Chum Salmon PSC Management Measures EA Appendices 5-7:

Appendix 5: Additional information on methodology for impact analyses

This appendix contains detailed supplemental information to Chapter 3 of the EA regarding the methodology for impact analyses for the EA, in particular information in deriving the AEQ estimates employed in this document. Some of this information is repeated and/or summarized in Chapter 3 of the EA.

Appendix A6: Alaskan salmon stock status overviews by river system

This appendix contains detailed stock status and harvest information on Alaskan river systems with a particular focus on western Alaskan and Alaskan Peninsula stocks. A snapshot of this information is summarized in Chapter 5 of the EA and Chapter 7 of the RIR.

Appendix A7: Additional RHS analyses: Alternatives 1 and 3

This appendix contains detailed analyses of the current RHS system (under the status quo, Alternative 1) as well as the revised RHS program (under Alternative 3). Some of these analyses are summarized in Chapters 5 and 6 of the EA as well as Chapter 6 of the RIR while this appendix contains all analyses conducted for informing this EA.

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A5 Methods for estimating impacts under the alternatives

A5.1 Estimating non-Chinook salmon saved and forgone pollock catch

The first step in the impact analysis was to estimate how Chum salmon bycatch (and pollock catch) might have changed in each year from 2003 to 2011 under the different alternatives. The years 2003 to 2011 were chosen as the analytical base years because that was the most recent 8 year time period reflective of recent fishing patterns at the time of initial Council action, with 2005 representing the highest historical bycatch of non-Chinook. Catch accounting changed beginning in the 2003 pollock fishery with the CAS. Since 2003, the CAS has enabled consistent sector-specific and spatially-explicit treatment of the non-Chinook salmon bycatch data for comparative purposes across years. Thus, starting the analysis in 2003 provides the most consistent and uniform data set that was available from NMFS on a sector-specific basis.

This analysis assumes that past fleet behavior approximates operational behavior under the alternatives, but stops short of estimating changes in fishing vessel operations. While it is expected that the vessel operators will change their behavior to avoid salmon bycatch and associated potential losses in pollock revenue, data were unavailable to accurately predict the nature of these changes.

In some cases, the alternative and options would have closed the pollock fisheries earlier than actually occurred. When an alternative would have closed the pollock fishery earlier, an estimate is made of (1) the amount of pollock TAC that remained and (2) the reduction in the amount of chum salmon bycatch as a result of the closure. The unharvested or forgone pollock catch and the reduction in chum salmon bycatch is then used as the basis for assessing the impacts of the alternative. For some alternatives, the closures are spatial rather than complete and fishing can continue elsewhere. The components of the pollock fishery that are excluded from the closure areas are redistributed to outside areas and assumed to be able to continue fishing at the rate that boats within their sector caught pollock and prohibited species such as chum and Chinook salmon. This estimate of forgone or redistributed pollock catch and reduction in chum salmon bycatch also is used as a basis for estimating the economic impacts of the alternatives.

The analysis used actual catch of chum salmon in the Bering Sea pollock fishery, by season, first at the fleet level (CDQ and non-CDQ), and then at the sector-level (inshore CV (S), Mothership (M), offshore CP (P), and CDQ) for the years 2003-2011. Weekly data from the NMFS Alaska Region were used to approximate when the potential cap would have been reached. The day when the fishery trigger areas would have closed was approximated as mid-week. This date was then used to compute the bycatch rate for the remaining open areas (assuming that the same amount of pollock would have been harvested). The cost of moving from the closed areas was evaluated qualitatively in the RIR. For the shore-based catcher-vessel fleet, average distances to fishing grounds with and without closure scenarios were computed for 2003-2011 data. *In all cases the analysis was at the sector-level in terms of caps.* In practice, there can be cooperative level caps but data limitations prevent analysis at this resolution.

For transferability between sectors, for analysis this is just a special case removing any sector specific chum salmon allocation. This would result in higher bycatch and lower pollock diverted or foregone.

The following sections present the approaches used to break down chum salmon bycatch to account for the fact that only some of the bycatch would have returned to a river system or hatchery in the year it was caught in the pollock fishery and further that the bycatch originates from broadly different regions. The lagged impact of the bycatch is presented in section 3.2.1 below and the stock composition of the bycatch is in section 3.2.2.

A5.1.1 Estimating Chum salmon adult equivalent bycatch

To understand impacts on chum 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. This analysis relies on analyses of historical data using a stochastic “adult equivalence” model similar to that developed for Chinook salmon. This approach strives to account for sources of uncertainty.

Adult-equivalency (AEQ) of the bycatch was estimated to translate how different trigger cap scenarios may affect chum salmon stocks. Compared to the annual bycatch numbers recorded by observers each year for management purposes, the AEQ mortality considers the extensive observer data on chum salmon length frequencies. These length frequencies are used to estimate 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 applying available genetics studies from samples collected in 2005-2009 (see section 3.2.2). Even though sample collection issues exist, stock composition estimates appear to have consistencies depending on the time of year and location.

A5.1.1.1 Estimating Chum salmon catch-at-age

In order to appropriately account for the impact of salmon bycatch in the groundfish fisheries, it is desirable to correct for the age composition of the bycatch. For example, the impact on salmon populations of a bycatch level of 10,000 adult mature salmon is likely greater than the impact of catching 10,000 juvenile salmon that have just emerged from rivers and only a portion of which are expected to return for spawning in several years’ time. Hence, estimation of the age composition of the bycatch (and the measure of uncertainty) is critical. The method follows an expanded version of Kimura (1989) and modified by Dorn (1992). Length at age data are used to construct age-length keys for each time-area stratum and sex. These keys are then applied to randomly sampled catch-at-length frequency data. The stratum-specific age composition estimates are then weighted by the catch within each stratum to arrive at an overall age composition for each year. The actual data and resultant age-length keys are extensive but can be provided on request to NMFS AFSC.

The modification from Kimura’s (1989) approach was simply to apply a two-stage bootstrap scheme to obtain variance estimates. In the first stage, for a given year, sampled tows were drawn with replacement from all tows from which salmon were measured. In the second stage, given the collection of tows from the first stage, individual fish measurements were resampled with replacement. All stratum-specific information was carried with each record. For the length-age data, a separate but similar two-stage bootstrap process was done. Once samples of lengths and ages were obtained, age-length keys were constructed and applied to the catch-weighted length frequencies to compute age composition estimates. This process was repeated 100 times, and the results stored to obtain a distribution of both length and age composition.

Length frequency data on chum salmon from NMFS observer database was used to estimate the overall length and age composition of the bycatch (Figure A5-1). The first step in conducting this analysis was to estimate the catch by area and period within the season because there is a clear within-season pattern in length frequency (Figure A5-2). Initially a simple 2-area and 2-period approach was considered for a total of 4 strata. However, in some historical years the bycatch and data for the “early” period of the B-season (June and July) had very low sampling levels and bycatch, particularly for the region west of 170°W (Table A5-1 and Table A5-2). Consequently, the strata were re-considered as being EBS-wide for the early period and geographically stratified from the later period (Aug-October). This provided a compromise of samples and bycatch over the entire time series from which ages, lengths, and catch (Table A5-3) could be applied. Note that the stratification used here is independent from that used for the genetic stock composition estimation presented in the next section. The age data were used to construct annual stratified age-length keys when sample sizes were appropriate and stratified combined-year age-length keys for years where age samples were limited. To the extent possible, sex-specific age-length keys within each stratum were created and where cells were missing, a “global” sex-specific age-length key was used. The global key was computed over all strata within the same season. For years other than 2005-2009, a combined-year age-length key was used (based on data spanning all years).

Applying the available length frequencies with stratified catch and age data result in age composition estimates in the bycatch that are predominately age 4 (Table A5-4). Generally, it is inappropriate to use the same age-length key over multiple years because the proportions at age for given lengths can be influenced by variability in relative year-class strengths. Combining age data over all the years averages the year-class effects to some degree but may mask the actual variability in age compositions in individual years. To evaluate the sensitivity of our estimates to this problem we compared results by using the combined-year age-length key with results when annual keys were available. Results suggested that the differences associated with using the combined-year age-length key were relatively minor (Figure A5-3). For the purposes of this analysis, i.e., to provide improved estimates of the impact of bycatch on salmon returns, having age-specific bycatch estimates from these data is preferred. The estimates of uncertainty in the age composition due to sampling (via two-stage bootstrap application) were relatively minor (Figure A5-4).

The body size of chum salmon in the bycatch is generally larger during June and July than for the rest of the summer-fall season (Stram and Ianelli 2009). This pattern is also reflected by age as well with the average age of the bycatch older in the first stratum (June-July) compared to the other strata (Figure A5-5). Also apparent in these data are the differences in size frequency by sex with males consistently bigger than females (Stram and Ianelli 2009).

Table A5-1. Number of chum salmon length samples by area and season strata used for converting length frequency data to age composition data. Columns with labels E and W represent geographic strata for east and west of 170°W, respectively. *Source: NMFS Alaska Fisheries Science Center observer data.*

	June-July			Aug-Oct			Other months			Total
	E	W	Total	E	W	Total	E	W	Total	
1991	646	128	774	1,622	375	1,997	40	3	43	2,814
1992	1,339	565	1,904	6,921	2	6,923	163	1	164	8,991
1993	870	7	877	23,508	599	24,107	68	3	71	25,055
1994	773	36	809	12,552	1,734	14,286	81	3	84	15,179
1995	7	1	8	5,517	65	5,582	37	1	38	5,628
1996	407		407	14,593	2,735	17,328	45	1	46	17,781
1997	1		1	10,923	5,821	16,744	745	12	757	17,502
1998	59		59	8,684	404	9,088	453	20	473	9,620
1999	12	1	13	13,269	387	13,656	39	3	42	13,711
2000	1,872	46	1,918	14,391	1,199	15,590	108	4	112	17,620
2001	1,302	714	2,016	12,774	2,675	15,449	914	81	995	18,460
2002	1,556	591	2,147	23,597	954	24,551	169	6	175	26,873
2003	6,909	828	7,737	47,147	7,673	54,820	1,391	84	1,475	64,032
2004	10,117	8,369	18,486	31,925	13,926	45,851	250	97	347	64,684
2005	19,905	2,871	22,776	20,871	30,284	51,155	153	137	290	74,221
2006	19,175	2,228	21,403	18,119	7,714	25,833	628	22	650	47,886
2007	2,147	2,154	4,301	15,444	10,615	26,059	3,771	43	3,814	34,174
2008	85	2,659	2,744	79	5,524	5,603	84	58	142	8,489
2009	289	9,846	10,135	108	8,690	8,798		27	27	18,960
2010	82	3,736	3,818	49	2,734	2,783	2	22	24	6,625
Total	67,553	34,780	102,333	282,093	104,110	386,203	9,141	628	9,769	498,305

Table A5-2. Numbers of chum salmon age samples by area and season strata used for converting length frequency data to age composition data. Columns with labels E and W represent geographic strata for east and west of 170°W, respectively.

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

Table A5-3. Numbers and percentages of chum salmon caught by area and season strata (top section) used for converting length frequency data to age composition data. Also shown are estimates of pollock catch (bottom section). Note that these totals differ slightly from NMFS official values due to minor spatio-temporal mapping discrepancies.

Year	June-July	E Aug-Oct	W Aug-Oct	Total	June-July	E Aug-Oct	W Aug-Oct
				Chum (numbers)			
1991	4,817	19,801	2,796	27,414	18%	72%	10%
1992	8,781	30,330	34	39,145	22%	77%	0%
1993	4,550	229,180	7,142	240,872	2%	95%	3%
1994	5,971	75,239	7,930	89,140	7%	84%	9%
1995	122	18,329	418	18,870	1%	97%	2%
1996	893	45,707	31,058	77,659	1%	59%	40%
1997	319	31,503	32,452	64,274	0%	49%	50%
1998	102	44,895	2,217	47,214	0%	95%	5%
1999	470	44,438	874	45,783	1%	97%	2%
2000	10,229	44,502	2,286	57,017	18%	78%	4%
2001	6,371	36,578	10,105	53,055	12%	69%	19%
2002	3,712	71,096	2,067	76,875	5%	92%	3%
2003	14,843	142,319	18,986	176,147	8%	81%	11%
2004	48,540	345,507	44,780	438,827	11%	79%	10%
2005	238,338	304,078	128,740	671,156	36%	45%	19%
2006	177,663	90,507	34,898	303,068	59%	30%	12%
2007	13,352	31,901	39,841	85,094	16%	37%	47%
2008	5,544	6,513	2,514	14,571	38%	45%	17%
2009	23,890	16,879	4,576	45,346	53%	37%	10%
2010	8,284	2,869	1,946	13,099	63%	22%	15%
				Pollock (t)			
1991	480,617	146,566	258,332	885,515	54%	17%	29%
1992	481,266	225,503	23,639	730,407	66%	31%	3%
1993	16,780	583,778	111,519	712,077	2%	82%	16%
1994	33,303	516,557	154,842	704,703	5%	73%	22%
1995	9,359	558,420	87,949	655,728	1%	85%	13%
1996	12,139	513,922	103,967	630,028	2%	82%	17%
1997	2,736	257,394	301,282	561,412	0%	46%	54%
1998	1,748	441,128	133,283	576,159	0%	77%	23%
1999	15,518	359,934	190,750	566,203	3%	64%	34%
2000	68,868	351,649	244,314	664,831	10%	53%	37%
2001	184,100	439,385	203,622	827,107	22%	53%	25%
2002	268,146	478,689	132,809	879,644	30%	54%	15%
2003	349,518	313,814	208,151	871,483	40%	36%	24%
2004	360,000	245,770	249,329	855,099	42%	29%	29%
2005	372,508	133,659	354,905	861,072	43%	16%	41%
2006	347,953	105,202	409,078	862,234	40%	12%	47%
2007	327,698	136,438	309,729	773,865	42%	18%	40%
2008	277,689	48,327	245,132	571,147	49%	8%	43%
2009	279,731	28,013	158,797	466,540	60%	6%	34%
2010	298,925	39,816	133,066	471,808	63%	8%	28%

Table A5-4. Estimated number of chum salmon by age based on stratified, catch-corrected application of bycatch length frequencies, 1991-2010. Due to the limited availability of samples, a combined age-length key was used (italicized values) for all years except 2005-2009. Note that these totals differ slightly from NMFS official values due to minor spatio-temporal mapping discrepancies.

				Age				
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
1991	*63*	*564*	*7,552*	*15,641*	*3,315*	*204*	*24*	27,363
1992	*64*	*136*	*11,409*	*22,869*	*4,372*	*224*	*48*	39,122
1993	*201*	*912*	*70,305*	*141,809*	*25,939*	*1,258*	*302*	240,726
1994	*200*	*69*	*17,133*	*58,652*	*12,214*	*680*	*164*	89,112
1995	*15*	*66*	*3,430*	*12,311*	*2,809*	*172*	*53*	18,856
1996	*585*	*1,443*	*20,195*	*43,908*	*10,651*	*620*	*138*	77,540
1997	*600*	*953*	*17,683*	*34,726*	*9,374*	*681*	*107*	64,124
1998	*65*	*55*	*6,244*	*31,672*	*7,877*	*530*	*109*	46,552
1999	*37*	*153*	*7,952*	*30,313*	*6,792*	*374*	*102*	45,723
2000	*140*	*82*	*9,243*	*37,670*	*9,260*	*511*	*70*	56,976
2001	*252*	*425*	*9,771*	*33,582*	*8,490*	*455*	*58*	53,033
2002	*86*	*291*	*13,554*	*50,440*	*11,658*	*630*	*185*	76,844
2003	*454*	*1,943*	*37,379*	*109,221*	*25,249*	*1,520*	*311*	176,077
2004	*1,260*	*1,408*	*103,576*	*266,650*	*61,006*	*3,380*	*661*	437,941
2005	12,849	2,273	132,119	439,843	77,139	3,742	78	668,043
2006	0	0	47,852	155,360	93,930	3,997	70	301,209
2007	0	506	17,287	48,913	15,323	2,110	128	84,267
2008	4	7	1,848	9,471	3,022	141	23	14,516
2009	9	335	10,916	26,834	6,384	236	77	44,791
2010	*81*	*68*	*2,121*	*7,991*	*2,654*	*156*	*21*	13,093

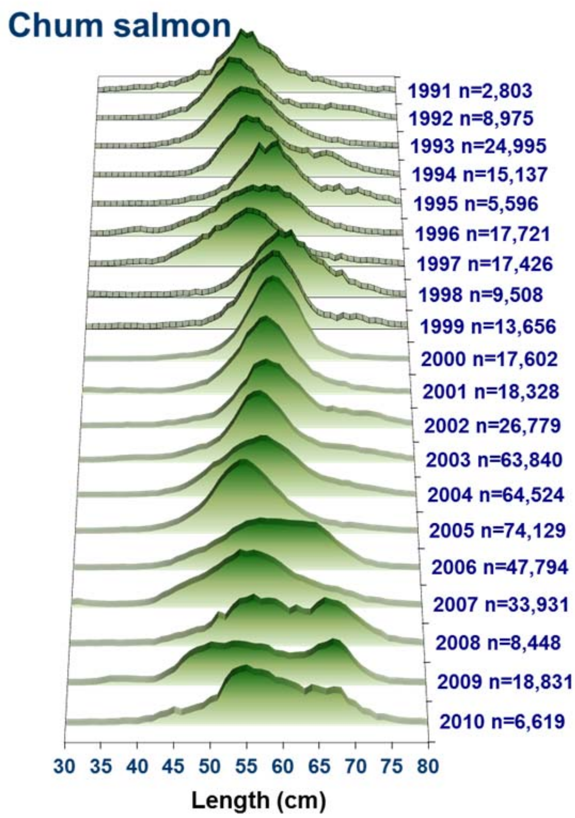

Figure A5-1. Chum salmon length frequency from the eastern Bering Sea pollock fishery, 1991-2010.

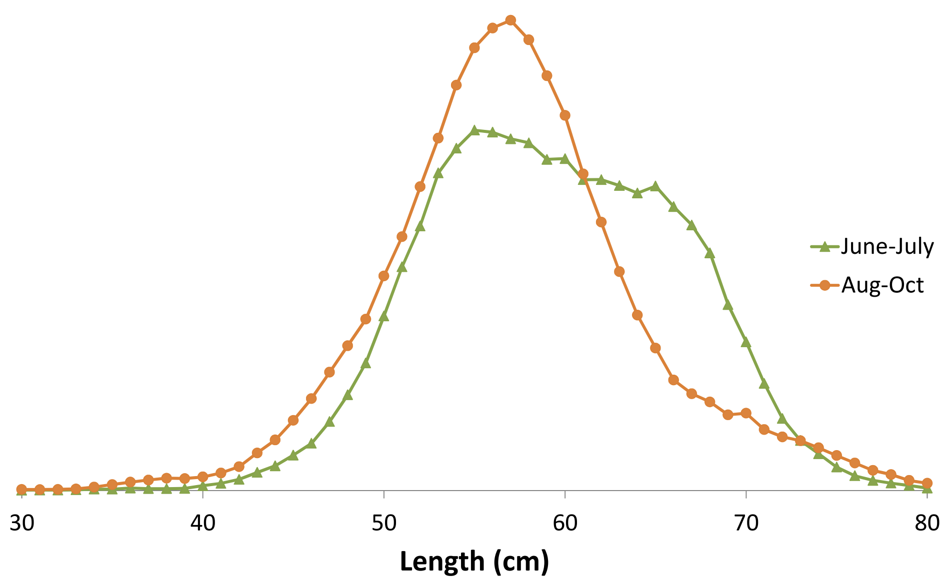

Figure A5-2. Aggregated chum length frequency from the eastern Bering Sea pollock fishery by period within the B-season, 1991-2010.

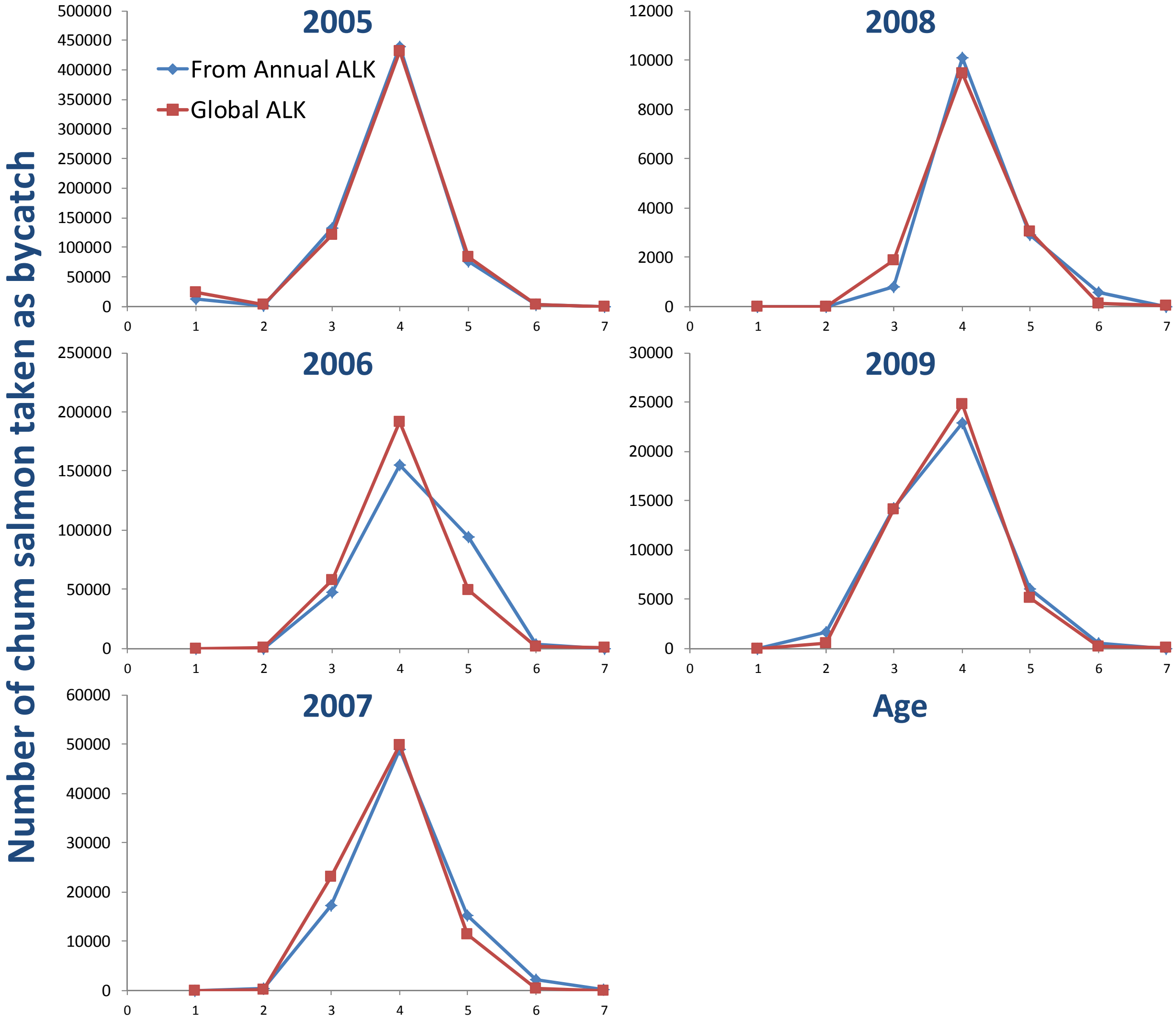

Figure A5-3. Estimated chum bycatch at age as estimated by using the combined-year stratified age-length key compared to estimates from annually varying stratified age-length keys, 2005-2009.

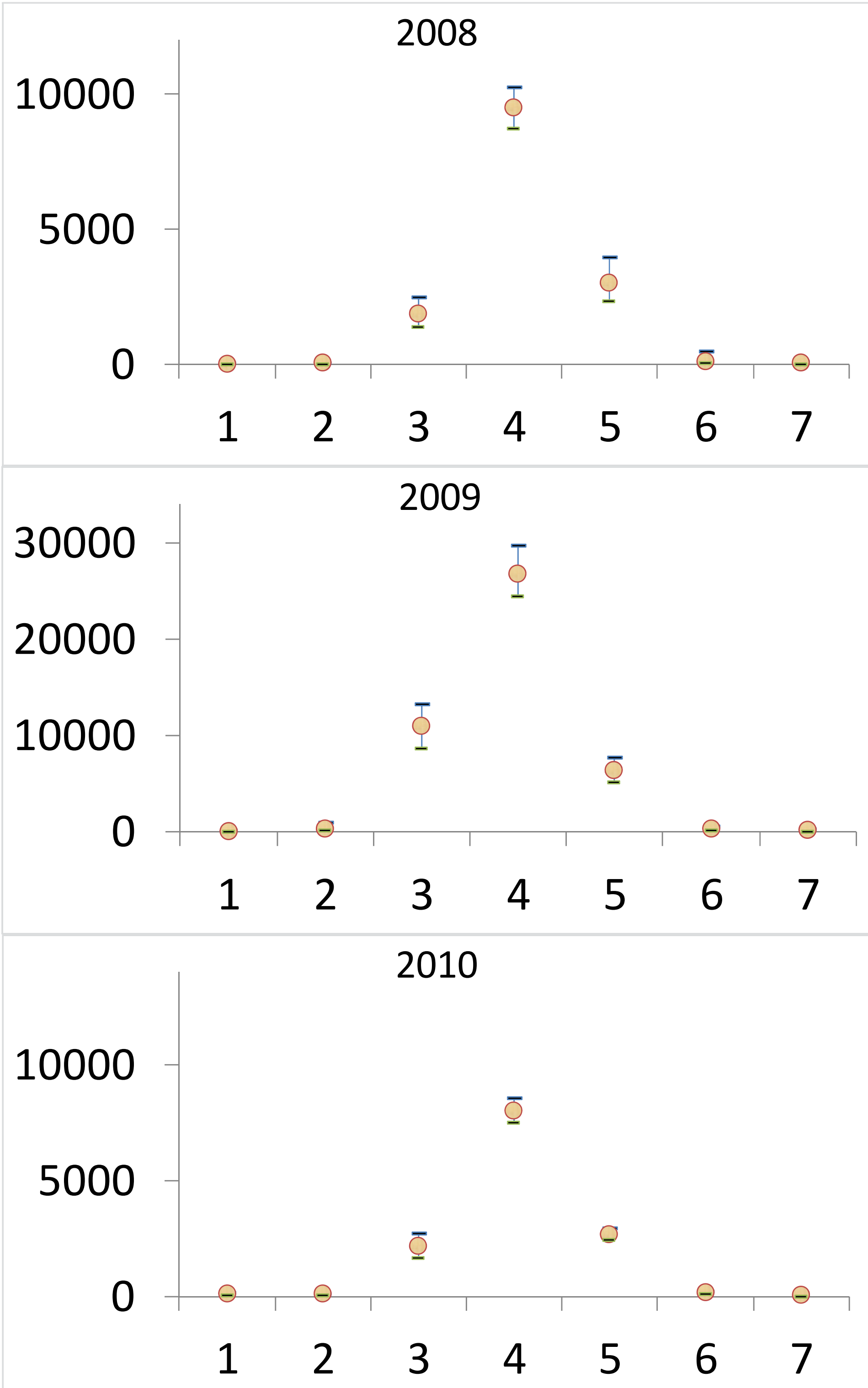

Figure A5-4. Examples of estimated chum bycatch at age and bootstrap quantiles (0.05 and 0.95) by using stratified age-length keys, 2008-2010.

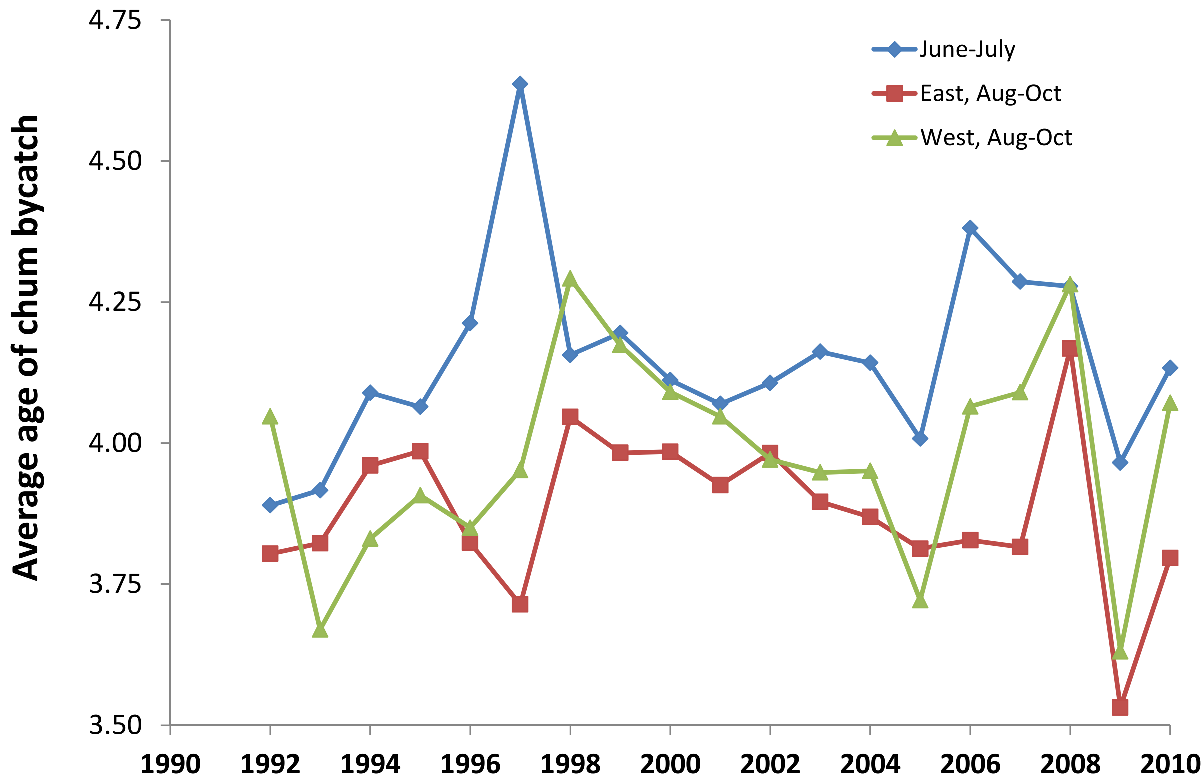

Figure A5-5. Stratified estimates of average age (years) of chum bycatch based on catch-at-age estimates from NMFS observer collected length frequencies and age determinations, 1991-2010.

A5.1.1.2 Adult equivalence model

A simplified version of implementing Adult equivalence (AEQ) analysis to chum was possible because most of the bycatch occurred during the summer-fall fishery (only samples from this period are used for analysis). As with the Chinook model, given the age specific bycatch estimates by strata, oceanic natural mortality, and age composition of chum returning to spawn (for the AYK region), it is possible to estimate the AEQ for chum salmon. Alternative oceanic mortality rates can also evaluated because these are poorly known.

The impact of bycatch on salmon runs measures the historical bycatch levels relative to the subsequent returning salmon run *k* in year *t* as:

$$u_{t,k} = \frac{AEQ_{t,k}}{AEQ_{t,k} + S_{t,k}} \quad (1)$$

where $AEQ_{t,k}$ and $S_{t,k}$ are the adult-equivalent bycatch and stock size (actual run size that returned) estimates of the salmon species in question, respectively. The calculation of $AEQ_{t,k}$ includes the bycatch of salmon returning to spawn in year *t* and the bycatch from previous years for the same brood year (i.e., at younger, immature ages). This latter component needs to be decremented by ocean survival rates and maturity schedules. The impact of current year and previous years bycatch on salmon returning (as adult equivalents in year *t*) can be expressed in expanded form (without stock specificity) as:

$$
\begin{aligned}
AEQ_t = & \sum_{a=3}^{7} c_{t,a}\gamma_a + \\
& \gamma_4 \left(1-\gamma_3\right) s_3 c_{t-1,3} + \\
& \gamma_5 \left(1-\gamma_4\right)\left(1-\gamma_3\right) s_3 s_4 c_{t-2,3} + \\
& \gamma_6 \left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right) s_3 s_4 s_5 c_{t-3,3} + \\
& \gamma_7 \left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right) s_3 s_4 s_5 s_6 c_{t-4,3} + \\
& \\
& \gamma_5 \left(1-\gamma_4\right) s_4 c_{t-1,4} + \\
& \gamma_6 \left(1-\gamma_5\right)\left(1-\gamma_4\right) s_4 s_5 c_{t-2,4} + \\
& \gamma_7 \left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right) s_4 s_5 s_6 c_{t-3,4} + \\
& \\
& \gamma_6 \left(1-\gamma_5\right) s_5 c_{t-1,5} + \\
& \gamma_7 \left(1-\gamma_6\right)\left(1-\gamma_5\right) s_5 s_6 c_{t-2,5} + \\
& \\
& \gamma_7 \left(1-\gamma_6\right) s_6 c_{t-1,6}
\end{aligned}
\qquad (2)
$$

where $c_{t,a}$ is the bycatch of age *a* salmon in year *t*, s_a is the proportion of salmon surviving from age *a* to *a+1,* and γ_a is the proportion of salmon at sea that will return to spawn at age *a.* Since this model is central to the calculation of *AEQ* values, an explanatory schematic is given in Figure A5-6. Maturation rates vary over time and among stocks detailed information on this is available from a wide variety of sources. For the purpose of this study, an average over putative stocks was developed based on a variety of studies (Table A5-5). Note that there is a distinction between the distribution of mature age salmon found in rivers (Table A5-5) and the expected age-specific maturation rate of oceanic salmon ($\gamma_{a,k}$) used in this model (Table 3-6). However, given ocean survival rates the values for $\gamma_{a,k}$ can be solved which satisfy the age-specific maturation averaged over different stocks (2nd from bottom row of Table 3-5).

To carry out the computations in a straightforward manner, the numbers of salmon that remain in the ocean (i.e., they put off spawning for at least another year) are tracked through time until age 7 where for this model, all chum salmon in the ocean at that age are considered mature and will spawn in that year.

Stochastic versions of the adult equivalence calculations acknowledge both run-size inter-annual variability and run size estimation error, as well as uncertainty in maturation rates, the natural mortality rates (oceanic), river-of-origin estimates, and age assignments. The variability in run size can be written as (with $\dot{S}_{t,k}$ representing the stochastic version of $S_{t,k}$):

$$
\dot{S}_{t,k} = \overline{S}_k e^{\varepsilon_t + \delta_t} \quad \begin{aligned} &\varepsilon_t \sim N\left(0, \sigma_1^2\right), \\ &\delta_t \sim N\left(0, \sigma_2^2\right) \end{aligned} \qquad (3)
$$

where σ_1^2, σ_2^2 are specified levels of variability in inter-annual run sizes and run-size estimation variances, respectively. Note that for the purposes of this EA, estimates of run sizes were unavailable for some stocks hence this method is described here for conceptual purposes only.

The stochastic survival rates were simulated as:

$$\dot{s}_a = 1 - \exp\left(-M_a + \delta\right), \qquad \delta \sim N\left(0, 0.1^2\right) \tag{4}$$

whereas the maturity in a given year and age was drawn from beta-distributions:

$$\dot{\gamma}_a \sim B\left(\alpha_a, \beta_a\right) \tag{5}$$

with parameters α_a, β_a specified to satisfy the expected value of age at maturation (Table 3-5) and a pre-specified coefficient of variation term (provided as model input).

Similarly, the parameter responsible for assigning bycatch to river-system of origin was modeled by using a combination of years and "parametric bootstrap" approach, also with the beta distribution:

$$\dot{p}_k \sim B(\alpha_k, \beta_k) \tag{6}$$

again with α_k, β_k specified to satisfy the expected value of the estimates and variances shown from proportions based on the genetic analysis of the bycatch samples. For the purposes of this study, the estimation uncertainty is considered as part of the inter-annual variability in this parameter. The steps (implemented in a spreadsheet) for the AEQ analysis can be outlined as follows:

1. Select a bootstrap sample of salmon bycatch-at-age ($c_{t,a}$) for each year from the catch-age procedure described above;
2. Sum the bycatch-at-age for each year and proceed to account for year-of-return factors (e.g., stochastic maturation rates and ocean survival (Eqs. 2-5);
3. Partition the bycatch estimates to stock proportions (by year and area) drawn randomly from each parametric bootstrap;
4. Store stratum-specific AEQ values for each year;
5. Repeat 1-4 200 times;
6. Based on updated genetics results, assign to river of origin components ($\dot{p}_k$, Eq. 6).
7. Compile results over all years and compute frequencies from which relative probabilities can be estimated;

Sensitivity analyses on maturation rates by brood year were conducted and contrasted with alternative assumptions about natural mortality (M_a) schedules during their oceanic phase interacts with the corresponding age-specific probabilities that a salmon would return to spawn (Table 3-6; given the in-river mature population proportions shown in Table 3-5).Table A5-5).

The pattern of bycatch relative to AEQ is variable and relatively insensitive to mortality assumptions (Figure A5-7). For simplicity in presenting the analysis, subsequent values are based on the intermediate age-specific natural mortality (Scenario 2) which when evaluated with the stochastic components, revealed a fair amount of uncertainty in the AEQ estimates (Figure A5-8).

Notice that in some years, the bycatch records may be below the actual AEQ due to the lagged impact of previous years' catches (e.g., in 1994 and 2006; Table A5-7). A similar result would be predicted for

AEQ model results in 2010 regardless of actual bycatch levels in this year due to the cumulative effect of bycatch prior to 2010.

Overall, the estimate of AEQ chum salmon mortality from 1994-2010 ranged from about 16,000 fish to just over 540,000 (Table A5-7). The application of these results to the genetic stock identification derived from sampling is presented in the next section.

The approach for evaluating alternative management measures (detailed in subsequent sections) generally involves superimposing measures on observed data from 2003-2011. These data are collapsed to ADFG statistical area, pollock fleet sector, year, and week. Consequently, results are presented in terms of how much the actual bycatch tally (in a given year) would be reduced given a particular management measure. To easily map this into AEQ that can subsequently be applied to stock identification, we conducted a multiple regression from the results presented in which simply used the current year's bycatch and the bycatch the year before to predict this year's AEQ. Results indicated a highly significant (the intercept was found to be not significantly different than zero) fit:

	Regression Statistics
Multiple R	0.999818
R Square	0.999635
Adjusted R Square	0.94079
Standard Error	3929.607
Observations	19

ANOVA

	df	SS	MS	F	Significance F
Regression	2	7.2E+11	3.6E+11	23297.96	1.93E-28
Residual	17	2.63E+08	15441813		
Total	19	7.2E+11			

with coefficients:

	Coefficients	Standard Error
b_1	0.599723	0.006381
b_2	0.328816	0.006378

This produces an estimate of AEQ given last year's and the current year's bycatch which can be readily used for converting bycatch reductions to AEQ reductions. The formula is thus:

$$AEQ_t = C_t b_1 + C_{t-1} b_2 \quad (3)$$

where C_t, C_{t-1} is the total bycatch of chum the current year and the previous year, respectively.

Table A5-5. In-river maturity-at-age distribution of chum salmon by region. Note that the column "relative weight" was used for computing a weighted mean maturity rate for chum salmon arising from relative run sizes presented in section 5.0. *Source: Dani Eveson, ADFG pers. comm. 2010.*

		Age-specific in-river maturity				
Region	Relative weight	3	4	5	6	7
Norton Sound	0.14	4.8%	50.4%	40.7%	4.0%	0.1%
Yukon River summer	0.17	1.4%	52.9%	42.7%	3.1%	0.0%
Yukon River fall	0.17	3.8%	67.8%	27.5%	0.9%	0.0%
Nushagak	0.16	2.0%	64.0%	32.0%	1.0%	0.0%
Kuskokwim	0.35	1.9%	63.8%	33.3%	1.1%	0.0%
Weighted mean		2.6%	60.8%	34.7%	1.8%	0.0%

Table A5-6 Estimated maturity-at-age for chum salmon bycatch based on the weighted in-river maturity observations (Table 3-5) and different assumptions of ocean annual survival rates (as mapped through natural mortality, *M*).

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7
Scenario 1							
Maturity(γ_a)	0.000	0.000	0.118	0.760	0.984	0.999	1.000
M	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Scenario 2							
Maturity(γ_a)	0.000	0.000	0.110	0.744	0.986	0.999	1.000
M	0.400	0.300	0.200	0.150	0.100	0.050	0.000
Scenario 3							
Maturity(γ_a)	0.000	0.000	0.114	0.748	0.985	0.999	1.000
M	0.100	0.100	0.100	0.100	0.100	0.100	0.100

Table A5-7 Estimated chum bycatch by year, their age-equivalent removals to mature returning salmon (AEQ, with upper and lower confidence intervals from simulations) and removals by chum salmon brood year (last two columns) using natural mortality scenario 2. Italicised values represent predictions from Eq. 7).

Bycatch year	Annual bycatch	Mean AEQ	AEQ 5th percentile	AEQ 95th percentile	Brood year	Estimated bycatch
1991	28,951	16,884	14,791	18,754	1988	56,008
1992	40,274	31,539	27,733	38,968	1989	160,433
1993	242,191	154,290	138,556	172,756	1990	119,973
1994	92,672	132,571	100,609	186,132	1991	38,624
1995	19,264	47,948	36,212	75,265	1992	55,596
1996	77,236	53,984	47,699	61,907	1993	62,179
1997	65,988	60,301	51,509	80,216	1994	64,948
1998	64,042	66,699	59,521	78,004	1995	46,863
1999	45,172	48,279	41,618	61,929	1996	54,118
2000	58,571	52,581	45,178	61,074	1997	57,182
2001	57,007	52,743	46,109	65,963	1998	90,286
2002	80,782	69,344	61,280	82,058	1999	190,325
2003	189,185	141,869	125,711	171,351	2000	376,947
2004	440,468	325,945	292,873	377,794	2001	631,926
2005	704,552	567,893	501,585	671,478	2002	285,480
2006	309,630	419,542	335,831	591,359	2003	97,814
2007	93,783	150,434	116,769	214,919	2004	37,342
2008	15,267	45,958	34,578	70,315	2005	31,239
2009	46,127	36,435	31,402	43,711	2006	16,959
2010	13,222	21,765	15,983	32,509		
2011	191,445	*119,162*				
2012		*62,950*				

The sum over ages of catch in year *t* that would have returned in that year

$$AEQ_t = \sum_{a=3}^{7} c_{t,a}\gamma_a + \text{ Fish caught in earlier years that would have survived:}$$

The catch of age 3 salmon in previous years that survived and had not returned in earlier years

$$\begin{cases} \gamma_4(1-\gamma_3)s_3c_{t-1,3} + \\ \gamma_5(1-\gamma_4)(1-\gamma_3)s_3s_4c_{t-2,3} + \\ \gamma_6(1-\gamma_5)(1-\gamma_4)(1-\gamma_3)s_3s_4s_5c_{t-3,3} + \\ \gamma_7(1-\gamma_6)(1-\gamma_5)(1-\gamma_4)(1-\gamma_3)s_3s_4s_5s_6c_{t-4,3} + \end{cases}$$

The catch of age 4 salmon in previous years that survived and had not returned in earlier years

$$\begin{cases} \gamma_5(1-\gamma_4)s_4c_{t-1,4} + \\ \gamma_6(1-\gamma_5)(1-\gamma_4)s_4s_5c_{t-2,4} + \\ \gamma_7(1-\gamma_6)(1-\gamma_5)(1-\gamma_4)s_4s_5s_6c_{t-3,4} + \end{cases}$$

The catch of age 5 salmon…

$$\begin{cases} \gamma_6(1-\gamma_5)s_5c_{t-1,5} + \\ \gamma_7(1-\gamma_6)(1-\gamma_5)s_5s_6c_{t-2,5} + \end{cases}$$

$$\gamma_7(1-\gamma_6)s_6c_{t-1,6}$$

Figure A5-6. Explanatory schematic of main AEQ equation. Symbols are defined in text.

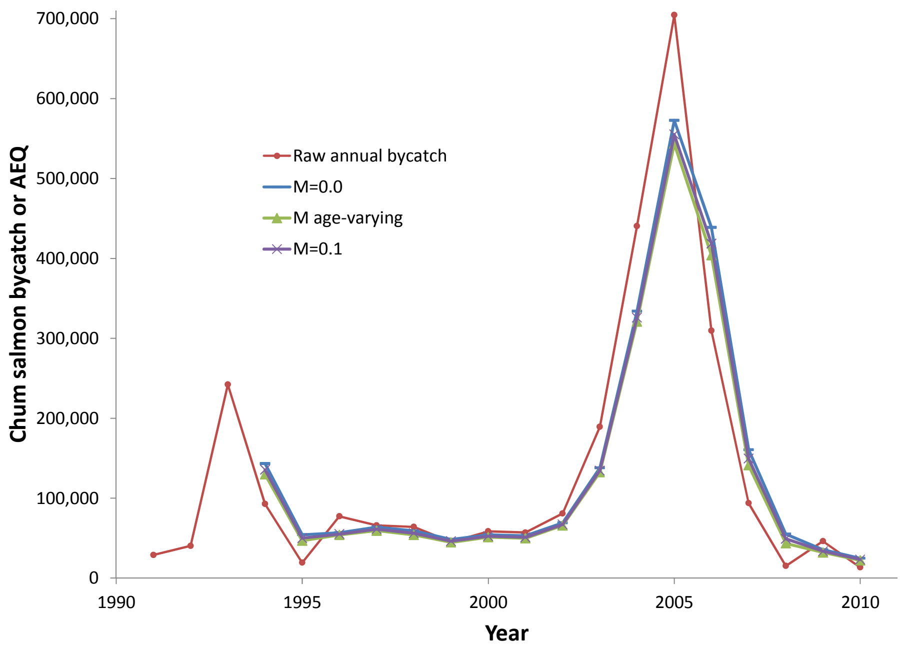

Figure A5-7. Estimated chum bycatch age-equivalent (AEQ) chum bycatch for three different assumptions about oceanic natural mortality rates compared to the annual tally.

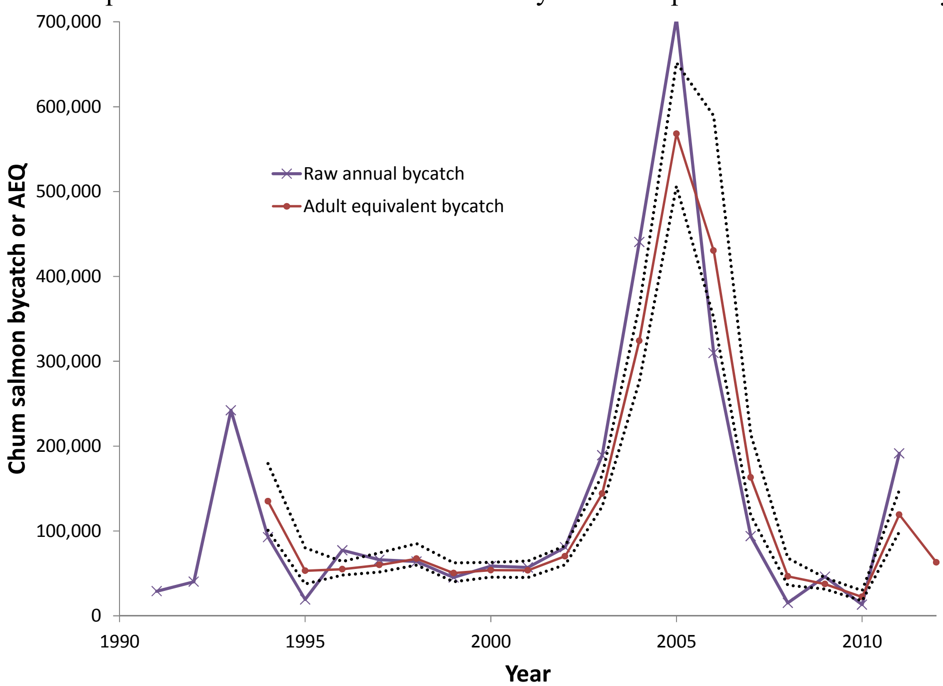

Figure A5-8. Estimated chum bycatch age-equivalent (AEQ) chum bycatch with stochastic (CV=0.4) age-specific oceanic natural mortality scenario 2 and rates compared to the annual tally. Dashed lines represent 5th and 95th percentiles based on 100 simulations. Note that values from 2011 and 2012 are based on predictions from equation 7.

A5.1.2 Estimating the stock composition of chum salmon bycatch

This section provides an overview the available information used to determine the region or river of origin of the chum salmon caught as bycatch in the Bering Sea pollock fishery.

To determine the stock composition mixtures of the chum salmon bycatch samples collected from the Bering Sea pollock fishery, a number of genetics analyses have been completed and presented to the Council (i.e., Guyon et al. 2010, Marvin et al. 2010, Gray et al. 2010, and McCraney et al. 2010). The details of this work are provided in these reports and build from earlier studies (e.g., Wilmot et al. 1998, Seeb et al. 2004). These studies represent a large body of work on processing and analyzing the available genetic data and include comparisons of stock composition (of the bycatch samples) between the early period of the B-season and later as summarized in Gray et al. (2010). Based on the available datasets, they found a consistent pattern that later in the B-season the potential impact on Alaska stocks declines with bycatch samples dropping from about 28% Alaska origin down to about 13% after July 18th. The proportions of bycatch from the SE Alaska-BC-Washington region also decreased later in the season while proportions from Russia and Japan increased later in the B-season. Given the available data, chum salmon bycatch origins appear to be affected by the relative amounts of bycatch that occur during the early and late periods within the B-season. The genetic analysis used here extends from the approaches reported earlier (e.g., Gray et al. 2010, Guyon et al. 2009) and spans the period 2005-2009. The main difference from these previous studies is that samples were temporally stratified to be from the period June-July or from August-October.

For this impact analysis, it is desirable to provide some estimates of AEQ specific to individual western Alaska river systems. On a gross scale, one approach would be to apply baseline average run-sizes for each system and apply these proportions to the "Western Alaska" group identified in the genetic analysis. An alternative approach might be to include the time series of run-size estimates so that a dynamic proportion for these sub-groups could be estimated. Neither approach is without problems but may help to provide some indication of the potential for specific in-river impacts due to bycatch. Because run size estimates are less reliable at fine regional scales results are presented at the level consistent with the genetics results (i.e., 6-regional breakouts; Figure A5-9). Individual populations from each region are identified in Table A5-8. To the extent possible assumptions of run sizes and maturity were used to provide qualitative results to individual western Alaskan river systems (See section 5.0).

Because mixing genetic samples with total bycatch levels and estimating bycatch proportions from stocks of interest (e.g., Western Alaska) requires careful consideration of variances, a model was developed from which a number of parameters of interest could easily be computed. It also provides a basis for more thorough evaluations on the significance of differences over years and areas. An integrated model approach provides a way to easily use existing genetics samples applied to stratified bycatch levels to appropriately weight annual estimates of total bycatch (and provide variance estimates). Namely

$$\hat{y}_{i,j,k} = N_{i,j}\hat{p}_{i,j,k} \qquad (4)$$

where $\hat{y}_{i,j,k}$ is the predicted bycatch in year *i,* stratum *j*, from regional "stock" *k*, $N_{i,j}$ is the number of adult-equivalent chum salmon taken as bycatch, and $\hat{p}_{i,j,k}$ is the predicted stratum-specific proportion of bycatch estimated to arise from stock *k* based on the genetic samples. Note that "data", $p_{i,j,k}$, from the genetics analysis include an estimated covariance matrix for each sample ($\Sigma_{i,j}$) which can be used to obtain the appropriate inverse-weights to estimate the mean proportions for each year (summed over strata: $y_{i,\bullet,k}$). Given this, the model fitting procedure via maximum likelihood is constructed to follow the multinomial or multivariate normal likelihood formulation (dropping subscripts for year and strata):

$$L = \frac{N!}{y_1! \cdots y_K!} p_1^{y_1} \cdots p_K^{y_K} \qquad (5)$$

$$L = (2\pi)^{-\frac{K}{2}} |\mathbf{\Sigma}|^{-\frac{1}{2}} e^{-\frac{1}{2}(\mathbf{p}-\hat{\mathbf{p}})' \mathbf{\Sigma}^{-1} (\mathbf{p}-\hat{\mathbf{p}})} \qquad (6)$$

where and N is the sample size from that stratum. This model requires as data (for each pre-defined stratum) the estimated proportion to stock of origin and covariance matrix of these estimates, the AEQ due to bycatch, and the sample size (for optionally ignoring the covariance matrix and assuming a multinomial distribution). The parameter estimates done within the integrated model and are consistent with the general form for computing variances of weighted sums of random variables (where a and b might represent the bycatch levels from different strata) for arbitrary random variables X and Y:

$$\text{var}(aX + bY) = a^2 \text{ var}(X) + b^2 \text{ var}(Y) + 2ab\,\text{cov}(X, Y)$$

The goal of this approach is to provide variance estimates for AEQ mortality to specific regions in different years. Analytical methods could be developed for these but would add complexity. The integrated model allows simple specification of variables such as year and strata factors that can be estimated simultaneously. Of particular interest for these data are whether seasonal differences in stock composition are significant and the degree to which stock composition estimates vary over years. Also, it may be possible to characterize the between year variability for the period that data are available and apply that variability to reconstruct historical bycatch patterns.

To test and illustrate the properties of the model, some simple example scenarios were developed. Specifically, a situation with three strata from a single year was used to contrast different levels of bycatch and sampling within each stratum (Table A5-9). For all scenarios the “true” proportion attributed to the stock of interest for each stratum was fixed. For each of these the MLE based on the multinomial was used (Eq. 5).

Results show that sample size affects the precision of estimates for a particular stock of interest within a stratum (Figure A5-10). When input sample size is crossed with different levels of bycatch by strata, the results for the final proportion attributed to a stock of interest is primarily a function of bycatch but the relative precision also plays a role (Figure A5-11).

Genetics results were compiled based on sampling schemes that were sub-optimal for minimizing variance (Table A5-10). I.e., Guyon et al. (2010) demonstrate that the sample collections were typically out of proportion with the bycatch (in time and areas) and were collected for a variety of projects with different objectives. Consequently, the ability to apply these data to determine overall annual stock-of-origin estimates of the bycatch requires careful consideration of how the sampling occurred. While this approach accounts for factors that are known and can be controlled (e.g., that stratum-level sampling for genetics is disproportionate to bycatch), there remains a general concern that the spatio-temporal resolution for the strata selected is too coarse which could result in biases due to sampling. With this in mind, an approach that tends to be conservative (reflecting a higher degree of uncertainty) was taken as described below.

The SPAM software (ADFG 2003) uses an algorithm to produce stock composition estimates and can account for missing alleles in the baseline (Pella and Masuda, 2001). SPAM stock composition estimates based on data from all 11 loci were derived for the six regional groupings (Table A5-11). This method accounts for two sources of error: that due to the resolution of the genetic information to ascertain stock of origin and that due to the sample size. Kalinowski (2006) describes this as the expected squared error (ESE) of stock composition estimates.

$$ESE_k = E\left(p_k - \hat{p}_k\right)^2$$

$$ESE_k = ESE_{k,fishery} + ESE_{k,genetic} \qquad (7)$$

where p_k, $\hat{p}_k$ are the observed and estimated proportions for stock k in a given stratum, respectively. Note that the $ESE_{k,fishery}$ is typically taken as being drawn randomly and follows a multinomial sampling process. From the point estimates and covariance matrices provided from the SPAM analysis, it is relatively simple to estimate the contribution of uncertainty due to the genetics by comparing the implied sample size ($\tilde{N}$):

$$N^2 \operatorname{var}\left(\hat{p}_k\right) = N\hat{p}_k\left(1-\hat{p}_k\right)$$

$$\tilde{N} = \hat{p}_k\left(1-\hat{p}_k\right)\operatorname{var}\left(\hat{p}_k\right)^{-1} \qquad (8)$$

For each strata and year from which samples were available, the implied sample size represented about 69% of the actual sample size based on an evaluation of all the estimates of $\hat{p}_k$ and variances from the genetic analysis (Figure A5-12). This suggests that the uncertainty due to the genetic analysis component lowers the implied sample size by about 30%. One way to clarify what this means (as proposed by Kalinowski 2006) is to contrast results as if there were no errors due to stock identification (i.e., each fish was perfectly "marked"). In that type of scenario, the implied sample size would equal the actual sample size.

In most fisheries sampling situations, rarely are data collected in a manner that can be considered as purely random with respect to the population of interest (in this case, the stock of origin of the bycatch). Composition data in general, be it stomach contents, lengths, or ages, are commonly afflicted with a situation where the actual number of fish sampled is much higher than the "effective" sample size (e.g., Pennington and Volstad 1994, Chih 2010). For length or age composition data, it is routine to apply an adjustment to the actual sample size in fitting stock assessment models because of the relatively low within-haul variability. While the practice of using these adjustment factors vary in technique, they are widely acknowledged as being an important consideration in stock assessment modeling (see Fournier and Archibald (1982) for early consideration of using the multinomial likelihood for fitting composition data). One conservative approach (which will likely lead to a positive bias in variance) would be to substitute the number of fish sampled with the number of hauls from which samples were collected. There are a number of hauls from which many chum salmon were used for genetics sampling (Figure A5-13). Also, there were differences in relative terms between the number hauls and the number of fish used for genetics over time (Figure A5-14).

Thus, we evaluated the effect of treating the genetics output to the actual PSC estimates a number of ways:

1) Using multinomial likelihood method assuming each fish was selected randomly with respect to bycatch (this implies negligible classification errors due to the genotypes);
2) Based on the covariance estimates arising from genetic analysis. Note that this is the same as in 1) but includes errors in stock composition estimation, Table 3-11); and

3) Based on adjustments that account for the fact that the effective sample size is less than the actual number of fish used for bycatch stock identification (conservatively set to the number of hauls from which samples were collected).

4) As in 3) but adjusted further to account for errors in the genetic information that leads to stock identification

Results for evaluating these alternative approaches shows that in most cases the 4th procedure provides higher levels of uncertainty (as expected) in the amount of bycatch that can be attributed to coastal western Alaska systems (Table A5-12). In general, the estimates of uncertainty are likely to be more robust using option 4) because there were sample design issues with these data. Assuming a more conservative (i.e., greater variance) estimate of uncertainty seems prudent and the inflation of the variance is actually relatively modest (Figure A5-15). Under this scenario, the average proportions of PSC chum salmon bycatch by six regions varies considerably by season with more from Japan and Russian during the latter part of the B season (Figure A5-16).

The SSC requested that year-effects on stock composition be tested to the extent possible. This was accomplished by estimating the mean June-July and August-October sub-season effect and computing the annual variability relative to these effects. The marginal distribution of the within-season effect indicates that western Alaska stocks comprise nearly 13% more in the June-July period compared to later in the season (Figure A5-17). However, there were some significant levels of between-year variability with lower proportions of western Alaska chum salmon evident in 2008 and 2009 samples during the June-July period (Figure A5-18). This indicates that year-effects are significant and would add to the uncertainty in extrapolating these results to an historical period. On the advice of the SSC, the stock composition estimates are focused on the period 2005-2009. However, for the earlier periods, the mean stratified stock composition estimates from this period could be used but with an added component of uncertainty equal to the estimated year-effect variability. This was accomplished by contrasting the within season mean estimates (and the variability associated with those) and adding the random-effects variance over different years. This is illustrated by comparing the proportion of stock composition that can be attributed to western Alaska stocks (coastal western AK plus Upper Yukon chum salmon) during the June-July period relative to the Aug-October period (Figure A5-19). Note that the variance due to the year effect is inflated and thus has the desired property of estimation “outside of sampled” years.

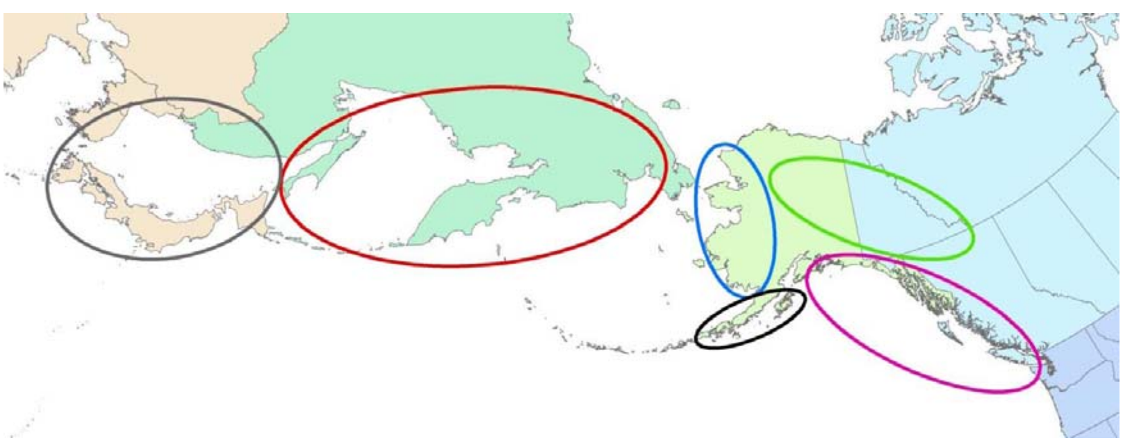

Figure A5-9. Six regional groupings of chum salmon populations used in the analysis including east Asia (grey), north Asia (red), coastal western Alaska (blue), upper/middle Yukon (green), southwest Alaska (black), and the Pacific Northwest (magenta). From Gray et al. 2010.

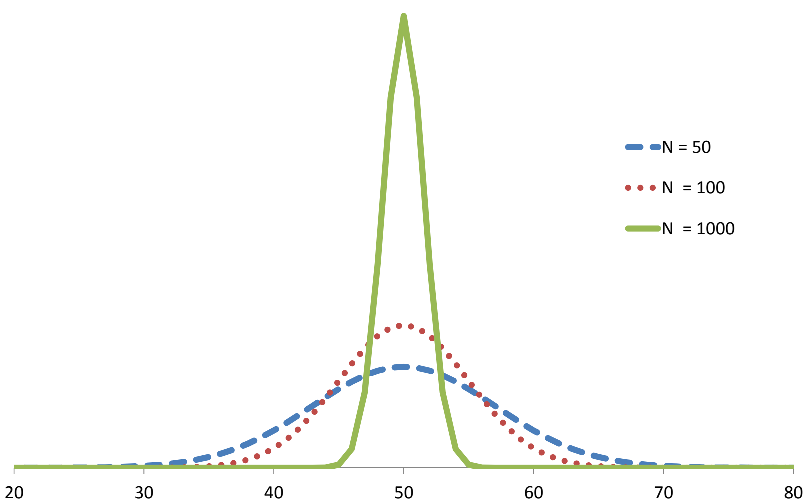

Figure A5-10. Example distributions for different effective sample sizes where the proportion for this example stock composition estimate is 0.5 applied to 100 chum salmon in the bycatch. *Note: this is an illustrative example to evaluate model behavior.*

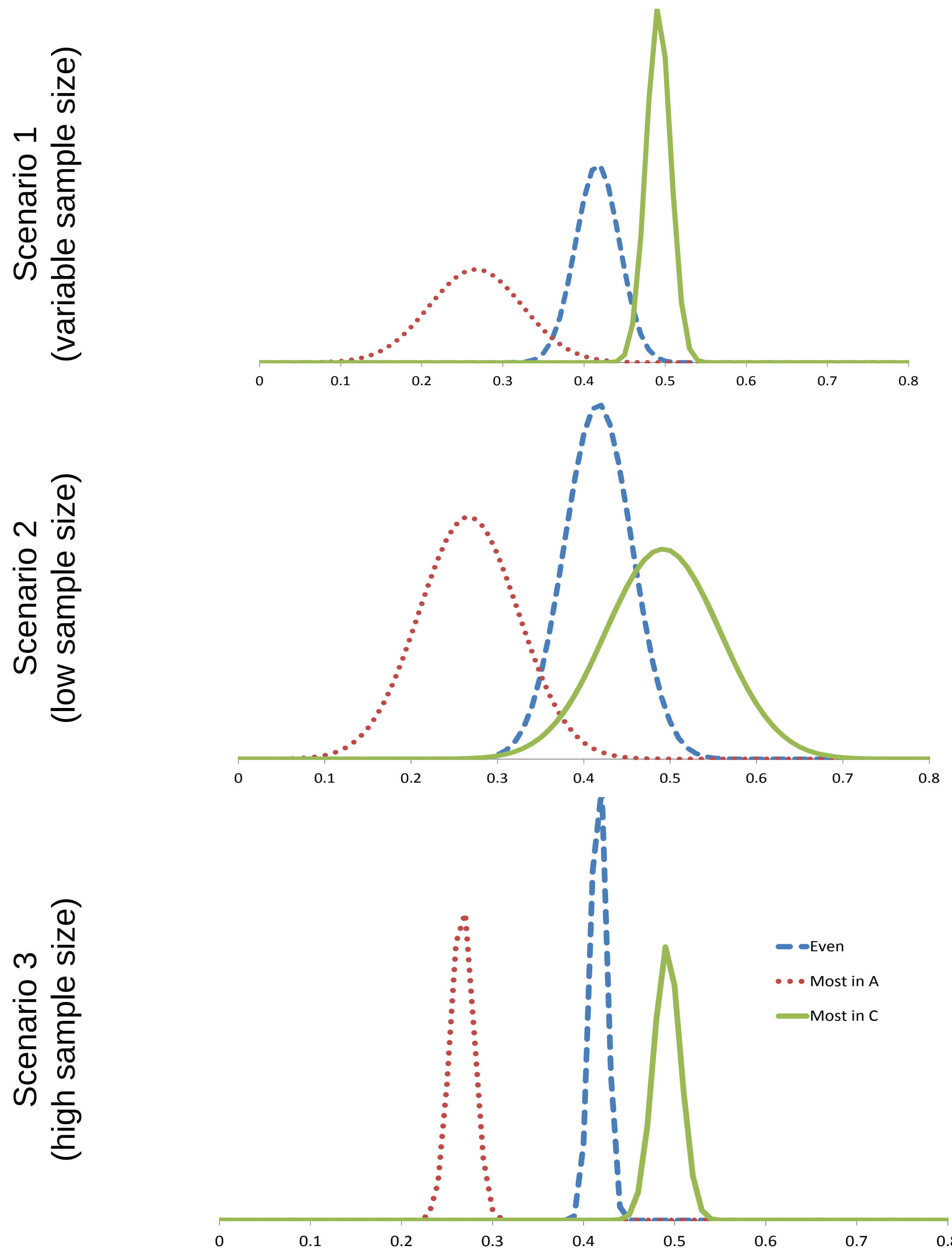

Figure A5-11. Example results of bycatch proportions assuming different bycatch levels within strata (dotted, dashed and solid lines) and different sample size configurations (scenarios 1-3). Each distribution is the integrated (variance weighted) estimate over all strata. *Note: this is an illustrative example to evaluate model behavior.*

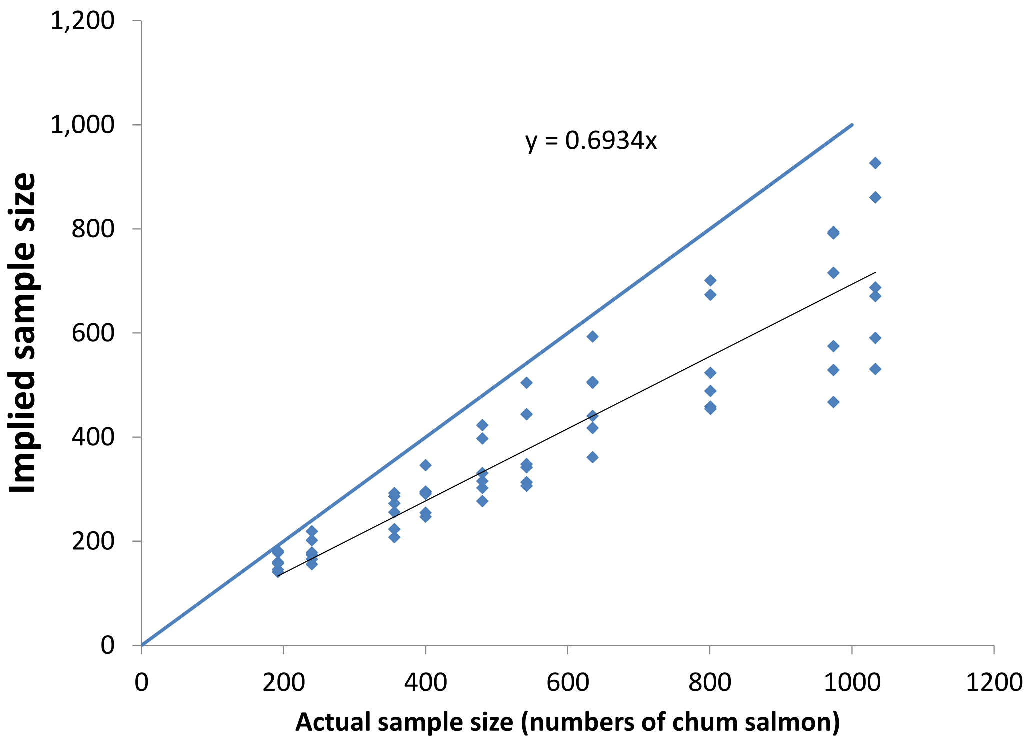

Figure A5-12. Comparison of the implied sample size (as derived from the estimated proportions and variances from the genetic samples) to the actual sample size, 2005-2009 data. Thick diagonal line represents the 1 to 1 line and the thin line represents the fit to the points.

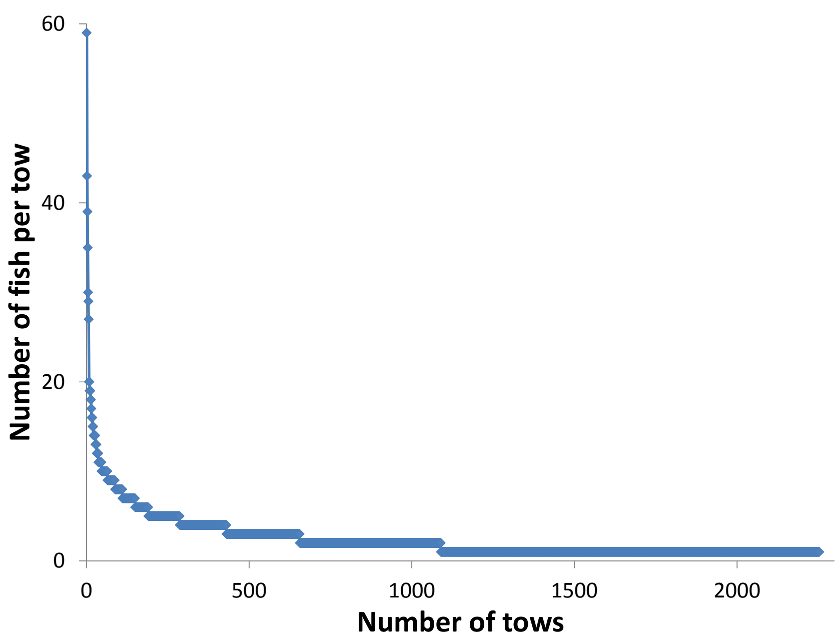

Figure A5-13. Number of B-season chum salmon per tow (trawl fishing operation) from which samples were obtained for genetic analysis compared to the number of tows, 2005-2009.

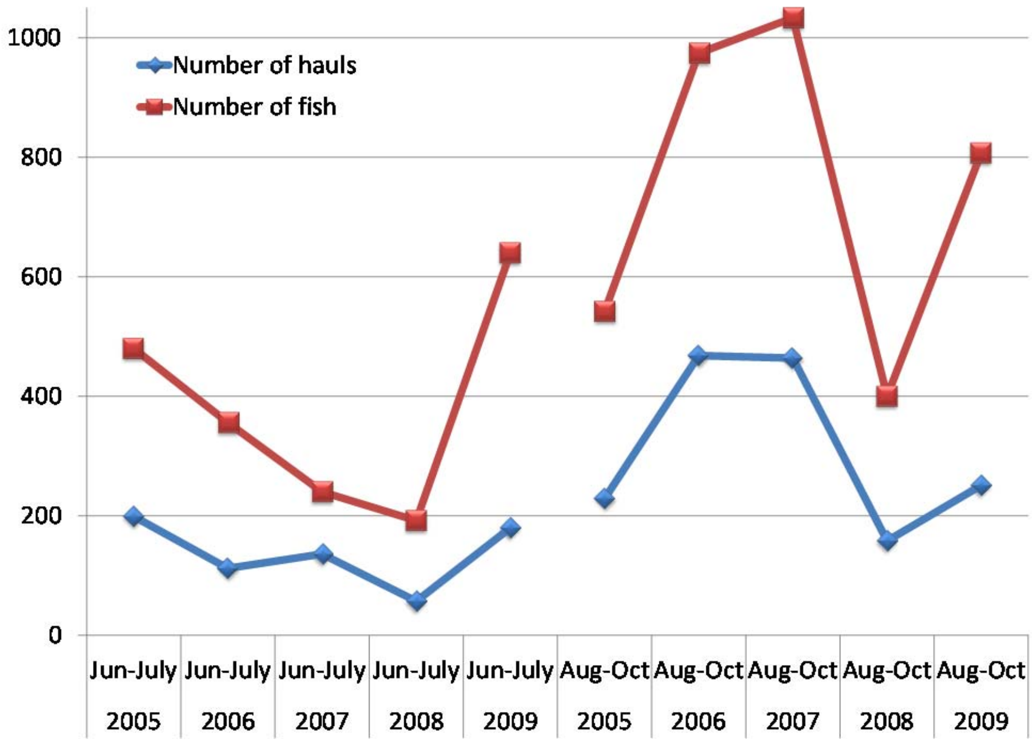

Figure A5-14. Number of fish and number of hauls from which samples were obtained for genetic analysis by early and late B-season strata, 2005-2009.

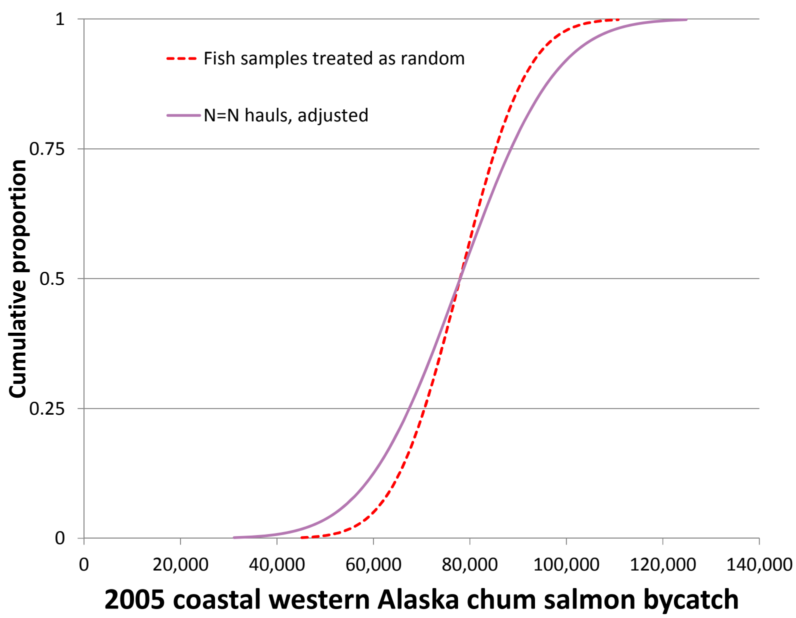

Figure A5-15. Cumulative probability of using the default estimate of uncertainty from the genetic results for chum salmon bycatch (dashed line) compared with that where an adjustment to reflect variable sampling schemes is included (solid line).

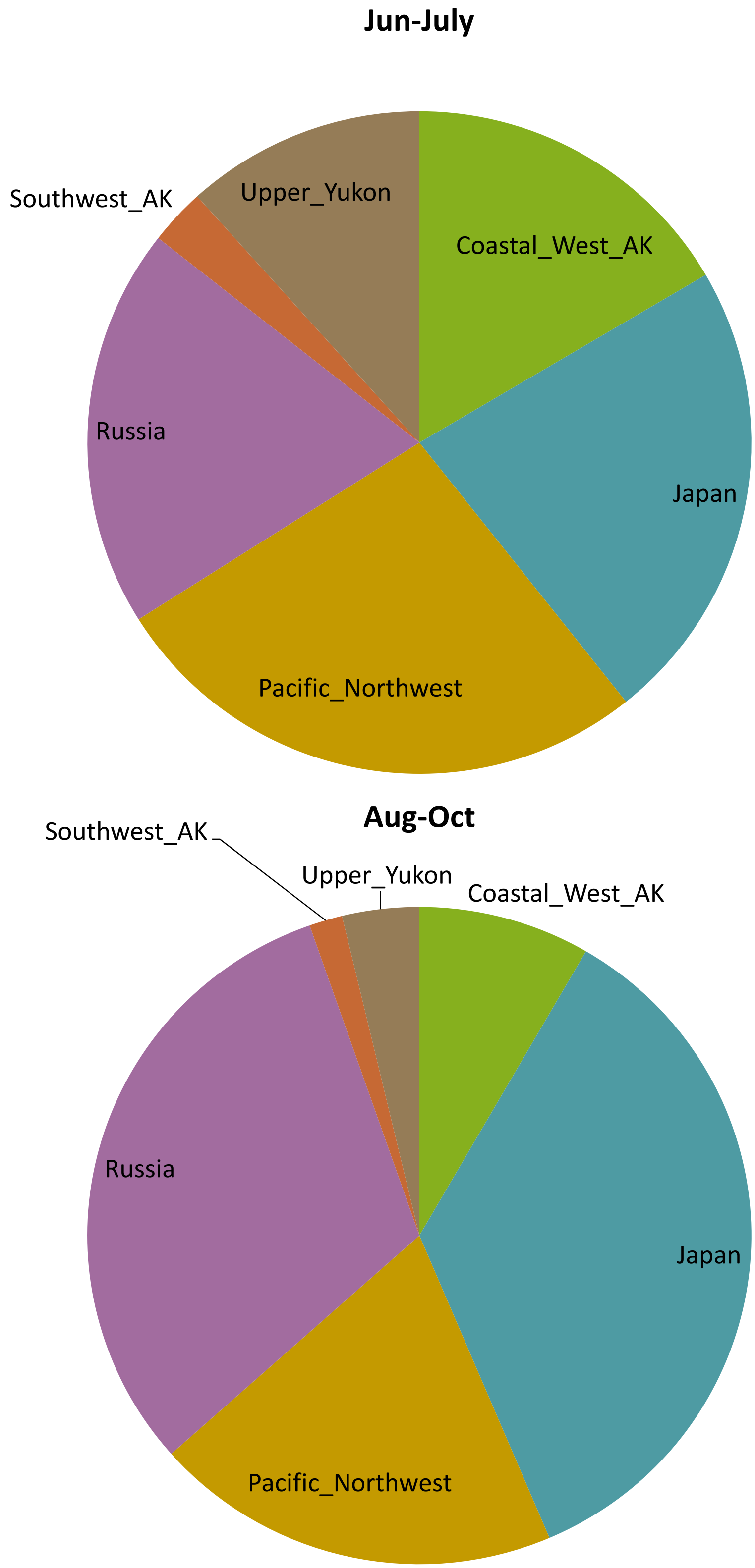

Figure A5-16. Average breakout of bycatch based on genetic analysis by early and late B-season strata, 2005-2009.

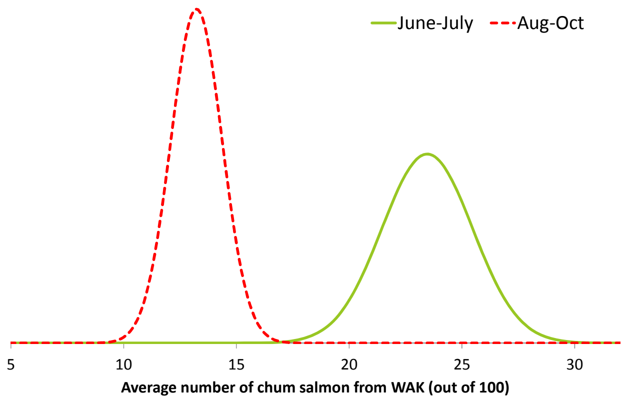

Figure A5-17. Genetic results showing the distribution of the mean WAK (coastal western Alaska and Upper Yukon combined) chum salmon in the bycatch for the early (June-July) compared to the late (Aug-Oct) B-season based on genetic data from 2005-2009.

