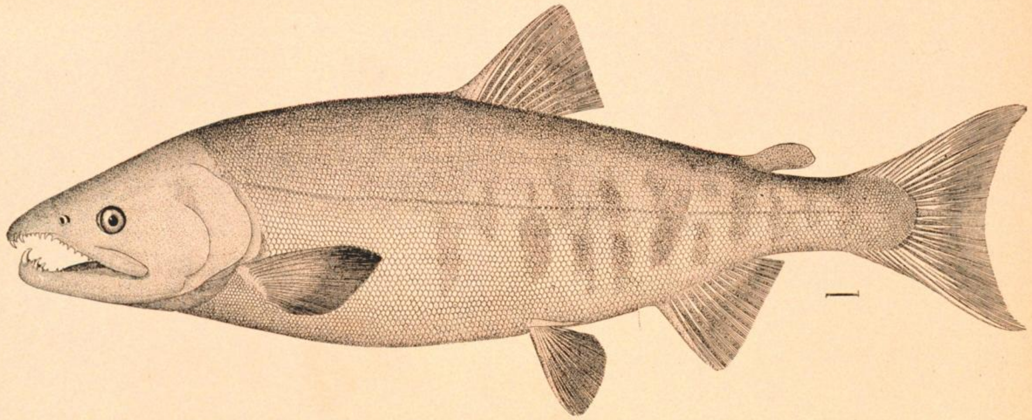
AGENDA C-5
JUNE 2011

Bering Sea Non-Chinook Salmon Bycatch Management

Initial Review Draft Environmental Assessment



THE KAYKO OR DOG SALMON.

Oncorhynchus keta (Walb.), Gill & Jordan. (p. 476.)

Drawing by H. L. Todd, from No. 27617, U. S. National Museum, collected at Fort Alexander, Cook's Inlet, Alaska, July 4, 1880, by J. Cohen.

PLATE 188 B.

North Pacific Fishery Management Council

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service, Alaska Region

May 2011

For more information contact:
Diana L. Stram
NPFMC
605 West 4th Ave
Anchorage, AK 99501
(907) 271-2809
diana.stram@noaa.gov

[blank page]

Executive Summary

This executive summary summarizes the draft Bering Sea Chum Salmon Bycatch Management Environmental Assessment (EA) and Regulatory Impact Review (RIR). The EA and RIR provide decision-makers and the public with an evaluation of the predicted environmental, social, and economic effects of alternative measures to minimize chum salmon bycatch in the Bering Sea pollock fishery.

The proposed action is to amend the Bering Sea Aleutian Islands groundfish fishery management plan (FMP) and federal regulations to establish new measures to reduce chum salmon bycatch in the Bering Sea pollock fishery to the extent practicable while achieving optimum yield. The proposed action is focused on the Bering Sea pollock fishery because this fishery catches the majority of the chum salmon taken incidentally as bycatch in the Bering Sea and Aleutian Islands (BSAI) groundfish fisheries. Since 2005 the pollock fishery contribution to the total non-Chinook bycatch has ranged from 88% in 2010 to 99.3% in 2005.

Any amendment to the FMP must comply with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and all other applicable federal laws. With respect to the Magnuson-Stevens Act, the amendment must be consistent with all ten national standards. The most relevant for this action are National Standard 9, which requires that conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch; and National Standard 1, which requires that conservation and management measures prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry. The Magnuson-Stevens Act defines optimum yield as the amount of harvest which will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems. Therefore, this action must minimize chum salmon bycatch in the Bering Sea pollock fishery to the extent practicable while achieving optimum yield. Minimizing chum salmon bycatch while achieving optimum yield is necessary to maintain a healthy marine ecosystem, ensure long-term conservation and abundance of chum salmon, provide maximum benefit to fishermen and communities that depend on chum salmon and pollock resources, and comply with the Magnuson-Stevens Act and other applicable federal law.

This EA examines four alternatives to reduce chum salmon bycatch in the Bering Sea pollock fishery. The EA evaluates the environmental consequences of each of these alternatives with respect to four resource categories:

- Pollock
- Chum salmon
- Chinook salmon
- Other Marine Resources including groundfish species, ecosystem component species, marine mammals, seabirds, essential fish habitat and marine ecosystem.

The RIR evaluates the social and economic consequences of the alternatives with respect to three major issues:

- economic impacts and net benefits to the Nation
- Alaska Native, non-native minority, and low income populations
- fisheries management and enforcement

Bering Sea Pollock Fishery

The pollock fishery in waters off Alaska is the largest U.S. fishery by volume. The economic character of the fishery derives from the products produced from pollock: roe (eggs), surimi, and fillet products. In

2008, the total value of pollock was an estimated $1.331 billion. This dropped to $1.030 billion in 2009. Table ES-1 shows the number of participating vessels in the Bering Sea pollock fishery and the pollock total allowable catch (TAC) in metric tons from 2003 to 2010.

Until 1998, the Bering Sea pollock fishery was managed as an open access fishery, commonly characterized as a “race for fish.” In October 1998, Congress enacted the American Fisheries Act (AFA) to rationalize the fishery by identifying the vessels and processors eligible to participate in the Bering Sea pollock fishery and allocating specific percentages of the Bering Sea directed pollock fishery TAC among the competing sectors of the fishery. Each year, NMFS apportions the pollock TAC among the inshore catcher vessel (CV) sector, offshore catcher/processor (CP) sector, and mothership sector after allocations are made to the Community Development Quota (CDQ) Program and incidental catch allowances.

The Bering Sea pollock TAC is divided into two seasons –the A season (January 20 to June 10) and the B season (June 10 to November 1). Typically, the fleet targets roe –bearing females in the A season and harvests the A season TAC by early April. The B season fishery focuses on pollock for filet and surimi markets and the fleet harvests most of the B season TAC in September and October.

The AFA also allowed for development of pollock fishing cooperatives. Ten such cooperatives were developed as a result of the AFA: seven inshore CV cooperatives, two offshore CP cooperatives, and one mothership cooperative. Catcher vessels in the inshore CV sector deliver pollock to shorebased processors. Catcher/processors harvest and process pollock on the same vessel. Catcher vessels in the mothership sector deliver pollock to motherships, which are processing vessels.

The CDQ Program was created to improve the social and economic conditions in coastal western Alaska communities by facilitating their economic participation in the BSAI fisheries, which had developed without significant participation from rural western Alaska communities. These fisheries, including the Bering Sea pollock fishery, are capital-intensive and require large investments in vessels, infrastructure, processing capacity, and specialized gear. The CDQ Program was developed to redistribute some of the BSAI fisheries’ economic benefits to adjacent communities by allocating a portion of commercially important fisheries to six groups representing those communities as fixed shares of groundfish, halibut, crab, and prohibited species catch. These allocations, in turn, provide an opportunity for residents of these communities to both participate in and benefit from the BSAI fisheries through revenues derived from the fisheries, employment, capital projects, and fisheries infrastructure. Currently, NMFS allocates 10 percent of the pollock TAC and 7.5 percent of the Bering Sea Chinook salmon prohibited species catch limit to the CDQ Program.

