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Chinook Salmon Bycatch in Gulf of Alaska Groundfish Fisheries

March 2009

Staff Discussion Paper

Table of Contents

List of Tables

List of Figures

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. During this process, the Council focused the scope of the discussion paper 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. In October 2009, the Council initiated a separate analysis for protection measures for *C. bairdi* crab. At that time, the Council requested that this discussion paper be updated with further information on Chinook salmon bycatch, and consequently information on *C. bairdi* bycatch has now been removed. This discussion paper provides a general overview of the available information on bycatch levels for Chinook (Section 5), and species abundance and directed fisheries (Section 6). Preliminary alternatives have been proposed for bycatch management measures in previous iterations of this discussion paper, and they are included here (Section 7.1), along with strawman closure areas that may be considered for managing bycatch (Section 7.3).

2 Changes to the discussion paper since the previous draft

The most recent draft of this discussion paper was dated September 2009, and the paper was reviewed byt the Council in October 2009. At the Council's request, the following changes have been made for this version of the discussion paper:

- *C. bairdi* Tanner crab bycatch information has been removed from this discussion paper
- Catch data has been updated through the end of 2009

The spatial mapping of bycatch, and development of strawman closures, has not been updated for this version of the discussion paper.

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

3 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 3.1. In short bycatch rates from observed vessels are applied to the fleet as a whole. The resulting estimates are used in Sections 5.1 and 5.2. Further discussion on the proportion of GOA groundfish fisheries that are observed is addressed in Section 3.2.

Spatial analysis of bycatch in this discussion paper used only the data directly from observed vessels, and is described in Section 3.3. The spatial analysis is used to describe the location of bycatch (Section 5.3), as well as to develop preliminary strawman closures under the management options (Section 7.3).

3.1 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.

[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.

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:
  - 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 multi-year 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

[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).

changes to improve estimation and to recognize statistical uncertainty in NMFS estimates of catch and bycatch. The first component, documenting the processes, was released as an AFSC publication in February 2010 (Cahalan et al. 2010).

3.2 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[4]. 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.

[4] The proportion of hauls, sets, or pots that are sampled while an observer is onboard is approximately 70% for hook and line and pot gear, 75% for nonpelagic trawl gear, and 85% for pelagic trawl gear (pers. comm., J. Mondragon 11/25/08).

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.[5] 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

[5] 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.

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.

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

Gear	Trip target	Sector	Length	2004			2005			2006			2007		
				Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent
NPT	Pacific cod	CP	>=60 and <125	--	--	0%	565	411	73%	--	--	0%	0	166	0%
			>=125	--	--	100%	0	0	0%	0	0	0%	0	0	0%
		S	<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%
	Rockfish	CP	>=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%
		S	<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%
	Flathead sole	CP	>=60 and <125	--	--	104%	--	--	77%	--	--	70%	--	--	104%
	Arrowtooth	CP	>=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%
		S	<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%
	Rex sole	CP	>=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%
	Shallow water flatfish	S	<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%
POT	Pacific cod	CP	>=60 and <125	0	0	0%	0	0	0%	0	0	0%	--	--	0%
		S	<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	S	>=60 and <125	66	217	327%	535	636	119%	1,999	1,211	61%	2,990	4,029	135%
	Pollock, bottom and midwater	S	<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

Gear	Trip Target	Sector	Length	2004			2005			2006			2007		
				Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent	Total	Observed	Percent
HAL	Pacific cod	CP/M	<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%
		S	<60	--	--	0%	242	0	0%	78	0	0%	327	0	0%
			>=60 and <125	4	0	0%	--	--	0%	0	0	0%	--	--	0%
	Sablefish	CP/M	>=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%
		S	<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	CP/M	>=60 and <125	635	0	0%	--	--	625%	--	--	0%	--	--	39%
			>=125	--	--	100%	0	0	0%	0	0	0%	0	0	0%
		S	<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%
	SW Flatfish	CP/M	>=60 and <125	--	--	0%	--	--	21%	--	--	57%	--	--	0%
	Rockfish	CP/M	>=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	CP/M	>=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	CP/M	>=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	CP/M	>=60 and <125	--	--	5%	--	--	12%	--	--	21%	--	--	56%
			>=125	--	--	100%	0	0	0%	0	0	0%	--	--	100%
POT	Pacific cod	CP/M	<60	0	0	0%	0	0	0%	0	0	0%	--	--	0%
			>=60 and <125	--	--	0%	--	--	34%	--	--	0%	--	--	18%
		S	<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	S	<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.

3.3 Spatial analysis of bycatch patterns

In order to map the location of Chinook salmon 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, 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 levels 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 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.

4 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 6 (in Section 11 at the end of the document) maps the existing closures in the entire GOA management area; Figure 7 and Figure 8 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). **Nonpelagic 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 and Pacific cod (2003). **Pollock and Pacific cod trawl fishing closures** related to SSL conservation establish 10- to 20-nm fishing closures surrounding rookeries to protect endangered Steller sea lions. Some hook and line and pot gear closures for Pacific cod fishing are also in effect off Chignik, and around Marmot, Sugarloaf, and Outer Pye Islands in the northeast Kodiak and southeast Kenai peninsula areas.

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). **Prohibit commercial bottom trawling** in all state waters (0–3 nm) to protect nearshore habitats and species. However, specific areas in the Shelikof Straits along the west side of Kodiak Island are open to bottom trawling from January 20 to April 30 and October 1 to November 30, and areas around Shumagin and Sanak Islands are open year round.

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

5 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 seven years (average of 20,723 salmon, 2003–2009) is similar to the time series average (average of 20,395 salmon, 1990–2009, 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, 1990-2009

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	15,172	10,362				
2004	17,596	5,816				
2005	30,724	6,694				
2006	18,726	4,273				
2007	40,320	3,487				
2008	15,299	2,156				
2009	7,714	2,355				
Average 1990–2009	**20,395**	**14,084**[b]				
Average 2003–2009	**20,793**	**5,020**				

[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 2003-2009 (non-Chinook species); AKFIN Comprehensive PSC data for 2003-2009 (Chinook).

5.1 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 2003-2009 across western and central regulatory and reporting areas. The eastern regulatory area salmon bycatch is less than 2% of total Chinook bycatch, and since 1998, 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 7% and 26%, by year, but averages to approximately 18%. The remainder of salmon bycatch, in the central GOA, is on average, divided evenly between reporting areas 620 and 630 (Chignik and Kodiak).

Table 5 Chinook salmon bycatch by reporting area, 2003-2009, in Gulf of Alaska groundfish fisheries

Year	Western		Central				Total
	610		620		630		
	Number of salmon	% of total	Number of salmon	% of total	Number of salmon	% of total	
2003	2,859	19%	3,876	26%	8,437	56%	15,172
2004	4,184	24%	5,320	30%	8,092	46%	17,596
2005	7,567	25%	6,976	23%	16,180	53%	30,724
2006	4,880	26%	5,678	30%	8,168	44%	18,726
2007	3,666	9%	28,942	72%	7,712	19%	40,320
2008	2,398	16%	7,173	47%	5,728	37%	15,299
2009	556	7%	3,039	39%	4,118	53%	7,714
Average 2003-2009	**3,730**	**18%**	**8,715**	**42%**	**8,348**	**40%**	**20,793**

Source: AKFIN Comprehensive PSC data, February 2010.

