[a] | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 171°–172° W | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 173°–174° W | 1 | 3 | 0 | 0 | 0 | 0 | 4 |
| 176°–177° W | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 177°–178° W | 9 | 81 | 0 | 0 | 1 | 0 | 91 |
| 178°–179° W | 36 | 18 | 216 | 5 | 17 | 0 | 292 |
| 179°–180° W | 216 | 267 | 6 | 18 | 12 | 57 | 576 |
| 179°–180° E | 163 | 398 | 54 | 59 | 1 | 4 | 679 |
| 178°–179° E | 40 | 1 | 0 | 23 | 2 | 6 | 72 |
| 177°–178° E | 5 | 0 | 0 | 0 | 0 | 1 | 6 |
| 176°–177° E | 35 | 56 | 4 | 97 | 2 | 24 | 218 |
| 175°–176° E | 19 | 0 | 1 | 7 | 1 | 4 | 32 |
| 172°–173° E | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Unknown | 12 | 0 | 1 | 0 | 0 | 0 | 13 |
| Total | 540 | 828 | 283 | 209 | 36 | 96 | 1980 |

a. East of 171° W longitude and, hence, not inside the Adak Area.

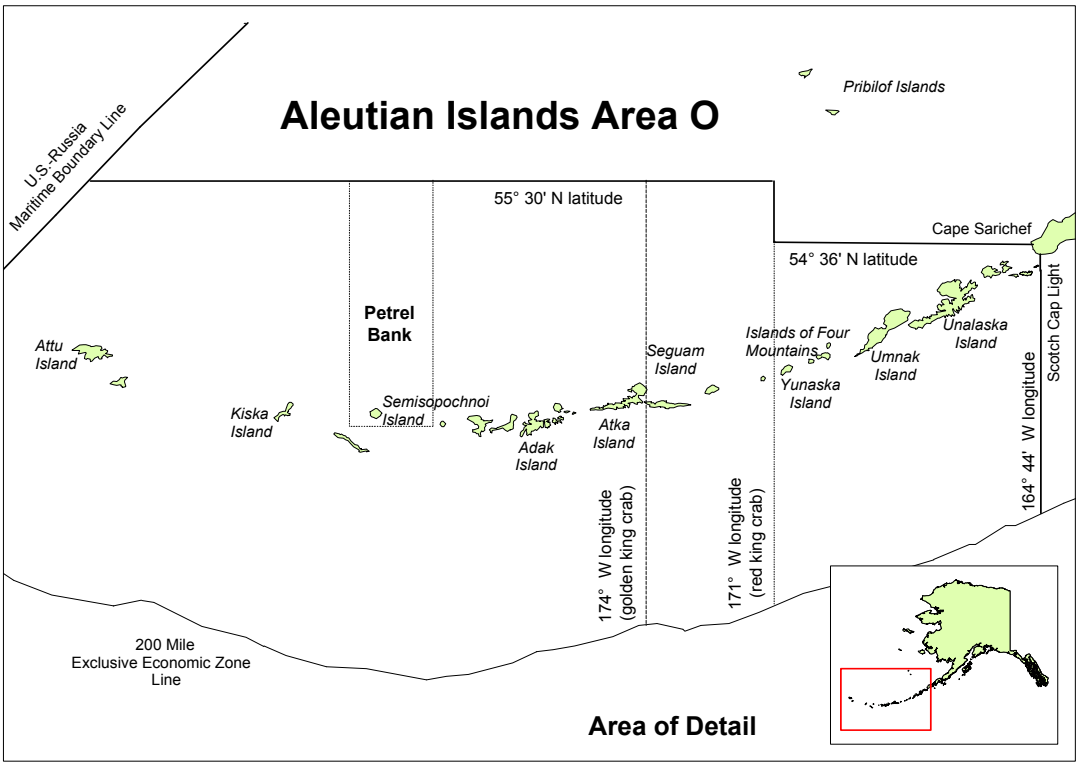



Figure 1. Aleutian Islands, Area O, red and golden king crab management area (from Failor-Rounds 2008).

