Chinook Salmon Bycatch in Gulf of Alaska Groundfish Fisheries

November 2010

Staff Discussion Paper

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1 Introduction

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

To further reduce the bycatch of these prohibited species, various bycatch control measures have been instituted in the Alaska groundfish fisheries (a history is provided in NMFS 2004, Appendix F.5). In the Gulf of Alaska (GOA) groundfish fisheries, halibut bycatch limits (which close the groundfish target fisheries after the limits are reached) and bottom trawl seasonal and permanent closure areas to protect red king crab have been established. The Council recently adopted a nonpelagic trawl closure area and areas requiring increased observer coverage off the eastern coast of Kodiak, in order to provide additional conservation for Tanner crab. To date, no bycatch control measures have been implemented for salmon 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 proposed 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, which have since been adopted by the Council. This discussion paper now focuses exclusively on Chinook salmon bycatch in the groundfish fisheries, and provides a general overview of the available information on bycatch levels for Chinook (Section 3.4), and species abundance and directed fisheries (Section 8). In previous iterations of this discussion paper, preliminary alternatives were proposed for bycatch management measures, as well as strawman closure areas that may be considered for managing bycatch, which are both included in Section 9.

2 Changes to the discussion paper since April 2010

The Council reviewed a draft of this discussion paper most recently in April 2010. At that time, the Council requested that the paper be expanded with further discussion of the following:

- Requirement for full retention of salmon in the GOA groundfish fisheries
- Data updates showing Chinook salmon bycatch by target fishery, statistical reporting area, statistical week indicating total catch, number of Chinook salmon bycatch, and bycatch rate
- Disaggregated spatial maps of Chinook bycatch by month and year for specific fisheries

The Council also requested that to the extent possible, additional background should be provided on current stock assessment data for the larger GOA Chinook salmon producing streams, information on the known relationships between environmental variables and the abundance of GOA Chinook salmon, stock of origin information for GOA Chinook salmon bycatch, and an expanded discussion on the limitations of the GOA observer data for enforcing PSC limits, MRA caps, and directing inseason management

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

decisions. The Council also wrote a letter to NMFS to request that the agency accelerate the establishment of protocols to identify stock of origin of GOA Chinook salmon bycatch, including analysis of existing GOA Chinook salmon bycatch samples.

To the extent possible in the time available, staff has addressed the Council's main requests. The discussion of full retention is included in Section 3.4 of the discussion paper. Updated bycatch data is included in Section 4. Some additional disaggregated mapping, on an annual basis, is discussed in Section 5, and included in Section 14 at the end of this paper. A complete seasonal and fishery spatial analysis has not been included in this discussion paper, however, for reasons discussed in Section 5.

The items requested for additional background have not yet been addressed in this discussion paper, but will be updated for a future draft. Note, the discussion of management measures and strawman closures in Section 9 has not been updated at all since October 2009, and the strawman closures themselves were developed in December 2008.

The level of GOA Chinook salmon bycatch in 2010 has exceeded the incidental take amount authorized in the Biological Opinion for endangered Chinook salmon stocks, and consequently consultation has been reinitiated between NMFS Alaska Region and the Northwest Region office. A letter reporting on information about the Chinook salmon incidental catch in 2010 has been sent by NMFS to the Northwest Region, and will be available at the December Council meeting. Additionally, the agency is also planning to respond to the Council's letter concerning a stock of origin sampling protocol in time for the December Council meeting.

3 Estimating Chinook salmon bycatch in the GOA groundfish fisheries

NMFS estimates Chinook salmon bycatch 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) are 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.

3.1 Observer program bycatch sampling

The Fisheries Monitoring and Analysis (FMA) Observer Program (Observer Program) collects catch and incidental catch data used for management and inseason monitoring of groundfish fisheries. Data from observed vessels are used to estimate the numbers of salmon by species taken as bycatch in the Alaska groundfish fisheries. Chinook salmon are the dominant salmon species taken as bycatch in the GOA, followed by chum. Very small numbers of sockeye salmon, coho salmon, pink salmon, and steelhead are also taken as bycatch in the GOA groundfish fisheries.

Chinook salmon are caught as bycatch primarily in the directed pollock trawl fisheries, although some salmon are also taken as bycatch in other trawl target fisheries (see Section 4.1). Very few salmon are taken by non-trawl gear fisheries.

Observer sampling for salmon composition in the GOA directed pollock fishery is a labor intensive process, as NMFS strives to obtain a census of all the salmon which are caught when an observer is on board. The census is challenging because salmon are interspersed in the high volume pollock catch and are rarely sorted out at sea. To get a good count of all the salmon in the catch, the entire catch is monitored as it is delivered to shore-side processing plants. This ensures that all salmon in the observed delivery are sorted out, identified, and counted. NMFS extrapolates the salmon bycatch numbers from the observed pollock trips to unobserved trips following the procedures outlined in NOAA Technical Memorandum NMFS -AFSC-205 (Cahalan et al. 2010).

Estimates for non-pollock fisheries are obtained from samples taken at-sea by observers. Vessels which are not fishing for pollock generally sort salmon at-sea. Thus, there is no need to follow the fish into the processing plants.

Observers send their data in to NMFS after each trip and those data are used to make in-season estimates of catch. Observers are deployed in the field for up to three months at a time, and debrief with FMA Division staff following their deployment to ensure the data were collected following NMFS protocols. Changes may occur to the data during the debriefing, and this is a routine and normal process. The 2010 data will not be finalized until all observers have returned from the field, are debriefed, and quality control on data is completed. Generally, the observer data are finalized in late February to early March of the year following the fishery. **Any 2010 information is preliminary until the observer data are finalized after the fishing year is completed**.

3.2 Prohibited species bycatch estimation procedure

Management of prohibited species catch (PSC) species, including Chinook salmon, is based solely on estimates derived from independent observer information, rather than from industry reported catch. PSC 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.

All available observer data which have been received by NMFS are used in the calculation of PSC estimates. PSC are calculated and managed in numbers of animals for crab and salmon, and in weights for halibut and herring, and are reported to the public on the NMFS website as the fisheries progress throughout the year.

The technical mechanics of how NMFS uses observer sampling ratios to estimate PSC are described in detail in NOAA Technical Memorandum NMFS -AFSC-205 (Cahalan et al. 2010). Detailed instructions on the procedures observers use to collect the data which are inputs into the estimation process can be found in the series of observer manuals available at:
http://www.afsc.noaa.gov/FMA/Manual_pages/MANUAL_pdfs/manual2010.pdf.

In order to continue to improve the NMFS catch accounting processes, the Alaska Fisheries Science Center and Alaska Region 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 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).

3.3 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. Under the current Observer Program, the amount of observer coverage is based on vessel length. 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. 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.

In October 2010, the Council took final action to restructure the Observer Program for vessels and processors that are determined to need less than 100% observer coverage in the federal fisheries including previously uncovered sectors such as the commercial halibut sector and <60' groundfish sector. The restructured program is intended to provide NMFS with the flexibility to deploy observers in response to fishery management needs and to reduce the bias inherent in the existing program, to the benefit of the resulting data.

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 current 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 western and central GOA, the total amount of groundfish that is caught while an observer is onboard the vessel, and the resulting percentage[2]. 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. 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.

[2] 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%

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, and in previous iterations of this discussion paper. Table 2 looks specifically at the pollock fishery, and provides information on how much of the fleet's attributed Chinook salmon bycatch is derived directly from observed vessels, and how much is estimated using one of the precedence rate aggregations described in Section 3.2.

Table 2 Sum of Chinook salmon bycatch in the pollock fishery, by year and reporting area, as aggregated using different observed rates

Year	Area	Observer onboard vessel	Rate for unobserved landings calculated using:	Total
2005	610	852	5,099	5,951
	620	1,622	5,148	6,770
	630	3,843	10,728	14,570
	640		474	474
2005 Total		6,317	21,448	27,765
2006	610	564	3,966	4,529
	620	1,105	3,752	4,857
	630	1,750	4,531	6,280
	640		54	54
2006 Total		3,419	12,302	15,721
2007	610	303	3,056	3,359
	620	21,815	6,220	28,035
	630	698	2,878	3,577
	640		34	34
2007 Total		22,816	12,189	35,005
2008	610		2,106	2,106
	620	2,103	4,593	6,696
	630	264	1,012	1,275
	640		340	340
2008 Total		2,367	8,050	10,417
2009	610	23	418	441
	620	367	992	1,359
	630	449	252	701
	640	13	17	31
2009 Total		852	1,680	2,532
2010*	610	3,555	26,283	29,839
	620	1,634	4,371	6,004
	630	2,422	3,533	5,955
	640	19	390	408
2010 Total		7,630	34,576	42,206

* 2010 data through November 12, preliminary.
Source: M. Furuness, NMFS inseason management

3.4 Retention of salmon

Currently, retention of salmon is prohibited in the GOA groundfish fisheries, though the retention of salmon in the pollock fishery is a longstanding practice. This is because of the operational characteristics whereby large volumes of pollock are brought aboard and rapidly stowed in below deck tanks. Detecting salmon as the pollock are brought aboard and stowed is not practical, and is considered generally unsafe due to stability concerns. Several industry members have commented that this practice of retaining salmon should be recognized in the regulations and potentially encouraged to enable observer sampling.

Regulations are currently in place in the Bering Sea pollock fishery requiring full retention of salmon by all participants in the fishery. Regulations require retention of salmon “until the number of salmon has been determined by the observer and the observer's collection of any scientific data or biological samples from the salmon has been completed," (50 CFR 679.21(c)(1)). It would be possible for NMFS to implement a similar regulation in the GOA pollock fishery. This would require processors to put salmon aside and count them.

In order to understand how best to implement such a regulation, however, it is important to consider what the full retention is intended to address. There are two policy goals which could be forwarded through full retention: 1) implementing a systematic sampling program to help inform genetic tissue sampling for stock composition of GOA Chinook bycatch; and 2) encouraging donations of bycaught salmon to the salmon food bank program.

