Chinook Salmon and *Chinoecetes Bairdi* Crab Bycatch in Gulf of Alaska Groundfish Fisheries

September 2009

Staff Discussion Paper

Note: Changes from the March 2009 draft of the discussion paper

This discussion paper is substantively the same as the March 2009 draft which was distributed to the Council. There are some minor updates and clarifications which have been made, and which are listed below:

- clarifications to description of data usage, in Section 2
- minor additions to discussion of the rockfish pilot program, paralleling evaluations in the rockfish program discussion paper that is scheduled for Council review in October 2009, in Sections 4.1 and 6.3
- table of Chinook bycatch in the pelagic trawl fishery by month (Section 4.2)

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1 Introduction

Since the implementation of the groundfish fishery management plans for Alaska, the North Pacific Fishery Management Council (Council) has adopted measures intended to control the bycatch of species taken incidentally in groundfish fisheries. Certain species are designated as 'prohibited' in the groundfish fishery management plans, as they are the target of other domestic fisheries. Catch of these species and species groups must be avoided while fishing for groundfish, and when incidentally caught, they must be immediately returned to sea with a minimum of injury[1]. These species include Pacific halibut, Pacific herring, Pacific salmon, steelhead trout, king crab, and tanner crab.

To further reduce the bycatch of these prohibited species, various bycatch control measures have been instituted in the Alaska groundfish fisheries (a history is provided in NMFS 2004, Appendix F.5). In the Gulf of Alaska (GOA) groundfish fisheries, halibut bycatch limits (which close the groundfish target fisheries after the limits are reached) and bottom trawl seasonal and permanent closure areas to protect red king crab have been established. To date, no bycatch control measures have been implemented for salmon or other crab species taken incidentally in GOA groundfish fisheries.

The Council has at various times in the past several years requested staff prepare and update discussion papers examining the scope of salmon and crab bycatch in the GOA groundfish fisheries, and proposing management options that might be considered to regulate such bycatch. Most recently, in June 2008, the Council limited the scope of the discussion paper to focus on two species and two areas with potentially high bycatch levels: Chinook salmon (*Oncorhynchus tshawytscha*) and *Chinoecetes bairdi* Tanner crab, in the central and western GOA. This discussion paper provides a general overview of the available information on bycatch levels (Section 2 for Chinook, and Section 6 for *C. bairdi* crab), and species abundance and directed fisheries (Sections 5 and 7 for Chinook and crab, respectively). Preliminary alternatives have been proposed for bycatch management measures in previous iterations of this discussion paper, and they are included here (Section 8.1), along with strawman closure areas that may be considered for managing bycatch (Section 8.3).

2 Data sources used in this discussion paper

Catch and bycatch data were obtained from the NMFS catch accounting database, and analyzed to represent the amount, species composition, timing, and location of salmon and crab caught incidentally in GOA groundfish fisheries. All NMFS data were screened to ensure confidentiality is maintained. The process that is used to estimate bycatch for GOA groundfish fisheries is described in Section 2.1. In short bycatch rates from observed vessels are applied to the fleet as a whole. The resulting estimates are used in Sections 4.1 and 4.2 for Chinook salmon, and Sections 6.2, 6.3, and 6.5 for *C. bairdi*. Further discussion on the proportion of GOA groundfish fisheries that are observed is addressed in Section 2.2.

Spatial analysis of bycatch in this discussion paper used only the data directly from observed vessels, and is described in Section 2.3. The spatial analysis is used to describe the location of bycatch (Sections 4.3 and 6.4), as well as to develop preliminary strawman closures under the management options (Section 8.3). Abundance estimates for crab were provided by Alaska Department of Fish and Game (ADFG) staff from the ADFG survey, and are included in Section 7.

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[1] Except when their retention is authorized by other applicable law, such as the Prohibited Species Donation Program.

2.1 Estimation procedures for prohibited species bycatch in the Alaska groundfish fisheries

The Alaska Region manages groundfish and prohibited species catch (PSC) under Fishery Management Plans for Groundfish of the Bering Sea/Aleutian Islands and for the Gulf of Alaska. NMFS estimates bycatch (here defined as PSC) based on data from the North Pacific Groundfish Observer Program, Weekly Production Reports (WPR), and Alaska Department of Fish and Game fish tickets. The observer data is used to create bycatch rates, and landings data (observer data, fish tickets or WPRs) is multiplied against the rates to provide bycatch estimates. In the Alaska Region, the source for landings data is observer data for 100% observed vessels, WPR data for catcher/processors with 30% observer coverage, and fish tickets for all shoreside deliveries. The estimation procedures for bycatch are designed to meet two key requirements. First, the estimation procedures are designed to provide a quick turn-around of the data so that inseason managers have useful information as quickly as possible. The system makes maximum use of small amounts of observer data quickly (at coarser aggregation levels) which are updated and refined as more data becomes available. Second, the system is flexible, so that changes to the management structure can be mirrored in the catch accounting structure to allow inseason management to stay current with fisheries regulations and specifications.

PSC and discard estimates are based on observer data, and estimates are made using automated procedures within NMFS catch accounting system. The estimation procedures are run daily to incorporate new data or any edits to existing data. It is assumed that unobserved vessels have incidental catch rates, and the bycatch rates are applied to unobserved catch as well[2].

Prohibited species bycatch estimation

Management of PSC species is based solely on estimates derived from the following procedure, rather than from reported catch. Note that PSC estimates are based on observer rates derived from sampling.

All available observer data are used in the calculation of PSC bycatch rates. Rates at five levels of aggregation are calculated daily. As landings data is updated or received, bycatch estimates are created by finding the best possible matching rate and multiplying the landed catch by that rate. PSC are calculated and managed in numbers of animals for crab and salmon, and in weights for halibut and herring.

Rates for each PSC species are calculated at the following levels of aggregation:

- Precedence 50 CV. Vessel specific catcher vessel (CV) rate aggregated by:
  - Vessel ID, year, trip target date, and fisheries management plan (FMP) area (BSAI or GOA);
- Precedence 50 CP. Vessel specific catcher processor (CP) rate aggregated by:
  - Vessel ID, year, trip target date, gear, federal reporting area, special subarea;
- Precedence 40. Sector specific 3-week average aggregated by:
  - Year, trip target code[3], week end date, processing sector (CV, CP, or Mothership), gear, federal reporting area, special subarea;
- Precedence 30. Across-sector 3-week average aggregated by:
  - Year, trip target code, week end date, gear, federal reporting area, special subarea;
- Precedence 20. FMP area rate aggregated by:

[2] PSC and discard estimates are also calculated for catch in the State Pacific cod fishery that sets its guideline harvest level based on the Federal Pacific cod acceptable biological catch.
[3] Targets include: A - Atka Mackerel, B - Bottom trawl Pollock, C - Pacific cod, D - Deepwater flatfish (GOA only), E - Alaska plaice, F - Other flatfish, H – Shallow water flatfish (GOA only), I - halibut (directed), K - rockfish, L - flathead sole, O - Other groundfish, P - Pelagic pollock, rocksole (BSAI only), S - sablefish, T - Greenland turbot, W - arrowtooth flounder, X - Rex sole (GOA only), and Y - Yellowfin sole (BSAI only).

- Year, trip target code, gear, FMP area.

Rates are calculated by summing the total number or weight of observed PSC and dividing by the total groundfish weight (retained and discarded catch of groundfish) of sampled observer hauls at the above levels of aggregation. Note that hauls or sets with no PSC are included in the denominator. At the end of 2005, 26,413 individual PSC rates were calculated for the 7 PSC species, and 134,604 estimates were calculated from these rates. The three-week averages in Precedence levels 30 and 40 above are 3-week moving averages that include catch from the previous and following weeks. At least 3 observed hauls or sets must be included in the average before it is used in the matching process.

As an example of the process, consider the case where the best rate available was Precedence 30. Each night the suite of all possible rates are calculated to include the most current data. When the reported catch from an unobserved catcher vessel from the GOA fishing in the Pacific cod target with hook and line gear in reporting area 630 is received, for example as a fish ticket from a shoreside plant, the program searches for a matching PSC rate. Since the vessel was unobserved, no vessel specific rates will be found (Precedence 50). If no observed trips were made by a similarly situated catcher vessel during the three-week period including the prior and the following weeks, no rate at Precedence 40 would be created for the match. The program would then look for a matching rate at the next precedence level (30) which would include observed bycatch by any observed vessel using hook and line gear in the Pacific cod target in reporting area 630, including catcher/processors or catcher vessels delivering to motherships. Upon finding a match, the catch would be multiplied by the Precedence 30 rate, providing an estimate of PSC.

The procedure described above details the technical mechanics of how NMFS uses observer sampling ratios to estimate PSC. Detailed instructions on the procedures observers use to collect their data can be found in the series of observer manuals available at: http://www.afsc.noaa.gov/Quarterly/jfm2008/jfm08feat.pdf. The observer procedures provide the data which are inputs into the estimation process.

In order to continue to improve the system for managing groundfish and prohibited species catch, the Alaska Fisheries Science Center and Alaska Region have collectively contracted with the Pacific States Marine Fisheries Commission to review the current data and data systems used for inseason management and catch accounting in Alaska. The purpose of the contract is to identify the types of data that are available, their limitations, and to look at the statistical assumptions associated with all estimation procedures. It is intended that the evaluation will result in recommendations for practical system design changes to improve estimation and to recognize statistical uncertainty in NMFS estimates of catch and bycatch.

2.2 Proportion of GOA groundfish catch that is observed

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. It is important to note that in a separate initiative, the Council has tasked staff with analyzing alternatives to address known problems with the existing Observer Program. While several issues are being addressed in that analysis, data quality is a key element particularly in fleets with less than 100 percent observer coverage. That analysis is proceeding in tandem with, but not linked to, this discussion paper. Concerns about data quality are intended to be addressed through the Observer Program restructuring initiative.

Under the current Observer Program, the amount of observer coverage is based on vessel length. No vessels less than 60 ft are required to have observers onboard. Trawl and hook and line vessels that are

60 ft to 125 ft must have an observer onboard for 30% of fishing days, by quarter. Similar gear vessels that are larger than 125 ft must have an observer onboard 100% of the time, and shore-based processing facilities must have an observer present for 100% of the time. All pot vessels greater than 60 ft LOA must have observer coverage while 30% of their pots are pulled for the calendar year.

There is a greater prevalence of smaller vessels participating in the GOA groundfish fisheries, and over the past 10 years, participation by smaller vessels in the GOA groundfish fisheries has generally increased, particularly catcher vessels less than 60 ft length overall (NPFMC 2003). Because observer coverage requirements are generally based on vessel length, the proportion of total catch that is observed in GOA groundfish fisheries is much lower than, for example, in the Bering Sea fisheries. The majority of the GOA fleet is subject to 30% observer coverage. Table 1 illustrates the total groundfish catch in the GOA, the total amount of groundfish that is caught while an observer is onboard the vessel, and the resulting percentage. In the western GOA, the proportion of catch that is caught while an observer is onboard ranges from 25-36% over the years 2004-2007; in the central GOA the range is from 32% to 37%. In comparison, the average percentage of observed catch in the Bering Sea is approximately 86%, and in the Aleutian Islands is approximately 95%. Please note that the percentage of observed catch provides only a gross overview as to the quality of information, and may mask data quality concerns. The goal is to have an unbiased estimate that is sufficiently precise to meet the management need for the information. The precision of bycatch estimates depends upon the number of vessels observed and the fraction of hauls sampled (Karp and McElderry 1999). Because of the relatively lower levels of observer coverage in the GOA, estimates of salmon and crab bycatch are less precise in the GOA than in Bering Sea groundfish fisheries. To what degree they are less precise, however, is not known, as current PSC estimates do not include a measure of uncertainty.

Table 1 Total catch, observed catch, and percent observed catch by area and year

Area	Year	Total (mt)	Observed (mt)	Percent
Western GOA	2004	50,853	14,414	28%
	2005	53,142	13,195	25%
	2006	51,944	17,253	33%
	2007	46,968	16,882	36%
Central GOA	2004	108,707	37,744	35%
	2005	120,030	41,586	35%
	2006	131,271	42,349	32%
	2007	118,871	44,113	37%
Eastern GOA	2004	7,610	2,911	38%
	2005	8,709	3,072	35%
	2006	8,772	3,293	38%
	2007	4,274	3,225	75%
Bering Sea	2004	1,695,228	1,450,413	86%
	2005	1,702,671	1,467,153	86%
	2006	1,696,337	1,470,680	87%
	2007	1,569,110	1,352,914	86%
Aleutian Islands	2004	98,169	93,188	95%
	2005	94,209	89,516	95%
	2006	95,288	91,461	96%
	2007	107,090	101,060	94%

Note: This table does not include jig gear, but otherwise includes all targets.
Source: http://www.fakr.noaa.gov/sustainablefisheries/inseason/percent_observed.pdf

Detailed information on percent of harvest observed in the GOA groundfish fisheries has been presented to the Council meeting as part of their reports from the Observer Advisory Committee, most recently at the April 2008 Council meeting. NMFS compiled a series of tables that provides a breakout of the percentage of harvest observed for each year 2004–2007, inclusive, in order to show the effective rate of coverage in particular target fisheries. The data are broken out by observer coverage category (30%, 100%), gear type, area, and component of the catch by the <60’ fleet that is unobserved.[4] The information for the central GOA and the western GOA is presented in Table 2 and Table 3, respectively.

Information in the tables pertinent to the discussion of fisheries in the GOA is summarized below. For the GOA Pacific cod pot fisheries, more than half the catch from 2004–2007 came from the <60 ft fleet, which is unobserved. The remaining catch primarily came from the >60 ft to <125 ft fleet where percent coverage ranged from 17-28% over the four years. For the Pacific cod trawl fisheries delivering shoreside, coverage in the >60 ft to <125 ft category ranged from 24%–30% in this time frame. The State waters Pacific cod fishery is unobserved, however bycatch rates from comparable vessels/areas are applied to the State waters Pacific cod catch. Bycatch attributable to the State waters Pacific cod fishery is included in this discussion paper, but is presented in a separate section.

For the pollock pelagic trawl fishery, data is mostly confidential for the unobserved <60 ft fleet each year, except in the western GOA in 2006 and 2007 where catch represented 54-71% of the total. The remaining catch came from the >60 ft to <125 ft fleet where coverage ranged from 31%–37% over the four years, with the exception of 51% coverage in the western GOA in 2005. For non-pelagic trawl arrowtooth flounder and shallow water flatfish targets delivered shoreside, the majority of the catch was in the >60 ft to <125 ft category and percentage covered ranged from 13%–34% over the three-year period. Catch of flatfish in the catcher processor fleet was largely in the >60 ft to <125 ft category, with the exception of arrowtooth flounder in the central GOA, and percentage covered varied widely.

At various times, it has been suggested that vessels might volunteer to take observers onboard even when it is not required under observer coverage requirements, in order to increase the proportion of catch that is observed in the GOA, particularly in certain fisheries or areas of interest, and hopefully to increase the accuracy of catch accounting extrapolations based on observer data. Currently, there is an outstanding regulatory issue that prevents observer providers from working with the fishing industry outside of providing observers as mandated under the regulations, because observer providers must not have a financial interest other than the provision of observers. In addition, ad hoc contributions of observer coverage could bias rather than improve estimation procedures. NMFS suggests that coverage be obtained through a sample design which is followed. Additional information on this topic will be developed through the Observer Program re-structuring analysis.

In 2008, there was one instance of a 58 ft catcher vessel fishing in the western GOA Pacific cod fishery taking an observer on board. The vessel’s incentive was to demonstrate that the western GOA has lower halibut bycatch rates than the central GOA, and as there were no vessels larger than 60 ft fishing in the western GOA, all catch from that area was assigned central GOA halibut bycatch rates. As noted, using observer data obtained in this voluntary manner may introduce a bias, as the industry would control the time, area, etc. of the observer data.

[4] 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 all sampled and unsampled hauls that occurred while an observer was onboard. 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.

Table 2 **Central Gulf of Alaska total catch (mt), observed catch, and percent observed catch by area, harvest sector, gear type, trip target fishery, and vessel length**

Sector	Gear	Trip target	Length	2004			2005			2006			2007		
				Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent
CP	NPT	Pacific cod	>=60 and <125	--	--	0%	565	411	73%	--	--	0%	0	166	0%
			>=125	--	--	100%	0	0	0%	0	0	0%	0	0	0%
		Rockfish	>=60 and <125	--	--	17%	0	0	0%	--	--	0%	0	4	0%
			>=125	6,654	6,655	100%	7,973	7,353	92%	7,716	7,716	100%	4,656	4,656	100%
		Flathead sole	>=60 and <125	--	--	104%	--	--	77%	--	--	70%	--	--	104%
		Arrowtooth	>=60 and <125	0	0	0%	2,735	2,150	79%	3,878	1,500	39%	518	0	0%
			>=125	--	--	100%	--	--	100%	3,785	3,785	100%	4,498	4,498	100%
		Rex sole	>=60 and <125	2,674	0	0%	2,776	1,133	41%	6,883	1,691	25%	--	--	36%
			>=125	--	--	100%	--	--	100%	0	0	0%	0	0	0%
	POT	Pacific cod	>=60 and <125	0	0	0%	0	0	0%	0	0	0%	--	--	0%
S	NPT	Pacific cod	<60	--	--	0%	--	--	0%	--	--	0%	--	--	0%
			>=60 and <125	12,443	3,716	30%	7,376	2,185	30%	4,861	1,152	24%	8,377	2,216	26%
		Arrowtooth	<60	0	0	0%	0	0	0%	0	0	0%	--	--	0%
			>=60 and <125	7,517	1,476	20%	8,519	2,212	26%	12,543	2,993	24%	12,818	2,574	20%
		Shallow water flatfish	<60	0	0	0%	11	0	0%	0	0	0%	547	0	0%
			>=60 and <125	3,339	1,127	34%	6,835	1,300	19%	10,432	1,393	13%	13,382	3,441	26%
		Rockfish	<60	120	0	0%	0	0	0%	0	0	0%	134	0	0%
			>=60 and <125	12,292	3,864	31%	9,477	2,989	32%	7,197	1,913	27%	5,758	3,522	61%
	POT	Pacific cod	<60	2,426	0	0%	3,233	0	0%	3,778	0	0%	4,296	0	0%
			>=60 and <125	2,475	687	28%	4,920	1,298	26%	4,369	981	22%	4,090	969	24%
			>=125	0	0	0%	0	0	0%	--	--	0%	0	0	0%
	PTR	Rockfish	>=60 and <125	66	217	327%	535	636	119%	1,999	1,211	61%	2,990	4,029	135%
		Pollock, bottom and midwater	<60	--	--	0%	1,677	0	0%	--	--	0%	--	--	0%
			>=60 and <125	36,431	13,520	37%	47,273	14,845	31%	44,371	14,187	32%	33,530	11,150	33%

Notes for Table 2 and Table 3 follow Table 3.

Source: http://www.fakr.noaa.gov/sustainablefisheries/inseason/percent_observed.pdf

Table 3 Western Gulf of Alaska total catch (mt), observed catch, and percent observed catch by area, harvest sector, gear type, trip target fishery, and vessel length

Source: http://www.fakr.noaa.gov/sustainablefisheries/inseason/percent_observed.pdf

Sector	Gear	Trip Target	Length	2004			2005			2006			2007		
				Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent
CP/M	HAL	Pacific cod	<60	0	0	0%	0	0	1%	0	0	0%	--	--	0%
			>=60 and <125	2,394	509	21%	--	--	7%	2,199	1,587	72%	2,895	1,989	69%
			>=125	925	925	100%	292	292	100%	956	956	100%	442	444	100%
		Sablefish	>=60 and <125	572	211	37%	618	254	41%	540	288	53%	758	447	59%
			>=125	359	359	100%	415	411	99%	344	341	99%	191	172	90%
	NPT	Pacific cod	>=60 and <125	635	0	0%	--	--	625%	--	--	0%	--	--	39%
			>=125	--	--	100%	0	0	0%	0	0	0%	0	0	0%
		SW Flatfish	>=60 and <125	--	--	0%	--	--	21%	--	--	57%	--	--	0%
		Rockfish	>=60 and <125	--	--	117%	--	--	0%	--	--	189%	0	0	0%
			>=125	5,291	5,298	100%	3,459	3,351	97%	6,625	6,623	100%	8,274	8,272	100%
		Flathead sole	>=60 and <125	1,047	114	11%	1,803	24	1%	--	--	35%	1,040	352	34%
			>=125	--	--	100%	--	--	100%	0	0	0%	0	0	0%
		Arrowtooth	>=60 and <125	--	--	1989%	--	--	2134%	--	--	71%	--	--	94%
			>=125	901	901	100%	1,220	1,220	100%	953	953	100%	1,771	1,771	100%
		Rex sole	>=60 and <125	--	--	5%	--	--	12%	--	--	21%	--	--	56%
			>=125	--	--	100%	0	0	0%	0	0	0%	--	--	100%
	POT	Pacific cod	<60	0	0	0%	0	0	0%	0	0	0%	--	--	0%
			>=60 and <125	--	--	0%	--	--	34%	--	--	0%	--	--	18%
S	HAL	Pacific cod	<60	--	--	0%	242	0	0%	78	0	0%	327	0	0%
			>=60 and <125	4	0	0%	--	--	0%	0	0	0%	--	--	0%
		Sablefish	<60	837	0	0%	728	0	0%	1,043	0	0%	982	0	0%
			>=60 and <125	529	41	8%	380	122	32%	461	141	31%	471	56	12%
			>=125	0	0	0%	--	--	0%	0	0	0%	0	0	0%
	NPT	Pacific cod	<60	1,464	0	0%	3,554	0	0%	5,114	0	0%	--	--	0%
			>=60 and <125	183	0	0%	783	392	50%	--	--	25%	--	--	77%
	POT	Pacific cod	<60	4,823	0	0%	1,962	0	0%	1,913	0	0%	2,441	0	0%
			>=60 and <125	5,016	1,138	23%	4,428	965	22%	3,882	683	18%	2,205	378	17%
			>=125	--	--	64%	--	--	0%	--	--	0%	--	--	0%
	PTR	Pollock, bottom and midwater	<60	--	--	0%	--	--	0%	13,391	0	0%	13,029	0	0%
			>=60 and <125	7,611	2,938	39%	10,988	5,613	51%	11,604	4,858	42%	5,258	1,662	32%

Notes for Table 2 and Table 3:

These tables do not include data from shoreside processors using paper weekly production reports because the data is at the processor level. The vessel length associated with the catcher vessels delivering to the shoreside processor is not available. This includes 5,717 mt of total groundfish catch in the GOA, consisting of 19 processors in 2004, 11 processors in 2005, and 8 processors in 2006 in the GOA.