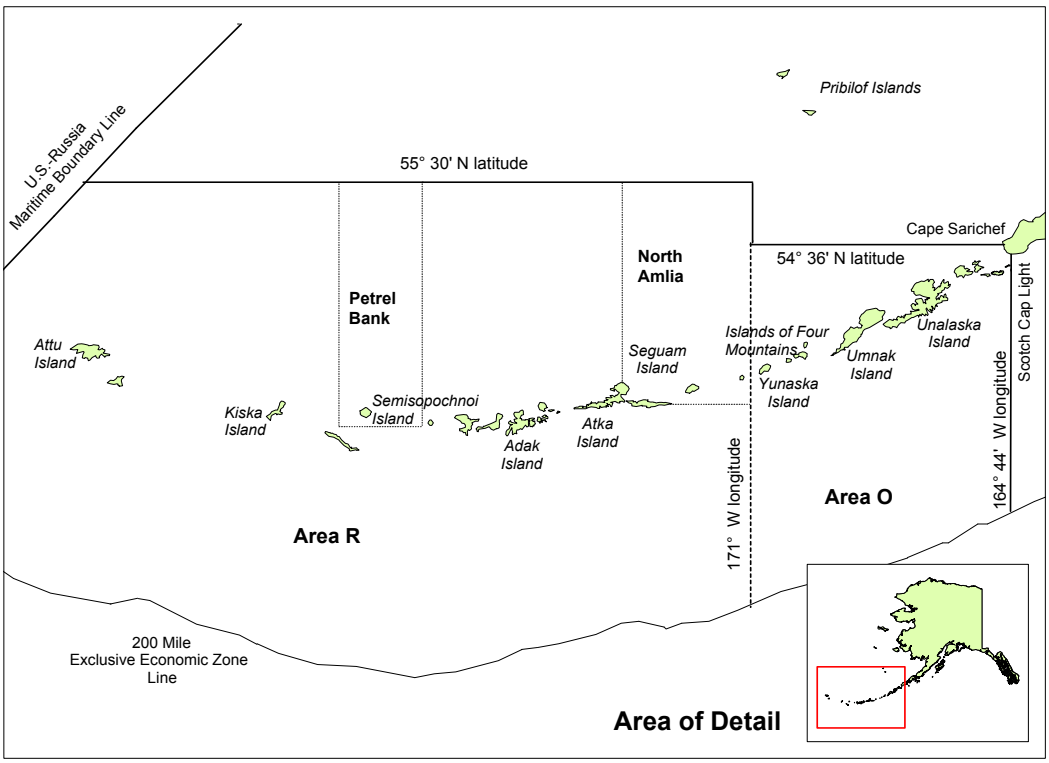
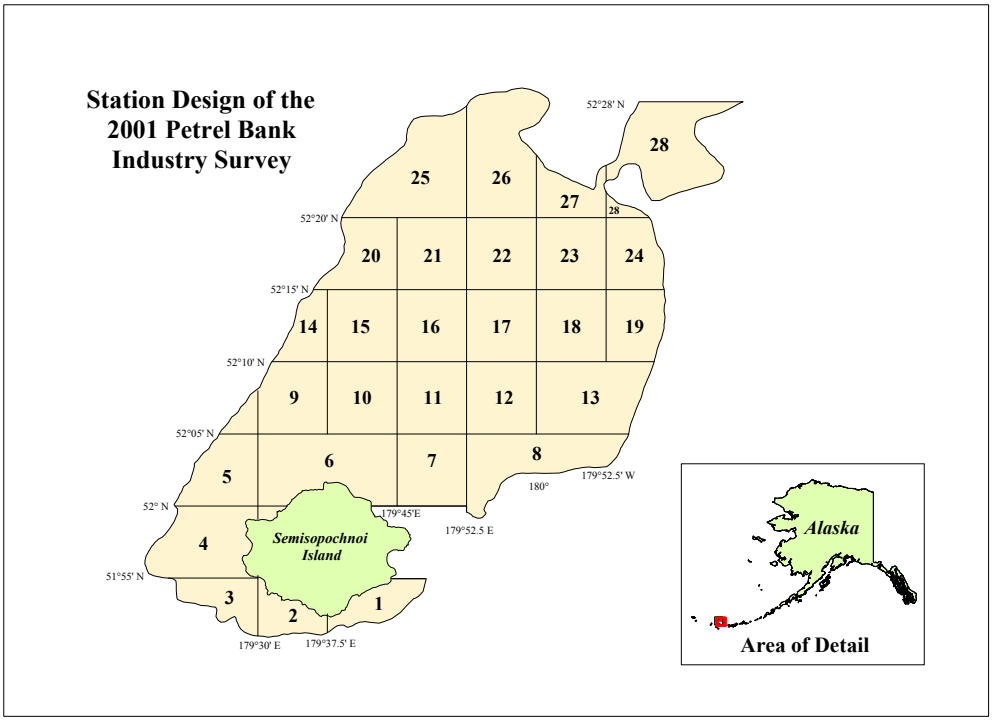



