

# **BSAI Salmon Bycatch**

February 2008

Staff Discussion Paper

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## INTRODUCTION

In order to move forward with a defined suite of alternatives for analysis in a forthcoming EIS, the Council needs to continue to refine the alternatives under consideration for salmon bycatch reduction measures. Aspects of the Council's December 2007 motion (attached as Appendix 1) have been incorporated into the alternative structure. Alternatives have been reorganized to facilitate the Council's review and further refinement. Specific aspects of the alternative structure that are highlighted in this paper include the following:

- **Revised alternative structure**: A new alternative structure is proposed using the approved elements from the Council's previous motions
- **Cap formulation** (Alternative 2: Hard cap): Preliminary numbers are presented in conjunction with the Council's December motion on cap formulation.
- **Area closure options**: Candidate closure options are presented for incorporation into the alternatives.
- **Sector split on salmon cap**: A discussion paper is provided which addresses the specific aspects of the cooperative-level bycatch caps as included per the December Council motion ("Addressing salmon bycatch through salmon bycatch quota trading among pollock cooperatives"). Another discussion paper included here addresses some monitoring and enforcement considerations with respect to sub-divided caps. *[The monitoring and enforcement paper will be provided in the Council briefing materials]*

Assimilation of this material within this paper is intended to provide sufficient information to inform the Council for refining alternatives only. It is not intended to preclude further, in-depth analysis of the potential impacts of each element and option to be included in the suite of alternatives. Full impact analysis will be provided upon review of the EIS for this amendment package currently scheduled for June 2008.

## DESCRIPTION OF ALTERNATIVES

The following represents a revised structure for the Council's alternatives and options for the forthcoming EIS analysis. Providing an organized structure for the major elements and options already approved by the Council into EIS-type alternatives at this point will facilitate the necessary structure to begin to organize and assemble the EIS analysis. These restructured alternatives incorporate all refinements through the Council's December 2007 motion. The Council may also formulate different alternatives to be analyzed by selecting aspects of the alternatives as listed below.

### **Alternative 1: Status Quo**

### **Alternative 2: Hard cap**

### **Alternative 3: Fixed closures**

### **Alternative 4: Triggered closures**

### **Option 1 (applies to Alternatives 2 and 4):**

Modify the PSC accounting period to begin at the start of the B season in one calendar year and continue through the A season of the following calendar year.

### **Option 2 (applies to Alternatives 3 and 4 only):**

Exempt those vessels participating in a VRHS system from area closures

Additional options are included under individual alternatives and are noted within the alternative accordingly. Note that these alternatives are not intended to be mutually exclusive and the Council may choose to select elements from each of the alternatives together to formulate their preferred alternative. Under the description of each alternative below, information is provided on the specific elements and options to the alternatives (for alternatives 2-4) as well as how the CDQ program will be treated under that alternative. It was specifically noted by the Council in their December 2007 motion that “The analysis will consider equal treatment by the CDQ program under each alternative. The intent is that any alternative under consideration would be no more restrictive than the other options to CDQ.”(Council motion December 2007, appendix 1)

## **Alternative 1: Status Quo**

Alternative 1 retains the current program of Chinook and chum Salmon Savings Area (SSA) closures triggered by separate non-CDQ and CDQ caps by species with the fleet’s exemption to these closures per regulations for amendment 84.

For Chinook salmon, the Chinook Salmon Savings Areas were established under BSAI Amendment 21b and revised under BSAI Amendment 58. These areas close to pollock trawling if 29,000<sup>1</sup> Chinook salmon are taken. The timing of the closure depends upon when the limit is reached:

1. If the limit is triggered before April 15, the areas close immediately through April 15. After April 15, the areas re-open, but are again closed from September 1-December 31.
2. If the limit is reached after April 15, but before September 1, the areas would close on September 1 through the end of the year.
3. If the limit is reached after September 1, the areas close immediately through the end of the year.

BSAI Amendment 58 modified the initial Chinook salmon savings area measures (established under amendment 21b). Modifications from this amendment in 1999 included: a reduced Chinook limit from 48,000 to 29,000 over a four year period, year-round accounting of Chinook bycatch in the pollock fishery beginning on January 1 of each year, revised boundaries of the savings area closures, and new closure dates. The initial Chinook Salmon Savings Areas included an area south of the Pribilofs. This area was removed as a savings area under amendment 58. The revision to the closure dates under this amendment specified the additional closure from September 1-December 31 under the conditions listed in bullets 1-3 above.

For Chum salmon, the Chum Salmon Savings Area was established in 1994 by emergency rule, and then formalized in the BSAI Groundfish FMP in 1995 under Amendment 35. This area is closed to pollock trawling from August 1 through August 31. Additionally, if 42,000<sup>2</sup> ‘other’ salmon are caught in the Catcher Vessel Operational Area (CVOA) during the period August 15-October 14, the area remains closed to pollock trawling. As catcher processors are prohibited from fishing in the CVOA during the “B” season, unless they are participating in a CDQ fishery, only catcher vessels and CDQ fisheries are affected by the PSC limit.

Amendment 84 to the BSAI groundfish FMP exempted vessels from both the Chum and Chinook SSAs if triggered provided they participate in the salmon bycatch inter-cooperative agreement (ICA) with the voluntary rolling hot spot (VRHS) system.

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<sup>1</sup> This number is inclusive of the allocation to CDQ groups. Non-CDQ Chinook salmon limit is 26,825.

<sup>2</sup> This number is inclusive of the allocation to CDQ groups. Non-CDQ ‘other salmon’ limit is 38,850.

Under this alternative, the CDQ Program would continue to receive allocations of 7.5 percent of the BS and AI Chinook salmon PSC limits and 10.7 percent of the non-chinook salmon PSC limit as "prohibited species quota reserves" or PSQ reserves. The PSQ reserves are further allocated among the six CDQ groups based on percentage allocations approved by NMFS on August 8, 2005. The salmon savings areas would continue to be closed to vessels directed fishing for pollock CDQ for a particular CDQ group when that group's salmon PSQ is reached. The CDQ groups would continue to be exempt from the salmon savings area closures if they participate in the salmon bycatch intercooperative agreement.

## **Alternative 2: Hard Cap**

This alternative would establish a salmon bycatch cap on the pollock fishery which, when a limit was reached, all directed pollock fishing would cease. For Chinook salmon, only those Chinook caught by the pollock fleet would accrue towards the cap and the cap applies only to the pollock fleet when triggered. For non-Chinook salmon all gears and targets accrue towards the cap. However, the cap only applies to the directed pollock fishery.

Six options for establishing the cap are presented. Options 1-4 establish the calculation upon which the cap is based, while options 5-6 subdivide the established cap amongst sectors (option 5) and further between cooperatives within sectors (option 6) according to the catch history as noted in the suboptions.

The CDQ Program would receive allocations of 7.5% of any hard cap established for Chinook salmon in the BS and 10.7% of any hard cap established for non-Chinook salmon. These PSQ reserves would be further allocated among the six CDQ groups based on percentage allocations approved by NMFS on August 8, 2005. Each CDQ group would be prohibited from exceeding its salmon PSQ allocation. This prohibition would require the CDQ group to stop directed fishing for pollock CDQ once its PSQ allocation is reached because further directed fishing for pollock likely would result in exceeding its PSQ allocation.

### **Option 1: Hard cap based upon average historical bycatch (1997-2006)**

Sub Option	Description	Chinook*	Chum
i)	3 year average (2004-2006)	75,296	498,563
ii)	5 year average (2002-2006)	64,232	355,078
iii)	10 year average (1997-2006)	49,561	207,629
iv)	10 year average (1997-2006): drop lowest year	54,154	225,450
v)	10 year average (1997-2006): drop highest year	45,315	113,382
vi)	10% increase of historical average (3 years, 2004-2006)	82,824	548,419
vii)	20% increase of historical average (3 years, 2004-2006)	90,354	598,275
viii)	30 % increase of historical average (3 years, 2004-2006)	97,883	648,132
ix)	10% increase of highest year (pre-2007)	96,548	783,133
x)	20% increase of highest year (pre-2007)	105,325	854,377
xi)	30% increase of highest year (pre-2007)	114,102	925,521

\*Cap levels will be based on historical Chinook bycatch numbers from the pelagic trawl pollock fishery only. Currently these values include other gears and targets hence are preliminary for discussion purposes only. Revised pollock-fishery only Chinook numbers will be provided in the Council briefing materials.

### **Option 2: Cap set relative to salmon returns**

Caps under this option will be based on analysis by species and involve consideration of run-size impacts. Since this approach involves a number of uncertain components (e.g., river-of-origin, ocean survival, run-size) the cap will be derived from an acceptance of this uncertainty and inherent risks. The developed

methods account for sources of uncertainty and natural variability and provide a more defensible approach to evaluating the uncertainty on picking management alternatives. An acceptable impact level (at specified probability), if provided for a set of rivers or systems, could be used to derive a cap level that satisfies that condition. This encompasses the uncertainty in measurements while at the same time acknowledges the year-to-year variability in salmon run-sizes. This work has been presented to the SSC and to the Salmon Bycatch Workgroup. Further details and explanations will be available at the Council's request in February.

**Option 3: Cap set based on Incidental Take Permit amount**

This involves setting the Chinook (only) cap at 87,500 fish.

**Option 4: Set cap in accordance with International treaty considerations (1992-2001, based on average historical bycatch pre-2002)**

Sub Option	Description	Chinook*	Chum
i)	3 year average (1999-2001)	21,123	55,764
ii)	5 year average (1997-2001)	34,890	60,180
iii)	10 year average (1992-2001)	39,288	78,010

\*Cap levels will be based on historical Chinook bycatch numbers from the pelagic trawl pollock fishery only. Currently these values include other gears and targets hence are preliminary for discussion purposes only. Revised pollock-fishery only Chinook numbers will be provided in the Council briefing materials.

**Option 5: Divide the final cap by sections based on**

- i) 50% shore based CV fleet; 10% for the mothership fleet; and 40% for the offshore CP fleet
- ii) Historical average of percent bycatch by sector: *Need clarification here if this is to be over the years under consideration by each option for the hard cap or over a pre-determined set of years only*

**Option 6: Divide the sector cap by cooperative based upon the percent of total sector pollock catch their coop allocation represents. When the Chinook salmon coop cap is reached, the coop must stop fishing for pollock and may:**

- i) Lease their remaining Pollock to another coop (inter-cooperative transfer) within their sector for that year (or similar method to allow pollock harvest with individual coop accountability)
- ii) Purchase salmon bycatch from other cooperatives.

**Alternative 3: Fixed closures**

Fixed closure management measures are simply pre-defined regulatory times and areas where pelagic pollock trawling would be prohibited.

The CDQ groups would be required to comply with any fixed closures that were established to reduce salmon bycatch. No salmon bycatch PSC limits would be established, so no allocations would be made to the CDQ Program or among the CDQ groups.

**Option 1: Timing options**

- i. A season (Chinook only)
- ii. B season (Chinook and Chum)

**Option 2: Area options**

Closure options will be selected by the Council at this meeting to be included in the analysis. Closures may be seasonal or annual and vary by species. Additional details of candidate closures are presented below.

**Option 3: Periodic adjustment for updated bycatch information**

A period may be specified after which areas may be re-specified with updated bycatch data.

**Alternative 4: Triggered closures**

Triggered closures are regulatory time area closures that are invoked when cap levels are exceeded. Cap levels for triggered closures would be formulated in a way similar to those specified under alternative 2. The duration of the closure may vary according to stair-stepped cap levels whereby additional areas close (or reopen) depending on seasonal thresholds for species specific bycatch levels. Closures may involve a single area or multiple areas. Additional details on candidate closure areas and times are presented below.

Similar to status quo, the CDQ Program would receive allocations of 7.5 percent of any BS Chinook salmon trigger cap and 10.7 percent of any non-Chinook salmon trigger cap as PSQ reserves. These PSQ reserves would be further allocated among the six CDQ groups based on percentage allocations approved by NMFS on August 8, 2005. Areas would close to directed pollock fishing for a particular CDQ group when that group's trigger cap is reached. Sub-division of trigger caps by sector would not apply to the CDQ fisheries.

**Option 1: Timing options**

- i. A season
- ii. B season

**Option 2: Area options**

- i. Adjust area according to the number of salmon caught
- ii. Single area closure
- iii. Multiple area closures

Closure options will be selected by the Council at this meeting to be included in the analysis. Closures may be seasonal or annual and vary by species. Additional details of candidate closures are presented below.

**Option 3: Periodic adjustment for updated bycatch information**

A time period may be specified after which areas may be re-specified with updated bycatch data.

**Option 4: Trigger Cap formulation**

See Alternative 2 for description of cap formulation options.

**Option 5: Divide the final cap by sections based on:**

- iii) 50% shore based CV fleet; 10% for the mothership fleet; and 40% for the offshore CP fleet
- iv) Historical average of percent bycatch by sector: *Need clarification here if this is to be over the years under consideration by each option for the hard cap or over a pre-determined set of years only*

**Option 6: Divide the sector cap by cooperative based upon the percent of total sector pollock catch their coop allocation represents. When the Chinook salmon coop cap is reached, the coop must stop fishing for pollock and may:**

- iii) Lease their remaining Pollock to another coop (inter-cooperative transfer) within their sector for that year (or similar method to allow pollock harvest with individual coop accountability)
- iv) Purchase salmon bycatch from other cooperatives.

### Candidate closures for Alternatives 3 and 4

Two types of closures, fixed and triggered, are under consideration in the Council’s suite of alternatives. Unless indicated otherwise, closures presented below could be formulated as triggered closures or fixed closures. The Council would need to select candidate areas for inclusion as options in the analysis. The areas presented below could be selected individually or in conjunction with each other for multiple closures. Closures are presented as three options based upon the primary methodology for determining the closures: historic effort, rate-based criteria delineation, percent bycatch reduction delineation. The EIS analysis will examine the impacts of displaced effort due to enactment of the closure.

#### 1) Closures areas defined by historic effort

##### 1a) Fixed A season closure (Chinook)

The following area was brought forward to the Council in December 2007 in public comment (Figure 1). This area is proposed as a fixed closure for the fleet in 2008 under the Intercooperative Agreement (Chinook salmon conservation zone). This area has also been shown in previous staff discussion papers as an area with historically high bycatch in the A season. This area is be proposed as a fixed closure for the duration of the A season. The coordinates of the closures are listed below.