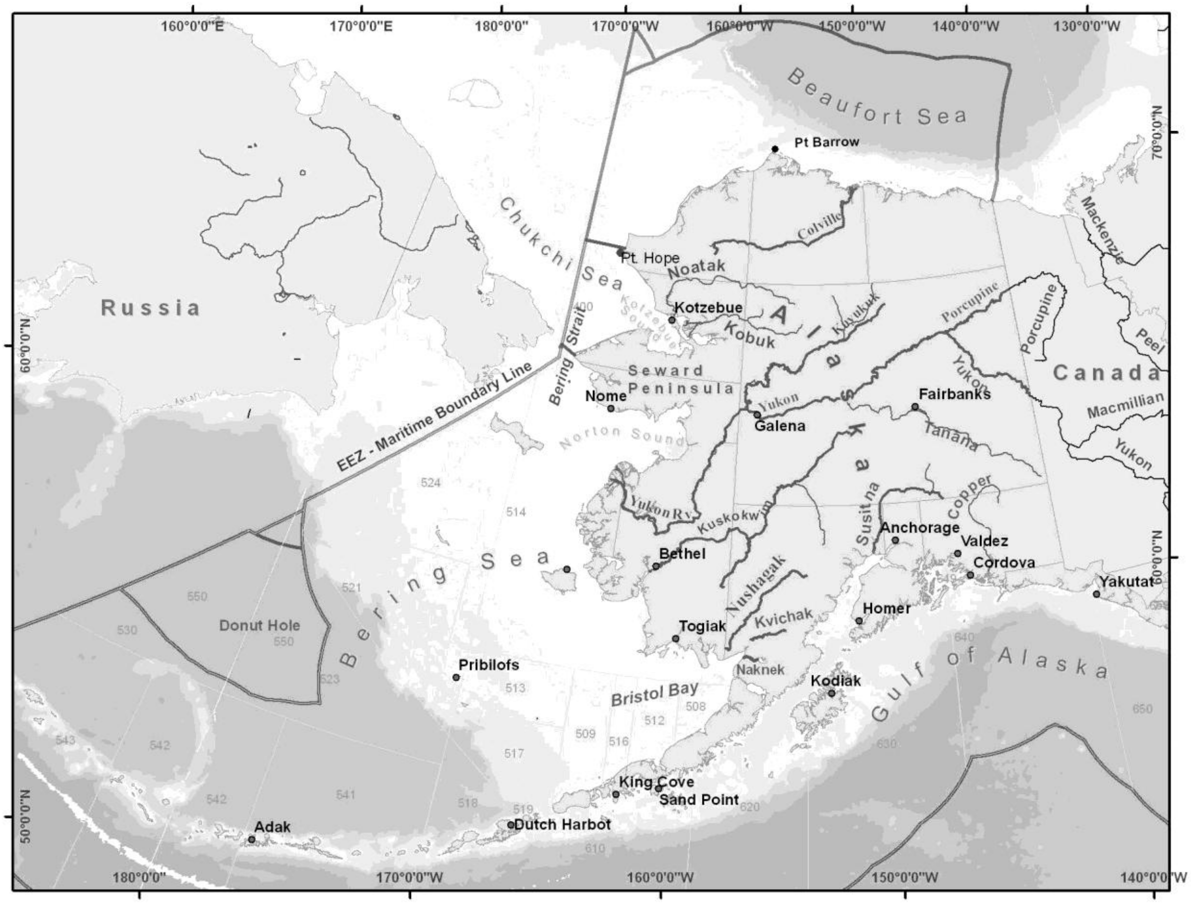


Figure ES-1 Map of the Bering Sea and major connected salmon producing rivers in Alaska and Northwest Canada

Salmon Bycatch in the Bering Sea Pollock Fishery

Pacific salmon are caught incidentally in the Bering Sea pollock fishery. Pollock is harvested with fishing vessels using trawl gear, which are large nets towed through the water. Salmon in the Bering Sea occur in the same locations and depths as pollock and are, therefore, caught in the nets as fishermen target pollock. Of the five species of Pacific salmon, Chinook salmon (*Oncorhynchus tshawytscha*) and chum salmon (*O. keta*) are caught most often in the pollock fishery. Chinook salmon is caught during both ‘A’ and ‘B’ seasons of the fishery while chum salmon are caught almost exclusively in the ‘B’ season.

Salmon are culturally, nutritionally, and economically significant to Alaska communities (see RIR Chapter 3). Salmon are fully allocated and used in subsistence, commercial, and recreational fisheries in and off Alaska and, in the case of Chinook and chum salmon, in Canada. Therefore, NMFS manages Chinook salmon and all other species of salmon (a category called non-Chinook salmon and here in this analysis summarized as ‘chum’ due to it being comprised of over 99% chum salmon) as prohibited species in the BSAI groundfish fisheries, including the Bering Sea pollock fishery. As a prohibited species, salmon must be avoided as bycatch, and any salmon caught must either be donated to the Prohibited Species Donation Program or be returned to the sea as soon as is practicable, with a minimum of injury, after an observer has determined the number of salmon and collected any scientific data or biological samples.

The Council took action in 2009 on management measures for Chinook salmon under the Amendment 91 Chinook salmon bycatch management program. The program imposes a dual cap system which is divided by sector and season. The program includes an annual 'high cap' of 60,000 fish and a lower cap of 47,591 fish. Annual bycatch is intended to remain below the lower cap to avoid penalty. Should any sector exceed its proportion of the lower cap 3 times in a rolling 7-year period, it would then be held to this lower cap only for all future years. In order to fish under the dual cap system (as opposed to solely the lower cap) sectors much participate in incentive program agreements (IPAs) that are approved by NMFS and are designed for further bycatch reduction and individual vessel accountability. This program was implemented in January 2011, thus the fishery has operated under the new program during the 'A' season thus far.

Several management measures have been used to reduce salmon bycatch in the Bering Sea pollock fishery. In the early-1990s, the Chum Salmon Savings Area was established as a large area closure in the Bering Sea in August and further closed when triggered by a cap of 42,000[1] non-Chinook salmon. The savings area was adopted based on areas of high historic observed salmon bycatch rates and designed to avoid areas and times of high salmon bycatch.

While chum salmon bycatch in the past few years has been declining, numbers reached an historical high in 2005 with approximately 705,000 fish taken as bycatch in the pollock fishery. Table ES-1 shows the number of chum salmon taken as bycatch from 2003 to 2010.

Table ES-1 The number of participating vessels in the Bering Sea pollock fishery, the pollock total allowable catch (TAC) in metric tons (t), and the number of non-Chinook (chum) salmon taken as bycatch from 2003 to 2010.[2]

Year	Number of pollock fishing vessels	Pollock TAC (t)	Non-Chinook (chum) salmon bycatch (numbers of fish)
2003	110	1,491,760	189,185
2004	113	1,492,000	440,459
2005	109	1,478,000	704,586
2006	105	1,487,756	309,644
2007	108	1,394,000	93,786
2008	108	1,000,000	15,142
2009	106	815,000	46,129
2010	104	813,000	13,306

The Council started considering revisions to existing chum salmon bycatch management measures in 2004 when information from the fishing fleet indicated that it was experiencing increases in chum salmon

---

[1] The Chum Salmon Savings Area is closed to pollock fishing from August 1 through August 31 of each year. Additionally, if the prohibited species catch limit of 42,000 non-Chinook salmon are caught by vessels using trawl gear in the Catcher Vessel Operational Area during the period August 15 through October 14, the Chum Salmon Savings Area remains closed to directed fishing for pollock for the remainder of the period September 1 through October 14. This limit is divided between with CDQ and combined non-CDQ fisheries.

[2] Non-Chinook (Chum) salmon bycatch is estimated using the NMFS Catch Accounting System (CAS). The CAS continually revises past bycatch estimates based on new information. Therefore, these numbers change slightly depending on when the analyst retrieved the data from the CAS. NMFS periodically revises the bycatch estimates and posts the most recent estimates on the NMFS Alaska Region webpage at: http://www.fakr.noaa.gov/sustainablefisheries/inseason/chum_salmon_mortality.pdf. Chapter 3 provides more detailed information on the CAS.

bycatch following the regulatory closure of the Chum Salmon Savings Area. Contrary to the original intent of the area closure, chum salmon bycatch rates appeared to be higher outside of the savings area than inside the area. To address this problem, the Council examined other means to minimize chum salmon bycatch that were more flexible and adaptive.

Since 2006, the pollock fleet has been exempt from regulatory closures of the Chum Salmon Savings Areas if they participate in a salmon intercooperative agreement (ICA) with a rolling hotspot system (RHS). The fleet started the RHS for chum salmon in 2001 (and similarly for Chinook salmon in 2002). It was intended to increase the ability of pollock fishery participants to minimize salmon bycatch by giving them more flexibility to move fishing operations quickly to avoid areas where they experience high rates of salmon bycatch. The exemption to area closures for vessels that participated in the RHS ICA was implemented in 2006 and 2007 through an exempted fishing permit and subsequently, in 2008, through Amendment 84 to the BSAI FMP. Since 2006, all AFA cooperatives and all six of the CDQ groups have participated in a salmon bycatch reduction ICA and have been exempt from closures of the Chum Salmon Savings Area in the Bering Sea.

The Council has taken recent action to minimize bycatch of Bering Sea Chinook salmon by recommending the Chinook salmon bycatch management program under Amendment 91. The Council had previously indicated its prioritization of a Chinook salmon bycatch management program in light of high Chinook salmon bycatch in 2007 (with declining trends in chum salmon simultaneously) but indicated that following action on Chinook salmon, the Council would then examine additional management measures to minimize chum bycatch to the extent practicable. This analysis evaluates four alternatives to meet that objective.

Description of Alternatives

Chapter 2 describes and compares four alternatives for minimizing chum salmon bycatch, including detailed options and suboptions for each alternative.

