

02/19/13
Overview:
Chinook
Salmon
Bycatch

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Salmon Bycatch</SUBJECT><COMM>HFSH28</COMM></TARGET>

from Rep. Paul Seaton, Homer Ak



WEST COAST SALMON GENETIC STOCK IDENTIFICATION COLLABORATION

2012 Summer Update

The 2012 sampling season is underway in Washington, Oregon, and California.

Fishermen collect data such as barcoding (left), length measurements (bottom left), scale samples for aging (below), and genetic data, as well as other catch information.

Laboratory staff are working to analyze the genetic data, enter it into the databases, and share the data as quickly as possible.

Photos courtesy of Evan Merz, Paul Merz, and Doug Fricke, commercial salmon fishermen.



West Coast Salmon Genetic Stock Identification Collaboration is a working partnership between fishermen, scientists, and managers in Washington, Oregon, California, and Idaho that aims to benefit fish and strengthen west coast salmon fisheries by protecting weak stocks, providing sustainable harvest, and improving economic opportunities and fishing practices through better understanding of stock specific ocean distribution and migration patterns of salmon.



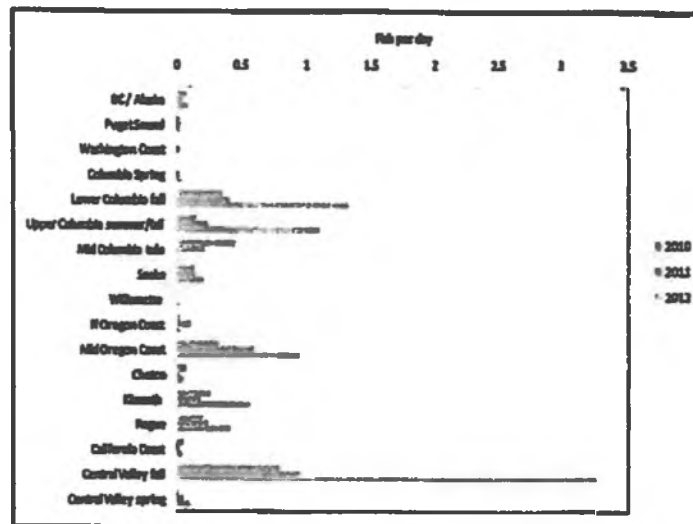
Please visit our websites at www.pacificfishtrax.org and www.fishtrax.org

Project Goals

- Goal 1: Improve understanding of the ocean ecology of salmon by integrating stock-specific distribution patterns over space and time with biological and environmental data.
- Goal 2: Integrate multiple disciplines to develop and apply new scientific technology to improve fisheries management strategies across geo-political boundaries.
- Goal 3: Improve economic opportunities for fishermen and coastal communities.

Latest Genetic Stock Identification results

- ◆ There is overall improvement in the 2012 commercial fishery since 2010 and 2011. This improvement is most significant in the stocks from the Columbia River and California Central Valley.
- ◆ GSI produces usable data faster than coded wire tags (CWTs). Genetic results can be available 24-48 hours after sampling.
- ◆ GSI supports regional management of Pacific salmon fisheries. Fish from California rivers comprise a large segment of the Oregon commercial fishery; management of Pacific salmon by single states would be insufficient.
(See the Central Valley fall contribution to catch.)
- ◆ With data collected over many years, we can analyze long-term trends and the effects of variables such as ocean conditions, river conditions, annual rainfall and other weather patterns.



Oregon catch rates, August. Combined catch per unit effort (number of fish caught per boat-day) for 17 stocks. Data are shown for the Oregon commercial salmon fishery in August of 2010, 2011, and 2012. Stocks are displayed in north to south order of the natal river.

2012 Season

- by the Trax fishermen*
- ◆ From May through August 2012, more than 1000 Chinook salmon tissue samples have been collected at sea in Washington, over 6800 samples in Oregon, and over 7500 in California.
 - ◆ In June and July 2012, Oregon conducted the second and third fishery-independent survey trials. This study explores the possibility of test fishing to determine stock distributions. Fishermen sample in a fixed grid pattern and scientists compare their catch with commercial catch from the same time period.
 - ◆ Preliminary data show that, to date, catch per unit effort (CPUE) is much higher in California and Oregon in 2012 than in either 2010 or 2011.
 - ◆ The SeaTab at-sea data entry system is under development and has been live tested on fishing boats to record catch and fishing data and transmit it directly to the FishTrax™ database on shore.

WCS-GSI Collaboration

- ◆ The Oregon Salmon Commission, California Salmon Council and Washington Trollers Association lead the Collaboration. Partners include Oregon Sea Grant, Community Seafood Initiative, Columbia River Inter-Tribal Fish Commission, University of California—Santa Cruz, Oregon State University, Oregon and Washington Departments of Fish and Wildlife, California and Idaho Departments of Fish and Game, National Marine Fisheries Service North-west and Southwest Fisheries Science Centers.
- ◆ This project has produced five years of fine-scale fish distribution data and fishing effort to support long term ecosystem-based fisheries science and management.
- ◆ A major objective is to prevent coast-wide fishing closures and enhance economic benefits to the salmon fishery and fishery-dependent coastal communities.

Please visit our website at www.fishtrax.org. For more information and to stay informed about our project, please contact Joe Dazey (Washington Trollers Association, jdazey@centurytel.net), Nancy Fitzpatrick (Oregon Salmon Commission, nancy@oregonsalmon.org) or David Goldenberg (California Salmon Council, golden59@pacbell.net), Sarah Bates, GSI fleet manager



Alaska Marine Conservation Council



Alaska State Legislature
House Fisheries Committee
February 19, 2013

The People of Alaska Place Chinook Salmon in High Regard



Chinook Bycatch in the Gulf of Alaska

- The North Pacific Fishery Management Council is Analyzing a Motion offered by Commissioner Campbell (ADF+G) to Cap the Chinook Bycatch in the GOA in the Non-Pollock Trawl Fisheries. This is the last of the trawl fisheries that are fishing without a cap.

Will Catch Shares Be the Solution to Chinook Bycatch?

- When caps were set in the Bering Sea, they were set higher than those recommended by the U.S. Fish and Wildlife Service, the U.S. Department of State, the Yukon River Panel, the Federal Subsistence Board, and the Alaska Board of Fisheries. In the Gulf of Alaska, the 25,000 cap set on the Pollock fishery exceeds the 10-year average. The hard caps set will prevent high bycatch rates, but do little to reduce bycatch of Chinook and Chum salmon.

Every Chinook Salmon Counts

- At times of low abundance, every fish counts. While other users have had to reduce their harvest to conserve Chinook salmon with tremendous economic and cultural impacts, the trawl fisheries must do the same.
- While there are a number of factors contributing to the current poor state of our Chinook salmon runs, bycatch mortality is one factor that we *can* control.

Wastefulness Is Not the Alaskan Way

- Alaska has a reputation for sustainable fisheries Management. We can and must do better when it comes to reducing bycatch.
- The best tools for reducing bycatch are caps on prohibited species, observation and sampling, and finally research funding to analyze the samples to determine river of origin and migration paths.

How Can the Legislature Help?

- A resolution from the legislature to the North Pacific Fishery Management Council that supports reduction of Chinook salmon bycatch in the Gulf of Alaska and Bering Sea would let the Governor-appointed Council know that the commercial, charter, sport, and subsistence fishermen of Alaska are being represented in their call for reductions in Chinook salmon bycatch.

All Users of Chinook Salmon
Thank You!



Questions? www.akmarine.org



Alaska Marine Conservation Council



Annual Report
Chinook Salmon Bycatch Reduction
Incentive Plan

2011

NMFS IPA No. CP IPA

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April 1, 2012

Introduction

Amendment 91 to the Bering Sea and Aleutian Islands Groundfish Fishery Management Plan (BSAI FMP) limits Chinook salmon bycatch in the eastern Bering Sea (EBS) pollock fishery. The rules and regulations implementing Amendment 91 came into force at the start of the 2011 fishery. Amendment 91 is an innovative approach to managing Chinook salmon bycatch in that it combines a prohibited species catch (PSC) limit on the amount of Chinook salmon that may be caught incidentally by the fishery with an incentive plan agreement (IPA) and performance-standard requirement designed to minimize bycatch to the extent practicable in all years. The approach is designed to motivate fishery participants to avoid Chinook salmon bycatch at the individual vessel level under any condition of pollock and Chinook abundance in all years. The vessel-level incentives are created through contracts among the fishery participants.

The Chinook Salmon Bycatch Reduction Incentive Plan (CP IPA) reported on here is designed to provide the incentives necessary to accomplish the goals and objectives of Amendment 91. The plan builds on experience gained in the development and refinement of time-and-area-based, rolling "hot-spot" avoidance programs. The plan creates incentives to avoid salmon bycatch by restricting the pollock fishing opportunities of vessels with poor Chinook bycatch performance while allowing vessels with good performance less restricted access to the fishing grounds. Losing access to good pollock fishing increases vessel operating costs and reduces product values. Avoiding grounds restrictions reduces operating costs and allows for the production of more high-value products (especially during the A-season), thus increasing profits.

The incentive plan is designed to work in concert with the annual Chinook salmon PSC limits specified in Amendment 91. The limits depend on whether the fishery participants develop IPAs. If IPAs are developed, then the annual limit is 60,000 Chinook during any two-out-of-seven years, and 47,591 Chinook in other years. During 2011 all pollock vessels participated in an IPA and the catcher-processor (CP) sector IPA participants included vessels harvesting the American Fisheries Act (AFA) CP Sector and Alaska Community Development Quota (CDQ) pollock allocations. For the CP sector, the Chinook quota was 13,516 fish and the pollock quota was 36 percent of the non-CDQ directed fishing allocation. For the CDQ sector, the Chinook quota was 3,883 fish and the pollock quota was 10 percent of the annual directed fishing allocation. These pollock and Chinook quotas were further allocated among the seasons and the participating vessels. Table 1 shows the CP IPA 2011 "day-one" allocations of pollock and Chinook salmon PSC quota.

Primary IPA components include: (1) data gathering, monitoring, reporting, and information sharing; (2) identification of bycatch avoidance areas (BAA); and (3) fishing-area prohibitions for vessels with poor bycatch performance. Additional components include: (1) an A-season closed area of approximately 755 square nautical miles on the northern flank of the Bering Canyon; and (2) a set of conditional, B-season closed areas of approximately 1,295 square miles along the outermost EBS shelf. Vessels are prohibited from fishing in the B-season areas beginning on October 15th and

continuing through to the end of the season during those years when the aggregate bycatch of all plan vessels during the month of September exceeds a preset threshold.

Table 1. CP IPA Day-One Allocations of Pollock and Chinook Salmon, 2011.

Vessel	Pollock (tons)	Chinook Salmon (n)
American Dynasty	41,737	1,318
American Triumph	41,737	1,318
Northern Eagle	41,737	1,318
Northern Jaeger	41,737	1,318
Ocean Rover	41,737	1,317
Arctic Fjord	44,766	1,205
Arctic Storm	38,433	1,271
Northern Hawk	59,316	1,378
Alaska Ocean	48,260	1,432
Pacific Glacier	47,745	1,433
Starbound	41,498	1,259
Island Enterprise	26,250	772
Kodiak Enterprise	26,250	772
Seattle Enterprise	26,250	772
Ocean Peace	1,327	66
Northern Glacier	515	3
Allocation Buffer	0	447
Total Allocation	569,295	17,399

Incentive Measures

One of the most practical and direct methods to create incentives to avoid Chinook salmon bycatch is to limit the pollock fishing opportunities of a vessel when bycatch performance is poor. This simple approach works especially well for catcher-processors because efficient processing requires an uninterrupted flow of fish, and this can be achieved most reliably with unrestricted access to the grounds. Because experience has shown that high, local concentrations of pollock may often be found where concentrations of Chinook are also high (the vessels can “see” the pollock but not the Chinook), limiting access to local areas of relatively high Chinook bycatch is an efficient way to create a financial incentive to avoid Chinook salmon bycatch. The reason for this is that losing access to good pollock fishing grounds increases vessel operating costs and reduces the amount of products that can be produced during a day of fishing. A vessel that retains nearly unrestricted access to good pollock fishing

opportunities avoids costs associated with moving and finding pollock in other areas, and so the vessel can produce more products each day.

About a decade of industry experience has shown that the most efficient way to reduce salmon bycatch to the maximum extent practicable is to focus incentive programs on those areas where Chinook salmon bycatch is highest when compared to the amount of pollock harvested. To accomplish this, vessel performance benchmarks are calculated in a way that reflects the amount of pollock harvested. The first step in creating a program to avoid Chinook bycatch is to employ data gathering, reporting, and information sharing to identify local areas of relatively high Chinook abundance on the pollock grounds. Pollock catch and Chinook bycatch records from all fishery participants are gathered, compiled, and evaluated each week during which an IPA vessel catches pollock. In this analysis, areas of relatively high Chinook bycatch are identified (bycatch avoidance areas; BAA). Should vessels continue to fish in these areas, high Chinook bycatch is likely to occur because local concentrations of Chinook routinely persist in time and space for several weeks.

An important component the evaluation of potential BAA is the generation of a useful grounds-wide index of salmon abundance. This "baseline" index of relative salmon abundance on the grounds over time is called the base rate. More information about the methods used to identify the base rate is in the IPA agreement (available at: www.fakr.noaa.gov/sustainablefisheries/bycatch/salmon/chinook/ipa/chinook_salm_on_ipa_2010.pdf). The base rate also takes into consideration the amount pollock harvested.

To establish and maintain incentives to avoid Chinook bycatch under any condition of pollock and Chinook salmon abundance, the bycatch performance of the IPA vessels is measured both currently (most recent two weeks) and cumulatively (over the entire fishing season). To evaluate current performance, vessel performance is measured during the prior two weeks and compared to a standard that represents better-than-average performance. The measure of current vessel bycatch performance is called the vessel bycatch ratio. The bycatch ratio is calculated by dividing the number of Chinook caught incidentally by the vessel during the prior two weeks by the metric tons of pollock caught by the vessel during the prior two weeks. A two week period is used because experience has shown that day-to-day vessel bycatch performance is influenced by random factors associated with changes in weather, winds, water temperatures, and currents, and measuring performance over a two-week period "dampens" the effects of these random influences. This increases the usefulness of the measure in the creation of an incentive for the individual vessel to avoid bycatch.

If the current bycatch performance of an IPA vessel is not better than average, then the vessel is prohibited from fishing in the BAA for a week. Because the base rate is calculated by aggregating pollock catch and bycatch data from all vessels fishing for pollock, the base rate provides a measure of the average bycatch performance of the vessels fishing for pollock. The plan establishes the better-than-average-performance standard at 75 percent of the base rate. So every plan vessel with current bycatch performance higher than 75 percent of the base rate is prohibited from fishing within the BAA for seven days (i.e., the following week). If during the following week the current bycatch performance of a vessel operating under a fishing prohibition remains

higher than 75 percent of the base rate, then the vessel is prohibited again from fishing in the bycatch avoidance areas for an additional seven days. A seven-day fishing prohibition is called a weekly fishing prohibition.

The cumulative bycatch performance of a vessel is measured as the total amount (number) of Chinook salmon bycatch by the vessel during the fishing year relative to the pollock allocation assigned to that vessel (Table 1 shows the day-one" assignments for 2011). So the measure of cumulative vessel performance accumulates from the first day of fishing through to the last. Vessel cumulative bycatch performance is evaluated against a standard designed to magnify the incentive to avoid salmon bycatch during years when the baseline abundance of Chinook is medium and high. Based on analysis of more than a decade of CP catch records, an annual bycatch of 8,500 Chinook indicates a year when Chinook abundance on the grounds traditionally fished by CP vessels is at a medium level.

Cumulative bycatch performance is evaluated only for those vessels that receive a weekly fishing prohibition. For these vessels, if the cumulative Chinook bycatch rate is higher than the medium-abundance standard, then the vessel is prohibited from fishing in the BAA for two weeks. This standard is called the vessel cumulative amount, and a fourteen-day fishing prohibition is called an extended fishing prohibition. If vessel Chinook bycatch is greater than its cumulative amount, then it is subject to the extended fishing prohibition. Additional information about how the vessel cumulative amount is determined is in the IPA agreement.

Chinook Salmon Conservation Areas

Chinook salmon feeding migrations produce concentrations of Chinook in discrete, local areas along the EBS outer continental shelf, and many of these areas are well known to pollock fishermen. The areas are known to pollock fishermen because more often than not high concentrations of pollock are found in the areas. However, the precise times during which pollock and Chinook may be concentrated in any local area depends on a host of environmental and physical-oceanographic conditions that change with the seasons and the weather, such that it is not generally possible to know precisely where and when pollock and Chinook are concentrated together before going fishing for pollock.

Analysis of catch records over a decade or more has revealed the existence of one area along the outer continental shelf within which it seems that high concentrations of Chinook salmon exist almost every year during the winter fishery. Based on this analysis, an A-season fishing prohibition within an approximately 735 square mile area is included in the plan as a means to reduce bycatch. The area is called the A-season Chinook Salmon Conservation Area (CSCA).

Analysis of B season catch records over two decades shows that when migrating Chinook arrive on the outer continental shelf in sufficient numbers during September, the odds that high concentrations of Chinook will be encountered by the fishery in October appear to increase. To create an incentive to reduce bycatch during the latter portion of the B-season, the CP IPA includes "triggered" fishing prohibition for three

areas of approximately 1,295 square miles along the outermost shelf. These areas are called the B-season Chinook Salmon Conservation Area. To implement the incentive, all vessels are prohibited from fishing in the areas beginning on October 15th and continuing through to the end of the season during those years when the aggregate bycatch rate for all vessels during the month of September exceeds 0.015 Chinook per metric ton of pollock harvest (n/t; hereafter metric tons are referred to simply as tons). Maps of these Chinook Salmon Conservation Areas and the latitude and longitude coordinates of their boundaries are provided in the IPA agreement. The CP IPA also specifies the penalties levied on a vessel for violating a BAA prohibition or fishing in a CSCA when fishing there is prohibited. These penalties are \$10,000 for the first annual violation, \$15,000 for a second annual violation, and \$20,000 for a third and each subsequent violation during a year, with every trawl inside a prohibited area considered a separate violation.

Effects of Incentive Measures on Individual Vessels

This annual report provides a qualitative evaluation and some quantitative information on the effectiveness of the plan. The CP IPA incentive program is largely an area-based program, and this evaluation relies heavily on spatial analysis of pollock trawl locations as well as the bycatch performance of the individual vessels. To begin an assessment of the IPA incentives on the individual vessels, the aggregate performance of the vessels in the 2011 fishery is tabulated and compared to performance during prior years. Table 2 shows the aggregate bycatch performance of CP IPA vessels during 2011.

Comparing years since just before the implementation of the AFA, Chinook salmon bycatch during 2011 is low, especially when adjusted for the size of the pollock catch. Since 1998, the number of bycatch Chinook is the fourth lowest, and only 25 percent higher than the lowest annual bycatch since then. After adjustment for the size of the pollock catch, the 2011 bycatch ratio is the second lowest over the time period, and just 15 percent above the lowest value (a difference of one salmon for every 1,000 tons of pollock catch).

Figure 1 shows how aggregate 2011 CP IPA Chinook bycatch performance compares with that of prior years. Since 1998 climate conditions over the EBS shelf and coastal Alaska are believed to have mainly determined the abundance of Chinook salmon on the pollock grounds, with the warm period during 2001 through 2005 believed to have increased both freshwater and marine survival. In 2011 the bycatch ratio remained at a very low level, continuing a slow downward trend that began in 2008.

Figure 2 shows how aggregate 2011 CP IPA chum bycatch performance compares with that of prior years. The pronounced effect of the warm-weather years on chum salmon survival is also apparent in the chum bycatch performance of the vessels. The bycatch ratios indicate that the abundance of chum salmon was likely higher in 2011 than during recent years. This is consistent with the summer of 2011 likely providing relatively favorable conditions for salmon on the EBS shelf, at least compared

to recent years, and these conditions probably persisted into the fall when concentrations of Chinook first moved onto the EBS shelf to feed.

Table 2. CP IPA Chinook Salmon Bycatch Performance, 2011.

Season	Pollock (t)	Chinook Salmon (n)	Ratio (n/t)
A	224,209	2,236	0.010
B	316,296	1,986	0.006
A + B	540,505	4,222	0.008

Figure 1. Chinook Bycatch Ratios, EBS Pollock, 1998-2011.

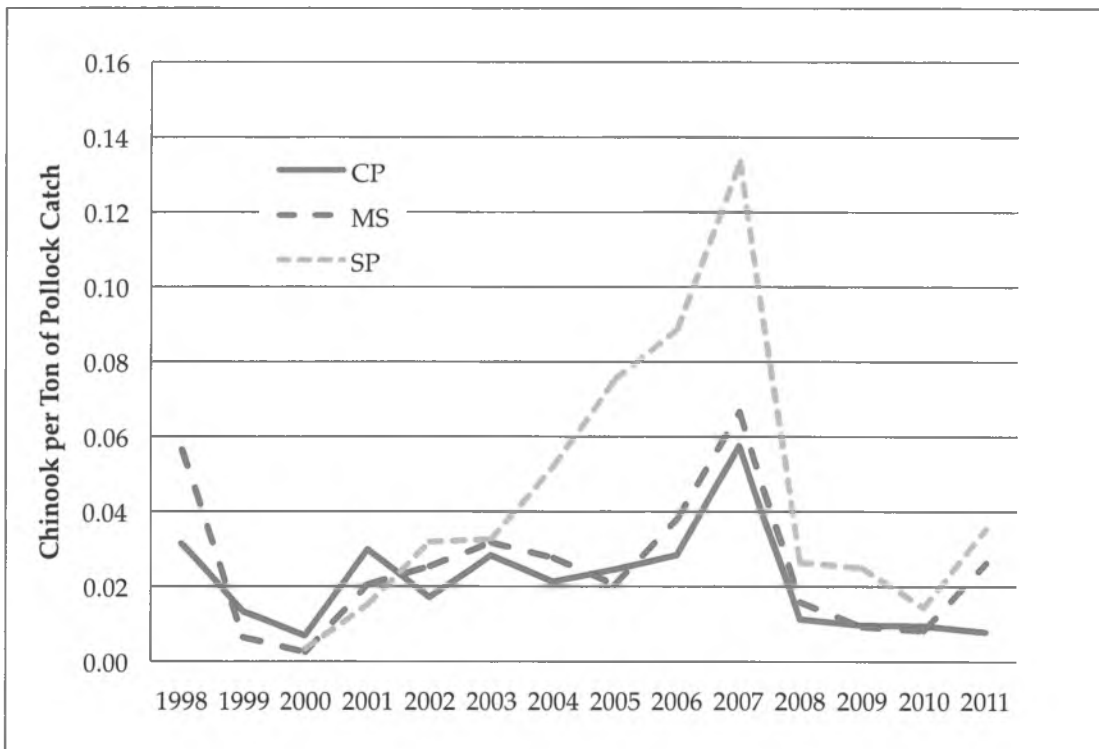


Figure 2. Chum Bycatch Ratios, EBS Pollock B-Season, 1998-2011.