1. Values where total and observed columns are blank (-) indicate confidential data. Confidential data have been defined as <3 vessels and processors for that given year, area, sector, gear type, target fishery, and vessel length.
2. Total catch data are from the catch accounting system, and the observer data are from the observer database in March 2008.
3. Harvest sector: S=shoreside; CP/M=catcher processor or mothership
4. Gear type: HAL=hook-and-line; JIG=jig (not included in this table); NPT=non-pelagic trawl, POT=pot; PTR=pelagic trawl
5. Vessel length: <60=vessels less than 60 ft length overall (LOA); >=60 and <125=vessels greater than or equal to 60 ft and less than 125 ft LOA; >=125=vessels greater than or equal to 125 ft LOA
6. Year= target fishery year
7. Weight is rounded to the nearest mt.
8. Percent= (mt of observed catch/mt of total groundfish catch in catch accounting system)*100
9. Not included in the GOA are trip target fisheries per gear type: HAL= pollock, deepwater flatfish, rockfish, other species, arrowtooth (2,406 mt shoreside, 404 mt CP/M); NPT= pollock, deepwater flatfish, shallow water flatfish, rockfish, flathead sole, other species, sablefish (21,367 mt shoreside, 1,633 mt CP/M); POT= pollock, other species (18 mt shoreside); PTR= Pacific cod, shallow water flatfish, flathead sole, other species, arrowtooth, sablefish (2,220 mt shoreside, 566 mt CP/M)
10. For CPs and motherships groundfish catch estimates, the catch accounting system uses weekly production reports for vessels>=60 and <125 and observer data for vessels >=125 except for pot gear uses weekly production reports for vessels >=60.
11. In some cases, the observed data are higher than the total catch for a given area, sector, gear type, target fishery, vessel length. There are several reasons that this occurs:
    a. In 2004-2006, four CPs >=125 ft. had haul data considered to be invalid by the Observer Program. These data were replaced with weekly production reports in the catch accounting system, but are still used as the observed total.
    b. For catcher/processors and motherships >=60 and <125, there can be a mismatch between the trip target that is assigned from the observed data and the trip target that is assigned based on weekly production report data. This occurs when a vessel targets more than one target species during a week.
    c. For the shoreside sector, the total catch is based on fish tickets, which could be different from the observer data.
    d. The two databases include separate sources of information. The catch accounting system partially uses weekly production reports, landing reports, and observer data. Production reports are focused on different goals from the observer data (production vs. total catch), uses a different method to determine catch and targets, and in the cases of 30% observer coverage include dis-coordinated time frames of estimates, especially at the target level (i.e. observer data may not cover the entire week that a production report is based on).
12. A high level of variability in the percent observed catch for a given target fishery may be explained by the level of coverage that vessels had prior to entering a different FMP area. Observer coverage is by quarter and by fishery category, not by FMP area. A 30% vessel may have enough observer coverage in one FMP area to meet the requirements for their fishing in another FMP area. A high level of variability in percent observed catch also may be attributed to a variable number of vessels that participate in certain GOA fisheries each year.
13. This is NMFS' approach to the OAC data request, as of March 26, 2008.

2.3 Spatial analysis of bycatch patterns

In order to map the location of Chinook salmon and *C. bairdi* crab bycatch in GOA fisheries, we used data from observed vessels only because they are associated with geographical coordinates. The observer program database contains detailed sample-level information on species composition and the results of extrapolations from the sample(s) to the haul level. Our spatial analysis uses the haul-level extrapolated bycatch numbers of Chinook and *C. bairdi*, as well as the official ton weight of the haul, to calculate and present bycatch rates.

Please note that there is an important limitation in the observer program data for PSC from the shoreside Pollock fishery when it is used for spatial analysis. The limitation is due to a technical database problem, which was corrected by NMFS re-design of the observer database implemented in 2008. The issue is that PSC in the shoreside Pollock fishery are sampled at the plant, rather than onboard the vessel. This is because of the particular handling of large volumes of catch in the pollock fishery. Typically, catch is rapidly placed in below deck refrigerated seawater tanks and there is limited opportunity to take large samples. As all hauls are mixed together in the vessel's hold, the entire delivery is monitored for PSC at the shoreside plant upon delivery. Prior to 2008 the Observer Program database did not provide for capturing the delivery level information. Instead, the delivery level were proportioned back to individual tows made during the trip. This was done to fit the data into the existing system. We caution that care must be exercised when attempting to interpret PSC rates at the haul level. The spatial distribution currently displayed in the document maps the bycatch data by individual tows. In effect, this averages the bycatch among several hauls at several locations, when in fact it could possibly be the case that all the bycatch was caught during one haul in one location, and other locations had little or no associated bycatch. To address this problem, it may be more appropriate, in future iterations of this discussion paper, to look at clusters of tows from deliveries with high bycatch. These alternative ways to map the data will be important if the data are used identify regulatory closures areas, and the impact would need to be investigated at that point.

The distribution of bycatch for 2001-2008 is mapped using data from the catch accounting database, as queried in March 2009, and provides an update of a previous iteration of this discussion paper. The strawman closures that are identified in this paper are based on the distribution of bycatch from 2003-2007, which was queried from the catch accounting database in October 2008. Specific locations of salmon and crab bycatch were input into a GIS to produce charts of catch locations, noting the caveat on the quality of these locations-specific data already noted above. Information on crab survey abundance estimates were obtained from published Alaska Department of Fish and Game (ADFG) reports, as well as data provided by ADFG staff.

3 Review of Existing Closures

There are already seasonal and permanent area closures that have been implemented for the GOA groundfish fisheries, many of which were instituted to reduce bycatch or interactions with Steller sea lions. It is important to consider the development of new spatial controls to reduce bycatch within the context of existing time and area closures. The various State and Federal closures affecting the GOA groundfish fisheries are described below, along with their intended purpose. The year the closure was implemented is noted in parentheses. Figure 16 (page A at the end of the document) maps the existing closures in the entire GOA management area; Figure 17 and Figure 18 (page B) pinpoint the western and central regulatory areas, respectively, which are the focus of this discussion paper.

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. In a given year, there may also be Type III areas, which are closed only during specified 'recruitment events', and are otherwise opened year-round.

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-trawl zones for pollock (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.

4 Chinook Salmon Bycatch

Pacific salmon, including Chinook, chum (*O. keta*), coho *(O. kisutch*), sockeye (*O. nerka*), and pink (*O. gorbuscha*) are taken incidentally in the groundfish fisheries within the Gulf of Alaska. Salmon bycatch is currently grouped as Chinook salmon or ‘other’ salmon, which consists of the other four species combined. Bycatch of Chinook salmon in the last six years (average of 23,750 salmon, 2003–2008) is higher than the time series average (average of 21,308 salmon, 1990–2008, Table 4). For the purpose of this discussion paper, it is assumed that salmon caught as bycatch has a 100% mortality rate in the groundfish fisheries.

The following sections provide updated information on Chinook salmon bycatch in the GOA groundfish fisheries. A historical report on salmon bycatch in groundfish fisheries off Alaska as it pertains to the GOA is provided in Witherell et al. (2002).

Table 4 Bycatch of Pacific salmon in Gulf of Alaska groundfish trawl fisheries, by species, 1990-2008

Year	Chinook	‘Other’ salmon[a]	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				
2003	15,358	10,362				
2004	21,447	5,816				
2005	31,207	6,694				
2006	18,816	4,273				
2007	39,733	3,487				
2008	15,939	2,156				
Average 1990–2008	**21,308**	15,454[a]				
Average 2003–2008	**23,750**	4,818				

[a] Combines chum, coho, sockeye, and pink salmon.

[b] Average combines chum, coho, sockeye, and pink salmon bycatch for 1990-1997.

Source: NMFS catch reports (http://www.fakr.noaa.gov/sustainablefisheries/catchstats.htm) for 1990-2002 (all species) and 2003-2008 (non-Chinook species); NMFS catch accounting PSC data for 2003-2008 (Chinook).

4.1 Bycatch by area, gear type, and target fishery

In the GOA, Chinook salmon bycatch primarily occurs in the western and central regulatory areas, and corresponds to the locations of the trawl fisheries. Table 5 illustrates bycatch for 2003-2007, and 2008-to-date, across regulatory and reporting areas. In all years except 2008 to date, salmon bycatch in the eastern regulatory area is less than 2% of total Chinook bycatch. 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. Chinook bycatch in the western regulatory area as a proportion of total GOA Chinook bycatch varies between a tenth and a third, by year, but averages to approximately 20%.

Table 5 Chinook salmon bycatch by reporting area, 2003-2008, in Gulf of Alaska groundfish fisheries

Regulatory Area		**2003**	**2004**	**2005**	**2006**	**2007**	**2008** (through 10/25/08)	**Average 2003-2007**
Western	610	2,859	6,162	7,567	4,880	3,671	2,268	5,028
Central	620	3,876	5,320	6,976	5,678	28,941	7,405	10,158
	630	8,437	9,957	16,180	8,168	7,084	6,115	9,965
Eastern	640	186	36	483	89	71	705	173
	650	0	4	0	0	2	0	1
Grand Total		15,358	21,478	31,207	18,816	39,768	16,493	25,325

Source: NMFS catch accounting PSC data, October 2008.

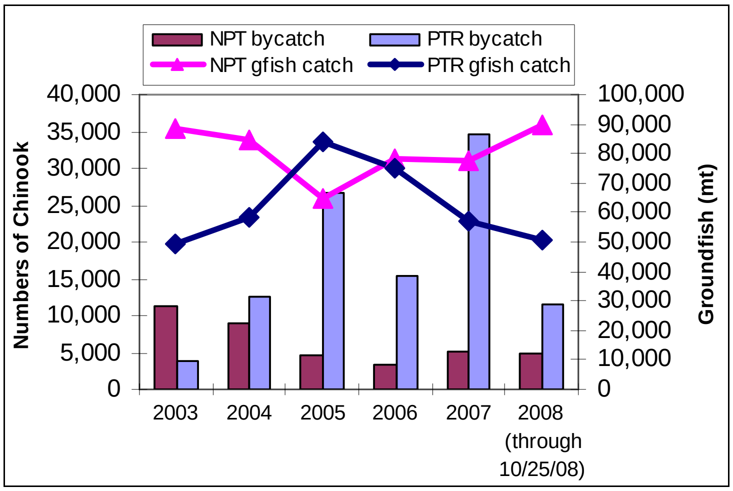
Table 6 identifies Chinook bycatch for 2003-2008, by gear type. Pelagic and non-pelagic trawling are almost entirely responsible for Chinook salmon bycatch. In 2005-2007, pelagic trawl gear accounted for over 80% of Chinook bycatch. The relationship between groundfish catch and pelagic and non-pelagic trawl Chinook bycatch was consistent from 2003-2005 (Figure 1), however since then bycatch rates in the pelagic trawl fishery have been highly variable and have not paralleled groundfish catch.

Table 6 Chinook salmon bycatch by gear type, in Gulf of Alaska groundfish fisheries, 2003-2008

Gear type	2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Hook and line	0	31	0	0	35	0	13
Non-pelagic trawl	11,388	9,006	4,593	3,434	5,071	4,975	6,698
Pelagic trawl	3,970	12,440	26,614	15,382	34,663	11,518	18,614
Pot	0	0	0	0	0	0	0
Grand Total	15,358	21,478	31,207	18,816	39,768	16,493	25,325

Source: NMFS catch accounting PSC data, October 2008.

Figure 1 Chinook bycatch in GOA Groundfish Trawl Fisheries



Source: Chinook bycatch from NMFS catch accounting PSC data, October 2008; groundfish catch from NMFS catch accounting data, October 2008. Represents total GOA groundfish catch excluding State waters catch.

Chinook bycatch with non-pelagic trawl gear is distributed among several target fisheries, while pelagic trawl bycatch occurs predominantly in the pollock target fishery (Table 7). In 2005–2007, the flatfish non-pelagic trawl target fisheries accounted for approximately 6-10% of Chinook bycatch in the GOA, although for 2008 through October 25th, that percentage has increased to 17%. In 2003 and 2004, the flatfish target fishery accounted for 45% and 31% of Chinook bycatch, respectively. Chinook bycatch in the rockfish target fishery has increased since the implementation of the rockfish pilot program in 2007. The number of vessels employing pelagic trawl gear in the rockfish fishery has increased under the pilot program, likely in an effort to reduce halibut bycatch (Table 7). Chinook bycatch by vessels using non-pelagic trawl gear in the rockfish fishery is also higher in 2007 and 2008, at 1,733 and 1,465 Chinook, respectively, compared to the years immediately previous. However, averaged over 2003-2007, bycatch in the pollock pelagic trawl target fishery represents 73.2% of total GOA Chinook bycatch, or 18,533 fish annually. Table 8 illustrates the distribution of bycatch in the pollock pelagic fishery among reporting areas. While bycatch in the western GOA is consistently lower than it is in the central regulatory area, the proportional bycatch by area within all years 2003-2008 is highly variable. 2007 was the year of highest bycatch in the Chignik area (620), with 28,034 Chinook, while in the Kodiak area (630), 2005 was the highest bycatch year with 13,370 Chinook.

Table 7 Chinook salmon bycatch by target fishery, in Gulf of Alaska groundfish fisheries, 2003-2008

Gear type	Target fishery	2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Pelagic trawl	Pollock	3,939	12,440	26,551	15,376	34,357	10,757	18,533
	Rockfish	2	*	63	0	304	761	92
Non-pelagic trawl	Arrowtooth Flounder	3,348	359	1,798	408	1,504	2,608	1,484
	Flathead Sole	598	5,289 [5]	16	56	0	0	1,192
	Pacific Cod	3,167	908	41	882	634	640	1,126
	Pollock	423	571	1,296	380	50	70	544
	Rex Sole	2,819	498	982	1,444	714	0	1,291
	Rockfish	917	885	397	263	1,733	1,465	839
	Shallow Water Flatfish	116	498	63	0	434	192	222

Source: NMFS catch accounting PSC data, October 2008.

Table 8 Chinook salmon bycatch in the pelagic pollock trawl fishery, by reporting area, 2003-2008

Reporting area		2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Western GOA	610	738	2,013	5,951	4,529	3,364	2,035	3,105
Central GOA	620	1,121	4,886	6,747	4,843	28,034	6,892	8,754
	630	2,013	5,513	13,370	5,915	2,925	1,448	5,197

Source: NMFS catch accounting PSC data, October 2008.

4.2 Timing of Chinook bycatch

The timing of salmon bycatch follows a predictable pattern in most years. Chinook salmon are caught in high quantities regularly from the start of the trawl fisheries on January 20 through early April, and again during September/October in the pollock B season fishery (Table 9). Figure 2 illustrates the difference in seasonal bycatch patterns between the pelagic and non-pelagic trawl fisheries with respect to Chinook bycatch. For the non-pelagic trawl fisheries, Chinook bycatch is caught consistently throughout the year, although in higher quantities in the spring months. Because of the varied target fisheries in which the non-pelagic trawl vessels participate, Chinook bycatch does not correlate well to groundfish catch by that sector as a whole. The spike in non-pelagic trawl groundfish catch in July is due to participation in the rockfish fisheries, which incur very low Chinook bycatch. Table 10 provides the bycatch numbers, by month, for the pelagic trawl fishery only. Chinook bycatch in the pelagic trawl fishery pulses in correlation with the seasons of the pollock target fishery. The annual TAC for pollock is divided into four seasons, as a protection measure for Steller sea lions (which prey on pollock). The regulatory pollock seasons are as follows: A season (January 20 to March 10), B season (March 10 to May 31), C season (August 25 to October 1), and D season (October 1 to November 1), although in many instances, the available TAC will be caught (and the fishery will be closed) well before the end of the season.

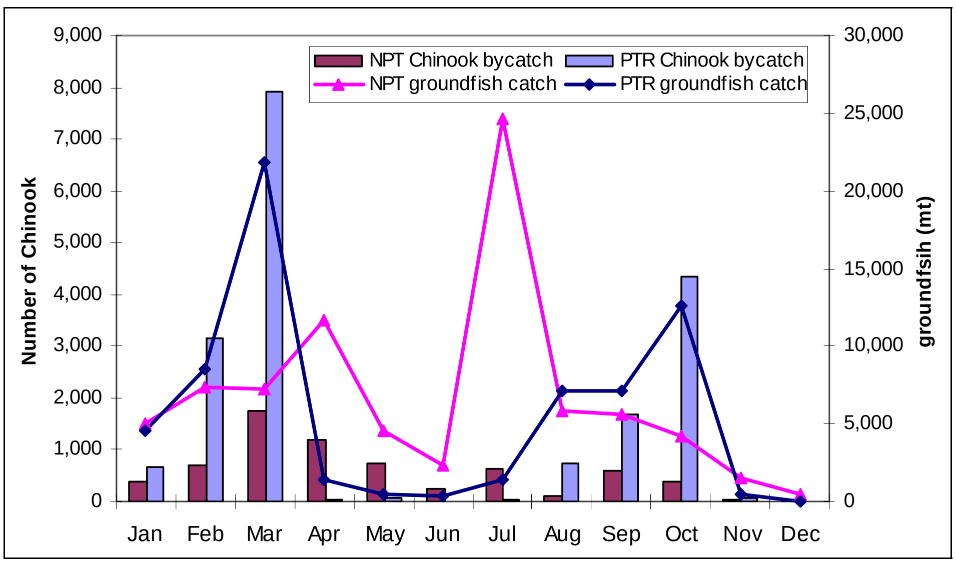
[5] Since this discussion paper was last presented to the Council, NMFS reloaded catcher vessel data from 2003-2008 into the Catch Accounting system in order to identify catcher vessels delivering to motherships. This resulted in the recalculation of some PSC estimates. As a result, Chinook bycatch in the 2004 flathead sole fishery increased from 1,446 to 5,289 Chinook. PSC associated with other target fisheries was not substantially affected. NMFS is currently reviewing these PSC estimates and may revise them at a future date. The data are current as of October 2008.

Table 9 Chinook salmon bycatch by month, 2003-2008, in Gulf of Alaska groundfish fisheries

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	1,988	1,524	1,005	3,286	2,372	0	929	1,203	470	2,580	*	
2004	285	3,765	7,019	1,042	34	38	1,034	1,484	2,759	4,018	0	*
2005	924	10,400	7,269	382	60	7	460	385	1,829	9,490	*	*
2006	1,952	1,816	4,799	1,143	10	28	235	811	4,098	3,786	138	
2007	169	1,664	28,226	203	1,402	1,089	654	253	2,179	3,859	19	50
2008 (through 10/25/08)	314	710	6,931	3,117	1,225	363	702	129	370	2,632		
Average 2003-2007	1,064	3,834	9,664	1,211	776	233	662	827	2,267	4,746	52	*

* = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: NMFS catch accounting PSC data, October 2008.

Figure 2 Average Chinook bycatch and groundfish catch by vessels using pelagic and non-pelagic trawl gear, by month, 2003-3007



Source: Chinook bycatch from NMFS catch accounting PSC data, October 2008; groundfish catch from NMFS catch accounting data, October 2008. Represents total GOA groundfish catch excluding State waters catch.

Table 10 Chinook salmon bycatch by pelagic trawl gear, by month, 2003-2008

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	239	365	243	72		*	*	948	*	2,101		
2004	283	3,278	1,599				*	1,465	1,842	3,973		
2005	798	9,717	5,538	*	*		63	385	1,323	8,789		
2006	1,847	910	4,128	63		0	0	776	4,059	3,460	138	
2007	165	1,467	28,141	*	131	8	93	88	1,103	3,467	*	
2008 (through 10/25/08)	129	489	6,886	561	600	65	96	129	156	2,407		
Average 2003-2007	666	3,147	7,930	34	65	3	32	733	1,666	4,358	69	

* = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: NMFS catch accounting PSC data, October 2008.

4.3 Location of Chinook bycatch

The data presented in the sections above has all been based on the NMFS catch accounting prohibited species catch data, which takes bycatch reports from observed fishing trips and applies these bycatch rates to all groundfish catch within each target, gear type, and reporting area. In order to examine the spatial distribution of bycatch at a finer scale than that of the reporting area, it is only possible to use the bycatch data collected on observed trips, as only observed hauls are associated with geographical coordinates. Section 2.1 describes the proportion of fishing trips which are observed in the GOA. Consequently, it should be remembered, while interpreting the series of maps cited in this section, that the data represents only a small proportion of the GOA fishing effort. Additionally, all of the maps use observer data that has been extrapolated to the haul level and, for the pollock fishery, has the quality problem noted earlier[6].

In the previous iteration of this discussion paper, dated December 2008, the distribution of bycatch was mapped for 2003-2007. Figure 21 and Figure 24, on pages E and G at the end of this document, map the total number of Chinook observed during the years 2001-2008, in fisheries using pelagic and non-pelagic trawl gear, respectively. In order to see how the most recent bycatch patterns compare to the eight-year time series, Figure 22 and Figure 25, on pages E and G, show bycatch distribution for 2008 only. Figure 23 and Figure 25 (pages F and G) illustrate the total bycatch rate, number of Chinook per metric ton of total catch, for the period 2001 to 2008, for the same gear types. Other closures already in effect for non-pelagic trawl and pot fisheries are illustrated on the maps.

4.4 Factors affecting bycatch: hatchery releases of Chinook salmon

The United States and Canada account for the highest numbers of hatchery releases of juvenile Chinook salmon, although a limited number are released from Russia. The North Pacific Anadromous Fish Commission compiles reports that summarize these hatchery releases (Table 11). Hatchery releases in each region have decreased in recent years.

The United States has the highest number of annual releases (81% of total in 2006), followed by Canada (18%). Of the US releases, the highest numbers are coming from the State of Washington (61% in 2006), followed by California (16% in 2006), and then Oregon (11% in 2007). Hatcheries in Alaska are located in southcentral and southeast Alaska. Since 2004, the number of hatcheries has ranged from 33 (2004–2005) to 31 (2006), with the majority of hatcheries (18–22) located in southeast Alaska, while 11 hatcheries are in Cook Inlet and 2 in Kodiak (Eggers, 2005a; 2006; Josephson, 2007).

The highest numbers of Canadian releases of Chinook in 2006 occurred in the West Coast Straits of Georgia (20 million fish) followed by Vancouver Island area (12.4 million fish) the Lower Fraser River (3.3 million fish) (Cook and Irvine, 2007).

No correlation is discernable between the bycatch of salmon in the GOA and the release from any of these hatchery sites.

[6] Observers do not sample the entire haul from a fishing tow, but rather collect one or several samples. The number of Chinook collected within the sample(s) is extrapolated by the Observer Program to represent the number of Chinook caught in the entire haul. Using the haul-level extrapolations allows the data to be better compared across hauls, even though individual sample sizes may differ.

Table 11 Hatchery releases of juvenile Chinook salmon, by country, compared to GOA groundfish bycatch, in millions of fish

Year	Russia	Canada	USA	Total	Total GOA groundfish Chinook bycatch
1999	0.6	54.4	208.1	**263.1**	.031
2000	0.5	53.0	209.5	**263.0**	.027
2001	0.5	45.5	212.1	**258.1**	.015
2002	0.3	52.8	222.1	**275.2**	.013
2003	0.7	50.2	210.6	**261.5**	.015
2004	1.17	49.8	173.6	**224.6**	.021
2005	0.84	43.5	184.0	**228.3**	.031
2006	0.78	41.3	181.2	**223.3**	.019
2007					.040

Source: North Pacific Anadromous Fisheries Commission reports: Russia (Anon. 2007; TINRO-centre 2006, 2005); Canada (Cook and Irvine 2007); USA (Josephson 2007; Eggers 2006, 2005a; Bartlett 2005, 2006, 2007).