Alternative 1: Status Quo (No Action)
Alternative 2: Hard cap
Alternative 3: Triggered closures
Alternative 4: Triggered closure with intercooperative exemption

The alternatives analyzed in the EA and RIR generally involve limits or "caps" on the number of non-Chinook (elsewhere in document referred to simply as chum salmon as they comprise over 99% of the composition of the bycatch) that may be caught in the Bering Sea pollock fishery and closures of all or a part of the Bering Sea to pollock fishing once the cap is reached. These closures would occur when a non-Chinook salmon bycatch cap was reached even if a portion of the pollock TAC has not yet been harvested. Alternatives 2 and 3 represent a change in management of the pollock fishery because if the non-Chinook salmon bycatch allocations are reached before the full harvest of the pollock allocation, then directed fishing for pollock must stop either BS-wide or in a specified area. Under Alternative 3, like Alternative 1, reaching the cap closes specific areas important to pollock fishing. Under Alternative 4, a closure is proposed to which the fleet would be exempt for participating in an RHS program similar to status quo.

Alternative 1: Status Quo (No Action)

Alternative 1 retains the current program of Chum Salmon Savings Area (SSA) closures in the BS triggered by separate non-CDQ and CDQ non-Chinook salmon prohibited species catch (PSC) limits, along with the exemption to these closures by pollock vessels participating in the Rolling Hot Spot intercooperative agreement (RHS ICA). This area is closed to all trawling from August 1 through August 31. Additionally, if 42,000 'other" salmon are caught in the Catcher Vessel Operational Area (CVOA) during the period August 15-October 14, the area remains closed remainder of the period September 1 through October 14. As catcher processors are prohibited from fishing in the CVOA during the "B" season, unless they are participating in a CDQ fishery, only catcher vessels and CDQ fisheries are affected by the PSC limit. Under this system, the pollock fishery can continue to harvest pollock outside of the closed areas. Pollock vessels participating in the RHS ICA, under regulations implemented for BSAI FMP Amendment 84, are exempt from these closures altogether.

Alternative 2: Hard cap

Alternative 2 would establish separate chum salmon bycatch caps for the pollock fishery (in the B season). When the hard cap is reached all directed fishing for pollock must cease. Only those non-Chinook salmon caught by vessels participating in the directed pollock fishery would accrue towards the cap. When the cap is reached, directed fishing for pollock would be prohibited. .

Alternative 2 contains components, and options for each component, to determine (1) the total hard cap amount, (2) whether and how to allocate the cap to sectors, (3) whether and how salmon bycatch allocations can be transferred among sectors, and (4) whether and how the cap is allocated to and transferred among CV cooperatives.

Setting the Hard Cap

Table 2-4 lists the range of numbers considered for the overall non-Chinook salmon hard caps, in numerical order, lowest to highest. As listed here, the CDQ Program of the fishery level cap would be allocated 10.7%, with the remainder allocated to the combined non-CDQ fishery.

Table ES-2 Range of suboptions for hard cap for non-Chinook with allocations for CDQ Program (10.7%) and remainder for non-CDQ fishery (89.3 %)

	Non-Chinook	CDQ	Non-CDQ
i)	**50,000**	5,350	44,650
ii)	75,000	8,025	66,975
iii)	125,000	13,375	111,625
iv)	**200,000**	21,400	178,600
v)	300,000	32,100	267,900
vi)	**353,000**	37,771	315,229

For analytical purposes only, a subset of the cap numbers included in the six suboptions were used in this document to assess the impacts of operating under a given hard cap. This subset approximates the upper and lower endpoints of the suboption range, and a midpoint (**bolded**).

Apportioning the hard cap

The hard caps could be apportioned as:

- fishery level caps for the CDQ fishery and the non-CDQ fishery;
- sector level caps for the three non-CDQ sectors: the inshore CV sector, the mothership sector, and the offshore CP sector; and
- cooperative level caps for the inshore CV sector.

A fishery level cap would be managed by NMFS with inseason actions to close the fishery once the cap was reached. The CDQ fishery caps would be allocated and managed at the CDQ group level, as occurs under status quo. The hard caps could be apportioned to sectors as sector level caps based on the percentages in Table 2-6. Non-CDQ sector level caps would be managed by NMFS with inseason actions to close the fishery once the cap was reached.

The inshore CV sector level cap could be allocated to cooperatives and the inshore CV limited access fishery. The cooperative transferable allocation amounts would be based on the proportion of pollock allocations received by the cooperatives.

For analytical purposes, a subset of the sector level cap options (shown in bold) providing the greatest contrast is used for detailed analysis.

Table ES-3. Sector percentage allocations resulting from options 1-3. Note that percentage allocations under Option 6 for the remaining sections are not included at this time. The allocation included for analytical purposes are shown in **bold**.

Time Period for Average	Option	% historical: pro-rata	CDQ	Inshore CV	Mothership	Offshore CPs
NA (AFA)	1	0:100	10.0%	45.0%	9.0%	36.0%
2007-2009	2i	100:0	4.4%	75.6%	5.6%	14.4%
	3i	75:25	5.8%	67.9%	6.5%	19.8%
	4i	50:50	7.2%	60.3%	7.3%	25.2%
	5i	25:75	8.6%	52.6%	8.2%	30.6%
2005-2009	**2ii**	**100:0**	**3.4%**	**81.5%**	**4.0%**	**11.1%**
	3ii	75:25	5.0%	72.4%	5.3%	17.3%
	4ii	**50:50**	**6.7%**	**63.3%**	**6.5%**	**23.6%**
	5ii	25:75	8.3%	54.1%	7.8%	29.8%
2000-2009	2iii	100:0	4.4%	76.0%	6.2%	13.4%
	3iii	75:25	5.8%	68.3%	6.9%	19.1%
	4iii	50:50	7.2%	60.5%	7.6%	24.7%
	5iii	25:75	8.6%	52.8%	8.3%	30.4%
1997-2009	2iv	100:0	4.4%	74.2%	7.3%	14.1%
	3iv	75:25	5.8%	66.9%	7.8%	19.5%
	4iv	50:50	7.2%	59.6%	8.2%	25.0%
	5iv	25:75	8.6%	52.3%	8.6%	30.5%
suboption(10.7% to CDQ)	**6**	**NA**	**10.7%**	**44.77%**	**8.77%**	**35.76%**

Transfers and Rollovers

To provide sectors and cooperatives more opportunity to fully harvest their pollock allocations, Alternative 2 could include the ability to transfer sector and cooperative allocations and/or rollover unused salmon bycatch (Table ES-4).

If the Council determines that sector level caps should be issued as transferable allocations, then these entities could request NMFS to move a specific amount of a salmon bycatch allocation from one entity's account to another entity's account during a fishing season. Transferable allocations would not constitute a "use privilege" and, under the suboptions, only a portion of the remaining salmon bycatch could be transferred. If NMFS issues the sector level cap as a transferable allocation to a legal entity representing all participants in that sector, that entity would be prohibited from exceeding its allocation and would be subject to an enforcement action if it exceeded its allocation.

Under the sector rollover option, rollovers would occur when a sector has harvested all of its pollock allocation but has not reached its seasonal sector level Chinook salmon bycatch cap. NMFS would move the unused portion of that sector's cap to the sectors still fishing in that season.

Table ES-4. Transfers and rollovers options for Alternative 2, hard caps.

	Option	**Provision**		
No transfer of salmon				
Sector transfers	Option 1	Caps are transferable among sectors in a fishing season		
	Suboption	Maximum amount of transfer limited to the following percentage of salmon remaining:	a	50%
			b	70%
			c	90%
Sector rollover	Option 2	NMFS rolls over unused salmon bycatch to sectors still fishing in a season, based on proportion of pollock remaining to be harvested		
Cooperative transfers	Option 1	Lease pollock among cooperatives in a season or a year		
	Option 2	Transfer salmon bycatch in a season		
	suboption	Maximum amount of transfer limited to the following percentage of salmon remaining:	a	50%
			b	70%
			c	90%

A summary of the Alternative 2 Components, option and suboptions for analysis is shown in Table ES-5 below.

Table ES-5. Alternative 2 components, options, and suboptions for analysis.