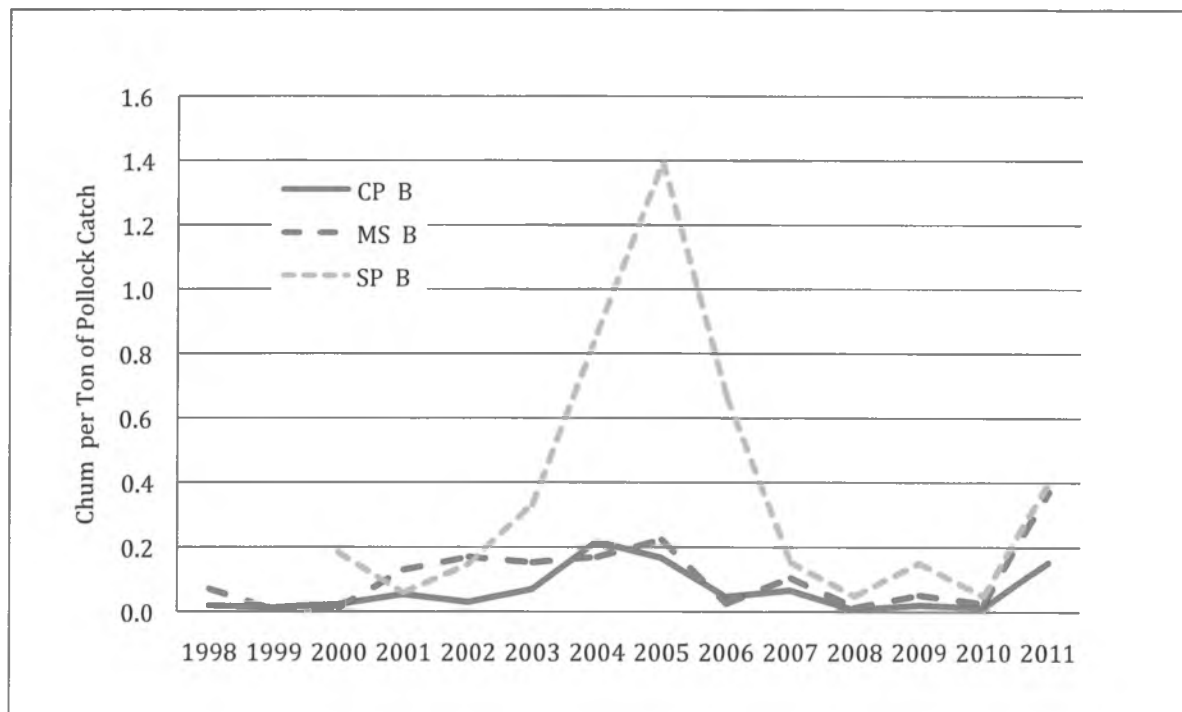


Figure 3 shows how the timing of 2011 IPA fishing activities compares with prior years. For the B-season, fishing spooled up very quickly at the start, but due to a combination of chum bycatch avoidance efforts and a grounds-wide reduction in pollock availability at the beginning of August, just about all of the vessels fished until the season ended. Despite this unusual pattern of effort, about 28,640 tons of pollock (about five percent of the annual quota) went uncaught.

Table 3 shows the Chinook salmon bycatch performance of the IPA vessels. Performance is shown by season because the Chinook bycatch environment is different during the A- and B-seasons. During the A-season, bycatch ratios are often double those of the B-season because when the season starts Chinook salmon are already feeding on the EBS shelf. As the season progresses, Chinook salmon migrate to basin waters, and abundance on the grounds generally reaches a low level by mid March. With the exception of one vessel, which did not catch very much pollock, vessel bycatch performance is tightly clustered around the A-season average ratio of 0.010 n/t.

During the B-season, and when fishing starts quickly, it is sometimes possible to almost complete fishing operations before Chinook salmon arrive on the shelf in the fall to feed. In other years they arrive earlier and great effort must be concentrated on limiting the bycatch. The weekly bycatch data shows that an initial wave of Chinook salmon arrived on the EBS outer continental shelf during the first week of September, and that a second wave arrived about the middle of October. The grounds-wide decrease in pollock availability that began during August persisted through to the end

of the season, and as a consequence, the risk of high pollock bycatch was significantly increased as just about all vessels were forced to fish through to the end of October.

Table 3 shows the range of vessel bycatch performance during the B-season. The data confirms that most vessels were very close to average performance. The exceptions are two vessels with double the average ratio and one at three times the average. The performance of these vessels was influenced most by a few high bycatch trawls near the end of the season. The main cause of this performance was the abrupt decrease in pollock availability during August and the subsequent requirement for most vessels to fish until the season ended. For one vessel (Northern Glacier), its only pollock fishing occurred late in October, and so the high ratio did not reflect many bycatch Chinook. In the latter case, the Northern Eagle obviously delivered the highest bycatch ratio, but the difference between its performance and average performance resulted in only 150 "additional" bycatch Chinook (the vessel did not catch a full share of B-season pollock).

The CP IPA agreement specifies that all fishing in the B-season CSCA is prohibited beginning on October 15th in those years when the bycatch performance for all plan vessels combined exceeds 0.015 n/t during the month of September. The IPA vessels caught 588 Chinook salmon and 59,189 tons of pollock in September, resulting in a bycatch ratio of 0.001 n/t. As such, the IPA vessels were not prohibited from fishing in the CSCA during the last two weeks of October.

Figure 3. Number of IPA Vessels in the Pollock Fishery by Week, 2000-2011.

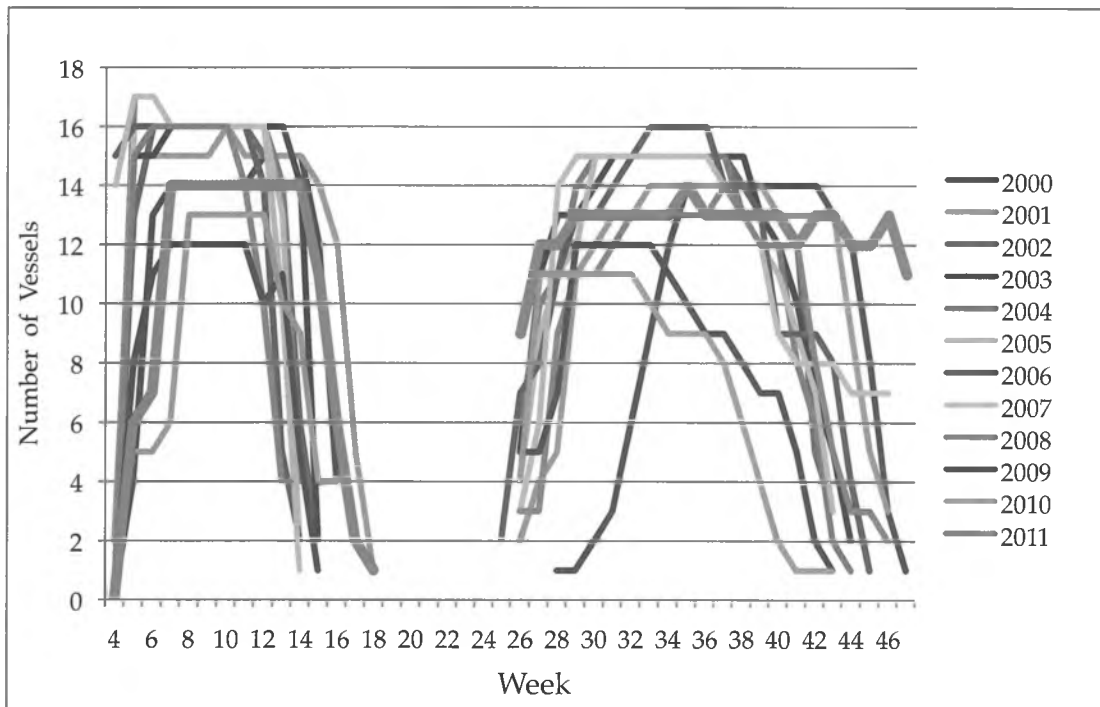


Table 3. CP IPA Pollock Catch and Chinook Bycatch Performance by Season and Vessel, 2011.

Vessel	A-Season Pollock (t)	Chinook Salmon A (n)	B-Season Pollock (t)	Chinook Salmon B (n)	A-Season Ratio (n/t)	B-Season Ratio (n/t)
American Dynasty	16,897	216	26,645	169	0.013	0.006
American Triumph	16,356	150	26,910	123	0.009	0.005
Northern Eagle	16,467	140	12,620	230	0.009	0.018
Northern Jaeger	16,032	90	23,799	154	0.006	0.006
Ocean Rover	16,660	127	24,922	98	0.008	0.004
Arctic Fjord	19,448	189	25,979	237	0.010	0.009
Arctic Storm	14,088	122	23,681	30	0.009	0.001
Northern Hawk	21,664	170	26,446	150	0.008	0.006
Alaska Ocean	22,290	255	29,799	149	0.011	0.005
Northern Glacier	485	22	1,446	16	0.045	0.011
Pacific Glacier	15,857	128	24,713	101	0.008	0.004
Starbound	14,454	185	22,249	147	0.013	0.007
Island Enterprise	11,105	143	21,023	184	0.013	0.009
Kodiak Enterprise	11,154	153	16,204	187	0.014	0.012
Seattle Enterprise	11,253	146	9,860	11	0.013	0.001
Ocean Peace	0	0	0	0		
Forum Star	0	0	0	0		
American Challenger	0	0	0	0		
Ocean Harvester	0	0	0	0		
Tracy Anne	0	0	0	0		
Neahkanie	0	0	0	0		
Sea Storm	0	0	0	0		
Muir Milach	0	0	0	0	Weighted Average	Weighted Average
Total	224,209	2,236	316,296	1,986	0.010	0.006

A-Season Fishery Details

The A-season fishery began on January 20th with vessels fishing along the 50 fathom curve to the east of 170° West longitude and well away from the shelf margin (100 fathom curve). All vessels experienced good daily catch rates with little Chinook bycatch and few tows with ratios higher than 0.075 n/t.¹ The incentive plan mandates that a short period at the beginning of each season be used to gather and evaluate catch and bycatch information and to assess the baseline abundance of Chinook on the grounds. The A-season period extends from January 20th to February 14th, and during this period the base rate is set at 0.040 n/t. The initial vessel performance evaluation was made on February 3rd (using the start-up base rate), and no BAA were identified. The average bycatch ratio (cumulative) through February 3rd was 0.015 n/t and the performance benchmark was 0.030 n/t. At this time a new, fishery-wide Chinook bycatch data sharing agreement was still being negotiated, and the technical representative could not use bycatch information from shore-plant catcher-vessels to identify BAA.

Figure 4 shows vessel trawl locations during the week following the first evaluation. At this time a portion of IPA vessels moved fishing operations to the northwest, within a 50-60 fathom depth band away from the shelf margin. The figure shows a half dozen trawl locations with moderate Chinook bycatch ratios (yellow stars) in depths close to 80 fathoms by vessels fishing to the south. Despite continuing, low average bycatch performance, these trawls resulted in the identification of the first BAA of the season. Figure 5 shows the BAA and the trawl locations from the performance evaluation of February 10th, with one vessel prohibited from fishing in the BAA. The trawl locations during February 12-18 confirm that vessels which had been fishing in the vicinity of the BAA moved to shallower grounds.

The performance evaluation sent to the vessels on February 17th shows two BAA in the same local area. These BAA were identified from a combination of IPA vessel and mothership catcher-vessel trawls, and two vessels were prohibited from fishing in the BAA. At this time the start-up period was complete and the base rate was recalculated using IPA and mothership catcher-vessel bycatch performance over the first three weeks of the season. This change reduced the base rate to 0.035 n/t and the vessel bycatch performance benchmark to 0.026 n/t. IPA vessel average bycatch ratio (cumulative) through February 17th was 0.015 n/t.

¹ A rule of thumb for quick appraisal of vessel annual bycatch performance is the 0.050 n/t benchmark (one salmon in every 20 tons of pollock). When Chinook salmon is relatively abundant on the pollock grounds, it is a significant challenge for vessels to remain under this standard (given experience and technology). The figure legend breakpoints correspond to the 0.05 n/t benchmark as per the equation $(0.40 \times 0.075) + (0.60 \times 0.035) = 0.05$. The breakpoints in the A-season figure legends are twice those of the B-season.

Figure 4. Vessel Trawl Locations and Bycatch Performance, February 5-11, 2011.

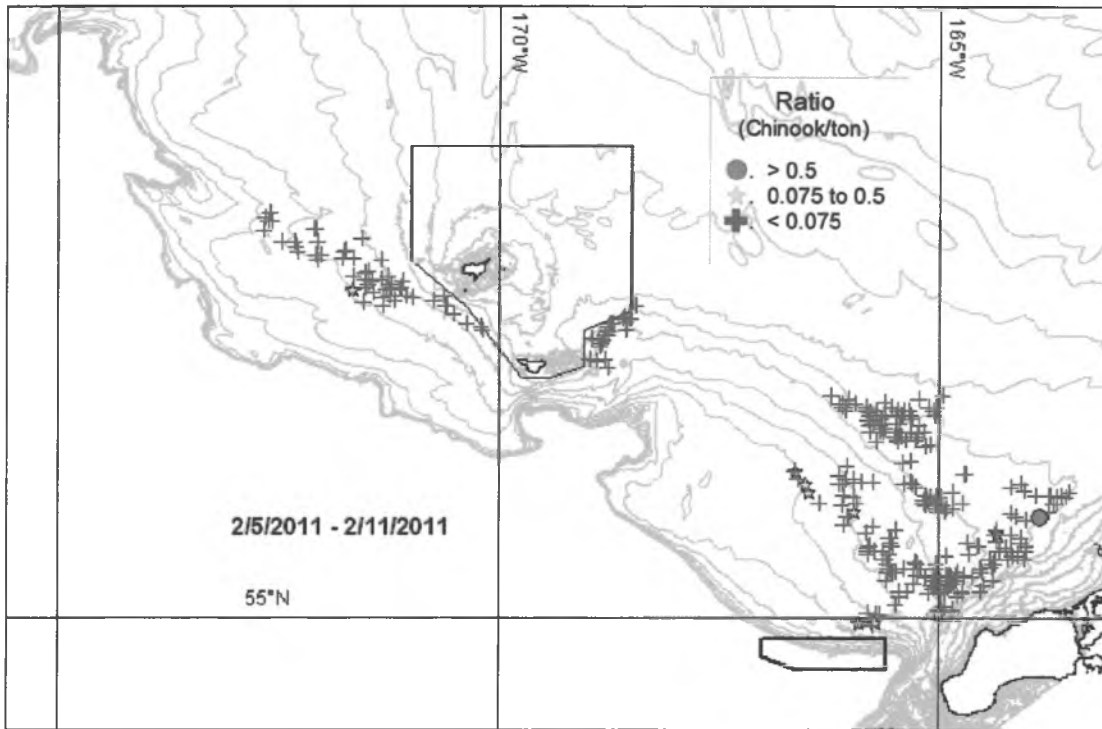
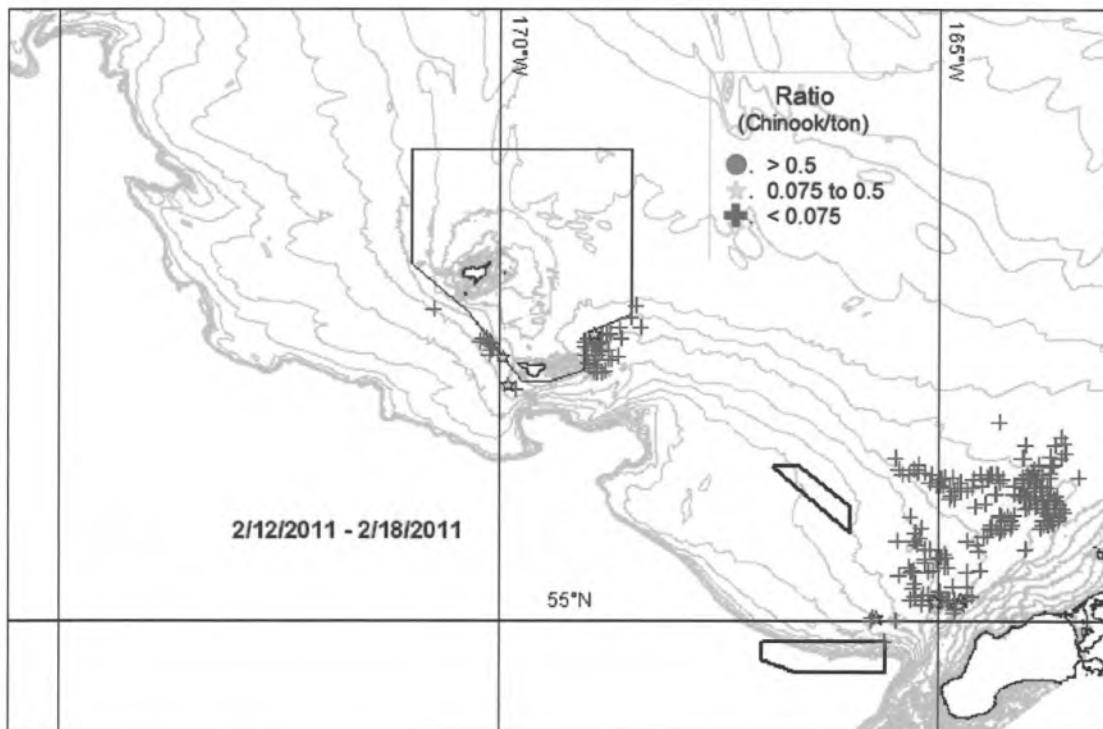


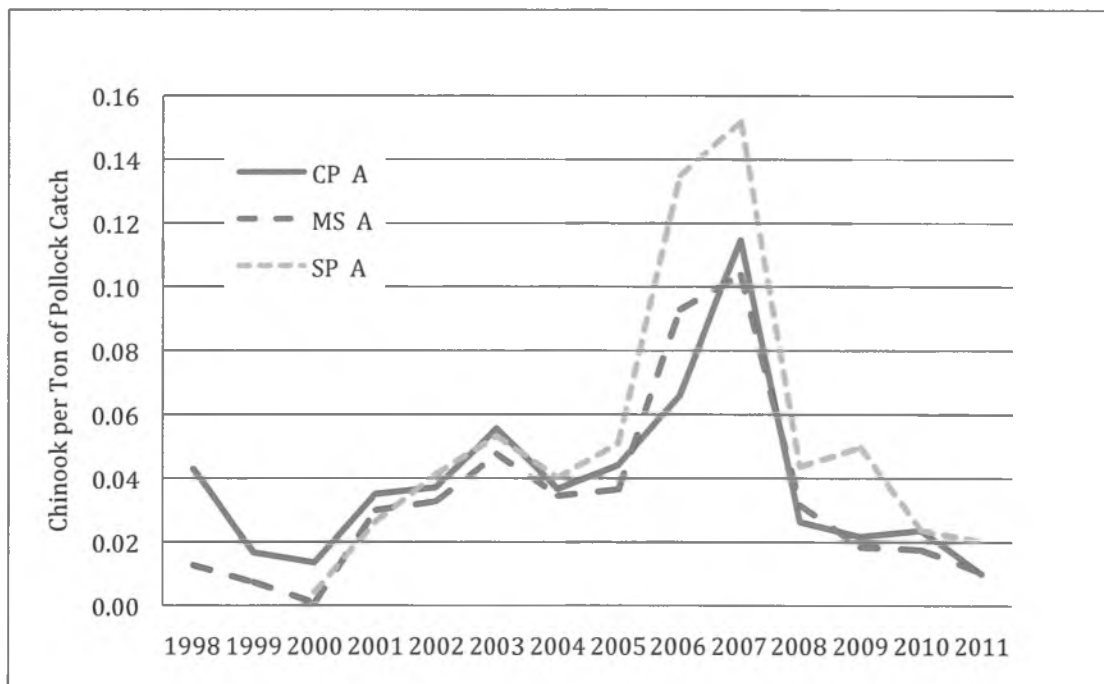
Figure 5. Vessel Trawl Locations and Bycatch Performance, February 12-18, 2011.



The performance evaluation sent to the vessels on February 24th was the first that could identify BAA using fishery-wide bycatch performance (the new Chinook data-sharing agreement was in place). The report shows high bycatch ratios in several areas from a combination of shore-plant and mothership catcher-vessel trawls, but all IPA vessels were below the performance benchmark. During the last week of February and through to the end of March IPA vessels located most fishing on grounds west of 170° West longitude and very few Chinook showed up as bycatch. At the beginning of March Chinook abundance on the grounds appeared to decrease, with high concentrations remaining only in the Bering Canyon (shore-plant catcher-vessel bycatch routinely identified BAA adjacent to the CSCA during March). The IPA vessels completed their A-season fishery during the first two weeks of April, again with very few bycatch Chinook. A final performance evaluation on April 14th showed a cumulative vessel average bycatch ratio of 0.010 n/t.