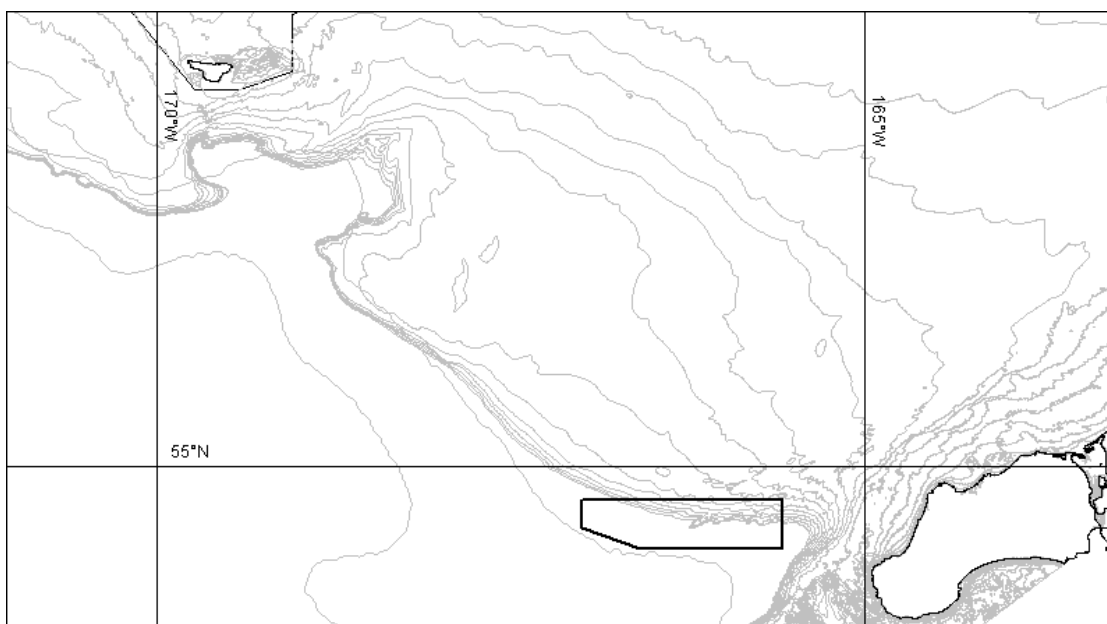


Figure 1. Fixed A season candidate closure for Chinook

Coordinates:	Latitude	Longitude
	54° 40'	165° 35'
	54° 40'	166° 35'
	54° 45'	167° 0'
	54° 52'	167° 0'
	54° 52'	165° 35'



1b) Sequential two-week A season closures (Chinook)

Closures presented below are for two week periods. The Alaska Department of Fish & Game (ADF&G) statistical areas are used. The specific areas, as closures, were identified by examining the spatial extent of the fishery, bycatch rates, number of Chinook caught, timing of fishery, and pollock catch per unit effort. The catch and bycatch information used was from 2004-2007 (A season), and from 2004-2006 (B season) observer data for the pollock fishery. Area configurations are summarized based on historic fishing and bycatch effort to indicate what the relative impacts of the closure might have been. Redistribution of effort is expected within the core fishing areas and a detailed methodology to determine the impact of this displaced effort will be addressed in the EIS.

Weekly catch and bycatch information were summarized and provided in the following histograms to determine appropriate period lengths for closures (A season Chinook Figures 2-6, B season Chinook Figures 12-14, B season chum Figures 18-21). Closure periods were based on historic high bycatch to catch ratios. The closures occur within the main footprint of the pollock fishery. Areas were selected based on overall Chinook and chum taken, bycatch rates, and pollock CPUE displayed in GIS. During the 3 years examined, substantial variability in weekly bycatch amounts and locations occurred.

For the A season pollock fishery, three fixed closures for a two week period are proposed (Figures 7-10) to reduce Chinook bycatch. These would occur during the first four weeks of the A season based on a start date of January 20<sup>th</sup> (i.e. 1<sup>st</sup> 2 weeks of season- January 20-31<sup>st</sup>; 2<sup>nd</sup> and 3<sup>rd</sup> weeks of season- January 26-February 7<sup>th</sup>; 3<sup>rd</sup> and 4<sup>th</sup> weeks of season- February 1-14<sup>th</sup>). Table 1 provides a historic perspective on both the number of salmon and pollock catch taken within the proposed fixed closure areas.

1c) Sequential two-week B season closures (Chinook)

For the B season pollock fishery three sequential closures are proposed for the month of October (Figures 15-17). Table 2 provides a summary of both the number of salmon and pollock catch taken within the proposed fixed closure areas over the 3 year time period.

1d) August B season closure (Chum)

An area closure for the month of August is proposed to reduce 'Other' Salmon bycatch in the Pollock B season fishery (figure 22). Similar to the method for Chinook salmon, weekly catch information were summarized and provided in the following histograms by 'Other' salmon bycatch numbers and Pollock catch (mt) (B season Figures 18-21). Based on historic high bycatch to catch ratios specific weeks were selected for the closure timing. The closures occur within the main footprint of the pollock fishery. The two statistical areas were selected based on overall 'Other' salmon taken, bycatch rates, and pollock CPUE. Table 3 provides a summary of both the number of salmon and pollock catch taken within the proposed fixed closure areas.

**2) Candidate Closure areas defined by rate-based criteria**

Closure areas can be developed based on rate-based bycatch goals. A series of smaller closures could have a set of smaller cumulative caps while one larger area similar to the current CSSA would have a larger cap. A season Chinook bycatch rate-based closures are proposed here using observed rates in the pollock pelagic trawl fishery 2004-2006 as an example. Additional exploration of B season rate-based closures by species could also be evaluated.

Observer data from the non-pelagic pollock trawl fishery were summarized by haul for salmon bycatch. Bycatch rates were calculated based on observed numbers of salmon per metric ton of pollock. Numbers are presented based on observer counts. Data were brought into a GIS to be viewed spatially and temporally. Examples here are based on 2004-2006 combined data from the pollock A season for

Chinook bycatch. Closure areas were determined by calculating average bycatch rates (number of extrapolated observed salmon per ton of pollock) within a 100 km<sup>2</sup> area (Figure 31). Observed values of bycatch rates are viewed by a consistent range of rate breaks (i.e., 0.1, 0.2, 0.3, ...) based on the Salmon Workgroup's recommendation (August 29, 2007 SBW report).

Within these examples there are several hauls that have very high rates compared to the majority of sets in the time period. To normalize the effects of these few hauls, the optimal method to depict bycatch rates would need to be analyzed. Preliminary concepts of this include transformations such as (log x+1), or normalizations as a percentage of the maximum rate or upper quartile. Configurations of the closure areas would vary based on the method to display rates and will need to be fully evaluated in the forthcoming EIS analysis.

The criteria are established such that if three or more 10 km<sup>2</sup> grids adjacent to each other exceed the established rate based threshold, an area closure is created.

2a) Rate-based criteria 0.10 Chinook/pollock (t)

Under Closure 2a, the threshold is set at an average bycatch rate that exceeds 0.10 Chinook/ pollock MT (Figure 24 provides an example with catch data; Figure 25 depicts the closure).

2b) Rate-based criteria 0.20 Chinook/pollock (t)

Under Closure 2b, the threshold is set at an average bycatch rate that exceeds 0.20 Chinook/ pollock MT (Figure 26).

2c) Rate-based criteria 0.30 Chinook/pollock (t)

Under Closure 2c, the threshold is set at an average bycatch rate that exceeds 0.30 Chinook/ pollock MT (Figure 27).

2d) Rate-based criteria 0.40 Chinook/pollock (t)

Under Closure 2d, the threshold is set at an average bycatch rate that exceeds 0.40 Chinook/ pollock MT (Figure 28).

**3) Candidate Closure areas defined by percent bycatch reduction criteria**

Area closures may also be configured based on a bycatch reduction goal, e.g. a percent reduction criteria. Here the amount of salmon necessary to achieve a goal is calculated and an area closed to meet that goal. The percent reduction is over the three-year average for the A season (2004-2006) in the examples provided below. One difficulty of achieving a large bycatch reduction level with one or more large contiguous closures will be allowing for an economically viable pollock harvest. Two examples of this methodology for Chinook A season are provided while additional percent reduction threshold closures could also be evaluated.

3a) 50% bycatch reduction closure

Closure 3a uses the criteria of a 50% bycatch reduction for Chinook (Figure 29).

3b) 75% bycatch reduction closure

Closure 3b uses the criteria of a 50% bycatch reduction for Chinook (Figure 29).

**Table 1. Summary table of closures by week, stat area closed, average amounts of Chinook inside and outside closure, and average amounts of pollock harvested inside and outside closure.**

Closure Week	Stat Area Closure	size (nm2)	Weekly Avg Chinook Inside	Weekly Chinook Average Overall	% Observed Chinook in closure	Weekly Avg Pollock Harvest in closure	Weekly Avg Pollock Harvest Overall	% of pollock in closure
Jan 20_25	645501	1,025	2,392	4095	58%	20,506	31656	65%
Jan 20_25	655430	836	402	4095	10%	2,880	31656	9%
	<b>Total Week 1</b>	<b>1,861</b>	<b>2,794</b>	<b>4095</b>	<b>68%</b>	<b>23,386</b>	<b>31656</b>	<b>74%</b>
Jan25_31	645501	1,025	1,445	5,206	28%	12,614	30,894	41%
Jan25_31	655430	836	2,376	5,206	46%	4,550	30,894	15%
Jan25_31	665430	836	1,254	5,206	24%	782	30,894	3%
	<b>Total Week 2</b>	<b>2,697</b>	<b>5,075</b>	<b>5,206</b>	<b>97%</b>	<b>17,946</b>	<b>30,894</b>	<b>58%</b>
Feb1_7	655430	836	1534	6,643	23%	2,907	42,094	7%
Feb1_7	665430	836	2618	6,643	39%	4,231	42,094	10%
Feb1_7	685530	1,019	465	6,643	7%	1,684	42,094	4%
	<b>Total Week 3</b>	<b>2,691</b>	<b>4,617</b>	<b>6,643</b>	<b>70%</b>	<b>8,822</b>	<b>42,094</b>	<b>21%</b>
Feb8_14	665430	836	499	5,509	9%	694	41,321	2%
Feb8_14	685530	1,019	425	5,509	8%	2,361	41,321	6%
Feb8_14	665401	1,087	1,233	5,509	22%	9,284	41,321	22%
Feb8_14	655409	305	2,405	5,509	44%	13,907	41,321	34%
	<b>Total Week 4</b>	<b>3,247</b>	<b>4,562</b>	<b>5,509</b>	<b>83%</b>	<b>26,246</b>	<b>41,321</b>	<b>64%</b>
All Closures			17,048	21,453	79%	76,400	145,965	52%

**Table 2. Summary table of fixed closures by week, stat area closed, average amounts of Chinook inside and outside closure, and average amounts of pollock harvested inside and outside closure.**

Closure Week	Stat Area	size (nm2)	Weekly Average Chinook Inside	Weekly Chinook Average	% Observed Chinook in closure	Weekly Average Pollock Harvest in closure	Weekly Average Pollock Harvest	% of pollock in closure
Oct1_8	645501	1,025	458	3,433	13%	871	12,766	7%
Oct1_8	655430	836	644	3,433	19%	4,067	12,766	32%
Oct9_15	705600	1,006	1,173	3496	34%	1,719	3,495	49%
Oct16_22	655409	305	300	1,983	15%	3,540	7134	50%
Oct16_22	665430	836	983	1,983	50%	3,616	7134	51%

**Table 3. Summary table of closures for August, stat area closed, average amounts of 'Other' salmon inside and outside closure, and average amounts of pollock harvested inside and outside closure.**

Closure Period	Stat Area	size (nm2)	Weekly Total Other Inside	Weekly Other Total	% Observed Chinook in closure	Weekly Total Pollock Harvest in closure	Weekly Total Pollock Harvest	% of pollock in closure
August	675530	1,019	31,430	116,002	27%	4,632	115836.4	4%
August	685530	1,019	15,249	116,002	13%	2,120	115836.4	2%
<b>Total Combined</b>		<b>2,038</b>	<b>46,678</b>	<b>116,002</b>	<b>40%</b>	<b>6,752</b>	<b>115836.4</b>	<b>6%</b>

**Table 4. Summary table of rate based closure areas for Pollock A season. Numbers represent the area of the closure, the entire harvest and bycatch inside and outside the closure areas for the entire A season, based on averages from 2004-2006.**

Closure Area	Rate Based	size (nm2)	Chinook Average Inside	Chinook Average Overall	% Observed Chinook in closure	Average Pollock Harvest in closure	Average Pollock Harvest Overall	% of pollock in closure
1	0.1	20,422	32,833	36,117	91%	223,235	298,842	75%
2	0.2	4,419	16,412	36,117	45%	63,065	298,842	21%
3	0.3	2,588	11,189	36,117	31%	30946	298,842	10%
4	0.4	2,219	10,325	36,117	21%	26,994	298,842	9%

**Table 5. Summary table of closure areas for Pollock A season. Numbers represent the area of the closure, the entire harvest and bycatch inside and outside the closure areas for the entire A season, based on averages from 2004-2006.**

Trigger Closure	size (nm2)	Chinook Average Inside	Chinook Average Overall	% Observed Chinook in closure	Average Pollock Harvest in closure	Average Pollock Harvest Overall	% of pollock in closure
6 Stat area Closure	5,741	21,029	36,117	58%	125,456	298,842	42%
10 Stat Area Closure	8,980	25,639	36,117	71%	172,719	298,842	58%

## Appendix 1. Council motion on BSAI Salmon Bycatch December 2007

The Council adopts the problem statement and moves forward the analysis and alternatives proposed by the Salmon Bycatch Workgroup in their May and August 2007 meetings and as described on pages 1 and 2 of D-1 (a)(1) and pages 3 and 4 of D-1 (a)(3) with the following changes:

Option B) Cap formulation based on:

2) Establish cap based on:

a) Average historical bycatch:

i) 3 years (2004-2006)

ii) 5 years (2002-2006)

iii) 10 years (1997-2006)

Suboption: drop lowest year

Suboption: drop highest year

b) Percentage increase of:

i. historical average (3 years, 2004-2006)

(1) 10%

(2) 20%

(3) 30%

ii. highest year, pre-2007

1. 10%

2. 20%

3. 30%

3) Set cap relative to salmon returns:

Recommend that analysts prepare draft language to better characterize on-going investigations

4) Incidental Take Permit amount

5) International treaty considerations

a) Average historical bycatch pre-2002

i) 3 years (1999-2001)

ii) 5 years (1997-2001)

iii) 10 years (1992-2001)

~~b) Percentage decrease of historical averages:~~

~~i) 10% decrease~~

~~(1) 3 years (1999-2001)~~

~~(2) 5 years (1997-2001)~~

~~(3) 10 years (1992-2001)~~

~~ii) 20% decrease~~

~~(1) 3 years (1999-2001)~~

~~(2) 5 years (1997-2001)~~

~~(3) 10 years (1992-2001)~~

~~iii) 30% decrease~~

~~(1) 3 years (1999-2001)~~

~~(2) 5 years (1997-2001)~~

~~(3) 10 years (1992-2001)~~

Add an option to the alternatives for new closures that would allow for an exemption such as the one currently implemented under amendment 84 for the fleet to these new closures.