4.5 Impacts of bycatch: river of origin of GOA Chinook

The direct effects of GOA groundfish bycatch of Chinook salmon on the sustainability of salmon populations is difficult to interpret without specific information on the river of origin of each bycaught salmon. No bycatch sampling studies have been conducted in the GOA trawl fisheries to look at the origin of salmon bycatch, although some studies have been undertaken in the Bering Sea pollock trawl fishery. Limited information is available from other studies into the river of origin of salmon species.

The High Seas Salmon Research Program of the University of Washington routinely tags and monitors Pacific salmon species. It should be noted that Coded Wire Tag (CWT) information may not accurately represent the true distribution of hatchery-released salmon. Much of the CWT tagging occurs within the British Columbia hatcheries and thus, most of the tags that are recovered also 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).

Chinook salmon tags have been recovered in the area around Kodiak through recovery projects in 1994, 1997, and 1999. The majority of tags recovered from non-Alaska Chinook salmon were from British Columbia, and the study concluded that there was only a low incidental harvest of Cook Inlet Chinook salmon in the Kodiak area (Dinnocenzo and Caldentey 2008).

Other CWT studies have tagged Washington and Oregon salmon, and many of these tagged salmon have been recovered in the GOA (Myers et al. 2004). In 2006, 63 tags were recovered in the eastern Bering Sea and GOA (Celewycz et al. 2006). Of these, 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 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 (Myers et al 2004).

Additional research on stock discrimination for Chinook salmon is being conducted by evaluating DNA variation, specifically single nucleotide polymorphisms (SNPs). A baseline has been developed that identifies the DNA composition of many BSAI and GOA salmon stocks. Until GOA trawl bycatch samples can be collected and analyzed, however, there is no information to determine what proportion of GOA Chinook bycatch is attributable to rivers of origin in the GOA or elsewhere. The Alaska Fishery Science Center is developing a research plan for sampling Chinook bycatch, but the focus is currently on bycatch in the Bering Sea pollock fishery, and GOA trawl bycatch has not yet been prioritized.

5 Chinook salmon stocks and directed fisheries

The State of Alaska manages commercial, subsistence and sport fishing of salmon in Alaskan rivers and marine waters and assesses the health and viability of individual salmon stocks accordingly. The catches of Chinook salmon in Southeast Alaska are regulated by quotas set under the Pacific Salmon Treaty. In other regions of Alaska, Chinook salmon fisheries are also closely managed to ensure stocks of Chinook salmon are not overharvested. No gillnet fishing for salmon is permitted in Federal waters (3-200 miles), nor commercial fishing for salmon in offshore waters west of Cape Suckling.

Directed commercial Chinook salmon fisheries occur in the Southeast Alaska troll fishery in the GOA, and in the Yukon River, Norton Sound District, Nushagak District, and Copper River. In all other areas, Chinook are taken incidentally, and mainly in the early portions of the sockeye salmon fisheries. Catches in the Southeast Alaska troll fishery have been declining in recent years due to U.S./Canada treaty restrictions and declining abundance of Chinook salmon in British Columbia and the Pacific Northwest. Chinook salmon catches have been moderate to high in most regions over the last 20 years (Eggers 2004).

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 GOA groundfish bycatch as compared to the commercial catch of salmon by area, Table 12 shows the commercial catch of Chinook species by management area between 2003 and 2007. The catches are shown here only as a proxy for an indication of run strength for Chinook stocks across the GOA. Available information on individual stocks and run strengths varies greatly by river and management area. A brief overview of Chinook stocks by area is included in Section 5.1 below. Commercial catches are subject to market constraints and, thus, are not the best estimate of the relative stock size. However, limited information regarding the health of the resource can be obtained by reviewing the commercial catch.

Table 12 Chinook salmon GOA commercial catch, by area, compared to GOA groundfish bycatch, 2003-2007, in 1000s of fish

Year	Southeast	Prince William Sound	Cook Inlet	Kodiak	Chignik	Alaska Peninsula/ Aleutian Islands[a]	Total	Total GOA groundfish Chinook bycatch
2003	431	49	20	19	3	7	**529**	15
2004	497	39	29	29	3	18	**615**	21
2005	462	36	29	14	3	14	**558**	31
2006	379	32	19	20	2	13	**465**	19
2007	359	41	18	17	2	13	**450**	40

[a] Area includes part of the Bering Sea Aleutian Islands

Source: ADFG (http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/catchval/blusheet/07exvesl.php), NMFS catch accounting PSC data, October 2008.

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 2005b). 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.. For Chignik, the 2004 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.

5.1 GOA Chinook salmon stocks

This section provides a brief overview of GOA Chinook salmon stocks. More detailed information on escapement and river systems is available and can be added to this section in future.

Southeast Alaska Stocks

Chinook salmon are known to occur in 34 rivers in the Southeast region of Alaska, or draining into the region from British Colombia or Yukon Territory, Canada (known as transboundary rivers). Harvest in Southeast Alaska occurs under the Pacific Salmon Treaty. 11 watersheds have been designated to track spawning escapement, and counts of these 11 stocks are used as indicators of relative salmon abundance as part of a coast-wide Chinook model. The Taku, Stikine, and Chilkat rivers together make up over 75% of the summed escapement goals in the region. Escapement on the Taku River remains low relative to the 1990-1999 average, but escapement to the Stikine River has increased greatly since 1999 (Pahlke 2007).

The Chinook salmon quota for Southeast Alaska, all gears, in 2006, was 329,400. In addition, a harvest sharing agreement with Canada under the treaty allows harvest in the Stikine River; the US allocation in 2006 was 13,350 fish. There was no directed fishery for Chinook salmon on the Taku River in 2006 due to low forecast returns (Nelson et al 2008).

Prince William Sound

The Prince William Sound management area encompasses all coastal waters and inland drainages entering the north central Gulf of Alaska between Cape Suckling and Cape Fairfield. An Sustainable Escapement Goal for Copper River Chinook is established at 24,000 fish, and inriver escapement to the upper Copper River is established for all salmon species combined. In 2005, about half of the Copper River Chinook salmon run was harvested commercially, a third went to spawning escapement, and the reminder was harvested by upriver sport users or personal and subsistence users (Hollowell et al. 2007).

Cook Inlet

The Cook Inlet management area is divided into 2 areas, the Upper Cook Inlet (northern and central districts) and the Lower Cook Inlet. Inseason management of Cook Inlet commercial salmon fisheries is based upon salmon run abundance and timing indicators. Catch data, catch per effort data, test fish data, catch composition data, and escapement information from a variety of sources is used to assess stock strength on an inseason basis. For Chinook salmon, surveys are made to index escapement abundance (Clark et al 2006).

There are three biological escapement goals (Kenai River early and late runs, Deshka River) and 18 sustainable escapement goals in effect for Chinook salmon spawning in Upper Cook Inlet. After experiencing a significant downturn in the early to mid-1990s, Northern District Chinook salmon stocks continue to trend sharply upward and most escapement goals are being met or exceeded. For the years 2000-2004, for the 15 Upper Cook Inlet populations with the most complete escapement observations, 97% of observed escapement exceeded the lower end of the escapement goal range (Clark et al 2006). Late-run Kenai River Chinook salmon runs are estimated by sonar, and have been relatively stable.

The recent 5-year average commercial harvest was used to forecast the harvest of Chinook salmon in 2008 for the Upper Cook Inlet. The commercial harvest estimate for Chinook salmon is 23,000 fish.

There are 3 sustainable escapement goals in effect for Chinook in the Lower Cook Inlet. Chinook salmon is not normally a commercially important species in the Lower Cook Inlet. The 2007 harvest totaled just under 500 fish, of which virtually all came from the Halibut Cove Subdistrict (Nelson et al 2008). Very little escapement information is available for this area.

Kodiak, Chignik, South Alaska Peninsula

There are three streams that support viable Chinook salmon in the Kodiak management area: Ayakulik River, Karluk River, and Dog Salmon Creek. Commercial harvest occurs during targeted sockeye salmon fisheries. Escapement objectives have been estimated for the Ayakulik and Karluk river systems, and escapement for all three rivers is estimated using fish counting weirs. In 2007, the escapement on the Ayakulik of 6,535 Chinook was within the escapement goal range, but below the previous ten-year average of 14,274 salmon (Dinnocenzo and Caldentey 2008). For the Karluk, 2007 escapement of 1,765 Chinook was below the escapement goal range of 3,600 to 7,300, although in previous years escapements have been within the goal range since 1998. Escapements have averaged 370 fish for Dog Salmon Creek since 1998 (Dinnocenzo and Caldentey 2008).

For the Chignik River, the 2004 Chinook escapement of 7,800 fish was the largest on record and greatly exceeded the escapement goal of 1,300-2,700 fish (Eggers 2006). There are no Chinook spawning streams in the South Alaska Peninsula district.

6 *C. Bairdi* Tanner Crab Bycatch

Several species of crabs may be taken incidentally in GOA groundfish fisheries, however this discussion paper focuses only on *C. bairdi* Tanner crab. The following sections provide updated information on bycatch in the GOA groundfish fisheries.

6.1 Mortality Rates

There are several sources that have calculated mortality rates for crab in various gear types and target fisheries, and many of them differ. The various studies are summarized in Table 13. At their May 2009 meeting, the Council's Crab Plan Team will be discussing the issue of appropriate mortality rates in both directed crab fisheries and other fisheries where crab is caught incidentally, and may be able to provide further guidance after that time. In the meantime, the data presented in the sections below do not account for handling mortality.

Table 13 Various calculations of mortality rates for harvested crab

Study		Directed crab fisheries			Groundfish fisheries			Scallop fishery
		King crab	*C. opilio* Tanner crab	*C.bairdi* Tanner crab				
		Pot	Pot	Pot	Pot	Trawl	Longline	Dredge
Council re-evaluation of overfishing levels	NPFMC et al 2007	20%	50%	20%				
Council's annual Crab SAFE report	NPFMC 2007	8%	24%	20%	20%	80%	20%	40%
Council's groundfish amendment	NPFMC 1995				8%	80%	37%	40%
NRC study	NRC 1990					12-82%		
1998 snow crab study	Warrenchuk and Shirley 2002			22.2%[a]				

[a] Estimate considered to be conservative because the estimated effects of wind and cold exposure as well as handling injuries were considered separately and not synergistically.

6.2 Bycatch in Federal groundfish fisheries, by area, gear type, and target fishery

In the GOA, *C. bairdi* bycatch primarily occurs in the western and central regulatory areas, and corresponds to the locations of the trawl and pot fisheries. Table 14 illustrates bycatch for 2003-2007, and 2008-to-date, across regulatory and reporting areas. Crab bycatch in the eastern regulatory area is negligable. Crab bycatch in the western regulatory area as a proportion of total GOA *C. bairdi* bycatch varies between 3% and 26% of the total, by year, and averages to approximately 10% over 2003-2007.

Table 14 *C. bairdi* bycatch by reporting area, 2003-2008, in GOA Federal[7] groundfish fisheries

Reporting area		2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Western	610	7,458	22,479	45,808	10,431	32,458	28,010	23,727
Central	620	24,033	5,893	9,578	67,316	57,452	43,746	32,854
	630	117,365	63,131	116,112	254,472	219,945	150,244	154,205
Eastern	640	1	0	33	28	17	64	16
	650	1	27	0	22	84	0	27
Grand Total		148,856	91,530	171,532	332,268	309,956	222,064	210,829

Source: NMFS catch accounting PSC data, October 2008. Excludes PSC attributed to the State Pacific cod fishery.

Table 15 identifies *C. bairdi* bycatch for 2003-2008, by gear type. Non-pelagic trawling and pot gear are almost entirely responsible for *C. bairdi* bycatch. In 2003, 2004, and 2006, non-pelagic trawl gear accounted for over 90% of *C. bairdi* bycatch, however since 2007, pot bycatch of *C. bairdi* crab has increased significantly. It should be remembered, however, that the relative observer coverage in these fisheries is notably limited, particularly in the Pacific cod pot fishery. Additionally, the relative impact of bycatch on the mortality of crab likely differs by gear type, although studies differ as to the degree. Section 6.1 provides information about the mortality rates of crab by gear type.

Table 15 *C. bairdi* bycatch by gear type, in GOA Federal groundfish fisheries, 2003-2008

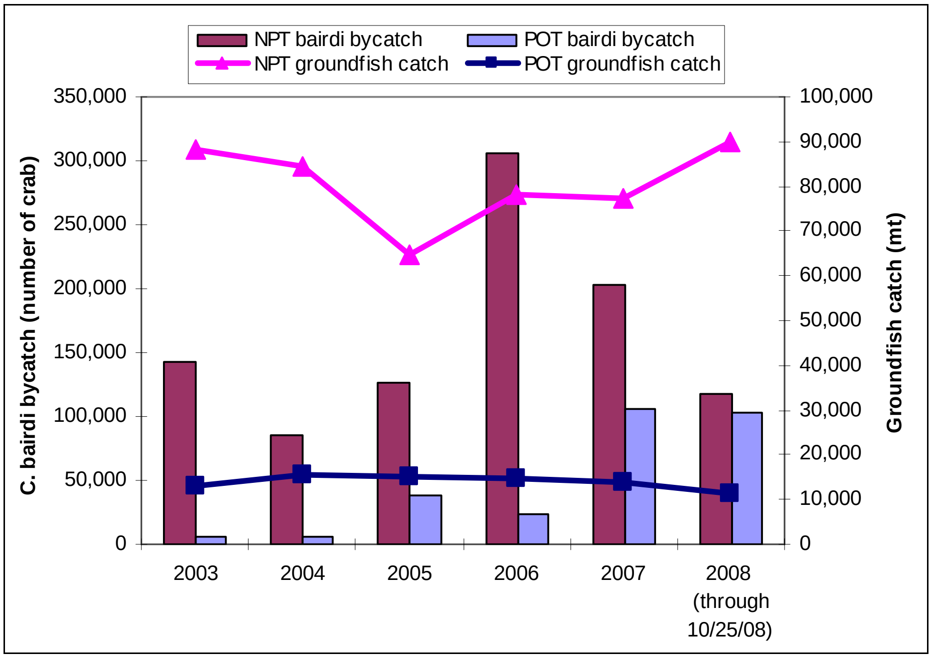
Gear type	2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Hook and line	21	28	1,770	596	272	1,638	538
Non-pelagic trawl	142,206	84,885	126,285	306,592	202,547	117,103	172,503
Pot	6,520	5,950	43,341	24,672	105,583	103,255	37,213
Pelagic trawl	110	667	136	407	1,554	67	575
Grand Total	148,856	91,530	171,532	332,268	309,956	222,064	210,829

Source: NMFS catch accounting PSC data, October 2008. Excludes PSC attributed to the State Pacific cod fishery.

Catch of groundfish by pot gear has remained relatively consistent throughout the last five years (Figure 3). In contrast, non-pelagic trawl bycatch has decreased somewhat since the high of approximately 300,000 crab in 2006, while groundfish catch has increased. Table 16 provides a time series of *C. bairdi* bycatch in groundfish trawl fisheries since 1993. Bycatch of *C. bairdi* Tanner crabs in the last 5 years (167,145 crabs per year average, 2003–2007) is higher than the average for the time series from 1993–2003 (108,540 crabs).

[7] Prohibited species catch (PSC), including catch of *C. bairdi*, is extrapolated to all catch in the GOA groundfish fleet using specific catch estimation procedures based on observed bycatch rates (see further explanation in Section 2.1). The observed bycatch rate is also applied to Pacific cod catch in the State managed fisheries that base their guideline harvest level on the Federal Pacific cod acceptable biological catch level (ABC). In order to provide the Council with an estimation of only the PSC taken in Federal fisheries, crab bycatch in the State waters pot fisheries was identified based on the date and location of catch. A discussion of the State waters Pacific cod fishery bycatch is presented separately in Section 6.5.

Figure 3 Annual bycatch of C. bairdi Tanner crab and groundfish catch, by Federal trawl and pot fishery sectors, 2003-2008



Source: *C. bairdi* crab bycatch from NMFS catch accounting PSC data, October 2008; excludes PSC attributed to the State Pacific cod fishery. Groundfish catch from NMFS catch accounting data, October 2008. Represents total GOA groundfish catch excluding State waters catch.

Table 16 *C. bairdi* crab bycatch in GOA groundfish trawl fisheries, 1993-2007

Year	*C. bairdi* Tanner		Year	*C. bairdi* Tanner
1993	55,304		2000	48,716
1994	34,056		2001	125,882
1995	47,645		2002	89,433
1996	120,796		2003	142,488
1997	134,782		2004	62,277
1998	105,817		2005	126,905
1999	29,947		2006	306,767
			2007	197,286
Average 1993-2007	**108,540**			
Average 2003-2007	**167,145**			

Data has been screened for confidentiality.

Source: M. Furuness, J. Keaton, NOAA Fisheries, 1993-2002; NMFS catch accounting PSC data for 2003-2007, October 2008.

The highest numbers of Tanner crab taken as bycatch occur primarily in the non-pelagic trawl fisheries (specifically the flatfish target fisheries, and sometimes Pacific cod and pollock targets) and in the pot fishery for Pacific cod (Table 17). Trawl flatfish fisheries represented approximately 90% of *C. bairdi* bycatch in 2003-2004, but has decreased in proportion since then to only 44% in 2008 to date. The pollock non-pelagic trawl fishery accounted for 35% of *C bairdi* bycatch in 2006, but only 6% in 2007, and negligible amounts in other years. Bycatch attributable to the trawl Pacific cod fishery has increased in 2007 and 2008, representing approximately 5% and 8% respectively, in those years. The Pacific cod pot fishery accounted for 25%, 34%, and 47% of GOA bycatch in 2005, 2007, and 2008, respectively, but only 4-7% in other years.

Table 17 Bycatch of *C. bairdi* Tanner crabs in Gulf of Alaska Federal groundfish fisheries, by gear type and target fishery, 2003-2008.

Gear type	Target Fishery	2003	2004	2005	2006	2007	2008 (through 10/25/08)	Average 2003-2007
Non-pelagic trawl	Arrowtooth Flounder	29,159	33,512	68,936	88,425	43,416	27,485	52,690
	Flathead Sole	17,534	30,410	43,956	25,884	254	6,776	23,608
	Pacific Cod	2,227	1,161	1,314	742	15,231	18,364	4,135
	Pollock	1	555	0	83,599	19,346	244	20,700
	Rex Sole	33,932	9,030	4,461	73,528	45,274	49,207	33,245
	Rockfish	178	1,517	1,445	959	152	62	850
	Shallow Water Flatfish	59,153	8,700	5,984	33,455	78,706	14,776	37,200
Pot	Pacific Cod	6,520	5,950	43,341	24,672	105,583	103,255	37,213

* = data is confidential.
Source: NMFS catch accounting PSC database, October 2008. Excludes PSC attributed to State Pacific cod fishery.

6.3 Timing of bycatch in Federal groundfish fisheries

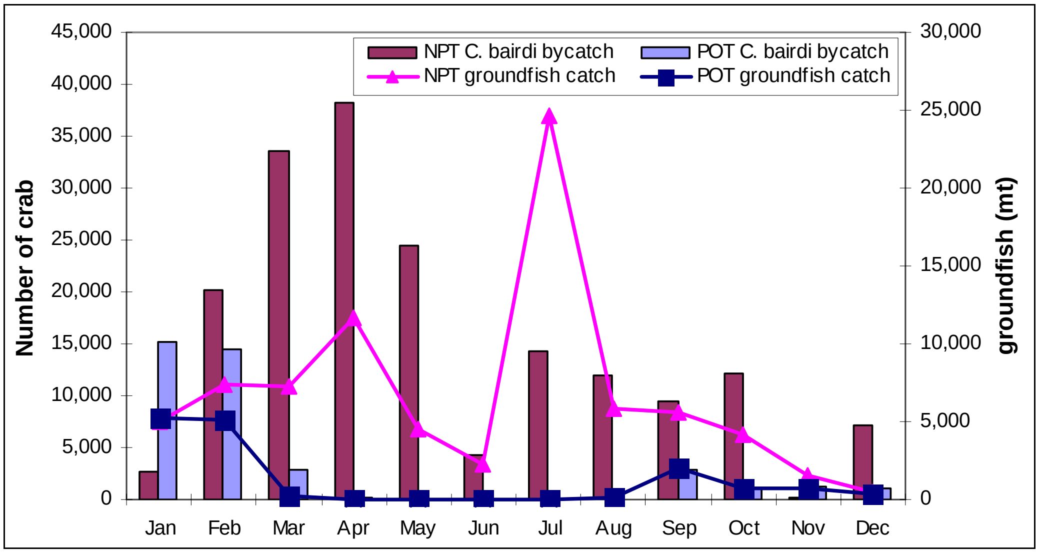
Bycatch amounts of *C. bairdi* Tanner crab taken in groundfish fisheries fluctuate temporally in direct response to groundfish catches (Table 18). Trawl Pacific cod and flatfish are managed on a quarterly basis, and the trawl fishery beginning on January 20th each year. The pot Pacific cod fishery has two seasons, and any catch in the Pacific cod target fishery from March to August has been attributed to the State managed Pacific cod fishery (see Section 6.5; Figure 4). In the trawl fisheries, average bycatch of Tanner crabs from 2003 - 2007 (in numbers of crabs) increased significantly in mid-March and April due to bycatch in the combined flatfish fisheries, and high bycatch was largely associated with the flatfish fisheries (Figure 4). If the spring months are indeed a time of high bycatch for Tanner crab, the Type II Red king crab closure in place in southeastern Kodiak (Section 3), which is in effect from February 15 to June 15, is likely to be effective at reducing Tanner crab bycatch in that area.

Table 18 *C. bairdi* crab bycatch by month, 2003-2008, in GOA Federal groundfish fisheries

Month	2003	2004	2005	2006	2007	2008	Average 2003-2007
January	4,315	1,999	31,788	9,903	43,411	59,974	18,283
February	9,930	7,519	19,878	66,206	69,675	64,346	34,642
March	19,281	34,643	39,790	71,340	12,482	8,969	35,507
April	22,715	24,492	47,696	64,496	32,177	31,165	38,315
May	35,929	1,615	11,553	21,640	51,343	2,491	24,416
June	10,298	1,893	1,093	7,707	8	54	4,200
July	6,097	16,698	8,518	22,765	17,499	35,653	14,316
August	9,346	354	481	36,878	12,736	18,546	11,959
September	6,300	1,491	5,497	19,495	29,198	200	12,396
October	24,645	725	1,839	10,569	28,990	666	13,354
November	*	78	2,841	494	1,895		1,061
December		24	559	776	10,542		2,975

* = data is confidential.
Source: NMFS catch accounting PSC data, October 2008. Excludes PSC attributed to State Pacific cod fishery.