Full retention may be a useful step in designing a sampling program for Chinook bycatch in the GOA fisheries. While the requisite elements are not in place in the GOA to implement the same census and sampling system that is going into effect in 2011 in the Bering Sea under Amendment 91 (see further discussion in Section 7), the potential exists to improve sampling if fish were made available shoreside. NMFS is addressing this issue in a letter to the Council which should be available at the December 2010 meeting.

SeaShare, the Alaska food bank donation program, does not currently receive deliveries of GOA Chinook salmon. Since the recent increase in bycatch, however, there has been interest in expanding the program to the GOA. A requirement for full retention of salmon might encourage the expansion of this program.

4 Chinook Salmon Bycatch in GOA groundfish fisheries

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 five years (average of 26,732 salmon, 2006–2010) exceeds that of the twenty-year average (average of 20,185 salmon, 1991–2010, Table 3). During the recent time period, there have been two years (2007 and 2010) with particularly high bycatch of Chinook salmon. For the purpose of this discussion paper, it is assumed that salmon caught as bycatch have 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). 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. In short bycatch rates from observed vessels are applied to the fleet as a whole. The resulting estimates are used in Sections 4.1 and 4.2.

Table 3 Bycatch of Pacific salmon in Gulf of Alaska groundfish trawl fisheries, by species, 1990-2010

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	7,767	2,355				
2010[c]	51,550	1,747				
20-year average 1991–2010	**20,185**	**14,013[b]**				
5-year average 2006–2010	**26,732**	**2,804**				

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

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

[c] 2010 data preliminary, through November 6, 2010.

Source: NMFS catch reports (http://www.fakr.noaa.gov/sustainablefisheries/catchstats.htm) for 1990-2002 (all species) and 2003-2010 (non-Chinook species); NMFS PSC database for 2003-2010 (Chinook).

4.1 Bycatch by area, gear type, and target fishery

In the GOA, Chinook salmon bycatch primarily occurs in the western and central regulatory areas, and corresponds to the locations of the trawl fisheries. Table 4 illustrates bycatch for 2003-2010 across western and central regulatory and reporting areas (Figure 1). 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. Prior to 2010, Chinook bycatch in the western regulatory area as a proportion of total GOA Chinook bycatch varied between a 7% and 26%, by year, but averaged to approximately 18%. The remainder of salmon bycatch, in the central GOA, has been on average, divided evenly between reporting areas 620 and 630 (Chignik and Kodiak). In 2010, however, an especially high amount of Chinook salmon were caught as bycatch in the western GOA, amounting to 31,039 salmon, based on preliminary data.

Table 4 Chinook salmon bycatch by reporting area, 2003-2010, 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	2,860	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%	6,987	23%	16,170	53%	30,724
2006	4,880	26%	5,678	30%	8,169	44%	18,727
2007	3,666	9%	28,942	72%	7,712	19%	40,320
2008	2,398	16%	7,173	47%	5,730	37%	15,300
2009	558	7%	3,041	39%	4,168	54%	7,767
2010*	31,039	61%	8,165	16%	12,054	24%	51,258
Average 2003-2010	**7,144**	**23%**	**8,648**	**35%**	**8,816**	**41%**	**24,608**

*preliminary data
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

Figure 1 Regulatory and reporting areas in the GOA

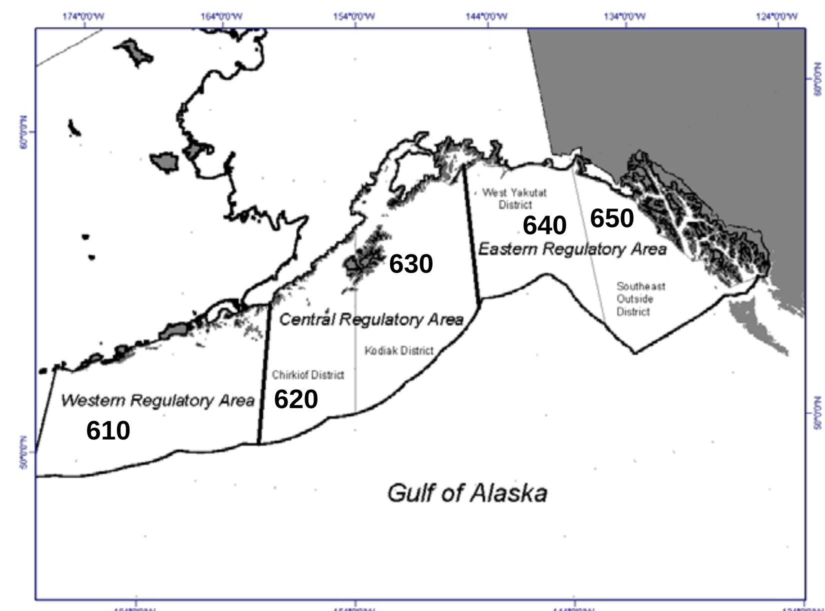


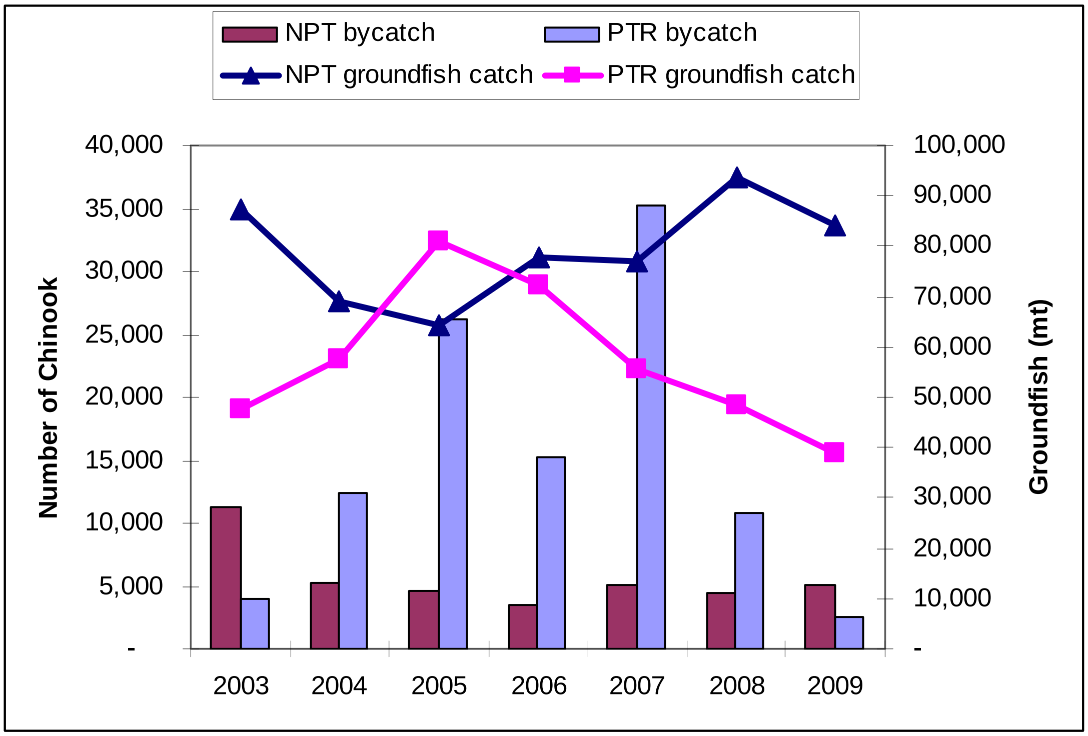
Table 5 identifies Chinook bycatch for 2003-2010, by gear type. Pelagic and non-pelagic trawling are almost entirely responsible for Chinook salmon bycatch. In 2004-2008, pelagic trawl gear accounted for over 70% of Chinook bycatch, however in 2003 and 2009, nonpelagic trawl caught 74% and 67% of the Chinook salmon. The relationship between groundfish catch and pelagic trawl Chinook bycatch is shown in Figure 2 for 2003-2009, and was consistent in all years except 2007. 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 5 Chinook salmon bycatch by gear type, in western and central groundfish fisheries, 2003-2010

Year	Pelagic trawl		Nonpelagic trawl		Hook and line		Pot		Total
	Number of salmon	% of total	% of total	Number of salmon	Number of salmon	% of total	Number of salmon	% of total	
2003	3,903	26%	74%	11,269	-	-	-	-	15,172
2004	12,411	71%	29%	5,164	21	0%	-	-	17,596
2005	26,148	85%	15%	4,576	-	-	-	-	30,724
2006	15,293	82%	18%	3,434	-	-	-	-	18,727
2007	35,249	87%	13%	5,062	8	0%	-	-	40,320
2008	10,803	71%	29%	4,498	-	-	-	-	15,300
2009	2,489	32%	68%	5,278	-	-	-	-	7,767
2010*	40,625	79%	21%	10,633	-	-	-	-	51,258
Average 2003-2010	**18,365**	**67%**	**33%**	**6,239**	**4**	**0%**	**-**	**-**	**196,864**

*preliminary data
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

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



Source: NMFS Catch Accounting System. Data compiled by AKFIN, February 2010.

Chinook bycatch with pelagic trawl gear occurs predominantly in the pollock target fishery (Table 6), and accounts for most of the western and central Chinook bycatch, an average of 72% over 2003-2009, or 14,900 fish. Table 7 illustrates the distribution of bycatch in the pollock pelagic fishery in the western and central GOA. While bycatch in the western GOA prior to 2010 has been generally lower than it is in areas 620 and 630, the proportional bycatch by area within all years 2003-2008 is highly variable. 2010 is the year of highest bycatch, primarily occurring in the western GOA (610). 2007 was also a year of high bycatch, primarily occurring in the Chignik area (620). In the Kodiak area (630), 2005 was the highest bycatch year with 13,370 Chinook. In 2009, trawl bycatch in the pollock fishery in all areas was considerably lower than in the previous five years.

