Bycatch Reduction Alternatives for Salmon and Crab Species (as modified in June 2005)

Chinook Salmon

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for salmon. Specific areas with high bycatch (or high bycatch rates) are closed seasonally (could be for an extended period of time) if or when a trigger limit is reached by the pollock fishery.
Alternative 3: Seasonal closure to all trawl fishing in areas with high bycatch or high bycatch rates.
Alternative 4: Voluntary bycatch coop for hotspot management.

Other Salmon

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for other salmon. Specific areas with high bycatch (or high bycatch rates) are closed for the remainder of the year if or when a trigger limit is reached by the pollock trawl fishery (and potentially additional areas for flatfish trawling).
Alternative 3: Seasonal closure to all trawl fishing in areas with high bycatch or high bycatch rates.
Alternative 4: Voluntary bycatch coop for hotspot management.

Tanner Crab

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for Tanner crab. Specific areas with high bycatch (or high bycatch rates) are closed for the remainder of the year if or when a trigger limit is reached by:
Options: a) trawl flatfish fishery
b) all bottom trawling
c) groundfish pot
Alternative 3: Year-round closure in areas with high bycatch or high bycatch rates of Tanner crab by gear type.
Alternative 4: Voluntary bycatch coop for hotspot management.

Red King Crab

Alternative 1: Status Quo (no additional bycatch controls).
Alternative 2: Trigger bycatch limits for red king crab. Specific areas with high bycatch (or high bycatch rates) are closed to flatfish trawling for the remainder of the year if or when a trigger limit is reached by the flatfish fishery.
Alternative 3: Year-round bottom trawl closure in areas with high bycatch or high bycatch rates of red king crab.
Alternative 4: Voluntary bycatch coop for hotspot management.

Salmon and Crab Bycatch Measures for GOA Groundfish Fisheries

October 2005 Staff Discussion paper

INTRODUCTION

The North Pacific Fishery Management Council (Council) has adopted measures over the years to control the bycatch of some species taken incidentally in groundfish fisheries (Witherell and Pautzke, 1997). Bycatch control measures have been established in the Bering Sea and Aleutian Islands trawl fisheries for Chinook salmon (*Oncorhynchus tshawytscha*), 'other salmon' (consisting primarily of chum salmon, *O. keta*), Pacific herring (*Clupea pallasi*), Pacific halibut (Hippoglosses stenolepis), red king crab (*Paralithodes camtschaticus*), Tanner crab *(Chionoecetes bairdi*), and snow crab (*C. opilio*). Halibut bycatch limits and bottom trawl closure areas to protect red king crab have also been established for Gulf of Alaska (GOA) groundfish trawl fisheries (NMFS 2003). To date, no bycatch control measures have been implemented for salmon or crab species taken incidentally in GOA groundfish fisheries.

Under the GOA groundfish rationalization initiative, the Council is considering bycatch reduction measures for salmon and crab species in the groundfish fisheries. Species currently under consideration are Chinook salmon, Chum (or 'other') salmon, *C. bairdi* Tanner crab and red king crab. In June 2005, the Council took action to revise the existing alternatives for Tanner crab as well as to provide additional clarifications for staff in proceeding with an analysis (see June 2005 Council motion, Appendix A). The Council further tasked staff to update and expand upon the preliminary description of available information on options for salmon and crab bycatch reduction measures in the GOA. In this paper, we provide a general overview of the available information on salmon and crab bycatch, an overview of species abundance and discuss the alternatives under consideration.

METHODS

Catch and bycatch data were provided by the NMFS regional office and the North Pacific groundfish fishery observer program, and examined to gain insight into the amount, species composition, timing, and location of salmon and crab caught incidentally in GOA groundfish fisheries. NMFS catch statistics for years 1990-2004 for salmon and crab bycatch were summarized annually by each groundfish trawl fishery. Additionally, the amount of bycatch was reported by both a weekly and quarterly period to determine any temporal aspect to the bycatch rates for the fisheries with the highest bycatch. Average amounts of bycatch for multiple years and for percent contribution by individual fisheries were calculated with equal weighting given to each year utilized. No attempt was made to weight individual years higher than others. The observer data represented all trawl catch for a given year, and was queried to produce bycatch of observed hauls by target fishery. Specific locations of salmon and crab bycatch were input into a GIS to produce charts of catch locations. Information on crab survey abundance estimates were obtained by published ADF&G reports as well as data provided by the ADF&G staff.

The North Pacific Groundfish Observer Program collects catch and bycatch data used for management and inseason monitoring of groundfish fisheries. Since 1990, all vessels larger than 60 ft (length overall) participating in the groundfish fisheries have been required to have observers onboard at least part of the time. The amount of observer coverage is based on vessel length, with 30% coverage required on vessels 60 ft to 125 ft , 100% coverage on vessels larger than 125 ft, and 100% coverage at shore-based processing facilities. There are no observer coverage requirements for vessels less than 60 ft. Since January 2003, observer requirements for pot vessels > 60 feet have been modified such that these vessels are only required to have coverage on 30% of their pots pulled for that calendar year as opposed to the

100% of the fishing days coverage required on other vessels > 125 feet. Observer data provide for accurate and relatively precise estimation of groundfish catch, particularly on fleets with high levels of observer coverage, such as the Bering Sea walleye pollock fishery (Volstad et al. 1997). However, the precision of salmon bycatch estimates depends upon the number of vessels observed and the fraction of hauls sampled within vessels (Karp and McElderry 1999). In the Bering Sea, fisheries such as walleye pollock have a high percentage of hauls that are sampled so fleet wide estimates of salmon bycatch are considered to be reasonably accurate for management purposes (NPFMC 1995a, 1995b, 1999).

For Gulf of Alaska fisheries, observer coverage is lower in some target fisheries due to the prevalence of smaller vessels in the GOA fishing fleet than in the Bering Sea fleet. Only 53% of bottom trawl vessels in the GOA had observed coverage between 1990-2000 (Coon and Heifetz, in press). Over the past ten years, there has generally been an increasing level of participation by smaller vessels in the GOA groundfish fisheries, particularly trawl and fixed gear catcher vessels less than 60 ft (NPFMC 2003). Therefore, it should be noted that estimates of salmon and crab bycatch in GOA fisheries may be less precise than estimates of bycatch in Bering Sea fisheries.

Catch Accounting

Data from observed vessels is utilized to determine prohibited species catch (PSC) rates when sufficient data are available. The PSC rate is the weight or number of animals per metric tons of groundfish; salmon are calculated by number. All shoreside processing with the same gear, target, and area use an average PSC rate for all observed catcher vessels with the same gear, target, and area. An observed catcher/processor uses the rates from the observer on the vessel. An unobserved catcher/processor uses a PSC rate from observed vessels in the same area and target fishery using the same gear type. The smaller vessels (under 60 ft) with no observers, and those that only require 30% observer coverage utilize rates calculated based on the best data available. The first choice is to use one of four different types of “three week average rates” for the same week, reporting area, gear and target. Three of the four types are sector rates that use either observer data from catcher vessels delivering to shoreplants, catcher vessels delivering to motherships or data from catcher processor observers. The sector rates are used and applied to unobserved catch from the corresponding sector if a sufficient number of observer reports are available. The fourth rate combines data from all catcher vessels and catcher processor observers. The combined rate is used only if an insufficient amount of observer data exists to be able to use one of the three sector rates. If one of the four different types of “three week average” sector rates do not have sufficient observations, a substitute rate based on data from prior years, in the same reporting area, gear and target may be used as the second choice. If that is not available, the third choice is for GOA and BSAI annual average year rates using the same gear and target.

Once the PSC rate has been determined, the PSC estimates are computed by multiplying the rate for each prohibited species times the total groundfish weight for the processor from the groundfish catch accounting system. Key information including week, reporting area, gear and target are used to match PSC rates with the groundfish catch.

Several improvements were made to the catch accounting system in 2003 which include computing PSC rates daily instead of weekly. Observed catcher vessels also now use the rates from the observer on the vessel rather than an average PSC rate for all observed catcher vessels applied to the shoreside processor data with the same gear, target, and area. Although this data methodology is not as accurate as having an observer onboard 100% of the hauls on all vessel sizes, it is repeatable and uses the best known information (NMFS, AKR, Mary Furuness personal communication).

MORTALITY RATES

Gear specific mortality rates for crab species have been calculated as 8% for pot gear, 80% for trawl gear, 37% for longline gear, and 40% for scallop dredge gear (NPFMC 1995). NRC (1990) estimates for trawl caught king crab range from 2-81%, while Tanner crab mortality estimates from trawl gear range similarly from 12-82% . Mortality studies for crab which did not distinguish between species estimate trawl mortality rates of 50-100%. Longline mortality rates for crab (no species distinguished) in the GOA range from 0-50% (FAO 1990).

Bycatch mortality rates in the directed snow crab fishery (pot rates) were estimated for discarded snow crabs during the 1998 fishery (Warrenchuck and Shirley 2002). An estimate of 22.2% mortality which included the estimated effects of wind and cold exposure as well as handling injuries was considered to be a conservative estimate because these factors were considered separately and not synergistically (Warrenchuck and Shirley 2002). These results were in agreement with NPFMC estimates for bycatch mortality in the directed crab pot fishery of 25% (NPFMC 1999). Available studies on Tanner crab mortality in the GOA were all laboratory studies of natural mortality in crabs and focused upon snow crab not *C. bairdi* Tanners (e.g. Shirley 2004). No additional studies on trawl or pot caught mortality rates for *C. bairdi* (or any other) crabs in the GOA were available at this time (T. Shirley, personal communication). A summary of mortality rate studies, information and estimated mortality rates is provided in the Stock Assessment and Fishery Evaluation (SAFE) report for the BSAI king and Tanner crabs (NPFMC 2005). Discard mortality rates for red king crab have been estimated at 37% for longline fisheries and 8% for pot fisheries (NPFMC 1999). Estimated bycatch mortality rates for Tanner crab were 45% in longline fisheries and 30% in pot fisheries. Observer data on condition factors collected for crab during the 1991 domestic fisheries, suggested lower mortality of red king crab taken in groundfish pot fisheries (NPFMC 1996).

Salmon mortality rates are also highly variable both by gear type and for different size salmon. Legal-size chinook salmon caught in troll gear have an estimated mortality rate as low as 8%, while longline gear mortality rates have been estimated to be as high as 100% (FAO 1990). For the purpose of this discussion it is assumed that the full bycatch of salmon has a 100% mortality rate within the longline and trawl fisheries.

REVIEW OF EXISTING CLOSURES

In consideration of additional time and area closures in the GOA groundfish fisheries, it is important to review and consider the interaction of the existing closures in this region. Supplemental Figures 1-4 show the existing state and federal closures in the GOA management area. The timing and purpose of each closure are summarized below (dates in parentheses indicate the year of implementation of the closure).