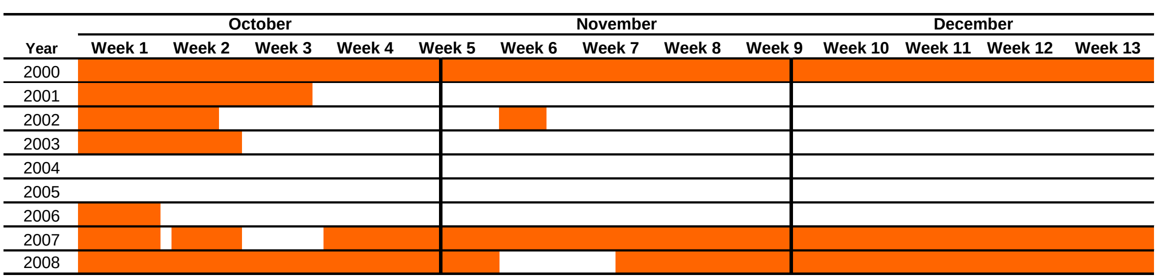
Figure 4 Average bycatch of C. bairdi Tanner crab and total groundfish catch by month, for non-pelagic trawl and pot sectors, in Federal fisheries, 2003-2007



Source: *C. bairdi* crab bycatch from NMFS catch accounting PSC data, October 2008; excludes PSC attributed to the State Pacific cod fishery. Groundfish catch from NMFS catch accounting data, October 2008. Represents total GOA groundfish catch excluding State waters catch.

The implementation of the rockfish pilot program, in 2007, has allowed some GOA non-pelagic trawl fisheries to occur later into the year than has been the case in years immediately previous. The rockfish pilot program has allowed fishery participants to reduce their catch of halibut PSC, which in previous years has closed down flatfish trawl fisheries in the GOA. Figure 5 illustrates the weeks in the last quarter of the year during which participants have been active in central GOA trawl fisheries, primarily for flatfish, from 2000 to 2008. Table 18 identifies that bycatch of crab in October, November, and December was higher in 2007, the only year of the program for which data is illustrated, than in previous years.

Figure 5 Season duration of the trawl Central Gulf of Alaska groundfish fisheries from October 1 to December 31, 2000 to 2008.



Source: NOAA Fisheries status reports and groundfish closure summaries

6.4 Location of *C. bairdi* bycatch

The data presented in the sections above has all been based on the NMFS catch accounting prohibited species catch data, which takes bycatch reports from observed fishing trips and extrapolates them to arrive at GOA-wide totals for recorded Chinook bycatch. In order to examine the spatial distribution of bycatch at a finer scale than that of the reporting area, it is only possible to use the bycatch data collected on observed trips, as only observed hauls are associated with geographical coordinates. Section 2 describes the proportion of fishing trips which are observed in the GOA. Consequently, it should be remembered, while interpreting the maps, that the data represents only a small proportion of the GOA fishing effort. Additionally, all of the maps use observer data that has been extrapolated to the haul level[8].

In the previous iteration of this discussion paper, dated December 2008, the distribution of bycatch was mapped for 2003-2007. Figure 26 and Figure 29 (on pages H and J, at the end of this document) map the total number of *C. bairdi* observed during the years 2001-2008, in Federal fisheries using non-pelagic trawl and pot gear, respectively. In order to see how the most recent bycatch patterns compare to the eight-year time series, Figure 27 and Figure 30, on pages H and J, show bycatch distribution for 2008 only. Figure 28 and Figure 31, on pages I and K, illustrate the total bycatch rate, number of Chinook per metric ton of total catch, for the period 2001 to 2008, for the same gear types. Other closures already in effect for non-pelagic trawl and pot fisheries are illustrated on the maps.

6.5 Bycatch of *C. bairdi* in the State waters Pacific cod pot fishery

The State-managed Pacific cod fishery in western and central GOA began in 1997, and is only open to pot and jig gear. The fishery is managed in five districts: South Alaska Peninsula, Chignik, Kodiak, Cook Inlet, and Prince William Sound. The State bases its guideline harvest level on the Federal acceptable biological catch for Pacific cod, and the Council and NMFS reduce the Federal total allowable catch for Pacific cod to accommodate the State fishery. In most cases, the fisheries open one week after the close of the Federal Pacific cod A season, and occur in late February – April.

In the discussion of bycatch numbers for *C. bairdi* above, catch amounts attributable to the State Pacific cod fishery have not been included in the data. Because the State Pacific cod fishery guideline harvest level is based on the Federal acceptable biological catch for Pacific cod, NMFS inseason management tracks the catch of Pacific cod in the State water fishery, and also makes prohibited species catch extrapolations based on that groundfish catch. In order to provide the Council with a separate estimation of *C. bairdi* crab taken in the Federal and State fisheries, crab bycatch in the State Pacific cod pot fishery was identified based on the date and location of catch. These data are presented separately in this section.

Table 19 identifies the *C. bairdi* bycatch attributable to the State managed Pacific cod pot fishery, which varied from approximately 6,600 crab in 2003, to 184,566 crab in 2007[9]. The contribution of the State managed fishery to overall *C. bairdi* bycatch in the GOA ranged from a low of 4%, in 2003, to a high of 37%, in 2007. Since 2005, the State Pacific cod fishery has contributed a minimum of 20% to the overall *C. bairdi* bycatch in the GOA (Figure 6). It is worth nothing that the bycatch estimates from the State managed fishery are based on minimal observer coverage, and these estimates should be interpreted with caution.

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[8] Observers do not sample the entire haul from a fishing tow, but rather collect one or several basket samples. The number of Chinook collected within the basket sample is extrapolated by the Observer Program to represent the number of Chinook caught in the entire haul. Extrapolating to the haul level allows the data to be better compared across hauls, even though individual sample sizes may differ.

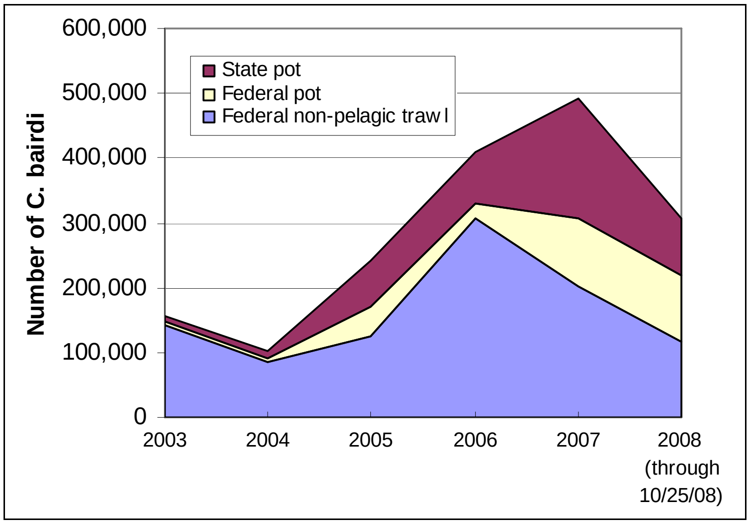
[9] In previous versions of this discussion paper, the *C. bairdi* crab bycatch attributable to the State versus Federal pot fishery was not presented separately.

Table 19 *C. bairdi* bycatch in Federal and State groundfish fisheries, 2003-2008

	2003	2004	2005	2006	2007	2008 (through 10/25/08)
Federal fisheries (hook and line, pot, and trawl)	148,856	91,530	171,532	332,268	309,956	222,064
State Pacific cod fishery (pot gear)	6,515	11,081	72,733	78,729	184,566	85,495
Grand Total	**155,372**	**102,610**	**244,265**	**410,997**	**494,522**	**307,559**
State as % of total	4.2%	10.8%	29.8%	19.2%	37.3%	27.8%

Source: NMFS catch accounting PSC database, October 2008.

Figure 6 Federal and State *C. bairdi* bycatch in GOA groundfish fisheries

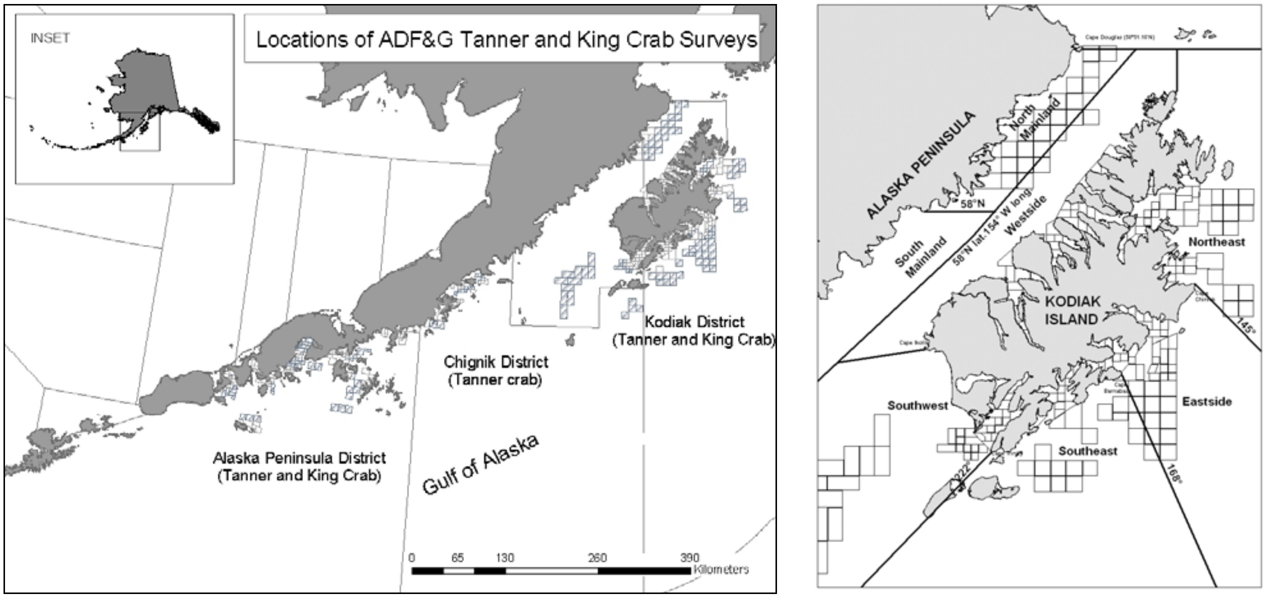


Source: NMFS catch accounting PSC data, October 2008.

7 *C. bairdi* Tanner crab stocks and directed fisheries

Crab fisheries in the GOA are 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 ADFG. The survey methodology is designed to concentrate sampling in areas of historical king and Tanner crab abundance (Figure 7).

Figure 7 ADF&G trawl survey stations for Tanner and king crab abundance, and fishery management districts around Kodiak Islands



Source: K Spalinger, ADFG

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 Alaska Peninsula District. Catch information for 2003 to 2008 is provided in Table 20. Guideline harvest levels (GHLs), by region, are the following for 2009: Kodiak (Eastside and Northeast sections combined) 400,000 pounds and South Peninsula 275,000 pounds (ADFG 2008). In 2007, the GHL for the two Kodiak districts was 800,000 pounds, and for the South Peninsula was 200,000 pounds (ADFG 2007).

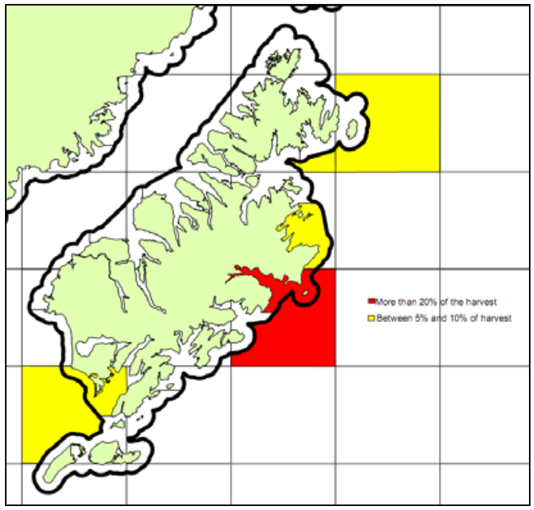
Table 20 Commercial fishery harvest from Kodiak, Chignik, and South Peninsula districts, compared to groundfish fisheries bycatch

	Tanner crab commercial fishery						***C. bairdi* Tanner crab bycatch in the groundfish fisheries** (number of crab, includes juvenile, male and female)
	Kodiak		**Chignik**		**South Peninsula**		
	millions of pounds	average number of crab	millions of pounds	average number of crab	millions of pounds	average number of crab	
2003	0.51	215,594	no fishery		no fishery		148,856
2004	0.795	253,971	no fishery		no fishery		91,530
2005	1.75	738,535	0.4	179,372	0.3	135,747	171,532
2006	2.1	887,534	0.2	80,000	0.29	128,889	332,268
2007	0.8	338,266	no fishery		0.2	87,719	309,956
2008	0.5	211,864	no fishery		0.25	108,696	222,064 (through 10/25/08)

Source: http://www.cf.adfg.state.ak.us/geninfo/shellfish/shellfish_harvest.php for commercial harvest, average crab weight from K. Spalinger; NMFS catch accounting PSC database, October 2008 for groundfish bycatch.

ADFG staff mapped the location of the majority of Tanner crab harvest, on average, between 2005-2008 (Figure 8). It was noted that relative importance of harvest may vary on a year to year basis.

Figure 8 Location of high percentages of the Tanner crab harvest, based on 2005-2008 average.



Note: Only one statistical area, Kiliuda, was not included that was important in one year.
Source: K. Spalinger and N. Sagalkin, ADFG

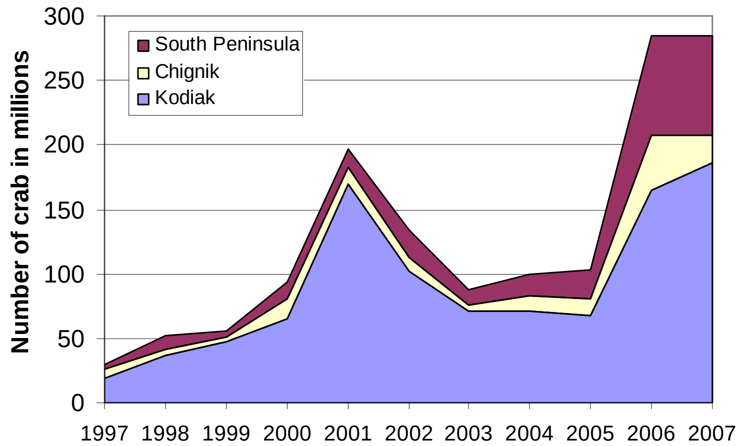
Population estimates for 1997-2007, based on the ADFG surveys, are provided in Table 21 and Figure 9. Population estimates are illustrated individually for the Kodiak, South Peninsula, and Chignik Districts in Figure 10 through Figure 12. The patterns in groundfish bycatch of Tanner crab are roughly comparable with the trends in abundance (see Figure 6 on page 26). 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). Maps of the juvenile and mature male and female Tanner crab density, from the 2007 ADFG survey, are included as Figure 19 and Figure 20, on pages C and D, at the end of this document.

Table 21 Population estimates for Kodiak, Chignik, and South Peninsula districts, from the ADFG bottom trawl survey, compared to groundfish fisheries bycatch (# of crab)

	Tanner crab population estimates				*C. bairdi* Tanner crab bycatch in the GOA groundfish fisheries
	Kodiak	Chignik	South Peninsula	Total GOA	
1997	19,549,768	6,187,241	3,423,890	29,160,899	
1998	37,301,601	3,638,101	11,494,791	52,434,493	
1999	47,308,846	3,679,516	4,821,093	55,809,455	
2000	65,757,053	15,016,398	13,236,554	94,010,005	
2001	169,728,000	12,661,036	14,285,065	196,674,101	
2002	102,080,109	10,770,374	20,741,451	133,591,934	
2003	70,568,053	5,736,390	11,267,753	87,572,196	148,856
2004	71,001,649	12,071,083	16,140,938	99,213,670	91,530
2005	67,676,189	13,425,618	22,258,555	103,360,362	171,532
2006	165,042,947	42,001,597	77,288,253	284,332,797	332,268
2007	186,255,950	21,372,141	76,775,256	284,403,347	309,956

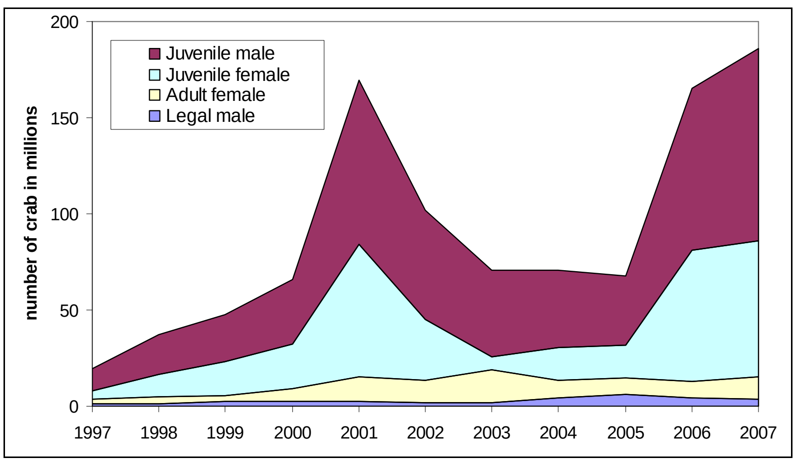
Source: Spalinger 2008 for ADFG survey; NMFS catch accounting PSC database, Oct 2008 for groundfish bycatch.

Figure 9 Population estimates for Kodiak, Chignik, and South Peninsula districts, from the ADFG bottom trawl survey



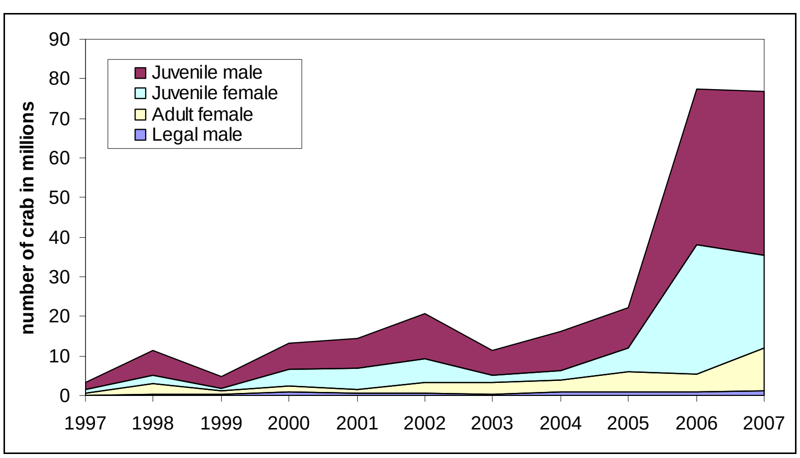
Source: Spalinger 2008.

Figure 10 Tanner crab population estimates in the Kodiak district, based on ADFG trawl surveys 1997-2007



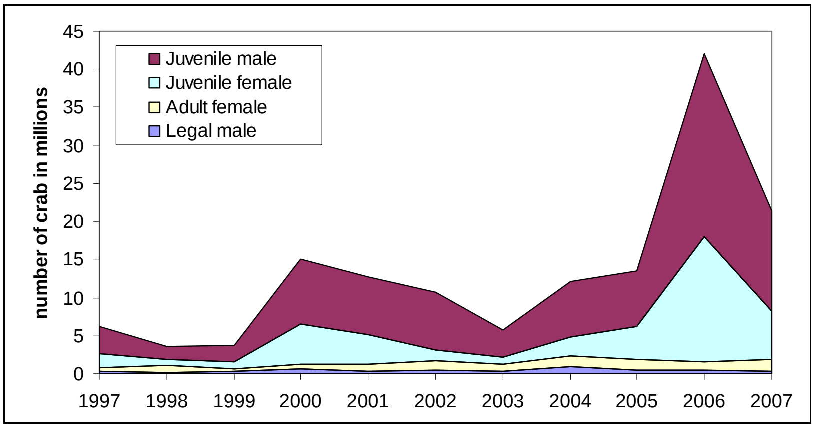
Source: Spalinger 2008.

Figure 11 Tanner crab population estimates in the South Peninsula district, based on ADFG trawl surveys 1997-2007



Source: Spalinger 2008.

Figure 12 Tanner crab population estimates in the Chignik district, based on ADFG trawl surveys 1997-2007



Source: Spalinger 2008.

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.

8 Management options to reduce bycatch

In order for the Council to move forward with management options to reduce bycatch, it is important to determine what is the Council's desired objective, as this influences what management options will appropriately address the problem. The Council has already narrowed the scope of this discussion paper down to two species of interest: Chinook salmon and *C. bairdi* Tanner crab. Bycatch of these two species in the GOA groundfish fisheries is high relative to other salmon or crab species. The Council's purpose in trying to reduce bycatch is likely to be one of the following factors, or a combination of them: a. groundfish bycatch of these species represents a conservation concern; b. groundfish bycatch of these species is impacting directed fisheries for these species; or c. mortality caused by groundfish bycatch of these species is at a socially unacceptable level (note, this is ties into one of the Council's management objectives for the groundfish fisheries).

In all cases, the Council is evaluating whether the groundfish fisheries' bycatch levels cross a threshold at which corrective action is warranted. For various reasons, information is not available to determine, with specificity, to what degree the amount of bycatch taken in groundfish fisheries is likely to affect the sustainability of salmon and crab populations. Sections 5 and 7 provide limited information on the Chinook and *C. bairdi* populations, with which to put in context the bycatch numbers presented in the discussion paper. Based on this information, the Council will decide further action should be considered, and management options to reduce bycatch should be instituted.

The type of management options available to the Council include seasonal and permanent area restrictions to a particular gear type or target fishery; temporal area restrictions, that may be triggered by attainment of a bycatch limit; or creation of industry-level bycatch management entities that can effect real-time communication to avoid 'hotspot' areas of high bycatch. All of these management options have benefits and disadvantages, which cannot be fully analyzed in this discussion paper, but which will be addressed in detail should the Council choose to initiate an analysis. The sections below provide a brief outline of the management options that could be included in an analysis, as well as some preliminary strawman closures to illustrate some of the options.

8.1 Draft alternatives

The following suite of draft alternatives for reducing salmon and crab bycatch in the GOA groundfish fisheries were first proposed by the Council in December 2003, and have been iteratively refined since that time. In June 2008, the Council eliminated alternatives for salmon and crab species other than Chinook salmon and *C. bairdi* Tanner crab, and requested staff to begin to develop strawman closures to pair with the draft alternatives. The following are the draft alternatives:

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 cooperative for hotspot management.

C. bairdi 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 cooperative for hotspot management.

In June 2005, the Council also provided, in their motion, the following comments on developing trigger limits, and general recommendations for an analysis.

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 Council 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.

8.2 Estimating trigger limits

Trigger limits, as proposed under Alternatives 2, would close designated areas to all or specified gear types or target fisheries once a bycatch limit has been reached. PSC limits and associated closures have been used for salmon and crab bycatch in the Bering Sea groundfish fisheries (Witherell and Pautzke 1997). For instance, the pelagic trawl pollock fishery accounts for a high percentage of GOA Chinook bycatch. The Council might set a bycatch limit for Chinook salmon, and once it has been attained (either by the fleet as a whole, or exclusively by the pollock fishery), a designated area might be closed to pollock fishing for the remainder of the year or season. Likewise for Tanner crab, the Council might establish a linkage between the bycatch limit and the non-pelagic trawl flatfish fishery, and once the bycatch limit has been reached, an area closure could apply to the flatfish fishery.