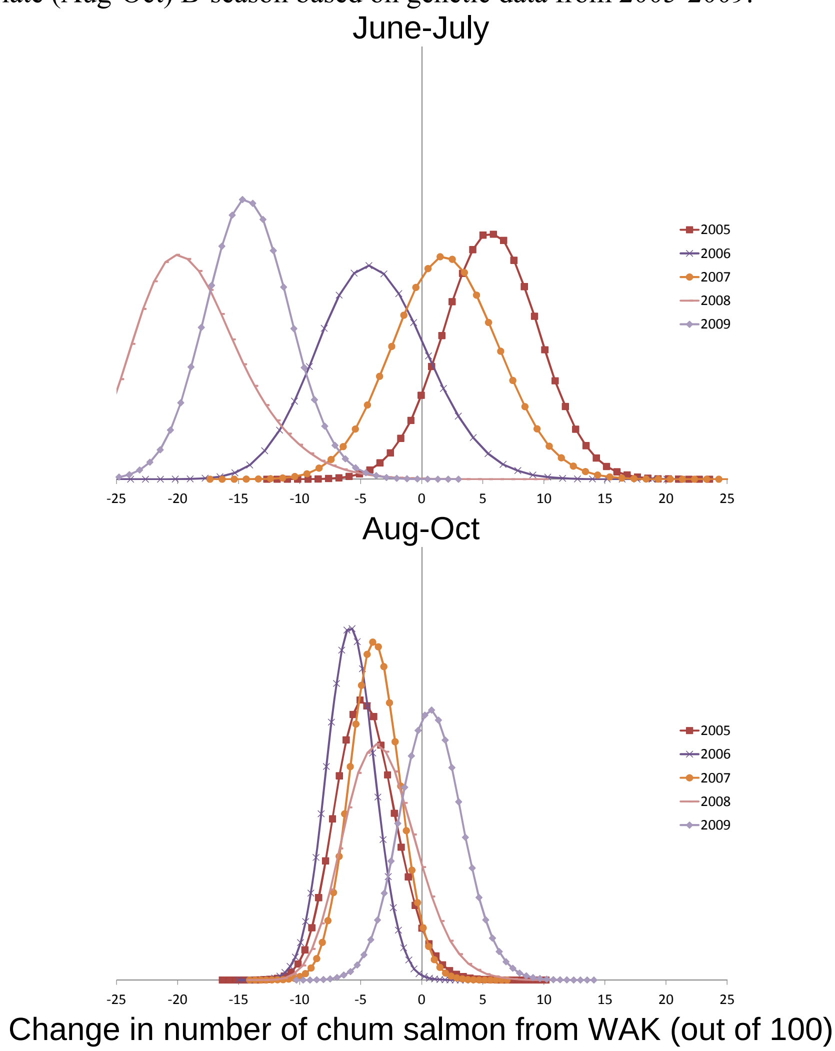

Figure A5-18. Genetics results showing the distribution of the mean WAK (coastal western Alaska and Upper Yukon combined) chum salmon in the bycatch for the early (June-July) compared to the late (Aug-Oct) B-season based on genetics data from 2005-2009.

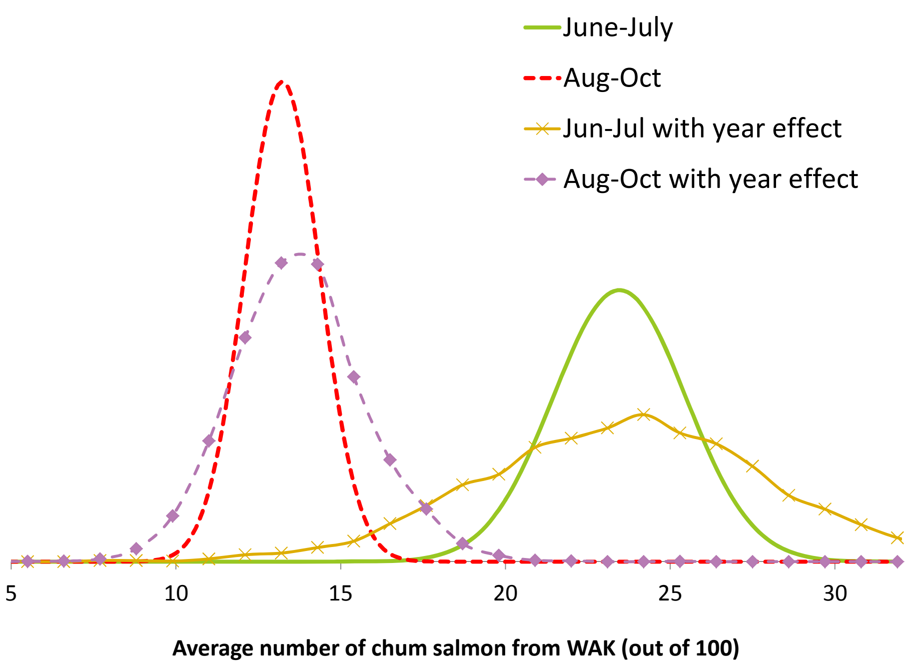

Figure A5-19. Comparison of the mean proportion of chum salmon bycatch originating from WAK (including upper Yukon) during early and late B-season and with the additional uncertainty due to year-effect variability.

Table A5-8. Chum salmon populations in the DFO microsatellite baseline with the regional designations used Gray et al, 2010.

DFO	Population	No.	DFO	Population	No.	DFO	Population	No.	DFO	Population	No.
41	Abashiri	1	230	Udarnitsa	2	439	Porcupine	4	107	Clatse_Creek	6
215	Avakumovka	1	290	Utka_River	2	83	Salcha	4	118	Clyak	6
40	Chitose	1	208	Vorovskaya	2	4	Sheenjek	4	62	Cold_Creek	6
315	Gakko_River	1	387	Zhypanova	2	1	Tatchun	4	77	Colonial	6
292	Hayatsuki	1	348	Agiapuk	3	9	Teslin	4	353	Constantine	6
44	Horonai	1	376	Alagnak	3	84	Toklat	4	168	Cooper_Inlet	6
252	Kawabukuro	1	3	Andreafsky	3	360	Alagoshak	5	197	County_Line	6
313	Koizumi_River	1	357	Aniak	3	333	American_River	5	12	Cowichan	6
300	Kushiro	1	301	Anvik	3	366	Big_River	5	414	Crag_Cr	6
37	Miomote	1	80	Chulinak	3	354	Coleman_Creek	5	161	Dak_	6
391	Namdae_R	1	347	Eldorado	3	355	Delta_Creek	5	259	Dana_Creek	6
231	Narva	1	358	George	3	359	Egegik	5	123	Date_Creek	6
298	Nishibetsu	1	307	Gisasa	3	332	Frosty_Creek	5	250	Dawson_Inlet	6
293	Ohkawa	1	371	Goodnews	3	365	Gertrude_Creek	5	91	Dean_River	6
297	Orikasa	1	288	Henshaw_Creek	3	370	Joshua_Green	5	261	Deena	6
214	Ryazanovka	1	339	Imnachuk	3	364	Meshik	5	170	Deer_Pass	6
312	Sakari_River	1	361	Kanektok	3	283	Moller_Bay	5	46	Demamiel	6
311	Shari_River	1	362	Kasigluk	3	369	Pumice_Creek	5	210	Dipac_Hatchery	6
36	Shibetsu	1	328	Kelly_Lake	3	367	Stepovak_Bay	5	319	Disappearance	6
299	Shikiu	1	340	Kobuk	3	335	Sturgeon	5	269	Dog-tag	6
253	Shiriuchi	1	343	Koyuk	3	350	Uganik	5	177	Draney	6
310	Shizunai	1	363	Kwethluk	3	334	Volcano_Bay	5	114	Duthie_Creek	6
217	Suifen	1	336	Kwiniuk_River	3	356	Westward_Creek	5	427	East_Arm	6
35	Teshio	1	303	Melozitna	3	239	Ahnuhati	6	266	Ecstall_River	6
39	Tokachi	1	373	Mulchatna	3	69	Ahta______	6	94	Elcho_Creek	6
38	Tokoro	1	372	Naknek	3	155	Ain_	6	193	Ellsworth_Cr	6
314	Tokushibetsu	1	330	Niukluk	3	183	Algard	6	203	Elwha	6
291	Toshibetsu	1	329	Noatak	3	58	Alouette	6	276	Ensheshese	6
296	Tsugaruishi	1	345	Nome	3	325	Alouette_North	6	263	Fairfax_Inlet	6
316	Uono_River	1	302	Nulato	3	270	Andesite_Cr	6	32	Fish_Creek	6
309	Yurappu	1	374	Nunsatuk	3	428	Arnoup_Cr	6	429	Flux_Cr	6
218	Amur	2	13	Peel_River	3	153	Ashlulm	6	102	Foch_Creek	6
207	Anadyr	2	322	Pikmiktalik	3	156	Awun	6	179	Frenchman	6
384	Apuka_River	2	331	Pilgrim_River	3	133	Bag_Harbour	6	227	Gambier	6
382	Bolshaya	2	346	Shaktoolik	3	164	Barnard	6	96	Gill_Creek	6
380	Dranka	2	341	Snake	3	16	Bella_Bell	6	166	Gilttoyee	6
223	Hairusova	2	368	Stuyahok_River	3	79	Bella_Coola	6	145	Glendale	6
378	Ivashka	2	375	Togiak	3	49	Big_Qual	6	135	Gold_Harbour	6
213	Kalininka	2	154	Tozitna	3	201	Big_Quilcene	6	11	Goldstream	6
225	Kamchatka	2	342	Unalakleet	3	281	Bish_Cr	6	66	Goodspeed_River	6
219	Kanchalan	2	344	Ungalik	3	198	Bitter_Creek	6	136	Government	6
379	Karaga	2	8	Big_Creek	4	103	Blackrock_Creek	6	205	Grant_Creek	6
294	Kikchik	2	89	Big_Salt	4	390	Blaney_Creek	6	100	Green_River	6
209	Kol_	2	86	Black_River	4	138	Botany_Creek	6	450	GreenRrHatchery	6
233	Magadan	2	87	Chandalar	4	264	Buck_Channel	6	237	Greens	6
211	Naiba	2	28	Chandindu	4	169	Bullock_Chann	6	141	Harrison	6
295	Nerpichi	2	82	Cheena	4	61	Campbell_River	6	438	Harrison_late	6
381	Okhota	2	81	Delta	4	323	Carroll	6	64	Hathaway_Creek	6
212	Oklan	2	7	Donjek	4	78	Cascade	6	234	Herman_Creek	6
222	Ola_	2	5	Fishing_Br	4	76	Cayeghle	6	17	Heydon_Cre	6
386	Olutorsky_Bay	2	88	Jim_River	4	42	Cheakamus	6	407	Hicks_Cr	6
228	Ossora	2	85	Kantishna	4	398	Cheenis_Lake	6	400	Homathko	6
224	Penzhina	2	2	Kluane	4	51	Chehalis	6	411	Honna	6
385	Plotnikova_R	2	59	Kluane_Lake	4	19	Chemainus	6	204	Hoodsport	6
221	Pymta	2	181	Koyukuk_late	4	47	Chilliwack	6	185	Hooknose	6
220	Tauy	2	90	Koyukuk_south	4	392	Chilqua_Creek	6	406	Hopedale_Cr	6
383	Tugur_River	2	10	Minto	4	117	Chuckwalla	6	412	Hutton_Head	6

Table 3-8. (continued) Chum salmon populations in the DFO microsatellite baseline (code) with the regional designations used in the analyses (column titled "No.";Gray et al. 2010).

DFO	Population	No.	DFO	Population	No.	DFO	Population	No.
			254	Mountain_Cr	6	265	Stanley	6
			111	Mussel_River	6	52	Stave	6
226	Tym_	2	157	Naden	6	396	Stawamus	6
6	Pelly	4	337	Nahmint_River	6	409	Steel_Cr	6
152	Inch_Creek	6	444	Nakut_Su	6	424	Stewart_Cr	6
146	Indian_River	6	14	Nanaimo	6	416	Stumaun_Cr	6
92	Jenny_Bay	6	122	Nangeese	6	327	Sugsaw	6
115	Kainet_River	6	422	Nass_River	6	324	Surprise	6
144	Kakweiken	6	399	Necleetsconnay	6	75	Taaltz	6
268	Kalum	6	113	Neekas_Creek	6	30	Taku	6
395	Kanaka_Cr	6	321	Neets_Bay_early	6	18	Takwahoni	6
402	Kano_Inlet_Cr	6	320	Neets_Bay_late	6	251	Tarundl_Creek	6
162	Kateen	6	173	Nekite	6	149	Theodosia	6
389	Kawkawa	6	104	Nias_Creek	6	22	Thorsen	6
95	Kemano	6	143	Nimpkish	6	129	Toon	6
192	Kennedy_Creek	6	53	Nitinat	6	279	Tseax	6
238	Kennell	6	191	Nooksack	6	202	Tulalip	6
351	Keta_Creek	6	186	Nooseseck	6	97	Turn_Creek	6
101	Khutze_River	6	318	NorrishWorth	6	430	Turtle_Cr	6
126	Khutzeymateen	6	159	North_Arm	6	247	Tuskwa	6
282	Kiltuish	6	377	Olsen_Creek	6	165	Tyler	6
93	Kimsquit	6	184	Orford	6	33	Tzoonie	6
187	Kimsquit_Bay	6	287	Pa-aat_River	6	124	Upper_Kitsumkal	6
419	Kincolith	6	260	Pacofi	6	140	Vedder	6
273	Kispiox	6	56	Pallant	6	70	Viner_Sound	6
106	Kitasoo	6	65	Pegattum_Creek	6	45	Wahleach	6
99	Kitimat_River	6	48	Puntledge	6	172	Walkum	6
275	Kitsault_Riv	6	98	Quaal_River	6	73	Waump	6
163	Kitwanga	6	147	Quap	6	232	Wells_Bridge	6
271	Kleanza_Cr	6	108	Quartcha_Creek	6	352	Wells_River	6
437	Klewnuggit_Cr	6	199	Quinault	6	105	West_Arm_Creek	6
21	Klinaklini	6	110	Roscoe_Creek	6	267	Whitebottom_Cr	6
418	Ksedin	6	397	Salmon_Bay	6	326	Widgeon_Slough	6
125	Kshwan	6	195	Salmon_Cr	6	277	Wilauks_Cr	6
423	Kumealon	6	134	Salmon_River	6	120	Wilson_Creek	6
112	Kwakusdis_River	6	200	Satsop	6	401	Worth_Creek	6
436	Kxngeal_Cr	6	236	Sawmill	6	60	Wortley_Creek	6
127	Lachmach	6	410	Seal_Inlet_Cr	6	248	Yellow_Bluff	6
262	Lagins	6	158	Security	6	434	Zymagotitz	6
131	Lagoon_Inlet	6	130	Sedgewick	6	139	Clapp_Basin	6
448	LagoonCr	6	393	Serpentine_R	6			
167	Lard	6	317	Shovelnose_Cr	6			
160	Little_Goose	6	249	Shustnini	6			
50	Little_Qua	6	206	Siberia_Creek	6			
413	Lizard_Cr	6	25	Silverdale	6			
119	Lockhart-Gordon	6	196	Skagit	6			
176	Lower_Lillooet	6	274	Skeena	6			
137	Mace_Creek	6	171	Skowquiltz	6			
242	Mackenzie_Sound	6	447	SkykomishRiv	6			
116	MacNair_Creek	6	132	Slatechuck_Cre	6			
55	Mamquam	6	43	Sliammon	6			
121	Markle_Inlet_Cr	6	15	Smith_Cree	6			
27	Martin_Riv	6	54	Snootli	6			
338	Mashiter_Creek	6	180	Southgate	6			
109	McLoughin_Creek	6	26	Squakum	6			
178	Milton	6	142	Squamish	6			
194	Minter_Cr	6	128	Stagoo	6			

Table A5-9. Scenario evaluations (sample sizes) for different example situations for bycatch within a year attributed to a single "stock". I.e., in stratum "A" the bycatch proportion attributed to the stock of interest is 25% whereas for the other strata it is 50%. *Note: this is intended as an illustrative example only.*

Strata	A	B	C
Stock of interest proportion w/in strata	0.25	0.5	0.5
Bycatch even among strata	**100**	**100**	**100**
Variable sample sizes	50	100	1000
Low sample sizes	50	50	50
High sample sizes	1000	1000	1000
Bycatch mostly in stratum A	**280**	**10**	**10**
Variable sample sizes	50	100	1000
Low sample sizes	50	50	50
High sample sizes	1000	1000	1000
Bycatch mostly in stratum C	**10**	**10**	**280**
Variable sample sizes	50	100	1000
Low sample sizes	50	50	50
High sample sizes	1000	1000	1000

Table A5-10. Sample sizes (numbers of B-season chum salmon) available for genetic stock-composition estimates (by sub-season stratified samples) compared to the number of hauls and the actual bycatch levels, 2005-2009. Note that bycatch totals may differ slightly from official totals due to minor differences encountered when matching spatially disaggregated data.

Year	2005	2006	2007	2008	2009
Number of chum used in genetics sampling					
Jun-Jul	480	356	240	192	635
Aug-Oct	542	974	1033	400	801
Total	1,022	1,330	1,273	592	1,436
Number of hauls from which samples were collected					
Jun-Jul	199	136	180	468	158
Aug-Oct	112	57	229	464	251
Total	311	193	409	932	409
Bycatch of non-Chinook salmon					
Jun-Jul	238,338	177,663	13,352	5,544	23,890
Aug-Oct	432,818	125,405	71,742	9,027	21,455
Total	671,156	303,068	85,094	14,571	45,346

Table A5-11. Summary results from genetic stock-composition estimates ($p_{i,k}$ for year *i* and sub-season stratum *k*) from the BAYES analysis. These data were used in conjunction with actual bycatch levels within sub-season strata. CV = coefficient of variation for $p_{i,k}$.

					Correlation					
Year	**Strata**	$p_{i,k}$	**CV**	**Region**	Japan	Russia	WAK	UppYuk	SW_AK	AKBCWA
2005	Jun-Jul	0.190	10%	Japan		-0.2493	-0.2588	-0.1796	-0.1020	-0.2535
2005	Jun-Jul	0.210	11%	Russia			-0.2751	-0.1909	-0.1085	-0.2694
2005	Jun-Jul	0.222	11%	WAK				-0.1982	-0.1126	-0.2796
2005	Jun-Jul	0.121	15%	UppYuk					-0.0781	-0.1941
2005	Jun-Jul	0.043	26%	SW_AK						-0.1103
2005	Jun-Jul	0.215	10%	AKBCWA						
2005	Aug-Oct	0.366	6%	Japan		-0.5038	-0.2374	-0.1374	-0.0928	-0.3629
2005	Aug-Oct	0.306	8%	Russia			-0.2074	-0.1200	-0.0810	-0.3170
2005	Aug-Oct	0.089	18%	WAK				-0.0566	-0.0382	-0.1494
2005	Aug-Oct	0.032	30%	UppYuk					-0.0221	-0.0865
2005	Aug-Oct	0.015	47%	SW_AK						-0.0584
2005	Aug-Oct	0.186	10%	AKBCWA						
2006	Jun-Jul	0.256	10%	Japan		-0.2810	-0.2339	-0.2108	-0.0676	-0.3773
2006	Jun-Jul	0.187	14%	Russia			-0.1910	-0.1721	-0.0552	-0.3081
2006	Jun-Jul	0.137	17%	WAK				-0.1433	-0.0459	-0.2565
2006	Jun-Jul	0.114	16%	UppYuk					-0.0414	-0.2312
2006	Jun-Jul	0.013	54%	SW_AK						-0.0741
2006	Jun-Jul	0.293	9%	AKBCWA						
2006	Aug-Oct	0.301	5%	Japan		-0.4304	-0.1687	-0.1444	-0.1000	-0.3952
2006	Aug-Oct	0.301	6%	Russia			-0.1686	-0.1444	-0.1000	-0.3951
2006	Aug-Oct	0.062	17%	WAK				-0.0566	-0.0392	-0.1548
2006	Aug-Oct	0.046	16%	UppYuk					-0.0335	-0.1326
2006	Aug-Oct	0.023	30%	SW_AK						-0.0918
2006	Aug-Oct	0.266	6%	AKBCWA						
2007	Jun-Jul	0.234	12%	Japan		-0.3074	-0.1873	-0.2774	-0.0667	-0.2816
2007	Jun-Jul	0.237	14%	Russia			-0.1890	-0.2799	-0.0673	-0.2842
2007	Jun-Jul	0.103	24%	WAK				-0.1706	-0.0410	-0.1732
2007	Jun-Jul	0.202	15%	UppYuk					-0.0608	-0.2565
2007	Jun-Jul	0.014	64%	SW_AK						-0.0617
2007	Jun-Jul	0.207	14%	AKBCWA						
2007	Aug-Oct	0.351	4%	Japan		-0.5292	-0.2292	-0.1478	-0.0736	-0.3267
2007	Aug-Oct	0.341	5%	Russia			-0.2242	-0.1446	-0.0719	-0.3196
2007	Aug-Oct	0.089	14%	WAK				-0.0626	-0.0312	-0.1384
2007	Aug-Oct	0.039	19%	UppYuk					-0.0201	-0.0892
2007	Aug-Oct	0.010	41%	SW_AK						-0.0444
2007	Aug-Oct	0.165	8%	AKBCWA						
2008	Jun-Jul	0.223	14%	Japan		-0.1942	-0.1207	-0.1487	-0.1124	-0.5353
2008	Jun-Jul	0.116	23%	Russia			-0.0815	-0.1004	-0.0759	-0.3613
2008	Jun-Jul	0.048	37%	WAK				-0.0624	-0.0472	-0.2246
2008	Jun-Jul	0.071	29%	UppYuk					-0.0581	-0.2767
2008	Jun-Jul	0.042	38%	SW_AK						-0.2092
2008	Jun-Jul	0.499	7%	AKBCWA						
2008	Aug-Oct	0.421	6%	Japan		-0.5371	-0.2504	-0.1992	-0.0971	-0.3564
2008	Aug-Oct	0.284	9%	Russia			-0.1848	-0.1470	-0.0717	-0.2631
2008	Aug-Oct	0.079	21%	WAK				-0.0685	-0.0334	-0.1226
2008	Aug-Oct	0.052	25%	UppYuk					-0.0266	-0.0975
2008	Aug-Oct	0.013	56%	SW_AK						-0.0476
2008	Aug-Oct	0.149	14%	AKBCWA						
2009	Jun-Jul	0.252	7%	Japan		-0.2742	-0.2094	-0.1136	-0.1394	-0.4301
2009	Jun-Jul	0.182	11%	Russia			-0.1703	-0.0925	-0.1134	-0.3499
2009	Jun-Jul	0.115	14%	WAK				-0.0706	-0.0866	-0.2672
2009	Jun-Jul	0.037	23%	UppYuk					-0.0470	-0.1450
2009	Jun-Jul	0.055	20%	SW_AK						-0.1778
2009	Jun-Jul	0.354	6%	AKBCWA						
2009	Aug-Oct	0.392	5%	Japan		-0.5557	-0.3244	-0.1413	-0.1415	-0.2248
2009	Aug-Oct	0.324	7%	Russia			-0.2793	-0.1216	-0.1218	-0.1935
2009	Aug-Oct	0.140	12%	WAK				-0.0710	-0.0711	-0.1130
2009	Aug-Oct	0.030	27%	UppYuk					-0.0310	-0.0492
2009	Aug-Oct	0.030	25%	SW_AK						-0.0493
2009	Aug-Oct	0.073	14%	AKBCWA						

Table A5-12. Results showing from genetic stock-composition estimates relative precision (by stratified samples) as applied to the bycatch totals for **coastal western Alaska** (excludes mid-upper Yukon River chum salmon). CV=coefficients of variation for stratum-specific estimates of chum salmon from coastal western Alaska. Because of consequences having several fish from the same tow, the estimates of uncertainty were based on adjusted sample sizes (bottom panel in bold).

		Jun-July	Aug-Oct
N=fish			
	2005	9%	14%
	2006	13%	13%
	2007	19%	10%
	2008	32%	17%
	2009	11%	9%
N=hauls			
	2005	13%	21%
	2006	24%	18%
	2007	25%	15%
	2008	59%	27%
	2009	21%	16%
Covariance matrix			
	2005	11%	18%
	2006	17%	17%
	2007	23%	14%
	2008	37%	21%
	2009	14%	12%
N=hauls adjusted			
	2005	**16%**	**26%**
	2006	**29%**	**22%**
	2007	**30%**	**18%**
	2008	**71%**	**33%**
	2009	**25%**	**19%**

Table A5-13. Time series of genetic stock-composition estimates of AEQ (percentages in top panel, total numbers in lower panel) based on B-season stratified samples. *Note—for 1994-2004 and 2010, mean stratified genetics data were applied to the bycatch levels.* ***All estimates include the lag-effect which accounts for the proportion of AEQ being caught in different calendar years.***

	AEQ	Coastal West AK	Japan	AKBCWA	Russia	SWAK	UppYukon
1994	132,571	9.4%	36.2%	17.5%	30.7%	1.9%	4.3%
1995	47,948	9.4%	36.3%	17.4%	30.8%	1.9%	4.3%
1996	53,984	9.3%	36.7%	17.0%	31.1%	1.8%	4.1%
1997	60,301	9.3%	36.7%	16.9%	31.2%	1.8%	4.0%
1998	66,699	9.3%	36.8%	16.9%	31.2%	1.8%	4.0%
1999	48,279	9.3%	36.8%	17.0%	31.2%	1.8%	4.0%
2000	52,581	9.7%	34.9%	18.9%	29.5%	2.0%	4.9%
2001	52,743	9.7%	35.0%	18.8%	29.6%	2.0%	4.9%
2002	69,344	9.5%	35.9%	17.8%	30.4%	1.9%	4.4%
2003	141,869	9.5%	35.7%	18.0%	30.3%	1.9%	4.5%
2004	325,945	9.6%	35.4%	18.4%	29.9%	2.0%	4.7%
2005	567,893	12.8%	31.6%	19.4%	27.9%	2.4%	6.0%
2006	419,542	11.9%	29.1%	24.2%	25.3%	2.0%	7.5%
2007	150,434	10.5%	30.5%	22.2%	27.9%	1.6%	7.3%
2008	45,958	9.6%	33.0%	22.4%	28.6%	1.7%	6.8%
2009	36,435	11.5%	31.5%	21.7%	24.8%	3.7%	3.8%
2010	21,765	12.1%	30.5%	23.9%	24.4%	3.6%	5.5%
2011	4,979	11.9%	29.8%	24.5%	24.0%	3.4%	6.4%
2012	464	11.5%	28.7%	25.5%	23.5%	3.0%	7.7%
1994	132,571	12,444	48,038	23,176	40,730	2,496	5,693
1995	47,948	4,492	17,407	8,346	14,761	899	2,042
1996	53,984	5,015	19,786	9,204	16,792	992	2,207
1997	60,301	5,587	22,153	10,218	18,805	1,102	2,435
1998	66,699	6,170	24,534	11,262	20,828	1,214	2,675
1999	48,279	4,478	17,753	8,190	15,070	883	1,952
2000	52,581	5,098	18,376	9,912	15,531	1,065	2,601
2001	52,743	5,100	18,458	9,891	15,603	1,063	2,586
2002	69,344	6,557	24,921	12,338	21,115	1,328	3,081
2003	141,869	13,484	50,713	25,540	42,947	2,749	6,444
2004	325,945	31,262	115,333	59,930	97,582	6,446	15,402
2005	567,893	72,605	179,225	110,351	158,205	13,400	34,093
2006	419,542	49,768	122,118	101,412	106,288	8,562	31,428
2007	150,434	15,814	45,875	33,427	41,974	2,366	11,039
2008	45,958	4,390	15,179	10,313	13,124	772	3,148
2009	36,435	4,203	11,481	7,890	9,046	1,353	1,392
2010	21,765	2,628	6,641	5,201	5,301	791	1,204
2011	4,979	593	1,482	1,221	1,197	169	317
2012	464	54	133	118	109	14	36

A5.1.3 Combining genetic information with AEQ results

The AEQ model uses genetic estimates of chum salmon taken as bycatch in the Bering Sea pollock fishery to determine where the AEQ chum salmon would have returned. In order to align the AEQ estimates with the available genetics information the AEQ results need to split out by the years when the bycatch mortality occurred. For example, the AEQ bycatch mortality in 2008 (i.e., the impact on returning chum salmon in calendar year 2008) is a result of bycatch that occurred in earlier years in addition to the mature (returning) fish that were taken in 2008. This step is needed to apportion the AEQ results to stock of origin based on genetic samples which consist of mature and immature fish.. By splitting the AEQ estimates to relative contributions of bycatch from previous years, and applying GSI data from those years, they can then be realigned and renormalized to get proportions from systems by year (Table A5-13). The impact of the correction due to the lag is illustrated in Figure A5-20. Since data from 1991-2004 and 2010 were unavailable for this analysis, mean GSI (with year-effect variability added to the estimates of uncertainty) were used.

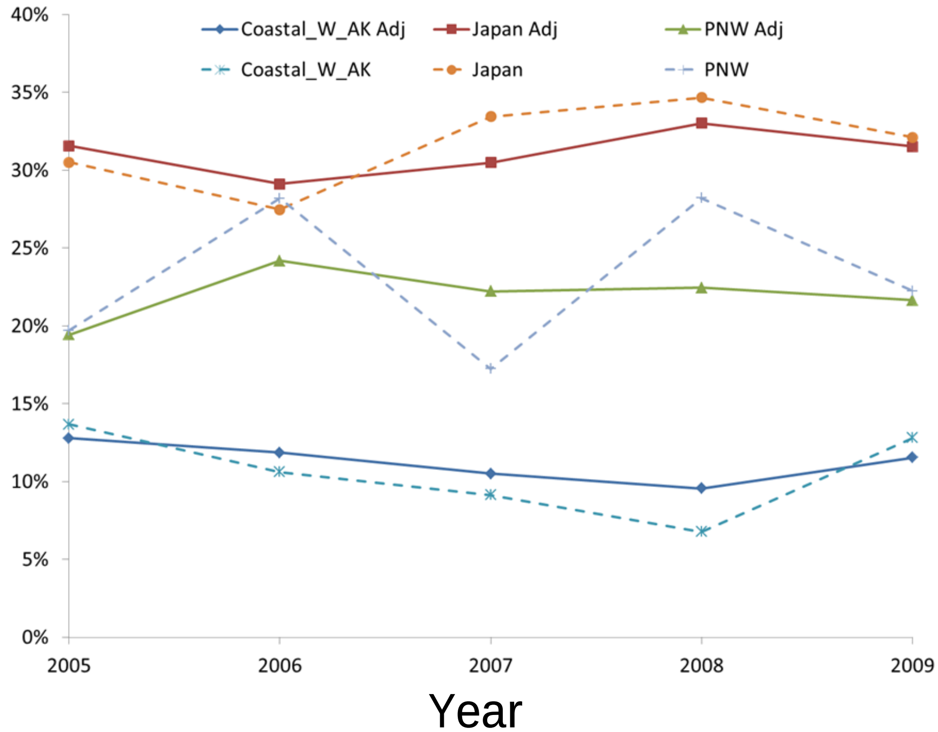

Figure A5-20. Comparison of the annual proportion of B-season chum salmon bycatch originating from different regions by year using the annual genetics results compared with the lag-corrected values (Adj).

A5.2 Approach to evaluate Status Quo/RHS program

A separate analysis was completed estimating the efficacy of the RHS program for salmon bycatch reduction compared to what salmon bycatch would have been in the absence of that program. Both the methodology for this analysis as well as the impact analysis are contained in Chapter 5, Section 5.4.1.1 The methodological portions of that analysis will be moved to this section for the public review draft.

Several different approaches were taken to evaluate the effectiveness of the RHS program. First, from 2003-2010, the average levels of bycatch reduction are examined before and after RHS closures are put in place. This enables an average salmon reduction or "treatment effect" of the closures to be estimated. However, because in some cases closures are left in place for several weeks and therefore no lasting impact of the closures is observed in data, a second method was utilized. For the period 1993-2000, the high-bycath areas were identified and hypothetical "closures" implemented. This allows for a better accounting of the longer-term benefits of the closures as well as exploration of how different elements of closures (e.g., size, frequency, the minimum rates used to close areas) impact their effectiveness.

A5.3 Approach to evaluate Alternative 2, hard caps

Hard caps were evaluated similar to the methods for determining closures in the next section except that for each sector allocation and cap combination, rather than diverting effort to other areas, they were treated as if their season was over. At that point, the amount of salmon was compared with the total actual non-Chinook salmon bycatch to evaluate potential salmon savings that might have occurred had the hard cap been in place (ignoring the fact that the fleet would likely have taken measures to avoid reaching the cap). Likewise, their pollock catch at the point the cap was reached was compared with actual values for that year (within sectors). The cap levels evaluated for analysis were 50,000, 200,000, and 353,000 non-Chinook salmon with three selected sector-allocation schemes as outlined in section 2.

Additionally, an approach that acknowledges that the industry would react differently when a cap appeared eminent, we evaluated an "effective cap" situation in which the fleet would stand down when they approached 75% of the sector split cap. This was done as a sensitivity.

A5.4 Evaluating Alternative 3

[To include if needed since mainly qualitative for RHS participation]

A5.5 Evaluating Alternative 4, trigger-cap scenarios

As noted in section 2.3.1, the 50% area scenarios were selected to evaluate the range of caps apportioned by sector and month. The historical data from 2003-2011 was used for each cap scenario. As a monthly trigger limit was reached, the areas designated for that month are closed to that sector and re-opened in the subsequent month (unless the cumulative total was exceeded for that month—if that is the case, then that month begins with the "optimal" closures for that month). When areas become closed, the remaining pollock observed for that sector is assumed to be taken *outside of the closed areas* at the mean bycatch rate / t of pollock observed outside the closed areas.

This process requires accounting to track open and closed area rates simply for each of the 4 options for triggering (options 1a, 1b, 2a, and 2b under component 2). The analysis focused on the historical period from 2003-2011 and evaluated three cap scenarios, each with three alternative sector-specific allocation schemes, for the four trigger closure methods. Presenting the results of this analysis by sector and year is challenging since there are nearly 3,000 values to display.

The historical NMFS observer data as described earlier allows flexibility in evaluating input specifications (i.e., different spatial closures, cap/sector allocations). To the extent possible, evaluations of alternative chum salmon trigger caps were thus based on re-casting historical catch levels as if a cap proposal had been implemented. Since the alternatives all have specific values by season and sector, the effect on bycatch levels can vary for each alternative and over different years. This is caused by the distribution of the fleet relative to the resource and the variability of bycatch rates by season and years.

The annual proportion of week-area chum bycatch was computed for each year and a gridded dataset with 10 alternative chum bycatch levels was constructed (with totals spanning 50,000, 100,000, … , 500,000 for each of the 9 years). This dataset was then used to evaluate the relative benefits of different trigger closure options. The point of this was to capture some of the spatio-temporal variability between years. One disadvantage of this approach is that it assumes that bycatch in years where levels were low would have a similar spatio-temporal patterns in high bycatch years (and vice versa).

Area closures (chum savings areas in 2003-2005 and VRHS in 2001-2010) affect the available data for evaluating optimal closure areas and regions. Additionally, a fishing patterns have shifted through this period (due to the relative abundance of pollock) with varying proportions of pollock taken west of the Pribilof Islands.

Within-season patterns are also illustrated by cap, sector split, and suboption. This is to show whether particular trigger cap options affect chum salmon bycatch earlier in the year when generally a proportion of western Alaska stocks in the bycatch would be expected to be lower (since the stock composition appears to vary between early and later in the season).

A6 Chum salmon stock status overview

A6.1 Alaskan Chum Salmon Stock Management and Harvest Summaries by Region

A6.1.1 Bristol Bay [1]

The five species of Pacific salmon found in Bristol Bay are the focus of major commercial, subsistence, and sport fisheries. Management of the commercial fishery in Bristol Bay is focused on discrete stocks with harvests directed at terminal areas around the mouths of major river systems. Each stock is managed to achieve a spawning escapement goal based on sustained yield. Escapement goals are achieved by regulating fishing time and area by emergency order (EO) and/or adjusting weekly fishing schedules. Legal gear for the commercial salmon fishery includes both drift (150 fathoms) and set (50 fathoms) gillnets. However, the Alaska Board of Fisheries (BOF) passed a regulation in 2003 allowing for 2 drift permit holders to concurrently fish from the same vessel and jointly operate up to 200 fathoms of drift gillnet gear. In 2009, this regulation was modified so that it does not apply when the Naknek Special Harvest Area is in use. Also in 2009, a regulation was adopted that allowed set gillnet permit holders to own and operate 2 permits with associated legal amounts of gear. Drift gillnet permits are the most numerous at 1,862 in Bristol Bay (Area T), and of those, 1,747 fished in 2011. There are a total of 981 set gillnet permits in Bristol Bay and of those, 878 fished in 2011 .

A6.1.1.1 Description of Management Area

The Bristol Bay management area includes all coastal and inland waters east of a line from Cape Newenham to Cape Menshikof (Figure A6-1). The area includes the communities of Aleknagik, Clarks Point, Dillingham, Egegik, Ekwok, Igiugig, Iliamna, King Salmon, Kokhanok, Koliganek, Levelock, Manokotak, Naknek, New Stuyahok, Newhalen, Nondalton, Pedro Bay, Pilot Point, Port Alsworth, Port Heiden, Portage Creek, South Naknek, Togiak, Twin Hills, and Ugashik. The area also includes nine major river systems: Naknek, Kvichak, Alagnak (Branch), Egegik, Ugashik, Wood, Nushagak, Igushik, and Togiak. The Bristol Bay area is divided into five management districts (Naknek-Kvichak, Egegik, Ugashik, Nushagak, and Togiak) that correspond to the major river drainages Sockeye salmon are by far the most abundant salmon species that return to Bristol Bay each year, but Chinook, chum, coho, and (in even years) pink salmon returns are important to the fishery as well. The management objective for each river is to achieve escapements within established ranges for the major salmon species while harvesting fish excess of those ranges through orderly fisheries. In addition, regulatory management plans have been adopted for individual species in certain districts.

[1] Information contained in this section is taken from : Jones, M., T. Sands, S. Morstad, T. Baker, G. Buck, F. West, P. Salomone, and T. Krieg. 2012. 2011 Bristol Bay area annual management report. Alaska Department of Fish and Game, Fishery Management Report No. 12-21, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-21.pdf.

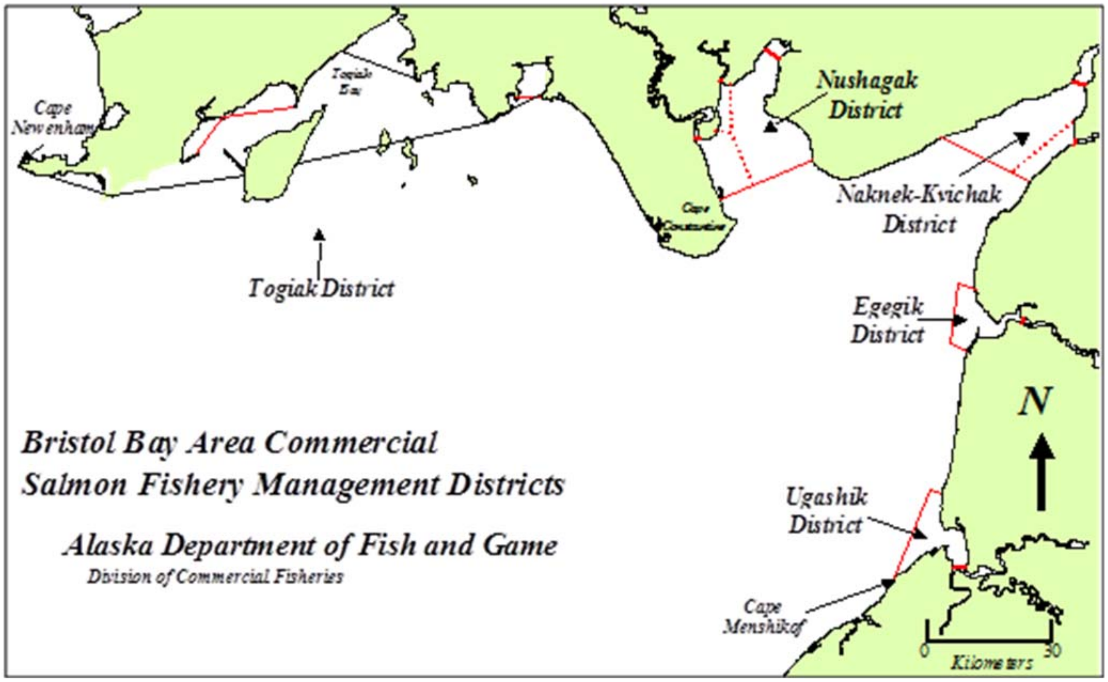

Figure A6-1. Bristol Bay area commercial fisheries salmon management districts.

A6.1.1.2 Bristol Bay Assessment (Nushagak River)

Stock Size

The largest run of chum salmon in Bristol Bay occurs in the Nushagak River. The 2011 total run of chum salmon to the Nushagak River was 589,159 (Table A6-1). The total run was 221,676 (27%) less than the recent 20-year (1991-2011) average of 810,835 and 45% less than the recent 10-year (2001 - 2011) average of 1,075,059 (Table A6-1).

Escapement

Chum salmon are enumerated in the Nushagak River using Dual Frequency Identification (DIDSON) sonar. The spawning escapement in the Nushagak River was 248,278 chum salmon in 2011. The Nushagak River has a sustainable escapement goal (SEG) threshold of 190,000 chum salmon. Chum salmon escapement has exceeded the 190,000 threshold in most years since 1991.

Table A6-1. Commercial harvest, spawning escapement, total run and exploitation rate of Nushagak River chum salmon, 1991 - 2011.

Year	Catch	Escapement[a]	Total Run	Exploitation
1991	463,780	287,280	751,060	62%
1992	398,691	302,678	701,369	57%
1993	505,799	217,230	723,029	70%
1994	328,267	378,928	707,195	46%
1995	390,158	212,612	602,770	65%
1996	331,414	225,331	556,745	60%
1997	185,620	61,456	247,076	75%
1998	208,551	299,443	507,994	41%
1999	170,795	242,312	413,107	41%
2000	114,454	141,323	255,777	45%
2001	526,602	564,373	1,090,975	48%
2002	276,845	419,969	696,814	40%
2003	740,311	295,413	1,035,724	71%
2004	470,248	283,805	754,053	62%
2005	874,090	448,059	1,322,149	66%
2006	1,240,235	661,003	1,901,238	65%
2007	953,275	161,483	1,114,758	86%
2008	541,469	326,300	867,769	62%
2009	745,083	438,481	1,183,564	63%
2010	509,628	273,914	783,542	65%
20-Year Avg.	498,766	312,070	810,835	62%
1991-00 Avg.	309,753	236,859	546,612	57%
2001-10 Avg.	687,779	387,280	1,075,059	64%
2011	340,881	248,278	589,159	58%

[a] Escapment based on sonar estimates from the Portage Creek site.

A6.1.1.3 Bristol Bay Commercial Chum Fishery Harvests

Harvest

A total of 340,881 chum salmon were harvested in the commercial fishery of the Nushagak District in 2011. It is assumed that these chum salmon are bound for the Nushagak River as this is the only river with a significant chum population within the District. The 2011 commercial harvest of chum salmon in the Nushagak District was 32% lower than the 20-year average of 498,766 and 50% lower than the 10-year average of 687,779.

Chum salmon are harvested incidentally to sockeye salmon. The total commercial harvest in Bristol Bay was 739,052 chum salmon in 2011. This was 29% less than the 20-year average of 984,505 chum salmon. Chum salmon catches were below 20-year averages in all districts except Naknek/Kvichak (Table 5-13). Annual commercial catches for the most recent 20-year span (1992–2011) average 984,505 chum salmon (Table A6-2). Since 1991, the value of the commercial salmon harvest in Bristol Bay has averaged \$115.3 million, with sockeye salmon being the most valuable, worth an average \$113.2 million.

Table A6-2 shows that, historically, Bristol Bay chum harvests generally trended downwards during the 1990's; however, since 2001, the trend has been generally upwards with a peak harvest of 2.2 million fish in 2006. With the exception of 2011, recent chum salmon harvests, have continued to be above the 5-year, 10-year, and 20-year averages. These trends are also depicted in Figure A6-2 below.

Table A6-2 Chum salmon commercial catch by district, in numbers of Fish, Bristol Bay, 1989-2011.

Year	Naknek-Kvichak	Egegik	Ugashik	Nushagak	Togiak	Total
1989	310,869	136,185	84,673	523,910	203,171	1,258,808
1990	422,276	122,843	31,798	375,361	102,861	1,055,139
1991	443,189	75,892	60,299	463,780	246,589	1,289,749
1992	167,168	121,472	57,170	398,691	176,123	920,624
1993	43,684	70,628	73,402	505,799	144,869	838,382
1994	219,118	62,961	52,127	328,260	232,559	895,025
1995	236,472	68,325	62,801	390,158	221,126	978,882
1996	97,574	85,151	106,168	331,414	206,226	826,533
1997	8,628	59,139	16,903	185,635	47,285	317,590
1998	82,281	29,405	8,088	208,551	67,345	395,670
1999	259,922	74,890	68,004	170,795	111,677	685,288
2000	68,218	38,777	36,349	114,454	140,175	397,973
2001	16,472	33,579	43,394	526,602	211,701	831,748
2002	19,180	23,516	35,792	276,777	112,987	468,252
2003	34,481	37,116	52,908	740,311	68,154	932,970
2004	29,972	75,061	49,358	458,902	94,025	732,481
2005	204,777	62,029	39,513	966,050	124,694	1,397,063
2006	457,855	153,777	168,428	1,240,235	223,364	2,243,659
2007	383,927	157,991	242,025	953,275	202,486	1,939,704
2008	237,260	92,901	135,292	541,469	301,967	1,259,761
2009	258,141	124,131	65,439	745,083	143,418	1,366,469
2010	330,342	64,539	70,839	509,628	123,703	1,522,965
2011	205,790	41,401	37,556	340,881	113,455	739,052
20-Year Ave.	168,063	73,839	71,078	498,766	153,367	984,505
10 year Ave.	216,173	83,246	89,715	687,779	150,825	1,260,238
5 year Ave.	283,092	96,193	110,230	797,938	177,006	1,365,590

a Total includes General District catch of 25,163.
Source: ADF&G 2012, Table A5.

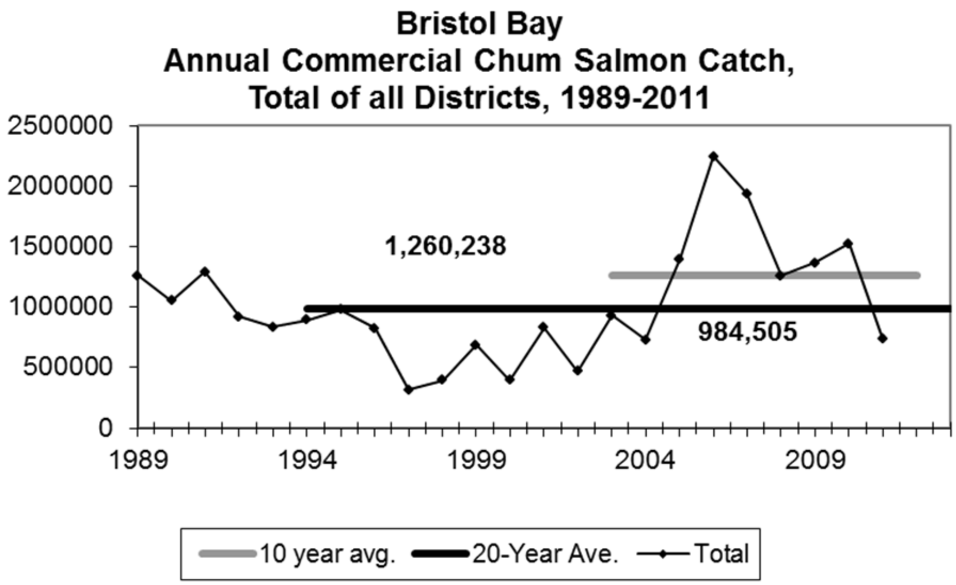

Figure A6-2 Bristol Bay annual commercial chum catch, total all districts, 1989-2011.
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A6.1.1.4 Bristol Bay Area Chum Salmon Subsistence Harvest[2]

In the Bristol Bay Management Area, subsistence fishing is permitted in all districts during commercial openings. In addition, all commercial districts were open for subsistence fishing in May and September, from Monday to Friday. In the late 1990s and early 2000s, declining Chinook salmon and coho salmon stocks resulted in longer commercial closures and some residents had difficulty obtaining fish for home uses. Since 2004, there have been improvements in abundance of all salmon species. Since 1988 in the Nushagak District, subsistence salmon fishing has been allowed by emergency order during periods of extended commercial fishing closures (Morstad et al., 2010).

In 2010, a total of 1,082 permits were issued for the Bristol Bay Management Area; of those 979 (90.5%) were returned. The largest number of permits were issued for the Nushagak (528 permits) and Naknek–Kvichak (437 permits) districts. The number of permits issued in 2008 was above both the five-year average (2003 - 2007) of 1,094 permits, the 10-year average (1998 - 2007) of 1,146 permits, and historical average of 1,090 permits (Fall et al., 2011).

Estimated total Bristol Bay subsistence salmon harvests in 2010 were 113,238 fish. The 2010 subsistence harvest was below both the five-year (2005 - 20010) average of 124,170 fish and the 10-year (2000 - 2010) average of 123,315 salmon, and below the historical average (1983 – 2010) of 147,669 salmon. The estimated harvest of 4,692 chum salmon was above both the five year average (4,953 fish) and the 10-year average (5,212 fish) (Table A6-3). In 2008, the Bristol Bay subsistence salmon harvest was composed of 77% sockeye salmon, 11% Chinook salmon, 6% coho salmon, 4% chum salmon, and 2% pink salmon (Figure A6-3; Fall et al., 2011).

[2] An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

Table A6-3 Estimated historical subsistence salmon harvests, Bristol Bay area, 1983 – 2010.

	Permits		Estimated salmon harvest					
Year	Issued	Returned	Chinook	Sockeye	Coho	Chum	Pink	Total
1983	829	674	13,268	143,639	7,477	11,646	1,073	177,104
1984	882	698	11,537	168,803	16,035	13,009	8,228	217,612
1985	1,015	808	9,737	142,755	8,122	5,776	825	167,215
1986	930	723	14,893	129,487	11,005	11,268	7,458	174,112
1987	996	866	14,424	135,782	8,854	8,161	673	167,894
1988	938	835	11,848	125,556	7,333	9,575	7,341	161,652
1989	955	831	9,678	125,243	12,069	7,283	801	155,074
1990	1,042	870	13,462	128,343	8,389	9,224	4,455	163,874
1991	1,194	1,045	15,245	137,837	14,024	6,574	572	174,251
1992	1,203	1,028	16,425	133,605	10,722	10,661	5,325	176,739
1993	1,206	1,005	20,527	134,050	8,915	6,539	1,051	171,082
1994	1,193	1,019	18,873	120,782	9,279	6,144	2,708	157,787
1995	1,119	990	15,921	107,717	7,423	4,566	691	136,319
1996	1,110	928	18,072	107,737	7,519	5,813	2,434	141,575
1997	1,166	1,051	19,074	118,250	6,196	2,962	674	147,156
1998	1,234	1,155	15,621	113,289	8,126	3,869	2,424	143,330
1999	1,219	1,157	13,009	122,281	6,143	3,653	420	145,506
2000	1,219	1,109	11,547	92,050	7,991	4,637	2,599	118,824
2001	1,226	1,137	14,412	92,041	8,406	4,158	839	119,856
2002	1,093	994	12,936	81,088	6,565	6,658	2,341	109,587
2003	1,182	1,058	21,231	95,690	7,816	5,868	1,062	131,667
2004	1,100	940	18,012	93,819	6,667	5,141	3,225	126,865
2005	1,076	979	15,212	98,511	7,889	6,102	1,098	128,812
2006	1,050	904	12,617	95,201	5,697	5,321	2,726	121,564
2007	1,063	917	15,444	99,549	4,880	3,991	815	124,679
2008	1,178	1,083	15,153	103,583	7,627	5,710	2,851	134,924
2009	1,063	950	14,020	98,951	7,982	5,052	442	126,447
2010	1,082	979	10,852	90,444	4,623	4,692	2,627	113,238
5-year average (2005-2010)	1,087	967	13,617	97,546	6,162	4,953	1,892	124,170
10-year average (2000-2010)	1,121	1,005	14,676	94,630	6,922	5,212	1,875	123,315
Historical average (1983-2010)	1,092	955	14,752	115,574	8,349	6,573	2,421	147,669

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2012).

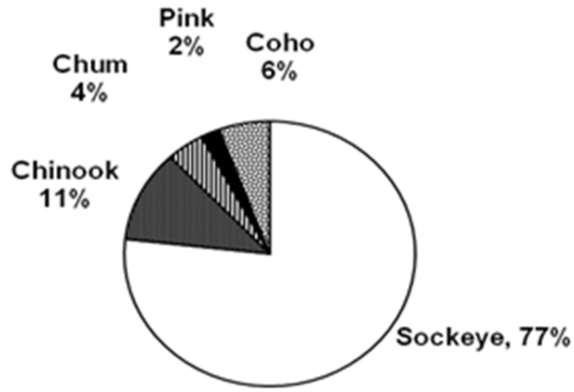
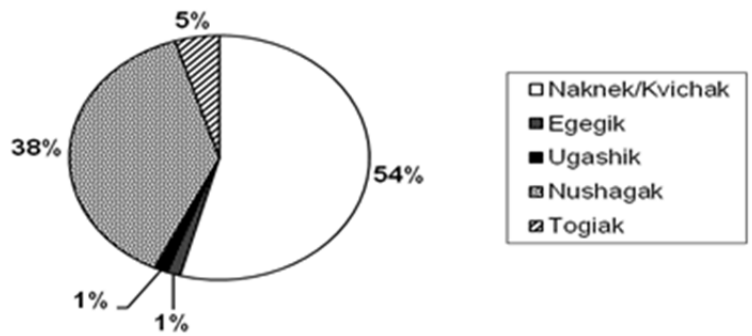


Figure A6-3 Composition of Bristol Bay area subsistence salmon harvest by species, 2008. Source: Fall et al., 2011.

In 2008, as over the last several decades, most of the Bristol Bay area subsistence harvest was taken in the Naknek–Kvichak (54%) and the Nushagak (38%) districts (Figure A6-4). The Naknek–Kvichak total harvest of 73,184 salmon in 2008 was slightly higher than in 2007 (72,280 salmon), 2006 (71,796 salmon), and 2005 (72,302 salmon). It was substantially higher than the 2003 harvest of 63,934 salmon. In the Nushagak District, the total estimated subsistence harvest in 2008 was 51,395 salmon. This was higher than the 2007 harvest of 44,944 salmon and the 2006 harvest of 40,373 salmon (Table A6-4) (Fall et al., 2011).



Source: Fall et al., 2011.

Figure A6-4 Subsistence salmon harvests by district, Bristol Bay area, 2008.

Table A6-4 Estimated subsistence salmon harvests by district and location fished, Bristol Bay area, 2010.

	Permits	Estimated Number of Salmon Harvested [a]					
Area and River System	Issued [b]	Sockeye	Chinook	Chum	Pink	Coho	Total
NAKNEK-KVICHAK DISTRICT	437	62,309	422	233	835	645	64,444
EGEGIK DISTRICT	37	1,657	93	59	8	275	2,091
UGASHIK DISTRICT	18	896	21	4	0	135	1,056
NUSHAGAK DISTRICT	528	22,326	9,150	3,660	1,672	2,983	39,790
TOGIAK DISTRICT	64	3,256	1,162	735	113	514	5,779
TOTAL BRISTOL BAY	1,082	90,444	10,852	4,692	2,627	4,623	113,238

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2009).

[a]Harvests are extrapolated for all permits issued, based on those returned and on the area fished as recorded on the permit. Due to rounding, the sum of columns and rows may not equal the estimated total. Of 1,082 permits issued for the management area, 979 were returned (90.5%).

[b] Sum of sites may exceed district totals, and sum of districts may exceed area total, because permittees may use more than one site.

A6.1.1.5 Bristol Bay Sport and Personal Use Fisheries

While the majority of sport fishing effort in the Bristol Bay area targets Chinook, coho, sockeye salmon and rainbow trout, several drainages, including the Togiak, Nushagak, and Alagnak, support directed chum salmon sport fisheries. The 2009 sport catch/harvest of chum salmon was estimated as follows: Togiak: 3,014/88; Nushagak: 10,009/1,239; Alagnak: 12,630/50; and Bristol Bay wide: 30,766/1,443. The recent five year (2004-2008) average sport catch/harvest was estimated as follows: Togiak: 3,938/79; Nushagak: 7,519/1,112; Alagnak: 13,321/321; and Bristol Bay wide: 26,898/1,760. The 2009 sport fishing effort (angler-days) was estimated as: Togiak: 3,638; Nushagak: 18,064; Alagnak: 9,995; and Bristol Bay wide: 76,848. The recent five year (2004-2008) average sport fishing effort (angler-days) was estimated as: Togiak: 5,426; Nushagak: 23,328; Alagnak: 9,907; and Bristol Bay wide: 98,249.

The majority of sport fishing effort (>90%) targets species other than chum salmon. In terms of effort, catch, and harvest, the directed chum salmon sport fisheries in Bristol Bay would be characterized as minor in relation to other sport fisheries in the area. Additionally, a significant proportion of the sport catch of chum salmon occurs incidentally in directed Chinook salmon sport fisheries. After a relatively steady increase from the 1970s through 2000, total sportfishing effort in the Bristol Bay Area declined during 2002 and 2003, followed by increasing effort through 2007 and another decline during 2008 and 2009. Catch and harvest of chum salmon in Bristol Bay sport fisheries have remained stable or declined slightly during the last 10 years (personal communication, Jason Dye, 2010).

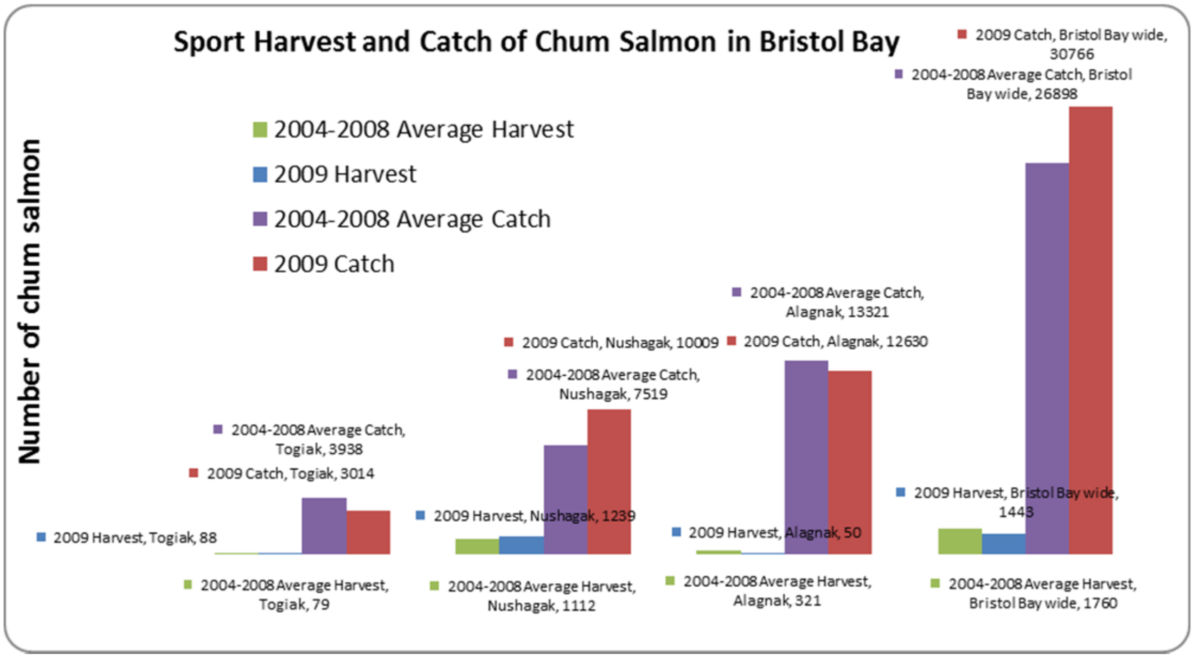


Figure A6-5 Sport Harvest and Catch of Chum Salmon in Bristol Bay.

Due to subsistence fishing opportunities in Bristol Bay and the limits on personal use fisheries, personal use fishing rarely occurs in the Bristol Bay area and no recent personal use chum salmon harvest has been documented (personal communication, Jason Dye, 2010).

A6.1.2 Kuskokwim Area[3]

Salmon spawn and rear throughout the Kuskokwim River drainage, which is the second largest river in Alaska, draining an area of about 130,000 km^2 along its 1,500 km course from interior Alaska to the Bering Sea (Johnson and Daigneault 2008; Figure A6-6). The river produces Chinook (*Oncorhynchus tshawytscha)*, chum (*O. keta)*, sockeye (*O. nerka)*, pink *(O. gorbuscha)*, and coho salmon (*O. kisutch)*, each with numerous stock assemblages and overlapping migratory timings as they enter the lower Kuskokwim River. Subsistence, commercial, and sport fisheries are directed at harvest of Chinook, chum, sockeye, and coho salmon. The commercial and sport fisheries are relatively modest in size, but the Kuskokwim River subsistence fishery is one of the largest in Alaska (e.g., Fall et al. 2007). Subsistence and sport fisheries occur throughout the drainage, but the commercial fishery is confined to two discrete commercial fishing districts.

District 1 extends from the mouth of the Kuskokwim River (rkm 0) upstream to Bogus Creek (rkm 203). Since 2000, District 1 may be managed as two subdistricts with fisherman required to only fish in one or the other subdistrict,of depending on fish processing capacity. Subdistrict 1-A is that portion of District 1 upstream ("above") Bethel (rkm 106) and subdistrict 1-B is downstream ("below") of Bethel.

[3] Information contained in this section taken from: Brazil, C., D. Bue, H. Carroll, and T. Elison. 2011 Kuskokwim area management report. Alaska Department of Fish and Game, Fishery Management Report No. 11-67, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR11-67.pdf . Information for the 2011 season was obtained from ADF&G Commercial Fisheries News Release October 12, 2011 titled "2011 Preliminary Kuskokwim Area Salmon Season Summary". http://www.adfg.alaska.gov/static/home/news/pdfs/newsreleases/cf/93505531.pdf.

District 2 is in the middle Kuskokwim River from rkm 262 near Lower Kalskag, and extends upstream to the rkm 322 at Chuathbaluk. The District 2 commercial fishery has been inactive, with the last harvest occurring in 2000. Historically, there was also a District 3 that encompassed waters upstream of District 2, but District 3 was deleted from regulation in 1966 due to inactivity of the commercial fishery.

The District 4 commercial salmon fishery was established in 1960. The boundaries of District 4 extend from the northern-most edge of the mouth of Oyak Creek to the southern-most tip of the south mouth of the Arolik River, and expand 3 mi from the coast into Kuskokwim Bay. Prior to 2001, the northern most boundary of the district was the northern most edge of Weelung Creek. The northern boundary was moved by regulation to minimize the number of Kuskokwim River bound Chinook and chum salmon harvested in the District 4 commercial fishery. The Kanektok and Arolik Rivers are the main spawning streams in the district. The village of Quinhagak is located at the mouth of the Kanektok River.

The District 5 commercial salmon fishery was established in 1968. The boundaries of District 5 extend from the southern most tip of the north spit to the northern most tip of the south spit at the entrance of Goodnews Bay, expanding east to a line between the mouth of Ukfigag Creek to the mouth of the Tunulik River. The Goodnews River drainage is the main spawning drainage in the district. The Goodnews and Middle Fork Goodnews Rivers are the primary spawning rivers within the drainage.

The Kuskokwim Area includes the Kuskokwim River drainage, all waters of Alaska that flow into the Bering Sea between Cape Newenham and the Naskonat Peninsula, and Nunivak and St. Matthew Islands (Figure A6-6). The 2007 Kuskokwim River salmon fisheries were managed according to the Kuskokwim River Salmon Management Plan (5 AAC 07.365). Kuskokwim Bay salmon fisheries were managed according to the District 4 Salmon Management Plan (5 AAC 07.367) and their associated regulations.

The Kuskokwim River Salmon Management Working Group (Working Group) was formed in 1988 by the BOF in response to requests from stakeholders in the Kuskokwim River drainage seeking a more active role in the management of salmon fishery resources. Since then, the Working Group has become increasingly active in the preseason, inseason, and postseason management of the Kuskokwim River drainage subsistence, commercial, and sport salmon fisheries. In 2001, the Working Group modified its charter in order to more effectively address the needs of the Federal Subsistence Management Program by including members of the Coordinating Fisheries Committee of the Yukon-Kuskokwim Delta and Western Interior Regional Advisory Councils. The Working Group now serves as a public forum for Federal and State fisheries managers to meet with local users of the salmon resource to review run assessment information and reach a consensus on how to proceed with management of Kuskokwim River salmon fisheries. Working Group meetings provide the forum for area fishermen, user representatives, community representatives, Regional Advisory Council representatives, Fish and Game Advisory Committee members, and State and Federal managers to come together to discuss issues relevant to sustained yield fishery management and providing for the subsistence use priority.

Improvements have been made toward strengthening the cooperative management process of the Kuskokwim River Salmon Management Working Group through funding provided by the Office of Surface Mining, Reclamation and Enforcement, Department of the Interior (OSM) in support of project Fisheries Information Services (FIS) 01-116. The funding provided by OSM allowed ADF&G staff and Working Group members to more effectively keep area fishermen informed of run abundance, fishery status, and management strategies through discussion, news releases, newspaper articles and radio talk shows. The funding allowed dedicated staff to more effectively prepare for meetings by providing complete and frequent distribution of updated fishery status information in a standardized format. The funding also allowed travel for Working Group members to participate in fishery meetings located outside the drainage. Although progress has been made toward strengthening cooperative management, it is an ongoing process that will require the continued participation by area fishermen and basic funding for material preparation, communication and travel to maintain the interaction of Working Group members with fishery managers, fishery project leaders, research planners, and policy makers.

Figure A6-6. Map of Kuskokwim River Alaska, showing the distribution of commercial harvest areas and escapement monitoring sites.

A6.1.2.1 Kuskokwim River Assessment

Entering the lower river from early June through mid-August, Kuskokwim River chum salmon are the most abundant salmon species in the drainage (Estensen et al. 2009). Two genetically distinct populations have been identified: the more predominant summer chum salmon that spawn mostly in July and August, and the less common fall chum salmon that spawn mostly in September (Gilk et al. 2005). Spawning distributions do not overlap between these two populations; summer chum salmon spawn mostly in tributaries of the lower and middle Kuskokwim River, and fall chum salmon are limited to a few upper Kuskokwim River tributaries. There is evidence that run timings through the lower Kuskokwim River do overlap between summer and fall chum salmon, but details are limited. Genetically, summer chum in the Kuskokwim and Yukon rivers are very similar; however, Kuskokwim fall chum are distinct from either river's summer chum, and from Yukon fall chum populations. Genetic mixed-stock analysis has shown that both summer and fall chum are exploited in the Kuskokwim River in-river fisheries but, unlike the Yukon River, management practices do not distinguish between the two populations.

Low chum salmon abundance from 1997 through 2000 prompted the Alaska Board of Fisheries to declare Kuskokwim River chum salmon as a stock of yield concern in September 2000 (Burkey et al. 2000). The chum salmon runs to the Kuskokwim River improved throughout 2000s, with near record runs from 2005 through 2007, which led to the stock of concern finding being lifted in January 2007 (Linderman and Bergstrom 2006).

Escapement

Escapement monitoring is limited to summer chum salmon and occurs on seven tributaries: six employing weirs and one sonar (Table A6-5). Collectively, these monitoring projects provide a means to index annual escapement abundance, but they do not provide absolute total annual abundance estimates. Efforts by Bue et al. (2008) and Shotwell and Adkison (2004) to reconstruct the total in-river chum salmon abundance based on these indices have been moderately successful. The estimates produced by each of these methods show a similar pattern in the variation of chum salmon abundances across years, but the values from the Shotwell and Adkison (2004) model are consistently lower than those produced by the Bue et al. (2008) model. The Bue et al. model had the advantage of more escapement information, so is thought to better reflect actual chum salmon abundance. Still, reliable historical total annual chum salmon abundance estimates for the Kuskokwim River remain elusive due to inadequate abundance estimates needed to scale the model.

Table A6-5. Kuskokwim River chum salmon escapement by projects, 2000-2011.

	Chum Salmon Escapement						
Year	Kwethluk	Tuluksak	George	Kogrukluk	Tatlawiksuk	Takotna	Aniak
2000	11,691	a	3,492	11,491	6,965	1,254	177,384
2001	a	19,321	11,601	30,570	23,718	5,414	408,830
2002	35,854	9,958	6,543	51,570	24,542	4,377	472,346
2003	41,812	11,724	33,666	23,413	a	3,393	477,544
2004	38,646	11,796	14,409	24,201	21,245	1,630	672,931
2005	a	35,696	14,828	197,723	55,720	6,467	1,151,505
2006	47,490	25,648	41,467	180,594	32,301	12,598	1,108,626
2007	57,230	17,286	55,842	49,505	83,246	8,900	696,801
2008	20,048	12,518	29,978	44,978	30,896	5,691	427,911
2009	32,028	13,658	7,941	84,940	19,975	2,487	479,531
2010	18,835	13,424	26,154	63,583	36,701	4,062	429,643
2011	18,261	9,948	44,640	76,384	84,202	8,414	345,630

a Weir did not operate or counts were incomplete

Escapement goals

There is no formal escapement goal for the overall Kuskokwim River chum salmon run; however, escapement goals have been established for the Kogrukluk River (assessed by weir) and the Aniak River (assessed with sonar counts unapportioned to species). The SEG for the Kogrukluk River was established in 2005 and is set at 15,000 – 49,000 chum salmon and the SEG for the Aniak River was established in 2007 and is set at 220,000 – 480,000 chum salmon. These goals have been annually achieved or exceeded in all but one of the last 10 years (Figure A6-8). Escapement goals have not been established at the five other locations where chum salmon escapements are currently being monitored.

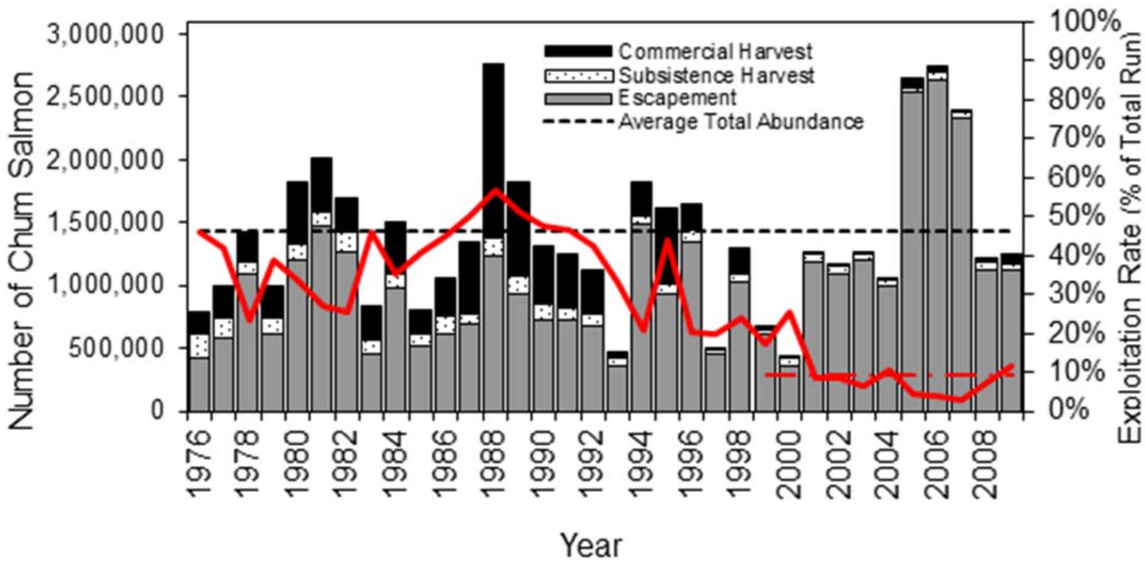


Figure A6-7. Draft Kuskokwim River chum salmon run reconstruction 1976-2009, showing total annual abundance and exploitation rates based on Bue et al. 2009.

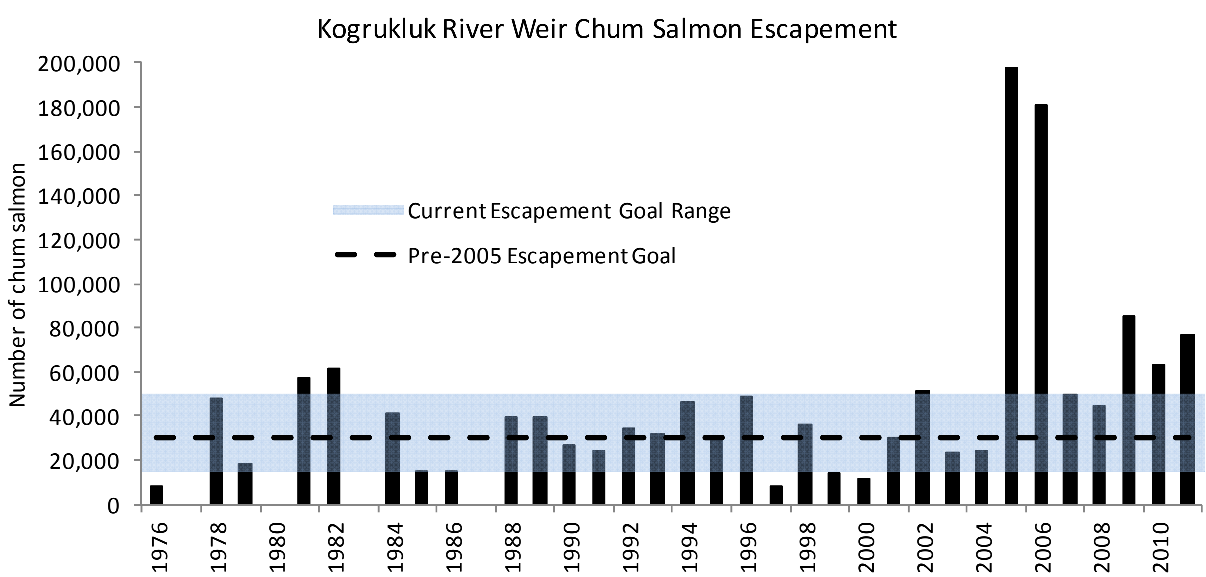


Figure A6-8. Chum salmon escapement at Kogrukluk River weir, 1976-2011 with escapement goal range (15,000 - 49,000) adopted in 2005, and the minimum escapement goal (30,000) used from 1983 to 2004.

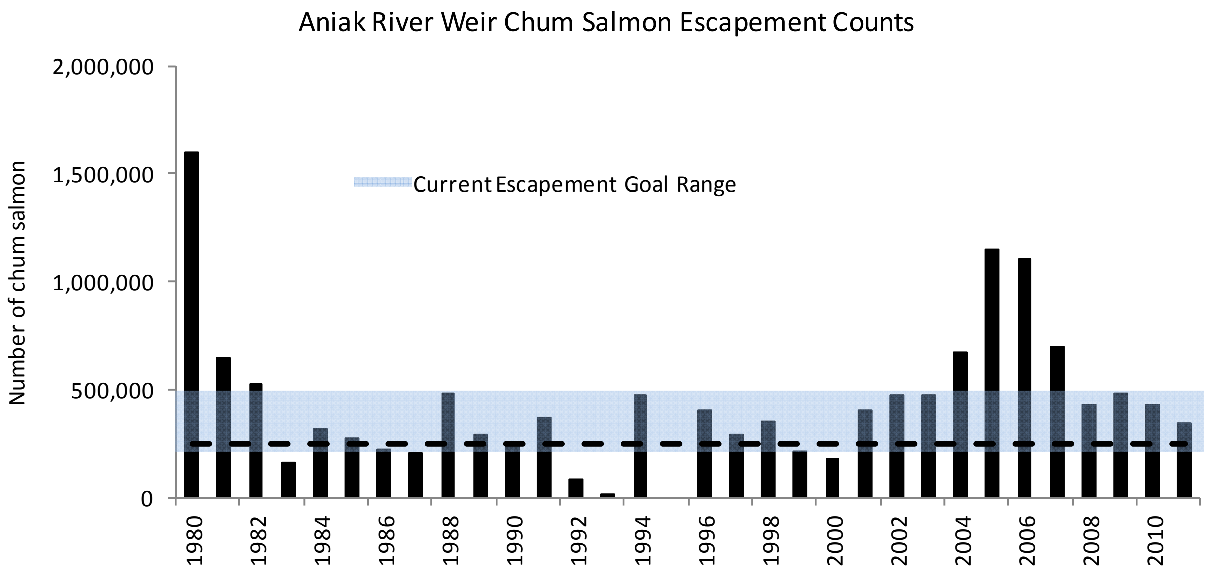


Figure A6-9. Chum salmon escapement index at the Aniak River Sonar site, 1980-2011 with the escapement goal range (220,000-480,000) adopted in 2007, and the minimum escapement goal (250,000) used from 1983 to 2004.

A6.1.2.2 Kuskokwim Bay Assessment

The Kuskokwim Bay in southwest Alaska is approximately 160 km wide by 160 km long and includes all waters from Cape Newenham to Cape Avinof. The primary salmon spawning tributaries are the Kuskokwim, Kanektok, Arolik, and Goodnews rivers. For management purposes Kukokwim Bay refers to the Kanektok, Arolik, and Goodnews Rivers. These drainages produce Chinook (*Oncorhynchus tshawytscha)*, chum (*O. keta)*, sockeye (*O. nerka)*, pink *(O. gorbuscha)*, and coho salmon (*O. kisutch)*.

Kuskokwim Bay supports commercial, subsistence, and sport fisheries harvesting predominately Chinook, sockeye, chum, and coho salmon. Although some pink salmon are harvested, there is no directed interest in harvest. While the commercial fishery is confined to the identified commercial fishing districts, the subsistence and sport fisheries occur within the commercial fishing districts and within the Kanektok, Arolik, and Goodnews Rivers.

Kuskokwim Bay chum salmon are harvested incidentally to sockeye salmon directed commercial fisheries in Districts 4 and 5. There is also a small subsistence harvest of chum salmon in Goodnews Village, Platinum, and Quinhagak, but these are likely harvested incidentally to Chinook and sockeye salmon.

Escapement

Kuskokwim Bay chum salmon start entering the rivers in late June and continue through early August. Chum salmon spawn throughout the Kanektok, Arolik, and Goodnews River drainages. Escapements are monitored using weirs on the Kanektok River and Middle Fork Goodnews River. These weirs observe only a portion of the total escapement into these drainages because of the location of weirs within the drainages. Since 2005 at Kanektok weir, escapement estimates have ranged from 50,908 to 133,215 (Table A6-6). Since 2005 at Middle Fork Goodnews River weir, escapement estimates have ranged from 19,715 to 54,699 (Table A6-6). Aerial surveys for chum salmon have not been flown since 2004.

Table A6-6. Chum salmon escapement at monitoring projects, Kuskokwim Bay, 1981-2011.

Year	Middle Fork Goodnews R. [d] Weir	Kanektok R. Weir
1981	21,827	
1982	6,767	
1983	15,548	
1984	19,003	
1985	10,367	
1986	14,764	
1987	17,517	
1988	20,799	
1989	10,380	
1990	6,410	
1991	31,644	
1992	22,023	
1993	14,952	
1994	34,849 [b]	
1995	33,699	
1996	40,450 [b]	
1997	17,369	
1998	28,832	
1999	19,513	
2000	13,791 [c]	
2001	26,829 [c]	1,056 [a]
2002	30,300	42,009 [c]
2003	21,637	40,066
2004	31,616	46,444
2005	26,690	53,580
2006	54,699	
2007	48,285	133,215
2008	44,310 [b]	54,024 [c]
2009	19,715	51,652 [c]
2010	26,687	62,567
2011	19,974	50,908

[a] Field operations were incomplete and total annual escapement was not estimated.

[b] Field operations were imcomplete; more than 20 percent of the total annual escapement is based on daily passage estimates.

[c] Field operations were incomplete; sum of daily count is an underestimate of total escapement, but considered reasonable. Additional estimates were not made.

[d] Prior to 1991 escapement was estimated at Middle Forl Goodnews River using a tower.