Figure 1 Regulatory and reporting areas in the GOA

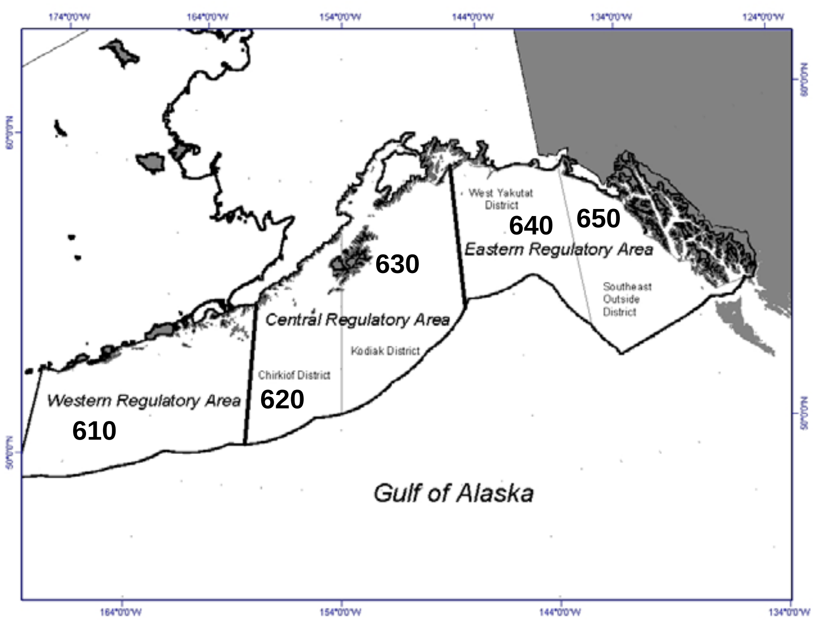


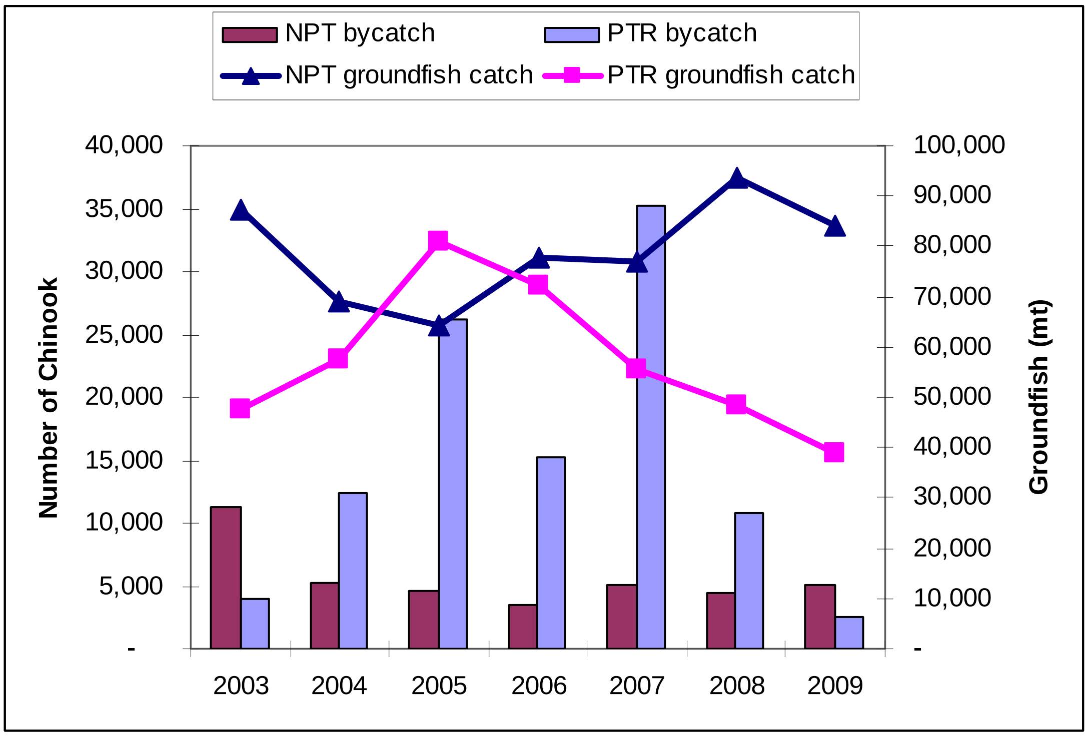
Table 6 identifies Chinook bycatch for 2003-2009, by gear type. Pelagic and non-pelagic trawling are almost entirely responsible for Chinook salmon bycatch. In 2004-2008, pelagic trawl gear accounted for over 70% of Chinook bycatch, however in 2003 and 2009, nonpelagic trawl caught 74% and 67% of the Chinook salmon. The relationship between groundfish catch and pelagic trawl Chinook bycatch was consistent in all years except 2007 (Figure 2). For nonpelagic trawl vessels, the bycatch trend paralleled groundfish catch for 2003-2005, but since then groundfish catch has generally increased, while bycatch has remained relatively constant.

Table 6 Chinook salmon bycatch by gear type, in western and central groundfish fisheries, 2003-2009

Year	Nonpelagic trawl		Pelagic trawl		Hook and line		Pot		Total
	Number of salmon	% of total	Number of salmon	% of total	Number of salmon	% of total	Number of salmon	% of total	
2003	11,269	74%	3,903	26%	-	-	-	-	15,172
2004	5,164	29%	12,411	71%	21	0%	-	-	17,596
2005	4,593	15%	26,131	85%	-	-	-	-	30,724
2006	3,434	18%	15,292	82%	-	-	-	-	18,726
2007	5,072	13%	35,239	87%	8	0%	-	-	40,320
2008	4,499	29%	10,799	71%	-	-	-	-	15,299
2009	5,149	67%	2,565	33%	-	-	-	-	7,714
Average 2003-2009	**5,597**	**27%**	**15,191**	**73%**	**4**	**0%**	**-**	**-**	**20,793**

Source: AKFIN Comprehensive PSC data, February 2010.

Figure 2 Chinook bycatch and groundfish catch in GOA pelagic and nonpelagic trawl fisheries, 2003-2009



Source: AKFIN Comprehensive PSC and Catch data, February 2010.

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 2003–2008, the combined flatfish non-pelagic trawl target fisheries accounted for approximately 7-18% of Chinook bycatch in the western and central GOA. In 2003 and 2009, the flatfish target fisheries accounted for 46% and 48% of Chinook bycatch, respectively. Chinook bycatch in the rockfish target fishery has increased since the implementation of the rockfish pilot program in 2007, by both nonpelagic and pelagic trawl vessels. 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). However, bycatch in the pollock pelagic trawl fishery represents most of the western and central Chinook bycatch, an average of 72% over 2003-

2009, or 14,900 fish. Table 8 illustrates the distribution of bycatch in the pollock pelagic fishery in the western and central GOA. While bycatch in the western GOA is generally lower than it is in areas 620 and 630, the proportional bycatch by area within all years 2003-2008 is highly variable. 2007 was the year of highest bycatch, primarily occurring in the Chignik area (620). In the Kodiak area (630), 2005 was the highest bycatch year with 13,370 Chinook. Pelagic trawl bycatch in 2009, in all areas, was considerably lower than in the previous five years. For the nonpelagic trawl fishery, bycatch is consistently highest in area 630.

Table 7 Chinook salmon bycatch by target fishery, in western and central groundfish fisheries, 2003-2009

Gear type	Target fishery	2003	2004	2005	2006	2007	2008	2009	Average 2003-2009
Nonpelagic trawl	Arrowtooth Flounder	3,348	359	1,798	408	1,502	2,608	6	1,433
	Flathead Sole	598	1,446	16	56	-	-	118	319
	Pacific Cod	3,167	908	41	882	634	433	111	882
	Pollock	423	571	1,296	380	50	32	277	433
	Rex Sole	2,819	498	982	1,444	714	-	1,907	1,195
	Rockfish	799	885	397	263	1,733	1,212	1,077	909
	Shallow Water Flatfish	116	498	63	-	438	213	1,653	426
Pelagic trawl	Pollock	3,872	12,411	26,068	15,292	34,946	10,054	2,284	14,990
	Rockfish	**		63	-	294	746	203	187

* = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: AKFIN Comprehensive PSC data, February 2010.

Table 8 Chinook salmon bycatch in the pelagic pollock trawl fishery, by reporting area, 2003-2009

Year	Nonpelagic trawl			Pelagic trawl		
	610	620	630	610	620	630
2003	2,122	2,755	6,393	738	1,121	2,044
2004	2,164	430	2,570	2,013	4,886	5,513
2005	1,616	230	2,747	5,951	6,747	13,433
2006	351	835	2,248	4,529	4,843	5,921
2007	304	904	3,863	3,359	28,036	3,845
2008	282	488	3,730	2,116	6,685	1,998
2009	117	1,896	3,136	440	1,143	982
Average 2003-2009	**994**	**1,077**	**3,527**	**2,735**	**7,637**	**4,819**

Source: AKFIN Comprehensive PSC data, February 2010.

