

# Adak Red King Crab

## 2008 Crab SAFE Report Chapter

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### 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 the directed red king crab fishery (when prosecuted), in the Aleutian Islands golden king crab fishery, and in the groundfish fisheries. Estimated annual non-retained catch during the 1996/97–2006/07 seasons has been low (<50-thousand pounds in crab fisheries and <50-thousand pounds in groundfish fisheries); the average total annual bycatch (i.e., in crab and groundfish fisheries combined) from 1996 through the 2007/08 season is estimated to be 25-thousand pounds. During 2002 and 2003, the estimated bycatch in the crab and groundfish fisheries was <20% 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) through the 2007/08 season, size-frequency data from samples of landed crabs, at-sea observer data from pot lifts sampled in 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) during 1996/97–2007/08, data on bycatch in groundfish fisheries within areas 541, 542, and 543 during 1996-2007 and 2007/08, 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.

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 stock is recommended for placement in Tier 5; the CPT concurred with this recommendation in May 2008, as did the SSC in June 2008. 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). Although the CPT recommended in May 2008 that the OFL for 2008/09 be set at 26,287 pounds of bycatch only (representing the estimated average annual bycatch for the period 1996–2007), the SSC recommended in June 2008 that the OFL be set at 464,762 pounds of retained catch (representing the average retained catch over the time period 1985/86–2007/08). See SSC comment #1, under “Responses to SSC Comments,” below.

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 end of the 2003/04 season; there is some bycatch in the golden king crab fishery (average per year = 6,724 pounds for 1996/97–2007/08) and groundfish fisheries (average per year = 13,173 pounds for 1996-2007 and 2007/08).

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 and to the groundfish fisheries in areas 541, 542, and 543) was less than 20% of the retained catch. The directed fishery has been closed since the end of the 2003/04 season. The fishery area west of 179° W longitude has been regulated under the BSAI Crab Rationalization program since 2005.

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. See also “Reference Points,” above, for recommendations concerning OFL.

### ***Responses to SSC Comments***

At their June 2008 meeting, the SSC reviewed the May 2008 draft of this SAFE chapter and the recommendations made in May 2008 by the CPT. Recommendations from the SSC specific to management of this stock or to this SAFE chapter are listed below followed by the response from the author.

1. Manage this stock as a Tier 5 stock with the OFL for 2008/09 set at the average retained catch over the time period 1985/86–2007/08, or 464,762 pounds.
  - The author and the CPT in May 2008 recommended that the stock be managed as a Tier 5 stock, but the author made no recommendation on the OFL level to the CPT at their May 2008 meeting. Due to the apparent current low level of the stock and the lack of retained

catch data from unconstrained fisheries in the last 12 seasons (many of which were closed due to conservation concerns), the assessment author could not recommend a time period for averaging retained catch to estimate OFL. However, four candidates for OFL, estimated as average retained catch for four different time periods from within 1985/86–2007/08, were presented and discussed in the May 2008 draft of this chapter. The CPT in May 2008 recommended a bycatch-only OFL of 26,287 pounds, representing the estimated average annual bycatch for the period 1996–2007. The SSC recommended the OFL be set as the average retained catch over the period 1985/86–2007/08 (464,762 pounds) because that period, “includes periods of high and low catches, including periods when the fishery was closed because of conservation concerns,” and because “these catches likely reflect fluctuations in stock abundance and the average retained catch should be a more appropriate proxy for long-term average production potential than a proxy based on bycatch only” (page 15 of the Draft Report of the Scientific and Statistical Committee to the North Pacific Fishery Management Council, June 2-4, 2008). The author notes that evidence is presented in this SAFE chapter (results of a recent survey and trends in catch and bycatch) that the stock may not have the potential for production in 2008/09 at the level of the long-term average. For example, a graph of the retained catch during 1984/85–2007/08 (added to this chapter at the request of the SSC; see comment 7, below), clearly shows a declining trend in retained catch from 1985/86 through 2007/08; i.e., the period of high catches was 1985/86–1993/94, whereas the period of low catches and of season closures because of conservation concerns was 1994/95–2007/08. Given that trend, the long-term average annual retained catch over 1985/86–2007/08 may not provide the best measure of production potential for 2008/09. Regardless of the OFL established, the author notes that the State of Alaska has stated its intention 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 indicate rebuilding of the population.

2. Explore the possibility of using a biomass dynamics (production) model to assess this stock, if the large observed changes in the distribution of the fishery can be adequately addressed.
  - The author recognizes the value of the recommendation and accepts it as a long-term goal for assessment of this stock.

Recommendations from the SSC on assessments in general that have application to this SAFE chapter are listed below followed by the response from the author.

3. Omit sections from chapter that are not relevant to this stock.
  - Sections that are not relevant to this stock and chapter have been removed (e.g., “Summary of Major Changes,” “Model Structure,” “Parameters Estimated Conditionally,” “Model Evaluation,” etc) and section/sub-section headings have been reworded or re-arranged as needed to be more appropriate to this chapter.
4. Clearly articulate the rationale for selecting a specific time period for establishing an OFL based on catch histories; the default should be the full time series for which data are available, unless compelling reasons exist to choose a different period.
  - See SSC comment #1, above.
5. To the extent possible, bycatch information should be provided in the SAFE in order to move stocks from “retained catch OFL” to “total catch OFL”.
  - The draft of this chapter in the May 2008 Draft Crab SAFE included data on bycatch from crab fisheries through the 2006/07 seasons and groundfish fisheries through 2007. Information on bycatch has been updated to include bycatch estimates for the crab and groundfish fisheries during the 2007/08 season. In next year’s report the author will consolidate tables on catch and bycatch to allow for easier inspection of data and consideration of a total catch OFL for this stock. Consideration of a total-catch OFL for

this stock will also involve consideration of the variety of fisheries in which bycatch can occur and the estimates of the handling mortality rates for red king crabs in those fisheries.

6. Expand ecosystem considerations section to include information on prey and predator composition in a consistent format (e.g., pie charts); a discussion of seabird predation would be a useful addition.
  - This chapter contains no section on ecosystem considerations. Realistically, a section on ecosystem considerations section for this unsurveyed, remote, and poorly-known stock is a long way away. Presently, priority effort should be towards gaining and presenting data on stock distribution, abundance, and dynamics. However, any information provided to the author on ecosystem considerations (e.g., predators and prey) for this stock would be included in future chapters.
7. Include figures showing available time series of catch (in addition to tables) to facilitate comparisons of appropriate time periods.
  - The draft of this chapter in the May 2008 Draft Crab SAFE included separate graphs of the time series of retained catch during 1985/86–1995/96 and of that for during 1996/97–2006/07; that choice apparently made sense to the author at the time that the May 2008 draft was prepared, but the reasoning behind that is now a little sketchy. A graph of retained catch for the period 1984/85–2007/08 is included in the present draft.

## ***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).

#### Description of management units and spatial and/or seasonal management measures

Although the Adak Registration Area is no longer defined in Stateregulation, in this chapter we will refer to the area west of 171° W longitude within the Aleutian Islands king crab Registration Area O as the “Adak Area”. The Aleutian Islands king crab Registration Area O is described by Failor-Rounds (2008, page 4) as follows (see also Figure 1):

The Aleutian Islands king crab Registration Area O has as its eastern boundary the longitude of Scotch Cap Light (164° 44' W longitude), its northern boundary a line from Cape Sarichef (54° 36' N latitude) to 171° W longitude, north to 55° 30' N latitude, and as its western boundary the Maritime Boundary Agreement Line as that line is described in the text of and depicted in the annex to the Maritime Boundary Agreement between the United States and the Union of Soviet Socialist Republics signed in Washington, June 1, 1990 [Figure 1]. Area O encompasses both the waters of the Territorial Sea (0-3 nautical miles) and waters of the Exclusive Economic Zone (3-200 nautical miles).

From the 1984/85 season until the March 1996 Alaska Board of Fisheries meeting, the Aleutian Islands king crab Registration Area O as currently defined had been subdivided at 171° W longitude into the historic Adak Registration Area R and the Dutch Harbor Registration Area O (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.

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 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.

