Council motion June 2010

The Council moves the following suite of alternatives for preliminary analysis of chum salmon bycatch management measures. Note bolded items are additions while strike-outs represent deletions from previous suite of alternatives.

C-1(b) Bering Sea Chum Salmon Bycatch

Alternative 1 – Status Quo

Alternative 1 retains the current program of the Chum Salmon Savings Area (SSA) closures triggered by separate non-CDQ and CDQ caps with the fleet's exemption to these closures per regulations for Amendment 84 and as modified by the Amendment 91 Chinook bycatch action.

Alternative 2 – Hard Cap

Component 1: Hard Cap Formulation (with CDQ allocation of 10.7%)

a) 50,000
b) 75,000
c) 125,000
d) 200,000
e) 300,000
f) 353,000

Component 2: Sector Allocation

Use blend of CDQ/CDQ partner bycatch numbers for historical average calculations.

a) No sector allocation
b) Allocations to Inshore, Catcher Processor, Mothership, and CDQ
   1) Pro-rata to pollock AFA pollock sector allocation
   2) Historical average
      i. 2007-2009
      ii. 2005-2009
      iii. 2000-2009
      iv. 1997-2009
   3) Allocation based on 75% pro-rata and 25% historical
   4) Allocation based on 50% pro-rata and 50% historical
   5) Allocation based on 25% pro-rata and 75% historical

For Analysis:

CDQ	Inshore CV	Mothership	Offshore CPS
3.4%	81.5%	4.0%	11.1%
6.7%	63.3%	6.5%	23.6%1
10.7%	44.77%	8.77%	35.76%

Suboption: Allocate 10.7% to CDQ, remainder divided among other sectors (**see table**).

Component 3: Sector Transfer

a) No transfers or rollovers
b) Allow NMFS-approved transfers between sectors

[1] Note the actual midpoint is CDQ = 7.05%, CV 63.14%, Mothership 6.39%, CP 23.43% . However as noted by staff during Council deliberation numbers reflected in the table are an existing option as the historical average from 2005-2009 allocated 50:50 pro-rata AFA to historical average by section.

Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:

1) 50%
2) 70%
3) 90%

c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing

Component 4: Cooperative Provision

a) Allow allocation at the co-op level for the inshore sector, and apply transfer rules (Component 3) at the co-op level for the inshore sector.

Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:

1) 50%
2) 70%
3) 90%

b) Allow NMFS to rollover unused bycatch allocation to inshore cooperatives that are still fishing.

Alternative 3 – Trigger Closure

Component 1: Trigger Cap Formulation

Cap level

a) 25,000
b) 50,000
c) 75,000
d) 125,000
e) 200,000

Application of Trigger Caps

a) Apply trigger to all chum bycatch
b) Apply trigger to all chum bycatch between specific dates
~~c) Apply trigger to all chum bycatch in a specific area.~~

Trigger limit application:

Two options for application of trigger caps for area closure options (applied to caps under consideration)

1- **Cumulative monthly proportion of cap (left-side of table below)**
2- **Cumulative monthly proportion AND monthly limit (left and right sides of table together. Note monthly limit should evaluate +/- 25% of distribution below)**

Option of cumulative versus monthly limit for trigger area closures (assuming a trigger cap of 100,000 fish). Monthly limit based on minimum of monthly cumulative value and 150% of monthly historical proportion. *NOTE: these cumulative proportions have changed slightly using updated data through 2010*

	Cumulative		Monthly limit	
Month	Cumulative Proportion	Monthly Cumulative	Monthly proportion	Monthly limit
June	10.8%	10,800	10.8%	10,800
July	31.5%	31,500	20.7%	31,050
August	63.6%	63,600	32.1%	48,150
September	92.3%	92,300	28.6%	42,900
October	100.0%	100,000	7.7%	11,550

Component 2: Sector allocation

Use blend of CDQ/CDQ partner bycatch numbers for historical average calculations.

a) No sector allocation

b) Allocations to Inshore, Catcher Processor, Mothership, and CDQ

1) Pro-rata to pollock AFA pollock sector allocation
2) Historical average
   i. 2007-2009
   ii. 2005-2009
   iii. 2000-2009
   iv. 1997-2009
3) Allocation based on 75% pro-rata and 25% historical
4) Allocation based on 50% pro-rata and 50% historical
5) Allocation based on 25% pro-rata and 75% historical

For Analysis:

CDQ	Inshore CV	Mothership	Offshore CPS
3.4%	81.5%	4.0%	11.1%
6.7%	63.3%	6.5%	23.6%2
10.7%	44.77%	8.77%	35.76%

Suboption: Allocate 10.7% to CDQ, remainder divided among other sectors.

~~Component 3: Sector Transfer~~

~~a) No transfers or rollovers~~

~~b) Allow NMFS approved transfers between sectors~~

~~Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:~~

~~1) 50%~~
~~2) 70%~~
~~3) 90%~~

~~c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing~~

~~Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:~~

~~1) 50%~~
~~2) 70%~~
~~3) 90%~~

Component 3~~Component 4~~: Cooperative Provisions

a) Allow allocation at the co-op level for the inshore sector, and apply transfer rules (Component 3) at the co-op level for the inshore sector.

   Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:

   1) 50%
   2) 70%
   3) 90%

b) Allow NMFS to roll-over unused bycatch allocation to cooperatives that are still fishing

[2] Note the actual midpoint is CDQ = 7.05%, CV 63.14%, Mothership 6.39%, CP 23.43% . However as noted by staff during Council deliberation numbers reflected in the table are an existing option as the historical average from 2005-2009 allocated 50:50 pro-rata AFA to historical average by section.

Component 4 ~~Component 5~~: Area and Timing Options

~~a. Large area closure~~

~~b. Discrete, small area closures identified by staff in February Discussion paper (20 ADF&G statistical areas, identified in Table 4)~~

c. **Groupings of ADFG area closures by month that represent 40%, 50%, 60% of historical bycatch.** ~~the small area closures (as presented) (described in Option b above) into 3 zones that could be triggered independently with subarea, rather than statistical area, level closures~~

The analysis should include quantitative analysis of the 50% closure options and qualitative analysis of the 40% and 60% closure options.

Component 5~~Component 6~~: Timing Option – Dates of Area Closure

a) Trigger closure ~~of Component 5 areas~~ when the overall cap level specified under Component 1(a) was attained

b) ~~Under Component 5(b)~~ discrete small closures would close when a ~~an overall~~ cap was attained and would close for the time period corresponding to periods of high historical bycatch.~~; considering both number of salmon. a (i.e. Table 11 in February Discussion Paper) Under Component 5(c) Subareas within a zone would close for the time period corresponding to periods of high historical bycatch within the subarea when a zone level cap was attained.~~

c) ~~Under Component 5, Areas close when bycatch cap is attained within that area (i.e. Table 12 in February Discussion Paper)~~

~~a. for the remainder of year~~

~~b. for specific date range~~

Component ~~6 Component 6~~: Rolling Hot Spot (RHS) **system** ~~Exemption~~ – Similar to status quo (**with RHS system in regulation**), participants in a vessel-level (platform level for Mothership fleet) RHS would be exempt from regulatory triggered closure below.

1. **A large area trigger closure (encompassing 80% of historical bycatch).**
   ~~a)~~ Sub-option: RHS regulations would contain an ICA provision that the regulatory trigger closure (as adopted in Component 4 ~~5~~) **apply to participants with a rate in excess of 200% of the Base Rate.** ~~that do not maintain a certain level of rate based chum salmon bycatch performance.~~

In constructing an ICA under this component, the following aspects should be considered:

- **Closures that would address timing & location of bycatch of Western AK chum stocks.**

In addition, include the following items in the initial review analysis:

1. Analyze discrete area approach normalized across years (i.e. proportion of salmon caught in an area in a year rather than numbers of salmon);
2. Discuss how Component ~~6 7 and suboption~~ would be applied;
3. In depth description of the rolling hot spot regulations (Amendment 84), focusing on parameters that could be adjusted if the Council found a need to refine the program to meet objectives under Component 7. **Specifically analyze:**
   a. **the base rate within the RHS program;**
   b. **the options for revising the tier system within the RHS program;**
   c. **the Council's options for revising the fine structure within the RHS program. Analysis should include a discussion of the meaningfulness of fines, including histograms of number and magnitude of fines over time as well as a comparison of penalties under the RHS program to agency penalties and enforcement actions for violating area closures.**
4. Discussion from NMFS of catch accounting for specific caps for discrete areas, and area aggregations described in Component 5 and for areas within those footprints that may have other shapes that could be defined by geographic coordinates [Component 6(c)] Discussion from NMFS on the ability to trigger a regulatory closure based on relative bycatch within a season

(with respect to catch accounting system and enforcement limitations) considering changes in bycatch monitoring under Amendment 91.

5. Contrast a regulatory closure system (Components 5 and 6) to the ICA closure system (Component 7) including data limitations, enforcement, potential level of accountability (i.e., fleet-wide, sector, cooperative, or vessel level).
6. Examine differences between high bycatch years (i.e. 2005) and other years to see what contributes to high rates (i.e. timing/location, including fleet behavior and environmental conditions).
7. Examine past area closures and potential impacts of those closures on historical distribution of bycatch and on bycatch rates (qualitative); include 2008 and 2009 data and contrast bycatch distribution under VRHS versus the Chum Salmon Savings Area.

Preliminary Review Draft: Evaluating the Effectiveness of Status Quo Chum Bycatch Management Measures[1]

Introduction

This analysis provides an evaluation of the status quo chum bycatch reduction measures. The status quo is defined in three ways: the Chum Salmon Savings Areas (SSA) only, Chum SSA and voluntary rolling hotspot system (VRHS), and VRHS only. The analysis will include an inter-cooperative agreement (ICA)-based exemption to new closures. Thus identifying the means to evaluate the efficacy of the rolling hotspot program helps both in defining the current status quo conditions of the fishery as well as proposing modifications to such a program to improve it effectiveness. The questions analyzed here and draft methodologies were reviewed by the SSC in June 2010.

Since 2001, there has been an ICA among pollock cooperatives to impose short-term "hot spot" closures designed to limit salmon bycatch in the Bering Sea pollock fishery. Sea State, Inc. is hired by the pollock industry to analyze NMFS Observer Program data, vessel monitoring system (VMS) data, and other real-time data to relay information to the fleet and to implement hotspot closures. Since August 2006, following approval of Amendment 84 by the NPFMC[2], these voluntary rolling hotspot (VRHS) closures have been the only chum-related spatial restrictions on the pollock fishery. This assessment of the status quo chum salmon bycatch measures gives primary attention to the voluntary rolling hotspot (VRHS) closures. Salmon Savings Areas will also be discussed, as well as the interaction between existing chum salmon reduction measures and Amendment 91, which creates a "hard cap" for Chinook salmon beginning in 2011 as well as the incentive plan agreements (IPA) that are in effect in 2011.

The three panes of Figure 1 show the locations of VRHS closures in the Bering Sea at different points in the B Season from 2003-2009, in the high-chum year of 2005, and the low-chum year of 2009. The closures have been imposed on much of the pollock fishing grounds at different points during the period of analysis.

Figure 1: VRHS B Season Closures 2003-2009 (left), 2005B (center) and 2009B (right)

The rolling hotspot program serves both informational and regulatory functions. If vessels perceive a strong enough incentive to avoid bycatch, there would be little *regulatory* necessity for hotspot closures, because vessels would avoid fishing in locations where they would expect to have high bycatch. Under the existing system, the direct costs of high chum bycatch – and the benefits of avoiding bycatch -- are not

[1] Chum salmon are prohibited species catch (PSC). Throughout the document, we use the term bycatch but we recognize the special status of chum salmon bycatch as prohibited species catch.

[2] Note that the exemption was implemented via an EFP in the B season of 2006 and was implemented by regulation following secretarial approval of Amendment 84 in January 2007.

born by the individual vessels or companies and some vessels have had much higher bycatch rates than others, in part due to their choices to fish areas where there have recently been high bycatch hauls. As well as informing vessels about where bycatch is high, the hotspot system restricts vessels from fishing in what have recently been the highest bycatch areas, thus providing a dynamic means to regulate bycatch in the fishery.

We note that there are inherent limitations to our ability to analyze how well the VRHS system works. There were times when closures were put in place or left in place for long periods where there may have been substantial salmon avoided or saved but there is no way to demonstrate this beyond looking at average variation in the fishery.[3] Importantly, there may be enormous gains in just a few of the highest bycatch periods that are not well measured by the examination of all of the closures.

Data for the Status Quo Analysis

The data for this part of the analysis consists of the SeaState VRHS reports that have been converted to an ArcGIS shapefile. The data from 2001-2006 was provided by SeaState in a tabular format for earlier Council analysis of the rolling hotspot program. Since 2006, twice-weekly SeaState reports have been provided to NMFS and Council staff and the coordinates and dates from these reports were used to define the VRHS closures. The same Observer data that is used in identifying potential fixed closures is used to evaluate the amount of catch and bycatch that occurs in each area. In summary tables in this document, the data is extrapolated from the observer data to match the NMFS Alaska Region totals in the summary table of all closures. Where appropriate our analysis is conducted with the non-adjusted numbers.

There is some ambiguity in how to define what constitutes a closure or closure period. Multiple closures (up to 3) may be in place at any time and a closure may be extended or modified on Monday or Thursday of each week when sufficient bycatch is present. Here a closure is defined as an area that is closed for some length of time – if a closure is in place for 2 weeks then it is recorded as one closure that lasts 14 days. If a closure changes shape then it is designated as a new closure. The goal of defining the closures in this manner is to allow analysts be able to assess the impact of closures being imposed, while at the same time minimizing double counting of sequential and overlapping closures.

[3] It has been suggested that experimental fishing would allow the assessment of bycatch rates within closures, but such fishing not have the same incentives to avoid salmon that exist in the regular fishery because catching salmon would not have the same potential repercussions (through peer pressure or potentially restrictive management action). Further, the largest bycatch events are "rare events" and would be unlikely to occur in sample hauls though these events would be most likely to occur in high bycatch areas.

BSAI chum bycatch

Voluntary Rolling Hotspot (VRHS) Summary information

This section of the analysis provides summary information on the VRHS closures as well as an analysis of rate change comparison before and after the closures.

The following tables show the number of closures implemented per year since closures were first imposed beginning in 2001. To be consistent with the other data used in this analysis, we focus on 2003-2009. VRHS closures are designated as "Chinook" or "chum" closures, with different rules applying to each according to the terms of the inter-cooperative agreement (ICA).

Table 1: Number of B-Season Closures and Average Length of Closures (days) by Closure Type

Year	Total Closures	Days (avg)	Chum Closures	Days (avg)	Chinook Closures	Days (avg)
2001	22	6.91	22*	6.91	*	*
2002	20	7.00	20*	7.00	*	*
2003	22	6.64	22*	6.64	*	*
2004	22	6.55	22*	6.55	*	*
2005	38	4.13	37*	4.14	1	4.00
2006	36	4.94	23	4.65	13	5.46
2007	34	5.68	17	5.76	17	5.59
2008	14	8.36	9	9.00	5	7.20
2009	21	6.71	14	7.50	7	5.14

* Note that closures for 2001-2004 are assumed to be chum Closures based on chum rates and pers. comm. with Karl Haflinger about their general timing, while later closures are reported as Chum closures in SeaState reports. Several of the closures in 2003 & 2004 that are designated as chum may be re-designated as Chinook closures in future analysis.

The number of days per month that closures were in place increased with rising bycatch in the middle of the last decade but has remained high through most of the fishing season in 2008 and 2009.

Table 2: Days per Month with Chum or Chinook Closures in Place

Year	Jun	Jul	Aug	Sep	Oct	Nov
2001	2	13	15	30	31	
2002		13	31	30	31	1
2003		21	25	27	24	
2004		30	31	15		
2005	7	31	29	25	25	
2006	11	31	31	30	31	
2007		23	31	28	31	2
2008		28	29	27	29	1
2009	2	28	31	28	13	

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Table 3 shows the concentration of pollock and bycatch in the closures prior to their being closed. This gives an indication of how much of the pollock fishery is directly impacted by the imposition of the closures because they were in the areas in the 5-deay time period prior to the closure. However, many of these vessels had already left the area and additional vessels might have visited those areas during the closure periods if the areas had not been closed.

Table 3: Average percent of total Chum, Chinook, and Pollock caught in VRHS Closures during the 5 days before each closure

	Catcher Vessels			CPs/MS		
Year	% Chum	% Chin	% Poll	% Chum	% Chin	% Poll
2003	28%	13%	22%	28%	4%	4%
2004	34%	10%	9%	23%	4%	3%
2005	22%	21%	13%	19%	3%	4%
2006	22%	30%	10%	16%	1%	0.6%
2007	15%	19%	10%	30%	22%	5%
2008	29%	52%	10%	2%	6%	0.3%
2009	33%	18%	13%	9%	18%	2%

The following table shows that vessels that did fish in a closure area before the closure also fished elsewhere. This illustrates that because of the high degree of movement in the pollock fishery, most vessels typically catch only a portion of their pollock in closure area prior to closures being implemented.

Table 4: For Vessels that fished in the VRHS during the 5 days before closures, % of their pollock caught in the VRHS Area during that 5 day period by Sector and Year

Year	CV % in VRHS	CP/MS % in VRHS
2003	49%	29%
2004	38%	17%
2005	49%	31%
2006	40%	17%
2007	54%	31%
2008	59%	15%
2009	51%	26%

Vessels that are members of cooperatives with low bycatch rates relative to the "base rate" (as defined in the ICA) qualify as Tier 1 or Tier 2 Vessels. Tier 1 cooperative vessels do not have to leave chum closures while Tier 2 vessels are prohibited from fishing the VRHS closures for 3 days. Nonetheless, vessels will often leave the closure areas because it is the end of their trip, fishing conditions have changed, or in some cases vessel operators report leaving areas because of their concern about high bycatch in the area. In the summer, the tier system has applied only to chum bycatch—all Chinook closures apply to all vessels. The tier system's largest value is that it does not force vessels with low bycatch to leave as a closure is put in place. The bycatch rates of Tier 1 and Tier 2 vessels legally fishing inside of VRHS closures after they are implemented will be examined in the initial review.

The impact of VRHS closures on observed bycatch levels

The two most direct potential methods for evaluating the success of hotspot systems that can be applied are:

1) calculating at the change in the overall bycatch rate for the entire fishery at the time that closures are implemented; and

2) examining the post-closure bycatch performance of vessels that fished in a hotspot area prior to its closure.

It should be noted that these approaches are subject to some limitations. First, attributing the effectiveness of the VRHS system to the overall change in bycatch rate does not account for seasonality, short-term trends in the fishery, or potentially many high bycatch areas that have been avoided. In periods of increasing bycatch, a hotspot closure might dramatically reduce bycatch relative to what would have occurred, but the rate after a given closure might nonetheless be higher than prior to the closure.

Before-after VRHS closure comparison of changes in average bycatch rates

Using bycatch data for before and after all of the closure periods, we calculate the changes in chum bycatch that resulted after B-season closures.[4] We calculate these changes for each closure *period* rather than each closure to minimize double-counting, aggregating across simultaneous closures.

While there are long-term trends of bycatch within a season that may be impacted by closures, it is difficult to separate these trends from the repeated "treatments" imposed by the VRHS closures. However, if the VRHS closures are effective, there should be some visible impact on chum bycatch when we compare the bycatch rates before and after the closures are implemented.

The following table presents a comparison of the average aggregate chum bycatch rates in the days before and after VRHS closures. Note that the negative numbers represent the days before the closures, with "-1" representing hauls deployed from 0 to 24 hours before the closure was put in place, for example.

Table 5: Average chum bycatch rate for the 5 days before and after Chum VRHS closure periods, All years 2003-2009

		Mean Chum rate	Std. Dev.	Hauls
Days Before Closure	-5	0.416	1.76	8,293
	-4	0.494	2.19	8,363
	-3	0.439	1.78	8,187
	-2	0.403	1.53	8,169
	-1	0.453	2.14	7,950
Days After Closure	1	0.379	1.89	8,154
	2	0.393	1.64	8,277
	3	0.419	1.77	8,080
	4	0.493	2.04	8,303
	5	0.440	1.82	8,182
	Total	0.433	1.866	81,958

Table 5 shows that there is on average a drop in rate following in the days immediately following the implementation of VRHS chum closures. A Wilcoxon rank sum test indicates that means are distinct when comparing from the bycatch rate, although comparing the impact from the all of the rates for the 5 days before and after is not statistically significant. This is not completely surprising, that seasonal factors, changing pollock and bycatch conditions, and at times the presence of other closures would dilute the impact of the closures over this timeframe.[5]

[4] Additionally, we limit the analysis to all closure periods in which there was a least one chum bycatch closure in place.

[5] Because of concerns that extrapolated bycatch data could change these results, we conduct the analysis here on the non-extrapolated chum and pollock data. The extrapolated data and results are not dramatically different from these.

BSAI chum bycatch

Table 6 presents a more detailed analysis on the impact of VRHS closures on the chum bycatch rate before and after VRHS closures. This shows the results of a linear regression of the chum bycatch rate (in natural logarithms) on a dummy for whether or not the rate is before or after the closure as well as for time-specific and vessel-specific fixed effects. Alternative models were run with and without year and week controls and present similar results.

Table 6: Results of 5 linear regressions capturing the change of chum bycatch for 0-5 days before and after VRHS closure implementation

Days Before/After Closure	Post-VRHS Change	Robust Std. Err.	t	P>|t|	R-Squared
0-1	-0.087	0.038	-2.28	0.025	0.274
<=2	-0.076	0.030	-2.54	0.012	0.264
<=3	-0.049	0.024	-2.03	0.045	0.256
<=4	-0.029	0.019	-1.51	0.134	0.239
<=5	-0.011	0.016	-0.68	0.498	0.231

The results of these regressions comparing the change of up to 3 days before/after the closures are implemented are statistically significant. In the table above, the 'Post-VRHS Change' columns indicate the percentage change that occurs after the closures, on average. For example, after controlling for vessels and closure period specific effects, there is an 8.7 percent reduction in chum bycatch from 1 day before to 1 day after the average closure was implemented. Similarly, there was a 7.6 percent reduction in chum salmon bycatch in the first two days following the average closure as compared to the two days before the closure. The following figure provides a graphical portrayal of this information for the days for which there is a statistically significant difference.

