

Report to the North Pacific Fishery Management Council  
on the 2016  
Bering Sea Pollock Intercooperative Salmon Avoidance  
Agreement

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This report is to the North Pacific Fishery Management Council and covers the Bering Sea and Aleutian Islands Management Area (BSAI) Pollock Intercoop Salmon Avoidance Agreement (“ICA”). During the course of the B season fishery, the pollock Intercoop closed 64 areas to fishing based on high bycatch rates of chum salmon experienced by vessels working in the area. Maps of the closures are shown in Figure 1.

Under the terms of the ICA, applicants are to submit to the Council a report analyzing:

1. Estimated number of salmon avoided as demonstrated by the movement of fishing effort away from salmon hot-spots.
2. A compliance/enforcement report that will include the results of an external audit designed to evaluate the accuracy of the approach used by Sea State to monitor compliance with the agreement, and a report on the effectiveness of enforcement measures stipulated under the ICA in cases of non-compliance. Examination of a randomly selected subset of vessel/days representing 10% of the catch during each season will be used as the basis of the audit.

**Number of non-Chinook salmon taken during the fishery (Table 1):**

For the sake of comparison we have included catch and bycatch amounts running back to 1993. These data are compiled from plant landing information for catcher vessels delivering to shoreside processors, and observer data for mothership catcher vessels and catcher-processors. The “other salmon” category includes all non-chinook salmon. Observer data for both offshore and shoreside deliveries show only very small numbers

of salmon other than chum in this category (for example, 152 unidentified, 31 pinks, and 5 silvers for the 2006B season EFP).

*Table 1. Catch and bycatch of pollock and “other” salmon in the directed pollock fishery B season, 1993 – 2016.*

<b>Year</b>	<b>B season pollock*</b>	<b>B season other salmon bycatch</b>
<b>1993</b>	<b>740,569</b>	<b>242,473</b>
<b>1994</b>	<b>718,582</b>	<b>89,117</b>
<b>1995</b>	<b>647,865</b>	<b>17,625</b>
<b>1996</b>	<b>633,639</b>	<b>77,028</b>
<b>1997</b>	<b>546,988</b>	<b>64,504</b>
<b>1998</b>	<b>539,432</b>	<b>60,040</b>
<b>1999</b>	<b>511,211</b>	<b>44,261</b>
<b>2000</b>	<b>631,755</b>	<b>57,228</b>
<b>2001</b>	<b>813,022</b>	<b>50,948</b>
<b>2002</b>	<b>866,034</b>	<b>83,033</b>
<b>2003</b>	<b>876,784</b>	<b>170,688</b>
<b>2004</b>	<b>858,799</b>	<b>427,234</b>
<b>2005</b>	<b>878,618</b>	<b>637,957</b>
<b>2006</b>	<b>874,435</b>	<b>276,779</b>
<b>2007</b>	<b>775,261</b>	<b>82,641</b>
<b>2008</b>	<b>572,384</b>	<b>14,453</b>
<b>2009</b>	<b>469,128</b>	<b>38,040</b>
<b>2010</b>	<b>471,983</b>	<b>13,585</b>
<b>2011</b>	<b>681,480</b>	<b>191,517</b>
<b>2012</b>	<b>705,716</b>	<b>22,149</b>
<b>2013</b>	<b>738,693</b>	<b>124,661</b>
<b>2014</b>	<b>745,808</b>	<b>217,572</b>
<b>2015</b>	<b>772,975</b>	<b>231,960</b>
<b>2016</b>	<b>789,524</b>	<b>338,801</b>

*\* For the years 1993-1999, total groundfish from P and B targets, available on files from NMFS site (below), were used instead of pollock.*

*Estimates of salmon bycatch for 1993-1999 are for all P and B trawl target fisheries, including CDQ, and are available on the NOAA Fisheries, AK Region web site. (<http://www.fakr.noaa.gov/sustainablefisheries/catchstats.htm>)*

## Evaluation of salmon savings.

The evaluation of the number of salmon saved by the IC program is based on tracking vessels that fished in a closed area before it closed, and then comparing their subsequent bycatch to see if it was lower than expected if the area had not closed. Put more simply, we perform a before-and-after comparison of the bycatch observed and expected from the vessels that triggered the closure. The procedure is as follows:

1. Extract all observer data for haul locations falling inside a closure area, for a 5 day period preceding the closure. For shoreside catcher vessels, aggregate the hauls that have the same “start fishing date” so that hauls with the same bycatch rate are not artificially repeated. As an example, if 2 hauls from the same catcher vessel trip show up in the closed area, they will have the same bycatch rate because observers pro-rate bycatch evenly across all hauls. Consider them a single observation with a value equal to the sum of the two hauls’ pollock and salmon.
2. Consider all of independent offshore sector (C/P and mothership) hauls, and combined “trip-level” hauls to be estimates of the bycatch ratio  $R_i = \sum y_i / \sum x_i$ , where y are counts of chinook or chum salmon, and x is the pollock catch from individual hauls (offshore sector) or grouped, same-trip hauls (shoreside), and i indicates a separate closure.
3. Extract the same haul or “grouped” haul information, for the same vessels, for the duration of the closure (either 3 or 4 days). Their associated bycatch is available from either observer or plant delivery information. Compute their expected bycatch had they been able to stay and fish inside the now-closed area, by summing the pollock catch of all vessels in this category, and multiplying this summed pollock catch by the matching bycatch ratio,  $R_i$  above.
4. Compute the standard error of this estimated Y (overall salmon bycatch if vessels had stayed in the area and fished with bycatch rate R) treating R as a ratio estimator (Snedecor and Cochran, Statistical Methods, 8<sup>th</sup> Edition, p 452).