#### Evidence of stock structure

Seeb and Smith (2005) analyzed microsatellite DNA variability in nearly 1,800 individual red king crab originating from the Sea of Okhotsk to Southeast Alaska, including a sample 75 specimens collected during 2002 from the vicinity of Adak Island in the Aleutian Islands (51° 51' N latitude, 176° 39' W longitude), to evaluate the degree to which the established geographic boundaries between stocks in the BSAI reflect genetic stock divisions. Seeb and Smith (2005) concluded that, “There is significant divergence of the Aleutian Islands population (Adak sample) and the Norton Sound population from the southeastern Bering Sea population (Bristol Bay, Port Moller, and Pribilof Islands samples).”

We know of no analyses of genetic relationships among red king crab from different locations within the Adak Area. However, given the expansiveness of the Adak Area and the canyons between some islands that are deep (>1,000 m) relative to the depth zone restrictions of red king 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.

#### Description of life history characteristics relevant to stock assessments

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 pereopods to the gonopores and coxae of the female’s third pereopods; 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)  $\geq 138$  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 Semisopchnoi 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.

## **Data**

### Survey data

Surveys on this stock 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 2. 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 3.

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).

#### Retained catch data

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 4a; 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 4b. Figure 5 provides a graphical presentation of the history of retained weights for the Adak Area red king crab fishery during 1984/85–2007/08, the period during which the Adak Area has been defined as it presently is (i.e., the area west of 171° W longitude within the Aleutian Islands king crab Registration Area O).

The fishery was only managed strictly towards a preseason GHF in the 2002/03 and 2003/04 seasons. The GHF for both of those seasons was set at 500,000 pounds and the retained catch was within 1% of the GHF (at 505,642 pounds) in the 2002/03 season and was within 4% of the GHF (at 479,113 pounds) in the 2003/04 season.

#### Bycatch and discard data

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 were instructed to document 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.

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, 1996/97–2007/08, are provided and compared with weight of retained catch in Table 5. Weight of non-retained discards in crab fisheries was highest (35-thousand to 48-thousand pounds) during the 2001/02–2003/04 seasons, when the fishery in the Petrel Bank area was either open under permit conditions for performance of an ADF&G-Industry stock survey (2001/02) or opened for fishing under a GH of 500-thousand pounds (2002/03–2003/04 seasons). Non-retained bycatch in crab fisheries during the 2002/03–2003/04 seasons was less than 10% of the retained catch.

Due to the frequent season closures of the directed red king crab fishery and to the restricted fishing area in the seasons when opened, the Aleutian Islands golden king crab fishery provides a longer and geographically broader data set on bycatch of Adak red king crabs than does the directed fishery. 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, and 2004/05–2007/08 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 (numbers) of red king crabs during the 2001/02–2007/08 Aleutian Islands golden king crab seasons are summarized in Table 6. The trend in catch of red king crabs during the 2001/02–2006/07 Aleutian Islands golden king crab seasons (Table 6) is graphed as documented catch (number) per observed effort (numbers of pot lifts) in Figure 6. 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 low during the 2001/02–2006/07 Aleutian Islands golden king crab seasons. Catch per observed effort increased for sublegal males and, especially, females during 2007/08, but not appreciably for legal males. Nearly 60% of the red king crabs documented to have been captured as bycatch during the 2001/02–2007/08 Aleutian Islands golden king crab seasons were captured between 179° W longitude and 179° E longitude (Table 7), with most of those being captured on the margins of Petrel Bank and Petrel Spur. However, during the 2003/04 and 2007/08 seasons a large portion of the documented catch of red king crabs occurred between 178° W longitude and 179° W longitude (Table 7), 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.

Estimated annual weight of red king crab captured as bycatch during groundfish fisheries, 1996–2007 and 2007/08, in reporting areas 541, 542, 543 (i.e., the Aleutian Islands west of 170° W longitude) is provided in Table 8. Highest bycatch tends to occur in reporting area 542 (defined as the Aleutian Islands between 177° W longitude and 177° E longitude), although the majority of bycatch since 2006 has been in reporting area 541 (defined as the Aleutian Islands between 170° W longitude and 177° W longitude).

Table 9 provides the estimated average annual bycatch weight of Adak red king crab during crab and groundfish fisheries, 1996/97–2007/08.

#### Total catch (retained catch and discard mortality) data for the crab fisheries

Table 10 provides the time series of GHs/TACs, retained catch, estimated discard, and estimated total catch (estimated discard mortality and retained catch) for the period that estimates of bycatch during crab fisheries are available (i.e., the crab 1996/97–2007/08 seasons). 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%. Under the assumption that handling mortality of discards is 30%, the total catch during the 2002/03 and 2003/04 seasons, when the directed fishery was managed under a GHL of 500-thousand pounds within the Petrel bank area, is only 2–3% greater than the retained catch when considering only the handling mortality to bycatch during crab fisheries. Handling mortality of discards during the groundfish fishery was not included in the total catch estimation due to the mis-match in reporting periods (calendar years for the groundfish data during 1996–2007 and fishery seasons for the crab fishery data).

#### Catch at age or catch at length data

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 11 and Table 12.

#### Fishing effort data

The 1984/95–2007/08 time series of fishing effort (pot lifts) is provided in Tables 4a and 4b.

#### Sample sizes for length sample data

Sample sizes for length samples from the Adak Area commercial fishery by season are provided in Table 11. 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 12.

### ***Independently-Estimated Life-History Parameters***

#### 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 13).

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 14 and 15).

#### 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 16.

#### 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.

### ***Background and Analysis for Tier-5 OFL and Recommended OFL***

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 it is recommended that the Adak Area red king crab stock be managed as 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 annual retained catch during the post-1984 period is graphed in Figure 5.

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 7). Before the 1990/92 season, however, 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 4, Figure 8). 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 11, Figure 9). 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 7), 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 4 and 10), 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) and the two fisheries opened for red king crabs in the Petrel Bank area in 2002/03 and 2003/04 (Bush et al. 2005) 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 subsection “Survey data,” in the section “DATA” of 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 subsection “Survey data,” in the section “DATA” of this chapter).

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:

<b>Season</b>	<b>Change in management measure</b>
1996/97–1997/98	<ul style="list-style-type: none"> <li>• Fishery closed</li> </ul>
1998/99	<ul style="list-style-type: none"> <li>• 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)</li> </ul>
1999/00	<ul style="list-style-type: none"> <li>• Fishery closed</li> </ul>
2000/01	<ul style="list-style-type: none"> <li>• Harvests during ADF&amp;G-Industry survey of Petrel Bank area conducted as commissioner’s permit fishery, Jan–Feb 2001</li> </ul>
2001/02	<ul style="list-style-type: none"> <li>• Harvests during ADF&amp;G-Industry survey of Petrel Bank area conducted as commissioner’s permit fishery, November 2001</li> </ul>
2002/03	<ul style="list-style-type: none"> <li>• Fishery opened with GHL of 500,000 pounds restricted to Petrel Bank area</li> <li>• ADF&amp;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)</li> </ul>
2003/04	<ul style="list-style-type: none"> <li>• Fishery opened with GHL of 500,000 pounds restricted to Petrel Bank area</li> </ul>
2004/05–2007/08	<ul style="list-style-type: none"> <li>• Fishery closed</li> </ul>

### Computations of average retained catch as estimate of OFL

Average retained catch was computed for four periods during 1985/86–2007/08 and presented to the CPT at their May 2008 meeting (Table 17):

- 1) The full time period of the 1985/86–2007/08 seasons
- 2) The period of the 1985/86–1995/96, 2002/03, and 2003/04 seasons; i.e., the seasons during 1985/86–2007/08 that the fishery was opened, but not including the seasons that the fishery was opened only for limited exploratory fishing (1998/99) or opened under conditions of a commissioner’s permit for conducting an ADF&G-Industry survey (2000/01 and 2001/02)
- 3) The period of the 1985/86–1994/95, 2002/03, and 2003/04 seasons; i.e., the same period as in (2), above, but excluding the 1995/96 season in which the harvest was low, fishery performance was poor, and which led managers to close the fishery for the next two seasons
- 4) The period during 1985/86–2007/08 in which the fishery was opened without intermittent closed seasons, but excluding the 1995/96 season in which the harvest was low, fishery performance was poor, and which led managers to close the fishery for the next two seasons.