Setting the hard cap (Component 1)	Option 1: Select from a range of numbers	**Non-Chinook**	**CDQ**	**Non-CDQ**	
		50,000	5,350	44,650	
		200,000	21,400	178,600	
		353,000	37,771	315,229	
Allocating the hard cap to sectors (Component 2)*		CDQ	Inshore CV	Mothership	Offshore CP
	No allocation	10.0%	45.0%	9.0%	36.0%
	1: Option 2ii	10%	45%	9%	36%
	2: Option 4ii	3%	70%	6%	21%
	3: Suboption	10.7%	44.77%	8.77%	35.76%
Sector transfers (Component 3)	No transfers				
	Option 1	Caps are transferable among sectors and CDQ groups within a fishing season			
		Suboption: Maximum amount of transfer limited to:	a	50%	
			b	70%	
			c	90%	
	Option 2	NMFS rolls over unused salmon PSC to sectors still fishing in a season, based on proportion of pollock remaining to be harvested.			
Allocating the hard cap to cooperatives (Component 4)	No allocation	Allocation managed at the inshore CV sector level.			
	Allocation	Allocate cap to each cooperative based on that cooperative's proportion of pollock allocation.			
	Cooperative Transfers	Option 1	Lease pollock among cooperatives in a season or a year		
		Option 2	Transfer salmon PSC (industry initiated)		
		Suboption Maximum amount of transfer limited to the following percentage of salmon remaining:	a	50%	
			b	70%	
			c	90%	

Alternative 3: Triggered Closures

Alternative 3 would establish monthly time and area closure systems that are triggered when specified cap levels are reached. As with Alternative 2, components and options for each component are specified and described below.

Trigger cap levels:

Table ES-6 lists the range of numbers considered for the overall non-Chinook salmon hard caps, in numerical order, lowest to highest. As listed here, the CDQ sector allocation of the fishery level cap would be 10.7%, with the remainder apportioned to the combined non-CDQ fishery.

Table ES-6. Range of suboptions for trigger cap levels for non-Chinook with allocations for CDQ (10.7%) and remainder for non-CDQ fishery.

	Non-Chinook	CDQ	Non-CDQ
i)	**25,000**	2,675	22,325
ii)	50,000	5,350	44,650
iii)	**75,000**	8,025	66,975
iv)	125,000	13,375	111,625
v)	**200,000**	21,400	178,600

For analytical purposes only, a subset of the cap levels included in the six suboptions were used in this document to assess the impacts of operating under a given hard cap. This subset approximates the upper and lower endpoints of the suboption range, and a midpoint (**bolded**).

Component 1B: Trigger limit application:

Three options are considered to apply trigger caps (Component 1B) to the area closure options. Option 1 would apply the trigger to all chum salmon bycatch, and use the calculated cumulative monthly proportion of the cap to establish monthly threshold limits. Here the cumulative monthly proportion (as noted in Table 2-10 below) is used to establish threshold limits by month for the overall cap as selected under Component 1A. The cumulative monthly proportion is calculated by estimating the average bycatch per month over the years 2003-2010.

Table ES-7. Monthly proportion of non-Chinook salmon limit that specifies option 1 of Alternative 3.

Month	**Option 1** : monthly threshold cumulative proportion
June	11.1%
July	35.4%
August	66.5%
September	92.8%
October	100.0%

Option 2 specifies a within-monthly limit defined as the minimum of the monthly cumulative and 150% of monthly historical proportion[3]. A suboption (referred to as Option 2a in the analysis) specifies a monthly trigger limit application that redistributes the monthly percentage such that trigger limits are lower in months where the western Alaska chum salmon bycatch component[4] is proportionately higher. This suboption is intended to provide similar protection levels for western Alaskan chum salmon stocks throughout the B-season. Note that in all months, results to date indicate that Asian stocks make up the

---

[3] Note monthly limit should evaluate +/- 25% of monthly limit distribution

[4] The category of western Alaska stocks includes coastal western Alaska and fall run Yukon chum salmon.

highest proportion of the bycatch. Similarly, the results from genetic studies indicate that the proportion of chum salmon bycatch that is western Alaska stock is higher during the early (June-July) part of the B-season compared to later in the season (August-October).

Under Option 3, a single (overall or sector-split) cap would be specified and bycatch would accrue toward it cumulatively over the season. When that cap was reached, the closure system specified in Component 4 would be enacted. There would be no additional monthly cap limit constraints as specified under Components 1A and 1B. The areas to be closed would depend upon the timing of when the overall cap (or sector-specific proportion) was reached and would continue monthly as specified under the closure system selected under Component 4.

Options 1-3 describe the mechanism by which the specific trigger limit (as selected under Component 1) is applied, which if reached enacts a series of closures, as described under Component 4. Under all three options, the closure system would be enacted for the remainder of the season should the cumulative total trigger by sector be reached. The distinction between the options is the progressively more restrictive within monthly limits imposed on either option 1 or 2 in addition to the cumulative cap. Component 4 describes the range of area closures under consideration based upon average historical bycatch percentages. Here Component 4B (50% historical bycatch) is selected for this example. The areas corresponding to these closures are shown in Figure 2-3.

Under option 1, the listed area will close for the month in which the sectors cap is reached. Those areas would then reopen at the end of the month. The next areas would remain open unless the cumulative bycatch by sector reaches the monthly limit. If bycatch reaches the monthly limit then the areas listed for that month will close for the remainder of the month. If in any month the cumulative total amount (listed in bold) is reached, then the CSSAs listed for each month would close according to their monthly schedule for the remainder of the season. In all cases there may be additional bycatch by sector outside of the CSSAs, however the sector whose limit has been reached will be prohibited from fishing in the CSSAs in each month in which the closure applies.

Under option 2, there are more restrictive within monthly limits in addition to the monthly cumulative limits shown in Table 2-10. For all sectors the monthly and cumulative amounts for June are equivalent (and for this sector allocation example they are equivalent in July as well). Should the within-monthly limit by sector be reached, regardless of the cumulative monthly limit not being reached, the CSSA would close for the remainder of the month. The following month, the CSSA would only close if the limit for that month was reached or if the cumulative bycatch reached the cumulative limits. As with option 1, if at any time the annual cumulative total (in bold) were reached, then the CSSAs would be enacted monthly for the remainder of the season and the sector or sectors reaching their limits would be prohibited from directed fishing for pollock within those areas in each month. As with option 1, bycatch by sector may continue to accrue outside of the CSSAs.

Under option 3, when the cumulative amount by sector is reached, the CSSA in the month in which the cap was reached will close for the remainder of the month and the CSSAs for all subsequent months through the end of the season will close as scheduled. No within monthly limit is applied in addition to the cumulative bycatch limit under this option. As with option 1 and 2, bycatch by sector may continue to accrue outside of the CSSAs.

Component 3: Cooperative Provisions

As with Alternative 2, the trigger cap may be further apportioned within the shoreside CV sector to the cooperative level if this component is selected.

Component 4: Area and Timing Options

Component 4 includes three options for a system of closure areas which change by month. Options represent the overall estimated bycatch percentage represented historically within these regions, on a monthly basis, over the years 2003-2010.

a) Area closure groupings by month that represent 40% of historical bycatch.
b) Area closure groupings by month that represent 50%[5] of historical bycatch.
c) Area closure groupings by month that represent 60% of historical bycatch.

Under the closure systems represented by Component 4, options a-c, the specified closures vary each month depending upon the selected historical bycatch percentage. Once a cap level and allocation as selected under components 1-3 are reached (by fishery, sector or cooperative depending upon the allocation level), the specified areas by month would close for the remainder of the month. At the end of the month, the areas would then reopen and if triggered (already based upon exceeding a cumulatively specified cap or within the subsequent month by triggering a within-month cap) new areas would close to those entities which exceeded their proportion of the cap the following month. In each month the areas to be closed are pre-specified but are not exactly the same from one month to the next. Under a cumulative cap scenario, once the cap is reached the closure system goes into place in every month for the remainder of the season. Further information on how the cap application corresponds to the closure system is contained in Chapter 2.

---

[5] The Council noted that the analysis should include quantitative analysis of the 50% closure options and qualitative analysis of the 40% and 60% closure options.