Figure 6 shows A-season bycatch ratios from 1998 through 2011. Despite what is believed to have been a similar level of Chinook abundance on the pollock grounds as during 2008-2010, the IPA vessels managed to achieve relatively low Chinook bycatch during 2011 A-season and so continued a trend of good bycatch performance that began in 2008.

Figure 6. Chinook Bycatch Ratios, EBS Pollock A-Season, 1998-2011.



B-Season Fishery Details

As Figure 3 shows, most IPA vessels were on the grounds as the B-season opened. The B-season data-gathering period extends from June 10th to July 14th, and during this period the base rate is set at 0.035 n/t. The initial vessel performance evaluation was made on July 14th using the start-up base rate and no BAA were identified. Pollock daily catch rates were good from the season start through to the end of July with virtually all fishing west of 170° West longitude. Very few concentrations of Chinook were encountered and no BAA were identified. During the second week of August the vessels experienced what many vessel masters characterized as a “never-before-seen,” abrupt change in pollock availability. Figure 7 shows trawl locations for the IPA vessels during the first week of August, which was the last time the vessels were observed fishing on a substantial aggregation of pollock. The figure also shows a chum-salmon BAA over a large portion of the grounds above the Bering Canyon.

Figure 8 shows a pattern that characterized fishing after the abrupt change in pollock distribution. For the remainder of August the vessels encountered very few Chinook, fishing operations remained west of 170° West longitude, and no BAA were identified (again a chum-salmon BAA is shown in the figure). The September 1st evaluation showed a B-season cumulative average bycatch ratio of 0.001 n/t. However, just after the beginning of September it became evident that an initial wave of Chinook salmon had begun to feed along the shelf margin. At this time most IPA vessels moved fishing to shallower water to limit bycatch, locating most fishing in 50-80 fathom depth bands to the east of Pervents Canyon.

The September 22nd bycatch report was the first B-season report that included a BAA. It was over deep water in the Bering Canyon and affected the CDQ fishing operations of one vessel. By this time the cumulative average bycatch ratio had increased to 0.003 n/t (three bycatch Chinook for every 1,000 tons of pollock catch). During the last week of September the vessels moved most fishing to the southeast, with virtually all fishing taking place east of 170° West longitude by the end of September. The September 29th report again identified a BAA over deep water in the Bering Canyon, and again the CDQ fishing operations of one vessel were affected (same vessel).

During the middle of October a second wave of Chinook arrived and the number of trawls with bycatch ratio greater than 0.035 n/t increased noticeably. The second wave is typically made up of more numerous, smaller (younger) Chinook. In response one IPA vessel made a 500 nautical mile round-trip to evaluate fishing conditions between the Pribilof Islands and the US-Russia convention line. Most of these trawls showed bycatch ratios greater than 0.035 n/t and no IPA vessels moved fishing operations back to the northwest. During most of October IPA vessels fished in the vicinity of the Pribilof Islands (performance reports for the last three weeks of the season showed advisory BAA in the Bering Canyon).

Figure 7. Vessel Trawl Locations and Bycatch Performance, July 30 - Aug. 5, 2011.

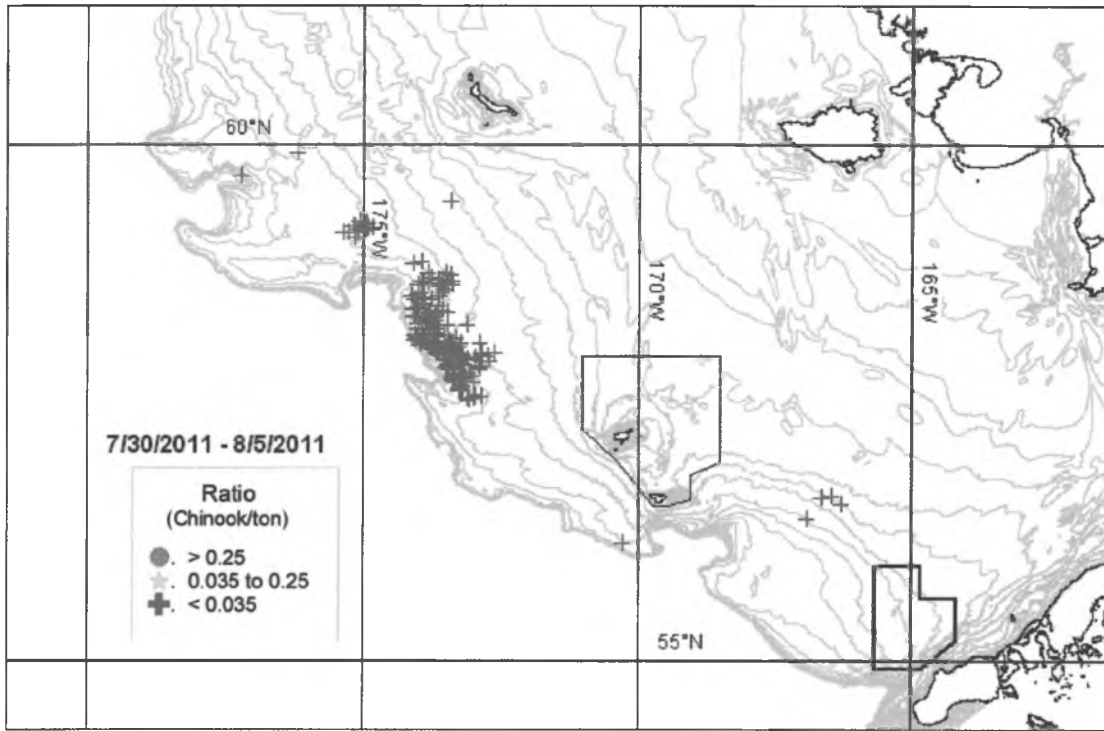
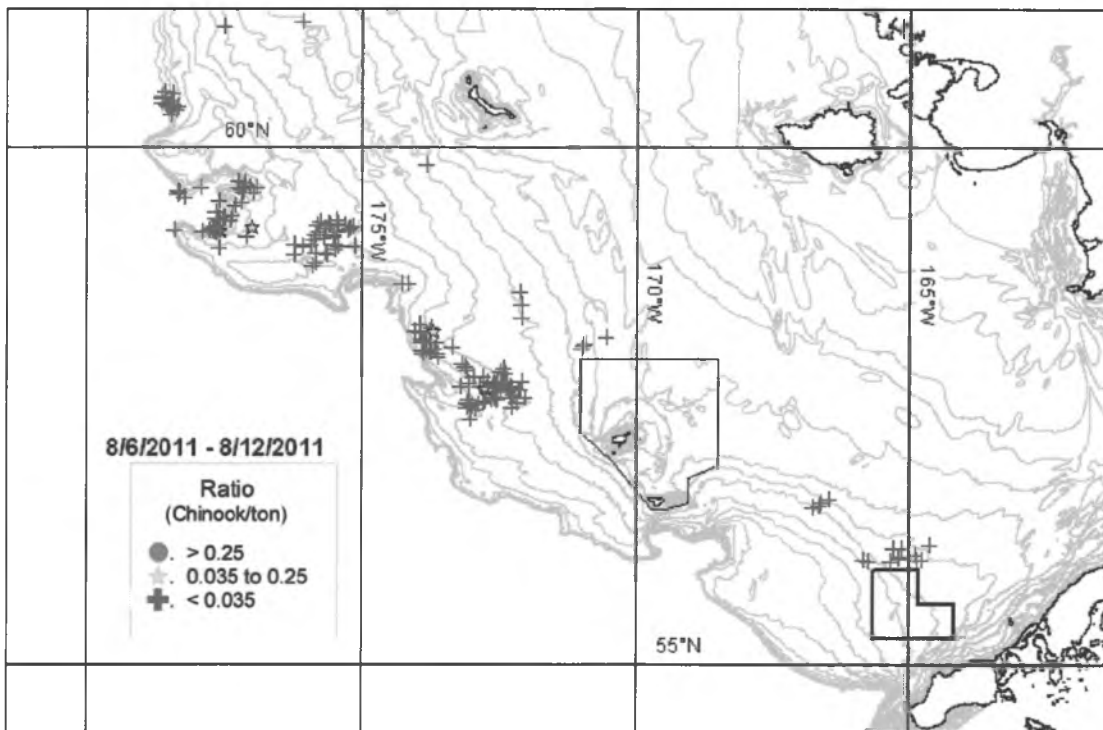


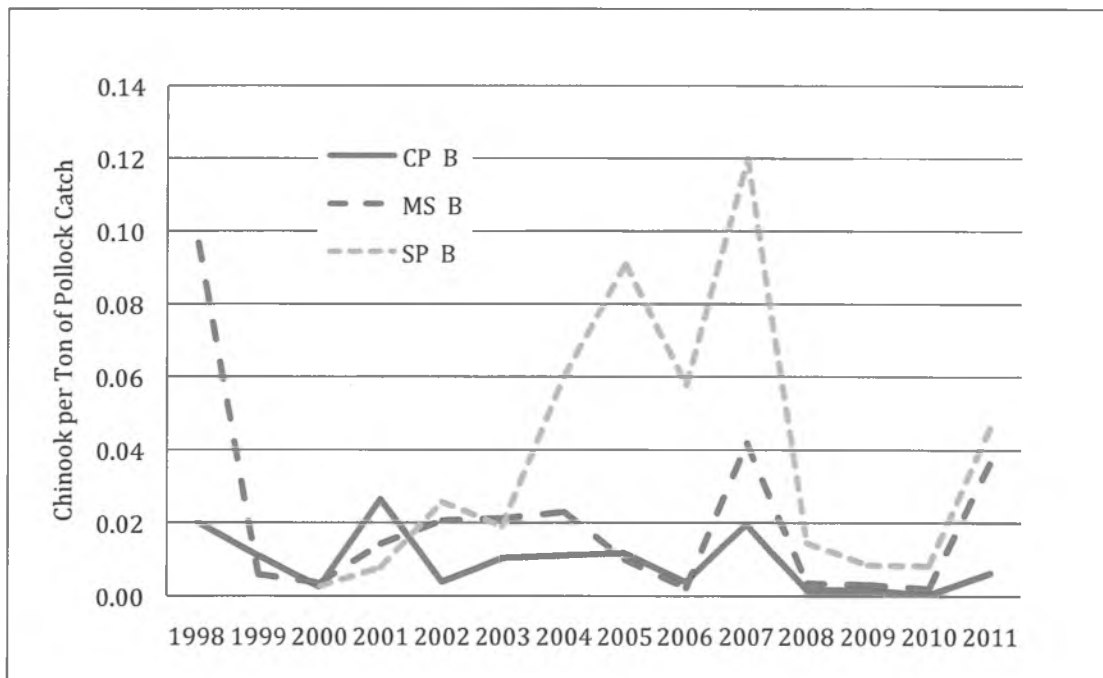
Figure 8. Vessel Trawl Locations and Bycatch Performance, August 6-12, 2011.



The final B-season report was distributed to the vessels on October 20th and showed the IPA vessels with a cumulative average bycatch ratio of 0.007 n/t. This ratio was one-third lower than for the mother-ship catcher vessels and just one-fourth as high as for shore-plant catcher-vessels.

Figure 9 shows Chinook bycatch ratios for the pollock fishery during the 1998-2011 B-seasons. The data shows that the unexpected, abrupt change in pollock abundance during the 2011 B-season resulted in a relatively adverse Chinook bycatch environment, at least when compared to recent years. Most IPA vessels fished for two weeks after the second wave of Chinook arrived, a period when Chinook abundance in local areas can reach high levels. IPA vessels responded to these conditions by fishing shallower grounds somewhat removed from the outer shelf, especially when concentrations of Chinook were believed present. After the pollock dispersed, the IPA vessels continued fishing on grounds to the northwest, and then, in what appeared to be a search for more favorable bycatch conditions, conducted a wholesale movement of fishing to grounds just east of 170° West longitude. The IPA vessels remained in this local area until the season closed, passing up good CDQ pollock fishing near the Bering Canyon because bycatch reports showed BAA and advisory BAA there.

Figure 9. Chinook Bycatch Ratios, EBS Pollock B-Season, 1998-2011.



Chinook Salmon Savings

The CP IPA is a time-and-area-based program that prohibits fishing in areas with high concentrations of Chinook salmon when compared to the abundance of pollock. Because performance benchmarks are calculated for each vessel individually, the program generates incentives to avoid Chinook bycatch for the individual vessel. This simple approach works especially well for CP vessels because efficient processing requires an uninterrupted flow of fish, and this can be achieved most reliably with unrestricted access to the grounds. Because CP vessels fully integrate catching and processing activities, the benefit of unrestricted access to good pollock fishing grounds includes economic profits that reflect both catching value and processing value. This obvious difference in operational structure is believed to play an outsized role in motivating the IPA vessels to avoid potentially significant risks to both catching and processing value from unexpected, repeated episodes of high Chinook bycatch. This economic motivation remains even when bycatch is anticipated to remain below the annual limit.¹

A close examination of the trawl locations in space and time, their bycatch ratios, and the bycatch performance of all of the IPA vessels shows clearly that the vessels changed their fishing strategy to avoid Chinook bycatch. The most salient feature of this changed approach was for vessels to locate initial fishing operations away from the outer margins of the shelf. Depending on the locations of pollock concentrations, any profitable movement of fishing to deeper water was accomplished via a deliberate, slow, and cautious progression while maintaining awareness of information about Chinook concentrations within the area. Evidence of local Chinook concentrations generally caused vessels fishing in deep water to move fishing to more shallow grounds. This behavior occurred in multiple areas when trawl bycatch ratios showed high concentrations of salmon, as, e.g., when a wave of Chinook salmon moved into a local area to feed.

Close tracking of the trawl locations and their bycatch ratios shows that Chinook bycatch would have been higher had IPA vessels not moved fishing when bycatch ratios showed concentrations of Chinook. Combining the trawl locations, their bycatch ratios, and the locations of both BAA and advisory BAA within the same week also shows that IPA vessels located very few trawls along the edges of the BAA, and in those few cases where trawls approached the edge of a BAA, very little Chinook bycatch was recorded.

Another way to look at bycatch performance is to make an evaluation using statistics. In this case, the statistics describe the distribution of the vessel bycatch ratios (relative performance). The hypothesis is that the current, Amendment 91-compliant

¹ A mothership and its catcher-vessels also integrate catching and processing activities, but the incentives in the mothership catcher-vessel IPA do not extend all the way down to the individual vessel.

IPA program creates a more uniform incentive to avoid Chinook salmon bycatch among the individual vessels. In the prior program, the bycatch performance of a cooperative vessel group was evaluated against a performance benchmark, and under some circumstances, incentives to avoid bycatch weakened for an individual vessel. With a more uniform incentive, the distribution of vessel bycatch performance is expected to narrow, reflecting more uniform vessel performance.

The standard deviation of a distribution provides information about data dispersion. A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data points are spread out over a large range of values. To interpret this statistic, it is believed that stronger, more uniform incentives for the individual vessel would reduce the “variability” of the observations. In this case, the standard deviation would be lower.

Skewness is another out-come statistic that may provide some perspective on incentive changes. Skewness is a measure of the asymmetry of the distribution of a random variable, and can be positive or negative. Negative skew indicates that the tail on the left side of the distribution is longer than the right side; a positive skew indicates that the right-side tail is longer than the left. A zero value indicates that the values are relatively evenly distributed on both sides of the mean, usually implying a symmetric distribution. To interpret this statistic, it is believed that stronger incentives for the individual vessel would reduce the likelihood of poor-performance outliers, thus increasing the symmetry of the distribution.

Table 4 shows features of the IPA vessel Chinook bycatch performance distribution during the 2008-2011 A-seasons. Salient changes in the distribution features for 2011 coincide with the implementation of the Amendment 91 CP IPA. Analysis of the IPA vessel data 2008-2011 seems to indicate approximately similar Chinook abundance on the grounds. A similar comparison of B-season performance was not considered useful, as the bycatch environment was significantly tougher in 2011 than during any of the previous three B-seasons (total IPA vessel bycatch for the 2008-2010 B-seasons combined is 797 Chinook). That a large change in bycatch conditions occurred during the same year that the Amendment 91 program was implemented makes it more difficult to measure the separate effect of the incentive change.

The IPA vessel pollock catch also changed during 2008-2011, ranging from a low of 140,000 tons in 2009 to a high of 224,000 tons in 2011. However, the influence of a larger pollock quota on the strength of the individual vessel incentive to avoid Chinook bycatch is a matter of opinion. The “experimental” conditions that did occur provide data consistent with a more uniform distribution of IPA vessel bycatch performance during the 2011 A-season. A skew of zero indicates that there were no poor-performance outliers in the distribution (no right-hand tail). The distribution coefficient of variation, which is a normalized measure of dispersion (standard deviation corrected for scale), is reduced by roughly half under the Amendment 91 program as compared to the 2008-2010 A-seasons.

Table 4. IPA Vessel A-season Bycatch Performance Distribution Features, 2008-2011.

Year	N (vessels)	Mean Ratio (n/t)	Standard Deviation (n/t)	Skewness	Coefficient of Variation
2008	16	0.026	0.013	0.2	0.49
2009	12	0.022	0.011	0.7	0.49
2010	13	0.025	0.011	0.8	0.43
2011	14	0.010	0.003	0.0	0.25

The 2011 year was the first for the CP IPA program. The program identified relatively few BAA during both seasons, and most were selected based on the bycatch performance at shore-plant and mothership catcher-vessel fishing locations. Nevertheless, the 2011 bycatch performance of the IPA vessels is just about the best recorded since 1998, and this period includes the salmon "crisis" years during which Chinook abundance on the grounds was low. The analyses carried out to assess the effectiveness of the CP IPA leaves an impression that the vessels relied on spatial, temporal, and bycatch performance data from a large number of individual pollock trawls to guide a cautious adaptation to the new program. The changed fishing strategy that resulted perhaps limited the number of BAA identified during 2011.

IPA Amendments

There were no amendments to the CP IPA during 2011.

Salmon Bycatch Research

The EBS pollock industry has supported research to reduce salmon bycatch for about ten years. During 2011 support was provided for research to improve the genetic baseline used to identify the stock of origin of chum salmon, and for efforts to develop a trawl-net section designed to reduce salmon bycatch. The design of the trawl-net section allows salmon caught by the trawl to swim free before the net is hauled back. A pelagic pollock trawl with the section installed is a salmon-excluder trawl.

Most but not all excluder-trawl development has been supported by the North Pacific Fishery Research Foundation via the development and execution of exempted fishing permits (EFP). The current EFP allows research to proceed during the 2011 and 2012 pollock seasons. A final report on these activities will be provided after the completion of the research planned for the 2012 A- and B-seasons.

EFP activities during 2011 focused on measuring chum-salmon escapement using the excluder-trawl design developed during 2010. Trials were made using a catcher vessel and a high-horsepower, catcher-processor vessel. The most recent design places

the excluder section just in front of the cod end where water flow (inside the net) is slowest. Prior designs placed the section more forward, where water flow is faster, in part due to the tapered shape of the net. Because chum salmon are not thought to be strong swimmers, it was believed that chum escapement rates from earlier designs (generally poor, less than three percent) could be improved upon with a revised design that would be easier for salmon to escape from. However, the trials did not reveal any improvement in chum escapement, with an average for all trials less than ten percent (but pollock escapement remained very low, about one-half of one percent).

The initial A-season trials occurred in an area with some intermittent Chinook salmon bycatch as well as reliable chum bycatch of between 30 and 100 fish. When Chinook were encountered, escapement averaged close to 40 percent, but chum escapement remained less than ten percent. The results reinforced conclusions drawn from video observations that chum and Chinook salmon behave differently inside the trawl and-or have different swimming abilities, or may react differently to escape path location. However, the EFP allowed for a total bycatch of just 125 Chinook for the A-season trials, and so research operations had to leave the area after making only eight trials. This limited the amount of data obtained about simultaneous Chinook and chum escapement.

Experimental fishing trials during the 2011 B-season were designed to investigate a modification of the excluder design that reduced somewhat the escape path. The hypothesis was that the change might allow slowly-swimming salmon to escape more frequently. The trials showed no change for both chum and pollock escapement. As no Chinook salmon were present where the trials were made, no information was obtained on whether the modification might affect Chinook escapement.

During 2011 the pollock industry also supported a research project to conduct a comprehensive gap analysis of deficiencies in genetic sample locations, sample sizes, and sample quality for Bering Sea and North Pacific Rim chum salmon populations. The project is headed by Dr. Tony Gharrett at the University of Alaska and the objective is to add genetic information for approximately 50 populations to the coast-wide genetic baseline for chum salmon. A second part of the project will develop new, single nucleotide polymorphism (SNP) markers to improve discrimination of coastal western Alaskan chum salmon, including lower Yukon River, Kuskokwim River, and Norton Sound populations.

If successful, the project will provide some new methods that may be used by NOAA Fisheries and Alaska Department of Fish and Game geneticists to detect and estimate the proportions of western Alaska chum salmon stocks taken in both directed and incidental fisheries. In particular, improved stock-or-origin estimates can be used to inform estimates of impacts of groundfish fisheries on chum stocks as well as provide temporal and spatial information that may be useful for forecasts of salmon abundance. This work is relevant to management of western Alaska chum salmon populations that support subsistence and commercial fisheries, and also should provide useful information about other North Pacific Ocean stocks of conservation and treaty interest.

