Salmon and Crab Bycatch Measures for Gulf of Alaska Groundfish Fisheries

June 2008

Staff Discussion Paper

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Introduction

The North Pacific Fishery Management Council (Council) has adopted measures over the years intended 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 other crab species taken incidentally in GOA groundfish fisheries.

In October 2007, the Council tasked staff to update a previous analysis on options for salmon and crab bycatch reduction measures in the GOA. The previous paper was presented to the Council in October 2005 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 this paper, we provide a general overview of the available information on salmon and crab bycatch, an overview of species abundance, where available, and discussion 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 1990–2007 for salmon and crab bycatch were summarized annually by each groundfish trawl fishery. Additionally, the amount of bycatch was reported on 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. 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 Alaska Department of Fish and Game (ADFG) reports, as well as data provided by the ADFG 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 shorebased 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 (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).

Observed catch estimates in the GOA

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. Because observer coverage requirements are generally based on vessel length, the majority of the GOA fleet is subject to 30% observer coverage (vessels ≥60' to <125'), while the majority of the BSAI fleet is subject to 100% or greater observer coverage (vessels ≥125' or participating in specific rationalization programs). Only 53% of bottom trawl vessels in the GOA had any observed coverage between 1990 and 2000 (Coon 2006). Over the past 10 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). Note that vessels <60' are not currently subject to any observer coverage requirements. 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.

Additional information on actual observed coverage levels in the GOA groundfish fisheries has been made available for the April Council meeting per distribution of a draft report in conjunction with the Observer Advisory Committee meeting on March 17, 2008. NMFS compiled a series of tables that provides a breakout of the percentage of harvest observed for each year 2004–2006, inclusive, in order to evaluate the effective rate of coverage in particular target fisheries. The data are broken out by observer coverage category (30%, 100%), gear type, area (BSAI, and Western and Central Gulf subareas), and component of the catch by the <60' fleet that is unobserved.[1] These tables are provided for review under the Council's Observer Advisory Committee report (C-5(a)) at the April Council meeting.

Information in the tables pertinent to the discussion of fisheries in the GOA is summarized below. Observer coverage is notably lower in the GOA than in the BSAI and any measures under discussion must take that into consideration as well. For the GOA Pacific cod pot fisheries, more than half the catch from 2004–2006 came from the <60' fleet that is unobserved. The remaining catch primarily came from the ≥60' to <125' fleet where percent coverage ranged from 19%–22% over these three years.[2] For the Pacific cod hook-and-line fisheries, in both 2004 and 2006, the catcher processor catch was nearly equally split between the ≥60' to <125' fleet and the ≥125' fleet where coverage ranged from 21%–73% and 100%, respectively. (Confidential data prevents this same comparison in 2005.) For catcher vessels, the majority of hook-and-line catch was in the <60' unobserved fleet. For the Pacific cod trawl fisheries delivering shoreside, approximately 10%–50% of the annual catch over the three-year period is in the unobserved fleet, while in the ≥60' to <125' category coverage ranged from 24%–32% in this time frame. For the pollock trawl fisheries, less than 25% of the catch was from the unobserved <60' fleet each year. The remaining catch came from the ≥60' to <125' fleet where coverage ranged from 33%–37% over these three years. For arrowtooth flounder, the majority of the catch delivered shoreside was in the ≥60' to <125' category and percentage covered ranged from 20%–26% over the three-year period. Catch of flathead sole in the catcher processor fleet was primarily in the ≥60' to <125' category and percentage covered ranged from 32%–54%. The relative coverage of catch in the shallow-water flatfish category was estimated at 0%–14% during the three-year period.

[1] Note that the total catch data referenced is from the NMFS catch accounting system, and the observer data is from the NMFS observer database. The observer data includes both sampled and unsampled hauls when an observer is onboard, as the data request attempts to determine the percent observed catch whenever an observer is onboard a vessel. High variability in percent observed catch among years has been correlated to several factors, such as the varying season lengths, number of participating vessels, different catch rates per year, weather, and market prices.
[2] In 2004, some catch is also attributed to the ≥125' fleet, whose effective rate of coverage was 64%.

Catch Accounting

Data from observed vessels are 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 exist to be able to use one of the three sector rates. If one of the four different types of "three week average" sector rates does 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 yearly 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 monitoring 100% of the hauls on all vessel sizes, it is repeatable and uses the best available information and approach (NMFS, AKR, Mary Furuness, pers. comm.).

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% to 81%, while Tanner crab mortality estimates from trawl gear range similarly from 12% to 82%. Some directed fishery information on mortality rates in the North Pacific are summarized below. Additional information on gear specific crab bycatch ranges can be found in the Crab Bycatch Chapter of the annual SAFE report for the BSAI Crab Fisheries (NPFMC 2007).

Recent analysis to re-evaluate appropriate biological parameters in establishing new overfishing definitions for BSAI crab stocks have employed 50% handling mortality rates for snow crabs, 20% for king crab, and 20% for Tanner crabs in the directed crab fisheries (NPFMC 2007). A range of rates have previously been considered for the directed crab species [by species and study]. 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). 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, pers. comm.). Discard mortality rates for red king crab have been estimated at 37% for longline fisheries and 8% for pot fisheries (NPFMC 1999). Gear-specific bycatch mortality rates are employed annually in the annual Crab SAFE report (NPFMC 2007) to summarize mortality by the directed crab and other fisheries and use the following for groundfish trawl, fixed gear, and scallop dredge gear mortality: 80%(trawl), 20% (fixed) and 40% (dredge). Species specific rates for the directed crab fisheries use the following: 24% for *C. opilio*, 20% for *C. bairdi*, and 8% for blue king crab and red king crab. Additional discussion of the these rates both for directed crab fisheries as well as incidentally-caught crab in other fisheries is likely to occur at the spring Crab Plan Team meeting in conjunction with implementation progress on revised Crab OFLs.

Salmon mortality rates are also highly variable, both by gear type and for different size salmon. 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% (Alverson et al. 1994). 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. Figures 1 through 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) 3-nautical mile (nm) 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-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 (0–3 nm) 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 groundfish fisheries off Alaska as it pertains to the GOA 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 four species combined. Over 95% of the 'other' salmon bycatch consists of chum salmon (Table 1). The bycatch of 'other' salmon in the last 3 years (average of 5,067 salmon, 2004–2007) is much lower than the time series average (average of 15,452 salmon, 1990–2007). Bycatch of Chinook salmon in the last 3 years (average of 27,195 salmon, 2004–2007) is higher than the time series average (average of 21,488 salmon, 1990–2007).

'Other' salmon bycatch declined substantially from the 1993-1995 period. Bycatch of 'other' salmon in the GOA groundfish trawl fisheries from 1993–1995 is shown in Table 2. Bycatch was typically highest in the month of July, reaching a peak of 48,518 salmon in 1998. 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 change, the 'other' salmon bycatch has been far less than the 1995 peak. Since 1995, the highest annual amount of 'other' salmon bycatch was 13,539 in 1998, with amounts decreasing to 3,487 in 2007. In more recent years, a maximum of 4,224 fish was reached in July (in 2005) and dropped to 605 in 2007 (Table 3). 'Other' salmon bycatch increased in 2003 to 10,362, but declined again in 2004 to 5,816, and has remained lower than 10,000 in the last 4 years.

Bycatch of Chinook salmon also fluctuates in the pollock fishery. In recent years the numbers of Chinook have increased from 15,506 in 2003, to over 40,000 in 2007. Bycatch is highest in February and March, with the greatest increase seen in March 2007, with over 28,654 estimated (Table 4). Additionally, Chinook bycatch is higher in October, with a range of 2,339 to 10,529 fish caught in the last three years.

In the 2003–2007 trawl fisheries, an average of about 11,000 Chinook salmon per year were taken by the walleye pollock pelagic trawl fishery; followed by 7,800 in the non-pelagic trawl fishery; 1,110 Chinook salmon in the Pacific cod fishery; 3,900 Chinook salmon in the flatfish fishery (all targets combined); and almost 1,000 Chinook salmon in rockfish target fisheries (Table 5). In an average year, the walleye pollock fishery accounted for 75% of the Chinook salmon bycatch, with the trawl fisheries targeting Pacific cod taking 4%, and flatfish fisheries taking 15%.

About 1,900 'other' salmon were taken in the walleye pollock fishery, on average, during the 2003–2007 fisheries (Table 6). In 2004, bycatch of 'other' salmon in this fishery was drastically reduced to 594 (in

2004), although the annual bycatch numbers show an increase to 1,417 and 817 in 2006 and 2007, respectively (Table 6). Out of the average 5 years more of the 'other' salmon bycatch has been taken in the flatfish fishery (44%) followed by the walleye pollock trawl fishery (30%), with the rockfish (26%) also taking a substantial proportion. 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.

Location and Timing of Bycatch

The timing of salmon bycatch follows a predictable pattern in most years. The average of 2003–2006 is shown as an example of the timing of bycatch in GOA groundfish fisheries (Figure 5). Chinook salmon were taken regularly from the start of the trawl fisheries on January 20 through early April, and also in high quantities during June/July and September/October in the walleye pollock fishery. 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 6). The timing of salmon bycatch in 2007 appears similar to what occurred in previous years. Recall that 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 (some over 200 salmon per haul from extrapolations), although they can be taken in relatively high numbers per haul in other areas (Figure 7). During the 2000–2002 period, 'other' salmon were taken in relatively low numbers along the shelf (Figure 8). Spatial information for recent years has not yet been investigated. Should the Council move forward with an analysis of GOA bycatch measures, updated spatial analysis will be done to better evaluate appropriate measures and candidate fisheries and areas for further management actions.

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 7). 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 each bycaught salmon. While some bycatch sampling studies have been conducted for the Bering Sea salmon bycatch in the 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 2006, 63 tags were recovered in the eastern Bering Sea and GOA (Celewycz et al. 2006). Of these 63 new CWT recoveries, 8 CWT Chinook salmon were recovered from the Gulf of Alaska trawl fishery in 2006 and 2007, 8 CWT Chinook salmon were recovered from the Bering Sea-Aleutian Islands trawl fishery in 2006 and 2007, 44 CWT Chinook salmon were recovered from the Pacific hake trawl fishery in the North Pacific Ocean off WA/OR/CA in 2006, and 3 CWT steelhead were also recovered from Japanese gillnet research in the central North Pacific Ocean. 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.

Allozyme methodology 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 by evaluating DNA variation, specifically single nucleotide polymorphisms (SNPs). Results, as they pertain to GOA trawl samples, have not yet been highlighted as the most recent focus for updated information and sampling has been on the Bering Sea pollock fishery. Additional information on stock of origin results for the Bering Sea pollock fishery in recent years will be presented at this meeting. The intent to replicate sampling and research in the GOA trawl fisheries is not yet clear.

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 ADFG. For purposes of evaluating the relative amount of bycatch as compared to the commercial catch of salmon by area, Table 8 and Table 9 show the commercial catch of Chinook and chum species by management area between 2004 and 2007. 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 this limitation, some limited information regarding the health of the resource can be obtained by reviewing the commercial catch. Should the Council move forward with an analysis of salmon bycatch measures in the GOA, data and information on run sizes, and management by river system will be compiled as well as an approximation made to the relative impact of bycatch in groundfish fisheries on individual river systems. A similar analysis is currently underway for the BSAI (Bering Sea Salmon Bycatch Management EIS). To date no analysis has been initiated by the Council in the GOA, thus commercial catch information only is summarized below to provide some indication of stock status in the GOA.

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 2007 harvest was below the projected harvest and the 7th largest since 1985. Cook Inlet harvests were low compared to long term averages as well. For Kodiak, the 2004 harvest was much higher than the previous 10-year average (Eggers 2006), with lower catches in 2007 compared to the long term average. 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 2006). The harvest of Chinook was approximately equal to the previous two years' harvests (under the cooperative management plan) and roughly half of the 10- and 20-year averages. South Alaska Peninsula Chinook harvest in 2007 was less than the 10-year average.