Table 6 Chinook salmon bycatch by target fishery, in western and central groundfish fisheries, 2003-2010

Gear type	Target fishery	2003	2004	2005	2006	2007	2008	2009	2010*	Average 2003-2010
Pelagic trawl	Pollock	3,872	12,411	26,085	15,287	34,955	10,057	2,285	40,508	18,183
	Rockfish	-		63	-	294	746	203	118	178
Nonpelagic trawl	Arrowtooth Flounder	3,348	359	1,798	408	1,502	2,608	6	4,044	1,759
	Flathead Sole	598	1,446	16	56	-	-	118	149	298
	Pacific Cod	3,167	908	41	882	624	433	111	461	828
	Pollock	423	571	1,296	380	50	30	278	1,287	539
	Rex Sole	2,819	498	982	1,444	714	-	1,907	2,237	1,325
	Rockfish	799	885	387	263	1,733	1,212	1,102	1,443	978
	Shallow Water Flatfish	116	498	56	-	438	213	1,756	1,013	511

*preliminary data
- = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

Table 7 Chinook salmon bycatch in the pollock trawl fishery, by reporting area, 2003-2010

Year	Pelagic trawl			Nonpelagic trawl		
	610	620	630	610	620	630
2003	738	1,121	2,044	2,122	2,755	6,393
2004	2,013	4,886	5,513	2,164	430	2,570
2005	5,951	6,764	13,433	1,616	222	2,738
2006	4,529	4,843	5,921	351	835	2,248
2007	3,359	28,036	3,854	304	904	3,853
2008	2,116	6,685	2,001	282	488	3,728
2009	441	1,143	904	117	1,898	3,264
2010*	29,839	5,425	5,362	1,201	2,741	6,692
Average 2003-2010	**6,123**	**7,363**	**4,879**	**1,019**	**1,284**	**3,936**

*preliminary data
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

Table 8 also provides overall Chinook bycatch numbers for the trawl sector, by target fishery for 2000-2010, although without distinguishing between pelagic and nonpelagic gear types. The table additionally provides the rate of bycatch, measured as number of Chinook salmon per mt of total groundfish. The bycatch rate averages 0.25 in the GOA pollock fishery, although annually it varies between 0.07 and 0.66 over the time series. (Note, the numbers in Table 8 and Table 9 are slightly different from the numbers reported in the remainder of the tables, as they were queried on different days). Table 9 looks specifically at 2010, and breaks down the Chinook salmon bycatch rate in the pollock target fishery by month and reporting area. From this table, it is evident that the bycatch rate in October was highest in the western GOA, at 3.62 salmon per mt groundfish. Even in 630, the bycatch rate was higher than the average in October, at 0.64. Data is also presented in this table for pollock catch in 640, which has only a small pollock quota and is not subject to the seasonal restrictions of the other GOA reporting areas. The bycatch rate for September was particularly high, but only a very small amount of pollock was taken in that area during that month.

Table 8 Chinook salmon bycatch (number of salmon) by trawl target fishery, 2000-2010, and bycatch rate (number of salmon per mt of groundfish)

Target		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Ave. 2000-2010
Pollock	Bycatch	9,531	18,413	5,161	4,400	13,152	27,927	15,944	35,040	10,427	2,620	42,206	
	Rate	0.13	0.25	0.10	0.09	0.20	0.33	0.21	0.66	0.21	0.07	0.55	0.25
Pacific Cod	Bycatch	2,747	2,830	4,066	3,167	908	41	888	624	433	111	461	
	Rate	0.11	0.10	0.27	0.20	0.05	0.00	0.08	0.04	0.02	0.01	0.03	0.08
Rockfish	Bycatch	445	1,153	1,250	919	885	450	263	2,038	2,280	1,432	1,627	
	Rate	0.02	0.05	0.05	0.04	0.03	0.02	0.01	0.09	0.09	0.06	0.06	0.05
Flatfish	Bycatch	2,297	2,443	4,392	6,909	2,800	2,853	1,909	2,654	2,822	3,787	7,442	
	Rate	0.06	0.10	0.11	0.15	0.13	0.10	0.05	0.06	0.06	0.07	0.18	0.10

Source: NMFS Catch Accounting System, November 2010.

Table 9 2010 Chinook salmon bycatch rates in the pollock fishery (pelagic and nonpelagic trawl gear combined), by month, all reporting areas

Reporting Area	Month	Total Chinook bycatch (number)	Total pollock catch (weight in MT)	Rate
610	January	329	942	0.35
	February	621	3,939	0.16
	March	384	2,207	0.17
	April	426	2,651	0.16
	August	353	1,631	0.22
	September	1,529	7,187	0.21
	October	26,241	7,251	3.62
620	January	42	42	0.99
	February	3,376	7,464	0.45
	March	198	11,607	0.02
	September	1,530	3,853	0.40
	October	1,010	4,607	0.22
630	January	-	102	0.00
	February	35	347	0.10
	March	1,105	6,206	0.18
	September	1,437	4,757	0.30
	October	3,380	5,274	0.64
640	March	215	1,428	0.15
	September	189	87	2.18

Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

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 6). For non-pelagic trawl gear, bycatch is distributed among several target fisheries. 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. For the nonpelagic trawl fishery, bycatch is consistently highest in area 630.

4.2 Timing of Chinook bycatch

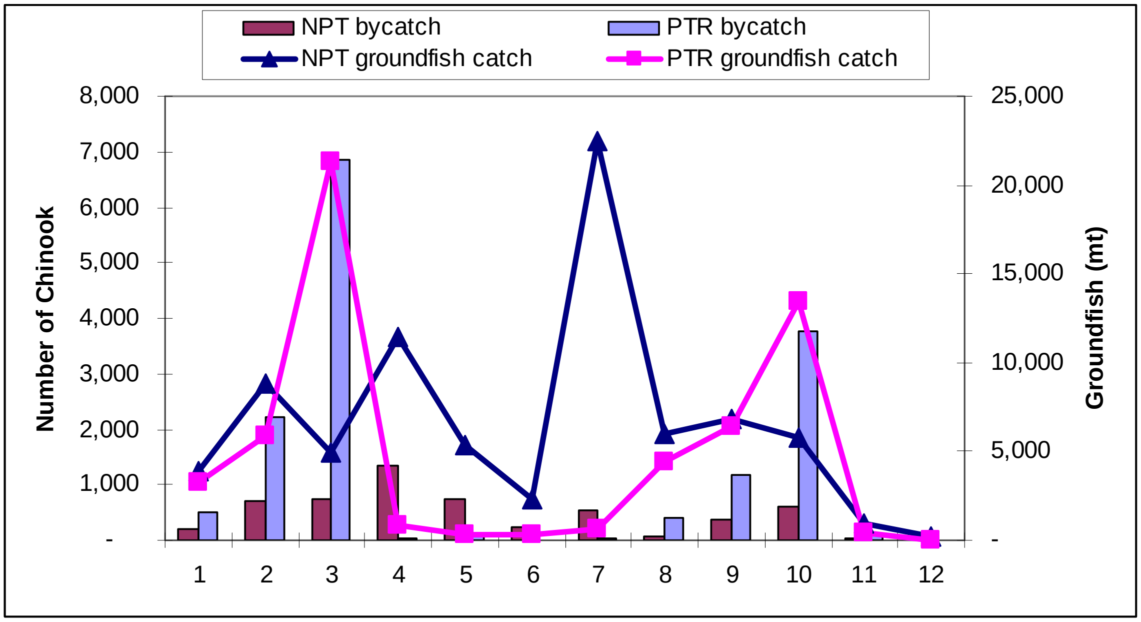
The timing of salmon bycatch follows a predictable pattern in most years. Chinook salmon are caught in high quantities regularly from the start of the trawl fisheries on January 20 through early April, and again during September/October in the pollock fisheries (Table 10). Figure 3 illustrates the difference in seasonal bycatch patterns between the pelagic and non-pelagic trawl fisheries for 2003-2009, with respect to Chinook bycatch. 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 most instances, the available TAC will be caught (and the fishery will be closed) well before the end of the season, often in only a few days. Table 11 provides the bycatch numbers, by month, for the pelagic trawl fishery only. For the nonpelagic trawl fisheries, Figure 3 illustrates that 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 Chinook salmon bycatch by month, 2003-2010, in western and central groundfish fisheries

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2003	1,173	2,311	1,026	2,991	2,608	-	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	6,734	451	56	5	450	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	2,433	3,704	634	50
2008	151	458	7,294	2,727	1,225	368	363	183	224	2,217	91	-
2009	162	411	1,466	1,171	595	157	406	170	233	2,579	233	183
2010*	371	4,363	2,127	4,768	729	594	559	380	5,110	32,256	-	
Average 2003-2010	**648**	**3,098**	**6,911**	**1,787**	**825**	**289**	**564**	**463**	**1,995**	**7,861**	**137**	**29**

*preliminary data
- = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

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



Source: NMFS Catch Accounting System. Data compiled by AKFIN, February 2010.

Table 11 **Chinook salmon bycatch by pelagic trawl gear, by month, 2003-2010**

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	5,072	**	**		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	1,341	3,310	615	
2008	77	218	7,157	173	600	65	81	166	223	2,003	41	
2009	16	**	1,264		49	4	4	33	161	928	**	
2010*	329	3,543	1,352	426	111	**	5	347	4,359	30,154		
Average 2003-2010	**469**	**2,387**	**6,158**	**76**	**111**	**10**	**29**	**390**	**1,569**	**7,063**	**99**	

*preliminary data
- = data is confidential. If cell is blank, no bycatch was recorded in those months.
Source: NMFS Catch Accounting System. Data compiled by AKFIN, November 2010.

5 Spatial analysis of bycatch patterns

The data presented in Section 4 is from the NMFS catch accounting prohibited species catch data, which applies bycatch rates from observed fishing trips to unobserved groundfish catch within each target, gear type, and reporting area (see Section 3). In order to examine the spatial distribution of bycatch at a finer scale than that of the reporting area, we rely on bycatch data from observed trips only, as only these observed hauls are associated with geographical coordinates. As only a small proportion of total groundfish catch in the GOA is observed, however, it should be remembered that the mapped data may not represent the total activity of the fisheries.

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 allow 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. This analysis of the data will be important if the data are used identify regulatory closure areas, and the impact would need to be investigated at that point.