Add an option to divide the final cap by sectors based upon:

Option 1: 50% shore based CV fleet; 10% for the mothership fleet; and 40% for the offshore CP fleet

Option 2: historical average of percent bycatch by sector

Add another option to further subdivide sector allocation by cooperative based upon the percent of total sector Pollock catch their coop allocation represents. When the Chinook salmon coop cap is reached, the coop must stop fishing for pollock and may lease their remaining Pollock to another coop (inter-cooperative transfer) within their sector for that year (or similar method to allow Pollock harvest with individual coop accountability) or purchase salmon bycatch from other cooperatives.

The analysis will consider equal treatment by the CDQ program under each alternative. The intent is that any alternative under consideration would be no more restrictive than the other options to CDQ.

The Council adopts the Notice of Intent as presented by the agency.

## Discussion paper: addressing salmon bycatch through salmon bycatch quota trading among pollock cooperatives

By Alan Haynie<sup>3</sup>

This short paper presents several options for market-based salmon bycatch reduction and a discussion of how these systems might function. The paper does not consider whether or not a hard cap is desirable, but attempts to assess the impact of different management instruments discussed in the December 2007 Council motion on salmon bycatch. There are many details to be considered in the analysis of alternatives, but this paper aims to present an overview of key features of several market-based policy options.

### Why consider a salmon quota market?

The North Pacific Fishery Management Council (“Council”) is considering the imposition of a hard cap on salmon bycatch in the Bering Sea pollock fishery. Creating a hard cap without allocating salmon via an individual bycatch quota system is likely to create a new ‘race for fish’ in pollock—pollock quota will become useless when the hard cap is reached so vessels will speed up fishing to ensure that quota is fished. Currently, salmon bycatch is an ‘externality’ to fishing for pollock, similar to pollution generated by operating a factory or a car that affects everyone and can be emitted for free. Imposing a hard cap on salmon bycatch limits the total amount of salmon that can be caught, but without a system that individually accounts for salmon bycatch, the fleet as a whole bears the costs of an individual’s choice to fish in a high-bycatch area. With a salmon quota market, the costs of this externality can be “internalized” by creating a market for bycatch. Although this requires one to pay directly for any bycatch above one’s allocated amount, “clean” fishermen have the option of selling their quota, and the overall cost of this system may be much less than the costs of having a hard cap without a salmon quota market.

When captains choose where to fish for pollock, they balance their expected revenue with the costs of operation – fuel, labor, insurance, bait, etc. Avoiding salmon can be very expensive and the benefit of avoiding the salmon does not go to the vessel that avoids it, but is shared by the fleet. The inclusion of bycatch costs in the fishing decision will lead to a consideration the cost of salmon bycatch in the decision about where to fish. Similar markets have been developed in other natural resource contexts and in the British Columbia trawl fishery bycatch was substantially reduced by the creation of bycatch quota (Diamond 2004).

The strongest argument for a salmon quota system is that it provides a direct incentive to cooperatives and vessels to avoid salmon, whether the vessel has had high or low bycatch. The benefits of bycatch reduction directly accrue to each vessel (in the form of reduced salmon bycatch purchases or as revenues from bycatch quota sales), as do the costs. Rather than a regulation that tells fishermen *how* to reduce bycatch, a quota market tells fishermen to reduce bycatch to what the Council deems an acceptable level in whatever way is most efficient for them to do so. For different cooperatives with different vessels and experience, this may mean avoiding hotspots all year, leaving an area as soon as they see high numbers of salmon, not fishing during certain high-bycatch periods, or investing more in bycatch-reducing technology. The substantial variation in bycatch rates among locations, cooperatives, and time-periods implies that choices can be made to reduce bycatch significantly. And if the fishing is really great in a high bycatch area, vessels may decide to buy salmon quota and enjoy higher-value pollock fishing.

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### Description of different proposed options

Two significant policy changes are being considered by the Council: (1) imposing a hard cap on salmon and (2) developing a tradable salmon mechanism to mitigate the economic impacts of a hard cap on the pollock fishery. We consider each of these policies below. The following table summarizes what each of these policies would entail followed by a more detailed description of each option.

**Table 1: Alternative Hard-cap Policies**

Policy Option	Tradable salmon	Benefits	Possible adverse side-effects
1) Salmon hard cap with no trading	No	Limit on salmon bycatch	Race for fish to ensure ability to catch pollock quota; potential lost pollock revenue with early fishery closure
2) Salmon quota trading under a hard cap	Yes	Limit on salmon bycatch; cost-effective reduction of bycatch	Natural variability in bycatch levels could lead to speculation in bycatch quota (see discussion)

1) Salmon hard cap with no trading (i.e., no quota market). A hard cap by definition would limit salmon bycatch, but without some sort of individual bycatch quota, it would create a “race for fish” within the pollock fishery to land pollock quota before the hard cap is reached. Because reaching the hard cap would render remaining pollock quota worthless, vessels would increase the pace of fishing to ensure that quota can be met. The lower the hard cap, the stronger would be the pressure to race for fish and the greater the potential economic loss. Rationalization allows fishers to slow down and can spend extra time looking for low-bycatch areas with the cost being search time but not lost fish. Under a race for fish, time spent looking for lower bycatch areas translates into uncaught fish, which we would expect might further increase bycatch *rates*.

If a salmon hard cap is implemented, it is possible that as part of the Inter-cooperative agreement (ICA) the cooperatives would negotiate some type of tradable salmon system or salmon fee system to discourage a race for fish in pollock. As a means of avoiding added bureaucracy, this system might be preferable to any Council-implemented system. However, several important differences between an industry and a Council-implemented system should be noted. First, under an industry-led system, all pollock coops would have to achieve consensus on the initial allocation of the system, and this would likely lead to a different sharing of the financial burden of salmon reduction than under a system where bycatch quota is allocated based on either historic pollock catch or salmon bycatch. Secondly, a Council-implemented quota market with observable transactions would reveal the cost of bycatch reduction, which would allow the Council to make future considerations about the costs of possible adjustments in the hard cap. If the Council adopts an industry-operated bycatch trading system, the Council should consider the value to future management decisions of requiring that information be provided about quota trades. A low quota price would imply that it is relatively inexpensive to reduce salmon bycatch, whereas a high quota price would imply that it is difficult for cooperatives to reduce bycatch levels. This information can give decision makers an actual cost of the reduction in salmon bycatch, which provides better information for future policy decisions.

2) Inter-coop salmon quota trading under a hard cap. This system would assign salmon bycatch quota to cooperatives so that salmon bycatch quota would be required to fish for pollock. Depending on how low the salmon hard cap is set, it is possible that it will be too expensive for all coops and vessel to



avoid salmon and the pollock quota might not be landed. Regardless of what level of pollock TAC or salmon bycatch hard cap, a tradable salmon quota system would lead to the greatest value of pollock being caught with the lowest bycatch avoidance costs. In the following section, variations of the bycatch trading system are discussed in further detail.

### **Different mechanisms to prevent a race for fish under a hard cap**

The most simple tradable salmon bycatch system would (1) develop an initial quota allocation system, (2) develop an accounting system so that observed salmon would be charged against salmon quota, and (3) require coops to buy or sell quota so that at the end of the season all landed salmon would be charged against quota holdings.

One complicating factor in operating a salmon bycatch quota market is the uncertainty of the cost of avoidance during a season or the year. As is evident in the variation in salmon bycatch rates that we have observed in the past, vessels and coops cannot know exactly how hard it will be to avoid salmon during the season. One could “over- conserve” and save salmon quota for the end of the season, but then be unable to use it. If there were less than expected Chinook late in the year, then there would have been an additional cost to the pollock fleet of avoiding salmon that was not necessary to stay below the hard cap. Similarly, high-late season bycatch surprises could lead to coops being unable to land their pollock quota.

There are several mechanisms to help mitigate the impacts of this uncertainty. One is to allow for some type of “carry over” of a percentage of salmon bycatch quota from one year to the next. In New Zealand, 10 percent of quota can be carried over or borrowed for the following year. Given the fact that we do not currently have a biological reason to think that several thousand salmon more or less is significantly better and that the fish in the summer and winter may be from the same run, some sort of inter-annual flexibility warrants consideration.<sup>4</sup>

Another element of New Zealand quota management that could be applicable here is the ‘deemed value system’. This system allows fishermen to buy additional fishing rights outside of the quota market at a price initially equal to the 80<sup>th</sup> percentile traded price in the quota market. The price increases as individuals increase their purchases. This system both allows flexibility in the system and minimizes potential monopoly or market power in the fishery. Given the small number of coops in the market, the ability of one coop to act as a monopolist at some point is a significant concern, though this may be mitigated to a degree with the flexibility mechanisms such as the deemed value system or inter-annual carry-overs. Of course, this makes the hard cap less rigid, but deemed value price could be set to steeply rise to insure that the amount of salmon caught is within an acceptable range.

In the discussion of designing a tradable salmon mechanism, a related mechanism warrants mention. An alternative way to reduce salmon bycatch would be to charge a “user fee” (i.e. tax) for each salmon caught. If the Council did not want to charge the pollock fleet, this money could be rebated to the fleet as a whole or used to fund additional research or monitoring. Like a bycatch quota, a fee provides a direct individual incentive for vessels to avoid bycatch. The main advantage of this system is that a fee would not require complicated forecasting or speculation about the value of quota. The main disadvantage is that we don’t know the “right” fee that would achieve a certain level of reduction. However, given the large degree of uncertainty about the biological costs of salmon bycatch, this may be acceptable. Potentially the fee could be increased annually until salmon bycatch declined to an acceptable level.

In summary there are really three possible instruments that could be used to ‘internalize the externality’ of bycatch: a salmon quota, a salmon quota system similar to the deemed value system, and a salmon bycatch fee. There are attractive features of each of these options, depending on the Council’s priorities for creating a more or less rigid hard cap and allowing more or less economic flexibility.

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<sup>4</sup> A comprehensive discussion of the New Zealand quota market flexibility mechanisms discussed here can be found in Lock and Leslie (2007).

## Pollock quota trading

There has been some discussion at the Salmon Bycatch Workgroup meetings of allowing pollock quota to move between the three sectors of the fishery after a bycatch cap is reached. The AFA prohibits pollock trades between sectors and among inshore cooperatives. Amendment 69, however, allows vessels to become de-facto members of other cooperatives and for any vessel to fish a coop's quota. Thus by allowing salmon bycatch quota to be traded among coops, vessels from coops that have salmon quota remaining when they complete their coop's pollock fishing could fish other coops' pollock quota.

There are some substantial perverse incentives that would be created by an inter-sector pollock-trade-only system that is triggered by a sector cap being reached. As well as creating "race for fish" problems similar to those described under the system with a hard cap only, this option would provide an incentive for coops to actually target salmon if their pollock quota could be sold at a higher value to other sectors after the coop's salmon cap is reached. There could be economic gains from the pollock trades because the value may be higher in a different sector.

Allowing trading of both pollock and salmon between sectors (again currently prohibited by the AFA) would be unlikely to reduce salmon bycatch beyond a system with only tradable salmon, but it would have other affects. The value of quota is higher in the offshore sector so we would expect that freeing pollock quota from the current sector split would cause some sale of pollock quota from the inshore to the offshore sector (resulting in higher value usage of quota). Conventional wisdom would suggest that this would be good for the offshore fleet and bad for the inshore sector, but since the initial allocation does not change, the negative impact would be on inshore captains and crew rather than quota holders, as inshore quota holders could either fish or trade pollock quota, whichever is better for them. The magnitude of pollock trading between sectors is difficult to anticipate but certainly could be substantial.

## Initial allocation options

For most quota managed fisheries, quota allocation starts with the provision of quota to fishers based on some formula that incorporates historic participation with other social goals, such as economic development or discouraging excessive market concentration. This process is never easy because of its long-term financial implications, but here it is even more complicated because there is a concern about rewarding "bad" behavior of past high bycatch. Below are several options for initial allocation proposed in the December 2007 Council motion on salmon bycatch and a brief consideration of the implications of these options.

- Option 1: Allocate bycatch to coops proportional to AFA pollock quota holdings (i.e. 50% shore-based CV fleet; 10% for the mothership fleet; and 40% for the offshore CP fleet. As illustrated in the October 2007 salmon bycatch discussion paper, this would require much more substantial reductions by inshore coops than by the offshore sectors. This option would not allocate bycatch within each sector.
- Option 2: Allocate bycatch based on historical average of percent bycatch by sector. This option assumes that inshore and offshore vessels have fundamentally different options for bycatch avoidance so would allocate a larger share of bycatch to the inshore fleet (the percentage would depend on the base years included). The option would not allocate bycatch within each sector.
- Additional option: allocate within sectors by pollock allocation. Within each sector, this option would allocate bycatch quota to coops based on pollock quota to avoid rewarding past "bad" high-bycatch behavior. This recognizes that some historically low-bycatch vessels have already taken many actions to avoid bycatch so it may be harder for them to reduce bycatch now and does not penalize them for previous bycatch avoidance.

Some combination of these previous options is of course possible. All of the above imply that bycatch quota will be "grandfathered" according to some combination of historic usage, but of course bycatch

rights could be also auctioned by the government. It should be noted that because it is essential to have bycatch rights to fish for pollock, this would be similar to auctioning off all pollock quota, and thus would represent a very large transfer of wealth away from pollock quota holders.

While from an overall point of view a tradable salmon bycatch system is likely to be more efficient than a system only with an overall cap, there will be economic losers in the system. The decision of how to allocate salmon initially will determine who will pay a larger cost under the new system. The magnitude of this cost is difficult to predict, however, as we do not really know anyone's actual costs of avoidance. Some previously high-bycatch vessels may well prove themselves to be adept at bycatch reduction under a new management system that requires them to pay for bycatch.

### **Other considerations**

This section briefly touches on other considerations for further analysis.

What is the likely price for salmon quota? This is uncertain and will depend on a number of factors including the size of the hard cap, the future abundance and distribution of salmon and pollock, and new developments in bycatch-avoidance technology.

One issue raised by industry is the fact that high bycatch does occur randomly even in low-bycatch times/locations. Insurance could be developed to share the costs of seemingly random high-bycatch events, so that if someone catches a large quantity of salmon in an otherwise clean area they would not have to bear the full cost of paying for the bycatch. This type of agreement could potentially be made among different vessels or cooperatives, though the challenge would be identifying what constitutes bad luck versus bad behavior.

There has been concern voiced about whether the Observer program can estimate bycatch with significant accuracy to allow for charging vessels for individual salmon landings. The complexities of monitoring and enforcement will be addressed elsewhere, but one point to note is that the unobserved trips could be charged usage fees for fishing in higher bycatch areas, so that a higher fee would be charged for fishing in higher bycatch areas.