For chum salmon, the statewide harvest of 17.3 million fish ranks within the top 10 harvests of all time, with an exvessel value of $39.5 million, compared to the most recent 10-year average of $32 million. (ADFG 2007). Not all areas experienced increases in harvests amounts (or value) in recent years, however 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 2006). 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 2006). 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 10-year average. Overall escapement for Kodiak met the escapement objective but was slightly below the 10-year average. Limited aerial surveys led to incomplete escapement estimation for some systems (Eggers 2006). 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 numbers of crabs taken as bycatch in GOA groundfish trawl fisheries are shown in Table 10. Bycatch of red king crabs is relatively low. An average of 256 red king crabs were taken in 2004–2007 trawl fisheries.

Since 2003, 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 2003 occurred in 2006 fishery, with 345 red king crabs caught, all were from the shallow water flatfish trawl fishery. Previous to that high bycatch was recorded in the rockfish fishery in 2004 with 275 crabs (Table 11).

The bycatch of *C. bairdi* Tanner crabs in GOA trawl fisheries has fluctuated through the time series, reaching a high of 306,767 crabs in 2006, to a low of 29,947 crabs in 1999. Bycatch of *C. bairdi* Tanner crabs in the last 4 years (167,145 crabs per year average, 2004–2007) is higher than the average for the time series from

1993–2004 (108,540 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 trawl fisheries has fluctuated through the time series, from a low of fewer than 35,000 crabs in 1994, to a high of over 300,000 crabs in 2007 (Figure 9).

During these years, the highest total bycatch of Tanner crabs occurred in 2007, where particularly elevated bycatch in the pot sector was observed (Figure 10). 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 (Table 12). The average percent contribution by gear type in 2007 for C. bairdi Tanner crab are: 40% for combined trawl fisheries, 60% for pot fisheries and <0.01% for all longline fisheries (Table 12). This is in contrast to the average from 2003–2007, where the trawl fisheries accounted for 60% of the bycatch and pot fisheries 39%. Bycatch of C. bairdi Tanner crabs in the Pacific cod pot fishery was notably higher from 2005–2007, than the estimates from 2003 and 2004. Further examination of the location of the pot cod fishery (and flatfish trawl fishery) may possibly provide an explanation for the relative decrease in crab bycatch in the pot cod fishery and increase in the flatfish trawl fishery. The relative observer coverage in these fleets is notably limited, particularly in the Pacific cod pot fishery. This will be an important aspect for examination in the forthcoming analysis.

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. Average bycatch of Tanner crabs between 2003 and 2006 (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 11), 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 2006 was highest (in numbers of crab) during late 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 12).

Bycatch in longline and pot fisheries

Bycatch of red king crab and *C. bairdi* Tanner crab, by gear and fishery, for 2003–2007, are shown in Table 11 and Table 12. Longline gear catches very few crabs of any species.

For red king crab, the average number of crabs taken in all fisheries for 2003–2007, is 200. Of this, 83% were in the trawl fishery, 3% 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 2005-2007. 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.

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 13). 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 district, data were obtained for observed trips in 1997–1999 and 2001. In the South Peninsula district, data were obtained in 1998–2002, 2004–2006 and in Chignik in 2003 only. Of these years, 2001 in Kodiak District showed the highest number of Tanner crab with 171. It was noted by ADF&G that this was obtained in only one observed trip. In the South Peninsula region, the highest number of Tanner crab was obtained in 2001, where 52 crab were caught, and 25 in 2006, as compared with 0 to 1 in all other years for which data were obtained for this region. 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. ADFG staff had noted that, due to rising concerns regarding the limited available observed pots, increased effort would be made to observe more trips in future fisheries. Unfortunately, the short and intense season in 2007, made it very difficult for ADFG staff to allocate a dockside sampler for an observer trip, thus, only one new observer trip was possible last year (Kally Spalinger, pers. comm.).

Overview of Crab Management and Stock Status

Crab fisheries in the GOA are managed by the State of Alaska, under a Federal FMP. 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 ADFG. The survey methodology is designed to concentrate sampling in areas of historical king and Tanner crab abundance (Figure 13).

Red King Crab

Major red king crab fisheries have occurred historically in the Kodiak and Alaska Peninsula Areas. Stock size is estimated by an annual trawl survey, and fisheries are opened only if biomass estimates meet or exceed threshold levels established by the State. The Kodiak area red king crab population remains at historically low levels (Mattes and Spalinger 2007). Fishing seasons for Kodiak red king crabs have remained closed since the 1982/1983 season.

Results from the 2006 Kodiak trawl survey estimated the red king crab population at 215,976 animals (up from 113,710 crabs in 2005, but down from 369,779 in 2004). The majority of the crabs were found in the Southwest and Shelikof districts (Spalinger, In prep.). The mature red king crab female population was estimated to be 74,259 animals, well below the 5.1 million threshold required for a fishery opening (Mattes and Spalinger, 2007) Population estimates for Kodiak, based on 1994–2004 ADFG trawl surveys, are shown in Figure 14.

Results from the 2006 Alaska Peninsula survey indicated that the red king crab population there remains at very low levels. The estimated population from the survey was 34,178 crabs, an increase from the estimated 31,102 from the 2005 survey (Spalinger, In prep.). 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 1982/1983 season. Population estimates for the Alaska Peninsula based on 1994–2004 ADFG trawl surveys are shown in Figure 15.

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 populations 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).

Tanner Crab

Commercial fishing for *C. bairdi* in 2007 occurred in areas of the Eastside and Northeast sections of the Kodiak District and the Western section of South Peninsula District. GHLs by region were the following in 2007: Kodiak (Eastside and Northeast sections combined) 800,000 pounds and South Peninsula 200,000 pounds. For 2008 (fishery begins January 15, 2008), the GHLs will be: Kodiak District 500,000 pounds and South Peninsula 250,000 pounds.

For *C. bairdi* Tanner crab, 2006 population estimates for the Kodiak District are at approximately 165 million crabs, for South Peninsula 77.3 million crabs, and Chignik 42 million crabs (Spalinger 2006). Population estimates for Kodiak and the South Peninsula District based on 1994–2006 ADFG trawl surveys are shown in Figures 16 and 17. For the South Peninsula this estimate represents an increase from the previous survey. Recent survey results indicate an increase in females from 2006–2007 (Spalinger 2007).

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 are 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)

Recent comparisons of survey abundance estimates with crab bycatch areas has not yet been analyzed. Should an analysis be initiated to evaluate bycatch reduction measures for crab and salmon species in the GOA, spatial analysis will be done utilizing the most current fishery and survey data. However, previous evaluations may be useful for discussion purposes of specific geographic regions with high bycatch by species. Evaluations done previously comparing 2002 fishery data with survey abundance estimates for the same year are summarized below.

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 (Figure 18). 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 (Figure 18). 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 (Figure 19). 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 was 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 2006).

Discussion

In February 2002, the Council initiated an 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 under that proposed action, 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. Analysis of those specified limits did not go forward, but instead the Council elected to continue evaluating salmon and crab bycatch to investigate whether these or other measures would be appropriate.

Draft Alternatives as modified by the Council in June 2005

Draft bycatch reduction alternatives have been incrementally refined by the Council since first drafted in December 2003. The alternatives had been folded into the larger GOA groundfish rationalization EIS package for analysis, however based on Council discussion in October 2007, the analysis may occur on a separate tract. Providing the additional information 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:

<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 co-op 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 co-op 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 co-op for hotspot management.

Red King Crab

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 co-op 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 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 through 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 Figures 1 and 3.

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 (e.g., an exemption to the area closures was granted under Amendment 84, provided participants are enrolled in a voluntary rolling hot spot (VRHS) system). The existing regulatory measures in the BSAI are closures areas, 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 14 through October 14 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). Since implementation of Amendment 84, the Council has been considering alternative means to reduce salmon bycatch, as bycatch of Chinook in recent years in the BSAI has exceeded historical highs, while the bycatch of chum salmon reached a historical high in 2005 and has since declined. The Council is currently considering measures such as hard caps on the pollock fishery, the attainment of which would close directed fishing for pollock by the fleet, and revised time and area closures based upon recent data. Given that the Council is currently revising bycatch reduction measures for salmon in the BSAI, any measures evaluated for bycatch reduction in the GOA should consider and build upon lessons learned in the BSAI. Some of the issues in the BSAI that are being raised in conjunction with evaluating hard caps on the pollock fisheries are sector-specific observer requirements in order for these limits to be appropriately maintained. As discussed earlier in this paper, observer coverage in the GOA is much more limited than in the BSAI, thus any measures under discussion would need to likewise consider the management and monitoring issues which are raised accordingly.

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). This system relies upon information voluntarily reported to Sea State by the fleet per their cooperative agreements.

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 co-op alternative include provisions for: allocation, monitoring and compliance of the PSC caps amongst the catcher vessel fleet; establishment of penalties for co-ops 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. 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.

Action by the Council

When the Council next addresses this issue (scheduled for June 2008), they 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.

The following items are put forward for discussion purposes as items in need of clarification when the Council next addresses this issue:

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?
   b. Should hard caps also be included for salmon species by fishery in the GOA per consideration of these measures in the BSAI?
   c. Management and monitoring concerns raised by relative observer coverage for the GOA.
3) Next steps for Council review:
   a. Staff could prepare “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 initiate an analysis for GOA bycatch reduction measures?

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Appendix A:

Council Motion on GOA Salmon and Crab Bycatch Measures June 2005
(as part of 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 ADFG 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.

Table 1. Bycatch of Pacific salmon in Gulf of Alaska groundfish trawl fisheries, by species, 1990-2007

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			
1999	30,600	7,529			
2000	26,705	10,996			
2001	14,946	5,995			
2002	12,921	3,218[a]			
2003	15,506	10,362[a]			
2004	17,919	5,816[a]			
2005	31,573	6,694[a]			
2006	19,158	4,273[a]			
2007	40,130	3,487[a]			
1990–2007 Avg.	21,488	15,452[b]			
2004–2007 Avg.	27,195	5,067[b]			

[a] Coho, sockeye, and pink salmon are combined with chum salmon.
[b] Average chum salmon bycatch includes chum, coho, sockeye, and pink salmon.
Source: NMFS catch reports (website)

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

Month	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. 'Other' salmon bycatch by month, 1996-2007, in GOA groundfish trawl fisheries

Month	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
January	132	-	105	291	145	43	1	0	5	-	-	-
February	167	60	201	3,990	502	298	67	255	18	-	117	0
March	422	65	220	72	387	888	56	161	7	-	13	38
April	557	40	149	338	632	213	4	228	774	163	239	-
May	5	4	-	22	780	388	123	261	23	25	-	152
June	2,075	672	8,652	429	44	433	1,489	-	2,942	-	-	244
July	439	543	603	553	797	1,326	548	2,715	848	4,224	2,362	605
August	17	20	742	1,033	3,671	141	193	5,931	578	1,411	130	1,305
September	232	1,288	2,354	595	2,116	967	697	42	377	547	350	493
October	112	73	518	206	1,851	1,362	41	770	244	236	1,047	463
November	17	249	-	-	53	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-	-	-	-	-

Data has been screened for confidentiality. Source: M. Furuness, J. Keaton, NOAA Fisheries, 1996-2002 (from blend database) 2003-2007 (from catch accounting database).