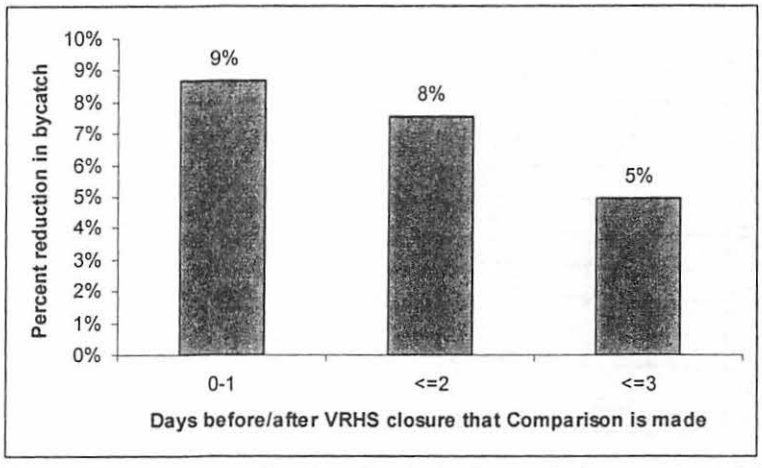


Figure 2: Average reduction in chum bycatch for the days following VRHS closure implementation, 2003-2009

On the annual level, there is considerable variation in the apparent impact before and after the implementation of the VRHS closures.

Table 7: Average chum bycatch rate for the 5 days before and after Chum VRHS closure periods, Individual Years, 2003-2009

	Year							
Days Before/ After VRHS	2003	2004	2005	2006	2007	2008	2009	Total
-5	0.22	0.458	0.804	0.5	0.149	0.034	0.13	0.416
-4	0.326	0.517	1.007	0.559	0.127	0.031	0.127	0.494
-3	0.239	0.486	0.863	0.497	0.141	0.03	0.104	0.439
-2	0.254	0.386	0.782	0.529	0.128	0.059	0.095	0.403
-1	0.285	0.465	0.841	0.544	0.176	0.053	0.127	0.453
1	0.39	0.311	0.713	0.351	0.147	0.066	0.192	0.379
2	0.227	0.386	0.754	0.423	0.133	0.027	0.205	0.393
3	0.242	0.418	0.822	0.473	0.199	0.033	0.142	0.419
4	0.412	0.632	0.841	0.524	0.202	0.069	0.139	0.493
5	0.248	0.593	0.783	0.464	0.207	0.049	0.114	0.44
Total	0.284	0.465	0.821	0.485	0.161	0.045	0.137	0.433

The table shows the most dramatic reduction after VRHS closures to appear to be in 2004 and 2006. Because there is on average 1/7 as much data at the annual level, further analysis is required to investigate these changes. At the annual level, several large increases in bycatch after a closure could significantly impact the results. This analysis will be done for initial review.

Vessel-level post-closure bycatch changes

The second proposed method of measuring closure impacts on bycatch, assessing the effectiveness of the hotspot system based on subsequent bycatch rates of vessels that are forced from extremely high bycatch areas, also has the potential to be misleading. Because bycatch has a random component that can be very large, we would expect to observe a reversion to the mean from extreme bycatch values in the data. Attributing all of the change from one period to the next after a closure is put in place is likely to overstate the impact of the closure. One means to examine to what degree there is reversion from high values is to look at the highest bycatch levels for vessels that did not fish inside the VRHS closure area. We can compare the degree to which they revert to the mean with how vessels in the closure areas display this partial reversion.

While the above measures account for the observed changes in bycatch resulting from the VRHS closures, closing an area also makes it unavailable to other vessels, so there is the potential for additional bycatch to be saved beyond the impact on the vessels that were fishing in an area prior to it being closed.

For Initial Review, we will include a table with Vessel-specific changes & a Comparison of non-VRHS high-bycatch vessels.

Does the effectiveness of VRHS closures differ at high or low levels of bycatch encounters?

Here we examine 2005 in contrast with several other years. An examination of the chum incidence rate and bycatch for all years for the shoreside, catcher/processor, and mothership sectors of the fishery is informative. The incidence rate is the proportion of time that there is any chum salmon in a haul/trip. [6]

[6] For shoreside deliveries, salmon bycatch is only observed at the trip level, so all of the hauls in a trip have a positive incidence rate when salmon bycatch occurs in the trip.

For example, an incidence rate of 0.95 means that 95% of the hauls/trips in the month encountered chum bycatch. As shown in the table below, the incidence rate in 2005 for the shoreside sector remained near 1 for almost 2 months. During this time, it was clearly extremely difficult to impossible to completely avoid chum salmon bycatch.

Table 8: Chum Salmon Incidence and Bycatch by Week and Year for Shoreside CVs, 2003-2010

Incidence Rate- Proportion of hauls with chum										Extrapolated Chum Bycatch								
Week	2003	2004	2005	2006	2007	2008	2009	2010	Wk	2003	2004	2005	2006	2007	2008	2009	2010
1			1.00			0.70	0.47	0.14	1			128			1,144	177	5
2	0.47	0.93	0.81	0.98	0.53	0.65	0.32	0.37	2	214	457	1,256	37,783	177	916	332	367
3	0.60	0.63	0.90	0.96	0.34	0.47	0.52	0.56	3	649	701	9,065	18,862	432	502	921	458
4	0.83	0.83	0.93	1.00	0.57	0.22	0.70	0.42	4	1,573	1,083	4,796	47,906	2,246	116	2,307	258
5	0.84	0.59	0.93	0.97	0.70	0.30	0.74	0.45	5	2,151	687	37,124	16,397	1,897	751	3,840	162
6	0.81	0.72	0.82	0.96	0.33	0.36	0.58	0.48	6	1,865	994	24,584	12,965	509	994	1,559	1,456
7	0.85	0.66	0.99	0.79	0.51	0.22	0.58	0.67	7	2,757	1,228	97,312	5,503	788	219	3,107	1,259
8	0.91	0.72	1.00	0.94	0.52	0.35	0.48	0.61	8	5,604	4,140	45,606	21,314	1,709	572	10,147	2,109
9	0.81	0.81	0.98	0.85	0.60	0.25	0.33	0.50	9	11,838	29,815	129,594	33,059	3,406	343	762	735
10	0.81	0.66	0.97	0.84	0.75	0.36	0.34	0.26	10	15,170	16,289	33,460	39,096	3,072	634	1,391	307
11	0.76	0.81	0.99	0.74	0.72	0.43	0.65	0.35	11	8,808	19,265	70,384	22,465	2,600	564	2,666	257
12	0.71	0.67	0.94	0.85	0.91	0.51	0.69	0.40	12	3,575	27,058	12,322	6,109	6,831	989	3,469	93
13	0.81	0.73	0.95	0.76	0.95	0.59	0.60	0.56	13	8,107	13,146	15,679	2,645	7,690	1,401	2,070	298
14	0.80	0.88	0.92	0.67	0.92	0.70	0.77	0.44	14	9,390	74,086	4,997	770	4,892	1,587	3,150	236
15	0.80	0.81	0.98	0.83	0.94	0.47	0.85	0.54	15	21,046	74,872	7,796	3,926	10,005	289	1,557	462
16	0.91	0.82	0.98	0.74	0.90	0.42	0.60	0.71	16	25,618	16,824	8,459	3,524	1,866	459	909	668
17	0.82	0.70	0.91	0.82	0.84	0.71	0.17	0.26	17	12,766	11,429	15,899	2,411	964	481	436	3
18	0.78	0.64	0.76	0.85	0.80	0.51	0.39	0.62	18	7,804	9,220	18,919	4,969	857	150	18	290
19	0.86	0.68	0.89	0.76	0.84	0.50		0.50	19	4,642	23,798	23,603	1,246	644	117		13
20		0.77	0.89	0.76	0.80	0.63			20		9,757	6,731	1,465	934	8		
21		0.93	0.88	0.86	0.71				21		4,558	17,018	513	418			
22				0.84	0.80				22				2	263			

Vessels caught more chum more frequently and when they caught it they caught a higher number, on average, though the relationship between incidence and bycatch reveals that higher incidence does not always equate to higher total bycatch. Table 9 shows incidence and bycatch information for the CP/MS sectors.

BSAI chum bycatch

Table 9: Chum salmon Incidence and Bycatch by Week & Year for CPs and Motherships, 2003-2010

Incidence Rate- Proportion of hauls with chum									Extrapolated Chum Bycatch								
Week	2003	2004	2005	2006	2007	2008	2009	2010	Week	2003	2004	2005	2006	2007	2008	2009	2010
1	0.39	0.91	0.75			0.06	0.06	0.06	1	117	1,432	377			12	10	1
2	0.30	0.85	0.36	0.50	0.08	0.10	0.03	0.14	2	276	9,601	1,120	889	25	34	20	57
3	0.25	0.78	0.54	0.18	0.36	0.08	0.27	0.28	3	262	6,482	4,626	124	472	66	586	652
4	0.16	0.76	0.13	0.22	0.16	0.03	0.10	0.15	4	218	3,049	248	942	617	34	116	119
5	0.17	0.63	0.21	0.25	0.29	0.04	0.12	0.12	5	198	2,137	396	1,449	614	34	160	289
6	0.24	0.55	0.13	0.15	0.10	0.05	0.06	0.10	6	497	2,663	143	122	88	59	113	105
7	0.16	0.67	0.28	0.29	0.17	0.03	0.23	0.13	7	248	6,904	521	2,343	805	44	178	164
8	0.24	0.67	0.26	0.27	0.08	0.05	0.33	0.14	8	370	4,121	741	1,239	33	59	746	99
9	0.35	0.60	0.41	0.22	0.11	0.10	0.13	0.13	9	1,276	15,995	1,418	3,334	300	132	113	64
10	0.31	0.33	0.53	0.19	0.16	0.09	0.12	0.29	10	1,004	3,442	951	396	204	158	149	252
11	0.33	0.51	0.71	0.11	0.28	0.10	0.18	0.23	11	1,010	3,631	3,391	284	1,912	195	268	177
12	0.51	0.66	0.75	0.25	0.36	0.12	0.25	0.31	12	5,108	7,019	15,446	634	5,098	74	368	330
13	0.78	0.64	0.84	0.30	0.61	0.12	0.35	0.14	13	2,128	5,714	18,730	586	4,641	135	273	77
14	0.75	0.71	0.89	0.39	0.61	0.17	0.32	0.31	14	1,826	3,470	4,860	1,808	5,736	123	257	50
15	0.65	0.89	0.88	0.63	0.61	0.20	0.37	0.46	15	1,176	3,679	6,803	2,343	1,408	321	215	115
16	0.57	0.70	0.83	0.38	0.50	0.09	0.58		16	1,421	3,433	2,964	295	592	72	437	
17	0.51	0.67	0.68	0.41	0.52	0.06	0.42	0.22	17	3,007	1,055	2,286	324	949	8	124	14
18	0.61	0.62	0.79	0.46	0.43	0.28			18	656	341	459	430	271	85		
19				0.22	0.50	0.47			19				37	231	50		
20				0.38	0.24	0.00			20				137	100	-		
21					0.15	0.03			21					67	1		
22					0.34				22					59			

For the CP/MS sectors, incidence rates were also elevated for a long period of 2005. In contrast to 2005, most other years show much reduced chum bycatch incidence rates, with the maximum incidence rate being approximately 0.7 in both 2008 and 2010. For CPs and Motherships, chum incidence is less than 10 percent for many weeks in 2008. Of course, it is not only whether or not a vessel encounters chum salmon but how many, but consistently catching chum in virtually every haul makes it much more likely that a vessel will catch large quantities of bycatch. When everyone is catching salmon in most locations and the variance of bycatch is large, it may also be harder to discern whether the bycatch conditions of a location are good relative to other locations. Further analysis will be included in initial review.

How do Chinook and chum bycatch closures interact?

In choosing where to implement VRHS closures for Chinook and chum bycatch reduction, SeaState recognizes that there are periods when there can be trade-offs between and Chinook and chum bycatch at times, which is occasionally noted in SeaState reports to the fleet. For example, the following description is from the 8/27/07 SeaState report to the fleet: "*The Chinook bycatch is 30% less than we had last year by this time (despite having taken 25,000 mt more pollock this season to date) and the chum bycatch is only 14% of what it was last year at this point. Unfortunately, we don't get to relax. We are not changing the Chinook closures to the north as they seem to have done a good job of reducing Chinook catches. I'm afraid that if we shifted the closures around to slow down the chum bycatch we might then see boats back in the current closures and catching more Chinook.*"

On the other hand, there are times when there are areas that have elevated levels of both species. For example, in mid-August 2006, a closure was put in place for 4 days as a Chinook closure but was later extended as a chum closure.

BSAI chum bycatch

To provide some additional insight into whether or not chum and Chinook VRHS closures complement one another, we examine the correlation between the bycatch rate in and out of each closure period for each species. This comparison is conducted as follows:

1. The bycatch rate inside each closure is calculated for the 5-day period prior to the closure for each bycatch species.
2. The bycatch rate outside each closure is calculated for the 5-day period prior to the closure for each bycatch species.
3. For each species, the ratio of bycatch inside to outside the closure is calculated.
4. The correlation of the ratios is then calculated for each closure.

The correlation for all B-season closure periods from 2003-2009 is found to be 0.57. If it were consistently necessary to trade-off chum and Chinook bycatch when creating hotspot closures, we would expect to see a negative correlation between these ratios. While more extensive analysis could reveal more information about when there are conflicts between reducing chum and Chinook bycatch, the positive correlation suggests that chum and Chinook bycatch reduction through VRHS closures is in general complementary. Further analysis of this relationship will be included in the initial review.

What are the observable economic impacts of the closures?

In some cases vessels are forced to take much longer trips as a result of closures, resulting in additional travel costs. Following data collection efforts from Amendment 91, there will be cost information available to estimate these costs but currently we do not know vessel fuel costs. There are times when SeaState reports note that catcher vessels will make large shifts to the north when closures are imposed in the south, but it is difficult to measure how frequently this is due to SeaState closures as these shifts happen to different degrees with or without closures.

We examine the changes in CPUE the periods 1-5 days before and after the VRHS closures. There is no statistically significant change in haul-level CPUE from the 0-2 days before VRHS closures are implemented to the 0-2 days after. There appears to be a small decline in CPUE when examining the change in CPUE from 0-5 days before VRHS closures to 0-5 days after the closures – approximately 3 percent after controlling for annual and vessel-specific effects. It appears that some of this reduction in CPUE is made up by longer fishing times in those days. Further examination is required however to explore the variation of the "duration" variable to explore what is driving this reduction. Concern is warranted here because of the lack of observed change from 0-2 days following the closure.

There is also the potential for significant economic losses when vessels are forced off of areas where higher value products are produced. This is likely to be a more dramatic impact in A-Season because of the high value of roe, but the amount of roe caught in the B-season has increased. With anecdotal input from vessel operators of specific closures inducing movement off of high-value fishing areas, it would be possible to make estimates of these impacts (subject to the limitations of having only annual price and quality information).

What is the impact of limits of the maximum VRHS closure size on the effectiveness of the chum bycatch hotspot system?

A key question that will be examined is whether the maximum area limitation of the VRHS system reduces its effectiveness. This question will be examined in the initial review.

While the size/number limit on VRHS closures that can be put in place at any time prevents SeaState from closing a larger part of the grounds that might be effective in reducing bycatch, this limitation also

reduces the impact of closures on the fishery and prevents "surprises" from sending people to search for pollock in areas that either are known to have high bycatch or that have an unknown amount of bycatch.

Discussion of Chum salmon bycatch rates in the Chum Salmon Savings Areas (SSA)

The Chum Salmon Savings Area was put into place according to the dates on the following table:

Table 10: Chum Salmon Savings Area (SSA) Dates in place

Year	Start Date	End Date	Type
1995-2005	8/1	8/31	Chum
2002	9/21/2002	10/14/2002	Chum
2003	9/24/2003	10/14/2003	Chum
2004	9/14/2004	10/14/2004	Chum

For 2005, most of the bycatch in the SSA occurred for the week of 10/8, so by the time the Region had the bycatch information to trigger the closures, it was 10/14 so the closures could not be triggered (Mary Furuness, pers. comm.).

An examination of the rates in and out of the chum SSA for the open periods from 2003-2009 shows that in less than 10 percent of B season months the observed bycatch rate was higher in the Chum SSA than outside of it (these three months are indicated with gray highlighting). In each of these 3 months, the difference between inside and outside the SSA was small. As indicated in the previous table, the Chum SSA was closed in part of September and October of 2003 and 2004.

Table 11: Chum salmon bycatch rates by Month & Year, In and Out of the Chum SSA

Year	In ChumArea?	Jun	Jul	Aug	Sep	Oct	Nov
2003	INSIDE Chum SSA	0.012	0.009	0.025	0.204	0.176	
	Outside Chum SSA	0.021	0.060	0.219	0.393	0.632	
2004	INSIDE Chum SSA	0.255	0.132	0.134	0.176	0.181	
	Outside Chum SSA	0.218	0.096	0.583	1.134	1.237	0.614
2005	INSIDE Chum SSA	0.123	0.046	0.142	0.316	0.438	
	Outside Chum SSA	0.217	0.978	1.225	0.461	1.210	
2006	INSIDE Chum SSA	0.025	0.131	0.028	0.059	0.023	
	Outside Chum SSA	1.087	0.417	0.509	0.109	0.119	0.000
2007	INSIDE Chum SSA	0.009	0.049	0.080	0.134	0.034	0.000
	Outside Chum SSA	0.043	0.041	0.210	0.358	0.044	0.142
2008	INSIDE Chum SSA	0.008	0.008	0.010	0.010	0.005	
	Outside Chum SSA	0.033	0.022	0.027	0.077	0.055	
2009	INSIDE Chum SSA	0.011	0.018	0.017	0.034	0.006	
	Outside Chum SSA	0.045	0.147	0.110	0.244	0.013	

BSAI chum bycatch

What is the likely interaction of status quo chum measures with Amendment 91 and potential IPAs?

The new Amendment 91 measures provide additional incentives to the pollock fishery to avoid Chinook salmon bycatch. Amendment 91 has two principal components for Chinook avoidance: a hard cap on the number of Chinook that can be caught each year, and incentive plan agreements (IPA) that provide additional incentives for Chinook bycatch avoidance at all bycatch levels including those well below the hard cap level.

The IPAs are different for each sector but all provide a mandate that vessels stay below the hard cap. In addition to other measures, a Rolling Hotspot Program (RHS) for Chinook bycatch is common to all three agreements. Thus there may be closures in place for Chinook bycatch as well as any fixed or rolling closures intended for chum avoidance.

How will these measures interact with current or potential future chum bycatch avoidance measures? The presence of the Amendment 91 measures mean that chum fixed or hotspot closures have the *potential* to be more expensive for the fleet and lead to higher Chinook bycatch. Similarly, the Chinook bycatch measures may make it more costly and/or difficult for vessels to avoid high chum bycatch area. If a vessel exceeds its allowance of Chinook salmon bycatch and is unable to obtain access to additional bycatch allowances, then it will be unable to fish more in a given year. Similarly, there is the potential that vessels would be forced by chum area closures to fish in high Chinook areas if low Chinook bycatch fishing grounds are closed by chum closures. It should be noted that vessels will be able to choose to not fish for periods of time which will reduce the likelihood of a short-term closure "forcing" vessels to fish in high Chinook areas. The time length a closure is in place will impact vessels' ability to do this and in general this is a costly decision for a vessel to have to make. However, as discussed in the VRHS status quo analysis, Chinook and chum bycatch are positively correlated.

SeaState carefully weighs the need to reduce bycatch of both species in its decision making. Any type of fixed closure system would eliminate this flexibility, which is also the case with the current Chum Salmon Savings Area. As discussed above, in general high chum and Chinook bycatch areas that become VRHS closures tend to be correlated.
Figure 3 displays one aspect of the Amendment 91 IPA that applies to all sectors – the implementation of a B-Season "Chinook Conservation Area." As indicated in the figure, the area will be closed from October 15-31 when the Chinook salmon bycatch rate in September exceeds 0.015 salmon per metric ton of pollock.

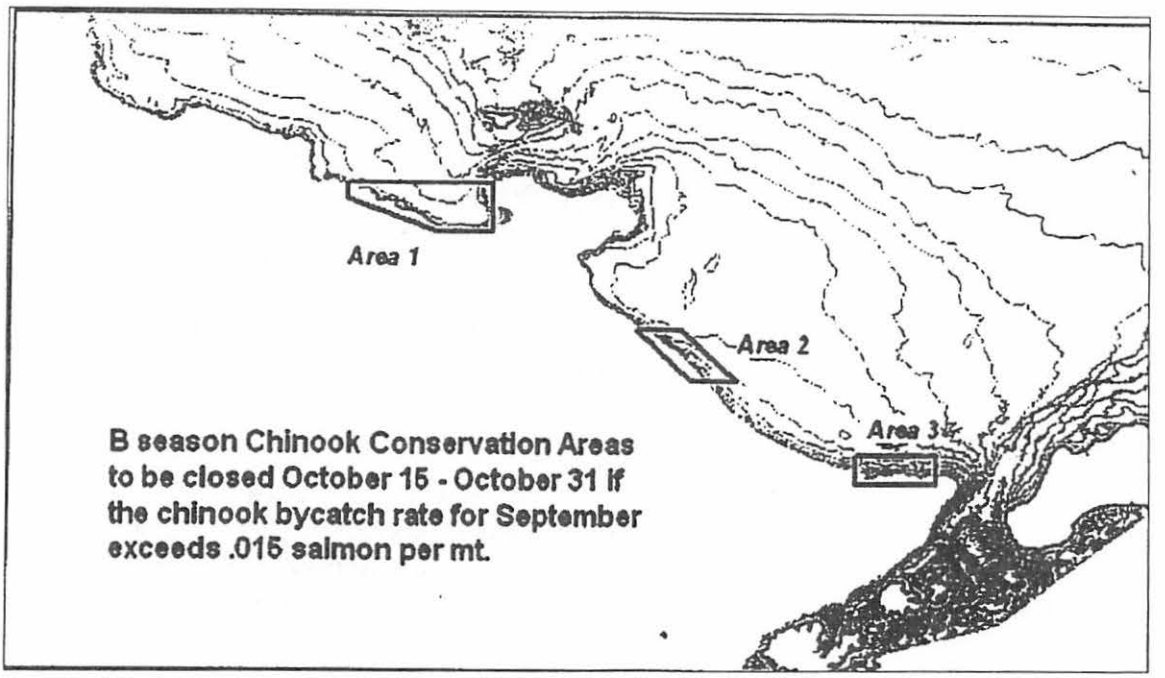


Figure 3: 2011 Amendment 91 IPA B Season Chinook Conservation Area

For the purposes of this chum bycatch analysis, the relevant question is how high chum bycatch is in these areas and whether the areas move people to higher or lower chum bycatch fishing areas. The following table displays the chum bycatch rates in and out of the B season Chinook Conservation Areas for 2003-2009.