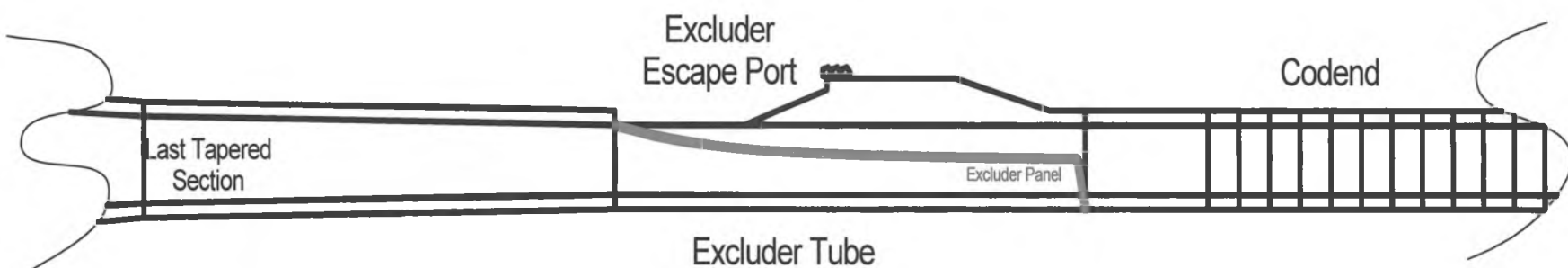
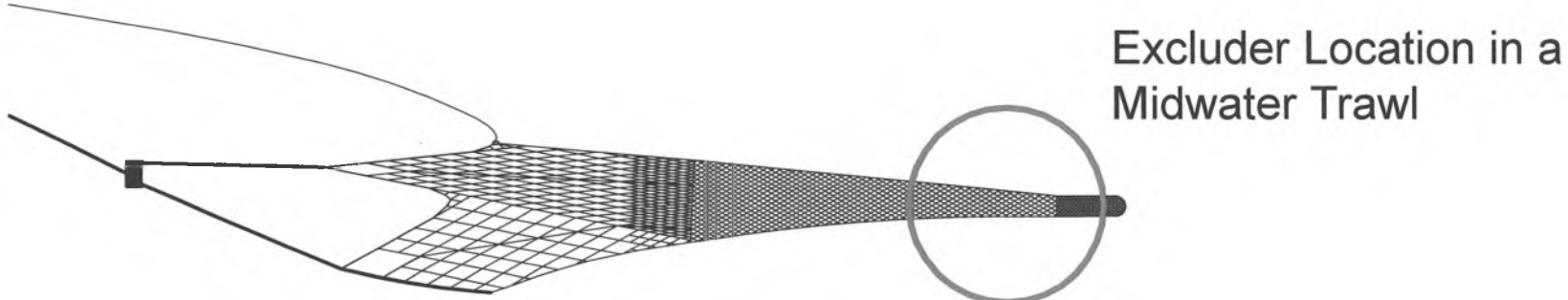
Use of New Gear Technologies

It is estimated that about half of the IPA vessels used salmon-excluder trawls for some portion of trawls made during 2011. One vessel conducted fishing trials that required the use of an excluder-trawl during 2011. A survey-based assessment of the degree that IPA vessels embody new technology to avoid Chinook bycatch will be provided in the 2012 annual report.

Salmon Excluder Update

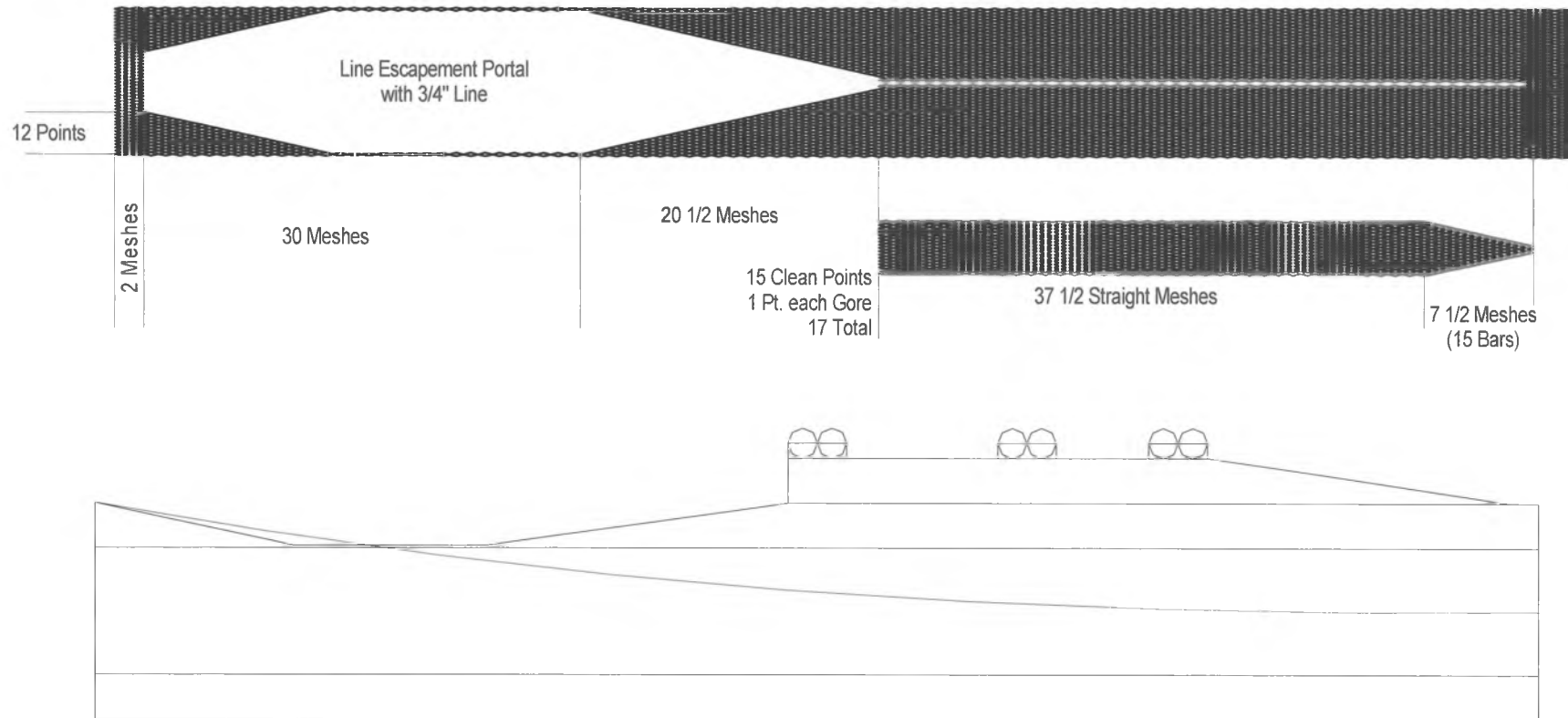
February 2013

Salmon Excluder



2010 EFP Excluder

Tube Excluder Section
100 Meshes Long by 46 Points Wide



Model of 2010 Excluder in Flume Tank



Results of excluder testing on Chinook Escapement; 2009 - 2010

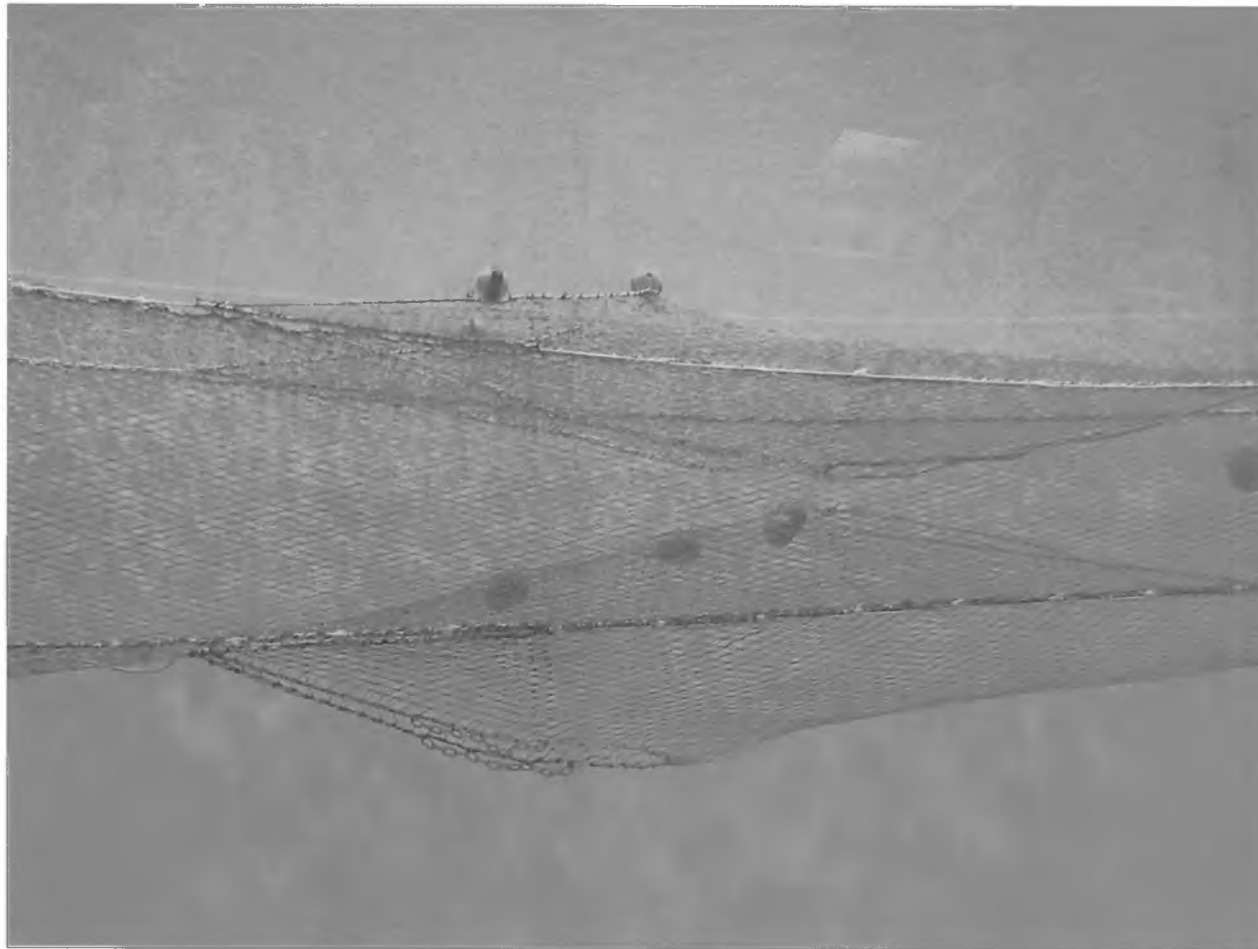
Test /date	Vessel	Codend salmon #	Recap salmon #	Salmon escape %
Winter 2009 P1	Pac Prince	726	91	11.1%
Winter 2009 P2	Pac Prince	1079	209	16.2%
Winter 2009	Starbound	720	70	8.9%
Fall 2009 P1 (chum)	Starbound	196	5	2.5%
Fall 2009 P2 (chum)	Starbound	643	34	5.0%
Winter 2010 P1	Pac Prince	122	62	33.7%
Winter 2010 P2	Pac Prince	37	25	40.3%
Winter 2010 P1	Starbound	150	49	24.6%
Winter 2010 P2	Starbound	38	21	35.6%

Future excluder design

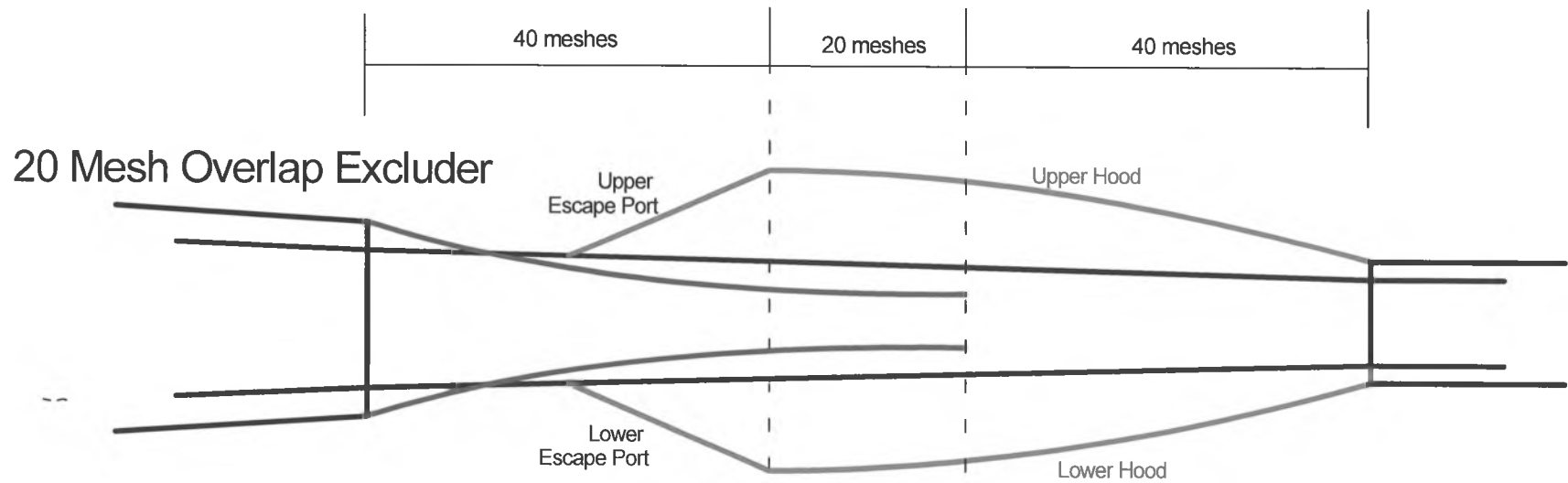
- Provide multiple escapement routes
- Increase both Chinook and chum salmon escapement rates
- Eliminate “touchy” excluder tuning issues
- Stabilize the design for wider horsepower ranges and fishing conditions.

Future excluder design – Over/Under Excluder Concept

Over/Under Excluder – 1:2 scale model in the flume tank.
October 2011..



Over/Under Excluder Development



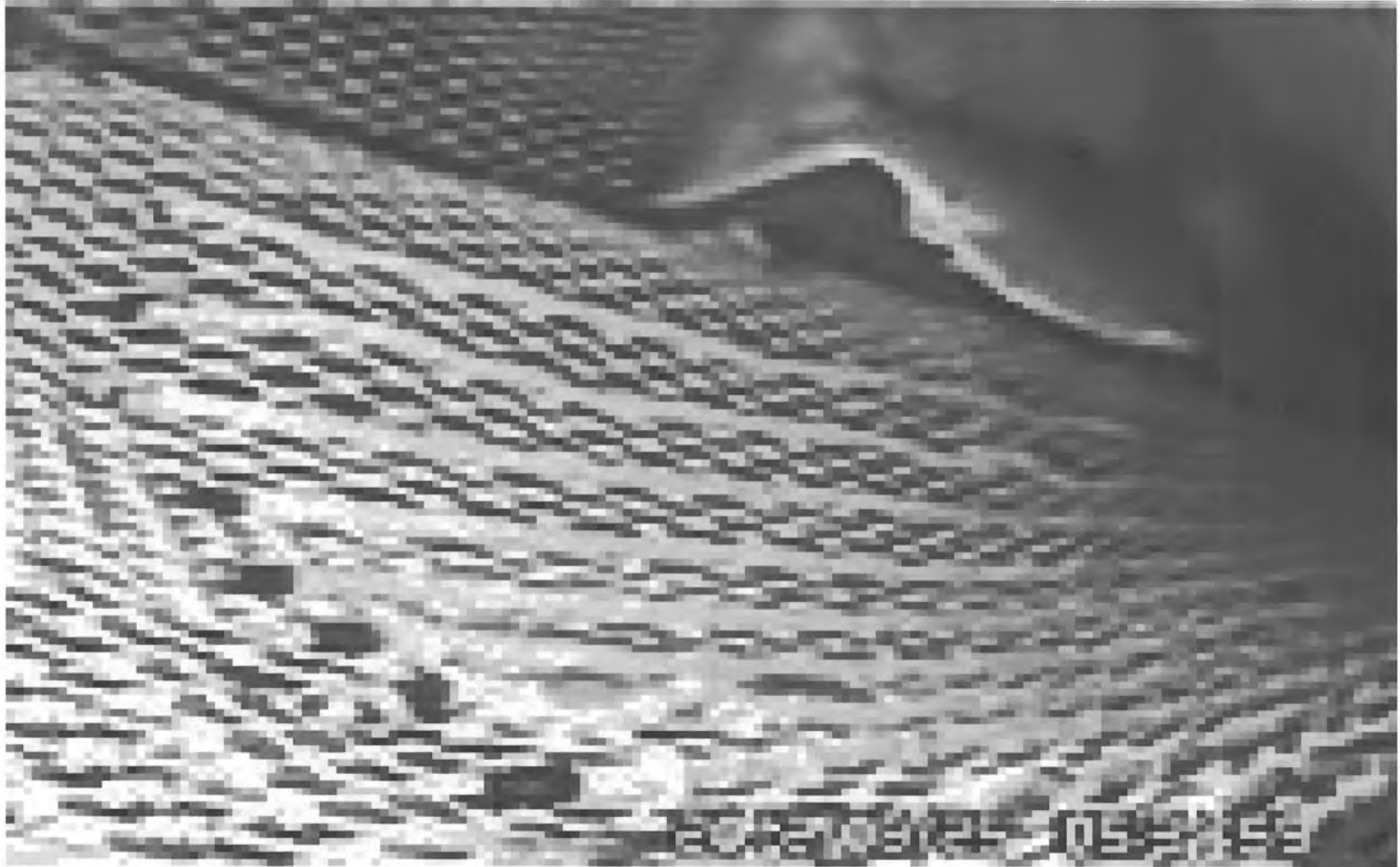
Over/Under Excluder Development

- Initial test fishing with the Over/Under Excluder took place during the 2012 B Season
- 2012 Test Goals:
 - Identify design flaws
 - Refine initial design characteristics
 - Obtain rough escapement estimates for both Chinook and chum salmon.

Over/Under Photos



Over/Under Photos



Over/Under Photos



Inshore Salmon Savings Incentive Plan – SSIP

Managing Chinook Bycatch for the Bering Sea
Inshore Pollock Sector



Bering Sea Pollock Fishery Chinook Bycatch Regulations

- New regulations for Chinook salmon came into place in 2011 – Amendment 91
- Implemented a Hard Cap on Chinook salmon bycatch in the Bering Sea pollock fishery
- Provided 3 Hard Cap options

Amendment 91

- Three Options
 1. 60,000 Chinook Hard Cap with Incentive Plan Agreement (IPA)
 2. 47,591 Chinook Hard Cap with no vessels participating in an IPA
 3. Up to 28,496 Chinook in an Opt Out Pool for vessels choosing not to participate in an IPA when a portion of the fleet does participate in an IPA.

Amendment 91

- Options 1 & 2 Include sub allocations to each pollock sector.
 1. CDQ
 2. Catcher/Processor
 3. Mothership
 4. Inshore

IPA Requirements

1. Provide incentives at the individual vessel level
2. Incentivize vessels to avoid Chinook bycatch at all levels of abundance in all years
3. Reward vessels that successfully avoid Chinook and/or penalize vessels that fail to avoid Chinook

IPA Requirements

4. Incentives must influence fishing decisions at levels below the hard cap
5. Hold Bycatch to a Performance Standard of 47,591 in most years

IPA Requirements

- The Incentive Plan Agreement must describe how each vessel will manage their bycatch to keep total bycatch below the sector level regulatory Performance Standard
 - The Agreement must contain rules to prevent the sum of vessel bycatch within a sector from exceeding that sector's portion of 47,591 in any 3 years within a consecutive 7 year period

INSHORE SECTOR'S SALMON SAVINGS INCENTIVE PLAN - SSIP -



IPAs found at: <http://www.fakr.noaa.gov/sustainablefisheries/bycatch/default.htm>

Inshore SSIP Rules

- Each vessel receives a Base Cap Allocation – its share of 47,591 Performance Standard and an Annual Use Limit – its share of the 60,000 Hard Cap

Inshore SSIP Rules

- Each vessel receives a Base Cap Allocation – its share of 47,591 – the Performance Standard and an Annual Use Limit – its share of the 60,000 Hard Cap
- **Base Cap allocations are made pro rata to a vessel's pollock allocation**

Inshore SSIP Rules

- Each vessel receives a Base Cap Allocation – its share of 47,591 Performance Standard and an Annual Use Limit – its share of the 60,000 Hard Cap
- Base Cap Allocations are made pro rata to a vessel's pollock allocation
- Vessels may not exceed their Base Cap Allocation unless they earn Salmon Savings Credits - *The Incentive* in SSIP

Inshore SSIP Rules

- Each vessel receives a Base Cap Allocation – its share of 47,591 – the Performance Standard and an Annual Use Limit – its share of the 60,000 Hard Cap
- Base Cap Allocations are made pro rata to a vessel's pollock allocation
- Vessels may not exceed their Base Cap Allocation unless they earn Salmon Savings Credits – The *Incentive* in SSIP
- Savings Credits bridge the gap between the Performance Standard and the Hard Cap

Inshore SSIP Rules

- Salmon Savings Credits
 - When a vessel's annual Chinook bycatch is below its Base Cap, Salmon Savings Credits are earned

Inshore SSIP Rules

- Salmon Savings Credits
 - When a vessel's annual Chinook bycatch is below its Base Cap, Salmon Savings Credits are earned
 - One credit earned for every 3 salmon avoided below the Base Cap