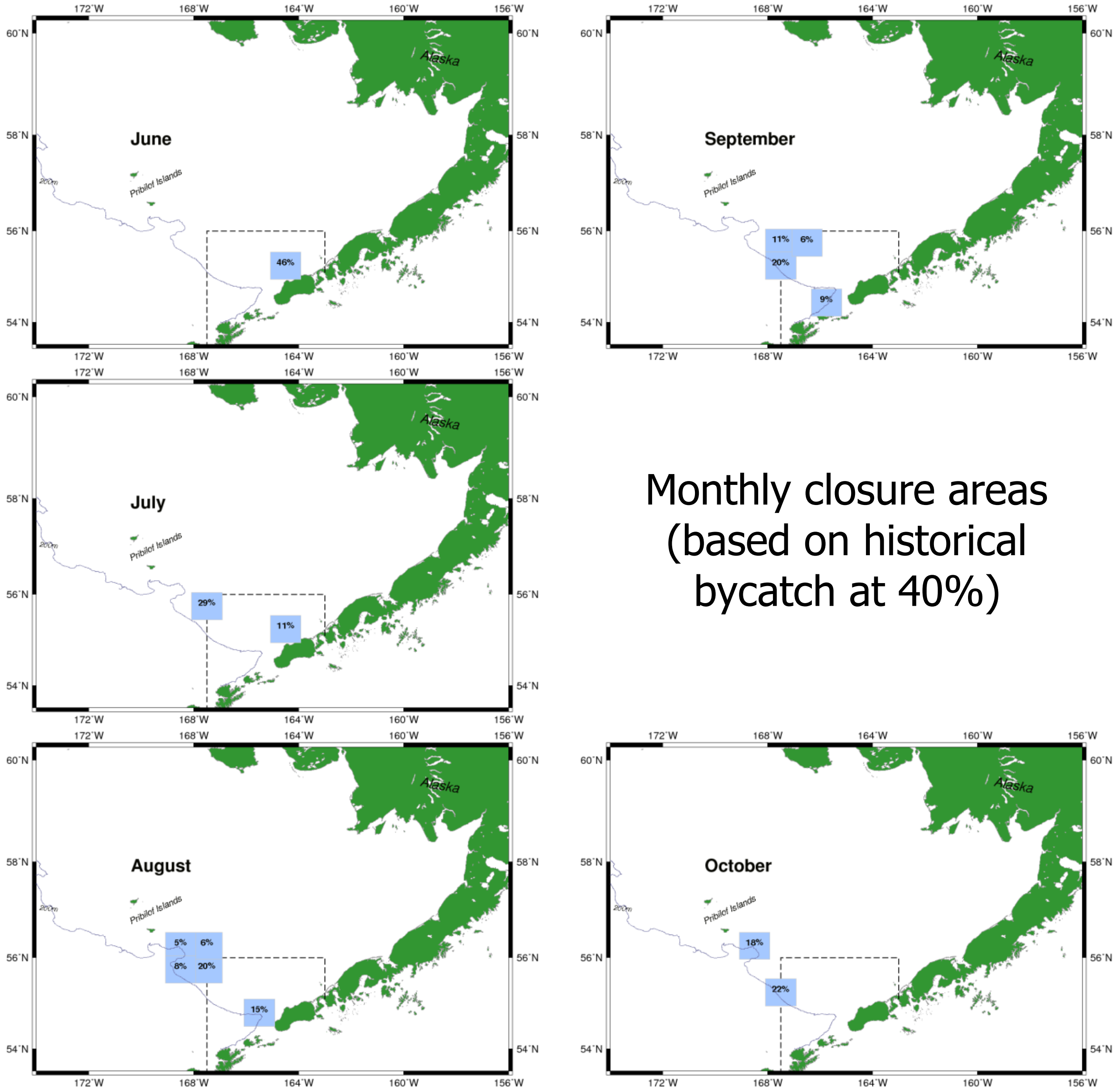


Figure ES-2. Monthly area closures based on ADFG areas that represented 40% of the historical chum salmon bycatch (within each month)

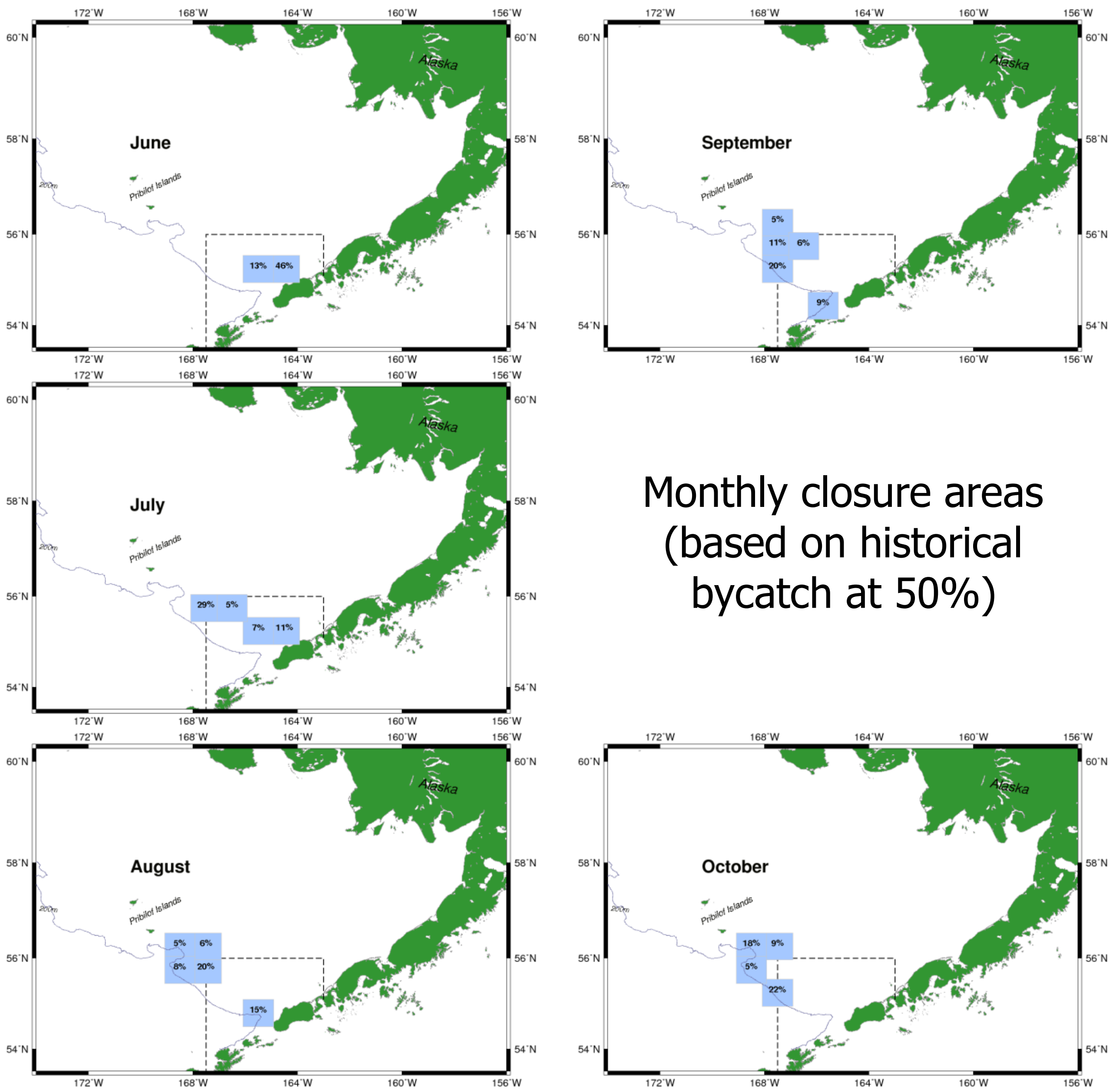
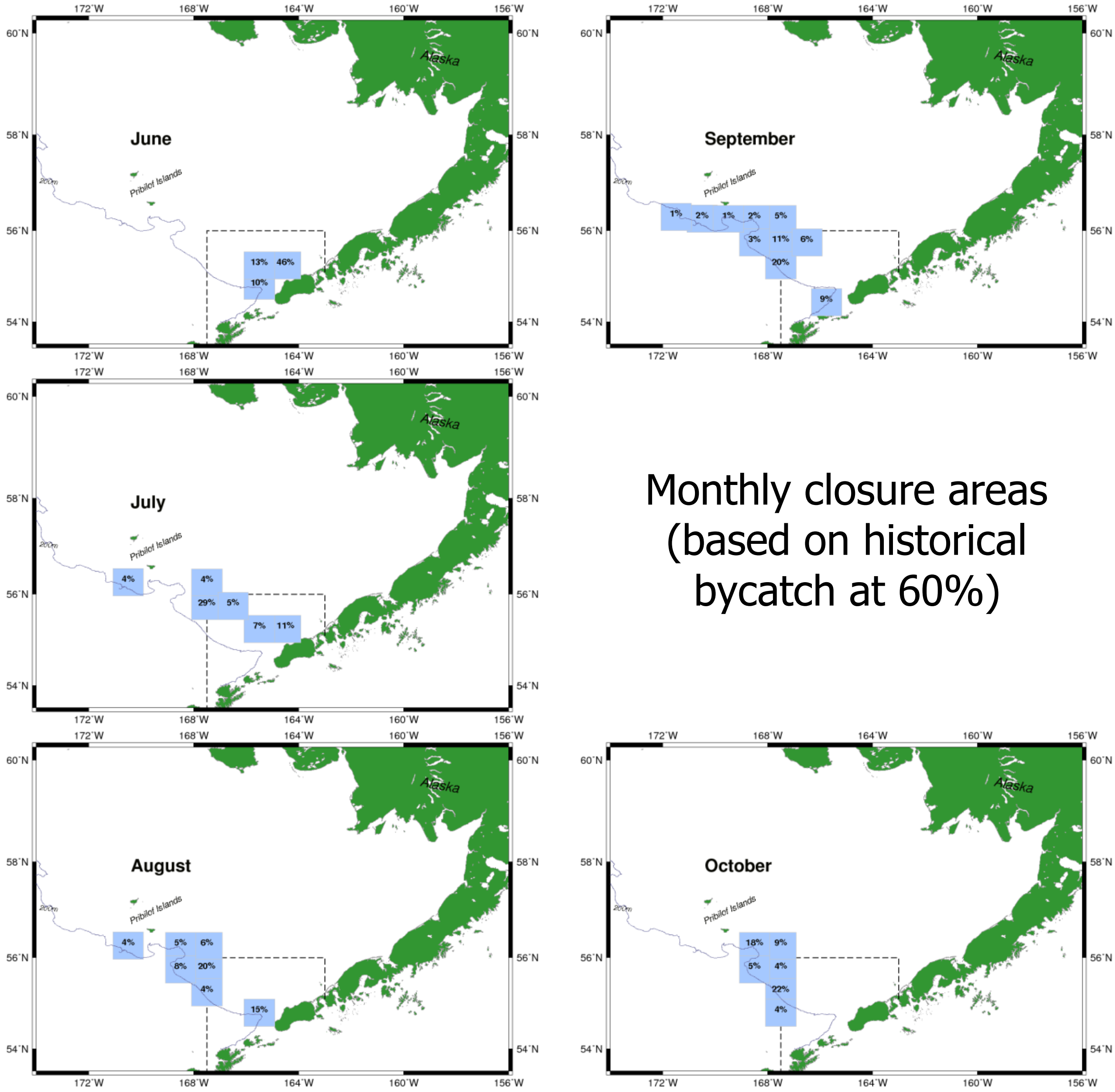