Table 12: Number of hauls, Chum, and Chinook inside and outside the Amendment 91 B-Season Chinook Conservation Area by Sector and Year, 2003-2009

Sector	In BCCA?	Year	Hauls	ChumNum	ChinNum	PollockMT	ChumRate	ChinRate
CV	Yes	2004	14	655	229	1,605	0.41	0.14
CV	Yes	2005	20	2,662	3,785	2,411	1.10	1.57
CV	Yes	2006	69	473	1,530	5,771	0.08	0.27
CV	Yes	2007	41	151	3,767	3,019	0.05	1.25
CV		2003	47	1,066	280	6,864	0.16	0.04
CV		2004	127	21,823	6,799	13,352	1.63	0.51
CV		2005	155	25,279	6,615	17,460	1.45	0.38
CV		2006	262	1,508	3,558	14,389	0.10	0.25
CV		2007	430	1,250	12,581	24,491	0.05	0.51
CV		2008	89	83	1,366	3,960	0.02	0.35
CP/MS	Yes	2004	8	758	79	76	9.94	1.03
CP/MS	Yes	2007	30	14	633	1,131	0.01	0.56
CP/MS		2003	47	95	233	2,079	0.05	0.11
CP/MS		2004	59	1,592	501	2,944	0.54	0.17
CP/MS		2005	51	297	39	3,374	0.09	0.01
CP/MS		2006	181	153	203	9,411	0.02	0.02
CP/MS		2007	468	529	2,797	26,523	0.02	0.11
CP/MS		2008	201	28	91	8,872	0.00	0.01

An estimate of what the chum and Chinook bycatch impacts from the closure would have been for past years can be made. Preliminary results indicate an extremely small (< 0.5 percent) increase in chum bycatch resulting from the B-Season Chinook Conservation Area. The key assumption of this estimate is that when pollock is caught outside of the BCCA instead of inside, the vessels would receive the same bycatch rate as the average outside of the area. This does not control for vessel-specific bycatch tendencies and further analysis is required to assess whether or not this is statistically significant.

The Dirty 20 List

An additional aspect connected to the VRHS system is the publication to the fleet of a list of vessels with high bycatch rates which is regularly published in SeaState reports. There is no financial penalty to being on the list, but vessel operators report that there are social pressures connected to being on the list. According to conversations with several vessel captains, Captains will give other captains a hard time for being on the list and one person regularly on the list expressed feeling very bad about it. The list has been refined over time so that both seasonal and recent activity list are published in SeaState reports for both Chinook and non-Chinook salmon. It is difficult to assess how much of a difference the list has made, but it provides transparency to the fleet about who is and is not avoiding bycatch and establishes a social norm in which vessels are publicly labeled as "dirty" for having high salmon bycatch.

Additional Flexibilities of VRHS System

While the VRHS system's primary purpose are to identify high bycatch areas, convey bycatch information to the fleet, and to close those areas with the highest rates, reading the SeaState reports reveals that SeaState attempts to use all available information to most effectively implement closures. Here are several examples that illustrate the type of information that is utilized in closure designation and how the information is interpreted.

The 8/2/07 SeaState report illustrates how near real-time VMS data is used to supplement observer data: "*East of 168 we have elevated rates in 655600 and a couple of reports of high-bycatch tows from that area as well. None of this is showing up in observer data, so we are stuck with making the closure based on VMS coverage of the vessels involved.*"

The 8/27/07 report shows the nuance of trying to separate low-bycatch fishing from higher bycatch areas: "*Finally, I think boats that visited 675500 and 675530 might have picked up some chums there as well, but again they fished in multiple areas and reports from the grounds are conflicting. The amount of pollock taken in those areas is so low that the areas don't even reach the "2% of pollock catch" threshold to be included in our bycatch rates tables. However, if you do try those areas you might want to wary because fishing is almost never clean out near edge in those stat areas. It can be OK in a bit from the edge (in, say, 70 – 75 fm), and that's where the fishing took place, but the boundary between areas of high and low bycatch can be pretty abrupt.*"

Figure 4, below, shows the overlapping closures that were put in place from mid-August to early-October, 2009. This was a low bycatch period but the closures were repeatedly moved to close areas with the highest bycatch at the time.

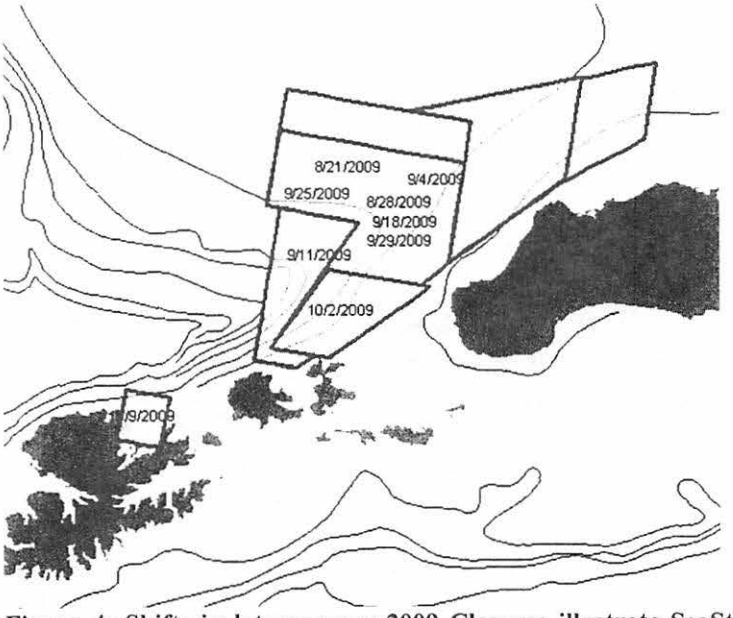


Figure 4: Shifts in late summer 2009 Closures illustrate SeaState efforts and ability to adjust to changing bycatch hotspots

Potential factors that can be considered to adjust the VRHS system

A number of issues related to the performance of the VRHS system and it's interaction with the status quo can be evaluated[7]. Some features of the VRHS system that could potentially be adjusted include:

- Base Rate: Lowering or eliminating the requirement that the base rate be exceeded in order to allow closures to be placed immediately if hotspots appear in VMS data or through vessel reports to SeaState. [Placeholder]
- Are Closure limitation: Allow for the expansion of the area closed if larger areas of hotspots occur.
- Tier System structure:
    - Provide stronger incentives linked to the Tier system. For example, more extensive hotspot closures could apply only to vessels based on their individual bycatch performance. This type of system potentially could have some of the individual incentive effects that are part of Amendment 91 while building directly on the VRHS system.
    - The hotspot system contained in the 2011 Chinook IPAs imposes closed areas on *vessels* whose Chinook bycatch rate is greater than 75 of the base rate. This type of system could also be considered for chum salmon.
- Modified RHS System (Component 6 of Alternative 3): Analysis of Alternative 3 will evaluate the large-scale triggered closure (defined to encompass 80% of the historical bycatch) which is selected would apply to participants with a rate in excess of 200% of the Base Rate. Evaluation of the number of participants to which this would have applied historically may also inform potential modifications to the existing RHS system under Status Quo in this analysis.

These factors as well as other factors as possible will be discussed in more detail in the initial review analysis.

[7] Note further analysis of these individual factors will be included in the initial review draft

Summary of Preliminary Findings

Collectively, the Chinook and chum salmon bycatch measures implemented through the VRHS system and Amendment 91 arguably represent the most extensive bycatch reduction efforts that have ever been undertaken. In this preliminary analysis, we present a number of relevant findings that will be refined and extended in subsequent analysis.

Key preliminary findings of this analysis include:

- Comparing the bycatch rates in the 1-3 days following the implementation of VRHS closures with the bycatch rates in the 1-3 days prior to VRHS closure implementation, preliminary results indicate that aggregate chum bycatch rates are 5 - 9 percent lower in the 3 days following a closure compared to the days before the closure. This should not be interpreted as the total bycatch reduction, as there may be additional chum bycatch reduction that occurs when high bycatch areas are closed and extremely high bycatch hauls are potentially avoided. However, this indicates that there is a statistically significant reduction in bycatch following the average closure from 2003-2009.
- When examining the impact of the closures on bycatch rates immediately following closure implementation in different years, there is significant variation. More analysis is needed to investigate this variation and will be provided in the initial review.
- An examination of the bycatch rates in the chum Salmon Savings Area (SSA) indicates that in over 90 percent of months from 2003-2009, chum bycatch was *lower* in the Chum SSA than outside of it.

Compared to alternative spatial management systems, the VRHS system has advantages and limitations. Key advantages of the hotspot system relative to fixed closures include:

- Sea State has shown the ability to make trade-offs between the bycatch of different species and to consider how vessels will respond.
- Adjustments to what areas will be closed can be made regularly in response to the substantial inter-annual variability in the quantity and concentration of bycatch.
- Anecdotal information from vessel operators and plant managers can be combined with observer data, VMS data, and knowledge of how seasonal bycatch conditions evolve to make well-informed predictions of where salmon bycatch will occur in the near-term.
- The system can adapt with new information. For example, from the 8/27/07 SeaState report – "It would be particularly useful to know if there is a temperature front associated with higher or lower bycatch, as there was further up on the shelf."
- Through regular reporting to the Council and independent audits of potential violations, there is transparency in whether vessels adhere to closures. The number of violations of the closures has been very limited and seemingly generally due to mistakes by vessel operators.
- In terms of allowing pollock to be caught, the VRHS system functions as a means to address bycatch at all levels of bycatch encounters.

In balancing the chum and Chinook bycatch, the VRHS system has demonstrated the ability to carefully balance the trade-offs in a manner that could not be done with fixed closures. The program has continued to evolve and learn from new challenges.

Several potential limitations to the SeaState system that can also be noted:

- When bycatch is abundant in many locations, such as 2005, bycatch rates remain high despite evidence that the VRHS closures reduce bycatch.

- The restrictions of the chum VRHS system constrain the maximum areas to be closed to be significantly lower than some of the closure systems under consideration by the Council. The impact of this restriction will be further analyzed as part of initial review.

Appendix: VRHS B-Season Closure Periods 2003-2009

The following table, Table 13, provides detailed information on chum and Chinook bycatch during periods that VRHS closures were implemented for 2003-2009. The table provides detailed information on the pollock fishing and bycatch for 1) the 5-day period before each closure – *inside the closure*, 2) the 5-day period before each closure – *outside the closure*, and 3) the 5-day period *after* each closure – in all locations.

We present this information for informational purposes. In the analyses above, we consider the changes ranging from 1-5 days before and after each closure. Future analysis will draw further from this and related information.

For each of the three 5-days groups, the following information is listed:

- Date the closure began
- Type of closure – chum or Chinook
- Number of hauls occurring
- Chum, Chinook, and pollock – the numbers are extrapolated to the Region's total as done elsewhere in this EA.
- Proportions of (extrapolated) chum, Chinook, and pollock occurring in the closure area prior to the closure

Several caveats should be noted when examining the table:

- As noted in the data description section, when a closure is extended, it is reported as one closure period and the length of the closure is reported.
- Double counting occurs for several reasons:
    - With simultaneous closures, because fishing that occurs outside of all of the closures in place at any one time listed for each closure. The fishing that occurs in the other closure(s) in place at the same time also is noted in for each closure.
    - Hauls may occur within 5 days of simultaneous closures.
- As noted above, the 2003-2005 closures are designated here as 'Chum*' but some of these closures may be re-designated as Chinook in future analyses.

Table 13: Comparison of pollock and bycatch activity in and out of VRHS Closures Before implementation and After Closures in All Locations

			Information for 5 days before VRHS closure -- Inside the Closure									
Start date	Days closed	Closure type	Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
07/11/03	7	Chum*	5	3	0	118	0.00	0.00	0.00	0.026	0.000	5
07/11/03	7	Chum*	25	262	2	4459	0.20	0.05	0.12	0.059	0.000	46
07/18/03	7	Chum*										
07/18/03	7	Chum*	32	313	4	5412	0.18	0.36	0.18	0.058	0.001	185
07/25/03	7	Chum*	31	146	0	1788	0.09	0.00	0.07	0.081	0.000	76
08/08/03	7	Chum*	83	6018	9	12414	0.59	0.10	0.35	0.485	0.001	519
08/15/03	7	Chum*	94	9937	8	12175	0.74	0.11	0.39	0.816	0.001	648
08/15/03	7	Chum*	13	394	17	936	0.03	0.23	0.03	0.421	0.018	24
08/22/03	7	Chum*	41	1953	4	6261	0.22	0.03	0.17	0.312	0.001	178
08/22/03	7	Chum*	3	555	3	250	0.06	0.02	0.01	2.223	0.013	8
08/29/03	7	Chum*	36	3750	28	3565	0.58	0.12	0.10	1.052	0.008	124
09/09/03	3	Chum*	5	97	29	459	0.02	0.09	0.01	0.211	0.063	22
09/12/03	7	Chum*	15	704	57	2092	0.09	0.11	0.06	0.336	0.027	72
09/12/03	7	Chum*	11	147	14	1027	0.02	0.03	0.03	0.143	0.014	55
09/26/03	7	Chum*	52	4322	124	4554	0.21	0.22	0.18	0.949	0.027	371
10/03/03	7	Chum*										
10/10/03	7	Chum*	31	287	137	1144	0.05	0.07	0.10	0.251	0.120	181
10/17/03	7	Chum*	14	1583	233	1301	0.46	0.28	0.14	1.217	0.179	109
07/02/04	7	Chum*	4	247	0	445	0.08	0.00	0.01	0.555	0.000	8
07/02/04	7	Chum*	14	124	2	2303	0.04	0.03	0.08	0.054	0.001	67
07/09/04	7	Chum*	22	325	11	1909	0.11	0.06	0.04	0.170	0.006	78
07/16/04	7	Chum*	8	334	6	435	0.13	0.06	0.01	0.769	0.015	28
07/23/04	7	Chum*	9	958	3	1039	0.18	0.03	0.03	0.922	0.002	18
07/23/04	7	Chum*	15	978	4	1324	0.19	0.05	0.04	0.739	0.003	62
07/30/04	7	Chum*	16	1432	16	1050	0.33	0.23	0.03	1.363	0.015	36
08/06/04	7	Chum*										
08/06/04	4	Chum*	27	4468	16	4345	0.12	0.07	0.19	1.028	0.004	128
08/10/04	3	Chum*	32	16069	25	3261	0.53	0.12	0.11	4.928	0.008	128
08/13/04	7	Chum*	14	6311	23	2624	0.42	0.10	0.07	2.405	0.009	115
08/17/04	14	Chum*	52	6591	106	5592	0.60	0.43	0.17	1.179	0.019	443
08/17/04	14	Chum*										
08/24/04	7	Chum*	50	23968	210	4160	0.67	0.20	0.15	5.761	0.051	350
08/27/04	4	Chum*										
08/31/04	7	Chum*	6	183	13	628	0.02	0.02	0.02	0.291	0.021	57
08/31/04	3	Chum*										
09/03/04	4	Chum*	3	800	17	190	0.06	0.01	0.00	4.213	0.087	26
09/10/04	7	Chum*	36	23655	103	3948	0.36	0.10	0.11	5.992	0.026	315

Start date	Information for 5 days before VRHS closure -- Outside the Closure							Information for 5 days after VRHS closure -- Outside the Closure						
	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
07/11/03	312	1309	42	35809	819	0.037	0.001	395	2193	30	43220	1279	0.051	0.001
07/11/03	292	1050	40	31467	778	0.033	0.001	395	2193	30	43220	1279	0.051	0.001
07/18/03	231	1735	10	29496	807	0.059	0.000	375	2668	33	34410	1421	0.078	0.001
07/18/03	199	1422	7	24085	622	0.059	0.000	375	2668	33	34410	1421	0.078	0.001
07/25/03	243	1566	10	25123	1159	0.062	0.000	522	2494	95	54600	1369	0.046	0.002
08/08/03	221	4187	83	22609	728	0.185	0.004	433	9702	95	44038	1853	0.220	0.002
08/15/03	186	3534	66	19068	738	0.185	0.003	396	6920	176	41064	1416	0.169	0.004
08/15/03	265	13034	57	29990	1336	0.435	0.002	396	6920	176	41064	1416	0.169	0.004
08/22/03	329	6986	149	31128	1356	0.224	0.005	516	8521	280	46155	1832	0.185	0.006
08/22/03	367	8384	150	37139	1526	0.226	0.004	516	8521	280	46155	1832	0.185	0.006
08/29/03	327	2685	197	30395	1180	0.088	0.006	441	6951	836	44559	1274	0.156	0.019
09/09/03	304	4871	282	32159	1278	0.151	0.009	367	9916	719	36421	1835	0.272	0.020
09/12/03	291	6808	446	31486	1413	0.216	0.014	364	10175	557	34311	1955	0.297	0.016
09/12/03	295	7365	489	32551	1430	0.226	0.015	364	10175	557	34311	1955	0.297	0.016
09/26/03	227	16476	433	20871	1208	0.789	0.021	262	3914	876	20458	1793	0.191	0.043
10/03/03	278	8704	1197	17105	1897	0.509	0.070	220	10073	2431	14769	1329	0.682	0.165
10/10/03	159	5788	1893	10164	950	0.569	0.186	132	7113	1661	11060	875	0.643	0.150
10/17/03	76	1891	603	8054	415	0.235	0.075	42	273	184	3280	225	0.083	0.056
07/02/04	262	3011	61	29996	969	0.100	0.002	424	2355	119	39596	1677	0.059	0.003
07/02/04	252	3134	59	28139	911	0.111	0.002	424	2355	119	39596	1677	0.059	0.003
07/09/04	432	2549	168	42864	1637	0.059	0.004	454	3220	153	43224	1482	0.075	0.004
07/16/04	411	2244	96	41141	1396	0.055	0.002	443	6133	87	42550	1708	0.144	0.002
07/23/04	327	4227	77	36322	1329	0.116	0.002	424	4154	88	46738	1567	0.089	0.002
07/23/04	321	4207	75	36038	1285	0.117	0.002	424	4154	88	46738	1567	0.089	0.002
07/30/04	268	2892	53	31591	1201	0.092	0.002	378	16554	127	36849	1442	0.449	0.003
08/06/04	170	38307	240	23112	929	1.657	0.010	495	18075	207	48471	1923	0.373	0.004
08/06/04	143	33839	224	18767	801	1.803	0.012	495	18075	207	48471	1923	0.373	0.004
08/10/04	229	14237	188	26961	1067	0.528	0.007	501	13935	278	48525	2192	0.287	0.006
08/13/04	335	8574	212	35374	1525	0.242	0.006	434	9343	291	38801	1969	0.241	0.007
08/17/04	302	4311	143	27939	1341	0.154	0.005	374	27992	629	32423	1911	0.863	0.019
08/17/04	351	10796	243	33289	1751	0.324	0.007	374	27992	629	32423	1911	0.863	0.019
08/24/04	286	11891	828	24093	1437	0.494	0.034	485	13996	758	40813	2535	0.343	0.019
08/27/04	313	18964	991	27234	1895	0.696	0.036	453	10419	951	46210	1959	0.225	0.021
08/31/04	331	9895	673	31479	1780	0.314	0.021	466	14354	1463	50451	1678	0.285	0.029
08/31/04	337	10078	686	32108	1838	0.314	0.021	466	14354	1463	50451	1678	0.285	0.029
09/03/04	366	12128	1150	42824	1357	0.283	0.027	440	54622	1300	40024	2152	1.365	0.032
09/10/04	344	42675	949	30857	1843	1.383	0.031	487	54211	2732	35393	2610	1.532	0.077

			Information for 5 days before VRHS closure -- Inside the Closure									
Start date	Days closed	Closure type	Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
06/24/05	7	Chum	63	6470	167	11605	0.47	0.41	0.29	0.557	0.014	306
06/24/05	4	Chum	22	251	1	1221	0.02	0.00	0.03	0.205	0.001	84
06/28/05	3	Chum	18	713	6	906	0.09	0.02	0.03	0.787	0.007	96
06/28/05	3	Chum	9	145	7	1118	0.02	0.02	0.03	0.129	0.006	33
07/01/05	4	Chum	14	180	9	423	0.04	0.03	0.01	0.425	0.022	101
07/01/05	4	Chum	25	472	4	904	0.12	0.01	0.03	0.522	0.005	124
07/05/05	3	Chum	48	3756	59	6292	0.26	0.31	0.22	0.597	0.009	369
07/05/05	3	Chum	116	9120	128	13849	0.63	0.67	0.49	0.659	0.009	780
07/08/05	4	Chum	7	11872	0	1812	0.35	0.00	0.06	6.552	0.000	64
07/08/05	4	Chum	8	1081	8	779	0.04	0.04	0.03	1.388	0.010	60
07/12/05	3	Chum	34	15608	28	3005	0.73	0.40	0.12	5.193	0.009	163
07/15/05	4	Chum	4	2466	4	459	0.23	0.03	0.02	5.371	0.008	22
07/19/05	3	Chum	7	2138	6	397	0.04	0.04	0.01	5.383	0.016	65
07/22/05	4	Chum	20	17932	12	2916	0.22	0.07	0.08	6.150	0.004	96
07/29/05	7	Chum	15	3841	7	339	0.10	0.04	0.02	11.338	0.019	107
08/05/05	4	Chum	25	30676	47	4275	0.28	0.24	0.15	7.176	0.011	199
08/09/05	7	Chum										
08/09/05	3	Chum										
08/12/05	4	Chinook	4	2141	17	330	0.11	0.03	0.01	6.481	0.052	61
08/16/05	3	Chum	26	8523	35	2598	0.26	0.06	0.11	3.281	0.013	159
08/19/05	4	Chum	43	20944	128	4166	0.30	0.22	0.14	5.027	0.031	321
08/19/05	4	Chum	50	3083	46	5088	0.05	0.08	0.18	0.606	0.009	148
08/23/05	3	Chum	4	1269	4	227	0.08	0.00	0.01	5.591	0.016	25
08/26/05	3	Chum	12	2142	38	2361	0.15	0.03	0.11	0.907	0.016	39
09/06/05	3	Chum	28	9623	10	2948	0.48	0.02	0.13	3.265	0.003	104
09/09/05	4	Chum	11	1208	29	760	0.19	0.04	0.03	1.589	0.038	71
09/13/05	3	Chum										
09/16/05	7	Chum	46	4460	97	6552	0.47	0.09	0.31	0.681	0.015	260
09/27/05	3	Chum	3	373	106	174	0.03	0.06	0.01	2.145	0.611	25
09/27/05	3	Chum	25	3434	733	2290	0.29	0.45	0.17	1.500	0.320	267
09/30/05	4	Chum	8	3153	88	454	0.32	0.05	0.04	6.938	0.194	70
10/07/05	4	Chum	30	5808	2313	3110	0.43	0.53	0.28	1.867	0.744	354
10/11/05	10	Chum	4	936	284	480	0.06	0.08	0.06	1.949	0.592	58
10/14/05	7	Chum	35	4190	1528	1249	0.27	0.30	0.13	3.354	1.223	200
10/21/05	4	Chum										