Two sets of maps are provided in the Section 14, mapping Chinook salmon bycatch. First, Figure 6 through Figure 11, provided by NMFS inseason management,offer an annual illustration of observed GOA Chinook salmon bycatch from 2006 to 2010. Figure 6 provides an overview of bycatch aggregated for all five years, and Figure 7 through Figure 11 present each year's distribution. It is apparent from the annual illustrations that there is considerable interannual variability in the locations of high Chinook bycatch.

Additionally, another set of aggregated maps is included, as presented in previous versions of this discussion paper. Figure 12 and Figure 14, in Section 14 at the end of this document, map the total number of Chinook observed during the aggregated years 2001-2008, in fisheries using pelagic and nonpelagic trawl gear, respectively. Figure 13 and Figure 15 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.

6 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 12). Hatchery releases in each region have decreased in recent years.

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

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

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

Table 12 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).

7 River of origin of GOA Chinook salmon bycatch

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. Limited information is available in the GOA groundfish fisheries on the river of origin of salmon species.

Genetic samples (pelvic axillary processes), maturity information, and scales from Chinook salmon were collected by observers in the 2010 GOA pollock fishery. All vessel observers collect a genetic sample, length, sex, and maturity information from every Chinook salmon in the species composition samples. Plant and floating processor observers collect genetic samples, length, sex, and maturity information from randomly selected Chinook salmon using a temporal sampling frame.

In 2011, these sampling procedures will be revised to be consistent with changes occuring in the Bering Sea polllock fishery. In 2011, the genetic samples noted above will be taken systematically from all salmon encountered in observed pollock deliveries. This should provide sample from throughout the observed deliveries in the Gulf of Alaska.

Genetic analysis of Chinook salmon is an ongoing coordinated effort among the Alaska Department of Fish and Game, Alaska Fisheries Science Center Auke Bay Laboratories (Auke Bay Lab), and the University of Washington. 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.

The Alaska Fishery Science Center has developed a comprehensive plan for counting all Chinook bycatch (a census) in the Bering Sea pollock fishery, and taking a systematic sample from that bycatch. This census and sample is scheduled for implementation in 2011. Full retention of salmon is currently required in the Bering Sea pollock fishery, and under the implementation of Amendment 91 in 2011, a minimum of 100% observer coverage will also be required on all vessels participating in the pollock fishery, regardless of length. Also, shoreside processors are required (under their Catch Monitoring and Control Plan) to provide a location from which the observer will be able to view all sorting and weighing of fish simultaneously. Most recently in April 2010, the Council wrote to NMFS to request that a similar Chinook salmon bycatch sampling protocol be put in place in the GOA groundfish fisheries, and that genetic analysis of samples collected from Chinook salmon in the GOA groundfish fisheries be initiated. NMFS will provide a written response to the Council's request prior to the December 2010 Council meeting.

Currently, coded wire tags (CWTs) are the primary source of information for the stock-specific ocean distribution of those Chinook salmon stocks which are tagged and caught as bycatch in the GOA groundfish fisheries. The High Seas Salmon Research Program of the University of Washington routinely tags and monitors Pacific salmon species. It should be noted that 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). We should note that numerous runs of Chinook salmon do not have coded wire tags.

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).

7.1 Bycatch of ESA-listed Pacific salmon stocks in the GOA groundfish fisheries

Of the larger number of Chinook salmon evolutionarily significant units (ESUs) in the Pacific Northwest that are listed on the Endangered Species Act, three are known to have been caught as bycatch in the Alaska groundfish fisheries. Chinook salmon from the Lower Columbia River (LCR), Upper Willamette River (UWR), and Upper Columbia River (UCR) Spring ESUs have been recovered in the GOA trawl fishery. A biological opinion dated November 30, 2000, and supplemented in January 11, 2007, was issued regarding the authorization of the Alaska groundfish fisheries. An incidental take statement was included in the Biological Opinion, which established a threshold of 40,000 Chinook salmon caught as bycatch in the GOA groundfish fisheries. If, during the course of the fisheries, the specified level of take is exceeded, a reinitiation of consultation is required, along with a review of the reasonable and prudent measures identified in the supplemental Biological Opinion.

Since 1984, CWTs have been recovered from 23 LCR, 98 UWR, and 1 UCR Chinook salmon in the GOA trawl fishery, both pre- and post-listing (Table 13). By applying mark expansion factors (which offer the closest approximation to the contribution of ESA-listed ESUs in the GOA), the estimated numbers increase to 112 LCR, 282 UWR, and 1 UCR Chinook salmon. Note, the most recent CWT recoveries in this table occurred in February 2010. A single Chinook salmon from the UWR has to date been analyzed and recorded. NMFS Auke Bay Lab is currently analyzing further CWTs that were recovered later in 2010. The results of this analysis may be available by the time of the December 2010 Council meeting.

The numbers provided here should be considered as minimum estimates of the number of ESA-listed ESUs in the GOA groundfish fisheries. Until adequate numbers of CWTs are recovered from *inside* the observers' samples, where the total number of fish sampled is known, an estimate of total contribution of ESA-listed ESUs in the GOA groundfish fisheries will remain unknown and indeterminable.

Table 13 Observed Number and Mark Expansion of ESA-listed coded wire tagged salmon, by evolutionarily significant unit (ESU), captured in the GOA trawl fishery, pre-listing and post-listing, 1984–2010.

Listing Status	ESU Name	GOA Observed Number	GOA Mark Expansion
Pre-listing	Lower Columbia River Chinook	12	82.1
	Upper Willamette River Chinook	43	143.8
Post-listing	Lower Columbia River Chinook	11	29.7
	Upper Columbia River spring Chinook	1	1.0
	Upper Willamette River Chinook	55	138.1

*2010 data are preliminary. The most recent CWT recoveries occurred in February 2010.
Source: NMFS Alaska Fisheries Science Center Auke Bay Lab, Adrian Celewycz, 11/8/2010

Because the 2010 GOA groundfish fisheries have exceeded the incidental take statement's threshold of 40,000 Chinook salmon caught as bycatch, NMFS Alaska Region has requested that formal consultation be reinitiated under Section 7 of the ESA. A memorandum to this effect is being sent to NMFS Northwest Region, and an annual report will be prepared in the early part of 2011. A copy of the memorandum will be available by the December 2010 Council meeting.

8 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.

8.1 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.

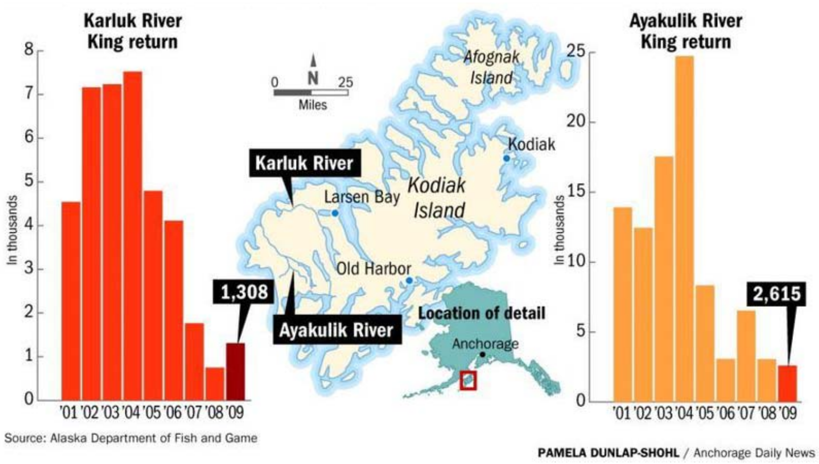
Kodiak

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). In 2010, the count increased to 5,319 Chinook salmon, which still falls below the ten-year average. 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). In 2010, escapement increased to 2,917 fish, which continues to fall below the escapement goal range. 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). In 2010, 354 Chinook were counted through the weir, which falls slightly below the ten-year average. 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). In 2010, escapement through the weir was 3,679 fish, which represents an increase over the last two years, although still falls below the ten-year average.

South Alaska Peninsula

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

8.2 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 14 shows the commercial catch of Chinook species by management area between 2003 and 2009.

Table 14 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[3], 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 in 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). In 2010, Chinook harvest (through September 15) was 9,353 Chinook, which continues to be below the previous 10-year average.

Harvest of Chinook in commercial fisheries by other gear types or in other Prince William Sound districts totaled 428 fish in 2009, and 360 in 2010 (through September 15). 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.

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

The 2009 total harvest of 1,266 Chinook in the Northern District was the third lowest harvest since 1986 (Eggers et al 2010). Preliminary catch totals for 2010 through August 30 report 9,631 Chinook salmon harvest.

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. In 2010, the total Chinook harvest through September 13, 2010 was 12,727 Chinook, which remains below the previuos 10-year average.

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. In 2010, fishermen have harvested an estimated 10,000 Chinook, a considerable increase from recent years.

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).

9 Review of Existing Closures

There are already seasonal and permanent area closures that have been implemented for the GOA groundfish fisheries, many of which were instituted to reduce bycatch or interactions with Steller sea lions. It is important to consider the development of new spatial controls to reduce bycatch within the context of existing time and area closures. The various State and Federal closures affecting the GOA groundfish fisheries are described below, along with their intended purpose. The year the closure was implemented is noted in parentheses. Figure 16 (in Section 14 at the end of the document) maps the existing closures in the entire GOA management area; Figure 17 and Figure 18 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.

10 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 8 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.

10.1 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.

<u>Trigger limits:</u>

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.

<u>General recommendations for the analysis:</u>

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.

10.2 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 8 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.

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.

10.3 Determining appropriate area 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 5 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.