Table 4. Chinook salmon bycatch by month, 1996-2007, in GOA groundfish trawl fisheries

Month	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
January	1,454	1,528	1,120	3,776	3,181	829	1,093	1,187	300	961	1,955	167
February	3,537	3,501	1,022	7,427	2,813	4,875	3,226	2,316	3,791	10,674	1,855	1,532
March	1,842	1,732	944	634	3,052	3,287	2,275	1,069	3,820	7,348	4,693	28,654
April	1,853	852	676	1,649	2,472	1,161	1,482	3,057	629	451	1,450	234
May	15	5	1	68	1,375	1,381	326	2,608	33	60	10	1,532
June	383	292	2,330	332	1	22	1,278	-	33	-	-	1,149
July	392	2,372	251	361	1,293	536	224	938	1,033	461	291	713
August	68	42	337	352	6,117	149	372	1,242	1,519	121	13	260
September	6,038	4,450	6,176	5,649	4,048	625	2,412	470	1,644	961	4,966	2,214
October	120	235	4,126	10,352	2,177	2,156	233	2,619	5,119	10,529	3,787	3,859
November	62	221	-	-	173	-	-	-	-	-	138	45
December	-	-	-	-	-	-	-	-	-	-	-	-

Data has been screened for confidentiality. Source: M. Furuness, J. Keaton, NOAA Fisheries, 1996-2002 (from blend database) 2003-2007 (from catch accounting database).

Table 5. Bycatch of Chinook salmon in Gulf of Alaska groundfish trawl fisheries, by target fishery, 2003-2007

Species	2003	2004	2005	2006	2007	Average 2003-2007
Arrowtooth flounder	3,378	359	1,802	414	1,462	1,483
Flathead sole	598	1,446	Conf.	56	-	700
Non pelagic pollock	895	5,302	15,032	10,187	7,661	7,815
Pacific cod	3,167	893	41	892	634	1,125
Pelagic pollock	3,605	8,039	13,176	5,873	26,847	11,508
Rex sole	2,819	498	982	1,444	Conf.	1,436
Rockfish	928	885	461	291	2,395	992
Shallow water flats	116	498	63	-	420	274

Data has been screened for confidentiality. Source: M. Furuness, J. Keaton NOAA Fisheries, from catch accounting database.

Table 6. Bycatch of 'Other' salmon in Gulf of Alaska groundfish trawl fisheries, by target fishery, 2003-2007

Species	2003	2004	2005	2006	2007	Average 2003-2007
Arrowtooth flounder	1,061	-	425	429	710	656
Deep water species	-	6	-	-	-	6
Flathead sole	-	91	-	-	-	91
Non pelagic pollock	44	152	104	592	162	211
Pacific cod	-	47	141	-	142	110
Pelagic pollock	6,156	442	689	825	750	1,772
Rex sole	479	1,053	109	conf	conf	573
Rockfish	2,603	499	3,453	1,870	827	1,850
Shallow water species	-	3,524	1,774	-	235	1,844

Data has been screened for confidentiality. Source: M. Furuness, NOAA Fisheries, from catch accounting database.

Table 7. Salmon hatchery releases by country from NPAFC for Chinook and chum salmon

Chum:

Year	Russia	Japan	Korea	Canada	US	Total
1999	278.7	1,867.90	21.50	172.0	520.8	2,860.9
2000	326.1	1,817.40	19.00	124.1	546.5	2,833.1
2001	316.0	1,831.20	5.30	75.8	493.9	2,722.2
2002*	306.8	1,851.60	10.50	155.3	507.2	2,831.4
2003*	363.2	1,840.60	14.70	137.7	496.3	4,091.5
2004	363.1	1,817.20	12.93	105.2		
2005	387.3	1,844.00	10.93	131.8		
2006	344.3	1,858.25	13.75	107.1		

Chinook:

Year	Russia	Japan	Canada	US	Total
1999	0.60	-	54.4	208.1	263.1
2000	0.50	-	53.0	209.5	263.0
2001	0.50	-	45.5	212.1	258.1
2002	0.30	-			
2003	0.74	-			

*Preliminary through November 6, 2007.

Table 8. Chinook salmon GOA commercial catch by area (1000's of fish)

Year	Southeast	PWS	Cook Inlet	Kodiak	Chignik	South Peninsula	Total
2004	497	39	29	29	3	18	615
2005	462	36	29	14	3	14	558
2006	379	32	19	20	2	13	465
2007	352	40	18	17	2	13	442

Source: ADFG (http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/catchval/blusheet/07exvesl.php)

Table 9. Chum salmon GOA commercial catch by area (1000's of fish)

Year	Southeast	PWS	Cook Inlet	Kodiak	Chignik	South Peninsula	Total
2004	11,372	2,002	352	1,122	1	810	15,659
2005	6,428	2,099	169	477	9	785	9,967
2006	13,993	2,182	137	1,082	62	1,320	18,776
2007	9,412	3,579	78	745	79	861	14,754

Source: ADFG (http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/catchval/blusheet/07exvesl.php)

Table 10. Bycatch of red king crab and Tanner crabs in Gulf of Alaska groundfish trawl fisheries, by species, 1993-2007

Year	*C. bairdi* Tanner	Red king crab
1993	55,304	1,012
1994	34,056	45
1995	47,645	223
1996	120,796	192
1997	134,782	18
1998	105,817	275
1999	29,947	232
2000	48,716	35
2001	125,882	46
2002	89,433	20
2003	142,488	60
2004	62,277	331
2005	126,905	91
2006	306,767	345
2007	197,286	0
Average 1993-2007	108,540	195
Average 2004-2007	167,145	165

Data has been screened for confidentiality. Source: M. Furuness, J. Keaton, NOAA Fisheries, 2003–2007 from catch accounting database.

Table 11. Bycatch of red king crab in Gulf of Alaska groundfish fisheries, by gear type and target fishery, 2003-2007

Gear and Target Fishery	**2003**	**2004**	**2005**	**2006**	**2007**
Hook & Line:					
Halibut	0	23	0	0	0
Pacific cod	0	0	0	0	0
Sablefish	29	0	88	0	0
Pot:					
Pacific cod	0	31	0	0	0
Non Pelagic Trawl:					
Arrowtooth	0	0	0	0	0
Arrowtooth flounder	0	0	0	0	0
Flathead sole	0	0	0	0	0
Non-pelagic pollock	0	0	0	0	0
Other species	0	0	0	0	0
Pacific cod	0	0	0	0	0
Pelagic pollock	0	0	0	0	0
Rex sole	0	0	0	0	0
Rockfish	60	275	0	0	0
Sablefish	0	0	0	0	0
Shallow water species	0	0	91	345	0
Pelagic Trawl:					
Non-pelagic pollock	0	56	0	0	0
Pacific cod	0	0	0	0	0
Pelagic pollock	0	0	0	0	0
TOTAL GOA	**89**	**385**	**179**	**345**	**0**

Data has been screened for confidentiality. Source: M. Furuness, J. Keaton, NOAA Fisheries, 2003-2007 from catch accounting database.

Table 12. Bycatch of *C. bairdi* Tanner crabs in Gulf of Alaska groundfish fisheries, by gear type and target fishery, 2003 -2007

Gear and Target Fishery	2003	2004	2005	2006	2007
Hook & Line:					
Arrowtooth	0	0	0	0	0
Cod			1,491	403	114
Halibut				138	
Sablefish	21	29	290	8	153
Non Pelagic Trawl:					
Arrowtooth	29,377	33,133	69,364	89,114	36,608
Cod	2,227	1,160	1,381	742	15,295
Flathead sole	17,484	7,514	43,957	25,885	254
other	20		Conf.		
Pollock	Conf.	474		83,598	18,801
Rex sole	33,932	9,030	4,461	73,528	45,274
Rockfish	183	1,510	1,475	957	161
Sablefish					171
Shallow water flatfish	59,153	8,789	5,942	32,533	79,167
Pelagic Trawl:					
Arrowtooth				Conf.	Conf.
Cod					280
Pollock	9	667	4	408	113
Rockfish	Conf.		Conf.		Conf.
TOTAL TRAWL	142,385	62,277	126,584	306,765	196,124
Pot:					
Cod	13,036	17,030	116,764	103,370	293,133
TOTAL GOA	**155,443**	**79,336**	**245,129**	**410,685**	**489,523**

Data has been screened for confidentiality. Source: M. Furuness, NOAA Fisheries, 2003-2007 from catch accounting database. 2007 data through 9/20/07.

Table 13. Pacific cod observer data, crab bycatch numbers, observed vessels only

Area	Year	Observed Trips	Pots Liftted	Tanner crab	King crab	Cod Catch Whole pounds	Cod Catch Metric tons	Tanner (mt)	King (mt)
Chignik	2003	1	268	42	0	28,297	12.84	3.27	0.00
Kodiak	1997	1	333	11	0	36,432	16.53	0.67	0.00
	1998	1	261	4	9	20,418	9.26	0.43	0.97
	1999	3	1,006	48	0	69,257	31.42	1.53	0.00
	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
	1999	1	240	0	0	40,952	18.58	0.00	0.00
	2000	2	419	0	0	126,908	57.57	0.00	0.00
	2001	2	619	52	0	130,771	59.32	0.88	0.00
	2002	1	58	1	0	10,248	4.65	0.22	0.00
	2004	1	30	1	0	13,099	5.94	0.17	0.00
	2005	1	76	0	0	13,554	6.15	0.00	0.00
	2006	2	433	25	0	94,827	43.01	0.58	0.00

Source: ADF&G K, Spalinger.

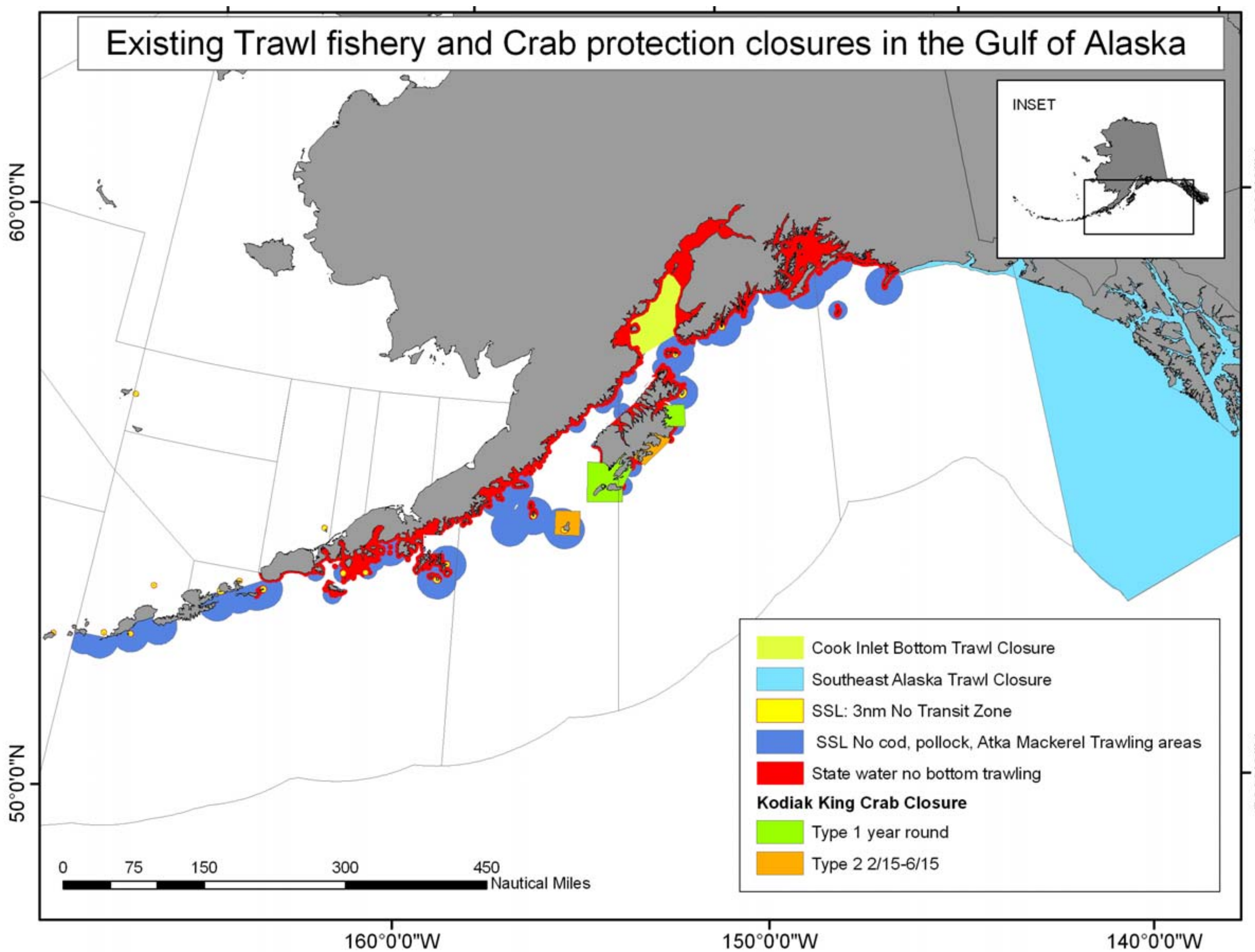

Figure 1. Locations of existing trawl fishery and crab protection closures in the Gulf of Alaska