Kodiak red king crab closures: Type 1 and Type II (1993)
Trawl closure areas, designed to protect Kodiak red king crab because of the poor condition of the king crab resource off Kodiak and because trawl bycatch and mortality rates are highest during the spring months when king crab migrate inshore for reproduction. The molting period off Kodiak begins around February 15 and ends by June 15. Type I areas have very high king crab concentrations and, to promote rebuilding of the crab stocks, are closed all year to all trawling except with pelagic gear. Type II areas have lower crab concentrations and are only closed to non-pelagic gear from February 15 through June 15.

Steller Sea Lion (SSL) 3nm No Transit Zone- (2003) Groundfish fishing closures related to SSL conservation establish 3 nm no-transit zones surrounding rookeries to protect endangered Steller sea lions.

SSL no pollock trawl zones- (2003) Groundfish fishing closures related to SSL conservation establish 10 nautical mile (nm) fishing closures surrounding rookeries to protect endangered Steller sea lions.

Scallop closures (1995) Year round closure to scallop dredging to reduce high bycatch of other species (i.e., crabs) and avoid and protect biologically critical areas such as nursery areas for groundfish and shellfish.

Prince William Sound rookeries no fishing zone (2003) Groundfish fishing closures related to SSL conservation include two rookeries in the PWS area, Seal Rocks (60° 09.78' N. lat., 146° 50.30' W. long.) and Wooded Island (Fish Island) (59° 52.90' N. lat., 147° 20.65' W. long.). Directed commercial fishing for groundfish is closed to all vessels within 3 nautical miles of each of these rookeries.

Cook Inlet bottom trawl closure- (2001) Prohibits non-pelagic trawling in Cook Inlet to control crab bycatch mortality and protect crab habitat in an areas with depressed king and Tanner crab stocks.

State Water no bottom trawling-(2000) State managed area provides year round protection from all bottom trawl gear. Closes all state waters (0-3nm) to commercial bottom trawling to protect nearshore habitats and species.

Southeast Alaska no trawl closure-(1998) Year round trawl closure E. of 140° initiated as part the license limitation program.

SALMON BYCATCH

The following section provides updated bycatch information for salmon in the GOA. A more detailed report on salmon bycatch in Alaska groundfish fisheries is provided by Witherell et. al (2002).

Amount of Bycatch

Pacific salmon, including Chinook, chum, coho *(O. kisutch*), sockeye (*O. nerka*), and pink (*O. gorbuscha*) are taken incidentally in the groundfish fisheries within the Gulf of Alaska. Salmon are not generally caught in longline and pot gear (Berger 2003). However, salmon are taken incidentally in most GOA trawl fisheries, thus this discussion focuses upon bycatch in the trawl sector. Salmon bycatch is currently grouped as Chinook salmon or ‘other’ salmon, which consists of the other 4 species combined. Over 95% of the ‘other salmon’ bycatch consists of chum salmon (Table 1). Bycatch of Chinook salmon in the last 5 years (average of 17,643 salmon, 2000-2004) is slightly lower than the time series average (average of 19,733 salmon, 1990-2004). The bycatch of ‘other’ salmon in the last 5 years (average of 7,252 salmon , 1990-2004) is much lower than the time series average (average of 17,572 salmon, 1990-2004).

Other salmon bycatch has declined substantially from the 1993-1995 period. Bycatch of ‘other’ salmon in the GOA groundfish trawl fisheries from 1993-1995 are shown in Table 2. Bycatch was highest in the month of July, hitting a peak in 1993 of 48,518, and again in 1995 of 42,164. This peak in other salmon bycatch during this period was due to the timing of the pollock trawl fishery. During these years the season opened in July. In 2000, the pollock trawl fishery timing was changed due to changes in regulation for Steller sea lions to the current seasonal openings of January 20, March 10, August 25 and October 1. Since this time the other salmon bycatch has been far less than the peak in 1995. Since 1995, the highest annual amount of other salmon bycatch was 13,539 in 1998, with amounts decreasing to 3,218 in 2002. Other salmon bycatch increased in 2003 to 10,400 but declined again in 2004 to 5,650. The average bycatch of other salmon during 1993-1995 was 52,803 while from 2000-2004 the average bycatch was 7,252.

In the 2000-2004 fisheries, an average of about 10,000 Chinook salmon per year were taken by the walleye pollock fishery, 2,700 Chinook salmon in the Pacific cod fishery, 3,800 Chinook salmon in the flatfish fishery (all targets combined), and 900 Chinook salmon in other target fisheries (Table 3). In an average year, the walleye pollock fishery accounted for 58% of the Chinook salmon bycatch, with the trawl fisheries targeting Pacific cod taking 16%, and flatfish fisheries taking 21%. About 3,600 'other' salmon were taken in the walleye pollock fishery, on average, during the 2000-2004 fisheries. In 2002 and 2004, bycatch of other salmon in this fishery was drastically reduced to 795 (in 2002) and 606 (in 2004), although the annual bycatch numbers showed an increase to 6,422 in 2003. Nevertheless, in an average year, more of the 'other' salmon bycatch has been taken in the walleye pollock trawl fishery (50%) than other target fisheries, with the flatfish fishery also taking a substantial portion (39%). It is likely that relative amounts of bycatch taken in the walleye pollock fisheries have been lower in recent years due to reduced catch limits for walleye pollock catches.

Location and Timing of Bycatch

The timing of salmon bycatch in GOA fisheries followed a predictable pattern in 2004. Chinook salmon were taken regularly from the start of the trawl fisheries on January 20th through early April, and also in high quantities during September and October in the walleye pollock fishery (Figure 1). Chum salmon were not taken in any great numbers until mid-June, after which they were taken regularly through the end of the season (Figure 2). The timing of salmon bycatch in 2004 appears similar to what occurred in previous years. However, the 2000 fishery exhibited a different temporal pattern of bycatch, perhaps due to the U.S. District Court order that forced the walleye pollock fleet to fish outside of Steller sea lion critical habitat (Witherell et al. 2002).

Salmon bycatch occurs in the western and central GOA management areas, corresponding to locations of the trawl fisheries. Since 1998, the eastern GOA (east of 140°W longitude) has been closed to all trawling, with the implementation of amendment 58 to the GOA groundfish FMP. During the 2000-2002 period, Chinook salmon were taken in relatively higher numbers in some trawl hauls to the east of Kodiak Island (up to 380 salmon per haul), although they can be taken in relatively high numbers per haul in other areas (Supplemental Figure 5). During the 2000-2002 period, Other salmon were taken in relatively low numbers along the shelf (Supplemental Figure 6).

Comparison of salmon bycatch with regional and foreign run strength and hatchery release

Several countries in addition to the U.S. have hatchery releases of chum and chinook salmon. The North Pacific Anadromous Fish Commission tabulates summaries of these hatchery releases in millions of fish (Table 5). For Chinook salmon, Canada and the United States share the highest amount of hatchery releases, with the U.S. releases predominantly in the Alaska region and the Canadian releases predominantly located in the western and southern coasts of Vancouver Island. For chum salmon a far greater amount of hatchery releases are recorded in Japan than Canada, the United States or Russia. No correlation is available, however, with the bycatch of salmon in the GOA and the release from any of these hatchery sites.

Origin of Chinook and chum bycatch in the Gulf of Alaska

It is difficult to ascertain direct effects of hatchery salmon releases and bycatch of salmon without specific information on those taken salmon. While some bycatch sampling studies have been conducted for the Bering Sea salmon bycatch in the BSAI trawl fisheries, no studies have been done to specifically address the origin of the GOA trawl fishery bycatch. However some information is available from other studies on the origin of salmon species. The High Seas Salmon Research Program of the University of Washington routinely tags and monitors Pacific salmon species. The Coded Wire Tag (CWT) information may not accurately represent the true distribution of hatchery caught salmon however as much of the CWT tagging occurs within the British Columbia hatcheries and thus most of the CWT recovered come from those same hatcheries. CWT tagging does occur in some Alaskan hatcheries, specifically in Cook Inlet, Prince William Sound, other Kenai region hatcheries as well as in hatcheries in Southeast Alaska (Johnson, 2004). Some CWT studies have also tagged Washington and Oregon salmon and many of these tagged salmon have been recovered in the GOA (Myers et al. 2004). The 2003 program report for the High Seas Salmon Research Program details additional data on west coast salmon tag recoveries (Myers et al 2004). In 2003, 124 tags were recovered in the eastern Bering Sea and GOA. Of these tags, 103 were recovered in groundfish trawl fisheries while 21 were recovered by U.S. and Japanese research vessels. Overall tagging results in the GOA showed the presence of Columbia River Basin chinook and Oregon Chinook salmon tag recoveries (from 1982-2003). Some CWT recovered by research vessels in this time period also showed the recoveries of coho salmon from the Cook Inlet region and southeast Alaska coho salmon tag recoveries along the southeastern and central GOA. Scientists at the University of Washington are currently studying the stock origins of Chinook salmon incidental catch in the eastern Bering Sea (Myers et al. 2004), however no studies have specifically examined the stock composition of salmon bycatch from GOA trawl fisheries.

Future studies of Chinook salmon bycatch will likely utilize allozyme methodology, because the allozyme baseline is complete enough to discriminate Chinook stocks in Bering Sea stock mixtures (Teel et al. 1999). Allozymes have been successfully applied to Chinook mixtures from confiscated high seas Chinook salmon catches (R. Wilmot, National Marine Fisheries Service, Juneau, personal communication). Attempts are underway to obtain further tissue collections from Russian stocks that would improve the accuracy of allozyme methods for delineating stock origins. However, funds to collect and analyze Chinook samples from trawl bycatch are limited. The allozyme methodology, however, has been applied to chum salmon samples collected by research gillnets in the high seas (Urawa et al. 2000). Results indicate that North American chum stocks were common in the central GOA (15% western Alaska, 25% Alaska Peninsula/Kodiak, 28% Southeast Alaska/Prince William Sound, 18% from Canada), and Asian chum salmon were predominant in the western GOA (25% Japan, 53% Russia, 13% western Alaska, 10% elsewhere). Chum salmon research in the Bering Sea was also recently completed, which details additional information on the origin of those stocks (Urawa et al. 2004).

Additional research on stock discrimination for Chinook salmon is being conducted using microsatellite DNA, but the microsatellite DNA baseline is not complete enough at present to be used for analysis of Chinook salmon mixtures that potentially include Chinook salmon throughout the Pacific Rim (A. Gharrett, University of Alaska Fairbanks, personal communication). Current research is focusing upon establishing this baseline for future use in this regard (Gharrett et al. 2005). Preliminary results suggest that there are distinguishable characteristics between U.S., Canadian and Russian salmon stocks (Gharrett et al. 2005).