Start date	Information for 5 days before VRHS closure -- Outside the Closure							Information for 5 days after VRHS closure -- Outside the Closure						
	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
06/24/05	325	7153	240	27967	1108	0.256	0.009	441	5760	322	34547	1928	0.167	0.009
06/24/05	362	12225	392	37046	1299	0.330	0.011	441	5760	322	34547	1928	0.167	0.009
06/28/05	398	7416	282	32963	1713	0.225	0.009	360	7563	269	38418	1841	0.197	0.007
06/28/05	407	7984	282	32751	1776	0.244	0.009	360	7563	269	38418	1841	0.197	0.007
07/01/05	363	3888	286	33825	1699	0.115	0.008	352	19242	220	33046	1422	0.582	0.007
07/01/05	352	3596	291	33344	1677	0.108	0.009	352	19242	220	33046	1422	0.582	0.007
07/05/05	226	10640	133	21983	1073	0.484	0.006	523	30458	158	42152	1551	0.723	0.004
07/05/05	158	5276	64	14427	662	0.366	0.004	523	30458	158	42152	1551	0.723	0.004
07/08/05	311	22502	192	28519	962	0.789	0.007	504	12701	88	40228	1609	0.316	0.002
07/08/05	308	27398	184	28766	940	0.952	0.006	504	12701	88	40228	1609	0.316	0.002
07/12/05	307	5668	41	22325	965	0.254	0.002	469	32926	168	46781	1573	0.704	0.004
07/15/05	276	8333	110	27529	1005	0.303	0.004	494	81010	177	48009	1731	1.687	0.004
07/19/05	254	48520	155	28954	959	1.676	0.005	444	66011	196	50532	1646	1.306	0.004
07/22/05	303	63750	172	34922	1065	1.826	0.005	376	38089	173	41640	1641	0.915	0.004
07/29/05	177	35200	170	20813	901	1.691	0.008	466	82224	224	41832	1792	1.966	0.005
08/05/05	249	80370	150	23579	993	3.408	0.006	438	44220	523	42408	1884	1.043	0.012
08/09/05	326	49822	417	29869	1607	1.668	0.014	492	13309	655	43900	1667	0.303	0.015
08/09/05	326	49822	417	29869	1607	1.668	0.014	492	13309	655	43900	1667	0.303	0.015
08/12/05	258	17019	491	26379	1113	0.645	0.019	485	55344	625	42829	1737	1.292	0.015
08/16/05	257	24811	511	21629	1160	1.147	0.024	312	51813	827	40910	1363	1.267	0.020
08/19/05	225	47823	444	24610	999	1.943	0.018	308	22518	987	36664	1312	0.614	0.027
08/19/05	216	65037	520	23530	1157	2.764	0.022	308	22518	987	36664	1312	0.614	0.027
08/23/05	195	13771	770	26105	989	0.528	0.029	431	19349	1519	39358	1680	0.492	0.039
08/26/05	203	11873	1132	19987	1018	0.594	0.057	435	19196	1269	40161	1767	0.478	0.032
09/06/05	221	10616	593	20017	915	0.530	0.030	321	7397	1327	34207	1298	0.216	0.039
09/09/05	249	5303	766	23050	855	0.230	0.033	268	8873	1313	30898	1245	0.287	0.042
09/13/05	134	3034	553	11210	555	0.271	0.049	341	14458	1267	33920	1894	0.426	0.037
09/16/05	116	5051	947	14835	671	0.341	0.064	321	8458	1110	23664	1795	0.357	0.047
09/27/05	169	11588	1530	13076	956	0.886	0.117	224	12675	2601	23419	1342	0.541	0.111
09/27/05	147	8527	903	10960	714	0.778	0.082	224	12675	2601	23419	1342	0.541	0.111
09/30/05	139	6691	1638	12410	674	0.539	0.132	189	11019	3173	17985	1356	0.613	0.176
10/07/05	110	7808	2048	7913	745	0.987	0.259	201	16939	4155	10510	1319	1.612	0.395
10/11/05	147	14697	3488	7499	1064	1.960	0.465	143	17005	4387	12557	983	1.354	0.349
10/14/05	104	11564	3574	8434	771	1.371	0.424	101	8744	1637	7657	778	1.142	0.214
10/21/05	85	5482	1469	5904	669	0.929	0.249	56	4419	1169	4101	414	1.078	0.285

Start date	Days closed	Closure type	Information for 5 days before VRHS closure -- Inside the Closure									
			Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
06/20/06	7	Chinook	48	6911	82	3016	0.35	0.32	0.17	2.292	0.027	427
06/20/06	7	Chum	24	133	2	1145	0.01	0.01	0.06	0.116	0.002	111
06/27/06	7	Chum	56	3575	43	2147	0.37	0.41	0.16	1.665	0.020	605
07/04/06	3	Chum	26	3112	74	2021	0.16	0.37	0.08	1.540	0.037	150
07/07/06	4	Chinook	6	505	16	377	0.04	0.12	0.02	1.339	0.043	51
07/07/06	4	Chum	26	699	0	1102	0.05	0.00	0.05	0.634	0.000	108
07/11/06	3	Chum	5	0	0	0	0.00	0.00	0.00			21
07/11/06	3	Chum	38	2047	22	1522	0.21	0.22	0.07	1.345	0.015	327
07/14/06	4	Chum	23	2812	9	1192	0.25	0.11	0.06	2.358	0.008	209
07/14/06	4	Chum	11	538	8	305	0.05	0.09	0.02	1.763	0.026	105
07/18/06	3	Chum	8	125	1	126	0.04	0.02	0.01	0.993	0.007	42
07/21/06	4	Chum	4	723	4	175	0.13	0.02	0.01	4.140	0.022	10
07/25/06	3	Chum	3	68	0	111	0.01	0.00	0.00	0.614	0.000	13
07/28/06	4	Chum	7	3467	8	355	0.22	0.08	0.01	9.755	0.023	40
08/01/06	3	Chum	9	5411	7	468	0.26	0.07	0.03	11.549	0.016	71
08/04/06	4	Chum	30	6332	25	2188	0.22	0.18	0.09	2.893	0.012	161
08/08/06	3	Chum	4	136	1	169	0.00	0.00	0.01	0.804	0.005	24
08/11/06	4	Chinook	14	15617	87	1658	0.59	0.66	0.08	9.421	0.053	95
08/15/06	7	Chum	26	3580	24	1302	0.21	0.15	0.06	2.750	0.018	188
08/22/06	10	Chum	46	1208	18	1556	0.32	0.08	0.07	0.777	0.011	297
08/25/06	7	Chum	3	434	7	224	0.09	0.02	0.01	1.935	0.032	27
09/01/06	7	Chinook	4	133	27	283	0.06	0.09	0.01	0.470	0.097	48
09/08/06	7	Chum	26	234	39	1539	0.14	0.20	0.18	0.152	0.025	163
09/15/06	4	Chinook	54	1450	1093	4004	0.32	0.52	0.25	0.362	0.273	526
09/22/06	7	Chinook	15	755	708	1273	0.30	0.29	0.04	0.594	0.556	115
09/29/06	7	Chinook	19	563	403	1494	0.34	0.48	0.08	0.377	0.270	204
10/06/06	7	Chinook	33	2097	1058	3094	0.51	0.46	0.15	0.678	0.342	218
10/10/06	3	Chum										
10/13/06	4	Chinook	7	103	772	717	0.13	0.25	0.08	0.143	1.077	74
10/17/06	7	Chinook	56	687	1673	6124	0.44	0.55	0.39	0.112	0.273	432
10/24/06	7	Chinook	18	120	529	1297	0.21	0.35	0.22	0.092	0.408	233

	Information for 5 days before VRHS closure -- Outside the Closure							Information for 5 days after VRHS closure -- Outside the Closure						
Start date	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
06/20/06	131	12750	174	15197	795	0.839	0.011	287	7676	122	28066	1842	0.274	0.004
06/20/06	155	19529	255	17068	1111	1.144	0.015	287	7676	122	28066	1842	0.274	0.004
06/27/06	146	6192	63	11640	972	0.532	0.005	413	43731	409	42243	2216	1.035	0.010
07/04/06	278	15952	128	22761	1601	0.701	0.006	427	8495	96	29758	1980	0.285	0.003
07/07/06	297	13326	113	22098	1649	0.603	0.005	408	11302	115	31358	2019	0.360	0.004
07/07/06	277	13132	129	21373	1592	0.614	0.006	408	11302	115	31358	2019	0.360	0.004
07/11/06	310	9725	101	20595	1603	0.472	0.005	433	7620	61	39639	1970	0.192	0.002
07/11/06	279	7684	79	19083	1304	0.403	0.004	433	7620	61	39639	1970	0.192	0.002
07/14/06	182	8355	76	17400	991	0.480	0.004	402	4703	158	41801	1641	0.113	0.004
07/14/06	194	10629	77	18287	1095	0.581	0.004	402	4703	158	41801	1641	0.113	0.004
07/18/06	124	3321	58	11560	638	0.287	0.005	349	8658	204	38738	1318	0.224	0.005
07/21/06	212	4733	190	26274	847	0.180	0.007	407	17157	135	38496	1556	0.446	0.004
07/25/06	297	11213	111	27894	1101	0.402	0.004	442	15866	106	38648	1858	0.411	0.003
07/28/06	297	12079	94	25731	1223	0.469	0.004	482	27830	155	44826	1847	0.621	0.003
08/01/06	180	15295	100	16390	813	0.933	0.006	467	31027	167	41280	1895	0.752	0.004
08/04/06	219	22155	113	21807	843	1.016	0.005	424	32527	171	41132	1872	0.791	0.004
08/08/06	252	32329	167	27042	1153	1.196	0.006	483	23210	93	45685	2088	0.508	0.002
08/11/06	203	11058	45	19169	1019	0.577	0.002	423	24400	187	38496	1873	0.634	0.005
08/15/06	217	13250	129	20041	1016	0.661	0.006	478	8190	144	42389	1965	0.193	0.003
08/22/06	212	2574	197	20158	892	0.128	0.010	507	5230	401	37051	2197	0.141	0.011
08/25/06	207	4434	299	15701	1090	0.282	0.019	433	3413	410	35821	2219	0.095	0.011
09/01/06	331	2218	287	19135	1693	0.116	0.015	423	2381	337	25796	2132	0.092	0.013
09/08/06	135	1451	159	7061	750	0.205	0.022	307	5428	2483	32006	1765	0.170	0.078
09/15/06	115	3061	1001	12177	540	0.251	0.082	351	2598	2038	35179	1750	0.074	0.058
09/22/06	266	1726	1692	28552	1252	0.060	0.059	350	2184	1029	29964	1562	0.073	0.034
09/29/06	174	1087	431	16145	825	0.067	0.027	253	4208	1954	27455	1476	0.153	0.071
10/06/06	174	2038	1262	16987	1105	0.120	0.074	222	1167	2437	13633	1465	0.086	0.179
10/10/06	145	1245	1023	10658	1078	0.117	0.096	281	1176	4063	14653	1786	0.080	0.277
10/13/06	158	668	2279	7968	967	0.084	0.286	228	1389	2525	16321	1564	0.085	0.155
10/17/06	151	868	1356	9399	1016	0.092	0.144	222	1121	2648	13724	2025	0.082	0.193
10/24/06	78	449	992	4726	763	0.095	0.210	110	185	984	4125	827	0.045	0.239

			Information for 5 days before VRHS closure -- Inside the Closure									
Start date	Days closed	Closure type	Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
07/06/07	7	Chum	26	401	13	1785	0.18	0.18	0.07	0.225	0.007	113
07/10/07	3	Chinook										
07/17/07	3	Chum	9	73	3	621	0.12	0.06	0.03	0.118	0.004	44
07/20/07	11	Chum										
07/24/07	7	Chum	22	97	0	1908	0.07	0.00	0.10	0.051	0.000	70
07/31/07	7	Chum	28	363	0	1648	0.16	0.00	0.09	0.220	0.000	92
08/03/07	4	Chum	10	352	13	648	0.11	0.14	0.04	0.543	0.019	94
08/07/07	3	Chum	9	240	5	418	0.11	0.12	0.06	0.575	0.013	59
08/10/07	7	Chum	36	455	4	1402	0.23	0.07	0.16	0.324	0.003	276
08/21/07	3	Chum	30	1024	28	3161	0.11	0.07	0.11	0.324	0.009	237
08/17/07	7	Chum	66	1385	216	6850	0.42	0.47	0.20	0.202	0.032	215
08/21/07	3	Chum	7	2884	33	367	0.31	0.09	0.01	7.860	0.089	36
08/21/07	7	Chum	20	1727	45	1314	0.18	0.12	0.05	1.314	0.034	85
08/21/07	7	Chum	11	4349	54	641	0.46	0.14	0.02	6.782	0.084	52
08/17/07	4	Chum	52	571	0	4468	0.17	0.00	0.13	0.128	0.000	416
08/28/07	3	Chinook	13	662	49	844	0.09	0.08	0.04	0.784	0.058	115
08/31/07	4	Chinook	9	209	22	400	0.04	0.03	0.02	0.522	0.055	72
08/31/07	4	Chum	10	379	23	970	0.07	0.03	0.06	0.391	0.023	57
09/04/07	3	Chinook	48	1100	334	3797	0.18	0.29	0.22	0.290	0.088	201
09/04/07	7	Chum	5	76	17	95	0.01	0.01	0.01	0.799	0.176	33
09/11/07	7	Chum	14	57	37	504	0.01	0.02	0.03	0.114	0.074	114
09/11/07	3	Chinook	16	1241	701	1628	0.19	0.45	0.10	0.762	0.430	137
09/14/07	4	Chinook	7	26	76	581	0.00	0.02	0.04	0.045	0.131	28
09/21/07	7	Chinook	51	789	817	2808	0.59	0.66	0.53	0.281	0.291	512
09/25/07	10	Chinook	16	163	229	559	0.14	0.21	0.05	0.291	0.409	177
09/25/07	10	Chinook	28	117	57	753	0.10	0.05	0.07	0.155	0.076	149
10/05/07	4	Chinook	8	13	68	584	0.02	0.01	0.02	0.034	0.176	55
10/09/07	3	Chinook	3	21	163	177	0.03	0.05	0.02	0.116	0.917	20
10/09/07	3	Chinook										
10/12/07	7	Chinook	51	131	3121	3446	0.20	0.44	0.26	0.038	0.906	581
10/12/07	7	Chinook	11	75	170	810	0.11	0.02	0.06	0.093	0.210	108
10/19/07	14	Chinook	23	38	1260	1545	0.04	0.23	0.07	0.024	0.816	198
10/23/07	3	Chinook	58	82	542	2501	0.14	0.10	0.13	0.033	0.217	285

	Information for 5 days before VRHS closure -- Outside the Closure							Information for 5 days after VRHS closure -- Outside the Closure						
Start date	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
07/06/07	285	1834	56	24991	1123	0.073	0.002	396	411	28	38600	1553	0.011	0.001
07/10/07	208	568	32	18975	827	0.030	0.002	364	469	61	37935	1751	0.012	0.002
07/17/07	174	541	48	18029	794	0.030	0.003	394	1887	58	35330	1622	0.053	0.002
07/20/07	278	1634	48	24033	1093	0.068	0.002	401	1230	43	32956	1752	0.037	0.001
07/24/07	226	1246	35	16925	925	0.074	0.002	364	1530	36	28596	1834	0.054	0.001
07/31/07	268	1908	46	17281	1618	0.110	0.003	492	3078	60	49116	2300	0.063	0.001
08/03/07	223	2965	74	14379	1453	0.206	0.005	452	2480	39	33520	1965	0.074	0.001
08/07/07	128	2025	39	6132	821	0.330	0.006	394	1692	93	30932	2079	0.055	0.003
08/10/07	93	1491	51	7617	531	0.196	0.007	457	3315	422	42462	2238	0.078	0.010
08/21/07	280	8412	351	24660	1163	0.341	0.014	428	10263	692	38057	2277	0.270	0.018
08/17/07	278	1901	244	28162	1379	0.068	0.009	347	10538	405	33476	1484	0.315	0.012
08/21/07	303	6552	346	27454	1364	0.239	0.013	428	10263	692	38057	2277	0.270	0.018
08/21/07	290	7709	334	26507	1315	0.291	0.013	428	10263	692	38057	2277	0.270	0.018
08/21/07	299	5087	325	27179	1348	0.187	0.012	428	10263	692	38057	2277	0.270	0.018
08/17/07	292	2715	460	30545	1178	0.089	0.015	347	10538	405	33476	1484	0.315	0.012
08/28/07	221	6469	529	18454	1171	0.351	0.029	402	9677	1351	27311	2506	0.354	0.049
08/31/07	212	4880	671	15667	1234	0.312	0.043	409	9288	1398	29406	2534	0.316	0.048
08/31/07	211	4710	671	15098	1248	0.312	0.044	409	9288	1398	29406	2534	0.316	0.048
09/04/07	196	5054	824	13086	1299	0.386	0.063	416	9276	1380	27112	2562	0.342	0.051
09/04/07	239	6079	1141	16788	1468	0.362	0.068	416	9276	1380	27112	2562	0.342	0.051
09/11/07	256	6358	1522	16329	1893	0.389	0.093	370	8302	4461	22891	2597	0.363	0.195
09/11/07	254	5174	858	15205	1870	0.340	0.056	370	8302	4461	22891	2597	0.363	0.195
09/14/07	206	8485	3930	13274	1666	0.639	0.296	308	2520	1823	17011	2147	0.148	0.107
09/21/07	70	543	414	2513	482	0.216	0.165	336	1394	1068	13775	2599	0.101	0.077
09/25/07	257	985	845	9801	1979	0.101	0.086	229	2228	1999	10029	1890	0.222	0.199
09/25/07	245	1031	1017	9608	2007	0.107	0.106	229	2228	1999	10029	1890	0.222	0.199
10/05/07	161	783	4777	15239	1300	0.051	0.313	294	829	4739	14211	2384	0.058	0.333
10/09/07	187	574	3336	10274	1490	0.056	0.325	301	828	7019	15844	2893	0.052	0.443
10/09/07	190	594	3499	10451	1510	0.057	0.335	301	828	7019	15844	2893	0.052	0.443
10/12/07	187	530	4014	9803	1761	0.054	0.409	303	922	4416	17448	2535	0.053	0.253
10/12/07	227	586	6965	12439	2233	0.047	0.560	303	922	4416	17448	2535	0.053	0.253
10/19/07	264	869	4105	19952	2054	0.044	0.206	294	581	6119	16945	2144	0.034	0.361
10/23/07	248	515	5150	16134	1940	0.032	0.319	263	327	4903	11733	2003	0.028	0.418

Start date	Days closed	Closure type	Information for 5 days before VRHS closure -- Inside the Closure									
			Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
07/04/08	14	Chum										
07/11/08	7	Chum	20	314	3	1665	0.48	0.23	0.14	0.188	0.002	114
07/18/08	14	Chum	26	614	11	2350	0.72	0.77	0.30	0.261	0.005	194
08/01/08	11	Chum	3	216	0	188	0.45	0.00	0.05	1.152	0.000	22
08/15/08	7	Chum	3	4	0	218	0.01	0.00	0.01	0.019	0.000	14
08/29/08	7	Chum	14	419	7	636	0.47	0.12	0.05	0.658	0.011	102
09/09/08	7	Chum	6	40	5	151	0.03	0.02	0.02	0.268	0.034	56
09/16/08	10	Chinook	75	294	105	1323	0.50	0.51	0.27	0.222	0.079	696
09/26/08	4	Chinook										
10/03/08	7	Chum	15	21	21	372	0.05	0.07	0.12	0.056	0.055	191
10/10/08	7	Chinook	8	28	92	397	0.16	0.35	0.18	0.071	0.231	73
10/17/08	7	Chinook	57	80	925	4811	0.67	0.80	0.85	0.017	0.192	654
10/24/08	8	Chinook	7	4	174	181	1.00	1.00	0.98	0.025	0.962	107
06/29/09	4	Chum	36	274	6	2613	0.14	0.01	0.11	0.105	0.002	204
07/03/09	4	Chum	85	1053	46	5872	0.68	0.57	0.26	0.179	0.008	632
07/03/09	7	Chum	5	8	1	279	0.01	0.01	0.01	0.029	0.003	33
07/07/09	3	Chum	16	248	27	1166	0.10	0.33	0.05	0.212	0.023	72
07/10/09	4	Chum	10	605	5	547	0.20	0.12	0.03	1.105	0.010	73
07/14/09	7	Chum	40	1235	7	2059	0.61	0.30	0.10	0.600	0.004	417
07/28/09	7	Chum	13	2361	48	946	0.61	0.57	0.04	2.495	0.051	126
08/14/09	21	Chum	4	0	0	523	0.00	0.00	0.06	0.000	0.000	33
08/21/09	7	Chum	4	359	5	178	0.26	0.15	0.01	2.018	0.027	28
08/28/09	7	Chum	25	1065	22	2072	0.33	0.17	0.17	0.514	0.011	140
09/04/09	7	Chum	7	0	0	0	0.00	0.00	0.00			58
09/08/09	7	Chinook	22	11	67	1412	0.00	0.25	0.18	0.008	0.047	117
09/11/09	4	Chinook	21	2632	97	1756	0.92	0.70	0.31	1.499	0.055	204
09/18/09	7	Chinook	20	941	129	1830	0.81	0.54	0.48	0.514	0.071	180
09/25/09	4	Chinook										
09/29/09	3	Chinook										
10/02/09	7	Chinook										
10/09/09	4	Chinook	3	0	0	945	0.00	0.00	0.37	0.000	0.000	28