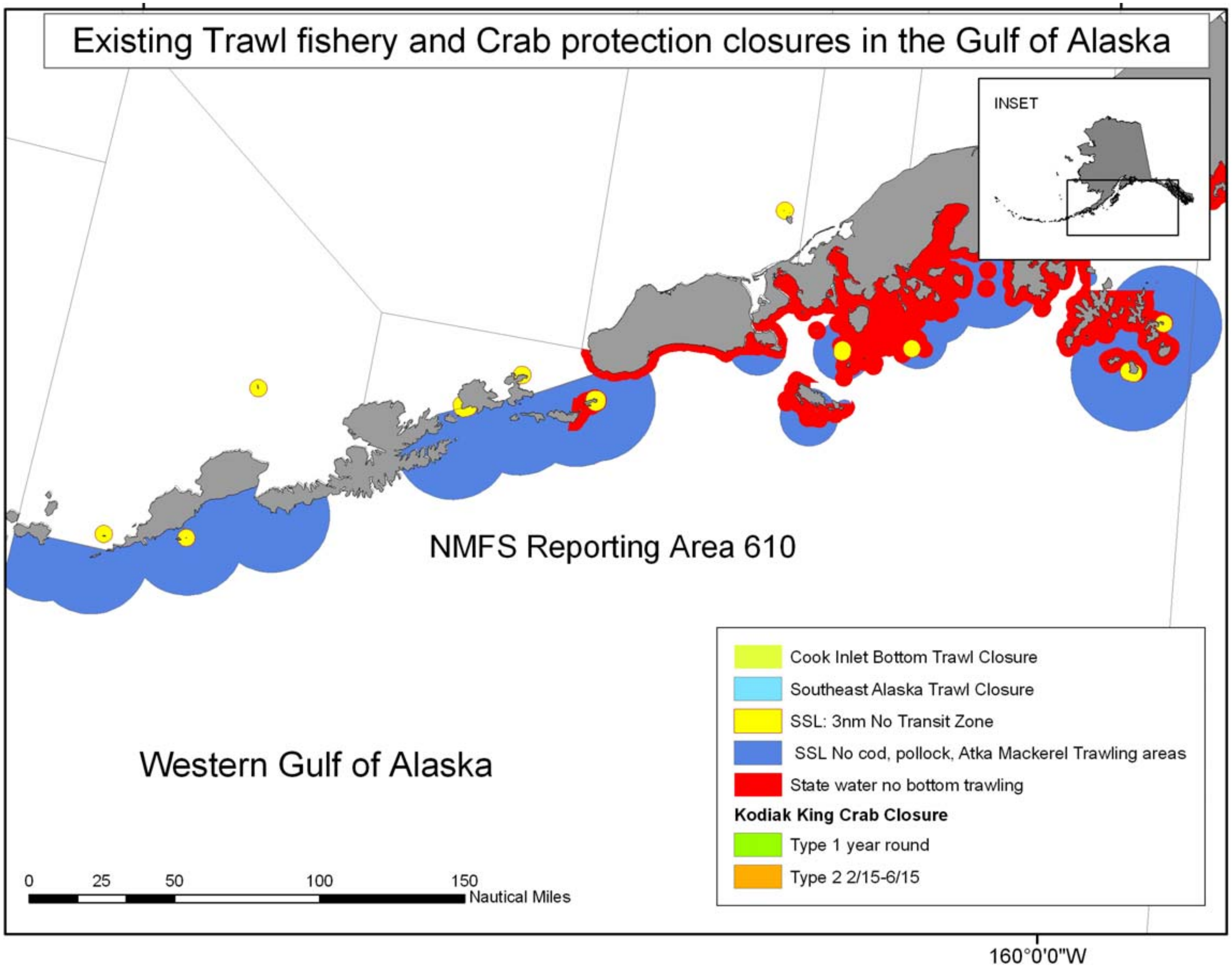

Figure 2. Locations of existing trawl fishery and crab protection closures in the Western Gulf of Alaska

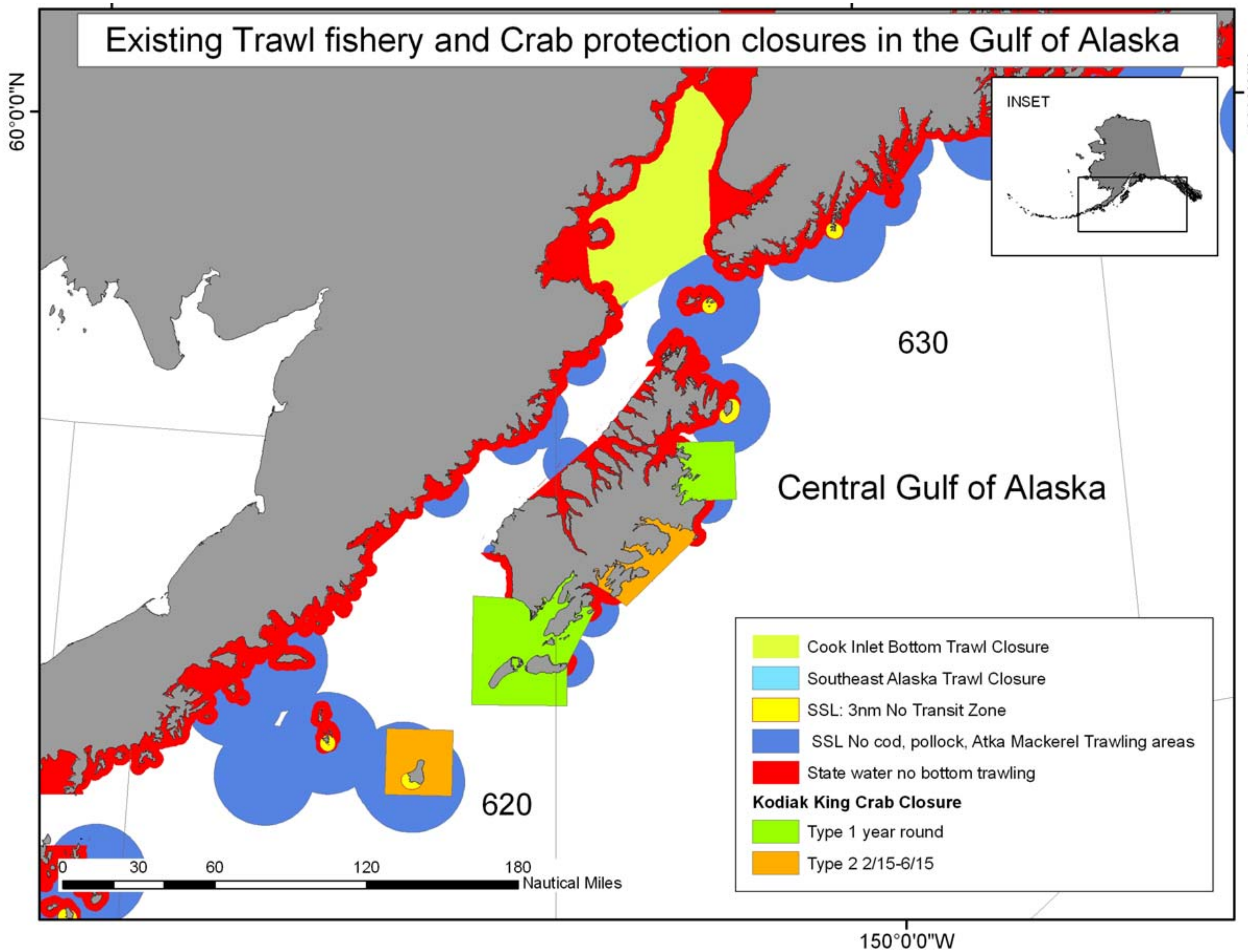

Figure 3. Locations of existing trawl fishery and crab protection closures in the Central Gulf of Alaska

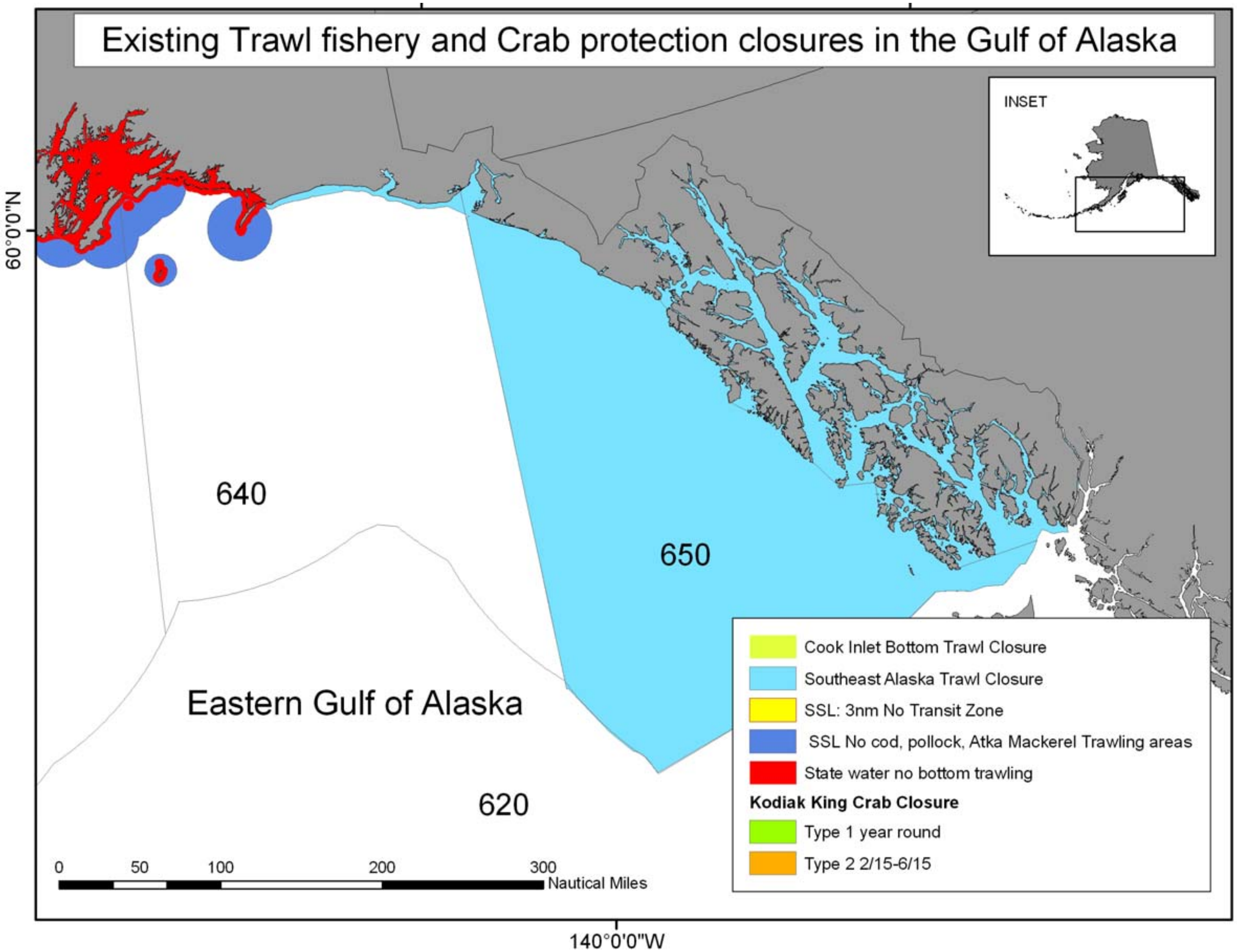

Figure 4. Locations of existing trawl fishery and crab protection closures in the Eastern Gulf of Alaska