Figure 2. Adak (Area R) and Dutch Harbor (Area O) king crab Registration Areas and Districts, 1984/85 – 1995/969 seasons (from Failor-Rounds 2008).



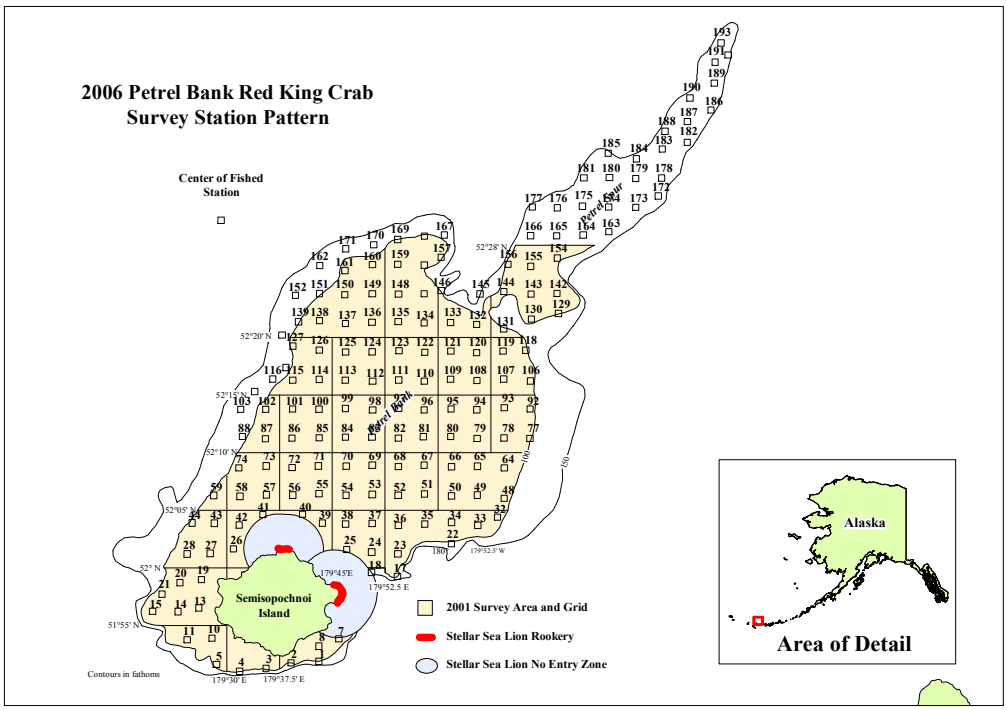




Figure 3. Survey area and grid design for the November 2001 ADFG-Industry industry survey (top panel) and station pattern and numbers of those fished during the November 2006 ADF&G Petrel Bank red king crab survey (bottom panel).