## Avoidance results from the 2016 Intercoop Agreement

Locations of the 2016 closures are shown in Figure 1.

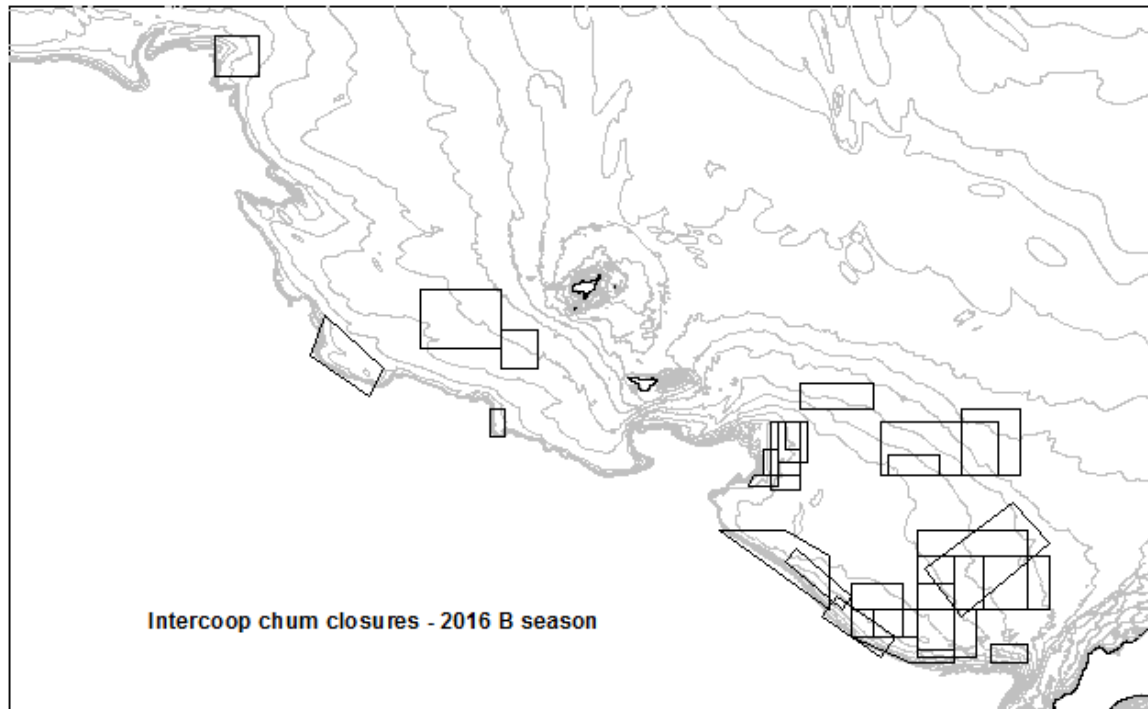


Figure 1. 2016 IC chum closures

Table 2 summarizes the results for both chum and chinook savings resulting from these closures (Appendix Tables A1 and A2 show the underlying data, by closure, with associated standard errors). A total of 51,757 mt of pollock was associated with boats that fished inside areas before they were closed. These same vessels caught 104,883 mt of pollock in the closure interval following the associated closure date. An estimated 111,159 fewer chum were taken outside the closures than would have been expected if the same amount of pollock had been taken inside the closures, based on the comparison of rates inside and outside closure areas. Chinook reduction was negative (that is, the closures are estimated to have increased chinook bycatch): 640 were taken outside the chum closures versus an estimated 561 that would have been caught at within-closure rates, or an increase of 75 chinook. These bycatch differences represent a 67% decrease in expected chum bycatch (for boats that fished in closures, for the 3 or 4 day period after the closure), and a 14% increase in expected chinook bycatch, for vessels that actually fished in the closures during the 5 day period preceding each closure.

Table 2. Chum salmon closure effectiveness for the 2016 B season. 51,757 mt of pollock were taken in closure areas prior to closure, and 104,888 mt were taken by the same vessels after closures.