Escapement goals

There are two formal escapement goals for chum salmon in Kuskokwim Bay. There is an aerial survey SEG threshold of greater than 5,200 for Kanektok River and an SEG threshold of greater than 12,000 at the Middle Fork Goodnews River weir. Both of these SEG's were established in 2005. Escapement goals have not been established at the Kanektok River weir because of an insufficient number of escapement estimates (Volk et al., 2009).

The escapement goal for Kanektok River aerial surveys has not been evaluated since it was established because aerial surveys for chum salmon have not been flown since 2004 (Estensen et al., 2009). The escapement goal at the Middle Fork Goodnews River weir has been achieved every year since it was established (Figure A6-10).

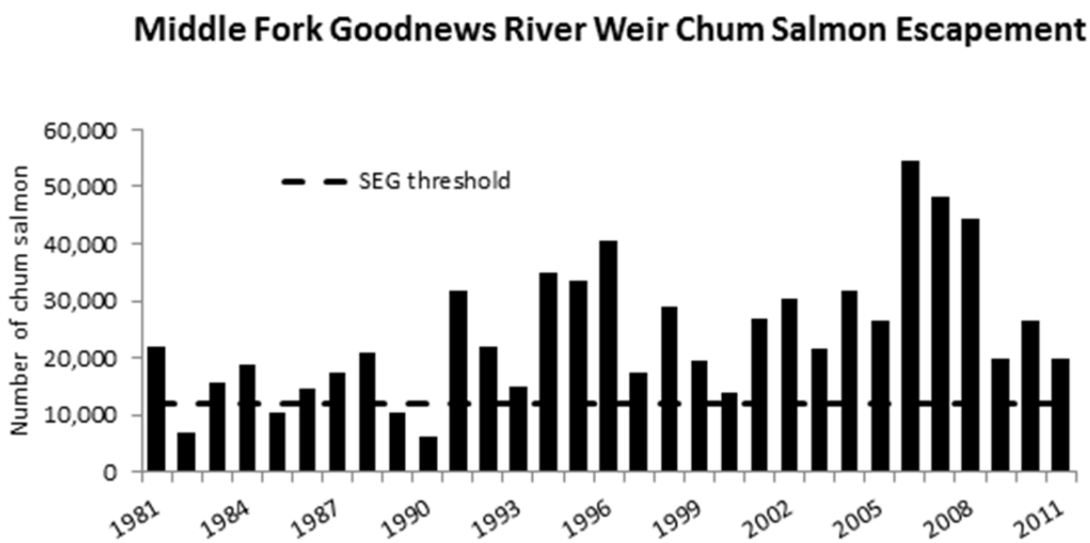


Figure A6-10. Chum salmon escapement, Middle Fork Goodnews River weir, Kuskokwim Bay, 1981-2011.

A6.1.2.3 Kuskokwim Area Chum Commercial Fishery Harvests

Kuskokwim River

Harvest and Exploitation

Historically, Kuskokwim River chum salmon, though an important subsistence species, have been primarily targeted for commercial harvest (Figure A6-7). From 1976 to 1989 the average commercial harvest was 430,868, but from 2000 to 2009 ther average declined to 26,893 due to low market interest in chum salmon and limited local processing capacity. In 2009, there was a modest increase in commercial harvest to 76,790 fish, the largest harvest since 1998, which was the result of improved processing capacity from a new fish processing plant in Platinum. Since 2005, commercial chum salmon harvests have contributed about 2% to the total exvessel value of the District 1 commercial salmon fishery. Preliminary run reconstruction information indicates the total in-river exploitation rate of chum salmon in 2009 was approximately 12%, compared to the recent 10-year average of 9% (Figure A6-7; Bue et al. 2008). Through the mid-1990s exploitation rates likely ranged between 20% and 60%.

2011 Summary

Chum salmon escapements were evaluated through enumeration at weirs on seven tributary streams and a tributary sonar project on the Aniak River. Overall, chum salmon escapements in 2011 were above average. Chum salmon escapement to the Kogrukluk River exceeded the upper end of the escapement goal, and reached the midpoint of the escapement goal range for the Aniak River. Chum salmon run timing was late. Commercial harvest on the Kuskokwim River in 2011 was 118,256 chum salmon, which was the largest harvest since 1998 (Table A6-7). A total of 413 individual permit holders recorded landings in District 1 of the Kuskokwim River during the 2011 season. This level of fishing effort was 9.5 percent above the recent 10-year average of 377 fishermen.

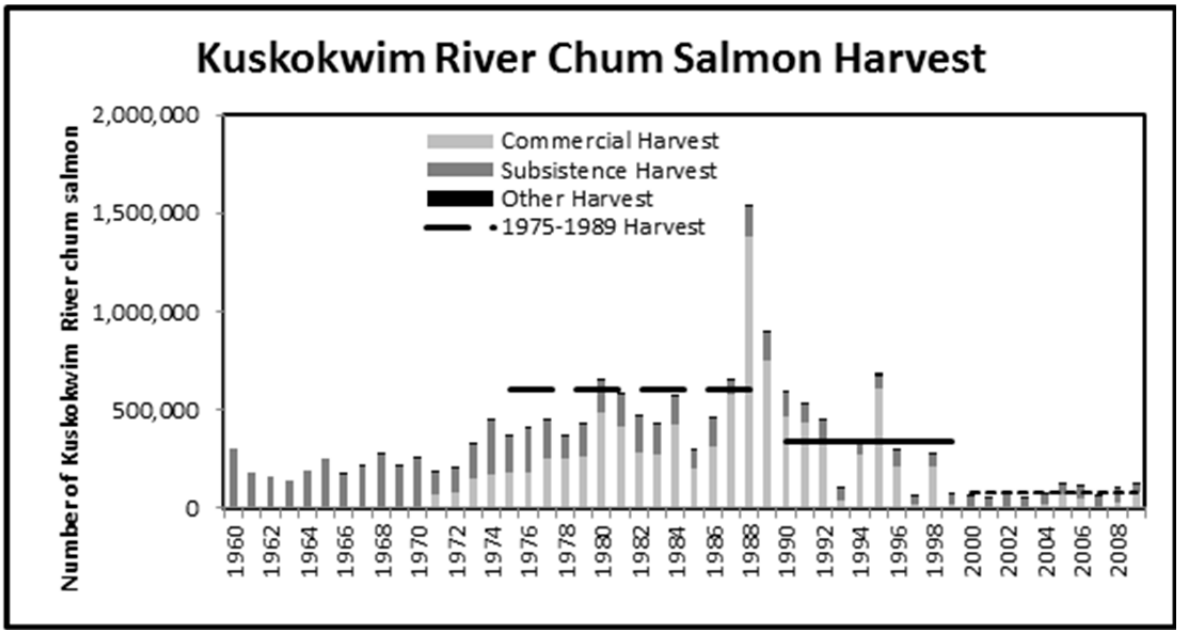


Figure A6-11. Kuskokwim River chum salmon harvest, from commercial, subsistence, test, and sport fisheries, 1960-2009, with approximately decadal average harvest ranges.

Table A6-7 Chum salmon harvests, Kuskokwim River Area, 1960–2011.

Year	Commercial Harvest[a]	Subsistence Harvest[b]	Test-Fish Harvest	Sport Fish Harvest	Total Harvest
1960	0	301,753 [c]			301,753
1961	0	179,529 [c]			179,529
1962	0	161,849 [c]			161,849
1963	0	137,649 [c]			137,649
1964	0	190,191 [c]			190,191
1965	0	250,878 [c]			250,878
1966	0	175,735 [c]	502 [d]		176,237
1967	148	208,445 [c]	338		208,931
1968	187	275,008 [c]	562		275,757
1969	7,165	204,105 [c]	384		211,654
1970	1,664	246,810 [c]	1,139 [d]		249,613
1971	68,914	116,391 [c]	254		185,559
1972	78,619	120,316 [c]	486		199,421
1973	148,746	179,259 [c]	675		328,680
1974	171,887	277,170 [c]	2,021		451,078
1975	184,171	176,389 [c]	1,062		361,622
1976	177,864	223,792 [c]	2,101		403,757
1977	248,721	198,355 [c]	576	129	447,781
1978	248,656	118,809 [c]	2,153	555	370,173
1979	261,874	161,239 [c]	412	259	423,784
1980	483,751	165,172 [c]	2,058	324	651,305
1981	418,677	157,306 [c]	1,793	598	578,374
1982	278,306	190,011 [c]	504	1125	469,946
1983	276,698	146,876 [c]	1,069	922	425,565
1984	423,718	142,542 [c]	1,186	520	567,966
1985	199,478	94,750	616	150	294,994
1986	309,213	141,931 [c]	1,693	245	453,082
1987	574,336	70,709	2,302	566	647,913
1988	1,381,674	151,967 [e]	4,379	764	1,538,784
1989	749,182	139,672	2,082	2,023	892,959
1990	461,624	126,509	2,107	533	590,773
1991	431,802	93,077	931	378	526,188
1992	344,603	96,491	15,330	608	457,032
1993	43,337	59,394	8,451	359	111,541
1994	271,115	72,022	11,998	1,280	356,415
1995	605,918	67,861	17,473	226	691,478
1996	207,877	88,966	2,864	280	299,987
1997	17,026	39,987	790	86	57,889
1998	207,809	63,537	1,140	291	272,777
1999	23,006	43,601	562	180	67,349
2000	11,570	51,696	1,038	26	64,330
2001	1,272	49,874	1,743	112	53,001
2002	1,900	69,019	2,666	53	73,638
2003	2,764	43,320	1,713	67	47,864
2004	20,429	52,374	1,810	117	74,730
2005	69,139	46,036	4,459	608	120,242
2006[f]	44,070	57,024	3,547	144	104,784
2007	10,783	51,308	3,237	424	65,752
2008	30,798	50,012 [f]	2,473	272 [f]	83,555
2009	76,790	50,012 [f]	2,741	272 [f]	129,815
2010	93,148	na	na	na	
2011	118,256	na	na	na	
5-yr avg	65,955	50,444	3,105	323	93,041
10-yr avg	46,808	52,388	2,325	245	87,548

[a] Districts 1 and 2 only; no chum harvests were reported in District 3.
[b] Estimated subsistence harvest expanded from villages surveyed.
[c] Includes small numbers of small Chinook, sockeye, and coho salmon.
[d] Includes small numbers of sockeye.
[e] Beginning in 1988, estimates based on a new formula. Data since 1988 is not comparable with previous years.
[f] 2008 and 2009 subsistence and sport harvest based on most recent 5-year average (2003–2007).

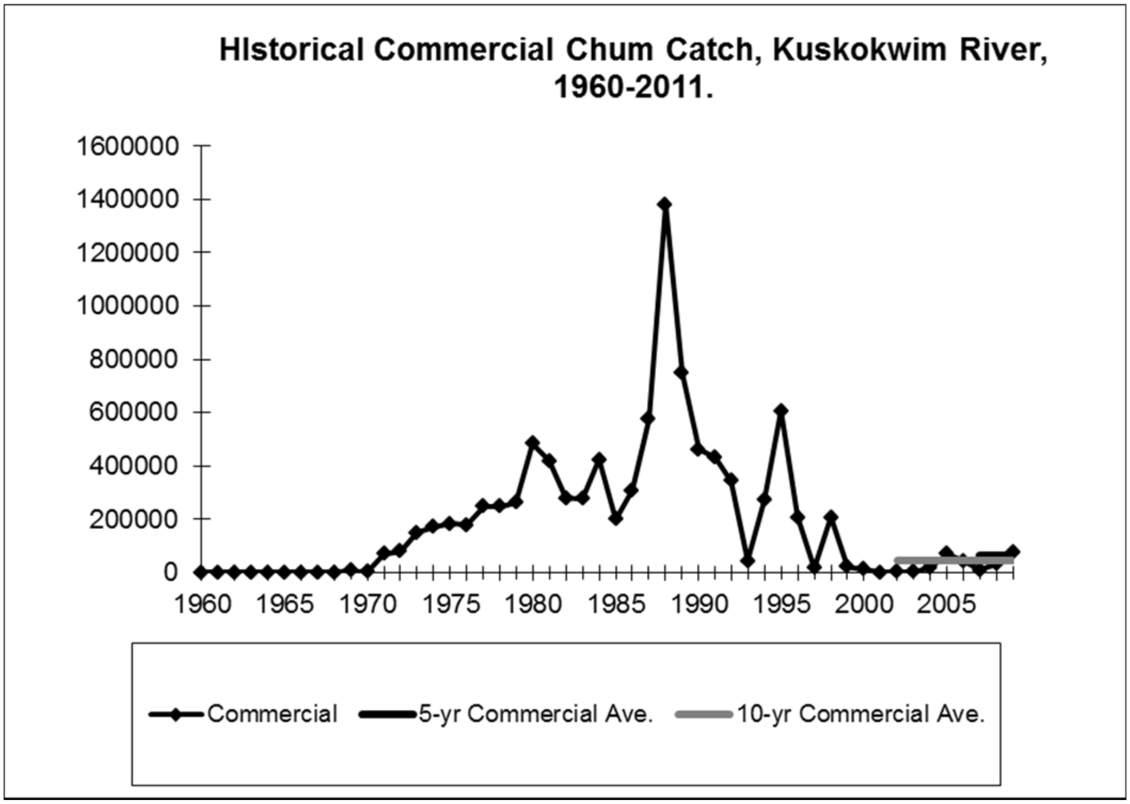


Figure A6-12 Kuskokwim River commercial chum salmon catch, 1960-2011. Source: Data provided to NMFS by ADF&G, in 2011, in response to a special data request.

Table A6-8 provides the real (inflation adjusted) value of commercial Chinook salmon harvest compared to total value of Kuskokwim Area commercial salmon harvest from 1993 through 2011. Over this time, real Chum value peaked in 1995 at $973,695, when it represented 26 percent of the overall real value. The decline in catch, combined with declining salmon prices in the late 1990s and early 2000s depressed overall chum value to $1,000 in 2001. Chum catch and value improved slowely thorugh the 200s and from 2008 to 2011, chum catches rose from just over 30,000 fish to 118,256 fish with 2011 value at $350,124. The 2011 value represented more than 45 percent of total value due to declines in Chinook catch and value. The remaining value is mostly derived from coho catches with sockeye providing the remainder of the total value.

Table A6-8 Salmon harvests and real (inflation adjusted) value by species, Kuskokwim River, 1993–2011.

Year	Chinook		Sockeye		Chum		Coho		Total	
	Number	Value	Number	Value	Number	Chum Value	Number	Value	Number	Total Value
1993	8,735	$101,817	27,008	$196,181	43,337	$158,005	610,739	$3,552,736	689,883	$4,008,821
1994	16,211	$174,144	49,365	$258,956	271,115	$523,755	724,689	$3,946,704	1,092,310	$4,915,866
1995	30,846	$376,811	92,500	$602,993	605,918	$973,695	471,461	$1,766,163	1,201,060	$3,719,728
1996	7,419	$31,220	33,878	$128,201	207,877	$225,564	937,299	$2,407,238	1,188,094	$2,793,205
1997	10,441	$47,762	21,989	$84,163	17,026	$25,291	130,803	$2,809,881	180,261	$2,967,099
1998	17,359	$95,355	60,906	$269,016	207,809	$234,978	210,481	$661,482	496,647	$1,260,901
1999	4,705	$28,129	16,976	$109,203	23,006	$20,754	23,593	$56,385	68,282	$214,471
2000	444	$3,764	4,130	$17,648	11,570	$9,851	261,379	$605,461	277,530	$636,728
2001	90	$646	84	$320	1,272	$1,000	192,998	$510,980	194,444	$512,946
2002	72	$252	84	$233	1,900	$1,416	83,463	$148,461	85,519	$150,362
2003	158	$985	282	$935	2,764	$1,266	284,064	$524,720	287,268	$527,907
2004	2,300	$11,118	9,748	$22,144	20,429	$7,489	433,807	$1,028,289	466,284	$1,069,039
2005	4,784	$31,832	27,645	$119,549	69,139	$25,338	142,319	$315,291	243,887	$492,010
2006	2,777	$17,189	12,618	$44,470	44,070	$15,911	185,598	$401,613	245,064	$479,184
2007	179	$1,657	703	$2,486	10,763	$3,128	141,049	$385,460	152,694	$392,731
2008	8,865	$71,639	15,601	$60,325	30,156	$11,315	142,877	$399,963	197,859	$543,246
2009	6,664	$61,452	25,673	$101,445	76,790	$76,494	104,546	$263,457	213,675	$502,848
2010	2,731	$53,134	22,438	$167,575	93,148	$162,445	58,031	$382,452	176,338	$765,606
2011	49	$411	13,482	$79,370	118,256	$350,124	74,108	$224,452	205,896	$764,357
5-yr avg	3,698	$37,659	15,579	$82,240	65,823	$120,701	104,122	$331,157	189,292	$593,758
10-yr avg	2,858	$24,967	12,827	$59,853	46,742	$65,492	164,986	$407,416	227,448	$568,729

NOTE: Pink have been omitted due to extremely low numbers in the past decade.

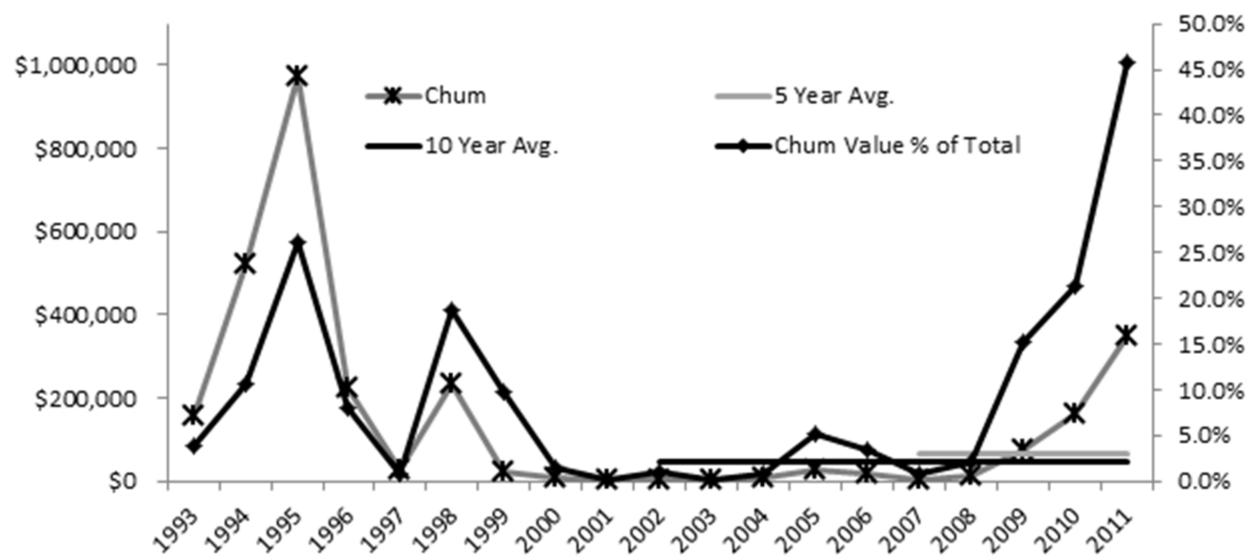


Figure A6-13 Real Kuskokwim River Chum commercial value relative to total value, 1993-2011
Source: Derived from data provided to NMFS by ADF&G in response to a special data request.

Kuskokwim Bay

Harvest

Historically, Kuskokwim Bay chum salmon harvests were at a low in 1985; average to above average from 1987 to 1999; and below average from 2000 to 2005, with 2005 experiencing the minimum harvest of 13,529 and 2,568 in Districts 4 and 5, respectively. Harvests have increase since 2005 (Figure A6-14).

2011 Summary

The 2011 commercial fishing season began on June 20 in Distric 4 and on June 27 in District 5. Both Districts were closed on August 26. A total of 104,959 and 13,191 chum salmon were harvested in Districts 4 and 5, respectively. Chum salmon harvest rates in both areas were above average. Total value was $603,855 in District 4. Total value of the District 5 chum salmon fishery was $78,980 (Table A6-9).

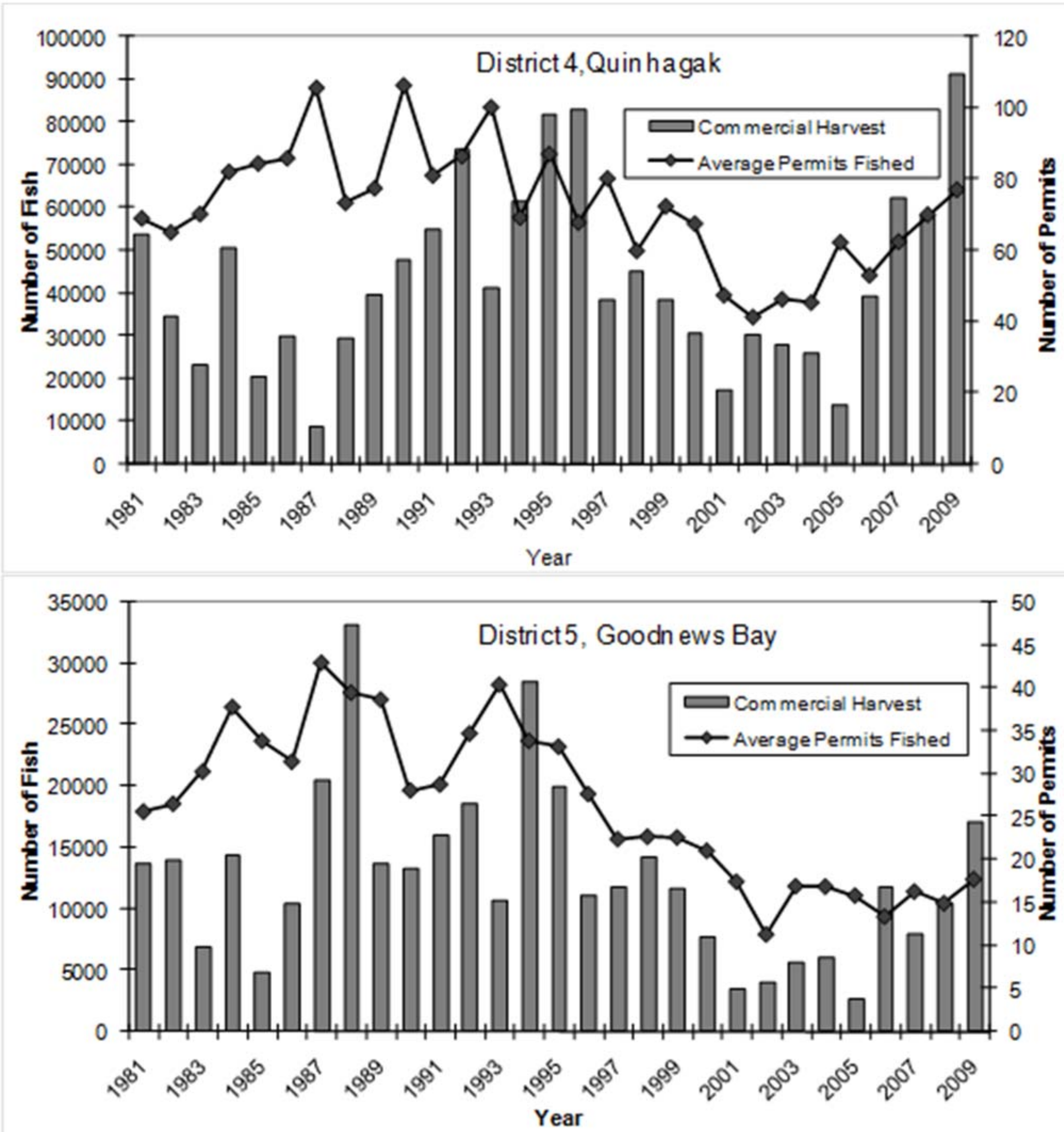


Figure A6-14. Commercial harvest of chum salmon and fishing effort, Districts 4 and 5, Kuskokwim Bay, 1981-2009.

Total commercial harvest for the entire Kuskokwim area in 2011 was 17,528 Chinook; 76,598 sockeye, 119,923 coho; and 236,406 chum salmon. Chum salmon harvests were above the recent 10-year average, while Chinook, coho, and sockeye salmon harvest was below the recent 10-year average. The 2010 chum salmon harvest was the highest since 1998 (Figure A6-15). Total ex-vessel value of the fishery was $682,835 (Table A6-10).

Table A6-9 Commercial salmon harvests, Kuskokwim Bay, Areas 4 and 5: 1990–2011.

	District W-4 (Quinhagak)				District W-5 (Goodnews Bay)				Total
Year	Chinook	Sockeye	Coho	Chum	Chinook	Sockeye	Coho	Chum	Harvest
1975	3,928	8,584	10,742	35,233	2,156	9,098	17,889	5,904	41,137
1976	14,110	6,090	13,777	43,659	4,417	5,575	9,852	10,354	54,013
1977	19,090	5,519	9,028	43,707	3,336	3,723	13,335	6,531	50,238
1978	12,335	7,589	20,114	24,798	5,218	5,412	13,764	8,590	33,388
1979	11,144	18,828	47,525	25,995	3,204	19,581	42,098	9,298	35,293
1980	10,387	13,221	62,610	65,984	2,331	28,632	43,256	11,748	77,732
1981	24,524	17,292	47,551	53,334	7,190	40,273	19,749	13,642	66,976
1982	22,106	25,685	73,652	34,346	9,476	38,877	46,683	13,829	48,175
1983	46,385	10,263	32,442	23,090	14,117	11,716	19,660	6,766	29,856
1984	33,633	17,255	132,151	50,422	8,612	15,474	71,176	14,340	64,762
1985	30,401	7,876	29,992	20,418	5,793	6,698	16,498	4,784	25,202
1986	22,835	21,484	57,544	29,700	2,723	25,112	19,378	10,355	40,055
1987	26,022	6,489	50,070	8,557	3,357	27,758	29,057	20,381	28,938
1988	13,883	21,556	68,605	29,220	4,964	36,368	30,832	33,059	62,279
1989	20,820	20,582	44,607	39,395	2,966	19,299	31,849	13,622	53,017
1990	27,644	83,681	26,926	47,717	3,303	35,823	7,804	13,194	60,911
1991	9,480	53,657	42,571	54,493	912	39,838	13,312	15,892	70,385
1992	17,197	60,929	86,404	73,383	3,528	39,194	19,875	18,520	91,903
1993	15,784	80,934	55,817	40,943	2,117	59,293	20,014	10,657	51,600
1994	8,564	72,314	83,912	61,301	2,570	69,490	47,499	28,477	89,778
1995	38,584	68,194	66,203	81,462	2,922	37,351	17,875	19,832	101,294
1996	14,165	57,665	118,718	83,005	1,375	30,717	43,836	11,093	94,098
1997	35,510	69,562	32,862	38,445	2,039	31,451	2,983	11,729	50,174
1998	23,158	41,382	80,183	45,095	3,675	27,161	21,246	14,155	59,250
1999	18,426	41,315	6,184	38,091	1,888	22,910	2,474	11,562	49,653
2000	21,229	68,557	30,529	30,553	4,442	37,252	15,531	7,450	38,003
2001	12,775	33,807	18,531	17,209	1,519	25,654	9,275	3,412	20,621
2002	11,480	17,802	26,695	29,252	979	6,304	3,041	3,799	33,051
2003	14,444	33,941	49,833	27,868	1,412	29,423	12,658	5,593	33,461
2004	25,465	34,627	82,398	25,820	2,565	20,922	23,690	6,014	31,834
2005	24,195	68,801	51,708	13,529	2,035	23,933	11,735	2,568	16,097
2006	19,004	106,424	26,831	39,191	2,899	29,858	12,561	11,678	50,869
2007	19,575	109,517	34,710	62,232	3,126	43,766	13,697	7,853	70,085
2008	13,812	69,776	95,073	57,663	1,278	27,237	22,547	10,408	68,071
2009	13,920	112,153	48,115	91,158	1,509	32,544	8,406	16,985	108,143
2010	14,230	138,362	13,960	106,610	1,752	41,074	4,900	26,914	133,524
2011	15,387	38,543	30,457	104,959	2,092	24,573	15,358	13,191	118,150
5-yr avg	15,385	93,670	44,463	84,524	1,951	33,839	12,982	15,070	99,595
10-yr avg	17,151	72,995	45,978	55,828	1,965	27,963	12,859	10,500	66,329

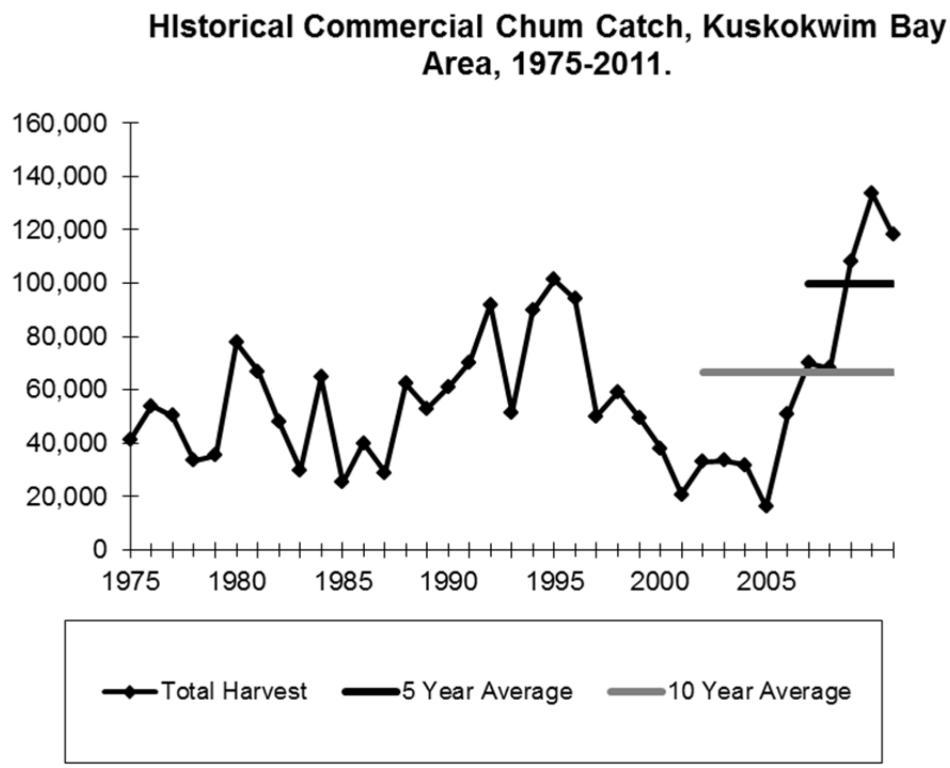


Figure A6-15 Kuskokwim Bay commercial chum salmon catch, 1960-2011.

Table A6-10 Kuskokwim Bay real value of commercial chum salmon catch, 1960–2011.

Year	District 4 (Quinhagak)	District 5 (Goodnews Bay)	Chum Total Value	Kuskokwim Bay Total	Chum Percent of Total Value
1990	$135,640	$39,119	$174,759	$2,086,203	8%
1991	$155,891	$46,031	$201,921	$1,271,738	16%
1992	$199,468	$56,017	$255,485	$2,003,888	13%
1993	$147,467	$39,662	$187,129	$1,876,882	10%
1994	$115,822	$56,692	$172,514	$2,040,602	8%
1995	$140,518	$28,806	$169,324	$1,792,840	9%
1996	$81,380	$11,893	$93,273	$999,098	9%
1997	$38,384	$12,131	$50,516	$803,674	6%
1998	$46,785	$14,271	$61,056	$835,925	7%
1999	$35,838	$10,520	$46,357	$483,536	10%
2000	$29,589	$7,420	$37,009	$803,221	5%
2001	$15,728	$3,127	$18,855	$395,973	5%
2002	$27,814	$3,545	$31,359	$229,124	14%
2003	$22,437	$4,523	$26,960	$512,150	5%
2004	$20,811	$4,807	$25,618	$612,348	4%
2005	$7,512	$1,594	$9,106	$774,167	1%
2006	$14,894	$4,637	$19,531	$735,084	3%
2007	$21,701	$2,868	$24,569	$910,772	3%
2008	$20,770	$3,946	$24,716	$957,501	3%
2009	$95,993	$18,998	$114,991	$939,356	12%
2010	$194,105	$49,679	$243,784	$956,150	25%
2011	$603,855	$78,980	$682,835	$1,522,458	45%
5-yr avg	$187,285	$30,894	$218,179	$1,057,247	
10-yr avg	$102,989	$17,358	$120,347	$814,911	

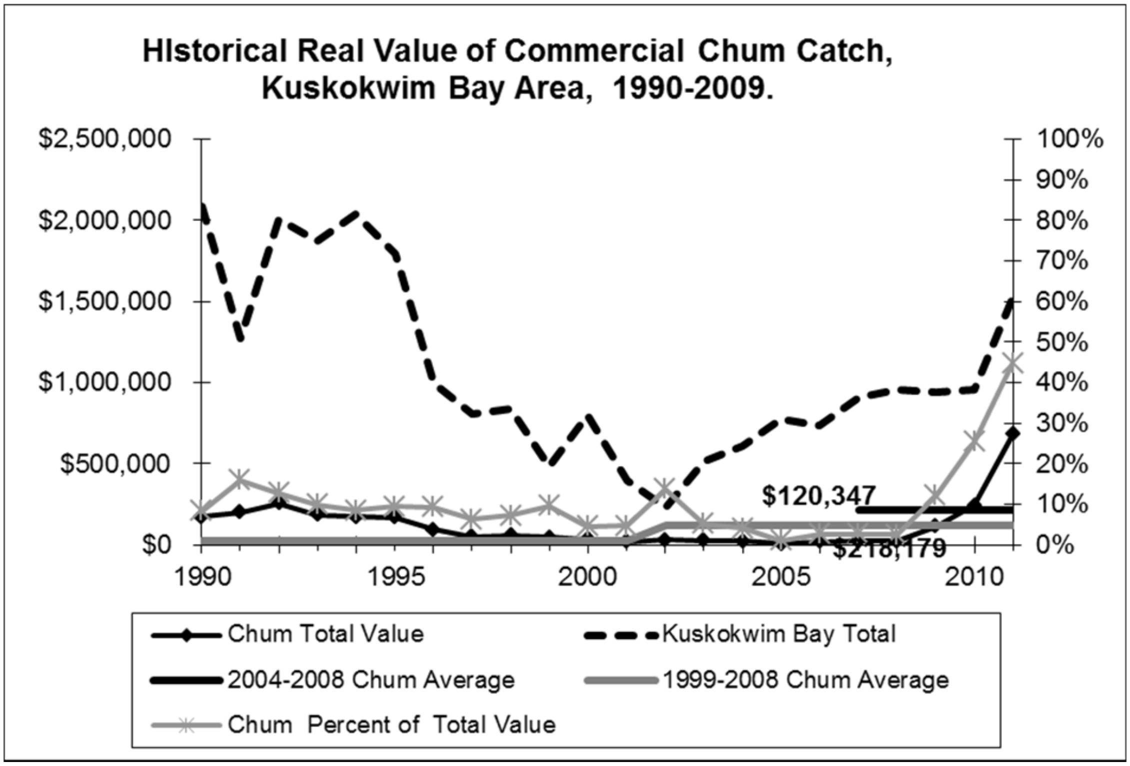


Figure A6-16 Kuskokwim Bay real value of commercial chum salmon catch, 1960-2011.
Source: Data provided to NMFS by ADF&G, in 2010, in response to a special data request.

A6.1.2.4 Kuskokwim Area Chum Salmon Subsistence Harvest[4]

There are 38 communities in the Kuskokwim Management Area, including the central hub city of Bethel. The Kuskokwim Subsistence Salmon Monitoring Program estimates the harvest of subsistence salmon primarily through household surveys and harvest calendars. The Division of Commercial Fisheries began conducting subsistence salmon harvest surveys among Kuskokwim River fishers in the Kuskokwim River drainage in 1960. During the 1980s, funding was insufficient to conduct surveys in all Kuskokwim Area communities; instead, subsets of villages sampled and then these data were expanded to produce an estimate of the salmon harvest by other communities. As such, while information from 1960 to 1988 is available, the data are not necessarily comparable from year to year because the statistical methods used to expand the harvest data and produce total harvest estimates of Kuskokwim Area subsistence salmon were not fully documented (personal communication, Holly Carroll, 2010; see also Simon et al., 2007 and Walker and Coffing, 1993).

The Division of Subsistence assumed responsibility for the Kuskokwim Subsistence Salmon Monitoring Program in 1988 and collected and analyzed subsistence data until 2007. The division developed a stratified household survey program to estimate Kuskokwim subsistence salmon harvests by community. Subsistence salmon harvests were estimated based on the total number of households in a community, not just the number of fishing households as in the previous method. Households in the Kuskokwim Area are assigned a "household identification number" (HHID) to aid in tracking a household's subsistence harvest over time. Not only are households that "usually fish" tracked on an annual basis, but households that "usually do not fish" and "unknown" households are also tracked annually as well as sampled during postseason harvest monitoring activities. This stratified method of estimating total community harvest

[4] An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

results in more complete data for all salmon species harvested for most communities in the Kuskokwim Area. When compared to the new method, the previous method significantly overestimated subsistence salmon harvests, due likely to the overemphasis on fishing households in the reporting of harvest information (personal communication, Holly Carroll, 2010; see also Simon et al., 2007 and Walker and Coffing, 1993).

In 2007, Subsistence Division ran an abbreviated version of the monitoring program with limited funding. In 2008, the Division of Commercial Fisheries reacquired supervision of the program in the Kuskokwim Area in order to continue the collection of this information that is important for managing the subsistence as well as the commercial and sport salmon fisheries in the Kuskokwim Area (personal communication, Holly Carroll, 2010). Given the history of differing methodologies used for estimating subsistence salmon harvest in the Kuskokwim Management Area, harvest numbers presented in this section are estimates only and cannot be compared to one another across the time series.[5]

The four primary objectives of the 2008 Kuskokwim Area postseason subsistence salmon harvest monitoring program included: 1) estimating the number of salmon harvest for subsistence by residents of Bethel; 2) estimating the number of salmon harvested for subsistence by residents of Aniak; 3) placing the Bethel and Aniak estimates within the context of the harvest estimates for the entire Kuskokwim Fisheries Management Area; and 4) where applicable, generation of estimated harvest for uncontacted communities. In 2008, subsistence salmon harvest data collection in Bethel was conducted by staff from the Orutsararmuit Native Council (ONC). ONC staff have been involved in subsistence salmon harvest monitoring in Bethel since 1999. Subsistence harvest data collection in Aniak was conducted by staff from the Kuskokwim Native Association (KNA). KNA staff have been involved in subsistence salmon harvest monitoring in Aniak since 2002 (Fall et al 2011).

Subsistence salmon harvest by Bethel residents was estimated by employing a simple random harvest survey method. The population of Bethel is highly fluid; therefore, it is difficult to maintain an accurate and complete household list. Subsistence salmon harvest of Aniak residents was estimated by employing a stratified random harvest survey method. Compared to Bethel, Aniak is small and there is less change among households. In both locations, ADF&G Commercial Fisheries Division was responsible for designing and producing the survey instrument and either ONC or KNA was responsible for conducting household surveys (Fall et al., 2011).

For the remaining 36 communities in the Kuskokwim Area, annual subsistence harvest surveys were conducted by ADF&G Commercial Fisheries staff from October through December. The survey design in each community was either a census (100% survey) or a stratified random sample, depending on community size. Every effort is made to survey all communities; however, there are several communities who refuse to participate. As such, they are not included in harvest estimates (Fall et al., 2011).

In addition to household surveys, subsistence salmon harvest calendars were mailed in late April or early May so that they were available to fishers prior to the start of the salmon fishing season. Calendar data is instrumental for examination of subsistence salmon harvest timing. Most subsistence salmon harvest data obtained from returned calendars are not used to directly calculate Kuskokwim Area subsistence salmon harvest estimates, but these data are used to corroborate household survey data.

From an estimated 4,734 households located in the Kuskokwim Area, contact was made with 992 unique households by household surveys among 23 communities. From this total, 577 households were identified

[5]ADF&G Division of Commercial Fisheries staff are currently involved in a project designed to revise historical harvest estimates to align them with the current monitoring methodology used. Project efforts include the use of statistical modeling to integrate the various datasets in order to provide estimates of historical run abundance.

as having subsistence fished for salmon in 2008, which represents a substantial decrease in the estimated proportion of Kuskokwim Area households engaged in subsistence fishing from previous harvest monitoring efforts (may be due to methodological shifts). Despite attempts to estimate subsistence salmon harvests where no household contact has been made, insufficient data exists and Kuskokwim Management Area subsistence harvest totals should be viewed as estimates only based on expanded harvest data (Fall et al., 2011).

The Kuskokwim River drainage (including North Kuskokwim Bay communities) represents 85% of the estimated total number of households in the entire Kuskokwim area and 91% of the identified subsistence fishing households. In the South Kuskokwim Bay region (Quinhagak, Goodnews Bay, and Platinum), 20% of households contacted were estimated to have subsistence fished in 2008, with 70% of those having harvested salmon for subsistence uses. Data from the Bering Sea coastal communities are limited , but harvest activity by households in the Bering Sea coastal communities is believed to be much greater than what the available data documents (Fall et al., 2011).

The Kuskokwim area subsistence salmon fishery is one of the largest in the state. From June through August, daily activities of many Kuskokwim area households revolve around harvesting, processing, and preserving salmon and non-salmon fishes for subsistence uses. Table A6-11 below lists subsistence salmon harvest by community in the Kuskokwim Management Area for 2008. The movement of families from permanent winter residences to summer fish camps situated along rivers and sloughs continues to be a significant element of the annual subsistence harvest effort in this area, even though many subsistence salmon fishers also fish directly from their home community. Division of Subsistence studies in the region indicate that fish (salmon and non-salmon) contribute 67% to 85% of the total wild resource harvest (in pounds) in a community, and salmon contribute 49% to 53% of the total pounds of fish and wildlife harvested in this area. The harvest of salmon for subsistence ranges from 241 usable pounds per person in some communities (e.g., Nunapitchuk, 1983) to 446 pounds per person (e.g., Kwethluk, 1986) and 649 pounds per person (e.g., Akiachak, 1998) in other Kuskokwim River communities (Andrews 1989, 1994; Coffing 1991; Coffing et al. 2001).

Table A6-11 Subsistence salmon harvests by community, Kuskokwim Area, 2008.

	Households		Estimated Salmon Harvests					
Community	Total	Contacted	Chinook	Sockeye	Coho	Chum	Pink	Total
Kipnuk	128	0	–	–	–	–	–	–
Kwigillingok	71	0	–	–	–	–	–	–
Kongiganak	83	22	2,086	1,347	551	1,592	0	5,576
North Kuskokwim Bay	**282**	**22**	**2,086**	**1,347**	**551**	**1,592**	**0**	**5,576**
Tuntutuliak[a]	92	0	4,420	2,226	3,238	4,655	–	14,539
Eek[a]	85	0	2,826	693	1,307	725	–	5,551
Kasigluk	98	30	2,928	1,230	917	1,677	0	6,752
Nunapitchuk[a]	111	0	4,361	2,410	648	5,057	–	12,476
Atmautluak[a]	66	0	1,868	1,406	403	2,428	–	6,105
Napakiak	90	32	2,183	1,630	1,383	1,809	0	7,005
Napaskiak	101	29	4,963	2,684	717	2,857	0	11,221
Oscarville	19	8	1,351	677	62	836	5	2,931
Bethel	1,981	446	35,205	18,016	16,998	18,660	178	89,057
Kwethluk	156	33	8,303	5,045	7,058	5,871	291	26,568
Akiachak	148	37	9,475	4,700	4,098	4,027	118	22,418
Akiak	75	25	3,493	2,539	1,276	2,949	47	10,304
Tuluksak	78	24	3,425	2,305	788	4,016	77	10,611
Lower Kuskokwim	**3,100**	**664**	**84,801**	**45,561**	**38,893**	**55,567**	**716**	**225,538**
Lower Kalskag	89	17	2,442	1,736	95	2,030	111	6,414
Kalskag (Upper)	52	20	2,241	961	1,939	1,751	68	6,960
Aniak	177	97	3,252	1,796	3,013	2,839	2	10,902
Chuathbaluk	38	12	785	379	554	606	0	2,324
Middle Kuskokwim	**356**	**146**	**8,720**	**4,872**	**5,601**	**7,226**	**181**	**26,600**
Crooked Creek	39	17	598	785	1,865	970	0	4,218
Red Devil	18	7	152	379	335	171	5	1,042
Sleetmute	31	13	644	1,071	210	346	14	2,285
Stony River	19	9	667	1,679	521	1,403	106	4,376
Lime Village[a]	12	0	59	1,180	624	452	–	2,315
McGrath	119	25	573	1,292	178	1,247	0	3,290
Takotna	25	0	0	0	0	0	–	0
Nikolai	27	15	221	16	63	65	0	365
Telida	2	0	–	–	–	–	–	–
Upper Kuskokwim	**292**	**86**	**2,914**	**6,402**	**3,796**	**4,654**	**125**	**17,891**
Kuskokwim River	**4,030**	**918**	**98,521**	**58,182**	**48,841**	**69,039**	**1,022**	**275,605**
Quinhagak	172	44	4,090	2,714	2,296	1,740	270	11,110
Goodnews Bay	69	20	1,060	3,131	1,491	764	49	6,495
Platinum	17	10	42	156	114	106	0	418
South Kuskokwim Bay	**258**	**74**	**5,192**	**6,001**	**3,901**	**2,610**	**319**	**18,023**
Mekoryuk	63	0	–	–	–	–	–	–
Newtok	79	0	–	–	–	–	–	–
Nightmute	50	0	–	–	–	–	–	–
Toksook Bay	114	0	–	–	–	–	–	–
Tununak	61	0	–	–	–	–	–	–
Chefornak	79	0	–	–	–	–	–	–
Bering Sea Coast	**446**	**0**	**–**	**–**	**–**	**–**	**–**	**–**
Total	**4,734**	**992**	**103,713**	**64,183**	**52,742**	**71,649**	**1,341**	**293,628**

Table 5-23 cont.

Source: ADF&G Division of Commercial Fisheries (2009). Preliminary results as of January 3, 2011.

Note: Includes harvests using rod and reel and the removal of salmon from commercial harvests as well as subsistence nets.

[a]These communities were not contacted during the 2008 study period, therefore the total harvest was estimated using Bayesian multiple imputation method.

[b]These communities were not contacted during the 2008 study period. Not enough data were available to estimate harvest.

– Data not available.

Chum salmon subsistence harvest estimates for 2008 were 71,649 fish out of an all salmon species[6] total of 292,287 fish (Table A6-12). Average annual subsistence harvest for the most recent five years is approximately 50,000 chum salmon and harvest has been within or above ANS every year since 1990 (Fall et al., 2011).

In 2008, estimates of subsistence salmon harvest for communities contacted in the Kuskokwim Area totaled 24% of the total subsistence salmon harvested (Figure A6-17). These estimates fall above the most recent five year averages for all species of salmon, with the exception of pink salmon. Table A6-12 below highlights historical subsistence chum salmon harvests for the Kuskokwim Area. Lower Kuskokwim River communities accounted for 77% of the 2008 estimated subsistence salmon harvests in the Kuskokwim Area. Residents of Bethel accounted for 30% of the Kuskokwim Area subsistence salmon harvests (Fall et at., 2011).

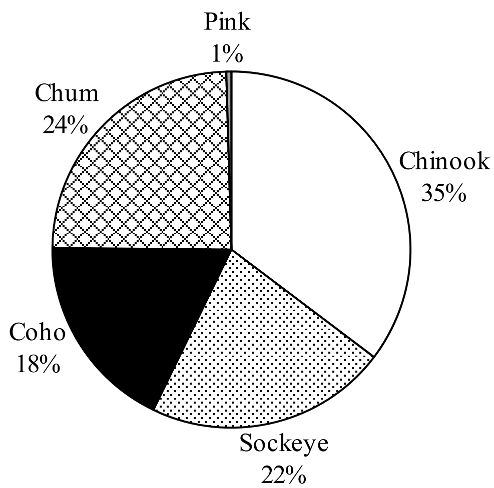


Figure A6-17 Kuskokwim Area subsistence salmon harvest composition, 2008.
Source: Fall et al., 2011.

[6] Pink salmon are not included in these data. ADF&G has only recently begun monitoring pink salmon in the Kuskokwim area; therefore, historical comparisons are not yet possible.

Table A6-12 Estimated historical subsistence chum salmon harvest, Kuskokwim Area, 1989-2008.

	Households		Estimated Salmon Harvest				
Year	Total	Surveyed	Chinook	Sockeye	Coho	Chum	Total
1989	3,422	2,135	85,322	37,088	57,786	145,106	325,287
1990	3,317	1,830	92,675	39,659	50,708	131,470	314,513
1991	3,347	2,024	90,226	56,401	55,620	96,314	298,561
1992	3,314	1,724	68,685	34,158	44,494	99,576	246,914
1993	3,274	1,816	91,722	51,362	35,295	61,724	240,103
1994	3,179	1,821	98,378	39,280	36,504	76,949	251,111
1995	3,652	1,894	100,157	28,622	39,165	68,941	236,885
1996	3,643	1,837	81,597	35,037	34,699	90,239	241,572
1997	3,510	1,831	85,506	41,251	30,717	40,993	198,466
1998	3,495	1,849	86,113	37,579	27,240	67,664	218,595
1999	4,180	2,523	77,660	49,388	27,753	47,612	202,413
2000	4,441	2,750	68,841	44,832	35,670	55,371	204,714
2001	4,483	2,297	77,570	51,965	31,686	51,117	212,338
2002	4,339	2,798	70,219	27,733	34,413	73,234	205,599
2003	4,535	2,375	72,498	36,894	38,791	46,291	194,474
2004	4,670	2,432	85,086	34,892	39,406	55,575	214,959
2005	3,903	1,610	72,174	47,656	36,751	28,838	186,762
2006	4,657	1,514	68,041	34,849	32,809	68,812	204,510
2007	4,618	1,356	72,097	34,578	26,270	53,298	186,243
2008	4,734	992	90,179	56,268	46,522	71,649	251,301
2003-2007 avg	4,477	1,857	73,979	37,774	34,805	50,563	197,121
1998-2007 avg	4,332	2,150	75,030	40,037	33,079	54,781	202,926
1993-2007 avg	4,039	2,047	80,511	39,728	33,811	59,110	213,160
1989-2007 avg	3,894	2,022	81,293	40,170	37,672	71,533	230,668

Source: Fall et al., 2011.

During 2008, out of 577 contacted fishing households, 438 households reported using drift gillnets for subsistence salmon harvests, 61 reported using setnets, and 70 reported using subsistence rod and reel gear. The most common gear type used in the Kuskokwim Area is the drift gillnet (76% of reporting households). Many households throughout the area also use rod and reel for subsistence fishing. Rod and reel is used by households that may not have access to other gear types, by fishers in areas where other gear types are not as effective or efficient, and to harvest fewer fish when less are sought (Fall et al., 2011).

In 2008, few households reported retaining commercially-caught salmon for subsistence uses. An estimated total of 1,630 salmon were retained from commercial catches, including 182 chum salmon (Fall et al., 2011).

2011 Fishery Update[7]

The 2011 preseason outlook for Chinook salmon was similar to 2010 when the Kuskokwim River Drainage experierienced the lowest estimated total run and spawning escapement on record and not achieving escapement goals for several years in Kuskokwim River tributaries was cause for conservation concern. Several preseason management measures were put into place from June 1 to July 25 to protect Chinook salmon. On June 29 through July 7, 2011, ADF&G restricted subsistence salmon fishing to 6-inch or smaller gillnets in District 1 of the Kuskokwim River drainage in order to conserve Chinook while providing harvest opportunities for more abundant chum and sockeye salmon. Post season subsistence harvest surveys are presently being conducted and subsistence harvest numbers for 2011 are not yet available.

[7] Chum Salmon RIR_IRFA_April 2012 initial review_working draft Feb 2012.doc

Average annual subsistence harvest in Quinhagak has been approximately 1,385 chum salmon annually. Average annual subsistence harvest in Platinum and Goodnews Bay Village has been approximately 350 chum salmon annually.

A6.1.2.5 Kuskokwim Sport and Personal Use Fisheries

Currently there are no personal use salmon fishing regulations in effect for the Kuskokwim Management Area and most of the Kuskokwim River and Kuskokwim Bay sport fishing effort occurs in the Lower Rivers of the Kuskokwim drainage and in the Goodnews and Kanektok Rivers of Kuskokwim Bay. Most effort is directed at Chinook and coho salmon and rainbow trout. Little sport fishing effort is directed at chum salmon, but there is a small yearly harvest. The amount of effort toward chum salmon catch and harvest is expected to remain similar in subsequent years.

As the Kuskokwim River and Kuskokwim Bay fisheries are not in the same drainage, they are calculated separately. From 2004-2008, the average Kuskokwim River chum salmon harvest in the sport fishery was 286 fish. For same time period 2004-2008, the average Kuskokwim Bay chum salmon harvest in the sport fishery was 88 fish. The total 2008 sport harvest of summer chum salmon in the Kuskokwim River drainage (not including Kuskokwim Bay) was estimated at 121 fish. The 2008 sport fish harvest of chum salmon in Kuskokwim Bay was 141 fish.

Sport fish harvest of chum salmon is minimal in Kuskokwim Bay with the Kanektok River averaging approximately 140 fish annually and Goodnews River averaging less than 25 fish annually.

A6.1.3 Yukon River[8]

The Yukon Area includes all waters of Alaska within the Yukon River drainage and coastal waters from Naskonat Peninsula to Point Romanof, northeast of the village of Kotlik. For management purposes, the Yukon Area is divided into 7 districts and 10 subdistricts (Figure A6-18). Commercial fishing may be allowed along the entire 1,224 miles of Yukon River in Alaska and along the lower 225 miles of Tanana River. Coastal District includes the majority of coastal marine waters within the Yukon Area and is only open to subsistence fishing. Lower Yukon Area (Districts 1, 2, and 3) includes coastal waters of the Yukon River delta and that portion of the Yukon River drainage downstream of Old Paradise Village (river mile 301). Upper Yukon Area (Districts 4, 5, and 6) is the Alaskan portion of the Yukon River drainage upstream of Old Paradise Village.

The Yukon River salmon fishery is among the most complex, in terms of management, in Alaska. The fishery is composed of four stocks; Chinook, summer chum, fall chum, and coho. No directed commercial fishing has occurred for pink *O. gorbuscha* salmon, which overlap in run timing with summer chum salmon. However, sporadic sales of incidental harvests of pink salmon have been documented. ADF&G manages the overall Yukon salmon fishery for escapement needs and, in portions of the region, jointly manages subsistence harvest with the U.S. Fish and Wildlife Service. In addition, the U.S./Canada panel of the Pacific Salmon Treaty annually negotiates escapement objectives for the Canadian portion of the Yukon River. The fishery supports subsistence, personal use, sport, and commercial harvests of salmon. For a complete treatment of the management of this fishery please refer to 2010 Yukon Area Management Report (Estensen et al., 2012)

[8] Information contained in this section taken from: Estensen, J. L., S. Buckelew, D. Green, and D. L. Bergstrom. 2012 Annual management report for the Yukon and Northern Areas, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 12-23, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-23.pdf.

As in other areas of the State, subsistence fishing has highest priority over other uses. ADF&G uses an adaptive management strategy that evaluates run strength in season to determine a harvestable surplus above escapement requirements and subsistence uses. In addition, ADF&G utilizes a subsistence fishery schedule, as well as emergency orders, to ensure adequate subsistence fishing opportunities are made available. There is also a personal use fishery schedule. Commercial openings are made when available surpluses are determined to be available.

Subsistence fishing in portions of the Yukon Area is under dual regulatory authority of Alaska Department of Fish and Game (ADF&G) and U.S. Fish and Wildlife Service (USFWS). Yukon River chum salmon consists of an earlier and typically more abundant summer chum salmon run, and a later fall chum salmon run.

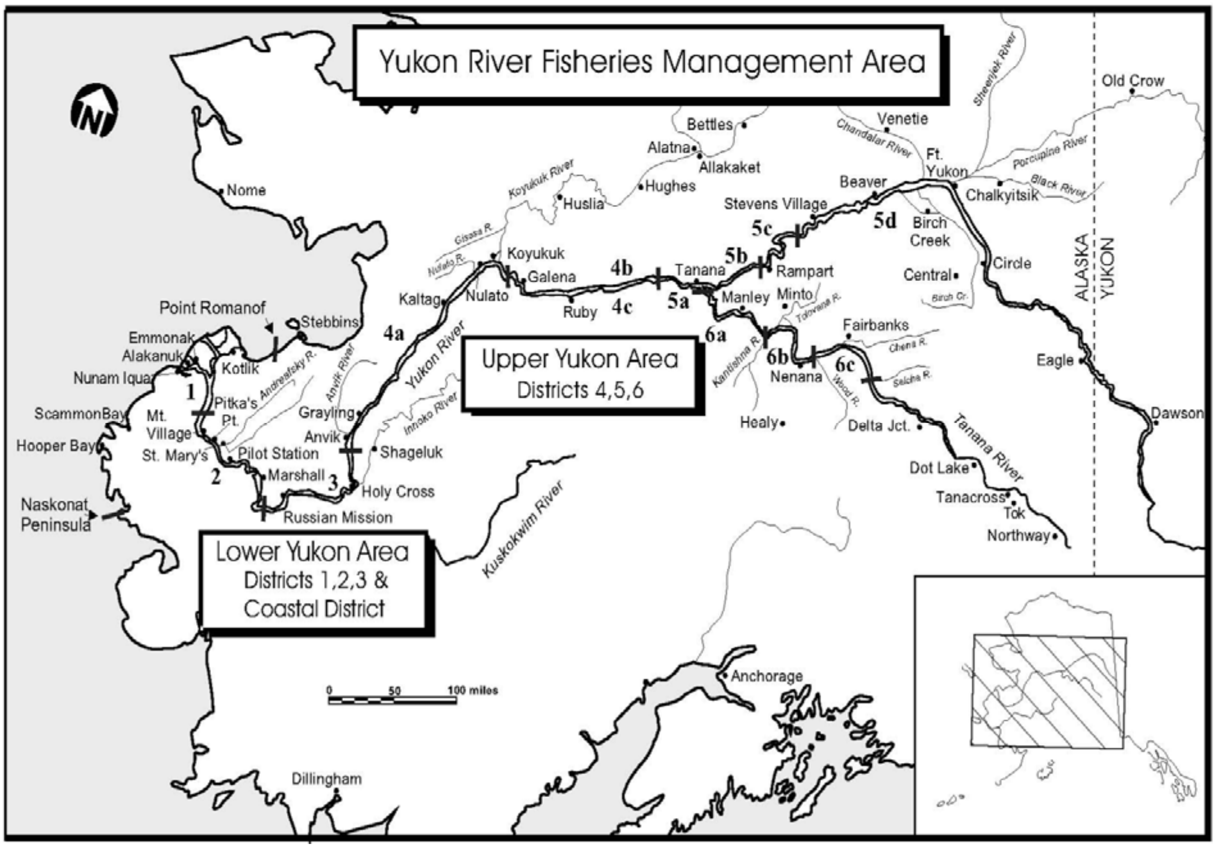


Figure A6-18 Yukon River Fisheries Management Area showing communities and fishing districts.

A6.1.3.1 Yukon Summer Chum Run Assessment

The Yukon River summer chum salmon stock was classified as a management concern in September 2000. This determination of a management concern was based on documented low escapements during 1998–2000 and an anticipated low run in 2001. An action plan was subsequently developed by the department (ADF&G 2000) and enacted by the BOF in January 2001. The classification as a management concern was continued at the January 2004 BOF meeting due to established escapement goals not being achieved in East Fork Andreafsky River from 1998–2003 and in Anvik River in 1998–2001 and 2003 (Salomone and Bergstrom 2004).

Given the collectively large spawning escapements of the Yukon River summer chum salmon stock over the 3 years preceding the January 2007 BOF meeting (2004–2006), including a near record run in 2006, the stock no longer met stock of management concern criteria (Clark et al. 2006). Although Yukon River drainage subsistence and commercial harvests from 1999–2003 were significantly below the 1989–1998 historic baseline average, a near average surplus yield available during 2004–2006 was not taken, primarily due to the lack of commercial markets. Based on definitions provided in the SSFP (5 AAC 39.222(f)(21) and (42)), the BOF discontinued the classification as a stock of concern in January 2007.

Escapement

Most summer chum salmon spawn in the Yukon River drainage downstream of and within the Tanana River drainage (Figure A6-18). The Yukon River summer chum salmon run is typically managed as a single stock for which there is currently a drainagewide OEG of 600,000, measured at Pilot Station sonar, as identified in the regulatory management plan, 5 AAC 05.362. *Yukon River Summer Chum Salmon Management Plan*. An approximate estimate of total run of summer chum salmon in Yukon River can be obtained by summing: (1) the sonar based estimates of summer chum salmon passage at Pilot Station, which successfully estimated summer chum salmon passage in the years 1995 and 1997–2009, (2) total harvest of summer chum salmon in District 1 and that portion of District 2 below the Pilot Station sonar site, and (3) summer chum salmon escapement estimates in East and West forks of Andreafsky River. The estimate is approximate because some commercial and subsistence harvest in District 2 may not be accurately reported by location in relation to the Pilot Station sonar site, the escapement to West Fork Andreafsky is estimated based on the numbers observed in East Fork (Clark 2001), and some minor stocks of summer chum salmon spawn in tributaries below Pilot Station. However, Pilot Station sonar counts are so much greater than total catch and monitored escapement, that the total run estimate is primarily based upon sonar passage estimates.

The total run of Yukon River summer chum salmon estimated in this manner averaged about 1.8 million fish during the 14-year period (1995 and 1997–2009), ranging from a low of about 550,000 fish in 2000 and 2001 to over 4.0 million fish in 1995 and 2006, about an 8-fold level of variation (Figure 5-39). Summer chum salmon run strength was poor to below average from 1998 through 2003 with 2000 and 2001 being the weakest runs on record. More recently, summer chum salmon runs have shown marked improvement with estimated drainagewide escapement exceeding 1.0 million salmon annually since 2001, with approximately 3.9 million in 2006, the largest escapement on record. The drainagewide OEG of 600,000 summer chum salmon was not met in 2000 and 2001, but has been exceeded annually since that time (Figure A6-19).

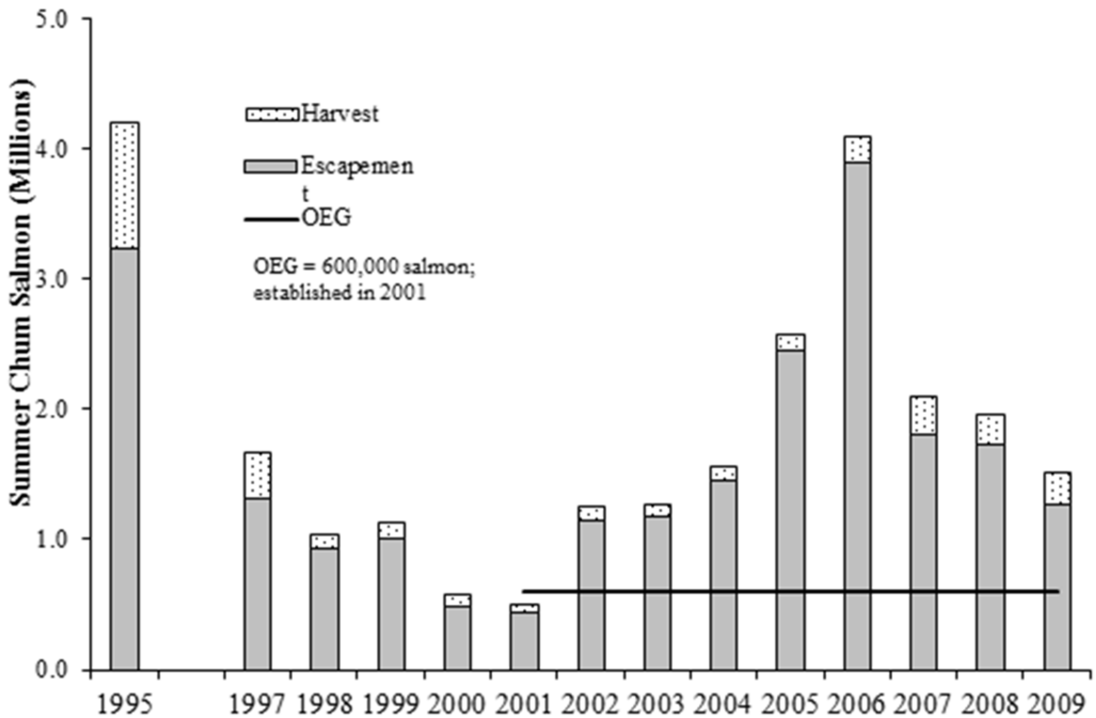


Figure A6-19. Estimated total annual runs of summer chum salmon by harvest and escapement and drainage-wide OEG, Yukon River, 1995 and 1997-2009. Data are unavailable for 1996.

Escapement Goals

Prior to the 2010 Board of Fisheries cycle, the comprehensive management plan identified summer chum salmon runs above a projected run size of 1 million fish as surplus available for commercial harvest (Table A6-13). Thus, in effect, there is an escapement threshold of 1 million minus the annual subsistence harvest. Typically this equates to a riverwide escapement greater than approximately 900,000 fish. Escapement goal analysis of fall chum salmon indicates that there is a wide range of escapement that will provide similar yield and this would likely be the case for summer chum salmon. Of note is that the near record abundance in 2006 was from some of the lowest parent year escapements on record (2001 and 2002).

Table A6-13. Yukon River drainage summer chum salmon management plan, 5 AAC 05.362.

	Recommended Management Action				
Projected Run Size [a]	Commercial	Personal Use	Sport	Subsistence	Target Escapement
600,000 or Less	Closure	Closure	Closure	Closure [b]	>600,000
600,000 to 700,000	Closure	Closure	Closure	Possible Restrictions [b]	
700,001 to 1,000,000	Restrictions [b]	Restrictions [b]	Restrictions [b]	Normal Fishing Schedules	
900,000 to 1,000,000	0 – 50,000 [c]	Open	Open	Normal Fishing Schedules	
Greater Than 1,000,000	Open [c]	Open	Open	Normal Fishing Schedules	≥1,000,000 [d]

[a] Projected Run Size: Mainstem river sonar passage estimate plus the estimated harvest below the sonar site and the Andreafsky River escapement.
[b] The fishery many be opened or less restrictive in areas that indicator(s) suggest the escapement goal(s) in that area will be achieved.
[c] Drainagewide Commercial Fisheries: The harvestable surplus will be distributed by district or subdistrict in proportion to the guideline harvest levels established in 5AAC 05.362 (f) and (g) and 5AAC 05.365 if buying capacity allows.
[d] Inriver run goal: This is a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated.

From 2001 to 2009, there were two established BEGs for summer chum salmon in the Yukon River drainage. The BEG range for the Anvik River has been 350,000–700,000 chum salmon and the BEG range for East Fork Andreafsky River was 65,000 – 300,000 chum salmon. The BEG for the Anvik River has been met or exceeded in 26 of 30 years (86%) since 1980; the 4 years when the BEG was not met were 2000, 2001, 2003, and 2009 (Table A6-14 and Figure A6-20). Assessment of annual escapements has occurred in 22 of 29 years since 1981 in the East Fork Andreafsky River with the BEG met or exceeded in 12 out of 22 years (54%), and last met in 2007 (Figure A6-20). In 2010, the escapment goal at the East Fork Andreafsky River Weir was adjusted to an SEG threshold of >40,000 chum salmon.

Recent BEGs for Yukon River summer chum salmon are >40,000 SEG for the East Fork of the Andreafsky River, 350,000 – 700,000 BEG for the Anvik River Index, and a Drainagewide Escapement OEG goal of 600,000.

Table A6-14. Yukon River summer chum salmon historical escapement 1980-2011, and Pilot Station sonar passage estimates 1995 and 1997-2011 in numbers of fish.

Year	Pilot Station Sonar	East Fork Andreafsky River	Anvik River Sonar	Kaltag Creek Tower	Nulato River Tower	Gisasa River Weir	(Clear Creek tower or weir)	Henshaw Creek Weir
1980			492,676					
1981		147,312 [a]	1,486,182					
1982		181,352 [a]	444,581					
1983		110,608 [a]	362,912					
1984		70,125 [a]	891,028					
1985		[b]	1,080,243					
1986		167,614 [c]	1,085,750					
1987		45,221 [c]	455,876					
1988		68,937 [c]	1,125,449					
1989			636,906					
1990			403,627					
1991			847,772					
1992			775,626					
1993			517,409					
1994		200,981 [b,d]	1,124,689	47,295	148,762 [b]	51,116 [b]		
1995	3,556,445	172,148 [d]	1,339,418	77,193	236,890	136,886	116,735	
1996	[e]	108,450 [d]	933,240	51,269	129,694	158,752	100,912	
1997	1,415,641	51,139 [d]	609,118	48,018	158,395	31,800	76,454	
1998	826,385	67,720 [d]	469,574	8,113	50,750	21,142	212 [b]	
1999	973,708	32,587 [d]	441,305	5,339	30,456	10,155	11,283 [b]	[b]
2000	456,271	24,783 [d]	205,460	6,727	24,308	11,410	19,376	27,271
2001	441,450	[b,d]	224,058	[b]	[b]	17,946 [b]	3,674	35,031
2002	1,088,463	44,194 [d]	462,396	13,583	72,286	33,481	13,150	25,249
2003	1,168,518	22,461 [d]	205,682	3,056 [b]	17,814 [b]	25,999	5,230	22,556
2004	1,357,826	64,883 [d]	365,556	5,247	[f]	37,851	15,661	86,474
2005	2,439,616	20,127 [d]	525,391	22,093	[f]	172,259	26,420	237,481
2006	3,767,044	102,260 [d]	992,378 [g]	[f]	[f]	261,305	29,166 [h]	[b]
2007	1,726,885	69,642 [d]	459,038	[f]	[f]	46,257	[f]	32,080
2008	1,665,667	57,259 [d]	374,929	[f]	[f]	36,938	[f]	97,281
2009	1,285,437 [i]	8,770 [d,i]	193,099 [i]	[f]	[f]	25,904 [i]	[f]	156,201 [i]
2010	1,327,581	72,893 [d]	369,173	[f]	[f]	47,667	[f]	100,670
2011	1,779,459	100,437 [d]	642,527	[f]	[f]	95,796	[f]	248,247
2007-2011 avg.	1,557,006	61,807	413,153	n/a	n/a	50,512	n/a	126,896
BEG		65,000-130,000	350,000-700,000	n/a	n/a	n/a	n/a	n/a

Note: Years with no data are years in which the project was not operated or was inoperable for a large portion of the season due to water conditions.
[a] Sonar counts used.
[b] Incomplete count caused by late installation and/or early removal of project, or high water.
[c] Tower counts used.
[d] Weir counts used.
[e] Pilot Station sonar operated in training mode only and no estimates were generated.
[f] Project did not operate.
[g] HTI and DIDSON sonar equuipment were both used in 2006, and the estimate reported is DIDSON derived.
[h] Videography count used.
[i] Data are preliminary.

The Anvik River BEG was met in 2004–2008 (Figure A6-20). A substantial decrease in Anvik River summer chum salmon production began with the 1993 brood year and has continued through the 2004 brood year. These escapements produced salmon that returned in 1997 through 2009. Escapements during this time period included large escapements in 1994, 1995, and 1996 (Figure A6-20) that failed to replace themselves (recruits per spawner (R/S) <1.0; Clark and Sandone 2001).

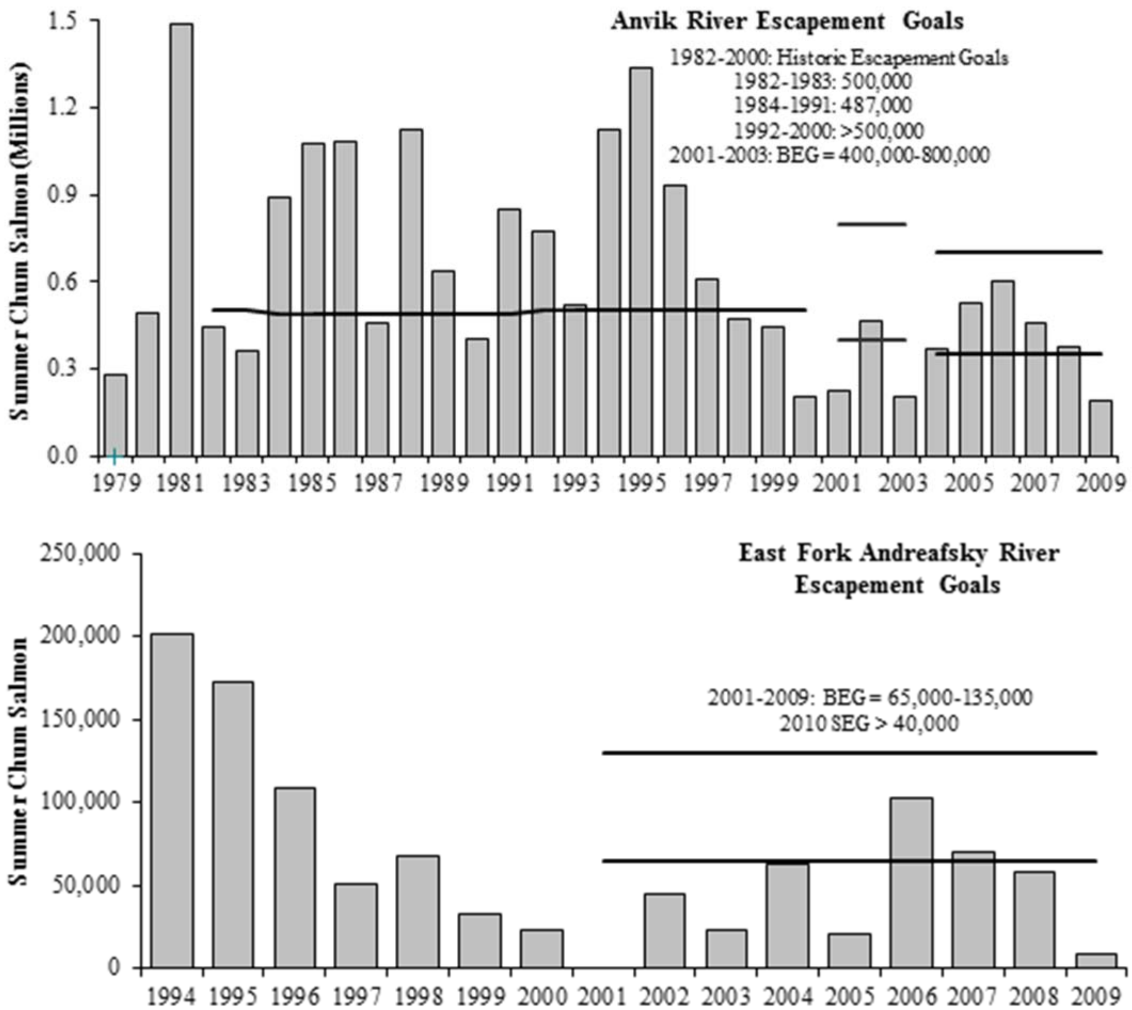


Figure A6-20. Summer chum salmon escapement estimates and escapement goals for Anvik River sonar (1979-2009), and E.F. Andreafsky River weir (1994-2009).

Stock composition of Yukon River summer chum runs has been in flux over the last decade. The Anvik River, the largest producer of summer chum salmon, contribution to the overall Yukon River stock production above Pilot Station sonar has decreased from approximately 46% during the period from 1995 through 2002 to an average of 24% after 2002. This reduction corresponds with a shift to increased production in other chum salmon spawning streams such as in the Koyukuk River drainage, where record escapements of 170,000 and 260,000 in Gisasa River were observed in 2005 and 2006, respectively. However, runs in the Tanana River drainage are also exhibiting instability with record escapements of over 100,000 summer chum salmon observed in Salcha River in 2005 and 2006, yet less than 15,000 observed in 2007. These fluctuations have been observed elsewhere in the Yukon River drainage. The disparate strength of individual stocks within and among years seems to signal a shift in summer chum production, and exploratory aerial surveys were conducted in 2009 to better assess primary locations of summer chum salmon escapement in lower and middle Yukon River tributaries.

Although the Yukon River summer chum salmon stock appears to have recovered as a whole, the BEG for East Fork Andreafsky summer chum salmon has been met four times (2006, 2007, 2010, 2011) since 2002 (Figure A6-20). However, the 2004 East Fork Andreafsky River escapement was within 2,000 summer chum salmon of the lower range of the BEG of 65,000. It is interesting to note that from 2002 through 2006, no directed summer chum salmon commercial fisheries occurred below the mouth of Andreafsky River, with the exception of a 3-hour commercial period in 2006, and the subsistence exploitation rate is relatively low. It is thought that Andreafsky River fish enter the Yukon River delta late in the run and are watermarked, making them less desirable to commercial buyers and fishermen. Further, it is believed that Andreafsky River fish are not readily susceptible to harvest because most, if not all, subsistence harvest has been completed by the time Andreafsky River summer chum salmon enter lower Yukon River. Regardless, under current management practices, Andreafsky River summer chum salmon are managed incidental to the overall Yukon River summer chum salmon run, and no management actions have been taken specifically for this tributary stock.

A6.1.3.2 Yukon River Fall Chum Run Assessment

The Yukon River fall chum salmon was classified as a stock of yield concern and theToklat and Fishing Branch rivers fall chum salmon were classified as stocks of management concerns in September 2000. The determination for the entire Yukon River fall chum salmon as a stock of yield concern was based on substantial decrease in yields and harvestable surpluses during the period 1998–2000, and the anticipated very low run expected in 2001. The determination for Toklat and Fishing Branch rivers as stocks of management concern was based on escapements not meeting the OEG of 33,000 for Toklat River from 1996 to 2000, and not meeting the escapement objective of 50,000–120,000 salmon for Fishing Branch River from 1997 to 2000. An action plan was subsequently developed by ADF&G (ADF&G 2000) and acted upon by the BOF in January 2001.

Yukon River fall chum salmon classification as a yield concern was continued at the January 2004 BOF meeting because the combined commercial and subsistence harvests showed a substantial decrease in fall chum salmon yield from the 10-year period (1989–1998) to the more recent 5-year (1999–2003) average (Bue et al. 2004). Toklat River stock was removed from management concern classification as a result of the BEG review presented at that BOF meeting. However, as a component of the Yukon River drainage, Toklat River fall chum salmon stock was included in the drainage-wide yield concern classification. Fishing Branch River stock was also removed from the management concern classification because management of that portion of the drainage is covered by the U.S./Canada Yukon River Salmon Agreement (Agreement), part of the Pacific Salmon Treaty, which is governed under the authority of the Yukon River Panel (Panel).

In January 2007, the BOF determined that Yukon River fall chum salmon stock no longer met the criteria for a yield concern. Run strength was poor from 1998 through 2002; however, steady improvement had been observed since 2003 (JTC 2006). The 2005 run was the largest in 30 years and 2006 was above average for an even-numbered year run; the drainagewide OEG of 300,000 fall chum salmon was exceeded in the preceding 5 years. The 5-year average (2002–2006) total reconstructed run of approximately 950,000 fish was greater than the 1989–1998 10-year average of approximately 818,000 fish, which indicated a return to historical run levels.

Escapement

Fall chum salmon spawn in fairly unique areas of the drainage where warmer upwelling waters can incubate eggs in a shorter time frame than summer chum salmon spawning habitats would allow (Figure A6-21). Analysis of biological escapement goals (BEGs) conducted by Eggers (2001) provided a drainagewide goal of 300,000 to 600,000 fall chum salmon, as well as tributary goals for main monitored systems in the upper Yukon River drainage, including Tanana River. Management of the fall season fishery is prescribed in 5 AAC 01.249. *Yukon River Drainage Fall Chum Salmon Management Plan* and describes recommended fishery actions based on estimates of run size (Table A6-15). The plan aligns the escapement goal threshold with the lower end of the established BEG range. This provides more subsistence fishing opportunity in years of poor runs while still attaining escapement goals. Drainagewide commercial fishing is allowed on the projected surplus above 600,000 fish which provides for subsistence use priority and bolsters escapement on strong runs.