Inshore SSIP Rules

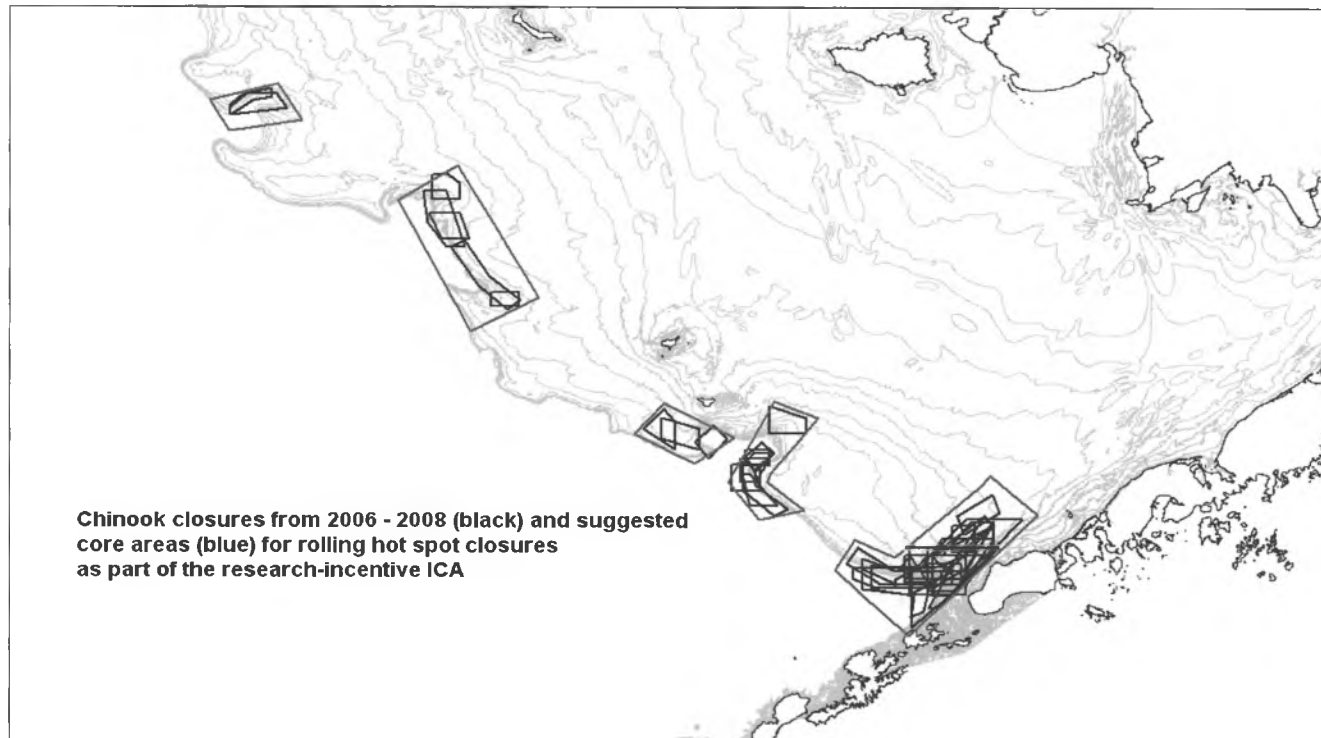
- **Salmon Savings Credits**
 - When a vessel's annual bycatch falls below its Base Cap it earns Salmon Savings Credits.
 - One credit earned for every 3 salmon avoided below the Base Cap.
 - Credits are saved in a Salmon Savings Credit Account until used – Unused credits expire after 5 years

Inshore SSIP Rules

- **Salmon Savings Credits**
 - When a vessel's annual bycatch falls below its Base Cap it earns Salmon Savings Credits.
 - One credit is earned for every 3 salmon avoided below their Base Cap.
 - Credits are saved in a Salmon Savings Credit Account until used – Unused credits expire after 5 years
 - Vessels may not exceed their share of the 60,000 Hard Cap in any given year even if they have Salmon Savings Credits to do so

Inshore SSIP Rules

- Includes a Rolling Hot Spot Program
- Includes a Chinook Conservation Closure in the A Season



Inshore SSIP Summary

- Under the SSIP program the 60,000 Hard Cap is not a Hard Cap in the usual sense.
- SSIP participants have their share of the 60,000 limit available to them only if they earned the necessary Salmon Savings Credits.
- The SSIP rules make it impossible for participants to continuously approach bycatch levels at, or even near, the hard cap.

Inshore SSIP Summary

- SSIP Program contains mechanisms that guarantees average bycatch will be at or below the 47,591 level.
- The 47,591 or less bycatch average is not theoretical or experimental; but rather an **absolute fact**.
- SSIP program provides incentives to keep bycatch at or below 35,000 Chinook salmon



AT-SEA PROCESSORS ASSOCIATION

Partners for Healthy Fisheries

House Special Committee on Fisheries

Chinook Salmon Bycatch Reduction Incentive Plan

February 19, 2013

Amendment 91 Limits

Inshore

Mothership

CDQ

CP

PCC

HSCC

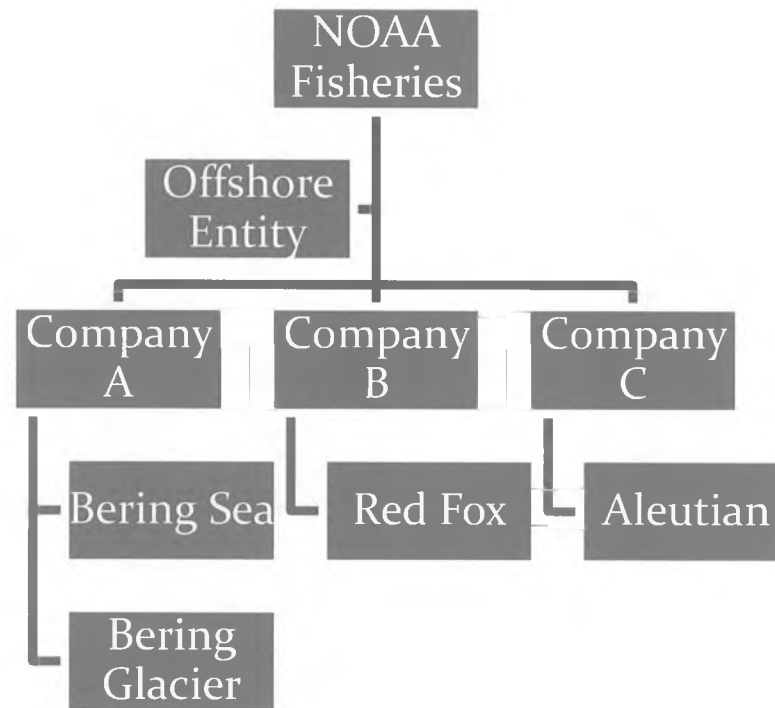
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Annual Threshold Amount		60,000 limit
26,484		33,390
3,707		4,674
3,883		4,896
13,516		17,040
A season		13,818
B season		3,222



A Chinook Salmon Bycatch Avoidance Program

Allocation of Salmon Bycatch Cap



IPA Required Components

1. Incentive(s) that ensure operator of each vessel will avoid Chinook salmon at all times while fishing for pollock in the BS.
2. Rewards for avoiding Chinook salmon, penalties for failure to avoid Chinook salmon at vessel level, or both.
3. Incentive measures to promote reductions in a vessel bycatch rates relative to what would have occurred in absence of the IPA.
4. A description how incentive measures promote savings in any condition of pollock or Chinook salmon abundance in a manner that is expected to influence decisions by vessel operators to avoid Chinook salmon bycatch.



IPA Required Components

5. How the IPA ensures operator of each vessel will manage bycatch to remain below the sector performance standard.
6. Annual reports are due April 1st
 - * comprehensive description of incentive measures
 - * description of how measures affected individual vessels
 - * evaluation of whether measures were effective in achieving salmon savings beyond the levels that would have been achieved in the absence of the measures.
 - * description and rationale of any amendments to the terms of the IPA.
7. Minimum participation
 - * must represent at least 9% pollock quota
 - * at least two unaffiliated AFA companies or CDQ groups.



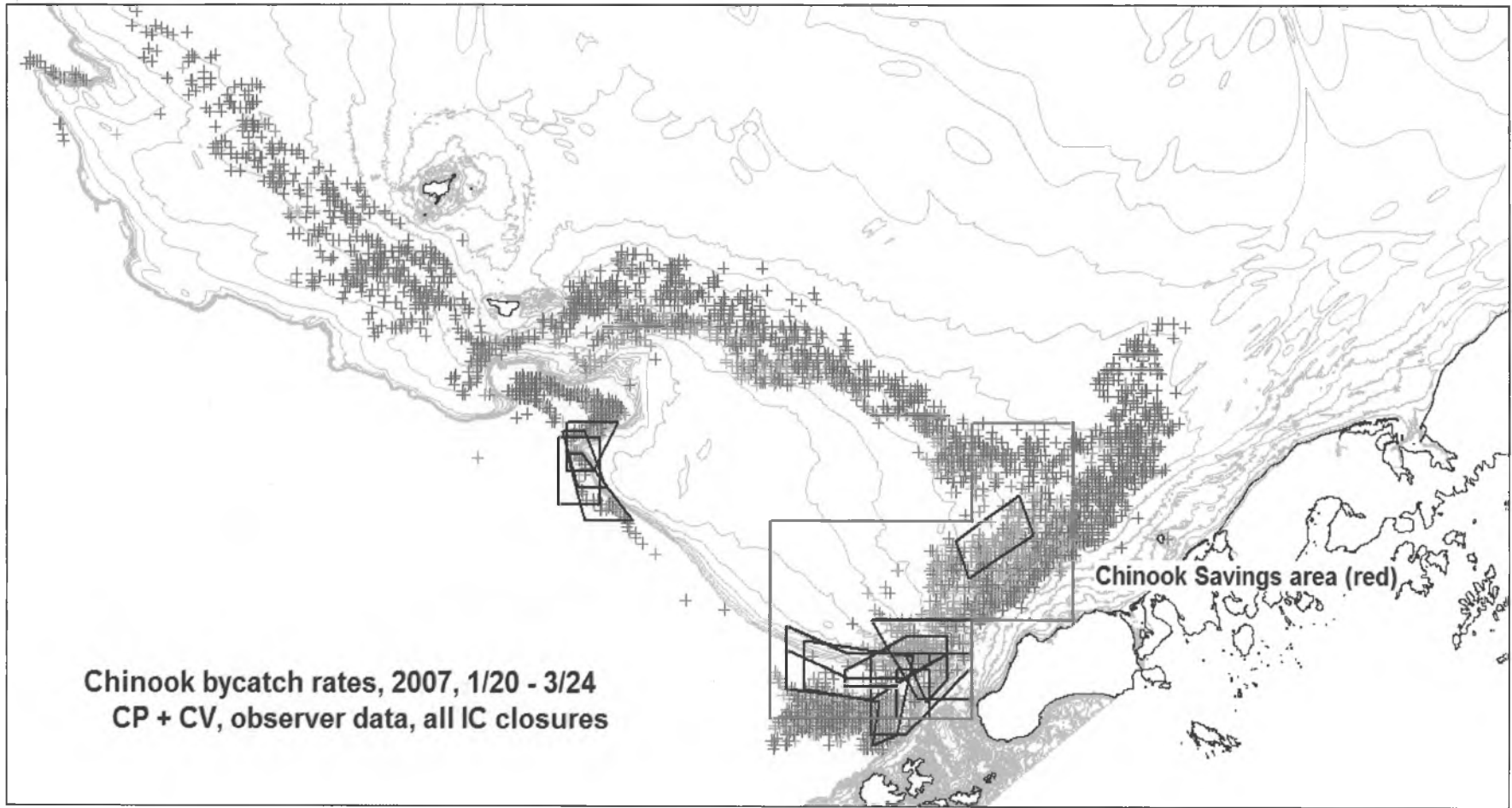
PCC Chinook IPA Development

The RHS program creates incentives to avoid salmon bycatch at low and moderate levels of abundance of salmon on the grounds.

- How to identify *bycatch avoidance areas*?
- Who is allowed to fish inside the areas?
- If a vessel is excluded from avoidance areas.... for how long?

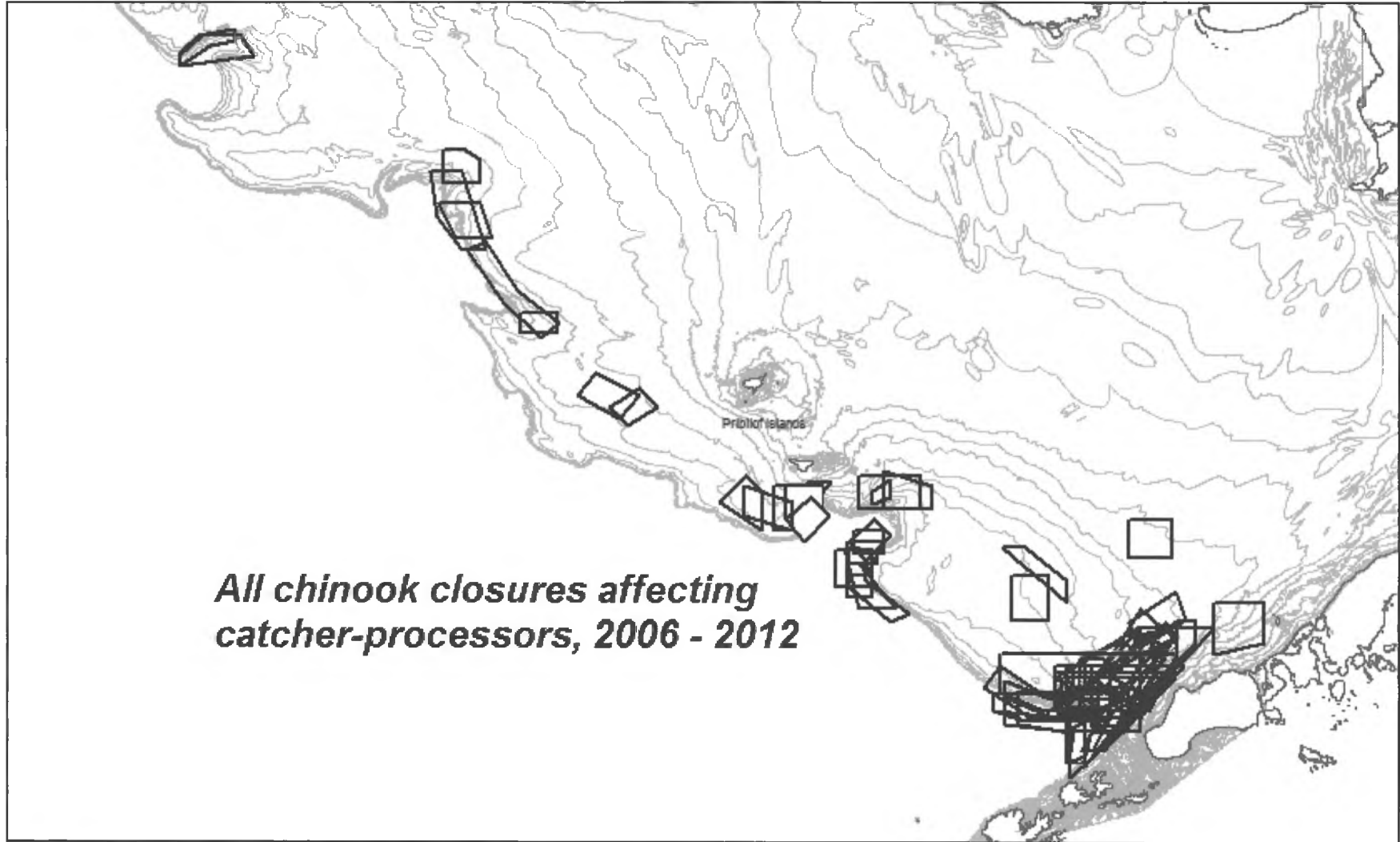


Rolling Hot Spot -- A Season 2007



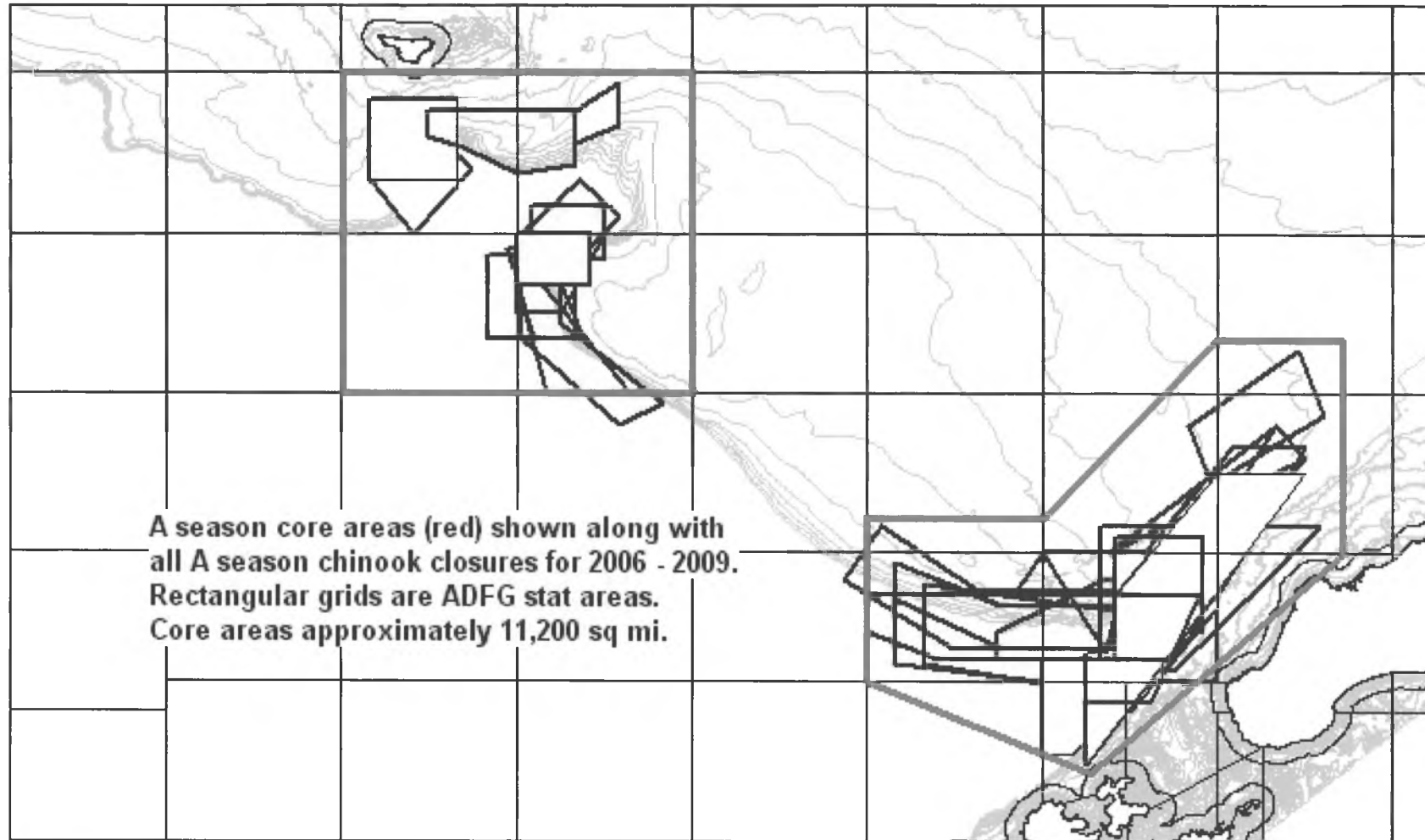
Sea State, Inc.

CP Chinook Closures 2006-2012



Bycatch Avoidance Core Areas

A season



How to identify avoidance areas?

- Bycatch avoidance areas are identified by comparing pollock-fishery bycatch performance* to a *base rate* of Chinook bycatch (n/mt). Areas, within the core areas, with bycatch rates higher than base rate may be specified as avoidance areas.
- The base rate is an important program parameter, and is allowed to change over time to reflect changes in salmon abundance on the grounds.
- Except at the start of the season,** the base rate is calculated as a 3 week rolling average.
- A minimum value (floor) is established at 3.5 Chinook per 100 tons of pollock catch (0.035/mt).
- Vessels are prohibited from fishing in the Chinook Salmon Conservation Area during the A season.

*bycatch data from all the pollock fishery cooperatives.

** the start of the season rate is set equal to base rate from the entire prior A season with same floor. Beginning February 1, a 3 week rolling average during the current A season.



Who is allowed to fish in those areas?

- Vessel bycatch performance is calculated using two week rolling sums of pollock catch and Chinook bycatch (n/mt).
- A vessel with a bycatch rate (n/mt) higher than 75 percent of the base rate must fish outside the bycatch avoidance areas during the current week.



If vessels are excluded from avoidance areas...for how long?

The X-RHS program creates incentives to avoid salmon bycatch at moderate to high levels of abundance on the grounds. The X-RHS adds to the incentives of the RHS by imposing a second vessel performance benchmark based on the amount of CP (fleet) Chinook bycatch.

- All vessels prohibited from fishing in the avoidance areas are subject to the X-RHS incentive.
- Vessel bycatch performance is calculated as Chinook salmon bycatch (n).
- Vessel bycatch performance is compared to a benchmark based on a CP-sector equivalent, cumulative A-season bycatch of 8,500 Chinook.*
- If vessel Chinook bycatch is higher than the benchmark, then it must fish outside of bycatch avoidance areas for 2 weeks.
- Vessel benchmarks are adjusted to compensate for pollock transfers.

*8,500 represents about half of the CP-sector limit of 17,040 Chinook or 63% of the sector annual threshold amount of 13,516 Chinook.



Buffer Components

Limit Buffer -to ensure the bycatch limit can be conserved.
115 salmon

Use Rules

1. A company taking bycatch from the limit must stop fishing.
2. A penalty would be paid for every salmon used.
3. To regain the right to go fishing, a company must replace all limit-buffer salmon: no refund of penalty funds.
4. Established using a company levy in proportion to its pollock allocation.
5. Penalty funds will be redistributed to companies in proportion to its pollock allocation



Buffer Components

Market Buffer

250 salmon

Use Rules

1. A company must use 95 percent of its non-buffer allocation before taking salmon from the market buffer.
2. A company would pay a penalty for every salmon from the market buffer.
3. Established using a company levy in proportion to its pollock allocation.
4. Maximum cap of 30% that any one company can use.
5. Penalty funds will be redistributed to companies in proportion to its pollock allocation.