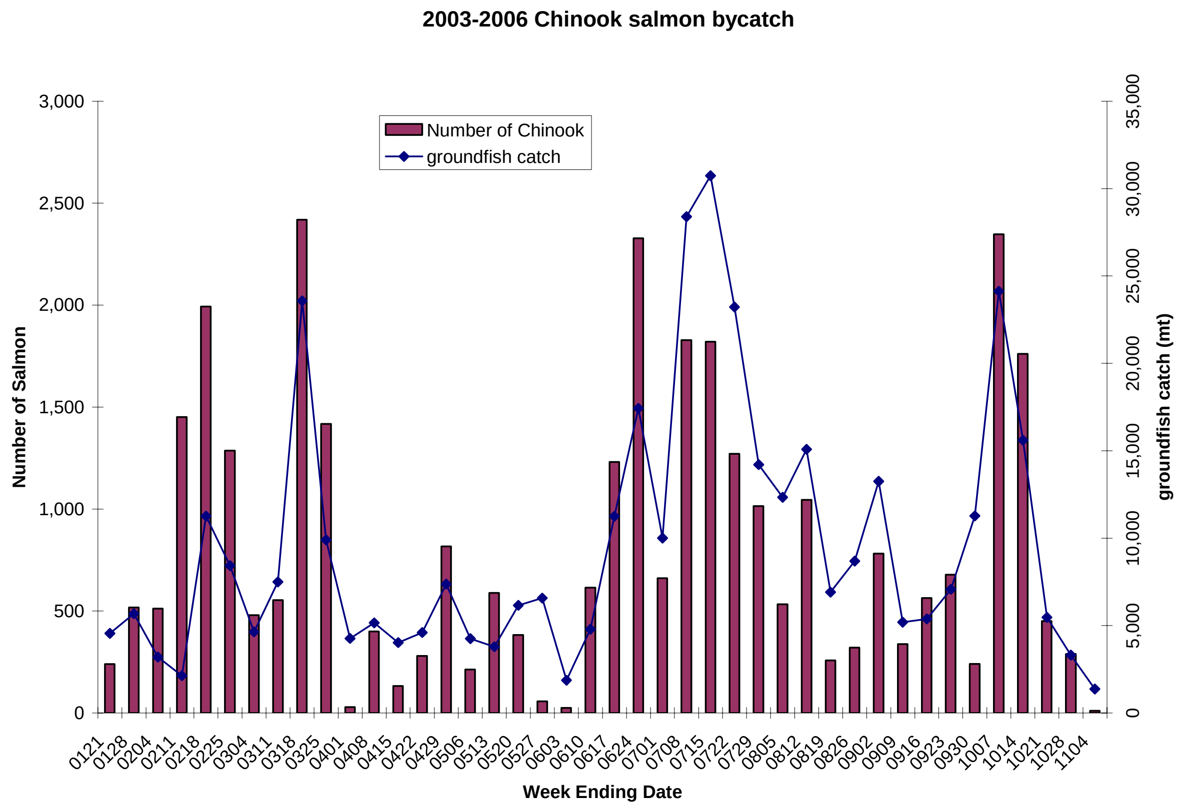

Figure 5. Chinook salmon bycatch rates within the groundfish fisheries by groundfish catch (mt) by week, 2003-2006

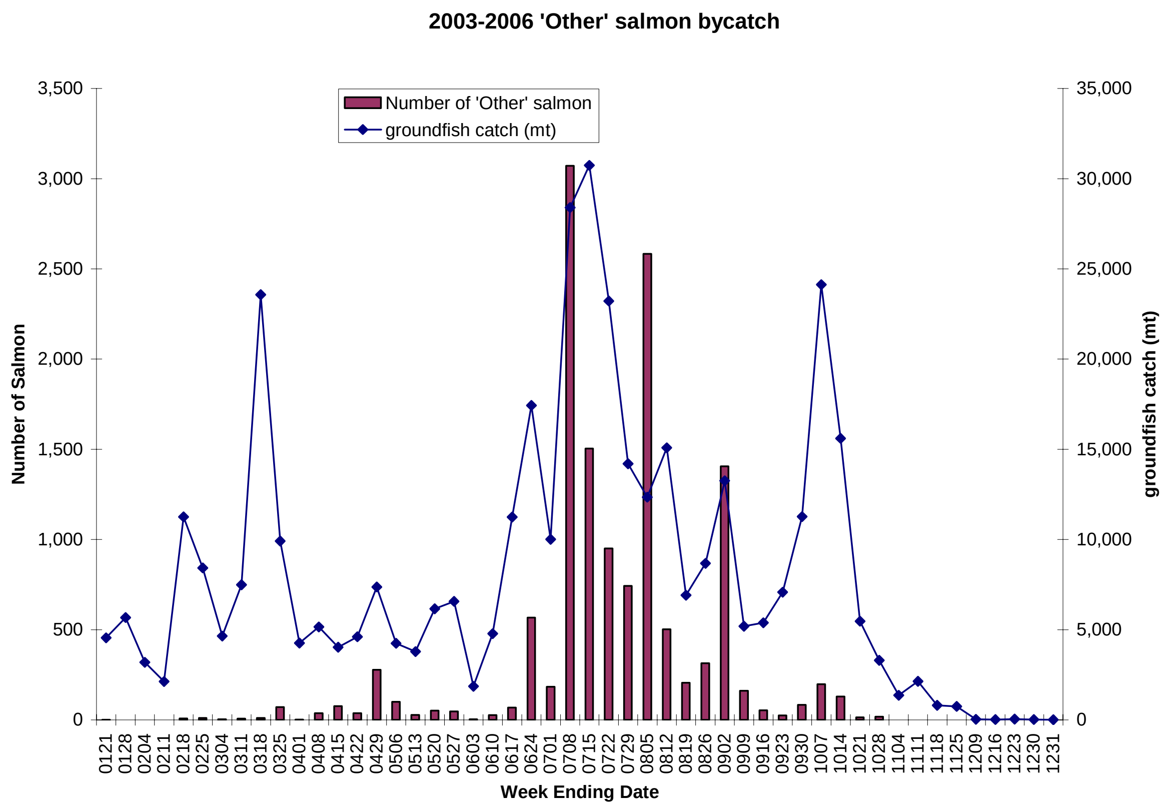

Figure 6. Other Salmon bycatch rates within the groundfish fisheries by groundfish catch (mt) by week, 2003-2006

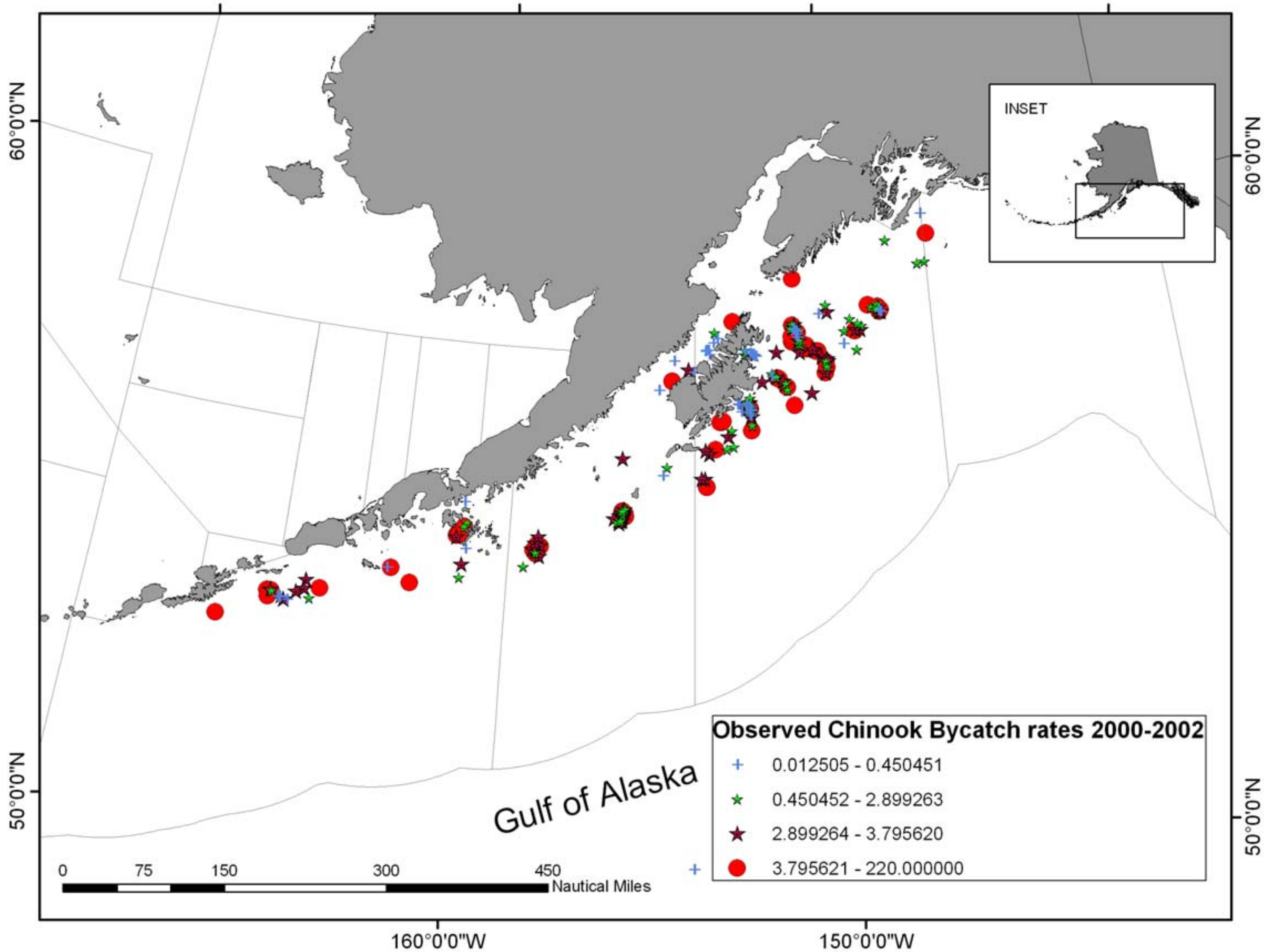

Figure 7. Locations of observed Chinook bycatch (#/mt) in all groundfish fisheries, 2000-2002