5.2 Timing of Chinook bycatch

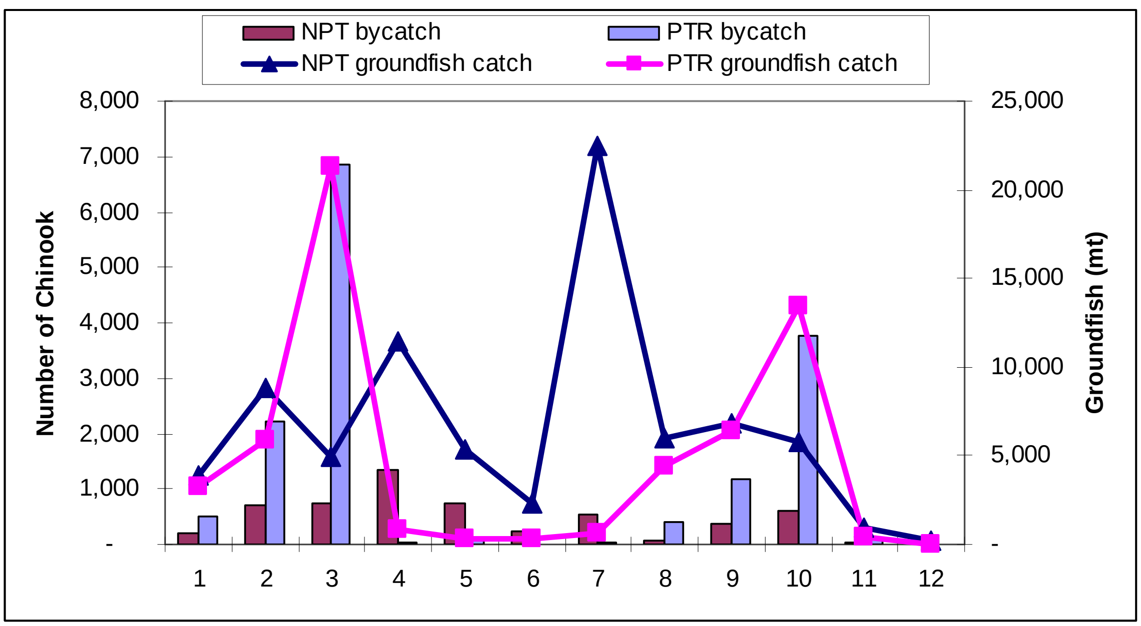
The timing of salmon bycatch follows a predictable pattern in most years. Chinook salmon are caught in high quantities regularly from the start of the trawl fisheries on January 20 through early April, and again during September/October in the pollock B season fishery (Table 9). Figure 3 illustrates the difference in seasonal bycatch patterns between the pelagic and non-pelagic trawl fisheries with respect to Chinook bycatch. For the nonpelagic 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 nonpelagic trawl groundfish catch in July is due to participation in the rockfish fisheries, which incurs 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.

Table 9 Chinook salmon bycatch by month, 2003-2009, in western and central groundfish fisheries

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	1,173	2,311	1,025	2,991	2,608	0	810	1,203	470	2,580	-	
2004	285	3,763	3,552	629	38	35	1,033	1,484	1,639	5,138	-	
2005	924	10,400	6,717	451	60	7	460	121	954	10,629	-	-
2006	1,952	1,816	4,498	1,355	10	-	263	13	4,896	3,786	138	
2007	167	1,265	28,594	202	1,338	1,153	630	150	2,435	3,702	634	50
2008	151	458	7,294	2,727	1,225	368	363	183	222	2,217	91	-
2009	162	410	1,465	1,171	570	157	406	170	233	2,554	233	183
Average 2003-2009	688	2,918	7,592	1,361	836	246	567	475	1,550	4,372	157	33

* = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: AKFIN Comprehensive PSC data, February 2010.

Figure 3 Average Chinook bycatch and groundfish catch by vessels using pelagic and non-pelagic trawl gear, by month, 2003-2009



Source: AKFIN Comprehensive PSC and Catch data, February 2010.

Table 10 Chinook salmon bycatch by pelagic trawl gear, by month, 2003-2009

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	238	339	263	12		**	**	948	**	2,101		
2004	283	3,275	1,572					1,465	723	5,092		
2005	798	9,717	5,055	**	**		63	121	919	9,458		
2006	1,847	910	4,102				-	13	4,823	3,460	138	
2007	165	1,091	28,483		131	8	82	23	1,333	3,308	615	
2008	77	218	7,157	173	600	65	81	166	220	2,003	41	
2009	16	**	1,262		49	4	4	33	161	1,006	**	
Average 2003-2009	489	2,226	6,842	26	111	11	33	396	1,168	3,775	113	-

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

5.3 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 3.1 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].

Figure 9 and Figure 12, in Section 11 at the end of this document, map the total number of Chinook observed during the years 2001-2008, in fisheries using pelagic and nonpelagic trawl gear, respectively. In order to see how the most recent bycatch patterns compare to the eight-year time series, Figure 10 and Figure 13 show bycatch distribution for 2008 only. Figure 11 and Figure 13 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 nonpelagic trawl and pot fisheries are illustrated on the maps.

5.4 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).

[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.

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.

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

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).

5.5 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 are 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 contribution of hatchery-produced Chinook salmon to the sampled harvested in the Kodiak commercial fishery ranged from 16% in 1999 to 34% in 1998; hatchery fish from British Colombia made up the majority of these fish. The study concluded that there was only a low incidental harvest of Cook Inlet Chinook salmon in the Kodiak area (Clark and Nelson 2001, 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 has developed a research plan for sampling Chinook bycatch, with the primary focus on the Bering Sea pollock fishery. In October 2009, the Council wrote a letter to the AFSC asking that the agency also apply the new sampling protocol (scheduled to begin in 2011) to Chinook caught as bycatch in GOA groundfish fisheries.

6 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.

6.1 GOA Chinook salmon stocks

A brief overview of Chinook stocks by area is included in this section. Available information on individual stocks and run strengths varies greatly by river and management area.

Southeast Alaska and Yakutat

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). The southeast Alaska Chinook stocks enter spawning streams during the spring and early summer months. 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 (Pahlke 2007). The Pacific Salmon Commission addresses coordinated management of the transboundary stocks of the Taku, Stikine, and Alsek Rivers. The Taku, Stikine, and Chilkat rivers together make up over 75% of the summed escapement goals in the region.

In 2007, escapements on 8 of the 11 tracked systems were above or within goals, with the Alsek, Taku, Chilkat, and Blossom Rivers being below goal, however Maximum Sustained Yield goals indicated that all Southeast Alaska and Transboundary River stocks were healthy and stable (Lynch and Skannes 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. A Sustainable Escapement Goal is established for the Copper River, at 24,000 Chinook, and inriver escapement to the upper Copper River is established for all salmon species combined (Hollowell et al. 2007). In 2007, escapement was 35,957 fish, meeting the escapement goal (Lewis et al 2008).

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. In 2008 and 2009, Chinook salmon escapement on the Deshka was below the escapement goal (13,000-28,000) for the first time since 1996, at 7,533 fish in 2008 and 11,960 in 2009 (Shields 2009, Eggers et al 2010). From 1999-2006, escapement exceeded the upper end of the escapement range. Kenai River escapement is monitored via sonar by the Division of Sport Fish. The late-run Chinook salmon returns have been relatively stable through 2008, and escapement objectives have been achieved (Shields 2009). The remainder of the northern Cook Inlet salmon escapements are monitored by a single aerial survey, which is the least reliable index method of escapements.