In the past, the Council has provided direction to staff with respect to establishing trigger limits. Staff were encouraged to look at abundance-based methodologies for developing potential trigger limits. These could either be based on an estimate of, or float as a percentage of, the overall biomass of Chinook or *C. bairdi* species. This abundance-based approach has been used in the BSAI groundfish fisheries for crab species. A stair-step procedure of increasing PSC limits corresponding to higher population levels is in place for red king crab; an abundance-based zonal approach is used for *C. bairdi* Tanner crab; and the snow crab PSC limit is based on the percentage of annual biomass estimates. Biomass-based limits require a good understanding of the relative stock status for that species. Sections 5 and 7 provide an overview of stock status for Chinook salmon and *C. bairdi* Tanner crab in the GOA, but a detailed understanding of the health and vulnerability of crab stocks will be integral to determining the appropriate mechanism for establishing trigger limits, if the Council chooses to include a trigger limit management option in a future analysis.

The proposed alternatives using trigger closures would work similar to other existing PSC management measures. Currently in the GOA, PSC limits are only set for halibut in the flatfish fisheries, so that if the PSC limit for the target fishery (or group of target fisheries) is reached within a given season, the fishery (or fisheries) is closed for the remainder of the season. Establishing trigger bycatch limits for Chinook salmon or *C. bairdi*, as proposed under Alternatives 2, would result in a similar procedure. Inseason management would monitor the accrual of bycatch toward the PSC limit. As most of the GOA groundfish fisheries are subject to less than 100% observer coverage, bycatch rates from observed vessels would be applied to catch on unobserved vessels using the catch accounting database estimation procedure, described in Section 2.1.

In order to establish PSC limits for Chinook or *C. bairdi*, the Council would first establish what type of bycatch would accrue to the trigger limit (e.g., all bycatch by any gear type, or specific bycatch by gear type, target fishery, and/or regulatory area). Next, the Council would establish what the consequence of arriving at the limit would be (e.g., an area closure for the remainder of the year or season), and to whom the consequence would apply (e.g., a particular gear type and/or target fishery).

It has been suggested that establishing trigger PSC limits for managing Chinook salmon and *C. bairdi* crab bycatch in the GOA is problematic. The low proportion of observed catch in the GOA means that the reporting of total bycatch numbers involves considerable extrapolation. Inherent in the catch estimation procedure is the fact that a catch of one salmon or crab in a small groundfish haul (resulting in a high bycatch rate) can sometimes be extrapolated to very large amounts of catch, resulting in exceedingly high bycatch totals for the GOA as a whole. The Alaska Fisheries Science Center is looking into the possibility of including estimates of statistical confidence into the bycatch estimation procedure, but for the moment, the current procedure is the best available. It is also the procedure that is currently used to manage the PSC limit for halibut in the GOA.

8.3 Determining appropriate area closures and preliminary strawman closures

Year-round and seasonal closures, such as those proposed under Alternatives 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. Area closures can also be associated with PSC trigger limits, as under Alternative 2, so that a particular area is closed once the PSC limit is reached.

For salmon, the highest bycatch is seasonal, and is tied to the timing of the pollock fishery. Seasonal closures of hot spot locations could merit examination, rather than year-round closures. Seasonal salmon closures have been used to control salmon bycatch in the BSAI groundfish fisheries, although in recent years these closures have been problematic, and measures to address salmon bycatch, including revised area closures and PSC limits that would close the pollock fishery when triggered, are currently under review (NMFS 2008). Given that the Council is currently revising bycatch reduction measures for salmon in the BSAI, any measures evaluated in the GOA should consider and build upon lessons learned in the BSAI.

There are various methodologies available for identifying appropriate areas to close in order to reduce bycatch of salmon and crab. One such is to look at areas of high abundance of the species in question, and restrict fishing in those areas. This methodology could be used for crab, but as discussed above, is less effective for Chinook salmon. To some extent, closures that protect *C. bairdi* crab are already in effect for non-pelagic trawl vessels, such as the Type I and II red king crab closures as well as State water closure, which encompass some areas of high Tanner crab abundance (see Section 7). However, Tanner crab abundance is variable from year to year, as are bycatch patterns, which complicates the identification of key abundance areas.

Another methodology that was used by the Council to create habitat closures in the Aleutian Islands and the northern Bering Sea is the footprint approach. For example, in the Aleutian Islands, closures were intended to protect coral (and fish habitat), and little is known about the abundance of coral in those areas. Closures in this instance were identified to contain fishing within historic limits. The footprint approach is not necessarily helpful when protecting highly mobile species such as salmon, however.

The default methodology for this preliminary analysis is to use bycatch locations as a proxy for abundance, and identify closure areas based on the locations of hauls with observed bycatch. High incidence of bycatch and high bycatch rates, summed over the years 2003-2007, were used to identify the strawman closures described below. There are many problems with this approach, some of which have already been described above. The observer data is the best available data for designing closures based on where the fishery encounters bycatch. However, the observed fishing trips represent only a relatively small proportion of total fishing trips in the western and central GOA. Also, for vessels that are not 100% observed, the areas where a vessel chooses to fish while it has an observer onboard may be purposefully different than the areas where it fishes without an observer. This might occur if a vessel chooses not to make longer trips with an observer onboard, because it might require paying the observer for a longer duration than is necessary to meet the observer requirement. If this is the case, basing a spatial analysis of where bycatch is occurring on the observer data may not always produce an accurate representation of actual bycatch distribution. Another issue with using the observer data for identifying regulatory closures was discussed in Section 2.3, on page 8, with respect to sampling bycatch at the plant in the pollock fishery, and the fact that it effectively averages the bycatch caught on a trip across all the hauls that occurred during that trip.

Additionally, areas with high numbers of bycatch also tend to be the areas where most of the catch is occurring. By prohibiting vessels from fishing in areas of high catch per unit effort, bycatch closures would force vessels to fish longer in other, less productive areas, which may result in higher bycatch rates in the long run. This issue can be addressed by looking at areas with high bycatch rates (e.g. crab/mt groundfish) instead of looking at absolute bycatch numbers. However, bycatch rates are also a problematic methodology, because some of the highest bycatch rates arise from having one salmon or crab caught in a small tow of groundfish, which may not necessarily be representative of a high abundance area that would benefit from a closure.

Bycatch patterns (as with abundance patterns for Tanner crab) are also highly variable from year to year. The correlation between the location of fishery catch and salmon and crab bycatch has not been fully investigated, but preliminary analysis seems to indicate that the variability is as much a function of salmon and crab life history changes or abundance as it is changes in the fleet's fishing patterns. This complicates the identification of appropriate closure areas to protect Chinook salmon and *C. bairdi* crab, as a closure that might be appropriate to protect the species in one year may be ineffective in another one. This appears to have been the case with the salmon closure areas for Chinook and chum salmon in the BSAI, which are currently under review by the Council. Since the initial evaluation of strawman closures was made, in the version of this discussion paper dated December 2008, staff have mapped and included additional years of observed bycatch history: 2001, 2002, and 2008. Consequently, it is the strawman closures that are described below, based on 2003-2007 bycatch, are often mapped against the 2001-2008 time series, or against 2008 alone. This comparison will allow the Council to see the annual variability in bycatch patterns, and some of the problems with establishing closure areas as a mechanism to reduce Chinook and Tanner crab bycatch in the GOA groundfish fisheries.

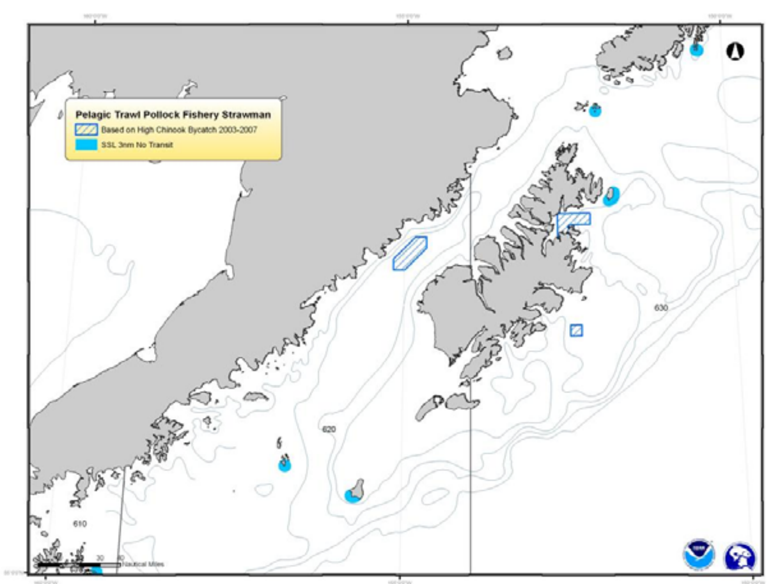
Strawman closures for Chinook salmon

For Chinook salmon, staff tried to look at separate strawman closures for vessels using pelagic and non-pelagic trawl gear. While the majority of salmon overall is taken in the pollock pelagic trawl fishery, the non-pelagic trawl fisheries combined contribute an average of 25% to the total GOA Chinook bycatch. Based on the observer data, however, it was very difficult to identify hotspot bycatch areas that could serve as strawman closure areas for the non-pelagic trawl fleet. For this reason, strawman closures for non-pelagic trawl gear are not included in this discussion paper, although it is possible that further detailed analysis of the observer data may be able to suggest a different methodology for identifying closures for this gear type in the future.

For pelagic trawl, strawman closures were identified based on high incidence of Chinook salmon in the pelagic pollock trawl fishery during 2003-2007 (Figure 13). The closures were identified by selecting areas with the highest category of observed bycatch during those years, extrapolated to the haul level, and also include any areas of the second highest category that surround it. An attempt was made to include areas of at least two blocks of high or highest catch. The closure areas are overlaid on maps of the observed number of Chinook salmon from 2001-2008 (Figure 32, on page L at the end of the document), and for 2008 only (Figure 33), which provides information on the spatial variability of the catch on an annual basis. Additionally, the strawman closures are compared to the bycatch rate of salmon, from 2001-2008, for the pelagic trawl fishery (Figure 34). This methodology results in three closure areas, all of which occur in the central GOA.

As discussed in Section 2.3 and above, prohibited species in the pollock fishery are sampled at the plant, and the location of the bycatch is averaged among all hauls in a given trip. Should the Council proceed with an analysis of closure areas for pelagic trawl gear, a more detailed spatial analysis would need to be conducted to investigate the impact of this averaging on the delineation of appropriate closure areas.

Figure 13 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch summed for 2003-2007



Strawman closures for *C. bairdi* Tanner crab

For *C. bairdi* crab, staff looked at separate strawman closure areas for vessels using non-pelagic trawl gear and for those using pot gear, using 2003-2007 bycatch data. The strawman closures do not overlap at all. All closure areas for non-pelagic trawl gear fall in the central GOA, as areas of bycatch in the western GOA did not meet the criteria used to develop the strawman areas. Pot strawman closures do extend into the western GOA. In order to provide different perspectives on the closures, given the problems with developing closures as noted above, staff looked at several ways of identifying strawman closures.

The first set of strawman closures (Figure 14 and Figure 15) are based on areas of high incidence of bycatch. The closures were identified by selecting areas with the highest category of observed bycatch in 2003-2007, extrapolated to the haul level, and also include any areas of the second highest category that surround it. An attempt was made to include areas of at least two blocks of high or highest catch. There are three individual strawman closures identified for non-pelagic trawl gear, and seven areas identified for pot gear, five in the central GOA and two in the western GOA. The non-pelagic trawl and pot closures identified through this method occur in completely different areas, and there is no overlap between them. Figure 14 illustrates the non-pelagic trawl and pot strawman closures for the central GOA on the same map.

The closure areas for non-pelagic trawl gear are overlaid on a map of high incidence of bycatch in the years 2001-2008 (Figure 35, on page N at the end of the document), and a map showing only 2008 (Figure 36), to illustrate the spatial variability on an annual basis. The map also denotes existing closures that pertain to vessels fishing with non-pelagic trawl gear. For pot gear, Figure 39 (page P) compares the pot strawman closures to high incidence of bycatch in 2001-2008, and Figure 40 does the same for the year 2008. Figure 41 compares the strawman closures based on high incidence of bycatch to the pot gear bycatch rate for 2001-2008. The strawman areas that are identified in the figures are also areas where the much of the catch is taken. Implementing closures in these areas will be disruptive to the fishery, and displacement of effort will occur, which may result in lower catch per unit effort and other bycatch effects.

Figure 14 ***C. bairdi*** **crab strawman closures in the central GOA, for non-pelagic trawl and pot gear, based on high incidence of bycatch summed over 2003-2007**

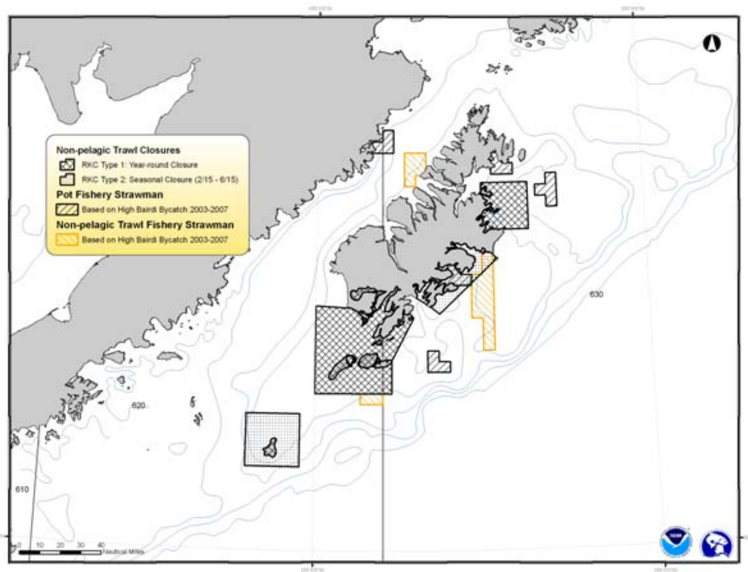
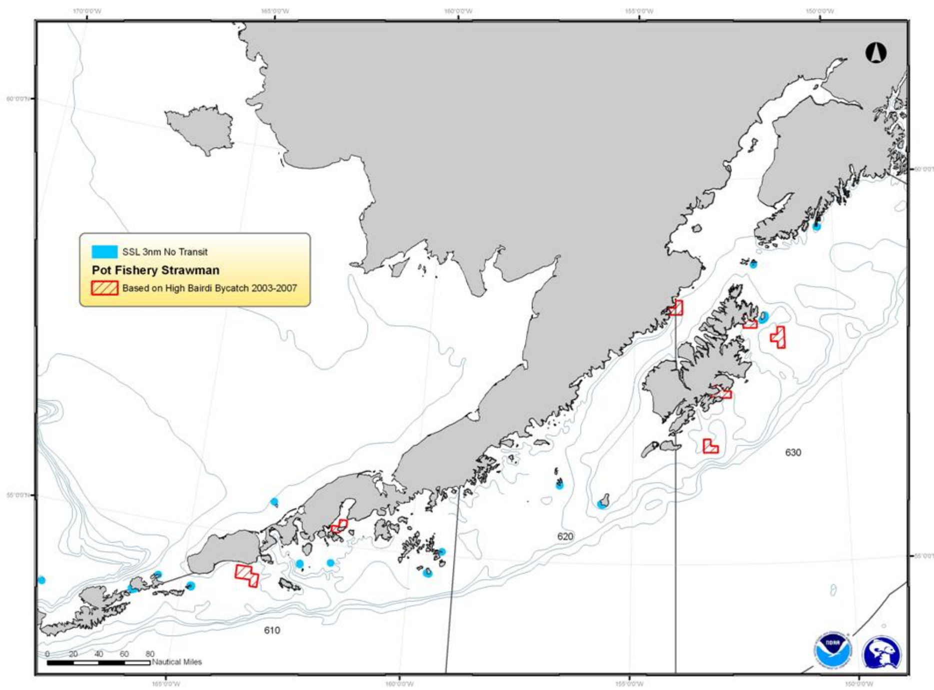


Figure 15 ***C. bairdi*** **crab strawman closures for pot gear in the western and central GOA, based on high incidence of bycatch summed over 2003-2007**



Staff also looked at areas where bycatch has repetitively been observed, without looking at the amount of bycatch that was reported for those areas. Areas that have repetitive bycatch may also be candidates for closure areas, and looking at bycatch in this way eliminates the extrapolation that occurs under the set of high incidence strawman closures. However, it is also likely that these areas are also the most heavily fished. The areas identified using this approach are similar to the areas identified using the high incidence of bycatch approach, and staff did not reproduce them in this paper. Similarly, staff evaluated strawman closure areas based on the top 10% of records of high bycatch, which were also little different from those identified by looking at high incidence overall.

For non-pelagic trawl gear, staff also provided another set of strawman closures identifying areas based on the bycatch rate (Figure 37, on page O). This approach results in fewer total closures areas than by looking at high incidence, and the closure areas do not overlap (see Figure 38 for a comparison). This approach was not used to develop strawman closure areas using bycatch rate for pot gear. The methodology used by staff involves identifying blocks with the highest bycatch rate as those for the strawman closure, and for pot gear, there were no particular areas with high bycatch rates in 2003-2007.

Catch statistics for strawman closures

Table 22 provides a synthesis of the strawman closures identified above. The data , summed for 2001 to 2008, is from the observer database which was used to map the distribution of Chinook and *C. bairdi* bycatch in the western and central GOA. The table provides the overall bycatch rate of Chinook salmon or *C. bairdi* crab per total catch in the western and central GOA, by gear type, for 2001-2008, and compares it to the bycatch rates in the areas encompassed under the sets of strawman closure areas. Additionally, the total number of tows or sets occurring in each set of closure areas is compared to the total number of hauls that contain the bycatch species in question, which gives an idea for the degree to which bycatch is pervasive in the strawman closures. The final columns identify how much of the total observed catch and total observed bycatch come from the strawman closure areas.

Table 22 Total observed catch and Chinook or bairdi bycatch in strawman closures, by gear type, compared to catch and bycatch of that gear type in the western and central (W/C) GOA, summed over 2001-2008

Area, gear type, and bycatch species	**Total Chinook or bairdi bycatch[2]** (number)	**Total fishery catch[2]** (mt)	**Bycatch rate** (bycatch/ total catch)	**Total number of tows/sets in strawman areas**	**Total tows/ sets with bycatch in strawman areas**	**% of total W/C GOA bycatch occurring in strawman areas**	**% of total W/C GOA catch occurring in strawman areas**
Chinook – pelagic trawl gear							
Pelagic trawl in western and central GOA	24,299	119,638	0.20				
Pelagic trawl strawman closures based on high incidence of Chinook[1]	9,524	32,567	0.29	965	702	39.2%	27.2%
C. bairdi – non-pelagic trawl gear							
Non-pelagic trawl in western and central GOA	249,277	219,768	1.13				
Non-pelagic trawl strawman closures based on high incidence of bairdi[1]	150,029	22,850	6.57	1,832	690	60.2%	10.4%
Non-pelagic trawl strawman closures based on high bycatch rates of bairdi[1]	13,426	355	37.82	60	34	5.4%	0.16%
C. bairdi – pot gear							
Pot gear in western and central GOA	41,569	10,550	3.94				
Pot gear strawman closures based on high incidence of bairdi[1]	14,937	849	17.59	215	124	36.9%	8.1%

Source: NMFS observer database, March 2009.
[1] The methodology used to identify the strawman closures is described earlier in Section 8.3, and the closures themselves are illustrated in Figure 13, Figure 14, Figure 15, and Figure 38 (on page O at the end of the document).
[2] These numbers are based on observer data that has been extrapolated to the haul level. Observers do not sample the entire haul from a fishing tow, but rather collect one or several samples. The number of a particular bycatch species collected within the sample(s) is extrapolated by the Observer Program to represent the number of that bycatch species caught in the entire haul.

For the pelagic trawl gear strawman closures for Chinook, the bycatch rate increases from an average of 0.20 GOA-wide to 0.29 in the strawman closure areas as a group. 73% of all observed tows in the strawman closure areas contained Chinook bycatch. The strawman closure areas encompass areas where almost 40% of the observed Chinook bycatch was reportedly caught[10], but they also represent areas where 27% of the total catch in the pelagic trawl fishery was harvested. Consequently, if these areas were made into regulatory closures, a quarter of the effort in the fishery would be dispersed into other areas. Should the Council choose to pursue an analysis with this as an alternative, the analysis would have to look at the likely areas where the fishery could recoup that effort, and what the bycatch rates would be likely to be in those areas.

For the non-pelagic trawl fishery, there are two proposed sets of strawman closure areas, based on areas of high bycatch incidence, and areas of high bycatch rates. It is apparent from Table 22 that the strawman closures based on high incidence of bycatch encompass much more fishing effort than those that are based on high bycatch rate. As discussed earlier in the section, a high bycatch rate may often be assigned to an area because there has been low groundfish fishing effort in the area, and so the catch of a relatively small amount of bycatch may result in an apparent high bycatch rate. Should the Council initiate an analysis that looked at the development of closure areas based on bycatch rates, the analysts would need to carefully examine the individual records for each area, in order to determine to what degree the closure of the area would be likely to assist the Council's overall goal to reduce bycatch. For the non-pelagic strawman closure areas based on high incidence, only a third of the tows encompassed in the strawman areas contained bairdi bycatch. The strawman closure areas account for approximately 60% of observed bairdi bycatch, and approximately 10% of observed catch.

The bycatch rate for pot gear within the pot strawman closure areas increases to 17.59, from the western/central GOA-wide pot gear bycatch rate of 3.94. Approximately 37% of the observed bairdi bycatch is caught in the strawman closure areas, compared to approximately 8% of the observed total catch. Pot and non-pelagic trawl gear are assumed to have different bycatch mortality rates for crab species, but because the calculated mortality rates differ widely according to the source (see Section 6.1), the calculation from overall bycatch to bycatch mortality is not made in this discussion paper.

8.4 Voluntary bycatch cooperatives

Alternative 4 for both crab and salmon species would establish 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 salmon bycatch in the pollock fishery. Currently in the BSAI, a program of voluntary area closures is in place with selective access to those areas for fleets which demonstrate success in controlling bycatch (Haflinger 2003, NMFS 2008). 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, NMFS 2008). This system relies upon information voluntarily reported to Sea State by the fleet per their cooperative agreements.

One problem with implementing a voluntary cooperative program in the GOA is the fact that the GOA fisheries tend to be of short duration. In the Bering Sea, hotspot areas can be closed on a weekly basis, however this approach would not work in the GOA fisheries. Additionally, the program is more easily implemented in the Bering Sea pollock fishery because the fishery is rationalized, and the agreement is between cooperatives with dedicated pollock allocations. An extensive discussion of the BSAI intercooperative agreement is included in the Draft Environmental Impact Statement for Bering Sea Chinook Salmon Bycatch (NMFS 2008).