OVERVIEW OF CHUM AND CHINOOK STOCK STATUS AND COMMERCIAL CATCH

Salmon stocks in the Gulf of Alaska are managed by the State of Alaska. Forecasts of salmon runs (catch plus escapement) for major salmon fisheries and projections of statewide commercial harvest are published annually by ADF&G. For purposes of evaluating the relative amount of bycatch as compared to the commercial catch of salmon by area, Tables 6 and 7 show the commercial catch of Chinook and chum species by management area in 2004 and 2005. It should be noted that these catches are shown here only as a proxy for an indication of run strength for Chinook and chum stocks across the GOA. Available information on individual stocks and run strengths varies greatly by river and management area. Commercial catches are subject to market constraints and thus are not the best estimate of the relative stock size. However, understanding these limitation, some limited information regarding the health of the resource can be obtained by reviewing the commercial catch.

For Chinook stocks, the 2004 catch in the southeast area represented the highest Chinook harvest on record (since statehood) and almost twice the 10-year average (Eggers, 2005). In Prince William Sound, the 2004 harvest was below the projected harvest and the 7th largest since 1985. Cook Inlet harvests were very high compared to long term averages as well. For Kodiak, the 2004 harvest was much higher than the previous 10-year average (Eggers, 2005). Estimated Chinook escapement was likewise higher than the escapement objective and greater than the previous 10-year average (Eggers, 2005). For Chignik, the 2004 escapement was the largest on record and greatly exceeded the escapement goal (Eggers, 2005). The harvest of Chinook was approximately equal to the previous 2 years' harvests (under the cooperative management plan) and roughly half of the 10 and 20-year averages. South Alaska Peninsula Chinook harvest in 2004 was above the 10 year average.

For chum salmon, the Southeast Alaska harvest in 2004 was the sixth highest in the last ten years. It was noted that the trend in reduced fishing effort is affecting the ability of the fleet to harvest the available fish in some areas thus the harvest of some species might have been higher had there been greater demand for the product (Eggers, 2005). Prince William Sound chum runs were below the expected enhanced run estimates. In the Upper Cook Inlet, the run was approximately 25% less than the recent 10 year average due primarily to reduced fishing time by the drift fleet (Eggers, 2005). While chum salmon production in south central Alaska has been poor since 1986, incremental improvements have been occurring each year since 1995-1996 and the 2004 runs to most of Cook Inlet were good (Eggers, 2005). Lower Cook Inlet chum harvest in 2004 was the highest catch since 1988 and over 7 times the 10 year average. For the Kodiak management area, the chum harvest was near the forecast and above the ten year average. Overall escapement for Kodiak met the escapement objective but was slightly below the ten year average. Limited aerial surveys led to incomplete escapement estimation for some systems (Eggers, 2005). Chum harvests in the Chignik area were below average but also likely attributable to a lack of commercial effort. Overall Chignik escapement estimates for chum exceeded the sustainable escapement goals. The South Peninsula indexed total chum escapement was above the escapement objective in 2004, while harvests were below the 10 year average (Eggers, 2005).

CRAB BYCATCH

Several species of crabs may be taken incidentally in GOA groundfish fisheries. For purposes of this discussion we are only characterizing the bycatch of red king crab and *Bairdi* Tanner crab species in the GOA groundfish fisheries. Additional information on the bycatch of other crab species in the GOA was provided in previous discussion papers. See the NPFMC website for additional background information: (http://www.fakr.noaa.gov/npfmc/current_issues/groundfish/goacoop.htm)

Amount of Bycatch in Trawl Fisheries

The number of crabs taken as bycatch in GOA groundfish trawl fisheries are shown in Table 8. Bycatch of red king crabs is relatively low. An average of 98 red king crabs were taken in 2000-2004 trawl fisheries.

Since 1993, the majority of red king crab have been taken in the combined flatfish fisheries, and in the rockfish trawl fisheries. The highest amounts of red king crab bycatch since 1998 occurred in 2004 fishery with 361 red king crabs caught. Of these 272 were from the rockfish trawl fishery (Table 9).

The bycatch of *C. bairdi* Tanner crabs in GOA trawl fisheries has fluctuated through the time series, reaching a high of 136,769 crabs in 2003 to a low of 29,947 crabs in 1999. Bycatch of *C. bairdi* Tanner crabs in the last 5 years (93,025 crabs per year average, 2000-2004) is slightly higher than the average for the time series from 1993-2004 (79,238 crabs). An examination of the seasonal and annual bycatch of *C. Bairdi* Tanner crabs since 1993, with a specific focus on the recent period (since 2000) was conducted to identify the appropriate limits and the fisheries for which these limits should apply. The bycatch of *C. bairdi* Tanner crabs in GOA groundfish fisheries has fluctuated through the time series, from a low of less than 50,000 crabs in 1994 to a high of over 300,000 crabs in 1997(Figure 3).

During these years, the highest bycatch of Tanner crabs occurred in 1997, where elevated bycatch in both trawl and pot sectors was observed (Figure 4). The highest numbers of Tanner crab taken as bycatch occur primarily in the trawl fisheries (specifically the Pacific cod trawl and flatfish trawl) and in the pot fishery for Pacific cod. The relative numbers taken over this time period by the combined trawl fisheries (again primarily for Pacific cod and flatfish) as well as the bycatch taken in the Pacific cod pot fishery are shown in Figure 4. In recent years the trawl contribution to bycatch has been much higher than the pot contribution to bycatch.

The average percent contribution by gear type for *C. bairdi* Tanner crab are: 65% for combined trawl fisheries, 35% for pot fisheries and <0.01% for all longline fisheries (Table 10). Bycatch of *C. bairdi* Tanner crabs in the Pacific cod pot fishery was notably higher from 2000-2002 but decreased dramatically in 2003 and 2004. Further examination of the location of the pot cod fishery (and flatfish trawl fishery) would possibly provide an explanation for the relative decrease in crab bycatch in the pot cod fishery and increase in the flatfish fishery. No data were available in order to further examine the location of effort in these fleets over this time period at this point. However this will be an important aspect for examination in the forthcoming analysis. The relative observer coverage in these fleets is notably limited, particularly in the Pacific cod pot fishery.

Location and Timing of Bycatch in Trawl Fisheries

Bycatch amounts of *C. bairdi* Tanner crab taken in trawl fisheries appear to fluctuate temporally in direct response to groundfish catches, particularly catches of Pacific cod and flatfish, which are managed on a quarterly basis, with the trawl fishery beginning on January 20th each year. The seasons for trawl gear increased to 5 beginning in 2001. Bycatch of Tanner crabs in 2003 (in numbers of crabs)increased dramatically in mid-March due to bycatch in the combined flatfish fishery, and was high from late April through May and once again in mid-October (Figure 5), each time in the flatfish fisheries, notably in the flathead sole fishery (March), Shallow water flatfish (April-May) and Arrowtooth flounder fisheries (October). Bycatch of *C. bairdi* Tanner crabs in 2004 was highest (in numbers of crab) during March and early April (shallow water flatfish), corresponding to seasonal release of the halibut PSC apportionment for use in the flatfish fishery with an additional spike in late July (Arrowtooth flounder) (Figure 6).

Bycatch in longline and pot fisheries

Bycatch of red king crab and *C. bairdi* Tanner crab by gear and fishery for 2000-2004 are shown in Tables 8, 9 and 10. Longline gear catches very few crabs of any species.

For red king crab, the average number of crabs taken in all fisheries for 2000-2004 is 132 crabs. Of this, 77% were in the trawl fishery, 8% in the pot fishery and 14% in the longline fishery.

Bycatch of *C. bairdi* Tanner crabs in the Pacific cod pot fishery was notably higher from 2000-2002 but decreased dramatically in 2003 and 2004. Further examination of the location of the pot cod fishery (and flatfish trawl fishery) would possibly provide an explanation for the relative decrease in crab bycatch in the pot cod fishery and increase in the flatfish fishery. Also, as was noted in the previous discussion, the relative observer coverage in these fleets is limited, particularly in the Pacific cod pot fishery (Table 11).

Contribution to bycatch by the state waters cod fishery

An examination was made of the state waters Pacific cod fishery contribution to the *C. bairdi* Tanner crab bycatch amounts (Table 11). Preliminary data were obtained by ADF&G for three locations in the Western GOA: Kodiak, South Peninsula and Chignik. Data were available for various years in each location. In the Kodiak region, data were obtained for 1997, 1998, 1999, 2001 and 2004. Of these years, 2001 showed the highest number of Tanner crab, 171 crab. It was noted by ADF&G that this was obtained in only one observed trip. In the S. Peninsula region, the highest number of Tanner crab was obtained in 2001 where 52 crab were caught as compared with 0 to 1 in all other years for which data were obtained for this region (1998-2004). For Chignik, 2003 was the only year for which preliminary data were available. Here 42 crabs were obtained as bycatch. The state waters bycatch numbers for *C. bairdi* Tanner crab are still low in comparison to total *C. bairdi* Tanner numbers in the GOA. Currently due to the absence of a full state onboard observer program less than 1% of the state waters fishery is observed. ADF&G staff had noted that due to rising concerns regarding the limited available observed pots increased effort would be made to observe more trips during the 2004 fisheries (Mike Ruccio, personal communication). Unfortunately, the short and intense season in 2004 made it very difficult for ADF&G staff to allocate a dockside sampler for an observer trip thus only one new observer trip was possible last year (Kally Spalinger, personal communication).

OVERVIEW OF CRAB MANAGEMENT AND STOCK STATUS

Crab fisheries in the GOA are solely managed by the State of Alaska. Abundance estimates are produced by region (where possible). For most regions actual abundance estimates are limited and commercial fishing has been closed. An annual trawl survey is conducted by ADF&G. The survey methodology is designed to concentrate sampling in areas of historical king and Tanner crab abundance (Figure 7).

Red King Crab:

Major red king crab fisheries have occurred historically in the Kodiak and Alaska Peninsula Areas. Stock size is estimated by a annual trawl survey, and fisheries are opened if biomass estimates meet or exceed threshold levels established by the state. The Kodiak red king crab population remains at historically low levels (Cavin et al., 2005). Fishing seasons for Kodiak red king crabs have remained closed since the 1982/83 season.

Results from the 2003 Kodiak trawl survey estimated the red king crab population at 72,245 animals. The majority of the crabs were found in the Southwest Section (Spalinger, 2004). The mature red king crab female population was estimated to be 13,172 animals, well below the 5.1 million threshold required for a fishery opening (Cavin et al., 2005) Population estimates for Kodiak based on 1994-2004 ADF&G trawl surveys are shown in Figure 8.

Results from the 2003 Alaska Peninsula survey indicated that the red king crab population there remains at very low levels. The estimated population from the survey was 39,859 crabs, a decrease from the estimated 185,072 from the 2002 survey (Spalinger, 2004). The stock is notably patchy in distribution as well as at low levels, hence biomass estimates can be wildly varying from year to year. The fishery has been closed since the 1982/83 season. Population estimates for the Alaska Peninsula based on 1994-2004 ADF&G trawl surveys are shown in Figure 9.