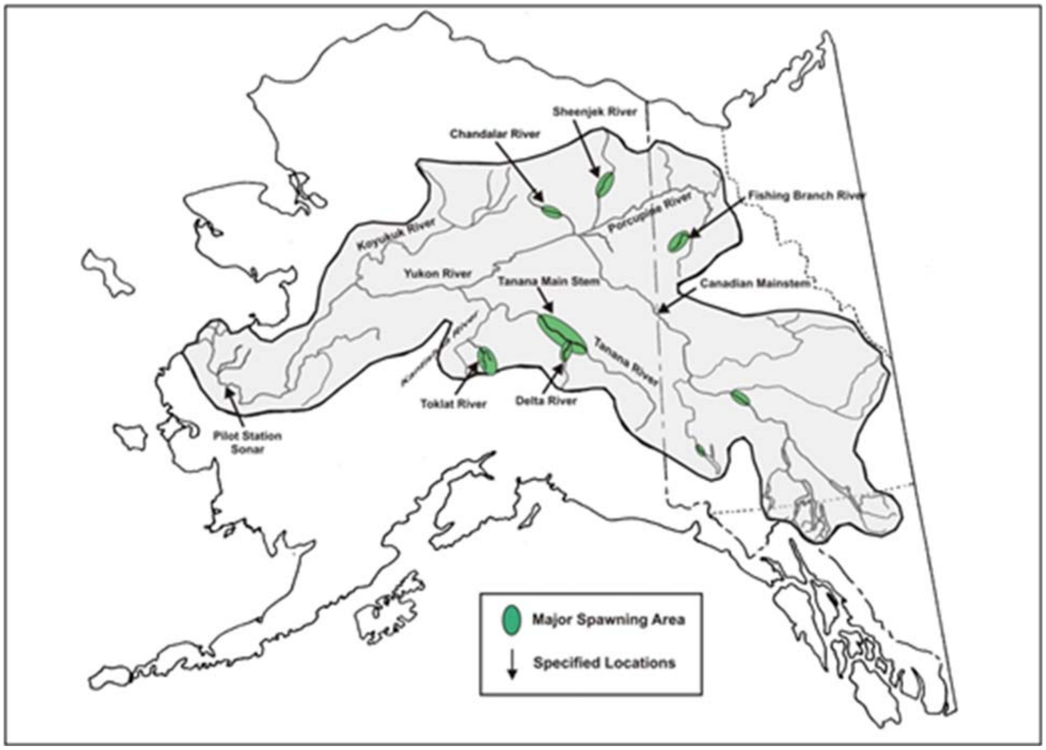


Figure A6-21 Map showing major spawning areas of fall chum salmon in Alaska and Canada.

Table A6-15 Yukon River drainage fall chum salmon management plan, 5AAC 01.249, 2012.

Run Size Estimate [b] (Point Estimate)	Recommended Management Action Fall Chum Salmon Directed Fisheries [a]				Targeted Drainagewide Escapement
	Commercial	Personal Use	Sport	Subsistence	
300,000 or Less	Closure	Closure	Closure	Closure [c]	
300,000 to 500,000	Closure	Closure [c]	Closure [c]	Possible Restrictions [c, d]	300,000 to 600,000
Greater than 500,000	Open[e]	Open	Open	Pre-2001 Fishing Schedules	

Note: This management plan was modified at the 2010 BOF cycle meeting.

[a] Considerations for the Canadian mainstem rebuilding plans may require more restrictive management actions.

[b] The department will use the best available data, including preseason projections, mainstem river sonar passage estimates, test fisheries indices, subsistence and commercial fishing reports, and passage estimates from escapement monitoring projects to project run size inseason.

[c] The fisheries may be opened or less restrictive in areas where indicator(s) suggest the escapement goal(s) in that area will be achieved.

[d] Subsistence fishing will be managed to achieve a minimum drainagewide escapement goal of 300,000 fall chum salmon.

Fall chum salmon run abundance is assessed inseason using estimates provided by Pilot Station sonar whereas post-season run reconstruction uses the estimates of the individual escapement projects. One method of obtaining an estimate of total run of fall chum salmon in Yukon River consists of the following summation: (1) the sonar based estimates of fall chum salmon passage at Pilot Station, in the years 1995 and 1997–2009, (2) the total harvest of fall chum salmon in District 1 and that portion of District 2 below the Pilot Station sonar site, and (3) an estimate of fall chum salmon passage after the sonar operations ceased, typically around end of August (on average 7% of total passage, based on years when sonar was operated to mid-September or on run timing of Mountain Village test fishery that operates annually beyond the first week of September). The second method used for run reconstruction post-season includes adding the escapement projects together including: Chandalar (sonar), Sheenjek (sonar), Fishing Branch (weir), Mainstem Yukon at U.S./Canada Border (mark-recapture to sonar) and Tanana (mark-recapture) rivers as well as consideration of harvests where appropriate. The most complete Yukon River escapement coverage of fall chum salmon occurred between 1995 and 200. Brood tables were updated from Eggers (2001), which included 1974 to 1995, by Fleischman and Borba (2009) through the 2004 brood year. Note that the harvest estimates that were used in the run reconstruction are slightly different (not significant) than those presented in the JTC (2010) report because of maintaining Eggers (2001) dataset with recent updates to US and Canadian harvests.

The total reconstructed run of Yukon River fall chum salmon averages about 868,000 fish during the 36-year period (1974–2009), ranging from a low of about 239,000 fish in 2000 to over 2.2 million fish in 2005, about an 8-fold level of variation (Figure A6-22). Historically estimated total returns indicated cycles in Yukon River fall chum salmon abundance from 1974 through 1992 even-odd numbered year cycles dominated and more recently a ten year pattern of high abundance also appears to be emerging (1975, 1985, 1995 and 2005). Generally, smaller run sizes occur during even-numbered years and larger returns in odd-numbered years fairly regularly between 1974 and 1992. From 1974 through 2009, estimated total run size in odd-numbered years averaged 1,000,000 fall chum salmon, ranging from approximately 382,000 fish (2001 – lowest odd-numbered year return on record) to 2,286,000 fish in 2005. Run size in even-numbered years averaged 687,000 fall chum salmon and ranges from approximately 239,000 fish (2000 – lowest return on record) to 1,144,000 fish in 2006. It is notable that 1996 and 2006 are the only even-numbered years that total fall chum salmon run size exceeded the average run size for odd-numbered years.

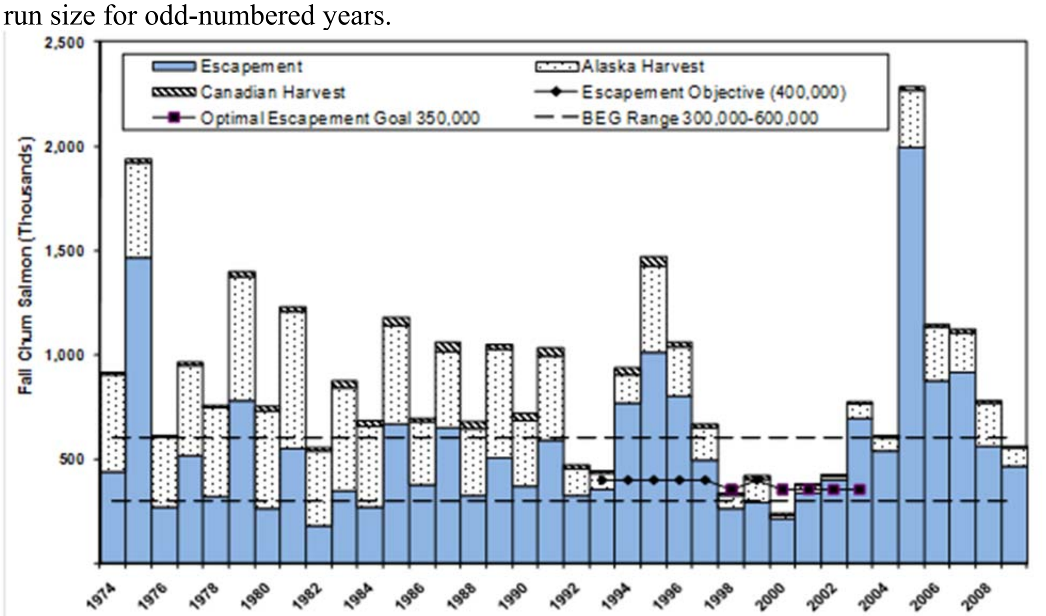


Figure A6-22. Total run reconstruction based on estimated harvest and escapement of fall chum salmon, Yukon River drainage, 1974–2008 with the 2009 run size estimate. *Note*: The drainagewide escapement goal of 400,000 fall chum salmon was established in 1993. In 1996, an optimal escapement goal of 350,000 fall chum salmon was established in the *Yukon River Fall Chum Salmon Management Plan* and was utilized in 1998, 2000, and 2001. In 2004, a drainagewide escapement goal range of 300,000 to 600,000 fall chum salmon was established.

Escapement goals

Table A6-16 Current BEGs and SEGs for Yukon River fall chum salmon

Stream (Project Type)	Current Goal	Type of Goal
Yukon Drainage (multiple)	300,000–600,000	SEG
Tanana River (mark-recapture)	61,000–136,000	BEG
Delta River (foot surveys)	6,000–13,000	BEG
Upper Yukon R. Tributaries (multiple)	152,000–312,000	BEG
Chandalar River (sonar)	74,000–152,000	BEG
Sheenjek River (sonar)	50,000–104,000	BEG
Fishing Branch River (weir)	22,000–49,000	IMEG[a]
Canadian Upper Yukon River (sonar)	70,000–104,000	IMEG[b]

[a] Canadian Interim Management Escapement Goal agreed to by the Yukon River Panel for 2012.

[b] The Yukon River Panel agreed to an interim management escapement goal (IMEG) of 70,000 to 104,000 to be determined by the sonar project near Eagle, Alaska for 2012 plus the Agreement stipulation of 29% to 35% of the TAC on the Canadian run component.

Fall chum salmon run strength was poor to below average from 1998 through 2002 with 1998 and 2000 being the weakest runs on record. More recently, fall chum salmon runs have shown marked improvement with estimated drainagewide escapement exceeding the upper end of the OEG range of 600,000 fish in 2003 and 2005 through 2007, with approximately 2.0 million in 2005, the largest escapement on record. The low end of the drainagewide escapement goal of 300,000 fall chum salmon was not met in 1998 through 2000, but has been exceeded annually since that time (Table A6-17).

Biological escapement goals in Chandalar and Delta rivers have been met or exceeded in each of the past 10 years, except for low escapements in 2000 (Table A6-17). Sheenjek River BEG is based on estimated passage for only one bank and the goal has only been met 4 times since 1997. Escapement objectives for fall chum salmon stocks in Yukon River Canadian mainstem and Fishing Branch River were originally recommended by the U.S./Canada Joint Technical Committee (JTC) and specifically stipulated in the Agreement. Because of poor runs in the early 2000s, the Panel agreed to lower escapement targets through 2005 for Canadian mainstem fall chum salmon stock to allow for some U.S. subsistence and Canadian aboriginal harvest, while rebuilding the stock over 3 life cycles. However, the escapement objective of >80,000 for this stock had been exceeded since 2002 and since 2006 goals were again based on rebuilt status (Table A6-17).

Table A6-17. Fall chum salmon passage estimates and escapement estimates for selected spawning areas, Yukon River drainage, 1971–2011.

	Alaska								Canada	
	Yukon	Tanana River Drainage					Upper Yukon River Drainage			
Year	River Mainstem Sonar Estimate	Toklat River [a]	Kantishna / Toklat Rivers Tagging Estimate [b]	Delta River [c]	Bluff Cabin Slough [d]	Upper Tanana River Tagging Estimate [e]	Chandalar River [f]	Sheenjek River [g]	Fishing Branch River [h]	Mainstem Tagging Escapement Estimate [i]
1971									312,800 [j]	
1972									35,125 [k]	
1973									15,989	
1974		41,798		5,915 [l]				89,966 [m]	31,525	
1975		92,265		3,734				173,371 [m]	353,282	
1976		52,891		6,312				26,354 [m]	36,584 [j]	
1977		34,887		16,876				45,544 [m]	88,400 [j]	
1978		37,001		11,136 [l]				32,449 [m]	40,800 [j]	
1979		158,336		8,355 [l]				91,372 [m]	119,898 [j]	
1980		26,346		5,137 [l]	3,190 [n]			28,933 [m]	55,268 [j]	22,912
1981		15,623		23,508 [l]	6,120 [n]			74,560	57,386 [o]	47,066 [p]
1982		3,624		4,235 [l]	1,156			31,421	15,901 [j]	31,958
1983		21,869		7,705 [l]	12,715			49,392	27,200 [j]	90,875
1984		16,758		12,411 [l]	4,017			27,130	15,150 [j]	56,633 [p]
1985		22,750		17,276	2,655 [n]			152,768 [q]	56,016	62,010
1986		17,976		6,703	3,458		59,313	84,207 [q, r]	31,723	87,940
1987		22,117		21,180 [l]	9,395		52,416	153,267 [q, r]	48,956	80,776
1988		13,436		18,024 [l]	4,481 [n]		33,619	45,206 [r]	23,597	36,786
1989		30,421		21,342	5,386 [n]		69,161	99,116 [r]	43,834	35,750
1990		34,739		8,992	1,632		78,631	77,750 [r]	35,000 [s]	51,735
1991		13,347		32,905	7,198			86,496	37,733	78,461
1992		14,070		8,893	3,615 [n]			78,808	22,517	49,082
1993	295,000	27,838		19,857 [l]	5,550 [n]			42,922	28,707	29,743
1994	407,000	76,057		23,777	2,277 [n]			150,565	65,247	98,358
1995	1,053,245	54,513 [t]		20,587 [l]	19,460	268,173	280,999	241,855	51,971 [u]	158,092

Table A6-17 continued.

Year	Alaska Yukon River M115 instem Sonar Estimate	Tanana River Drainage: Toklat River [a]	Tanana River Drainage: Kantishna / Toklat Rivers Tagging Estimate [b]	Tanana River Drainage: Delta River [c]	Tanana River Drainage: Bluff Cabin Slough [d]	Tanana River Drainage: Upper Tanana River Tagging Estimate [e]	Upper Yukon River Drainage: Chandalar River [f]	Upper Yukon River Drainage: Sheenjek River [g]	Canada: Fishing Branch River [h]	Canada: Mainstem Tagging Escapement Estimate [i]
1996		18,264		19,758	7,074 [d]	134,563	208,170	246,889	77,278	122,429
1997	506,621	14,511		7,705	5,707 [d]	71,661	199,874	80,423 [v]	26,959	85,439
1998	372,927	15,605		7,804	3,549 [d]	62,384	75,811	33,058	13,564	46,305
1999	379,493	4,551	27,199	16,534	7,037 [d]	97,843	88,662	14,229	12,904	58,682
2000	247,935	8,911	21,450	3,001	1,595	34,844	65,894	30,084 [w]	5,053	53,742
2001	376,182	6,007 [x]	22,992	8,103	1,808 [n]	96,556 [y]	110,971	53,932	21,669	33,851
2002	326,858	28,519	56,665	11,992	3,116	109,961	89,850	31,642	13,563	98,695
2003	889,778	21,492	87,359	22,582	10,600 [n]	193,418	214,416	44,047 [z]	29,519	142,683
2004	594,060	35,480	76,163	25,073	10,270 [n]	123,879	136,703	37,878	20,274	154,080
2005	1,813,589	17,779 [t]	107,719	28,132	11,964 [n]	377,755	496,484	438,253 [q]	121,413	437,920
2006	790,563	-	71,135	14,055	-	202,669	245,090	160,178 [q]	30,849	211,193
2007	684,011	-	81,843	18,610	-	320,811	228,056	65,435 [q]	33,750	214,802
2008	615,127	-	-	23,055	1,198 [n]	-	178,278	50,353 [q]	20,055 [aa]	174,424 [ae]
2009	240,449	-	-	13,492	2,900 [n]	-	150,000 [af]	54,126 [q]	25,828 [aa]	93,626 [ae]
2010	350,981	-	-	17,993	1,610 [n]	-	157,998	22,053	15,773	117,871 [ae]
2011 [ai]	695,011	-	-	N/A	N/A	-	295,335	97,976 [q]	13,297	200,000 [ae]
Five Year Average	610,171	N/A	76,489	17,441	1,903	261,740	191,884	70,429	24,758	170,481
BEG Range	300,000	15,000	N/A	6,000	N/A	46,000 [ac]	74,000	50,000	50,000	>80,000
	600,000	33,000		13,000		103,000	152,000	104,000	120,000	

-continued-

Table A6-17 continued.

Note: Latest table revision was completed May 2012.

[a] Total abundance estimates for upper Toklat River drainage spawning index area using stream life curve method developed with 1987 to 1993 data.

[b] Fall chum salmon passage estimate for Kantishna and Toklat river drainages is based on tag deployment from a fish wheel located at the lower end of Kantishna River and recaptures from three fish wheels; two located on Toklat River (1999 to 2007) about eight miles upstream of the mouth and one fish wheel on Kantishna River (2000 and 2007) near Bear Paw River.

[c] Population estimate generated from replicate foot surveys and stream life data (area under the curve method), unless otherwise noted.

[d] Peak counts from foot surveys unless otherwise noted.

[e] Fall chum salmon passage estimate for upper Tanana River drainage based on tag deployment from a fish wheel (two fish wheels in 1995) located just upstream of Kantishna River and recaptures from one fish wheel (two fish wheels from 1995 to 1998) located downstream from the village of Nenana.

[f] Side-scan sonar estimate from 1986 through 1990. Split beam sonar estimate from 1995 through 2006. DIDSON sonar estimate in 2007 to present.

[g] Side-scan sonar estimate from 1986 through 1999, 2001, and 2002. Split-beam sonar estimate from 2003 through 2004. DIDSON sonar estimate since 2005. Counts prior to 1986 are considered conservative, approximating the period from the end of August through middle of the fourth week of September. Since 1991, total abundance estimates are for the approximate period second week in August through the middle of the fourth week of September.

[h] Total escapement estimated using weir count unless otherwise indicated. Counts for 1974, 1975, and 1998 revised from DFO, February 23, 2000.

[i] Estimated border passage minus Canadian mainstem harvest and excluding Canadian Porcupine River drainage escapement. Based on mark-recapture from 1980 to 2007 and sonar thereafter.

[j] Total escapement estimated using weir to aerial survey expansion factor of 2.72.

[k] Weir installed on September 22, 1972. Estimate consists of a weir count of 17,190 after September 22 and a tagging passage estimate of 17,935 prior to weir installation.

[l] Total escapement estimate generated from the migratory time density curve method.

[m] Total escapement estimate using sonar to aerial survey expansion factor of 2.22.

[n] Peak counts aerial surveys.

[o] In 1981, the initial aerial survey count was doubled before applying the weir to aerial expansion factor of 2.72 since only half of the spawning area was surveyed.

[p] In 1984, the escapement estimate based on mark-recapture program is unavailable. Estimate is based on assumed average exploitation rate.

[q] Sonar counts included both banks in 1985-1987 and 2005 to present.

[r] Expanded estimates, using Chandalar River fall chum salmon run timing data, for the approximate period from mid-August through the middle of the fourth week of September 1986-1990.

[s] Population of spawners was reported by DFO as between 30,000 to 40,000 fish considering aerial survey timing. For purpose of this table, an average of 35,000 fall chum salmon was estimated to pass by the weir. Note: A single survey flown October 26, 1990, counted 7,541 chum salmon. A population estimate of approximately 27,000 fish was made through date of survey, based upon historic average aerial to weir expansion of 28%.

[t] Minimal estimate because of late timing of ground surveys with respect to peak of spawning.

[u] Minimal count because weir was closed while submerged due to high water, during the period August 31 to September 8, 1995.

Table A6-17 continued.

[v] The passage estimate includes an additional 15,134 salmon that were estimated to have passed during 127 hours that the sonar was inoperable due to high water from August 29 until September 3, 1997.

[w] Project ended early; sonar passage estimate was 18,652 (62% of normal run timing). The total sonar passage estimate, 30,083, was expanded to reflect the 1986-1999 average run timing through September 24.

[x] Minimal estimate because Sushana River was breached by the main channel and uncountable.

[y] Due to low numbers of tags deployed and recovered on Tanana River the estimate has a large range in confidence interval (95% CI + 41,172).

[z] Project ended on peak daily passages due to late run timing; estimate was expanded based on run timing (87%) at Rapids.

[aa] Project estimated for late run timing through October 25 as project ended on October 10, 2008 and October 12, 2009.

[ab] Preliminary.

[ac] Upper Tanana River goal is Tanana River drainage BEG (61,000 to 136,000) minus the lower and upper ranges of Toklat River goal based on Eggers (2001), and is not an established BEG.

[ad] Tanana River estimate is based on genetics apportionment to Pilot Station sonar and represents all Tanana fall chum as well as Tanana summer chum salmon after July 19th to be comparable to the historical mark-recapture estimates.

[ae] Estimated mainstem Canadian escapement derived from Eagle sonar estimate (2008 to present) minus harvest from Eagle community upstream including Canadian harvest.

[af] Excludes 2009 because of problems with apportionment during extremely low water operations.

[ag] Tanana River estimate is based on Delta River representing on average 10% of Upper Tanana plus 20,000 for Kantishna River component.

[ah] Project ended early, estimate based on regression of Chandalar to Fishing Branch River plus Mainstem Border from 1995 – 2009.

[ai] Preliminary data.

Escapements in fishing Branch River, Canada, have only met the escapement objective established in 1987 of 50,000 to 120,000 fall chum salmon once in the past 12 years, in 2005 (Table A6-17). ADF&G developed a BEG for this stock of 27,000 to 56,000 in conjunction with total run reconstruction analysis in 2000 (Eggers 2001); however, this goal has only been met 4 times since 1997. Like the Canadian mainstem stock, the Fishing Branch River fall chum salmon stock is managed based on recommendations of the Panel that are addressed annually. The Panel agreed to an interim management goal of 28,000 fish for the 2006 season and 33,667 fish in 2007, which were both exceeded. For the years 2008–2010, JTC has recommended an Interim Management Escapement Goal (IMEG) range of 22,000–49,000 fall chum salmon for Fishing Branch River (JTC 2009). This recommendation was based on the Bue and Hasbrouck[9] percentile method of determining an SEG. The IMEG for Fishing Branch River was nearly achieved in 2008 and was met in 2009.

In 1993, the BOF established the Toklat River OEG of 33,000 fall chum salmon based on an average return for this system. As part of the total run reconstruction analysis conducted by Eggers (2001), a BEG range of 15,000 to 33,000 fall chum salmon was recommended and adopted by ADF&G. The BOF removed the OEG from regulation in 2004. Based on the BEG range, the goal has been met each year from 2002 to 2005; however, assessment of the area has been hampered by the later freeze ups and counts used for developing an annual population estimate have not been achieved since 2005 (Table A6-17). At the 2010 BOF meeting this goal was discontinued. The results of mark–recapture projects on both Kantishna and Tanana rivers suggest that the index streams of Toklat and Delta rivers support relatively small proportions of fall chum salmon. A radiotelemetry study conducted in 2008 has confirmed major mainstem spawning in Tanana River between Fairbanks and Delta Junction.

A6.1.3.3 Yukon River Commercial Chum Fisheries Harvests

Recent Management Actions

In January 2010, the BOF modified The Yukon River Summer Chum Salmon Management Plan to allow, by emergency order, a commercial harvest up to 50,000 fish if the total run size is between 900,000 and 1,000,000 fish, distributed by district or subdistrict in proportion to the guideline harvest levels (Hayes and Norris, 2010).

As with summer chum salmon, the BOF also modified The Yukon River Fall Chum Salmon Management Plan in January 2010 by lowering the threshold required to allow a directed fall chum salmon commercial fishery from a run size of 600,000 fall chum salmon to 500,000 fall chum salmon (Hayes and Norris, 2010).

Since 2007, there has been a renewed market interest for summer chum salmon in the lower river districts. Based on the projected average run estimate for summer chum salmon, the department initiated eleven short commercial periods restricted to 6-inch maximum mesh size in Districts 1 and 2 directed at chum salmon. Additionally, seven commercial periods were established in Subdistrict 4-A. Six commercial periods were established in District 6 directed at summer chum salmon, but due to high water events, fishing effort was limited.

Yukon Summer Chum Salmon

Harvest

Combined commercial and subsistence harvests show a substantial decrease from the 1980s and 1990s compared to the recent 5-year (2005–2009) average of approximately 226,994 (Figure A6-23). The recent

[9] Bue, B. G., and J. J. Hasbrouck. *Unpublished*. Escapement goal review of salmon stocks of Upper Cook Inlet, Report to the Alaska Board of Fisheries, 2001. Alaska Department of Fish and Game, Anchorage.

decline in utilization is largely due to reductions in commercial harvest. Commercial harvest of summer chum salmon averaged about 394,400 during the 1990s and 130,611 from 2005 through 2009. Below average runs from 1998 through 2003 resulted in low available yields of summer chum salmon. In 2004, a modest surplus was identified, whereas in 2005 and 2006, substantial surpluses were available for commercial harvest. However, there was little exploitation of these available surpluses due to poor commercial market conditions for summer chum salmon. From 1997 through 2006, the commercial harvest of summer chum salmon was primarily incidental to directed Chinook salmon fisheries. Since 2007 there has been renewed market interest and directed summer chum salmon commercial opportunity has been provided in 2007 through 2009. Unfortunately, despite harvestable surpluses available in these years, redevelopment of this fishery has been largely hindered by management strategies taken in response to poor Chinook salmon runs, which co-migrate with summer chum salmon. Management actions taken to reduce Chinook salmon harvest, including incidental harvest in summer chum salmon-directed fisheries, have negatively affected the summer chum salmon fishery.

2011 Summary

In an effort to reduce incidental harvest of Chinook salmon during a poor run, management actions regarding the summer chum commercial salmon fishery were delayed until near the midpoint in the Chinook salmon run at the Lower Yukon test fishery. At that time, a harvestable surplus of summer chum had been identified as a total run size of approximately 2 million. The first summer chum directed commercial fishing periods took place June 24 in District 1 and June 26 in District 2. Gillnet gear was restricted to 6-inch or smaller mesh. Concurrent subsistence and commercial fishing periods in Districts 1 and 2 were instituted intermittently throughout the season in an effort to decrease the amount of time that Chinook salmon were susceptible to harvest.

The sale of incidentally caught Chinook salmon was not allowed during the summer season because subsistence fishing had been restricted during the season in Districts 1 – 5, and this action helped ensure escapement goals would be met. Fishermen could release any incidentally caught live Chinook salmon or use them for subsistence purposes.

Total commercial harvest for Districts 1, 2, and 6 combined was 275,161 summer chum salmon, which is 163% above the 2001 – 2010 average harvest of 104,579 fish.

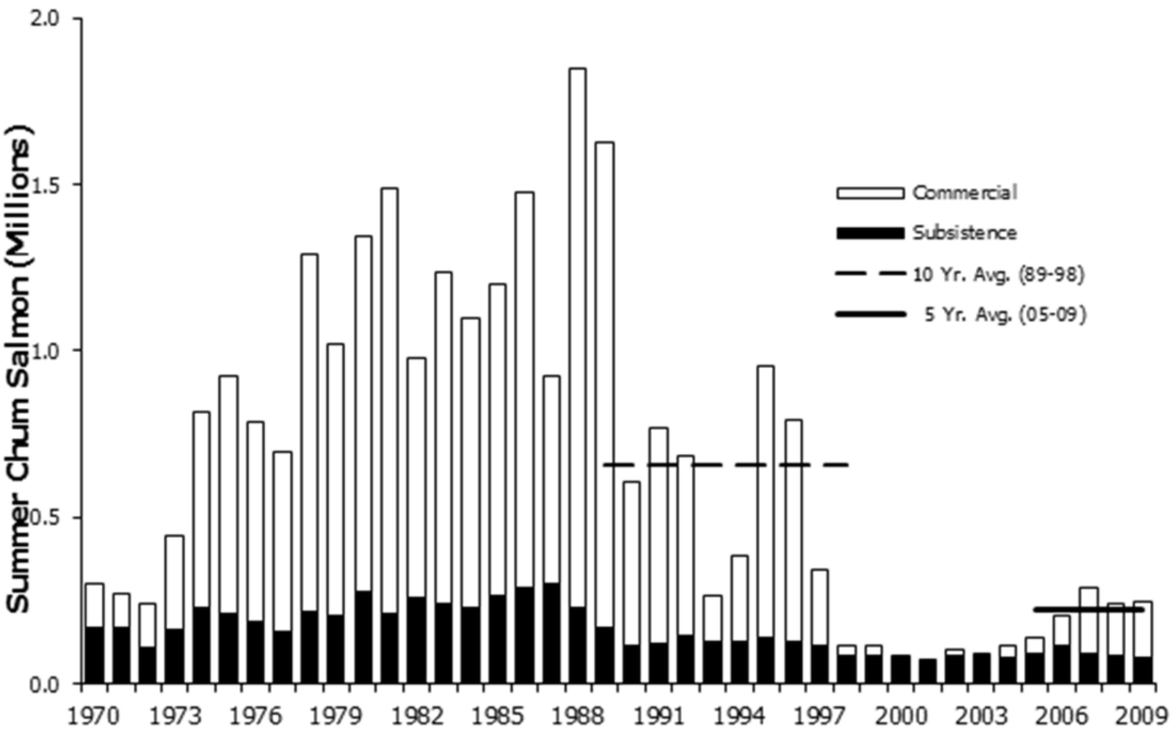


Figure A6-23. Yukon River summer chum salmon subsistence and commercial harvests from 1970 to 2009, compared to the 1989–1998 average (approximately 665,100 fish) and the 2005–2009 average (226,994 fish).

A6.1.3.4 Yukon Fall Chum Salmon

Harvest

Combined commercial and subsistence harvests of fall chum salmon in Alaska show a substantial decrease from the 1980s and 1990s compared to the recent 5-year (2005–2009) average of approximately 205,000 fish. The recent decline in subsistence harvest resulted from several extremely poor runs (1998 through 2002) where subsistence fishing was restricted and cultural changes reduced fishing activity, such as fishermen moving away from long-established fish camps and allowing fishing gear to fall into disrepair. During several years of poor returns, there was little to no commercial harvests, causing loss of markets as businesses shifted interest to other fisheries with more predictable run strength and lower operating costs than in remote Yukon River drainage communities. Commercial harvest of fall chum salmon averaged about 262,000 during the 1980s and 118,000 from 2005 through 2009. In 2004, a modest surplus was identified, whereas in 2005 and 2006, substantial surpluses were available for commercial harvest. However, there was little exploitation of these available surpluses due to poor commercial market conditions for fall chum salmon. Since 2007 there has been renewed market interest and directed fall chum salmon commercial opportunity has been provided in 2007 through 2009. Coho salmon runs overlap in timing with fall chum salmon and are typically taken as incidental harvest in the fisheries. Directed coho salmon fisheries are rare because of the tie between coho and fall chum salmon management plans. Coho salmon-directed fisheries were conducted on the Yukon in 2009 after the majority of the fall chum salmon had past.

2011 Summary

The fall season began by regulation on July 16. Subsistence fishing in District 1, 2, 3, and Subdistrict 5-D were open 7 days a week, 24 hours a day, while District 4 and Subdistricts 5-A, 5-B, and 5-C were on a 5 days a week schedule. A limited commercial harvest was allowed in Districts 1 and 2 during the transition time between the summer and fall seasons. By the last week of July, run assessment indicated that the 2011 run was below average, and no commercial fishing occurred during that time.

The first and largest pulse of fall chum salmon entered the Yukon River on July 30. Run assessment indicated that there was a surplus available for commercial harvest and commercial fishing in Districts 1 and 2 continued through the remainder of the season. Fall chum salmon continued to enter Yukon River over four additional pulses through September 7, and projections indicated a surplus of fall chum salmon for commercial harvest. Attempts were made to align commercial openings with pulses as they entered the river. In between pulses, commercial openings occurred on a set schedule. Limited commercial fishing also occurred in Subdisrticts 5-B and 5-C in early August, and in District 6 in September.

The 2011 total commercial harvest for the Yukon River fall season in the Alaskan portion of the drainage was 238,979 fall chum. Fall chum salmon harvest was the largest since 1995 (Figure A6-24).

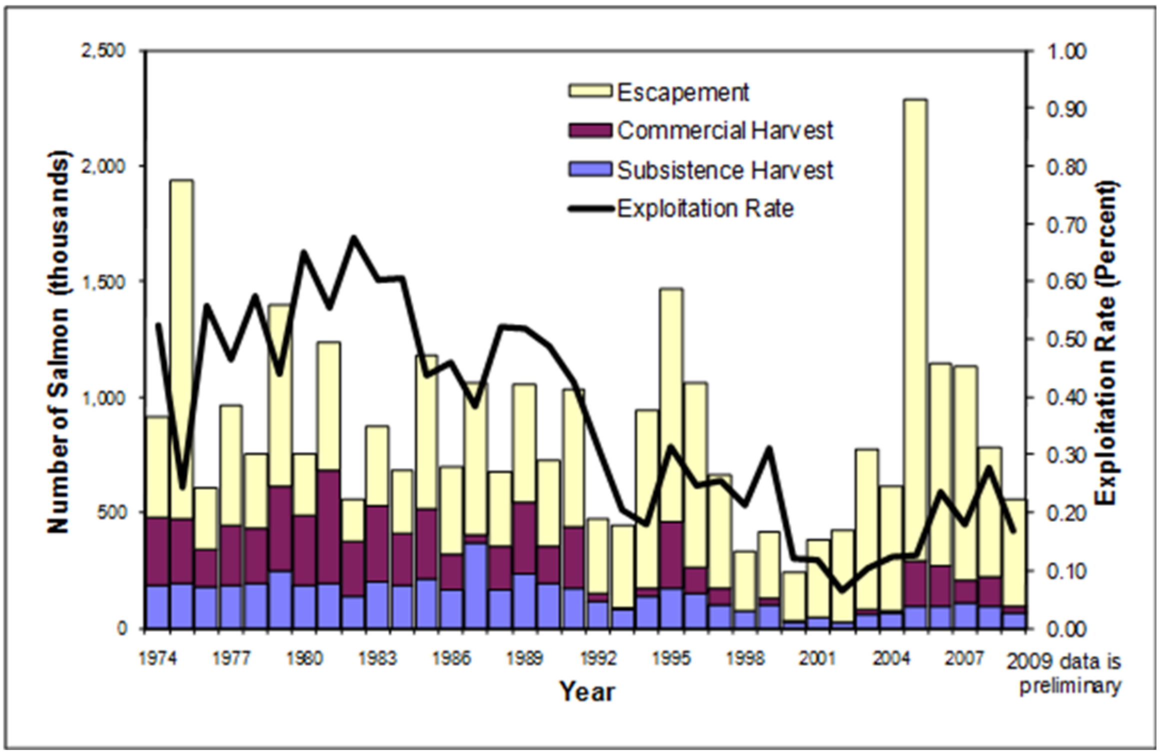


Figure A6-24 Estimated fall chum salmon harvest and escapement with exploitation rate, Yukon Area, 1974–2009.

Yields based on brood return from individual escapements have also become highly variable in the last two decades (Figure A6-25). Yields from brood years pre-1992 averaged 400,000 fish and ranged from 27,000 in 1975 to 840,000 in 1977, whereas yields after 1991 average 143,000 fall chum salmon, with 6 of the last 13 brood year returns (through 2005) resulting in negative yields representing substantially less production. Production levels for years 1974 through 1992 allowed for average harvests of 456,000 fish, whereas current production levels, conservative management actions, and weak market conditions through this period of high and low production extremes has reduced harvests to less than 200,000 fish. Harvests from 1999–2003 were at all time lows that averaged only 62,000 fall chum salmon drainagewide, whereas harvests from 2004–2008 average 211,000 fall chum salmon; this level of harvest is comparable to average harvest taken from 1994–1998 (Figure A6-25). As a result of previous poor fall chum salmon runs in the early 2000s and subsequent fishing restrictions and closures, it appears subsistence fishing effort and harvest has remained relatively low even in those years with much larger runs, as in 2003 and 2005 through 2008 (Figure A6-25). With the exception of 1995, fall chum salmon commercial harvests (Figure A6-25) have been low since 1992, partly due to weak market conditions, but also because of uncertainty in predicting run strength. Most recently this has resulted in underutilization of the stock in commercial fisheries in 2003, and 2005 through 2007. Fall chum salmon runs in 2008 and 2009 were fully utilized, with most escapement objectives attained and below average harvests due to below average available surpluses.

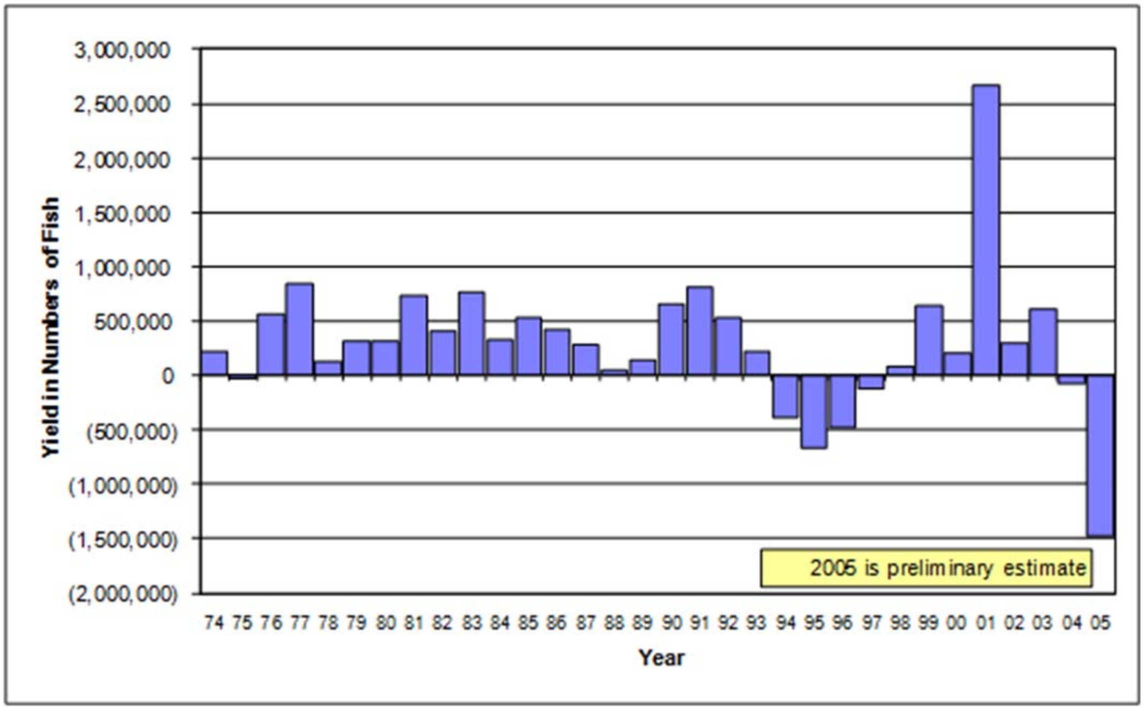


Figure A6-25. Yields of fall chum salmon based on parent year escapements and resulting brood year returns, 1974-2005.

Table A6-18 provides historic summer and fall chum salmon catches in the Alaska Yukon from 1961 through 2011. The catch data document a long term decline in commercial harvest of fall chum salmon prior to and during the early 2000s. Some recovery in fall chum commercial catch occurred from 2005 through 2008; however, the 2009 fishery declined significantly from 2008 catch numbers and 2010 was even lower. Harvest during the 2011 fishery was 238,979 chum salmon, the largest since 1995. In 2011, the summer chum commercial harvest was 275,161 (Table A6-18), which was well above the 5-year and 10-year averages.

Table A6-18 Alaska Yukon Area commercial chum salmon catch totals, 1970-2011.

Year	Summer Commercial Total	Fall Commercial Total
1970	137,006	209,595
1971	100,090	189,594
1972	135,668	152,176
1973	285,509	232,090
1974	589,892	289,776
1975	710,295	275,009
1976	600,894	156,390
1977	534,875	257,986
1978	1,077,987	247,011
1979	819,533	378,412
1980	1,067,715	298,450
1981	1,279,701	477,736
1982	717,013	224,992
1983	995,469	307,662
1984	866,040	210,560
1985	934,013	270,269
1986	1,188,850	140,019
1987	622,541	0
1988	1,616,682	136,990
1989	1,452,740	284,944
1990	517,177	136,342
1991	658,102	254,218
1992	543,577	19,022
1993	140,116	0
1994	258,741	7,999
1995	818,414	283,057
1996	682,233	105,630
1997	228,252	58,187
1998	28,798	0
1999	29,413	20,371
2000	6,624	0
2001	0	0
2002	13,577	0
2003	10,685	10,996
2004	26,410	4,110
2005	41,264	180,162
2006	92,116	174,542
2007	198,201	90,677
2008	151,201	119,265
2009	170,272	25,269
2010	232,888	2,250
2011	275,161	238,979
5 year av.	101,838	95,288
10 year av.	56,949	84,625

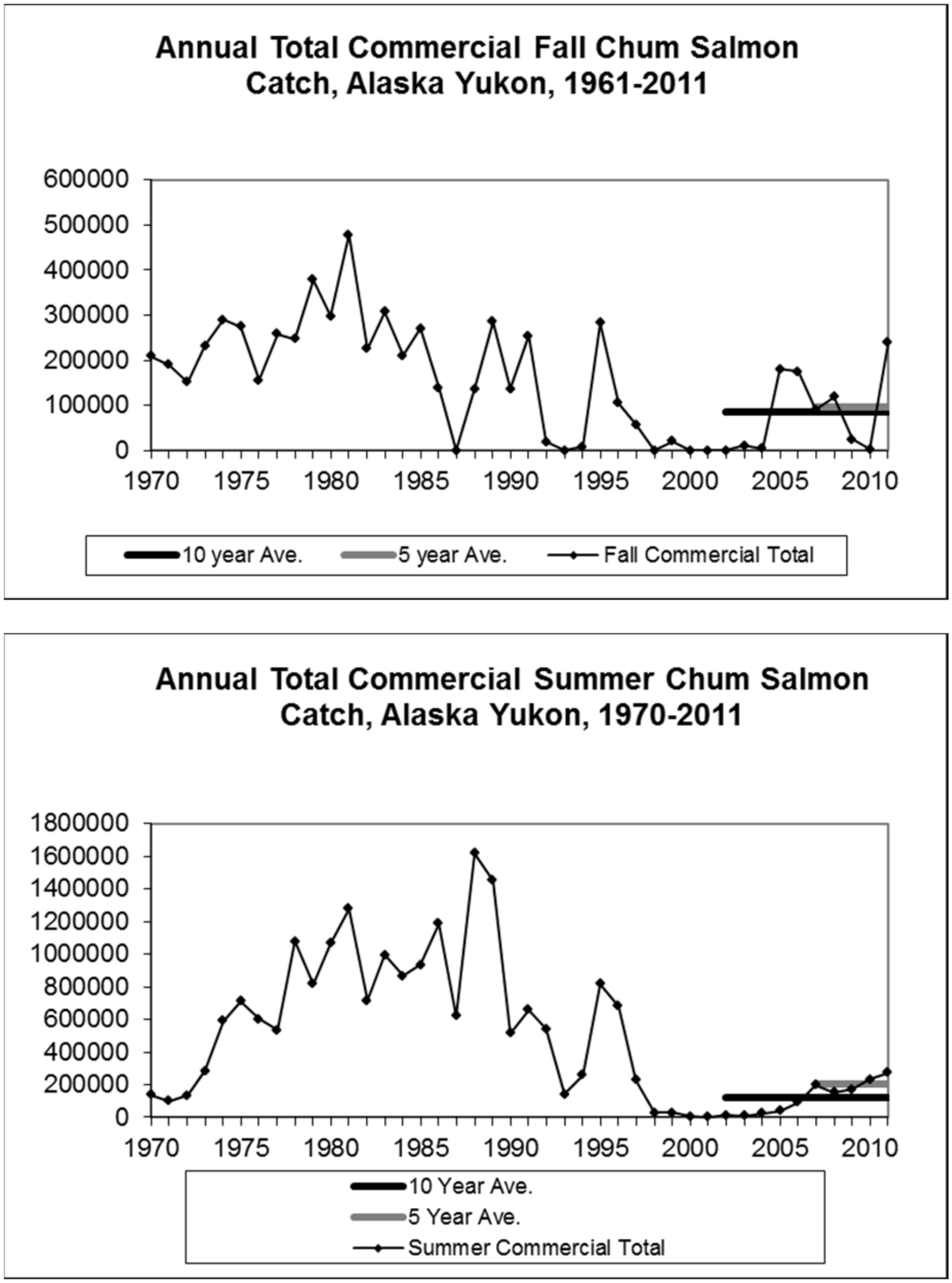


Figure A6-26 Alaska Yukon annual commercial chum salmon catch, 1970-2011.

Table A6-19 Canadian Yukon Area chum salmon catch totals, 1961-2009.

	Mainstem Yukon River Harvest						Porcupine River	Total
Year	Commercial	Domestic	Test	Aboriginal Fishery	Combined Non-Commercial	Total	Aboriginal Fishery Harvest	Canadian Harvest
1961	3,276			3,800	3,800	7,076	2,000	9,076
1962	936			6,500	6,500	7,436	2,000	9,436
1963	2,196			5,500	5,500	7,696	20,000	27,696
1964	1,929			4,200	4,200	6,129	6,058	12,187
1965	2,071			2,183	2,183	4,254	7,535	11,789
1966	3,157			1,430	1,430	4,587	8,605	13,192
1967	3,343			1,850	1,850	5,193	11,768	16,961
1968	453			1,180	1,180	1,633	10,000	11,633
1969	2,279			2,120	2,120	4,399	3,377	7,776
1970	2,479			612	612	3,091	620	3,711
1971	1,761			150	150	1,911	15,000	16,911
1972	2,532				0	2,532	5,000	7,532
1973	2,806			1,129	1,129	3,935	6,200	10,135
1974	2,544	466		1,636	2,102	4,646	7,000	11,646
1975	2,500	4,600		2,500	7,100	9,600	11,000	20,600
1976	1,000	1,000		100	1,100	2,100	3,100	5,200
1977	3,990	1,499		1,430	2,929	6,919	5,560	12,479
1978	3,356	728		482	1,210	4,566	5,000	9,566
1979	9,084	2,000		11,000	13,000	22,084		22,084
1980	9,000	4,000		3,218	7,218	16,218	6,000	22,218
1981	15,260	1,611		2,410	4,021	19,281	3,000	22,281
1982	11,312	683		3,096	3,779	15,091	1,000	16,091
1983	25,990	300		1,200	1,500	27,490	2,000	29,490
1984	22,932	535		1,800	2,335	25,267	4,000	29,267
1985	35,746	279		1,740	2,019	37,765	3,500	41,265
1986	11,464	222		2,200	2,422	13,886	657	14,543
1987	40,591	132		3,622	3,754	44,345	135	44,480
1988	30,263	349		1,882	2,231	32,494	1,071	33,565
1989	17,549	100		2,462	2,562	20,111	2,909	23,020
1990	27,537	0		3,675	3,675	31,212	2,410	33,622
1991	31,404	0		2,438	2,438	33,842	1,576	35,418
1992	18,576	0		304	304	18,880	1,935	20,815
1993	7,762	0		4,660	4,660	12,422	1,668	14,090
1994	30,035	0		5,319	5,319	35,354	2,654	38,008
1995	39,012	0		1,099	1,099	40,111	5,489	45,600
1996	20,069	0		1,260	1,260	21,329	3,025	24,354
1997	8,068	0		1,218	1,218	9,286	6,294	15,600
1998[a]				1,795	1,792	1,792	6,159	7,954
1999	10,402	0		3,234	3,234	13,636	6,000	19,636
2000	1,319	0		2,927	2,917	4,236	5,000	9,246
2001	2,198	3	1 [b]	3,077	3,030	5,228	4,594	9,872
2002	3,065	0	2,756 [b]	3,109	3,093	6,158	1,860	8,034
2003	9,030	0	990 [b]	1,493	1,943	10,973	382	10,905
2004	7,365	0	995 [b]	2,180	2,180	9,545	205	9,750
2005	11,931	13		2,035	1,813	13,744	4,593	18,572
2006	4,096	0		2,521	2,521	6,617	5,179	11,796
2007	7,109	0	3,765	2,221	2,221	9,330	4,500	13,830
2008	4,062	0		2,068	2,068	6,130	3,436	9,566
2009[c]	293	0		820	820	1,113	898	2,011
Average								
1961-2008	10,954	545	2,127	2,512	2,846	13,572	4,703	18,177
1999-2008	6,058	2	2,127	2,487	2,488	8,546	3,575	12,121
2004-2008	6,913	3	2,380	2,205	2,208	9,120	3,583	12,703

a A test fishery and aboriginal fisheries took place, but all other fisheries were closed.
b The chum salmon test fishery is a live-release test fishery.
c Data are preliminary.

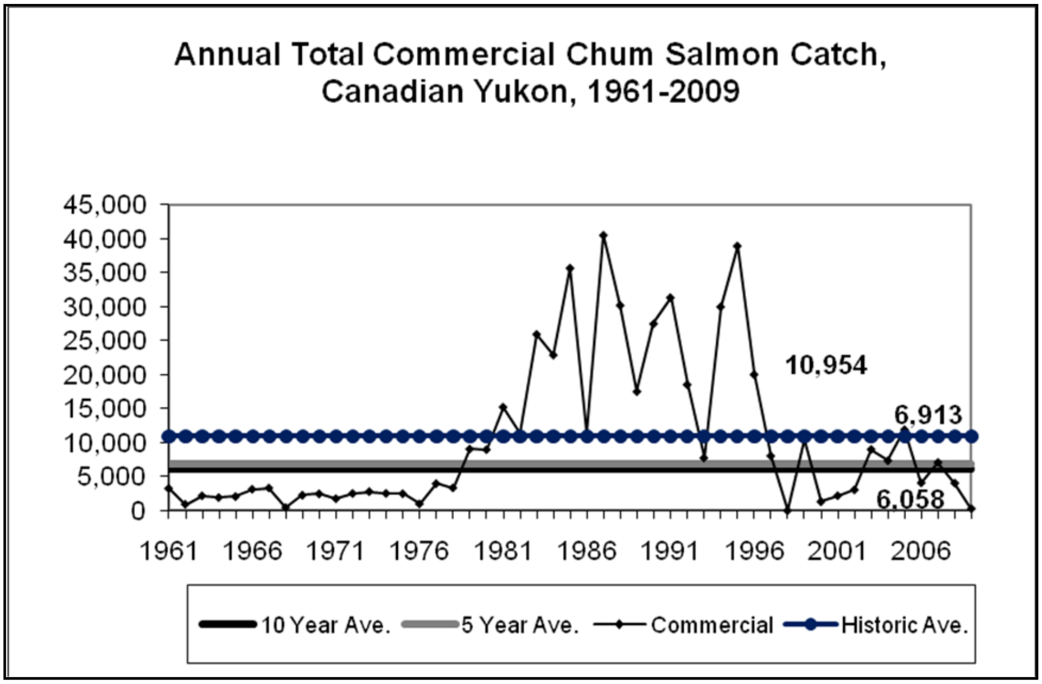


Figure A6-27 Canadian Yukon commercial chum salmon catch, 1960-2010.
Source: Data provided to NMFS by ADF&G, in 2010, in response to a special data request.

A total of 387 permit holders participated in the summer chum salmon fishery, which was approximately 33% below the 1999–2008 average of 575 permit holders. The Lower Yukon Area (Districts 1–3) and Upper Yukon Area (Districts 4–6) are separate Commercial Fisheries Entry Commission (CFEC) permit areas. A total of 376 permit holders fished in the Lower Yukon Area in 2009, which was approximately 32% below the 1999–2008 average of 555. In the Upper Yukon Area, 11 permit holders fished, which was approximately 48% below the 1999–2008 average of 21 (ADF&G 2010d Appendix A4).

Yukon River fishermen in Alaska received an estimated $556,000 for their Chinook and summer chum salmon harvest in 2009, approximately 73% below the 2004–2008 average of $2.1 million. Two buyer-processors operated in the Lower Yukon Area. Lower Yukon River fishermen received an estimated average price per pound of $5.00 for incidentally harvested Chinook and $0.50 for summer chum salmon. The average income for Lower Yukon Area fishermen in 2009 was $1,425. Two buyer-processors and one catcher-seller operated in the Upper Yukon Area. Upper Yukon Area fishermen received an estimated average price per pound of $0.26 for summer chum salmon sold in the round and $3.00 for summer chum salmon roe. The average price paid for summer chum salmon sold in the round in the Upper Yukon Area was approximately 8% above the 1999–2008 average of $0.24 per pound. No Chinook salmon were sold in the Upper Yukon Area. The average income for Upper Yukon Area fishermen that participated in the 2009 fishery was $1,857.

The preliminary 2009 commercial fall chum and coho salmon season value for the Yukon Area was $164,400 ($162,700 for the Lower Yukon Area, $1,700 for the Upper Yukon Area) (Appendix A5). The previous 5 year average value for the Yukon Area was $344,700 ($312,000 for the Lower Yukon Area, $32,700 for the Upper Yukon Area). Yukon River fishers received an average price of $0.70 per pound for fall chum salmon in the Lower Yukon Area and $0.19 per pound in the Upper Yukon Area in 2009. This compares to the 1999–2008 average of $0.28 per pound in the Lower Yukon Area and $0.16 per pound in the Upper Yukon Area. For coho salmon, fishermen in the Lower and Upper Yukon Areas received an average price of $1.00 per pound and $0.15 per pound compared to the recent 10-year average price of $0.39 and $0.12 per pound, respectively (ADF&G 2010d Appendix A5).

Table A6-20 (ADF&G 2007 NMFS data request) provides historic data on Yukon Chinook and Summer chum commercial sales value, from 1977-2007. In the lower Yukon River, Chinook commercial harvest value peaked in 1992 at just under $14 million, approximately 99 percent of which came from the lower Yukon. As harvest trended downward in the late 1990s so did Chinook value and, by 2001, there were no commercial Chinook openings in the Yukon River, partly due to the need to conserve chum stocks. Since 2001, the Chinook and chum runs have improved enough to allow for commercial openings; however, the catch, and value, are still much lower than historic levels and the 2009 harvest was worth just over a half a million dollars, which is the lowest level since complete closure of the Yukon in 2001. A review of the summer chum data shows that the value of the summer chum fishery has fallen precipitously since the late 1980s. Also evident is that the Chinook fishery is often more than ten times as valuable as the chum fishery. This fact highlights the importance of the commercial Chinook fishery as a major source of cash income in the region.

Table A6-20 Real gross ex-vessel revenue from commercial salmon fishing to Yukon Area fishermen, summer season, 1977-2011. (Values are inflation adjusted to 2010 value using the base 2005 GDP deflator).

	Yukon Chinook			Yukon Summer Chum				
Year	Lower Value	Upper Value	Subtotal	Lower Value	Upper Value	Subtotal	Total Season	Total Value
1977	$5,345,682	$431,962	$5,777,643	$2,924,770	$889,908	$3,814,678	$9,592,322	$12,391,150
1978	$5,558,550	$180,355	$5,738,904	$5,620,303	$1,779,176	$7,399,479	$13,138,383	$15,574,531
1979	$6,922,002	$311,178	$7,233,180	$5,617,300	$1,114,471	$6,731,770	$13,964,950	$17,963,612
1980	$7,825,785	$260,917	$8,086,702	$2,359,228	$1,439,884	$3,799,112	$11,885,814	$13,290,688
1981	$9,278,538	$433,171	$9,711,708	$5,753,456	$1,468,969	$7,222,425	$16,934,133	$21,032,238
1982	$7,454,000	$321,848	$7,775,848	$2,448,465	$895,794	$3,344,258	$11,120,107	$13,205,830
1983	$7,789,799	$200,920	$7,990,719	$3,300,210	$536,406	$3,836,616	$11,827,335	$13,252,504
1984	$6,439,277	$187,724	$6,627,001	$1,700,039	$702,038	$2,402,077	$9,029,078	$10,398,485
1985	$7,644,767	$147,119	$7,791,886	$1,838,369	$1,057,060	$2,895,429	$10,687,315	$12,495,585
1986	$5,512,497	$127,774	$5,640,271	$3,041,735	$1,104,372	$4,146,107	$9,786,378	$10,904,748
1987	$9,188,631	$230,516	$9,419,147	$2,223,338	$547,721	$2,771,059	$12,190,206	$12,190,206
1988	$8,940,623	$232,825	$9,173,447	$8,183,489	$1,986,499	$10,169,989	$19,343,436	$21,893,695
1989	$8,170,431	$170,574	$8,341,005	$3,496,838	$2,171,419	$5,668,257	$14,009,262	$16,050,655
1990	$7,318,991	$159,858	$7,478,849	$755,408	$769,133	$1,524,541	$9,003,390	$9,895,264
1991	$10,451,693	$142,429	$10,594,123	$1,147,028	$919,583	$2,066,611	$12,660,733	$14,006,551
1992	$14,260,996	$242,050	$14,503,046	$869,346	$752,228	$1,621,574	$16,124,620	$16,230,163
1993	$6,843,993	$158,651	$7,002,643	$317,775	$285,531	$603,306	$7,605,949	$7,605,949
1994	$5,721,837	$170,546	$5,892,383	$108,701	$544,404	$653,105	$6,545,488	$6,569,169
1995	$7,148,727	$117,040	$7,265,767	$324,798	$1,425,471	$1,750,269	$9,016,037	$9,612,829
1996	$4,606,318	$62,377	$4,668,696	$117,441	$1,274,774	$1,392,215	$6,060,911	$6,329,819
1997	$7,065,806	$143,526	$7,209,331	$73,291	$125,497	$198,787	$7,408,119	$7,634,742
1998	$2,450,151	$22,157	$2,472,308	$33,861	$1,052	$34,913	$2,507,221	$2,507,221
1999	$6,254,051	$94,085	$6,348,136	$24,871	$2,173	$27,044	$6,375,179	$6,425,882
2000	$897,236	$0	$897,236	$10,675	$0	$10,675	$907,911	$907,911
2001 [a]	$0	$0	$0	$0	$0	$0	$0	$0
2002	$2,012,315	$24,684	$2,037,000	$5,167	$7,349	$12,516	$2,049,515	$2,049,515
2003	$2,179,722	$47,710	$2,227,432	$1,846	$8,013	$9,860	$2,237,291	$2,275,329
2004	$3,470,330	$43,373	$3,513,703	$10,063	$10,925	$20,988	$3,534,691	$3,547,287
2005	$2,139,804	$26,763	$2,166,567	$12,062	$14,775	$26,837	$2,193,404	$2,706,218
2006	$3,492,970	$34,640	$3,527,610	$25,331	$45,635	$70,966	$3,598,576	$3,914,797
2007	$1,999,661	$28,039	$2,027,700	$227,607	$35,496	$263,102	$2,290,803	$2,590,270
2008	$328,469	$0	$328,469	$329,928	$66,444	$396,372	$724,840	$1,402,550
2009	$20,970	$0	$20,970	$514,856	$20,430	$535,286	$556,256	$720,696
2010	$639,230	$0	$639,230	$823,967	$61,534	$885,501	$1,524,731	
2011	$0	$0	$0	$1,301,403	$12,966	$1,314,369	$1,314,369	
5 year Ave.	$2,286,247	$26,563	$2,312,810	$120,998	$34,655	$155,653	$2,468,463	$2,832,224
10 year Ave.	$2,277,456	$29,929	$2,307,385	$64,755	$19,081	$83,836	$2,391,221	$2,581,976

Source: Data provided to NMFS by ADF&G in response to a data request.
a No commercial salmon fisheries occurred in the Yukon River in 2001.

Table A6-21 provides historic data on Yukon fall chum and coho commercial fisheries. The data shows that these fisheries have fallen in real commercial ex-vessel gross value from historic highs in the late 1980s and have had several periods of no commercial harvest since then. From 2000 through 2002, there were no commercial harvest of fall chum and coho in the Yukon River. Subsequently, harvests have been allowed; however, total value remains well below historic highs and averages.

Table A6-21 Real gross ex-vessel revenue from commercial salmon fishing to Yukon Area fishermen, fall season, 1977-2011. (Values are inflation adjusted to 2010 value using the 2005 GDP Deflator)

	Yukon Fall Chum			Yukon Coho			
Year	**Lower Value**	**Upper Value**	**Subtotal**	**Lower Value**	**Upper Value**	**Subtotal**	**Total Season**
1977	$2,086,466	$296,664	$2,383,130	$409,162	$6,536	$415,698	$2,798,828
1978	$1,877,168	$279,711	$2,156,879	$262,704	$16,564	$279,269	$2,436,147
1979	$2,901,838	$871,224	$3,773,062	$209,070	$16,530	$225,600	$3,998,662
1980	$904,820	$454,722	$1,359,542	$39,883	$5,450	$45,333	$1,404,874
1981	$3,156,207	$748,898	$3,905,104	$183,412	$9,588	$193,000	$4,098,104
1982	$1,674,515	$105,354	$1,779,869	$268,692	$37,162	$305,855	$2,085,723
1983	$1,124,658	$245,384	$1,370,042	$33,296	$21,831	$55,126	$1,425,168
1984	$686,600	$189,674	$876,274	$469,614	$23,518	$493,132	$1,369,406
1985	$1,129,717	$317,091	$1,446,807	$313,760	$47,703	$361,463	$1,808,270
1986	$695,482	$52,788	$748,270	$369,131	$968	$370,100	$1,118,370
1987	$0	$0	$0	$0	$0	$0	$0
1988	$1,045,129	$247,578	$1,292,707	$1,201,727	$55,825	$1,257,552	$2,550,259
1989	$1,124,879	$353,194	$1,478,073	$509,775	$53,546	$563,321	$2,041,394
1990	$361,580	$265,631	$627,211	$208,451	$56,213	$264,663	$891,874
1991	$642,661	$231,416	$874,077	$440,134	$31,606	$471,740	$1,345,817
1992	$0	$77,573	$77,573	$0	$27,971	$27,971	$105,543
1993	$0	$0	$0	$0	$0	$0	$0
1994	$0	$11,689	$11,689	$0	$11,993	$11,993	$23,682
1995	$248,758	$225,278	$474,036	$107,576	$15,181	$122,756	$596,792
1996	$64,089	$59,945	$124,033	$127,698	$17,177	$144,875	$268,908
1997	$112,170	$9,401	$121,571	$103,675	$1,377	$105,052	$226,623
1998	$0	$0	$0	$0	$0	$0	$0
1999	$45,023	$1,107	$46,130	$4,573	$0	$4,573	$50,703
2000	$0	$0	$0	$0	$0	$0	$0
2001 [a]	$0	$0	$0	$0	$0	$0	$0
2002	$0	$0	$0	$0	$0	$0	$0
2003	$6,981	$3,958	$10,939	$21,163	$5,935	$27,099	$38,038
2004	$1,275	$961	$2,236	$3,142	$7,218	$10,360	$12,596
2005	$347,149	$52,789	$399,938	$91,850	$21,026	$112,876	$512,814
2006	$215,114	$35,888	$251,002	$53,396	$11,823	$65,219	$316,221
2007	$148,760	$17,435	$166,195	$131,862	$1,411	$133,272	$299,467
2008	$432,903	$22,292	$455,194	$218,765	$3,751	$222,516	$677,710
2009	$110,408	$1,262	$111,670	$52,303	$467	$52,770	$164,440
2010	$5,428	$2,761	$8,189	$20,535	$442	$20,977	$29,166
2011	$1,627,575	$16,114	$1,643,689	$472,168	$6,792	$478,960	$2,122,649
2004-2008 Ave.	$465,015	$11,973	$476,987	$179,126	$2,573	$181,699	$658,686
1999-2008 Ave.	$289,559	$15,346	$304,905	$106,518	$5,886	$112,405	$417,310

Source: Derived from data provided to NMFS by ADF&G in response to a data request.

[a] No commercial salmon fisheries occurred in the Yukon River in 2001.

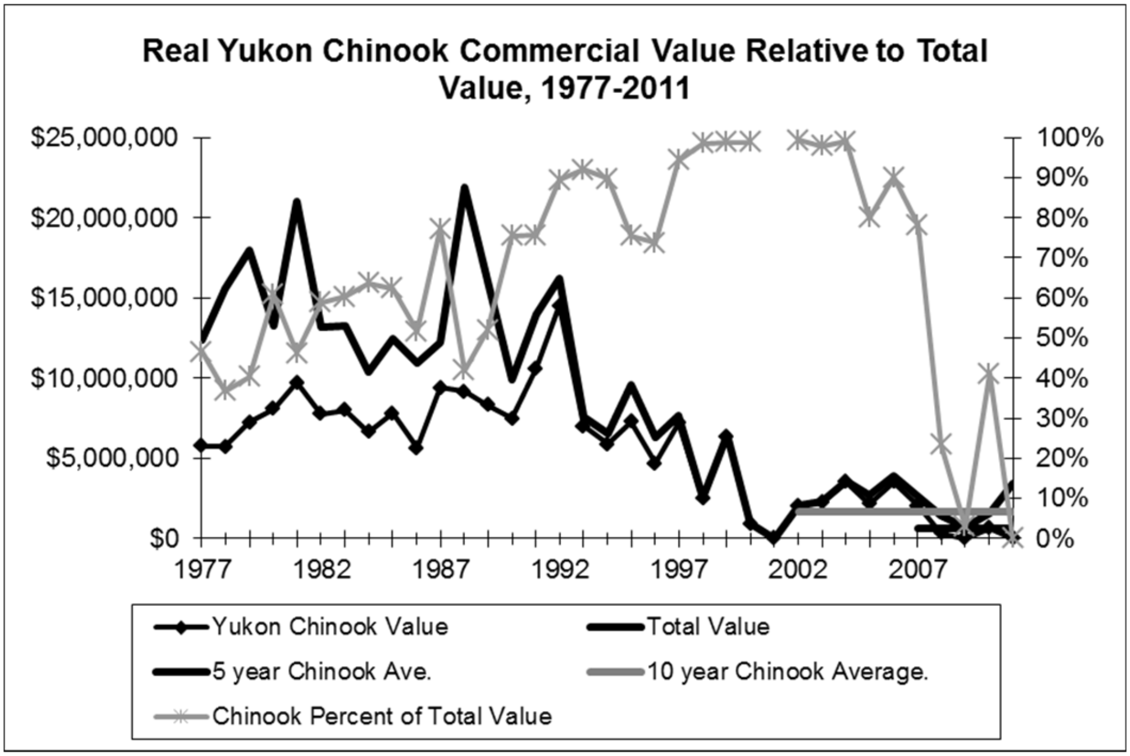


Figure A6-28 Real Yukon Chinook commercial value relative to total value, 1977-2011. (Values are inflation adjusted to 2010 value using the base 2005 GDP deflator).
Source: Derived from data provided to NMFS by ADF&G in response to a data request.

Figure A6-29 depicts the comparison between Yukon Chinook commercial value and total commercial value from all salmon fisheries from 1977-2009. Also shown is the percent of total value that the commercial Chinook value represents. Since the early 1990s, Chinook has accounted for 70 percent to nearly 100 percent of the total commercial value. Also shown is the decline in Chinook value and total value during the 1990s, as well as the fall to zero when all the fisheries were closed in 2001. As Chinook catch improved, since 2001, so has Chinook value and total value; however, the 2008 and 2009 Chinook catch and values fell sharply from previous years.

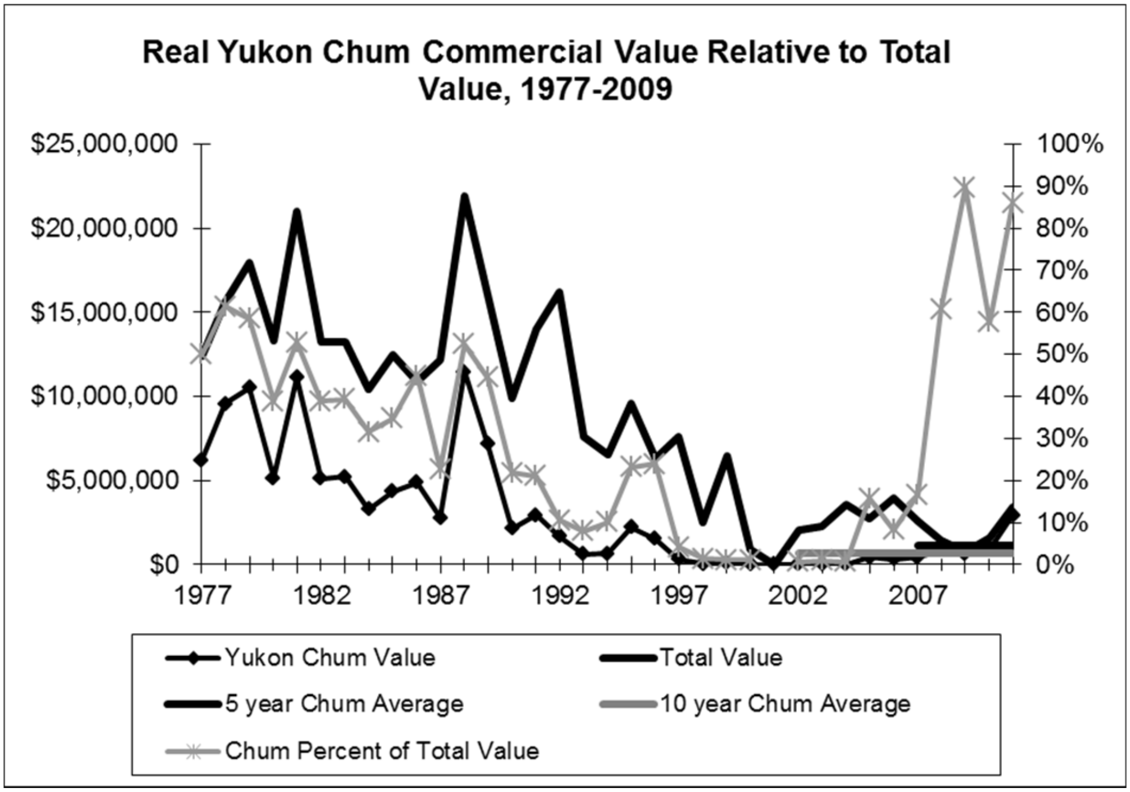


Figure A6-29 Real Yukon Chum commercial value relative to total value, 1977-2011. (Values are inflation adjusted to 2010 value using the base 2005 GDP deflator).
Source: Derived from data provided to NMFS by ADF&G in response to a data request.

Figure A6-30 depicts the comparison between Yukon Chum commercial value and total commercial value from all salmon fisheries from 1977-2009. Also shown is the percent of total value that the commercial chum value represents. Historically, chum salmon has represented as much as half of all commercial value earned in the Alaska Yukon. As chum harvests trended downward the proportion of chum to total value also fell. However, with the concurrent decline in Chinook value, some improvement in chum harvests overall, and continued decline in Chinook value, chum salmon value has become increasingly important in the past several years. In 2009, for example, chum value was 90 percent of the total value earned in the Alaska Yukon commercial salmon fishery.

A6.1.3.5 Yukon Rivery Chum Salmon Subsistence Harvest[10]

Depending on the area of the Yukon River drainage and salmon species' run timing, subsistence fishing occurs from late May through early October; fishing opportunity in the Lower Yukon Area in May and in the Upper Yukon Area in October is highly dependent upon river ice conditions. Table A6-23 below lists subsistence salmon harvest by community in the Yukon River Management Area for 2008. Chum salmon in the Yukon River consist of an earlier, and typically more abundant, summer chum salmon run and a later fall chum salmon run. Fishing activities are based either from fish camps or from the home villages; fishing patterns and preferred sites vary from community to community. Extended family groups, typically representing several households, often undertake subsistence salmon fishing together. Households and related individuals typically cooperate to harvest, process, preserve, and store salmon for subsistence uses (JTC, 2010).

[10] An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

Since adopted by the BOF in 2001, the subsistence salmon fishery has been managed based on a schedule implemented chronologically consistent with migratory timing as the run progresses upstream. Subsistence fishing is open 7 days per week until the schedule is established. The subsistence salmon fishing schedule is based on current or past fishing schedules and provides reasonable opportunity for subsistence during years of normal to below average runs. The objectives of the schedule are to 1) reduce harvest early in the run when there is a higher level of uncertainty, 2) spread the harvest throughout the run to reduce harvest impacts on any particular component of the run and 3) provide subsistence fishing opportunity among all users during years of low salmon runs (personal communication, J. Linderman, 2010). Table A6-22 below presents the 2010 subsistence fishing schedule as it was established prior to the start of the season. Once commercial fishing is opened, subsistence fishing is open seven days per week, 24 hours per day, with the exception of closed periods 18 hours before, during, and 12 hours after commercial openings.

Table A6-22 Yukon Area subsistence fishing schedule by Yukon River district, 2012.

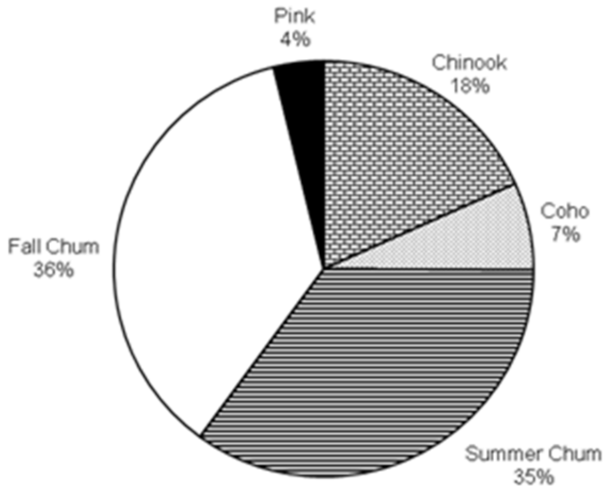
Geographic Area/District	Fishing Period	Schedule to Begin	Days of the Week
Coastal District	7 days/week	All season	M/T/W/Th/F/Sa/Su - 24 hours
District Y-1	Two 36-hour periods/week	May 31	Mon. 8 pm to Wed. 8 am/Thu. 8 pm to Sat. 8 am
District Y-2	Two 36-hour periods/week	June 3	Wed. 8 pm to Fri. 8 am/Sun. 8 pm to Tue. 8 am
District Y-3	Two 36-hour periods/week	June 6	Wed. 8 pm to Fri. 8 am/Sun. 8 pm to Tue. 8 am
Subdistrict Y-4-A	Two 48-hour periods/week	June 10	Sun. 6 pm to Tue. 6 pm/Wed. 6 pm to Fri. 6 pm
Subdistricts Y-4-B, C	Two 48-hour periods/week	June 17	Sun. 6 pm to Tue. 6 pm/Wed. 6 pm to Fri. 6 pm
Koyukuk and Innoko Rivers	7 days/week	All season	M/T/W/Th/F/Sa/Su - 24 hours
Subdistricts Y-5-A, B, C	Two 48-hour periods/week	June 22	Tue. 6 pm to Thu. 6 pm/Fri. 6 pm to Sun. 6 pm
Subdistricts Y-5-D	7 days/week	All season	M/T/W/Th/F/Sa/Su - 24 hours
District Y-6	Two 42-hour periods/week	All season	Mon. 6 pm to Wed. Noon/Fri. 6 pm to Sun. Noon
Old Minto Area	5 days/week	All season	Friday 6 pm to Wednesday 6 pm

Most Yukon Area communities have no regulatory requirements to report their subsistence salmon harvest. For these communities, ADF&G operates a voluntary survey program. Harvest information is collected through postseason household interviews, follow-up telephone interviews and postal questionnaires, and harvest calendars. In select areas, fishermen must document their harvest on a subsistence or personal use permit. Subsistence harvest information is necessary to determine if sufficient salmon are returning to the Yukon Area for escapement and subsistence requirements, and if adequate fishing opportunity is provided to meet subsistence uses. Subsistence harvest information is critical for run reconstruction analysis and forecasting (Bergstrom et al., 2009).

Table A6-23 Estimated subsistence salmon harvests by community, Yukon Area, 2008.

	Households or permits		Estimated salmon harvests[a]					
Community	Total	Surveyed or returned	Chinook	Coho	Summer Chum	Fall Chum	Pink	Total
Alakanuk	123	48	1,238	157	6,881	423	494	9,193
Alatna	14	8	16	0	66	0	0	82
Allakaket	48	22	58	152	3,229	1,345	0	4,784
Anvik	32	26	1,433	40	340	317	23	2,153
Beaver	32	24	546	6	27	13	0	592
Bettles	22	18	0	0	0	0	0	0
Birch Creek	19	6	32	0	0	30	0	62
Central	12	12	48	0	0	0	0	48
Chalkyitsik	32	18	0	0	0	0	0	0
Circle	20	14	519	0	5	3,198	0	3,722
Eagle	41	39	1,068	0	14	15,269	0	16,351
Emmonak	154	81	2,696	717	9,646	1,670	641	15,370
Fairbanks	282	272	2,127	356	465	1,310	0	4,258
Fort Yukon	174	71	1,991	1,618	230	14,252	196	18,287
Galena	185	63	2,232	558	758	1,364	31	4,943
Grayling	48	13	1,761	25	660	1,012	200	3,658
Healy	5	4	13	1,105	0	1,030	0	2,148
Holy Cross	54	33	2,509	38	441	920	20	3,928
Hooper Bay	202	83	388	66	12,007	329	1,013	13,803
Hughes	28	24	61	0	944	127	0	1,132
Huslia	82	27	255	100	4,377	64	100	4,896
Kaltag	68	25	2,403	45	916	620	383	4,367
Kotlik	94	39	2,066	313	4,291	671	1,161	8,502
Koyukuk	33	29	513	84	1,104	1,177	67	2,945
Manley Hot Springs	19	19	106	4,243	144	7,058	0	11,551
Marshall	73	27	3,284	490	3,023	748	26	7,571
Minto	46	41	12	0	9	28	0	49
Mountain Village	144	64	1,645	518	7,559	926	500	11,148
Nenana	35	33	327	2,775	950	7,512	0	11,564
Nulato	83	26	1,250	195	468	729	35	2,677
Nunam Iqua (Sheldon Point)	37	29	163	24	1,949	59	757	2,952
Pilot Station	107	53	1,597	268	6,012	917	34	8,828
Pitka's Point	28	23	544	130	1,246	101	15	2,036
Rampart	3	3	136	0	27	1,000	0	1,163
Ruby	61	28	637	291	655	657	184	2,424
Russian Mission	69	26	2,949	372	2,400	578	436	6,735
Saint Marys	124	61	1,756	591	6,451	830	367	9,995
Scammon Bay	80	33	1,104	50	6,113	57	2,766	10,090
Shageluk	37	25	397	0	130	323	0	850
Stevens Village	30	22	753	0	163	643	0	1,559
Tanana	97	48	3,981	1,511	2,877	17,478	80	25,927
Venetie	62	23	292	0	50	1,563	0	1,905
Other Communities	91	81	406	67	25	3,190	0	3,688
Total	**3,030**	**1,664**	**45,312**	**16,905**	**86,652**	**89,538**	**9,529**	**247,936**

The species composition of the estimated 2008 subsistence–personal use salmon harvests for the entire Yukon Area included 86,652 summer chum salmon (35%) and 89,538 fall chum salmon (36%) out of a estimate of 247,936 total salmon (all species) (Figure A6-30). This is an estimated total based on household surveys and returned permits and calendars, and it includes subsistence harvests, personal use harvests, commercial harvests retained for home uses, and fish distributed from ADF&G test fisheries. The 2008 harvest estimates registered above the 5-year average for fall chum salmon and below the 5-year average for summer chum salmon. While low salmon abundance in 2001 closed commercial fishing in the Alaska portion of the Yukon River drainage, a small commercial fishery for Chinook and summer chum salmon has been offered in every year since, including 2007 (Fall et al., 2011).



Source: Fall et al., 2011.

Figure A6-30 Yukon area estimated subsistence salmon harvests, 2008.

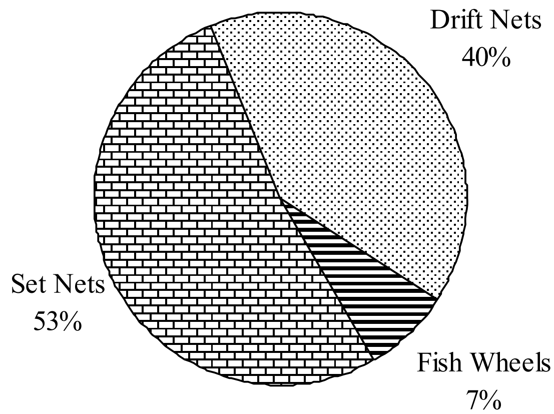
The estimated 2008 subsistence harvest of 86,652 summer chum salmon was below both the five year and 10-year averages (93,011 and 86,947, respectively). While summer chum salmon harvests have been relatively stable since 1990, they mark a significant decrease from the 1980s when harvests were higher, likely due to the then-existing commercial roe fishery in the middle Yukon River. The fall chum salmon harvest of 89,538 is also an increase in harvest since 1997 and registers above both the 5-year average of 79,540 fall chum salmon and the 10-year average of 61,973 fall chum salmon, both of which reflect multiple years of poor runs and harvests (Table A6-24). It should be noted that regulatory restrictions were implemented so as to protect fall chum salmon stocks due to these poor runs in 1998, and 2000 through 2003. While harvests of fall chum salmon have recently climbed from earlier years' estimates, comparison with average fall chum salmon harvests for 1976–2007 begins to show the true magnitude of the harvest decline in this fishery between 2000 and 2003; the historical average (1976–2007) harvest of fall chum salmon was 117,460 fish (Fall et al., 2011).