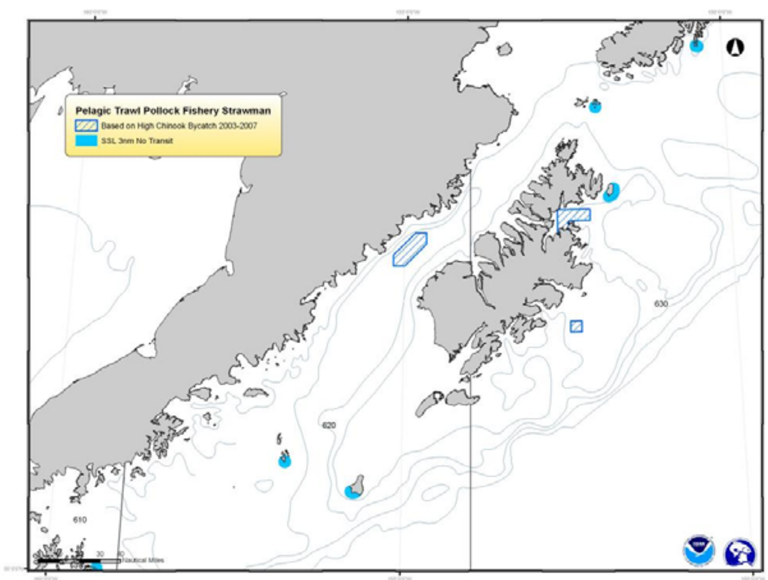
10.4 Preliminary strawman closures for Chinook salmon (developed in November 2008)

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 19), in Section 14 at the end of the document), and for 2008 only (Figure 20), 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 21). This methodology results in three closure areas, all of which occur in the central GOA.

As discussed in Section 5 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 15 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 15 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 10.3, and the closures themselves are illustrated in Section 14 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[4], 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.

10.5 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

[4] See Section 5 for discussion of the sampling mechanism for the GOA pollock fishery, and impacts on the averaging of bycatch across multiple haul locations.

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

11 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 were developed by staff in previous drafts of this paper, in order to provide a starting point for discussion of management options that include spatial or temporal fishery closures. This spatial analysis was, however, prepared in November 2008, and does not incorporate recent data. Additionally, for the pollock fishery, the closures do not account for the averaging of a trip bycatch rate across several hauls which may have occurred in different locations.

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.

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14 Color figures

Figure 6 Observed Chinook salmon bycatch in the GOA groundfish fishery, summed over 2006-2010