For the Cook Inlet management region, no population abundances are estimated, but the survey is used to provide a relative abundance index (thus no extrapolation is done on survey data for an overall population abundance estimate). However, based on the abundance index, the red king crab stocks in the Cook Inlet management region are considered to be severely depressed and patchily distributed. It was noted in the assessment that all of the current population of red king crabs in the region are vital to supporting the existing population (Bechtol et al. 2002).

In the Southeast management region, pot surveys are used to estimate trends in abundance in northern and southern bays of the region, however a regional estimate of total population is not available. Survey results are utilized to estimate relative abundances, estimated as catch per pot day for each sex and size class of crabs. Survey results indicated greater increases in abundance in the northern regions though both northern and southern regions have abundances comparable to the relatively high abundances seen in the early 1980s (Clark et al. 2003). A commercial fishery for combined red and blue king crab in the Southeast will open in 2005 with a combined GHL of 20,000 pounds.

Tanner Crab:

Commercial fishing for *C. Bairdi* in 2004 occurred in areas of the Kodiak District, the Chignik District and the South Peninsula District. GHLs by region were the following in 2004: Kodiak (all regions combined) 1,750,000 (pounds), Chignik 400,000 pounds and South Peninsula 300,000 pounds.

For *C. bairdi* Tanner crab, population estimates for the Kodiak District are at approximately 175.9 million crabs, for S. Peninsula 14.3 million crabs, and Chignik 12.7 million crabs (Worton 2002). Population estimates for Kodiak based on 1994-2004 ADF&G trawl surveys are shown in Figures 10. For the S. Peninsula this estimate represents an increase from the previous survey. Recent survey results indicate an increase in females from 2000-2002 (Worton 2002).

Population estimates for Cook Inlet management region list male *C. bairdi* Tanner crab abundances in the Southern region as 3.1 million males, however it was noted that the estimate of legal sized males is at a historic low. Female abundance in this region was estimated at 2.1 million crabs in 2001, primarily due to a very high number of estimated juveniles. The southern region has been closed to commercial fishing due to low crab abundances since 1995 (Bechtol et al 2002).

The Kamishak and Barren Islands District of the Cook Inlet management region has also been closed to commercial fishing (since 1991) due to concerns of low crab abundance. In these regions the male abundance is estimated at 6.1 million crabs, with a near historic low in mature males, while female abundance is estimated at 5.1 million crabs with a record low percentage of mature females. There is limited data to assess the Outer, Eastern, and Central Districts of the Cook Inlet management region and both regions have been closed to commercial fishing (since 1998 for Central and 1993 for Eastern/Outer).

For the Southeast region, a population survey was begun in 1997/1998 to evaluate regional distribution of *C. bairdi* Tanner crab stocks and the relative abundance estimates. However, at present, no estimates of overall *C. bairdi* Tanner crab abundance in the region are available.

COMPARISON OF SURVEY ABUNDANCE, EXISTING CLOSURES AND TRAWL FISHERY BYCATCH (through 2002)

Tanner crab bycatch in all fisheries from 2000-2002 is shown with the survey abundance estimates for 2002 and existing closures in the area near Kodiak Island (Supplemental Figure 7). The bycatch is highest in the areas of Marmot Bay, along Albatross Bank, the southern and eastern shore of Kodiak, and northeast of the Trinity Islands. Some bycatch is also concentrated in Shelikof Strait. The highest concentration of Tanner crabs from the ADF&G survey are found in Alitak Bay, Ugak Bay and to the north of Marmot Bay (Supplemental Figure 7). The ADF&G survey area is not uniform across the Kodiak Region, and is instead concentrated in areas of historical biomass of king and Tanner crabs (Figure 7). Additional information on the actual size and sex distributions of crabs by area and year are available in the assessment report (e.g., Worton, 2002).

Red king crab bycatch in all fisheries from 2000-2002 is shown with the survey abundance estimates for 2002 and the existing closures in the area near Kodiak Island (Supplemental Figure 8). Limited bycatch is observed in this area in these years, however some red king crab bycatch was observed on Portlock Bank to the east of Marmot Island. The highest concentration of red king crabs from the 2002 survey were observed in Alitak Bay and Uyak Bay. Smaller numbers of crabs were found near Cape Chiniak. Again, additional information on the actual size and sex distribution of red king crabs by area and year are available in the assessment report (Spalinger, 2004).

DISCUSSION

In February 2002, the Council initiated the analysis of alternatives to control salmon bycatch in the GOA groundfish trawl fisheries, and proposed alternatives, which included bycatch limits based on 1990-2001 average bycatch amounts (21,000 Chinook salmon and 20,500 ‘other’ salmon). Attainment of these limits by trawl fisheries would result in closure of specified areas for the remainder of the fishing year. The Council further clarified that specified areas would be designated based on analysis of areas that have had historically high bycatch rates. Recent analysis suggests that these bycatch limit amounts may not reflect the current manner in which the groundfish trawl fisheries operate and the reduced bycatch of salmon in more recent years.

Draft Alternatives

Draft bycatch reduction alternatives have been incrementally refined by the Council since first drafted in December 2003. The alternatives have been folded into the larger GOA groundfish rationalization EIS package for analysis. Providing the additional information as contained in this paper is intended to assist the Council in further refining the alternatives and focusing the measures appropriately.

The following are the draft alternatives as modified by the Council in June 2005 (specific modifications from June 2005 are shown in Appendix A):

<u>Chinook Salmon</u>

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for salmon. Specific areas with high bycatch (or high bycatch rates) are closed seasonally (could be for an extended period of time) if or when a trigger limit is reached by the pollock fishery.
Alternative 3: Seasonal closure to all trawl fishing in areas with high bycatch or high bycatch rates.
Alternative 4: Voluntary bycatch coop for hotspot management.

<u>Other Salmon</u>

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for other salmon. Specific areas with high bycatch (or high bycatch rates) are closed for the remainder of the year if or when a trigger limit is reached by the pollock trawl fishery (and potentially additional areas for flatfish trawling).
Alternative 3: Seasonal closure to all trawl fishing in areas with high bycatch or high bycatch rates.
Alternative 4: Voluntary bycatch coop for hotspot management.

<u>Tanner Crab</u>

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for Tanner crab. Specific areas with high bycatch (or high bycatch rates) are closed for the remainder of the year if or when a trigger limit is reached by:
Options: a) trawl flatfish fishery
b) all bottom trawling
c) groundfish pot
Alternative 3: Year-round closure in areas with high bycatch or high bycatch rates of Tanner crab by gear type.
Alternative 4: Voluntary bycatch coop for hotspot management.

<u>Red King Crab</u>

Alternative 1: Status Quo (no bycatch controls).
Alternative 2: Trigger bycatch limits for red king crab. Specific areas with high bycatch (or high bycatch rates) are closed to flatfish trawling for the remainder of the year if or when a trigger limit is reached by the flatfish fishery.
Alternative 3: Year-round bottom trawl closure in areas with high bycatch or high bycatch rates of red king crab.
Alternative 4: Voluntary bycatch coop for hotspot management.

Estimating Trigger Limits

Trigger limits as proposed under alternative 2 would close designated areas (as yet to be defined) to trawling in specified fisheries once a bycatch limit has been reached. For instance, for Chinook salmon, once a bycatch limit has been reached, the designated area closure would be closed to pollock fishing for the remainder of the year. Likewise for Tanner crab, once the bycatch limit has been reached, the area closure for the flatfish fishery would go into effect for the remainder of the year. For other salmon, trigger limits may also be considered for flatfish trawl fishery (in addition to pollock trawl fishery) given the relative contribution of bycatch by that fishery.

At their June 2005 meeting, the Council provided direction to staff in proceeding with this analysis (Appendix A). Staff were encouraged to look at abundance-based methodologies in considering potential trigger limits. These could be either based on an estimate of, or float as a percentage of, the overall biomass of PSC species. This approach has been utilized in the BSAI groundfish fisheries using a stair-step procedure for crab species such as red king crab, an abundance-based zonal approach for *C. bairdi* Tanner crab and as a percentage of annual biomass estimates for snow crab. Biomass-based limits require a good understanding of the relative stock status for that species. A full description of stock status and the relative understanding of the health and vulnerability of crab stocks in the GOA will be included in the forthcoming analysis of these measures and will be integral to determining the appropriate mechanism for establishing trigger limits.

The proposed alternatives using trigger closures would work similar to other existing PSC management measures. Currently in the GOA, PSC limits exist in the flatfish fishery for halibut only, whereby if a given apportionment is reached within a specified season, the flatfish fishery is then closed for the remainder of that season. Trigger bycatch limits as proposed here would be similar, but would not close the area-wide flatfish fishery. Instead, designated high bycatch or hotspot areas would be closed to the fishery if the given trigger bycatch limit was reached while the fishery was being prosecuted. Similar trigger closures have been implemented in the Bering Sea to control the bycatch of Tanner crab, snow crab (*C. Opilio*) and red king crab (Witherell and Pautzke 1997).

Determining Appropriate Area Closures

Year-round and seasonal trawl closures, such as those as proposed under alternative 3, have also been used in both the GOA and BSAI fisheries to control the bycatch of prohibited species. Currently in the GOA, trawl closure areas have been implemented around Kodiak Island to protect red king crab. Specific areas are designated as Type I, Type II and Type III areas depending upon the importance of the area to concentrations of red king crab at various life stages. Type I closures are closed year-round to all non-pelagic trawling. Type II areas are closed during the molting period for red king crab (February 15-June 15), while Type III areas are closed only during specified ‘recruitment events” and are otherwise opened year-round. These closures are delineated in green (year-round) and red (seasonal) in figure 18.

For salmon, however, the highest bycatch is seasonal and is tied to the timing of the walleye pollock fishery. Here seasonal closures of hot spot locations could possibly be examined rather than year-round closures. Seasonal salmon closures have been utilized to control salmon bycatch in the BSAI groundfish fisheries, although in recent years these closures have been problematic and will potentially be revised by the Council at this meeting due to increased bycatch of salmon in the BSAI pollock fishery since 2003. The Council is currently evaluating alternatives means to reduce salmon bycatch in the BSAI, including potentially suspending the existing closure areas and allowing the fleet to work within their cooperative structure to control bycatch. The existing regulatory measures in the BSAI are closures areas which are triggered upon the attainment of a specified limit in the designated fishery. The Chum Salmon Savings

Area in the eastern Bering Sea is closed to trawl fishing for all of August, and can be extended from September 14th through October 14th if specified chum salmon bycatch limits are reached in the trawl fishery. For Chinook salmon, the Chinook Salmon Savings Areas are closed when annual Chinook salmon bycatch limits are reached by the trawl fishery (similar to a seasonal closure under the trigger bycatch limits as described for alternative 2). Given that the Council is currently looking to revise the closure areas in the BSAI, any measures evaluated for bycatch reduction in the GOA should consider and build upon lessons learned in the BSAI.