Draft 2012 – Final Report Due April 1

▶ DRAFT Table 2. CP IPA Chinook Salmon Bycatch Performance, 2012

▶

▶

Season	Pollock (t)	Chinook Salmon (n)	Bycatch Ratio (n/t)
A	218,011	2836	0.013
B	327,003	97	0.002
A + B	545,014	2933	0.005

▶



North Pacific Fishery Management Council – Update on Chinook Bycatch



Diana Evans

North Pacific Fishery Management Council

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North Pacific Fishery Management Council

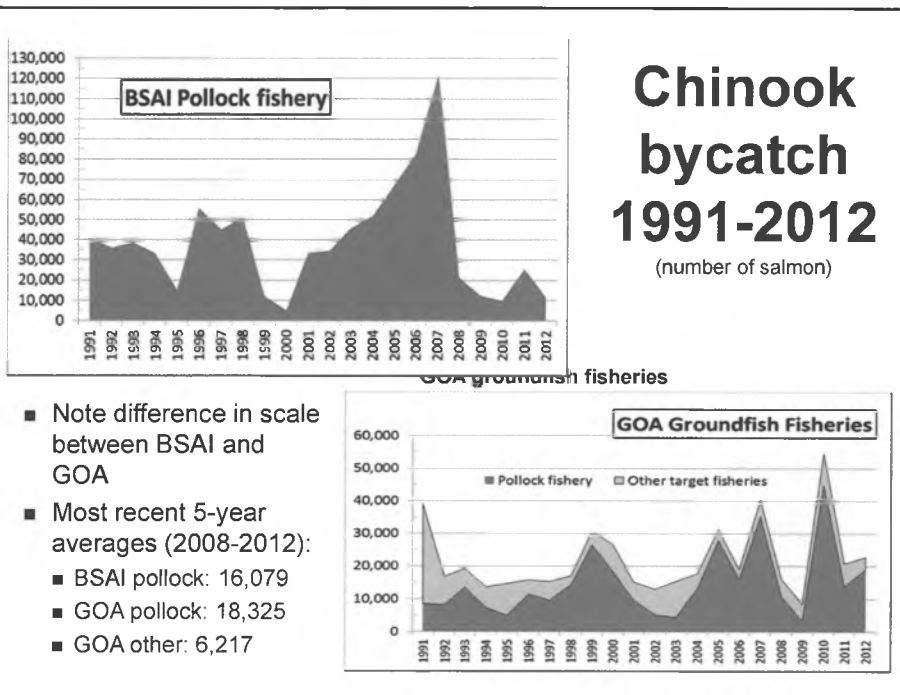
- manages offshore Federal fisheries off Alaska (3-200 miles) with NMFS
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 - Minimize (salmon) bycatch to extent practicable
 - Prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery (e.g., the Alaska groundfish fisheries)
 - Provide for the sustained participation of and minimize adverse impacts on fishing communities

Salmon bycatch in the Alaska groundfish fisheries

NOTE: Council does not regulate any salmon fisheries (State of Alaska), only salmon bycatch occurring in offshore groundfish fisheries

- Trawl fisheries catch Chinook salmon as bycatch
 - In the Bering Sea, bycatch is in the pollock fishery
 - In the GOA, it is mostly in the pollock fishery (~75%), but also in flatfish, Pacific cod, and rockfish fisheries
- By law, bycatch is counted, but cannot be retained or sold

prohibited



What action has the Council taken? Bycatch limits that close the fishery

- Bering Sea pollock fishery
 - 60,000 Chinook salmon bycatch limit, with incentive plans to remain below 47,951 salmon (*implemented 2011*)
 - Apportioned by sector (catcher vessel, catcher processor, mothership, CDQ) and inshore cooperative
 - If sector exceeds its apportionment of 47,591 Chinook salmon 3 times in 7 year period, sector's limit will permanently reduce to lower cap
 - Council receives annual report on incentive programs

What action has the Council taken? Bycatch limits that close the fishery

- GOA pollock fishery
 - 25,000 Chinook salmon bycatch limit (*implemented mid-2012*)
 - Apportioned between the central and western regulatory area pollock fisheries
- GOA non-pollock fisheries
 - Limits currently under review range from 5,000-12,500 Chinook salmon
 - Council final action scheduled for June

What action has the Council taken? Stock of origin research

- Purpose:
 - to understand relationship between Chinook salmon bycatch in the groundfish fisheries and the status of individual Chinook stocks

What action has the Council taken? Stock of origin research

- Bering Sea
 - Basis of Council action in 2009 (PSC limit)
 - bycatch and genetics information from 2005-2007
 - AEQ model provided information on proportional stock of origin of bycatch, broken out to regional and western Alaska river systems
 - Coastal western Alaska is largest component of bycatch
 - Since 2011: systematic sampling procedure for Chinook
 - including full census and increased observer coverage (min. 100%)
 - genetic breakdown of samples presented each April
 - April 2013 is first time will receive complete annual report based on full census and systematic sampling protocol (for 2011)
 - Best information on impact rate to western Alaska
 - bycatch was between 0.7% - 2.4% of combined run sizes in 2011
 - See *Stram and Ianelli paper from AYKSSI, December 2012*

What action has the Council taken? Stock of origin research

- GOA
 - Very limited information to date
 - Insufficient samples for stock composition analysis
 - Indication of presence of stocks from limited samples (primarily from pollock fishery) and coded wire tags
 - Systematic sampling procedure now underway in pollock fishery (result of Council action)
 - Census from observed and unobserved pollock deliveries, but lower observer coverage than Bering Sea
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 - awaiting 2011 results; 2010: stocks present predominantly Pacific Northwest, British Columbia, and coastal southeastern AK
 - Full retention under review in non-pollock fisheries
 - Census sampling will likely not be possible, but other sampling methodology may be used.

What action has the Council taken?

- Extensive outreach to coastal and interior communities
 - Purpose: solicit input on salmon bycatch actions prior to Council action, promote 2-way dialogue
 - Community meetings, participation at subsistence regional advisory council meetings, regional large forums (e.g., AVCP, YRDFA, YRP), statewide teleconferences
- Food bank donations
 - Council amended requirements in 1996 to allow donation of bycaught salmon to food banks
 - Voluntary industry program; heightened participation in recent years, in Bering Sea and GOA
 - Donations of salmon and halibut in 2012:
 - BSAI: 73,000 lbs; ~85% salmon
 - GOA: 30,000 lbs; ~15% salmon

What action is the Council taking? Chinook salmon bycatch reduction in other management actions

- Bering Sea chum salmon bycatch reduction
 - Measures to reduce chum salmon bycatch in pollock fishery need to be tempered by concurrent objective to not increase Chinook salmon bycatch
 - To date, measures under consideration have been shown to exacerbate Chinook bycatch reduction. Council is developing more adaptive approaches.
- Development of bycatch management tools for GOA underway
 - Council considering cooperative management and bycatch avoidance incentives for trawl fisheries
 - Necessary in context of Chinook salmon PSC limits as well as recent halibut and crab protections

Summary

- Chinook salmon bycatch reduction is continuing priority for Council
- Management achieved through hard cap limits as well as incentive programs
- Regular reporting of Chinook salmon bycatch levels allows the Council to react to potential problems



North Pacific Fishery Management Council – Update on Chinook Bycatch



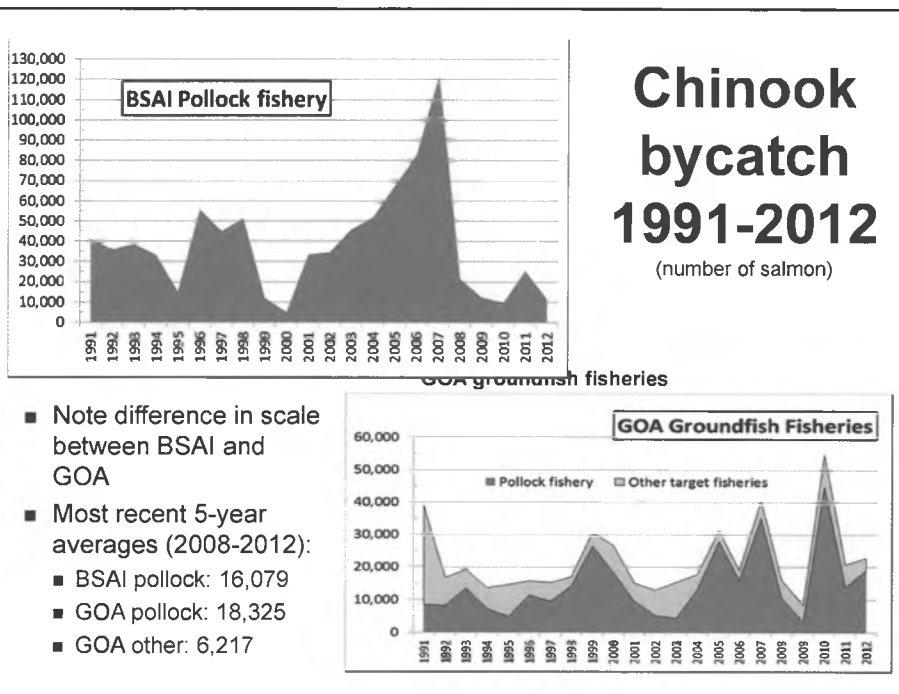
North Pacific Fishery Management Council

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AYKSSI paper-Hypothesis #5: Ocean Bycatch/Ecosystem Overfishing – Fishery caused mortality or changes in Bering Sea ecosystem structure and function have contributed to the decline of AYK-region Chinook salmon stocks.

Diana L. Stram, North Pacific Fishery Management Council and James N. Ianelli, Alaska Fisheries Science Center, NOAA.

Note that per request this paper only addresses the 'ocean bycatch' component of this hypothesis

Introduction

The North Pacific Fishery Management Council (NPFMC or Council) is one of eight regional councils established by the Magnuson Fishery Conservation and Management Act in 1976 to oversee management of the nation's fisheries. With jurisdiction over the million square mile Exclusive Economic Zone (EEZ) off Alaska, the Council has primary responsibility for groundfish management in the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI), including cod, pollock, flatfish, mackerel, sablefish, and rockfish species harvested mainly by trawlers, hook and line longliners and pot fishermen.

While the State of Alaska has management authority for salmon stocks, the NPFMC is responsible for managing the bycatch of salmon species in the groundfish fisheries. Of groundfish fisheries in the Bering Sea, the walleye pollock fishery is responsible for the majority of the salmon taken as bycatch. Chinook and chum salmon are the main species taken incidentally (<0.1% of the salmon bycatch is made up of other species). Consequently, the Council has enacted management measures to minimize the bycatch of Chinook and chum salmon in the pollock fishery since the mid-1990s. Early management measures focused on large scale area closures in the Bering Sea based on historic spatial concentrations of bycatch. These areas would close during times of high bycatch. In 2011 the Council's new management program for Chinook salmon went into effect. This program imposes a strict limit on Chinook salmon bycatch in the pollock fishery. The limits are apportioned by season and fishery sector which if reached would prohibit further pollock fishing for those vessels. Additional measures are being considered currently for chum salmon bycatch by the Council.

Chinook salmon bycatch in the EBS pollock fishery occurs in both the winter (A) and summer (B) seasons (Table 1) while chum salmon bycatch occurs only in the B season (Table 2).

Table 1 Chinook salmon bycatch from the pollock fishery, 1991-2012 by season.

Year	A-season	B-Season	Total
1991	38,791	2,114	40,906
1992	25,691	10,259	35,950
1993	17,264	21,252	38,516
1994	28,451	4,686	33,136
1995	10,579	4,405	14,984
1996	36,068	19,554	55,623
1997	10,935	33,973	44,909
1998	15,193	36,130	51,322
1999	6,352	5,627	11,978
2000	3,422	1,539	4,961
2001	18,484	14,961	33,444
2002	21,794	12,701	34,495
2003	32,609	12,977	45,586
2004	23,104	28,595	51,699
2005	27,285	40,050	67,335
2006	58,287	24,306	82,592
2007	69,139	52,350	121,488
2008	16,574	4,842	21,415
2009	9,683	2,718	12,401
2010	7,624	2,067	9,692
2011	7,136	18,363	25,499
2012	7,773	3,577	11,350

Table 2 Non-Chinook (chum) salmon mortality in BSAI pollock directed fisheries 1991-2012.

Year	Total
1991	28,951
1992	40,274
1993	242,191
1994	92,672
1995	19,264
1996	77,236
1997	65,988
1998	64,042
1999	45,172
2000	58,571
2001	57,007
2002	80,782
2003	189,185
2004	440,468
2005	704,552
2006	309,630
2007	93,783
2008	15,267
2009	46,127
2010	13,222
2011	191,445
2012	22,213

Evidence for/against hypothesis

In conjunction with the Council's decision on a new management program for Chinook salmon bycatch in the EBS pollock fishery a comprehensive analysis (an environmental impact statement or EIS) as required under the National Environmental Policy Act (NEPA) was prepared to assist the policy makers with the impacts of their alternatives management decisions on the environment. This Chinook FEIS (NPFMC/NMFS 2009) evaluated, to the extent possible, proposed hypotheses for bycatch fluctuations, the impact of current levels of bycatch to western Alaskan rivers as well as the potential impact of the proposed management measures. Information below summarizes some of the methods employed and analysis completed in 2009 to facilitate management decisions. Following this an updated (through A-season 2012) analysis is provided using a simplified assumption to estimate the adult equivalent (AEQ) returns to western Alaska.

Why have bycatch levels fluctuated?

In conjunction with the FEIS analysis, potential changes in fishing patterns or practices that could contribute to increased bycatch in some years was investigated. Tow duration based on NMFS observer data indicated that a measure of total hours fishing increased by about 20% in 2006 and 2007. This compares with a nearly three-fold increase in the levels of Chinook bycatch (Figure 1). This suggests that other factors may affect bycatch levels. Increased numbers of Chinook found on the pollock fishing grounds due to run-sizes or environmental conditions clearly affects the magnitude of bycatch. Changes in fishing gear depth were examined to be similar through this period. Anecdotally, trawl gear (dimensions, net material etc.) has changed over time but information on this is unavailable for analysis. Seasonally, for the period 1991-2007 February averages to be the highest month of bycatch in the pollock fishery even though the average tow duration is relative low whereas October tends to be the second-highest month when bycatch occurs and is also when the average tow duration is the highest (Figure 2). Over time, tow duration in October has steadily increased (Figure 3).

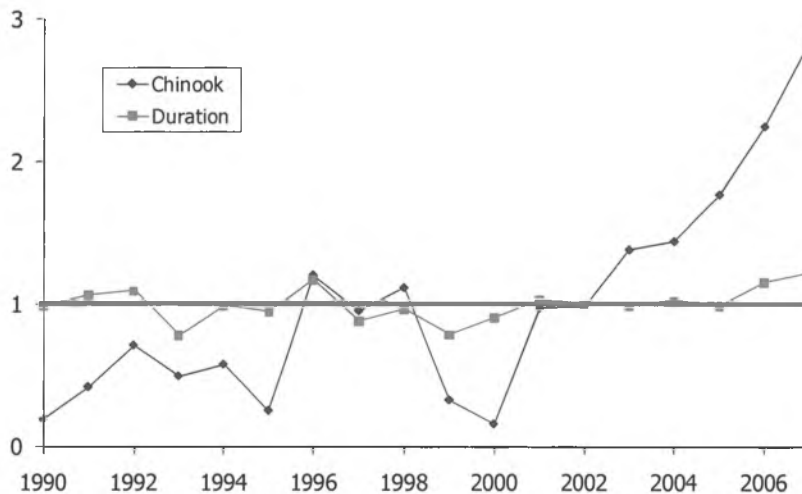


Figure 1. Standardized (to have mean values of 1) relative Chinook catch and pollock fishing effort (annual total hours spent tows).

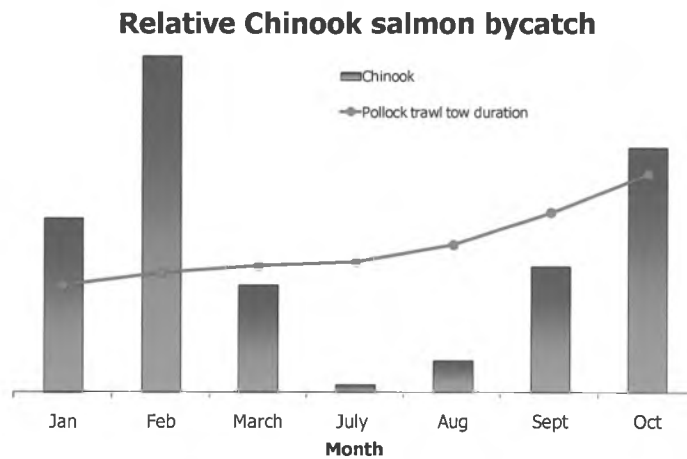


Figure 2. Average relative Chinook bycatch (columns) and tow duration (marked line) by month based on NMFS observer data, 1991-2007.

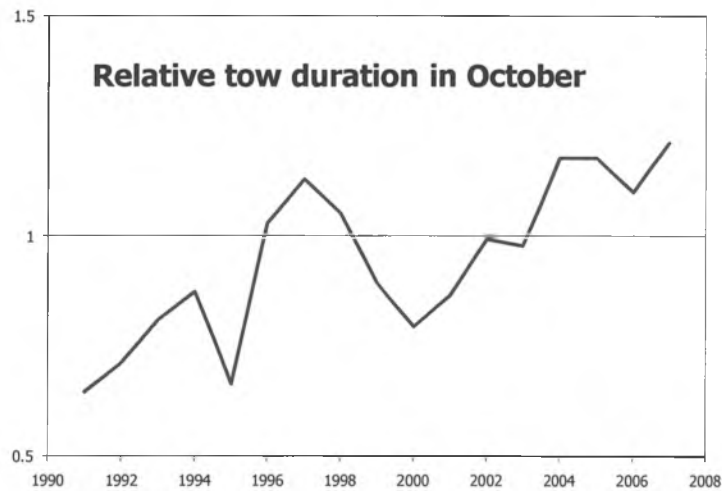


Figure 3. Average relative tow duration (scaled to have mean value of 1.0) for October based on NMFS observer data, 1991-2007.

AEQ analysis of Chinook bycatch

An adult equivalency model was developed for use in the FEIS (NPFMC/NMFS 2009). To understand impacts on Chinook populations, a method was developed to estimate how the different bycatch numbers would propagate to adult equivalent spawning salmon. Estimating the adult equivalent bycatch is necessary because not all salmon caught as bycatch in the pollock fishery would otherwise have survived to return to their spawning streams. Currently, accurate in-season Chinook salmon abundance levels are unavailable. Therefore, the analysis relied on analyses of historical data. Developing regulations designed to reduce the impact of bycatch requires methods that appropriately assess the impact of bycatch on the various salmon populations. A stochastic “adult equivalence” model was developed, which accounts for sources of uncertainty. The model is an extension of Witherell et al.’s (2002) evaluation, and relaxes a number of that study’s assumptions.

Adult-equivalency (AEQ) of the bycatch was estimated to translate how different management cap levels may affect Chinook salmon stocks. This is distinguished from the annual bycatch numbers that are recorded by observers each year for management purposes. The AEQ bycatch applies the extensive observer datasets on the length frequencies of Chinook salmon found as bycatch and converts these to the ages of the bycaught salmon, appropriately accounting for the time of year that catch occurred. Coupled with information on the proportion of salmon that return to different river systems at various ages, the bycatch-at-age data is used to pro-rate, for any given year, how bycatch affects future potential spawning runs of salmon.

Evaluating impacts to specific stocks was done by using historical scale-pattern analysis (Myers et al. 1984, Myers and Rogers 1988, Myers et al. 2003) and preliminary genetics studies from samples collected in 2005, 2006 and 2007 (Seeb et al. 2008). While sample collection issues exist and different methodologies were employed (scale pattern analyses and genetic analyses), these stock estimates nonetheless provide similar overall proportions of between 54-60% for western Alaska. The consistency of these results from these different methodologies lends credibility to this general estimate. Where possible, historical run sizes were contrasted with AEQ mortality arising from the observed pollock fishery Chinook bycatch to river of origin. Additional information on the methodology for the AEQ analysis is available in Chapter 3 of the FEIS (NPFMC/NMFS 2009).

One issue that should be highlighted in estimating the AEQ to regions of origin was in equating the actual bycatch levels to the samples collected opportunistically for genetics between 2005 to 2007. The Seeb et al. (2008) study analyzed samples taken from the bycatch during the 2005 B season, both A and B seasons during 2006, and a sample from an excluder test fishery during the 2007 A season. Where possible, the genetics samples from the bycatch were segregated by major groundfish bycatch regions. Effectively, this entailed a single region for the entire fishery during winter (which is typically concentrated in space to the region east of 170°W) and two regions during the summer, a NW region (west of 170°W) and a southeast region (east of 170°W). The genetic sampling distribution varies considerably by season and region compared to the level of bycatch.

The samples used in the Seeb et al. (2008) analysis were obtained opportunistically for a study to evaluate using scales and other tissues as collected by the NMFS observer program for genetic sampling. Unfortunately, during this study, the collected samples failed to cover the bycatch in groundfish fisheries in a comprehensive manner. For example, in 2005 most sampling was completed prior to the month (October) when most of the bycatch occurred (Figure 4). To account for these sampling issues we computed a weighted average of the samples over years within regions and seasons. The 2005 B-season stock composition results were given one third of the weight since sampling effort was low during October of that year (relative to the bycatch) while the 2006 B-season stock composition data was given two-thirds of the weight in simulating stock apportionments. For the A season, the 2007 data (collected from a limited number of tows) were given one fifth the weight while the 2006 was weighted 4 times that value.

Once these mean stock composition estimates (and associated uncertainties) were obtained, it was necessary to apply the stratum-specific stock composition levels (Table 3) to the stratum specific bycatch totals to arrive at an annual stock-specific bycatch level for application in the model (Figure 5). An important feature of this analysis is that the bycatch amounts by location and season were used explicitly for the estimates of the relative contribution of bycatch from different salmon regions. This is also an important distinction from previous studies (e.g., Myers et al, 2003) which assumed that the stock identification samples were proportional to the season and area specific bycatch over all years.