Closure statistic	Bycatch species	
	Chum	Chinook
Actual bycatch (outside, after closures)	54,892	640
Expected bycatch (at pre-closure rate)	166,050	561
Savings	111,158	-79
% reduction	67%	-14%

A comparison with results from chum closures from previous years is shown in Table 3. The “After-closure pollock” column shows the total tonnage of pollock harvested after closures by vessels that fished inside closures during the closure duration (3 or 4 days, depending on the day of closure). This amount of pollock can be viewed as having been moved from inside the closure area to outside due to the closures. The 2016 amount (104,888 mt) is higher than average (average = 53,813 from 2006 - 2016). The chum savings percentage, for vessels that fished in closures prior to the closures, was 67%, close to the series average of 64%. The reductions estimated by the methods outlined are likely to be conservative, as they do not account for any change in behavior of vessels that did not fish in closures in the 5 day period preceding the closure announcement. Chum-related closures continued through October 7, and all pollock fishing effort was concluded by October 17th. These later closures may have had the unintended effect of moving vessels into areas with high chinook bycatch, although the estimated increase of 79 chinook taken as bycatch is not large.

*Table 3. Comparison of the effects of chum closures across years.*

Year	After-closure pollock	% of harvest affected	Chinook savings	Chinook % reduction	Chum savings	% reduction	Actual chum catch	Percentage reduction
2006	23,049	3%	-97	-21%	65,299	64%	276,779	19%
2007	107,646	14%	2007	56%	75,970	82%	82,641	48%
2008	3,448	1%	53	82%	768	73%	14,453	5%
2009	5,701	1%	52	50%	6,270	76%	38,040	14%
2010	12,537	3%	61	85%	1,808	84%	13,585	12%
2011	146,846	22%	73	7%	79,657	63%	191,517	29%
2012	12,246	2%	48	11%	3,530	50%	22,149	14%
2013	49,818	7%	1051	74%	34,231	65%	124,661	22%
2014	65,232	9%	9	13%	57,938	58%	217,572	21%
2015	60,536	8%	-75	-16%	18,774	27%	231,960	7%
2016	104,888	13%	-79	-14%	111,158	67%	338,801	25%
Totals	591,947				455,403		1,552,158	23%

### Compliance/ Enforcement

No violations were referred to coops for enforcement actions. An audit of Sea State compliance monitoring has again been awarded to ABR Inc of Fairbanks, Alaska. ABR reviewed 10% of the coop fishing records and associated VMS information. The report for this audit states that:

“ABR agreed with the determinations of Sea State for the 10% sample that we examined, and we found no closure zone violations. Of points examined, our determination agreed with Sea State for all 10,542 locations in our subsample.”

### Comparison of the 2016 chum ICA program with previous years.

The 2016 B pollock season differed markedly from most years in that 86% of the catch came from waters south of 56 30 N, which is approximately the southern extent of St. George Island. The 2000 – 2015 average for these water was 41%, with the next highest value of 68% was found back in 2002. Over the same period, 80% of the chum bycatch occurred south of 56 30, so there is clearly more chum bycatch associated with fishing on the southern part of the eastern Bering Sea shelf. The spatial pattern of the 2016 fishery is shown in Figure 2. Strong catches were found in the CVOA, with both catcher vessels and catcher-processors (fishing CDQ) preferring to fish inside the CVOA over much of the season. Catcher/processors pursued much of their non-CDQ quota between the CVOA western boundary and the shelf edge.

The bycatch rate for chum salmon (numbers of salmon per mt of pollock) south of the Pribilofs also rose 7% in 2016 relative to 2015 levels. This rise was in response to the 62 percent rise in the numbers of chum salmon encountered while towing (Table 5). Fortunately, the cpue on pollock also increased last year, by 51% (Table 5). Recalling that the bycatch rate is equal to the ratio of chum cpue to pollock cpue, the increase in chum bycatch rate, and ultimately the total bycatch of chums, would have been much higher had pollock CPUEs been lower.

The movement of the fleet south was explained by captains as necessary to target fish large enough to harvest. The 2012 year class appears to be particularly strong, and in the

summer of 2016 were not large enough to process effectively, but certainly large enough to harvest in large numbers. Smaller fish are generally found to the north, but often the offshore sectors in particular are able to stay on schools of larger fish that are in the same areas as smaller fish. For unknown reasons, the year classes showed more of a stratified distribution last year, with mostly large fish to the south. Harvesting more to the north, while reducing chum bycatch, would likely have resulted in a large percentage of fish turned into lower value product, or for shoreside catchers, sent directly to meal plants.

Bycatch rates for chum salmon were also high to the north last year as well (Table 6 and figure 6), but so little fish were actually taken north of the Pribilofs that it's not clear that those high rates would have prevailed over the entire B season if the fleets had worked that area more intensely.