Voluntary Bycatch Cooperatives

Alternative 4 for both crab and salmon species proposes enacting a bycatch pool or cooperative for hotspot area management. This alternative is designed after the current BSAI bycatch cooperatives in use by industry to control bycatch in the pollock fishery. Currently in the BSAI, a program of voluntary area closures exists with selective access to those areas for fleets which demonstrate success in controlling bycatch (Haflinger 2003). Voluntary area closures can change on a weekly basis and depend upon the supply and monitoring of information by fishermen. The sharing of bycatch rates among vessels in the fleet has allowed these bycatch hotspots to be mapped and identified on a real-time basis, so that individual vessels can avoid these areas (Smoker 1996, Haflinger 2003).

A voluntary cooperative program could be modeled after the AFA catcher vessel Intercooperative Agreement between the nine catcher vessel cooperatives in the BSAI pollock fishery (Gruver 2003). Some aspects of this inter-cooperative agreement which would be useful to include in a GOA coop alternative include provisions for: allocation, monitoring and compliance of the PSC caps amongst the catcher vessel fleet; establishment of penalties for coops which exceed allocations; promoting compliance with PSC limits while allowing for maximum harvest of allocated groundfish; and the reduction of PSC bycatch in the groundfish fishery. For the BSAI cooperative, Sea State is retained to provide data gathering, analysis and reporting services to implement the bycatch management agreement, and in doing so provides timely hot spot reports to the fleet as well as summaries of bycatch characteristics, trends and/or fishing behaviors which may be having an effect on bycatch rates (Gruver 2003). Fleets are notified of avoidance areas for Chinook salmon and have previously agreed within the cooperative to avoid these areas as notified. Cooperative agreements in the BSAI vary between salmon species, with bycatch rates calculated for use in monitoring access to the Chum Salmon Savings Area while hot spot avoidance areas are utilized for Chinook salmon bycatch reduction. Specific cooperative measures would need to be created for the characteristics of the GOA groundfish fishery, however measures from the BSAI cooperatives may prove useful in designing appropriate programs for salmon and crab bycatch co-ops in the GOA.

Implications and coordination with GOA groundfish rationalization initiative

Rationalization programs, such as IFQ's or cooperatives, may also provide additional benefits for controlling bycatch. Rationalization programs eliminate the race for fish, thereby allowing fishermen to modify fishing practices (e.g., time and areas fished, gear modifications, etc.) to reduce bycatch, whether in response to regulatory requirements or on a voluntary basis. In a rationalized fishery, members are more likely to actively exchange information to avoid areas of high bycatch rates. In an absolute sense, rationalization programs would be expected to reduce effort, thereby reducing the amount of time gear is in the water and the probability of intercepting bycatch species.

If the Council elects to limit salmon and crab bycatch in the Gulf, those limitations will need to be coordinated with any rationalization program. Limits on salmon and crab could be applied as a fleet cap with rules similar to the current halibut PSC rules. This overall limit would have the potential to perpetuate a race for fish, if the cap is binding. Optionally, salmon and crab bycatch shares could be allocated to individuals or cooperatives. A system for allocation and management of these shares would need to be developed. In the June 2005 Council motion, the Council expressed their intention to keep the GOA bycatch reduction measures for salmon and crab species linked with the overall GOA groundfish rationalization program.

ACTION BY THE COUNCIL AT THE OCTOBER 2005 MEETING:

At this meeting the Council may wish to refine the existing draft alternatives in order to better focus measures prior to the initiation of the analysis. At the June 2005 meeting, the Council provided guidance to staff on methodologies for the analysis as well as refined alternatives 2 and 3 for Tanner crab.

At this meeting the Council may wish to review the following:

1) Current range of species covered for bycatch reduction:
    a. Are all of these salmon and crab species priorities for bycatch reduction measures under current fishing practices?
2) Current alternatives for species:
    a. Are there similar refinements (as per June 2005 Tanner crab action) to make for the other species under consideration?
3) Next steps for Council review:
    a. Staff will be preparing “strawman” trawl closure areas based on data as specified by the alternatives. Does the Council wish to review these closure area boundaries as the next step?
    b. Does the Council wish to further review bycatch reduction measures prior to the analysis?

Appendix A:

Council Motion on GOA Salmon and Crab Bycatch Measures
(under C-2 GOA Groundfish Rationalization)

The Council recommends the following to address staff questions and clarifications per directions for GOA bycatch reduction measures:

Trigger Limits:

1- Average numbers are not an appropriate approach to establishing trigger limits. The analysis should instead focus upon the use of biomass-based approaches for establishing appropriate trigger levels.
2- Trigger limits under consideration should be separated by gear type (i.e. separate limits for pot gear versus trawl gear)
3- Rather than considering an improperly defined duration of a triggered closure, the AP recommends moving in the direction of dynamic revolving closures (hot spots) which reflect the distribution and mobility of the crab population.

General recommendations for the analysis:

1- Differential discard mortality rates by gear type should be addressed in the analysis using the most up-to-date and applicable information.
2- Additional information must be included with respect to the overall precision of bycatch estimates given the low levels of observer coverage in many of the fisheries under consideration.
3- The addition of another alternative (from staff discussion paper) for an exemption from time and area closures if an observer is on board, seems pre-mature at this time.
4- Emphasis should be focused on alternatives 3 and 4 rather than focusing attention on trigger limits under alternative 2.
    a. With respect to alternative 3, additional information may be necessary (in addition to ADF&G survey information and bycatch information from the NOAA groundfish observer program) in order to appropriately identify sensitive regions for year-round or seasonal closures. Some of this additional information may include catch data from the directed Tanner crab fisheries in these areas.
    b. Alternative 4 should include the concept of required participation in a contractual agreement for a hot spot management system
5- A rate-based approach format should be added as much as possible in all graphs and figures for the analysis.
6- Consideration should be given to the overall significance of the total amount of Tanner bycatch numbers as compared with the best available information on the population abundance in order to evaluate the actual population-level impact of the bycatch from the directed groundfish fisheries.

GOA bycatch reduction measures will continue to be linked with the GOA groundfish rationalization initiative.

The Tanner crab alternatives are amended as follows (in bold and strike-out):

<u>Tanner Crab</u>

Alternative 1: Status Quo (no bycatch controls).

Alternative 2: Trigger bycatch limits for Tanner crab. Specific areas with high bycatch (or high bycatch rates) are closed for the remainder of the year if or when a trigger limit is reached ~~by the flatfish fishery~~.
Options: a) trawl flatfish fishery
b) all bottom trawling
c) groundfish pot

Alternative 3: Year-round ~~bottom trawl~~ closure in areas with high bycatch or high bycatch rates of Tanner crab **by gear type**.

Alternative 4: Voluntary bycatch coop for hotspot management.

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Table 1. Bycatch of Pacific salmon in Gulf of Alaska groundfish trawl fisheries, by species, 1990-2004.

Year	Chinook	Chum	Coho	Sockeye	Pink
1990	16,913	2,541	1,482	85	64
1991	38,894	13,713	1,129	51	57
1992	20,462	17,727	86	33	0
1993	24,465	55,268	306	15	799
1994	13,973	40,033	46	103	331
1995	14,647	64,067	668	41	16
1996	15,761	3,969	194	2	11
1997	15,119	3,349	41	7	23
1998	16,941	13,539[a]			
1999	30,600	7,529[a]			
2000	26,705	10,996[a]			
2001	14,946	5,995[a]			
2002	12,921	3,218[a]			
2003	15,860	10,400[a]			
2004	17,785	5,650[a]			
Averages					
(1990-2004)	19,733	17,572[b]			
(2000-2004)	17,643	7,252[b]			

[a] Coho, sockeye, and pink salmon are combined with chum salmon.
[b] Average chum salmon bycatch includes chum, coho, sockeye, and pink salmon.

Table 2. "Other salmon" bycatch by month, 1993-1995, in GOA groundfish trawl fisheries

	1993	1994	1995
January	203	3,690	2
February	919	3,950	2,007
March	213	164	39
April	227	109	1,290
May	150	0	39
June	4,927	5,956	9,928
July	48,518	18,709	42,163
August	303	15	0
September	4	1	11
October	832	4,632	9,313
November	64	2	0
December	28	0	0
Total	56,388	37,228	64,792

Table 3 . Bycatch of Chinook salmon in Gulf of Alaska groundfish trawl fisheries, by target fishery, 2000-2004.

Fishery	2000	2001	2002	2003	2004	average (2000-2004)
Walleye pollock	18,413	9,421	5,162	4,639	13,301	10,187
Pacific cod	2,747	2,796	4,066	3,157	977	2,749
Flatfish	4,386	2,295	2,443	7,136	2,640	3,780
Other targets[a]	1,160	434	1,250	928	867	928
Total GOA	26,706	14,946	12,921	15,860	17,785	17,644

Table 4. Bycatch of 'Other salmon' in Gulf of Alaska groundfish trawl fisheries, by target fishery, 2000-2004

Fishery	2000	2001	2002	2003	2004	average (2000-2004)
Walleye pollock	7,450	2,741	795	6,422	606	3,603
Pacific cod	0	677	29	0	51	151
Flatfish	2,979	1,857	1,500	3,354	4,548	2,848
Other targets[a]	567	720	894	624	445	650
Total GOA:	10,996	5,995	3,218	10,400	5,650	7,252

[a] Other targets include rockfish and sablefish.

Table 5. Salmon hatchery releases by country from NPAFC

chum	millions of fish				
year	Russia	Japan	Canada	US	Total
1999	278.7	1867.9	172	520.8	2839.3
2000	326.1	1817.4	124.1	546.5	2814.1
2001	316	1831.2	75.8	493.9	2716.8
2002	306.8	1851.6			
2003	363.2	1840.6			
no data available yet for 2004(and 02 and 03 preliminary)					
Chinook	millions of fish				
year	Russia	Japan	Canada	US	Total
1999	0.6	-	54.4	208.1	263.1
2000	0.5	-	53	209.5	263
2001	0.5	-	45.5	212.1	258.1
2002	0.3	-			
2003	0.74	-			

Table 6. Chinook salmon GOA Commercial Catch (1000's of fish)

Year	Area: Southeast	PWS	Cook Inlet	Kodiak	Chignik	South Peninsula	Total
2004	497	39	29	29	3	7	604
2005*	381	33	27	14	3	4	462

Source: ADF&G
*preliminary through 9/16/05.

Table 7. Chum salmon GOA Commercial Catch (1000's of fish)

Year	Area: Southeast	PWS	Cook Inlet	Kodiak	Chignik	South Peninsula	Total
2004	11,372	2,002	352	1,122	1	795	15,644
2005*	6,163	2,070	161	498	9	704	9,605

Source: ADF&G
*preliminary through 9/16/05.

Table 8. Bycatch of red king crab and Tanner crabs in Gulf of Alaska groundfish trawl fisheries, by species, 1990-2004.