Table A6-24 Estimated historical subsistence chum salmon harvest, Yukon River area, 1976-2008.

	Households or Permits[a]		Estimated salmon harvest[a]					
Community	Total	Surveyed or Returned	Chinook	Coho	Summer Chum	Fall Chum	Pink	Total
1976			17,530	12,737		1,375		31,642
1977			16,007	16,333		4,099		36,439
1978			30,785	7,965	213,953	95,532		348,235
1979			31,005	9,794	202,772	233,347		476,918
1980			42,724	20,158	274,883	172,657		510,422
1981			29,690	21,228	210,785	188,525		450,228
1982			28,158	35,894	260,969	132,897		457,918
1983			49,478	23,905	240,386	192,928		506,697
1984			42,428	49,020	230,747	174,823		497,018
1985			39,771	32,264	264,828	206,472		543,335
1986			45,238	34,468	290,825	164,043		534,574
1987			55,039	46,213	300,042	226,990		628,284
1988	2,700	1,865	45,495	69,679	229,838	157,075		502,087
1989	2,211	983	48,462	40,924	169,496	211,303		470,185
1990	2,666	1,121	48,587	43,460	115,609	167,900		375,556
1991	2,521	1,261	46,773	37,388	118,540	145,524		348,225
1992	2,751	1,281	47,077	51,980	142,192	107,808		349,057
1993	3,028	1,397	63,915	15,812	125,574	76,882		282,183
1994	2,922	1,386	53,902	41,775	124,807	123,565		344,049
1995	2,832	1,391	50,620	28,377	136,083	130,860		345,940
1996	2,869	1,293	45,671	30,404	124,738	129,258		330,071
1997	2,825	1,309	57,117	23,945	112,820	95,141		289,023
1998	2,986	1,337	54,124	18,121	87,366	62,901		222,512
1999	2,888	1,377	50,515	19,984	79,250	83,420		233,169
2000	3,209	1,341	36,844	16,650	77,813	19,402	1,591	152,300
2001	3,072	1,355	56,103	23,236	72,392	36,164	403	188,298
2002	2,775	1,254	44,384	16,551	87,599	20,140	8,425	177,100
2003	2,850	1,377	56,872	24,866	83,802	58,030	2,167	225,737
2004	2,721	1,228	57,549	25,286	79,411	64,562	9,697	236,506
2005	2,662	1,406	53,547	27,357	93,411	91,667	3,132	269,114
2006	2,833	1,473	48,682	19,985	115,355	84,320	4,854	273,196
2007	2,819	1,495	55,292	22,013	93,075	99,120	2,118	271,618
2008	3,030	1,664	45,312	16,905	86,652	89,538	9,529	247,936
5-year average (2003-2007)	2,777	1,396	54,388	23,901	93,011	79,540	4,394	255,234
10-year average (1998-2007)	2,882	1,364	51,391	21,405	86,947	61,973	4,048	224,955
Historical average (1976-2007)	2,807	1,347	45,293	28,368	158,645	117,460	4,048	340,864

Source: ADF&G Division of Commercial Fisheries personal communication, preliminary report. Tables 1, 3, 7, and 11. Preliminary results as of June 9, 2009.

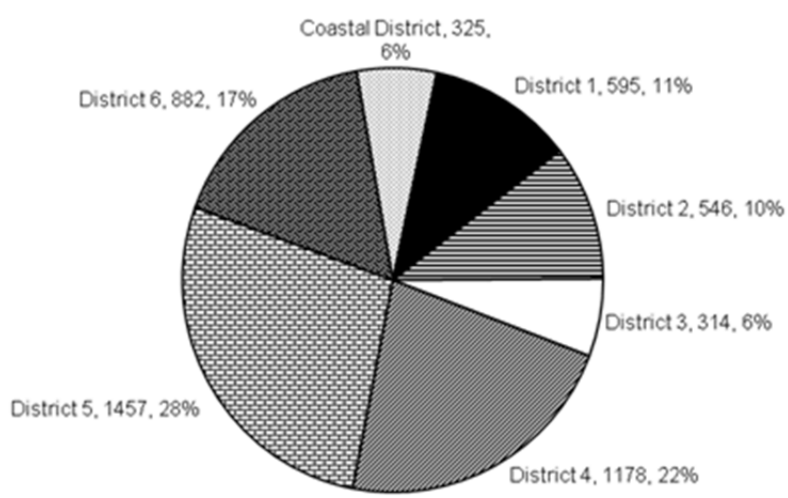
[a]Estimates prior to 1988 are based on fish camp surveys and sampling information is unavailable.



Source: Fall et al., 2011.

Figure A6-31 Primary gear type utilized for subsistence salmon fishing, Yukon area, 2008
Primary gear types used by fishing households in surveyed villages in 2008 included set gillnet (53%), drift gillnet (40%), and fish wheel (7%), largely the same as 2006 and 2007 (Fall et al., 2009).

Of the estimated 1,732 households (drainage-wide) owning dogs, about 16% (268 households) are estimated to have fed their dogs whole salmon in 2008. Of the 5,5,310 dogs owned by fishing households in 2008, about 67% (3,530 dogs) were owned by households in the Upper Yukon River, which includes districts 4, 5, and 6. In 2008, species-specific information on the number of salmon retained for dog food was collected from subsistence harvests in surveyed communities; in permit communities, only the number of whole salmon, not species-specific, was documented. In the Coastal District and in districts 1 through 5, an estimated 12,045 summer chum salmon and 29,583 fall chum salmon were retained for dog food from subsistence salmon harvests. An additional 24,487 whole salmon (species unknown) were fed to dogs by permit holders, including those users in District 6. From commercial harvests, 2,322 summer chum salmon and 9,005 fall chum salmon were retained and used as dog food in Districts 1–5 (Fall et al., 2009).



Source: Fall et al., 2011.

Figure A6-32 Estimated number of dogs by district, Yukon area, 2008.

Since 1992, ADF&G has inquired as to whether surveyed households were meeting their subsistence salmon needs for that year. The disastrous fishing year in 2000 resulted in restrictions and closures in subsistence salmon fishing schedules and made it extremely difficult for fishing families to meet their needs (64% of surveyed households reported not meeting their needs in 2000). In 2003, ADF&G began asking this question in a species-specific manner, measuring responses by community and by species. Specifically, surveyed households were asked whether 100%, 75%, 50%, or <25% of their harvest needs were met for each species. Two checkboxes, "0%" and "no need," were added to the 2005 survey in order to distinguish those who had a need, but no success in harvesting a species, from those who had no need and therefore, did not harvest any fish. In 2008, 1,142 households (46% of the estimated total in Distrits 1-5) and 522 permit holders (466 subsistence permit holders and 56 personal use permit holders) provided harvest data for the Yukon area subsistence-personal use salmon fishery. According to the 2008 data, 51% of all households reported meeting >75% of their needs for summer chum salmon and 37% reported meeting >75% of their needs for fall chum salmon. Forty-two percent and 58%of households reporting meeting less than one-half their needs for summer chum salmon and fall chum salmon, respectively(Fall et al., 2011).

In 1993, the BOF made a positive customary and traditional (C&T) use finding for all salmon in the Yukon–Northern Area. Since 1990, the overall total subsistence salmon harvest in the Yukon area has declined by approximately 30%. The ANS determination for summer chum salmon was established at 83,500-142,192 and at 89,500-167,900 for fall chum salmon. In 2001, the BOF determined species-specific amounts of salmon necessary for subsistence. Only summer chum salmon harvests were within ANS ranges in 2008. All species were within ANS ranges in 2007; 2005 and 2007 mark the only times this has happened since 2001 (and 1998, if species-specific ANS estimates are projected back to 1998) (Table A6-25) (Fall et al., 2011).

Table A6-25 Comparison of amounts necessary for subsistence (ANS) and estimated subsistence chum salmon harvests, Yukon River area, 1998-2008.

	Chinook	**Coho**	**Summer Chum**	**Fall Chum**
ANS Range	45,500-66,704	20,500-51,980	83,500-142,192	89,500-167,900
Year	Estimated Number of Subsistence Salmon Harvested			
1998	54,124	**<u>18,121</u>**	87,366	**<u>62,901</u>**
1999	53,305	20,885	83,784	89,940
2000	**<u>36,404</u>**	**<u>14,939</u>**	**<u>78,072</u>**	**<u>19,395</u>**
2001	55,819	22,122	**<u>72,155</u>**	**<u>35,703</u>**
2002	**<u>43,742</u>**	**<u>15,489</u>**	87,056	**<u>19,674</u>**
2003	56,959	23,872	**<u>82,272</u>**	**<u>56,930</u>**
2004	55,713	20,795	**<u>77,934</u>**	**<u>62,526</u>**
2005	53,409	27,250	93,259	91,534
2006	48,593	**<u>19,706</u>**	115,093	**<u>83,987</u>**
2007	55,156	21,878	92,891	98,947
2008	**<u>45,184</u>**	**<u>16,855</u>**	86,504	**<u>89,357</u>**

Source: ADF&G Division of Commercial Fisheries preliminary report; Appendices B1-B4. Preliminary results as of June 9, 2011.

<u>Bold underlined</u> cells indicate harvest amounts are below the minimum ANS. Totals include Coastal District, harvests from subsistence permits, and test fish. Totals do not include personal use salmon harvests.

In January 2001, the BOF used ADF&G's harvest data to adjust the amount necessary for subsistence, a measure which attempts to quantify the amount of salmon reasonably necessary for subsistence use in the Yukon area. Harvest estimates include personal use, test fish distributions, and commercial retained and these parameters were included in harvest estimates used to establish current ANS ranges[11]. The BOF established maximum and minimum ANS harvest ranges based on the total historic estimated harvest for each species by all districts combined for the years from 1990 to 1999, with exceptions for years when subsistence fishing was restricted to meet escapement requirements for fall chum salmon and coho salmon. The ANS levels represent the needs of all subsistence users drainage-wide and do not necessarily reflect the needs of specific individuals, communities, or sections of the drainage.

2011 Fishery Update[12]

According to preseason management strategies and inseason assessment through the early poton of the run, the Chinook salmon run was expected to be large enough to provide for escapement but not large enough to meet subsistence needs.

Consistent with preseason management strategies, a conservation management plan was initiated in District 1 and the northern portion of the Coastal District on June 13. Based upon historical run timing and the current inseason information, a subsistence salmon fishing period was cancelled to protect the first pulse of Chinook in each fishing district and subdistrict based on migratory timing. As the run developed it became evident that the Chinook salmon run size would likely be at or below the lower end of preseason projections. Consequently, it was necessary to protect the second pulse of Chinook salmon. An additional two subsistence periods were reduced by half in District 1 and an additional subsistence period in Districts 2-5 was cancelled to ensure that escapement goals were met.

Furthermore, beginning June 27 in District 1 and June 29 in District 2, the mesh size during subsistence fishing periods was restricted to six inch or smaller for the remainder of the summer season to provide further protection on the third pulse of Chinook salmon as it passed through the districts. This management action was taken with the intent that Chinook salmon incidentally harvested during summer chum directed commercial fishing periods in these districts would be used for subsistence purposes, which would help offset a reduction in subsistence fishing opportunity.

Some subsistence fishermen were able to take advantage of early Chinook salmon throughout the drainage, but many delayed harvest effort, preferring better processing weather and higher abundance later in the run. Preliminary reports from fishermen incidate that management actions taken later in the run to reduce the subsistence havest of Chinook salmon resulted in many fishermen throughout the drainage not meeting their subsistence needs. Subsistence harvest surveys are currently being conducted by the deparement and the 2011 harvest information is not available at this time.

A6.1.3.6 Yukon River Sport and Personal Use Fisheries

Most of the Yukon River drainage's sport fishing effort occurs in the Tanana River drainage along the road system and most effort is directed primarily at Chinook and coho salmon. Little sport fishing effort is directed at chum salmon, but all chum salmon harvested in the sport fishery are categorized as summer chum salmon. Although a portion of the genetically distinct fall chum salmon stock may be taken by sport fishers, most of the sport chum salmon harvest is thought to be made up of summer chum salmon because: 1) the run is much more abundant in tributaries where most sport fishing occurs; and 2) the

[11] It should be noted that harvest estimates derived from source data presented in Table 8 will differ when compared to harvest estimates (prior to 2005) presented in The 2008 Annual Subsistence Report (2011). Subsistence harvest estimates presented in the 2008 Annual Subsistence Report have been adjusted and do not include personal use harvests, ADF&G test fishery distributions, or salmon retained from commercial harvests.

[12] http://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercial.main.

chum salmon harvest is typically incidental to efforts directed at Chinook salmon, which overlap in run timing with summer chum salmon (JTC, 2010).

From 2004-2008, the Tanana River on average made up 36% of the total Yukon River drainage summer chum salmon harvest. On September 1, 2009 two Emergency Orders were issued to close all waters of the Yukon and Tanana River drainages to the retention of chum salmon. These actions remained in effect throughout the remainder of the 2009 salmon season. The total 2008 sport harvest of summer chum salmon in the Alaskan portion of the Yukon River drainage (including the Tanana River) was estimated at 371 fish. The recent five year (2004-2008) average for sport harvest of summer chum salmon was estimated at 367 fish (JTC, 2010).

Personal Use Fisheries

The Fairbanks Nonsubsistence Area, located in the middle portion of the Tanana River, contains the only personal use fishery within the Yukon River drainage. The management area known as Subdistrict 6-C is completely within the Fairbanks Nonsubsistence Area. Personal use salmon and a valid resident sport fishing license are required to fish within the Fairbanks Nonsubsistence Area. The harvest limit for a personal use salmon household permit is 10 Chinook, 75 summer chum salmon, and 75 fall chum salmon and coho salmon combined. The personal use salmon fishery in Subdistrict 6-C has a harvest limit of 750 Chinook, 5,000 summer chum salmon, and 5,200 fall chum salmon and coho salmon combined (JTC, 2010).

In 2009, the personal use salmon fishery followed the regulatory fishing time of two 42-hour periods per week except during the time period September 3-17 when it was closed to conserve fall chum salmon with precedence for subsistence fisheries and escapement requirements. The 2009 preliminary harvest (as of February 2010) based on permits returned for Subdistrict 6-C included 308 summer chum salmon and 78 fall chum salmon. The recent five year (2004-2008) average personal use harvest was estimated at 193 summer chum salmon and 210 fall chum salmon in the Yukon River drainage (JTC, 2010).

A6.1.4 Norton Sound[13]

Description of Management Area

Norton Sound Salmon District consists of all waters between Cape Douglas in the north and Point Romanof in the south. The district is divided into six subdistricts: Subdistrict 1, Nome; Subdistrict 2, Golovin; Subdistrict 3, Moses Point; Subdistrict 4, Norton Bay; Subdistrict 5, Shaktoolik; and Subdistrict 6, Unalaklee(tFigure A6-33). The subdistrict and statistical area boundaries were established to facilitate management of individual salmon stocks, and each subdistrict contains at least one major salmon-producing stream. In 2001, a regulatory change by the BOF made rod and reel a legal subsistence fishing gear type in the area from Cape Espenberg on northern Seward Peninsula to Bald Head, which is between Elim and Koyuk. This area includes subsistence fishing areas used by the residents of Nome, White Mountain, Golovin, Elim, Koyuk, Shaktoolik, and Unalakleet (Fall et al., 2009). Although a fishing pole can be used for subsistence fishing, sport fish methods and means requirements still apply to harvesting of fish.

[13] Unless otherwise noted, information in this section taken from: Mendard, J., J. Soong, and S. Kent. 2012. 2010 Annual Management Report Norton Sound, Port Clarence, and Kotzebue. Alaska Department of Fish and Game, Fishery Management Report No. 12-31, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-31.pdf
Data for 2011 was taken from ADF&G News Release titled 2011 Norton Sound Salmon Season Summary, Dec. 22, 2011. http://www.adfg.alaska.gov/static/fishing/PDFs/commercial/2011_norton_salmon_summary.pdf

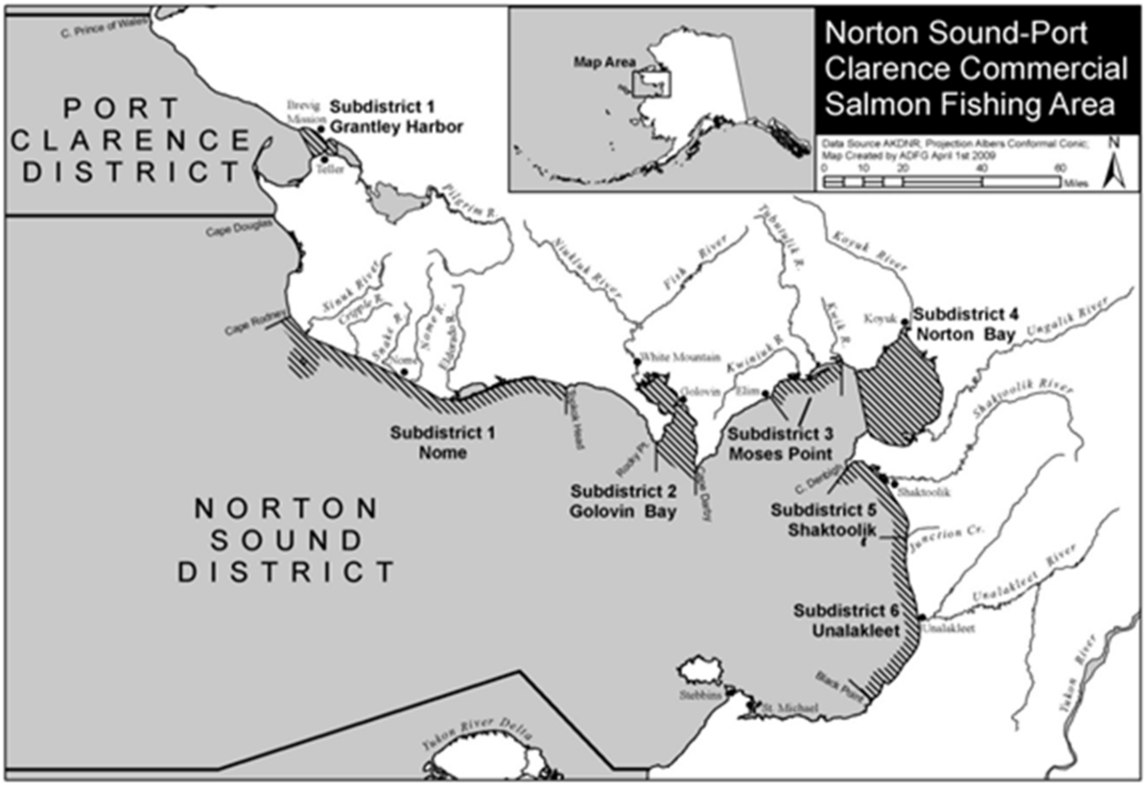


Figure A6-33. Norton Sound commercial salmon fishing districts and subdistricts.

Salmon management in Norton Sound has changed significantly since the mid-1990s because of limited market conditions and marginal returns of many salmon stocks within the district. Except for the Nome Subdistrict, commercial fishing can occur if salmon runs are sufficient and a commercial market opens. The Nome Subdistrict is managed intensively for subsistence use: Tier II chum salmon subsistence permits, registration permits, closed waters, setting fishing period length, limiting gear, and harvest limits are all tools employed throughout the season to provide for escapement needs and to maximize subsistence opportunity.

A6.1.4.1 Northern Norton Sound chum salmon assessment

Northern Norton Sound includes Subdistricts 1, 2, and 3 (Figure A6-33). In response to guidelines established in the SSFP (5 AAC 39.222(f)(21)), the BOF classified Subdistrict 1 chum salmon stock as a management concern in 2000 (Bue 2000a). The classification was upheld at the 2004 BOF meeting (Menard and Bergstrom 2003a). In 2007, based on definitions provided in SSFP (5 AAC 39.222(f)(21) and (42)), only the most recent 5-year yield and escapement information (2002–2006), and the historical level of yield or harvestable surpluses were considered. Accordingly, ADF&G recommended a change in status of the Subdistrict 1 chum salmon stock from a management concern to a yield concern at the October 2006 BOF work session because in the preceding 5 years (2002–2006) a majority of chum salmon escapement goals had been achieved in Subdistrict 1. The BOF accepted ADF&G's recommendation and the Subdistrict 1 chum salmon stock was reclassified at its 2007 meeting (Menard and Bergstrom 2006a). At the 2010 BOF meeting, ADF&G recommended continuation of Norton Sound Subdistrict 1 chum salmon as a stock of yield concern (Menard and Bergstrom 2009a): ADF&G's recommendation was based on low yields from the recent 5-year period (2005 – 2009) compared to historical yields iin the 1980s, but a majority of chum salmon escapement goals being achieved in Subdistrict 1 in the most recent five years (2005 – 2009). Since the 2006 fishing season, Subdistrict 1 reverted back to Tier I subsistence fishing regulations because projected runs of chum salmon exceeded the Amount Necessary for Subsistence (ANS).

In response to the guidelines established in the SSFP (5 AAC 39.222(f)(42)), the BOF classified Norton Sound Subdistricts 2 and 3 chum salmon as a stock of yield concern at its September 2000 work session. This determination as a yield concern was based on low harvest levels for the previous 5-year period (1995–1999). An action plan was subsequently developed by ADF&G (Bue 2000b) and acted upon by the BOF in January 2001. The classification as a yield concern was continued at the January 2004 BOF meeting (Menard and Bergstrom 2003b) and at the January 2007 BOF meeting (Menard and Bergstrom 2006b). ADF&G recommended continuation of the Norton Sound Subdistrict 2 and Subdistrict 3 chum salmon as a stock of yield concern at the 2010 BOF meeting (Menard and Bergstrom 2009b). From 2005 to 2009, low yields of chum salmon have continued in Norton Sound Subdistrict 2 and in Subdistrict 3; yields have been inconsistent, but often low.

Escapement

The Subdistrict 1 BEG was achieved or exceeded from 2005–2008, fell short of the goal in 2009, and was once again exceeded in 2010 and 2011 (Figure A6-34). Comparing escapements during 2005–2011 to the escapement goals established in 2001 shows there has not been a chronic inability to meet escapement goals.

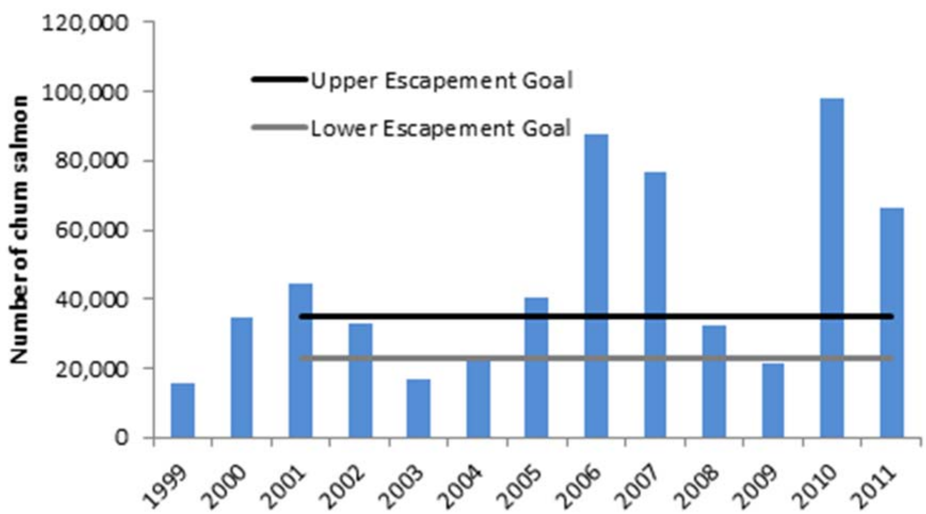


Figure A6-34. Subdistrict 1 estimated chum salmon escapement, 1999–2011 in relation to the biological escapement goal range.

Niukluk River in Subdistrict 2 exceeded the SEG of 30,000 chum salmon in 2007. In 2010 the SEG was lowered to 23,000 chum salmon and this goal was met in both 2010 and 2011. There had been a decreasing trend in escapement since the project was established in 1995. Escapement increased from 2005 to 2007, dropped again in 2008 and 2009, and appears to be picking up again in recent years (Figure A6-35).

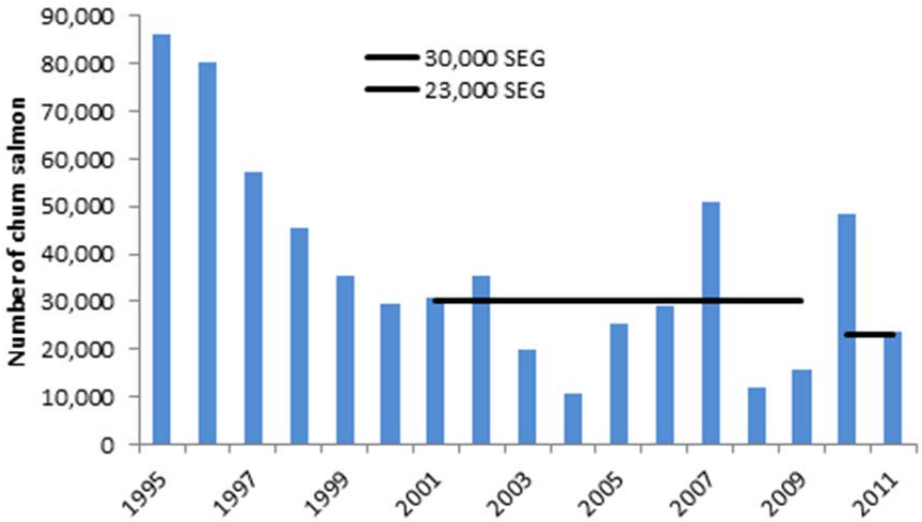


Figure A6-35. Niukluk River estimated chum salmon escapement, 1995–2011, and in relation to the sustainable escapement goal.

Based on escapement counts from the Kwiniuk River counting tower project, the OEG for Subdistrict 3 of 11,500 to 23,000 chum salmon has been achieved or exceeded in 5 of the 7 recent years (2005–2011). The Kwiniuk River tower count of 71,388 chum salmon in 2010 eclipsed the previous record coutn of 66,604 chum salmon set in 1970 (Figure A6-36). It is difficult to determine if the SEG was achieved in most years because aerial surveys were often incomplete due to poor weather conditions or lack of aircraft. Another difficulty in surveying Tubutulik River beginning in 2004 was the huge numbers of pink salmon with the same run timing as chum salmon. Pink salmon prevented accurate enumeration of chum salmon in 2004–2006 and in 2008. An aerial survey in 2011 counted 14,127 chum salmon on Tubutulik River. Overall, chum salmon runs in Subdistrict 3 have been lower in the 1990s and 2000s than in the 1980s based on Kwiniuk River escapements and reported harvests.

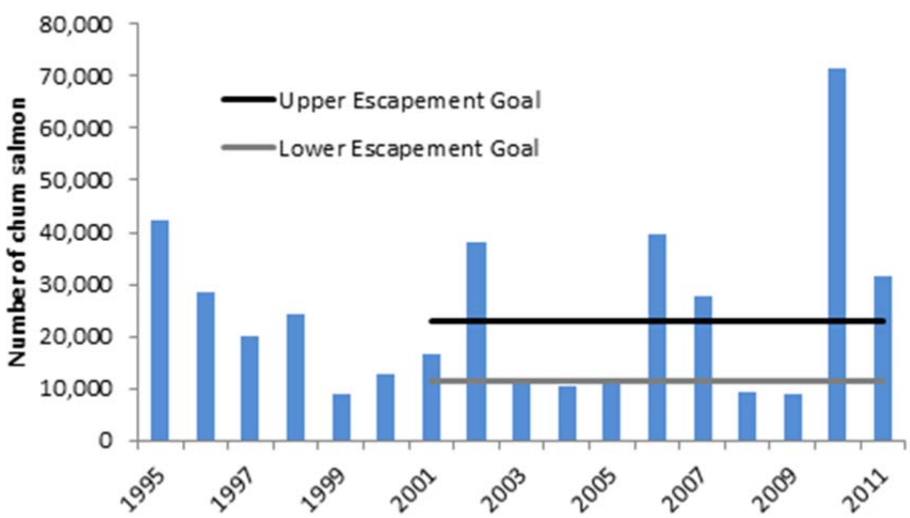


Figure A6-36. Kwiniuk River estimated chum salmon escapement, 1995–2011, and in relation to the optimal escapement goal range.

Escapement goals

In 2001, ADF&G established a BEG for Subdistrict 1 chum salmon of 23,000–35,000 fish (Clark 2001). At this time, SEGs were also established for the major rivers within the subdistrict. Nome, Snake, and Eldorado rivers used weirs and towers to assess escapement while the other 4 river systems relied on expanded aerial surveys to obtain escapement estimates. In 2010, ADF&G eliminated the SEGs on those rivers using expanded aerial surveys yet maintained aerial surveys to help obtain information to assess the overall escapement to Subdistrict 1 in relation to the BEG.

There is no district-wide escapement goal for Subdistrict 2 (Volk et al 2009). However, in 2005, an SEG of >30,000 chum salmon passed the Niukluk River counting tower was established; in 2010 ADF&G lowered the SEG threshold to > 23,000 chum salmon passed the counting tower.

In Subdistrict 3, there are two major river drainages, Kwiniuk and Tubutulik Rivers with biological escapement goals (BEG) of 10,000–20,000 and 8,000–16,000 chum salmon, respectively. In January 2001, the BOF established optimal escapement goal (OEG) ranges for chum salmon in Kwiniuk River and Tubutulik River by adding an additional 15% to the BEG range to account for subsistence harvests that may occur above the tower site (Table A6-26).

Table A6-26 Chum salmon counting tower (TCE) and weir counts (WCE) estimates and unexpanded aerial surveys (UAS) from Norton Sound drainages compared to escapement goals, Norton Sound.

River System	Enumeration Method	Escapement Goal	2011 Escapement
Nome River	WCE	SEG range (2,900 – 4,300)	3,582
Eldorado River	WCE	SEG range (6,000 – 9,200)	16,227
Snake River	WCE	SEG range (1,600-2,500)	4,343
Nome Subdistrict		BEG range (23,000-35,000)	66,122
Niukluk River	TCE	SEG threshold (23,000)	23,607
Kwiniuk River	TCE	OEG range (11,500 – 23,000)	31,604
Tubutulik River	UAS	OEG range (9,200 – 18,400)	14,127
Unalakleet/Old Woman River	UAS	SEG range (2,400 – 8,400)	7,021

A6.1.4.2 Eastern Norton Sound chum salmon assessment

Eastern Norton Sound includes Subdistricts 4, 5, and 6 (Figure A6-33) and the majority of the chum salmon run comes from the Koyuk, Inglutalik, and Ungalik Rivers in Subdistrict 4, Shaktoolik River in subdistrict 5 and Unalakleet River in Subdistrict 6. Aerial surveys are used to assess chum salmon escapements in Subdistricts 4 and 5. In Subdistrict 6, chum salmon escapement is assessed using a test fishery on the Unalakleet River and a counting tower on the North River, a tributary of the Unalakleet River. Commercial fisheries in Subdistricts 5 and 6 are managed concurrently according to test fishery and escapement indices in Subdistrict 6 because tagging studies conducted in the late 1970s showed an intermingling in near-shore waters of chum salmon bound for both subdistricts. Subdistrict 4 is typically managed similar to Subdistricts 5 and 6 because they are believed to have similar trends in salmon run strength and timing; however there have been limited commercial fishing opportunities in Subdistrict 4.

Escapement

There are no escapement monitoring programs in Subdistricts 4 and 5. Area managers estimate drainagewide chum salmon escapement in the Unalakleet River by expanding North River tower chum salmon passage estimates using proportional abundance estimates determined from radiotelemetry investigations. The 2011 Old Woman and Unalakleet Rivers aggregate aerial survey index of 7,021 is considered to be very conservative due to poor viewing conditions but was 50% above the aerial survey SEG (2,400 – 4,800 chum salmon).

Escapement goals

There are no chum salmon escapement goals for Subdistricts 4 and 5. In Subdistrict 6, an aerial survey SEG of 2,400–4,800 chum salmon for Old Women River, in the upper Unalakleet River is the only established escapement goal. Additionally, drainage-wide escapement is estimated using North River chum salmon proportional abundance estimates determined by radiotelemetry during the 2004–2006 seasons. Drainage-wide chum salmon escapement estimates for the 2004–2006 seasons were calculated by dividing the North River tower chum salmon passage by the actual proportional abundance estimates for those years. The average North River abundance proportion (0.138) was used to expand North River tower chum salmon passage for years radiotelemetry work was not conducted.

A6.1.4.3 Norton Sound Commercial Chum Salmon Fishery Harvests

Table A6-27 provides historic Chum salmon catches in the Norton Sound District from 1961 through 2011. The catch data document a long term decline in commercial harvest of chum salmon. From peak numbers of more than 300,000 in the 1980s, commercial harvest of chum salmon declined to a period low of just 600 fish in 2002. The 2004 commercial chum harvest was 6,296; however, since then the commercial chum harvest has improved considerably and the 2010 harvest of 117,743 chum salmon is the largest since 1986 (Table A6-27). This trend in Norton Sound commercial Chum harvests is depicted graphically in Figure A6-37. In addition, Table A6-28 provides historic data on the numbers of permits fishing in the Norton Sound area. This data shows a similar decline in permits fished as harvest of Chinook and chum salmon declined. However, the 2010 total of 115 permits fished is nearly triple the five year average and more than double the ten year average. The 2011 chum salmon harvest of 110,555 for the Norton Sound District ranks 19th best in 51 years of commercial chum salmon harvests and was 164% above the recent five year average. 2011 also marks the first time in 24 years that there have been consecutive years with harvest exceeding 100,000 chum salmon. Of note; however, is that while these numbers are showing strong improvement in most areas of the District, the Nome Subdistrict remains closed to commercial salmon fishing and had no commercial chum salmon catch in 2011.

Table A6-27 Commercial salmon catch by species, Norton Sound District, 1961-2011.

Year	Chinook	Sockeye	Coho	Pink	Chum	Total
1961	5,300	35	13,807	34,327	48,332	101,801
1962	7,286	18	9,156	33,187	182,784	232,431
1963	6,613	71	16,765	55,625	154,789	233,863
1964	2,018	126	98	13,567	148,862	164,671
1965	1,449	30	2,030	220	36,795	40,524
1966	1,553	14	5,755	12,778	80,245	100,345
1967	1,804	-	2,379	28,879	41,756	74,818
1968	1,045	-	6,885	71,179	45,300	124,409
1969	2,392	-	6,836	86,949	82,795	178,972
1970	1,853	-	4,423	64,908	107,034	178,218
1971	2,593	-	3,127	4,895	131,362	141,977
1972	2,938	-	454	45,182	100,920	149,494
1973	1,918	-	9,282	46,499	119,098	176,797
1974	2,951	-	2,092	148,519	162,267	315,829
1975	2,393	2	4,593	32,388	212,485	251,861
1976	2,243	11	6,934	87,916	95,956	193,060
1977	4,500	5	3,690	48,675	200,455	257,325
1978	9,819	12	7,335	325,503	189,279	531,948
1979	10,706	57	31,438	167,411	140,789	350,401
1980	6,311	40	29,842	227,352	180,792	444,337
1981	7,929	56	31,562	232,479	169,708	441,734
1982	5,892	10	91,690	230,281	183,335	511,208
1983	10,308	27	49,735	76,913	319,437	456,420
1984	8,455	6	67,875	119,381	146,442	342,159
1985	19,491	166	21,968	3,647	134,928	180,200
1986	6,395	233	35,600	41,260	146,912	230,400
1987	7,080	207	24,279	2,260	102,457	136,283
1988	4,096	1,252	37,214	74,604	107,966	225,132
1989	5,707	265	44,091	123	42,625	92,811
1990	8,895	434	56,712	501	65,123	131,665
1991	6,068	203	63,647	0	86,871	156,789
1992	4,541	296	105,418	6,284	83,394	199,933
1993	8,972	279	43,283	157,574	53,562	263,670
1994	5,285	80	102,140	982,389	18,290	1,108,184
1995	8,860	128	47,862	81,644	42,898	181,392
1996	4,984	1	68,206	487,441	10,609	571,241
1997	12,573	161	32,284	20	34,103	79,141
1998	7,429	7	29,623	588,013	16,324	641,396
1999	2,508	0	12,662	0	7,881	23,051
2000	752	14	44,409	166,548	6,150	217,873
2001	213	44	19,492	0	11,100	30,849
2002	5	1	1,759	0	600	2,365
2003	12	16	17,058	0	3,560	20,646
2004	0	40	42,016	0	6,296	48,352
2005	151	280	85,255	0	3,983	89,669
2006	12	3	130,808	0	10,042	140,865
2007	19	2	126,115	3,769	22,431	152,336
2008	83	60	120,293	75,384	25,124	220,944
2009	84	126	87,041	17,364	34,122	138,737
2010	140	103	62,079	31,557	117,743	211,622
2011	185	369	58,917	7,141	110,555	177,167
Average 2007-2011	102	132	90,889	27,043	61,995	180,161
Average 2002--2011	69	100	73,134	13,522	33,446	120,270

Source: Data provided to NMFS by ADF&G in response to a special data request and Norton Sound Annual Management Report data courtesy of Jim Menard, ADF&G.

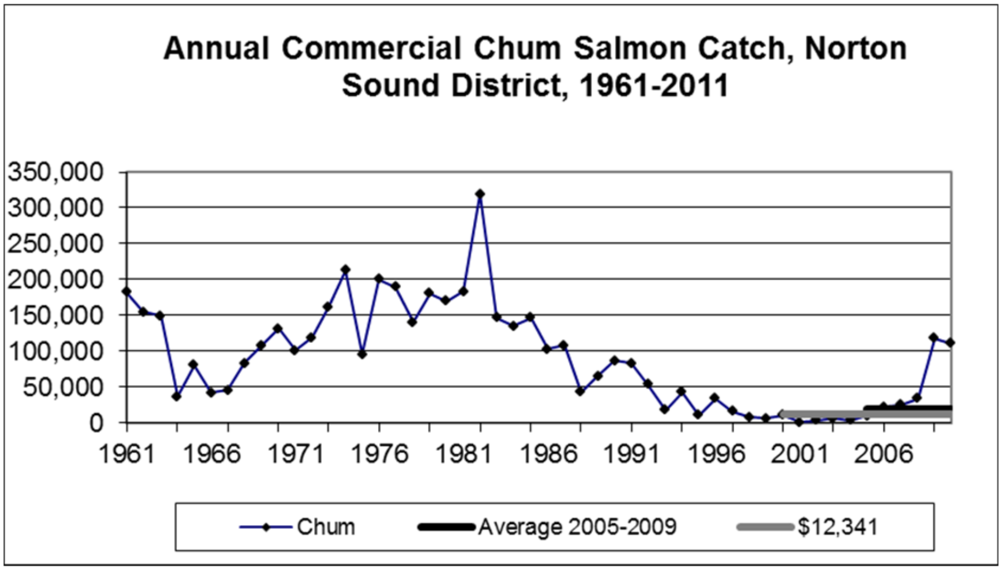


Figure A6-37 Norton Sound commercial chum salmon catch, 1961-2010.

Source: Data provided to NMFS by ADF&G, in 2010, in response to a special data request, and updated with prelinary 2011 data.

Table A6-28 Number of commercial salmon permits fished, Norton Sound, 1970–2011.

Year	SUBDISTRICT						District
	1	2	3	4	5	6	Total [a]
1970	6	33	21	0	12	45	[b]
1971	7	22	45	6	19	72	[b]
1972	20	20	48	32	20	71	[b]
1973	21	34	57	30	27	94	[b]
1974	25	25	60	8	23	53	[b]
1975	24	42	67	42	39	61	[b]
1976	21	22	54	27	37	60	[b]
1977	14	25	52	24	30	45	164
1978	16	24	44	26	26	51	176
1979	15	21	41	22	29	63	175
1980	14	17	26	13	26	66	159
1981	15	19	33	10	26	73	167
1982	18	17	28	10	32	68	164
1983	19	21	39	15	34	72	170
1984	8	22	25	8	24	74	141
1985	9	21	34	12	21	64	155
1986	13	24	34	9	30	73	163
1987	10	21	34	12	39	65	164
1988	5	21	36	13	21	69	152
1989	2	0	13	0	26	73	110
1990	0	15	23	0	28	73	128
1991	0	16	24	0	25	75	126
1992	2	1	21	9	25	71	110
1993	1	8	26	15	37	66	153
1994	1	5	21	0	39	71	119
1995	2	7	12	0	26	58	105
1996	1	4	12	0	20	54	86
1997	0	11	21	9	19	57	102
1998	0	16	23	0	28	52	82
1999	0	0	0	0	15	45	60
2000	0	12	13	0	26	49	79
2001	0	5	5	0	13	29	51
2002	0	0	0	0	7	5	12
2003	0	0	0	0	10	20	30
2004	0	0	0	0	11	25	36
2005	0	0	0	0	12	28	40
2006	0	0	0	0	22	40	61
2007	0	0	11	0	15	47	71
2008	0	4	12	4	23	58	91
2009	0	5	17	7	21	49	88
2010	0	10	19	5	35	49	115
2011							123
Average 2005-2009	b	2	13	b	19	44	36
Average 2000-2009	0	3	6	1	16	35	56

Source: Data provided to NMFS by ADF&G in response to a special data request.

[a] District total is the number of fishermen that actually fished in Norton Sound; some fishermen may have fished more than one subdistrict.

[b] Data not available.

Table A6-29 provides the real (inflation adjusted) value of commercial Chum salmon harvest compared to total real value of Norton Sound commercial salmon harvest from 1967 through 2010. The decline in catch of both chum and Chinook salmon, combined with declining salmon prices since the late 1970s, have depressed overall fishery value, from a peak of nearly $2.5 million in the late 1970s to a period low of just $3,500 in 2002. Over this time, Chum real value peaked in 1979 at $1.253 million. Chum real value has fluctuated since the 1980s; however, has had a generally downward trend to the period low of $379 in 2002. Since 2002, chum harvest and value have trended upwards and the 2010 harvest value of nearly half a million dollars is the highest real value recorded since 1985.

Table A6-29 Real historical value of commercial chum catch, Norton Sound, 1967-2010 (inflation adjusted to 2010 value using the GDP deflator).

Year	Reported Total Value	Chum Value	Chum Value % of Total
1967	$228,616	$135,248	59.16%
1968	$317,212	$152,815	48.17%
1969	$452,227	$276,260	61.09%
1970	$446,353	$275,238	61.66%
1971	$433,600	$367,922	84.85%
1972	$420,718	$321,815	76.49%
1973	$1,203,847	$1,055,094	87.64%
1974	$1,562,604	$1,238,366	79.25%
1975	$1,349,669	$1,033,172	76.55%
1976	$881,155	$620,577	70.43%
1977	$1,585,412	$1,233,446	77.80%
1978	$2,461,806	$1,131,264	45.95%
1979	$2,201,247	$1,028,581	46.73%
1980	$1,313,344	$687,265	52.33%
1981	$1,598,643	$700,802	43.84%
1982	$2,116,106	$847,477	40.05%
1983	$1,800,622	$1,253,255	69.60%
1984	$1,353,661	$449,260	33.19%
1985	$1,457,018	$518,675	35.60%
1986	$951,735	$475,809	49.99%
1987	$876,551	$408,622	46.62%
1988	$1,244,666	$489,585	39.33%
1989	$503,766	$84,339	16.74%
1990	$719,720	$168,328	23.39%
1991	$606,253	$236,449	39.00%
1992	$642,217	$187,591	29.21%
1993	$451,381	$116,724	25.86%
1994	$1,184,449	$48,770	4.12%
1995	$478,818	$70,284	14.68%
1996	$449,008	$8,902	1.98%
1997	$471,761	$36,079	7.65%
1998	$460,173	$12,308	2.67%
1999	$97,098	$8,012	8.25%
2000	$185,365	$7,474	4.03%
2001	$68,830	$18,278	26.56%
2002	$3,500	$379	10.84%
2003	$75,103	$3,863	5.14%
2004	$138,767	$6,722	4.84%
2005	$324,629	$4,523	1.39%
2006	$413,703	$10,180	2.46%
2007	$590,061	$37,467	6.35%
2008	$766,415	$27,635	3.61%
2009	$722,167	$79,366	10.99%
2010	$1,220,487	$495,721	40.62%
2011	$1,269,730	na	na

Source: Calculated from data provided to NMFS by ADF&G in response to a special data request.

Real historic chum salmon value, real total value, and the percentage of real chum value in real total value are displayed in Figure A6-38. Both chum value and total value are displayed with respect to the left vertical axis and chum percent of total value is displayed on the right vertical axis. From this figure it is easy to see the divergence of chum and total value during the 2000s as commercial chum harvests in

Norton Sound have been in decline. Also evident is the sharp increase in value of chum harvest in 2010 and that chum harvests accounted for just over 40 percent of the total value of all salmon harvested in Norton Sound. Total Norton Sound harvested value rose slightly in 2011, based on prelinary data. However, the specific value of the chum salmon harvest has not yet been reported.

Historically, chum value was as much as 87 percent of total value in the early 1970s and trended downward in importance to the regions total fishery value through the early 2000s. In 2005, for example, chum accounted for only about 1.4 percent of the total commercial harvest value in Norton Sound. This decline was coincident with similar declines in Chinook salmon harvest and value leaving coho, pink, and sockeye as the primary sources of commercial salmon income in the region.

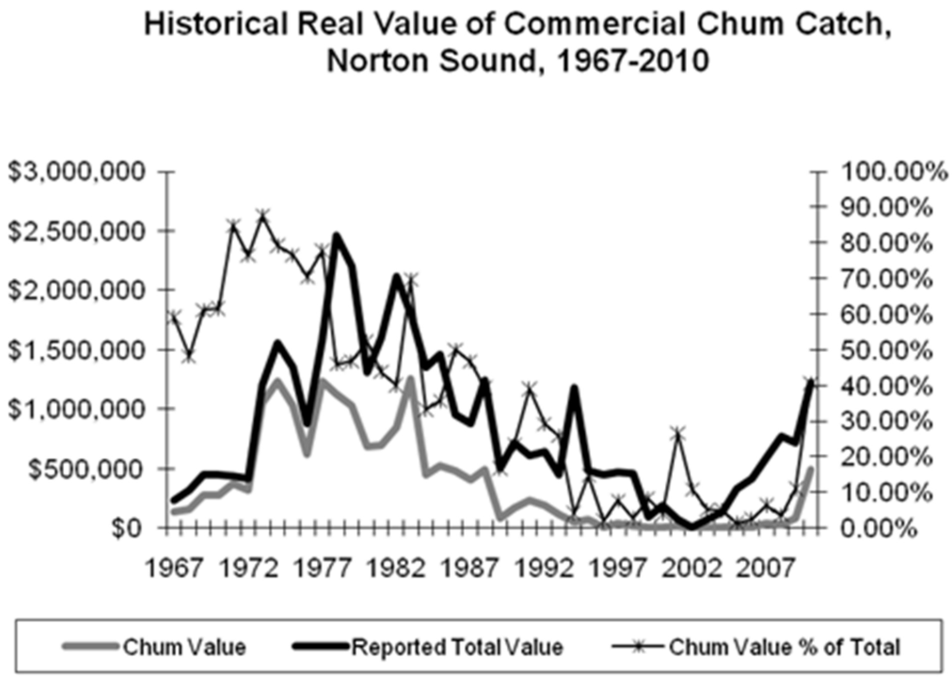


Figure A6-38 Norton Sound commercial real Chum value, total value, and percent Chum value in total value, 1967-2010 (values are inflation adjusted to 2009 values using the GDP deflator). Source: Derived from data provided to NMFS by ADF&G in response to a special data request.

The Norton Bay Subdistrict typically has difficulty attracting a buyer due to its remoteness and reputation for watermarked fish. Because of lack of timely salmon escapement information, Norton Bay Subdistrict is typically managed similar to the Shaktoolik and Unalaklett Subdistricts. Both Shaktoolik and Unalakleet Subdistricts consistently attract commercial markets due to larger volumes of fish and better transportation services. In 2009, ADF&G delayed the onset of the chum salmon fishery until they could project that Chinook salmon escapement goals would be reached. When the escapement goal was projected to be reached, a 24-hour commercial chum salmon opening was permitted in Subdistricts 5 and 6 to evaluate chum salmon run strength and evaluate Chinook salmon incidental catches. Subdistricts 5 and 6 Chinook salmon were designated a stock of yield concern in 2004 and the BOF continued the designation in February 2007. To increase Chinook salmon escapements, the BOF also adopted a more conservative Subdistricts 5 and 6 King Salmon Management Plan (5 AAC 04.395) that was first implemented during the 2007 season (ADF&G, 2009).

The BOF met in Fairbanks in January 2010. At the meeting the department presented reports for Stock of Concern status for chum salmon in Subdistricts 1 (Nome), 2 (Golovin), and 3 (Moses Point) and king salmon in Subdistricts 5 (Shaktoolik) and 6 (Unalakleet). At this time ADF&G recommended continuation of a yield concern for those stocks.

Northern Norton Sound

Harvest

There has been no commercial harvest of chum salmon in Subdistrict 1 since 1996 and subsistence harvest has been diminishing since the 1980s (Figure A6-39). The average subsistence harvest of 1,272 chum salmon for the most recent 10-year period (2002–2011) was jut below the previous 10-year average of 1,659 chum salmon. Both of these averages are less than half of the 10-year average from 1982-1991 of 5,626 chum salmon. Contributing to this decrease were low runs and increasing subsistence restrictions. However, even with fishing closures, escapements did not increase in the late 1990s and early 2000s in response to less fishing pressure. In recent years, chum salmon runs have started increasing, yet subsistence harvests remain low in large part due to a preference for pink and coho salmon by subsistence users.

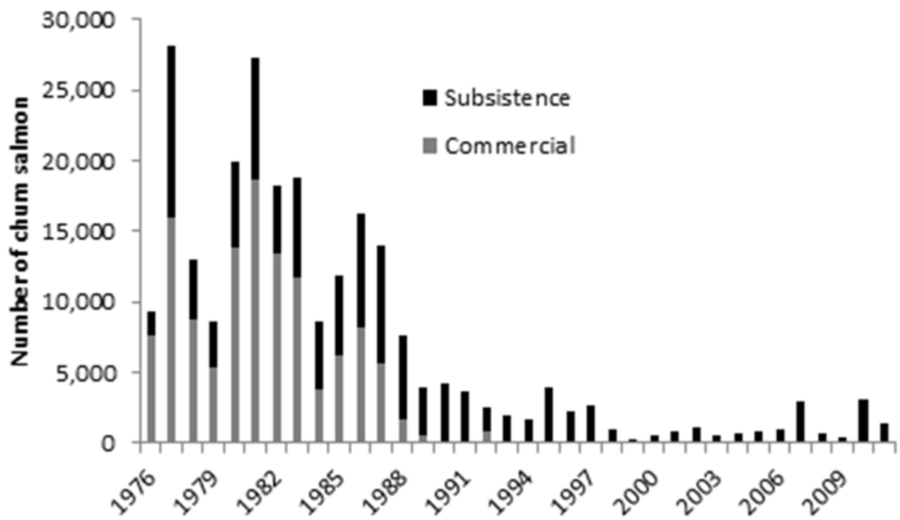


Figure A6-39. Subdistrict 1 commercial and subsistence chum salmon harvest, 1976–2011.

In Subdistricts 2 and 3, chum salmon subsistence harvests in the 2000s have been very minimal. In Subdistrict 2, subsistence chum salmon harvests averaged 1,633 fish from 2002 through 2011, only slightly more than one half the previous 10-year (1992–2001) average subsistence harvest of 2,946 chum salmon (Figure A6-40). In Subdistrict 3, an average of 1,750 chum salmon were harvested for subsistence from 2002 through 2011, slightly less than the previous 10-year (1992–2001) average subsistence harvest of 1,872 chum salmon (Figure A6-41). In most years since 2003, chum salmon runs have been insufficient to allow for a commercial harvest in Subdistricts 2 and 3. However, in recent years commercial harvests have exceeded 23,000 chum salmon.

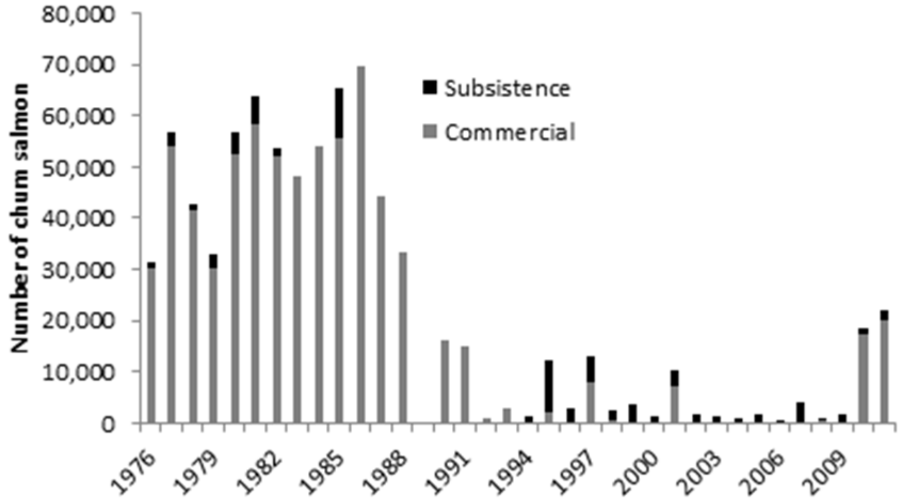


Figure A6-40. Subdistrict 2 commercial and subsistence chum salmon harvest, 1976–2011. Subsistence information was not collected in all years.

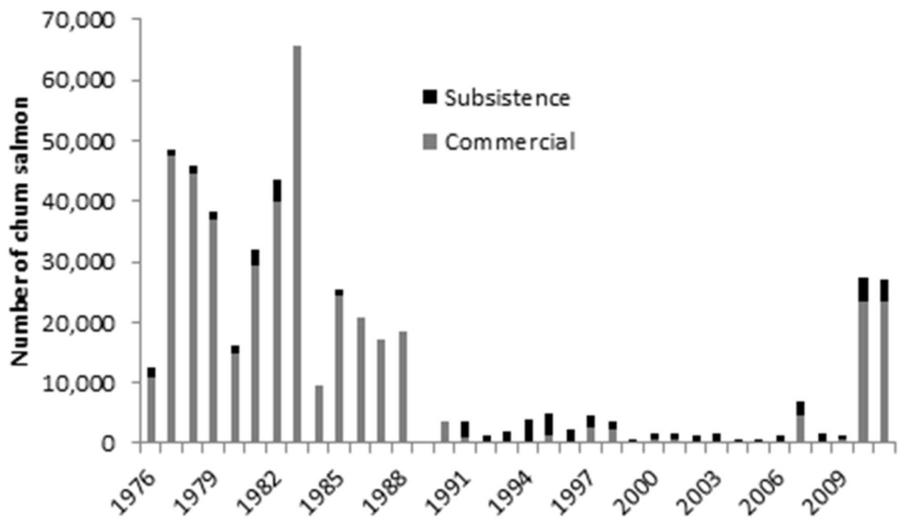


Figure A6-41. Subdistrict 3 commercial and subsistence chum salmon harvest, 1976–2011. Subsistence information was not collected in all years.

Eastern Norton Sound

Harvest

Subdistrict 4 typically has difficulty attracting a buyer due to its remoteness and its reputation for watermarked fish. Improving market conditions allowed for commercial chum salmon fishing in Norton Bay since 2998. Commercial chum salmon fishing has only occurred 6 times since 1988 and the harvest of 7,558 chum salmon in 2011 was the highest since 1985 (Figure A6-42). Subsistence harvest in Subdistrict 4 was not assessed from 2004–2007 but shows a slight decreasing trend with an average harvest of 3,811 chum salmon from 1992-2001 and 2,059 chum salmn from 2002-2011 (Figure A6-42).

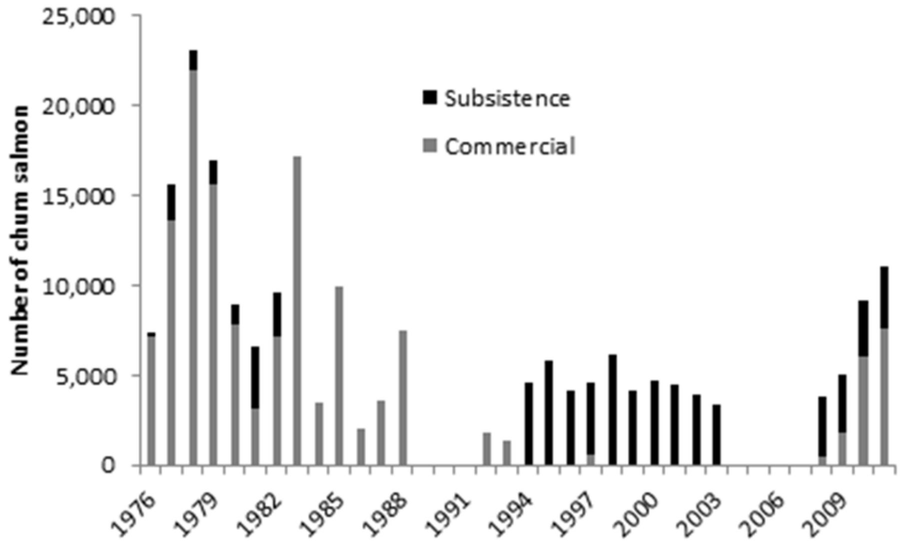


Figure A6-42. Subdistrict 4 commercial and subsistence chum salmon harvest, 1976–2011. Subsistence information was not collected in all years.

In Subdistrict 5, the majority of chum salmon are taken in the commercial fishery; there is little subsistence harvest. There has been a trend of increasing commercial harvest since 2006. The 2011 commercial harvest was 25,388 chum salmon, well above the recent 10-year (2002–2011) average harvest of 9,516 chum salmon, but very similar to the 1982-1991 average harvest of 26,401 chum salmon (Figure A6-43).

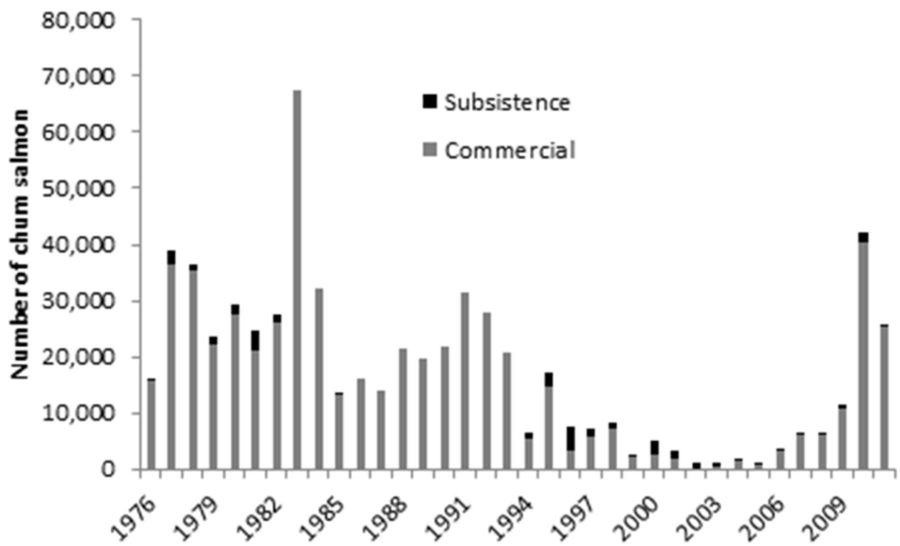


Figure A6-43. Subdistrict 5 commercial and subsistence chum salmon harvest, 1976–2011. Subsistence information was not collected in all years.

In Subdistrict 6, commercial harvest is also showing an increase since 2006. The commercial harvest in 2011 of 34,003 chum salmon was well above the most recent 10-year (2002–2011) average of 13,293 chum salmon. Subsistence harvest has remained relatively consistent since 2004, averaging 2,723 chum salmon from 2002-2011 (Figure A6-44).

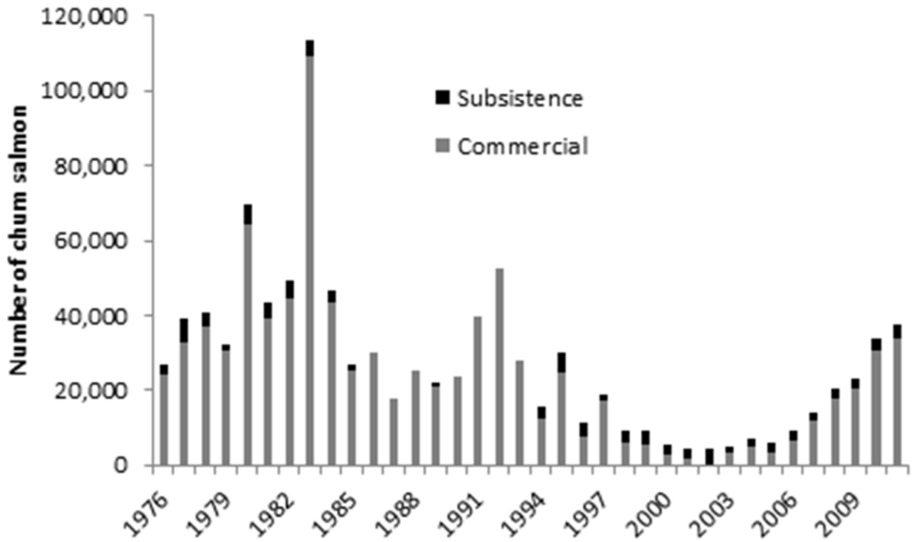


Figure A6-44. Subdistrict 6 commercial and subsistence chum salmon harvest, 1976-2011. Subsistence information was not collected in all years.

2011 Summary

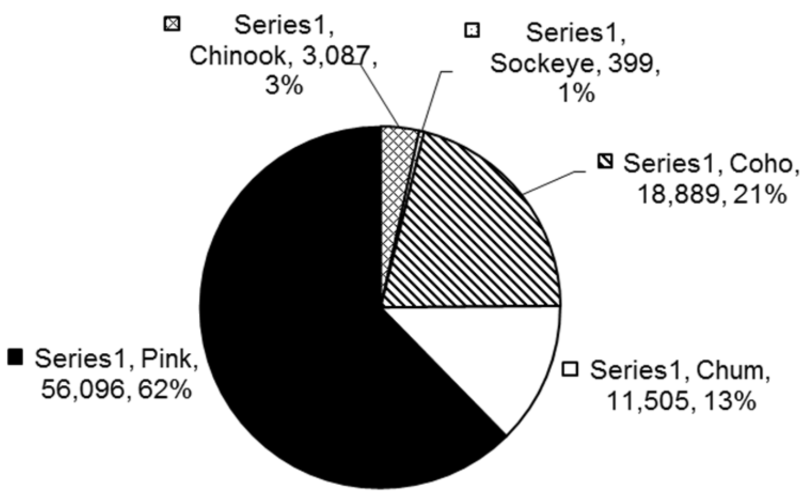
The 2011 chum salmon harvest of 110,555 for the Norton Sound District ranks 19th best in 51 years of commercial chum salmon harvests and was 164% above the recent 5-year (2006 – 2010) average harvest of 41,892 chum salmon, and 23% above the long-term (1961 – 2010) average harvest of 89,522 chum salmon.

A6.1.4.4 Chum Salmon Subsistence Harvest[14]

Arctic Alaska includes the Norton Sound, Port Clarence, and Kotzebue management districts. These three districts include all waters from Point Romanoff in southern Norton Sound to Point Hope, and St. Lawrence Island. These management districts encompass over 65,000 square miles and have a coastline exceeding that of California, Oregon, and Washington combined (Soong et al., 2008). There are approximately 17,000 people in the area, the majority of whom are Native Alaskans residing in more than 30 villages scattered along the coast and major river systems (Menard et al., *2010*).

The estimated 2008 subsistence harvest of salmon by communities in the Norton Sound District was 89,976 fish. This was the highest total harvest for the district since 2002, driven by strong pink salmon and coho salmon returns. Chum salmon runs were below average for northern Norton Sound. Subsistence harvesters took 11,505 chum salmon runs (13%) in 2008, compared to just over 18,000 in 2007 and 10,000 in 2006 (Figure A6-45). Very little of the documented subsistence salmon harvest was taken by residents from outside the district (Fall et al., 2011).

[14]An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.



Source: Fall et al., 2011.

Figure A6-45 Species composition of estimated subsistence salmon harvests, Norton Sound District, 2008.

Subdistrict 1 (Nome)

In Subdistrict 1 (Nome), subsistence harvests consist primarily of pink salmon, coho salmon, and chum salmon. Chum salmon runs have been depressed for over 20 years, leading to increasing restrictions on all types of harvest. Upstream portions of most rivers are closed to protect spawning salmon, and harvests are limited in all Subdistrict rivers. For 16 years, subsistence fishing has been prosecuted primarily by emergency order, with openings much less frequent than in regulation (Fall et al., 2009).

In September 2000, the BOF classified chum salmon in the Nome Subdistrict as a stock of management concern. The stock of concern determination was a result of persistent low chum salmon productivity since the mid-1980s. Commercial and sport fishing for chum salmon are closed in Subdistrict 1 and subsistence salmon management is among the most restrictive in Alaska with a Tier II chum salmon fishery in effect from 1999-2005. A Tier II subsistence permit program is necessary when the number of participants in a subsistence fishery must be limited because the harvestable surplus of the fish stock is less than the amount necessary to provide for subsistence uses. Individuals are scored based on their history of uses of the particular resource and the ability to obtain food; those with the highest scores receive Tier II permits. In 1999, the chum salmon return was so poor that even Tier II fishing was closed; in 2000, only 10 permits were awarded (Menard and Bergstrom, 2009). Under a Tiered management system, subsistence fishing participation is limited through a process where individual Alaskans are ranked against one another according to their customary and traditional dependence upon the fish stock in question to determine who would be provided an opportunity to fish for subsistence uses. Those Alaskans who do not qualify for a Tiered subsistence fishery (where there is insufficient harvestable surplus to provide a reasonable opportunity for all subsistence uses) generally would shift to other salmon stocks or other resources to ensure sufficient wild resources are obtained to support household economies (Wolfe, 2009 and personal communications, John Linderman and Jim Simon, 2010). In such cases, harvest and use of another species may then increase such that the amount necessary for subsistence for the replacement species may need to be adjusted by the BOF.

Qualifications for a Tier II chum salmon permit are established under 5 AAC 01.184 and utilize a point system based upon the following criteria:

- An applicant's customary and direct dependence on the chum salmon stock for human consumption as a mainstay of livelihood may provide up to 75 points; one point will be given for each year above the age of five years in which any one member of an applicant's household has fished for (or processed) chum salmon in Subdistrict 1, plus the number of years in which that member would have fished for (or processed) chum salmon but did not because for chum salmon was closed due to a low number of returning stock, or the Department did not issue a permit to fish to that member for which the member applied.

- An applicant's direct dependence on subsistence chum salmon fishing and ability to obtain food if subsistence uses of Subdistrict 1 chum salmon are restricted or eliminated, based on the relative availability of alternative sources of chum salmon to the applicant's household may provide up to 10 points (measured by the percentage of chum salmon taken by the household in Subdistrict 1 over the four years immediately preceding the date of application).

The maximum amount of points available under the Tier II permitting system is 85. Over the years in which ADF&G utilized Tier II permits in the Nome Subdistrict, criticism of the program centered on the way in which the maximum number of points could go only to households with an elder (80+ years old) who relied entirely on the Nome subdistrict for his/her chum. As such, high Tier II scores (and thus permits) were awarded to elders no longer physically able to fish. Younger people in an elder household could fish on the same permit, but not all elders who received permits had such fishing assistance. In addition, subsistence permit histories had no influence on Tier II scores assigned. Families with long, consistent fishing permit histories could be denied permits while other families that occasionally (or perhaps never) appeared in the permit record were awarded Tier II subsistence permits (Jim Magdanz, personal communication, 2011).

The classification of chum salmon as a management concern was continued at the January 2004 BOF meeting. In 2007, the BOF changed the status of Subdistrict 1 chum salmon from a stock of management concern to a stock of yield concern based on data showing that during the preceeding five years[15] (2002-2006) a majority of chum salmon escapement goals had been achieved in Subdistrict 1. Since the 2006 fishing season, Subdistrict 1 has reverted back to Tier I[16] subsistence fishing regulations (including observance of the fishing schedule provided in regulation) because projected runs of chum salmon exceeded the amount necessary for subsistence; however, at the October 2009 BOF work session, ADF&G recommended continuation of Norton Sound Subdistrict 1 chum salmon as a stock of yield concern based on low yields for the recent five year (2005-2009) period compared to historical yields in the 1980s. While the majority of chum salmon escapement goals were achieved during the preceding five years, the inability, despite the use of specific management measures, to consistently maintain expected yields (or harvestable surpluses) above the stock's escapement needs was the basis for continuation as a stock of yield concern. In 2009, ADF&G forecasted the chum salmon run to reach the lower end of the escapement goal range, but by mid-July the chum salmon run in Subdistrict 1 was projected to fall short of the escapement goal, and subsistence salmon gillnetting and subsistence chum salmon fishing was subsequently closed. Even though Tier II fishing restrictions have been suspended since 2006, subsistence harvests of chum salmon continue to be low in the later 2000s and may be the result of record pink and coho salmon runs in recent years allowing subsistence permit holders in Subdistrict 1 to target those species (Menard and Bergstrom, 2009).

In 2001, ADF&G recommended, and later established, a chum salmon biological escapement goal (BEG) for Subdistrict 1 chum salmon at 23,000-35,000 fish. In January 2001, the BOF established optimal escapement goal (OEG) ranges for chum salmon on three rivers in Subdistrict 1 (Nome, Snake, and

[15] Based on definitions provided in the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP), only the most recent five-year yield and escapement information and the historical level of yield or harvestable surpluses are considered when recommending stock of concern designations.

[16] In a Tier I subsistence fishery, all interested Alaska residents may participate. Other harvesters (commercial, sport, and personal use) are prohibited or restricted.

Eldorado Rivers) in order to index the district-wide BEG. In Subdistrict 1, larger chum salmon runs are typically east of Nome, particularly in the Eldorado and Flambeau rivers. OEG ranges for the three rivers are as follows: Snake River: 1,600 to 2,500 chum salmon; Nome River: 2,900 to 4,300 chum salmon; and Eldorado River: 6,000 to 9,200 chum salmon. Chum salmon have been counted via towers or weirs on these rivers since 1994, 1995, and 1997, respectively. ADF&G also established sustainable escapement goal (SEG) ranges, based on aerial survey information, on four other rivers in Subdistrict 1. All BOF-established OEGs and ADF&G established SEGs were set in conjunction with the overall Subdistrict 1 BEG, and have been used to assess the overall escapement to Subdistrict 1 in relation to the BEG. The Subdistrict 1 BEG was achieved or exceeded from 2005-2008 and fell short in 2009. During this same time period (2005-2009), the OEG has been achieved or exceeded for three of five years at Snake and Nome rivers and four of five years at Eldorado River. In the 5-year period (2005-2009), the majority of escapement goals were achieved except for 2009; however, the average total chum salmon harvest and available yield continues to be below the historical yield (combined subsistence and commercial harvests) of the 1980s and early 1990s (Menard and Bergstrom, 2009).

ADF&G manages Subdistrict 1chum salmon stocks to achieve optimal escapement goals for chum salmon spawning streams and to restore chum salmon abundance to that a Tier II subsistence fishery will not be necessary. Specifically, ADF&G manages chum salmon in Subdistrict 1 as follows:

1. Commercial fishing for chum salmon is closed and will be reopened only after
   a. The harvestable surplus of chum salmon has met Tier 1 subsistence needs for four consecutive years; and
   b. The Department has proposed to the BOF and the Board has adopted an abundance-based management plan supported by inseason enumerator counts of abundance.

2. In the subsistence fishery,
   a. Subsistence chum salmon fishing will be opened and closed by emergency order on a stream-by-stream basis, to be determined by the department, when chum salmon stocks are abundant enough to provide for optimal escapement goals and a harvestable surplus;
   b. A subsistence fishing permit is required and will be issued to a household; the permit will identify the body of water to be fished, the annual limit for each salmon species, and the allowable gear;
   c. Pink salmon may be taken only with gillnets that have a mesh size of 4.5 inches or less (Menard and Bergstrom, 2009).

Permits have been required for subsistence salmon fishing in Norton Sound Subdistrict 1 since 1974. By regulation, permits with catch calendars are issued to each requesting household listing all Nome Subdistrict fishing locations, catch limits, and gear restrictions. After the fishing season, households are required to return the completed permit to ADF&G regardless of whether or not they actually fished. Since 1998, the Nome permit data have not been expanded to account for households whose permits were not returned. This contrasts with earlier years when permit data were expanded by drainage, with expansion factors based upon the fraction of unreturned permits for that drainage. ADF&G staff believed that expansion of the permit data led to an overestimation of the salmon harvest because the unreturned permits were most likely from households that did not fish (Fall et al., 2009). Beginning in 2004, stricter enforcement of regulations including fines for failure to return a permit has resulted in nearly all permits issued being returned (Menard et al., *2010*). In 2008, the Nome ADF&G office issued 461 subsistence (Tier I) salmon permits; 450 were returned and 363 households reported fishing. While the number of permits issued was less than in 2004, permit numbers were greater than the previous two years (368 and 329). Fisheries managers in Nome attribute the increase in permits in 2008 to below average returns of sockeye salmon to the Pilgrim River and increased fishing costs due to rising fuel prices (Fall et al, 2011).

Subdistricts 2 (Moses Point), 3 (Golovin), and 4 (Norton Bay)

At its September 2000 work session, the BOF classified Norton Sound Subdistricts 2 and 3 chum salmon as a stock of yield concern. This determination was based on low harvest levels for the previous five year (1995-1999) period. The classification was continued at the January 2004 BOF meeting and at the January 2007 BOF meeting. At the October 2009 BOF work session, ADF&G recommended continuation of the Norton Sound Subdistrict 2 and Subdistrict 3 chum salmon as a stock of yield concern. Based on data from 2005-2009, low yields of chum salmon continue in Subdistricts 2 and 3; yields have been inconsistent, but often low. Subsistence chum salmon harvests averaged 1,767 and 1,216 fish in Subdistricts 2 and 3, respectively, from 2005-2009. From 2004-2009, the SEG in Subdistrict 2 was achieved only in 2007. Since the stock was first identified in 2000, ADF&G has restricted chum salmon subsistence fishing opportunities in Subdistricts 2 and 3 only once, in 2003 (Menard and Bergstrom, 2009).

In Subdistrict 2 (Moses Point), ADF&G established a threshold SEG of 30,000 chum salmon for Niukluk River tower in 2004. In Subdistrict 2, most subsistence fishing occurs in the Niukluk and Fish rivers. From 2004 to 2009, this SEG was achieved only in 2007, but was within 801 fish of the goal in 2006. There has been a decreasing trend in escapement since the project was established in 1995 (Menard and Bergstrom, 2009).

In 2001, ADF&G established chum salmon BEG goals for the Kwiniuk River (10,000 to 20,000 chum salmon) and for the Tubutulik River (8,000 to 16,000 chum salmon) in Subdistrict 3. In the Golovin Subdistrict, most subsistence fishing occurs in the Kwiniuk and Tubutulik rivers. The BOF established OEG ranges for chum salmon in the Kwiniuk and Tubutulik rivers by adding an additional 15% to the BEG range to account for subsistence harvests that may occur above the tower site. Based on escapement counts from the Kwiniuk River, the OEG of 11,500 to 23,000 chum salmon has been achieved or exceeded in three of the five (2005-2009) most recent years. The OEG for the Tubutulik River is 9,200 to 18,400 chum salmon and is assessed via aerial survey. It is difficult to determine if the OEG for this river was achieved in most recent years because aerial surveys were often incomplete due to poor weather conditions or lack of aircraft. In addition, huge numbers of pink salmon arriving at the same time have prevented adequate survey of chum salmon. Overall, chum salmon runs in Subdistrict 3 have been lower in the 1990s and 2000s than in the 1980s based on Kwiniuk River escapements and reported harvests (Menard and Bergstrom, 2009).

In Subdistricts 2 and 3, chum salmon harvests in the 2000s have been very minimal. Subsistence chum salmon harvest averaged 1,767 and 1,216 fish in Subdistricts 2 and 3, respectively, from 2005 through 2009. The total subsistence salmon harvest has usually been double in even-numbered years compared to odd-numbered years as fishermen take advantage of the greater runs of pink salmon in even-numbered years. In most years since 2003, chum salmon runs have been insufficient to allow for a commercial harvest in Subdistricts 2 and 3; however, in 2007 there was a large surplus of chum salmon, but the buyer was only able to purchase fish in Subdistrict 3. In 2008 and 2009 there was not a surplus of chum salmon in either subdistrict. During the last five years (2005-2009), with the exception of 2007, available yield has been much less than historical yield in the 1980s (Menard and Bergstrom, 2009).

ADF&G manages the commercial, sport, subsistence, and personal use fisheries for chum salmon, to the extent practicable, in Subdistricts 2 and 3 to achieve escapement goals. Specifically, ADF&G manages chum salmon in Subdistricts 2 and 3 as follows:

1. In the commercial chum salmon fishery:
    a. ADF&G shall manage the fisheries to achieve the following optimal escapement goal ranges:

    i. Kwiniuk River – 11,500 to 23,000 chum salmon and
    ii. Tubutulik River – 9,200 to 18,400 chum salmon;
  b. The chum salmon harvest may not exceed 15,000 fish before ADF&G's mid-July run assessment in Subdistrict 2;
  c. The fishery may occur only if the department projects that chum salmon escapement goals will be achieved and the harvestable surplus will more than meet subsistence needs.

2. In the commercial pink salmon fishery, the fishery may occur only if subsistence needs are expected to be met and chum salmon escapement goals achieved.

3. In the commercial coho salmon fishery, the fishery may occur only when the chum salmon escapement goals for the Norton Sound District index rivers are achieved or when ADF&G determines that further restrictions would have no impact on achieving chum salmon escapement goals.

4. The Commissioner may not place restrictions on subsistence fishing for chum salmon by emergency order, unless all directed chum salmon commercial fishing has been closed and sport fishing has been appropriately restricted in the subdistrict (Menard and Bergstrom, 2009).

Subsistence permits were required for salmon fishing in Golovin and Moses Point for the fifth year as of 2007. In 2008, 155 permits were issued for Subdistrict 2; fewer than in 2004 (199) and 2005 (174). All the permits issued in subdistrict 2 were returned; 100 reported fishing. The number of Subdistrict 2 permits issued to Nome residents dropped by 25% from 2004 to 2008. Fishery managers attribute the decline to easing of fishing restrictions in the Nome subdistrict. In 2008, ADF&G issued 57 permits for Subdistrict 3, the lowest number since the permit system began. All permits were returned. No subsistence harvest information was obtained for Norton Bay in 2008 (Fall et al., 2011).

Subdistricts 5 (Shaktoolik) and 6 (Unalakleet)

The Shaktoolik and Unalakleet subdistricts are typically managed together because actions in one subdistrict are believed to affect the movement of fish in the other. Restrictions were placed upon subsistence and sport fisheries in 2003, 2004, 2006, and 2008. Under the Chinook salmon management plan adopted by the BOF in February 2007 (5 AAC 04.395), subsistence gillnet salmon fishing (all species) is limited to two 48-hour fishing periods per week in marine waters from mid-June to mid-July. On the Unalakleet River, subsistence fishing is limited to two 36-hour fishing periods per week. Fishing time could be increased only if ADF&G were to project that the lower end of the SEG range would be reached. In 2008, early run timing and strength indicators suggested that the Chinook return would be weak and late. In order to protect larger females entering the Unalakleet River, on June 30 a mesh size restriction of six inches or less was enacted for subsistence gillnets on the river. On July 5, further restrictions were put in place that included closing marine waters to subsistence fishing with gillnets as well as the freshwaters of the Unalakleet River drainage. The emergency order did, however, open all fresh waters to beach seining for salmon other than Chinook. On July 16, with coho salmon beginning to arrive, restrictions were eased on gillnets in order to allow subsistence fishers to target this species (Fall et al., 2011).