*Table 4. Percent of pollock harvest and chum bycatch taken from water north vs south of 56 30 N, 2000 – 2016.*

Year	Pollock %		Chum %	
	N	S	N	S
2000	50%	50%	8%	92%
2001	37%	63%	17%	83%
2002	32%	68%	5%	95%
2003	44%	56%	11%	89%
2004	39%	61%	11%	89%
2005	63%	37%	20%	80%
2006	75%	25%	8%	92%
2007	75%	25%	58%	42%
2008	82%	18%	25%	75%
2009	82%	18%	26%	74%
2010	80%	20%	34%	66%
2011	56%	44%	23%	77%
2012	72%	28%	13%	87%
2013	68%	32%	22%	78%
2014	50%	50%	27%	73%
2015	43%	57%	14%	86%
2016	14%	86%	10%	90%

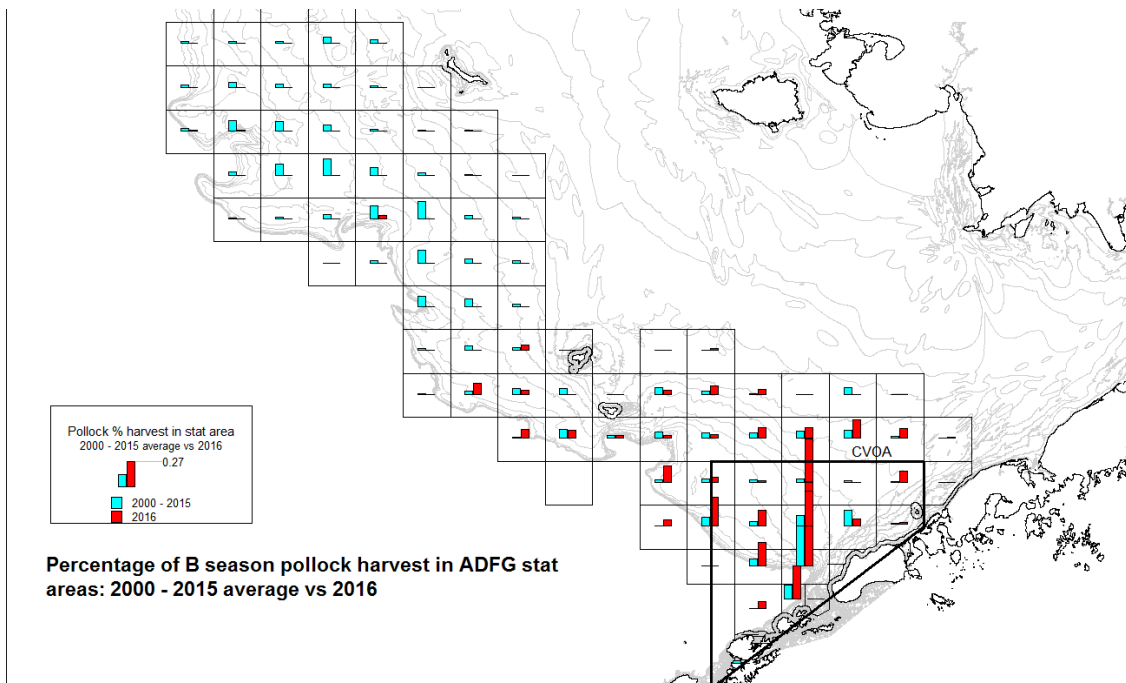


Figure 2. Percentage of pollock catch in ADFG stat areas during the pollock B season: 2000 – 2015 average vs 2016.

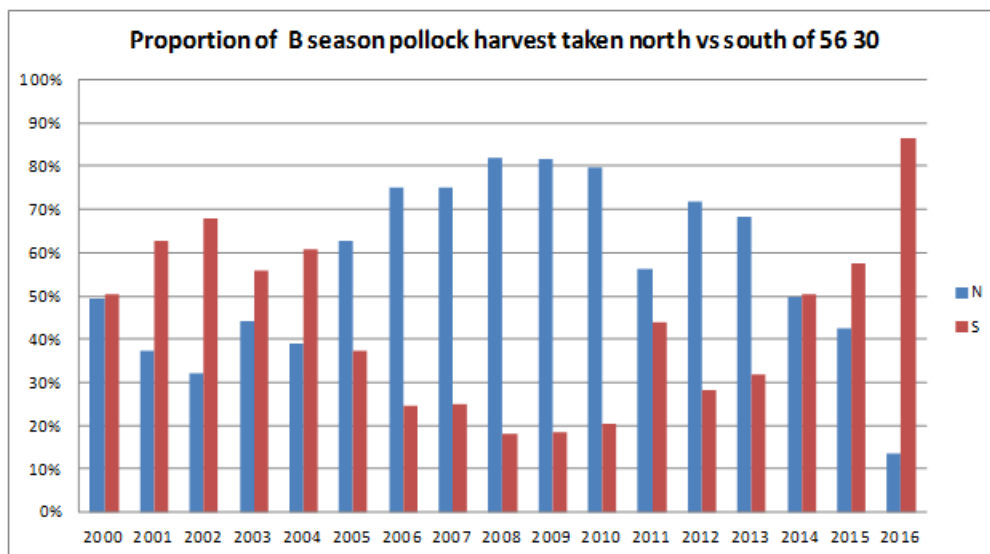


Figure 3. Proportion of the pollock B season harvest taken north and south of 56 30, 2000 - 2016