While there is significant work to be done in the design of a tradable salmon quota system, there are also significant costs of both the status quo and the imposition of a salmon hard cap without a salmon quota system. More restrictive spatial management would also have a significant cost. The relative magnitude of these different options can be analyzed as part of future Council analyses.

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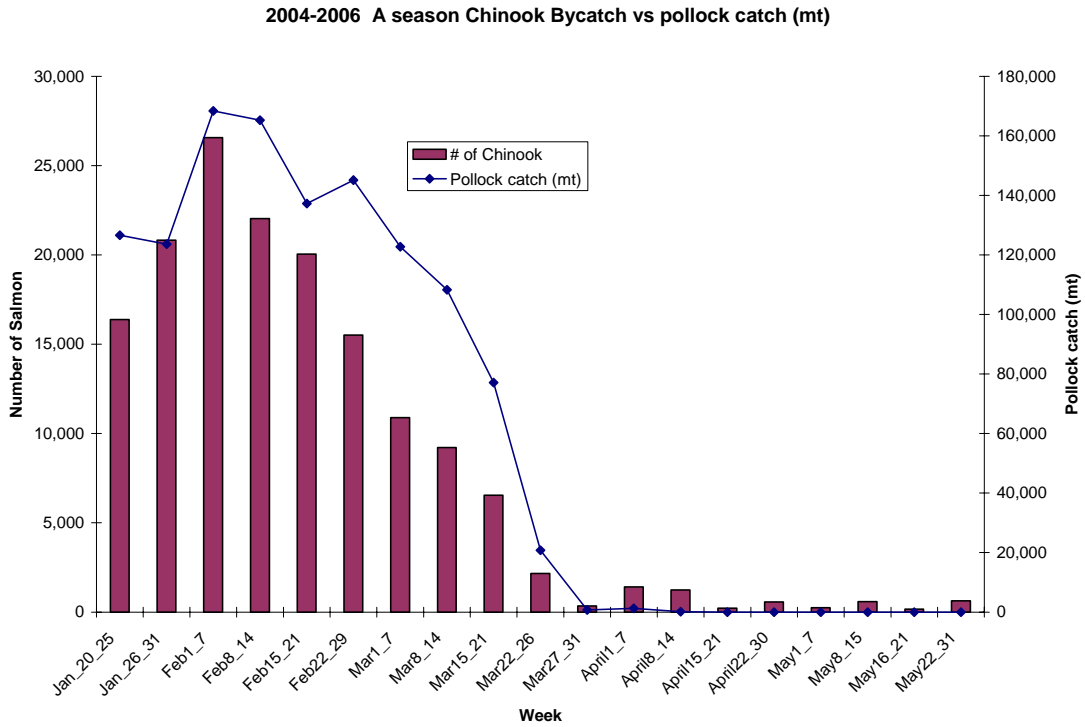


Figure 2. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock A season with pollock catch (mt) summarized for years 2004-2006.

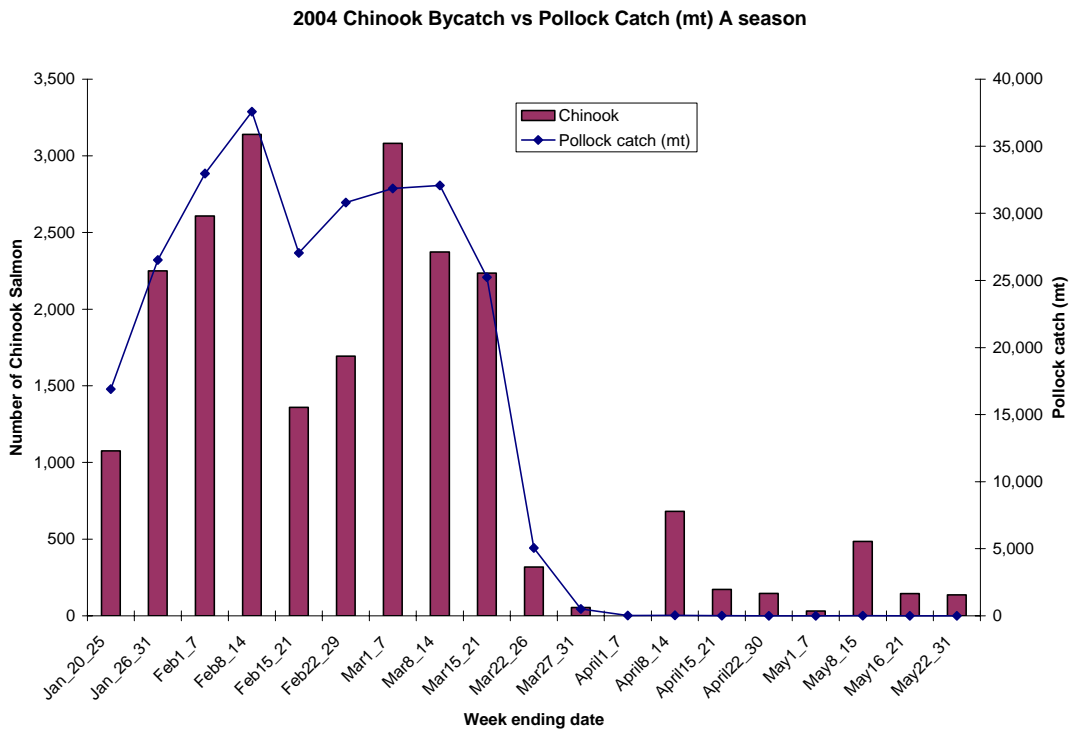


Figure 3. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock A season with pollock catch (mt) in 2004.

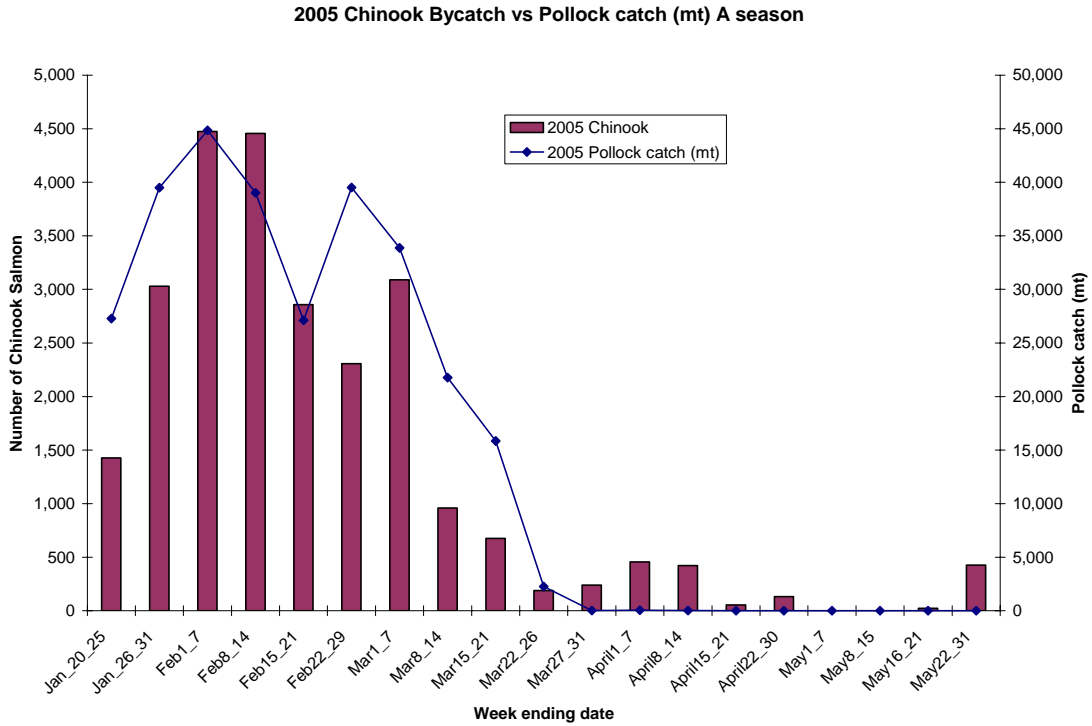


Figure 4. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock A season with pollock catch (mt) in 2005.

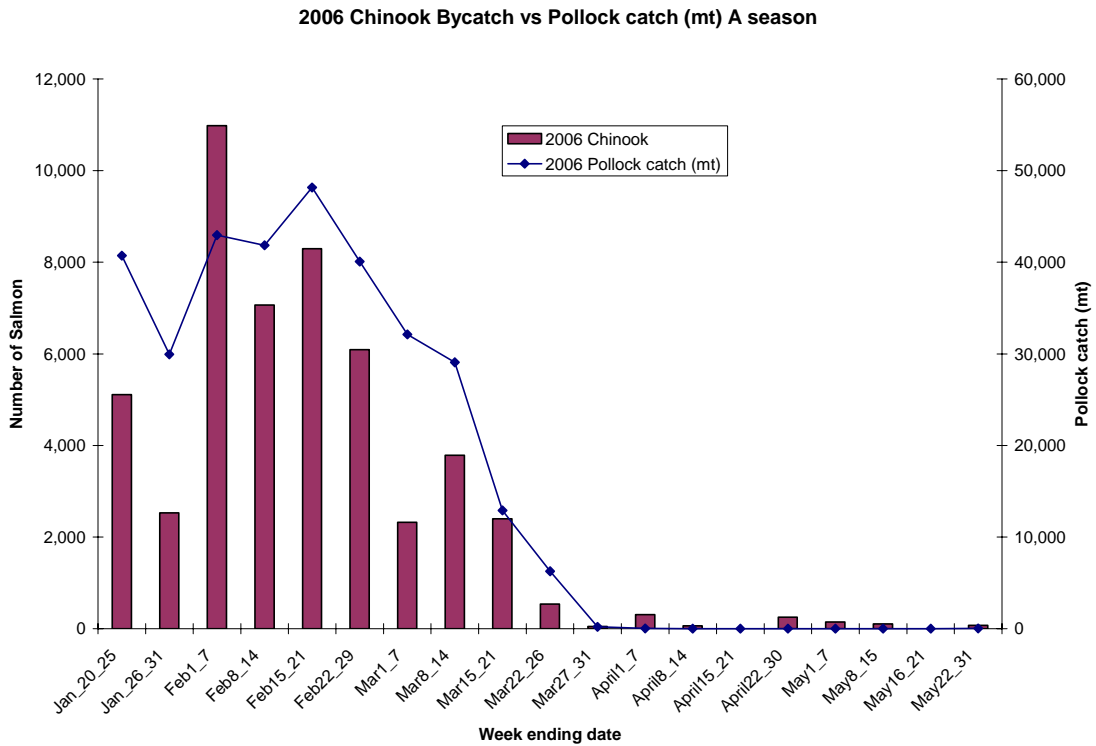


Figure 5. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock A season with pollock catch (mt) in 2006.

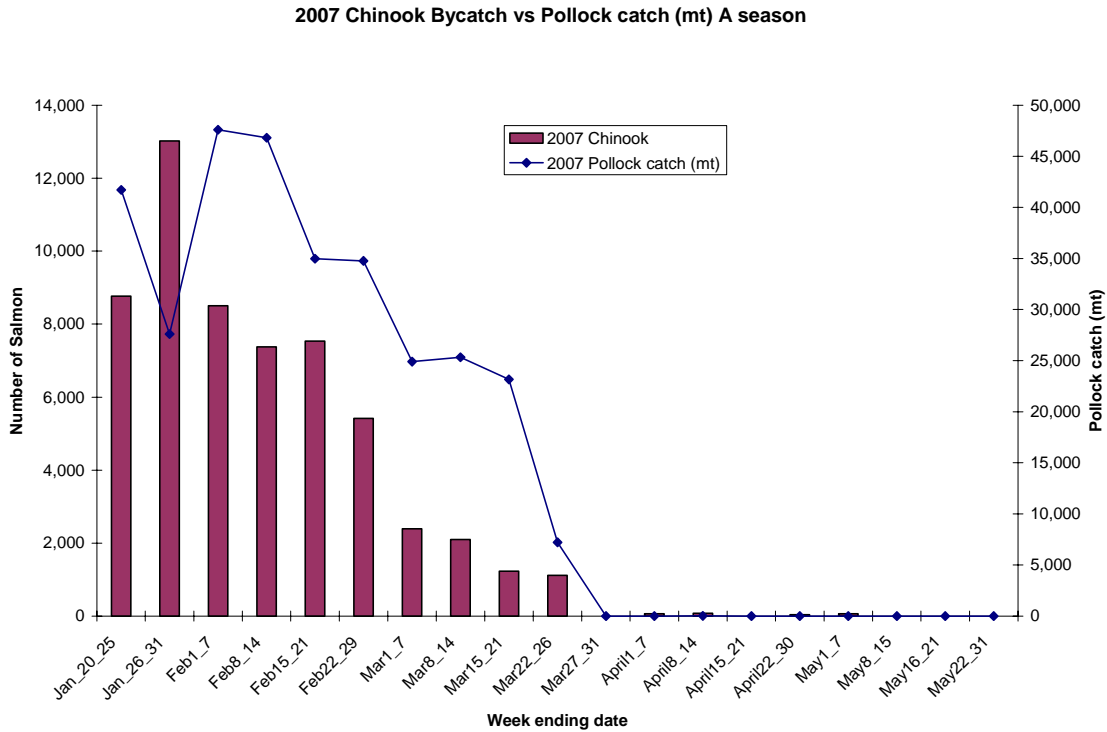


Figure 6. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock A season with pollock catch (mt) in 2007.

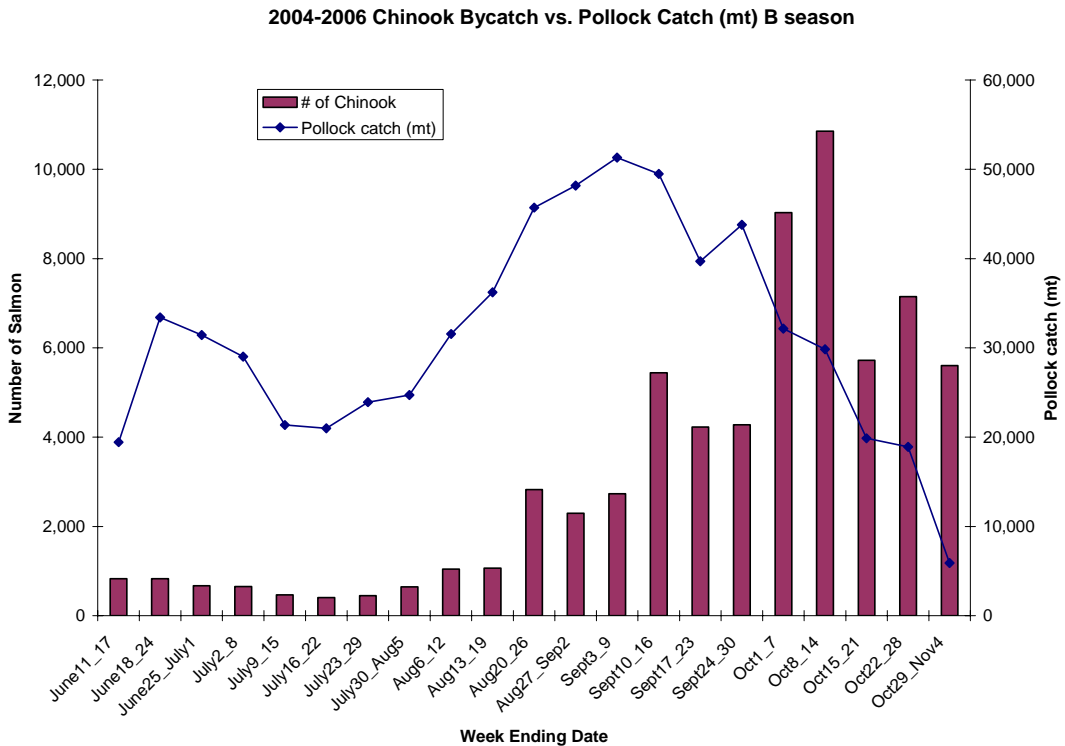


Figure 11. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) combined for years 2004-2006.