For the purposes of assigning the bycatch to region of origin, the level of uncertainty is important to characterize. While there are many approaches to implement assignment uncertainty, the method chosen here assumes that the stratified stock composition estimates are unbiased and that the assignment

uncertainty based on a classification algorithm (Seeb et al. 2008) adequately represents the uncertainty (i.e., the estimates and their standard errors are used to propagate this component of uncertainty). Inter-annual variability is introduced two ways: (1) by accounting for inter-annual variability in bycatch among strata; and (2) by using the point estimates (and errors) from the data over the different years (2005-2007) while weighting appropriately for the sampling intensity. The procedure for introducing variability in regional stock assignments of bycatch followed a Monte Carlo procedure with the point estimates and their variances used to simulate beta distributed random variables (which have the desirable property of being bounded by 0.0 and 1.0) and applied to the catch weightings (for the summer/fall (B) season) where areas are disaggregated. Areas were combined for the winter fishery since the period of bycatch by the fishery is shorter and from a more restricted area.

Application of GSI to estimate the composition of the bycatch by reporting region suggests that, if the goal is to provide estimates on the stock composition of the bycatch, there is a need to adjust for the magnitude of bycatch occurring within substrata (e.g., east and west of 170°W during the B season, top panels of Fig. 5). Applying the stock composition results presented in over different years and weighted by catch gives stratified proportions that have similar characteristics to the raw genetics data (Table 4). Importantly, these stratified stock composition estimates can be applied to bycatch levels in other years which will result in overall annual differences in bycatch proportions by salmon stock region. These simulations can be characterized graphically in a way that shows the covariance structure among regional stock composition estimates. This application extrapolates beyond the current analysis of these genetic data however and additional investigation of the temporal variation in stock composition is recommended.

The preliminary stock composition estimates for this more recent study based on the genetics are shown broken out by regions, year and season for the 9 stock units identified (Table 3). Accounting for sampling variability, the mean stock compositions by strata, and mean apportionments of the bycatch to stock (region) of origins by area and season of the pollock fishery are shown in Table 4.

While stock units differ from previous studies in levels of aggregation, results for western Alaskan aggregate river systems (e.g., AYK region) are similar to the scale-pattern study presented by Myers and Rogers (1988) and Myers et al. (2003; Table 5). The three studies indicate similarities in overall estimates of stock composition by river system even though aggregation levels, years of samples, and methodologies differ (Table 5). However, comparisons of stock composition estimates from other areas are more variable. For example the contribution from Cook Inlet stocks ranges from 4%-31% amongst studies while Russian stocks vary from 2%-14% (Table 5). There is particular variation amongst the two scale patterns studies (Myers and Rogers 1988 and Myers et al. 2003) for these other stocks. Impacts were characterized in aggregate Coastal western Alaska grouping (which includes the lower Yukon, Kuskokwim and other minor stocks) as well as by individual river system.

Table 3. ADF&G preliminary estimates of stock composition based on genetic samples stratified by year, season, and region (SE=east of 170°W, NW=west of 170°W). Standard errors of the estimates are shown in parentheses and were used to evaluate uncertainty of stock composition. Source: Seeb et al. 2008.

Year / Season / Area	PNW	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Russia	TBR	Upper Yukon	Other
2005 B SE	45.3%	34.2%	5.3%	0.2%	8.8%	0.6%	3.3%	0.0%	2.4%
N = 313	(0.032)	(0.032)	(0.019)	(0.003)	(0.021)	(0.005)	(0.016)	(0.001)	(0.015)
2005 B NW	6.5%	70.9%	2.2%	4.7%	6.7%	2.0%	3.5%	2.8%	0.7%
N = 543	(0.012)	(0.047)	(0.011)	(0.013)	(0.042)	(0.007)	(0.012)	(0.009)	(0.008)
2006 B SE	38.4%	37.2%	7.5%	0.2%	7.0%	0.6%	4.3%	0.1%	4.7%
N = 309	(0.029)	(0.032)	(0.020)	(0.004)	(0.019)	(0.005)	(0.017)	(0.002)	(0.020)
2006 B NW	6.4%	67.3%	3.0%	8.0%	2.1%	3.3%	0.5%	8.0%	1.4%
N = 296	(0.016)	(0.035)	(0.020)	(0.020)	(0.016)	(0.013)	(0.007)	(0.019)	(0.014)
2006 A All	22.9%	38.2%	0.2%	1.1%	31.2%	1.1%	1.1%	2.3%	1.9%
N = 902	(0.015)	(0.038)	(0.004)	(0.005)	(0.039)	(0.004)	(0.007)	(0.006)	(0.011)
2007 A All	9.4%	75.2%	0.1%	0.5%	12.0%	0.2%	0.1%	0.1%	2.4%
N = 380	(0.016)	(0.031)	(0.004)	(0.005)	(0.025)	(0.003)	(0.002)	(0.003)	(0.014)

Table 4. Mean values of catch-weighted stratified proportions of stock composition based on genetic sampling by season, and region (SE=east of 170°W, NW=west of 170°W). Standard errors of the estimates (in parentheses) were derived from 200 simulations based on the estimates from Table and weighting annual results as explained in the text.

Season / Area	PNW	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Russia	TBR	Upper Yukon	Other
B SE	45.0% (0.025)	34.7% (0.024)	5.1% (0.017)	0.1% (0.002)	8.6% (0.016)	0.6% (0.004)	3.4% (0.014)	0.0% (0.001)	2.4% (0.014)
B NW	6.4% (0.010)	68.9% (0.023)	2.6% (0.012)	6.6% (0.011)	4.4% (0.019)	2.7% (0.007)	1.8% (0.006)	5.6% (0.012)	1.0% (0.008)
A All	12.1% (0.012)	67.7% (0.021)	0.1% (0.003)	0.6% (0.004)	16.0% (0.019)	0.4% (0.002)	0.2% (0.002)	0.6% (0.003)	2.3% (0.010)

Table 5. Comparison of stock composition estimates for three different studies on Chinook bycatch samples taken from trawl fisheries in the eastern Bering Sea.

Study	Myers and Rogers (1988)			Myers et al (2003)			Seeb et al. 2008			
Years sampled	1979-1982			1997-1999			2005-2007 ¹			
Stocks and estimated aggregate % composition in bycatch	Western AK	60%			56%					
		Yukon	Bristol Bay	Kuskokwim	Yukon	Bristol Bay	Kuskokwim			
		17%	29%	24%	40%	34%	26%			
Smaller scale breakouts (where available) listed to the right (with associated % contrib. of aggregate below)	Coastal WAK (also includes Norton Sound)							48%		
							Lower Yukon	Kuskokwim	Bristol Bay	
							Na	Na	Na	
	Middle Yukon							3%		
	Upper Yukon							3%		
	NAK Penin							13%		
	Cook Inlet	17%			31%			4%		
	SEAK/Can	9%			8%					
	TBR							2%		
	PNW ²							23%		
Russia	14%			5%			2%			
Other ³							3%			

¹note for purposes of comparison, only 2006 stock composition estimates *averaged annually and across regions* are shown here.

²PNW is an aggregate of 54 stocks from British Columbia, Washington, Oregon and California. For a full list of stocks included see Table 3-7 of FEIS (NPFMC/NMFS 2009).

³'other' is comprised of minor components after aggregation to major river systems as described in Table 3-7 of FEIS (NPFMC/NMFS 2009).

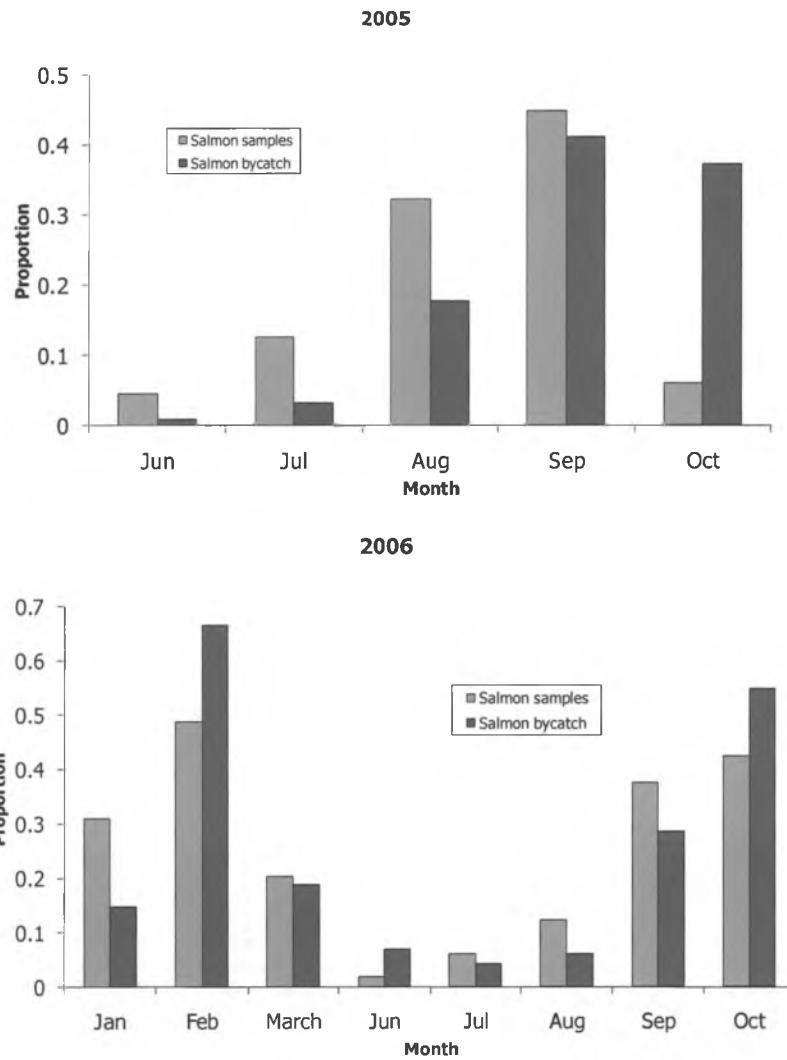


Figure 4. Proportion of Chinook salmon samples collected for genetics compared to the proportion of bycatch by month for 2005 B-season only (top panel) and 2006 A and B season combined (bottom panel).

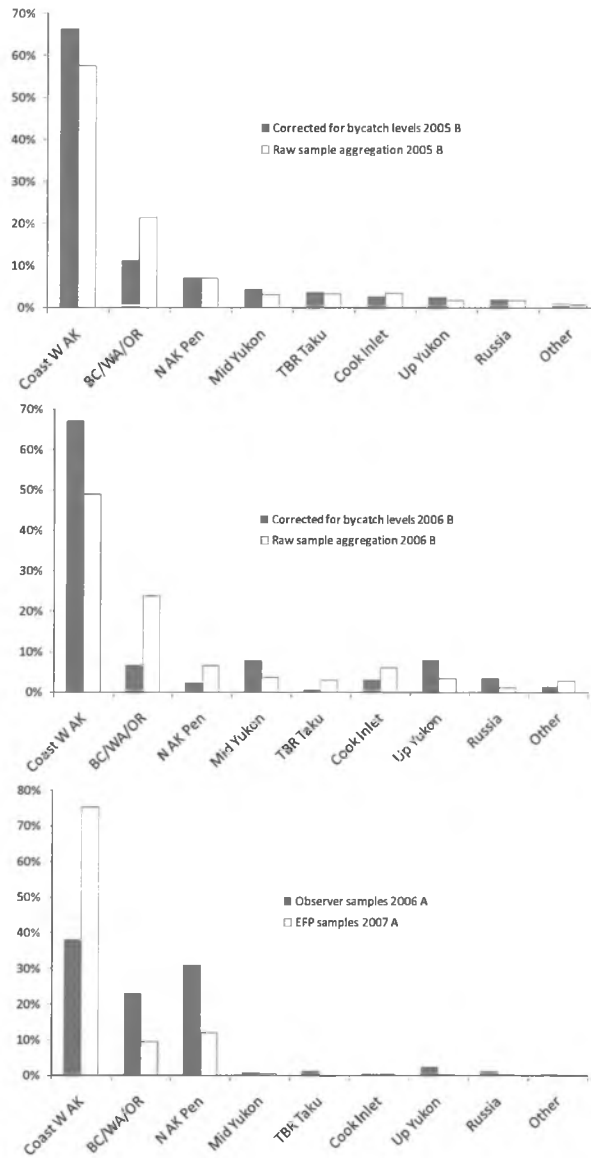


Figure 5. Chinook salmon bycatch results by reporting region for 2005 B season (top), 2006 B season (middle), and the 2006 and (partial sample) of 2007 A seasons (bottom). The top two panels include uncorrected results where bycatch differences between regions (east and west of 170°W) are ignored (empty columns).

AEQ results and estimated proportions to western Alaska

The pattern of bycatch relative to AEQ is variable. In some years, the bycatch records may be below the actual AEQ, due to the lagged impact of previous years catches. For example, in 2000, as shown in Figure 6, actual bycatch is below the predicted AEQ bycatch. This is because 1996-1998, the actual bycatch was high. The impacts from those high bycatch years show up in the AEQ bycatch for subsequent years. Some of the Chinook salmon caught as bycatch in those years would not have returned to their river of origin in the year of bycatch. Based on their age and maturity, they might have returned up to one to four years later. Some proportion of the bycatch would not have returned in any year due to ocean mortality.

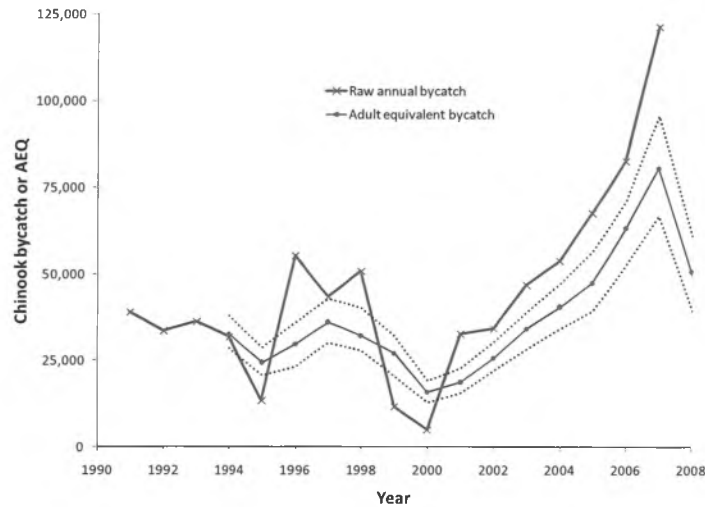


Figure 6. Time series of Chinook actual and adult equivalent bycatch from the pollock fishery, 1991-2007 (2008 raw annual bycatch also indicated separately). The dotted lines represent the uncertainty of the AEQ estimate, due to the combined variability of ocean mortality, maturation rate, and age composition of bycatch estimates.

Historical estimates of AEQ are shown for the aggregate coastal western Alaska stocks (Figure 7; which includes the lower Yukon River, Kuskokwim, Bristol Bay and other components). Note that indicating historical AEQ removals by region implies that the relative distribution of salmon bycatch occurring in space and time would be the same as what was observed during the genetics sampling years (2005-2007). As described previously, the relative intensity of inter-annual patterns of pollock fishing areas and seasons affects the relative contribution of various stocks by year in the bycatch (Figure 8). As the proportion of fishing in the NW region of the EBS increases, the proportional contribution of Upper Yukon Chinook in the bycatch increases. Likewise the relative proportional increase in fishing in the SE results in an increase in the bycatch of Chinook stocks from the Pacific Northwest.

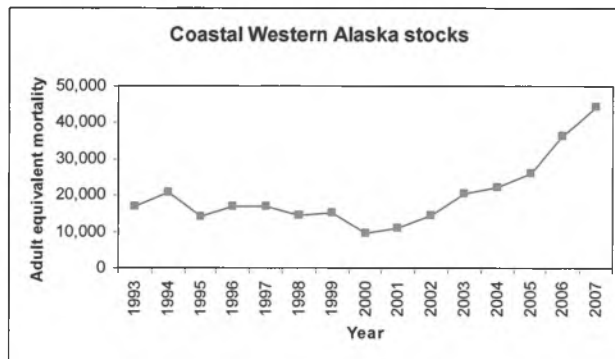


Figure 7. Annual estimated pollock fishery adult equivalent removals on stocks from the Coastal western Alaska returns, 1993-2007.

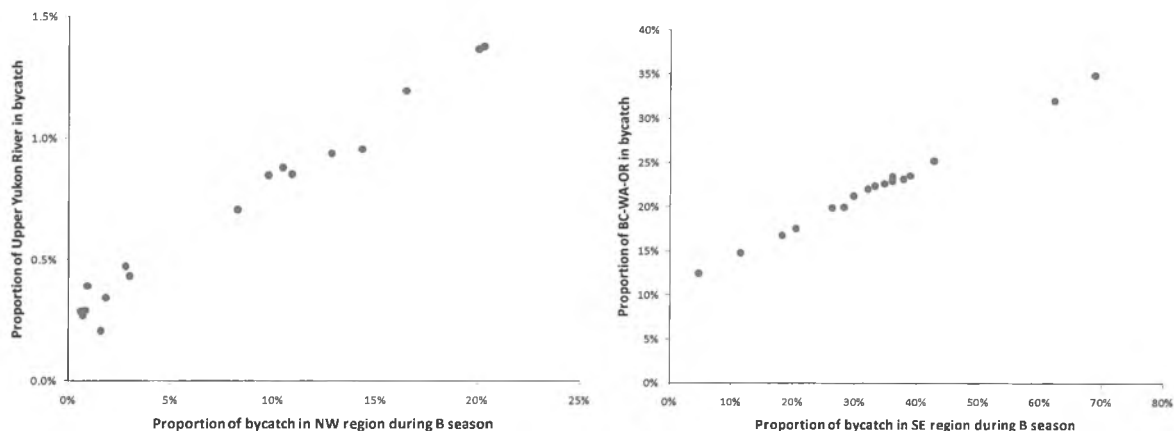


Figure 8. Illustration of how the overall proportion of Upper Yukon River relates to the bycatch proportion that occurs in the NW region (west of 170°W; top panel) and how the proportion of the BC-WA-OR (PNW) relates to the SE region (east of 170°W; bottom panel) during the summer-fall pollock fishery, 1991-2007.

Update to AEQ analysis

A short study extends the analysis provided in the FEIS (and summarized above) through to 2012, by relating season- and area-specific PSC totals with the estimates of impact on numbers of returning adult equivalent Chinook salmon. Without re-running the AEQ model, it is possible to derive a simple calibration using regression analysis against available data on the absolute PSC levels by season and region in order to predict the anticipated impact of bycatch on in-river runs.

Two pieces of information are required. First, a time series of AEQ estimates is needed, which take into account age structure of the PSC, where and when the PSC occurred, the maturation rates observed for Chinook salmon, and the available information on stock identification. These are taken from the FEIS, and provided in Table 6. Second, Chinook salmon PSC by the pollock fleet in the eastern Bering Sea, updated through A-season 2012 (i.e., the winter fishery), are in Table 7.

Since the AEQ model from the EIS clearly indicates a lag effect (e.g., Fig. 6), and given that genetic estimates of stock identification vary by bycatch locales, creating a simple proxy approach that retains these characteristics was desired. For example, let the AEQ (y_t) estimate in year t be

$$y_t = \beta_0 + \beta_1 T_{t-1} + \beta_2 T_{t-2} + \beta_3 A_t + \beta_4 B_{t-1}^{SE} + \beta_5 B_{t-1}^{NW} \dots$$

where T_{t-1} is the total Chinook PSC in the previous year, A_t is the PSC in the A-season in year t , B_{t-1}^{NW} is the PSC in the NW region in the previous year's B-season and so on. The coefficients β_i are parameters to be estimated. A variety of models were proposed and AIC (Akaike 1974) statistic was used as a model selection criteria.

A stepwise model selection procedure ("stepAIC", Crawley 2007) in R was used to select among diverse sets of models. For coastal western Alaska Chinook salmon stocks, the following model was selected:

lm(formula = AEQ ~ A_0 + A_1 + BNW_0 + BNW_1 + BSE_0 + BSE_1)

with coefficients and diagnostics:

Residuals:					
Min	1Q	Median	3Q	Max	
-1522.4	-497.6	-137.8	574.0	1455.7	
Coefficients:					
	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	5854.33118	589.69481	9.928	2.24e-05	***
A_0	0.34787	0.02317	15.016	1.39e-06	***
A_1	0.20676	0.03171	6.521	0.000328	***
BNW_0	0.32788	0.10000	3.279	0.013506	*
BNW_1	0.30027	0.10223	2.937	0.021804	*
BSE_0	-0.13617	0.03739	-3.642	0.008263	**
BSE_1	0.10771	0.03604	2.989	0.020265	*
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1					
Residual standard error: 1106 on 7 degrees of freedom					
Multiple R-squared: 0.9931, Adjusted R-squared: 0.9872					
F-statistic: 167.8 on 6 and 7 DF, p-value: 3.346e-07					

all indicating a reasonable fit (~99% of the variability explained).

In words, this model indicates that coastal western Alaska Chinook salmon AEQ in year t can be well approximated with Chinook salmon PSC records on A-season catches in years t and $t-1$ (A_0 and A_1 in the notation above) together with the same statistics for B-season but stratified to be east and west of 170°W (i.e., columns 2, 4, and 5 of Table 7 with appropriate lags). Applying recent data allows one to estimate updated AEQ impacts for coastal western Alaska and for 2011 the impact ranged from 5.4 thousand to 11.5 thousand Chinook salmon (Fig. 9; Table 8). Even though the 2012 A-season Chinook PSC presently was relatively low (less than 9,000 fish) due to the higher PSC in 2011 (25,510 fish) the impact (in AEQ –in rivers terms) has already reached 12.5 thousand Chinook salmon (with 95% prediction interval ranging from 9.5 to 15.4 thousand fish).