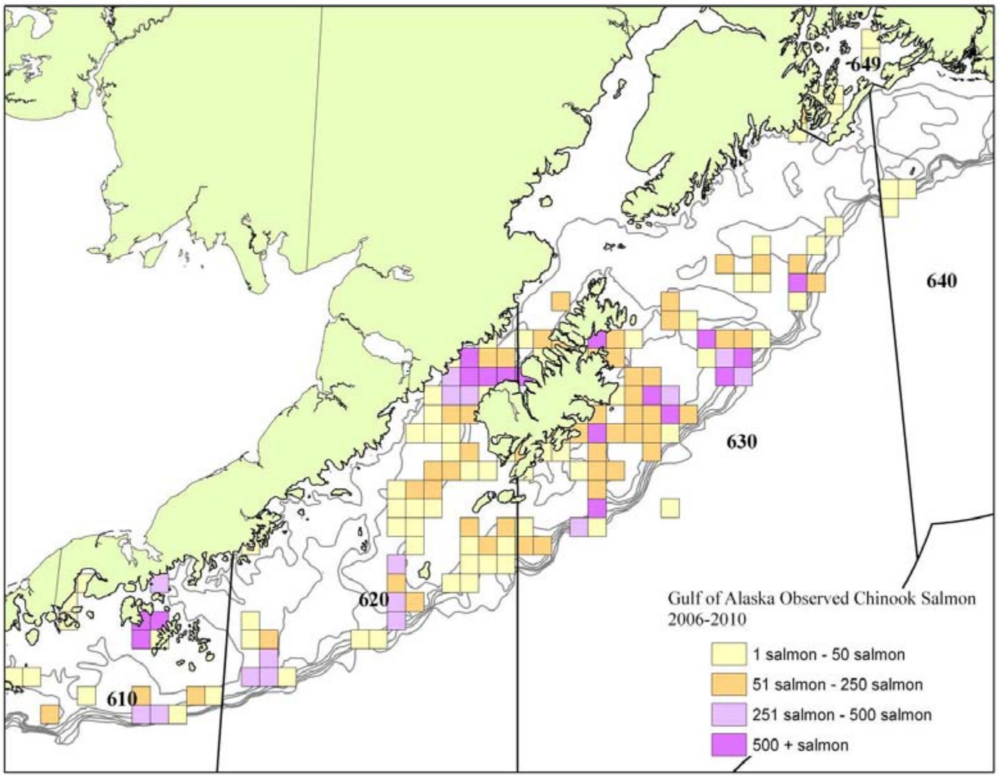

Figure 7 Observed Chinook salmon bycatch in the GOA groundfish fishery, 2006

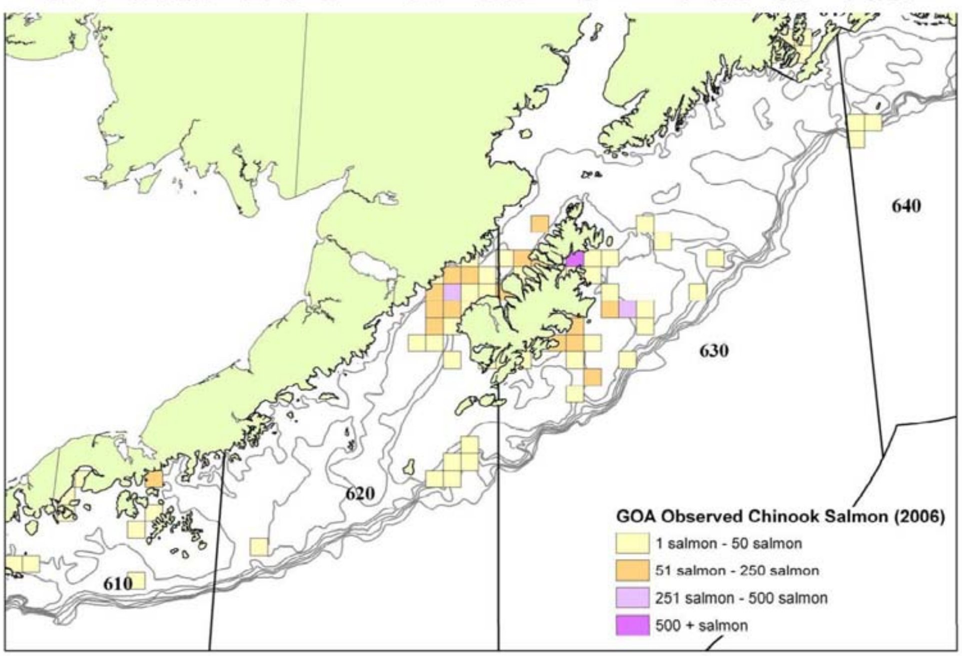

Figure 8 Observed Chinook salmon bycatch in the GOA groundfish fishery, 2007

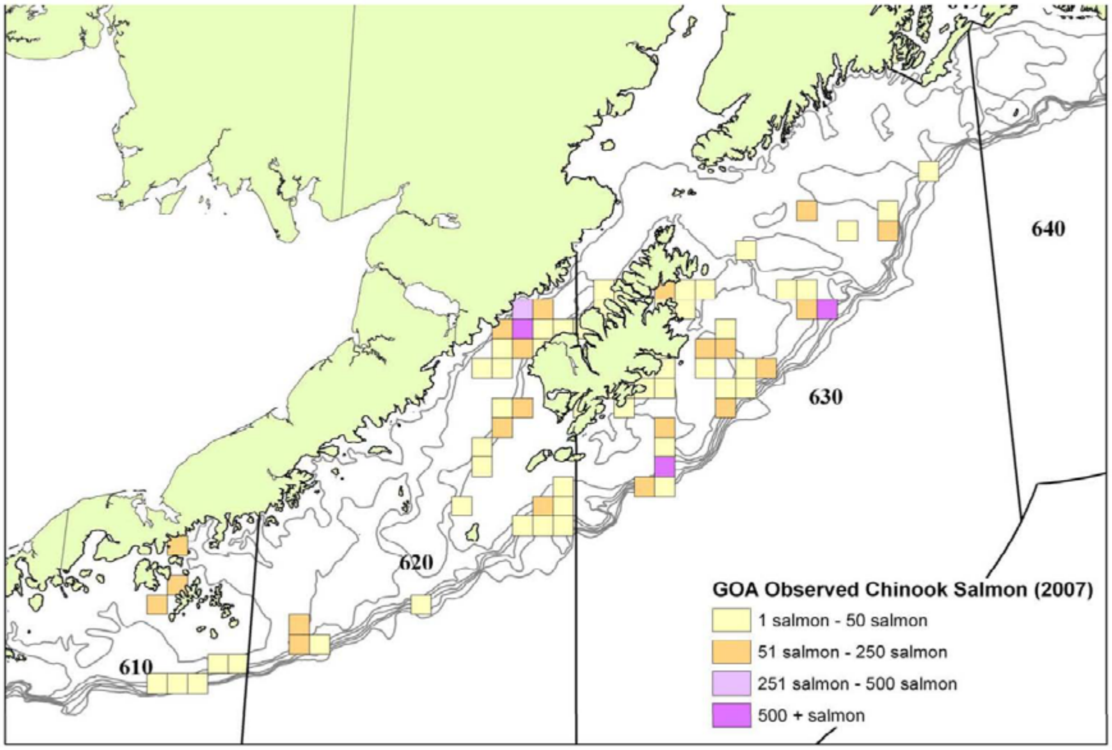

Figure 9 Observed Chinook salmon bycatch in the GOA groundfish fishery, 2008

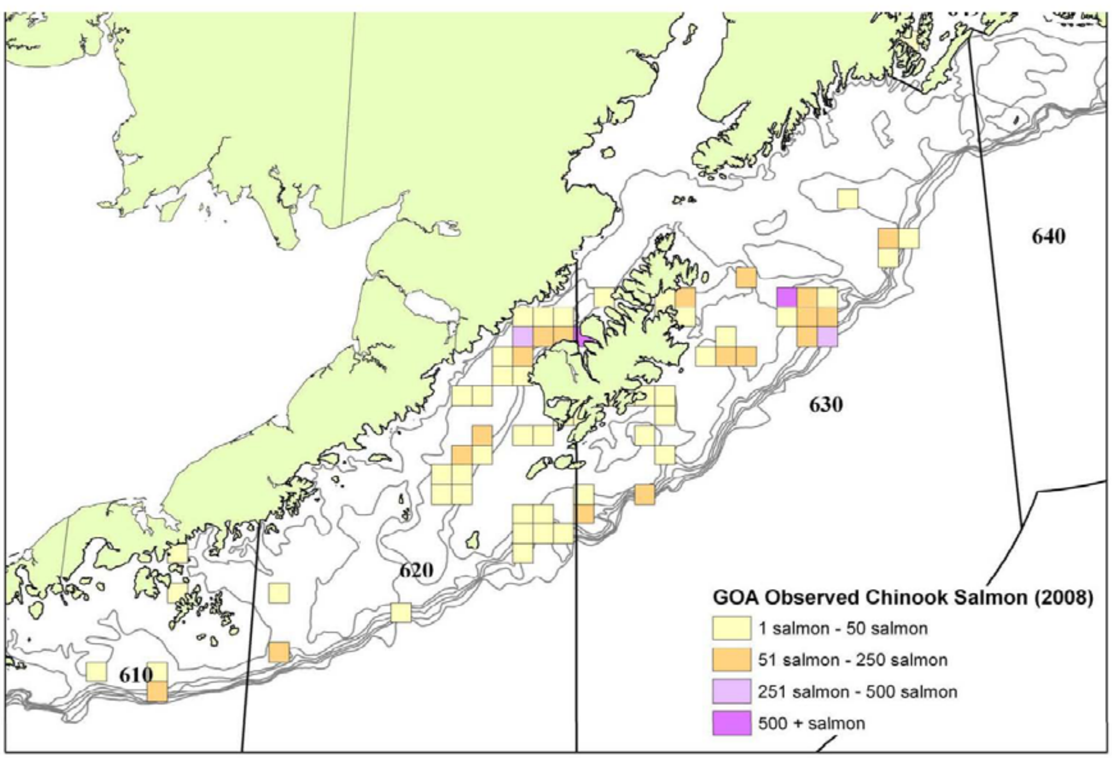

Figure 10 Observed Chinook salmon bycatch in the GOA groundfish fishery, 2009

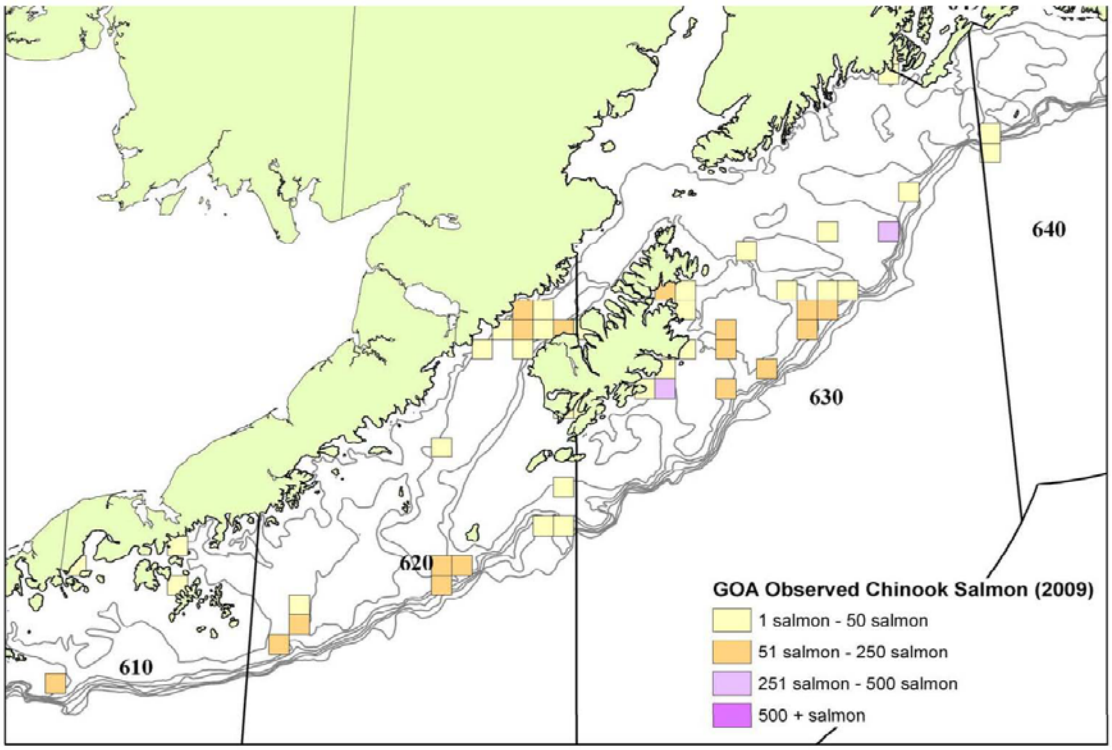

Figure 11 Observed Chinook salmon bycatch in the GOA groundfish fishery, 2010

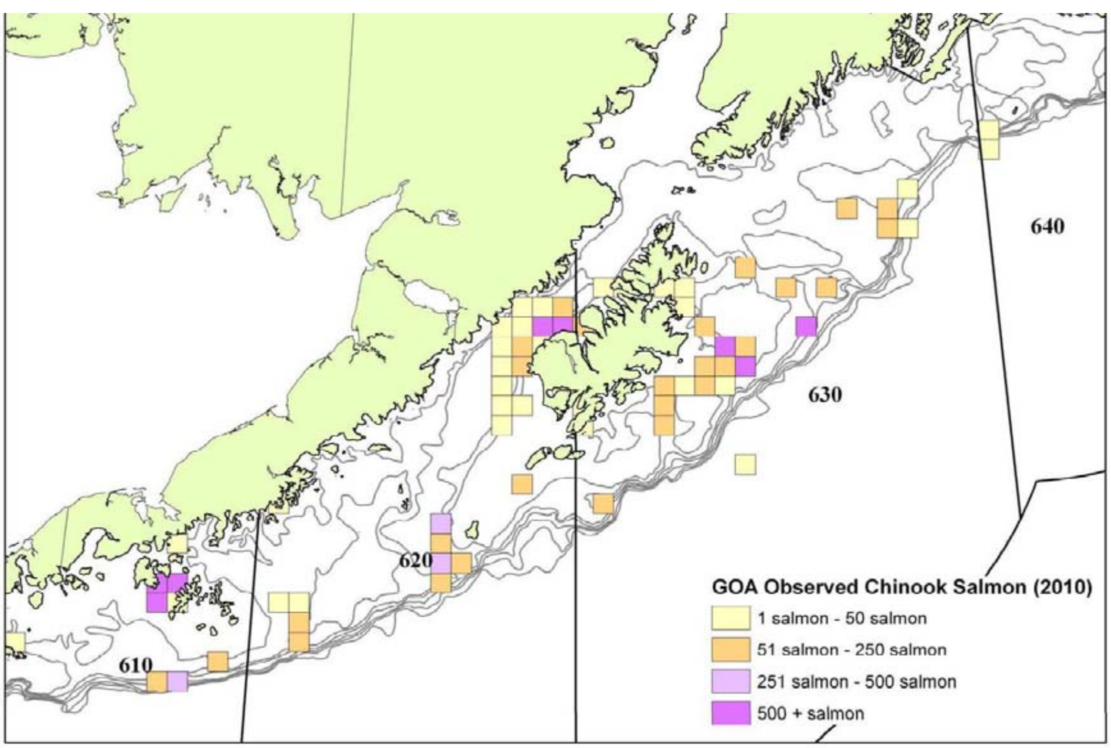

Figure 12 Observed Chinook salmon bycatch in the pelagic trawl fishery, summed over 2001-2008

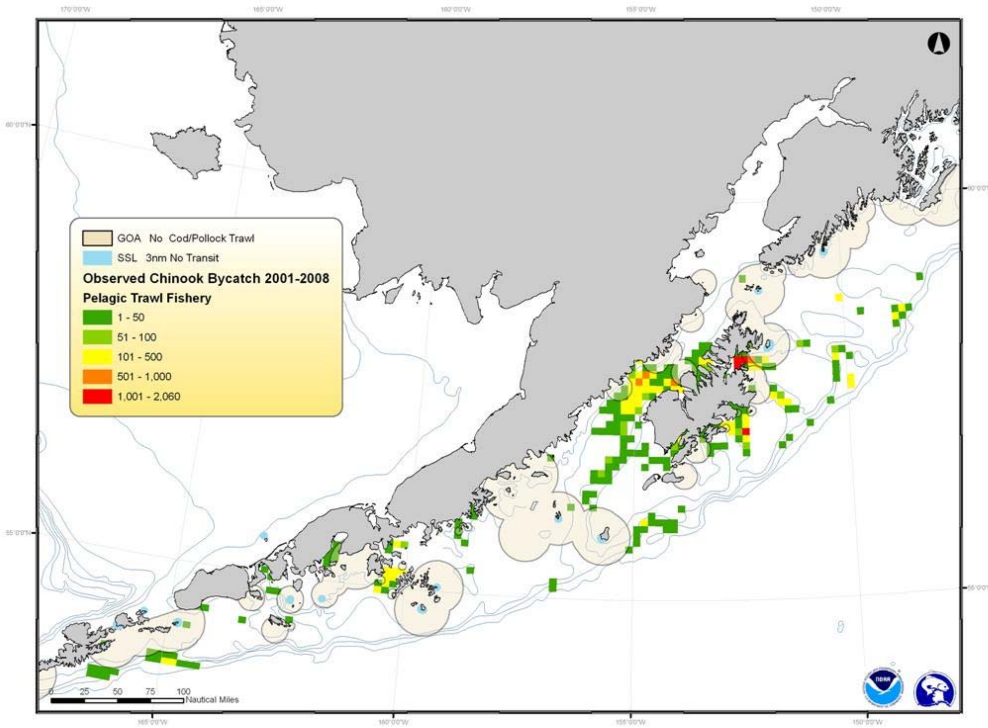

Figure 13 Observed Chinook salmon bycatch rate in the pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