Figure ES-3. Monthly area closures based on ADFG areas that represented 50% of the historical chum salmon bycatch (within each month).



Monthly closure areas
(based on historical
bycatch at 60%)

Figure ES-4. Monthly area closures based on ADFG areas that represented 60% of the historical chum salmon bycatch (within each month)

A summary of the Alternative 3 components and options for analysis are show in Table ES-8.

Table ES-8. Alternative 3 Components and options.

Setting the cap (Component 1)	1A: How to formulate the cap	Select a cap from a range of numbers, 25,000 –200,000 (same range as Alternative 2)			
	1B: How to apportion cap by season	Option 1: monthly apportionment of cap			
		Option 2: monthly threshold and within monthly limit			
Allocating the hard cap to sectors (Component 2)		CDQ	Inshore CV	Mothership	Offshore CP
	No allocation	3.4%	81.5%	4.0%	11.1%
	1: Option 2ii	6.7%	63.3%	6.5%	23.6%
	2: Option 4ii	10.7%	44.77%	8.77%	35.76%
	3: Option 6	3.4%	81.5%	4.0%	11.1%
Cooperative Provisions (Component 3)	Voluntary transfers among sectors are allowed				
	NMFS can reapportion unused salmon to other sectors based on their proportion of remaining pollock (except not from CDQ groups)				
Area and Timing Options (Component 4)	a	Area closure groupings by month that represent 40% of historical PSC			
	b	Area closure groupings by month that represent 50% of historical PSC			
	c	Area closure groupings by month that represent 60% of historical PSC			

Alternative 4-Closure with RHS exemption

Alternative 4 would establish a large area closure, with an option to select a cap to trigger the closure. If the triggered closure option is not selected, the area would be closed during the entire B-season. Similar to status quo (rolling hot-spot (RHS) system in regulation), participants in a vessel-level (platform level for the mothership sector) RHS would be exempt from the regulatory closure system under Alternative 4. The area proposed to be closed under Alternative 4 represents an area encompassing 80% of historical bycatch (Figure ES-5). A summary of the Components and options under Alternative 4 are provided in Table ES-9.

Table ES-9. Alternative 4 components

<table>
<tr><td rowspan="2">Fleet PSC management with non-participant fixed closure</td><td>B Season</td><td colspan="4">Fixed closure encompassing 80% of historical PSC</td></tr>
<tr><td>RHS Exemption</td><td colspan="4">Participants in RHS would be exempt from the regulatory closure</td></tr>
<tr><td rowspan="3">Trigger Closure Option 1</td><td>All B Season</td><td colspan="4">Fixed closure encompassing 80% of historical PSC for all RHS non-participants</td></tr>
<tr><td>Trigger Caps</td><td colspan="2">1a</td><td colspan="2">50,000</td></tr>
<tr><td></td><td colspan="2">1b</td><td colspan="2">200,000</td></tr>
<tr><td>Sector Allocation Suboption</td><td colspan="5">Trigger cap options under 1a and 1b would be apportioned to the sector level. This would result in separate sector level caps for the CDQ sector, the inshore catcher vessel (CV) sector, the mothership sector, and the offshore catcher processor (CP) sector.</td></tr>
<tr><td rowspan="5">Allocating the hard cap to sectors (functionally same as under Alternative 2) see table 2-20 and Chapter 2 for cap numbers.</td><td></td><td>CDQ</td><td>Inshore CV</td><td>Mothership</td><td>Offshore CP</td></tr>
<tr><td>No allocation</td><td>3.4%</td><td>81.5%</td><td>4.0%</td><td>11.1%</td></tr>
<tr><td>1: Option 2ii</td><td>6.7%</td><td>63.3%</td><td>6.5%</td><td>23.6%</td></tr>
<tr><td>2: Option 4ii</td><td>10.7%</td><td>44.77%</td><td>8.77%</td><td>35.76%</td></tr>
<tr><td>3: Option 6</td><td>3.4%</td><td>81.5%</td><td>4.0%</td><td>11.1%</td></tr>
</table>

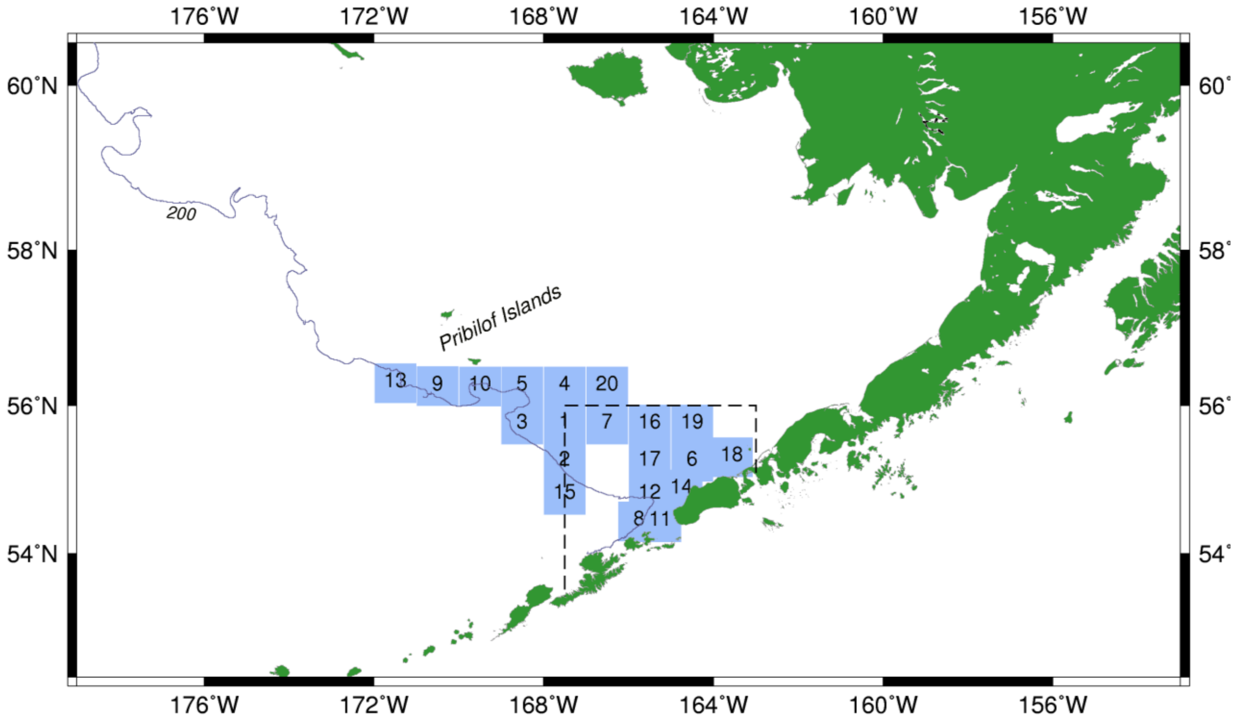


Figure ES-5. Large area closure based on ADFG areas that represented about 80% of the historical chum salmon bycatch