Year	Red King Crab	Tanner Crab
1993	1,012	55,304
1994	45	34,056
1995	223	47,645
1996	192	120,796
1997	18	134,782
1998	275	105,817
1999	232	29,947
2000	55	48,715
2001	47	125,883
2002	20	89,431
2003	59	136,769
2004	330	64,325
Ave. 2000-2004	98	93,025

Table 9 Bycatch of red king crab in Gulf of Alaska groundfish fisheries, by gear type and target fishery, 2000-2004

Gear and Fishery	Year:				
	2000	2001	2002	2003	2004
Longline:					
Pacific cod	45	0	19	0	0
Sablefish	0	0	0	29	0
Pot:					
Pacific cod	7	8	10	0	31
Trawl:					
Walleye pollock	0	0	0	0	58
rockfish	0	0	0	59	272
Flatfish:					
DWF	0				
SWF	55	47	3	0	0
Flathead sole	0	0	17	0	0
Total GOA:	107	55	49	88	361

Table 10 Bycatch of *C. bairdi* Tanner crabs in Gulf of Alaska groundfish fisheries, by gear type and target fishery, 2000 - 2004.

Gear and Fishery	Year				
	2000	**2001**	**2002**	**2003**	**2004**
Longline					
Pacific cod	167	14	17	0	0
Other species	1	17	5	0	0
Sablefish	0	0	0	20	26
Pot					
Pacific cod	65,786	69,091	95,766	10,076	8,918
Trawl					
Pollock	1,821	11,362	774	7	2,432
Pacific cod	11,177	46,822	4,905	2,519	1,180
Flatfish:					
DWF	45	2,533	185	0	0
SWF	18,924	13,164	33,914	59,600	10,016
Flathead sole	3,015	45,269	26,924	17,330	7,275
Arrowtooth flounder	10,610	2,194	14,626	28,337	32,992
Rex sole	2,897	2,145	7,198	28,780	9,014
Rockfish	226	2,394	905	183	1,416
Other species	0	0	0	13	0
Total Trawl	48,715	125,883	89,431	136,769	64,325
Total GOA	114,669	195,005	185,219	146,865	73,269

Table 11 Pacific cod observer data (1997-2004, observed vessels only) Crab bycatch numbers. Source: ADF&G.

						Cod catch			
Area	**Year**	**Observed trips**	**Pots lifted**	**Tanner Crab**	**King crab**	**Whole pounds**	**Metric tons**	**Tanner/mt**	**king/mt**
Kodiak	1997	1	333	11	0	36,432	16.53	**0.67**	**0.00**
Kodiak	1998	1	261	4	9	20,418	9.26	**0.43**	**0.97**
Kodiak	1999	3	1006	48	0	69,257	31.42	**1.53**	**0.00**
Kodiak	2001	1	200	171	0	6,638	3.01	**56.79**	**0.00**
South Peninsula	1998	1	174	1	0	47,453	21.53	**0.05**	**0.00**
South Peninsula	1999	1	240	0	0	40,952	18.58	**0.00**	**0.00**
South Peninsula	2000	2	419	0	0	126,908	57.57	**0.00**	**0.00**
South Peninsula	2001	2	619	52	0	130,771	59.32	**0.88**	**0.00**
South Peninsula	2002	1	58	1	0	10,248	4.65	**0.22**	**0.00**
South Peninsula	2004	1	30	1	0	13,099	5.94	**0.17**	**0.00**
Chignik	2003	1	268	42	0	28,297	12.84	**3.27**	**0.00**

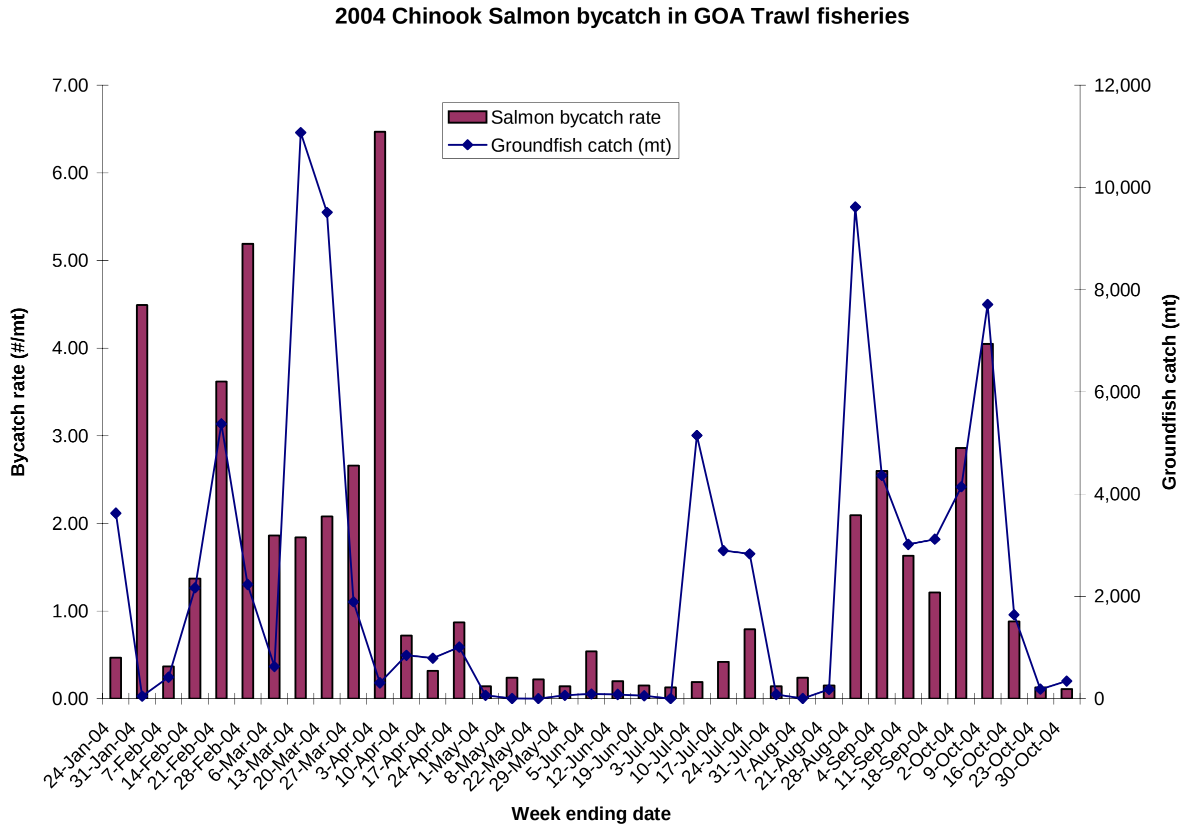

Figure 1 Chinook salmon bycatch rates within the groundfish fisheries by groundfish catch (mt) by week, 2004.

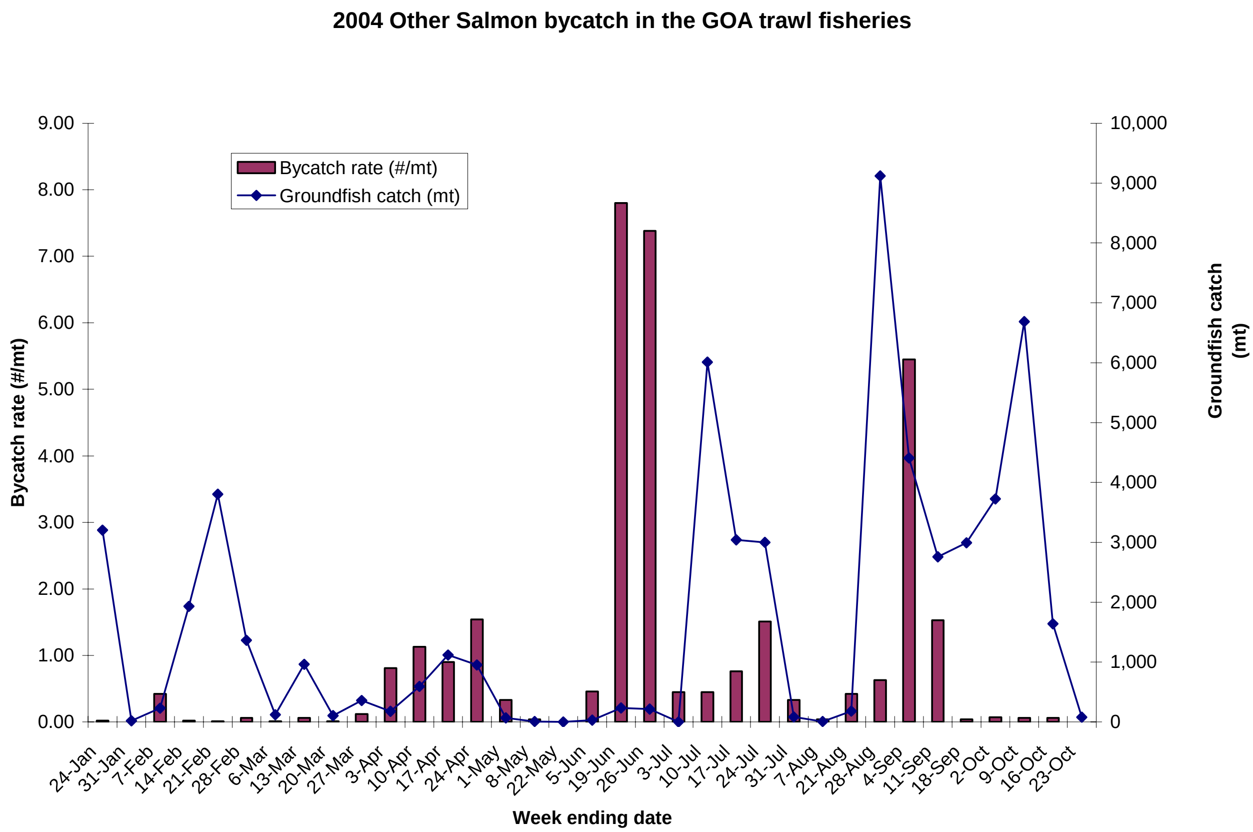

Figure 2 Other Salmon bycatch rates within the groundfish fisheries by groundfish catch (mt) by week, 2004.