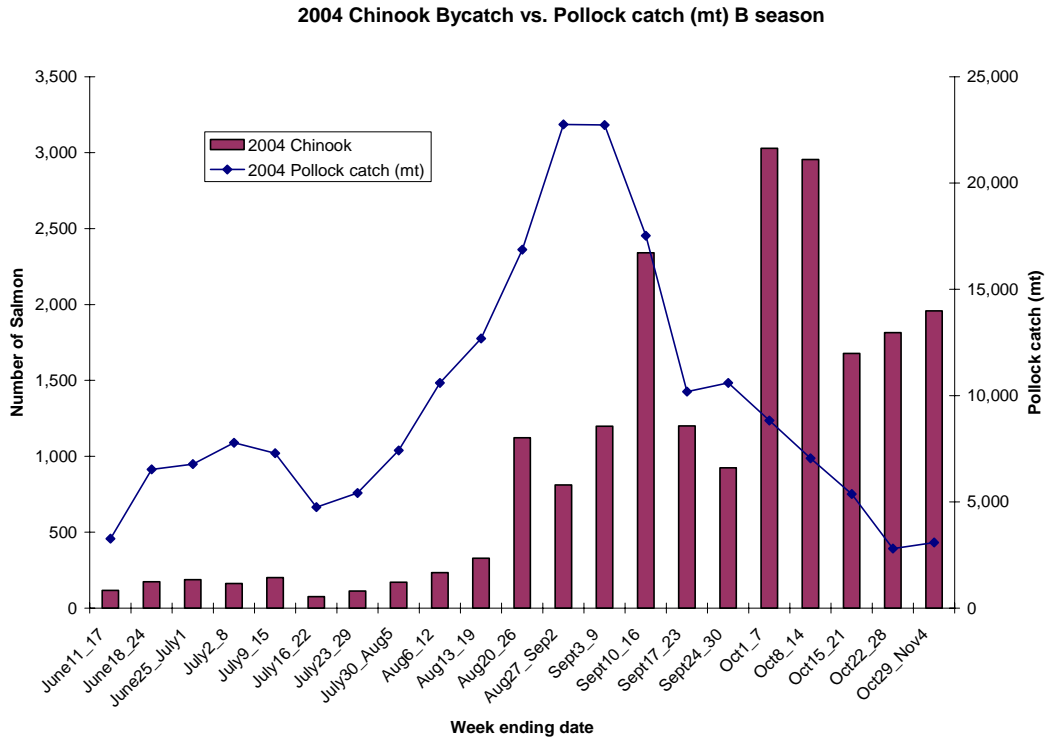


Figure 12. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) combined for 2004.

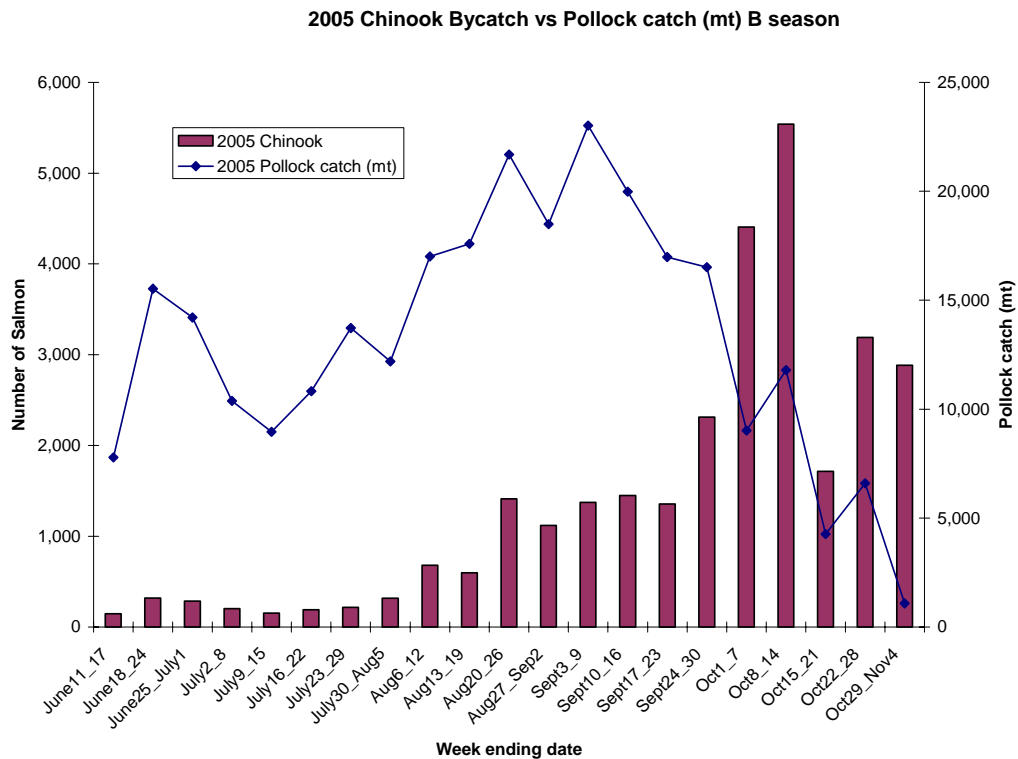


Figure 13. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) combined for 2005.

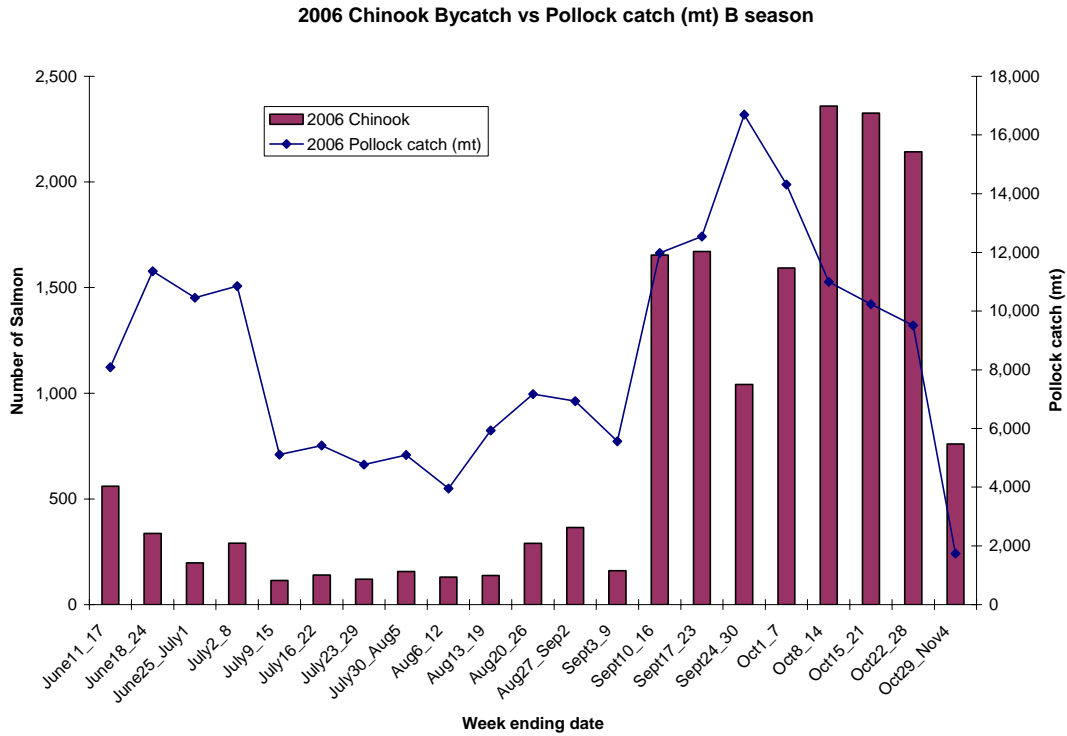


Figure 14. Weekly bycatch of Chinook salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) combined for 2006.

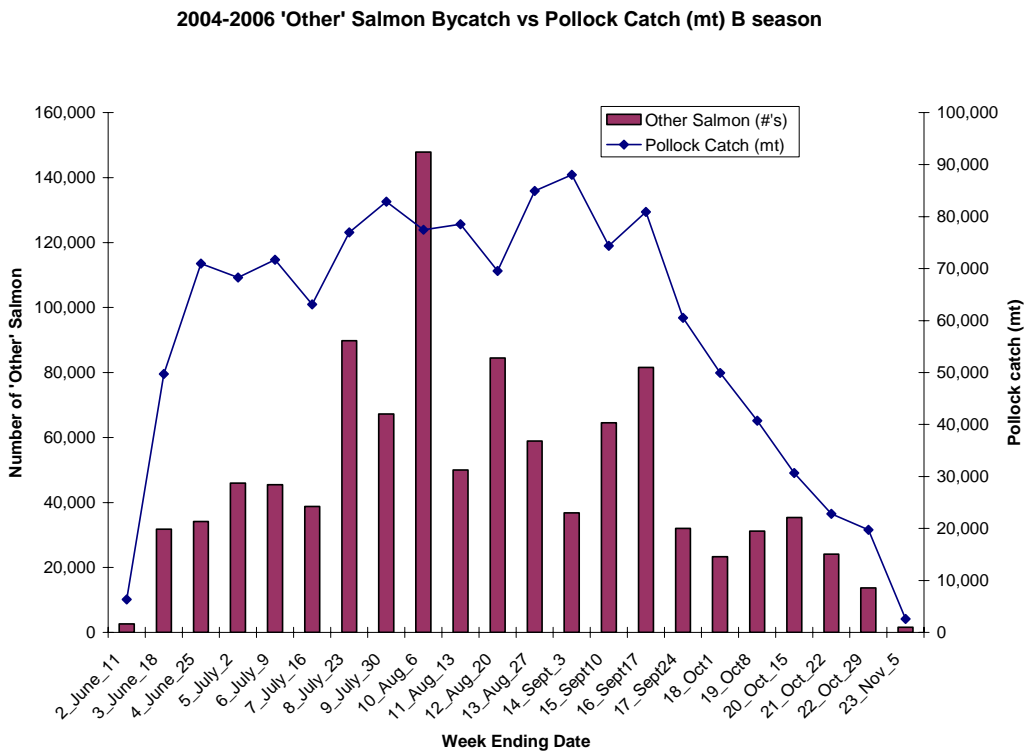


Figure 18. Weekly bycatch of 'Other' salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) combined for years 2004-2006.

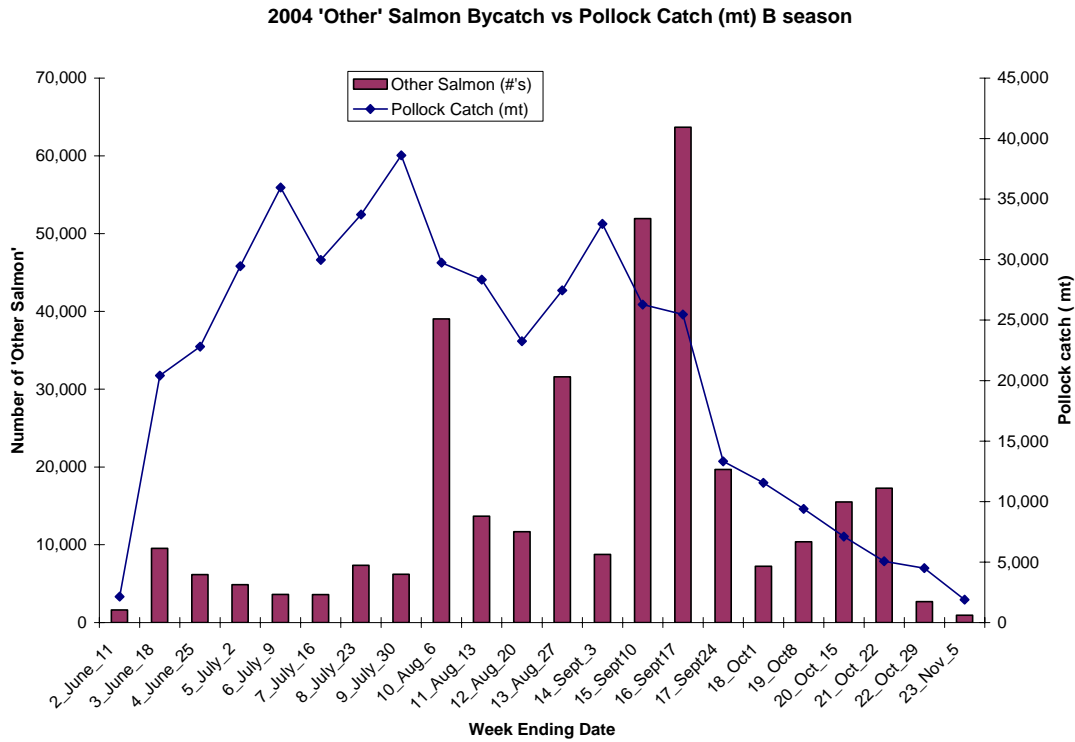


Figure 19. Weekly bycatch of 'Other' salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) for 2004.