As noted in the FEIS (NPFMC/NMFS 2010), genetic delineation was plausible for the middle and upper Yukon Chinook runs. The same model selection process resulted in a model that indicated for the Upper Yukon stock that the PSC in the current-year A season and regionally split B-seasons explained nearly 96% of the variability:

```

lm(formula = AEQ ~ A_0 + BNW_0 + BSE_0 + BSE_1)      Upper Yukon
Residuals:
  Min       1Q   Median       3Q      Max
-70.747 -15.037   1.346  20.120  49.114

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 61.8881130 18.7598286   3.299  0.00925 **
A_0          0.0028181  0.0006251   4.509  0.00147 **
BNW_0       0.0406229  0.0031203  13.019 3.83e-07 ***
BSE_0      -0.0034026  0.0011900  -2.859  0.01880 *
BSE_1       0.0034277  0.0010548   3.250  0.01000 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 36.44 on 9 degrees of freedom
Multiple R-squared: 0.9713, Adjusted R-squared: 0.9586
F-statistic: 76.23 on 4 and 9 DF, p-value: 6.143e-07

```

Projecting this model forward for the Upper Yukon indicates variability with the upper 95% confidence bands from 2008-2012 ranging from 180 fish to 387 fish (Fig. 10; Table 9).

For the middle Yukon region, the characteristic and selected model was very similar to results from the Upper Yukon:

```

lm(formula = AEQ ~ A_0 + BNW_0 + BSE_0 + BSE_1)      Middle Yukon
Residuals:
  Min       1Q   Median       3Q      Max
-86.00 -14.69  -1.94  23.43  54.11

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 71.3855795 22.7854771   3.133  0.01206 *
A_0          0.0025905  0.0007592   3.412  0.00772 **
BNW_0       0.0493457  0.0037899  13.020 3.83e-07 ***
BSE_0      -0.0036238  0.0014453  -2.507  0.03346 *
BSE_1       0.0040784  0.0012812   3.183  0.01112 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 44.26 on 9 degrees of freedom
Multiple R-squared: 0.9697, Adjusted R-squared: 0.9562
F-statistic: 71.95 on 4 and 9 DF, p-value: 7.897e-07

```

Results for the middle Yukon show the upper 95% confidence bands from 2008-2012 ranging from 210 fish to 451 fish (Fig.11; Table 10).

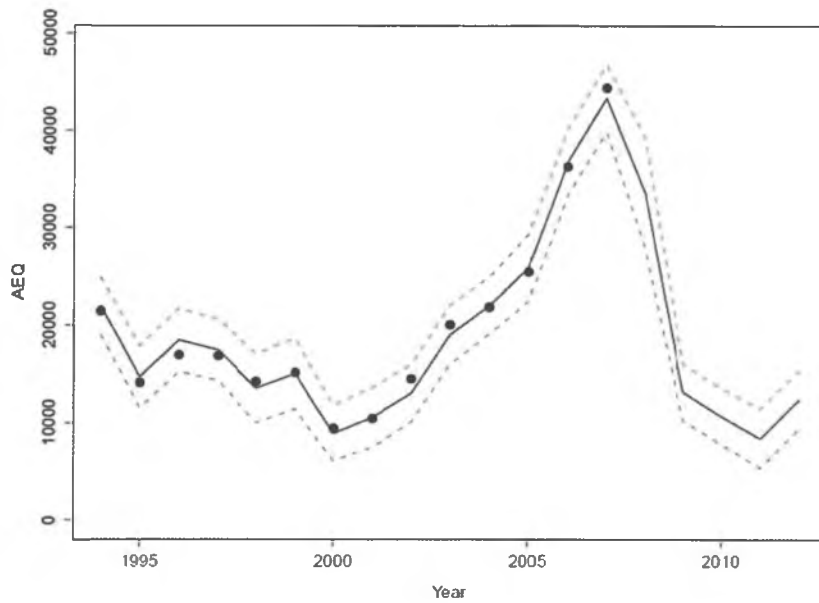


Figure 9. Estimated **coastal western Alaska** Chinook salmon adult equivalent mortality (AEQ; in numbers of fish) due to PSC in the eastern Bering Sea pollock fishery.

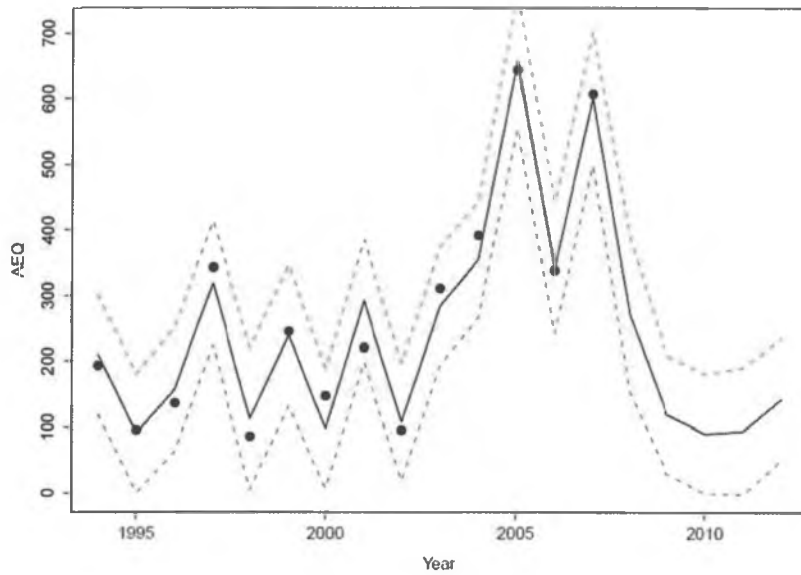


Figure 10. Estimated **Upper Yukon** Chinook salmon adult equivalent mortality (AEQ; in numbers of fish) due to PSC in the eastern Bering Sea pollock fishery.

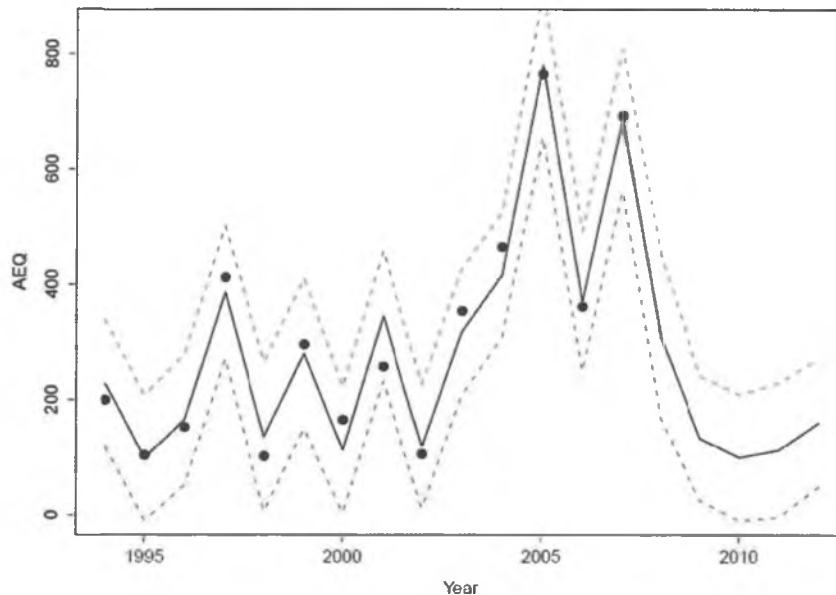


Figure 11. Estimated **Middle Yukon** Chinook salmon adult equivalent mortality (AEQ; in numbers of fish) due to PSC in the eastern Bering Sea pollock fishery.

Table 6. Median values of stochastic simulation results of AEQ Chinook mortality attributed to the pollock fishery by region, 1994-2007. These simulations include stochasticity in natural mortality (Model 2, CV=0.1), PSC age composition (via bootstrap samples), maturation rate (CV=0.1), and stock composition (as detailed above). **NOTE: these results are based on the assumption that the genetics findings from the 2005-2007 data represent the historical pattern of PSC stock composition (by strata).**

	BC, WA, OR, and CA	Coastal W. AK	Cook Inlet	Middle Yukon	N. Alaska Peninsula	Other	Russia	Upper Yukon	TBR (SE)	Total
1994	5,198	21,518	242	201	4,898	714	147	194	198	33,310
1995	5,635	14,084	415	104	3,302	532	112	96	279	24,559
1996	6,974	17,025	520	154	3,939	632	142	137	364	29,886
1997	11,376	16,895	1,276	413	3,364	715	277	343	783	35,442
1998	10,967	14,218	1,110	103	3,382	696	165	87	711	31,439
1999	6,429	15,099	573	297	3,193	561	188	245	387	26,973
2000	2,815	9,383	219	167	2,106	330	99	147	152	15,418
2001	3,694	10,473	349	260	2,141	375	149	221	238	17,899
2002	6,236	14,516	509	106	3,467	609	117	96	341	25,997
2003	5,743	20,065	398	356	4,424	679	207	311	292	32,475
2004	10,164	21,904	1,018	466	4,592	859	305	393	685	40,386
2005	11,169	25,462	1,203	767	5,107	923	439	645	772	46,487
2006	12,719	36,337	892	363	8,355	1,348	290	339	633	61,275
2007	18,079	44,380	1,597	694	9,743	1,688	485	608	1,069	78,344

Table 7. Chinook salmon PSC from the eastern Bering Sea pollock fishery (all sectors including CDQ) by season and by region during the B-season, 1991-2012 (as of July 16, 2012). NW and SE regions encompass the area west and east of 170°W, respectively.

Year	A-season	B-season	B-NW region	B-SE region	Total
1991	36,838	2,215	366	1,849	39,053
1992	23,413	10,258	213	10,045	33,671
1993	15,415	21,204	7,344	13,860	36,619
1994	27,285	4,605	892	3,713	31,890
1995	8,982	4,421	112	4,309	13,403
1996	35,985	19,488	1,021	18,467	55,473
1997	10,347	33,974	6,358	27,616	44,321
1998	15,118	36,127	820	35,307	51,245
1999	6,351	5,626	1,309	4,317	11,977
2000	2,410	668	379	290	3,078
2001	8,571	10,477	5,460	5,018	19,049
2002	10,076	2,524	200	2,324	12,599
2003	30,805	12,016	3,802	8,214	42,821
2004	24,493	27,589	6,578	21,011	52,082
2005	28,581	38,277	13,021	25,256	66,858
2006	58,952	23,560	2,444	21,116	82,512
2007	70,879	51,480	10,033	41,447	122,359
2008	16,938	4,819	793	4,026	21,757
2009	9,514	2,708	582	2,126	12,222
2010	7,834	2,220	144	2,077	10,054
2011	7,147	18,363	1,531	16,832	25,510
2012	8,289	299	9	290	8,588

Table 8. **Coastal western Alaska** Chinook salmon PSC impact (in AEQ terms) from the eastern Bering Sea pollock fishery (all sectors including CDQ), 1994-2012 (as of July 16, 2012). Columns 3-5 contain predictions based on the linear model described in the text; bolded numbers are point estimates of impact due to PSC.

Year	EIS AEQ Model	Linear Model Estimate	Lower CI	Upper CI
1994	21,518	22,018	19,064	24,972
1995	14,084	14,738	11,558	17,918
1996	17,025	18,547	15,310	21,784
1997	16,895	17,514	14,379	20,649
1998	14,218	13,597	10,054	17,141
1999	15,099	15,080	11,452	18,707
2000	9,383	8,949	6,077	11,820
2001	10,473	10,586	7,523	13,649
2002	14,516	13,060	10,118	16,002
2003	20,065	19,092	16,068	22,117
2004	21,904	22,066	19,160	24,973
2005	25,462	25,930	22,505	29,354
2006	36,337	36,827	33,451	40,203
2007	44,380	43,354	39,905	46,802
2008		33,590	27,953	39,227
2009		13,239	10,328	16,151
2010		10,715	7,833	13,597
2011		8,437	5,365	11,509
2012		12,452	9,470	15,434

Table 9. **Upper Yukon** Chinook salmon PSC impact (in AEQ terms) from the eastern Bering Sea pollock fishery (all sectors including CDQ), 1994-2012 (as of July 16, 2012). Columns 3-5 contain predictions based on the linear model described in the text; bolded numbers are point estimates of impact due to PSC.

Year	EIS AEQ Model	Linear Model Estimate	Lower CI	Upper CI
1994	194	210	119	301
1995	96	90	0	179
1996	137	157	63	251
1997	343	319	224	413
1998	87	112	5	220
1999	245	239	132	347
2000	147	98	7	188
2001	221	292	199	385
2002	96	108	18	197
2003	311	283	193	373
2004	393	355	266	444
2005	645	657	554	761
2006	339	342	242	442
2007	608	601	499	703
2008		270	153	387
2009		119	30	208
2010		90	0	180
2011		94	0	190
2012		142	50	234

Table 10. **Middle Yukon** Chinook salmon PSC impact (in AEQ terms) from the eastern Bering Sea pollock fishery (all sectors including CDQ), 1994-2012 (as of July 16, 2012). Columns 3-5 contain predictions based on the linear model described in the text; bolded numbers are point estimates of impact due to PSC.

Year	EIS AEQ Model	Linear Model Estimate	Lower CI	Upper CI
1994	201	229	119	340
1995	104	100	0	209
1996	154	166	52	280
1997	413	387	272	502
1998	103	136	5	266
1999	297	281	150	411
2000	167	113	3	223
2001	260	346	233	459
2002	106	119	11	228
2003	356	318	209	428
2004	466	417	309	525
2005	767	782	656	908
2006	363	371	250	493
2007	694	686	562	810
2008		309	167	451
2009		133	25	242
2010		100	0	210
2011		113	0	230
2012		161	49	273

The combined 2011 Alaska harvests of Chinook salmon are reported at 468,000 fish (Eggers and Carroll 2012). For western Alaska region, the combined run sizes are on the order of 500-800 thousand fish whereas for the Upper Yukon, the run sizes average around 75-100 thousand fish. In comparison, recent estimates of PSC impacts are on the order of 10 – 15 thousand Chinook for all of coastal western Alaska and in the 100-500 fish range for the middle and Upper Yukon.

Overview of Council action –Amendment 91

The Council took final action on Amendment 91, Chinook salmon PSC management measures in the Bering Sea pollock fishery in April 2009. NMFS approved regulations implementing Amendment 91 on August 30, 2010 (72 FR 53026), and the fishery has been operating under the requirements since January 2011. Amendment 91 established two Chinook salmon PSC limits (60,000 Chinook salmon and 47,591 Chinook salmon) for the Bering Sea pollock fishery. For each PSC limit, NMFS issues A season and B season Chinook salmon PSC allocations to the catcher/ processor sector, the mothership sector, the inshore cooperatives, and the CDQ groups. When a PSC allocation is reached, the affected sector, inshore cooperative, or CDQ group is required to stop fishing for pollock for the remainder of the season even if its pollock allocation had not been fully harvested.

NMFS issues transferable allocations of the 60,000 Chinook salmon PSC limit to those sectors that participate in an incentive plan agreement (IPA) and remain in compliance with the performance standard. Sector and cooperative allocations would be reduced if members of the sector or cooperative decided not to participate in an IPA. Vessels and CDQ groups that do not participate in an IPA fish under a restricted opt-out allocation of Chinook salmon. If a whole sector does not participate in an IPA, all members of that sector would fish under the opt-out allocation.

The IPA component was designed as an innovative approach for fishery participants to design industry agreements with incentives for each vessel to avoid Chinook salmon bycatch at all times and thus reduce bycatch below the PSC limits. To ensure participants develop effective IPAs, the final rule required that participants submit annual reports to the Council that evaluate whether the IPA is effective at providing incentives for vessels to avoid Chinook salmon at all times while fishing for pollock. The sector-level performance standard ensures that the IPA is effective and that sectors cannot fully harvest the Chinook salmon PSC allocations under the 60,000 Chinook salmon PSC limit in most years. Each year, each sector is issued an annual threshold amount that represents that sector's portion of 47,591 Chinook salmon. For a sector to continue to receive Chinook salmon PSC allocations under the 60,000 Chinook salmon PSC limit, that sector must not exceed its annual threshold amount three times within 7 consecutive years. If a sector fails this performance standard, it will permanently be allocated a portion of the 47,591 Chinook salmon PSC limit. Under Amendment 91, NMFS would issue transferable allocations of the 47,591 Chinook salmon PSC limit to all sectors, cooperatives, and CDQ groups if no IPA is approved, or to the sectors that exceed the performance standard.

This program was implemented in January 2011, thus the fishery has operated under the new program for one year. The first annual reports by the industry to the Council were provided in April 2012.

Status of 2011-12 first two years of implementation

2011 was the first year of implementation under the new program for Chinook bycatch management. The industry began with a voluntary stand down in late January to avoid Chinook. Incidental catch of Chinook salmon by the pollock fishery participants in the 2011 indicated that pollock fishery participants remained well below their limits and with catch much lower than in the recent five years. Total 2011 A-season PSC was 7,136 fish. This compares to Chinook salmon PSC ranging from 7,624 fish in the A season of 2010 to 69,139 fish in the A season of 2007. In the B-season incidental catch of Chinook salmon by the pollock fishery was also well below the seasonal PSC limits with a total B-season bycatch of 18,363. This is higher than B-season PSC in the previous 3 years but is substantially less than the B-season of 2007 where 25,499 fish were taken. The overall 2011 total Chinook PSC was 25,499. While this amount is higher than the recent years (driven by the increase in the B-season) this was nonetheless well below both the overall PSC limit under Amendment 91 as well as the (lower) performance standard established under that management program. In contrast, in 2012, the A-season PSC was 7,773 fish while B-season catch was substantially lower at 3,577.

Council consideration of chum measures and impacts on Chinook

The Council is now considering additional management measures targeted at chum salmon bycatch reduction on the EBS pollock fishery. As with the measures considered for Chinook, the Council is considering a combination of hard cap limits and area closures as well as conferring primary management responsibility to the industry to manage a rolling hotspot program as is done currently. Measures under consideration are intended to target providing protection for WAK chum stocks by focusing on June and July measures when genetic information has indicated there is a higher proportion of WAK bound chum on the fishing grounds (Kondzela et al. 2012; Gray et al, 2011, Gray et al., 2010). However, policy decisions for alternative management measures for chum must also consider the potential impact on the catch of Chinook salmon as a result of imposing additional management measures on the same pollock fishery. The pollock fishery catches both chum and Chinook salmon PSC in the B-season. The timing of this catch is dissimilar amongst the two species, with Chinook salmon caught in the latter part of the B season and chum salmon caught throughout the B season (Figure 12). Current analysis of the impact of various chum management measures under consideration show that chum measures appear to result in more fishing later in the year and thus will result in more Chinook bycatch. A revised industry-initiated and managed rolling hot-spot program is under consideration which attempts to address the balance between prioritization of Chinook and chum avoidance measures in the same season. The Council will

review a draft analysis in December 2012. Final action by the Council is likely in April 2013 with any regulations to implement a new program likely by 2015.

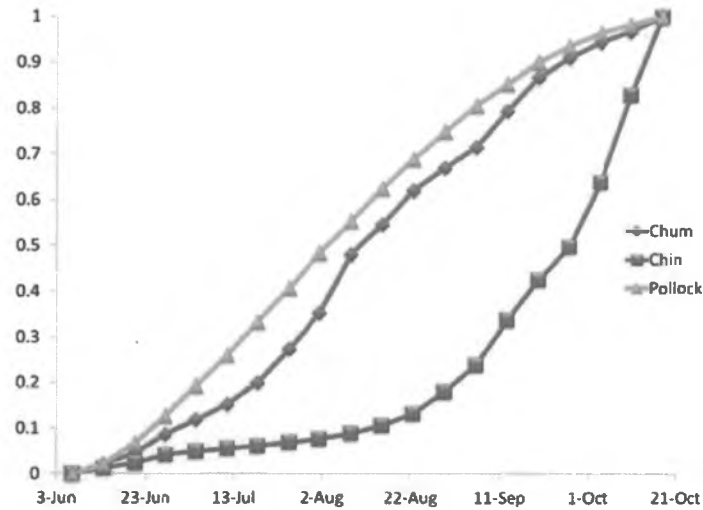


Figure 12. Mean relative values of pollock catch (triangles) compared with catch of chum (diamonds) and Chinook (squares) salmon species in the pollock fishery during the B-season.

Research Recommendation

Several recommendations for additional analyses to assist management are provided below based on experiences with analyzing these data for impact analyses as well as new genetics information.

1. AEQ/genetics analysis of bycatch on recent genetics data: To date the only AEQ and genetics evaluations on EBS bycatch that have been conducted have been done so in conjunction with Council analyses of modifying management measures. As a result of Amendment 91 annual reports of genetics of proportions from bycatch in the groundfish fisheries are being provided, however absent a Council decision to conduct an analysis of modifying management measures, no additional updated analysis of bycatch AEQ and genetic stock of origin is anticipated. Ideally an annual or periodic update to the Council on the genetic analysis of the bycatch (specifically in the EBS pollock fishery) would be advisable.
2. Spatial analysis of genetics for potential consistency over time: In evaluating appropriate management measures to reduce WAK bound Chinook (and chum) salmon additional analyses on the spatial consistency over time on a small a scale as possible would be extremely useful.
3. Evaluation of bycatch of Chinook in other EBS fisheries outside of pollock: Currently management measures are targeted at the EBS pollock fishery as this comprises the majority of the bycatch of both salmon species. Recent genetic stock composition proportions however include bycatch from other groundfish fisheries. To the extent that these fisheries bycatch could be examined separately for spatial and temporal consistency in genetic stock proportions this may give an indication of other fisheries contribution to bycatch impacts. Potentially should information indicate that fisheries outside of the EBS pollock fishery contribute less bycatch annually but a disproportionate impact consistently on some stocks (e.g. Upper Yukon Chinook) this would be informative for future management actions on other groundfish fisheries.

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ADF+G

Pollock + Chinook bycatch

closure fish area

Rolling Hotspot - smaller areas

2011 First Hard Cap. ranges

60,000

47,000

performance std.

if more than 2 of 7 years

manage to lower

each individual vessel

incentive cumulative

GOA

Limited access

Hard cap 25,000

2012 → 20,000

Bob Clark (BS) ^{High} obaener ^{high} age genetics

Research plan Higher proportion of AK in Pollock A
~42% c 20 upper Yukon

GOA

anticipate GOA + BC lower 48

545⁰⁰ net palloc
ch 2930



Diana



uncertainty + no confidence limits

Art Nelson Yukon

96% ↓ from 20 yr. Average
Substantially unmet