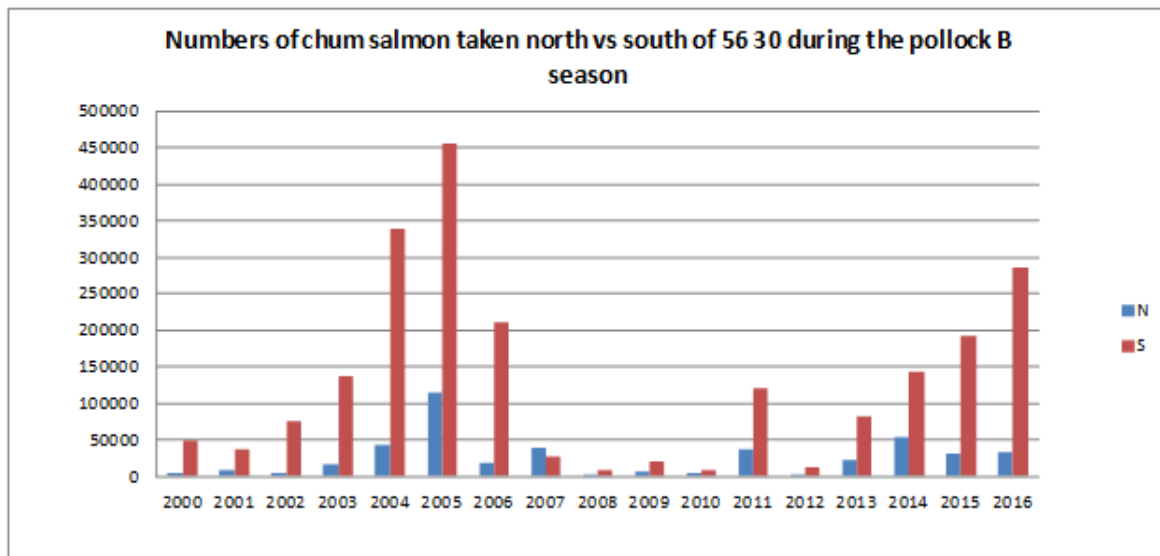


Figure 4. Numbers of chum salmon taken north and south of 56 30 during the pollock B season, 2000 – 2016.

Table 5. CPUE of chum and pollock (N chum or mt pollock per hour towed) and chum bycatch rate (N salmon per mt pollock), south of 56 30, over the 2016 pollock B season.

Year	Pollock CPUE (mt/hr)	Pollock CPUE% change over previous yr	Chum CPUE (N/hr)	Chum CPUE % change over previous yr	Chum bycatch rate (N/mt pollock)	Bycatch rate change over previous yr
2011	7.5		2.3		0.31	
2012	6.8	-9%	0.3	-87%	0.05	-85%
2013	10.5	55%	2.2	620%	0.21	365%
2014	11.9	14%	2.9	30%	0.24	14%
2015	18.6	56%	6.2	111%	0.33	36%
2016	28.0	51%	10.0	62%	0.36	7%

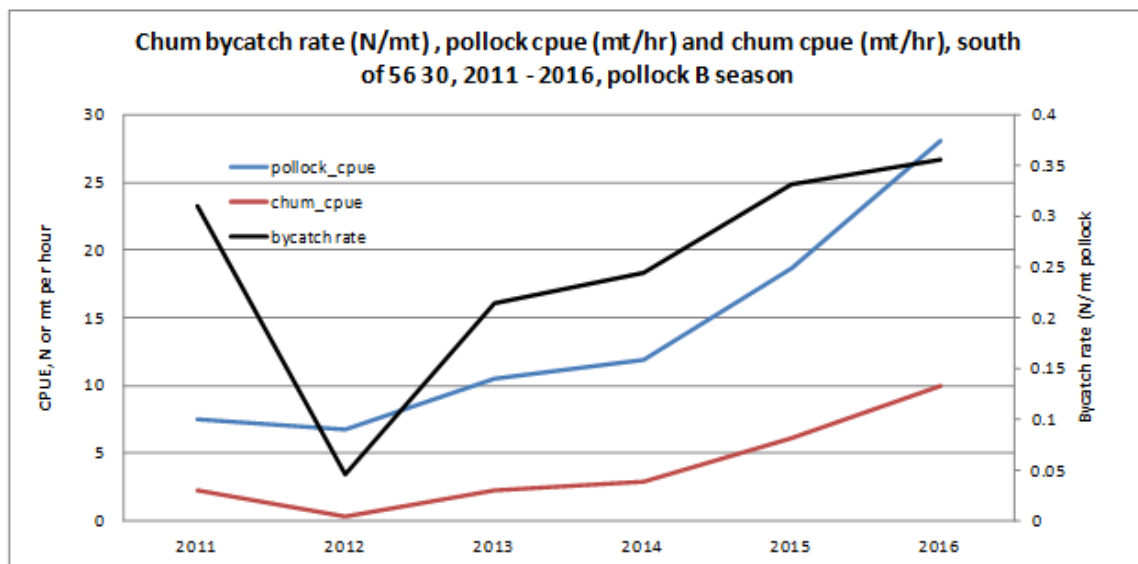


Figure 5. Pollock and chum CPUE, and chum bycatch rate relative to pollock, during the 2011 – 2016 B seasons.