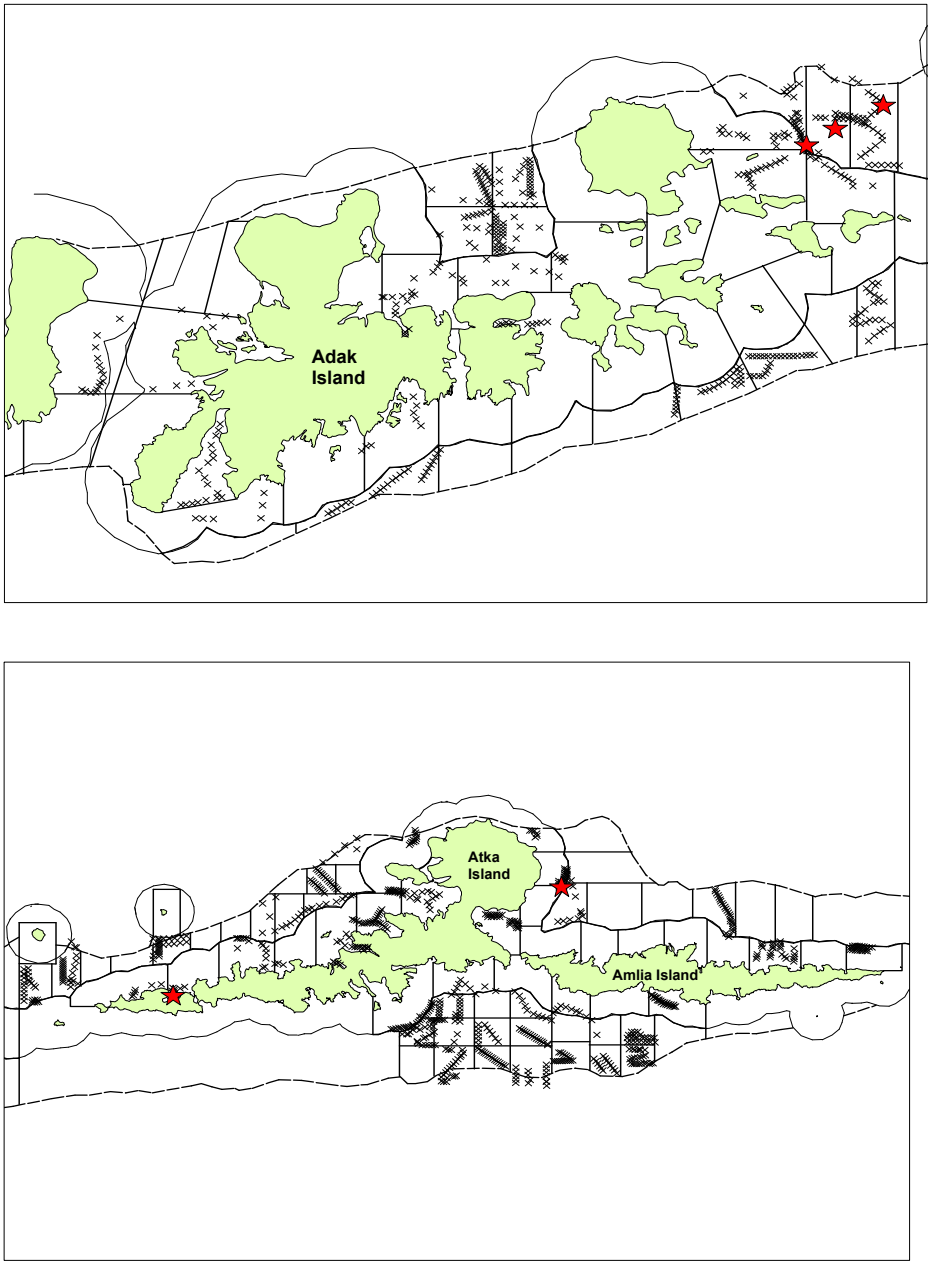



Figure 4. Locations (x) of pots fished in the Adak Island locale (top panel) and Atka-Amlia Islands locale (bottom panel) during the ADF&G-Industry red king crab pot survey conducted as a commissioner's permit fishery in November 2002; stars mark locations where legal male red king crabs were captured (from Granath 2002).