ADF&G personnel conduct household surveys in Shaktoolik and Unalakleet. Researchers attempt to contact all of the households in each of the surveyed communities. For 2008, actual sample rates ranged from 93% in Unalakleet, where 201 of the 217 households were surveyed, to 89% in Shaktoolik, where 51 of the 57 households were surveyed. The salmon survey data were expanded by community to account for the households not contacted (Fall et al., 2011).

Shaktoolik and Unalakleet continue to be surveyed postseason, by household. Additionally, daily surveys of Unalakleet River and ocean subsistence fishermen have been conducted annually during the Chinook salmon run since 1985. Although total harvests by subsistence fishermen are not documented, effort and catch information are used to judge timing and magnitude of the Chinook salmon return. The commercial fishery in these areas is delayed until it becomes apparent subsistence needs are being met and Chinook salmon are beginning their upstream migration as indicated by ADF&G test net in the lower Unalakleet River (Menard et al., *2010*).

Table A6-30 Subsistence chum salmon harvest by subdistrict in Norton Sound, 1998 – 2008.

	Subsistence Chum Salmon					
Year	Nome	Golovin	Elim	Norton Bay	Shaktoolik	Unalakleet
1998	964	1,893	1,831	6,192	1,034	3,038
1999	337	3,656	975	4,153	467	3,692
2000	535	1,155	1,429	4,714	2,412	3,000
2001	858	3,291	1,352	4,445	1,553	2,918
2002	1,114	1,882	1,801	3,971	800	3,877
2003	565	1,477	1,143	3,397	587	1,785
2004	685	880	683	ND	139	2,154
2005	803	1,852	598	ND	202	2,660
2006	940	722	1,267	ND	351	2,712
2007	2,938	4,217	2,334	ND	465	2,057
2008	739	350	1,284	3,330	201	2,805
2009	387	1,694	600	3,183	374	2,708
2010	3,124	1,133	3,925	3,180	1,680	3,159
2011	1,428	2,122	3,671	3,529	490	3,316

ND = no data. Source: Menard et al., *2012*.

2011 Fishery Update[17]

In the Nome Subdistrict, the 2011 chum salmon run was above average and easily provided for escapement needs and subsistence harvest above the ANS (Amounts Necessary for Subsistence) range of 3,430-5,716 chum salmon. By the first week of July, assessments ofchum salmon abundance were tracking with forecast and good numbers of chum salmon were observed in most Nome Subdistrict drainages. On July 8, the upper end of the Eldorado River chum salmon escapement ogal (6,000-9,200 chum salmon) was projected to be reached and all subsistence catch limits in freshwater areas east of Cape Nome were waived with the exception of the Solomon River. Chum salmon surpluses in 2011 were large enough to easily provide for customary levels of subsistence use and buffer greatly reduced Chinook salmon harvest in all areas of Norton Sound (ADF&G 2011 Norton Sound Season Summary).

Chinook *Oncorhynchus tshawytscha,* chum *O. keta,* pink *O. gorbuscha*, and coho *O. kisutch* salmon are harvested in Norton Sound commercial, subsistence, and sport fisheries all managed by ADF&G. All commercial salmon fishing in the district is by set gillnets in marine waters and fishing effort is usually concentrated near river mouths. Commercial fishing typically begins in June and targets Chinook salmon if sufficient run strength exists. Emphasis switches to chum salmon in late June and then to coho salmon at the end of July. Most commercial fishing is completed by early September. Pink salmon returns are much more abundant in even numbered years. A pink salmon directed fishery may coincide with or be scheduled to alternate periods with the historical chum directed fishery. Subsistence fishermen operate gillnets or seines in the main rivers, and to a lesser extent in coastal marine waters, capturing salmon, whitefish, Dolly Varden, and inconnu (sheefish). Beach seines are used to catch schooling or spawning salmon and other species of fish. The major portion of fish taken during summer months is air dried or smoked for later consumption by residents or occasionally their dogs.

[17] http://www.adfg.alaska.gov/index.cfm?adfg=fishingCommercial.main.

A6.1.4.5 Norton Sound Sport Fisheries

In Norton Sound, most of the sport fishing effort occurs along the Nome road system, and to the south in the Unalakleet River drainage, where king and coho salmon fishing is popular and two large sport guiding operations are located. Pink salmon fishing is also popular, but sockeye fishing is nearly nonexistent. Chum salmon stocks have steadily declined in many places on the Seward Peninsula since the early 1980s. This has led to increasingly restrictive sport and commercial management, and the initiation of Tier II subsistence in the Nome Subdistrict (as previously discussed in Section 3.3.5.1.1). All rivers in northern Norton Sound from the Sinuk River in the west to Topkok in the east have been closed to sportfishing for chum salmon since 1992. It is anticipated that until chum salmon populations recover, there will be a need to continue with very restrictive measures to protect local stocks. In the Golovin, Elim, Norton Bay, Shaktoolik, and Unalakleet subdistricts, sport fishing for chum remains open, with recent ten-year average catches of 3,892 and harvests of 616 fish per year, with an average annual fishing effort of 17,027 angler days. In 2009, catches of chum salmon in Norton Sound was 2,113 and harvest was 412 fish (personal communication, Brendan Scanlon, 2010).

A6.1.5 Kotzebue[18]

Description of the Management Area

Kotzebue Sound District encompasses all waters from Point Hope to Cape Prince of Wales, including those waters draining into the Chukchi Sea and includes fishing areas used by residents of Point Hope, Kivalina, Noatak, Kotzebue, Kiana, Noorvik, Selawik, Ambler, Shungnak, Kobuk, Buckland, Deering, Shismaref, and Wales. Kotzebue Sound District supports the northernmost commercial salmon fishery in Alaska and is divided into three subdistricts; commercial salmon fishing may occur in subdistrict 1 (Figure A6-46). Commercial fishing began in 1962 primarily harvesting chum salmon, and in recent years has been limited by processing capacity

Salmon, saffron cod, whitefish, and herring are the major subsistence species. There are two rivers in the Kotzebue area providing the majority of chum salmon, the Kobuk River and Noatak River. Along the Noatak and Kobuk rivers, where runs of chum salmon are strong, household subsistence activities in mid and late summer revolve around the harvesting, drying, and storing of salmon for uses during the winter. In southern Kotzebue Sound, fewer salmon are taken for subsistence because of low availability. Chum salmon predominate in the district, but small numbers of other salmon species are present in the district.

[18] Unless otherwise noted, information in this section taken from: Mendard, J., J. Soong, and S. Kent. 2012. 2010 Annual Management Report Norton Sound, Port Clarence, and Kotzebue. Alaska Department of Fish and Game, Fishery Management Report No. 12-31, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-31.pdf

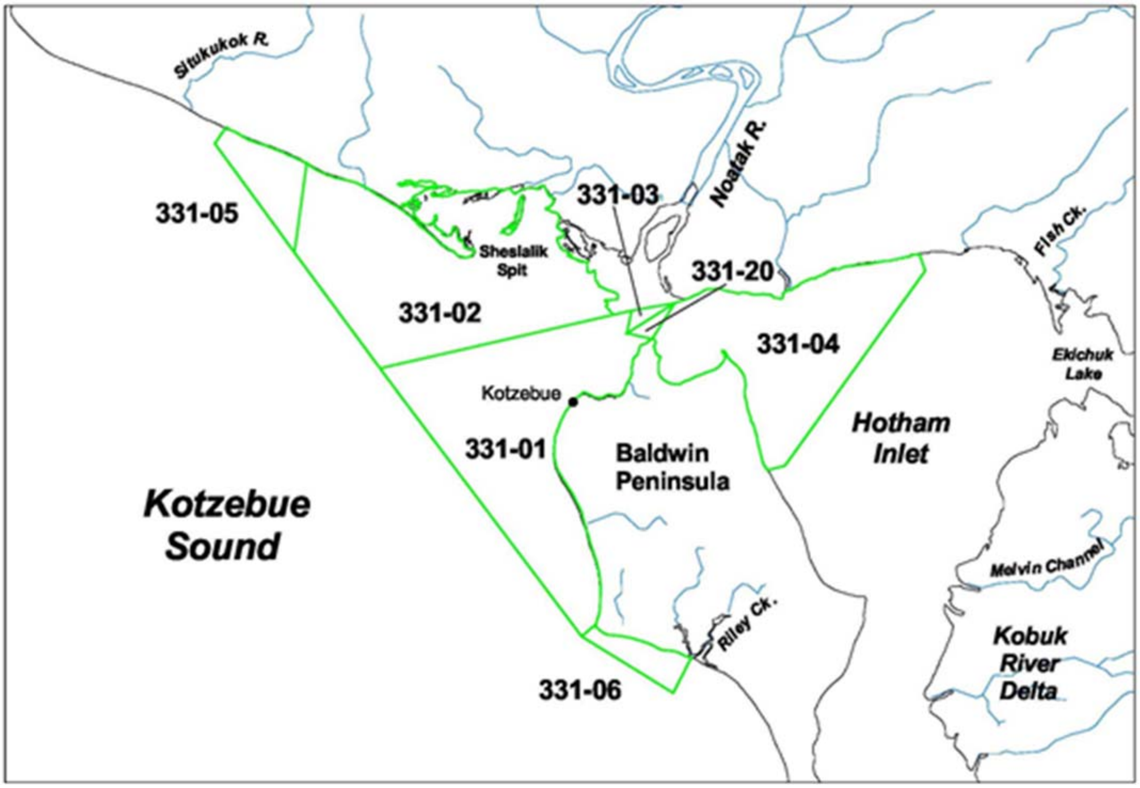


Figure A6-46. Kotzebue Sound commercial fishing subdistricts.

A6.1.5.1 Kotzebue Chum Assessment

Escapement

Escapement for the Kotzebue Sound District is determined with aerial survey SEGs within the two major river drainages and a district-wide BEG. Aerial surveys are infrequent on the Kobuk and Noatak Rivers because of poor weather conditions (Figure A6-46).

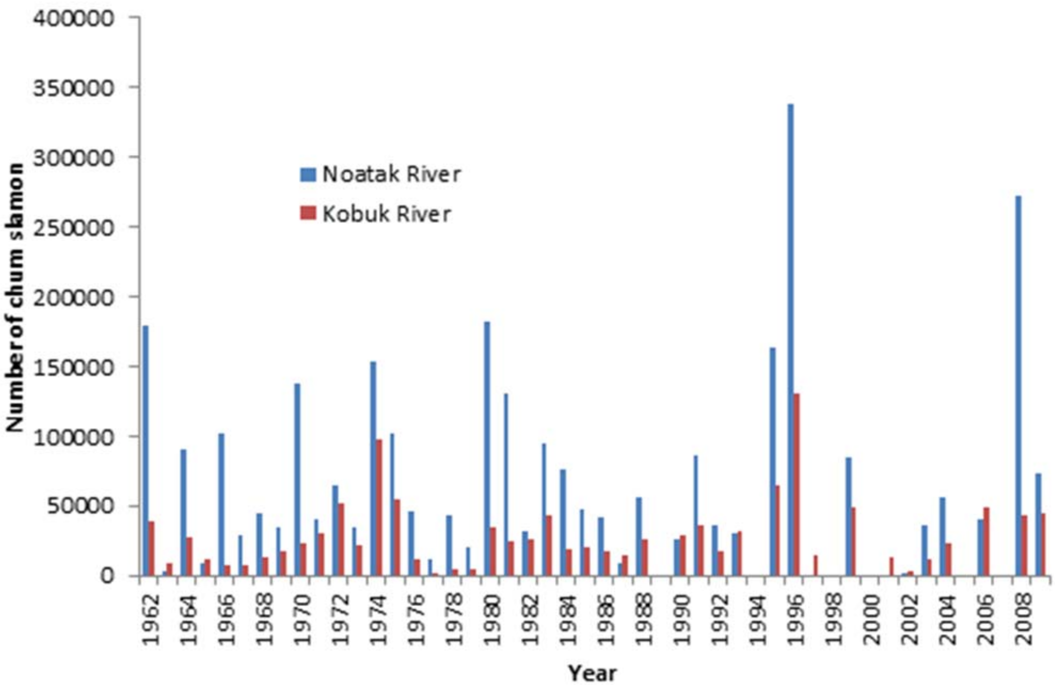


Figure A6-47. Chum salmon escapement in to the Noatak and Kobuk River drainages in Kotzebue Sound District determined by aerial surveys, 1962–2009. Note: Foot surveys were conducted in 1962 and 1968; blanks represent years with no surveys or poor survey conditions. No surveys were conducted in 2010 or 2011.

Escapement Goals

Table A6-31 Chum salmon escapement goals were established in 2007 for the Kotzebue area. All goals are determined from aerial surveys.

River	Enumeration method	Goal	Type
Noatak/Eli Rivers	Aerial Survey	42,000-91,000	SEG
Kobuk River drainage			
Salmon River	Aerial Survey	3,300-7,200	SEG
Squirrel River	Aerial Survey	4,900-10,500	SEG
Tutuksuk River	Aerial Survey	1,400-3,000	SEG
Upper Kobuk/Selby River	Aerial Survey	9,700-21,000	SEG
Kotzebue (all areas)	Expanded aerial survey	196,000-421,000	BEG

A6.1.5.2 Management of Kotzebue Area Chum Salmon Fisheries

Recent Management Actions

Primary commercial fishery management objectives are to provide adequate chum salmon escapement through the commercial fishery to: 1) ensure sustained runs by allowing adequate escapement, and 2) meet subsistence harvest needs. During the last five years, the commercial fishing schedule has been set by the buyer. ADF&G opens the commercial fishery to the hours requested by the buyer in order to allow the buyer flexibility. If poor run strength necessitates fishing restrictions, ADF&G establishes periodic closures of the fishery. Only in 2006 has ADF&G restricted fishing time to allow for more chum salmon passage through the commercial fishing district (Menard, 2010).

A6.1.5.3 Kotzebue Sound Area Commercial Chum Fishery Harvests

The historical commercial chum salmon harvests are listed in Table A6-32. Commercial chum salmon harvests during the 20 years when there was a major buyer (1982-2001) ranged from 55,907 to 521,406 fish, the 20-year average being 220,720. The 5-year (1997-2001) average catch was 141,741. This significant decrease reflects the lack of demand for salmon on the open market that began in the mid-1990s as buyers began to purchase less salmon. Fishing effort during 1982–2001 ranged from 45 to 199 fishermen. The 20-year average was 129 fishermen; the 5-year average from 1997–2001 was 61 fishermen. The decrease in participation was likely due to substantial price declines and lack of market.

In 2002, the last significant buyer in the commercial fishery decided to not purchase fish in Kotzebue. Because there was no major buyer only 3 permit holders fished in 2002. Likewise, in 2003 there were only 4 permit holders. In both 2002 and 2003, one permit holder became a licensed agent for a buyer outside of Kotzebue, and worked with other permit holders to provide product for that market.

Beginning in 2004 one buyer provided a limited market for permit holders. The fishing effort (permits fished) over the last 5 years has one-quarter the fishing effort of 20 years ago. From 2004–2008 there were less than 50 permit holders participating in the commercial fishery each year with the average being 44 permit holders. In 2009 there was an increase to 62 permit holders participating in the fishery. The 2010 harvest of 270,343 chum salmon was the highest since 1995. Also, harvested for personal se in 2009 were 13 Chinook salmon, 6 sockeye salmon, 557 pink salmon, 7 coho salmon, 1,323 Dolly Varden and 3,021 sheefish. A total of 2,160,264 pounds of chum salmon were sold with a total ex-vessel value of $860,125. The 2010 average value per permit holder was $12,837 and was the highest value since 1988 (Table A6-32). Historic catches and values, compared to average catch and value, are depicted in Figure A6-48.

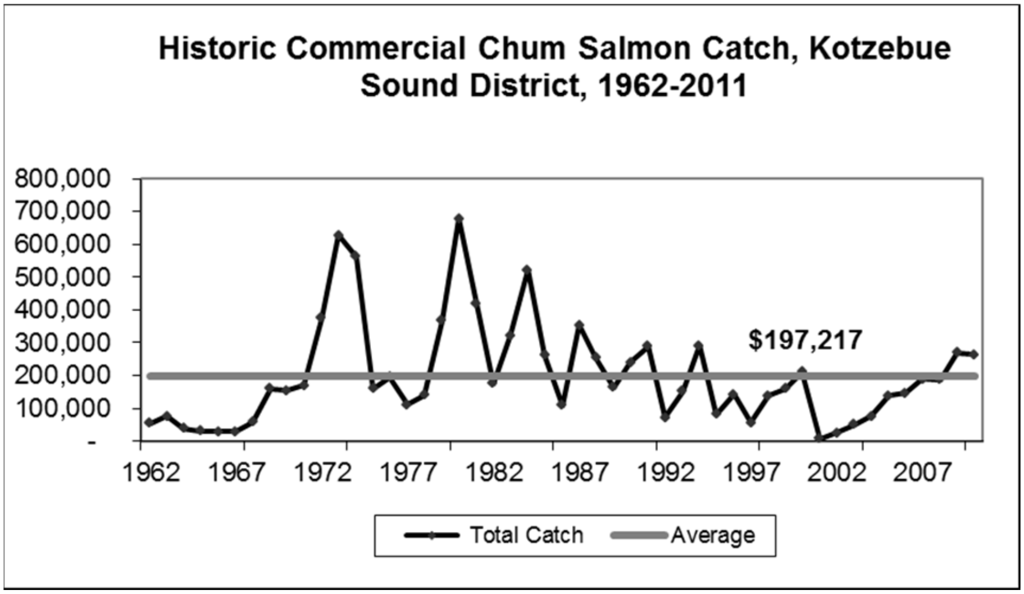
Table A6-32. Kotzebue district chum salmon catch and dollar value 1963-2011.

Year	Total Catch	Number of Permits [a]	Season Catch per Permit Holder	Gross Value of Catch to Permit Holders [b]	Real Value of Catch to Permit Holders [b]
1962	129,948	84	1,547	$4,500	$25,877.01
1963	54,445	61	893	$9,140	$52,005.25
1964	76,449	52	1,470	$34,660	$194,206.20
1965	40,025	45	889	$18,000	$99,054.67
1966	30,764	44	699	$25,000	$133,781.24
1967	29,400	30	980	$28,700	$148,991.26
1968	30,212	59	512	$46,000	$229,070.05
1969	59,335	52	1,141	$71,000	$336,926.49
1970	159,664	82	1,947	$186,000	$838,441.83
1971	154,956	91	1,703	$200,000	$858,614.34
1972	169,664	104	1,631	$260,000	$1,070,057.07
1973	375,432	148	2,537	$925,000	$3,606,782.69
1974	627,912	185	3,394	$1,822,784	$6,515,929.69
1975	563,345	267	2,110	$1,365,648	$4,460,134.84
1976	159,796	220	726	$580,375	$1,792,606.32
1977	195,895	224	875	$1,033,950	$3,002,209.99
1978	111,494	208	536	$575,260	$1,560,819.92
1979	141,623	181	782	$990,263	$2,480,466.14
1980	367,284	176	2,087	$1,446,633	$3,320,824.20
1981	677,239	187	3,622	$3,246,793	$6,814,690.56
1982	417,790	199	2,099	$1,961,518	$3,880,238.86
1983	175,762	189	930	$420,736	$800,634.98
1984	320,206	181	1,769	$1,148,884	$2,107,133.15
1985	521,406	189	2,759	$2,137,368	$3,804,852.43
1986	261,436	187	1,398	$931,241	$1,621,907.34
1987	109,467	160	684	$515,000	$871,652.85
1988	352,915	193	1,829	$2,581,333	$4,223,932.90
1989	254,617	165	1,543	$613,823	$967,867.43
1990	163,263	153	1,067	$438,044	$665,035.01
1991	239,923	142	1,690	$437,948	$642,130.42
1992	289,184	149	1,941	$533,731	$764,440.48
1993 [c]	73,071	114	641	$235,061	$329,390.10
1994	153,452	109	1,408	$233,512	$320,467.97
1995	290,730	92	3,160	$316,031	$424,864.33
1996	82,110	55	1,493	$56,310	$74,287.75
1997	142,720	68	2,099	$187,978	$243,690.01
1998	55,907	45	1,242	$70,587	$90,484.20
1999	138,605	60	2,310	$179,781	$227,119.38
2000	159,802	64	2,497	$246,786	$305,159.20
2001	211,672	66	3,207	$322,650	$390,152.01
2002	8,390	3	2,797	$7,572	$9,010.23
2003	25,763	4	6,441	$26,377	$30,725.98
2004	51,077	43	1,188	$64,420	$72,970.94
2005	75,971	41	1,853	$124,820	$136,821.44
2006	137,961	42	3,285	$216,654	$229,994.37
2007	147,087	46	3,198	$243,149	$250,741.12
2008	190,550	48	3,970	$385,270	$388,802.80
2009	187,562	62	3,025	$585,240	$585,240.00
2010	270,343	67	4,035	$860,125	$860,125
2011	264,321	89	2,970	$867,085	$867,085
Average	197,217	111	1,952	590,850	$1,282,885

[a] During 1962-1966 and 1968-1971 figures represent the number of vessels licensed to fish in the Kotzebue District, not the number of fishers.

[b] Some estimates between 1962 and 1981include only chum value which in figures represent over 99% of the total value. Figures after 1981 represent the chum value as well as incidental species such as Dolly Varden, whitefish and other salmon.

[c] Includes 2,000 chum salmon and $3,648 from the Sikusuilaq springs Hatchery terminal fishery.



Source: Data provided to NMFS by ADF&G, in 2010, in response to a special data request.

Figure A6-48 Kotzebue Sound commercial chum salmon catch, 1962-2010.

2011 Summary

Strong commercial and test fish catches in July indicated a very large chum salmon run and the department opened fishing any time either of the two buyers requested. In August, several day closures of the main runway at the airport limited fishing time. Despite the closures, catch volume was high in August. As a consequence, the majory buyer requested fisheing periods as short as three hours and the fishing time was switched from overnight to early evening hours to ensure that processing capacity was not exceeded.

The biggest single day catch was on August 15, when 14,855 chum salmon were sold during a four hour opening. The season catch of 264,321 was the second highest catch since 1995 (Figure A6-49).

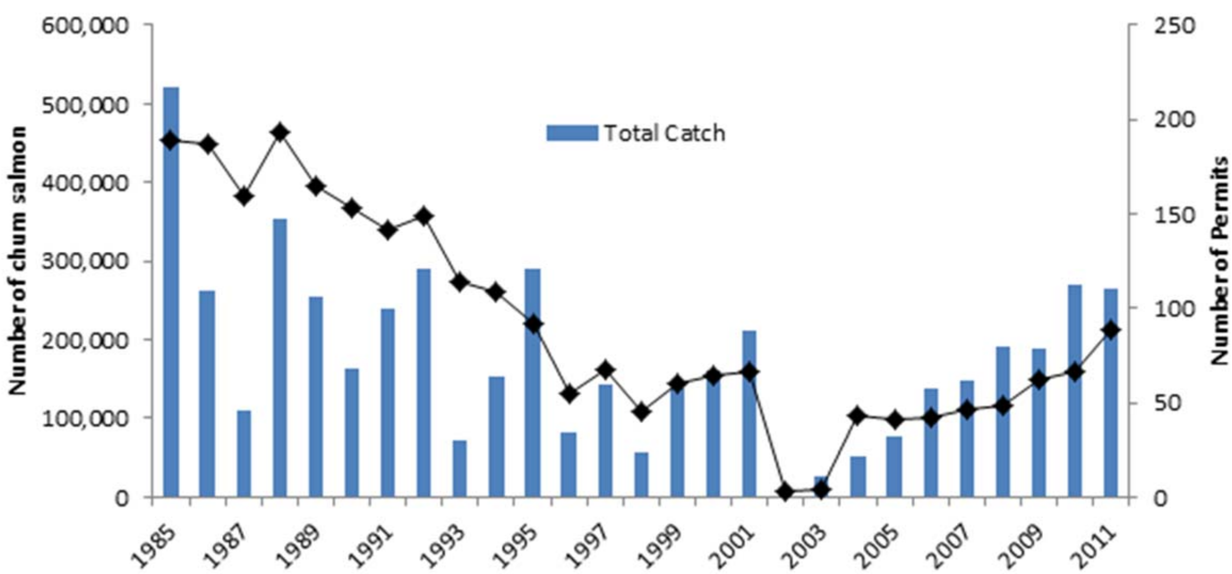


Figure A6-49. Kotzebue Sound commercial chum salmon harvest and permit fished, 1985–2011.

A6.1.5.4 Kotzebue Area Subsistence Chum Salmon Harvests[19]

In the Kotzebue area, subsistence salmon fishing has few restrictions, other than the general statewide provisions. Standard conditions include prohibition of fishing within 300 ft of a dam, fish ladder, weir, culvert, or other artificial obstruction. Salmon may be taken in the district at any time with no harvest limits and no required permits. Commercial fishermen, however, are not allowed to subsistence fish for salmon during the commercial season (Fall et al., 2009).

From 1994 through 2004, with funding from the Division of Commercial Fisheries, the Division of Subsistence conducted household surveys in selected Kotzebue Sound communities to collect subsistence salmon harvest data. Since funding for that effort has not been available since 2004, no surveys have been conducted; therefore, no subsistence salmon harvest estimates are available since that time. The average yearly subsistence harvest between 1994 and 2004 was 59,650 salmon, the majority of which were chum salmon (
Table A6-34). This average may be low due to incomplete datasets resulting in low harvest totals for several years during that period. Harvest estimates for 1994, 2002, 2003, and 2004 do not include the city of Kotzebue. Because Kotzebue is the largest community in the region, residents typically harvest as much salmon as residents from all other communities in the region combined. No harvest information is available for Ambler, a Kobuk River village, for 2001. Data for 2002 include only harvest information from Noatak and Noorvik (Fall et al., 2009).

Historical subsistence surveys for the Kotzebue Area have been less complete than for Norton Sound and Port Clarence Districts. Expanded surveys from 1995 to 2004 result in an estimated total subsistence harvest for Kotzebue to be 57,977 annually, the majority of which are chum salmon (Menard et al., *2010*). The ADF&G 2011 Kotzebue Salmon Season Summary indicates that subsistence harvests were very good in 2011.

Arctic Area Subsistence Harvests

The five species of Pacific salmon are indigenous to the area; however, chum salmon, coho salmon, and pink salmon are the most abundant. Table A6-33 below provides a summary of subsistence salmon harvest for Arctic Alaska in 2008 (Fall et al., 2011). In summer, subsistence fishermen harvest salmon with gillnets or seines in the main Seward Peninsula rivers and in the coastal marine waters. Beach seines are used near the spawning grounds to harvest schooling or spawning salmon and other species of fish. A major portion of fish taken during the summer months is air dried or smoked for later consumption by residents. Chum and pink salmon are the most abundant species throughout the area (Fall et al., 2009).

Two visits by ADF&G personnel are made to each village in the management area in order to issue Tier I subsistence fishing permits. Villagers can also call the Nome office toll free and a permit will be mailed or faxed when possible. Village residents are able to mail completed permits to the Nome office postage free. Attempts are made to contact all permit holders who did not return their household permit by phone or letter. Also, trips to villages are made postseason by ADF&G personnel to collect permits and discuss the fishing season (Menard et al., *2010*).

In 2004, ADF&G's subsistence salmon harvest assessment program changed when household surveys were discontinued in most communities because the Tier 1 household subsistence permit system was expanded from Nome to include Port Clarence District and Norton Sound Subdistricts 2 and 3. Thereafter, subsistence salmon harvests for these communities are reported totals from subsistence permits, so household surveys have not been necessary (Menard et al., *2010*).

[19] An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

In 2007, the BOF approved new regulations to allow for cash sales of up to $200 worth of subsistence-taken finfish per household, per year, harvested in Norton Sound-Port Clarence Area only. Persons intending to sell any subsistence-taken salmon (and other finfish) need to obtain a free customary trade permit from Nome ADF&G and record cash sales on the permit. Sales cannot be made to a fishery business or resold by the buyer (Menard et al., 2010).

Table A6-33. Subsistence salmon harvests by district, Arctic Alaska, 2008.

		Estimated salmon harvest[a]					
District	Households surveyed or permits returned	Chinook	Sockeye	Coho	Chum	Pink	Total
Norton Sound District[b]	1,151	3,087	399	18,889	11,505	56,096	89,976
Port Clarence District[c]	399	125	5,144	562	2,499	7,627	15,957
Kotzebue Area[d]	ND	ND	ND	ND	ND	ND	ND
Total[e]	1,172	3,212	5,543	19,451	14,004	63,723	105,933

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2009) and Kawerak, Inc., household survey, 2009.

a. Harvests reported during household surveys are expanded into estimates to account for uncontacted households. Harvests reported on permits are not expanded.

b. Household surveys conducted in Unalakleet, Koyuk, Shaktoolik, St. Michael, and Stebbins. Permits issued for Cape Woolley, Nome Subdistrict (Tier I), Golovin Subdistrict, and Elim Subdistrict.

c. Permits issued for Port Clarence Subdistrict, Pilgrim River, and Salmon Lake.

yearly subsistence harvest of salmon in the Kotzebue area between 1994 and 2004 was 59,650 fish. ND = No data. Districts

Table A6-34. Estimated historical subsistence chum salmon harvests by district, Arctic Alaska, 1994 - 2008.

Year	Number of households	Chinook	Sockeye	Coho	Chum	Pink	Total
Norton Sound District							
1994	839	7,212	1,161	22,108	24,776	70,821	126,077
1995	851	7,766	1,222	23,015	43,014	38,594	113,612
1996	858	7,255	1,182	26,304	34,585	64,724	134,050
1997[a]	1,113	8,998	1,892	16,476	26,803	27,200	81,370
1998[a]	1,184	8,295	1,214	19,007	20,032	51,933	100,480
1999	898	6,144	1,177	14,342	19,398	20,017	61,078
2000	860	4,149	682	17,062	17,283	38,308	77,485
2001	878	5,576	767	14,550	20,213	30,261	71,367
2002	935	5,469	763	15,086	17,817	64,354	103,490
2003	940	5,290	801	14,105	13,913	49,674	83,782
2004	1,003	3,169	363	8,225	3,200	61,813	76,770
2005	1,061	4,087	774	13,896	12,008	53,236	84,000
2006	1,066	3,298	901	19,476	10,306	48,764	82,745
2007	1,041	3,744	923	13,564	18,170	21,714	58,116
2008	1,151	3,087	399	18,889	11,505	56,096	89,976
Port Clarence District							
Year	Number of households	Chinook	Sockeye	Coho	Chum	Pink	Total
1994	151	203	2,220	1,892	2,294	4,309	10,918
1995	151	76	4,481	1,739	6,011	3,293	15,600
1996	132	194	2,634	1,258	4,707	2,236	11,029
1997	163	158	3,177	829	2,099	755	7,019
1998	157	289	1,696	1,759	2,621	7,815	14,179
1999	177	89	2,392	1,030	1,936	786	6,233
2000	163	72	2,851	935	1,275	1,387	6,521
2001	160	84	3,692	1,299	1,910	1,183	8,167
2002	176	133	3,732	2,194	2,699	3,394	12,152
2003	242	176	4,436	1,434	2,425	4,108	12,578
2004	371	278	8,688	1,131	2,505	5,918	18,520
2005	329	152	8,532	726	2,478	6,593	18,481
2006	345	133	9,862	1,057	3,967	4,925	19,944
2007	362	85	9,484	705	4,454	1,468	16,196
2008	399	125	5,144	562	2,499	7,627	15,957
Kotzebue Area[b]							
Year	Number of households	Chinook	Sockeye	Coho	Chum	Pink	Total
1994[c]	557	135	33	478	48,175	3,579	52,400
1995[d]	1,327	228	935	2,560	102,880	2,059	108,662
1996	1,187	550	471	317	99,740	951	102,029
1997	1,122	464	528	848	57,906	1,181	60,925
1998	1,279	383	392	461	48,979	2,116	52,330
1999	1,277	9	478	1,334	94,342	841	97,004
2000	1,227	211	75	2,557	65,975	75	68,893
2001[e]	1,149	11	14	768	49,014	36	49,844
2002[f]	216	3	9	56	16,880	8	16,955
2003[g]	488	40	53	1,042	19,201	583	20,918
2004[g]	440	54	18	1,502	23,348	1,259	26,181
2005[h]	ND	ND	ND	ND	ND	ND	ND
2006[h]	ND	ND	ND	ND	ND	ND	ND
2007[h]	ND	ND	ND	ND	ND	ND	ND
2008[h]	ND	ND	ND	ND	ND	ND	ND

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2009) and Kawerak, Inc., household survey, 2009.

a. Includes Gambell and Savoonga.
b. Normally includes Ambler, Kiana, Kobuk, Kotzebue, Noatak, Noorvik, and Shungnak.
c. Includes Deering and Wales; does not include Kotzebue.
d. Includes Shishmaref.
e. Does not include Ambler.
f. Includes only Noatak and Noorvik.
g. Does not include Kotzebue.
h. Due to lack of funding, no collection of subsistence salmon harvest data took place in Kotzebue area communities from 2005-2008. The average yearly subsistence harvest of salmon in the Kotzebue area between 1994 and 2004 was 59,650 fish. ND = No Data.

Table A6-35 Historic subsistence salmon harvests, Arctic Alaska, 1975 – 2008.

	Households or permits		Estimated salmon harvest[a]					
Year	Total	Surveyed or returned	Chinook	Sockeye	Coho	Chum	Pink	Total
1975	117	79	3	225	102	3,698	7,298	11,326
1976	138	104	6	0	275	1,856	5,472	7,609
1977	195	181	35	64	623	12,222	2,839	15,783
1978	168	126	31	0	242	4,035	10,697	15,005
1979	138	119	519	0	1,007	3,419	5,842	10,787
1980	232	161	135	0	2,075	5,839	21,728	29,777
1981	236	169	47	88	1,844	9,251	6,100	17,330
1982	230	182	33	6	2,093	5,719	20,480	28,331
1983	243	189	74	40	1,950	7,013	8,499	17,576
1984	240	189	85	0	1,890	4,945	18,067	24,987
1985	215	198	56	114	1,054	5,717	2,117	9,058
1986	279	240	157	127	788	8,494	9,011	18,577
1987	235	173	97	102	812	7,265	705	8,981
1988	192	166	67	171	1,089	6,379	2,543	10,249
1989	173	130	24	131	549	3,456	924	5,084
1990	188	165	60	234	542	4,525	2,413	7,774
1991	155	128	83	166	1,279	3,715	194	5,437
1992	163	132	152	163	1,720	2,030	7,746	11,811
1993	142	104	51	74	1,780	1,578	758	4,241
1994	1,547	1,169	7,713	3,414	24,494	75,489	78,954	190,063
1995[b]	2,329	1,445	8,070	6,639	27,314	151,905	43,947	237,874
1996	2,177	1,454	7,999	4,287	27,879	139,032	67,911	247,108
1997[c]	2,398	1,645	9,620	5,597	18,153	86,808	29,135	149,314
1998[c]	2,620	1,730	8,967	3,301	21,226	71,632	61,863	166,989
1999	2,351	1,300	6,242	4,046	16,706	115,676	21,644	164,315
2000	2,247	1,336	4,399	3,612	20,654	84,196	40,499	153,360
2001[d]	2,192	1,259	5,671	4,473	16,617	71,138	31,480	129,378
2002[e]	1,327	1,204	5,624	4,504	17,838	37,396	67,756	133,119
2003[f]	1,670	1,488	5,505	5,289	16,580	35,540	54,365	117,279
2004[g]	1,915	1,814	3,534	9,159	11,585	31,386	70,841	126,506
2005[g,h]	1,129	1,104	4,239	9,306	14,622	14,486	59,829	102,481
2006[g,h]	1,125	1,099	3,431	10,763	20,533	14,273	53,689	102,689
2007[g,h]	1,122	1,073	3,829	10,407	14,269	22,624	23,182	74,312
2008[h]	1,247	1,172	3,212	5,543	19,451	14,004	63,723	105,933
5-year average (2003-2007)	1,392	1,316	4,108	8,985	15,518	23,662	52,381	104,653
10-year average (1998-2007)	1,770	1,341	5,144	6,486	17,063	49,835	48,515	127,043
Historical average (1975-2007)	904	668	2,623	2,621	8,793	31,901	25,410	71,349

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2009) and Kawerak, Inc., household survey, 2009.
Note: Since 1994 ADF&G has conducted an annual subsistence salmon harvest assessment effort in Northwest. Alaska that provides more extensive and reliable estimates. Harvest estimates prior to 1994 cannot be directly compared.
a. Includes selected communities in the Norton Sound District, Port Clarence District, and Kotzebue Area.
b. Includes Shishmaref.
c. Includes Gambell and Savoonga.
d. Does not include Ambler.
e. For the Kotzebue Area, includes only Noatak and Noorvik.
f. Does not include Kotzebue.
g. Does not include Koyuk.
h. Does not include Kotzebue Area.

A6.1.5.5 Kotzebue Sound Area Sport Fisheries

Chum salmon are far and away the most abundant of the five Pacific salmon in the Kotzebue area, therefore, virtually all of the salmon sport fishing effort directed at chum salmon. However, while some salmon fishing effort occurs in association with wilderness float trips in Kotzebue Sound drainages, the amount of sport fishing effort expended toward salmon in the northern part of the management area is very light and harvests are very small, with sheefish and Dolly Varden being the principle target species. The recent 10-year average chum salmon harvest for the entire Kotzebue Area was 978 fish, the average catch was 2,903 fish, and the average of annual sport fishing effort was 5,779 angler-days. In 2009, catches of chum salmon in the Kotzebue area was 3,232 and harvest was 229 fish (personal communication, Brendan Scanlon, 2010).

A6.1.6 Port Clarence[20]

Description of Management Area

The Port Clarence District includes all waters from Cape Douglas north to Cape Prince of Wales, including Salmon Lake and the Pilgrim River drainage (Figure A6-50). Port Clarence District also encompasses the towns of Brevig Mission and Teller. Salmon, saffron cod, whitefish, and herring are the major subsistence species.

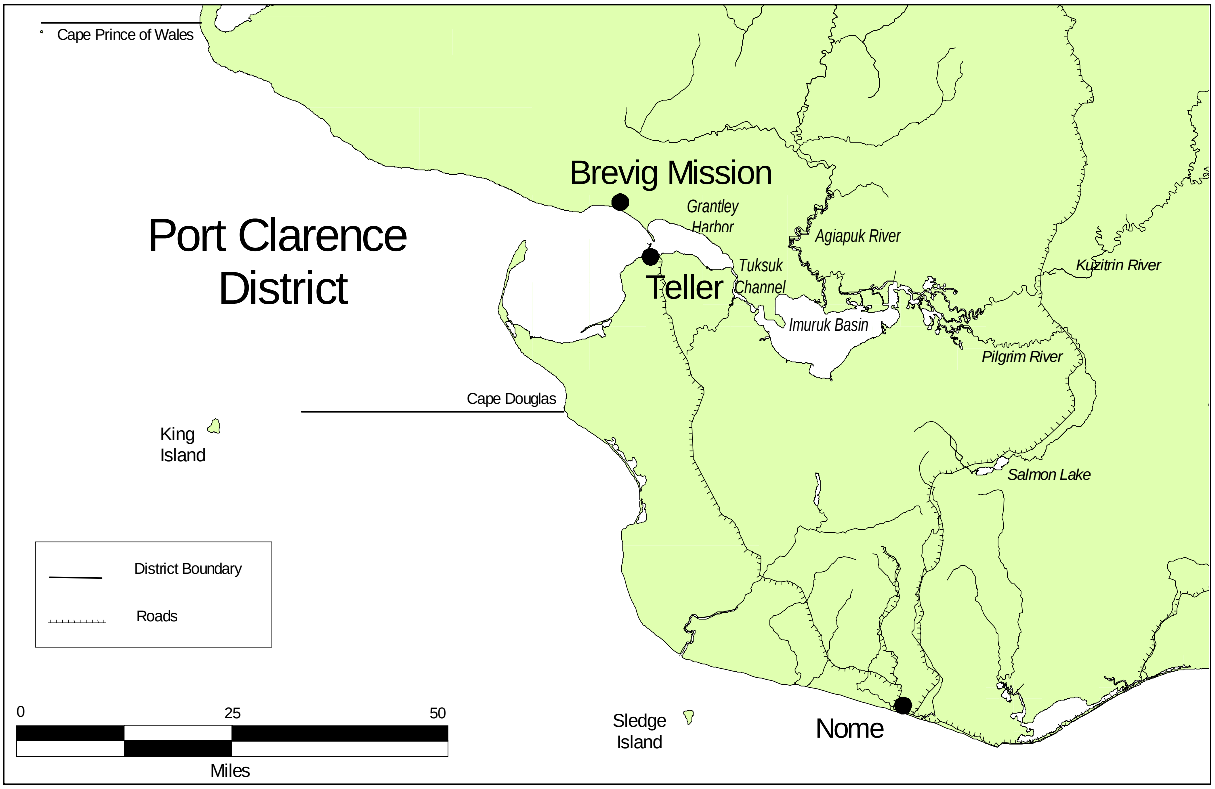


Figure A6-50 Port Clarence District.

A6.1.6.1 Port Clarence Chum Salmon Commercial Harvest

Some subsistence caught salmon are belived to be sold or bartered each year in Teller and Nome, but commercial fishing has been limited in Port Clarence Disrtict. In 1966, a total of 1,146 salmon consisting of 93 sockeye salmon, 131 pink salmon, and 922 chum salmon were taken in a commercial fishery in the Grantley Harbor/Tuksuk Channel area. Since then, commercial salmon fishing in this district had been prohibited due to relatively small runs in this area and the existence of a subsistence fishery. However, large increases in sockeye salmon runs in the mid-200s and positive resuls from an ADF&G test fishery in 2006 led to the opening of a limited commercial fishery beginning in 2007 with a catch of 1,152 sockeye salmon and 3.183 chum salmon. In 2008 the commercial fishery harvest was 89 sockeye salmon, 256 chum salmon, and 910 pink salmon. The 2008 commercial fishery was closed when the inriver goal of 30,000 sockeye salmon for the Pilgrim River was projected to fall short. The commercial fishery remained closed from 2009 – 2011 because of poor runs of sockeye salmon.

[20] Unless otherwise noted, information in this section taken from: Mendard, J., J. Soong, and S. Kent. 2012. 2010 Annual Management Report Norton Sound, Port Clarence, and Kotzebue. Alaska Department of Fish and Game, Fishery Management Report No. 12-31, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-31.pdf

A6.1.6.2 Chum Salmon Subsistence Harvest[21]

In most of the district, subsistence salmon fishing has few restrictions other than the general statewide provisions. Salmon may be taken in most areas at any time, with no harvest limits. Since 2004, subsistence salmon permits have been required in all Port Clarence waters. In addition, in the Pilgrim River drainage, including Salmon Lake and the Kuzitrin drainage, harvests are limited, and specified areas are closed to subsistence salmon fishing. For Salmon Lake, 2008 was the fourth year salmon fishing was opened in a portion of that body of water since its closure in 1972 (Fall et al., 2011).

In 2008, 405 Port Clarence Pilgrim River permits were issued, compared to 363 in 2007, 345 in 2006, and 330 in 2005. Of the permits issued in 2008, 255 were to fish the Pilgrim River only; 150 were for other waters in the district. The number of permits for the Pilgrim River has grown substantially, perhaps corresponding to several consecutive years of record sockeye salmon runs. ADF&G issued 3 permits for Salmon Lake in 2008 (Fall et al., 2011).

The estimated 2008 subsistence harvest of salmon in the Port Clarence District was 15,957 fish (Table A6-33). This was the lowest harvest in four years, but still above harvests from 1994-2003. Of the total salmon harvest, 16% were chum salmon (Figure A6-51) (Fall et al., 2011).

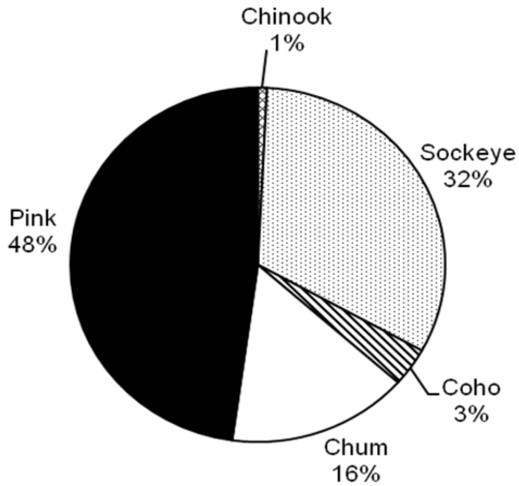


Figure A6-51 Species composition of estimated subsistence salmon harvests, Port Clarence District, 2008 Source: Fall et al., 2011.

A6.1.7 Alaska Peninsula/Area M[22]

A6.1.7.1 Description of Management Area

The Alaska Peninsula area includes all Pacific Ocean waters of Alaska between a line extending southeast from the tip of Kupreanof Point and the longitude of the tip of Cape Sarichef, and all Bering Sea waters of Alaska east of the longitude of the tip of Cape Sarichef and south of the latitude of the tip of Cape

[21] An updated report from the Division of Subsistence, which will update data in this section through 2010, is expected in late 2012.

[22] Unless otherwise noted, information in this section taken from: Hartill, T. G., and R. L. Murphy. 2011. North Alaska Peninsula commercial salmon annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 11-07, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMR11-07.pdf and Poetter, A. D., M. D. Keyse, and A. C. Bernard. 2011. South Alaska Peninsula salmon annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 11-33, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMR11-33.pdf

Menshikof. The communities of the Alaska Peninsula area are Port Heiden (estimated population 83 in 2009), Nelson Lagoon (population 60 in 2009), False Pass (population 41 in 2009), Cold Bay (population 84 in 2009), King Cove (population 744 in 2009), and Sand Point (population 1,001 in 2009) (http://laborstats.alaska.gov). Port Heiden is in the Lake and Peninsula Borough; the other communities are in the Aleutians East Borough (which also includes Akutan in the Aleutian Islands area) (Fall et al., 2011).

The Alaska Peninsula Management Area is further divided into the North Peninsula portion and the South Peninsula portion. The North Alaska Peninsula includes those waters from Cape Sarichef to Cape Menshikof and consists of two districts: The Northwestern District (includes all waters between Cape Sarichef and Moffet Point) and the Northern District (includes all water between Moffet Point and Cape Menshikof) (Hartill and Murphy, 2010). The South Peninsula portion is divided into four management districts: 1) Southeastern District, consisting of waters between Kupreanof Point and McGinty Point; 2) South Central District, consisting of waters between McGinty Point and Arch Point Light; 3) Southwestern District, consisting of waters between Arch Point Light, False Pass, and Cape Pankof Light; and 4) Unimak District, consisting of waters between Cape Pankof Light and Scotch Cap, including Sanak Island (Poetter et al., 2009). It should be noted that the Alaska Peninsula Area (Area M) and Bristol Bay Are (Area T) overlap consists of the Cinder River Section, Inner Port Heiden Section, and Ilnik Lagoon .

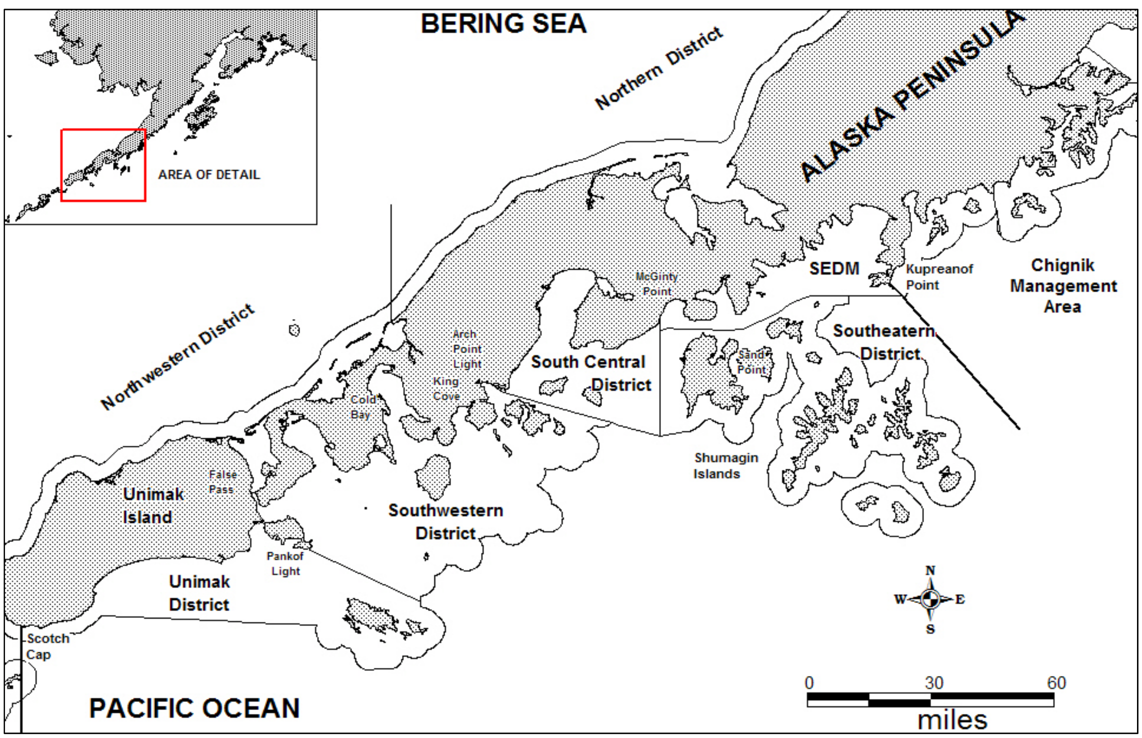


Figure A6-52 Alaska Peninsula Area

A6.1.7.2 Alaska Peninsula/Area M Asssessment

Area M Escapement

Salmon migration or spawning has been documented in approximately 307 Area M streams. The South Peninsula has approximately 136 systems with chum salmon spawning populations while the North Peninsula has approximately73 systems with chum salmon spawning populations. A total of six stock-aggregate escapement goals have been established for chum salmon in Area M. These stock-aggregate goals comprise the respective sums of aerial survey escapement objectives for 136 individual index streams (Honnold et al. 2007; Nelson and Lloyd 2001). Sixty-seven of these index streams are located along the South Peninsula and 69 are found along the North Peninsula.

North Peninsula Chum salmon Escapement

The North Alaska Peninsula has two chum salmon escapement goals, one for the entire Northern District and one for the entire Northwestern District. In 2011, the Northern District chum salmon escapement goal (119,600 to 239,200 fish; Honnold et al. 2007) was not met when 96,952 fish were documented in Northern District streams (Figure A6-53). The Northwestern District chum salmon escapement of 151,400 fish did meet the goal of 100,000 to 215,000 fish, and was below the previous ten year average of 319,706 fish (Figure A6-54).

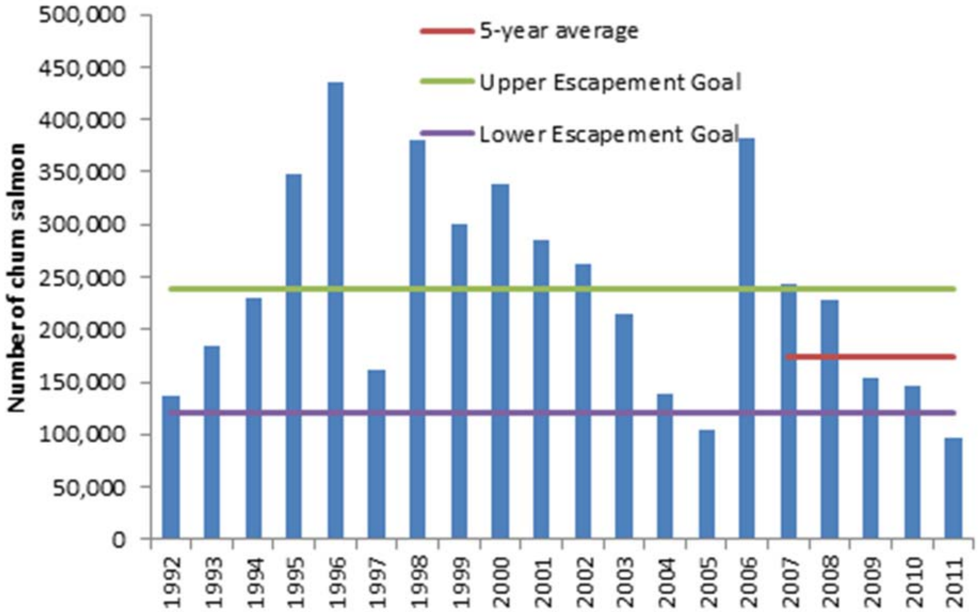


Figure A6-53. Northern District chum salmon escapement with comparison of upper and lower escapement goal and 5 year average, 1992-2011.

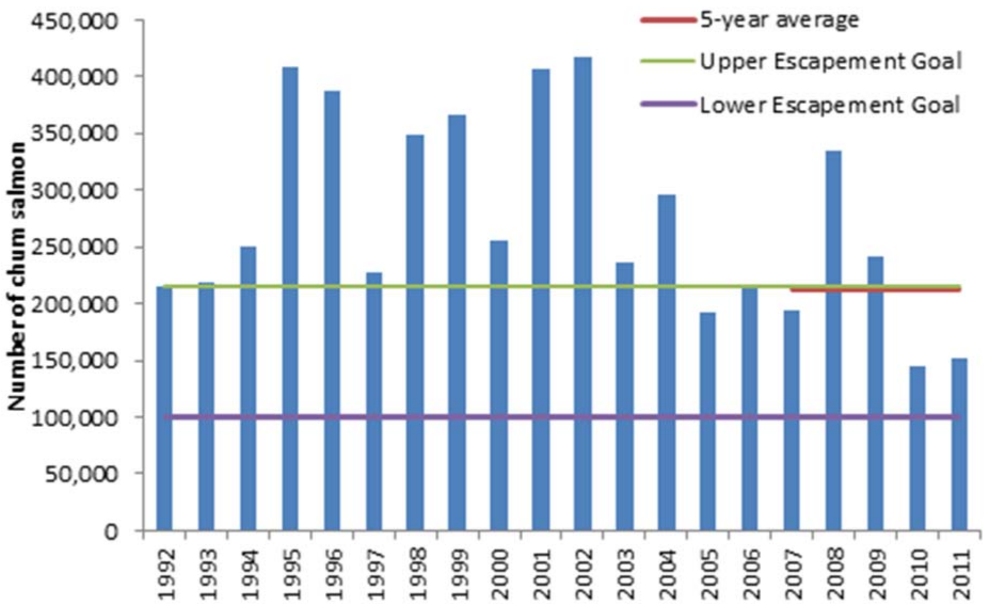


Figure A6-54. Northwestern District chum salmon escapement with comparison of upper and lower escapement goal and 5 year average, 1992-2011.

South Peninsula Chum salmon Escapement

Chum salmon escapment goals, aggregated by district, were established in 1992 and remained unchanged after a review by the Board of Fish in 2003. The 2006 escapement goal review of South Peninsula chum salmon corroborated the original goals with the exception of Unimak Distric fish, which was changed from and SEG to an SEG threshold after revew of rish analysis resuls (Honnold et al. 2007). The current chum salmon escapement goal ranges are : 106,400 to 212,800 fish for Southeastern District; 89,800-179,600 fish in the South Central District; 133,400 to 266,800 fish in the Southwestern District; and a lower bound SEG of 800 fish for the Unimak District (Honnold et al. 2009). The 2011 South Peninsula total indexed chum salmon escapement of 497,725 fish was within the combined escapement goal range of 330,400 to 659,200 fish (Figure A6-55).

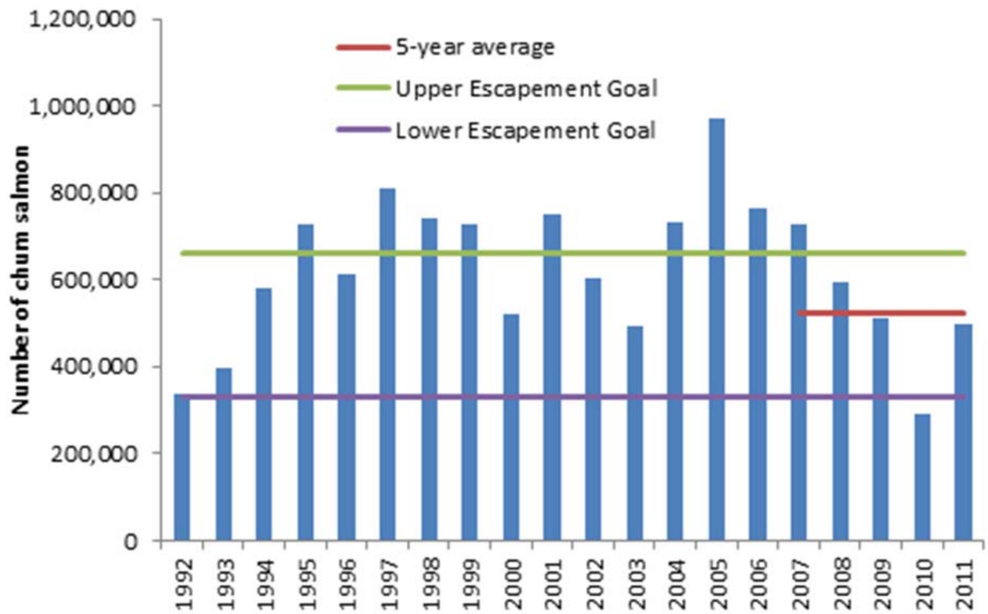


Figure A6-55. South Peninsula chum salmon escapement including the lower and upper escapement goal and 5 year average, 1992-2011.

A6.1.7.3 Alaska Peninsula/Area M Commercial fisheries

Area M Commercial Chum Salmon Fishery

2011 Summary

The South Unimak and Shumagin Islands fishing season began at 6:00 a.m. on June 7 with an 88-hour fishing period for all gear types (purse seine, drift gillnet, and set gillnet gear). During the June fishery, there were four 88-hour periods and one 64-hour fishing period. The commercial chum salmon harvest for the June fishery was 423,335 chum salmon. The total commercial harvest for the South Peninsula post-June fishery (including the Southeastern District mainland) was 502,891 chum salmon. Commercial salmon fishing during the post-June Southeastern District mainland fishery remained closed for most of August due to low escapements of both pink and chum salmon. In 2011, the Alaska Peninsula Area commercial chum salmon harvest totaled 1,273,171 fish which was higher than the 1999-2008 average harvest of 939,588 (Table A6-36).

North Alaska Peninsula

The total commercial harvest for the North Alaska Peninsula fishery was 293,848 chum salmon in 2011. The North Alaska Peninsula fishery is predominantly a sockeye salmon fishery, although depending on market conditions, directed Chinook, coho, and chum salmon fisheries occur in some locations. In 2011, the North Alaska Peninsula harvest of chum salmon was above the previous 10-year (2002–2011) average of 129,628 chum salmon (Table A6-36).

South Alaska Peninsula

The 2011 South Alaska Peninsula chum salmon harvest of 979,187 fish was above the 2002 - 2011 average harvest of 909,818 fish. In the Southeastern District, the chum salmon harvest of 520,254 fish was above the 2002 – 2011 average of 490,023 fish. For the South Central District a total of 85,797 chum salmon were harvested which was above the previous ten year average of 58,778 fish. Fishermen in the Southwest District harvested 135,978 chum salmon which was less than the 2002 – 2011 average harvest of 231,448 fish. A total of 237,158 chum salmon were harvest in the Unimak District, which was above the previous ten-year average of 129,570 fish (Table A6-36).

Table A6-36. Area M chum salmon harvest by year and district, 1980-2011.

	Area M Salmon Management Districts						
Year	Northern	Northwest	Southeastern	South Central	Southwestern	Unimak	Total
1980	332,685	367,511	534,752	191,080	223,100	404,540	2,053,668
1981	351,322	355,496	781,060	240,631	273,239	475,770	2,477,518
1982	236,014	95,119	845,086	240,172	643,885	545,504	2,605,780
1983	178,681	169,626	637,701	128,906	207,956	728,824	2,051,694
1984	614,268	182,455	630,929	311,193	430,211	282,332	2,451,388
1985	423,489	243,127	482,176	165,893	428,201	272,181	2,015,067
1986	157,653	113,563	825,398	254,835	467,475	201,943	2,020,867
1987	155,446	213,250	591,960	198,350	230,802	354,775	1,744,583
1988	214,790	178,285	736,086	155,378	514,960	502,083	2,301,582
1989	131,250	25,742	418,334	49,861	129,786	419,792	1,174,765
1990	95,541	30,572	564,118	60,370	208,090	445,430	1,404,121
1991	128,538	62,740	509,423	156,552	322,742	585,056	1,765,051
1992	236,884	104,732	441,023	253,811	358,237	257,266	1,651,953
1993	86,563	48,394	337,403	143,660	232,895	332,449	1,181,364
1994	43,658	40,239	581,256	317,664	962,369	317,621	2,262,807
1995	72,588	26,705	684,643	176,827	551,587	302,010	1,814,360
1996	60,225	7,731	446,435	70,607	170,952	87,063	843,013
1997	51,169	46,211	172,629	55,050	240,914	137,661	703,634
1998	37,487	32,029	252,947	90,080	217,498	151,001	781,042
1999	42,220	7,900	385,200	69,651	235,981	126,134	867,086
2000	63,087	30,609	390,120	118,854	424,916	121,426	1,149,012
2001	61,297	113,226	331,095	122,593	451,313	16,985	1,096,509
2002	29,201	21,839	342,590	44,283	320,902	111,255	870,070
2003	22,178	16,577	271,634	15,376	271,316	78,979	676,060
2004	8,480	6,478	557,336	40,423	100,116	92,234	805,067
2005	8,915	33,617	459,546	51,248	148,139	80,527	781,992
2006	92,330	39,388	664,189	110,116	326,023	77,478	1,309,524
2007	85,003	96,006	352,448	42,511	170,809	114,019	860,796
2008	73,224	104,140	337,605	71,108	121,331	272,360	979,768
2009	51,825	54,169	866,938	77,233	605,457	131,091	1,786,713
2010	119,993	139,070	527,690	49,680	114,404	100,595	1,051,432
2011	64,450	229,398	520,254	85,797	135,978	237,158	1,273,035
2002-11 average	55,560	74,068	490,023	58,778	231,448	129,570	1,039,446

A6.1.7.4 Area M Subsistence Harvest[23]

The estimated subsistence chum salmon harvest in the Alaska Peninsula Management Area in 2008 was 1,078 fish. The estimated subsistence harvest for all salmon species in 2008 was 15,022 fish. This is an increase from the year before (10,811 salmon) and higher than the most recent five year average (14,736 salmon), but lower than the historical average (1985–2008; 18,552 salmon). (Table A6-37). The 2008 subsistence harvest was made up of 51% sockeye salmon, 29% coho salmon, 11% pink salmon, 7% chum salmon (Figure A6-56), and 2% Chinook salmon. Of the total salmon harvest, residents of Cold Bay harvested 3%, Sand Point residents 28%, Port Moller and Nelson Lagoon residents 4%, King Cove residents 44%, and False Pass residents 2%. Other Alaska residents harvested 6% (Figure A6-57) (Fall et al, 2011).

Table A6-37 Estimated historical subsistence salmon harvest, Alaska Peninsula, Area M, 1985-2008.

	Permits		Estimated salmon harvests					
Year	Issued	Returned	Chinook	Sockeye	Coho	Chum	Pink	Total
1985	161	95	74	4,037	7,504	1,566	574	13,755
1986	147	84	101	5,396	2,996	1,455	1,779	11,727
1987	191	144	193	5,777	4,259	1,943	1,547	13,719
1988	183	114	257	5,501	5,646	1,692	1,666	14,762
1989	188	139	88	10,404	3,505	2,104	1,213	17,314
1990	201	157	246	8,588	4,029	1,589	736	15,188
1991	249	185	458	11,345	5,551	3,551	1,878	22,783
1992	229	177	385	10,739	4,267	2,574	1,840	19,805
1993	262	215	615	12,478	5,753	1,997	1,189	22,032
1994	256	213	674	11,884	6,086	4,406	2,206	25,256
1995	260	198	492	12,716	5,021	3,369	2,653	24,251
1996	234	178	362	12,176	7,743	2,728	2,569	25,578
1997	217	172	420	15,224	4,612	2,885	2,955	26,096
1998	233	153	407	12,920	5,820	1,326	2,286	22,759
1999	185	148	391	15,119	4,961	2,235	2,136	24,843
2000	180	152	341	9,955	5,239	1,699	950	18,185
2001	185	155	570	12,259	3,940	1,963	1,181	19,912
2002	157	133	345	9,384	3,188	1,603	532	15,052
2003	166	128	312	10,103	4,266	2,353	1,194	18,228
2004	147	135	218	9,484	3,787	951	609	15,049
2005	160	139	192	11,260	4,089	716	1,054	17,310
2006	153	131	110	7,847	2,452	910	961	12,280
2007	150	124	100	6,872	2,648	498	693	10,811
2008	199	164	280	7,623	4,355	1,078	1,687	15,022
5-year average (2003–2007)	155	131	186	9,113	3,448	1,086	902	14,736
10-year average (1998–2007)	172	140	299	10,520	4,039	1,426	1,160	17,443
Historical average (1985–2007)	195	151	320	10,064	4,668	2,005	1,496	18,552

Source: ADF&G Division of Subsistence, ASFDB 2009 (ADF&G 2009).

23 An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

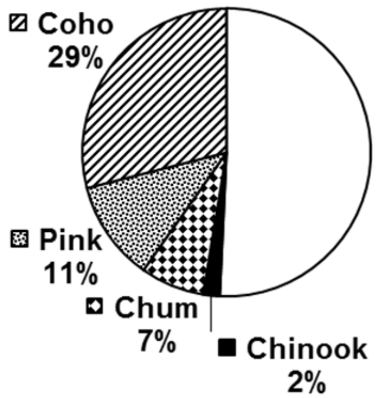


Figure A6-56 Composition of Alaska Peninsula area subsistence salmon harvest by species, 2008.
Source: Fall et al., 2011.

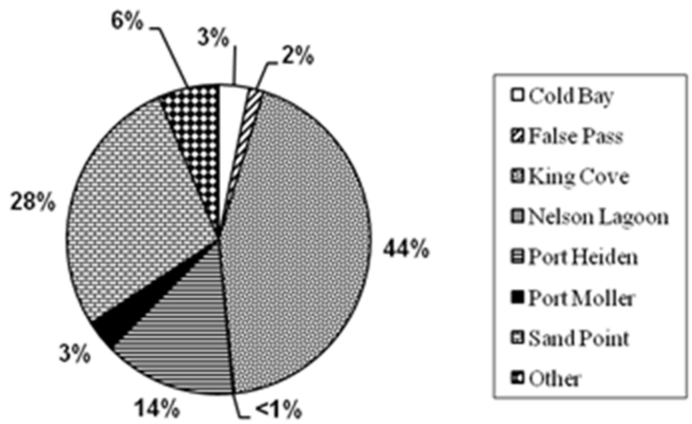


Figure A6-57 Subsistence salmon harvests by community, Alaska Peninsula area, 2008.
Source: Fall et al., 2011.

In interviews with ADF&G Division of Subsistence staff, fishery managers expressed the view that the subsistence permit program did not completely document all subsistence salmon harvesting activities because some subsistence users did not obtain permits. A comparison of permit and household interview data for 1992 for King Cove found that about 31% of interviewed households that reported subsistence fishing did not have permits. The estimated total subsistence salmon harvest for the community based on the interviews was 7,036 (±1,773), compared to 5,856 based on permit returns. At Sand Point in the same year, 41% of interviewed households reported that they harvested salmon for subsistence but did not have permits. The estimated total subsistence salmon harvest for Sand Point based on the household interviews was 11,338 (±2,551), compared to 7,833 based on estimates using permit return information (Fall et al., 2009).

The subsistence permit program for the Alaska Peninsula area does not account for salmon withheld from commercial catches for home uses. However, commercial fishermen are required to report the retention of fish taken in a commercial fishery on commercial harvest fish tickets. Fishery managers believe that this number is substantial, especially in years when commercial salmon prices are low. For 1992, it was estimated that 51% of the salmon harvested for home uses at King Cove, and 45% at Sand Point, were removed from commercial harvests (Fall et al., 2009).

A6.1.7.5 Alaska Peninsula/Area M Sport and Personal Use Fisheries

A significant percentage of the Alaska Peninsula/Aleutian Islands Regulatory Area sport fishing effort occurs in the Chignik River drainage and is directed at Chinook and coho salmon. Relatively little sport fishing effort is directed at chum salmon, and few are harvested annually. Currently there are no personal use salmon fishing regulations in effect for the Alaska Peninsula/Aleutian Islands Regulatory Area.

The annual chum salmon sport harvest typically represents around 1% of the total salmon harvest within the regulatory area. Most chum salmon sport fishing effort normally occurs in freshwaters of the Russel Creek drainage near Cold Bay (personal communication, 2010). From 2000-2009, Alaska Peninsula chum salmon sport harvests averaged 303 fish, although the median harvest during this period equaled 173. Total chum catch (including harvests) averaged just below 3,700. With the exception of 2009, when the chum salmon harvest appeared to increase substantially from historic levels, the most recent 10-year trend shows relatively little change in sport fishing activity targeting this species (personal communication, Donn Tracy, 2010).

Table A6-38 Alaska Peninsula/Aleutian Islands chum salmon catch and harvest, 2000 – 2009.

Alaska Peninsula/Aleutian Islands
Chum Salmon Catch and Harvest

Year	Catch*	Harvest
2000	7,217	213
2001	784	174
2002	1,734	107
2003	5,631	179
2004	3,024	435
2005	2,648	64
2006	1,856	109
2007	2,382	171
2008	3,443	62
2009	8,194	1,519
Avg.	3,691	303
Median	2,836	173

*Includes harvest.

Regarding the table above, the terms catch and harvest are often used interchangeably in commercial and subsistence fisheries; however there is a distinction between catch and harvest in the sport fisheries. When reporting or speaking of harvest, it is simply the number of fish that are caught and taken (killed) by an angler of a particular species for a certain fishery or location. Catch, however, are the numbers of fish of a particular species that are caught but not retained or harvested. In sport fishery terms, catch is the total number of fish that were caught including those fish that were released, while harvest is the number of fish caught that were kept. As such, harvest is a subset of catch when reviewing statewide harvest survey numbers (personal communication, Charlie Swanton and Tom Taube, 2010).

It should be noted, however, that when evaluating or reporting catch, there is often confusion regarding the distinction between catch and harvest so that catch statistics may (and often times do) include fish that have been harvested. In a strict interpretation, it cannot be emphatically stated that all fish reported as caught are released which is why both catch and harvest are reported (personal communication, Charlie Swanton and Tom Taube, 2010).

A6.1.8 Aleutian Islands and Atka-Amlia Management Area[24]

The Aleutian Islands Management Area (AIMA) consists of the Bering Sea and Pacific Ocean waters of the Pribilof Islands and the Aleutian Islandswest ofUnimak Island, and (Figure A6-58). The AIMA is one of three subareas comprising Area M, the other two of which are the North and South Alaska Peninsula management areas and are included in the Western Alaska portion of this document. A fourth subarea, the Atka-Amlia Islands Management Area, encompasses Aleutian Islands waters between Seguam Pass and Atka Pass (Figure A6-58).

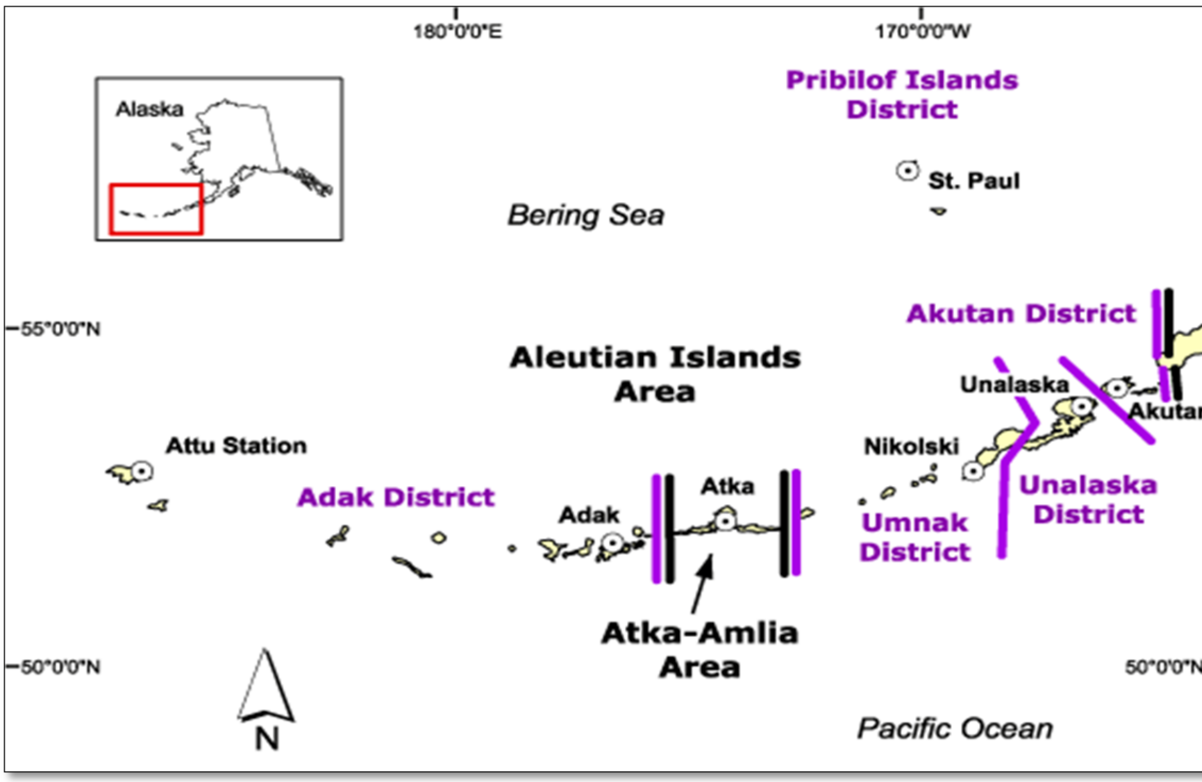


Figure A6-58. The Aleutian Islands and Atka-Amlia Islands management areas.

Streams in the Aleutian Islands have runs of sockeye, coho, pink, and chum salmon; however, poor salmon markets have generally limited commercial salmon harvests in both the Unalaska Island and Atka-Amlia Island fisheries. Pink salmon are the dominant harvest species in the Aleutian Islands.

A6.1.8.1 Aleutian Islands and Atka-Amlia Chum Assessment

Escapement

The Aleutian Islands and Atka-Amilia Islands Management areas have at least 335 salmon systems, with chum salmon present in approximately 11 systems.There is little salmon escapement information collected for the Aleutian Islands and Atka-Amlia Islands areas. Poor weather, remoteness, unavailability of suitable aircraft, and the high cost of aircraft charters limit surveys.

[24] Information contained in this section is taken from: Hartill, T.G. and M.D. Keyse. 2010. Annual summary of the commercial, subsistence, and personal use salmon fisheries and salmon escapements in the Alaska Peninsula, Aleutian Islands, and Atka-Amlia Islands Management Areas, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-21, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr10-21.pdf.

A6.1.8.2 Aleutian Islands and Atka-Amlia Chum Salmon Fishery Management

Purse seines, hand seines, and beach seines are the only legal gear types allowed to fish for salmon in the Aleutian Islands Management Area. In the Atka-Amlia Area, salmon may be taken by purse seine and set gillnet only.

A6.1.8.3 Aleutian Islands and Atka-Amlia Subsistence Chum Salmon Harvest[25]

Under subsistence fishing regulations, the Atka-Amlia Islands area is considered a district of the overall AIMA. Subsistence salmon fishing is important to Aleutian Islands communities; however, due to the remoteness of most villages in the AIMA, subsistence salmon fishing permits are only required in the larger communities in the Unalaska and Adak districts. Subsequently, Unalaska and Adak are the only communities from which subsistence information (from returned permits) is compiled on an annual basis. Sockeye salmon are the preferred species in the Unalaska subsistence fishery.

The total estimated harvest of 4,513 salmon in 2009 was more than the 2004-2008 average estimated harvest of 4,062 salmon. Chum salmon are not abundant in Unalaska Island waters and account for only a small portion of the subsistence harvest. In 2009, an estimated 182 chum salmon were caught in the Unalaska District subsistence fishery (Table A6-39).

Table A6-39. Estimated chum salmon subsistence harvest in the Aleutian Islands and Atka-Amlia Management Area, 1985-2009.

Year	Chum Salmon	Total Salmon
1985	20	2,418
1986	375	7,139
1987	151	3,406
1988	83	4,069
1989	36	2,912
1990	100	4,570
1991	45	3,080
1992	11	5,067
1993	136	4,268
1994	48	4,635
1995	23	5,805
1996	49	2,686
1997	110	5,728
1998	26	4,807
1999	13	5,065
2000	24	4,003
2001	100	5,280
2002	63	6,252
2003	41	5,878
2004	26	5,538
2005	15	5,198
2006	92	2,932
2007	36	3,400
2008	115	3,243
2009	182	4,513

[25] An updated report from the Division of Subsistence, which will update data in this section through 2010, is expected in late 2012.

A6.1.8.4 Aleutian Islands and Atka-Amlia Commercial Chum Salmon Harvest[26]

In 2009, the total Area M commercial chum salmon harvest was almost 1.8 million fish. Very small commercial harvests of chum salmon occurd in the AIMA and Atka-Amlia Islands Management Area. Interest in this fishery has diminished due to lack of markets, high processing costs, and low volumes of fish.

Table A6-40. Commercial chum salmon harvest in the Aleutian Islands Management Area (excluding Atka-Amlia Islands Area), 1980-2009.

Year	Chum Salmon	Year	Chum Salmon
1980	4,874	1995	-
1981	6,553	1996	-
1982	6,148	1997	-
1983	11,361	1998	-
1984	32,025	1999	-
1985	14,175	2000	-
1986	38,819	2001	-
1987	-	2002	-
1988	450	2003	-
1989	-	2004	-
1990	1,038	2005	-
1991	-	2006	1,534
1992	1,230	2007	-
1993	-	2008	261
1994	617	2009	2,005

In total 2,005 chum salmon were harvested in the commercial fishery in the Aleutian Islands Management Area in 2009 (Table A6-40), along with 1,625,910 pink salmon. All the commercial harvest was around Unalaska Island and most of that harvest occurred in the Makushin Bay area. There was no commercial salmon harvest in the Atka-Amlia Islands Area in 2009 (Table A6-41).

PLACEHOLDER: Need commercial value information

[26] While commercial salmon harvest information is not available for 2010 in the AIMA or Atka-Amlia Management Area, preliminary 2011 harvest data shows a commercial chum salmon harvest of 235 fish for the Aleutian Islands and zero fish for Atka and Amlia Islands. http://www.adfg.alaska.gov/static/fishing/PDFs/commercial/2011_akpeninsula_salmon_summary.pdf.

Table A6-41. Commercial chum salmon harvest in the Atka-Amlia Islands Area, 1992-2009.

Year	Chum Salmon
1992	308
1993	563
1994	0
1995	0
1996	0
1997	0
1998	0
1999	0
2000	0
2001	0
2002	0
2003	0
2004	0
2005	0
2006	0
2007	0
2008	0
2009	0

A6.1.9 Upper Cook Inlet[27]

Description of Management Area

The Upper Cook Inlet (UCI) commercial fisheries management area consists of that portion of Cook Inlet north of the latitude of the Anchor Point Light and is divided into the Central and Northern Districts (Figure A6-59). The Central District is approximately 75 miles long, averages 32 miles in width, and is divided into six subdistricts. The Northern District is 50 miles long, averages 20 miles in width and is divided into two subdistricts. At present, all five species of Pacific salmon are subject to commercial harvest in Upper Cook Inlet.

[27]Information contained in this section is taken from: Shields, P. and A. Dupuis. 2012. Upper Cook Inlet commercial fisheries annual management report, 2011. Alaska Department of Fish and Game, Fishery Management Report No. 12-25, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-25.

Figure A6-59. Upper Cook Inlet Management Area showing Northern and Central commercial fishing districts.

A6.1.9.1 Upper Cook Inlet Chum Assessment

Chum Salmon Escapement

Evaluation of chum salmon runs in UCI is made difficult because of the lack of information other than commercial harvest data. Chum salmon are no longer enumerated at either the Deshka River or Little Susitna River weirs.The only chum salmon escapement goal in all of UCI is an aerial SEG survey in Chinitna Bay (Clearwater Creek) set at 3,800-8,400 fish. This SEG has been met or exceeded every year since it was established in 2002. While ADF&G lacks long-term quantitative chum salmon escapement information, escapements to streams throughout UCI have benefited by management actions or regulatory changes aimed principally at other species.