Effects of the Alternatives

Quantitative analysis was completed on the potential impacts of the alternatives on chum salmon, pollock, Chinook salmon, and related economic analyses. Chapter 3 describes the methodology for the quantitative analysis. For the remaining resource categories considered in this analysis - marine mammals, seabirds, other groundfish, essential fish habitat, ecosystem relationships, and environmental justice - impacts of the alternatives were evaluated largely qualitatively based on results and trends from the quantitative analysis.

The estimated impacts of alternative chum salmon bycatch management measures were evaluated by examining when cap options would have resulted in fishery closures and then estimating the numbers of salmon that would have been 'saved' by virtue of the fishery (or sector) closing earlier. The salmon saved is then compared to the amount of pollock that would have been forgone or diverted to open areas (for Alternative 3). The analyses were based on 2003-2010 NMFS observer data combined with NMFS regional office catch-accounting. For Alternative 3 triggered closures, data were augmented by using the same spatial and temporal patterns of PSC observed but with different absolute levels. This was done to provide resolution needed to distinguish characteristics between triggered closure options. For this reason proportional change between scenarios are reported and application to a "prototypical year" is presented to evaluate the expected consequences. Alternative 4 was analyzed two ways: 1) as a fixed B season closure should all vessels fail to participate in a voluntary rolling hotspot program, and 2) with 100% vessel participation in a rolling hotspot program. This allows for evaluation of two bookends of the potential impacts under this alternative.

Results presented in Chapter 5 include both overall changes in chum salmon bycatch due to alternative management measures, as well as resulting estimates of the amount of chum salmon that would have returned to natal rivers as adult fish.

The RIR examines the costs and benefits of the alternatives based on the analysis in Chapters 4 and 5 that estimates the likely dates of pollock fishery closures and thereby retrospectively projects likely forgone pollock harvest and the number of chum salmon that may have been saved. Under Alternative 3, the RIR uses estimates of pollock caught outside of proposed closure areas. In this way, estimates of direct costs, in terms of potentially forgone gross revenue due to unharvested pollock, may be compared to the estimated benefits, in terms of the numbers of chum salmon that would not be taken as bycatch. Potentially forgone pollock fishery gross revenue is estimated by tabulating the amount of pollock historically caught after a closure date and applying established sector and seasonal prices. However, it is not a simple matter to estimate changes in gross revenues due to changes in chum salmon bycatch predicted under the alternatives. The analysis relies on estimates of chum salmon saved as the measure of economic benefits of the alternatives.

Chum Salmon

The chum salmon taken as bycatch in the pollock fishery originate from Alaska, the Pacific Northwest, Canada, and Asian countries along the Pacific Rim. Combined there about 3 billion chum released each year from hatcheries around the Pacific Rim. The majority of hatchery releases are from Russia and Japan. Currently the North Pacific groundfish observer program treats hatchery and wild origin chum salmon the same even though a less than 20% of hatchery fish are released with thermal signatures that can be identified from otoliths. The percentage of chum salmon in the PSC that are of hatchery origin is unknown but genetic analyses provide estimates of chum that are Asian versus Alaskan origin. Estimates are provided in this analysis of the relative stock composition of the chum salmon PSC from broad regional groupings around the Pacific Rim. The majority of bycatch appears to be of Asian origin. For PSC impact considerations, analyses focus on the impact to Alaska and in particular to PSC attributed to be from western Alaskan rivers.

Summaries on the status of wild chum salmon stocks in Alaska are presented to provide context of where issues and concerns are highest. These sections include tables of catch, the types of fisheries that the stocks support, whether escapement goals have been met, and whether there are stock concerns which are further summarized here (Table ES-10).

Table ES-10. Overview of Alaskan chum salmon stock performance, 2010.

Chum salmon stock	Total run size?	Escapement goals met?[1]	Subsistence fishery?	Commercial fishery?	Sport fishery?	Stock of concern?
Bristol Bay	Above average	1 of 1	Yes	Yes	Yes	No
Kuskokwim Bay	Above average	2 of 2	Yes	Yes	Yes	No
Kuskokwim River	Average	2 of 2	Yes	Yes	Yes	Yield concern discontinued 2007
Yukon River summer run	Average	2 of 2	Yes	Yes, but limited by low Chinook	Yes	Management concern discontinued 2007
Yukon River fall run	Below average	6 of 8	Restrictions	Limited late season (Tanana River)	No	Yield concern discontinued 2007
Eastern Norton Sound	Above average	1 of 1	Yes	Yes	Yes	No
Northern Norton Sound	Above average	7 of 7	Yes	Yes	Yes, except for Nome Subdistrict	Yield concern (since 2000)
Kotzebue	Above average	6 of 6	Yes	Yes	Yes	No
North Peninsula	Average	2 of 2	Yes	Yes	Yes	No
South Peninsula	Below average	2 of 4	Yes	Yes	Yes	No
Aleutian Islands	n/a	n/a	Yes	Yes	Yes	No
Kodiak	Below average	2 of 2	Yes	Yes	Yes	No
Chignik	Average	1 of 1	Yes	Yes	Yes	No
Upper Cook Inlet	Above average	1 of 1	Yes	Yes	Yes	No
Lower Cook Inlet	Average	9 of 12	Yes	Yes	Yes	No
Prince William Sound	Average	5 of 5	Yes	Yes	Yes	No
Southeast	Below average	6 of 8	Yes	Yes	Yes	No

[1] Some aerial survey-based escapement goals were not assessed due to inclement weather or poor survey conditions.

Chum salmon support subsistence, commercial, personal use, and sport fisheries in their regions of origin. The State of Alaska Department of Fish & Game manages the commercial, subsistence, sport, and personal use salmon fisheries. The Alaska Board of Fisheries (BOF) adopts regulations through a public process to conserve fisheries resources and to allocate fisheries resources to the various users. The first priority for state management is to meet spawning escapement goals to sustain salmon resources for future generations. The highest priority use is for subsistence under both state and federal law. Subsistence fisheries management includes coordination with the Federal Subsistence Board and Office of Subsistence Management, which manages subsistence uses by rural residents on federal lands and applicable waters under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA). Surplus fish beyond escapement needs and subsistence use are made available for recreational, personal use, and commercial fisheries. Yukon River salmon fisheries management includes obligations under an international treaty with Canada.

Chum salmon serve an integral cultural, spiritual, nutritional, and economic role in the lives of Alaska Native peoples and others who live in rural communities. For Alaska Natives and others throughout western and interior Alaska, harvesting and eating wild subsistence foods are essential to personal, social, and cultural identity, and salmon comprise the majority of subsistence foods harvested and used. In addition, commercial fishing for chum salmon provides a significant source of income for many people who live in remote villages, which often supports the ability to engage in subsistence harvests. For purposes of the RIR and this action, subsistence harvest by rural Alaskan communities is limited to the regions of western Alaska and includes: Norton Sound/Kotzebue (the Arctic Area); the Yukon River; the Kuskokwim Area; Bristol Bay; and the Alaska Peninsula.