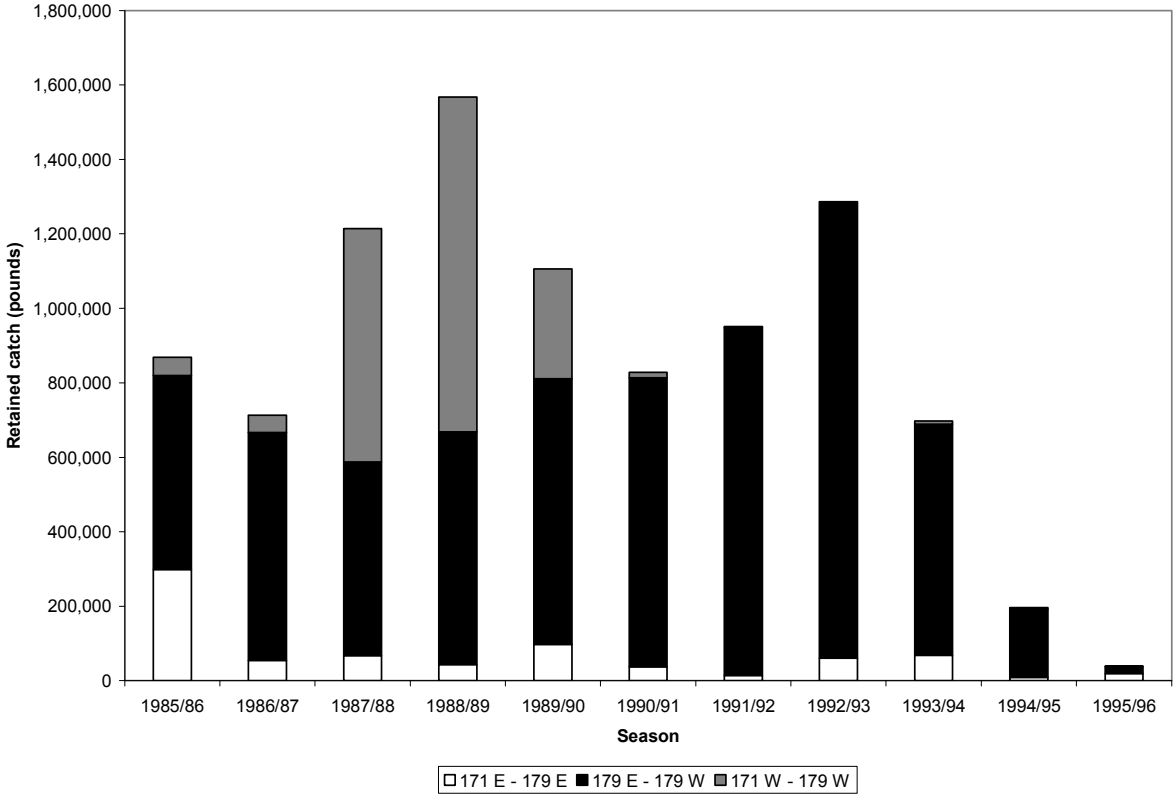



Figure 5. Retained catch (pounds) by longitudinal zones in the 1985/86–1995/96 red king crab fishery in the Adak Area (from fish ticket data summaries provided by ADF&G, Dutch Harbor, March 2008).