	Information for 5 days before VRHS closure -- Outside the Closure							Information for 5 days after VRHS closure -- Outside the Closure						
Start date	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
07/04/08	191	81	3	14325	861	0.006	0.000	384	337	8	26233	2105	0.013	0.000
07/11/08	157	346	9	10089	924	0.034	0.001	306	592	18	25356	1644	0.023	0.001
07/18/08	89	243	3	5569	491	0.044	0.001	367	404	133	32274	2065	0.013	0.004
08/01/08	58	260	6	3401	357	0.076	0.002	335	304	27	24908	2026	0.012	0.001
08/15/08	236	577	13	16663	1388	0.035	0.001	444	895	46	28833	2741	0.031	0.002
08/29/08	200	467	50	11196	1441	0.042	0.004	379	757	83	23884	2870	0.032	0.003
09/09/08	158	1392	283	7516	1379	0.185	0.038	306	1055	275	12746	2438	0.083	0.022
09/16/08	91	289	99	3664	643	0.079	0.027	354	291	49	27380	1750	0.011	0.002
09/26/08	43	396	168	2839	332	0.139	0.059	176	285	166	7085	1529	0.040	0.023
10/03/08	75	398	285	2797	793	0.142	0.102	190	329	344	6781	1595	0.048	0.051
10/10/08	87	144	169	1843	640	0.078	0.092	130	150	763	5853	1231	0.026	0.130
10/17/08	43	40	225	881	281	0.045	0.255	121	30	508	5126	1132	0.006	0.099
10/24/08	6	0	0	3	29	0.000	0.000	41	5	155	1784	346	0.003	0.087
06/29/09	253	1725	670	21258	1559	0.081	0.032	407	1671	90	27203	2367	0.061	0.003
07/03/09	230	484	35	16410	1286	0.030	0.002	321	2758	63	21093	1765	0.131	0.003
07/03/09	310	1529	80	22002	1885	0.069	0.004	321	2758	63	21093	1765	0.131	0.003
07/07/09	296	2120	54	20285	1626	0.105	0.003	394	2991	50	23259	2353	0.129	0.002
07/10/09	284	2353	39	17514	1694	0.134	0.002	384	1949	21	27826	2154	0.070	0.001
07/14/09	232	800	18	17704	1192	0.045	0.001	343	987	17	29253	1883	0.034	0.001
07/28/09	238	1514	37	24621	974	0.061	0.001	337	9552	33	32140	1548	0.297	0.001
08/14/09	118	986	10	8751	706	0.113	0.001	227	2129	43	21344	1150	0.100	0.002
08/21/09	130	1035	26	12112	712	0.085	0.002	246	4088	124	19717	1324	0.207	0.006
08/28/09	130	2134	111	9881	730	0.216	0.011	176	781	61	11243	975	0.069	0.005
09/04/09	75	773	77	5068	482	0.153	0.015	174	4621	249	11321	1023	0.408	0.022
09/08/09	100	4696	195	6618	660	0.710	0.030	147	676	116	9704	832	0.070	0.012
09/11/09	61	227	41	3840	354	0.059	0.011	137	928	193	9366	813	0.099	0.021
09/18/09	35	218	109	1982	244	0.110	0.055	105	1718	203	9546	653	0.180	0.021
09/25/09	65	1172	63	5501	399	0.213	0.011	89	426	169	3949	442	0.108	0.043
09/29/09	57	289	159	2613	302	0.111	0.061	120	288	51	2928	573	0.098	0.017
10/02/09	103	417	142	1909	505	0.219	0.075	58	34	33	3078	302	0.011	0.011
10/09/09	22	18	37	1604	130	0.011	0.023	1	*	*	*	*	*	*

Preliminary results on chum salmon bycatch analyses

Goals

1. Provide Council with estimates of chum bycatch impacts on salmon runs

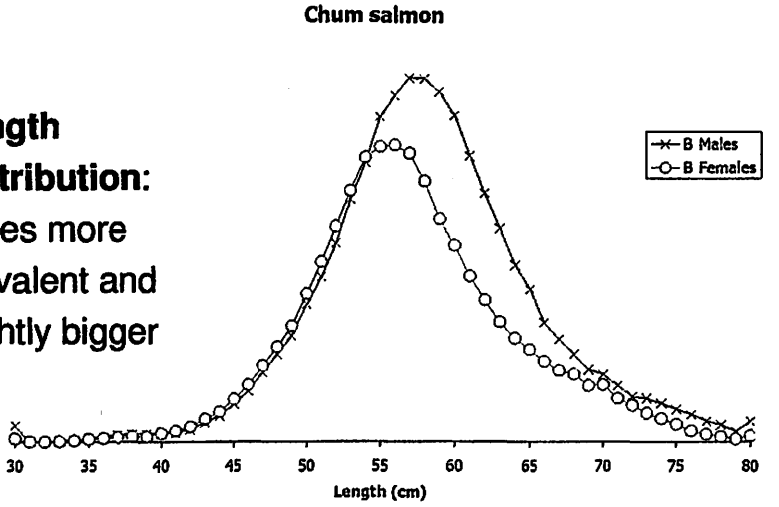
2. Evaluate alternative management options intended to reduce these impacts

Outline

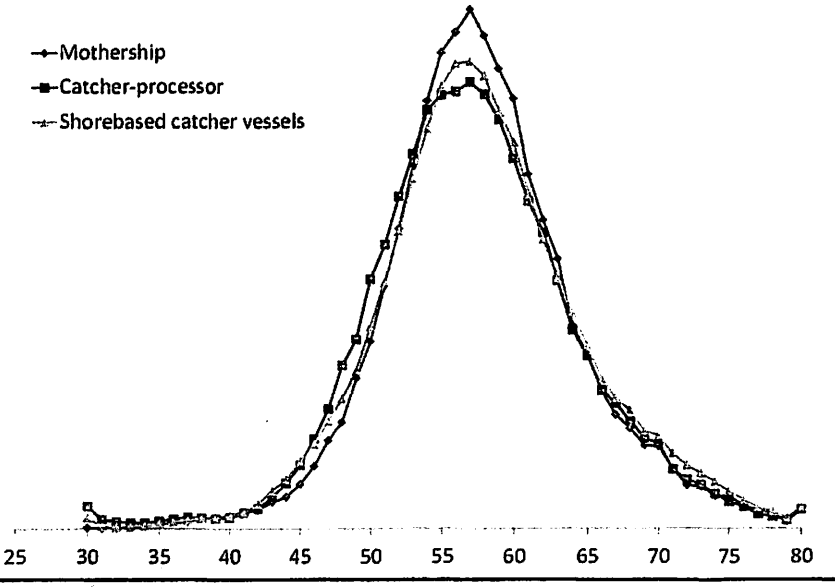
- Adult equivalent model
  - correct for lagged impact of bycatch
- Application of stock composition estimates
  - Assess origins of bycatch
- Trigger closures
  - Analysis of Alternative 3

Biological characteristics of chum salmon bycatch

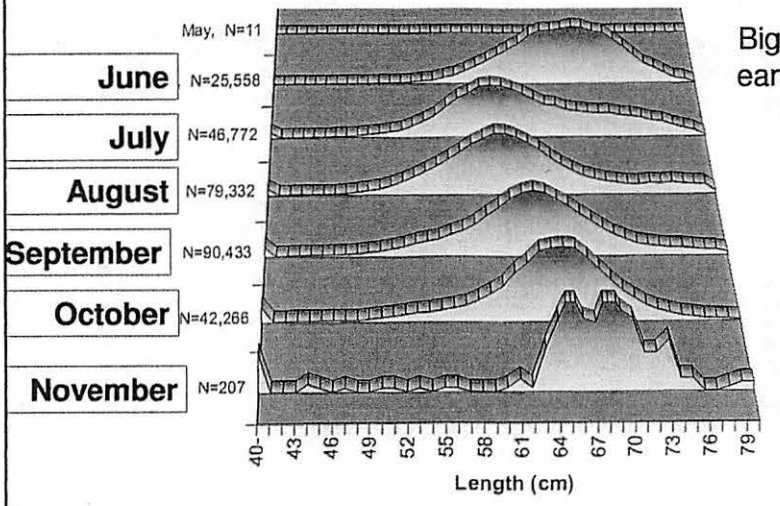
Length Distribution: Males more prevalent and slightly bigger



Sector-differences in size

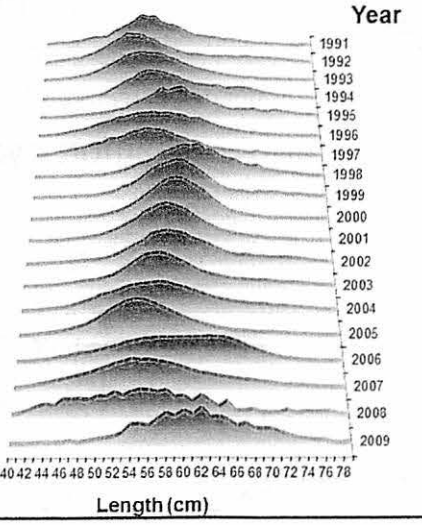


Length of chum by month



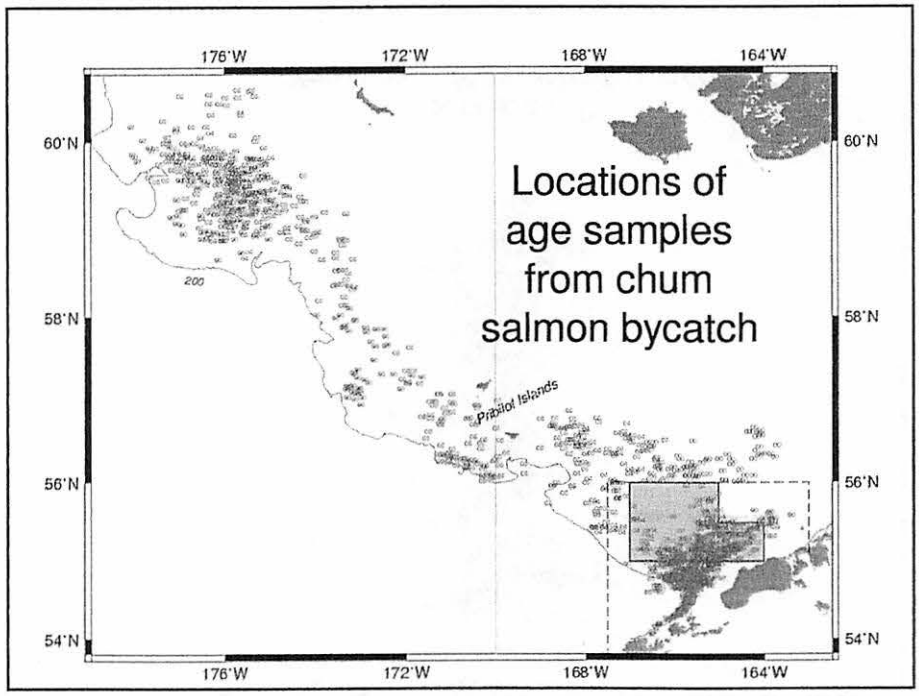
Bigger fish earlier in B season

Chum bycatch length frequency (proportions)



Number of observer length sampling by areas/seasons

	June-July			Aug-Oct			Other months			Total
	E	W	Total	E	W	Total	E	W	Total	
1991	646	128	774	1,622	375	1,997	40	3	43	2,814
1992	1,339	565	1,904	6,921	2	6,923	163	1	164	8,991
1993	870	7	877	23,508	599	24,107	68	3	71	25,055
1994	773	36	809	12,552	1,734	14,286	81	3	84	15,179
1995	7	1	8	5,517	65	5,582	37	1	38	5,628
1996	407		407	14,593	2,735	17,328	45	1	46	17,781
1997	1		1	10,923	5,821	16,744	745	12	757	17,502
1998	59		59	8,684	404	9,088	453	20	473	9,620
1999	12	1	13	13,269	387	13,656	39	3	42	13,711
2000	1,872	46	1,918	14,391	1,199	15,590	108	4	112	17,620
2001	1,302	714	2,016	12,774	2,675	15,449	914	81	995	18,460
2002	1,556	591	2,147	23,597	954	24,551	169	6	175	26,873
2003	6,909	828	7,737	47,147	7,673	54,820	1,391	84	1,475	64,032
2004	10,117	8,369	18,486	31,925	13,926	45,851	250	97	347	64,684
2005	19,905	2,871	22,776	20,871	30,284	51,155	153	137	290	74,221
2006	19,175	2,228	21,403	18,119	7,714	25,833	628	22	650	47,886
2007	2,147	2,154	4,301	15,444	10,615	26,059	3,771	43	3,814	34,174
2008	85	131	216	79	725	804	84	9	93	1,113
2009	284	879	1,163	98	1,076	1,174		1	1	2,338
2010	82	865	947	44	500	544	2	5	7	1,498
Total	67,548	20,414	87,962	282,078	89,463	371,541	9,141	536	9,677	469,180



Number of observer-collected ages data by areas/seasons

	June-July			Aug-Oct			Total
	E	W	Total	E	W	Total	
1988	0	0	0	204	0	204	204
1989	0	0	0	94	59	153	153
1990	103	0	103	281	41	322	425
1997	0	0	0	163	53	216	216
1998	0	0	0	92	69	161	161
1999	0	0	0	115	0	115	115
2000	0	0	0	122	0	122	122
2001	89	0	89	135	0	135	224
2002	67	0	67	144	0	144	211
2003	125	0	125	0	0	0	125
2004	224	0	224	103	62	165	389
2005	591	55	646	265	763	1,028	1,674
2006	202	65	267	280	483	763	1,030
2007	34	138	172	274	569	843	1,015
2008	106	41	147	151	213	364	511
2009	304	128	432	216	375	591	1,023
Total	1,845	427	2,272	2,639	2,687	5,326	7,598

Chum bycatch proportions vary spatially and within season

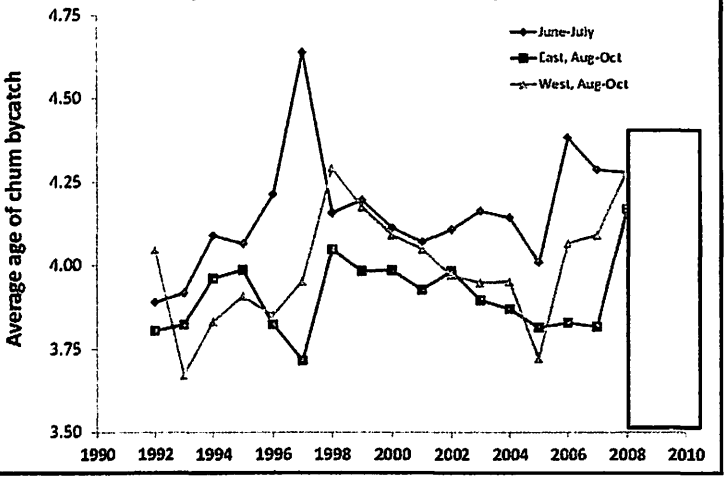
Table 3-6. Chum salmon caught by area and season strata (top section) used for converting length frequency data to age composition data. Also shown are estimates of pollock catch (bottom section). Note that these totals differ slightly from the actual total values due to minor spatio-temporal mapping discrepancies.

Year	June-July	E Aug-Oct	W Aug-Oct	Total	June-July	E Aug-Oct	W Aug-Oct
			Chum (numbers)				
1991	4,817	19,801	2,796	27,414	18%	72%	10%
1992	8,781	30,330	34	39,145	22%	77%	0%
1993	4,550	229,180	7,142	240,872	2%	95%	3%
1994	5,971	75,239	7,930	89,140	7%	84%	9%
1995	122	18,329	418	18,870	1%	97%	2%
1996	893	45,707	31,058	77,659	1%	59%	40%
1997	319	31,503	32,452	64,274	0%	49%	50%
1998	102	44,895	2,217	47,214	0%	95%	5%
1999	470	44,438	874	45,783	1%	97%	2%
2000	10,229	44,502	2,286	57,017	18%	78%	4%
2001	6,371	36,578	10,105	53,055	12%	69%	19%
2002	3,712	71,096	2,067	76,875	5%	92%	3%
2003	14,843	142,319	18,986	176,147	8%	81%	11%
2004	48,540	345,507	44,780	438,827	11%	79%	10%
2005	238,338	304,078	128,740	671,156	36%	45%	19%
2006	177,663	90,507	34,898	303,068	59%	30%	12%
2007	13,352	31,901	39,841	85,094	16%	37%	47%
2008	5,544	6,513	2,514	14,571	38%	45%	17%
2009	23,890	16,879	4,576	45,346	53%	37%	10%
2010	8,284	2,869	1,946	13,099	63%	22%	15%

Average age of bycatch by strata

- Based on observer lengths and global ALK
  (for years when age data unavailable)

Mainly age 4 chum, older earlier in season



Adult equivalent estimation key requirements

- Age composition of chum in bycatch
- Maturity estimates in ocean
  - Function of ocean mortality and in-river maturity

Chum maturity rates in Alaska rivers

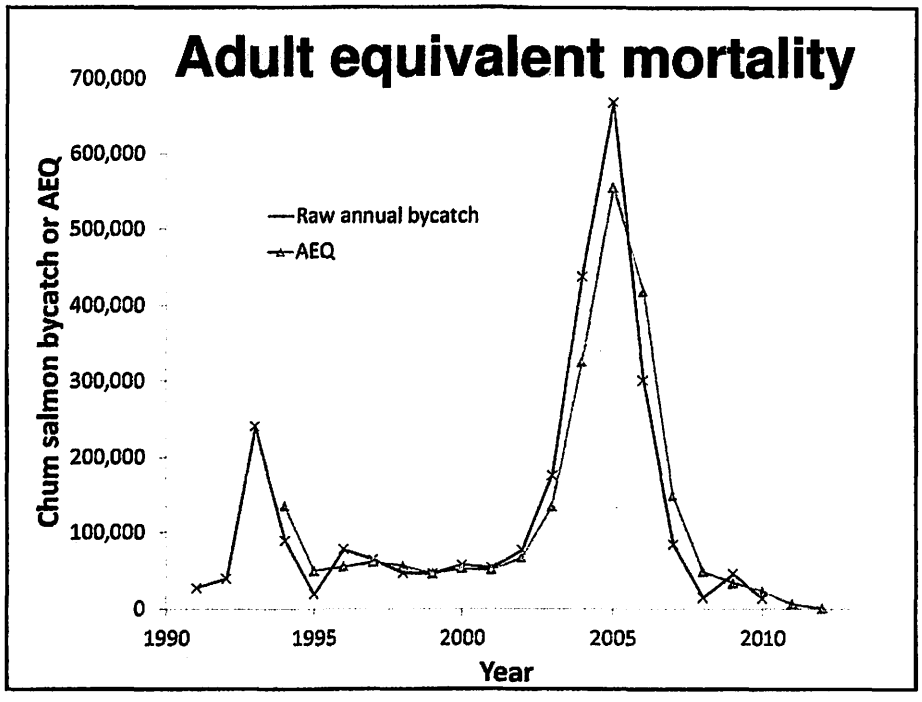
Table 3-8. In-river maturity-at-age distribution of chum salmon by district. Note that the column "assumed average run" was used for computing a weighted mean maturity rate for chum salmon. *Source: Dani Eveson, ADFG pers. comm. 2010.*

Area	Approx size	Assumed Average run	Age-specific in-river maturity 3	4	5	6	7
Kotzebue	>200k	250,000	5.0%	52.4%	38.1%	4.4%	0.1%
Pilgrim	<100k	75,000	3.1%	51.1%	39.6%	6.0%	0.2%
NS Subdistrict 1 (Nome)	<100k	75,000	2.3%	52.9%	41.6%	3.2%	0.0%
NS Subdistrict 2 (Niukluk)	<100k	75,000	7.0%	49.4%	40.5%	3.1%	0.0%
NS Subdistrict 3 (Kwiniuk)	<100k	75,000	7.0%	49.4%	40.5%	3.1%	0.0%
NS Subdistrict 5 (Shaktoolik)	<100k	75,000	6.4%	46.3%	43.7%	4.5%	0.0%
NS Subdistrict 6 (Unalakleet)	<100k	75,000	2.3%	47.3%	47.3%	3.2%	0.1%
Yukon River summer	>500k	600,000	1.4%	52.9%	42.7%	3.1%	0.0%
Yukon River fall	>300k	350,000	3.8%	67.8%	27.5%	0.9%	0.0%
Kuskokwim	1,500,000	1,500,000	2.0%	65.0%	32.0%	1.0%	0.0%
District 4 (Quinhagak)	150,000	150,000	2.0%	60.0%	37.0%	2.0%	0.0%
District 5 (Goodnews Bay)	100,000	100,000	1.0%	51.0%	47.0%	1.0%	0.0%
Weighted average		3,400,000	2.6%	59.5%	35.9%	2.0%	0.0%
Simple mean			3.6%	53.8%	39.8%	2.9%	0.0%

Estimates of chum bycatch impact on returning salmon

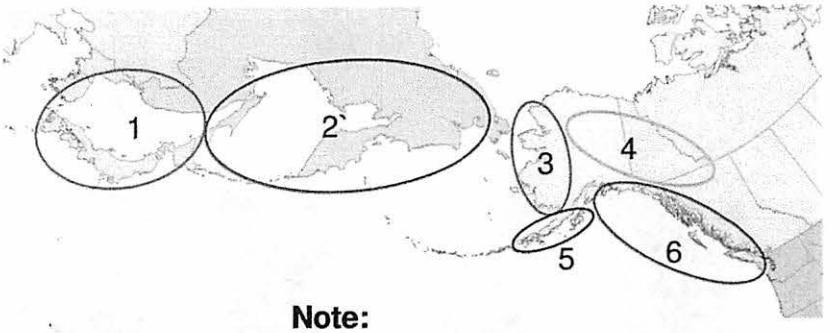
Table 3-10. Estimated chum bycatch by year, their age-equivalent removals to mature returning salmon (AEQ) and removals by chum salmon brood year (last two columns).