The assessment author made no recommendation to the CPT at their May 2008 meeting on a specific time period for averaging retained catch to estimate the 2008/09 OFL; the apparent (to the author) current low level of the stock and the lack retained catch data from unconstrained fisheries in the last 12 seasons were cited as reasons for the difficulty in making such a recommendation. The CPT recommended that OFL be set as **26,287 pounds of bycatch only**, with the value 26,287 pounds computed as the estimated average annual bycatch for the period 1996-2007 (Note that Table 9 provides an estimate of the annual bycatch updated with data through mid-June 2008, resulting in an annual average bycatch of 25,040 pounds). The SSC at their June 2008 meeting recommended that the 2008/09 OFL be set at **464,762 pounds of retained catch**, computed as the average retained catch over the time period 1985/86–2007/08.

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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; Appendix C.31 from Barnard and Burt 2004) and the 2003/2004 Adak (Petrel Bank) red king crab fishery (bottom panel; Appendix C.31 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 <sup>a</sup>	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

<sup>a</sup> 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 <sup>a</sup> (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

<sup>a</sup> Mean depth = 82.4 fathoms.

Table 2. 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 <sup>a</sup>	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

<sup>a</sup> Station areas are illustrated in Figure 3 and are described in Appendix B of Bowers et al. (2002).

Table 3. 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 4a. 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 <sup>a</sup>	Harvest Pounds <sup>a</sup>	Pot lifts	CPUE <sup>b</sup>	Average Weight <sup>c</sup>
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 <sup>d</sup>	749	5,900	102	7.3	7.88
1999/00			Fishery closed		
2000/01 <sup>e</sup>	11,299	76,562	496	22.8	6.78
2001/02 <sup>f</sup>	22,080	153,961	564	39.1	6.97
2002/03 <sup>g</sup>	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		

<sup>a</sup>. Includes deadloss.

<sup>b</sup>. Catch (number of crabs) per pot lift.

<sup>c</sup>. Average weight (pounds) of landed crabs, including deadloss.

<sup>d</sup>. Fishery closed between 179° W longitude and 179° E longitude.

<sup>e</sup>. 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).

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

<sup>g</sup>. 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).

Table 4b. Aleutian Islands, Area O, red king crab commercial fishery data, 1960/61 - 2006/07 (from Bowers et al. 2008); the fishery was closed for the 2007/08 season.

Season	Locale	Number of				Harvest <sup>b,c</sup>	Average			Deadloss <sup>c</sup>
		Vessels <sup>a</sup>	Landings	Crabs <sup>b</sup>	Pots Lifted		Weight <sup>c</sup>	CPUE <sup>d</sup>	Length <sup>e</sup>	
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
	<b>TOTAL</b>									
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
	<b>TOTAL</b>		<b>287</b>			<b>6,647,000</b>				
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
	<b>TOTAL</b>		<b>350</b>			<b>9,542,000</b>				
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
	<b>TOTAL</b>		<b>769</b>			<b>21,797,000</b>				
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
	<b>TOTAL</b>		<b>778</b>			<b>34,954,000</b>				
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
	<b>TOTAL</b>		<b>986</b>			<b>32,111,000</b>				
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
	<b>TOTAL</b>		<b>983</b>			<b>38,735,000</b>				
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
	<b>TOTAL</b>		<b>1,252</b>			<b>36,840,000</b>				
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
	<b>TOTAL</b>					<b>27,400,000</b>				
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
	<b>TOTAL</b>		<b>810</b>		<b>188,612</b>	<b>26,966,000</b>				
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
	<b>TOTAL</b>		<b>646</b>		<b>180,433</b>	<b>25,709,000</b>				
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
	<b>TOTAL</b>		<b>376</b>		<b>77,542</b>	<b>24,867,555</b>				
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
	<b>TOTAL</b>		<b>604</b>	<b>4,961,929</b>	<b>115,170</b>	<b>29,174,520</b>	<b>5.9</b>	<b>43</b>		
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
	<b>TOTAL</b>		<b>529</b>	<b>3,625,647</b>	<b>111,899</b>	<b>22,464,124</b>	<b>6.2</b>	<b>32</b>		

(continued)

Table 4b. page 2 of 3.

Season	Locale	Number of				Harvest <sup>b,c</sup>	Average			Deadloss <sup>c</sup>
		Vessels <sup>a</sup>	Landings	Crabs <sup>b</sup>	Pots Lifted		Weight <sup>c</sup>	CPUE <sup>d</sup>	Length <sup>e</sup>	
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
	<b>TOTAL</b>		<b>469</b>	<b>2,344,945</b>	<b>104,441</b>	<b>16,766,153</b>	<b>7.1</b>	<b>22</b>		
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
	<b>TOTAL</b>		<b>394</b>	<b>2,227,327</b>	<b>95,205</b>	<b>16,318,243</b>	<b>7.3</b>	<b>23</b>		
1976/77	East of 172° W	72	226	1,273,298	65,796	9,367,965 <sup>f</sup>	7.4	19		
	East of 172° W	38	61	86,619	17,298	830,458 <sup>g</sup>	9.6	5	NA	NA
	West of 172° W	F I S H E R Y C L O S E D								
	<b>TOTAL</b>		<b>287</b>	<b>1,359,917</b>	<b>83,094</b>	<b>10,198,423</b>	<b>7.5</b>	<b>16</b>		
1977/78	East of 172° W	33	227	539,656	46,617	3,658,860 <sup>f</sup>	6.8	12		
	East of 172° W	6	7	3,096	812	25,557 <sup>h</sup>	8.3	4	NA	NA
	West of 172° W	12	18	160,343	7,269	905,527	5.7	22	152.2	NA
	<b>TOTAL</b>		<b>252</b>	<b>703,095</b>	<b>54,698</b>	<b>4,589,944</b>	<b>6.5</b>	<b>13</b>		
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
	<b>TOTAL</b>		<b>327</b>	<b>1,383,249</b>	<b>65,731</b>	<b>7,631,988</b>	<b>5.5</b>	<b>21</b>		
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
	<b>TOTAL</b>		<b>565</b>	<b>2,633,366</b>	<b>130,311</b>	<b>15,478,069</b>	<b>5.9</b>	<b>20</b>		
1980/81	East of 172° W	114	830	2,772,287	231,607	17,660,620 <sup>f</sup>	6.4	12	NA	NA
	East of 172° W	54	120	182,349	30,000	1,392,923 <sup>h</sup>	7.6	6		
	West of 172° W	17	52	254,390	20,914	1,419,513	5.6	12	149	54,360
	<b>TOTAL</b>		<b>1,002</b>	<b>3,209,026</b>	<b>282,521</b>	<b>20,473,056</b>	<b>6.4</b>	<b>11</b>		
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
	<b>TOTAL</b>		<b>789</b>	<b>1,033,277</b>	<b>260,784</b>	<b>6,804,271</b>	<b>6.6</b>	<b>4</b>		
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
	<b>TOTAL</b>		<b>469</b>	<b>349,167</b>	<b>139,817</b>	<b>2,132,997</b>	<b>6.1</b>	<b>3</b>		
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 4b. Page 3 of 3.