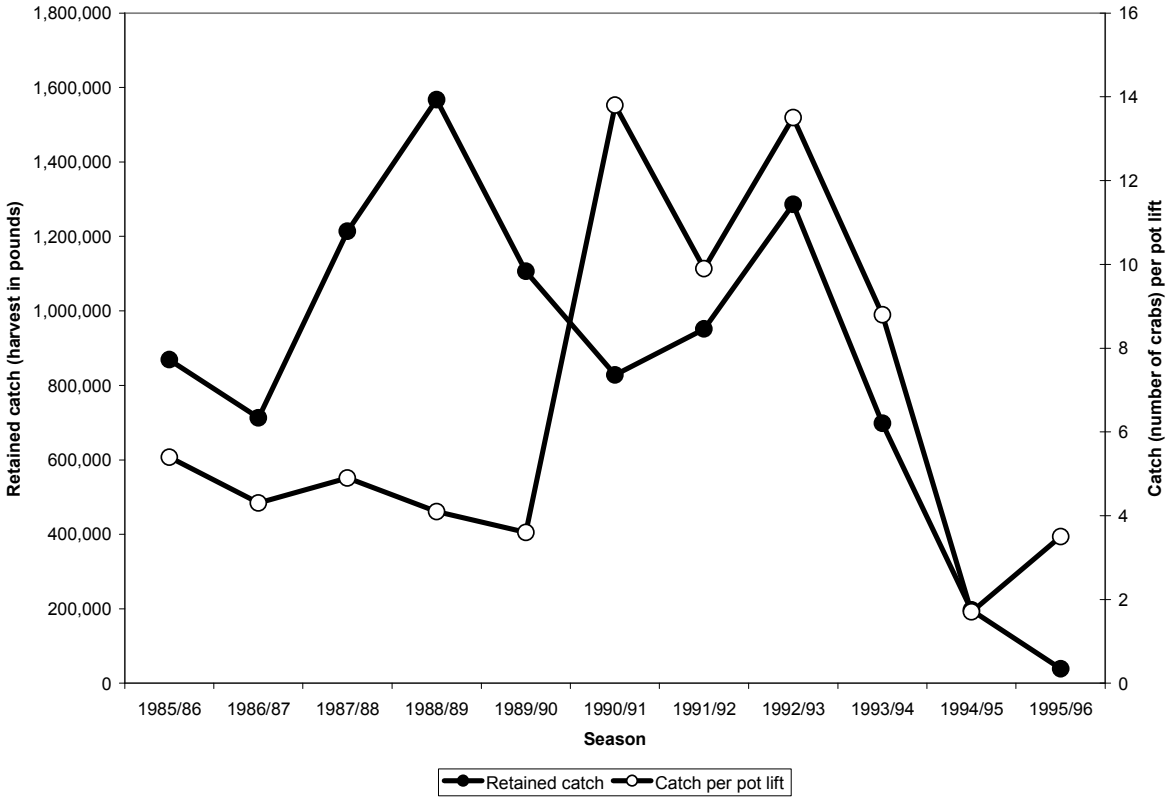



Figure 6. Retained catch (harvest in pounds) and catch (number of retained legal crabs) per pot lift (CPUE) in the Adak Area red king crab fishery, 1985/86–1995/96 seasons.