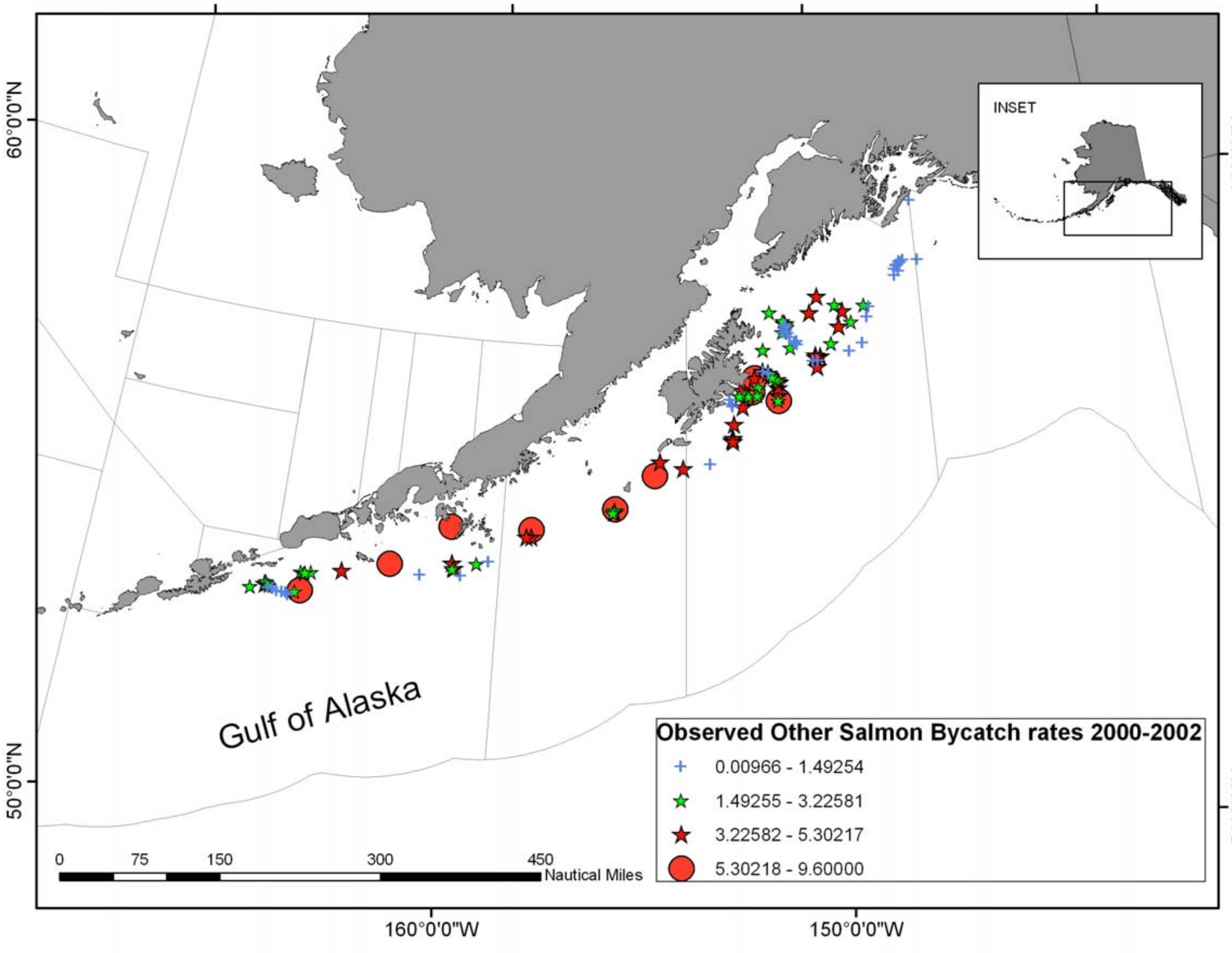

Figure 8. Locations of observed 'Other Salmon' bycatch (#/mt) in all groundfish fisheries, 2000-2002

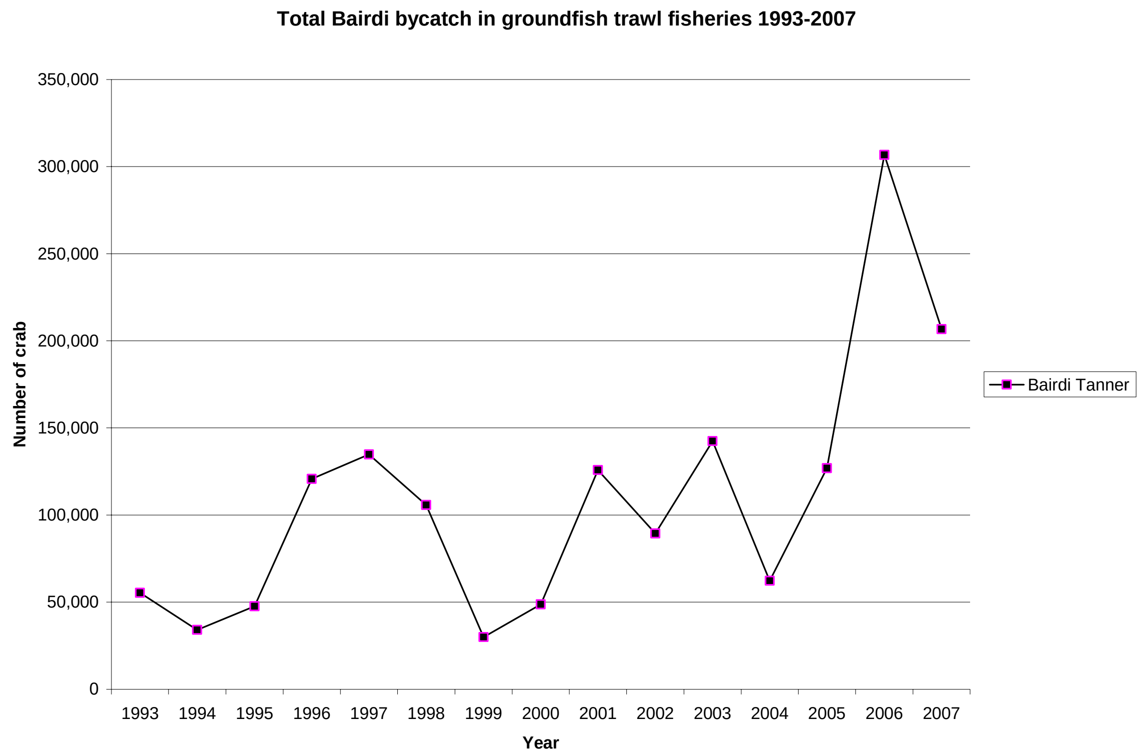

Figure 9. Total bycatch of C. bairdi Tanner crabs in all GOA groundfish trawl fisheries 1993-2007

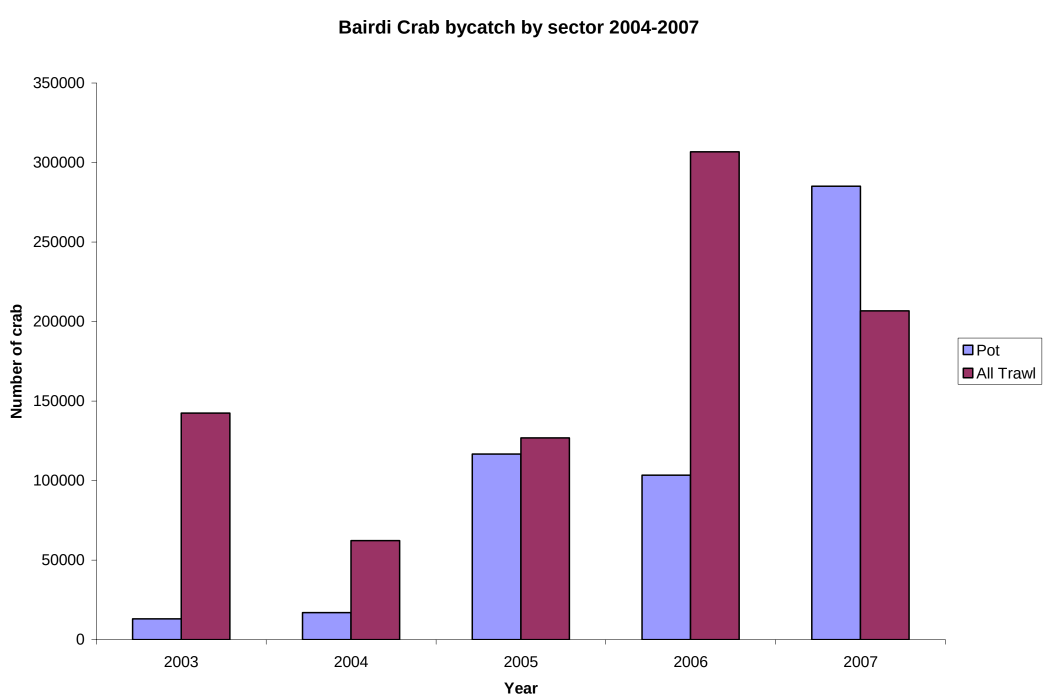

Figure 10. Overall annual bycatch of C. bairdi Tanner crab by trawl and pot fishery sectors (2004-2007)

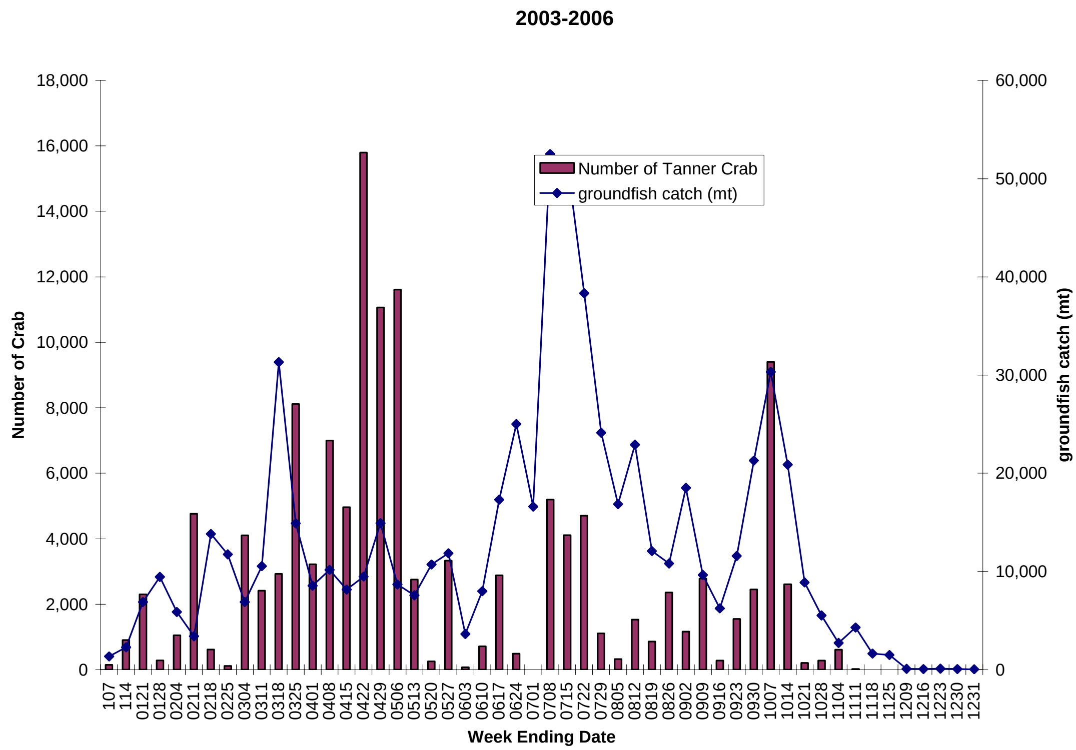

Figure 11. Bycatch of C. bairdi Tanner crab and associated groundfish catch in 2003-2006