Season	Locale	Number of				Harvest <sup>b,c</sup>	Average			Deadloss <sup>c</sup>
		Vessels <sup>a</sup>	Landings	Crabs <sup>b</sup>	Pots Lifted		Weight <sup>c</sup>	CPUE <sup>d</sup>	Length <sup>e</sup>	
1988/89	East of 171° W West of 171° W	FISHERY CLOSED								
		73	156	266,053	64,334	1,567,314	5.9	4	153.1	557
1989/90	East of 171° W West of 171° W	FISHERY CLOSED								
		56	123	193,177	54,213	1,105,971	5.7	4	151.5	759
1990/91	East of 171° W West of 171° W	FISHERY CLOSED								
		7	34	146,903	10,674	828,105	5.6	14	148.1	0
1991/92	East of 171° W West of 171° W	FISHERY CLOSED								
		10	35	165,356	16,636	951,278	5.8	10	149.8	0
1992/93	East of 171° W West of 171° W	FISHERY CLOSED								
		12	30	218,049	16,129	1,286,424	6.0	14	151.5	5,000
1993/94	East of 171° W West of 171° W	FISHERY CLOSED								
		12	21	119,330	13,575	698,077	5.9	9	154.6	7,402
1994/95	East of 171° W West of 171° W	FISHERY CLOSED								
		20	31	30,337	18,146	196,967	6.5	2	157.5	1,430
1995/96	East of 171° W West of 171° W	FISHERY CLOSED								
		4	12	6,880	1,986	38,941	5.7	3	153.6	235
1996/97		FISHERY CLOSED								
1997/98		FISHERY CLOSED								
1998/99	West of 174° W	3	6	749	102	5,900	7.9	7	NA	0
1999/2000		FISHERY CLOSED								
2000/01 <sup>i</sup>	Petrel Bank <sup>j</sup>	1	3	11,299	496	76,562	6.8	23	161.0	0
2001/02 <sup>k</sup>	Petrel Bank <sup>j</sup>	4	5	22,080	564	153,961	7.0	39	159.5	82
2002/03	Petrel Bank <sup>l</sup>	33	35	68,300	3,786	505,642	7.4	18	162.4	1,311
2003/04	Petrel Bank <sup>l</sup>	30	31	59,828	5,774	479,113	8.0	10	167.9	2,617
2004/05		FISHERY CLOSED								
2005/06		FISHERY CLOSED								
2006/07		FISHERY CLOSED								

Table 5. 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 1996/97–2007/08 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 2008; bycatch weight estimates for 2007/08 were provided by D. Pengilly using data from the ADF&G crab observer database, Kodiak, 18 August 2008 and are preliminary).

Season	Adak red king crab fishery				AI golden king crab fishery			Total non-retained
	Retained	Non-retained			Legal male	Sublegal male	Female	
	legal male	Legal male	Sublegal male	Female				
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 <sup>a</sup>	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
2007/08	0	0	0	0	517	1,528	471	2,516
Average	101,765	224	1,815	3,103	4,922	1,028	744	11,438

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

Table 6. 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, 2001/02-2007/08 seasons.

Season	Fishery effort <sup>a</sup>	Observed effort <sup>b</sup>	Number of red king crabs		
			Legal	Sublegal	Female
2001/02 <sup>c</sup>	168,151	168,151	457	36	47
2002/03 <sup>c</sup>	131,021	131,021	772	26	30
2003/04 <sup>d</sup>	125,119	7,294	61	102	120
2004/05 <sup>c</sup>	91,694	91,694	115	57	37
2005/06 <sup>e</sup>	54,685	41,323	6	16	14
2006/07 <sup>e</sup>	53,065	38,388	37	35	24
2007/08 <sup>e,f</sup>	52,603	30,052	47	256	131

- 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).
- f. Preliminary data summaries.

Table 7. Number of red king crabs documented as captured during the, 2001/02-2007/08 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	2007/08 <sup>b</sup>	Total
169°–170° W <sup>a</sup>	4	0	1	0	0	0	0	5
170°–171° W <sup>a</sup>	0	1	0	0	0	0	0	1
171°–172° W	0	1	0	0	0	0	0	1
172°–173° W	0	0	0	0	0	0	0	0
173°–174° W	1	3	0	0	0	0	0	4
174°–175° W	0	0	0	0	0	0	0	0
175°–176° W	0	0	0	0	0	0	0	0
176°–177° W	0	1	0	0	0	0	0	1
177°–178° W	9	81	0	0	1	0	0	91
178°–179° W	36	18	216	5	17	0	182	474
179°–180° W	216	267	6	18	12	57	182	758
179°–180° E	163	398	54	59	1	4	6	685
178°–179° E	40	1	0	23	2	6	0	72
177°–178° E	5	0	0	0	0	1	2	8
176°–177° E	35	56	4	97	2	24	46	264
175°–176° E	19	0	1	7	1	4	10	342
174°–175° E	0	0	0	0	0	0	0	0
173°–174° E	0	0	0	0	0	0	0	0
172°–173° E	0	1	0	0	0	0	0	1
Unknown	12	0	1	0	0	0	6	19
<b>Total</b>	<b>540</b>	<b>828</b>	<b>283</b>	<b>209</b>	<b>36</b>	<b>96</b>	<b>434</b>	<b>2,426</b>

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

b. Preliminary data summary.

Table 8. 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) and 2007/08 (summary of the data provided by J. Mondragon, NMFS-Alaska Region Office through G. Harrington, NMFS-Alaska Region Office, 23 June 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
2007/08 <sup>a</sup>	5,976	2,310	688	8,973
Average	1,915	8,785	2,473	13,173

a. Derived from groundfish observer data between 1-Jul-2007 and 18-Jun-2008.

Table 9. Estimated average annual weight (pounds) of discarded bycatch of red king crabs (all sizes, males and females) in Aleutian Islands crab fisheries during the 1996/97–2007/08 seasons and in groundfish fisheries (all gear types and fisheries pooled) in reporting areas 541, 542, and 543 (Aleutian Islands west of 170° W longitude) during 1996–2007 and the 2007/08 season); see Tables 5 and 8.

Red king crab	Fishery		Total
	Golden king crab	Groundfish - all gears	
5,143	6,724	13,173	25,040

Table 10. Annual guideline harvest level (GHL, 1996/97–2004/05) or total allowable catch (TAC, 2005/06–2007/08) for retained catch (pounds), actual retained catch (pounds), estimated non-retained discards (pounds) during crab fisheries, and estimates of total catch (retained catch plus discard mortality; pounds) during crab fisheries for the red king crabs in the Adak Area, 1996/97–2007/08.

Season	Retained GHL/TAC	Retained Catch	Non- retained discards	Total Catch <sup>a</sup>		
				<i>hm</i> =10%	<i>hm</i> =20%	<i>hm</i> =30%
1996/97	0	0	5,982	598	1,196	1,795
1997/98	0	0	936	94	187	281
1998/99 <sup>b</sup>	15,000	5,900	1,071	6,007	6,114	6,221
1999/00	0	0	1,010	101	202	303
2000/01 <sup>c</sup>	-	76,562	1,819	76,744	76,926	77,108
2001/02 <sup>c</sup>	-	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
2007/08 <sup>d</sup>	0	0	2,516	252	503	755

- 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.
- d. Preliminary data summary.

Table 11. 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 12. 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)

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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 12. 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)

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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 <sup>a</sup>
Total	460	589	2 <sup>b</sup>

a. One at 193-mm CL and one at 194-mm CL.

b. Only four legal males were captured (Granath 2003).

Table 13. 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 <sup>1</sup>		Nov-Dec 1971-1973 <sup>2</sup>		Nov-Dec 1973, Jan-Mar 1975 <sup>3</sup>		1975, 1978-1979		1972, 1973, 1975	
Sample Size	239		297		497		53		70	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
<b>No Molts:</b>										
Proportion	0.84	0.024	0.19	0.024	0.39	0.023	0.69	0.065	0.34	0.063
Mean <sup>4</sup>	-0.01	0.044	0.08	0.112	-0.07	0.033	0.13	0.151	0.03	0.134
Standard Deviation <sup>5</sup>	0.62	0.032	0.78	0.082	0.41	0.030	0.90	0.107	0.58	0.108
<b>Single Molt:</b>										
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
<b>Double Molt:</b>										
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 14. 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 15. 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 16. 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,  $Weight = A \cdot CL^B$  (from Table 3-5, NPFMC 2007).

Parameter	Males	Ovigerous females
A	0.000361	0.022863
B	3.16	2.23382

Table 17. Average retained catch (pounds) computed for four periods during 1985/86–2007/08 for consideration as the retained-catch OFL for the 2008/09 Adak red king crab fishery.