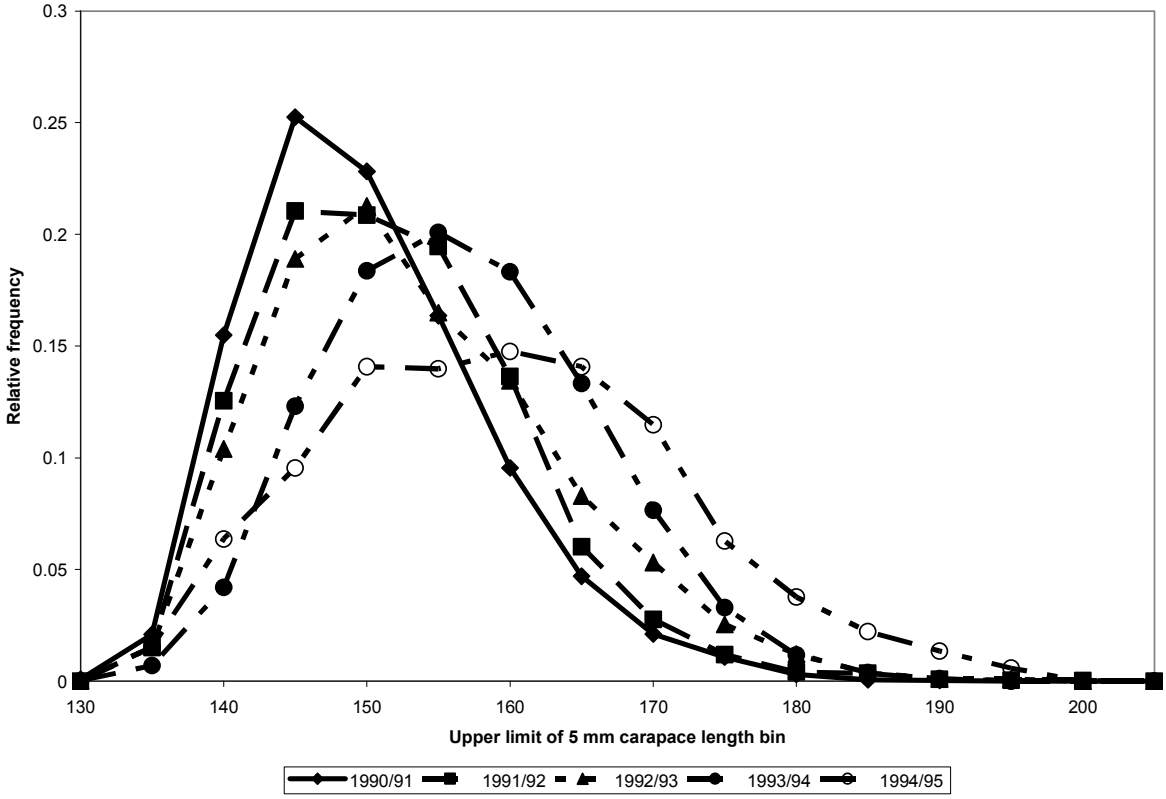



Figure 7. Size frequency distribution (carapace length, mm, in 5-mm bins) from samples of the retained catch during the 1990/91 through 1994/95 Adak red king crab fishery.

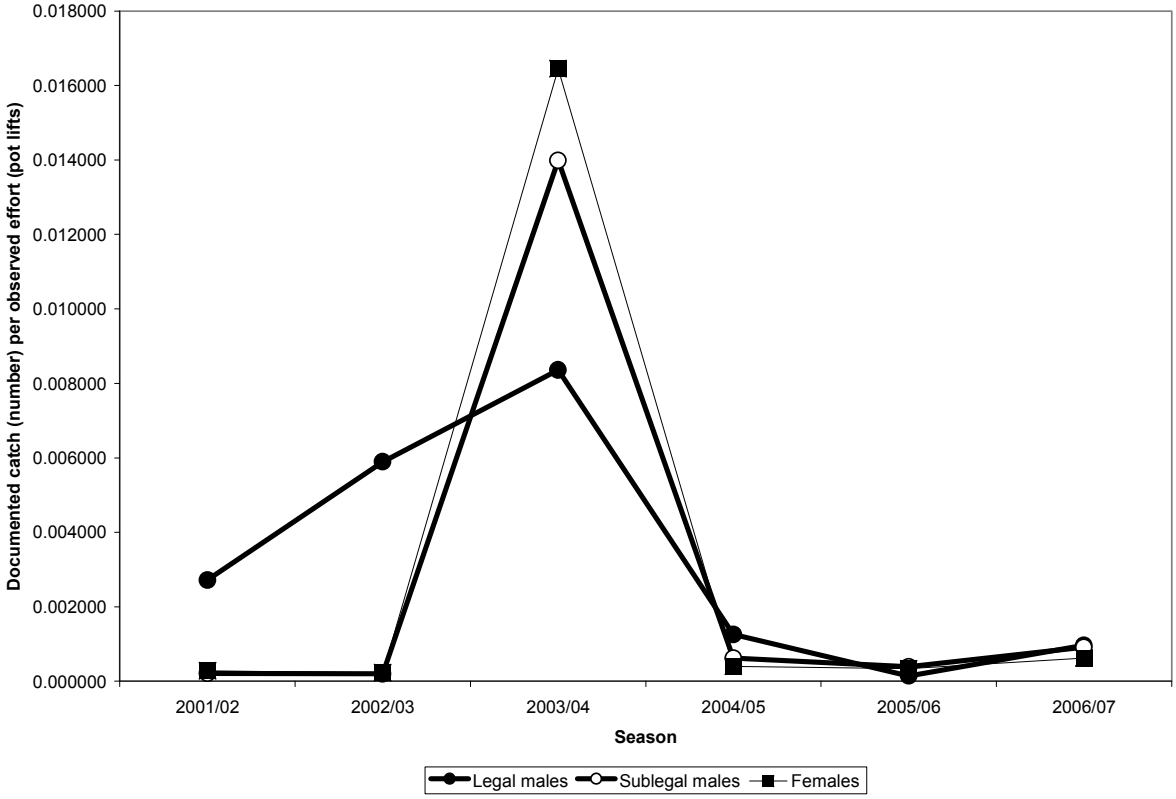



Figure 8. Catch of red king crabs by sex-size class documented by observers during the 2001/02-2006/07 Aleutian Islands golden king crab fishery per unit of observer effort (see Table 13).