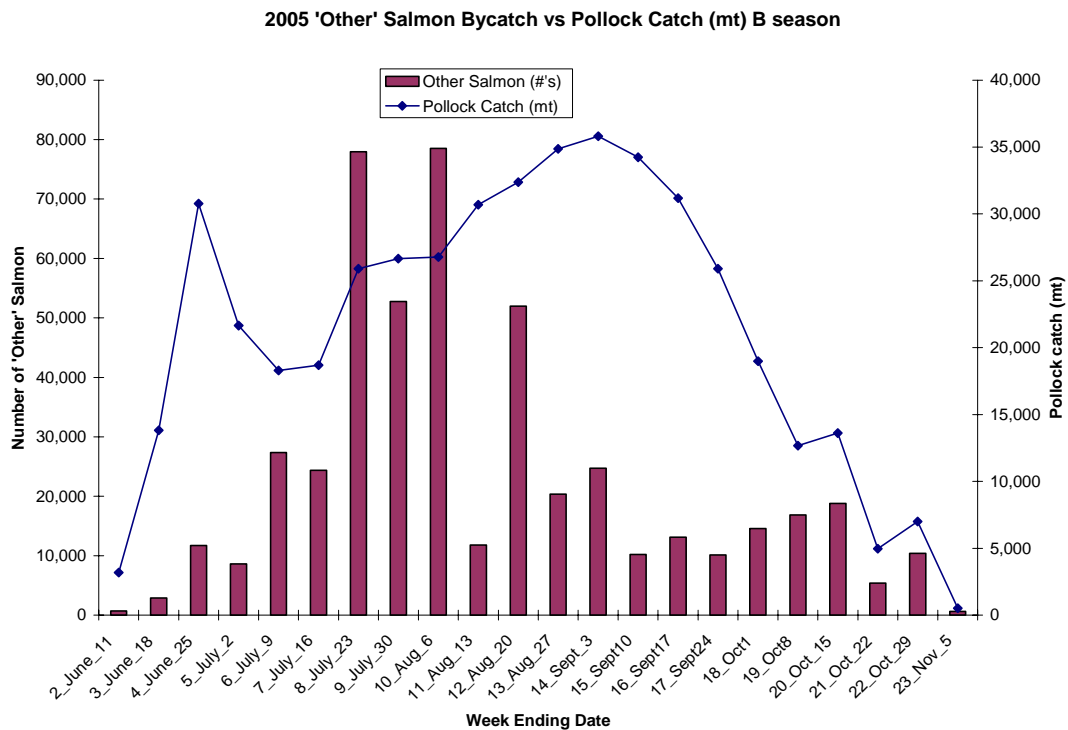


Figure 20. Weekly bycatch of 'Other' salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) for 2005.

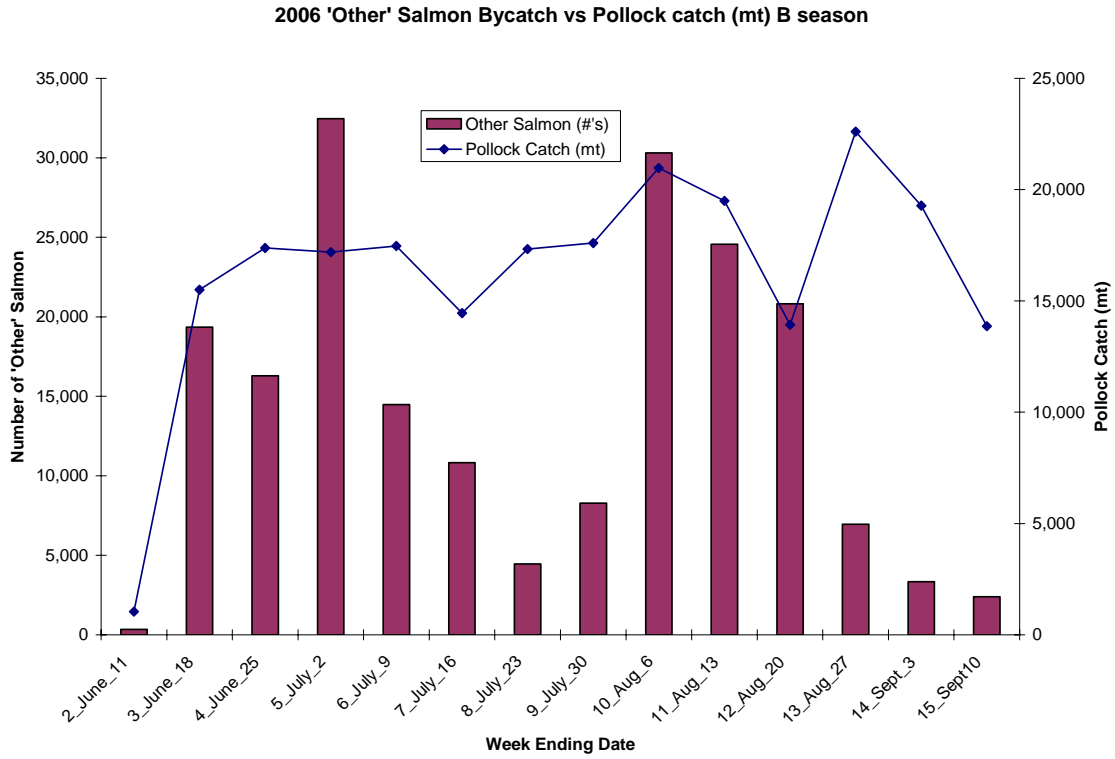


Figure 21. Weekly bycatch of 'Other' salmon (in numbers) caught in the BS Pollock B season with pollock catch (mt) for 2006.

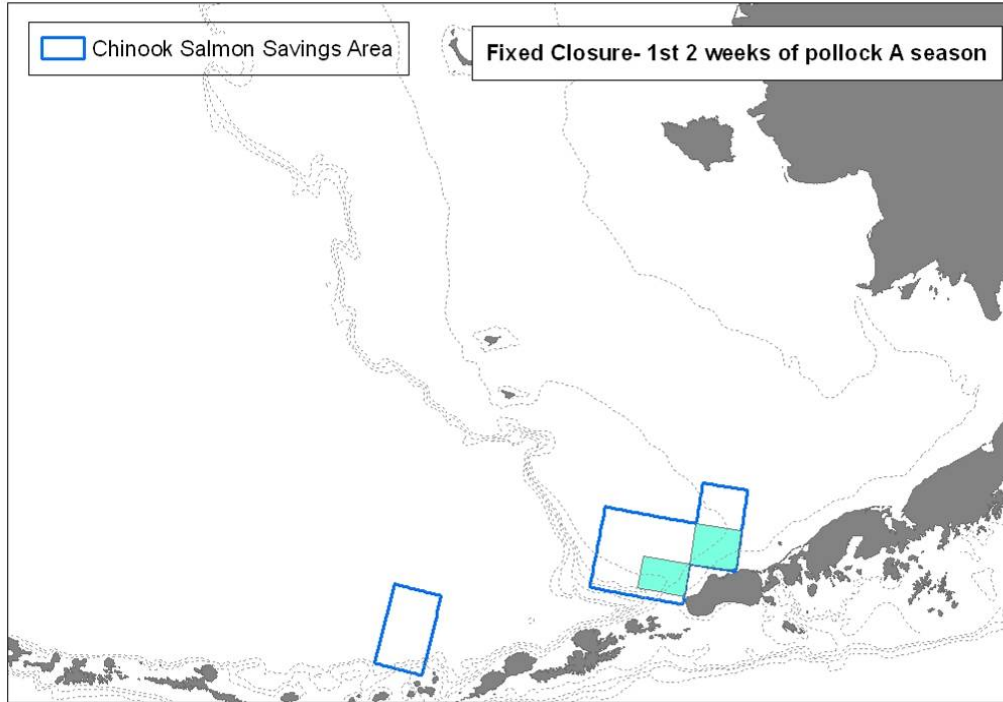


Figure 7. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 1<sup>st</sup> two weeks of Pollock A season. Areas are composed by ADF&G statistical areas 645501 and 655430.

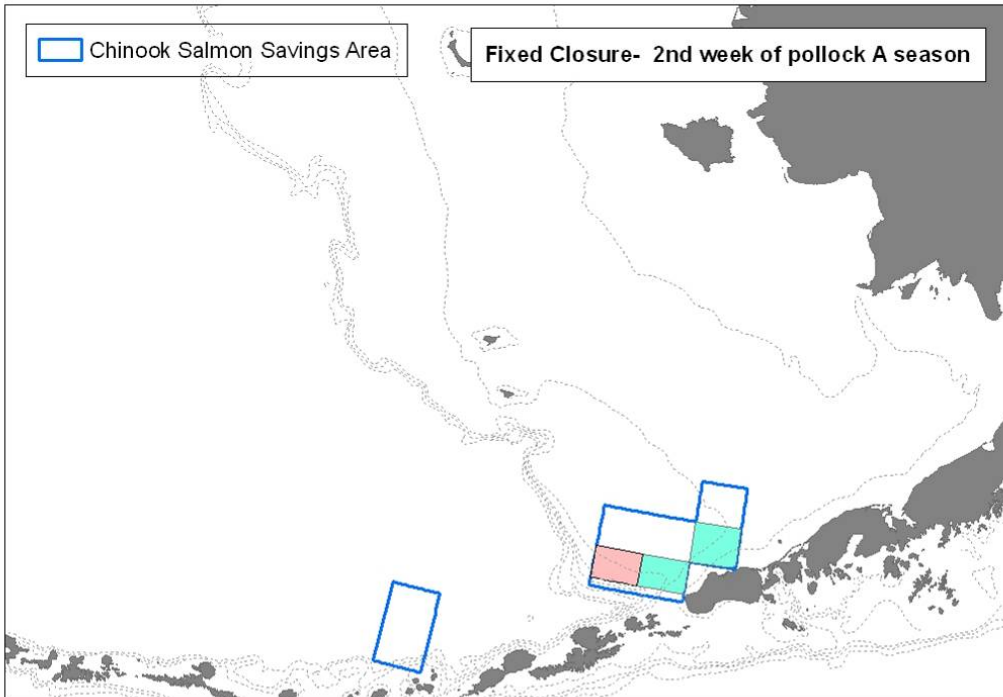


Figure 8. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 2nd week of Pollock A season. Areas are composed by ADF&G statistical areas 645501, 655430 and 665430.

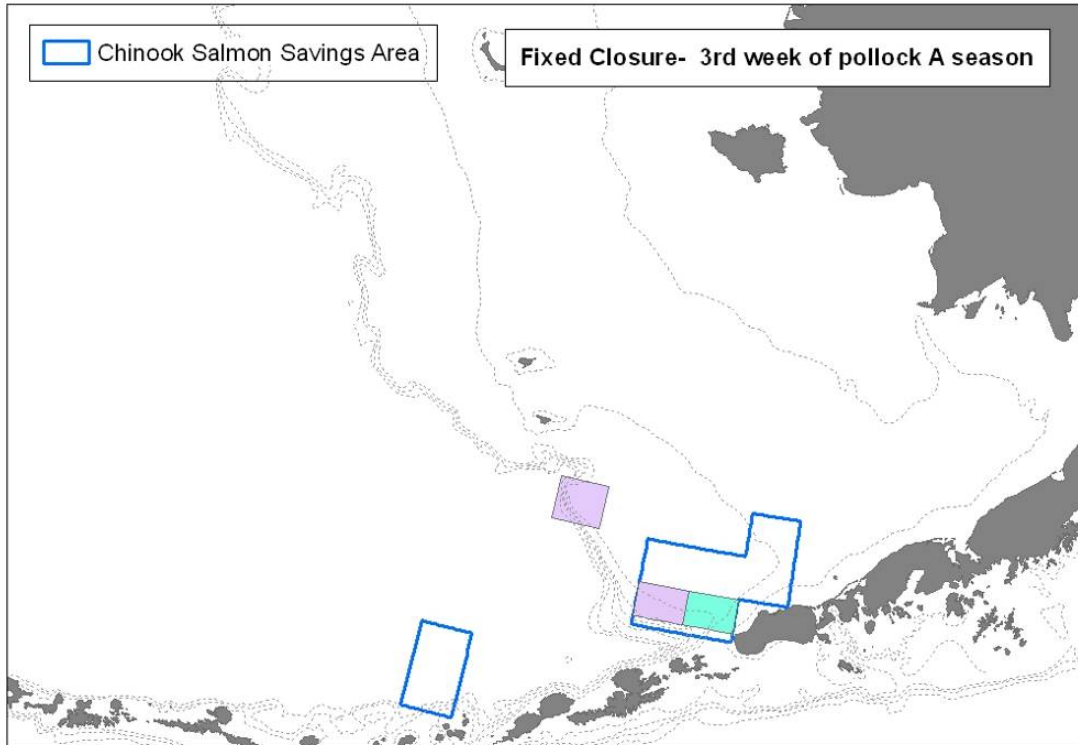


Figure 9. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 3rd week of Pollock A season. Areas are composed by ADF&G statistical areas 655430, 665430, and 685530.

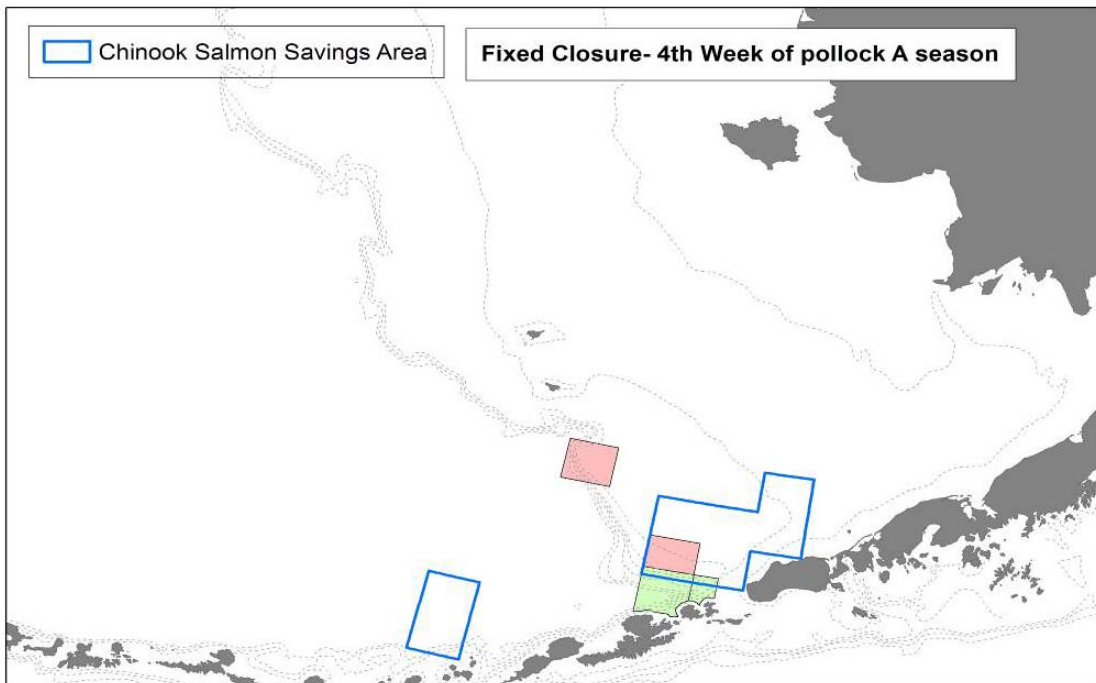


Figure 10. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 4th week of Pollock A season. Areas are composed by ADF&G statistical areas 665430, 685530, 665401, and 655409.