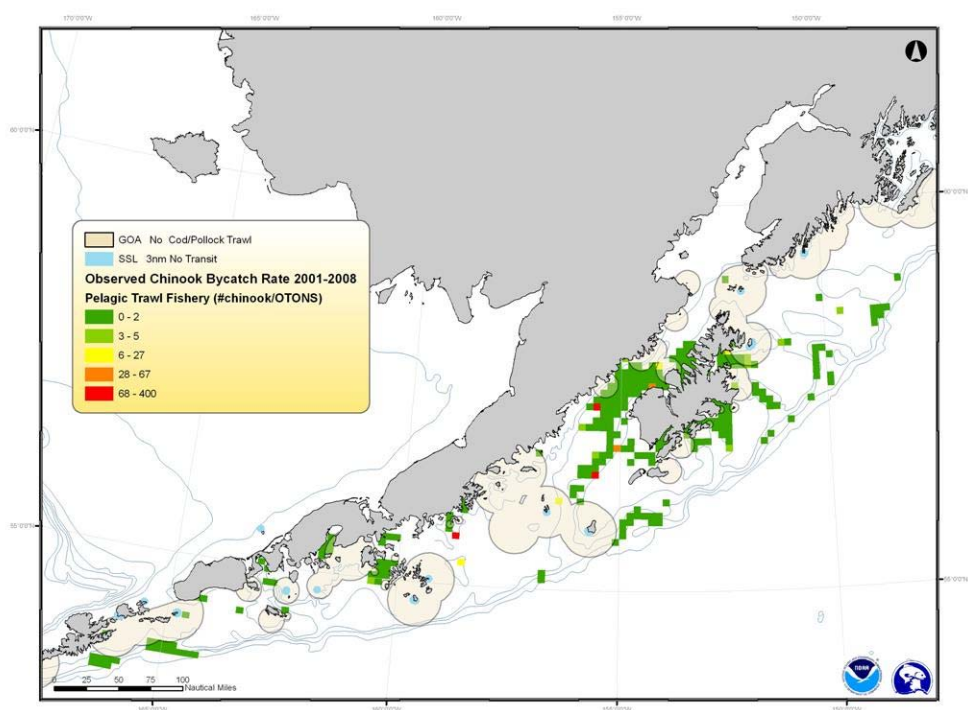

Figure 14 Observed Chinook salmon bycatch in the non-pelagic trawl fishery, summed over 2001-2008

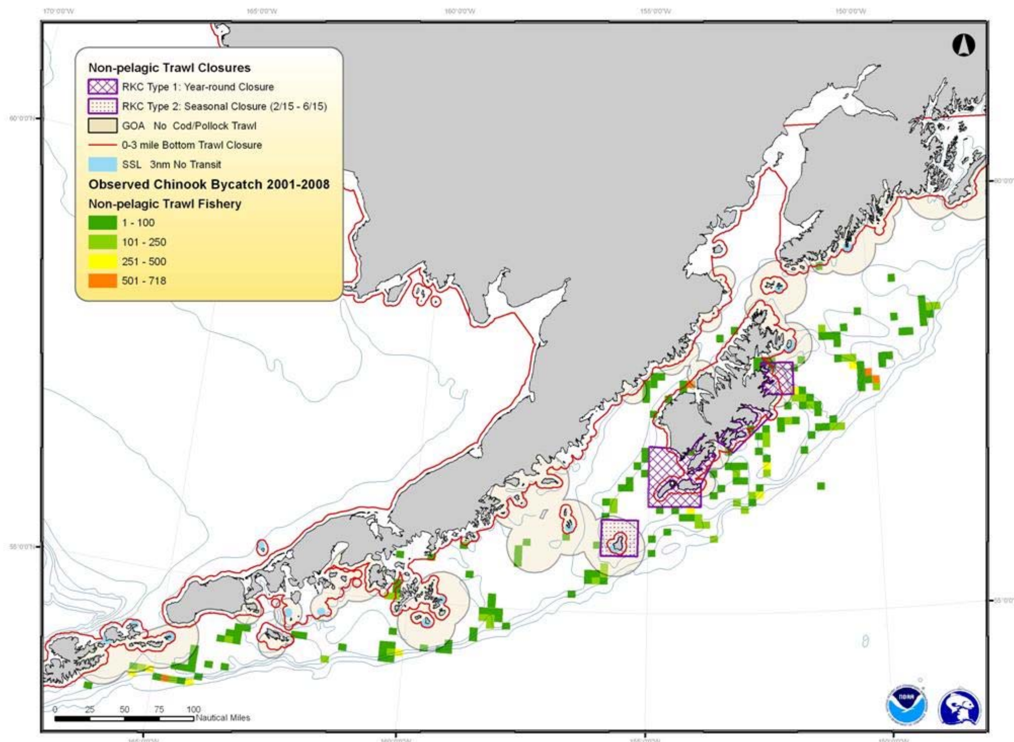

Figure 15 Observed Chinook salmon bycatch rate in the non-pelagic trawl fishery, summed over 2001-2008, number of salmon per metric ton of total catch

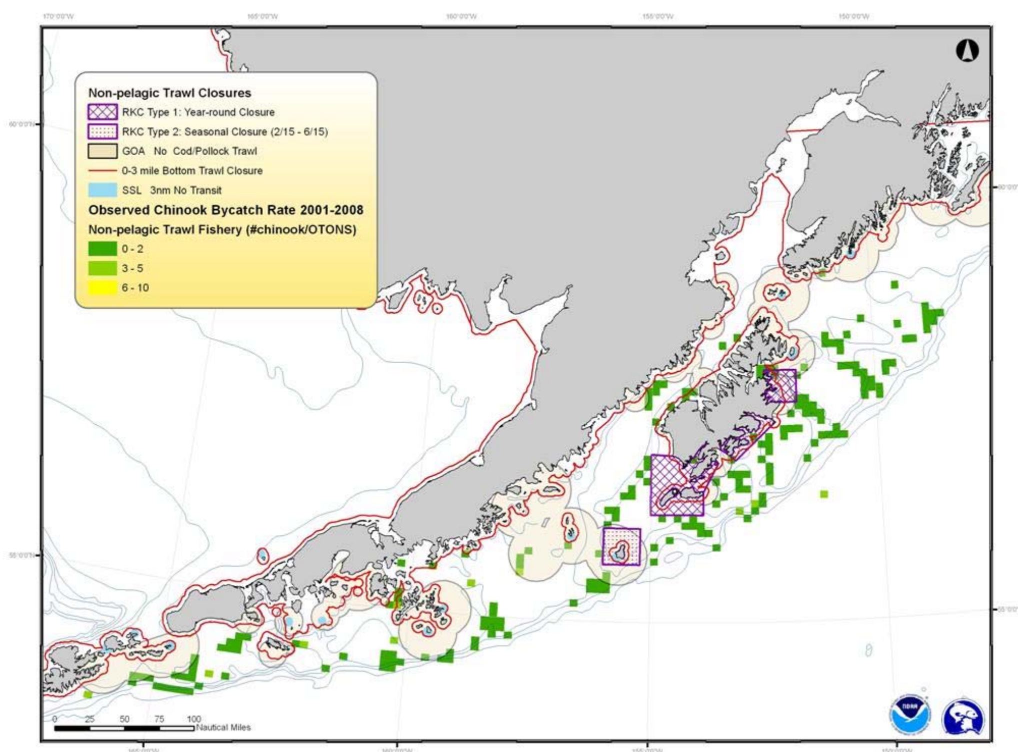

Figure 16 Locations of existing trawl fishery and crab protection closures in the Gulf of Alaska

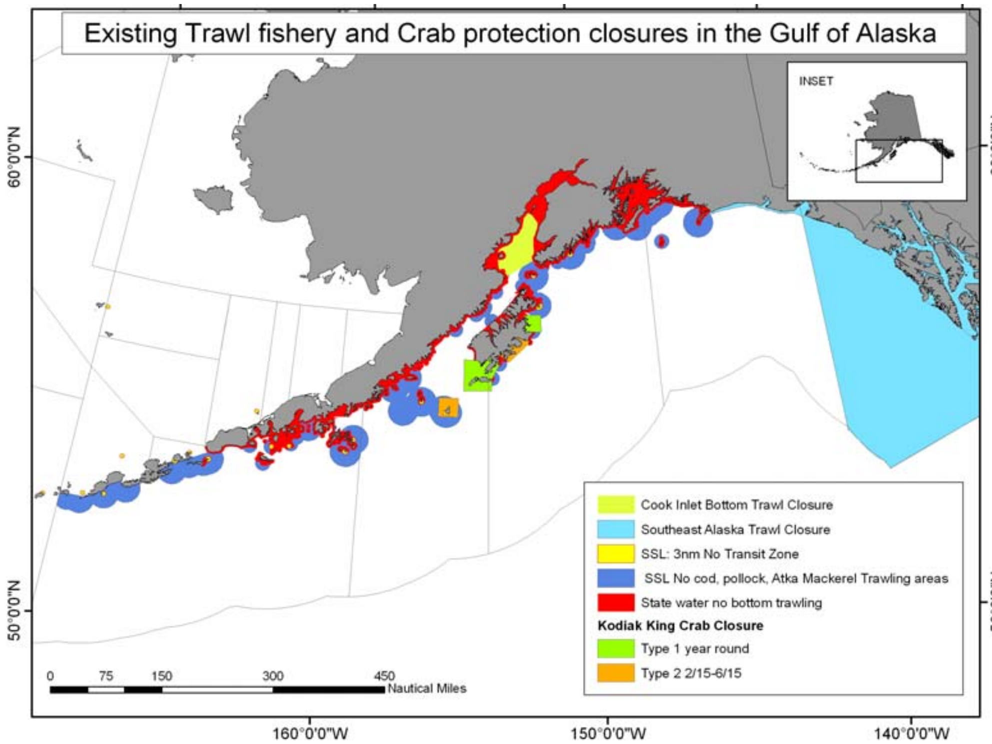

Figure 17 Locations of existing trawl fishery and crab protection closures in the Western Gulf of Alaska