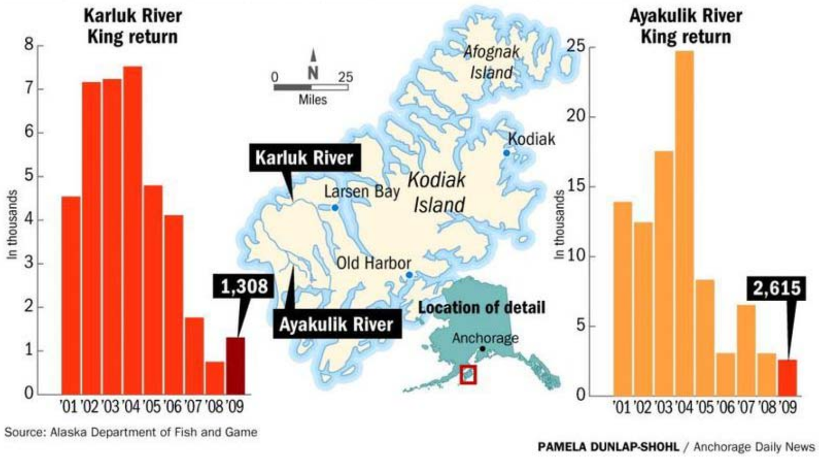
There are 3 sustainable escapement goals in effect for Chinook in the Lower Cook Inlet. Chinook salmon is not normally a commercially important species in the Lower Cook Inlet. Very little escapement information is available for this area.

Kodiak

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.

The escapement goal range for the Ayakulik is 4,800-9,600 fish; in 2006, 2008, and 2009 escapement has been below the goal range. In 2009, 2,615 Chinook were counted through the weir (Campbell 2010; Figure 4), well below the ten-year average for 1997-2006 of 14,274 salmon (Dinnocenzo and Caldentey 2008). For the Karluk, 2007-09 escapement has been below the escapement goal range of 3,600 to 7,300, although between 1998 and 2006, escapements have been within the goal range. Escapement in 2008, especially, was extremely weak, at 752 Chinook, even though retention by seine gear of Chinook salmon greater than 28 inches in length was prohibited in June and July (Dinnocenzo 2010). Escapements averaged 370 fish for Dog Salmon Creek from 1998 to 2007, however only 90 Chinook were counted through the weir in 2008 (Dinnocenzo 2010). No escapement goal has been established for this system.

Figure 4 Chinook returns to the Karluk and Ayakulik Rivers, in Kodiak, 2001-2009



Chignik

The Chignik River is the only Chinook salmon producing stream within the Chignik management area, and has an escapement goal range of 1,300-2,700 fish. The 2009 escapement through the weir was 1,680 Chinook (Eggers et al 2010), lower than the 2008 escapement of 1,730 Chinook, and the 5-, 10-, and 20-year averages. Average escapement for 2003-2007 was 5,255 fish, and for 1998-2007 was 4,393 fish (Jackson and Anderson 2009).

South Alaska Peninsula

There are no Chinook spawning streams in the South Alaska Peninsula district.

6.2 Salmon fisheries

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 2009.

Table 12 Chinook salmon GOA commercial catch, by area, compared to western and central groundfish bycatch, 2003-2009, in 1000s of fish

Year	Southeast	Prince William Sound	Cook Inlet	Kodiak	Chignik	South Alaska Peninsula	Total	Total GOA groundfish Chinook bycatch
2003	431	49	20	19	3	3	**525**	15
2004	497	39	29	29	3	7	**575**	21
2005	462	36	29	14	3	5	**549**	31
2006	379	32	19	20	2	5	**457**	19
2007	359	41	18	17	2	5	**442**	40
2008	241	12	13	17	1	4	**288**	15
2009	268	11	9	7	3	6	**304**	8

Source: ADFG (http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/catchval/blusheet/07exvesl.php), Volk et al 2009, Eggers et al 2010, Harthill 2009, AKFIN Comprehensive PSC data, February 2010.

Southeast Alaska and Yakutat

Based on current information from age composition, coded wire tagging studies, and general productivity considerations, the majority of Chinook salmon harvested in the Southeast Alaska troll fishery originate from spawning streams and hatcheries in the Pacific Northwest and Canada (Lynch and Skannes 2008). The Pacific Salmon Treaty Agreements determine Chinook allocations for Treaty fish; the fishery also harvests Alaskan hatchery fish. The Chinook salmon all-gear treaty quota for Southeast Alaska was 218,800 fish in 2009, divided among troll, purse seine, drift and set gillnet, and sport fisheries (Eggers et al 2010). In addition, a harvest sharing agreement with Canada under the treaty allows harvest in the Taku River; there was no directed fishery for Chinook salmon on the Stikine River in 2009 due to low forecast returns. The total regional fishery Chinook harvest, including Treaty fish and Alaskan hatchery fish, was 268,500[7], which is below the long-term average harvest of 301,000 and the recent 10-year harvest of 339,000 (Eggers et al 2010).

Prince William Sound

Chinook harvest in the Copper River District 2009 was 9,456 Chinook salmon, below the previous 10-year average of 37,000 fish (Eggers et al 2010). Chinook were harvested in the drift gillnet fishery. In 2007, harvest of Chinook in the Copper River District was 51,768 Chinook, with 76% harvested commercially, 2% through educational and subsistence permits, 12% by upriver personal use and subsistence usres, and 8% by sport users (Lewis et al 2008).

Harvest of Chinook in commercial fisheries by other gear types or in other Prince William Sound districts totaled 428 fish in 2009. 876 Chinook were harvested in personal use fisheries, and 50 by educational permit (ADFG 2010). Sport and subsistence permit harvests were not yet available.

Cook Inlet

Poor returns in the 2008 and 2009 Deshka River salmon runs resulted in closures for both sport and commercial fisheries. Commercial harvest of Chinook salmon in 2008 was 13,202 fish, lower than the 1998-2007 average of 16,166 fish. 396 Chinook were harvested in 2008 under educational permits, and 1,600 in personal use fisheries (Shields 2009). Approximately 9,000 Chinook were harvested in 2009. The 2009 total harvest of 1,266 Chinook in the Norhtern District was the third lowest harvest since 1986 (Eggers et al 2010).

[7] The salmon catch accounting year period extends from October 1, 2008 to September 30, 2009.

In 2008, harvest of Chinook salmon in the Lower Cook Inlet (while not normally a commercially important species) totaled just under 200 fish, or less than 20% of the average for the previous 10 years (Hammerstrom and Ford 2009). The 2009 harvest in the Lower Cook Inlet totaled 84 fish, the lowest total since 1971(Eggers et al 2010). In both years, virtually all catch was taken in the Southern District, primarily the commercial set gillnet fishery, which targets sockeye salmon.

In 2008, personal use catch of Chinook was 2 fish in the Lower Cook Inlet, the lowest since 1974 and much lower than the long term average (1967-2007) of 46 fish. This is attributable to the discontinuation (after 1999) of the Division of Sport Fish program to stock late run juvenile Chinook at the Homer Spit (Hammarstrom and Ford 2009).

Kodiak

There are no directed Chinook commercial fisheries in the Kodiak management area, but Chinook are harvested incidentally in target sockeye salmon fisheries. The 2009 commercial harvest was 7,219 Chinook, considerably lower than the 2008 harvest of 17,176 fish, as well as the previous 10-year average (19,000 Chinook) (Dinnocenzo 2010, Eggers et al 2010). No commercial openings were allowed in the Inner or Outer Karluk or the Inner Ayakulik sections in June and July of 2009, and due to low returns, non-retention of Chinook salmon was implemented during the one fishing period allowed in the Outer Ayakulik, in July 2009.

Due to weak Chinook runs on the Ayakulik and Karluk Rivers, subsistence fishing for Chinook was closed by emergency order in June 2008. In 2008, commercial finfish permit holders reported retention of 76 Chinook from their commercial harvest, for personal use (Dinnocenzo 2010).

Chignik

3,319 Chinook were commercially harvested in 2009, which exceeds recent average harvests (Eggers et al 2010). The majority of the harvest occurred from late June through July. Harvest in 2008 was the lowest since 1977, at 970 Chinook (Jackson and Anderson 2009). Average harvest for 2003-2007 was 2,433 fish.