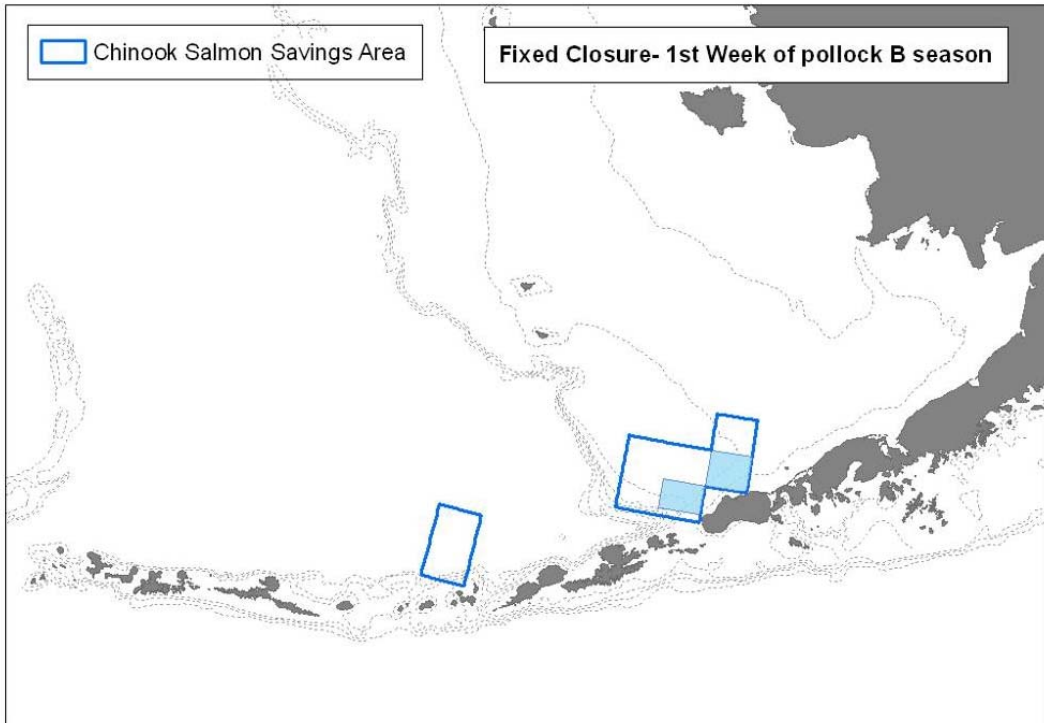


Figure 15. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 1st week of October Pollock B season. Areas are composed by ADF&G statistical areas 645501 and 655430.

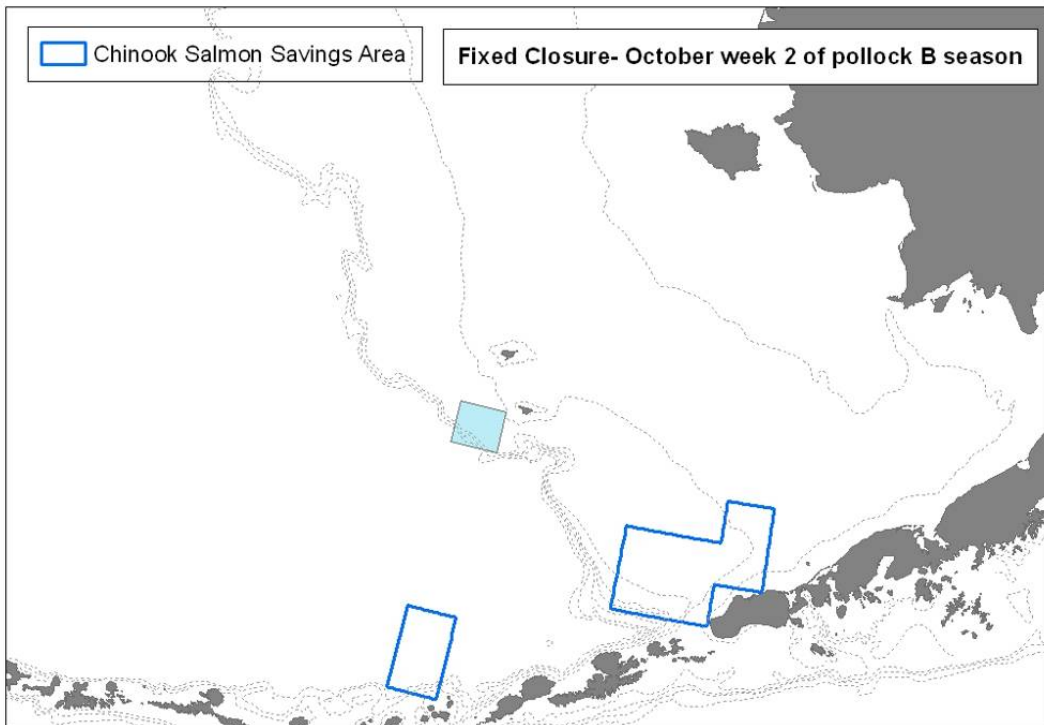


Figure 16. Proposed fixed area closure for reducing Chinook salmon bycatch for BS pelagic trawlers during 2nd week of October Pollock B season. Area is composed by ADF&G statistical area 705600.

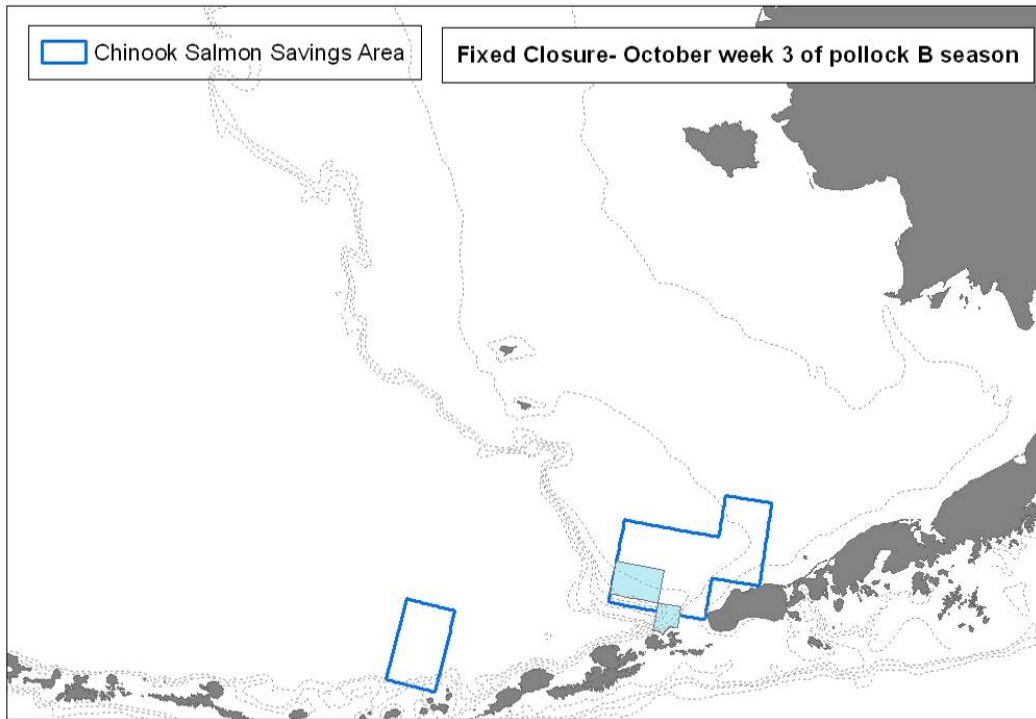


Figure 17. Proposed fixed area closure for reducing salmon bycatch for BS pelagic trawlers during 3<sup>rd</sup> week of October Pollock B season. Areas are composed by ADF&G statistical areas 655409 and 665430.

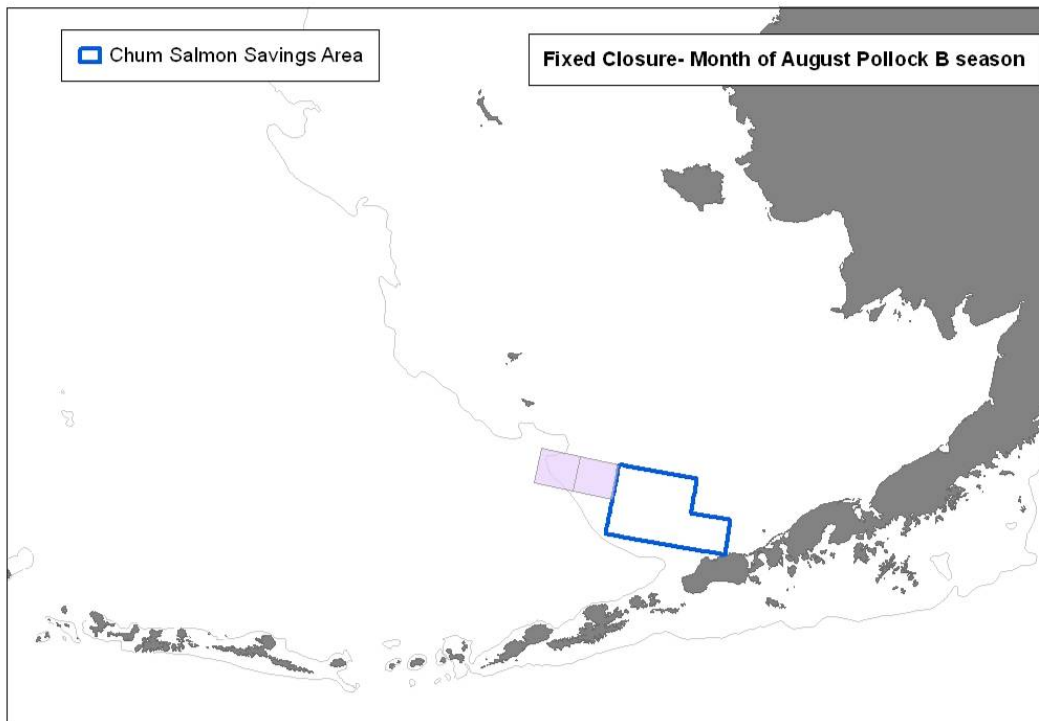


Figure 22. Fixed area closure for reducing salmon bycatch for BS pelagic trawlers August Pollock B season. Areas are composed by ADF&G statistical areas 685530 and 675530.



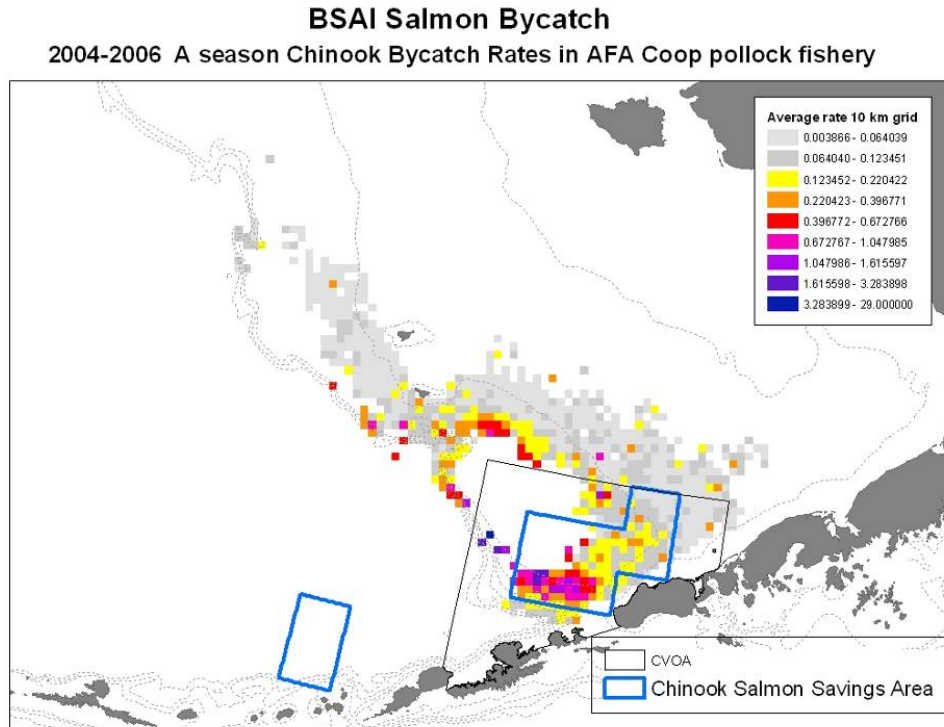


Figure 23. Average observed Chinook bycatch rates in the pollock A season 2004- 2006.

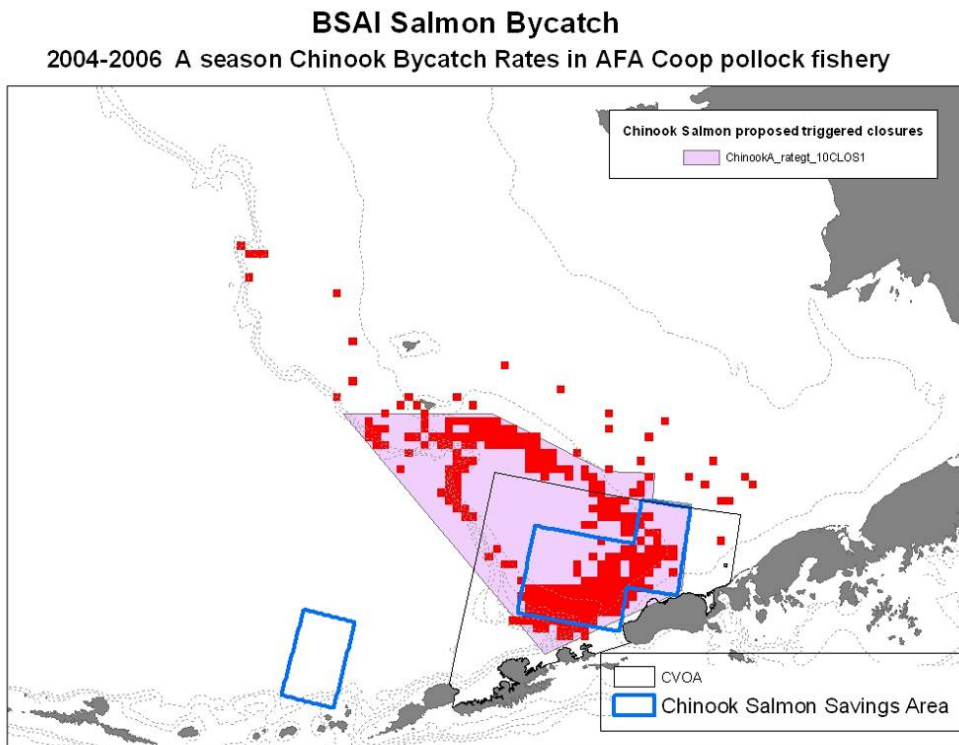


Figure 24. Example methodology to create closure configuration #2a determined by threshold bycatch rate (.10 Chinook/pollock mt) using 2004-2006 observer estimates in the pollock A season.