A6.1.9.2 Upper Cook Inlet Chum Salmon Management

Currently, set (fixed) gillnets are the only gear permitted in the Northern District while both set and drift gillnets are used in the Central District. The use of seine gear is restricted to the Chinitna Bay subdistrict. Drift gillnets have accounted for approximately 88% of the annual chum salmon harvest since 1966. Set gillnets have harvested virtually all of the remainder; however, in the last 10 years (2001-2010), the proportion of the total annual chum salmon harvest taken by drift gillnets has increased. Run-timing and migration routes utilized by all species of salmon overlap to such a large extent that the commercial fishery is largely mixed-stock and mixed-species in nature. Typically, the UCI salmon harvest represents approximately 5% of the statewide catch.

A6.1.9.3 Upper Cook Inlet Subsistence, Educational, and Personal Use Chum Salmon Harvest

The only subsistence fishery that has occurred consistently in Cook Inlet is the Tyonek Subsistence fishery; however, there is also a subsistence salmon fishery allowed in the Yentna River drainage. Subsistence permits for both areas allows for the harvest of 25 salmon per permit holder plus 10 salmon (exceptions apply to Chinook salmonin both areas) for each additional member. The preliminary subsistence harvest for 2011 from Tyonek was seven chum salmon and for the Yentna River drainage was 21 chum salmon (Table A6-42).

Educational fisheries in UCI first began in 1989. The total harvest of all salmon species for educational fisheries in 2011 was 11,166 fish, which was the largest harvest ever recorded since the educational fisheries began. The 2011 education chum salmon harvest in UCI was 1,271 fish (Table A6-42).

As with the subsistence fishery, permit holders in the personal use fishery are allowed to harvest 25 salmon with an additional 10 salmon (with exceptions for Chinook salmon) for each household member. Personal use fishing using gillnets is only open near Kasilof River in waters normally closed to commercial set gillnet fishing. In addition, personal use fishing with dip nets is allowed at the terminus of the Kenai and Kasilof riversand in some years at Fish Creek. A personal use fishery for senior citizens allows salmon to be taken with dip nets on the Beluga River. The 2011 personal use harvest of chum salmon was 1,169 fish(Table A6-42).

Table A6-42. Upper Cook Inlet subsistence, educational, and personal use chum salmon harvest, 1998-2011.

	Chum Salmon			
Year	Subsistence		Educational	Personal
	Tyonek	Yentna		
1998	2	20	137	220
1999	11	11	75	168
2000	0	7	69	290
2001	6	4	34	276
2002	4	28	112	757
2003	10	13	66	371
2004	0	2	100	502
2005	2	25	79	428
2006	1	27	38	746
2007	2	18	20	614
2008	10	7	23	728
2009	2	6	36	559
2010	4	18	78	1,095
2011	7	21	1,271	1,169

Note: Subsistence harvest estimates are from returned permits only and not expanded for non-returned permits.

A6.1.9.4 Upper Cook Inlet Commercial Chum Salmon Harvest

The 2011 UCI commercial harvest of 5.5 million salmon was approximately 34% more than the 1966-2010 average annual harvest of 4.1 million fish. Chum salmon returns to UCI are concentrated predominately in the western and northern watersheds, with the most significant harvest coming from the Central District drift gillnet fleet. In 2011, approximately 129,000 chum salmon were commercially harvested, which was the fourth largest catch in the past 10 years and the seventh largest catch since 1995. This harvest was nearly 11% more than the previous 10-year average annual harvest of 116,000 chum salmon, but 71% less than the average annal harvest of 445,000 chum salmon taken from 1966 to 2010. (Figure A6-60). It should be noted that assessing chum salmon stocks based on recent harvest trends is suspect. For example, the drift gillnet fleet is the primary harvester of chum salmon. Drift gillnet fishing time in the Central District has been significantly altered, primarily to conserve Susitna River sockeye salmon. These restrictions have resulted in a marked reduction of chum salmon harvest.

PLACEHOLDER: Need commercial value information

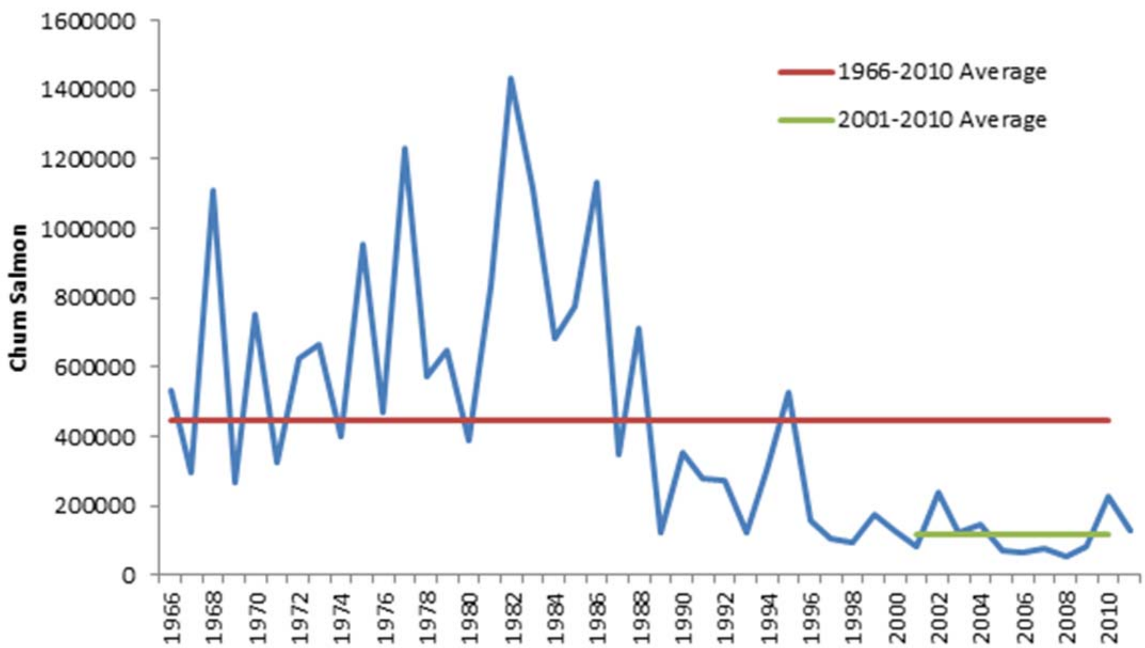


Figure A6-60. Upper Cook Inlet commercial chum salmon harvest, 1966-2011.

Table A6-43. Upper Cook Inlet commercial chum salmon harvest by district and gear type, 2011.

Gear	District	Chum Salmon
Drift	Central	111,082
Setnet	Central	11,607
	Northern	6,513
Total		129,202

A6.1.10 Lower Cook Inlet[28]

Description of Management Area

The Lower Cook Inlet (LCI) management area is comprised of all waters south of the latitude of Anchor Point including the western shore of Cook Inlet south to Cape Douglas and the eastern shore of Cook Inlet along the Kenai Peninsula to Cape Fairfield. This area is divided into five commercial salmon fishing districts (Figure A6-61). Barren Islands District is the only fishing district where no salmon fishing occurs, with the remaining four districts (Southern, Outer, Eastern, and Kamishak Bay) separated into approximately 40 subdistricts and sections to facilitate management of discrete stocks of salmon.

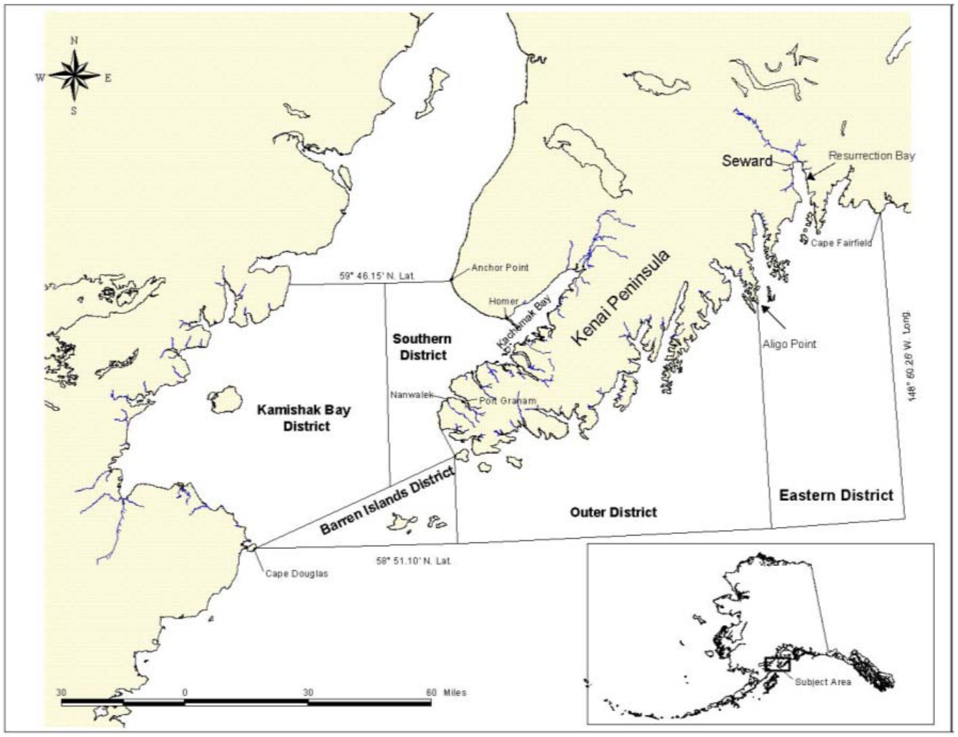


Figure A6-61. Lower Cook Inlet Management Area showing the five management districts.

Several hatchery facilities occur in Lower Cook Inlet and salmon fisheries enhancement continues to play a major role in LCI salmon production as it has over the past three decades. And while enhancement and rehabilitation projects make significant contributions to both commercial and sport fishing harvests, chum salmon in this region consists exclusively of natural production fish. At the Tutka Bay Lagoon Hatchery, pink salmon were the primary species produced with chum salmon as a secondary species during the early years of this facility before these efforts were discontinued in favor of experimental efforts directed towards sockeye salmon production.

[28] Information contained in this section is taken from: Hollowell, G., T. Otis, and E. Ford. 2012. 2011 Lower Cook Inlet area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 12-30, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-30.pdf.

A6.1.10.1 Lower Cook Inlet Assessment

Escapement

Escapement estimates for chum salmon in LCI are derived from periodic ground surveys with stream life factors applied, or from periodic aerial surveys that also incorporate stream life factors. For 2011, escapements into most (9 out of 12) LCI chum salmon systems were sufficient to achieve SEG goals, with the exception of the Big Kamishak River, the Bruin River, and Cottonwood Creek..

A6.1.10.2 Lower Cook Inlet Chum Salmon Management

Gear utilized in the commercial salmon fisheries of LCI includes purse seine and set gillnet. Purse seine gear is permitted to fish in the Southern, Outer, Eastern, and Kamishak districts. Set gillnet gear is permitted to fish in the Southern district. The management objective for all districts is the achievement of spawning escapement goals for major stocks, while allowing for orderly harvest of fish surplus to spawning requirements. In addition, ADF&G follows regulatory guidelines to manage fisheries and allow private non-profit hatcheries to achieve cost recovery and broodstock objectives.

A6.1.10.3 Lower Cook Inlet Subsistence and Personal Use Chum Salmon Harvest[29]

The total all-species LCI management area personal use and subsistence salmon fisheries harvest was approximately 12,000 fish. Subsistence and personal use chum salmon fisheries occur primarily in the Southern District of LCI in Nanwalek/Port Graham, and Seldovia. Gear in this fishery is limited to set gillnets. In Nanwalek/Port Graham, most fishing occurs within close proximity to the respective villages, primarily targeting Chinook salmon transiting area waters and sockeye salmon returning to the English Bay Lakes system early in the summer, although participants will occasionally target pink salmon returning to Port Graham and English Bay Rivers later in the summer. Some additional fishing also occurs in Koyuktolik (Dogfish) Baytargeting non-local stocks of Chinook salmon as well as local stocks of chum salmon. In 2011, Port Graham subsistence fishermen reported a harvest of 150 chum salmon and Nanwalek subsistence fishermen reported 362 chum salmon harvested out of a combined total subsistence salmon harvest of 10,377 fish. In Seldovia, no chum salmon were reported as subsistence harvest in 2011. Two personal use fisheries are authorized in LCI: the China Poot personal use dip net fishery and the Southern District personal use coho fishery. The daily bag limit for the China Poot fishery is six salmon per day with an annual bag limit of 25 salmon and an additional 10 salmon for each dependent in the household.

A6.1.10.4 Lower Cook Inlet Commercial Harvest

The cumulative 2011 LCI all-species commercial salmon harvest was787,423 fish, which included approximately 32,000 chum salmon. The majority of the commercial harvest or chum salmon occurs in the Outer and Kamishak Bay districts. Commercial harvests in 2011 of chum salmon were well below the most recent 10-year average of 89,000 fish). (Figure A6-62).

[29] There are no reported educational salmon fisheries in Lower Cook Inlet.

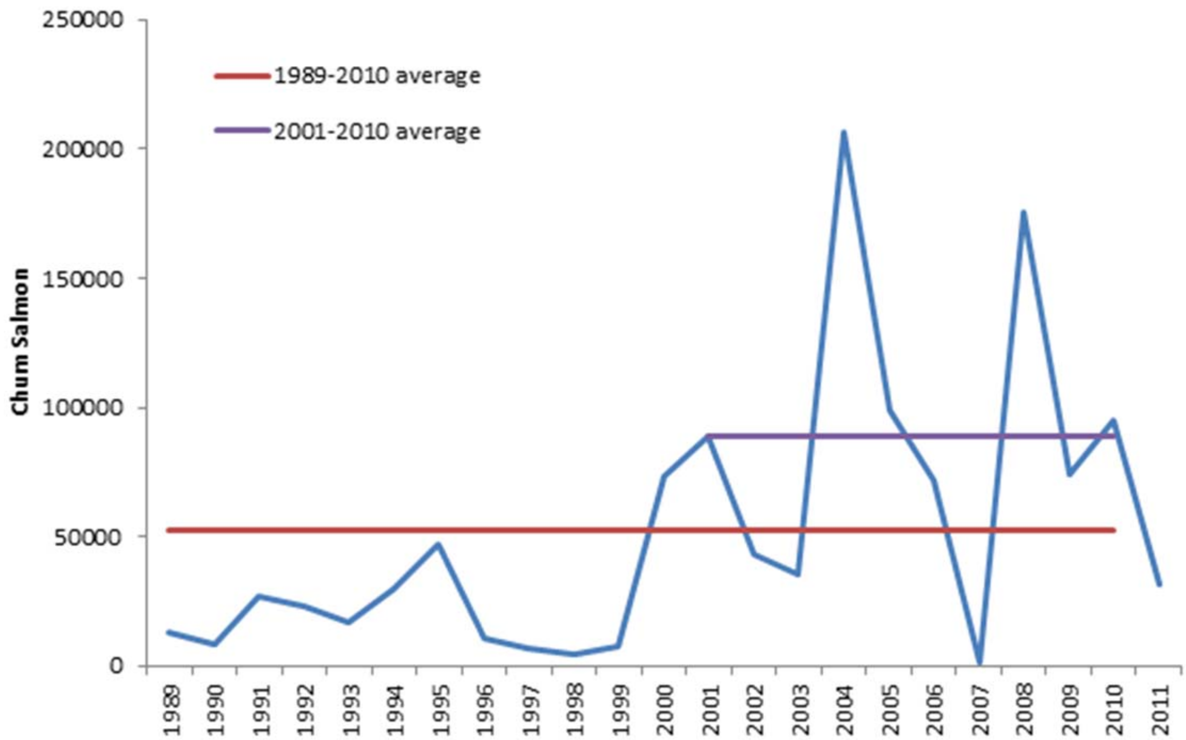


Figure A6-62. Lower Cook Inlet commercial chum salmon harvest for all gear and harvest types, 1989-2011.

After an extremely weak chum salmon season in 2007, chum salmon runs have since rebounded and were a major bright spot for the LCI area between 2008 and 2010. The 2010 chum salmon harvest of 94,748 fish was the fourth highest for the species in LCI during the past two decades.

Table A6-44. Commercial chum salmon catches by district and gear type, 2011.

District	Gear Type	Chum Salmon
Southern	Set Gillnet	1,946
	Purse Seine	16
Outer	Purse Seine	25,763
Eastern	Purse Seine	112
Kamishak Bay	Purse Seine	3,850
LCI Total		31,687
2001-2010 Average		89,086

A6.1.11 Prince William Sound[30]

Description of Management Area

The Prince William Sound (PWS) management area encompasses all coastal waters and inland drainages entering the north central Gulf of Alaska between Cape Suckling and Cape Fairfield (Figure A6-63). This area includes the Bering River, Copper River and all of Prince William Sound with a total adjacent land area of approximately 38,000 square miles.

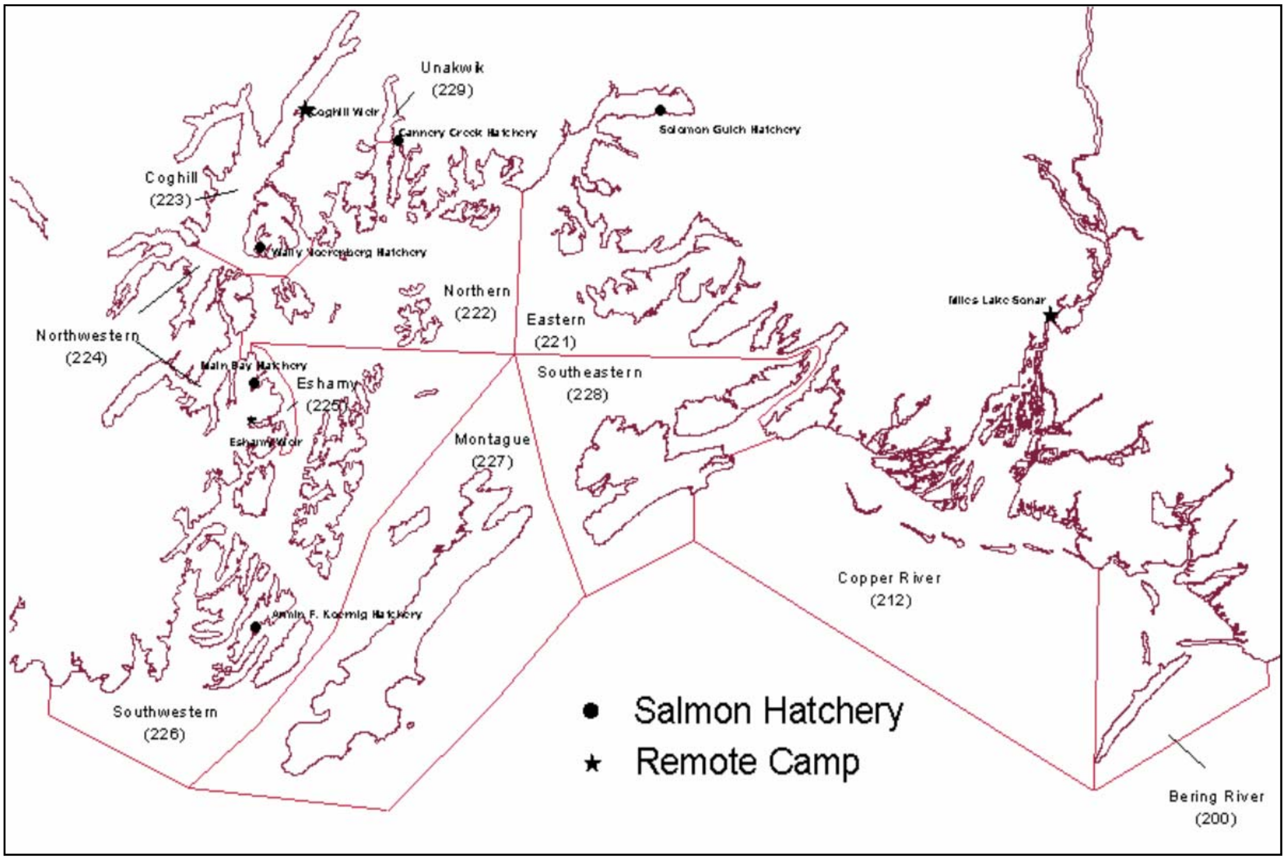


Figure A6-63. Prince William Sound Management Area showing commercial fishing districts, salmon hatcheries, weir locations, and Miles Lake sonar camp (Copper River district).

The salmon management area is divided into 11 districts (see Figure A6-63 above) that correspond to local geography and distribution of the five species of salmon harvested by the commercial fishery.

Six hatcheries contribute to the area's fisheries. Prince William Sound Aquaculture Corporation (PWSAC) operates five of the hatcheries: Gulkana Hatchery (GH) in Paxson; Cannery Creek Hatchery (CCH) located on the north shore of PWS; Armin F. Koernig (AFK) Hatchery in southwestern PWS; Wally Noerenberg Hatchery (WNH) in northwestern PWS; and Main Bay Hatchery (MBH) in western PWS. Valdez Fisheries Development Association (VFDA) operates Solomon Gulch Hatchery (SGH) in Port Valdez. Of these six hatcheries, only the Wally Noerenberg Hatchery augments production of chum salmon. Eggs are collected for chum salmon broodstock and fry are released onsite at WNH; dyed eggs

[30] Information contained in this section is taken from: Botz, J., G. Hollowell, T. Sheridan, R. Brenner, and S. Moffitt. 2012. 2010 Prince William Sound area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 12-06, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-06.pdf.

are transferred to AFK for release with those fry transferred to Port Chalmers for remote release. PWSAC is the largest producer of hatchery salmon in Alaska, with a permitted capacity of 685 million eggs. They are also the largest producer of enhanced chum salmon in Alaska with a permitted capacity of 165 million eggs. The Armin F. Koerning Hatchery currently produces only pink salmon, although chum salmon were produced in 1996 and 1997.

A6.1.11.1 Prince William Sound Assessment

Escapement

The general purse seine districts are managed to achieve wild chum SEGs by district. Escapement of chum salmon is monitored through the season by weekly aerial surveys of 215 index streams. Aerial survey escapement trends, compared to average historical performance, determine the duration of openings in PWS management districts. Aerial surveys of the index streams occur on a weekly basis, weather permitting. Inseason modifications to harvest projections, season opening dates, and strategies for weekly fishing periods occur as fisheries develop and wild salmon escapement needs are met. Management to achieve hatchery corporate escapement goals is accomplished by opening and closing hatchery subdistricts and terminal harvest areas. Subdistrict and terminal harvest area openings are also utilized to target fishing effort on hatchery stocks when wild salmon escapement is weak.

Chum salmon SEGs in PWS were met in each of the districts with established goals each year since 2006. No estimates for chum salmon escapements are included for the Unakwik, Eshamy, Southwestern, or Montague districts because there are no escapement goals for these districts.

A6.1.11.2 Prince William Sound Chum Salmon Management

Gear utilized in the PWS salmon fisheries includes purse seine, drift gillnet, and set gillnet. Drift gillnet permits are the most numerous and are permitted to fish in the Bering River, Copper River, Coghill, Unakwik, and Eshamy Districts. Set gillnet gear is permitted to fish only in the Eshamy District. Purse seine gear is permitted to fish in the Eastern, Northern, Unakwik, Coghill, Northwestern, Southwestern, Montague, and Southeastern Districts. In 2009 and 2010 drift gillnet gear was permitted to harvest hatchery chum salmon in the Port Chalmers subdistrict of the Montague District. The management objective for all districts is the achievement of spawning escapement goals for major stocks, while allowing for orderly harvest of fish surplus to spawning requirements. In addition, ADF&G follows regulatory guidelines to manage fisheries and allow private non-profit hatcheries to achieve cost recovery and broodstock objectives. As an avenue for the commercial fishing industry to formally provide management recommendations to ADF&G, representatives from PWS area processors, gear groups, and aquaculture associations sit on an advisory body known as the PWS Salmon Harvest Task Force.

A6.1.11.3 Prince William Sound Subsistence Chum Salmon Harvest

Subsistence fishing permits are not required in the PWS Management Area for marine finfish other than salmon. The Subsistence Management Area is divided into two districts: the Prince William Sound District and the Upper Copper River District. The Prince William Sound Management District includes the PWS and Lower Copper River subsistence fisheries and the Tatitlek and Chenega area subsistence fisheries. The Upper Copper River Management District includes the Glenallen subsistence fishery, the Batzulnetas subsistence fishery, and the Chitina personal use fishery.

The Tatitlek and Chenega area subsistence fisheries are the most significant in all of PWS for chum salmon harvest (Table A6-45). The Chenega area includes the entirety of the Southwestern District as well as a portion of the Montague District along the northwestern shore of Green Island from the westernmost tip to the northernmost tip of the island. The Tatitlek subsistence area is located south of Valdez narrows in portions of the Northern and Eastern districts.

Table A6-45. Chum salmon harvest in the Tatilek and Chenega subsistence fisheries, 1988-2010.

	Tatitlek		Chenega	
Year	Chum Salmon	Total	Chum Salmon	Total
1988	245	811	294	604
1989	43	837	180	1,056
1990	4	260	2	64
1991	28	1,439	53	638
1992	49	891	99	962
1993	74	1,217	124	1,293
1994	70	313	161	837
1995	0	0	41	329
1996	0	38	46	315
1997	54	206	272	649
1998	28	355	119	331
1999	31	947	101	887
2000	40	688	143	646
2001	12	416	146	454
2002	36	575	60	418
2003	12	298	147	677
2004	28	713	84	722
2005	16	600	174	908
2006	25	81	111	299
2007	unknown	unkown	55	381
2008	0	60	30	276
2009	0	301	84	285
2010	10	317	87	148

A6.1.11.4 Prince William Sound Commercial Chum Salmon Harvest[31]

The 2010 PWS commercial salmon harvest was 78 million fish (approximately 72 million common property fish and 6 million hatchery cost recovery fish), which included a commercial harvest of 4.3 million chum salmon. Of this total, the common property fishery harvest of chum salmon was 3.6 million fish. Hatchery runs of chum salmon were at or above forecast. Total harvest of chum salmon was above both the 10-year (2000-2009) commercial average of 3,659,874 fish and historical average of 1,707,637 fish (Figure 5-84). The majority of chum salmon harvested in PWS is taken by drift gillnet gear (Table 5-58).

[31] While a 2011 Fishery Management Report is not available at this time, preliminary commercial harvest information for PWS results in a chum salmon harvest of 1.8 million fish (1.4 million common property and 0.4 million hatchery) (http://www.adfg.alaska.gov/static/fishing/PDFs/commercial/pws_salmon_summary_11.pdf).

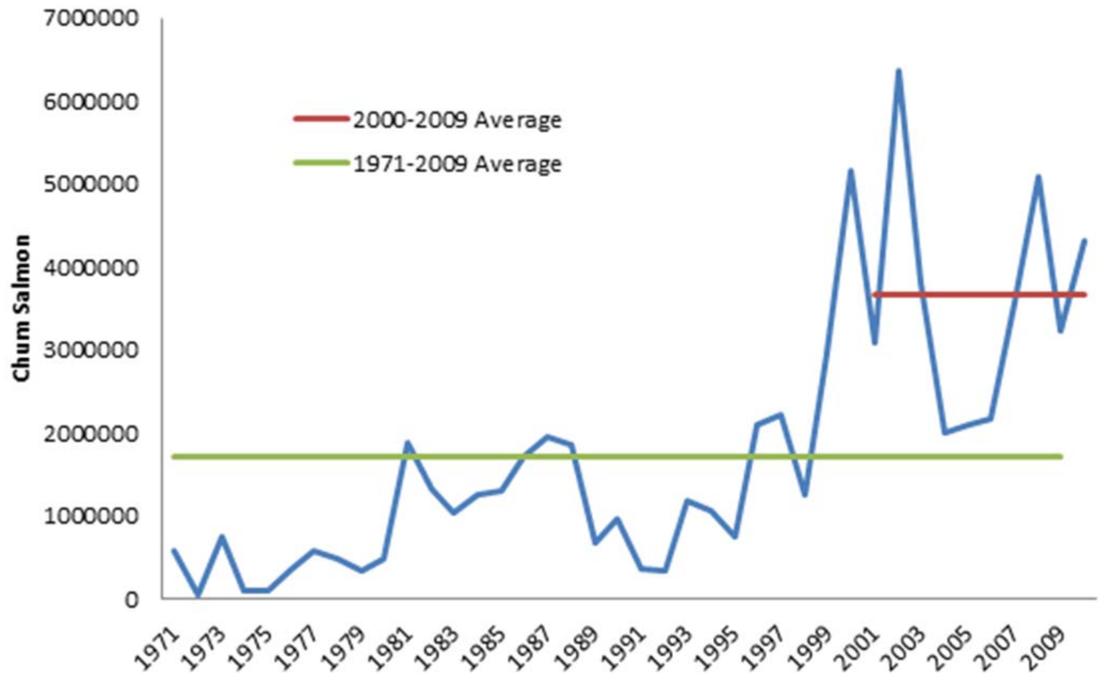


Figure A6-64. Total commercial chum salmon harvest by all gear types in Prince William Sound, 1971-2010.

PLACEHOLDER: Need commercial value information

Table A6-46. Prince William Sound Management Area commercial chum salmon harvest by gear type and district, 2010.

District	2010 Chum Salmon
Eastern	14,383
Northern	2,438
Coghill	3,207
Southwestern	166,464
Montague	19
Southeastern	-
Unakwik	26
Purse Seine	186,537
Bering River	-
Copper River	15,694
Coghill	2,512,005
Eshamy	529,860
Montague	243,456
Unakwik	-
Drift Gillnet	3,301,015
Eshamy	80,516
Set Gillnet	
Solomon Gulch	5,042
Cannery Creek	-
Wally Noerenberg	749,763
Main Bay	-
Armin F. Koernig	-
Hatchery	754,805
Prince William Sound Total	4,322,873

A6.1.12 Kodiak[32]

Description of Management Area

The Kodiak Management Area (KMA) comprises the waters of the western Gulf of Alaska surrounding the Kodiak Archipelago and that portion of the Alaska Peninsula bordering the Shelikof Strait between Cape Douglas and Kilokak Rocks (Figure A6-65). The archipelago is approximately 150 miles long, extending from northeast to southwest. In season management of the KMA commercial salmon fishery is structured around seven management districts that are further subdivided into 56 sections. Each section defines a traditional geographic harvest area managed for specific stocks or traditional fishing patterns.

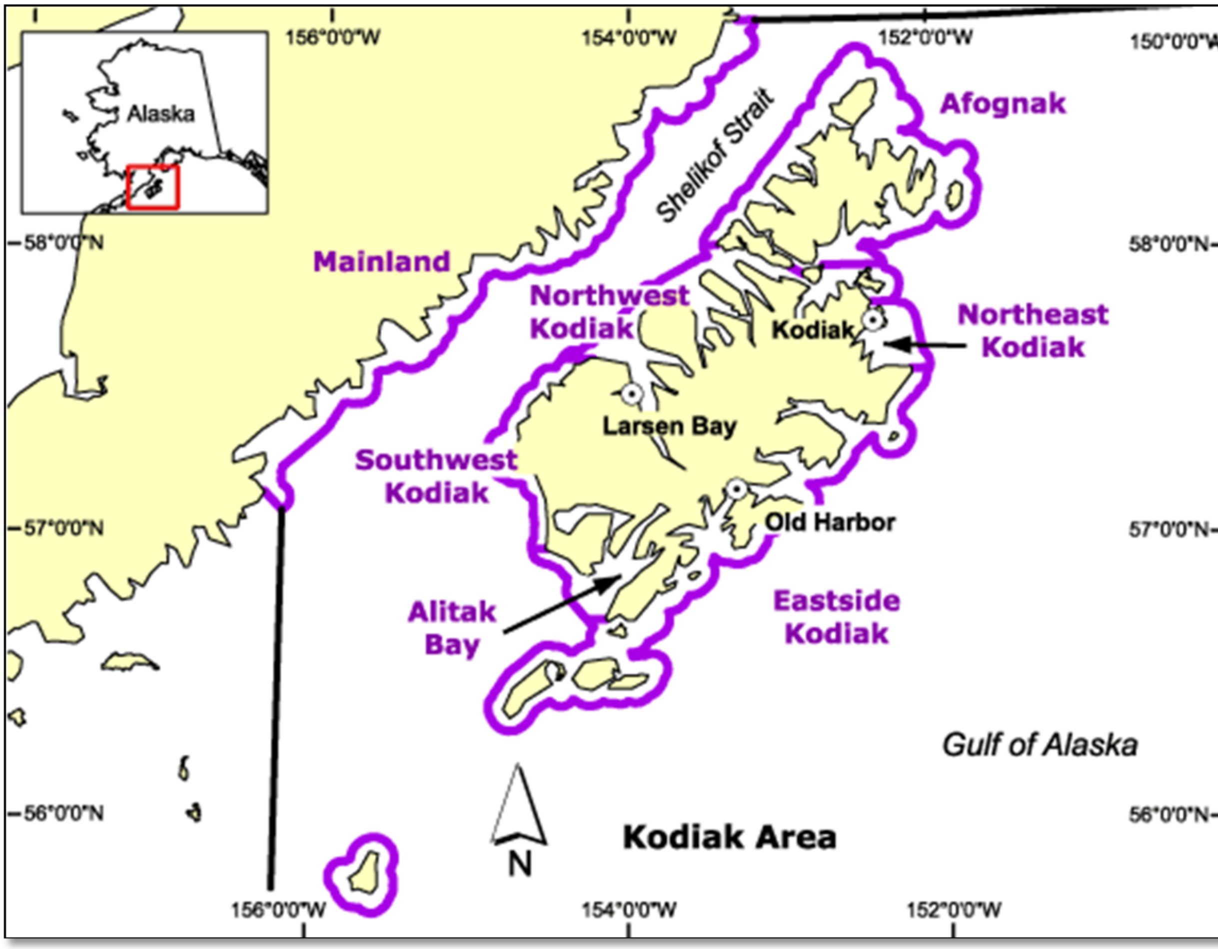


Figure A6-65. Kodiak Management Area identifying commercial salmon fishing districts.

Salmon migration or spawning has been documented in approximately 750 streams within the KMA. Of these, 411 streams have been documented to support yearly spawning populations of salmon while the remaining 349 are small streams used by pink salmon in years with very large returns. Chum salmon stocks are found in approximately 174 streams within the KMA (Table A6-47).

[32] Information contained in this section is taken from: Jackson, J., J. Dinnocenzo, and G. Spalinger. 2010. Kodiak Management Area commercial salmon fishery annual management report, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-47, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR10-47.pdf.

Table A6-47. Estimated number of streams in the Kodiak Management Area with documented chum salmon production by district.

Management District	Number of Streams	Number of Streams with Chum salmon
Afognak	91	9
Northwest Kodiak	67	22
Southwest Kodiak	10	5
Alitak	30	15
Eastside Kodiak	89	50
Northeast Kodiak	27	12
Mainland	97	61
Total	411	174

The KMA has two hatcheries, the Kitoi Bay and Pillar Creek hatcheries, that currently produce salmon to supplement natural salmon production. Both hatcheries are located on the east side of Afognak Island, are operated by the Kodiak Regional Aquaculture Association (KRAA), and mainly produce pink salmon; however, sockeye, chum, and coho salmon are also cultured.

A6.1.12.1 Kodiak Area Assessment

Chum Salmon Escapement

Since 2008, the KMA commercial chum salmon fisheries have been managed to exceed the lower bounds of sustainable escapement goals (LB SEGs) for two aggregate stocks, the Mainland District (104,000 chum salmon) and the Kodiak Archipelago (151,000 chum salmon). These two aggregates were designated as a result of the most recent escapement goal review by ADF&G salmon management and research staff in 2007 (Honnold et al. 2007), and replaced the seven district goals that had been in existence prior. In 2008, the LB SEG was met for the Mainland District aggregate stock, but not for the Kodiak Archipelago stock. In 2009, the LB SEG was met for the Kodiak Archipelago aggregate stock, but not for the Mainland District aggregate stock.

The majority of the 2010 chum salmon escapement was estimated from aerial surveys of bays and streams with less than 1% counted through weirs. Estimating chum salmon escapements using aerial observations is more difficult than estimating escapements of other species of salmon since chum salmon migrate into small sloughs and side creeks as well as major river systems. Limited aerial surveys were conducted on several major KMA chum salmon systems along Kodiak Island’s west side and in the Mainland District. Escapement estimates based on aerial surveys are considered minimum estimates of actual escapement. Foot surveys were also conducted on a few streams, primarily along the Kodiak road system. Aerial and foot survey counts were considered indices of actual escapement for use inseason to aid fishery management. Peak indexed escapement was calculated postseason for all systems surveyed and, together with weir escapement data, was used to estimate an area-wide escapement. Peak indexed escapement for chum salmon was defined as the highest daily aerial or foot survey count for each system for each year

In 2010, chum salmon escapement to the Mainland District was 144,715 fish (above the minimum goal) and escapement to the Kodiak Archipelago was 155,570 fish (also above the minimum goal).

A6.1.12.2 Kodiak Area Chum Salmon Management

In the KMA there are restrictions on which gear types can operate in specific management districts based on historical gear use patterns. The majority of the KMA is open to seine (purse and beach) gear only. Set gillnet and seine gear are allowed in the Central and North Cape sections of the Northwest Kodiak District and the Olga Bay, Moser Bay, and Alitak Bay sections of the Alitak District. All gear types are allowed in the Central and North Cape sections for the entire season, however only set gillnet gear is allowed in the Olga Bay, Moser Bay, and Alitak Bay sections until September 4, after which all gear is allowed. To regulate Kodiak commercial salmon fisheries, ADF&G staff are guided by ten KMA salmon management plans that describe biological and allocative constraints.

A6.1.12.3 Kodiak Area Subsistence Chum Salmon Harvest[33]

With few restrictions, the entire KMA has been open to subsistence salmon fishing in recent years. Only the freshwater systems of Afognak Island (which are relatively small, easily accessible, and at risk of over-exploitation) and some areas near heavily exploited salmon systems were closed to subsistence salmon fishing by regulation.

The 2009 reported subsistence harvest of 29,688 salmon included 345 chum salmon. Historically, the most utilized subsistence fishery areas are the north end of Kodiak Island, the Buskin and Pasagshak rivers, and the southeast side of Afognak Island at Litnik. Reported subsistence salmon harvests averaged 36,411 fish annually for the 10-year period 2000-2009.

Table A6-48. Estimated subsistence salmon harvest for the Kodiak Management Area, 2000-2009.

Year	Chum Salmon	Total All Salmon
2000	375	39,753
2001	427	41,656
2002	350	42,622
2003	388	40,698
2004	261	38,403
2005	592	38,743
2006	441	32,173
2007	266	32,429
2008	186	27,947
2009	345	29,688

A6.1.12.4 Kodiak Area Commercial Chum Salmon Harvests[34]

A total of 11.3 million salmon were harvested during the 2010 KMA commercial fisheries (all gear common property and cost recovery combined). This included a total of 649,893 chum salmon harvested by seine gear and a total of 82,967 chum salmon harvested by set gillnet gear. The total chum salmon harvest of 734,806 fish was below the forecast of 1.02 million chum salmon and below the 2000-2009 average harvest of 932,402 fish. Westside Kodiak fisheries harvested 175,305 chum salmon, which was below the forecast of 291,000 fish.The eastside and the north end of Kodiak Island accounted for 136,434 chum salmon, which was below the forecast of 220,000 fish. Mainland District harvest totaled 175,340 chum salmon, just above the forecast of 154,000 fish. Kitoi Bay Hatchery chum salmon production was weaker than expected, with 191,284 harvested, below the 2010 forecast of 273,668 fish.

[33] An updated report from the Division of Subsistence is expected in the fall of 2012.

[34] While a 2011 Fishery Management Report is not available at this time, preliminary commercial harvest information for KMA results in a total chum salmon harvest of 823,249 fish compared to a projected harvest of 1.1 million chum salmon (http://www.adfg.alaska.gov/static/fishing/PDFs/commercial/2011_kodiak_salmon_summary.pdf).

Table A6-49. Projected vs. actual 2010 commercial chum salmon harvest for Kodiak Management Area.

Fishery	2010 Harvest Projection	Actual
Kitoi Bay Hatchery	273,668	191,284
Afognak	30,000	37,607
Westside Kodiak	291,000	175,305
Alitak District	48,000	18,836
Eastside/Northend Kodiak	220,000	136,434
Mainland District	154,000	175,340
Total	1,016,668	734,806

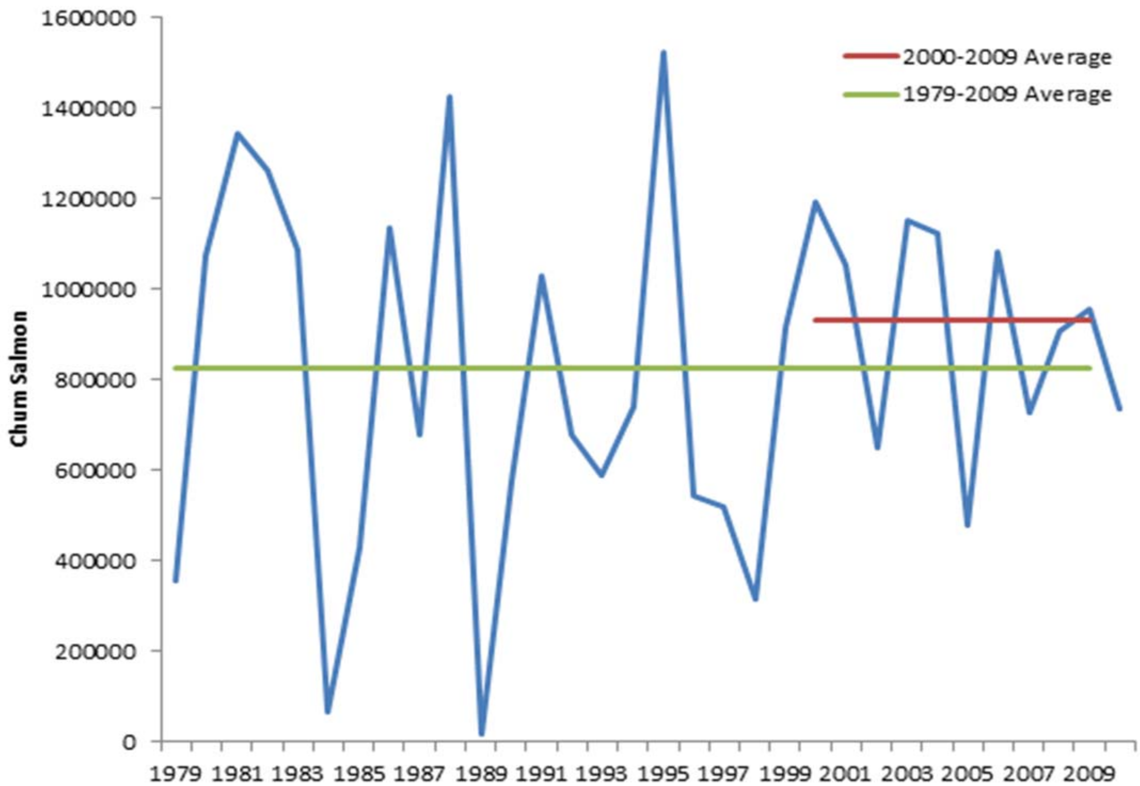


Figure A6-66. Commercial chum salmon harvest in the Kodiak Management Area, 1979-2010. Note: Average does not include 1989, when commercial fisheries were severely limited due to the M/V Exxon Valdez oil spill.

PLACEHOLDER: Need commercial value information

Table A6-50. Projected commercial chum salmon harvest for the Kodiak Management Area, 2012.

Fishery	2012 Projection
Kitoi Bay Hatchery	241,000
Afognak (wild)	35,670
Westside Kodiak	178,493
Alitak District	52,531
Eastside/Northend Kodiak	246,582
Mainland District	135,108
Total	889,384

A6.1.13 Chignik[35]

Description of Management Area

The Chignik Management Area (CMA) encompasses all coastal waters and inland drainages of the northwest Gulf of Alaska between Kilokak Rocks and Kupreanof Point (Figure A6-67). For management purposes, these waters are divided into five fishing districts: Eastern, Central, Chignik Bay, Western, and Perryville districts. Each district is further broken down into sections and statistical reporting areas.

All five species of Pacific salmon are commercially harvested in the CMA; however, sockeye salmon are the primary species targeted and the most important commercial and subsistence salmon species in the CMA. The majority of fishing effort is concentrated on salmon returning to the Chignik River watershed.

[35] Information contained in this section is take from: Anderson, T.J. and N.W. Nichols. 2012. Chignik Management Area Salmon and Herring Annual Management Report, 2011. Alaska Department of Fish and Game, Fishery Management Report No. 12-18, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMR12-18.pdf.

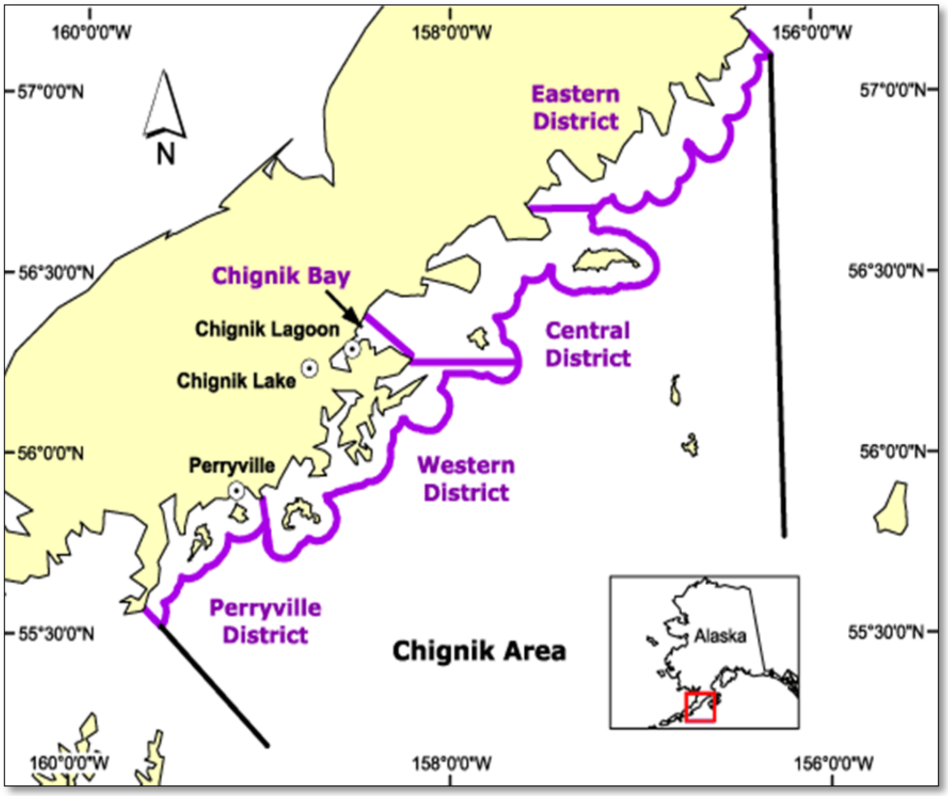


Figure A6-67. Chignik Management Area identifying the five commercial salmon fishing districts.

A6.1.13.1 Chignik Area Assessment

Chum Salmon Escapement

In 2010, a salmon escapement goal review team (with staff from ADF&G's Divisionof Commercial Fisheries and Sport Fish Division) was formed to review salmon escapement goals in the CMA. The team recommended no change to any of the CMA salmon escapement goals. Salmon escapements in the CMA are enumerated through the use of a weir on the Chignik River, and while several individual escapement goals are established for different salmon species, the overall escapement goal is an aggregate, area-wide lower-bound SEGof 57,400 fish. Aerial surveys flown over spawning grounds of the Chignik River watershed and other CMA streams are also utilized to assess salmon spawning escapement levels and distribution.

A limited number of chum salmon return to the Chignik River, mainly in August. In 2011, chum salmon escapement for the Chignik River totaled 145 fish out of a total chum salmon escapement of 278,145 fish for the entire CMA.

A6.1.13.2 Chignik Chum Salmon Fishery Management

Several management plans are used to manage the commercial salmon fishery in the CMA, of which the primary purpose is to achieve escapement goals for early-run and late-run sockeye salmon stocks, as well as local stocks of pink, chum, coho, and Chinook salmon . Purse and hand purse seines are the only legal commercial salmon fishing gear within this area.

A6.1.13.3 Chignik Area Subsistence Chum Salmon Harvest[36]

In 2010, the estimated subsistence salmon harvest totaled 11,034 salmon, which included only 222 chum salmon(Table A6-51). Sockeye salmon comprise the majority of the subsistence harvest in CMA.

Table A6-51. Estimated subsistence salmon harvest for the Chignik Management Area, 1999-2009.

Year	Chum Salmon	Total All Salmon
1999	136	12,289
2000	517	13,228
2001	213	13,663
2002	23	11,980
2003	286	15,395
2004	202	10,357
2005	353	11,590
2006	275	11,186
2007	165	13,372
2008	57	8,783
2009	137	8,907
2010	222	11,034

A6.1.13.4 Chignik Area Commercial Chum Salmon Harvest

A total of 269,503 chum salmon were harvested from the CMA during the 2011 season, out of an all species total salmon harvest of 3.75 million fish.(Figure A6-68). The majority of the chum harvest in 2011 took place in the Central, Eastern, and Western Districts, from mid-June until mid-August (Table A6-52).

[36]An updated report from the Division of Subsistence, which will update all data in this section through 2010, is expected in late 2012.

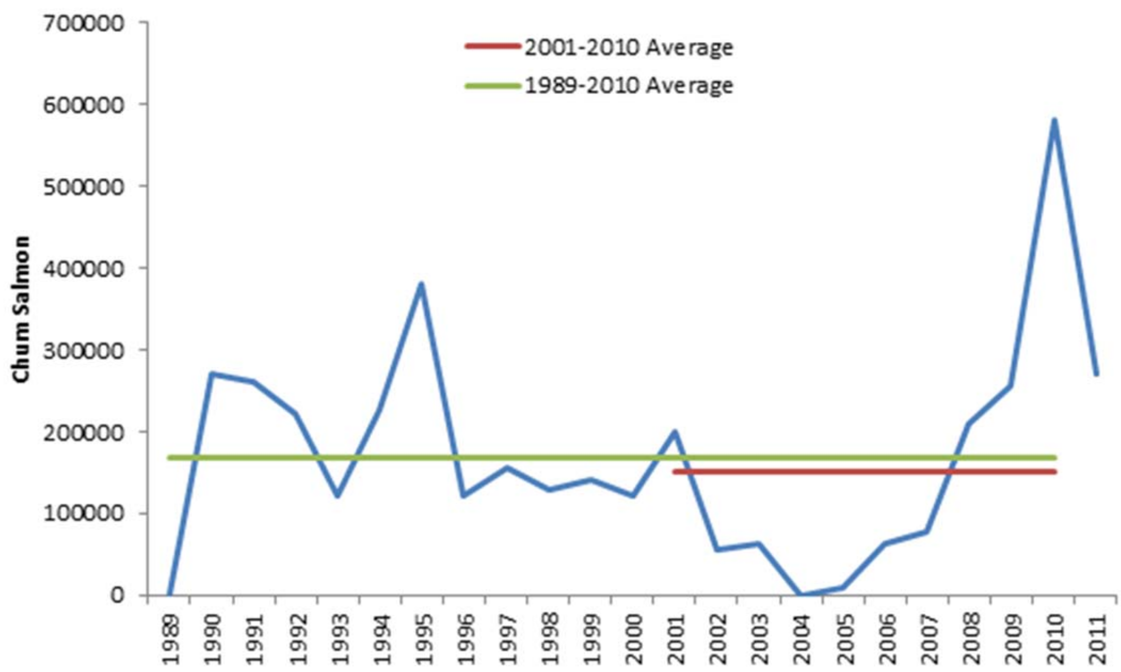


Figure A6-68 Commercial chum salmon harvest in the Chignik Management Area, 1999-2011.

Table A6-52 Chignik Management Area commercial chum salmon harvest by district, 1999-2011.

	Chum Salmon Harvested					
Year	Chignik Bay	Central	Eastern	Western	Perryville	Total
1999	12,150	75,495	11,332	37,089	4,531	140,597
2000	8,389	66,904	8,045	34,823	2,796	120,957
2001	11,534	84,132	50,911	37,466	14,960	199,003
2002	3,949	9,643	513	40,337	117	54,559
2003	10,891	11,304	50	39,883	1,916	64,044
2004	499	6	-	-	-	505
2005	2,370	5,329	2	1,054	66	8,821
2006	2,303	9,455	776	49,096	-	61,630
2007	3,829	19,595	7,851	46,943	335	78,553
2008	13,453	40,130	58,925	88,078	8,739	209,325
2009	14,553	62,149	59,800	116,231	3,692	256,425
2010	27,388	226,501	116,336	204,911	6,193	581,329
2011	9,077	116,580	51,989	75,363	16,494	269,503

PLACEHOLDER: Need commercial value information

A6.1.14 Southeast Alaska and Yakutat[37]

Description of Management Area

The Southeast Alaska/Yakutat Region (Region I) consists of Alaska waters between Cape Suckling on the north and Dixon Entrance on the south (Figure A6-69). Troll fisheries are managed regionally, and drift gillnet, set net, and purse seine fisheries are managed by area offices in Ketchikan, Petersburg/Wrangell, Sitka, Juneau, Haines, and Yakutat.

Region I is divided into 2 salmon net registration areas. Registration Area A, the Southeast Alaska area, extends from Dixon Entrance to Cape Fairweather. The Southeast Alaska area is divided into 17 regulatory districts, Districts 1 through 16 and the Dixon Entrance District. Registration Area D, the Yakutat area, extends from Cape Fairweather to Cape Suckling. The Yakutat area is further divided into the Yakutat District, extending from Cape Fairweather to Icy Cape, and the Yakataga District extending westward from Icy Cape to Cape Suckling (Figure A6-70).

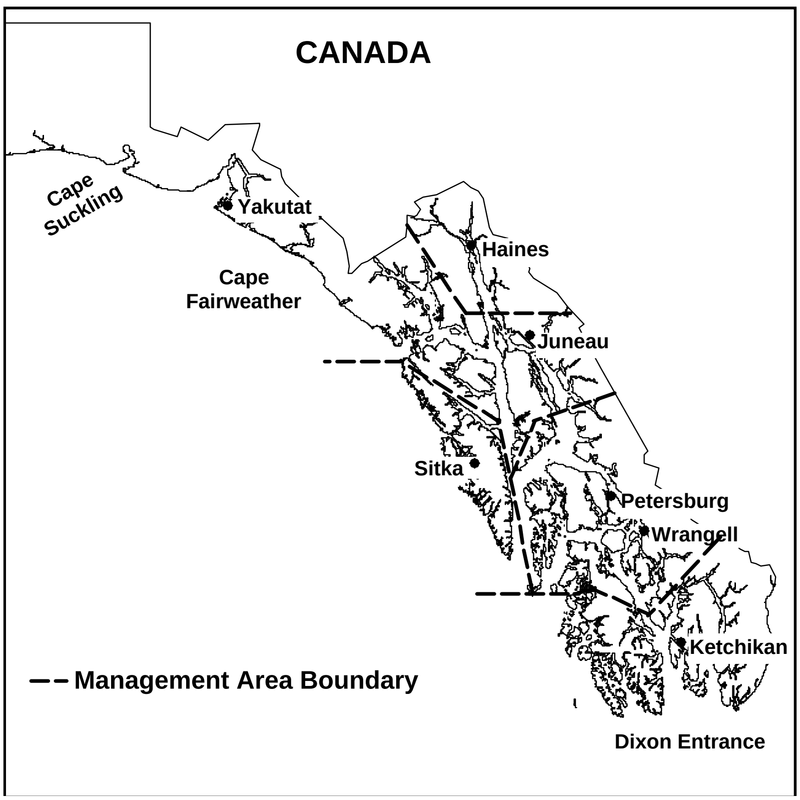


Figure A6-69. The Southeast Alaska/Yakutat Region (Region I) consists of Alaska waters between Cape Suckling on the north and Dixon Entrance on the south.

[37] Unless otherwise noted, the majority of information in this section on the Southeast Alaska/Yakutat chum salmon fisheries is taken from: Tingley, A. and W. Davidson. 2011. Overview of the 2010 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 11-39, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/FMR11-39.pdf.

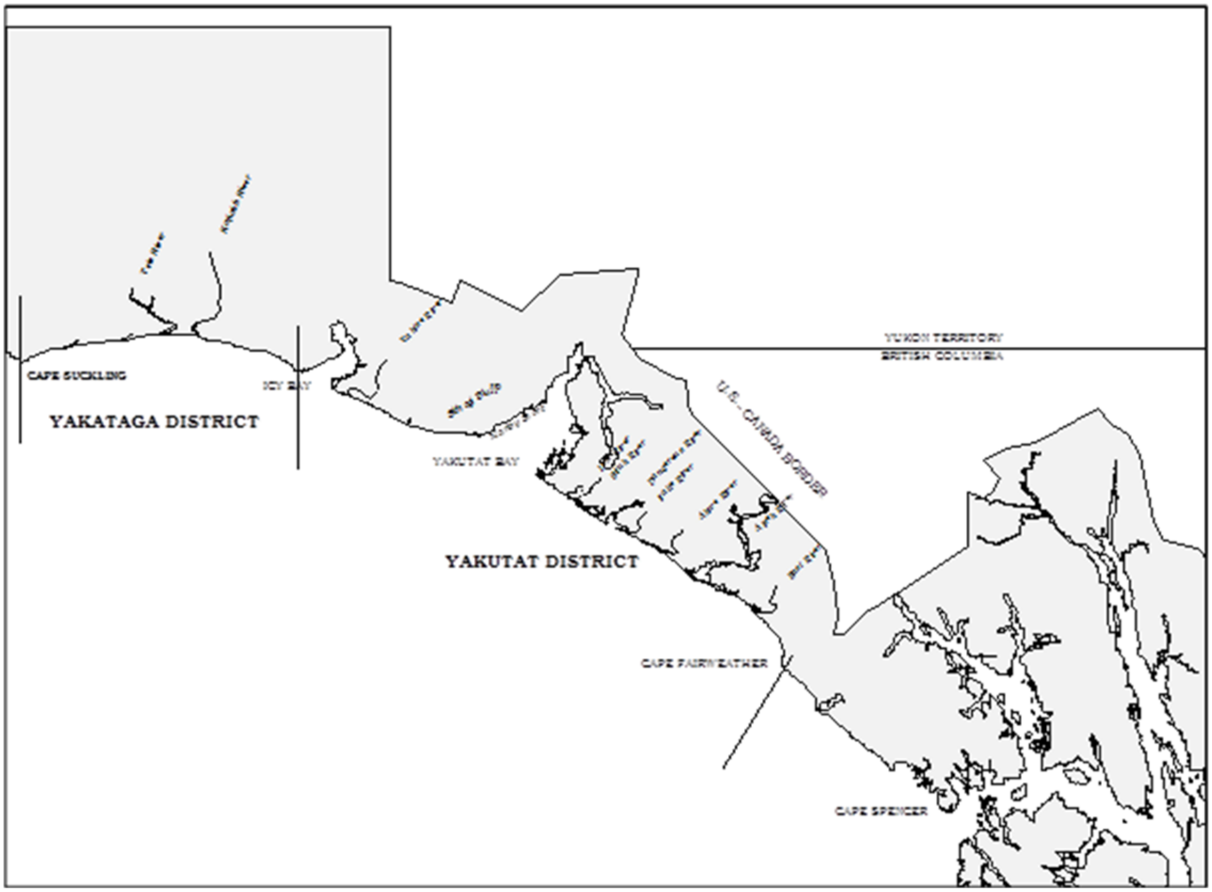


Figure A6-70. Boundaries for Yakutat and Yakataga regulatory districts, within the Yakutat management area (Registration Area D).

There are seven major hatcheries operating in Southeast Alaska: the Southern Southeast Regional Aquaculture Association (SSRAA); the Northern Southeast Regional Aquaculture Association (NSRAA); Douglas Island Pink and Chum Inc. (DIPAC); the Prince of Wales Hatchery Association (POWHA); the Kake Nonprofit Fishery Corporation (KAKE); Armstrong Keta, Inc. (AKI); and Sheldon Jackson College (SJC).

A6.1.14.1 Southeast Alaska Assessment

Southeast Alaska Chum Salmon Escapement

Chum salmon are known to spawn in more than 1,200 streams in Southeast Alaska. The vast majority of those streams do not have a long time series of survey information—probably because most are not significant producers of chum salmon, and survey effort has been directed at the more productive chum salmon streams. Of the chum salmon populations that have been monitored, most have been monitored through aerial surveys, although several have been monitored annually by foot surveys, and in-river fish wheel counts have been used to monitor salmon escapements to the Taku and Chilkat rivers. ADF&G completed work in 2009 to establish sustainable escapement goals for chum salmon in Southeast Alaska. Survey information from 88 Southeast Alaska chum salmon index streams was divided into appropriate stock groups by area and migration run-timing (summer or fall). Summer-run fish generally peak during the period mid-July to mid-August and fall-run fish peak in September or later. For summer runs, which are typically harvested in mixed-stock fisheries, stocks were divided into three aggregates of streams. The abundance of summer-run chum salmon has increased since the early 1970s and escapement indices have been stable or increasing since 1980. The 2008 and 2009 and 2010 summer chum salmon runs in Southeast Alaska were generally weak,

For fall runs that support, or have supported, a directed fishery, stocks were divided into five aggregates. Fall-run chum salmon escapement indices have been relatively stable for two decades and have increased since the mid 1990s for the Chilkat River. Escapement indices for fall chum salmon for 2011 were generally within or above escapement goalswith the exception of Excursion Inlet.

A6.1.14.2 Southeast Alaska Chum Salmon Fishery Management

For salmon management in Region 1, separate annual management reports are issued, which provide detailed summaries of the Southeast and Yakutat Salmon Troll Fishery, the Yakutat Area Commercial Set Net Fishery, and the Southeast Alaska Purse Seine and Drift Gillnet Fisheries.

Salmon are commercially harvested in Southeast Alaska (Registration Area A) with purse seines and drift gillnets; in Yakutat (Registration Area D) with set gillnets; and in both areas with hand and power troll gear. The salmon net fisheries are confined to state waters. The troll fishery operates in both state waters and in the federal waters of the Exclusive Economic Zone (EEZ). The use of floating fish traps is only allowed within the Annette Island Fishery Reserve.

Region 1 salmon fisheries are complex due to the mixed stock and mixed species nature of the returns and to the utilization of returns by several different gear groups that often harvest the same stocks of fish. Because the region contains approximately 5,500 salmon producing streams and tributaries of various productivity levels, it is not possible to apply stock specific fisheries management according to the run strength for most individual streams. Net and troll fisheries in Southeast Alaska and Yakutat are managed forsustained yield, allocated among users according to Alaska Board of Fisheries regulations, and also in accordance with harvest sharing provisions of the Pacific Salmon Treaty.

A6.1.14.3 Southeast Alaska and Yakutat Subsistence Chum Salmon Harvest

For Southeast Alaska and Yakutat during 2010, there was a total reported subsistence and personal use harvest of almost 42,000 fish, of which only 721 (1.7%) were chum salmon (Table A6-53). Sockeye salmon are the primary target and made up 83% of the annual subsistence and personal use harvest for the region in 2011.

Table A6-53. Reported chum salmon subsistence and personal use harvest in Southeast Alaska and Yakutat, 1999–2010.

Year	Total Southeast Harvest	Southeast Chum Harvest	Total Yakutat Harvest	Yakutat Chum Harvest
1999	53,857	4,356	5,909	-
2000	47,832	2,954	6,552	27
2001	52,614	3,298	6,726	10
2002	50,377	1,833	7,765	13
2003	61,143	3,206	6,010	1
2004	57,219	2,722	5,886	26
2005	38,793	1,631	4,039	5
2006	48,823	1,520	5,118	6
2007	36,482	625	5,381	3
2008	39,115	1,319	4,375	6
2009	46,767	1,710	6,122	4
2010	38,805	671	3,095	50
2000-2009 Avg.	47,917	2,082	5,797	10

A6.1.14.4 Southeast Alaska Commercial Chum Salmon Harvest

A total of 37.2 million salmon were harvested in the commercial salmon fisheries in the Southeast Alaska and Yakutat Region in 2010. Of this, the total harvest of almost 9.5 million chum salmon was slightly less than the most recent 10-year average of 10.3 million chum salmon (Figure A6-71). Salmon harvest by gear type for 2010 included 24.2 million by purse seine, 4.4 million by drift gillnet, 0.4 million by set net, and 2 million by hand and power troll. Additional commercial harvests included 4.4 million salmon for private non-profit hatchery cost recovery and 1.7 million salmon within the Annette Island Reservation. Of the total chum salmon harvest, purse seiners accounted for 34% , drift gillnetters for 23%, trollers for 4%, and hatchery cost recovery for 35% (Table A6-54).

Harvests of chum salmon have increased from historical levels as new hatchery production came on line in the mid-1980s. In recent years the majority of chum salmon harvests in the region are attributable to hatchery production.

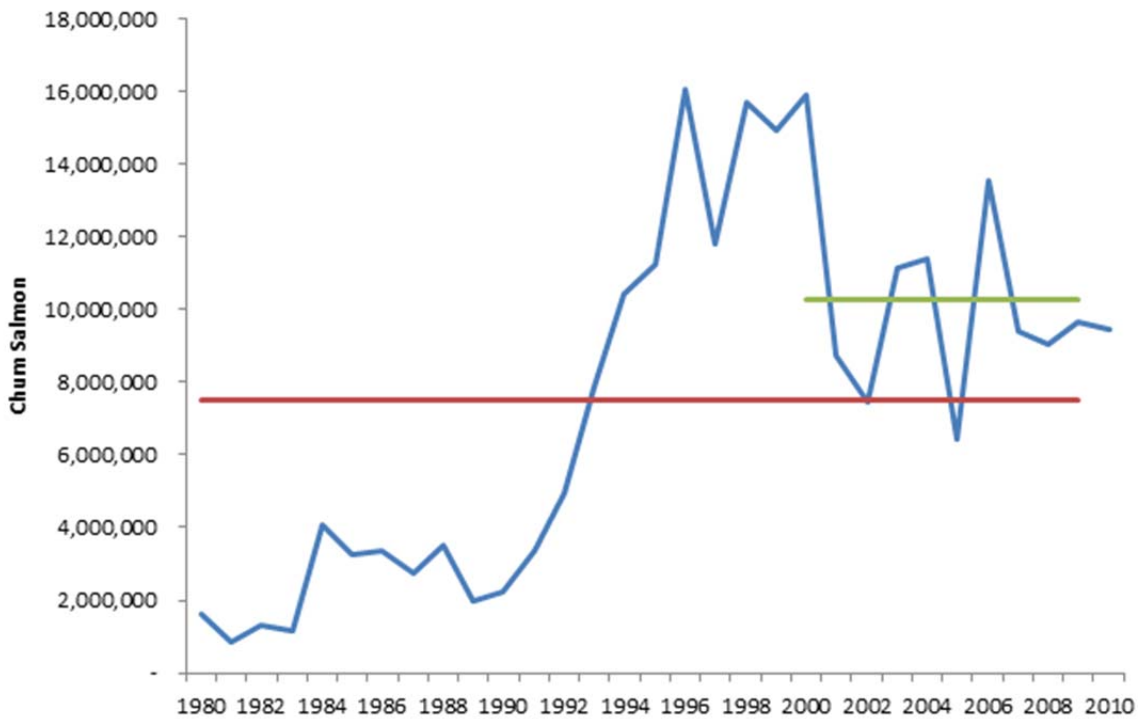


Figure A6-71. Southeast Alaska and Yakutat Area total chum salmon harvest , 1980-2010.

Table A6-54. Southeast Alaska and Yakutat Area commercial chum salmon harvest by fishery, 2010.

Fishery	Chum Salmon	Percentage
Purse Seine	3,235,629	34%
Drift Gillnet	2,219,585	23%
Set Gillnet	1,239	<1%
Troll	394,696	4%
Annette Island	313,618	3%
Hatchery Cost Recovery	3,299,035	35%
Miscellaneous	9,945	<1%
Total	9,473,744	

Note: Miscellaneous fishery includes chum salmon that were confiscated, caught in sport fish derbies, or commercial test fisheries, and sold.

Southeast Alaska Commercial Purse Seine and Drift Gillnet Fisheries[38]

In 2011, the total harvest by purse seine gear was 64 million salmon (all species combined) of which the total common property purse seine harvest was 58.8 million salmon. Common property fisheries include traditional wild stock fisheries and terminal harvest area (THA) fisheries where fishermen compete to

[38] Information on the Southeast Alaska commercial purse seine and drift gillnet fisheries can be found in: Davidson, W., R. Bachman, D. Gordon, A. Piston, K. Jensen, K. Monagle, T. Thynes and S. Walker. 2102. Annual management report of the 2011 Southeast Alaska commercial purse seine and drift gillnet fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 12-03, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-03.pdf.

harvest surplus returns. The total common property purse seine harvest included approximately 2.7 million chum salmon..

Historically, (1960-2011), the total purse seine fishery in Southeast Alaska has accounted for approximately 77% of the total commercial salmon harvest (all species combined). Pink salmon is the primary species targeted by the purse seine fleet; therefore, most management actions are based on inseason assessments of the abundance of pink salmon. Other salmon species are harvested incidentally to pink salmon in the purse seine fishery. Historically, the common property purse seine harvests account for 59% of the chum salmon harvests in the region. Long-term average species composition of the common property purse seine fishery harvest includes 9.5% chum salmon. The common property chum salmon harvest for 2011 was approximately 4.6% of the total Southeast Alaska common property harvest.Cost recovery seine harvests to support privately operated salmon enhancement programs totaled 4.5 million fish, of which 79% were chum salmon. Seine harvests reported by the Annette Island Reservation[39] totaled 0.7 million fish, which included approximately 139,000 chum salmon. Miscellaneous harvests of 63,000 salmon (5,300 chum salmon) include test fisheries authorized by the department as well as illegally harvested fish, later confiscated by the Alaska Wildlife Troopers.

Total common property harvests in the northern districts (Districts 9 through 14) for 2011 were 47.2 million fish, including 1.2 million chum salmon. Total common property harvests in the southern districts (Districts 1-7) for 2011 were 11.6 million fish, including 1.5 million chum salmon. (Table A6-55).

[39] Presidential proclamation established the Annette Island Fishery Reserve in 1916. It provides a 3,000-foot offshore zone wherein the reserve natives have exclusive fishing rights. Salmon are harvested by purse seine, gillnet, and troll gear.

Table A6-55. Southeast Alaska annual commercial, common property, purse seine chum salmon harvest (from traditional and terminal areas), 1980-2011.

Year	Total Chum Salmon	Northern Southeast Contribution	Southern Southeast Contribution
1980	1,002,478	415,511	586,967
1981	517,002	282,754	234,248
1982	828,444	162,007	666,437
1983	579,168	271,365	307,803
1984	2,433,749	1,473,603	960,146
1985	1,849,523	1,011,367	838,156
1986	2,198,907	947,510	1,251,397
1987	1,234,552	833,647	400,905
1988	1,625,435	653,809	971,626
1989	1,079,555	336,503	743,052
1990	1,062,522	603,299	459,223
1991	2,125,308	1,063,401	1,061,907
1992	3,193,433	1,948,819	1,244,614
1993	4,606,463	3,004,370	1,602,093
1994	6,376,472	4,781,593	1,594,879
1995	6,600,529	4,310,379	2,290,150
1996	8,918,577	6,246,728	2,671,849
1997	5,863,603	3,534,803	2,328,800
1998	9,406,979	4,800,326	4,606,653
1999	8,944,184	6,148,309	2,795,875
2000	8,306,257	6,232,888	2,073,369
2001	4,436,178	2,203,419	2,232,759
2002	3,110,330	2,057,813	1,052,517
2003	4,336,128	2,864,976	1,471,152
2004	5,684,447	4,098,981	1,585,466
2005	2,817,026	1,835,247	981,779
2006	5,614,232	3,810,988	1,803,244
2007	3,043,839	1,242,925	1,800,914
2008	3,215,231	2,332,622	882,609
2009	35,029,998	2,427,762	1,075,236
2010	3,234,567	1,921,639	1,312,928
2011	2,700,914	1,171,493	1,529,421
2001-2010 Average	5,569,879	2,479,637	1,419,860

Drift gillnet fishing is allowed by regulation in District 1 (Sections 1-A and 1-B), District 6 (Sections 6-A, 6-B, 6-C, and 6-D), District 8, District 11 (Sections 11-B and 11-C), and District 15 (Sections 15-A, 15-B, and 15-C). The 2011 drift gillnet common property fisheries (traditional and THA) harvested 5.2 million salmon (all species combined), which included approximately 2.8 million chum salmon (54% of the harvest) (Table A6-56,). Historically, chum salmon comprise approximately 38% of the common property drift gillnet catch by species.The 2011 common property chum salmon harvest was 133% above the most recent 10-year average harvest of 2.1 million fish. Since 1992, chum salmon has made up a large component of the traditional and THA drift gillnet harvest in Southeast Alaska, which is attributable to hatchery production. There were no cost recovery harvest by drift gillnet gear in 2011. Drift gillnet harvests from the Annette Island Reservation were 534,000 salmon (all species combined), which included 263,824 chum salmon.

Table A6-56. Southeast Alaska total commercial, common property, drift gillnet chum salmon harvest (from traditional and terminal areas), 1980-2011.

Year	Chum Salmon
1980	548,674
1981	270,231
1982	448,332
1983	516,639
1984	1,030,346
1985	1,134,446
1986	815,813
1987	747,363
1988	1,144,856
1989	542,846
1990	616,226
1991	707,277
1992	845,176
1993	1,401,186
1994	1,823,497
1995	2,478,672
1996	2,033,650
1997	1,689,474
1998	1,923,764
1999	2,166,260
2000	2,561,607
2001	1,576,881
2002	1,415,849
2003	1,528,198
2004	1,835,679
2005	1,511,570
2006	3,126,663
2007	2,484,769
2008	2,592,212
2009	2,729,966
2010	2,219,761
2011	2,800,609
2001-2010 Avg.	2,102,257

Yakutat Set Gillnet Fishery[40]

The Yakutat District set gillnet fisheries primarily target sockeye and coho salmon although all five species of salmon are harvested. The Yakataga District fisheries only target coho salmon. In 2011, the Yakutat set gillnet fishery produced a cumulative harvest of 501,200 salmon (all species combined), which was 56% above the most recent 10-year average (2001-2010). The chum salmon harvest of 900 fish was slightly below the recent 10-year average (Table A6-57). Chum salmon are a non-target species in the Yakutat Area due to the combination of low abundance and low price, and the harvest is entirely incidental. The East River was the only consistent producer of chum in the Yakutat Area; however, the chum salmon run in the East River has been in declineduring the past decade, probably due to changes in habitat. A total of 330 chum salmon were harvested in the East River fishery in 2011.

Table A6-57. Commercial chum salmon harvest in the Yakutat area set gillnet fishery, 1998-2011.

Year	Chum Salmon
1998	1,351
1999	928
2000	1,185
2001	406
2002	204
2003	542
2004	1,555
2005	525
2006	1,225
2007	2,782
2008	546
2009	871
2010	1,239
2011	900
2001-2010 Avg.	990

Southeast Alaska/Yakutat Troll Fishery[41]

The commercial troll fishery in Southeast Alaska and Yakutat occurs in State of Alaska waters and in the Federal Exclusive Economic Zone (EEZ) east of the longitude of Cape Suckling. All other waters of Alaska are closed to commercial trolling. The commercial troll fleet is comprised of hand and power troll gear types. Approximately 2.8 million salmon were harvested in the 2011 Southeast Alaska/Yakutat troll fishery (common property and terminal areas). This harvest included 702,769 chum salmon, which ranked as the highest chum salmon harvest on record.A total of 569 chum salmon were reported as harvested outside state waters in the EEZ; when all species are combined, only 2% of the troll salmon harvest was reported to be taken outside State waters.

Historically, chum salmon were harvested incidentally in the general summer troll fishery and were not targeted until the Cross Sound pink and chum fishery was established in 1988 as an indicator of pink and chum salmon abundance in inside waters. The troll chum harvest increased significantly in 1992. Since that time, trollers have targeted chum and, with the exception of 1999 and 2008, the annual troll harvest

[40] Information on the Yakutat set gillnet fishery can be found in: Woods, G.F. and N.L. Zeiser. 2012. Annual Management Report of the 2011 Yakutat Area commercial salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 12-01, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-01.pdf.

[41] Information on the Southeast Alaska-Yakutat troll fishery can be found in: Skannes, P., G. Hagerman and L. Shaul. 2012. Annual management report for the 2011 Southeast Alaska/Yakutat salmon troll fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 12-02, Anchorage. http://www.adfg.alaska.gov/FedAidpdfs/FMR12-02.pdf.

of chum salmon outside of terminal harvest areas has been consistently greater than 100,000 fish (Table A6-58). Effort directed at targeting hatchery-produced chum salmon has increased in recent years as has the price being paid for them.

Table A6-58. Southeast Alaska/Yakutat Region commercial troll (common property) chum salmon harvest, 1980-2011.

Year	Total Chum Salmon	Hand Troll Contribution	Power Troll Contribution
1980	12,048	4,532	7,516
1981	8,680	2,582	6,098
1982	5,700	1,187	4,513
1983	20,309	2,777	17,532
1984	28,052	4,894	23,158
1985	52,787	9,746	43,041
1986	51,389	6,687	44,702
1987	12,846	3,016	9,830
1988	88,261	14,536	73,725
1989	68,988	6,578	62,410
1990	62,818	6,489	56,329
1991	28,438	3,839	24,599
1992	85,013	6,023	79,003
1993	525,138	34,449	490,711
1994	330,376	32,061	298,315
1995	277,453	21,282	256,171
1996	406,244	53,646	352,775
1997	312,042	20,042	292,000
1998	117,642	2,051	115,591
1999	74,672	583	74,121
2000	478,144	6,427	471,717
2001	467,830	12,480	455,357
2002	117,672	578	117,094
2003	286,410	3,095	281,610
2004	161,070	861	170,465
2005	165,393	418	174,1815
2006	143,030	437	153,108
2007	185,800	1,389	190,296
2008	60,291	863	59,966
2009	153,770	5,427	337,571
2010	298,476	9,861	384,834
2011	702,769	13,500	689,269
2001-2010 Avg.	251,789	3,712	232,448

A7 Analytical results of Alternatives 1 and 3 on impacts to chum salmon

A7.1 Bycatch under RHS/Inter-cooperative Agreement

This analysis provides an evaluation of the status quo chum PSC reduction measures[42]. The status quo is defined in three ways: the Chum Salmon Savings Areas (SSA) only, Chum SSA and rolling hotspot system (RHS), and RHS only. Thus identifying the means to evaluate the efficacy of the rolling hotspot program helps both in defining the current status quo conditions of the fishery as well as proposing modifications to such a program to improve its effectiveness. The questions analyzed here and draft methodologies were reviewed by the Scientific and Statistical Committee (SSC) of the North Pacific Fishery Management Council (Council) in June 2009, June 2010, and April 2012.

Since 2001, there has been an inter-cooperative agreement (ICA) among pollock cooperatives to impose short-term "hot spot" closures designed to limit chum salmon PSC in the Bering Sea pollock fishery. A description of the current ICA including modifications made to it since 2005 is contained in Appendix 2. Sea State, Inc. is hired by the pollock industry to analyze the National Marine Fisheries Service (NMFS) Observer Program data, vessel monitoring system (VMS) data, and other real-time data to relay information to the fleet and to implement hotspot closures. Since August 2006, following approval of Amendment 84 by the Council[43], these rolling hotspot (RHS) closures have been the only chum-related PSC restrictions on the pollock fishery. This assessment of the status quo chum salmon PSC measures gives primary attention to estimating the efficacy of the rolling hotspot (RHS) closures at reducing bycatch.

Salmon Savings Areas will also be discussed, as well as the interaction between existing chum salmon reduction measures and Amendment 91, which allows for incentive plan agreements (IPA) and created a "hard cap" for Chinook salmon beginning in 2011. Because the pollock industry has not yet reported results to the Council on the IPAs, only a limited discussion can be offered on how the Amendment 91 measures have interacted with the chum RHS measures.