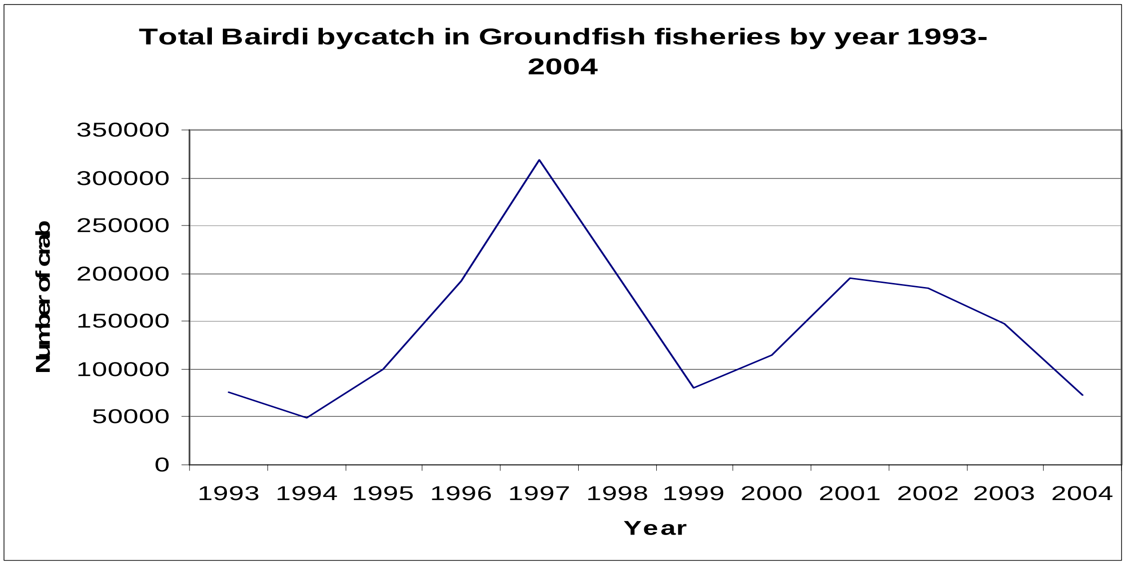

Figure 3 Total bycatch of *C. bairdi* Tanner crabs in all GOA groundfish fisheries 1993-2004

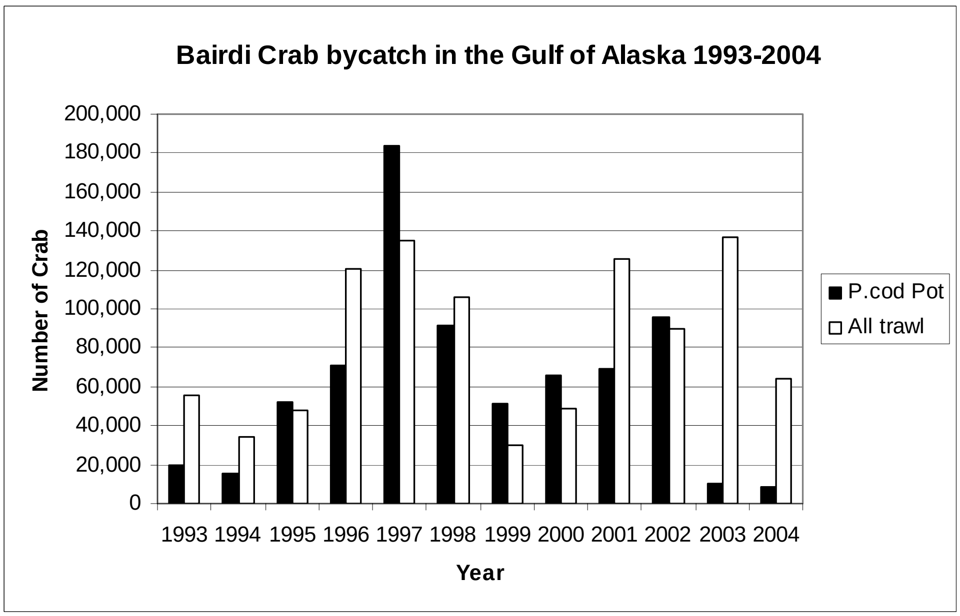

Figure 4 Overall annual bycatch of *C. bairdi* Tanner crab by trawl and pot fishery sectors (1993-2004)

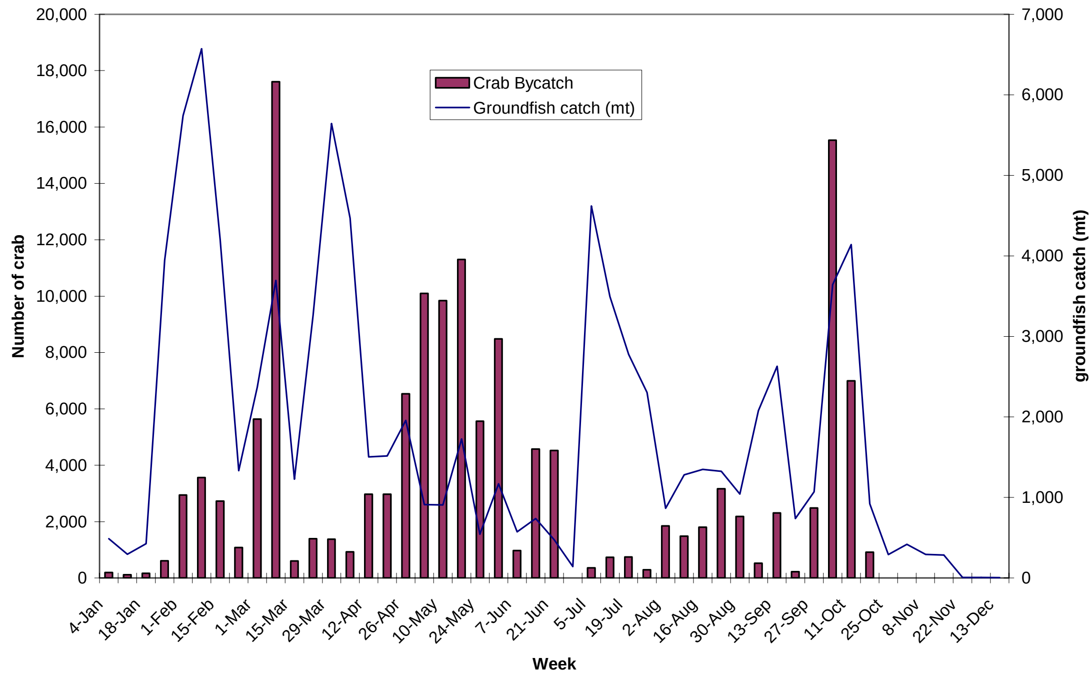

Figure 5: Bycatch of *C. bairdi* Tanner crab and associated groundfish catch in 2003

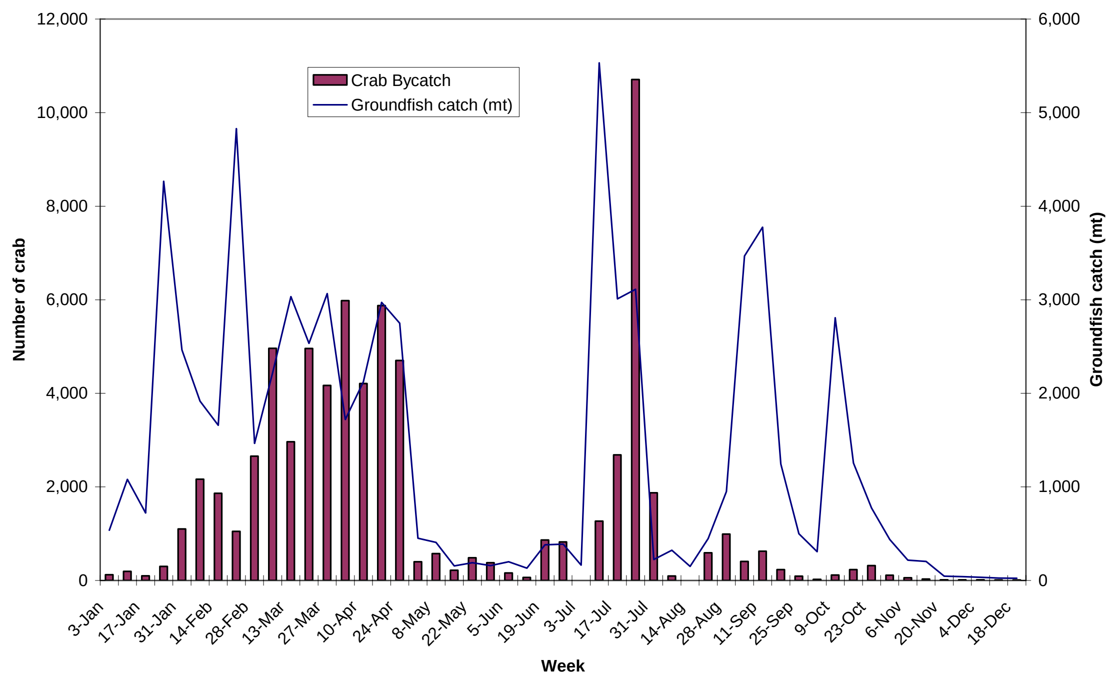

Figure 6: Bycatch of *C. bairdi* Tanner crab and associated groundfish catch in 2004

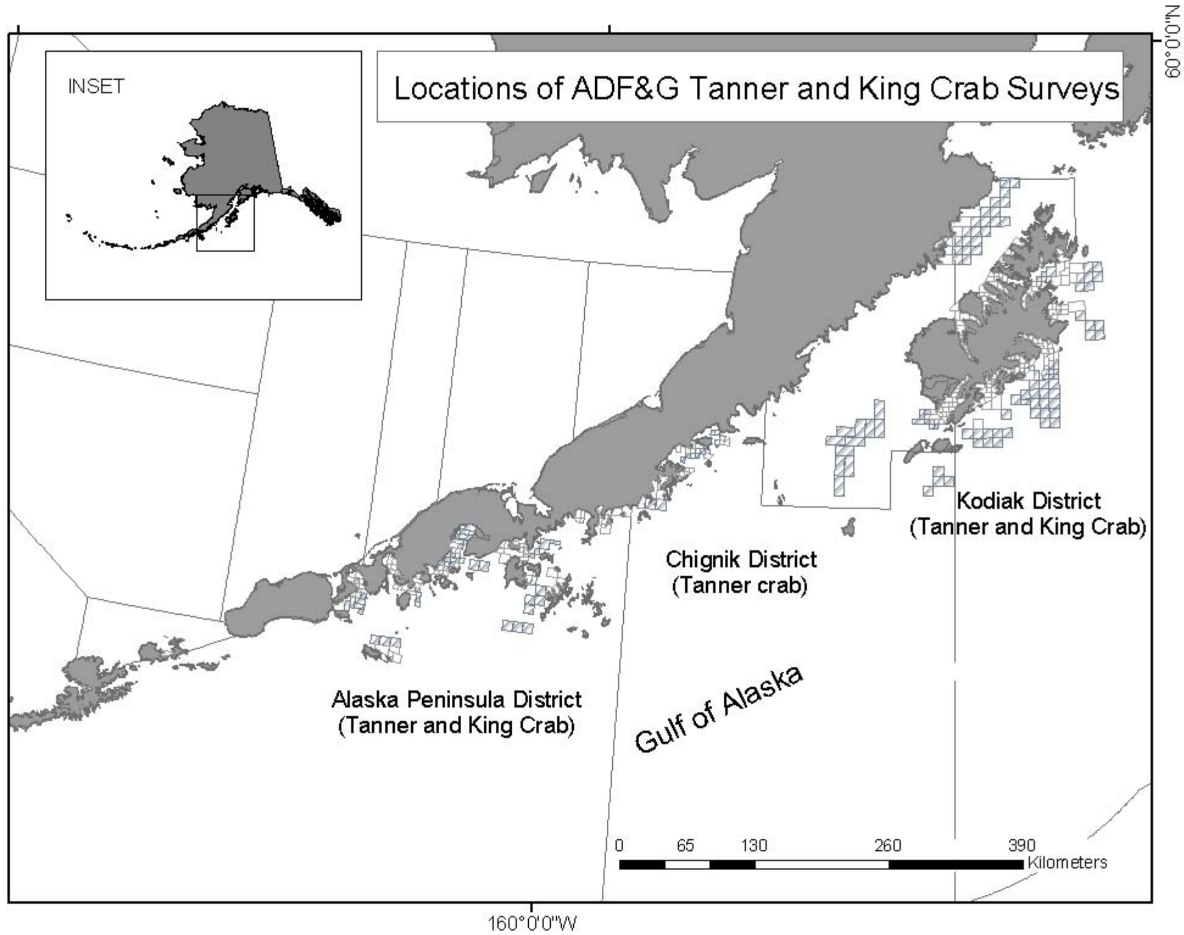

Figure 7 Locations of ADF&G trawl surveys for Tanner and king crab abundance.