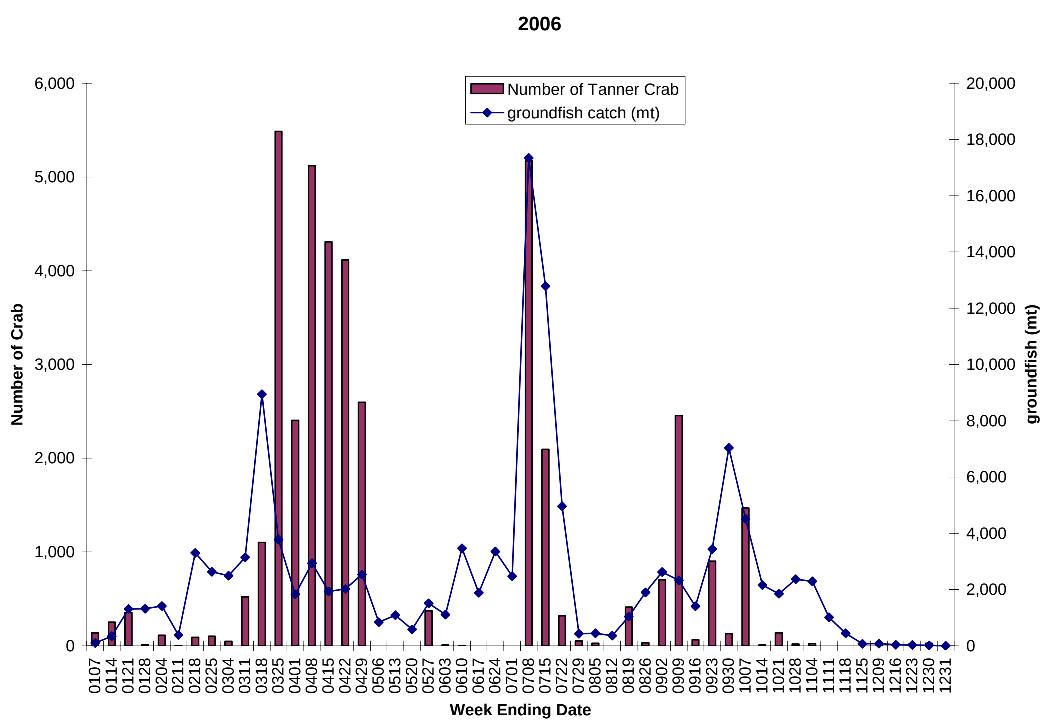

Figure 12. Bycatch of C. bairdi Tanner crab and associated groundfish catch in 2006

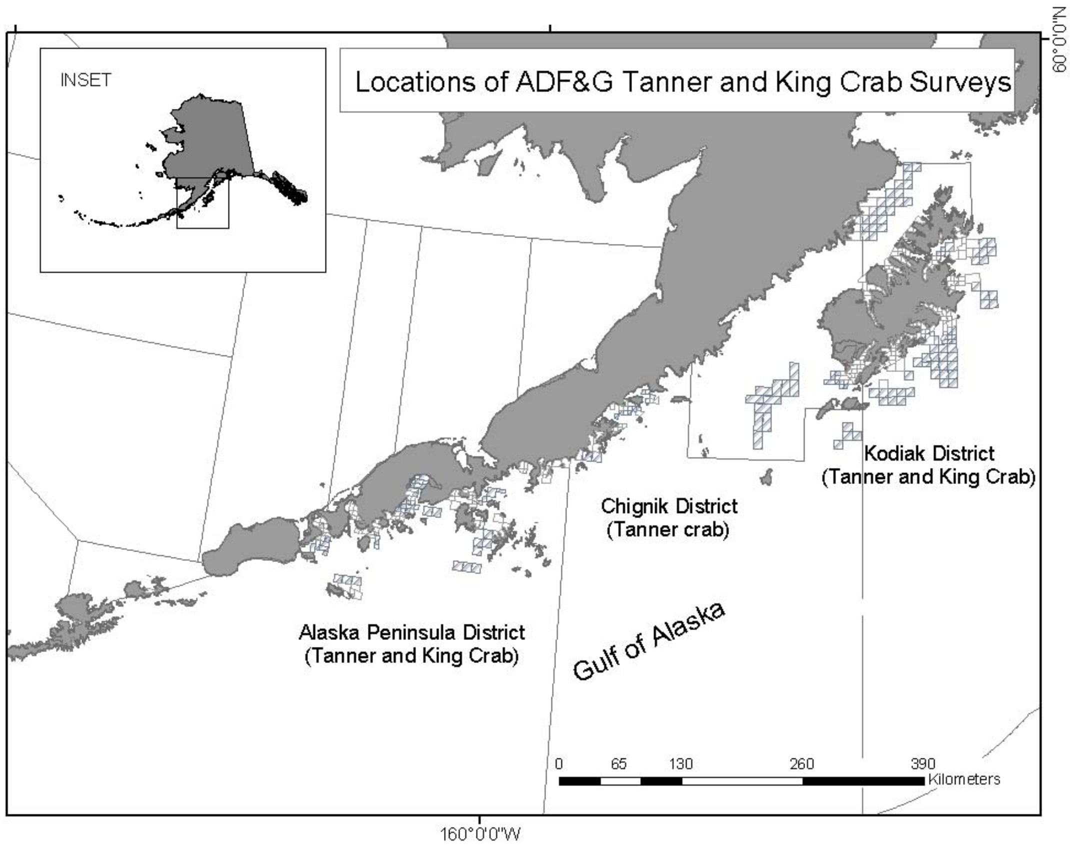

Figure 13. Locations of ADF&G trawl surveys for Tanner and king crab abundance.

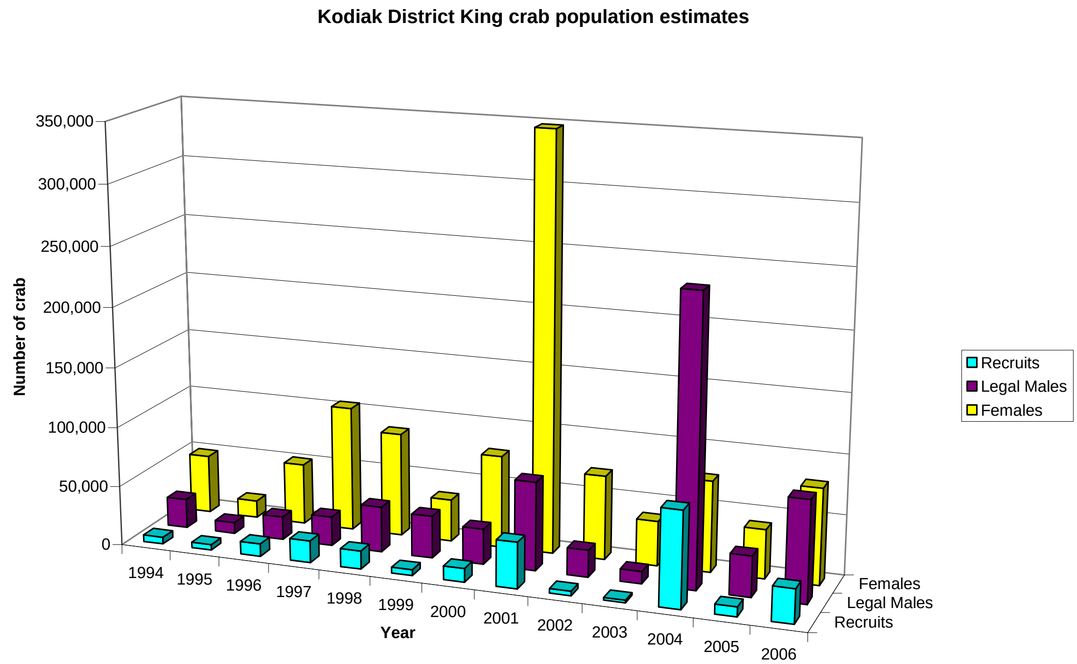

Figure 14. Red king crab population estimates Kodiak District based on ADF&G trawl surveys 1994-2006. Source: ADF&G K, Spalinger.

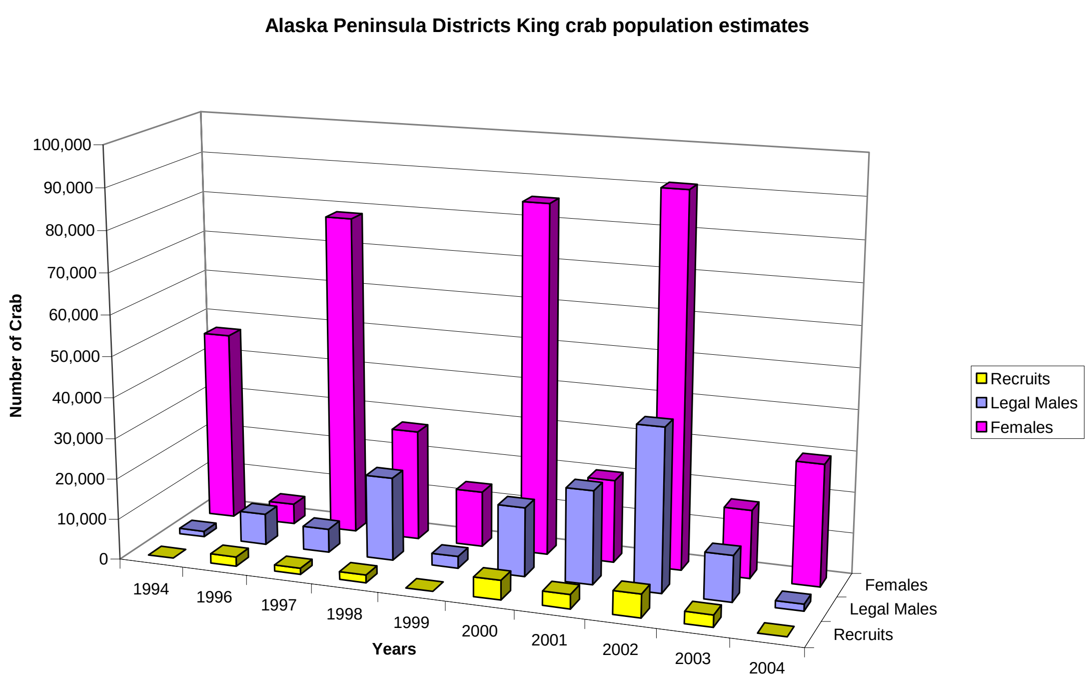

Figure 15. Red king crab population estimates for Alaska Peninsula based on ADF&G trawl surveys 1994-2004.

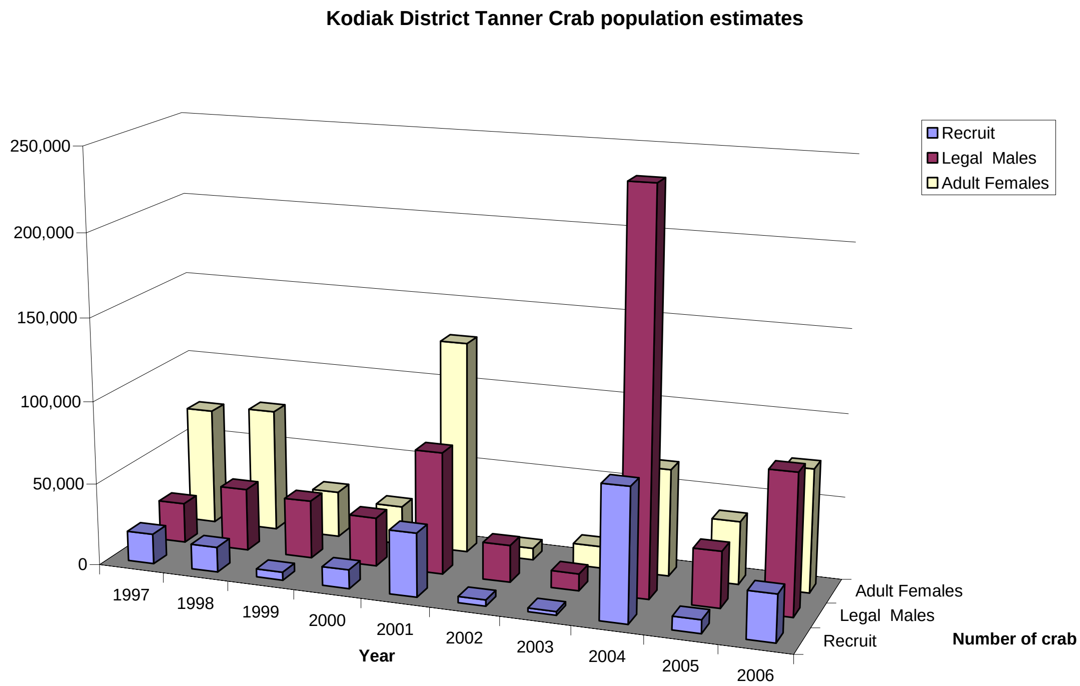

Figure 16. *C. bairdi* Tanner crab population estimates for Kodiak District based on ADF&G trawl surveys 1997-2006.