Bycatch year	Annual bycatch	AEQ	Brood year	Estimated bycatch
1991	26,736	15,958	1988	54,817
1992	38,923	30,427	1989	158,818
1993	239,613	153,021	1990	117,300
1994	88,842	129,753	1991	37,788
1995	18,775	46,715	1992	55,229
1996	75,512	53,947	1993	58,314
1997	62,571	59,266	1994	53,125
1998	46,431	53,945	1995	44,991
1999	45,534	44,654	1996	52,469
2000	56,754	51,204	1997	53,823
2001	52,356	49,754	1998	85,298
2002	76,468	65,714	1999	181,345
2003	173,680	132,441	2000	368,851
2004	435,273	320,923	2001	605,280
2005	652,920	543,645	2002	274,052
2006	301,209	404,106	2003	91,338
2007	83,761	141,135	2004	35,156
2008	14,402	43,440	2005	25,851
2009	43,648	31,911	2006	18,954
2010	12,922	22,114		
2011		*5,885*		
2012		*632*		



Stock origin of chum salmon AEQ bycatch

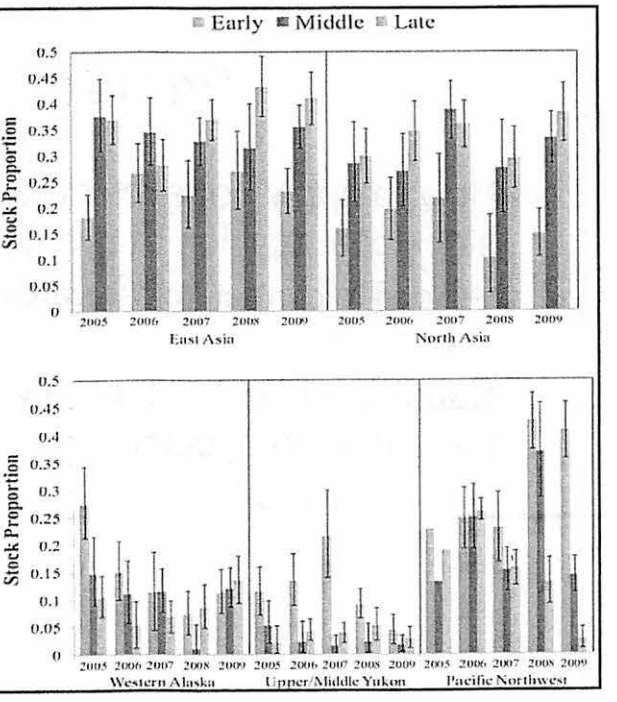
Broad areas for stock ID resolution

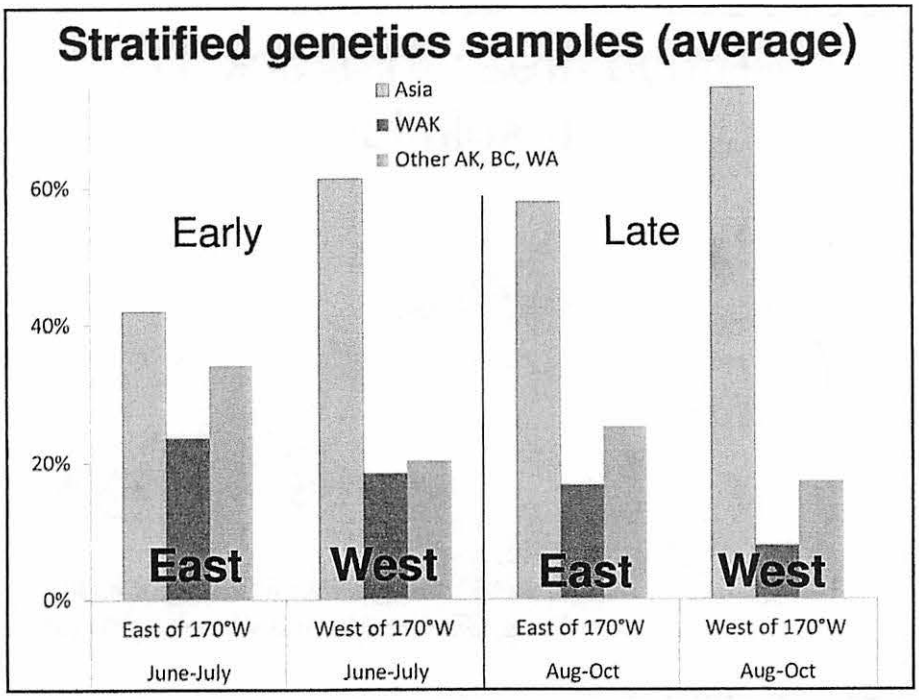


Note:
Area "6" named "Pacific NW" but includes PWS, SE AK, BC, and Washington state.

Auke Bay Lab studies

Chum salmon genetics analysis by season





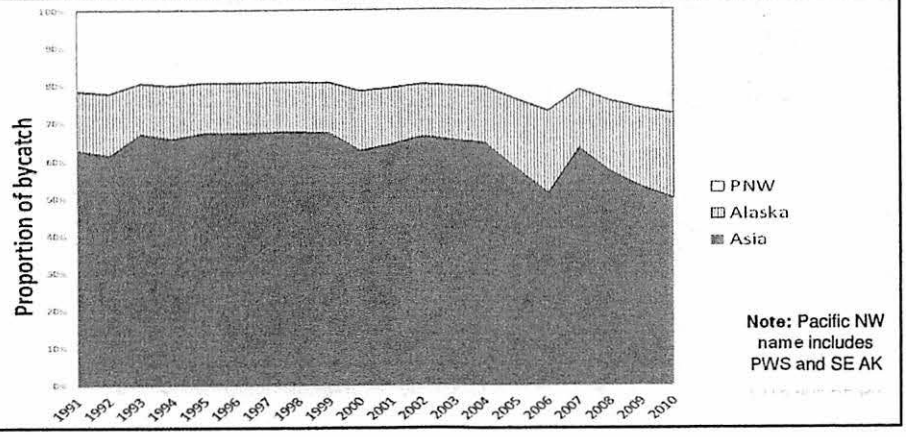
Problem

- How to apply genetics data to estimate stock composition of bycatch?
  - Need to correct from ***sample*** composition to *bycatch*
- Samples collected typically out of proportion to bycatch
  - In space and time

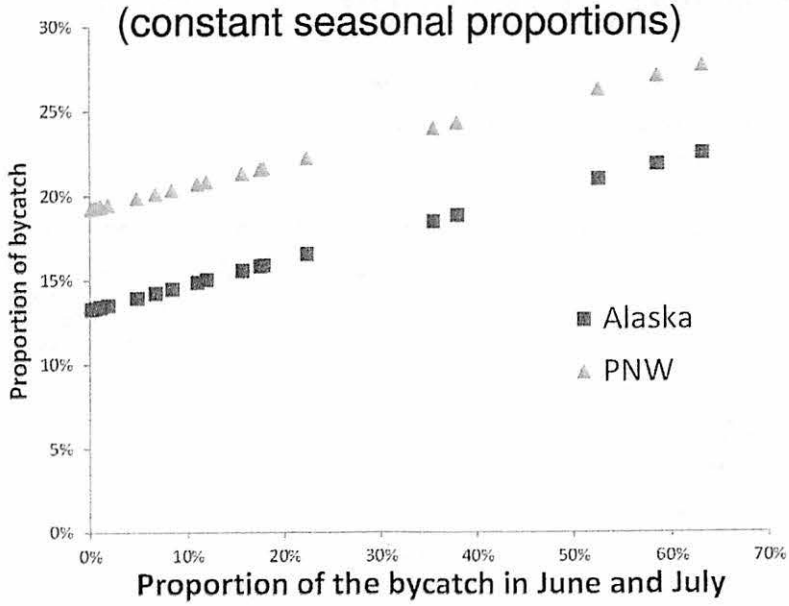
Bycatch stock composition
(constant seasonal proportions)

Table 3-1. Average percentage breakouts by aggregated regions and periods based on bycatch samples from 2005-2009. *Source: Combined data presented in Gray et al. 2010 (*Figure 3-1).

	Asia	Alaska	Pacific NW
Jun-July	39%	28%	33%
July-Aug	65%	13%	22%
Aug-Oct	71%	13%	16%



Bycatch stock composition
(constant seasonal proportions)



Refinements of regional stock ID

- Genetics only to coarse regions
- How to break out on a finer scale for WAK?
  - Important for impact specific rivers/systems

Regional breakouts of WAK chum

- Based on coarse run-size estimates
- Reasonable? (request to SSC)
  note: subdistrict 4 missing

Table 3-2. Annual percentage distribution of chum bycatch by year and the averages used for monthly breakouts based on 2003-2010 data.

	Approximate percentages by run size		
Stock or stock grouping		Area	
Kotzebue	7%	Kotzebue	7%
Pilgrim	2%	Port Clarence	2%
Subdistrict 1 (Nome)	2%		
Subdistrict 2 (Niukluk)	2%		
Subdistrict 3 (Kwiniuk)	2%	Norton Sound	11%
Subdistrict 5 (Shaktoolik)	2%		
Subdistrict 6 (Unalakleet)	2%		
Yukon River summer	18%	Yukon	28%
Yukon River fall	10%		
Kuskokwim	44%		
District 4 (Quinhagak)	4%	Kuskokwim	51%
District 5 (Goodnews Bay)	3%		

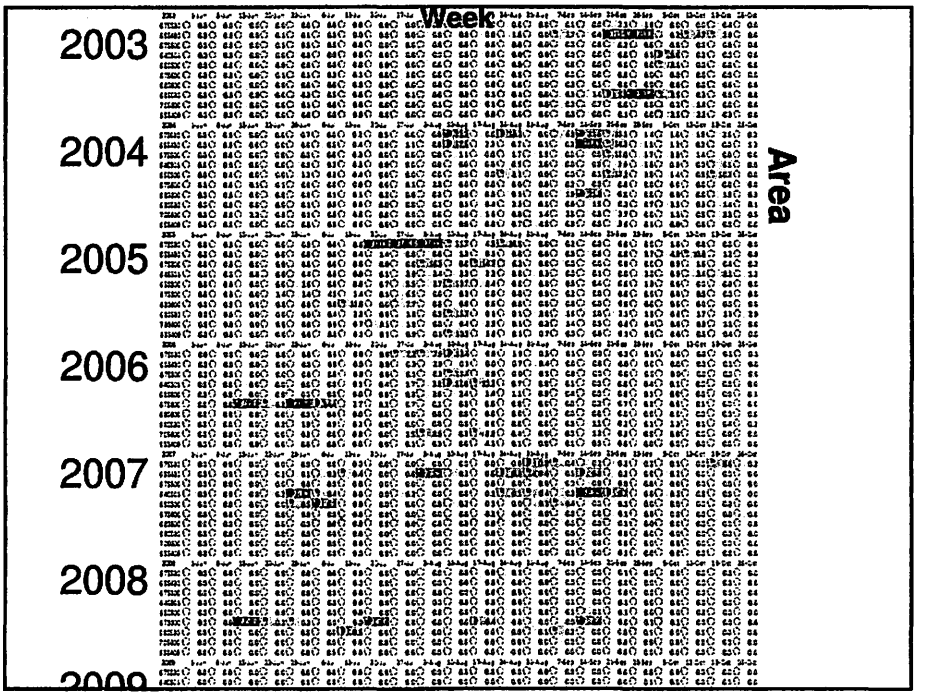
Stock composition estimation refinements

- Use uncertainty estimates from genetics studies (covariance matrices)
  - Estimate bycatch totals and test for
    - Year
    - Month
    - Area
    - Chum length
- Run size estimates
- Provide a more complete presentation of uncertainty

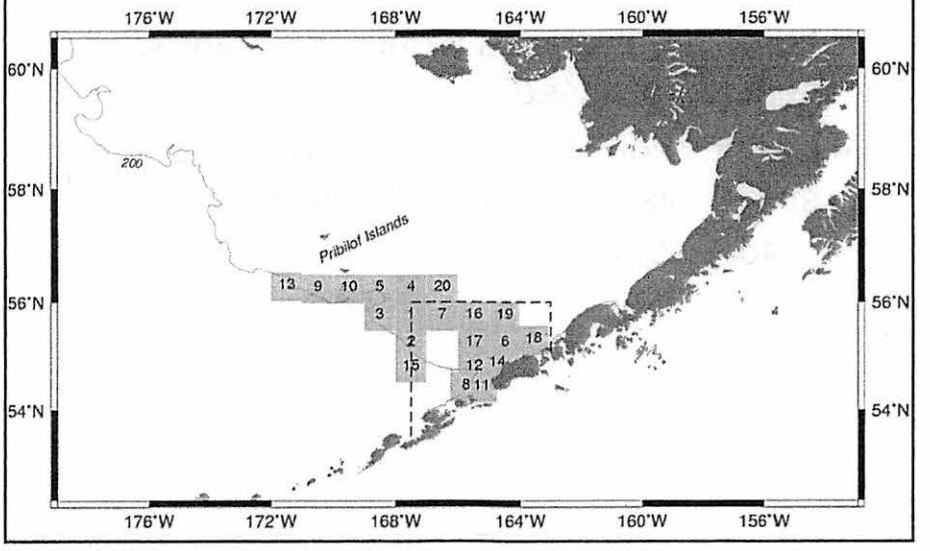
Triggered closures

Area Closure development

- Past developments
  - Revised criteria for electing area for a triggered closure
    - Include consideration of ADFG areas where chum bycatch was high **and** pollock catch relatively low
  - Triggers applied on a monthly schedule

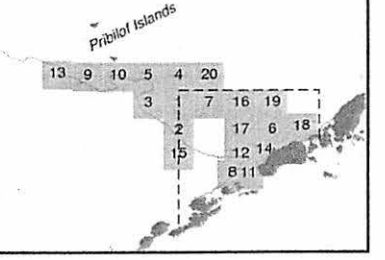


Top 20 areas



Ranking	Stat Area	Cumulative percent	Ranking	Stat Area	Cumulative percent
1	675530	16%	11	655410	62%
2	675500	25%	12	655430	71%
3	685530	30%	13	715600	72%
4	675600	35%	14	645434	72%
5	685600	40%	15	675430	73%
6	645501	47%	16	655530	74%
7	665530	50%	17	655500	78%
8	655409	55%	18	635504	79%
9	705600	59%	19	645530	79%
10	695600	61%	20	665600	80%

Top 20 areas



- If triggered within a month, what areas should be closed?
- Council selected closure areas based on similar historical bycatch levels
  - 40%, 50%, and 60%

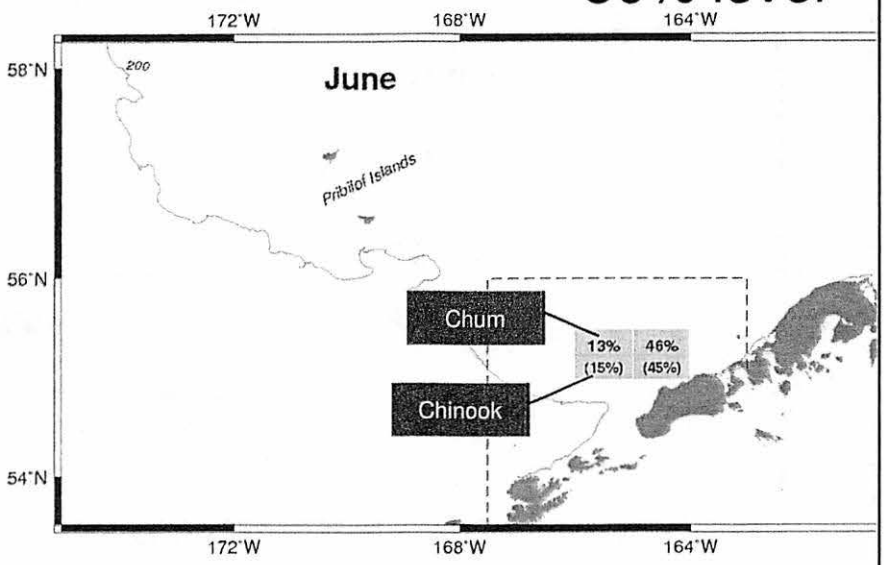
Example with 50% level ranked stat areas (rows)

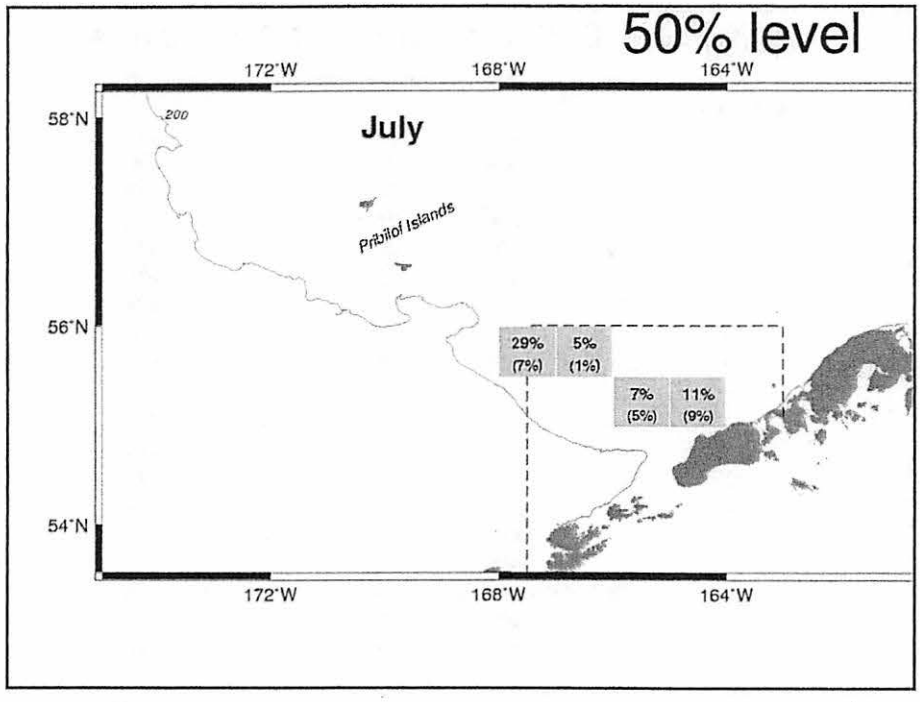
Overall Rank	June	July	August	September	October
1	46%	29%	20%	20%	18%
2	59%	40%	28%	31%	40%
3	70%	45%	35%	36%	49%
4	73%	52%	40%	46%	55%
5	76%	57%	55%	50%	59%
6	76%	61%	59%	54%	63%
7	79%	63%	63%	56%	65%
8	80%	66%	67%	57%	67%
9	80%	70%	71%	59%	69%
10	81%	76%	73%	61%	74%
11	81%	78%	74%	61%	74%
12	81%	79%	75%	61%	74%
13	81%	80%	76%	62%	74%
14	81%	81%	76%	66%	74%
15	81%	81%	77%	66%	83%
16	81%	82%	77%	66%	83%
17	84%	84%	77%	66%	87%
18	84%	85%	77%	69%	87%
19	86%	85%	77%	70%	88%
20	86%	85%	77%	74%	91%

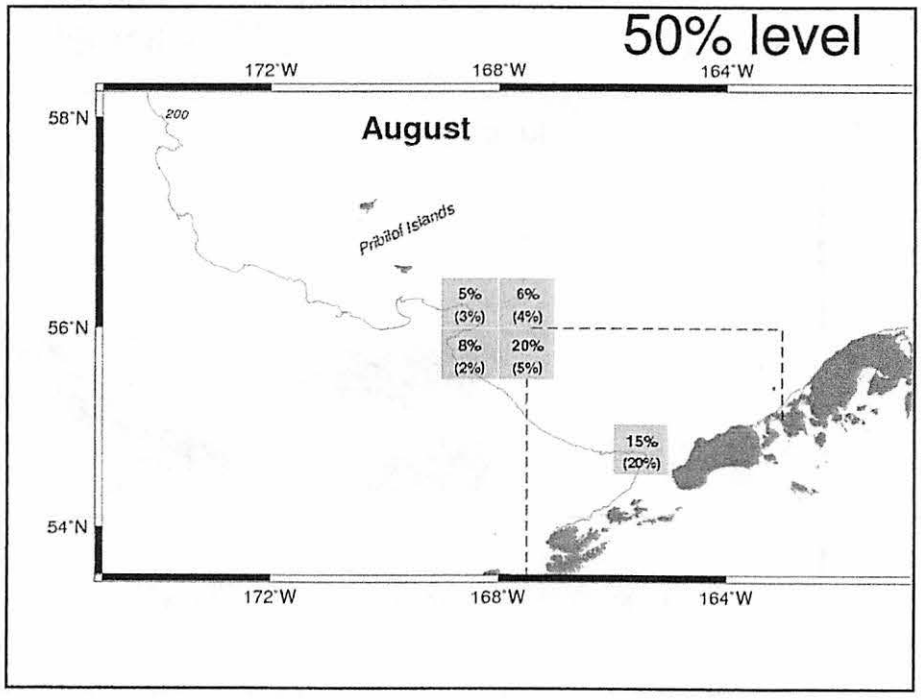
Example with 60% level ranked stat areas (rows)