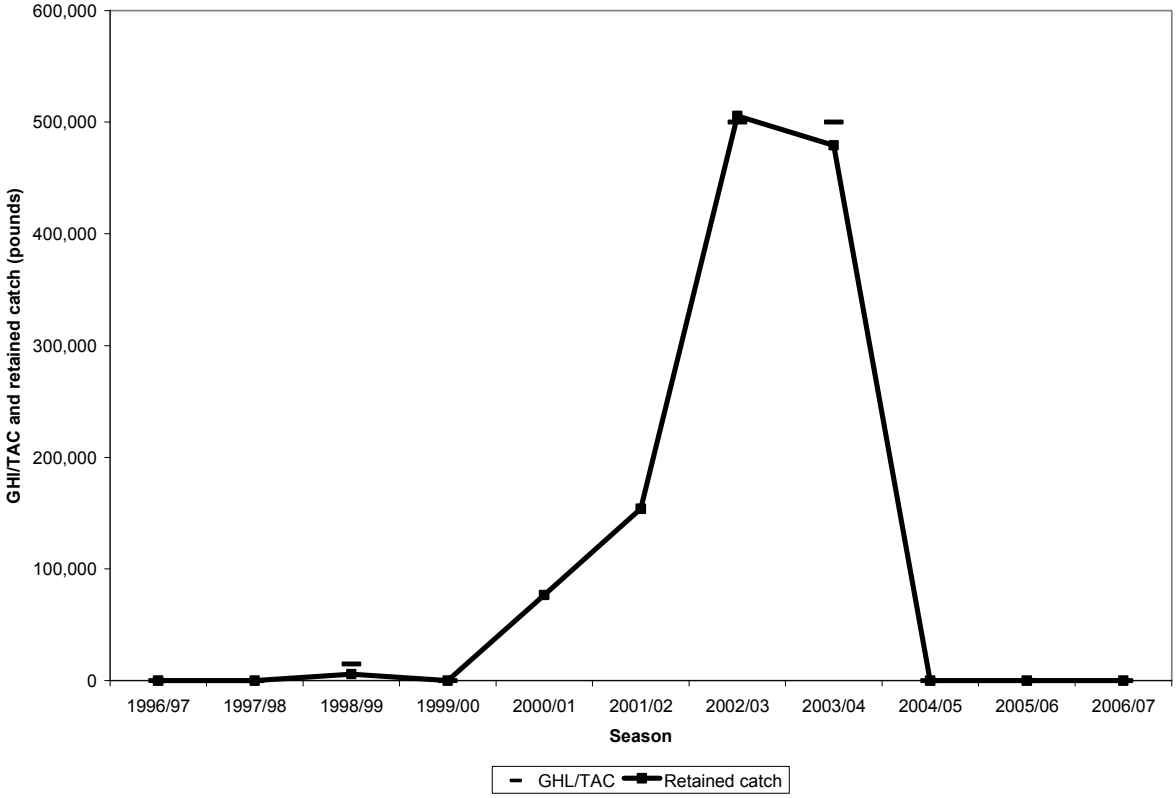



Figure 9. Pre-season GHL (in pounds for the 1996/97–2004/05 seasons) and TAC (in pounds for the 2005/06–2006/07 seasons) compared to the retained catch (pounds) during the 1996/97–2006/07 seasons for the red king crab fishery in the Adak Area (no GHL was established for the ADF&G-Industry red king crab surveys of the Petrel Bank area conducted as a commissioner's permit fishery in the 2000/01 and 2001/02 seasons).