[10] See Section 2.3 for discussion of the sampling mechanism for the GOA pollock fishery, and impacts on the averaging of bycatch across multiple haul locations.

9 Action by the Council

The decision before the Council is whether to initiate an analysis to examine one or more of the management options proposed in this discussion paper, or others that the Council may wish to include in an analysis. Strawman closures have been developed by staff in order to provide a starting point for discussion of management options that include spatial or temporal fishery closures.

If the Council chooses to initiate an analysis, the Council should articulate a problem statement for this action, and a set of alternatives to analyze. It would be helpful for staff to receive guidance on how to continue refinement of the strawman alternatives if they are to remain part of the package.

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12 Color figures

Figure 16 Locations of existing trawl fishery and crab protection closures in the Gulf of Alaska

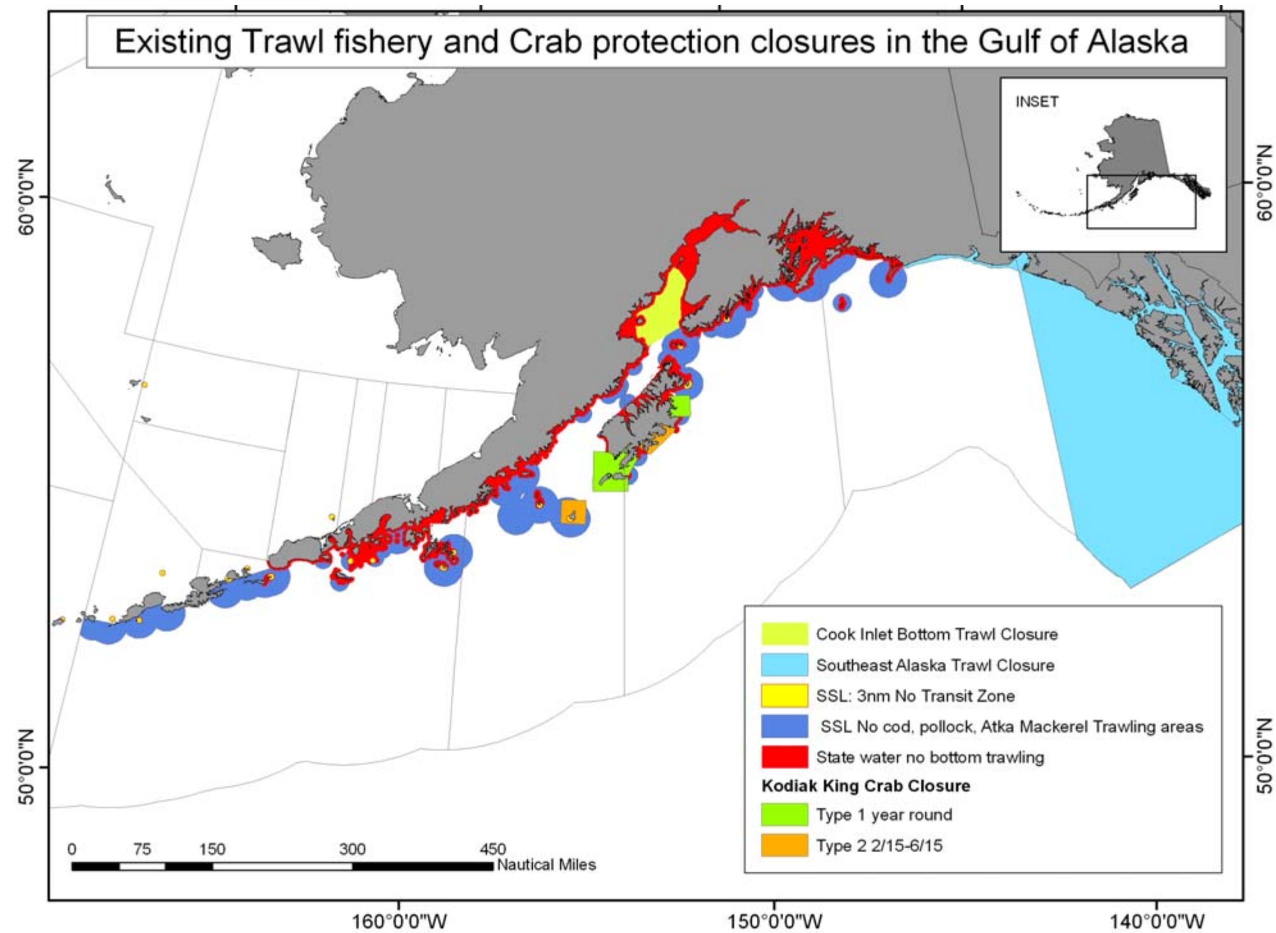


Figure 17 Locations of existing trawl fishery and crab protection closures in the Western Gulf of Alaska

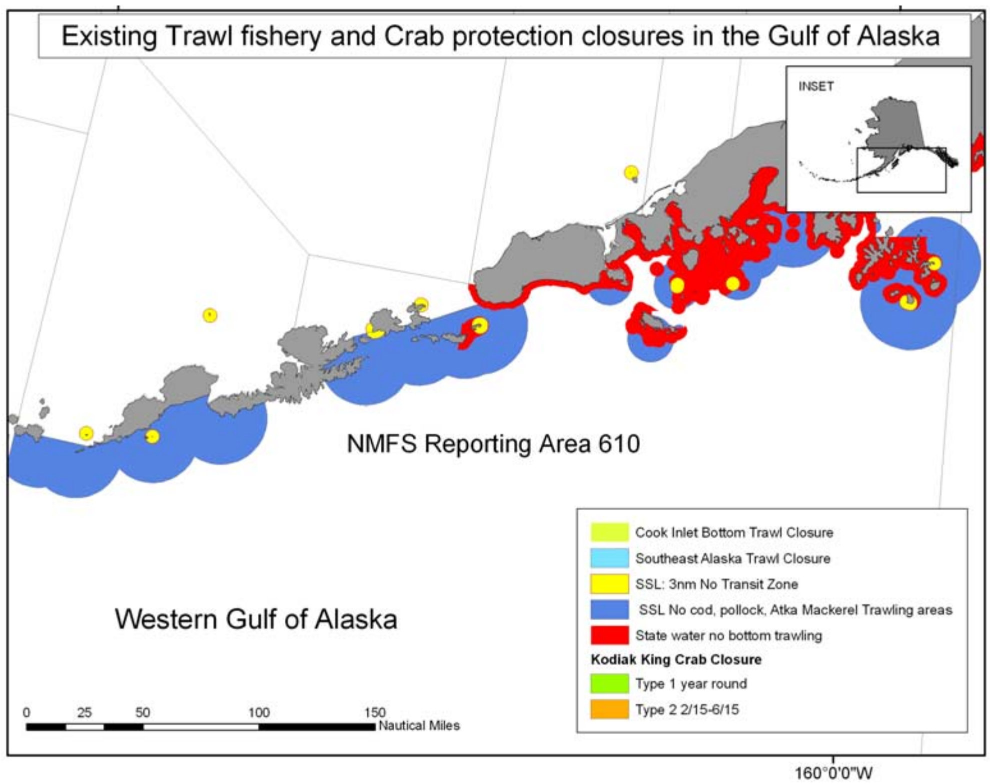


Figure 18 Locations of existing trawl fishery and crab protection closures in the Central Gulf of Alaska

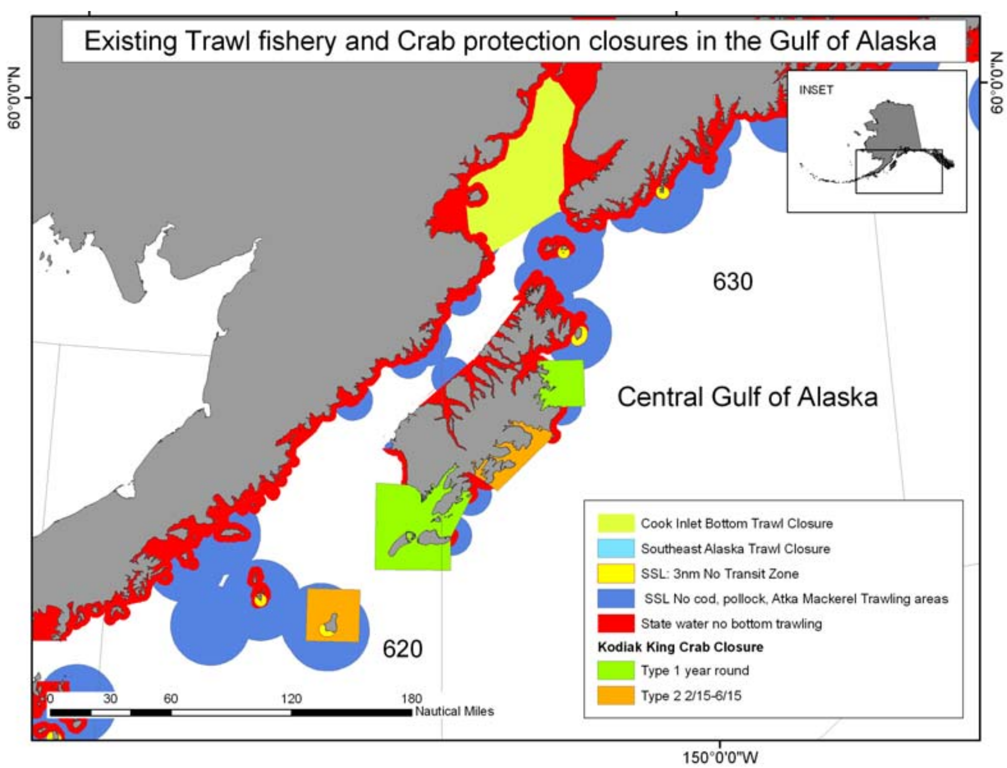
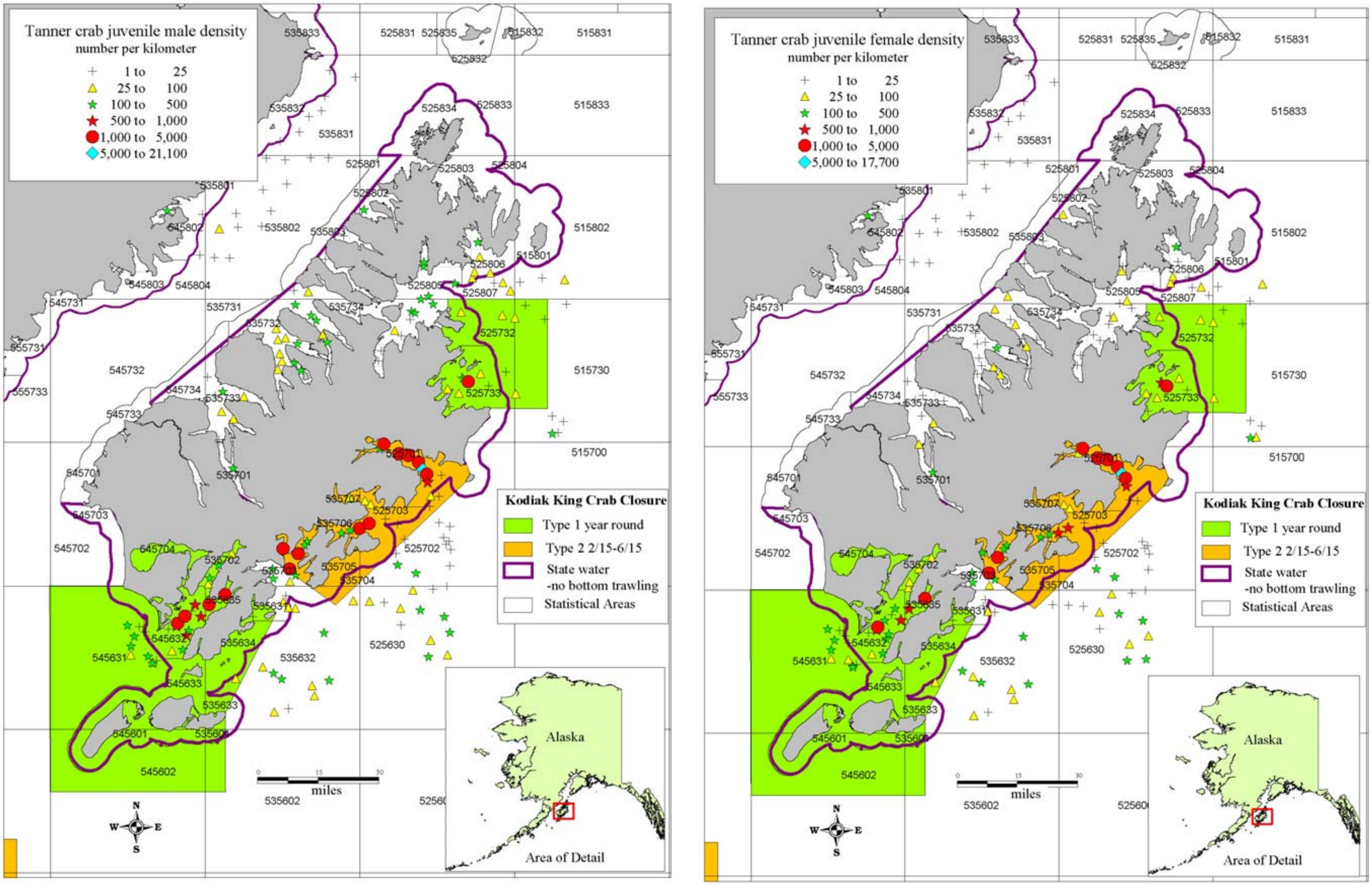
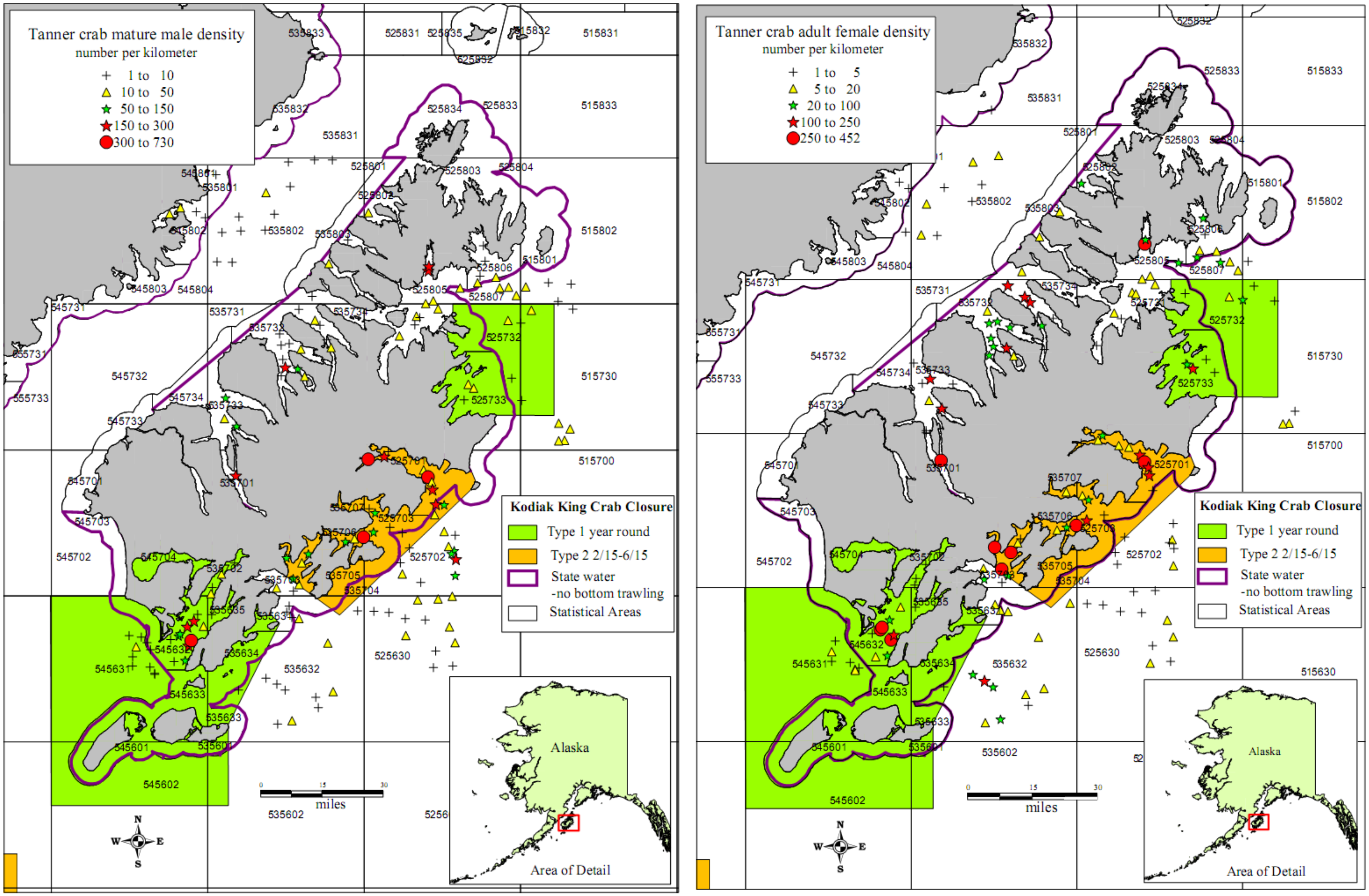


Figure 19 Juvenile male and female Tanner crab density, from the 2007 ADFG survey.



Source: K. Spalinger and N. Sagalkin, ADFG

Figure 20 Mature male and female Tanner crab density, from the 2007 ADFG survey.



Source: K. Spalinger and N. Sagalkin, ADFG

Figure 21 Observed Chinook salmon bycatch in the pelagic trawl fishery, summed over 2001-2008

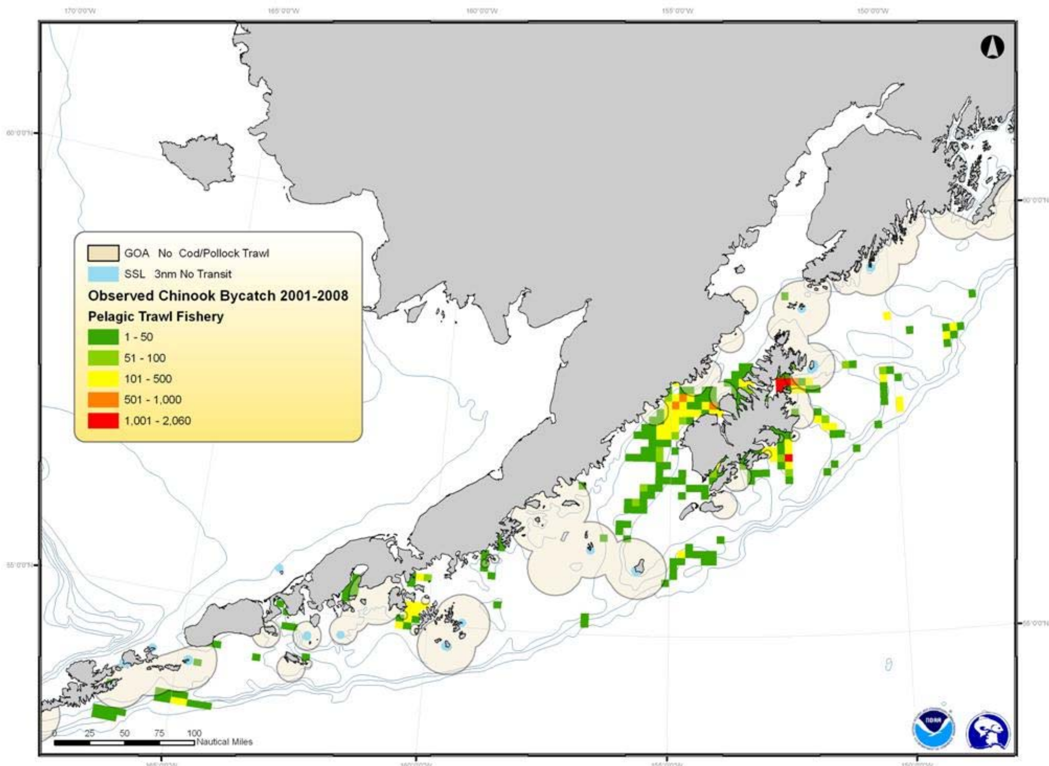


Figure 22 Observed Chinook salmon bycatch in the pelagic trawl fishery, 2008 only

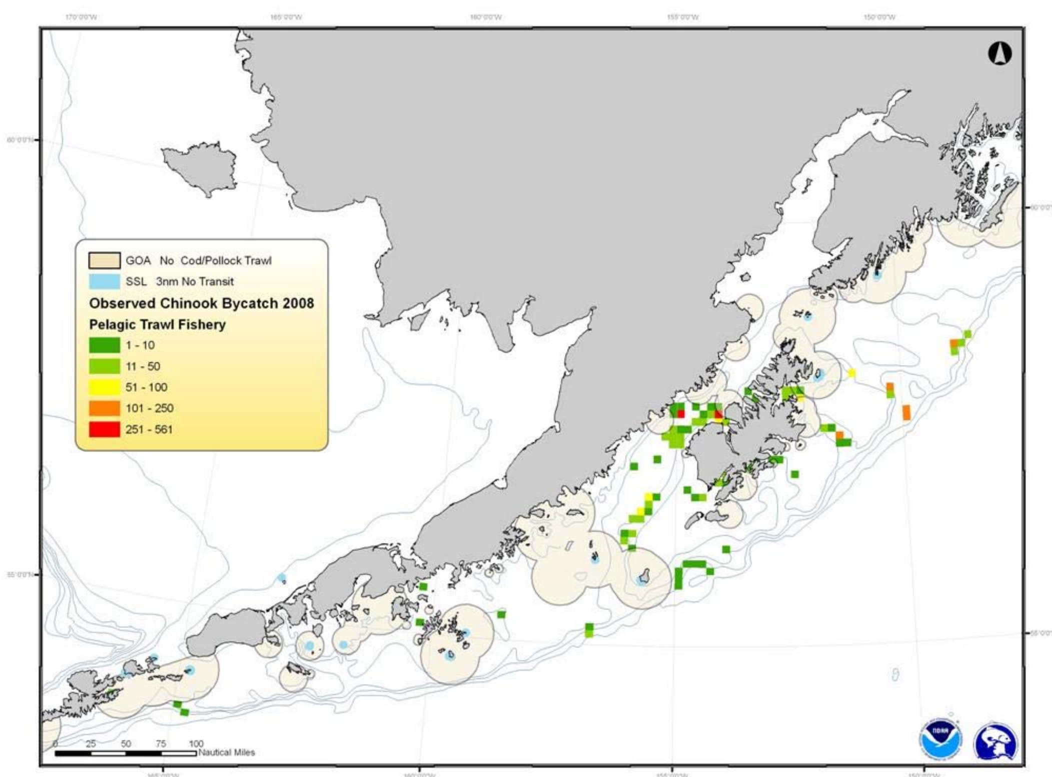


Figure 23 Observed Chinook salmon bycatch rate in the pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