Time period	Number of seasons	OFL ( = average retained catch, pounds)
1985/86–2007/08 <sup>a</sup>	23	464,762
1985/86–1995/96, 2002/03, 2003/04 <sup>b</sup>	13	804,084
1985/86–1994/95, 2002/03, 2003/04 <sup>c</sup>	12	867,846
1985/86–1994/95 <sup>d</sup>	10	942,940

- a. The full time period of the 1985/86–2007/08 seasons.
- b. The seasons during 1985/86–2007/08 that the fishery was opened, but not including the seasons that the fishery was opened only for limited exploratory fishing (1998/99) or opened under conditions of a commissioner’s permit for conducting an ADF&G-Industry survey (2000/01 and 2001/02)
- c. The same period as in (b), above, but excluding the 1995/96 season in which the harvest was low, fishery performance was poor, and which led managers to close the fishery for the next two seasons
- d. The period during 1985/86–2007/08 in which the fishery was opened without intermittent closed seasons, but excluding the 1995/96 season in which the harvest was low, fishery performance was poor, and which led managers to close the fishery for the next two seasons.

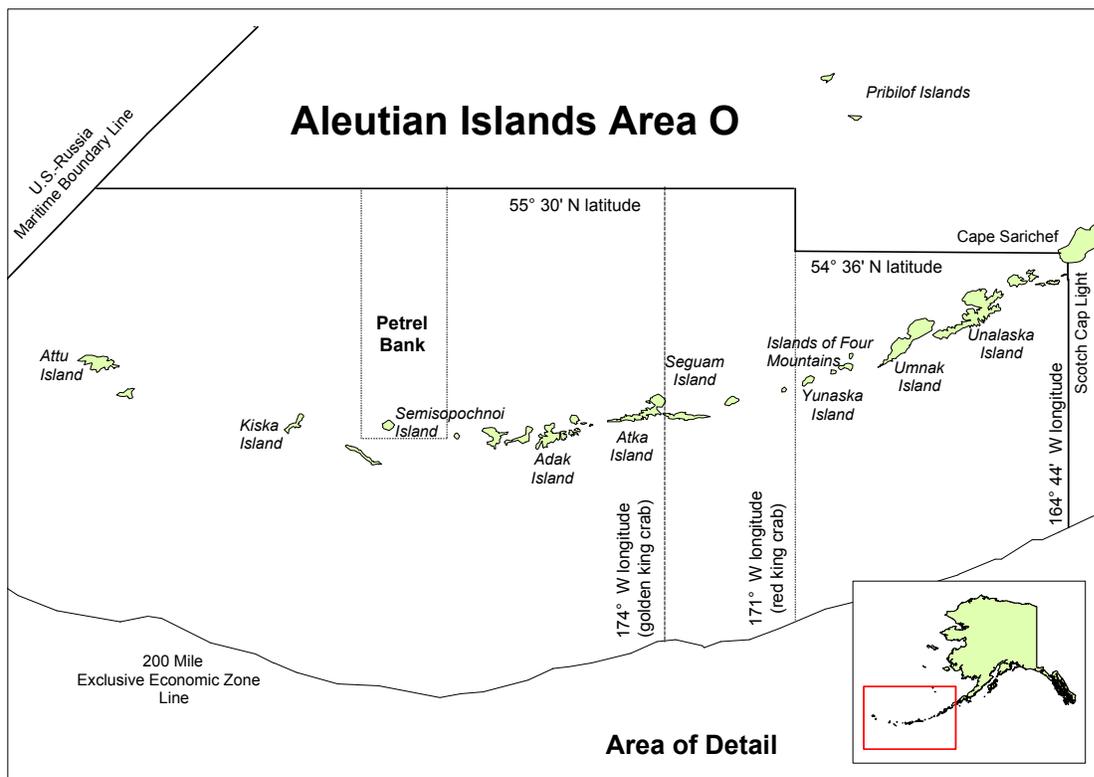


Figure 1. Aleutian Islands, Area O, red and golden king crab management area (from Failor-Rounds 2008).

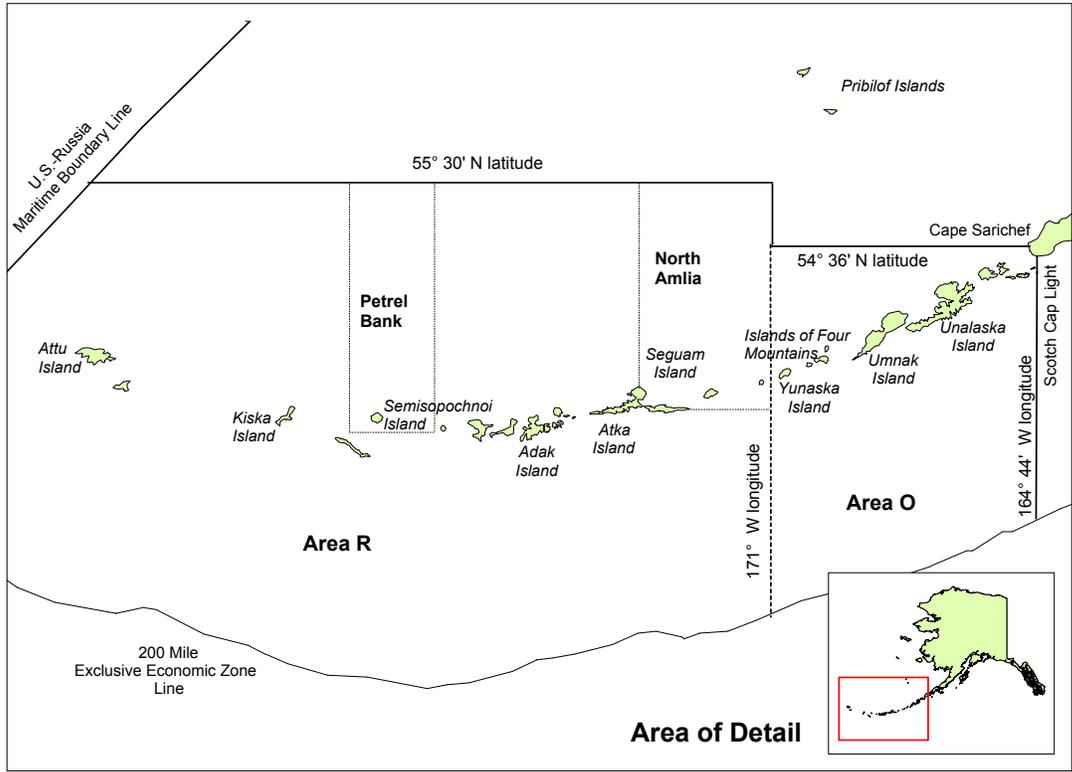


Figure 2. Adak (Area R) and Dutch Harbor (Area O) king crab Registration Areas and Districts, 1984/85 – 1995/1969 seasons (from Failor-Rounds 2008).