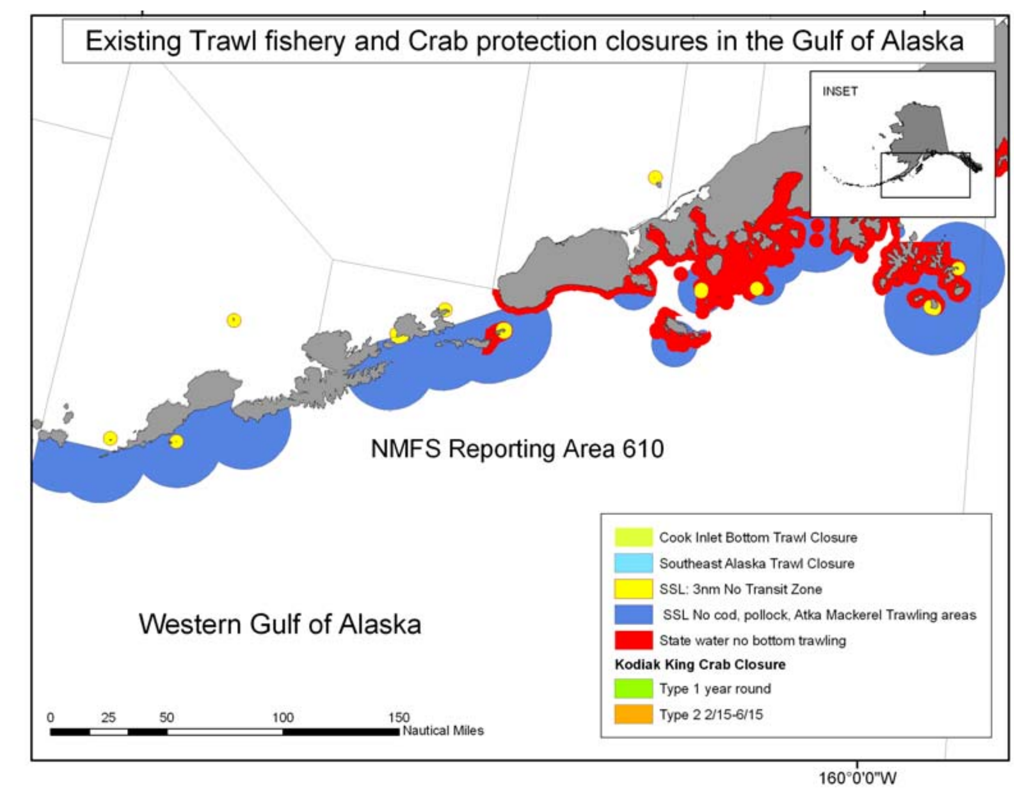

Figure 18 Locations of existing trawl fishery and crab protection closures in the Central Gulf of Alaska

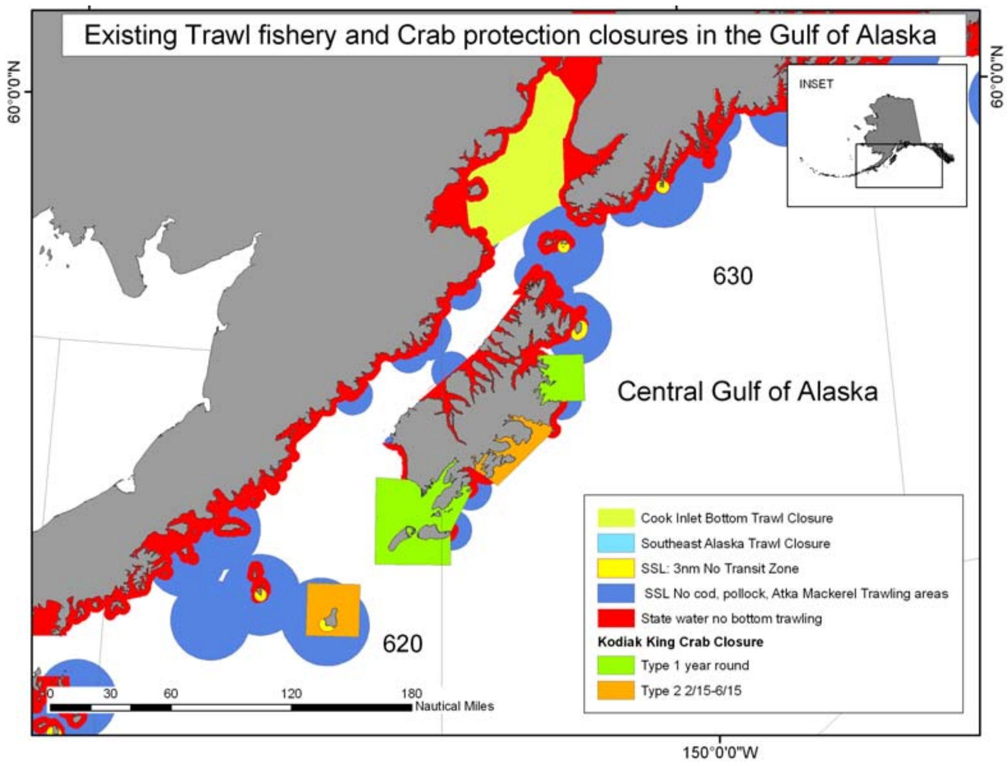

Figure 19 Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2001-2008

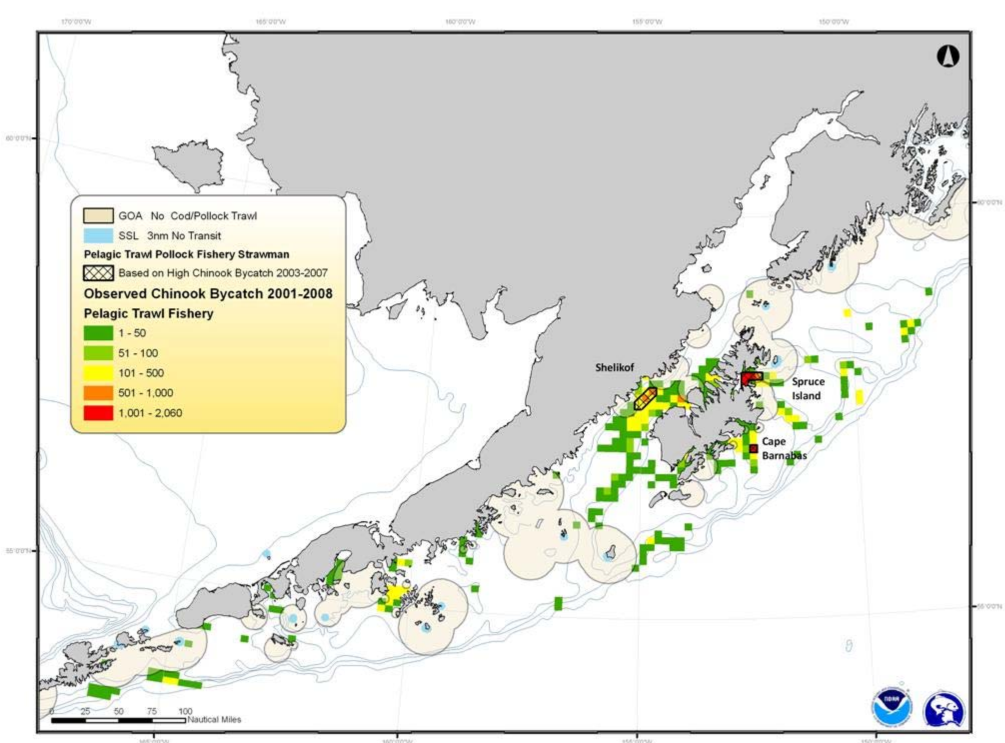

Figure 20 **Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch incidence in 2008 only**

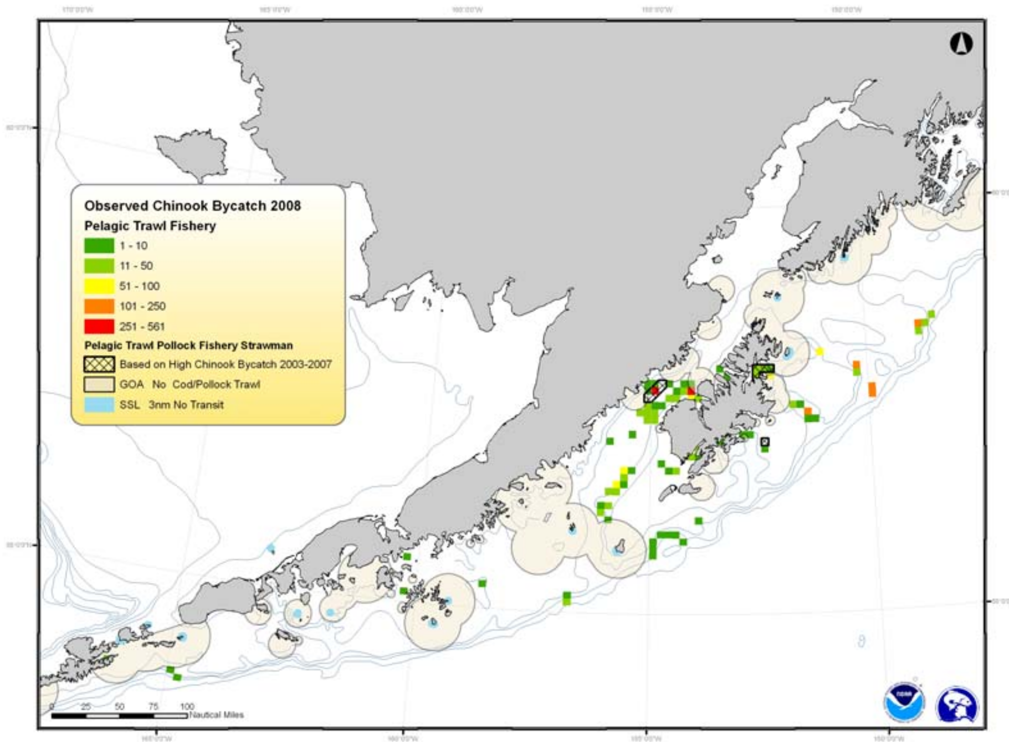

Figure 21 **Chinook salmon strawman closures for pelagic trawl gear, based on high incidence of bycatch in 2003-2007, compared to areas with high bycatch rates in 2001-2008**