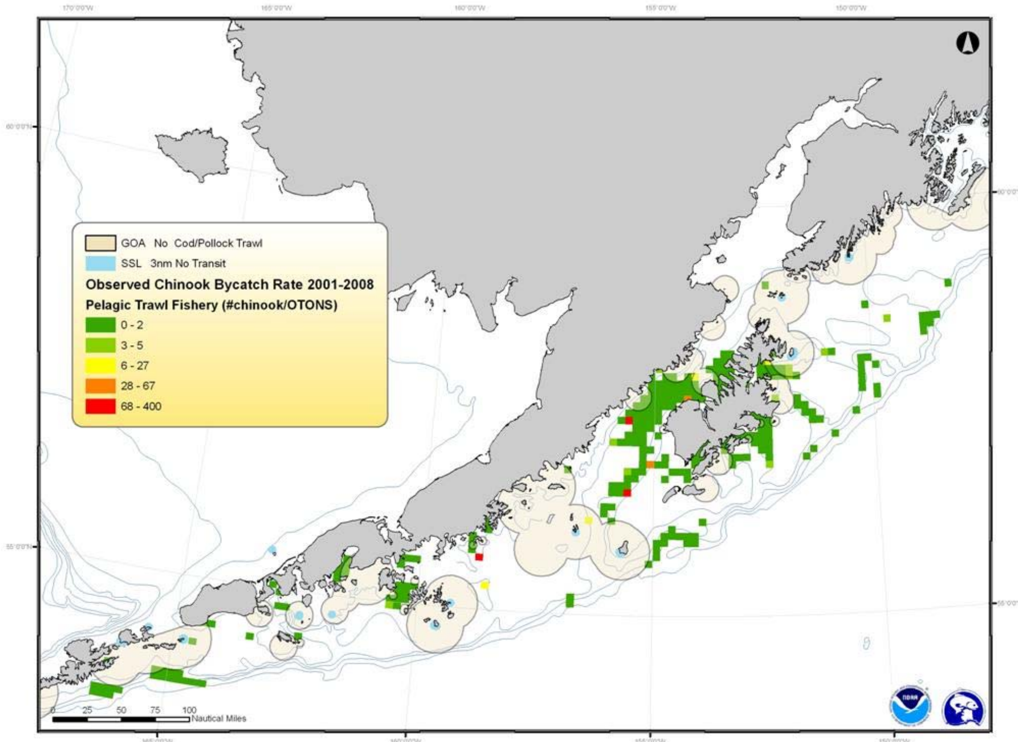


Figure 24 Observed Chinook salmon bycatch in the non-pelagic trawl fishery, summed over 2001-2008

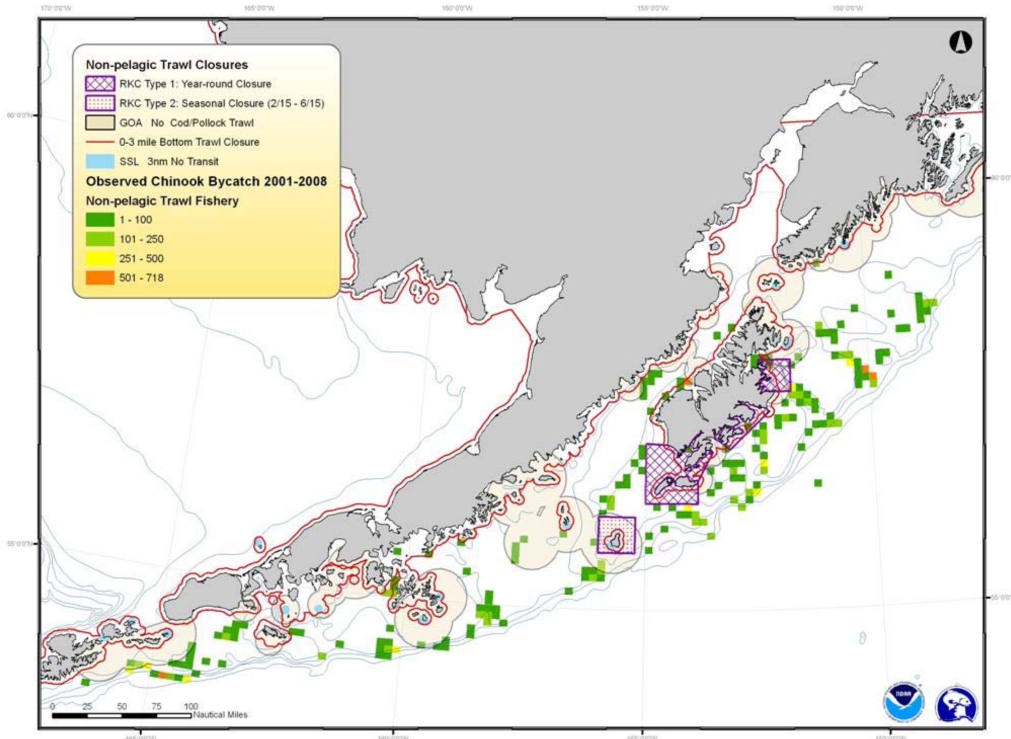


Figure 25 Observed Chinook salmon bycatch rate in the non-pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

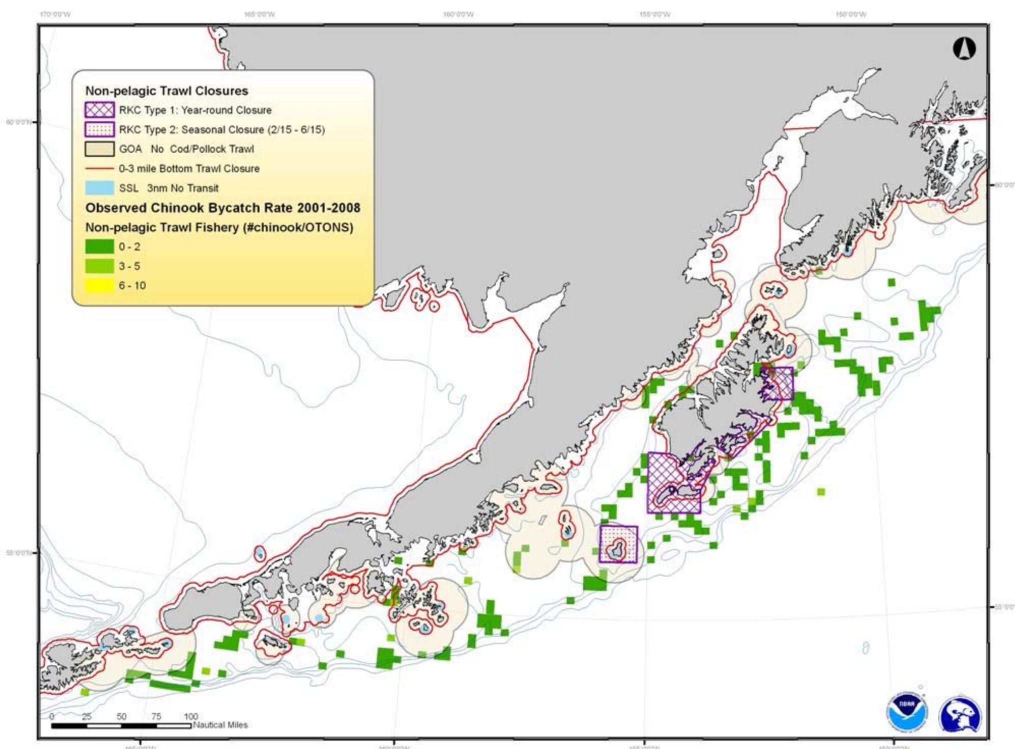


Figure 26 Observed *C. bairdi* Tanner crab bycatch in the non-pelagic trawl fishery, summed over 2001-2008

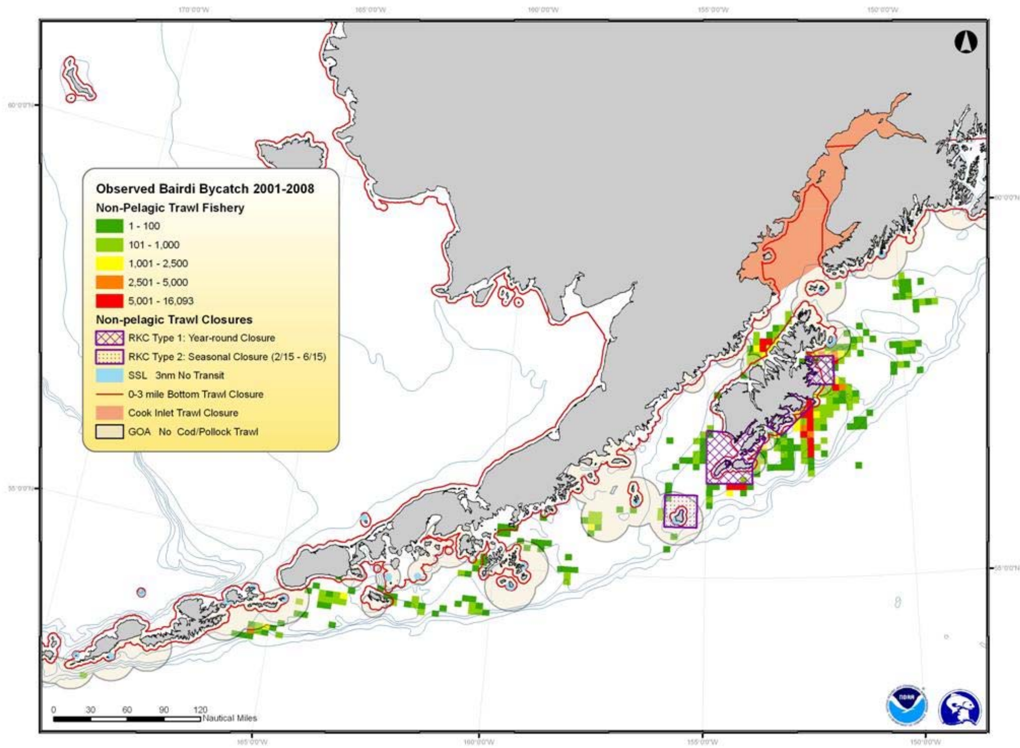


Figure 27 Observed *C. bairdi* Tanner crab bycatch in the non-pelagic trawl fishery, 2008 only

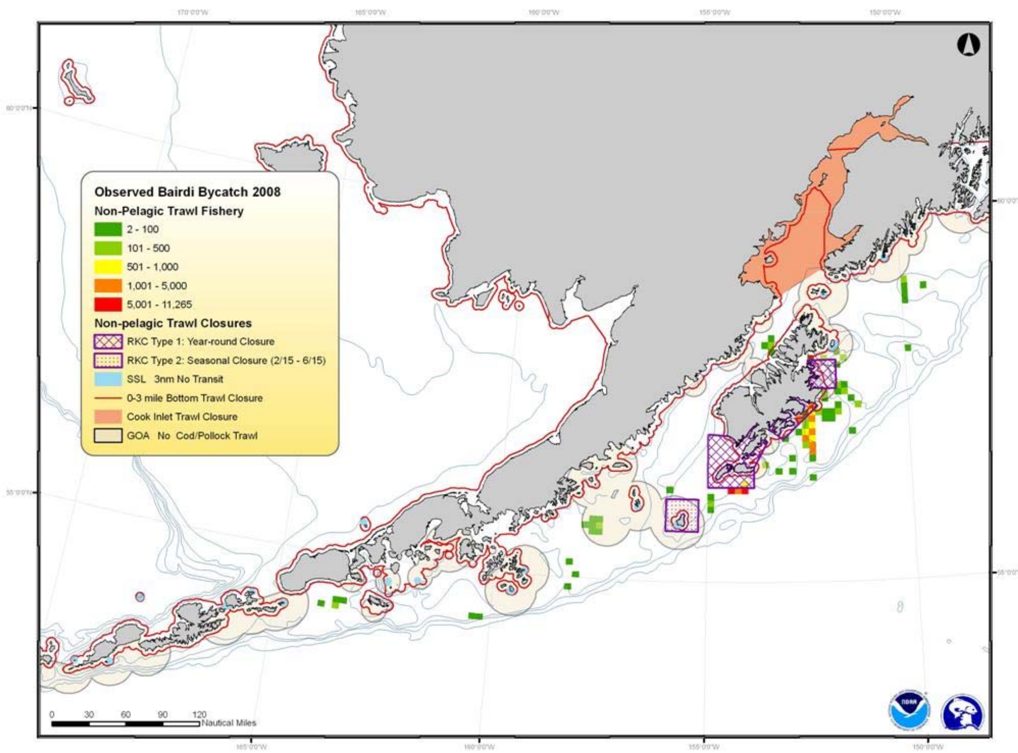


Figure 28 Observed *C. bairdi* Tanner crab bycatch rate in the non-pelagic trawl fishery, summed over 2001-2008, number of crab per metric ton of total catch

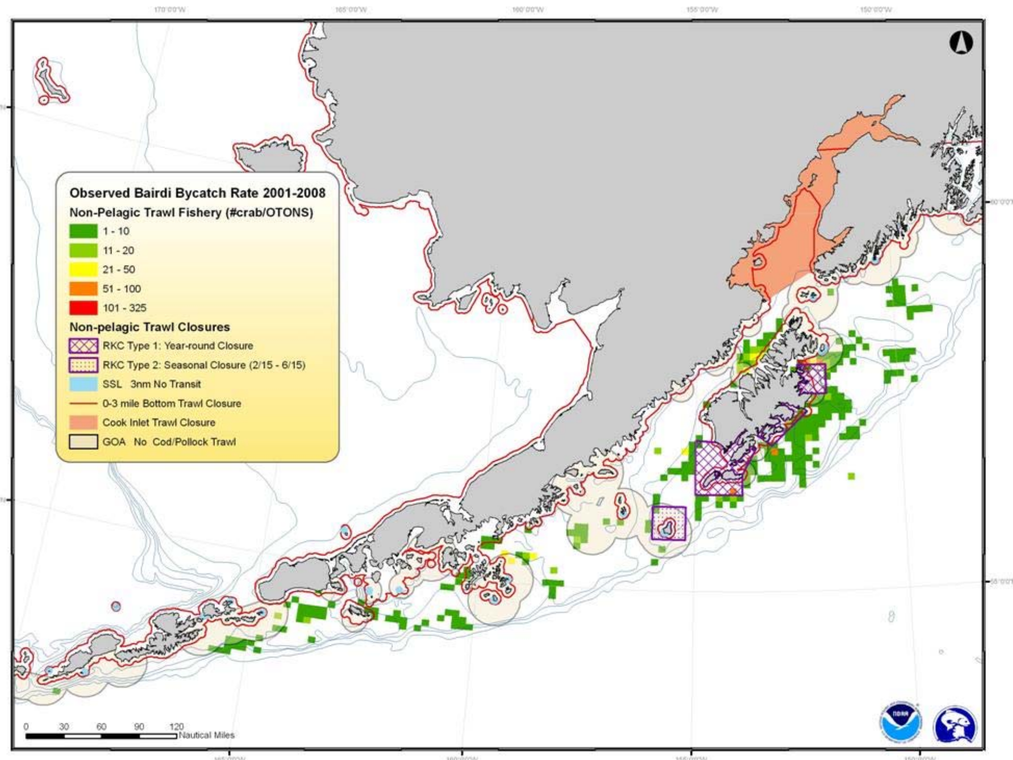


Figure 29 Observed *C. bairdi* Tanner crab bycatch in the Federal pot fishery, summed over 2001-2008

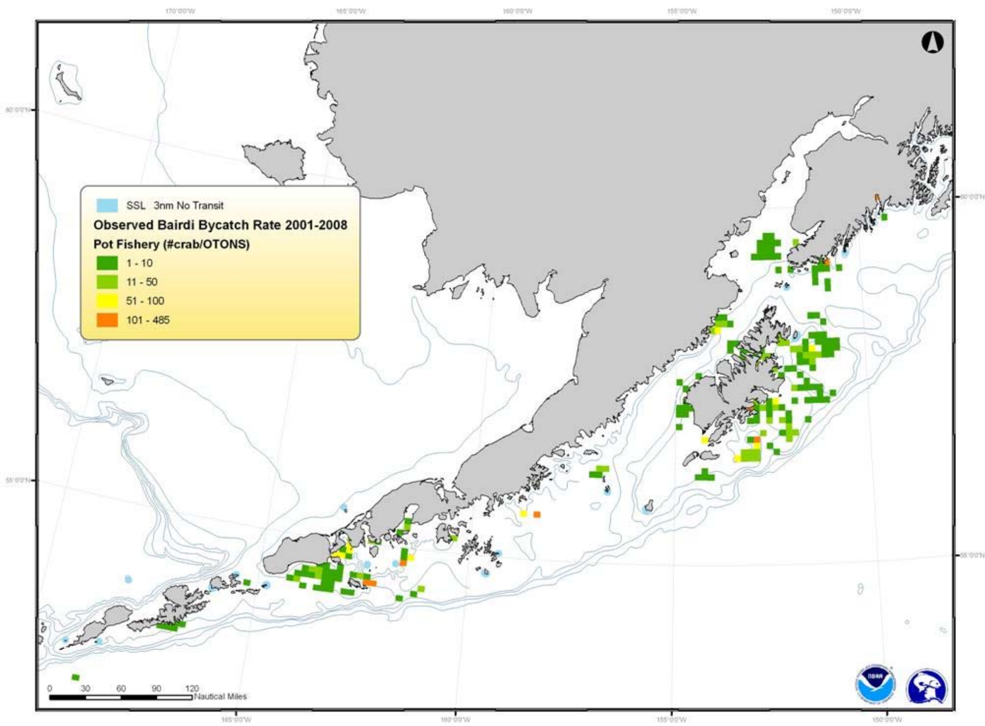


Figure 30 Observed C. bairdi Tanner crab bycatch in the Federal pot fishery, 2008 only

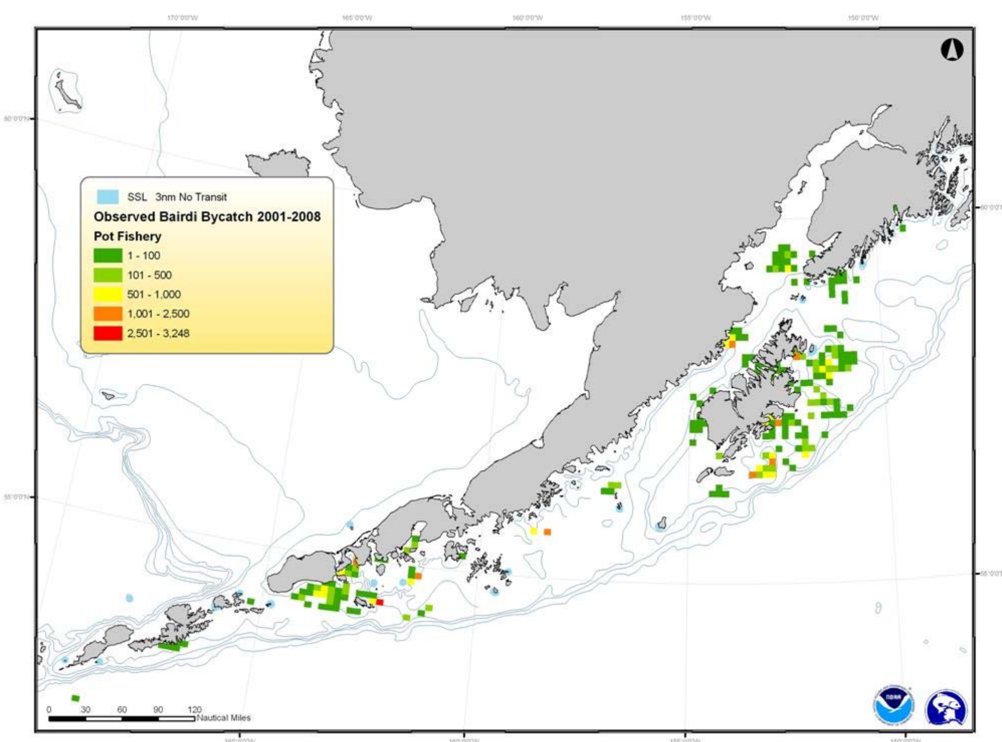


Figure 31 Observed *C. bairdi* Tanner crab bycatch rate in the Federal pot fishery, summed for 2003-2007, number of crab per metric ton of total catch