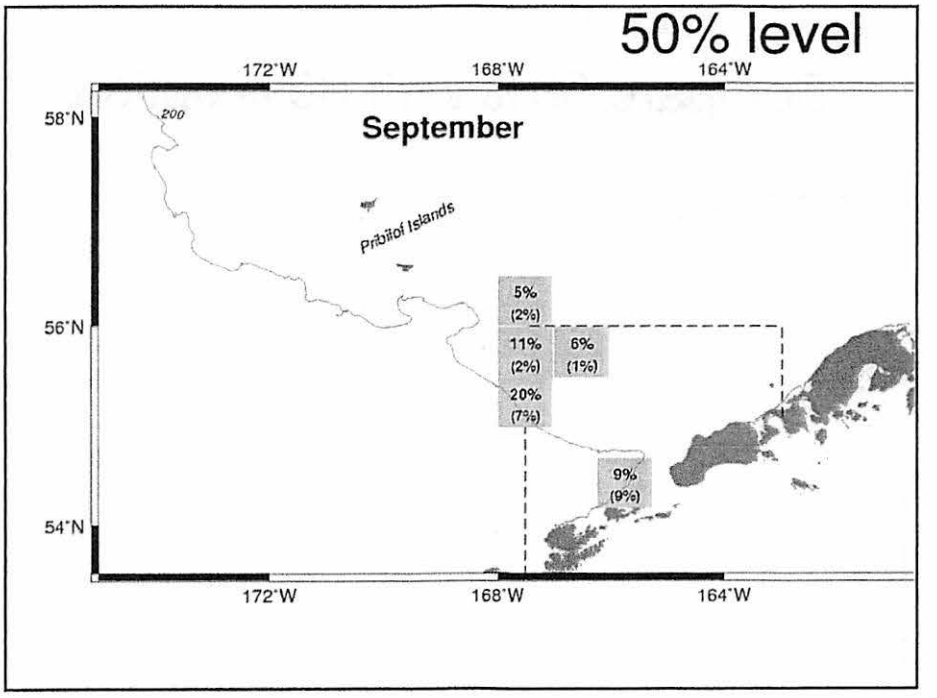
Overall Rank	June	July	August	September	October
1	46%	29%	20%	20%	18%
2	59%	40%	28%	31%	40%
3	70%	45%	35%	36%	49%
4	73%	52%	40%	46%	55%
5	76%	57%	55%	50%	59%
6	76%	61%	59%	54%	63%
7	79%	63%	63%	56%	65%
8	80%	66%	67%	57%	67%
9	80%	70%	71%	59%	69%
10	81%	76%	73%	61%	74%
11	81%	78%	74%	61%	74%
12	81%	79%	75%	61%	74%
13	81%	80%	76%	62%	74%
14	81%	81%	76%	66%	74%
15	81%	81%	77%	66%	83%
16	81%	82%	77%	66%	83%
17	84%	84%	77%	66%	87%
18	84%	85%	77%	69%	87%
19	86%	85%	77%	70%	88%
20	86%	85%	77%	74%	91%

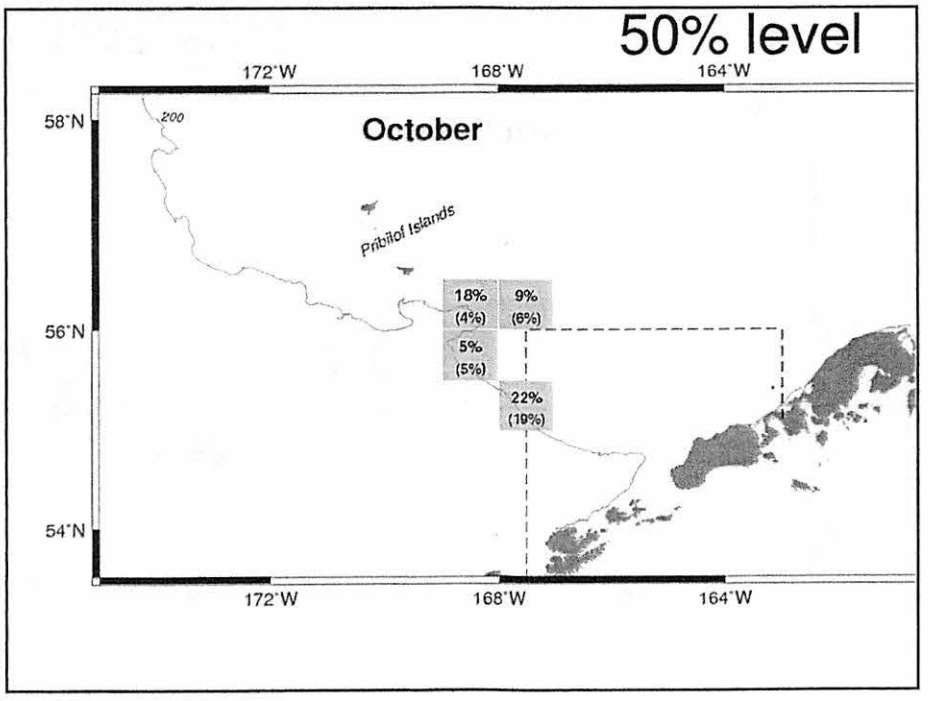
50% level




50% level
172°W
168°W
164°W
58°N
56°N
54°N
200
July
Pribilof Islands
29%
(7%)
5%
(1%)
7%
(5%)
11%
(9%)
172°W
168°W
164°W

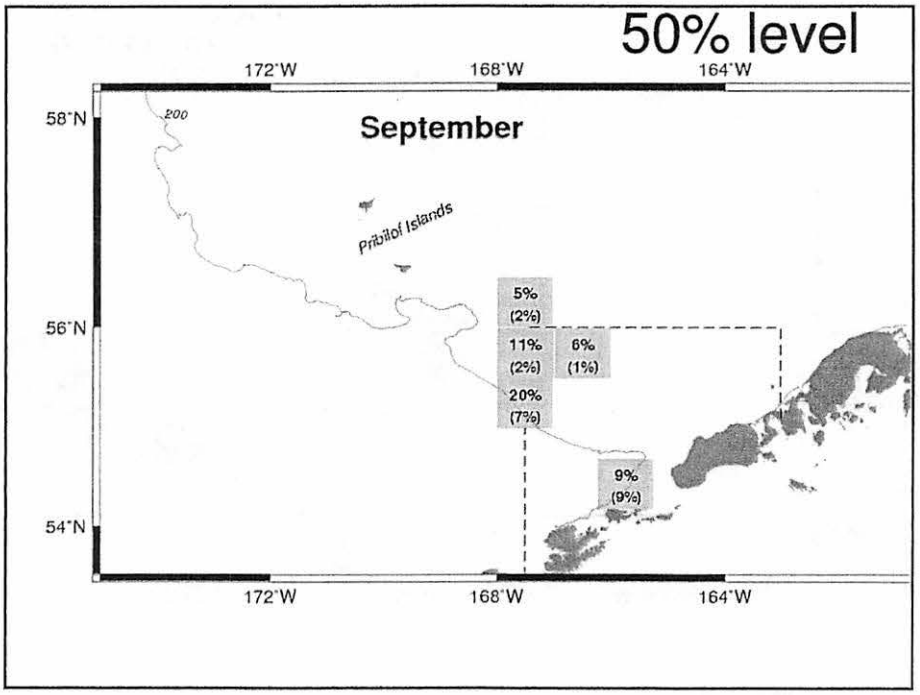

50% level
172°W
168°W
164°W
58°N
56°N
54°N
200
August
Pribilof Islands
5%
(3%)
6%
(4%)
8%
(2%)
20%
(5%)
15%
(20%)
172°W
168°W
164°W

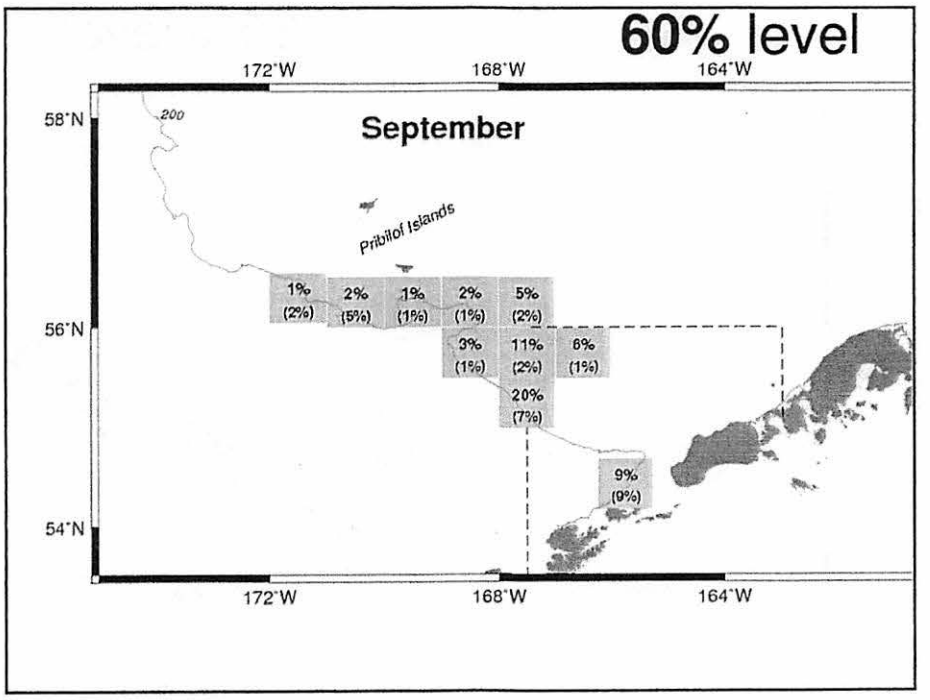

50% level
172°W
168°W
164°W
58°N
56°N
54°N
200
September
Pribilof Islands
5%
(2%)
11%
(2%)
6%
(1%)
20%
(7%)
9%
(9%)

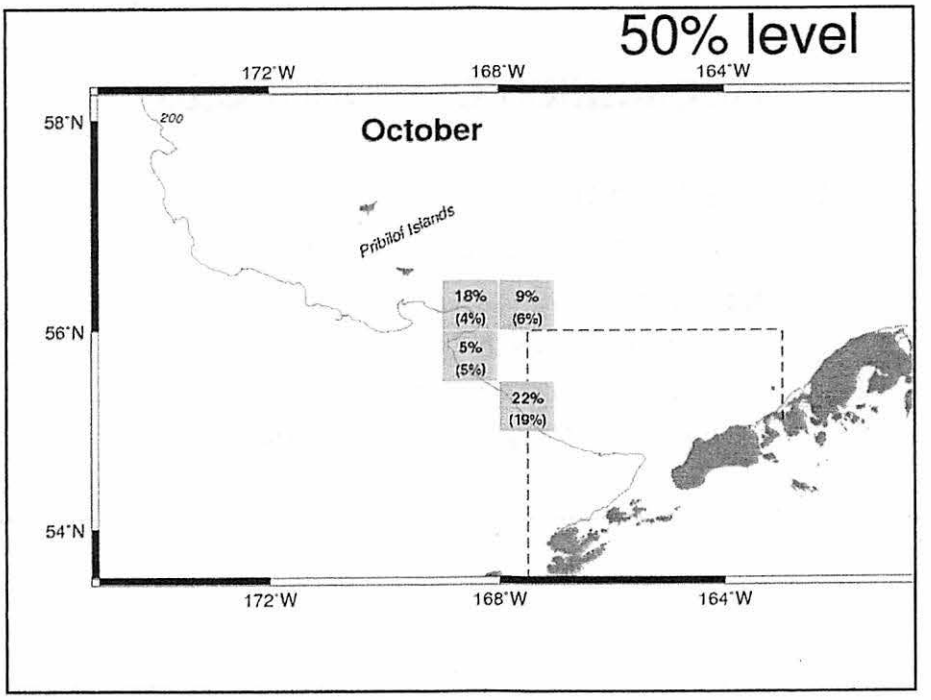

50% level
172°W
168°W
164°W
58°N
56°N
54°N
200
October
Pribilof Islands
18%
(4%)
9%
(6%)
5%
(5%)
22%
(19%)

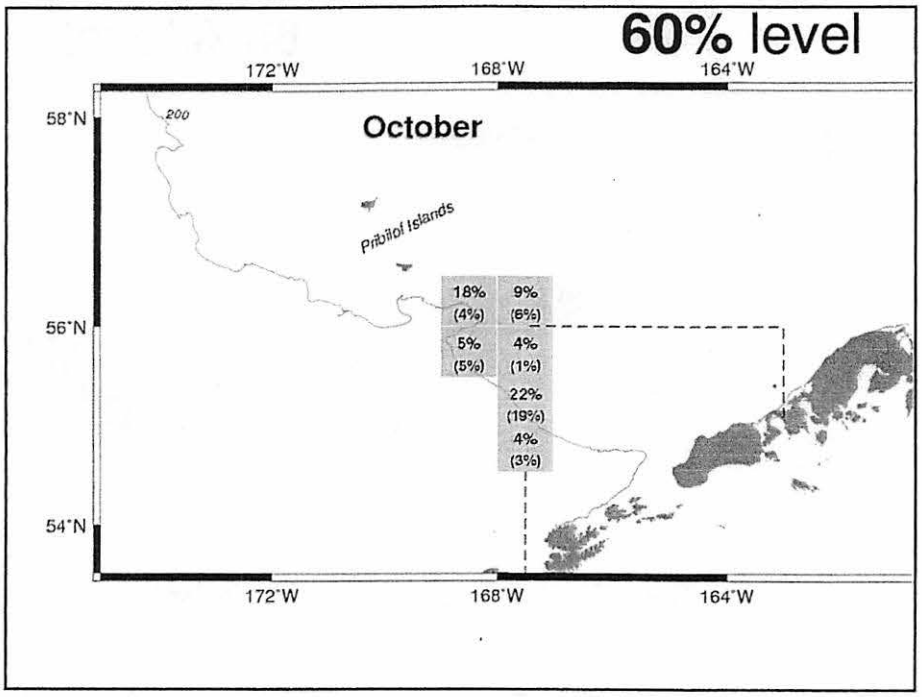
Compare 50% with 60% option

- Spatially



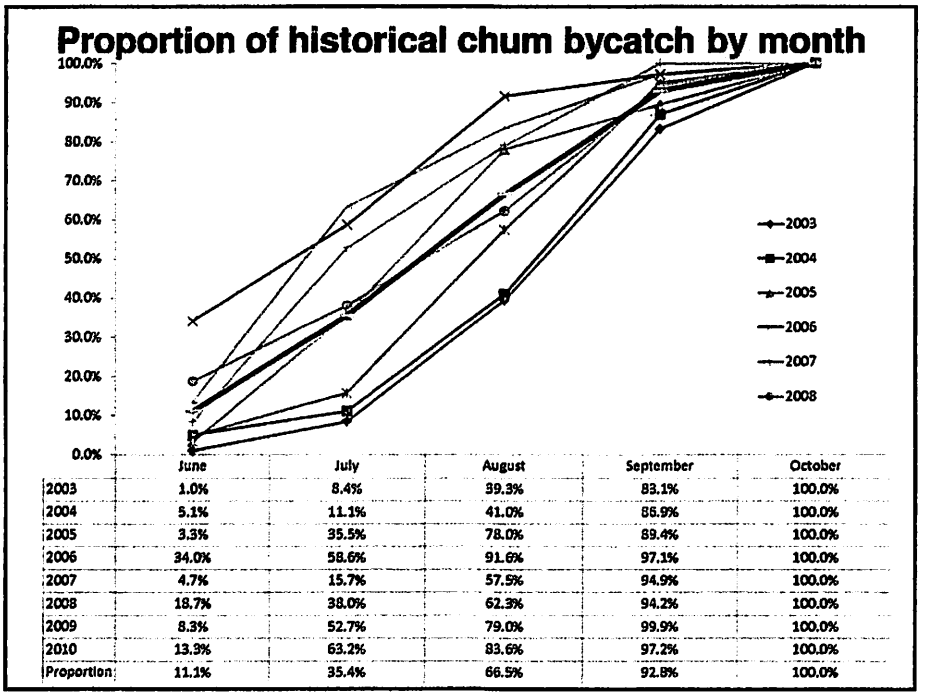

60% level
September
172°W
168°W
164°W
58°N
56°N
54°N
200
Pribilof Islands
1% (2%)
2% (5%)
1% (1%)
2% (1%)
5% (2%)
3% (1%)
11% (2%)
6% (1%)
20% (7%)
9% (9%)


50% level
October
172°W
168°W
164°W
58°N
56°N
54°N
200
Pribilof Islands
18% (4%)
9% (6%)
5% (5%)
22% (19%)

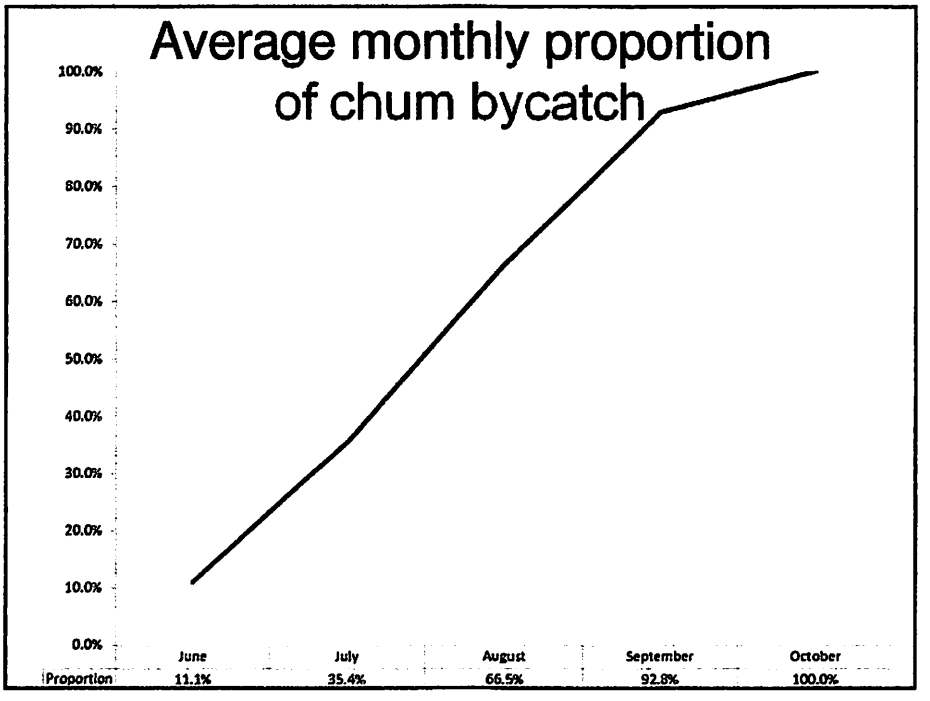


Application of trigger cap

- EBS-wide cap
  - Cumulative through the B-Season
  - Closure areas:
    - Change each month
    - Computed based on history
    - Ranked according to chum and pollock



	June	July	August	September	October
2003	1.0%	8.4%	39.3%	83.1%	100.0%
2004	5.1%	11.1%	41.0%	86.9%	100.0%
2005	3.3%	35.5%	78.0%	89.4%	100.0%
2006	34.0%	58.6%	91.6%	97.1%	100.0%
2007	4.7%	15.7%	57.5%	94.9%	100.0%
2008	18.7%	38.0%	62.3%	94.2%	100.0%
2009	8.3%	52.7%	79.0%	99.9%	100.0%
2010	13.3%	63.2%	83.6%	97.2%	100.0%
Proportion	11.1%	35.4%	66.5%	92.8%	100.0%



	June	July	August	September	October
Proportion	11.1%	35.4%	66.5%	92.8%	100.0%

Monthly trigger example

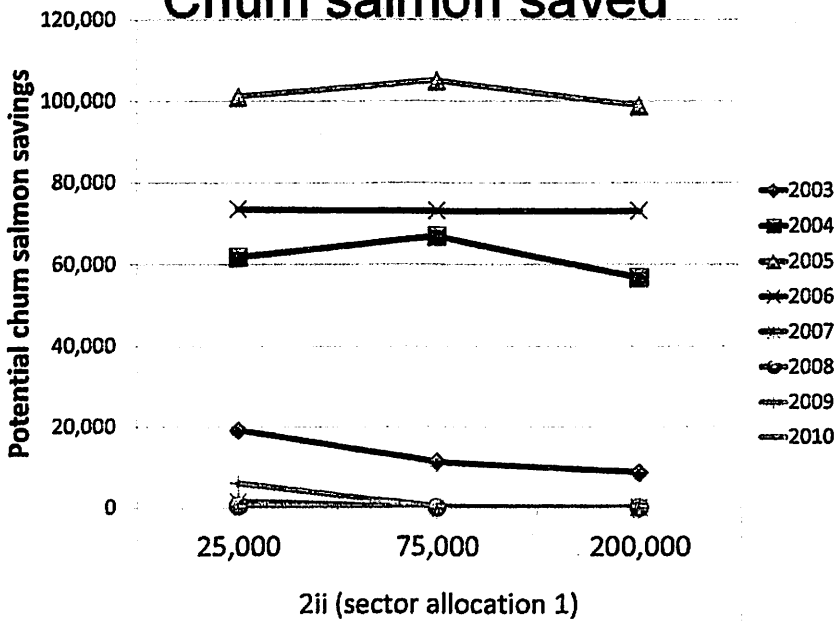
Month	Proportion	EBS bycatch trigger level 100,000
June	11%	11,100
July	35.4%	35,400
August	66.5%	66,500
September	92.8%	92,800
October	100%	100,000