The three panes of Figure A7-1 show the locations of RHS closures in the Bering Sea at different points in the B Season from 2003-2011 (left panel), in the high-chum year of 2005 (middle), and the low-chum year of 2009 (right). The closures have been imposed on much of the pollock fishing grounds at different points during the period of analysis.

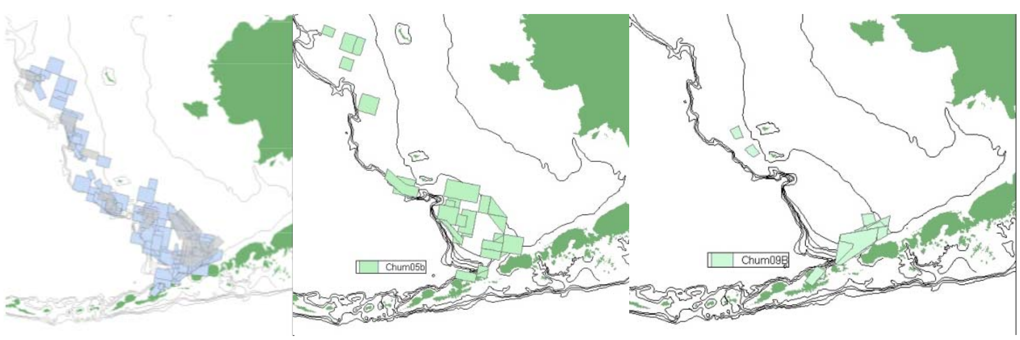


Figure A7-1. RHS B Season Closures 2003-2011 (left), 2005B (center) and 2009B (right)

[42] Note for the public review draft the methodological sections of this analysis will be moved to Chapter 3 but are currently retained within the whole impacts section presented here for the initial review draft.
[43] Note that the exemption was implemented via an EFP in the B season of 2006 and was implemented by regulation following secretarial approval of Amendment 84 in January 2007.

As described in the EA, the rolling hotspot program (RHS) serves both informational and regulatory functions. If vessels perceive a strong enough incentive to avoid chum PSC, there would be little necessity for the *regulatory* function of hotspot closures, because vessels would avoid fishing in locations where they would expect to have high PSC.

Under the existing system, the direct costs of high chum PSC – and the benefits of avoiding chum PSC – are not born by the individual vessels or companies and some vessels have had much higher chum bycatch rates than others, in part due to their choices to fish in areas where there have recently been high PSC hauls. As well as informing vessels about where bycatch rates are high, the hotspot system restricts vessels from fishing in what have recently been the highest bycatch areas, thus providing a dynamic means to regulate chum PSC in the fishery.

This analysis attempts to address the following questions. Has chum salmon been reduced by the RHS system, and if so, how much chum salmon has been avoided beyond what would have occurred without the system?

In order to evaluate these questions, we first need to identify the mechanisms though which the RHS hotspot system could lead to salmon bycatch reduction. The primary mechanisms include:

1. Closing an area causes vessels in an area to move to other areas, hopefully with lower bycatch
2. The awareness by vessel operators that an area may be closed could lead to a reduction in fishing effort in the soon-to-be closed area immediately prior to the closure.
3. Preventing additional fishing from occurring in the area during closure periods by other vessels after the closure is put in place.

The mapping and information sharing that is part of the system (as described in Section 2.1.2 also facilitates more informed decision-making, though how this affects behavior is difficult to measure.

A7.2 Overview of Status Quo Analysis

This portion of the overall analysis considers the status quo chum measures, with primary attention to the RHS program. Previous analysis had focused upon identifying reductions in chum PSC following the implementation of the VRHS. A key challenge to evaluating the total salmon avoided through the RHS program is extending the analysis to understand estimate what the total savings might be from the RHS program. We observe chum PSC levels of the current system, but to calculate the savings relative to what would have happened without the closures, it's necessary to estimate what chum PSC levels would have occurred in the parallel universe without the RHS closures.

Unfortunately, such a control group universe doesn't exist, so we have turned to evaluating the behavior of the fleet and the persistence of chum PSC prior to the first implementation of the RHS system in 2001. The benefit of examining this period is that it allows us to apply closure rules similar to the RHS system and then to observe the actual fishing in the "closures." Details are explained below, but this approach allows an estimation of "salmon saved" and an exploration of the impacts of different characteristics of the closure system on its effectiveness.

The goal is to provide a better understanding of how much salmon was saved and how much is likely to be saved per year in the future. Additionally, following the Council's June 2010 motion, we consider the potential factors that could be adjusted to potentially improve the effectiveness of the chum RHS system. This portion of the analysis is organized as follows:

- Description of status quo data
- Summary statistics about the RHS system
- Examination of daily chum PSC rates
- Examination of impacts of the RHS system on chum bycatch levels following closure implementation
- Presentation and discussion of pre-RHS chum bycatch analysis
- Consideration of the Salmon Savings Areas
- Examination and discussion of Amendment 91 Chinook measures
- Discussion of other features of the RHS System
- Possible adjustments of the RHS system to improve its effectiveness
- Presentation of summary findings
- Appendix 3: RHS B-Season Closure Periods 2003-2009.

A7.3 Data for the status quo analysis

The data for this part of the analysis consists of the SeaState RHS reports that have been converted to an ArcGIS shapefile. The data from 2003-2006 was provided by SeaState in a tabular format for earlier Council analysis of the rolling hotspot program. Since 2006, twice-weekly SeaState reports have been provided to NMFS and Council staff and the coordinates and dates from these reports were used to define the RHS closures. The same observer data that is used in identifying potential fixed closures is used to evaluate the amount of pollock catch and PSC that occurs in each area. In summary tables in this document, the data is extrapolated from the observer data to match the NMFS Alaska Region totals in the summary table of all closures. Where appropriate such as when examining rate changes in and out of areas, the analysis is conducted with the non-adjusted numbers.

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

A7.3.1 Rolling hotspot (RHS) summary information

This section of the analysis provides summary information on B-Season RHS closures and data on chum bycatch rates before and after closure implementation. The following tables show the number of closures implemented per year since closures were first imposed beginning in 2001. To be consistent with the other data used in this analysis and because the RHS program was in a developmental phase for 2001-2002, the focus of the analysis here is 2003-2011. RHS closures are designated as “Chinook” or “chum” closures, with different rules applying to each according to the terms of the inter-cooperative agreement (ICA). Beginning in 2011, the functioning of the RHS for Chinook is part of the IPAs of the different sectors are described in the IPA reports to the Council.

Table A7-1. Number of B-Season Closures and Average Length of Closures (days) by Closure Type

Year	Total Closures	Days (avg)	Chum Closures	Days (avg)	Chinook Closures	Days (avg)
2001	22	6.91	22*	6.91	*	*
2002	20	7.00	20*	7.00	*	*
2003	22	6.64	22*	6.64	*	*
2004	22	6.55	22*	6.55	*	*
2005	38	4.13	37*	4.14	1	4.00
2006	36	4.94	23	4.65	13	5.46
2007	34	5.68	17	5.76	17	5.59
2008	14	8.36	9	9.00	5	7.20
2009	21	6.71	14	7.50	7	5.14
2010	20	6.45	11	6.64	9	6.22
2011	36	6.17	36	6.17	6	*

* Note that closures for 2001-2004 are assumed to be chum Closures based on chum rates and pers. comm. with Karl Haflinger about their general timing, while later closures are reported as Chum closures in SeaState reports. Several of the closures in 2003 & 2004 that are designated as chum may be Chinook closures. Because Chinook IPA-related closures for 2011 were partially “advisory areas” and applied to only some vessels, we do not report an average length in days.

The number of days per month that closures were in place increased with rising Chinook and chum PSC in the middle of the last decade but has remained high through most of the fishing season beginning in 2005 (Table A7-2). Closures have been in place for a significant number of days in June in 2005, 2006, and 2011. Note that through the tier system, not all closures applied to all sectors or cooperatives.

Table A7-2. Days per Month with Chum or Chinook Closures in Place, 2003-2011

Year	June	July	Aug	Sept	Oct	Nov
2001	2	13	15	30	31	
2002		13	31	30	31	1
2003		21	25	27	24	
2004		30	31	15		
2005	7	31	29	25	25	
2006	11	31	31	30	31	
2007		23	31	28	31	2
2008		28	29	27	29	1
2009	2	28	31	28	13	
2010	2	29	22	24	20	1
2011	14	31	31	30	29	1

There have typically been more closure periods in years with higher chum PSC. Closure areas are more typically extended than moved in low PSC periods. Figure A7-2 shows the number of distinct periods per year. Note that periods are defined when one or more closures are new. Thus if one closure is left in place but another is added or moved, this becomes a new closure period and the analysis evalutes the impact of this additional closure.

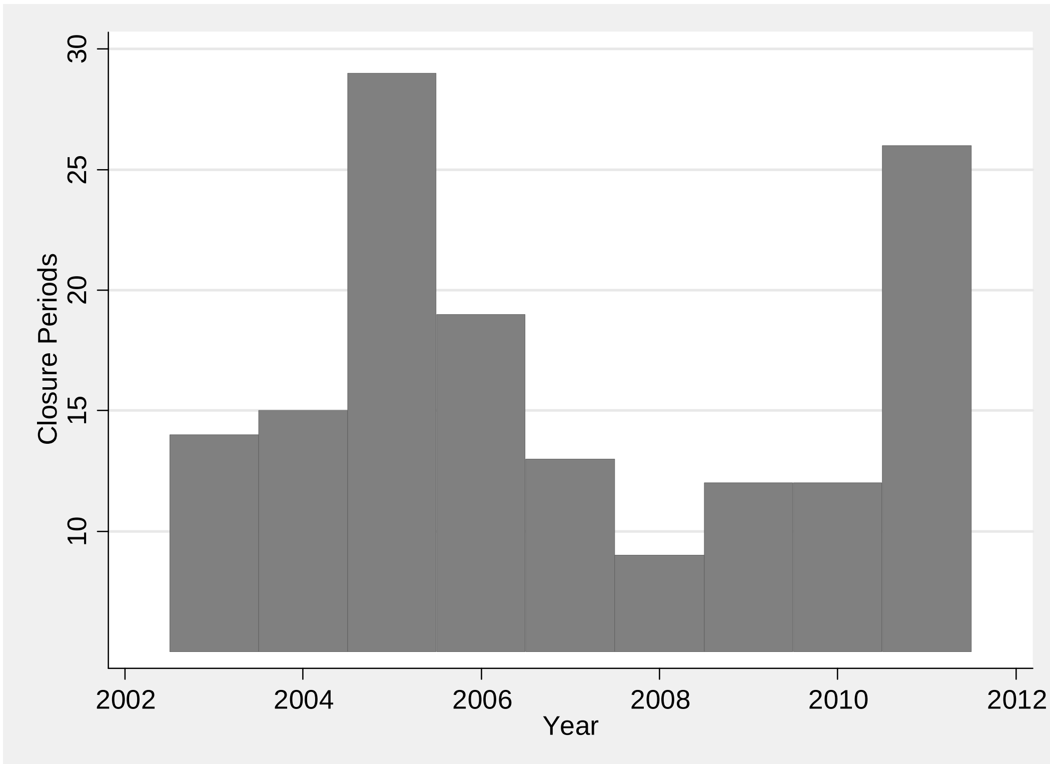


Figure A7-2. Distinct chum RHS closure periods per year, B-Seasons, 2003 – 2011. Vertical lines represent days a closure

Figure A7-3 shows the percentage of vessels/platforms from the shoreside and offshore sectors that fished in closure area at some point during the B-season. There has been considerable variation in different years. The concentration of pollock and salmon PSC in the closures prior to their being closed gives an indication of how much of pollock fishery effort is directly impacted by the imposition of the closures because vessels were in the areas in the 5-day time period prior to the closure (Table A7-4). However, many of these vessels had already left the area when the closure was imposed, while additional vessels might have visited those areas during the closure periods if the areas had not been closed.

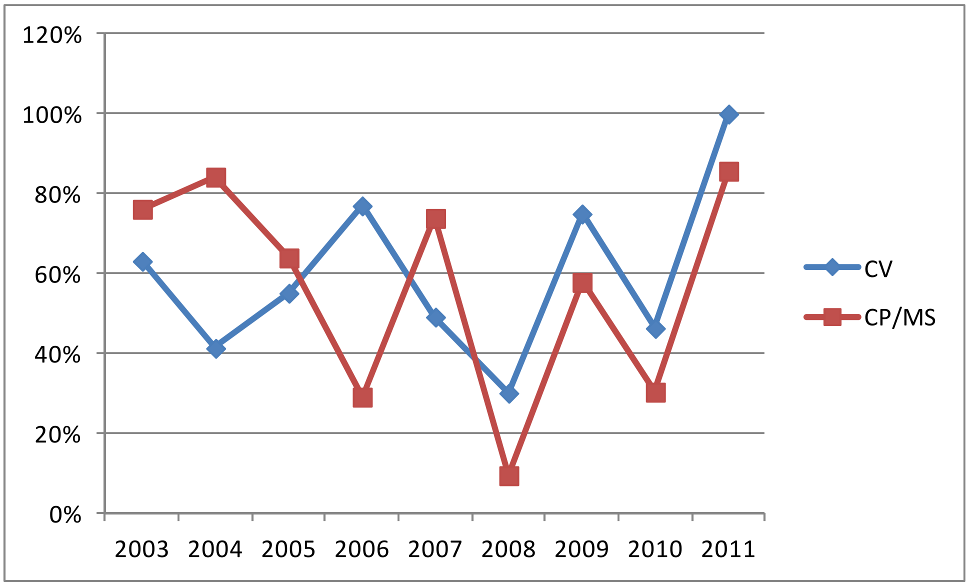


Table A7-3. Percentage of vessels that fished in chum RHS Closures during the 5 days before each closure, 2003-2011

Table A7-4. Average percent of total observed Chum, Chinook, and Pollock caught in RHS Closures during the 5 days before each closure, 2003-2011

	Catcher Vessels				CPs/MS		
Year	% Chum	% Chin	% Poll		% Chum	% Chin	% Poll
2003	27%	10%	21%		28%	4%	4%
2004	33%	9%	8%		23%	4%	3%
2005	21%	21%	12%		19%	3%	4%
2006	19%	28%	9%		15%	0.7%	0.5%
2007	11%	19%	7%		30%	22%	5%
2008	29%	52%	11%		2%	6%	0.3%
2009	33%	18%	13%		9%	18%	2%
2010	33%	47%	9%		13%	35%	2%
2011	36%	7%	17%		32%	6%	6%

Vessels that fished in a closure area before the closure also fished elsewhere to differing degrees by year and sector (Table A7-5). This illustrates that, because of the high degree of movement in the pollock fishery, most vessels typically catch only a portion of their pollock in a closure area prior to closures being implemented. Vessels that are members of cooperatives with low bycatch rates relative to the "base rate" (as defined in the ICA) qualify as Tier 1 or Tier 2 Vessels. Tier 1 cooperative vessels do not have to leave chum closures while Tier 2 vessels are prohibited from fishing the RHS closures for the first 3 days of each 7-day period beginning at 6pm on Tuesday, even if the area closed changes on Thursday. Under the current RHS program, Tier 3 vessels are prohibited from fishing in closures for 7 days. Regardless of Tier, vessels will often avoid the closure areas because either it is the end of their trip, fishing conditions have changed, or in some cases vessel operators report leaving areas because of their concern about high PSC in the area. In the summer, the tier system has applied only to chum PSC—all Chinook closures applied to all vessels from 2003-2010.

The tier system provides some incentive to vessels to have lower bycatch rates so that they will be in Tier 1or 2 and therefore be allowed to fish in the closure areas. It is hard to quantify the value of being able to stay in an area when it's closed to other vessels, but at times it may be quite valuable. However, the fact that many closure areas have no fishing in them even when some cooperatives are in Tier 1 and Tier 2 suggests that, in those cases, the value of fishing in the closures is not larger than the value of fishing out of the closure areas. It is possible that in some cases some vessels may be avoiding the area out of concern about higher PSC, but if this happened all the time it would imply the tier system is unnecessary and therefore not providing any additional incentives.

Table A7-5. For Vessels that fished in the RHS during the 5 days before closures, % of their observed pollock caught in the RHS Area during that 5 day period by Sector and Year

Year	CV % in VRHS	CP/MS % in VRHS
2003	48%	28%
2004	36%	18%
2005	45%	28%
2006	44%	21%
2007	46%	31%
2008	60%	16%
2009	48%	29%
2010	56%	17%
2011	54%	24%

The Chum PSC rates of Tier 1 and Tier 2 vessels legally fishing inside of RHS closures after they are implemented shows that approximately 4 percent of CV fishing occurred in the B season closures during the time closures were in place, while less than 1 percent of the fishing for other sectors occurred in the closures (Table A7-6). In many cases this small percentage of effort by CP/MS vessels may be the result of the hotspot closures being located in the CVOA. The average Chum PSC rate for 2003-2011 for Tier 1 & 2 shoreside catcher vessels fishing inside closures was 0.57 chum/t. At the same time, the rate outside the closures was 0.18. For other sectors, the Chum PSC rate was 0.43 inside versus 0.65 outside. For Chinook PSC (not shown), the average rate for CVs fishing in the closures over the period was 0.08 versus 0.06 outside. For other sectors, the rate was 0.03 versus 0.01. The relatively small amount of fishing that occurs in the areas can make these rates quite variable from year to year.

Table A7-6 Observed activity & Chum PSC inside RHS Closures by Tier 1 & 2 Vessels, 2003-2011.

Year	CV	% Hauls In	# Hauls In	# Hauls Out	% Chum In	Chum In VRHS	Chum Out VRHS	Chum Rate In	Chum Rate Out	% Pollock In	Pollock In (MT)	Pollock Out (MT)	Chum PSC Rate Ratio In/Out
2003	CV	7.4%	166	2,063	3.9%	3,323	80,887	0.190	0.433	8.6%	17,479	186,616	0.44
2004	CV	3.1%	65	2,009	1.7%	2,629	148,498	0.524	0.875	2.9%	5,018	169,661	0.60
2005	CV	1.7%	47	2,711	1.3%	4,918	384,980	1.314	1.812	1.7%	3,743	212,409	0.72
2006	CV	0.8%	28	3,401	1.0%	1,544	158,589	0.996	0.634	0.6%	1,551	250,166	1.57
2007	CV	2.7%	75	2,755	6.0%	1,722	26,921	0.538	0.170	2.0%	3,200	158,011	3.16
2008	CV	3.4%	74	2,092	8.5%	419	4,506	0.156	0.039	2.3%	2,682	115,060	3.99
2009	CV	4.8%	72	1,420	9.4%	1,735	16,699	0.522	0.183	3.5%	3,325	91,107	2.85
2010	CV	0.6%	8	1,298	3.7%	150	3,955	0.540	0.043	0.3%	278	92,820	12.67
2011	CV	7.5%	382	4,693	7.7%	7,828	93,766	0.402	0.373	7.2%	19,487	251,382	1.08
2003	CP/MS/CDQ	1.0%	41	4,139	0.9%	314	35,311	0.143	0.108	0.7%	2,192	326,201	1.32
2004	CP/MS/CDQ	0.0%	2	4,319	0.1%	80	64,513	1.037	0.187	0.0%	77	344,340	5.53
2005	CP/MS/CDQ	0.2%	12	5,005	1.4%	810	58,923	0.869	0.142	0.2%	932	414,048	6.11
2006	CP/MS/CDQ	0.0%	0	5,941	0.0%	-	18,985		0.040	0.0%	-	473,228	*
2007	CP/MS/CDQ	1.0%	51	5,047	1.0%	292	30,142	0.092	0.085	0.9%	3,184	353,850	1.08
2008	CP/MS/CDQ	0.0%	1	3,954	0.5%	9	1,900	0.146	0.007	0.0%	62	255,459	*
2009	CP/MS/CDQ	0.8%	23	2,763	0.1%	6	4,747	0.010	0.025	0.3%	631	193,012	0.39
2010	CP/MS/CDQ	0.3%	6	1,958	1.4%	31	2,142	0.052	0.014	0.4%	595	155,534	3.78
2011	CP/MS/CDQ	2.2%	119	5,384	5.3%	3,773	66,945	0.571	0.184	1.8%	6,611	362,974	3.09
2003-11	CV	3.9%	917	22,442	2.6%	24,268	918,801	0.428	0.647	3.6%	56,763	1,527,231	0.66
Avg/Total	CP/MS/CDQ	0.7%	255	38,510	1.8%	5,315	283,608	0.372	0.086	0.5%	14,284	2,878,645	4.32

A7.4 Evaluating and quantifying impacts of the RHS system

How many total chum that are avoided because of closure areas? The amount of salmon saved or avoided is equal to the PSC that would have resulted if vessel operators had fished in a closed area minus what actually occurred when the vessels fished outside of the closures. It's important to note that this measure is the impact on the fleet as a whole – not just the vessels that were in the area prior to it being closed. Some of the vessels in an area prior to a closure would not have returned and other vessels could have visited the area if it had been open.

Some RHS closures are extended multiple times, for periods up to several weeks in duration. A particularly challenging part of this analysis is the estimation of how much salmon would have been caught if fishing had occurred inside of the closed areas when closures were in place for longer time periods. An additional challenge is that because this method of analysis examines changes relative to when closures are implemented, it's possible that as a result of closures, high PSC never occurred so there's no change to pick up in a statistical analysis. However, an examination of historical PSC patterns suggests that the magnitude of this type of PSC reduction is very unlikely to be very large.

Importantly, there may be disproportionate gains in just a few of the highest bycatch periods that are not well-measured by the examination of all of the closure areas via averaging. However, there are also other times when average methods may over-estimate PSC that would have occurred, either because salmon PSC rates or fishing activity in an area would have declined even without the closure. Similarly, as with fixed closures, hotspot closures may, at times, cause vessels to choose to fish in areas that turn out to have higher PSC than if they had remained in the closure.

A7.4.1 The impact of RHS closures on observed PSC levels

Figure A7-3 displays the observer-derived chum PSC rates, by day for 2003-2011. The vertical lines in the figures represent days when RHS "chum" closures were implemented. The figures are intended to provide a sense of the day-to-day variation in chum salmon PSC in the fishery from 2003-2011. Note that the scale varies from year to year among the diagrams so a spike in 2005 many more chum than a spike in 2009.

Examining these figures gives several impressions. First, in both high- and low-PSC years, there are periods with relatively high and very low PSC. There are several times a year where there are days with much higher PSC than any other neighboring days. Typically chum PSC rates fall quickly from peak values. This rapid fall from peak values is also visible when observing PSC rates in the 1990s before RHS closures were utilized. The variations do not show whether or not the closures are effective, but illustrate the highly variable nature of chum PSC from day to day. Anecdotal observations of chum PSC rising or falling dramatically are not a sound basis for judging the efficacy of the RHS system.

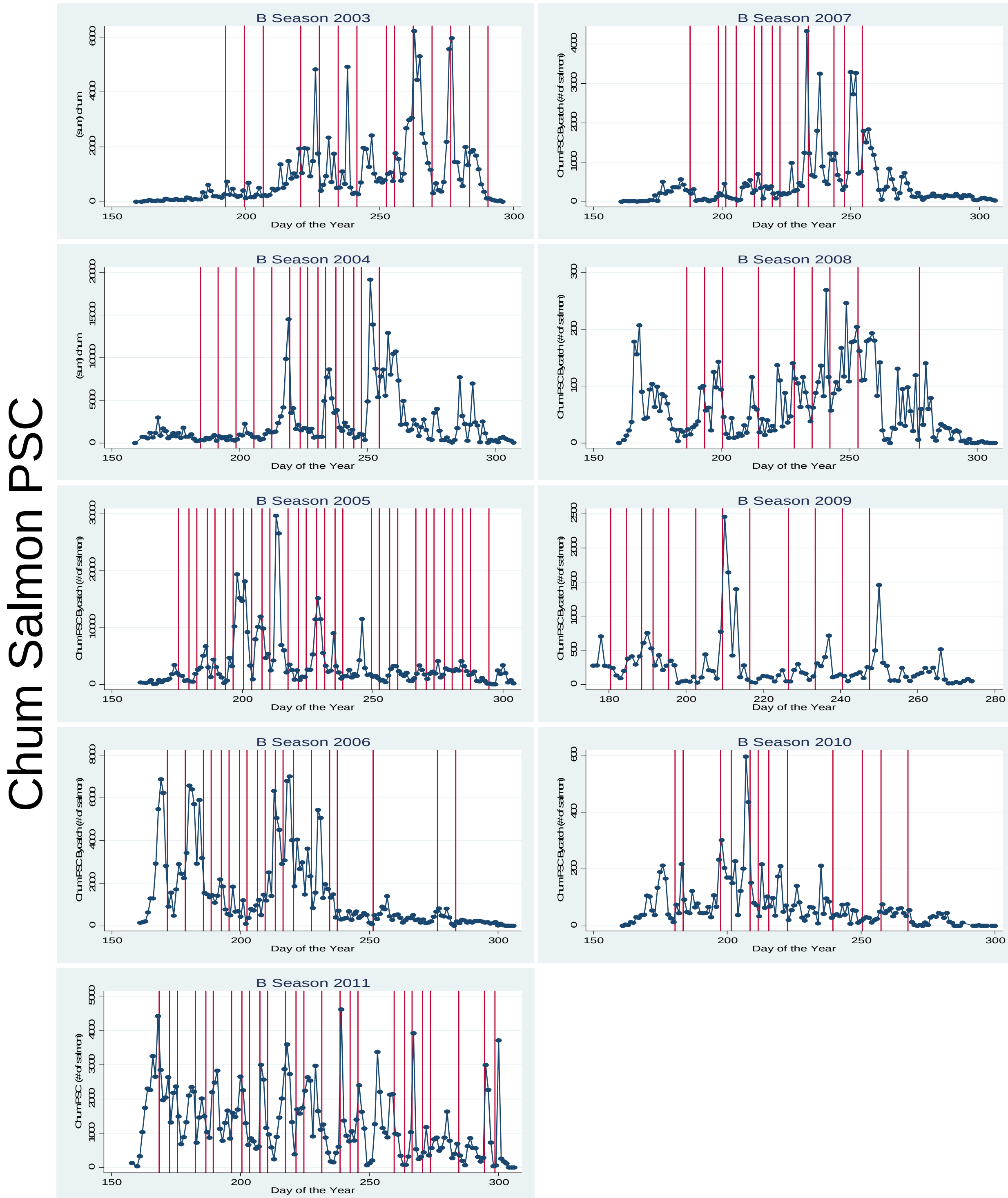


Figure A7-3. Chum PSC by day of the year, B-Seasons, 2003 – 2011. Vertical lines represent days a closure was put in place.

To evaluate the effectiveness of the hotspot system, we estimate the change in the overall PSC rate for the entire fishery at the time that closures are implemented relative to the period immediately prior to the closures being implemented. This analysis draws upon a literature in economics and statistics called regression discontinuity design that focuses on evaluating the effectiveness of different programs (e.g., Thistlewaite and Campbell (1960), Davis (2008), and Lee and Lemieux (2009)). There is an extensive and active literature in economics, statistics, and other fields that is still expanding this methodology, but the basic idea is that we can focus upon the change near to closures to isolate the effect of a policy measure, in this case the imposition of the RHS closure areas. By examining the PSC rates in the days right before and right after closures have been implemented, we are able to focus on the impact of the closures in changing the PSC rates.

In considering what methodology is most appropriate, a key consideration is the fact that while only the some vessels were in a closure area before a closure, *the closures potentially have an impact on the whole fleet because they also prevent vessels from entering.* All vessels would have had some probability of fishing in the closed area after the closure. To answer the question of how effective the RHS program is, we want to know the average impact on the fleet, which is what is assessed here.

It should be noted that there are some limitations to this approach. First, attributing the effectiveness of the RHS system to the overall change in PSC rate may not always account for seasonality, short-term trends in the fishery, or potentially high-PSC areas that have been avoided. In periods of increasing PSC, a hotspot closure might dramatically reduce PSC relative to what would have occurred; however, due to the movement of chum salmon the rate after a given closure might nonetheless be higher than prior to the closure. If we focus on period right around closures, we can still measure the change in chum PSC that occurs when closures are implemented. This is a better measure of overall effectiveness than the impact of any particular closure which will be more swayed by random events.

Before-after RHS closure comparison of changes in average chum PSC rates

While there are long-term trends of PSC within a season that may be impacted by closures that this analysis addresses by examining the pre-RHS period, care must be taken to separate these seasonal trends from the repeated "treatments" imposed by the RHS closures when RHS closures are in place. If the RHS closures are effective, there should on average be some visible impact on chum PSC when we compare the PSC rates immediately before and after the closures are implemented. Controlling for variation in bycatch levels and the vessels participating at different points, the magnitude of this effect can be statistically tested.

The changes in chum PSC that resulted after B-season closures are estimated by use of PSC data before and after all of the closure periods.[44] These changes are estimated for each closure *period* rather than each closure area to minimize double-counting. If two closures are in place at the same time, the salmon and pollock inside either closure are totaled and considered to be inside the closure area and the salmon and pollock caught outside of the areas are considered outside.

Chinook closures were given a prioty later in the year, so that while chum closures were sometimes in place late in the year, these closure periods were not very focused on chum. Therefore, we consider the effectiveness of chum RHS closures for two, overlapping periods:

[44] Additionally, we limit the analysis to all closure periods in which there was a least one chum bycatch closure in place (i.e., not periods with only Chinook closures). Note that some catcher vessel trips involve fishing in the closure before it is imposed and then out of the closure after. Because PSC is counted per trip and then assigned to hauls, this has the potential to confound the identification of the effect. We ran these models with and without trips that spanned the closure in the dataset and this did not meaningfully change the results. The models shown here include all of the data.

- June – August (early season), and
- B-season (All B-season).

Before carefully modeling the impact of the closures, the averge changes from before to after the closures are examined. There is, on average, a small drop in PSC rate in the days immediately following the implementation of RHS chum closures (Figure A7-4).

Several techniques are utilized to further examine this change and to control for the fact that different vessels fish at different times and for the large variation in background PSC rates across closures.. All of the analysis was conducted using the STATA statistical package (version 12.1). Chum bycatch are not at all normally distributed, so a linear model is clearly not suitable. A standard poisson, a negative binomial (which is the same as a glm with a log-link), a zero-inflated poisson, and a zero-inflated negative binomial (ZINB) model are all considered and compared via information criteria (AIC, BIC) and measures of overdispersion. We run these models under a suite of data sets (ranging from 1-3 days before and after the closures) that capture the before and after affects, for both the entire B-season and the June-August period. The data show clear evidence of overdispersion (the variance is much larger than the mean, which), so it is not suprising the negative binonmial out-performs the Poisson. In some cases, the ZINB has better information criteria and a Vuong test suggest that it is preferred to a negative binomial model. However, convergence was not reached for several of the ZINB models with appropriate closure-period controls, so negative binomial are utilized for all data periods (1-3 days before/after the closures). For models where both models could be successfully run, the results differed only slightly.

The negative binomial models run in STATA were executed in variants of the following command:

nbreg chum afterVRHS i.closureid i.vessid if dayrelativetoclosure>=-Days & dayrelativetoclosure <=Days, exposure(duration) vce(robust)

where *afterVRHS* is the coefficient of interest (whether observation following the closures had a different level of PSC), 'closureid' and 'vesselid' are closure- and vessel-level controls, and 'Days' creates a window of data ranging from 1-3 days. Duration is included as an exposure variable and robust standard errors are estimated to better account for the heterogeneiety in the data.

The results of the negative binomial models are shown in Table A7-7. Note that because this is a negative binomial regression, the percentage change from the regression coefficients is calculated using the formula:

$$Chum = \exp(afterVRHS) - 1$$

Table A7-7 Estimated reduction of chum PSC from the days before to the days after RHS closures, 2003-2011.

	B-Season					June-August				
Days Before/After Closure	Coefficient	Robust Std. Err.	t	P>|t|	Percent Change	Coefficient	Robust Std. Err.	t	P>|t|	Percent Change
1	-0.069	0.041	-1.7	0.089	-0.067	-0.231	0.044	-5.22	0	-0.206
≤2	-0.106	0.032	-3.33	0.001	-0.100	-0.166	0.037	-4.45	0	-0.153
≤3	-0.122	0.028	-4.33	0	-0.115	-0.182	0.033	-5.48	0	-0.167
				Average	-9%				Average	-18%

The model with vessel-level and closure-level fixed effects seems to be the best model to capture the variation in the fishery. However, models were also conducted without vessel-fixed effects and with year-week interactions, and these models produced similar results.

One measure of the robustness of the analysis was a A Mann-Whitney-Wilcoxon rank sum test, which indicates that the means of chum PSC rates are different from one another in the 3 days following a closure. This is a non-parametric statistical test appropriate for unmatched data such as chum bycatch hauls before and after closures. For 2003-2011, the rank test indicated a significant effect of the closures .However, comparing rates for the 3 days before and 3 days when 2011 data are included is *not* statistically significant. This is consistent with the extreme value nature of these data, where some observations are many thousands and a large number of the hauls have zero salmon. In a number of cases, a change in closure location may have occurred 3 or 4 days before. Seasonal factors such as changing pollock and PSC conditions could dilute the impact of the RHS closures over this longer timeframe.[45]

A counter-factual break was also tested one day earlier and later to evaluate if the model is perceiving a "false positive.' There is no statistical difference between 2 and 1 days before the closure and between 1 and 2 days after the closure.

In light of there being evidence that the closures are effective, one test of robustness is to counter-factually assume that the closures were implemented 1-2 days before or after each actual closure and assess whether there is a measurable impact. This assesses whether the observed chum PSC reductions might be "false positives." In all cases, there is no statistically observable difference in chum PSC when the wrong break day is assumed. This is strong evidence that the observed impact measured at the time of closure implementation is due to the presence of closure areas.

Figure A7-4 displays the average chum PSC rates for the three days before and after chum closures are implemented. In the figure, the larger drop is visible in the right hand panel. The pre-RHS analysis, below, provides a means to estimating the total salmon saved. Details on this method are discussed below.

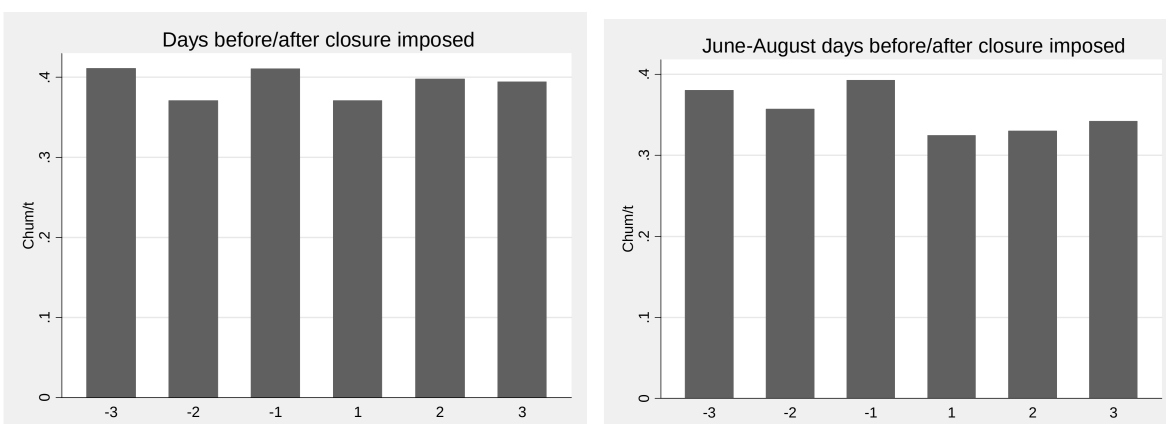


Figure A7-4. Chum PSC / MT Before & After Closures Implementation (left panel: B-season, right panel: Septeber2, 2003-2011.

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

Table Table A7-8 shows the most dramatic reductions observed after RHS closures appear to be in 2004 and 2006. However, the table also displays that there is no reduction on average in the days following closures for several days. Because there is on average 1/9 as much data at the annual level as in the aggregate comparison, several large increases in PSC after a closure have a larger impact on the results. Additionally, in low chum PSC years there are fewer closure periods so the impacts of any extreme event would be magnified in this table.

Table A7-8. Average chum PSC rate for the 3 days before and after Chum RHS closure periods, Individual Years, 2003-2011

Day Relative to	Year									
Closure	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Total**
-3	0.239	0.486	0.862	0.497	0.141	0.03	0.103	0.058	0.41	0.411
-2	0.253	0.386	0.782	0.529	0.128	0.059	0.095	0.056	0.331	0.371
-1	0.285	0.465	0.841	0.544	0.176	0.053	0.127	0.054	0.352	0.411
1	0.39	0.311	0.712	0.35	0.147	0.066	0.192	0.035	0.435	0.371
2	0.227	0.385	0.753	0.423	0.133	0.027	0.204	0.119	0.493	0.398
3	0.242	0.418	0.821	0.473	0.199	0.033	0.142	0.033	0.396	0.395
Total	0.273	0.408	0.795	0.467	0.154	0.045	0.144	0.059	0.404	0.393

Table A7-9. Average chum PSC rate for the 3 days before and after Chum RHS closure periods beginning in June-August, Individual Years, 2003-2011

	Year									
Days Before/ After VRHS	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
-3	0.15	0.379	0.89	0.536	0.096	0.025	0.104	0.057	0.39	0.38
-2	0.176	0.359	0.794	0.57	0.107	0.036	0.094	0.055	0.34	0.357
-1	0.12	0.48	0.832	0.575	0.167	0.04	0.122	0.053	0.358	0.393
1	0.093	0.275	0.695	0.369	0.113	0.06	0.188	0.032	0.425	0.325
2	0.095	0.312	0.676	0.461	0.08	0.018	0.199	0.038	0.38	0.33
3	0.139	0.322	0.811	0.527	0.107	0.021	0.122	0.03	0.306	0.342
Total	0.128	0.353	0.782	0.504	0.112	0.033	0.138	0.044	0.368	0.354

The results of this section suggest that RHS Program has led chum PSC reduction in the periods from before to after the closures.

A7.4.2 Pre-RHS Examination of Chum PSC from 1993-2000

A major challenge of this evaluation is, of course, that it is unclear what levels of chum PSC would have occurred if there had been no RHS closures in place. From 2001-2010, one can observe how rates change around closures but it's impossible to observe how PSC behaves without the presence of closures. Therefore, to better understand chum PSC without closures the analysis examines the years from 1993-2000, prior to implementation of voluntary closures.

Figure 5-86 displays annual PSC catch 1993-2000 and Figure 5-87 shows the daily variation in Chum PSC from 1991-2002. The simulation concentrates on 1993-2000 because the hotspot program began in 2001.

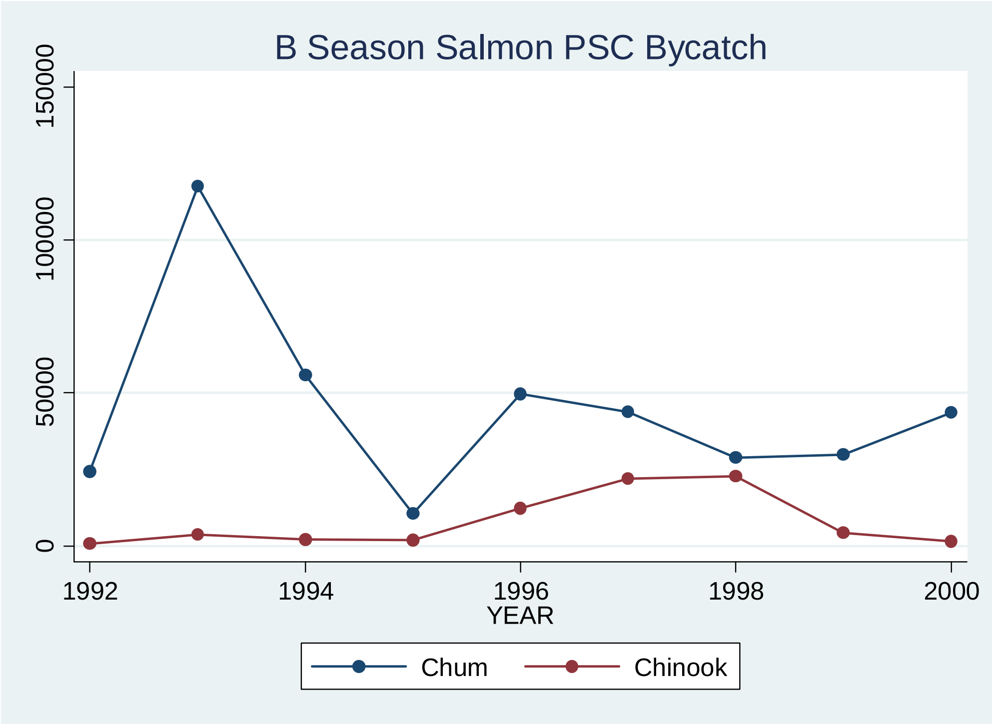


Figure A7-5. Salmon PSC catch by Bering sea pollock fishery, 1992-2000.

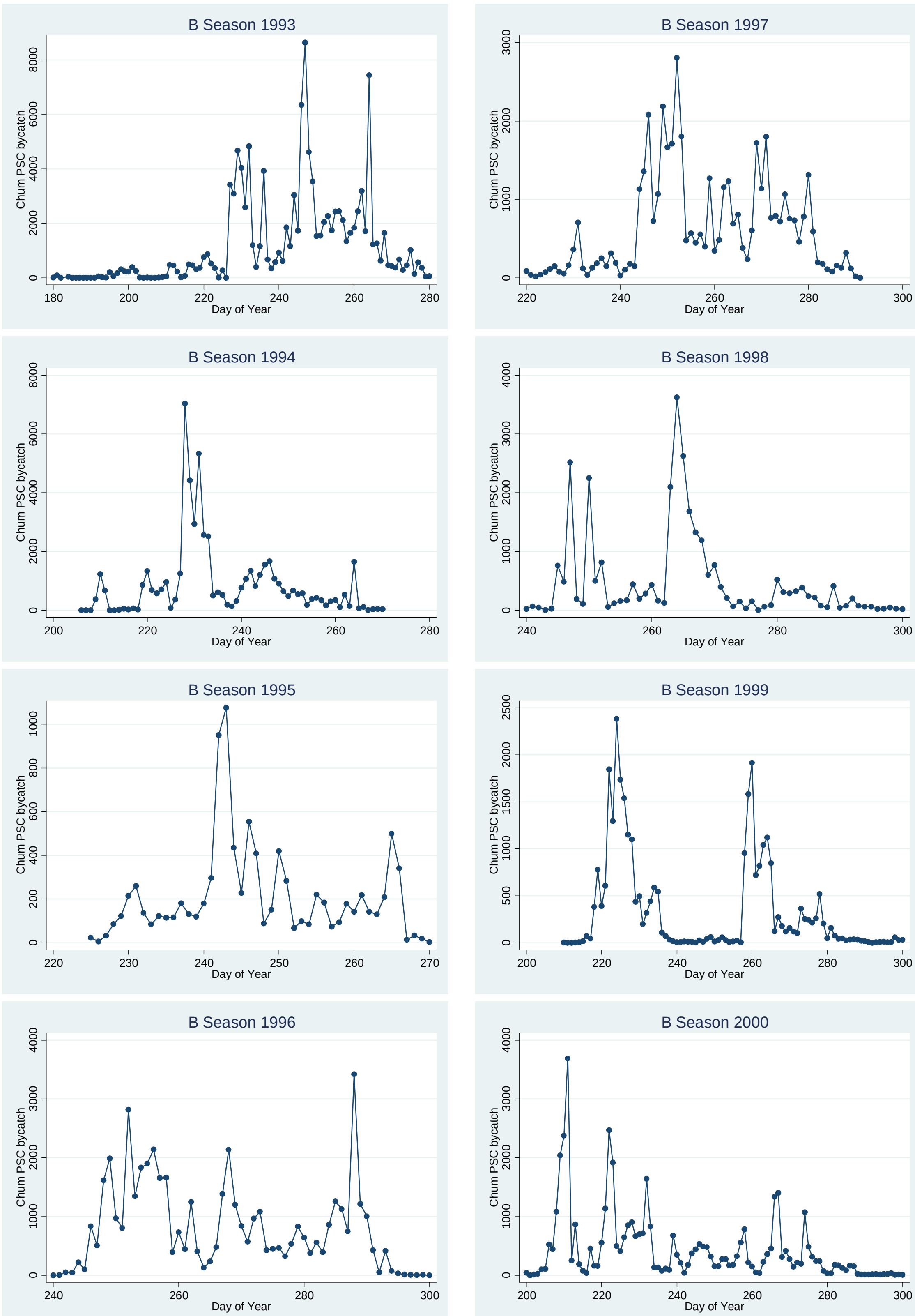


Figure A7-6. Daily chum salmon PSC in the Bering Sea pollock fishery, 1993-2000.

A7.4.2.1 Simulation of hotspot closures from 1993-2000

Hypothetical closures were imposed on the observed fishery data from 1993-2000 using rules similar to the current RHS procedures. The advantage of using data from this period is that they are unaffected by closures. This complements the information gained from examining the current RHS system because reactions to actual closures were observed and a statistically significant reduction in chum PSC following the closures were apparent. Analysis of the earlier pre-RHS system allows estimation of season-long impacts of hypothetical RHS-like closures. So as to limit confusion with the existing RHS system, the model of the RHS closure applied to the earlier data will be referred to as the PRHS system (for pre-RHS or pseudo-RHS system).

The PRHS hotspot simulation method required developing a model that attempted to mimic the current RHS system while at the same time provided opportunities to evaluate alternative parameters including:

- The number of ADF&G statistical areas that are closed
- The number of days that closures are imposed at a time
- The threshold or "base" rate that triggers closures
- The proportion of pollock that must be in an area for it to warrant closure
- The number of days used to decide on which area(s) should be closed. SeaState flexibly adjusts this parameter but several were considered to examine sensitivity.
- The "information lag" between when information is available and when closures are imposed. This allows for the assessment of whether delays in information impact closure effectiveness.
- The day that closures are imposed (3 different days at start of season). Averaging over 3 starting days provides information about the uncertainty involved in the timing of closures, because closures can appear to do better or worse depending on how they fall relative to really large PSC events.

Three model configurations (which were averaged over a range of parameters) were labeled as "baseline," "high end," and "low end" (Table 5-62). The baseline PRHS configuration was intended to be most comparable to RHS program and the other configurations are included for sensitivity. Allowing the day that the first closures are implemented to vary provides some stochasticity in the application and reduces the chance that random high-bycatch days occurring before or after a closure do not drive the estimated effectiveness of the closures.

The logic behind choosing the sets of PRHS control parameters was as follows:

Statistical areas closed: 1-2 chum areas are designated in the real RHS, but the areas are more targeted and typically smaller than these closures.

Days of closures: 3, 7, and 12 day closures are considered. The RHS closures are put in place for 3 days and most commonly extended, but then are occasionally extended for 1-3 additional weeks if they appear to be effective.

Base rate: variations in the base are evaluated below, but the models average over base rates of 0.06 and 0.19.

Information Lag: Sea State reports are issued approximately 1 ¼ days before they go into effect, so information is always that old, but is typically longer given the delays in reporting of shore-based deliveries.

Days to use in decision: the choices here provide some variety in the information used in implementing the closures.

Starting day: this shifts when closures start by 0, 1, or 2 days (averaged over the random possibilities of when closures begin).

Table A7-10. Description of baseline, high-end, and low-end models to evaluate the RHS for the period 1993-2000.

	Model 1	Model 2	Model 3
Model Name	Baseline	High-end	Low-end
Stat Areas closed	1 or 2	2	1
Days of closures	3 or 7	3	3 or 7 or 12
Base rate	0.06, 0.19	0.06, 0.19	0.19
Min pollock proportion	0.02	0.02	0.02
Information lag	2 or 3	2	3
Days to use in decision	3, 4, 5	3, 4, 5	3,4,5
Starting day	0, 1, 2	0, 1, 2	0,1,2
# of Closures per year (Avg)	16.7	23.7	11.6
Parameter combinations	192	36	24

A7.4.2.2 Pre-RHS hotspot simulation results

Results are presented around a number of questions of interest for each suite of control parameters listed in Table 5-62.

Do these hotspot closure reduce chum PSC?

For the wide range of closure variables presented here, the net impact of almost any combination of closures is some average reduction in chum PSC. The annual and total average reduction in chum PSC resulting from the high, baseline, and low impact models are displayed in Table 5-63. The baseline model estimates 14.5 percent of chum would have been avoided with a RHS-like system in place from 1993-2000. The annual variation in average benefits is 4-28 percent, though in some PRHS configurations, the annual benefits may be close to zero or larger than the averages. Results indicate that the hypothetical PRHS system would have reduced chum PSC.

How much pollock is moved by the hotspot closures?

Table 5-64 displays the average amount of pollock relocated per year under the three different models. Under the different models, 4-10 percent of pollock would have been relocated in the historical RHS simulation.

How do the hotspot closures impact Chinook PSC?

On average, there is considerable savings in the historical simulations in Chinook PSC from an effort targeting chum PSC. During 1993-2000, targeting chum alone in designating hotspot closures appears to significantly reduce Chinook bycatch as well, with the baseline model estimating a 10 percent reduction. The average annual Chinook PSC was much lower from 1993-2000 than from 2003-2010 (Figure 5-86). It’s hard to know how this is likely to affect Chinook reduction in years like 2007, though it is notable that the average reductions in Chinook from hypothetical PRHS closures are actually greater in the highest years (1996-1998) of the early period.

How does closure size impact average chum PSC reduction?

For the baseline PRHS configuration, more chum PSC are avoided with larger closures (Table 5-66 and Figure 5-88). However, as the number of closures exceeds three statistical areas, the benefits diminish while the amount of pollock relocated continues to increase. Also, with large closure areas uncertainty on how vessel operators will react increases.

Table A7-11. Percent chum reduced per year with different with different PRHS configurations, 1993-2000.

	Baseline		High-end		Low-end	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1993	0.147	0.062	0.237	0.028	0.087	0.04
1994	0.132	0.053	0.206	0.044	0.104	0.044
1995	0.044	0.025	0.048	0.025	0.043	0.035
1996	0.147	0.116	0.238	0.049	0.076	0.052
1997	0.133	0.049	0.172	0.024	0.085	0.027
1998	0.123	0.071	0.198	0.032	0.069	0.045
1999	0.159	0.06	0.245	0.063	0.077	0.056
2000	0.277	0.098	0.404	0.045	0.167	0.091
Total	14.5%	0.093	21.9%	0.101	8.9%	0.062

Table A7-12. Percent pollock reallocated per year with different with different PRHS configurations, 1993-2000

	Baseline		High-end		Low-end	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1993	0.081	0.034	0.122	0.013	0.054	0.02
1994	0.088	0.046	0.128	0.02	0.065	0.039
1995	0.039	0.02	0.043	0.019	0.035	0.027
1996	0.066	0.029	0.095	0.009	0.04	0.013
1997	0.087	0.043	0.127	0.018	0.048	0.021
1998	0.063	0.026	0.081	0.017	0.039	0.016
1999	0.038	0.022	0.058	0.025	0.013	0.006
2000	0.09	0.04	0.124	0.04	0.048	0.022
Total	6.9%	0.039	9.7%	0.038	4.3%	0.026

Table A7-13. Proportion of Chinook PSC reduced per year with different PRHS configurations, 1993-2000.

	Baseline		High-end		Low-end	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1993	0.059	0.042	0.104	0.026	0.029	0.02
1994	0.115	0.054	0.156	0.026	0.083	0.053
1995	0.029	0.027	0.041	0.03	0.007	0.007
1996	0.144	0.092	0.214	0.022	0.077	0.033
1997	0.109	0.054	0.17	0.039	0.062	0.035
1998	0.125	0.043	0.169	0.034	0.094	0.035
1999	0.11	0.054	0.138	0.056	0.065	0.024
2000	0.075	0.045	0.096	0.051	0.033	0.024
Total	9.6%	0.065	13.6%	0.062	5.6%	0.042

Table A7-14. Estimated annual chum PSC reduction from different size hotspot closures under the baseline PRHS system, 1993-2000.

Avg. % Chum reduced per year

	Maximum number of area(s) closed						
Year	1	2	3	4	5	6	7
1993	0.105	0.188	0.249	0.279	0.303	0.32	0.328
1994	0.089	0.162	0.215	0.226	0.24	0.255	0.259
1995	0.037	0.053	0.069	0.076	0.082	0.084	0.088
1996	0.098	0.281	0.379	0.442	0.472	0.49	0.494
1997	0.047	0.139	0.199	0.228	0.263	0.296	0.315
1998	0.075	0.152	0.187	0.202	0.21	0.217	0.22
1999	0.134	0.182	0.219	0.241	0.25	0.252	0.252
2000	0.246	0.308	0.33	0.349	0.356	0.357	0.358
Total	10%	18%	23%	26%	27%	28%	29%

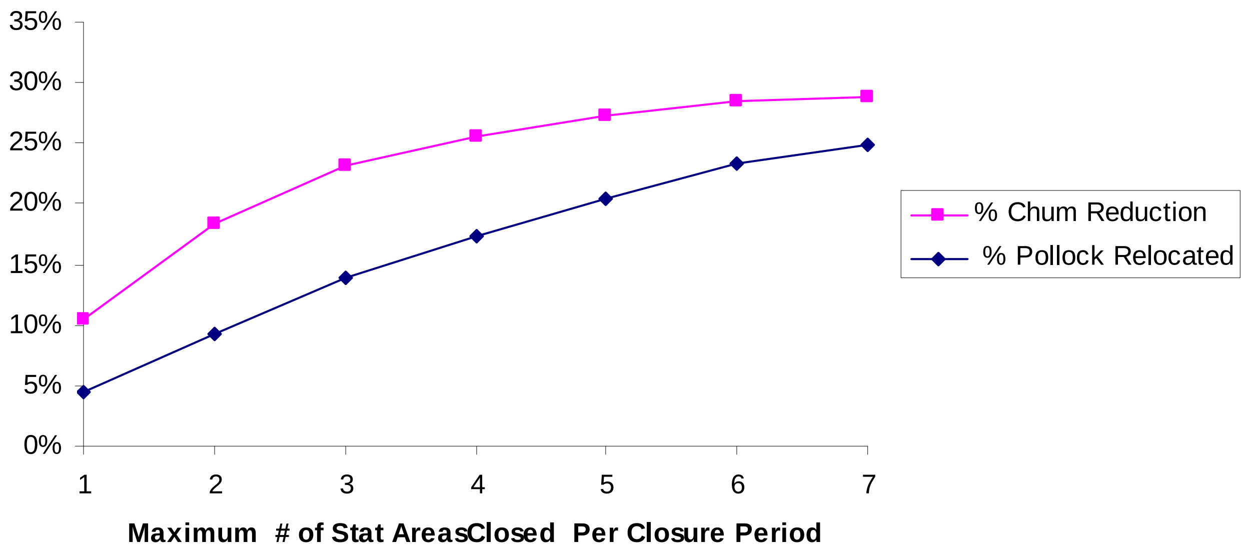


Figure A7-7. Percentage reduction in Chum bycatch and pollock reallocated with different sized closures.

How does the base rate–the minimum chum PSC necessary to trigger a closure–impact the PSC?
The baseline PRHS uses base rates of 0.06 and 0.19 chum/t but the model setup allows examining how average PSC changes under different base rates (Table 5-67**)**. Under the larger of the base rates examined, it is less likely to be in place when large PSC events occur.[46] Interestingly though, low base rates can at times cause more chum to be caught, as is shown for 1996 (Table 5-67). The lower reduction in this case occurs because closures are put in place that end up diverting vessels away from relatively low-PSC fishing. A super low base rate also adds costs through unnecessary reallocation of pollock effort.

[46] One caveat to note about the base rates here is that they are base on the recent window of data considered (which varies from 2-5 days), rather than the 3 weeks before.

Table A7-15. Average simulated chum PSC reductions for different base rates, for the baseline PRHS configuration, 1993-2000. Note that the base rate displayed is for the 2-5 day reference period of the model (not the 3-week window or the fixed annual level that has been features of the Sea State model).

	Base Rate (short-term)						
Year	0.01	0.02	0.06	0.12	0.19	0.3	0.4
1993	0.147	0.147	0.147	0.146	0.146	0.136	0.135
1994	0.13	0.132	0.124	0.128	0.128	0.128	0.125
1995	0.087	0.069	0.051	0.044	0.029	0.027	0.017
1996	0.034	0.022	0.165	0.16	0.156	0.144	0.111
1997	0.104	0.104	0.104	0.103	0.099	0.095	0.085
1998	0.116	0.116	0.114	0.114	0.104	0.083	0.077
1999	0.198	0.197	0.168	0.157	0.143	0.128	0.124
2000	0.304	0.304	0.296	0.28	0.258	0.214	0.176
Total	0.140	0.136	0.146	0.141	0.133	0.119	0.106

Is the minimum pollock requirement (2 percent of recent pollock) reasonable?
Under the assumptions of this historical analysis, there is little impact from this choice with minimum pollock from 1-5 percent. Greater or less than this however, is considerably less effective.

How does a time lag in using data to implement closures impact closure effectiveness?
In order to choose which area(s) to close, recent data on bycatch are utilized. Sea State announces closures approximately 30 hours before they are put in place and there is typically a delay on inshore delivery information that can be several days, though there can also be instant communication between vessel operators and SeaState when vessel operators report observing many salmon being caught (K. Haflinger, pers. com.). The baseline model averages the results between a 2- and 3-day information lags, while the high-end model assumes a 2-day lag and the low-end assumes a 3-day lag. Figure A7-8 illustrates how the effectiveness of closures declines in a near-linear fashion as the information delay in information gets larger.

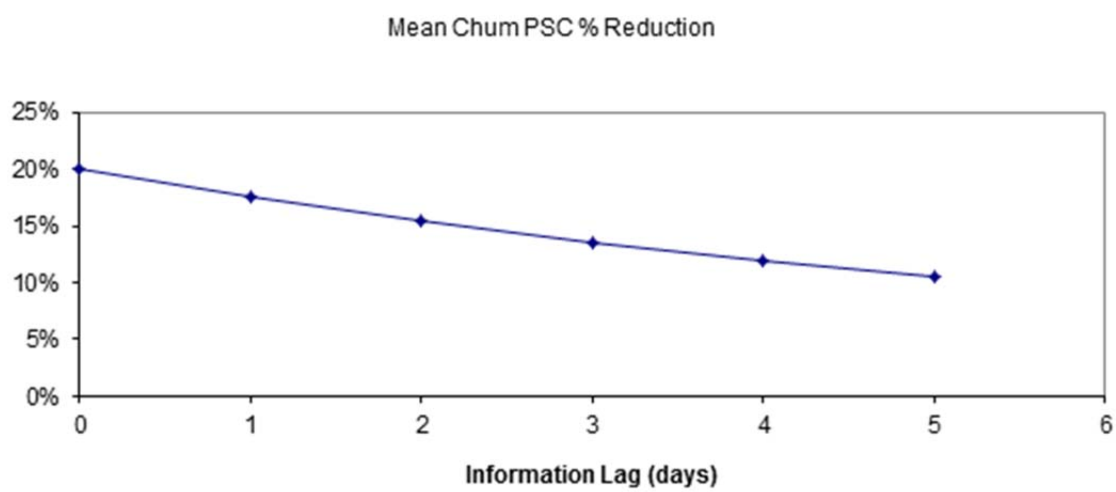


Figure A7-8. Impact on chum PSC reduction efficacy of a lag in information in implementing closures

A7.4.2.3 Discussion and caveats related to the PRHS analysis

Several issues are worth noting about factors that potentially influence the estimated salmon reduction upwards, downwards, or in an unknown direction.

Features that have an unknown impact on the reduction estimates:

- *The smaller, targeted nature of the RHS closures.* On the one hand, the smaller closures can target hotspots that cross multiple statistical areas, but smaller areas are also closed in the current RHS system. .
- *AFA.* While this period was primarily before the American Fisheries Act (AFA), the daily bycatch variation in the fishery does not appear to have changed significantly. The RHS was only possible with intercooperative agreements (ICAs) after the AFA, but the impact on fishing behavior is unclear. The AFA allows vessels to travel further in search of more valuable fishing without losing a share of the total catch, but this has the potential to influence closure effectiveness in either direction.
- *The Steller Sea Lion Conservation Area (SCA Emergency Closure in 2000*. The highest reduction in the analysis occurred in this year, which catcher vessel effort was reallocated for much of this year.
- *Average Chinook and Chum PSC levels were much higher from 2003*-2011 than in the previous decade.

Features that could lead to an understatement of estimates of hotspot reductions:

- Sea State balances available information, historical experience, and predictions about how salmon are likely to move to implement closures, while these historical RHS-like closures uses a window of information in recent days to design closures.
- Unmeasured bycatch may occur because vessels may plan to start fishing outside of a RHS closure after it is announced, which is not accounted for in the historical RHS simulations.

Features that could lead to an overstatement of estimates of hotspot reductions:

- Bycatch rates are assumed to be the daily average rate for the sector on each day of relocation. Examining the bycatch rates from 2003-2011 of vessels that are moved out of RHS closures, they have higher than average rates. However, for CVs, an unknown portion of this increase is due to how salmon from a trip that starts and ends after a closure are divided between all hauls of a trip, so some portion of this different may be due to accounting.
- The areas closed by the simulation can be much larger at times than the RHS closures, especially when two high bycatch areas are closed in core catcher vessels fishing areas. The “low-end” estimate only closes one area to attempt to account for this.

A7.4.3 Vessel-level post-closure PSC changes

Assessing the effectiveness of the hotspot system based on subsequent bycatch rates of vessels that are forced from extremely high chum PSC areas has the potential to be misleading. Because bycatch has a random component that can be very large, one would expect to observe a “reversion to the mean” from extreme bycatch values in the data. Attributing all of the change from one period to the next when a closure is put in place following a high-PSC event may overstate the impact of the closure, because a closure by definition focuses on high-value hauls that at some point must come down. A visual examination of day-by-day PSC rates makes this point very clearly – the days with the highest PSC rates are typically much higher than even the days immediately before and afterward.

While the above measures account for the observed changes in PSC resulting from the RHS closures, closing an area also makes it unavailable to other vessels, so there is the potential for additional PSC to be avoided beyond the impact on the vessels that were fishing in an area prior to it being closed. The historical simulation attempts to capture these impacts.

One insight into the impacts of RHS closures comes from examining the PSC rates after the closures are put in place for vessels that were in closures before they were implemented. In the historical simulations and in the design of trigger closures, we assume that vessels reallocate effort proportional to their sector and receive the average bycatch. However, the an examination of data from 2003-2010 table suggests that the chum PSC rates are actually considerably higher than average, with the rate for catcher vessels being 1.5 times higher and the rate for the other sectors being 2.2 times hgher.

Does the effectiveness of RHS closures differ at high or low levels of PSC encounters?

To provide insight into how bycatch changes from high to low conditions, here we examine the high chum bycatch year of 2005 in contrast with other years through 2010. An examination of the chum incidence rate and bycatch for all years for the shoreside, catcher/processor, and mothership sectors of the fishery is informative. The incidence rate is the proportion of time that there is any chum salmon in a haul/trip. [47] For example, an incidence rate of 0.95 means that 95% of the hauls/trips in the month encountered chum PSC. As shown in the table below, the incidence rate in 2005 for the shoreside sector remained near 1 for almost 2 months. During this time, it was extremely difficult to impossible to completely avoid chum salmon bycatch.

Table A7-16. Chum Salmon Incidence and bycatch by week and year for shoreside CVs, 2003-2010

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

Vessels caught more chum more frequently and in greater numbers, on average, though the relationship between incidence and bycatch reveals that higher incidence does not always equate to higher total bycatch. Table 5-70 shows incidence and bycatch information for the CP/MS sectors.

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

Table A7-17. Chum salmon Incidence and bycatch by Week & Year for CPs and Motherships, 2003-2010

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

For the CP/MS sectors, incidence rates were also elevated for a long period of 2005. In contrast to 2005, most other years show reduced chum bycatch incidence rates, with the maximum incidence rate being approximately 0.7 in both 2008 and 2010. For CPs and motherships, chum incidence is less than 10 percent for many weeks in 2008.

How do 2003-2010 Chinook and chum PSC closures interact?

The pre-RHS historical simulation analysis suggests that targeting Chinook and chum reduction is in general complementary. Here we focus upon 2003-2010 and discuss the interaction of some of the Amendment 91 and chum PSC measures below.

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

On the other hand, there are times when there are areas that have elevated levels of both species in the same locations, so closing an area is expected to reduce both chum and Chinook. For example, in mid-August 2006, a closure was put in place for 4 days as a Chinook closure but was later extended as a chum closure.

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

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

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

Observable economic impacts of the RHS closures

In some cases vessels are forced to take longer trips as a result of closures, resulting in additional travel costs. Following data collection efforts from Amendment 91 that will begin in 2012 and 2013, there will be cost information available to estimate these costs but currently we do not know vessel fuel costs. There are times when SeaState reports note that catcher vessels will make large shifts to the north when closures are imposed in the south (East of 168), but it is difficult to measure how frequently this is due to SeaState closures as these shifts happen to different degrees with or without closures.

We examine the changes in CPUE for the periods 1-3 days before and after the RHS closures. Because observed catch rate are not zero but are not normal, we log-transfom CPUE data run a linear regression on a constant and vessel- and closure-level controls. There is no reduction in haul-level CPUE from the 1-3 days before RHS closures are implemented to the 1-3 days after.

There is also the potential for economic losses when vessels are forced off of areas where higher value products are produced. This is likely to be a more dramatic impact in the A-season fishery because of the high value of roe, but product-specific targeting and the amount of roe caught in the B-season has increased so that there can be meaningful differences in the value of fishing in one area versus another beyond what's captured in CPUE. With anecdotal input from vessel operators of specific closures inducing movement off of high-value fishing areas, it would be possible to make estimates of these impacts (subject to the limitations of having only annual price and product quality information). Additionally at times, travel costs may increase significantly with closures, especially for some catcher vessels and at time when it is difficult to locate pollock close to port.

What is the impact of limits of the maximum RHS closure size on the effectiveness of the chum bycatch hotspot system? While the size/number limit on RHS closures that can be put in place at any time prevents SeaState from closing a larger part of the grounds that might be effective in reducing bycatch, this limitation also reduces the impact of closures on the fishery and prevents "surprises" from sending people to search for pollock in areas that either are known to have high bycatch or that have an unknown amount of bycatch. The impact of closure size is explored in the pre-RHS analysis.

Examination of 100 percent impact on 2011 bycatch rates

A number of elements of the fishery changed in 2011 with Amendment 91 protections being imposed to reduce Chinook PSC. One significant change in the fishery is that all vessels have 100 percent observer coverage. **An examination of the expanded coverage indicates that this was not a significant factor in 2011 being a relatively high bycatch year.**

The percentage of observed hauls by vessels <125 feet in length increased significantly to 53 percent of total hauls in B-season 2011 versus 30-37 percent in 2003 to 2010. However, there is no correlation from 2003-2010 between the percentage of covered trips and the observed bycatch rate. The observed chum PSC rates during this period were almost identical, while the "raised rates" – the total PSC including extrapolation, were on average 19 percent higher for the partial coverage vessels, but showed significant variation among years. In 2011, chum PSC rates were 25 higher for the 30 percent coverage vessels, statistically indistiguisable from the raised rates in the former years.

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

Following the Amendment 84 analysis, an examination of the bycatch rates in and out of the CSSA indicates that chum bycatch rates are generally higher outside of the CSSA than inside.

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

Table A7-18. Dates when Chum Salmon Savings Area (CSSA) was closed to non-CDQ Fishing

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

For 2005, most of the PSC in the CVOA that would trigger a closure of the CSSA occurred for the week of 10/8, so by the time the Region had the PSC information to trigger the closure, it was 10/14 and the closure could not be triggered (Mary Furuness, pers. comm.).

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

Table A7-19. Chum salmon PSC rates by Month & Year, In and Out of the Chum SSA, 2003-2009

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

A7.4.3.1 What is the likely interaction of status quo chum measures with Amendment 91 and IPAs?

Figure A7-9 displays one aspect of the Amendment 91 IPA that applies to the CP/MS/CDQ sectors – the implementation of a B-Season "Chinook Conservation Area." As indicated in the figure, the area will be closed from October 15-31 when the Chinook salmon PSC rate in September exceeds 0.015 salmon per metric ton of pollock.

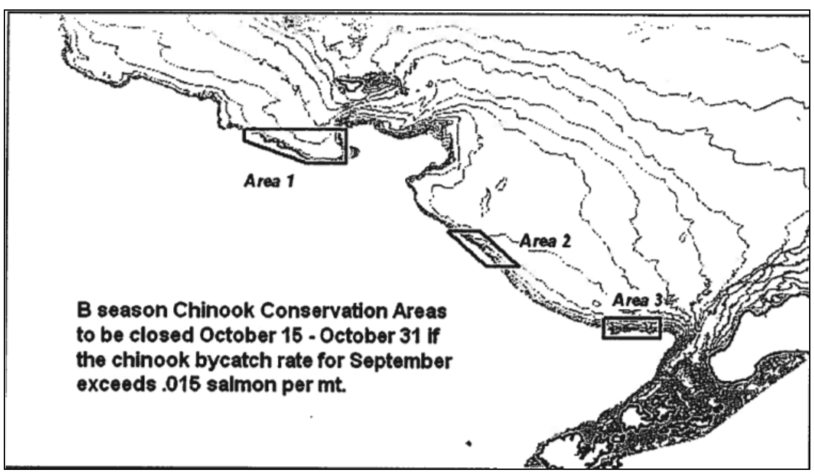


Figure A7-9. 2011 Amendment 91 IPA B Season Chinook Conservation Area

For the purposes of this chum PSC analysis, the relevant question is how high chum PSC is in these areas and whether the areas move people to areas with higher or lower chum PSC. The following table displays the chum PSC rates in and out of the B season Chinook Conservation Areas for 2003-2010.

Table A7-20. Number of hauls, Chum, and Chinook inside and outside the Amendment 91 B-Season Chinook Conservation Area by Sector and Year, 2003-2010

Sector	In BCCA?	Year	Hauls	ChumNum	ChinNum	Pollock (t)	ChumRate	ChinRate
CP/MS		2003	47	95	233	2,079	0.05	0.11
CP/MS	Yes	2004	8	758	79	76	9.94	1.03
CP/MS		2004	59	1,592	501	2,944	0.54	0.17
CP/MS		2005	51	297	39	3,374	0.09	0.01
CP/MS		2006	181	153	203	9,411	0.02	0.02
CP/MS	Yes	2007	30	14	633	1,131	0.013	0.56
CP/MS		2007	468	529	2,797	26,523	0.020	0.11
CP/MS		2008	201	28	91	8,872	0.00	0.01
CP/MS		2010	22	53	458	1,020	0.05	0.00

These results suggest that there is little evidence to suggest the BCCA is likely to have a significant impact on chum PSC. For the two years where fishing occurred in the BCCA, there was considerably higher PSC in the area in 2004 but only 8 hauls. In 2007, there was slightly lower PSC in the area. Most years there was no fishing in this area during the closure period.

A7.4.3.2 The Vessel Performance List

An additional aspect connected to the RHS system is the publication to the fleet of a list of vessels with high PSC rates which is regularly published in SeaState reports. The list is called the “vessel performance” list but was previously called the “Dirty 20” list. There is no financial penalty to being on the list, but vessel operators have reported that there are social pressures connected to being on the list. According to conversations with several vessel captains, captains will give other captains a hard time for being on the list and one person regularly on the list expressed feeling very bad about it. The list has been refined over time so that both seasonal and recent activity list are published in SeaState reports for both Chinook and non-Chinook salmon. It is difficult to assess how much of a difference the list has made, but it provides transparency to the fleet about who is and is not avoiding PSC and establishes a social norm in which vessels are publicly labeled as “dirty” for having high salmon PSC.

A7.4.3.3 Summary of Findings on Status Quo Chum PSC-reduction measures

Collectively, the Chinook and chum salmon PSC measures implemented through the RHS system and Amendment 91 arguably represent the most extensive bycatch reduction efforts that have been undertaken. In this analysis, we concentrate on the RHS components of the chum reduction measures. A number of relevant findings are summarized below.

Key findings of the status quo current-period and historical analysis include:

- Chum PSC has been reduced by the chum RHS program. Looking at the change in rates following the RHS closures, the reduction is several percent, but this number is larger after controlling for vessel and closure-specific effects. The reduction in chum PSC is also larger in the June-August period than in the B-season as a whole. However, in 2011, there was not an observable average chum PSC reduction from the RHS program.
- From 2003-2011, chum PSC rates for the entire B-season in the 1-3 days following RHS closures are approximately 9 percent lower than in the 1-3 days before, after controlling for vessel- and closure-specific variation. For June-August, this average PSC reduction was 15 percent.
- Evaluating the 1993-2000 period, an RHS-like system would have reduced chum PSC by an estimated 9-22 percent on average with about 4-10% percent of pollock fishing have been relocated to other areas.
- The current period RHS analysis provides an estimate of the impact soon after the closures, but it does not account for some reduction that may occur when closures are left in place for a long

period of time. However, closures are typically left in for long periods in times of relatively low chum PSC, so the majority of chum typically occurs in periods when closures are moved to address new hotspots. Further, the reduction farther away from the closures is likely to be less substantial, as the closures will usually have less impact on fishing choices as the fleet readjusts. So it is reasonable in light of these analyses, including the historical simulations, to estimate that the total chum PSC reduction to be in the range of 10-15 percent.

- Annual average share of chum PSC *caught in the* closures in the 5-days before closures were imposed from 2003-2011 ranged from 11-36 percent for CVs and from 2-32 percent for other sectors, with the majority of years being in the upper end of this range for CVs. The average percentage of pollock range caught in the closures areas during this period ranged from 7-21 percent for CVs and was 6 percent or less for the other sectors.
- The pre-RHS analysis suggest that often 'what's good for chum is good for Chinook' with the range of Chinook PSC savings as 6-14 percent per year when areas are closed because of high chum rates only.
- Based on 1993-2000 data, increasing the number of closures always reduces salmon PSC more, but at the cost of reallocating additional pollock effort per unit of PSC avoided.
- Closures based on the most recent information possible lead to larger average reductions and moderately small base rates appear on average to be more effective. At a very low PSC level, closures do not appear to be effective.
- The current "tier system" of the RHS program allows cooperatives with low PSC relative to the base rate to fish inside closed areas. This could provide some incentive for cooperatives to have lower chum PSC rates in order to be able to fish in closed areas, though these vessels often choose to fish elsewhere regardless of tier status. *During closure periods, 4.6 percent of CV pollock and 0.3 percent of pollock by the other sectors was taken inside the closure areas.* Thus there is little evidence that the incentives within the current tier system are likely to provide strong motivation for chum PSC reduction.
- An examination of the chum PSC rates in the chum Salmon Savings Area (SSA) indicates that in over 90 percent of months from 2003-2010, chum PSC rates were *lower* in the Chum SSA than outside of it, suggesting that a trigger closure of this area could be actually increase chum PSC.
- An evaluation of the B-season Chinook Conservation Area (BCCA) which is imposed by the CP/MS/CDQ incentive plan agreement (IPA) suggests that there is little evidence to suggest the BCCA is likely to have a significant impact on chum PSC rates.
- In 2011, chum RHS closures were in place throughout the B season, whereas in previous years Chinook closures were explicitly given regulatory priority. Additionally, in 2011 all vessels had 100 percent coverage and salmon was censused in the plant. This did not lead to greater chum reduction.
- As well as changing Chinook-avoidance incentives, Amendment 91 also changes the incentive to avoid Chinook *relative* to chum – vessels do not pay an individual cost of chum, but do for Chinook – therefore vessels will be likely to choose to fish in high chum grounds with zero Chinook over low chum grounds with any Chinook in them.

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

- Sea State has shown the ability to make trade-offs between chum and Chinook PSC and to consider how vessels will respond.
- Adjustments to what areas will be closed can be made regularly in response to the substantial inter-annual variability in the quantity and concentration of PSC. This prevents the possibility that

fixed closures would consistently force vessels from low-PSC areas, which is a possibility with any system that cannot adjust.

- Anecdotal information from vessel operators and plant managers can be combined with observer data, VMS data, and knowledge of how seasonal PSC conditions evolve to make well-informed predictions of where salmon PSC will occur in the near-term. For example, from the 8/27/07 SeaState report – "It would be particularly useful to know if there is a temperature front associated with higher or lower PSC, as there was further up on the shelf."

A7.5 Alternative 3 – Revised Rolling Hotspot (RHS) Exemption

A7.5.1 Revised Industry-designed non-Chinook RHS Program

The following discussion provides additional information about how closures impact the fishery in June.

Council Motion item: Increase chum salmon protection measures during June/July.
For example:

- Weekly threshold amounts that would trigger additional protection measures when bycatch is abnormally high;
- Initiate "Western Alaska chum core closure areas." These areas would trigger during abnormally high encounters of chums believed to be returning to Western Alaska river systems;

Description of measures: The new industry non-Chinook RHS proposal allows closures to target areas with high Western Alaska returns and June and July closures are more stringent, as discussed in the analysis below. There are no provisions in industry's revised RHS program for "Western Alaska core closure areas" or threshold amounts that would be triggered at higher levels.

Analysis: Under the new proposal, the first closure will be in place 8-15 days after the start of the season, depending on the day of the week that June 10 falls. As shown in Figure A7-3 in the status quo analysis, over the 2003-2011 period, closures have been in place for a significant number of days in June in 2005, 2006, and 2011. Closures were not implemented in other years because chum PSC rates were very low – for 2008-2010, for example, below 0.03 chum / MT. The analysis above suggests that these closures at this extremely low level would be unlikely to have any significant benefit.

While the June closures are mandatory and therefore apply to all vessels, little fishing occurred in closures in most years, as illustrated in the following table. The new closures do not have any incentive effect because they apply to all vessels regardless of rate; if any incentive affect exists now, this would be lost under the new closures.

Table A7-21. Fishing inside RHS closures that begain in June during the 5 days after closures were implemented, 2003-2011.

Year	CV	% Hauls In	# Hauls In	# Hauls Out	% Chum In	Chum In VRHS	Chum Out VRHS	Chum Rate In	Chum Rate Out	% Pollock In	Pollock In (MT)	Pollock Out (MT)	Chum PSC Rate Ratio In/Out
2005	CV	15.5%	26	142	9.9%	273	2,476	0.133	0.204	14.4%	2,048	12,150	0.65
2006	CV	0.7%	2	265	2.2%	620	27,984	2.929	1.326	1.0%	212	21,102	2.21
2011	CV	6.0%	37	579	5.3%	772	13,868	0.200	0.349	8.9%	3,859	39,695	0.57
2005	CP/MS /CDQ	0.3%	1	378	0.2%	6	2,889	0.141	0.091	0.1%	42	31,595	1.55
2006	CP/MS /CDQ	0.0%	0	395	0.0%	-	632		0.022	0.0%	-	28,453	*
2011	CP/MS /CDQ	7.6%	46	560	23.7%	2,423	7,786	0.746	0.183	7.1%	3,249	42,620	4.08
2003-11	CV	6.2%	65	986	3.6%	1,665	44,328	0.272	0.647	7.7%	6,119	72,947	0.42
Avg/ Total	CP/MS /CDQ	3.4%	47	1,333	17.7%	2,429	11,307	0.738	0.086	3.1%	3,292	102,668	8.57

The differences in the RHS tier structure by month are as follows under the new program is as follows. RHS closures that begin in late June apply to all vessels; July closures allow vessels with a chum bycatch rate <75 percent to fish in the closure for the first 4 days it is in place; in August and beyond, vessels with a chum bycatch rate <75 percent of the base rate are not subject to the closures, while Tier 2 vessels with a bycatch rate from 75-125 percent of the base rate would have to leave after 4 days, while Tier 3 vessels would be prohibited for fishing for the entire management week.

As in June, little fishing has occurred inside the closures in most years so the change in Tier structure is unlikely to have a significant impact on the efficacy of the closures. However, in June if the fishing that occurred were moved out of the closures and occurred at the average rate, it could result in some chum savings, as reflected below. Note that under the new tier system it is possible that a small amount of additional savings could occur in July, but the vast majority of fishing in the period after closures was by Tier 1 vessels (because under the status quoa Tier 2 vessels are prohibited from fishing in the closure for the first 4 days after the closures are in place).

Table A7-22. Potential chum PSC reduction from vessels being prohibited from fishing in RHS closures that began in in June, 2003-2011.

Year	Potential June Chum Reduction	% of June chum PSC	% Annual chum avoided
2005	(142)	-0.6%	-0.02%
2006	339	0.3%	0.11%
2011	1,253	2.9%	0.65%

An assumption for the above calculation is that vessels forced out of the areas would have had chum PSC equal to other vessel outside of the closures, which may or may not have been the case.