Table 6. CPUE of chum and pollock (N chum or mt pollock per hour towed) and chum bycatch rate (N salmon per mt pollock), north of 56 30, over the 2016 pollock B season.

Year	Pollock CPUE (mt/hr)	Pollock CPUE% change over previous yr	Chum CPUE (N/hr)	Chum CPUE % change over previous yr	Chum bycatch rate (N/mt pollock)	Bycatch rate change over previous yr
2011	12.8		1.2		0.09	
2012	20.3	58%	0.1	-92%	0.00	-95%
2013	24.5	21%	0.7	643%	0.03	515%
2014	19.4	-21%	2.9	327%	0.15	440%
2015	23.9	23%	2.5	-14%	0.11	-31%
2016	29.1	22%	9.9	294%	0.34	223%

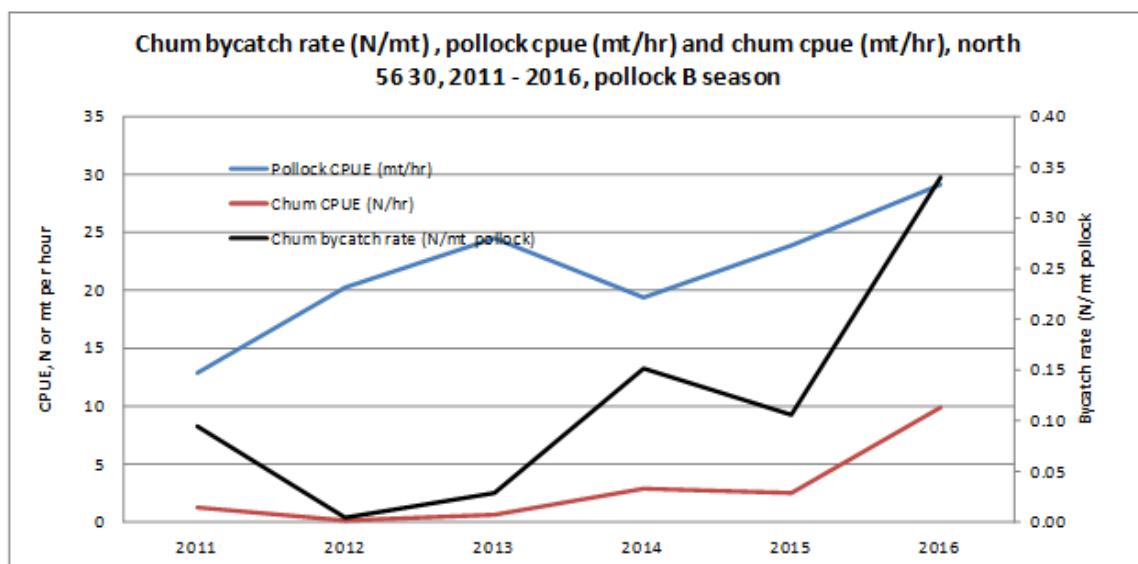


Figure 6. Pollock and chum CPUE, and chum bycatch rate relative to pollock, during the 2011 – 2016 B seasons.

**Appendix 1. Before-and-after closure fishing comparisons, by closure.***Table A1. Chum savings by closure*

Date	Pollock catch (mt) in closures, prior to closure	Chum rate in closure (N/mt)	Chum rate after closure	Displaced pollock (mt)	Actual chum bycatch (N)	Est chum bycatch at closure rate	Chum reduction (estimate - actual)	N Before hauls (N in closure)	N After hauls	Std err
6/21/16	40	0.06	0.04	385	14	24	10	1	3	
6/24/16	971	2.53	0.09	3,738	340	9,473	9,133	9	32	1,847
7/1/16	1,320	1.39	0.12	8,700	1063	12,116	11,053	13	86	3,648
7/8/16	1,008	0.50	0.20	6,961	1396	3,472	2,076	12	70	1,165
7/15/16	1,422	1.09	0.10	5,280	534	5,748	5,214	20	71	1,617
7/15/16	3,508	0.30	0.09	8,881	835	2,681	1,846	27	73	415
7/26/16	6,108	1.17	0.37	9,861	3645.716	11,557	7,911	63	109	2,350
7/29/16	4,612	1.59	0.89	9,031	8052.902	14,380	6,327	49	86	1,781
8/5/16	1,412	3.65	1.01	4,856	4921	17,739	12,818	14	53	3,368
8/5/16	3,838	0.81	1.08	2,088	2261	1,692	-569	26	21	509
8/9/16	8,785	2.02	0.71	8,327	5880.592	16,797	10,916	98	102	3,534
8/12/16	1,214	2.99	0.60	6,982	4164	20,892	16,728	10	70	5,355
8/16/16	86	0.41	0.05	1,488	81	608	527	1	11	
8/16/16	1,933	2.38	0.23	2,555	582	6,086	5,504	18	23	2,634
8/16/16	209	0.26	0.11	1,676	187	442	255	2	21	450
8/19/16	102	0.38	1.25	1,499	1877	575	-1,302	1	15	
8/26/16	1,068	3.42	0.47	6,289	2974	21,513	18,539	8	46	4,893
8/26/16	4,045	1.49	0.70	7,114	4996	10,608	5,612	32	55	2,146
9/9/16	5,639	0.85	1.89	5,441	10288.33	4,636	-5,653	72	55	382
9/13/16	56	1.00	0.25	392	98	391	293	1	7	
9/16/16	1,287	3.41	0.34	955	329	3,254	2,925	10	5	398
9/16/16	2,104	0.73	0.21	1,361	286	997	711	26	16	489
9/30/16	991	0.36	0.08	1,031	86	371	285	11	11	72
Totals	51,757			104,888	54,892	166,050	111,159	524	1,041	37,052