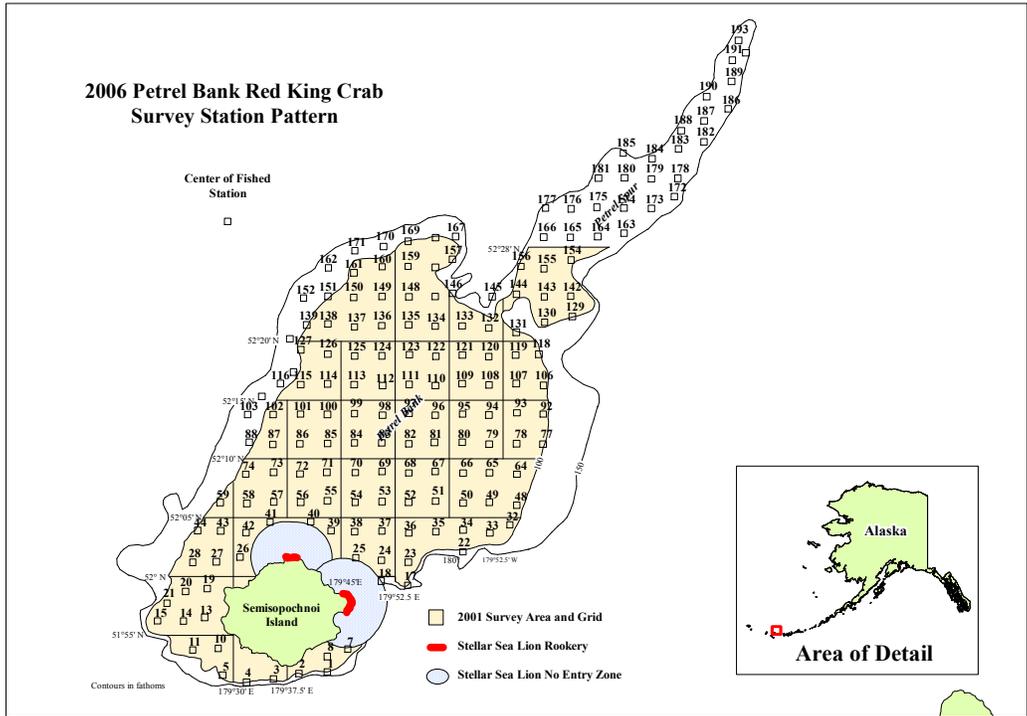
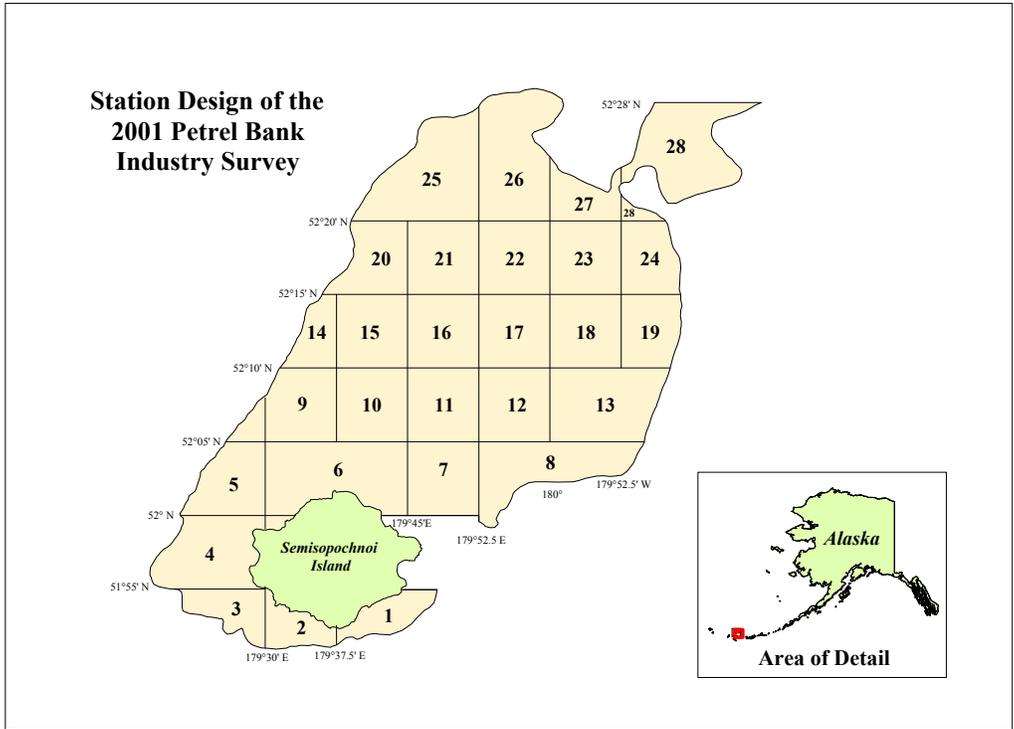


Figure 3. Survey area and grid design for the November 2001 ADFG-Industry industry survey (top panel) and station pattern and numbers of those fished during the November 2006 ADF&G Petrel Bank red king crab survey (bottom panel).

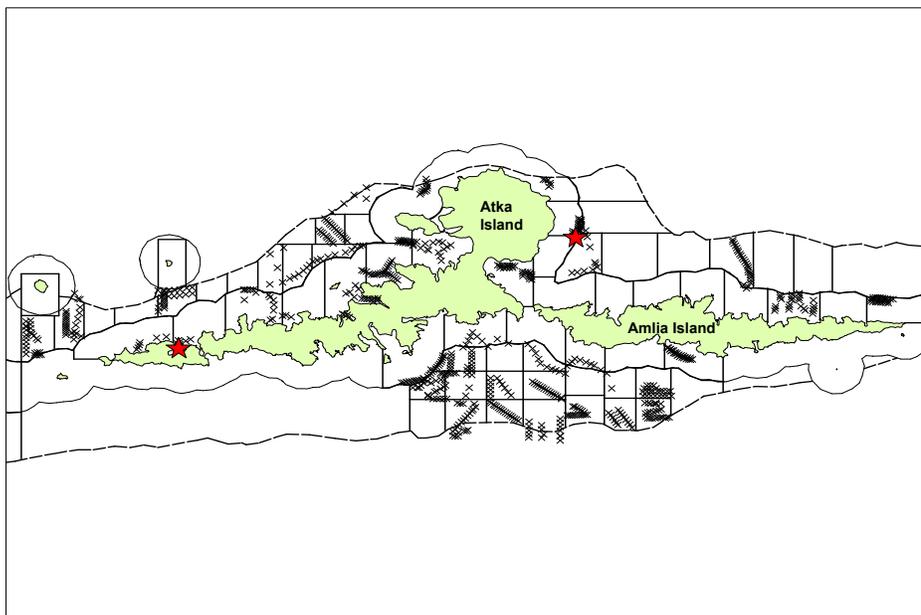
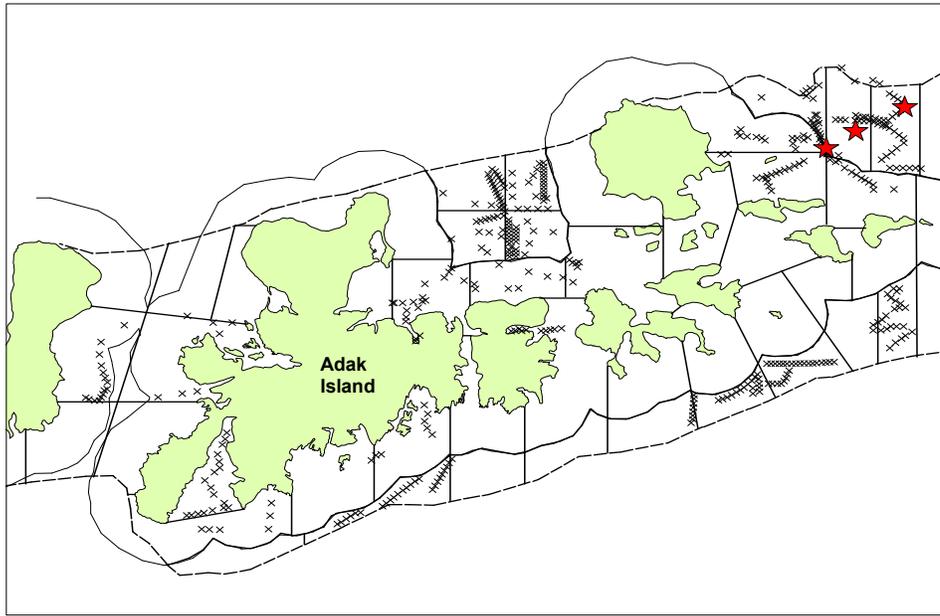


Figure 4. Locations (x) of pots fished in the Adak Island locale (top panel) and Atka-Amlia Islands locale (bottom panel) during the ADF&G-Industry red king crab pot survey conducted as a commissioner's permit fishery in November 2002; stars mark locations where legal male red king crabs were captured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