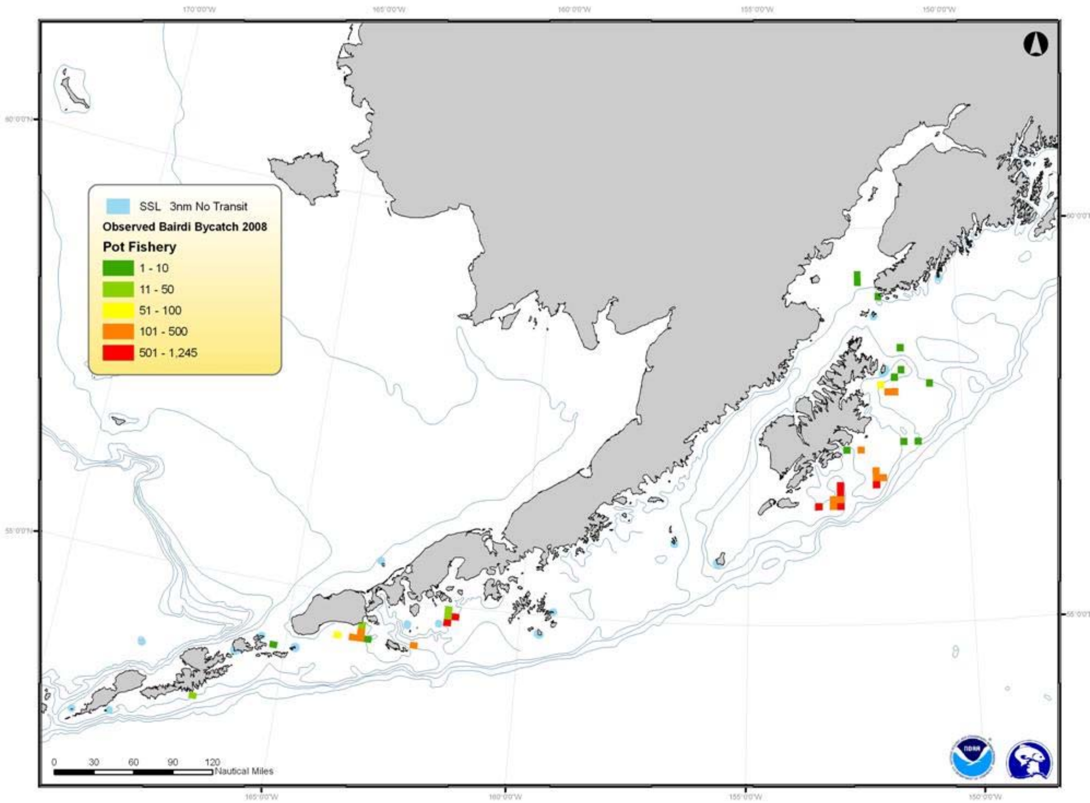


Figure 32 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2001-2008

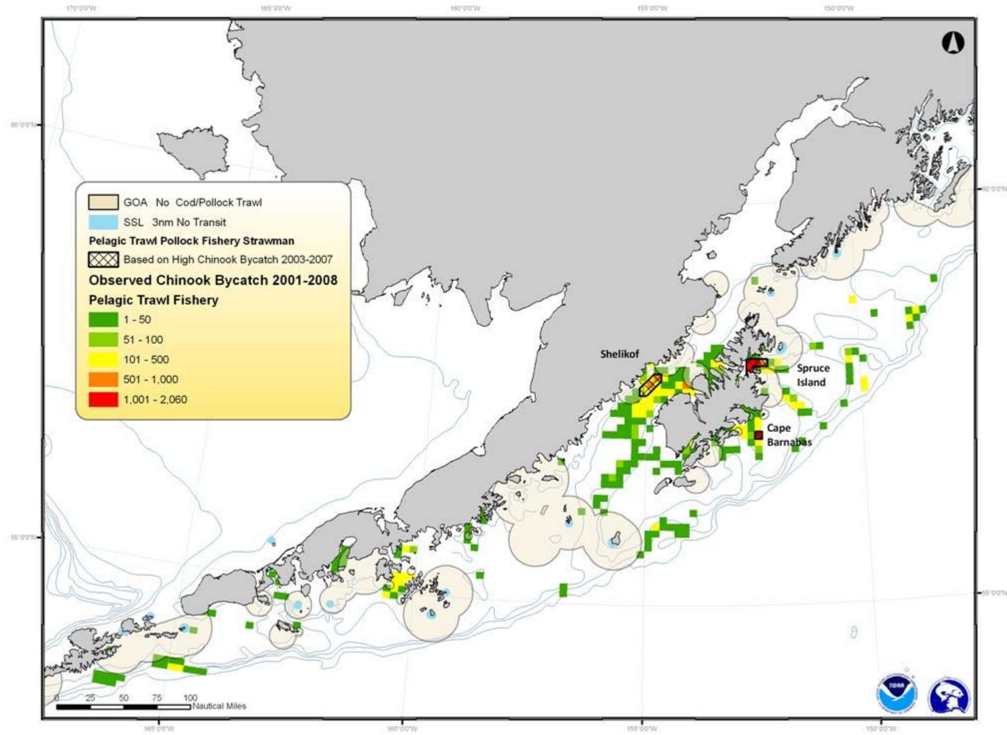


Figure 33 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2008 only

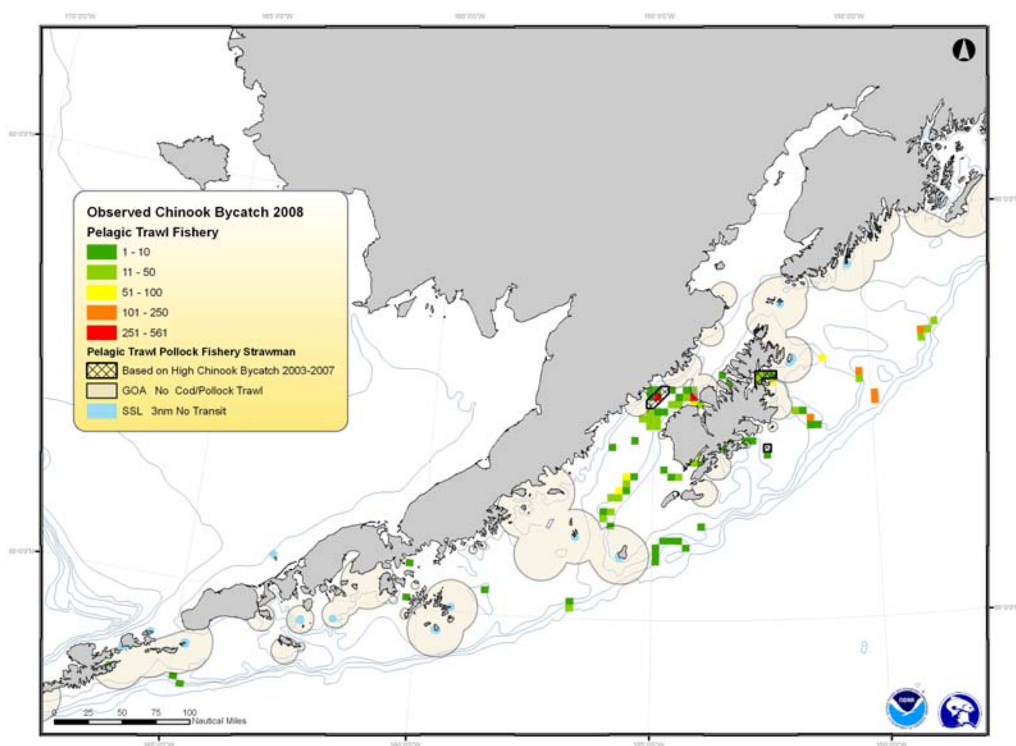


Figure 34 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch rates in 2001-2008

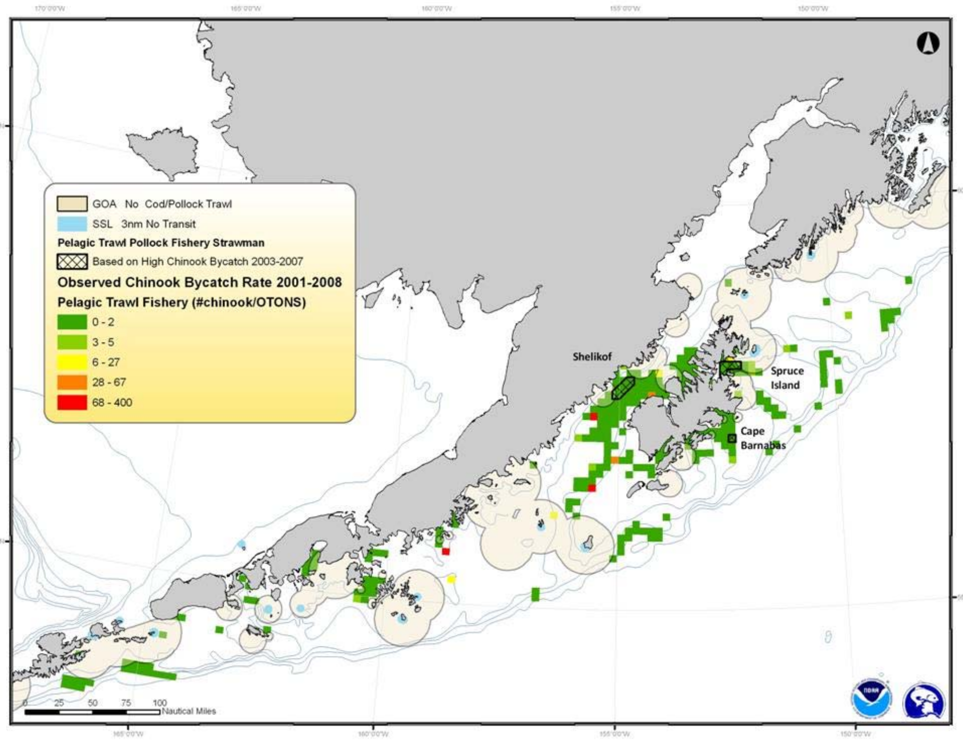


Figure 35 ***C. bairdi*** **crab strawman closures for non-pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high incidence of bycatch in 2001-2008**

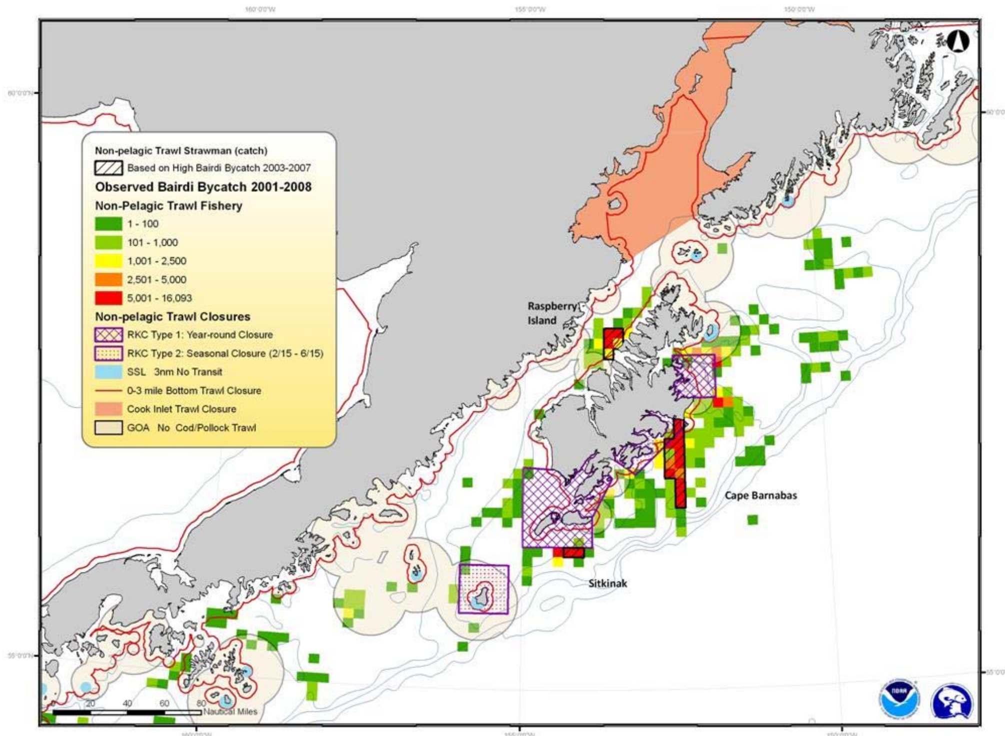


Figure 36 **C. bairdi crab strawman closures for non-pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high incidence of bycatch in 2008 only**

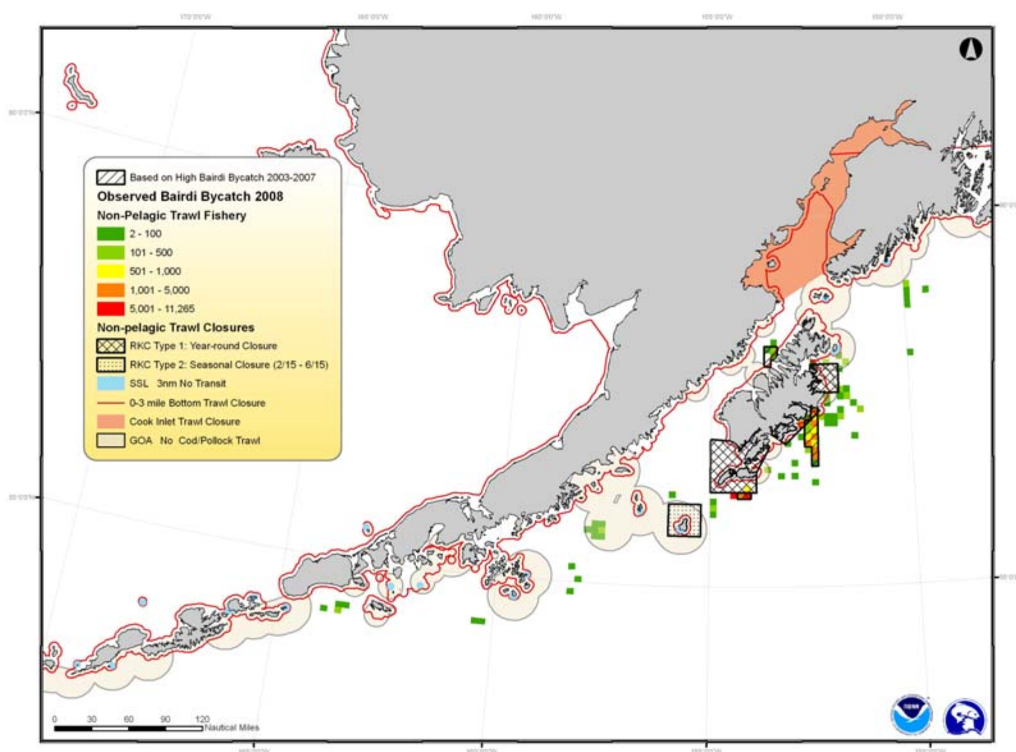


Figure 37 ***C. bairdi*** **crab strawman closures for non-pelagic trawl gear, based on high bycatch rate in 2003-2007 (number of crab per metric ton of total catch, summed for 2003-2007), compared to incidence of bycatch in 2001-2008**

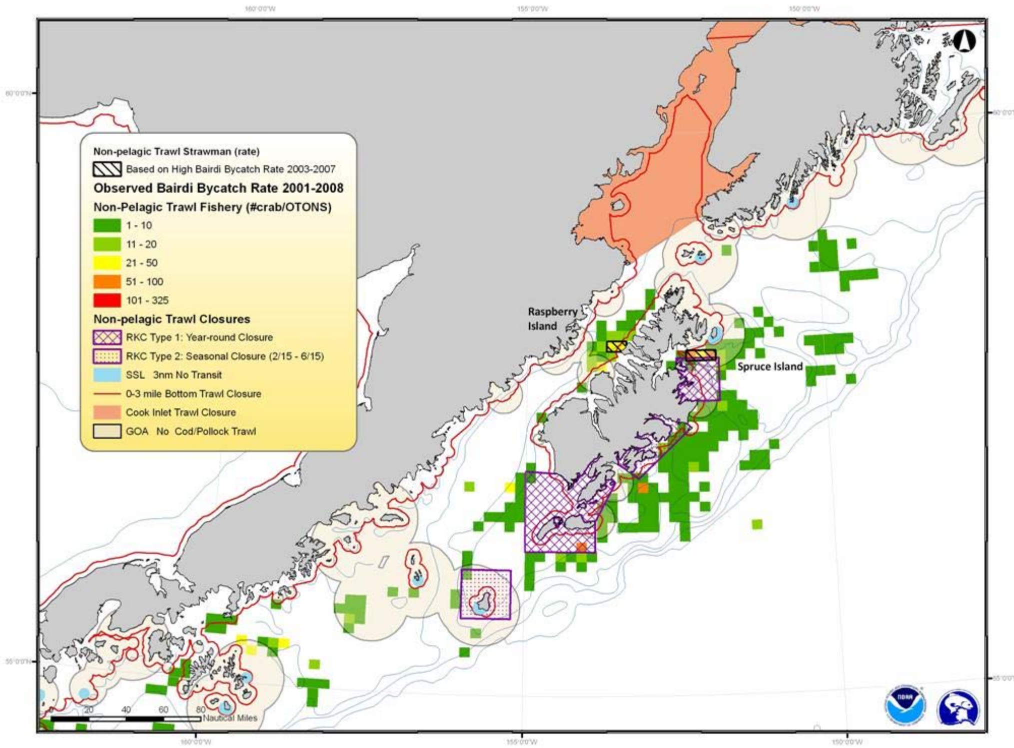


Figure 38 **Comparison of *C. bairdi* crab strawman closures for non-pelagic trawl gear, high incidence of bycatch versus high bycatch rate during 2003-2007**

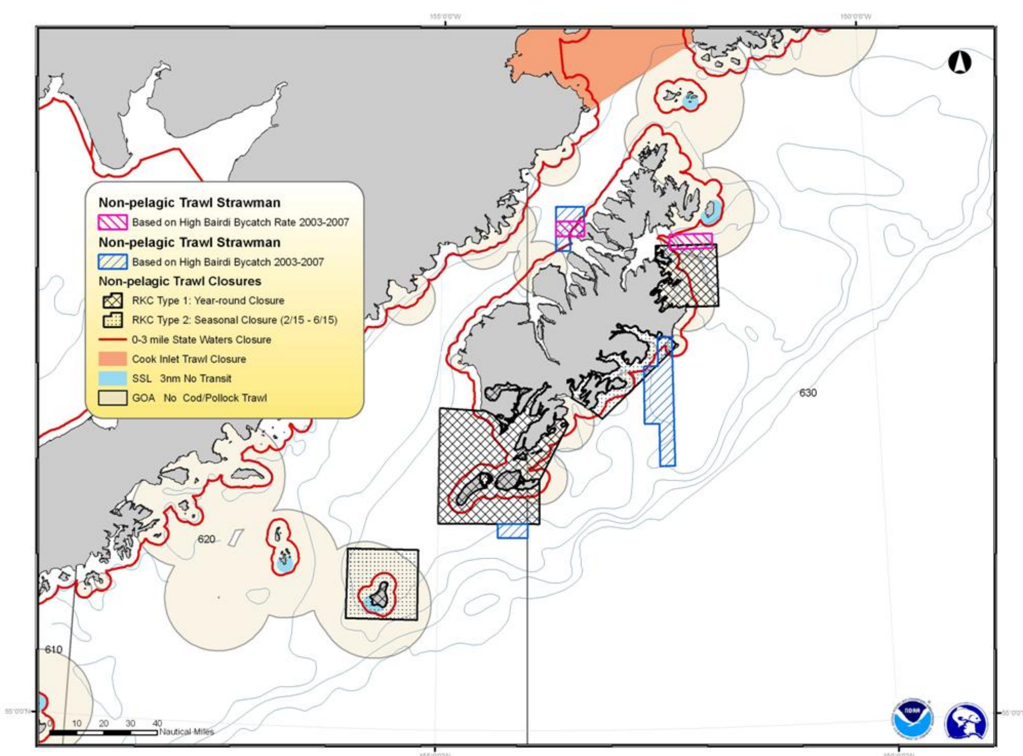


Figure 39 ***C. bairdi*** **crab strawman closures for pot gear, based on high incidence of bycatch during 2003-2007, compared to incidence of bycatch in 2001-2008**

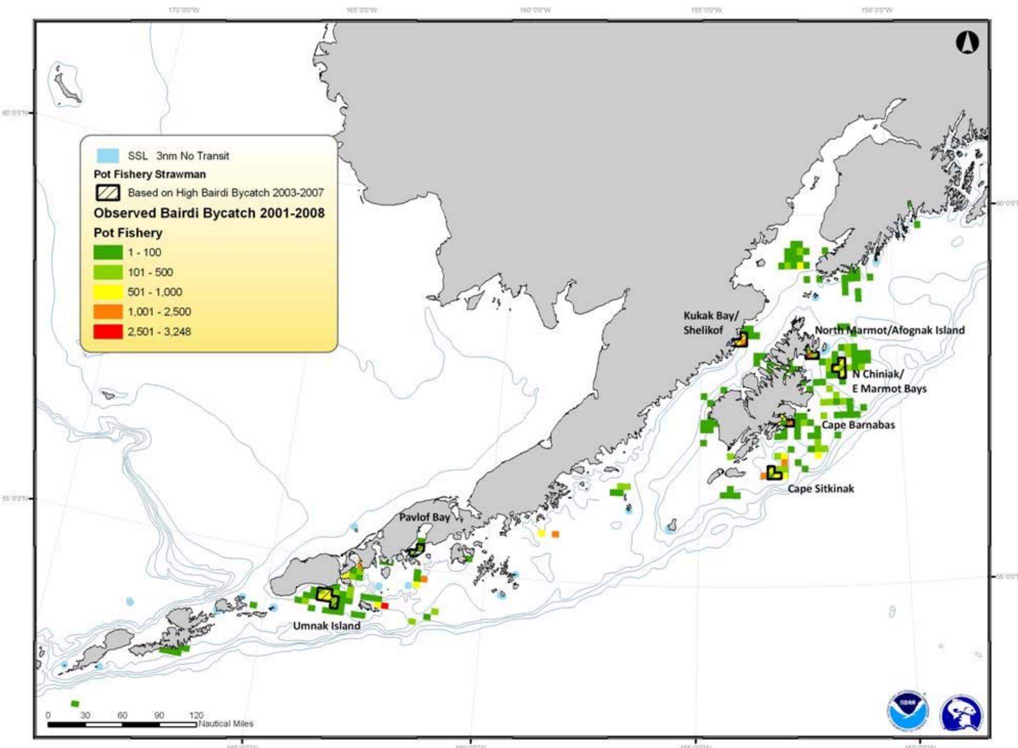


Figure 40 ***C. bairdi*** **crab strawman closures for pot gear, based on high incidence of bycatch during 2003-2007, compared to incidence of bycatch in 2008 only**

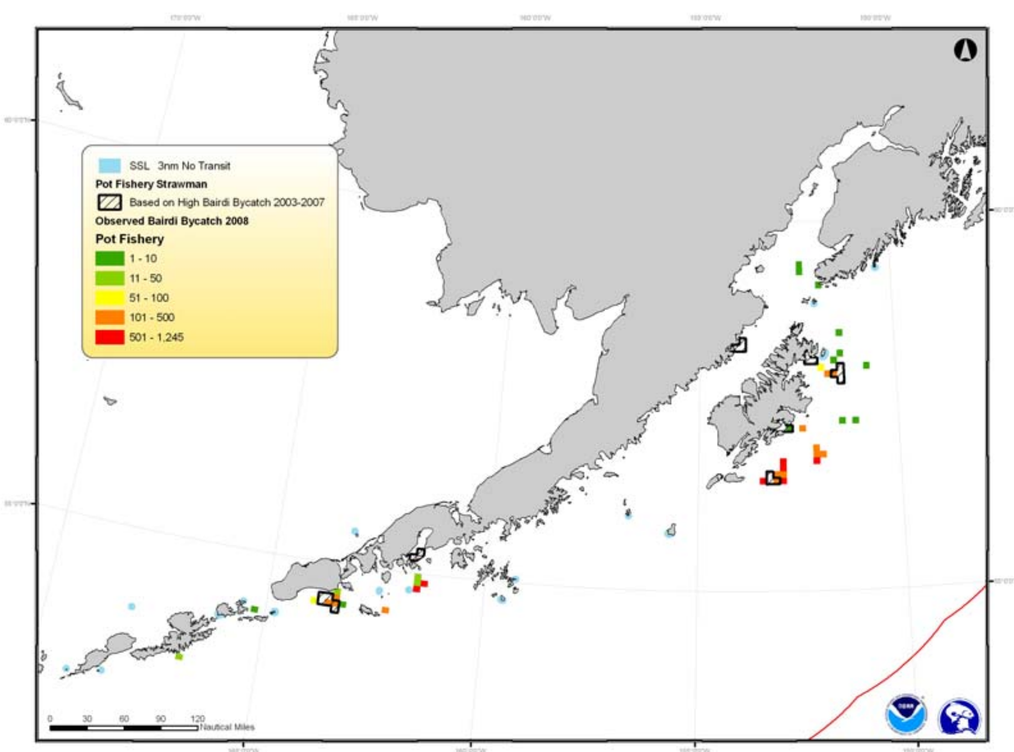


Figure 41 ***C. bairdi*** **crab strawman closures for pot gear, based on high incidence of bycatch during 2003-2007, compared to bycatch rate (number of crab per metric ton of total catch) in 2001-2008**