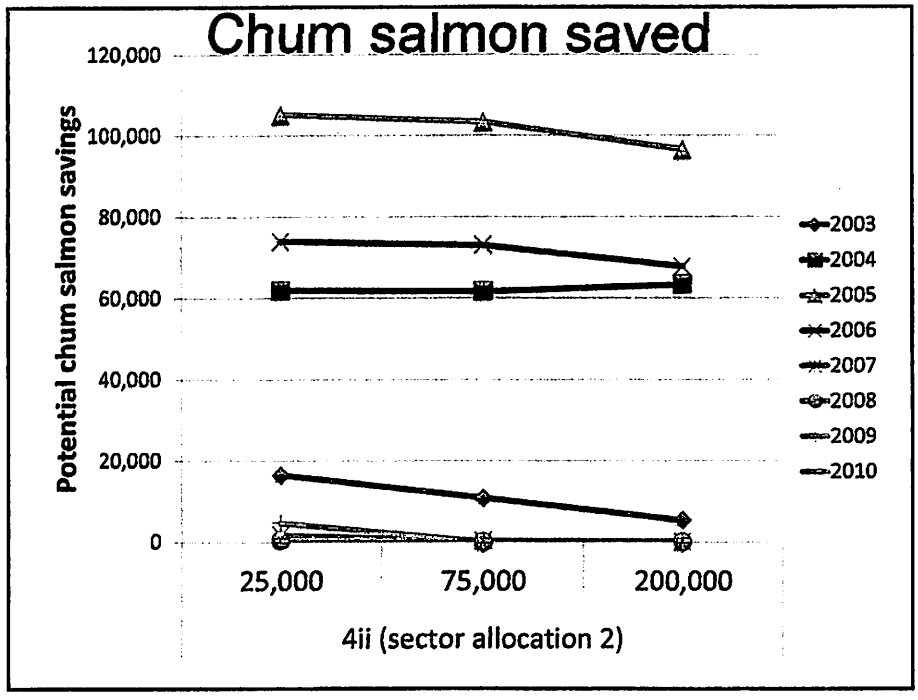
Trigger closure approach

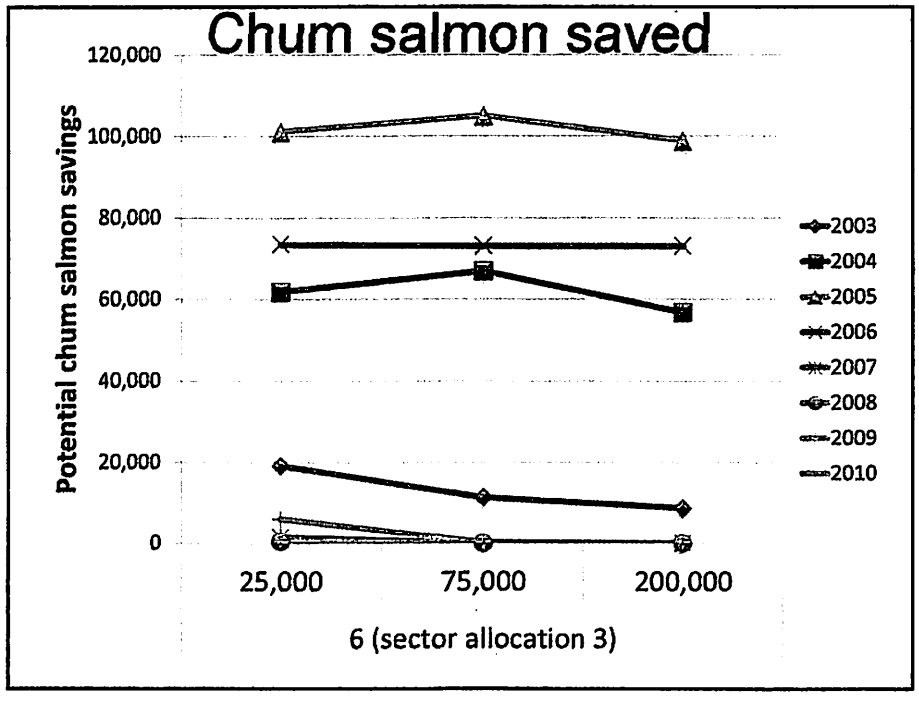
- With data resolved to week and ADFG area
  1. Sort by year, sector, week (track month)
  2. Monitor catch against cap
     - If exceeds: trigger closure for the rest of that month for that sector go to 3.
     - Otherwise: Continue with history as observed…
  3. For sector with restricted catch (closed from trigger areas) catch chum at rate experienced by all outside of closure (and based on pollock).

Pitfalls of approach used…

- Historical data only
  - Amendment 91 regulations not in effect
  - Voluntary hotspot closures occurred
    - If trigger was hit true savings may be low if already closed by VRHS
  - Assumes that pollock catch could occur elsewhere
  - Rates tracked by whole fleet
    - Sensitivity to using sector specific rates explored—lower savings using those rates



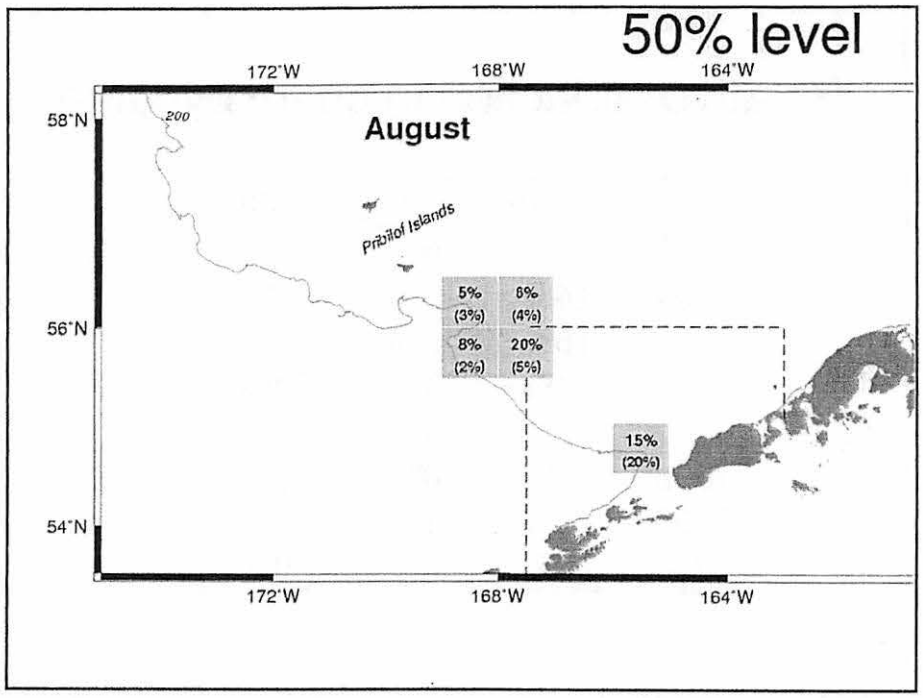

Chum salmon saved
120,000
100,000
80,000
60,000
40,000
20,000
0
Potential chum salmon savings
25,000
75,000
200,000
4ii (sector allocation 2)
2003
2004
2005
2006
2007
2008
2009
2010

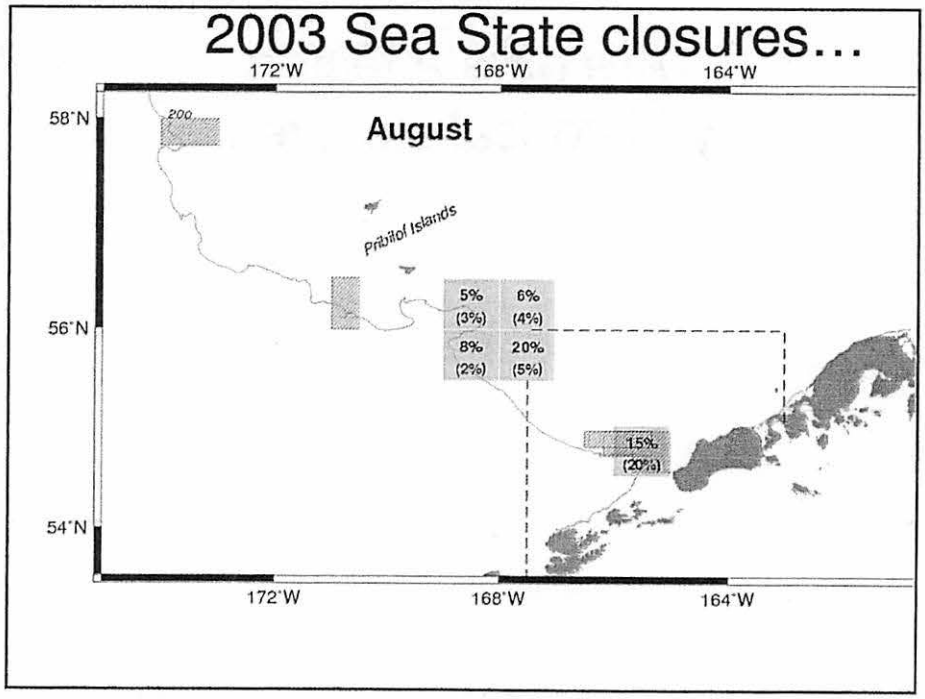

Chum salmon saved
120,000
100,000
80,000
60,000
40,000
20,000
0
Potential chum salmon savings
25,000
75,000
200,000
6 (sector allocation 3)
2003
2004
2005
2006
2007
2008
2009
2010

Relative reduction in chum bycatch

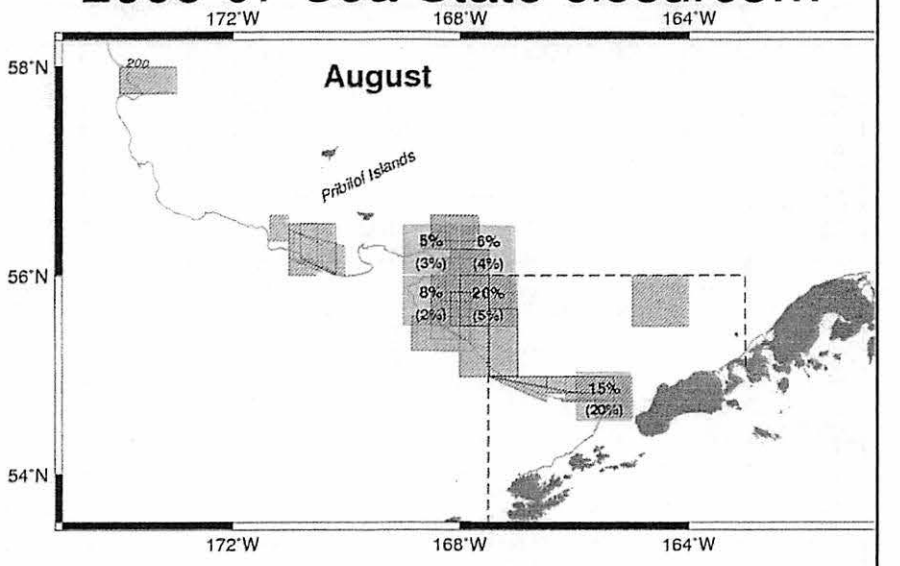
	25,000	75,000	200,000
2003	11%	6%	5%
2004	14%	16%	13%
2005	16%	16%	15%
2006	24%	24%	24%
2007	2%	0%	0%
2008	3%	0%	0%
2009	13%	1%	0%
2010	0%	0%	0%

Are data affected by historical closures…

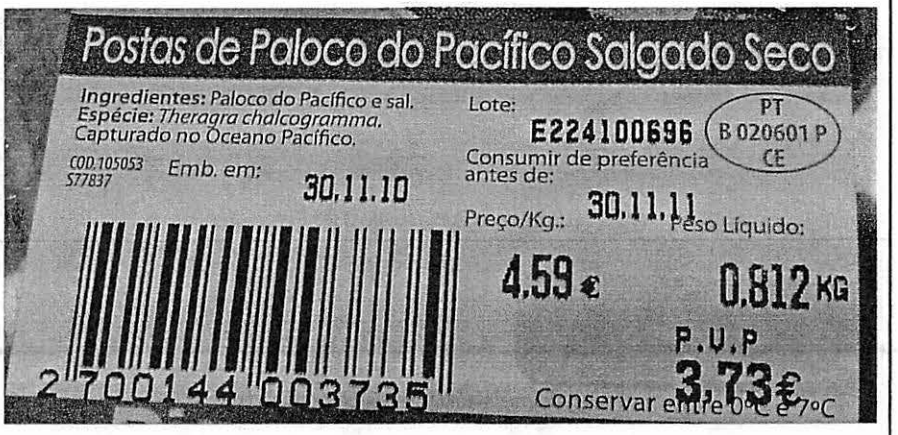

50% level
172°W
168°W
164°W
58°N
56°N
54°N
200
August
Pribilof Islands
5%
(3%)
6%
(4%)
8%
(2%)
20%
(5%)
15%
(20%)
172°W
168°W
164°W


2003 Sea State closures…
172°W
168°W
164°W
58°N
56°N
54°N
200
August
Pribilof Islands
5%
(3%)
6%
(4%)
8%
(2%)
20%
(5%)
15%
(20%)
172°W
168°W
164°W

2003-07 Sea State closures…



Pollock



Pollock redirected by triggered closures

2ii (sector allocation 1)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	14,569	3,859	4,350	38,328	2,894	0	4,172	7,474	0	0	0	0
2004	1,401	11,204	9,671	41,384	527	11,029	4,298	23,738	459	6,811	0	3,937
2005	0	0	6,162	95,442	0	0	6,162	74,417	0	0	0	34,268
2006	0	2,855	0	55,458	0	1,193	0	41,517	0	0	0	25,137
2007	0	871	482	3,741	0	789	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0	0	0	0
2009	0	0	616	2,477	0	0	0	0	0	0	0	0
2010	0	0	2,778	0	0	0	0	0	0	0	0	0

4ii (sector allocation 2)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	7,514	0	4,350	44,730	0	0	1,934	15,101	0	0	0	0
2004	975	11,204	5,758	41,466	527	7,210	4,298	23,738	0	1,696	0	8,627
2005	0	0	6,162	112,773	0	0	6,162	83,626	0	0	0	43,183
2006	0	2,855	0	55,458	0	0	0	46,896	0	0	0	33,246
2007	0	789	0	3,741	0	0	0	0	0	0	0	0
2008	0	0	0	4,725	0	0	0	0	0	0	0	0
2009	0	0	0	6,015	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

6 (sector allocation 3)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	2,894	0	4,284	46,506	0	0	0	25,533	0	0	0	0
2004	527	11,029	4,298	41,660	0	4,586	0	41,384	0	0	0	18,559
2005	0	0	6,162	113,487	0	0	0	85,583	0	0	0	46,660
2006	0	1,193	0	57,742	0	0	0	54,943	0	0	0	40,266
2007	0	717	0	4,902	0	0	0	0	0	0	0	0
2008	0	0	0	11,125	0	0	0	0	0	0	0	0
2009	0	0	0	23,772	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0	0	0	0	0

Pollock redirected by triggered closures

2ii (sector allocation 1)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	18%	1%	6%	10%	3%		6%	2%				
2004	1%	4%	13%	11%	1%	4%	6%	6%	0%	2%		1%
2005			8%	16%			8%	10%				9%
2006		1%		15%		0%		11%				7%
2007		0%	1%	1%		0%						
2008												
2009			1%	1%								
2010			7%									

4ii (sector allocation 2)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	9%		6%	11%			3%	4%				
2004	1%	4%	8%	11%	1%	2%	6%	6%		1%		2%
2005			8%	16%			8%	12%				12%
2006		1%		15%				13%				9%
2007		0%		1%								
2008				2%								
2009				3%								
2010												

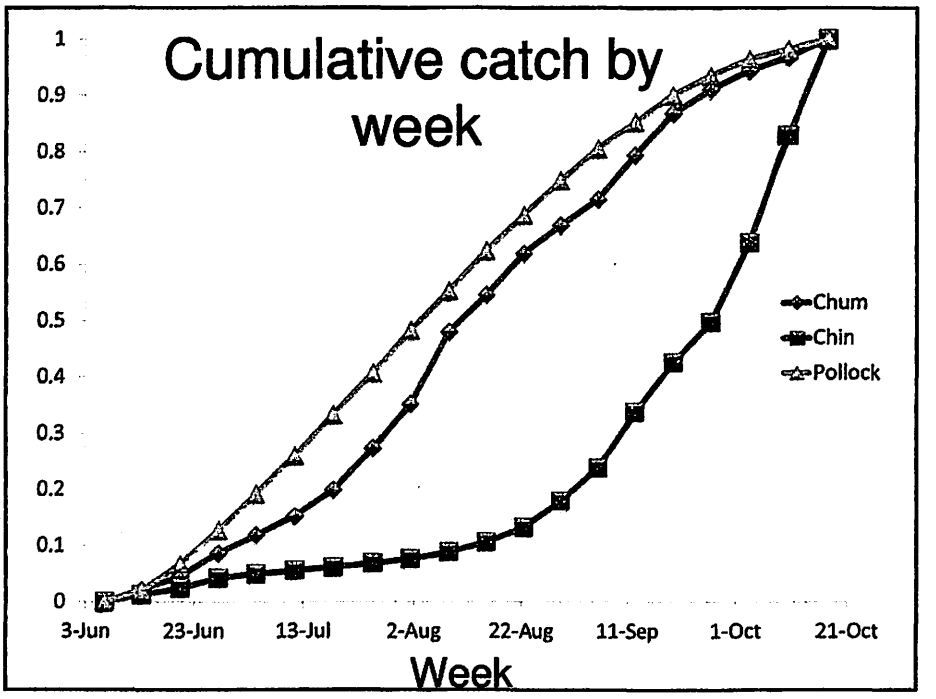
6 (sector allocation 3)

Cap:	25,000				75,000				200,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	3%		6%	12%				7%				
2004	1%	4%	6%	11%		1%		11%				5%
2005			8%	16%				12%				13%
2006		0%		16%				15%				11%
2007		0%		2%								
2008				4%								
2009				12%								
2010												

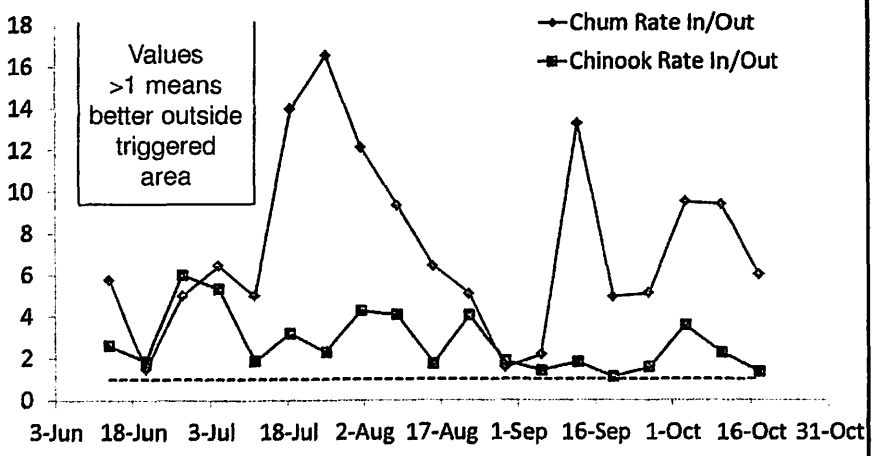
Proportion of sector-specific pollock catch

Chinook considerations

- Problem: do trigger closures force fishing in worse Chinook salmon bycatch areas?
- A fundamental question…and check of areas selected



All sectors all years by week



Area closures based on 50% scenario

Week from start of B season

Sector	CDQ	CP	MS	CV	Total
Number					
Both Better outside	7	18	17	75	117
Both worse outside	3	2	3	13	21
Chum only worse outside	2	5	5	23	35
Chinook only worse outside			1	24	25
Pollock Outside triggered zone					
Both Better outside	27,860	276,351	51,570	979,356	1,335,136
Both worse outside	13,590	16,086	6,847	135,204	181,728
Chum only worse outside	13,078	68,484	11,479	276,562	369,603
Chinook only worse outside			255	233,558	233,813
Pollock inside triggered zone					
Both Better outside	15,685	15,014	14,500	275,553	320,751
Both worse outside	1,408	2,864	8,002	77,100	89,374
Chum only worse outside	1,077	4,247	12,140	116,063	135,523
Chinook only worse outside			164	225,573	225,737
Average Chum In/Out					
Both Better outside	6.97	14.99	12.88	7.83	9.61
Both worse outside	0.31	0.28	0.33	0.62	0.50
Chum only worse outside	0.29	0.48	0.85	0.80	0.59
Chinook only worse outside			3.58	2.72	2.69
Average Chinook In/Out					
Both Better outside	1.88	14.45	4.02	5.55	6.50
Both worse outside	0.59	0.69	0.49	0.54	0.56
Chum only worse outside	2.29	3.34	6.53	3.58	3.83
Chinook only worse outside			0.21	0.61	0.59

Additional month-closure considerations

- Do current genetics data suggest seasonal benefits to varying closure rates?
  - Should certain periods within a season be given more protection than others?
- How might this be done?
  - Modify option 2 to be responsive to early season Alaskan chum bycatch e.g.,
    - Have cap be 50% of average proportion for June and July, then 150% (within month) for rest of season

Summary of trigger closures

- Areas identified work
  - Likely underestimate total due to past spatial closures
- Inter-annual variability high

C-3(a) BSAI Chum salmon bycatch
February 4, 2011

The Council adopts the following problem statement and moves the analysis for initial review.

Problem statement:

Magnuson-Stevens Act National Standards direct management Councils to balance achieving optimum yield with bycatch reduction as well as to minimize adverse impacts on fishery dependent communities. Non-Chinook salmon (primarily made up of chum salmon) prohibited species bycatch (PSC) in the Bering Sea pollock trawl fishery is of concern because chum salmon are an important stock for subsistence and commercial fisheries in Alaska. There is currently no limitation on the amount of non-Chinook PSC that can be taken in directed pollock trawl fisheries in the Bering Sea. The potential for high levels of chum salmon bycatch as well as long-term impacts of more moderate bycatch levels on conservation and abundance, may have adverse impacts on fishery dependent communities.

Non-Chinook salmon PSC is managed under chum salmon savings areas and the voluntary Rolling Hotspot System (RHS). Hard caps, area closures, and possibly an enhanced RHS may be needed to ensure that non-Chinook PSC is limited and remains at a level that will minimize adverse impacts on fishery dependent communities. The Council should structure non-Chinook PSC management measures to provide incentive for the pollock trawl fleet to improve performance in avoiding chum salmon while achieving optimum yield from the directed fishery and objectives of the Amendment 91 Chinook salmon PSC management program. Non-Chinook salmon PSC reduction measures should focus, to the extent possible, on reducing impacts to Alaska chum salmon as a top priority.

The Council forwards the AP motion and asks staff to incorporate the SSC and AP comments to the extent practicable.