Table A2. Chinook savings by closure

Date	Pollock catch (mt) in closures, prior to closure	Chinook rate in closure (N/mt)	Chinook rate after closure	Displaced pollock (mt)	Actual chinook bycatch (N)	Est chinook bycatch at closure rate	Chinook reduction (estimate - actual)	N Before hauls (N in closure)	N After hauls	Std Err
6/21/16	40	0.00	0.00	385	0	0	0	1	3	
6/24/16	971	0.00	0.00	3,738	14	4	-10	9	32	4
7/1/16	1,320	0.00	0.00	8,700	8	21	13	13	86	14
7/8/16	1,008	0.00	0.00	6,961	8	21	13	12	70	9
7/15/16	1,422	0.01	0.00	5,280	9	56	47	20	71	20
7/15/16	3,508	0.00	0.00	8,881	10	0	-10	27	73	0
7/26/16	6,108	0.00	0.00	9,861	18	17	-2	63	109	9
7/29/16	4,612	0.00	0.00	9,031	43	18	-25	49	86	5
8/5/16	1,412	0.01	0.00	4,856	21	55	34	14	53	18
8/5/16	3,838	0.01	0.01	2,088	12	16	4	26	21	7
8/9/16	8,785	0.00	0.01	8,327	79	14	-65	98	102	6
8/12/16	1,214	0.01	0.01	6,982	62	69	7	10	70	35
8/16/16	86	0.01	0.00	1,488	1	17	16	1	11	
8/16/16	1,933	0.00	0.01	2,555	14	11	-3	18	23	4
8/16/16	209	0.00	0.01	1,676	20	0	-20	2	21	0
8/19/16	102	0.01	0.02	1,499	23	15	-8	1	15	
8/26/16	1,068	0.01	0.00	6,289	30	53	23	8	46	24
8/26/16	4,045	0.01	0.01	7,114	42	100	58	32	55	23
9/9/16	5,639	0.00	0.01	5,441	50	19	-31	72	55	4
9/13/16	56	0.00	0.01	392	5	0	-5	1	7	
9/16/16	1,287	0.00	0.01	955	8	4	-4	10	5	2
9/16/16	2,104	0.02	0.04	1,361	50	29	-21	26	16	17
9/30/16	991	0.02	0.11	1,031	113	24	-89	11	11	8
Totals	51,757			104,888	640	561	-79	524	1,041	208

## Appendix 2: Dirty 20 list appearances

Number of times each vessel was on a 2016 chum weekly dirty 20 list. Includes only AFA vessels that fished during the 2016 B season.

Vessel	N times on dirty 20 list	N weeks fishing	Vessel	N times on dirty 20 list	N weeks fishing	Vessel	N times on dirty 20 list	N weeks fishing
Alaska Ocean	3	12	Destination	3	12	Ocean Rover	3	10
Alaska Rose	2	13	Dominator	2	10	Oceanic	6	9
Alaskan Defender	0	11	Elizabeth F	1	4	Pacific Challenger	4	9
Aldebaran	2	13	Excalibur II	0	5	Pacific Explorer	2	11
Aleutian Challenger	4	9	Fierce Allegiance	0	7	Pacific Fury	8	14
Alsea	2	9	Gladiator	2	12	Pacific Glacier	3	16
American Beauty	1	4	Gold Rush	0	7	Pacific Prince	3	12
American Dynasty	5	14	Golden Dawn	0	13	Pacific Viking	2	9
American Eagle	0	10	Golden Pisces	2	17	Patricia L	2	13
American Triumph	8	13	Great Pacific	1	12	Peggy Jo	1	2
Anita J	3	12	Half Moon Bay	2	10	Progress	0	10
Arctic Explorer	1	11	Hickory Wind	1	11	Royal American	1	11
Arctic Fjord	5	14	Island Enterprise	4	14	Royal Atlantic	2	12
Arctic Ram	1	8	Kodiak Enterprise	3	13	Sea Wolf	2	12
Arctic Storm	4	10	Leslie Lee	1	11	Seadawn	2	10
Arctic Wind	0	6	Majesty	3	13	Seattle Enterprise	5	16
Arcturus	0	13	Marcy J	1	4	Seeker	2	13
Argosy	0	8	Margaret Lyn	6	13	Sovereignty	1	12
Auriga	3	11	Mark I	4	7	Starbound	0	11
Aurora	3	10	Misty Dawn	8	13	Starfish	0	10
Bering Defender	2	15	Morning Star	4	14	Starlite	4	9
Bering Rose	2	13	Nordic Fury	2	10	Starward	3	10
Bristol Explorer	0	14	Nordic Star	0	9	Storm Petrel	2	12
Caitlin Ann	4	14	Northern Eagle	3	12	Traveler	0	7
Cape Kiwanda	1	6	Northern Hawk	1	10	Vanguard	1	7
Chelsea K	7	14	Northern Jaeger	5	11	Vesteraalen	4	6
Collier Brothers	0	3	Northern Patriot	1	13	Viking	2	14
Columbia	1	10	Ocean Explorer	0	12	Viking Explorer	1	10
Commodore	1	13	Ocean Hope 3	1	7	Walter N	0	5
Defender	0	2	Ocean Leader	3	11	Western Dawn	4	10
						Westward I	2	15