15 Chinook were retained in 2008 for personal use, compared to an average from 2003-2007 of 169 fish.

South Alaska Peninsula

In 2009, 3,800 Chinook were caught in the South Unimak and Shumagin Islands June fisheries, 152 in the Southeastern District Mainland fishery, and 1,900 in the South Peninsula post-June fishery (Eggers et al 2010). The 2009 harvest was higher than the 2008 harvest of 4,839 fish, and also higher than the 4,839 fish average 1998-2007 Chinook harvest for the South Peninsula (Harthill 2009).

7 Management options to reduce Chinook salmon 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’s purpose in trying to reduce Chinook salmon bycatch is likely to be one of the following factors, or a combination of them: a. groundfish bycatch of this species represents a conservation concern; b. groundfish bycatch of this species is impacting directed fisheries for this species; or c. mortality caused by groundfish bycatch of this species is at a socially unacceptable level (note, this 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 populations. Section 6 provides limited information on Chinook 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.

7.1 Draft alternatives

The following suite of draft alternatives for reducing salmon bycatch in the GOA groundfish fisheries was first proposed by the Council in December 2003, and has been iteratively refined since that time. In June 2008, the Council eliminated alternatives for salmon species other than Chinook salmon, 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.

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.
    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.

7.2 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 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.

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. 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, however, require a good understanding of the relative stock status for that species, which may not be available for Chinook salmon in the GOA. Section 6 provide an overview of stock status for Chinook salmon, but a detailed understanding of the health and vulnerability of salmon stocks would 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, 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 3.1.

In order to establish PSC limits for Chinook, 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 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 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.

7.3 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. In a separate action, the Council is currently considering establishing area closures around Kodiak Island for protection of *C. bairdi* 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. One such is to look at areas of high abundance of the species in question, and restrict fishing in those areas, however this methodology is less effective for Chinook salmon. 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 also 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 3.3 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 are also highly variable from year to year. The correlation between the location of fishery catch and salmon bycatch has not been fully investigated, but preliminary analysis seems to indicate that the variability is as much a function of salmon 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, 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 have recently been revised or are 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 bycatch in the GOA groundfish fisheries.

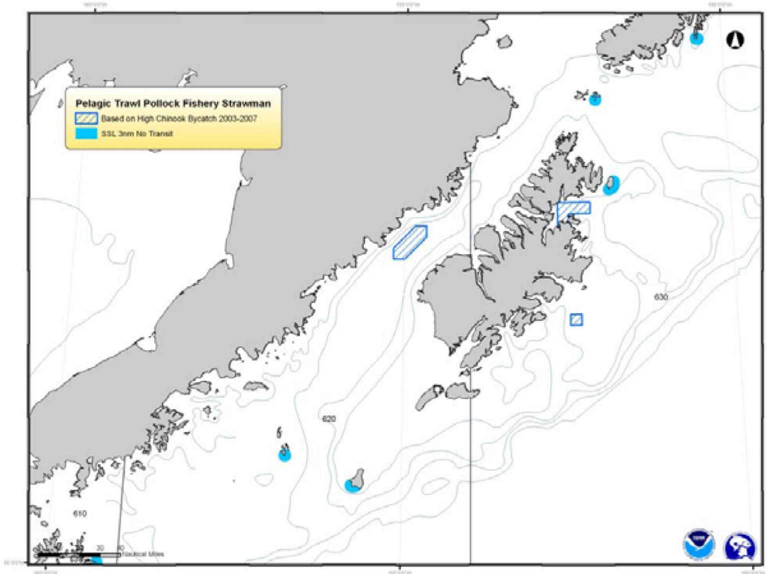
Strawman closures for Chinook salmon

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 5). 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 14, in Section 11 at the end of the document), and for 2008 only (Figure 15), 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 16). This methodology results in three closure areas, all of which occur in the central GOA.

As discussed in Section 3.3 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 5 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch summed for 2003-2007



Catch statistics for strawman closures

Table 13 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 bycatch in the western and central GOA. The table provides the overall bycatch rate of Chinook salmon 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 occurring in each set of closure areas is compared to the total number of hauls that contain Chinook salmon, 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 13 Total observed catch and Chinook 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 and gear type	**Total Chinook bycatch**[2] (number)	**Total fishery catch**[2] (mt)	**Bycatch rate** (bycatch/ total catch)	**Total number of tows in strawman areas**	**Total tows with Chinook bycatch in strawman areas**	**% of total W/C GOA bycatch occurring in strawman areas**	**% of total W/C GOA catch occurring in strawman areas**
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%

Source: NMFS observer database, March 2009.
[1] The methodology used to identify the strawman closures is described earlier in Section 7.3, and the closures themselves are illustrated in Section 11 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[8], 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.

7.4 Voluntary bycatch cooperatives

Alternative 4 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

[8] See Section 3.3 for discussion of the sampling mechanism for the GOA pollock fishery, and impacts on the averaging of bycatch across multiple haul locations.

between cooperatives with dedicated pollock allocations. An extensive discussion of the BSAI intercooperative agreement is included in the Final Environmental Impact Statement for Bering Sea Chinook Salmon Bycatch (NMFS 2008).

8 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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11 Color figures

Figure 6 Locations of existing trawl fishery and crab protection closures in the Gulf of Alaska

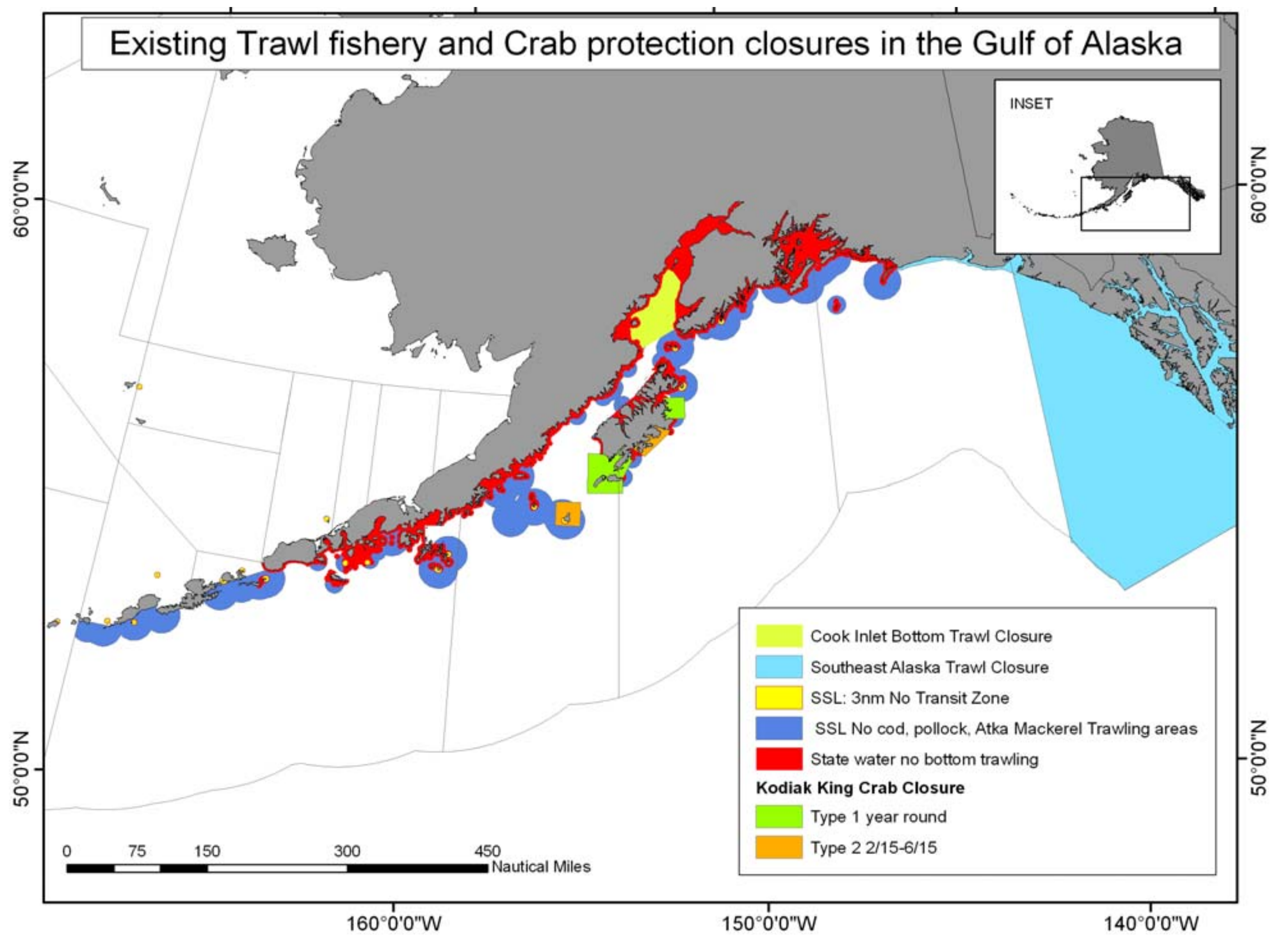

Figure 7 Locations of existing trawl fishery and crab protection closures in the Western Gulf of Alaska