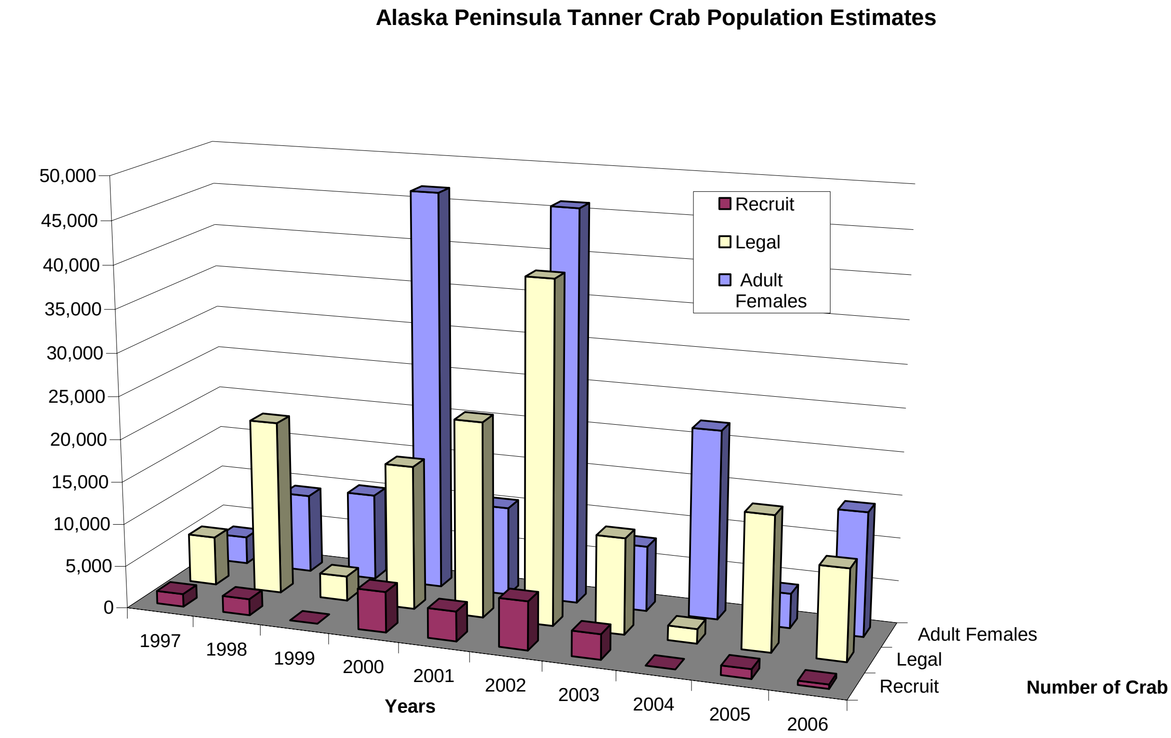

Figure 17. *C. bairdi* Tanner crab population estimates for Alaska Peninsula District based on ADF&G trawl surveys 1997-2006.

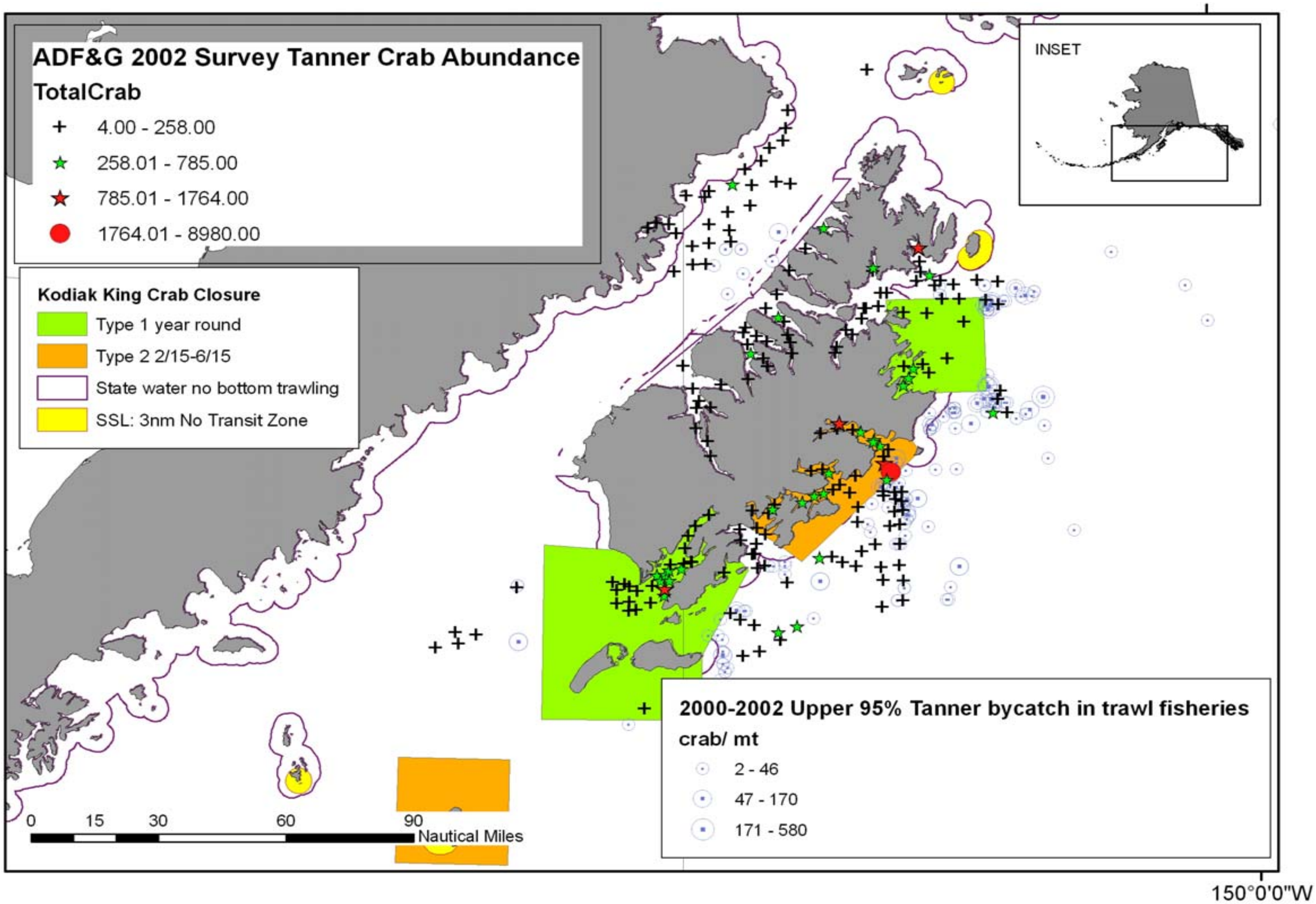

Figure 18. Locations of observed Tanner crab bycatch (#/mt) in all groundfish trawl fisheries, 2000-2002 and ADF&G Tanner Crab Abundance estimates from 2002 survey.

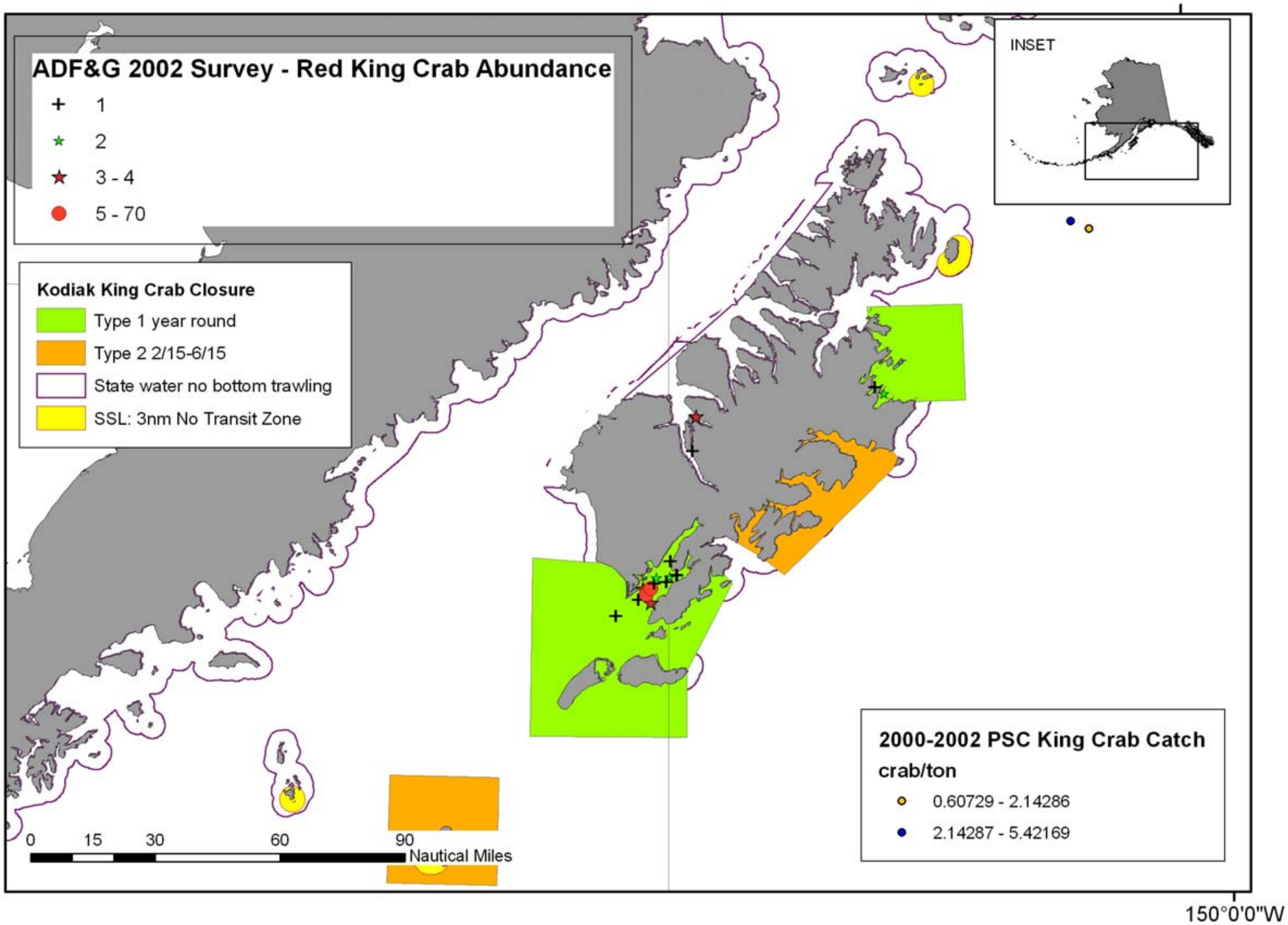

Figure 19. Locations of observed Red King crab bycatch (#/mt) in all groundfish trawl fisheries, 2000-2002 and ADF&G Red King crab Abundance estimates from 2002 survey.