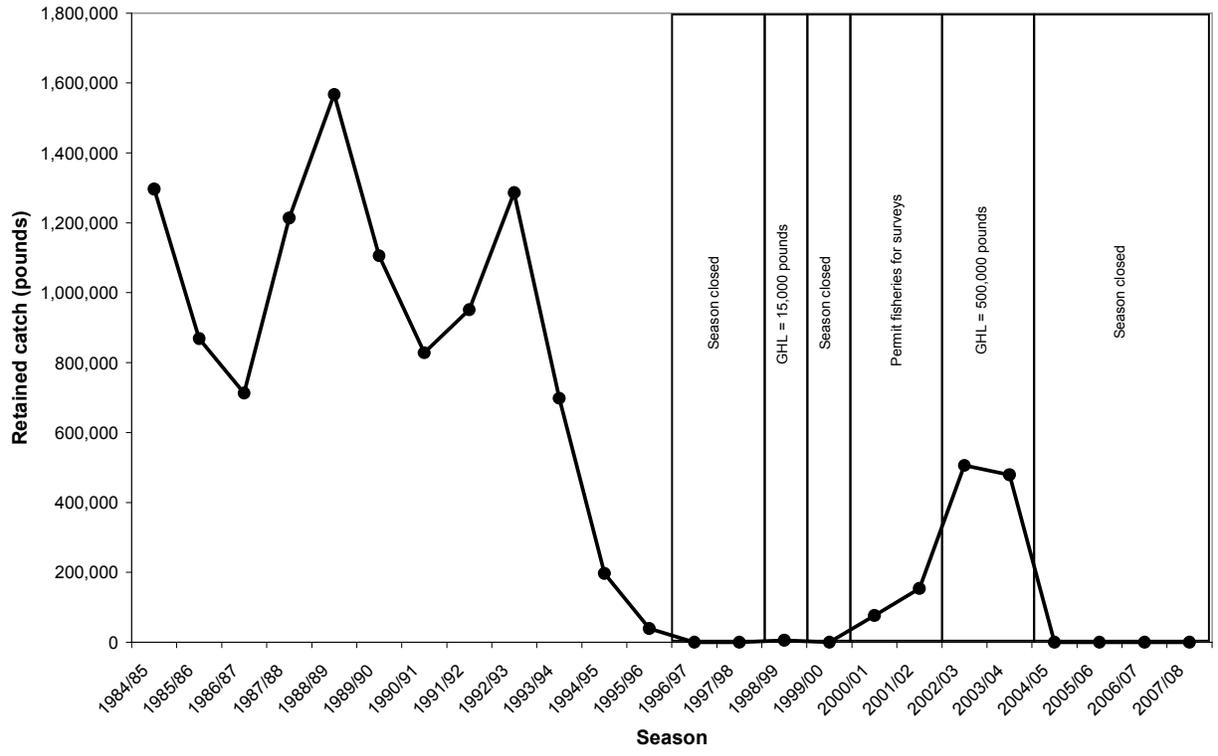


Figure 5. Retained catch (pounds) during the 1984/85–2007/08 seasons for the red king crab fishery in the Adak Area.

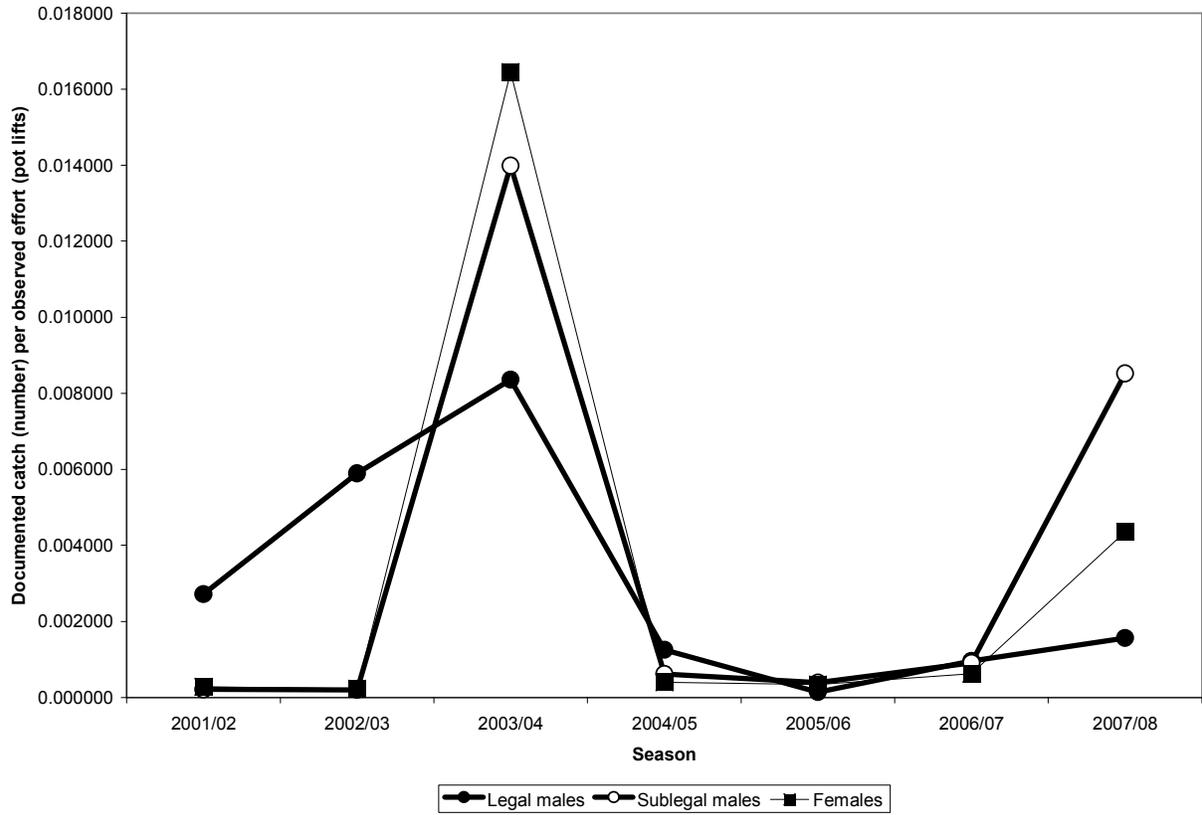


Figure 6. Catch of red king crabs by sex-size class documented by observers during the 2001/02-2007/08 Aleutian Islands golden king crab fishery per unit of observer effort; preliminary data summary for 2007/08 season.