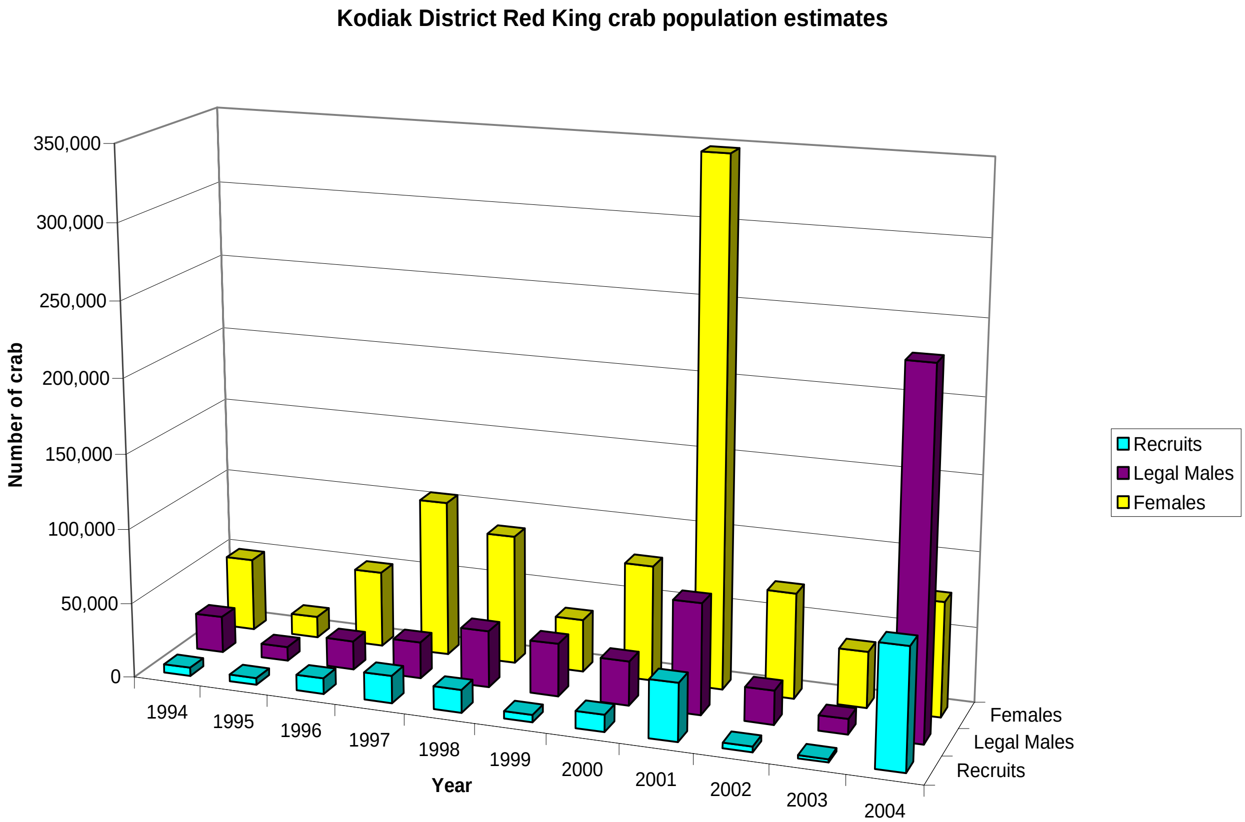

Figure 8 Red king crab population estimates Kodiak District based on ADF&G trawl surveys 1994-2004.

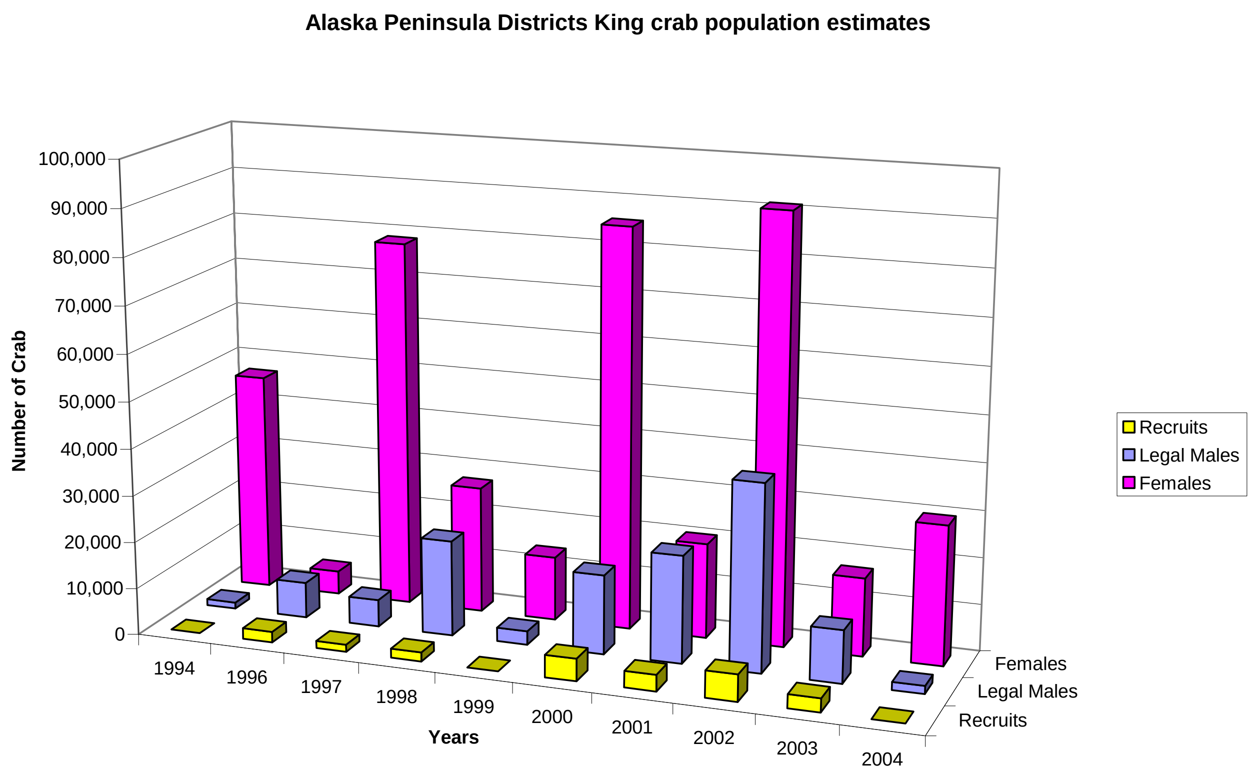

Figure 9 Red king crab population estimates for Alaska Peninsula based on ADF&G trawl surveys 1994-2004.

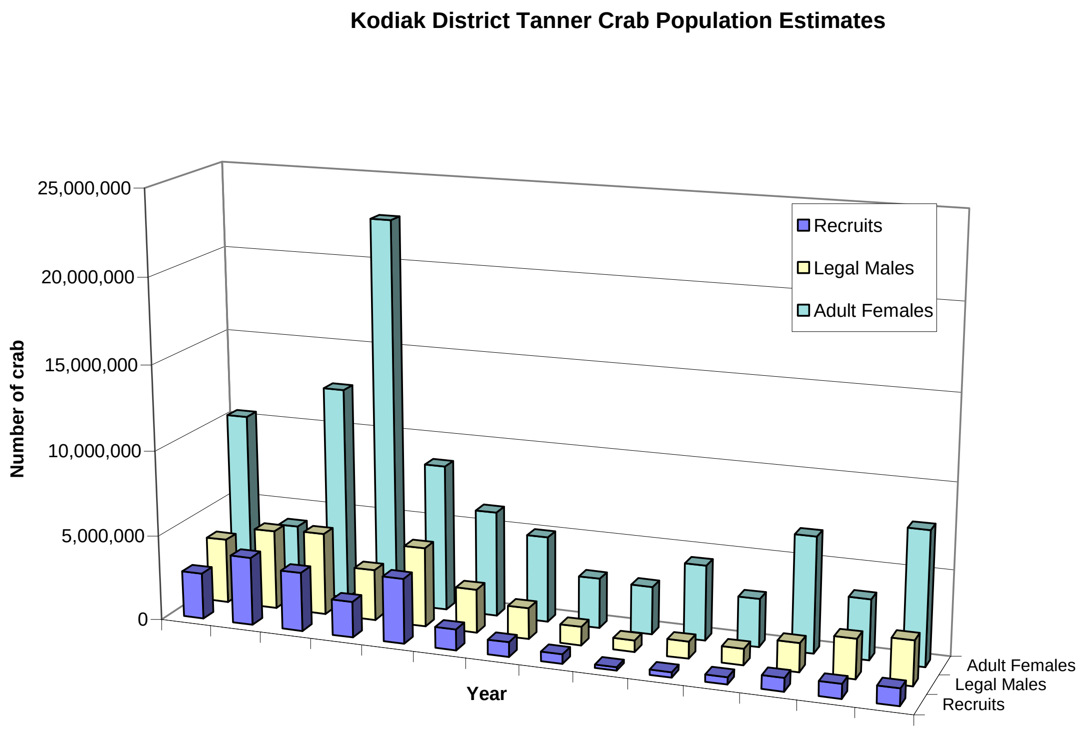

Figure 10 *C. bairdi* Tanner crab population estimates for Kodiak District based on ADF&G trawl surveys 1994-2004.