Appendix 3. Chum closures, 2011 - 2016

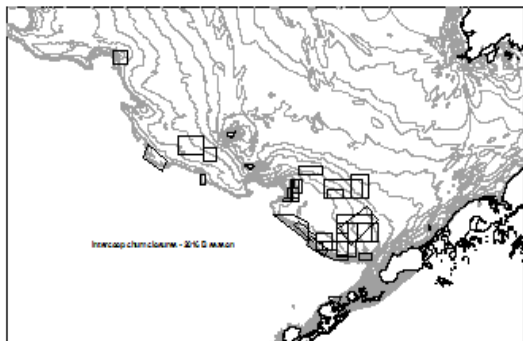


Figure 2a. 2016 Chum closures areas (64 closures)

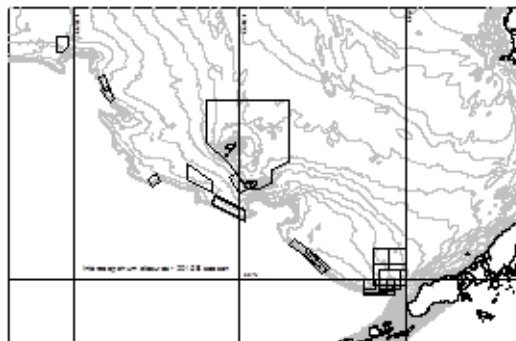


Figure 2b. 2015 Chum closures areas (62 closures),

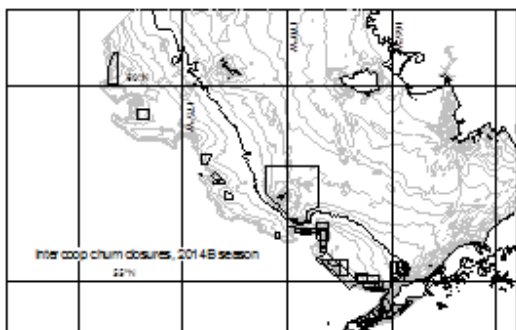


Figure 2c. 2014 Chum closures areas (63 closures),  
55-fm contour in bold, 217,572 chums taken

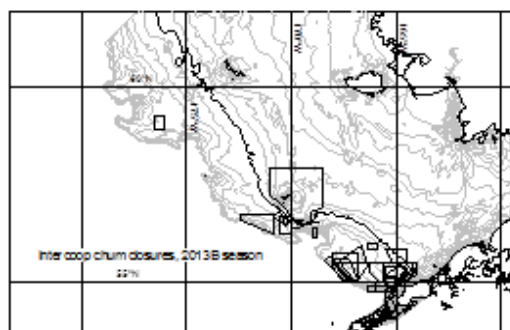


Figure 2d 2013 Chum closures areas (52  
closures), 55-fm contour in bold, 124,661  
chums taken

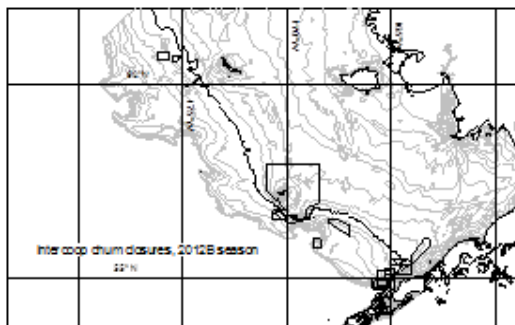


Figure 2e. 2012 Chum closures areas (32 closures),  
55-fm contour in bold, 22,149 chums taken

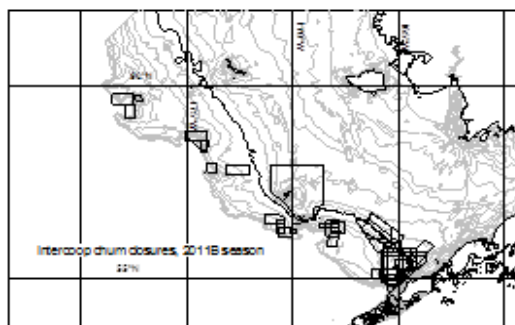


Figure 2f. 2011 Chum closures areas (70 closures), 55-  
fm contour in bold, 191,517 chums taken