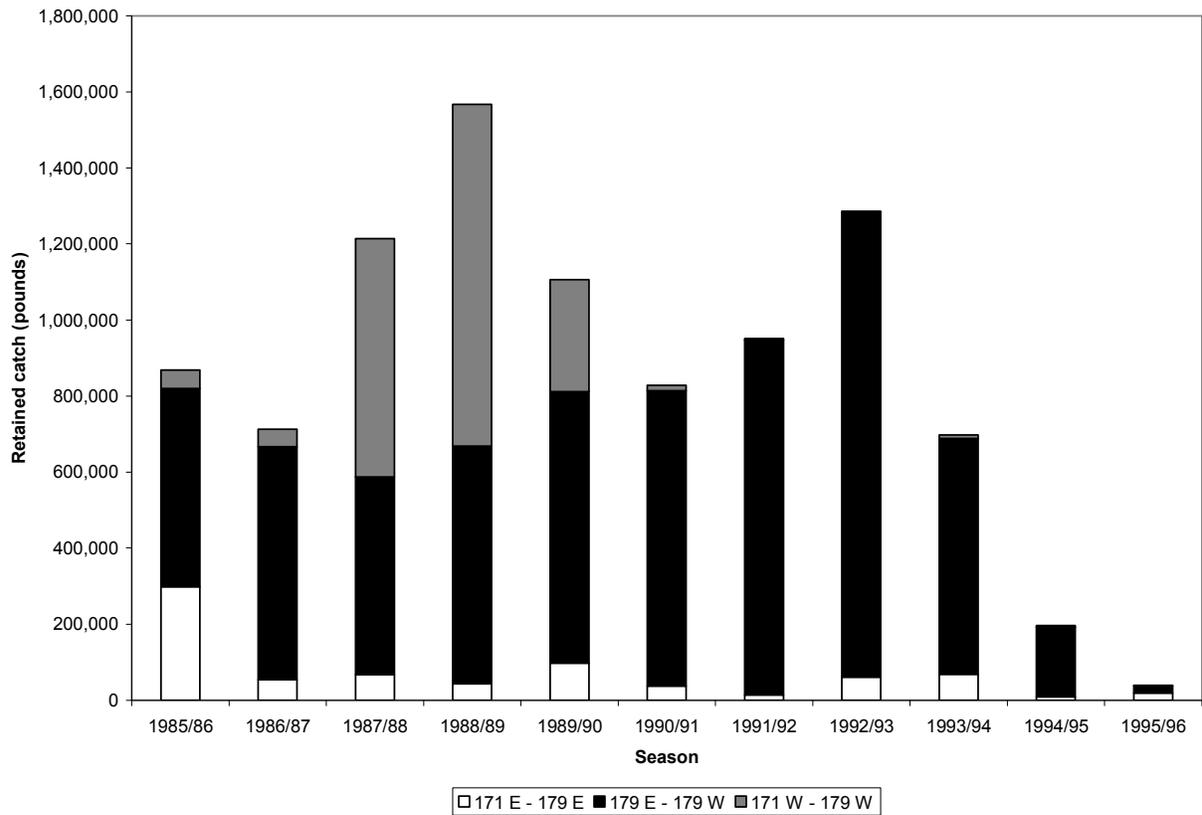


Figure 7. Retained catch (pounds) by longitudinal zones in the 1985/86–1995/96 red king crab fishery in the Adak Area (from fish ticket data summaries provided by ADF&G, Dutch Harbor, March 2008).

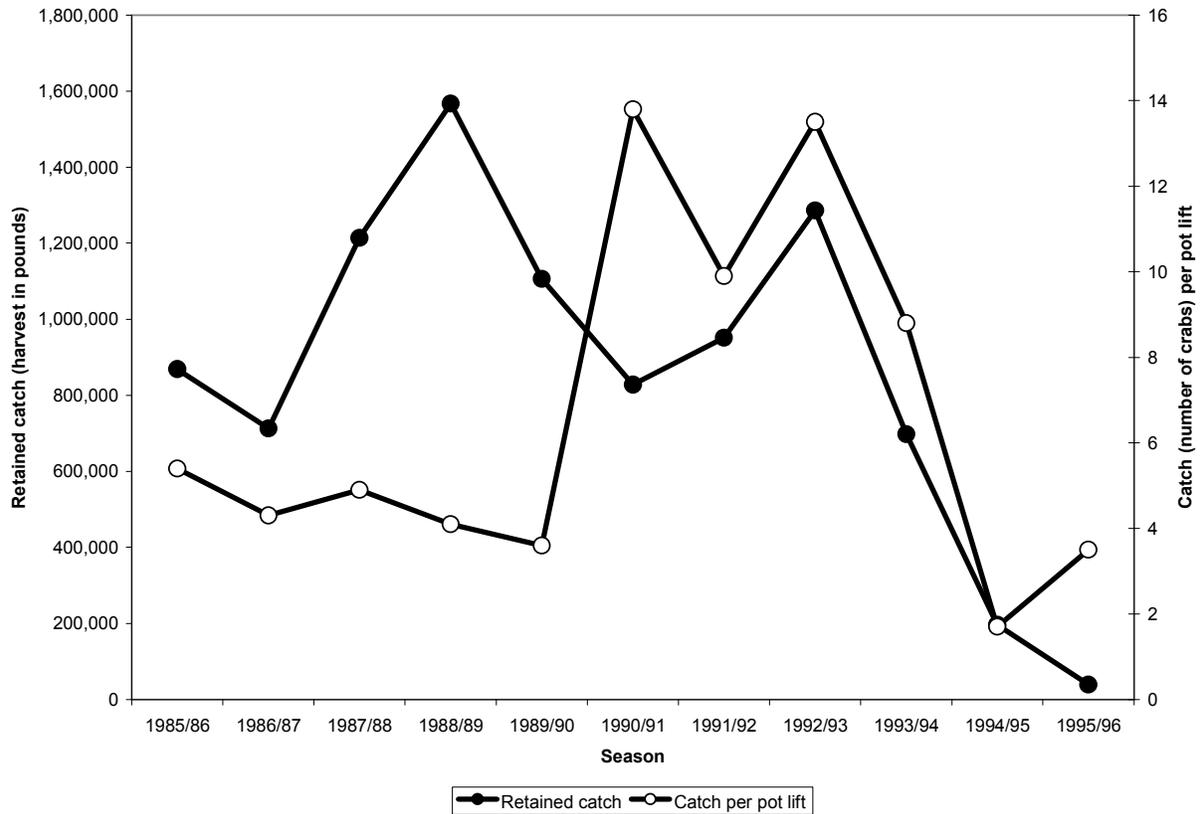


Figure 8. Retained catch (harvest in pounds) and catch (number of retained legal crabs) per pot lift (CPUE) in the Adak Area red king crab fishery, 1985/86–1995/96 seasons.

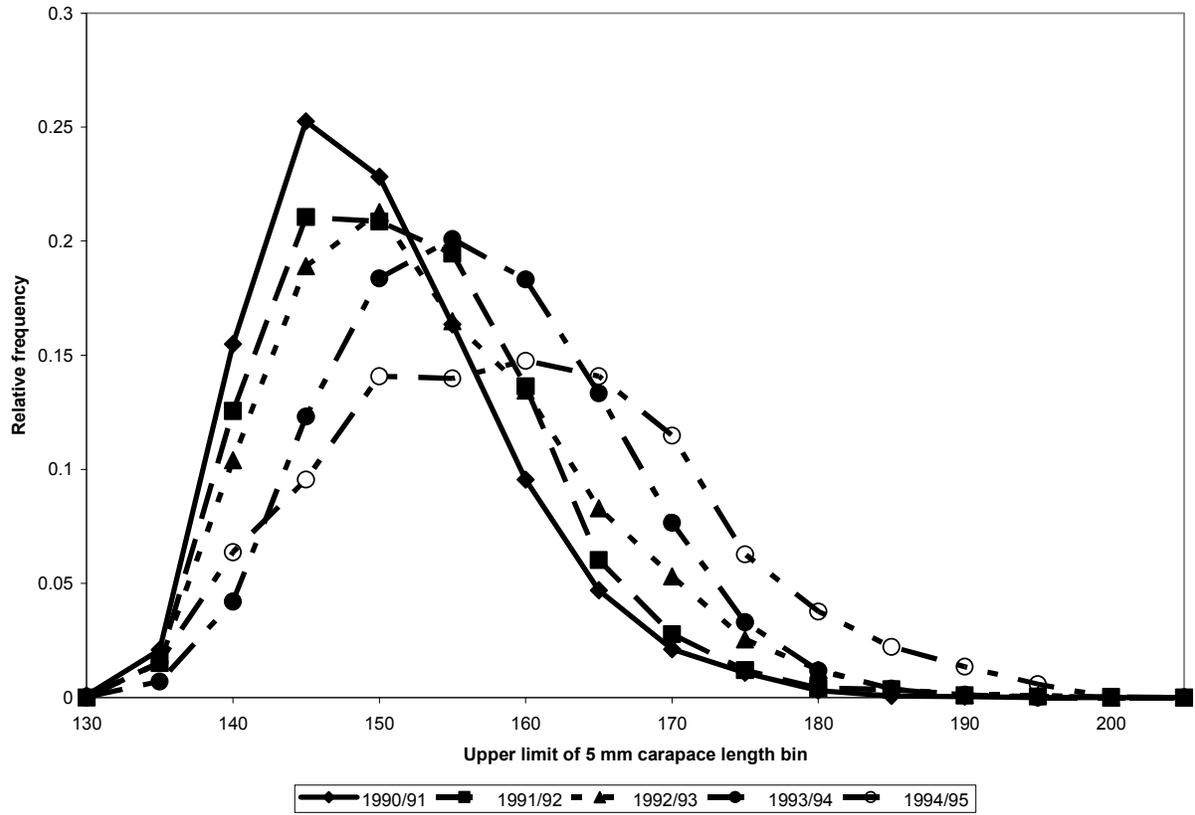


Figure 9. Size frequency distribution (carapace length, mm, in 5-mm bins) from samples of the retained catch during the 1990/91 through 1994/95 Adak red king crab fishery.