**BSAI Salmon Bycatch**  
 2004-2006 A season Chinook Bycatch Rates in AFA Coop pollock fishery

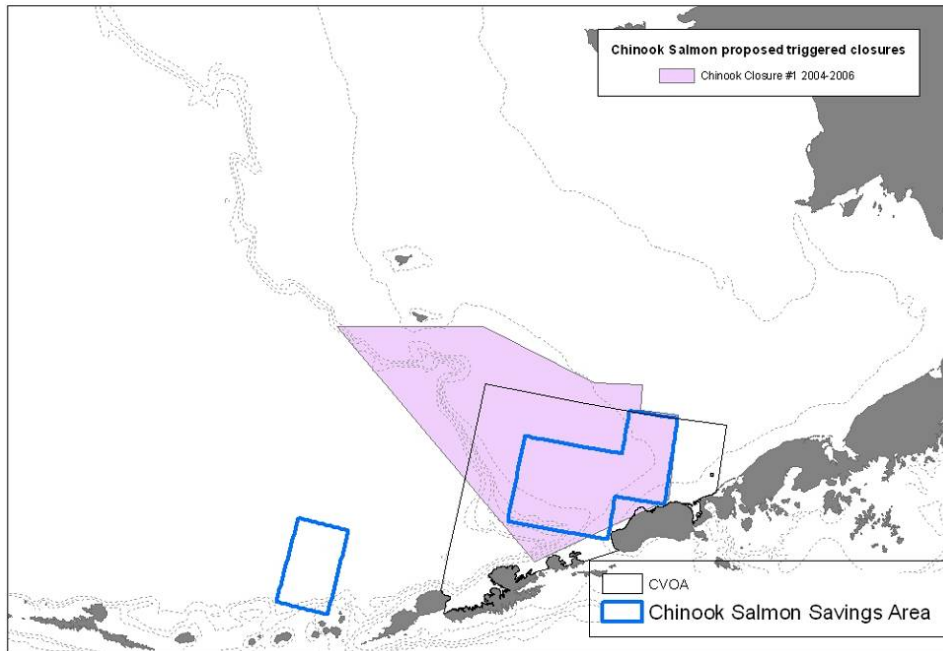


Figure 25. Example of Closure configuration #2a determined by threshold bycatch rate (.10 Chinook/pollock mt) using 2004-2006 observer estimates in the pollock A season.

**BSAI Salmon Bycatch**  
 2004-2006 A season Chinook Bycatch Rates in AFA Coop pollock fishery

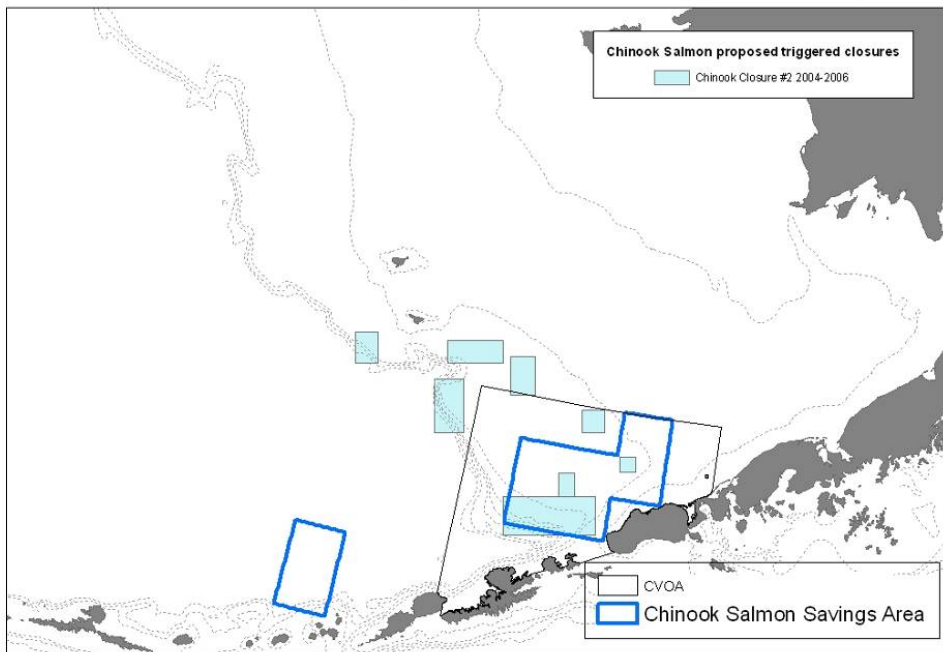


Figure 26. Example of Closure configuration #2b determined by threshold bycatch rate (.20 Chinook/pollock mt) using 2004-2006 observer estimates in the pollock A season.

**BSAI Salmon Bycatch**  
 2004-2006 A season Chinook Bycatch Rates in AFA Coop pollock fishery

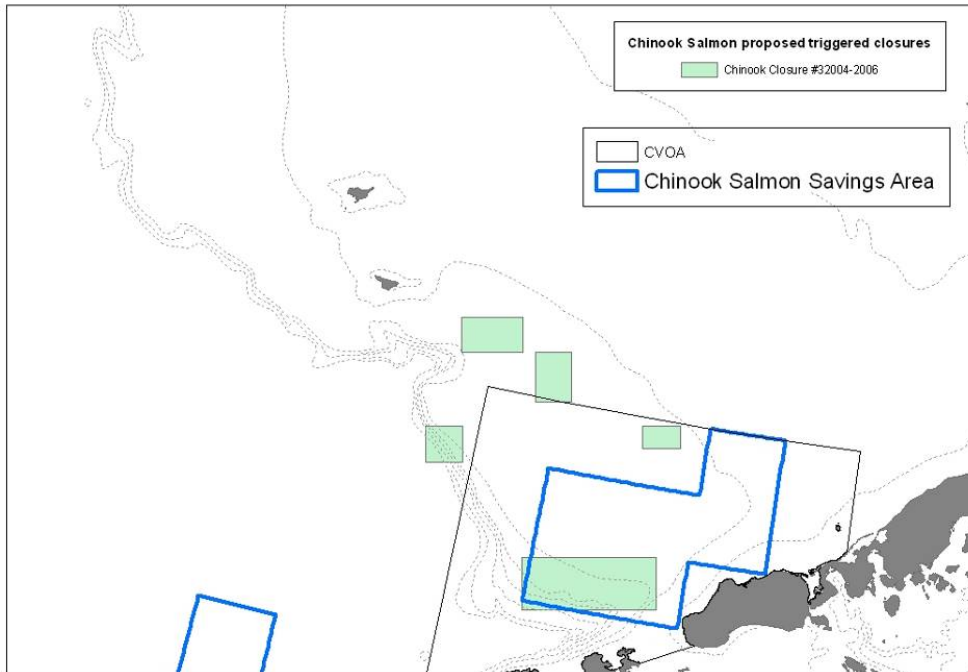


Figure 27. Example of Closure configuration #2c determined by threshold bycatch rate (.30 Chinook/pollock mt) using 2004-2006 observer estimates in the pollock A season.

**BSAI Salmon Bycatch**  
 2004-2006 A season Chinook Bycatch Rates in AFA Coop pollock fishery

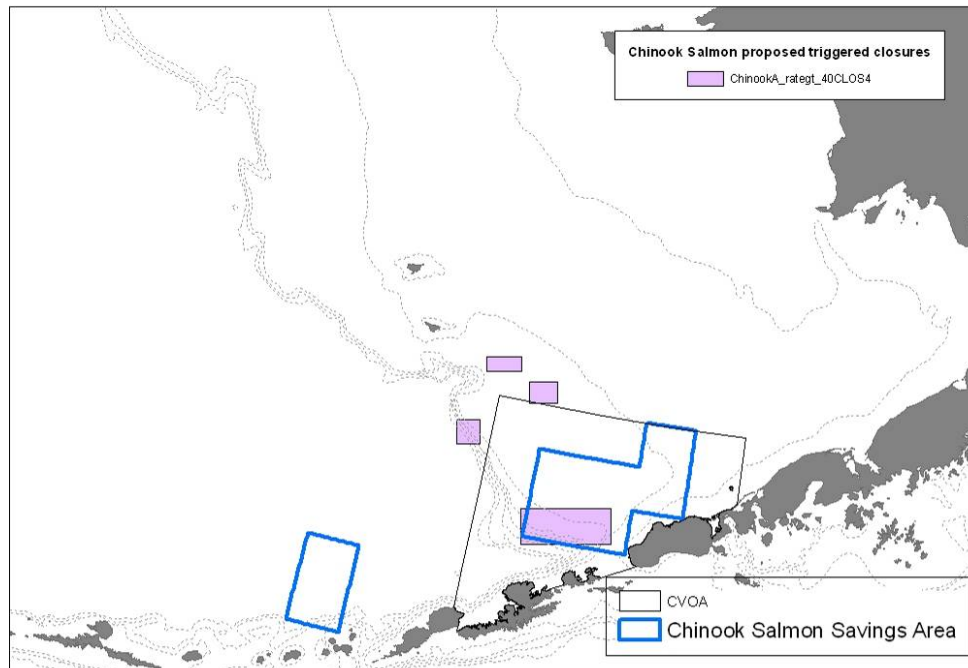


Figure 28. Example of Closure configuration #2d determined by threshold bycatch rate (.40 Chinook/pollock mt) using 2004-2006 observer estimates in the pollock A season.

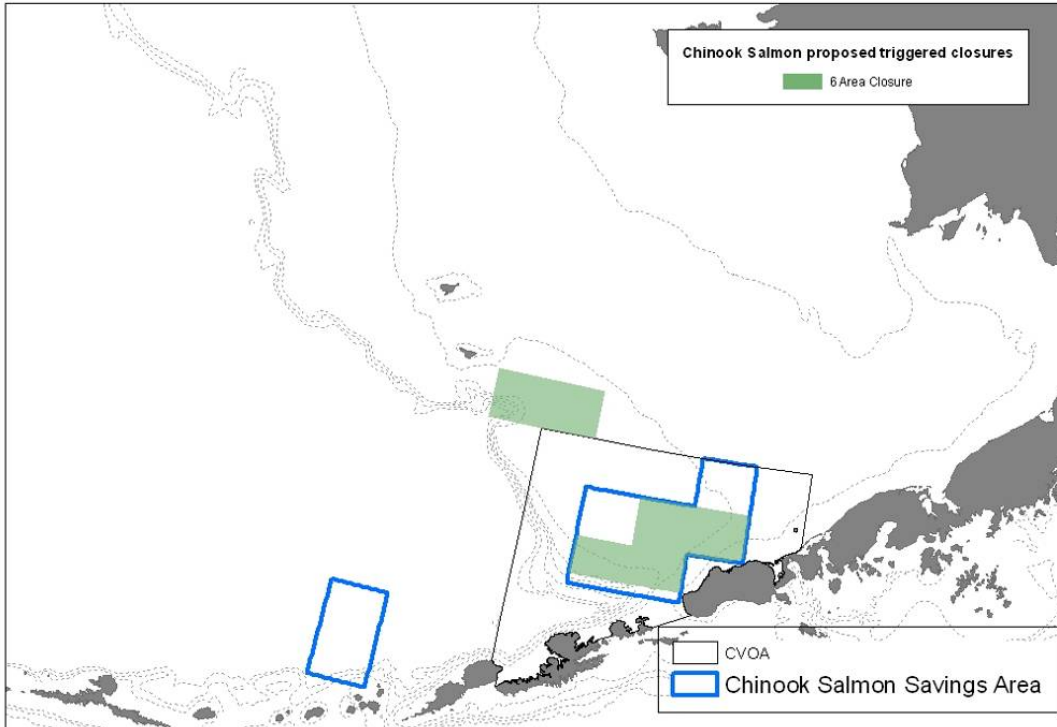


Figure 29. Example of Closure configuration 3a based on overall bycatch reduction goal, example of 50% bycatch reduction based on 2004-2006 observed bycatch numbers and pollock CPUE.

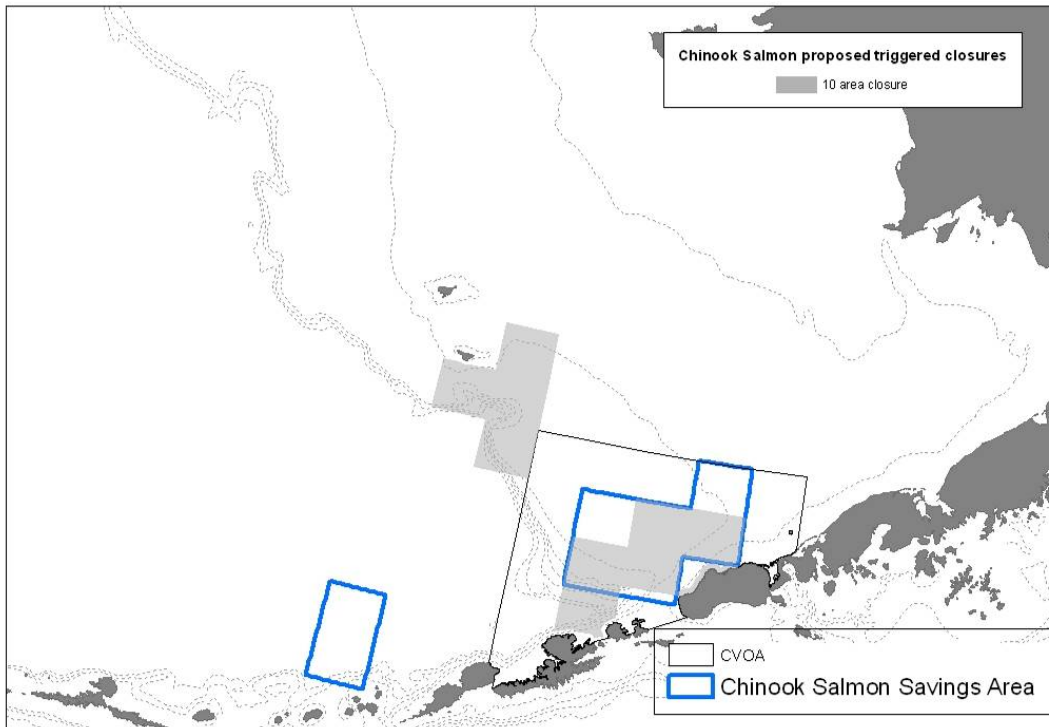


Figure 30. Example of Closure configuration 3b based on overall bycatch reduction goal, example of 75% bycatch reduction based on 2004-2006 observed bycatch numbers and pollock CPUE.