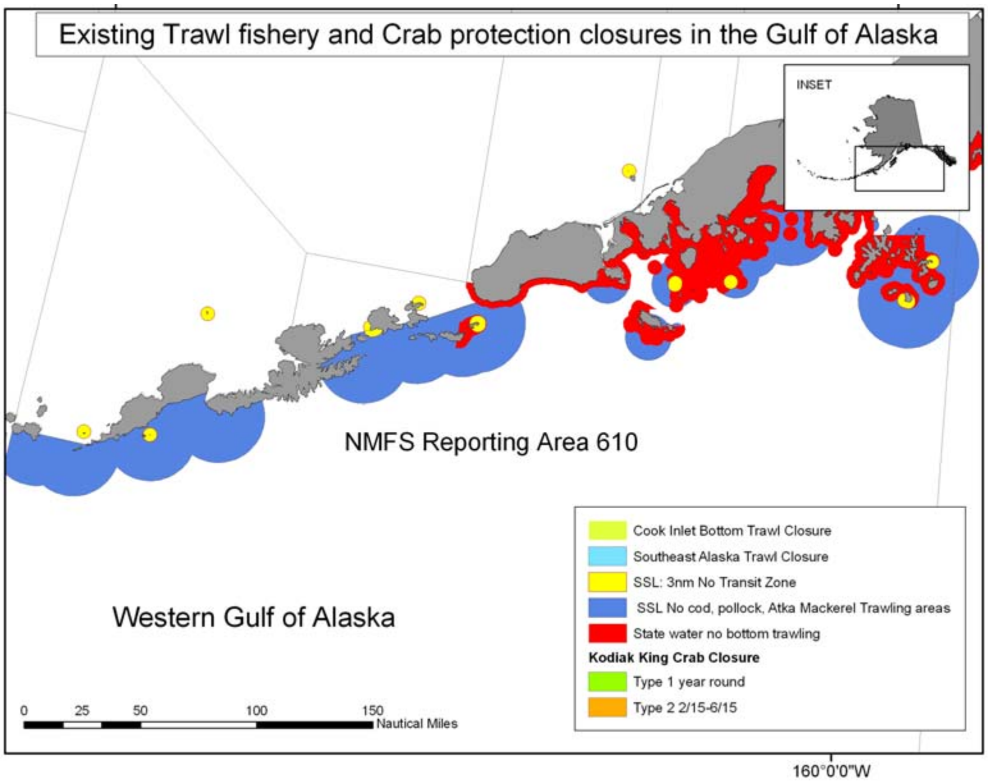

Figure 8 Locations of existing trawl fishery and crab protection closures in the Central Gulf of Alaska

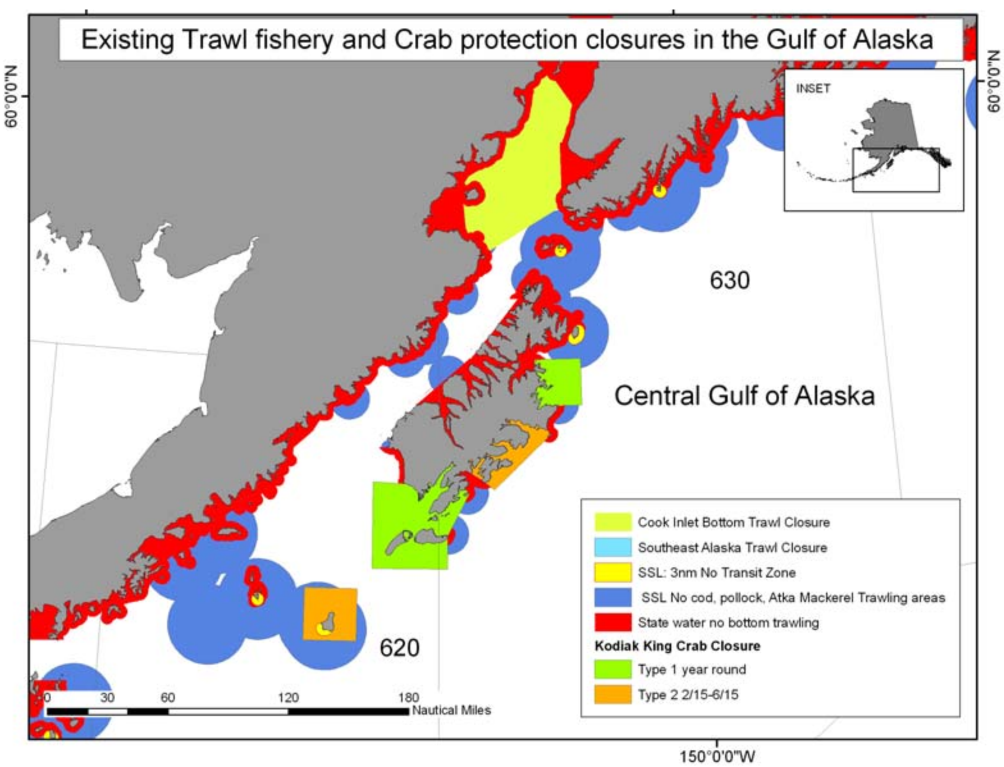

Figure 9 Observed Chinook salmon bycatch in the pelagic trawl fishery, summed over 2001-2008

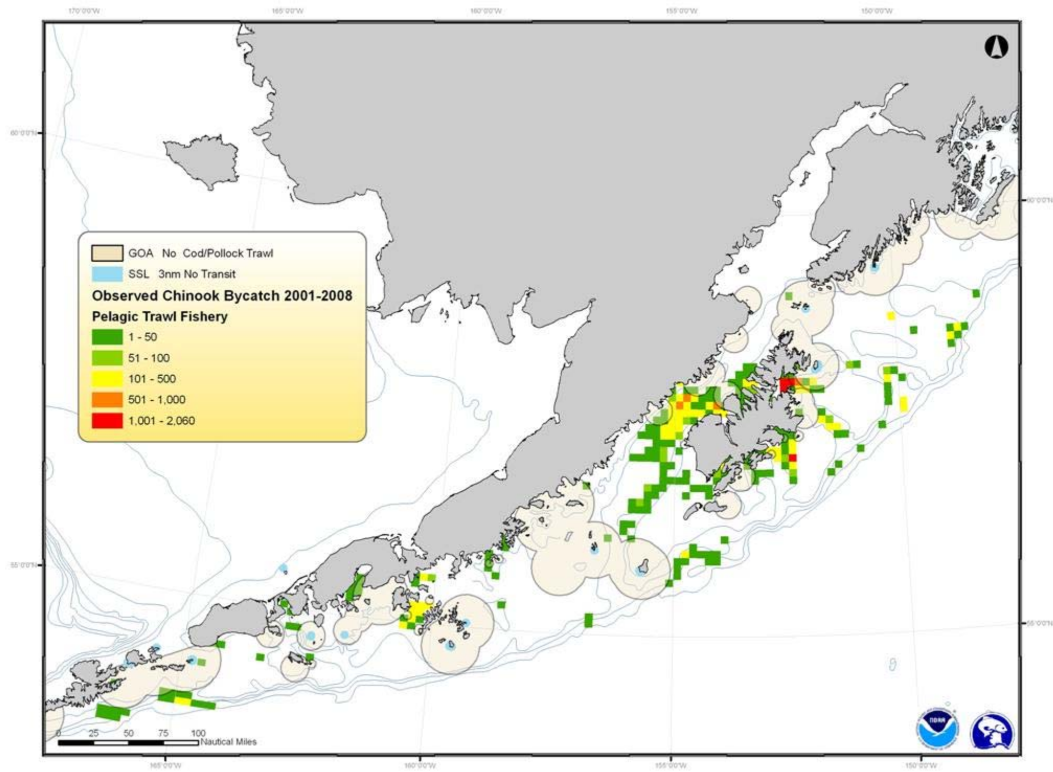

Figure 10 Observed Chinook salmon bycatch in the pelagic trawl fishery, 2008 only

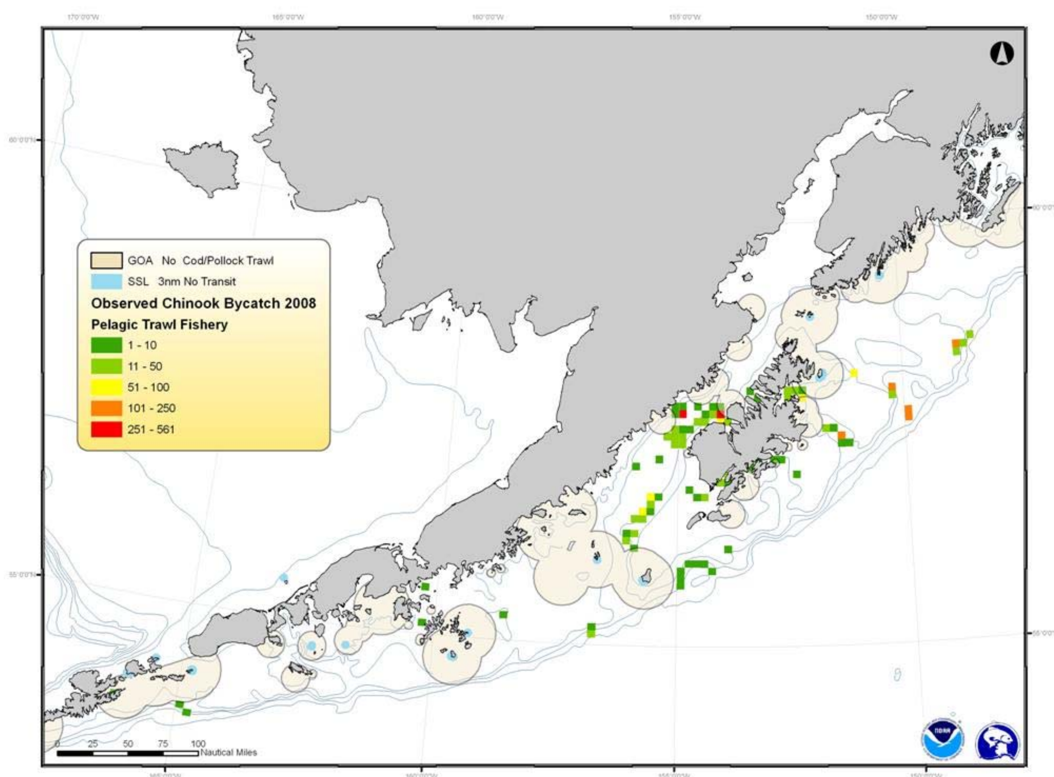

Figure 11 Observed Chinook salmon bycatch rate in the pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

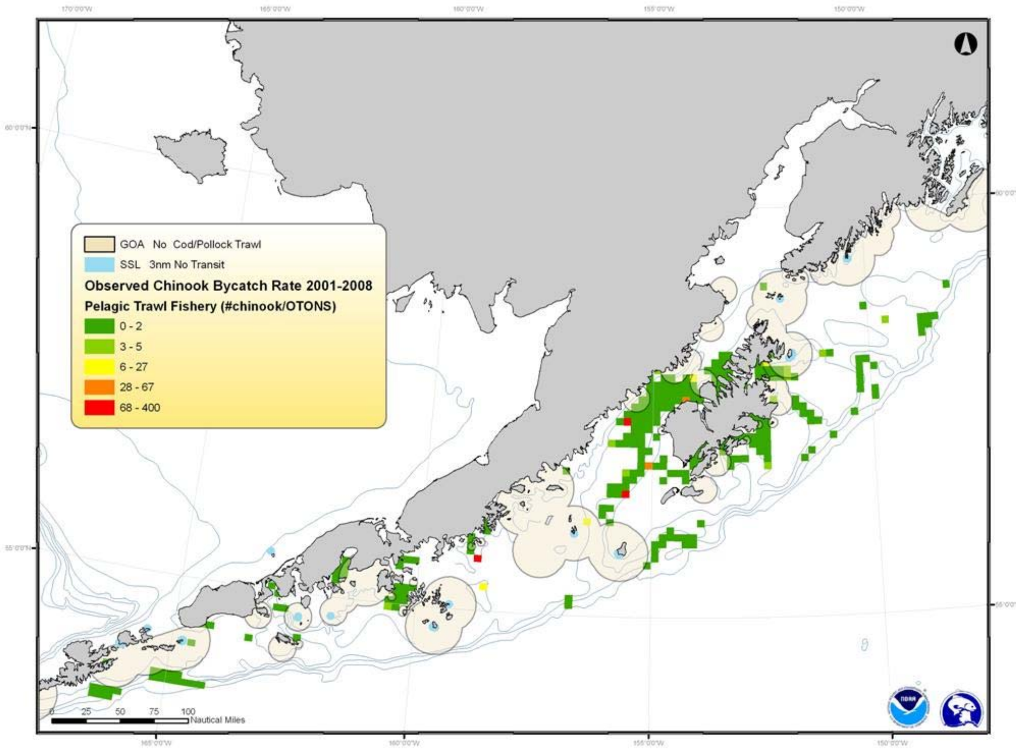

Figure 12 Observed Chinook salmon bycatch in the non-pelagic trawl fishery, summed over 2001-2008

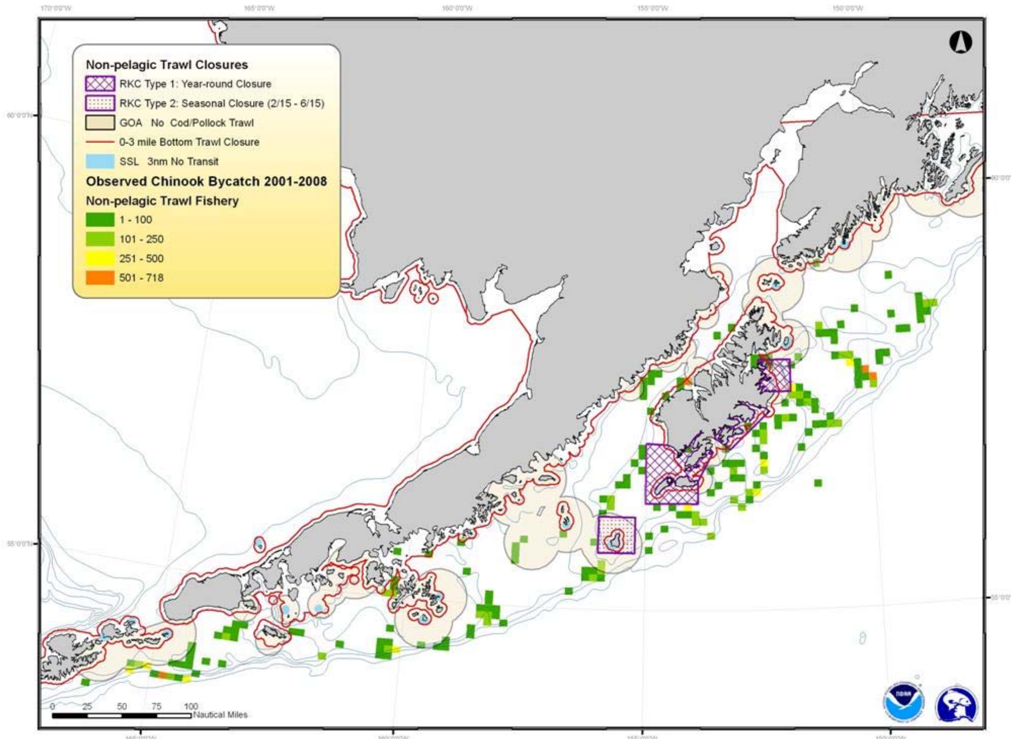

Figure 13 Observed Chinook salmon bycatch rate in the non-pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

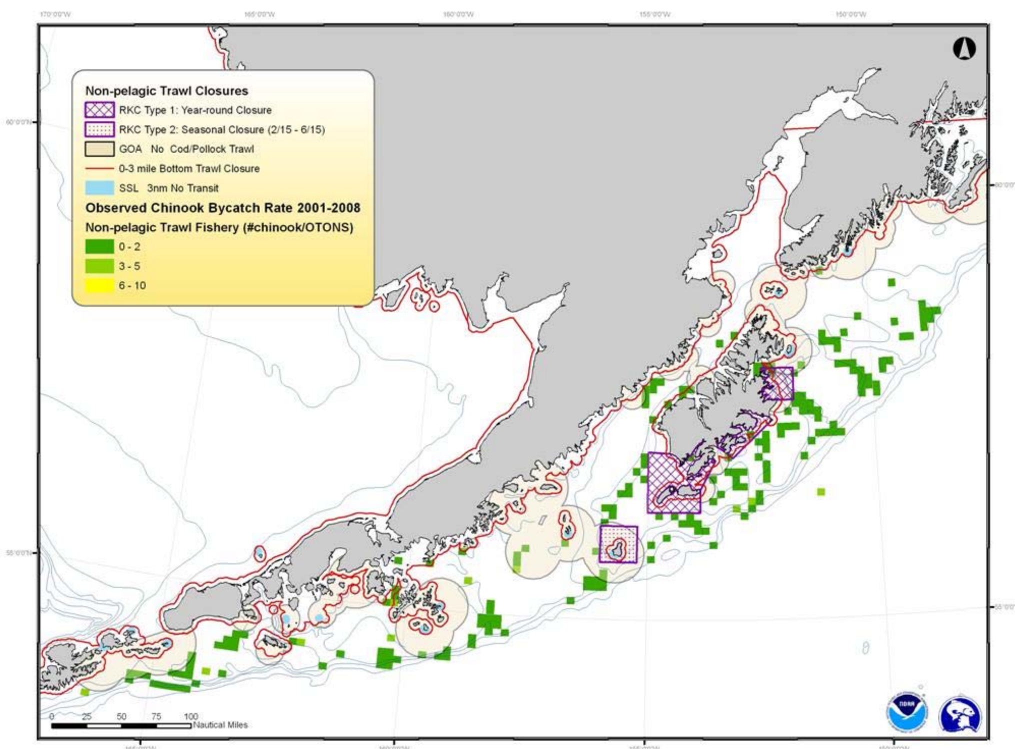

Figure 14 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2001-2008

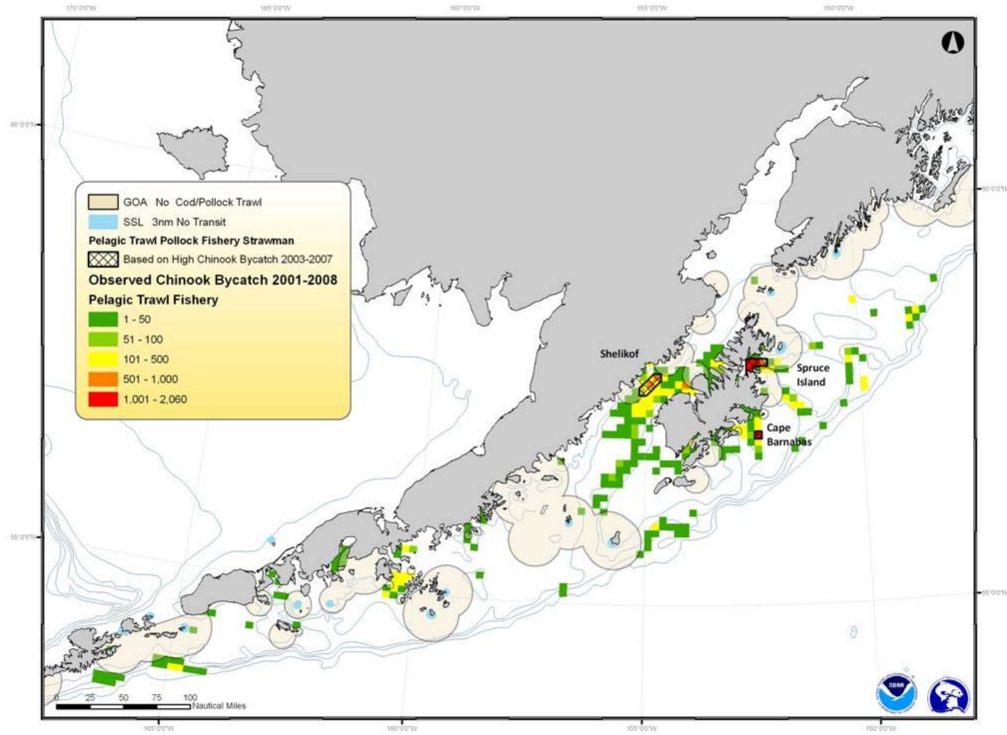

Figure 15 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2008 only

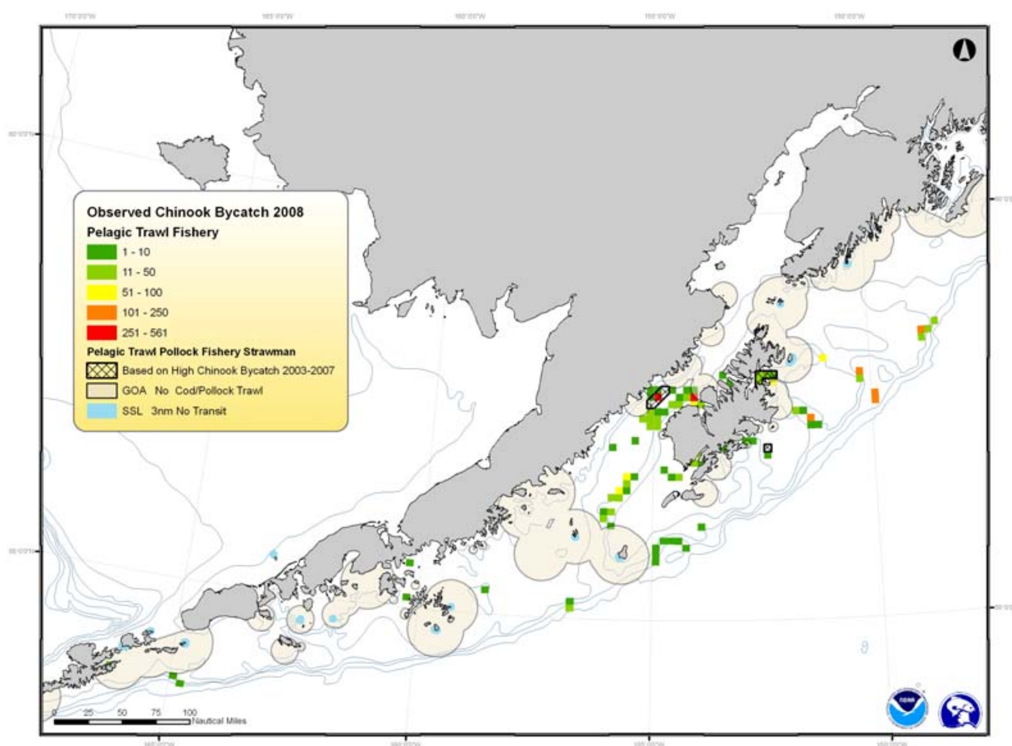

Figure 16 Chinoook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch rates in 2001-2008