Under Alaska's subsistence statute, the BOF must identify fish stocks that support subsistence fisheries and, if there is a harvestable surplus of these stocks, determine the amount of the harvestable surplus that is reasonably necessary for subsistence uses, and adopt regulations that provide reasonable opportunities for these subsistence uses to take place. The BOF evaluates whether reasonable opportunities are provided by existing or proposed regulations by reviewing harvest estimates relative to the "amount reasonably necessary for subsistence use" (ANS) findings as well as subsistence fishing schedules, gear restrictions, and other management actions.

The Alaska Board of Fisheries has made ANS findings for salmon throughout the areas under discussion in the RIR, which provides a perspective on the importance of salmon harvests to subsistence economies of rural Alaska given that these findings are based upon historical harvest patterns within each fisheries management area. The number of summer chum salmon harvested for subsistence from the Yukon River has fallen below the lower limit of the ANS four times between the years 1998 and 2008. Similarly, fall chum salmon harvests have fallen below the lower limit of the ANS eight times between 1998 and 2008. In years of poor salmon abundance, restrictions or closures to the subsistence fishery reduced the harvest success in order to achieve adequate escapements and likely resulted in the lower bound of ANS ranges not being achieved. However, in some years when ANS was not achieved, total summer chum and fall chum runs (and other runs) were adequate to provide for subsistence harvests and no additional restrictions were in place on the subsistence fishery. The importance of salmon for subsistence and other uses is the subject of Chapter 3 of the RIR.

Chum salmon savings

Chapter 5 analyzes the impacts of the alternatives on chum salmon. First, estimates on the number of chum salmon saved under each alternative compared to Alternative 1 (status quo) are made based on the details of the alternatives and options. These estimates were then combined with data on the ages of chum salmon taken by the pollock fishery to provide annual estimates on the numbers of chum salmon that would have returned to spawn (referred to as adult equivalents or AEQ). Finally, the data from genetic samples available from 2005-2009 were combined with the AEQ and run size estimates (along with associated uncertainties) to evaluate impacts on specific chum salmon runs or groups of runs to different regions.

Estimates of historical bycatch represent actual numbers of chum salmon taken and include benefits of existing management measures. A separate analysis of the current mechanisms in place under status quo (i.e., the fleet-based rolling hot spot program) estimates what percentages of salmon are likely already being saved. These estimates are provided to understand the effectiveness of the current system relative to one which lacked any salmon bycatch avoidance program. The reduction due to this program is estimated to range from 4-28% based on estimation of imposing the system in years prior to its operation. Comparing alternatives against status quo requires understanding that the relative benefits are in addition to the current status quo measures.

Analysis of the efficacy of the existing RHS program showed the following general conclusions:

- From 2003-2010, chum bycatch rates in the 1-3 days following RHS closures are approximately 8 percent lower than rates prior to the closure
- Annual average chum bycatch rates by sector in the 5-days before closures (imposed on 2003-2010 data) ranged from 11-33 percent for CVs and from 2 percent to 30 percent for other sectors, most years in the upper end of this range.

- The average percentage of pollock catch that was moved due to closures ranged from 7 percent to 21 percent for CVs and was less than 5 percent for other sectors.
- Evaluating the pre-RHS data from 1993-2000, an RHS-like system would likely have reduced chum bycatch by 9 percent to 22 percent on average with about 4-10% percent of pollock fishing have been relocated to other areas.
- The pre-RHS analysis suggests that closures in place for chum have likewise been effective for Chinook with the range of Chinook savings as 6 percent to 14 percent per year.

Some additional considerations in analyzing the RHS system include the following:

- Based on 1993-2000 data, large closures reduce salmon PSC more but at the cost of reducing the areas where pollock could be taken. Also, closures based on the most recent information possible lead to larger average reductions and relatively small base rates appear on average to be more effective.
- The “tier system” of the RHS program allows cooperatives with low PSC relative to the base rate to fish inside closed areas. This provides some incentive for cooperatives to have lower chum PSC rates in order to be able to fish in areas closed to others. During closure periods, 4.6 percent of pollock from shore-based catcher vessels and 0.3 percent of pollock from other sectors was taken inside the closure areas.

Compared to alternative spatial management systems, the RHS system has advantages and limitations. Some of the key advantages include the flexibility to adapt to new information rapidly, the ability to explicitly make trade-offs between chum and Chinook as necessary and reporting requirements that allow for transparency in the adherence of vessels to designated closures. Some limitations include provisions on the maximum area that can be closed and a lack of incentives at the vessel level when restrictions are based on a cooperative level bycatch rate. Further information on the methodology and detailed impacts under the RHS system are contained in Chapter 5.

Adult Equivalent chum salmon savings

AEQ bycatch takes into account the fact that some of the chum salmon taken in the pollock fishery would not have returned to their river of origin in that year. Based on their age and maturity, they might have returned one to two years later. Also, the approach accounts for that fact that some proportion of the bycatch may have suffered mortality in the ocean (e.g., predation). AEQ bycatch estimates provide a way to evaluate the impacts to spawning stocks and future mature returning chum salmon.

Results show that the extent that bycatch is adjusted depending on the ages (to obtain the AEQ estimate) for chum salmon is variable (Figure ES-6). In some years, the actual bycatch may be below the AEQ estimates, due to the lagged impact of higher bycatch in previous years. Overall, the range of uncertainty

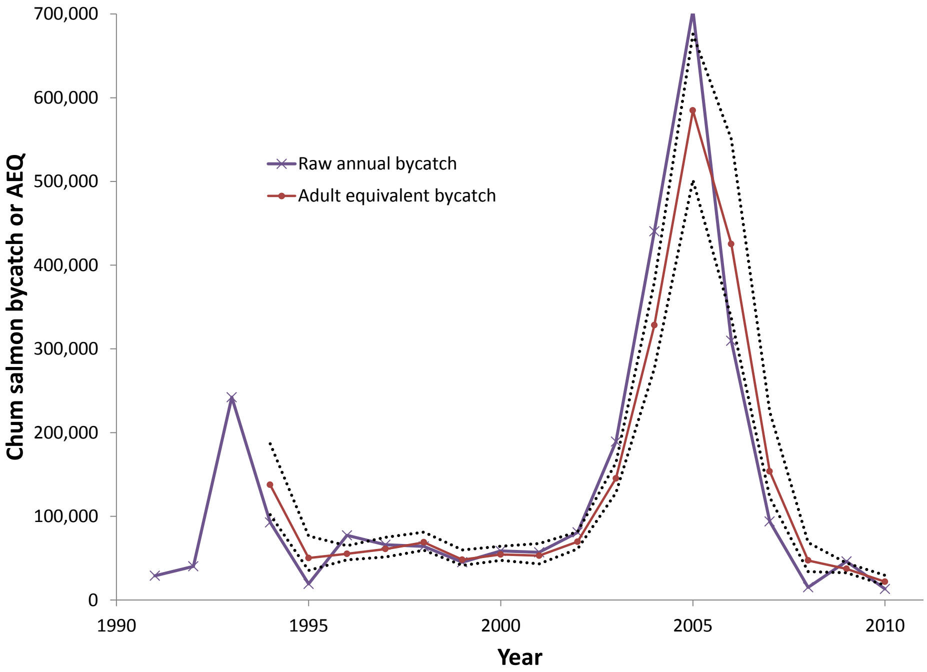


Figure ES-6. Time series of non-Chinook (chum) annual bycatch estimates compared to the adult equivalent estimates from the pollock fishery, 1991-2010. The dotted lines represent the uncertainty of the AEQ estimate, due to the combined variability of ocean mortality, maturation rate, and age composition of bycatch estimates.

AEQ chum salmon returns to rivers of origin

Combining the AEQ results with genetic analysis from 2005-2009 and estimates of run sizes (for coastal west Alaska and the Upper Yukon) provides the means to evaluate the historical impact of chum salmon bycatch. In particular, it provides estimates on how many salmon would have returned to specific river systems and regions had there been no pollock fishing. The stock composition mixtures of the chum salmon bycatch were based on samples collected from the Bering Sea pollock fishery. Results from a number of these 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). This analysis used the same approach and genetic breakouts to 6 individual regions to characterize region of origin for chum bycatch but with a slightly different sample stratification scheme. The regions that could be clearly resolved using genetics were: East Asia (referred in analysis as ‘Asia’), north Asia (referred in analysis as ‘Russia’), coastal western Alaska (including all WAK systems with the exception of the upper/middle Yukon), upper/middle Yukon, Southwest Alaska (including river systems in Kodiak as well as North and South Peninsula stocks) and Pacific Northwest (which includes river systems from Prince William Sound to WA/OR in the lower 48; Figure 3-9).

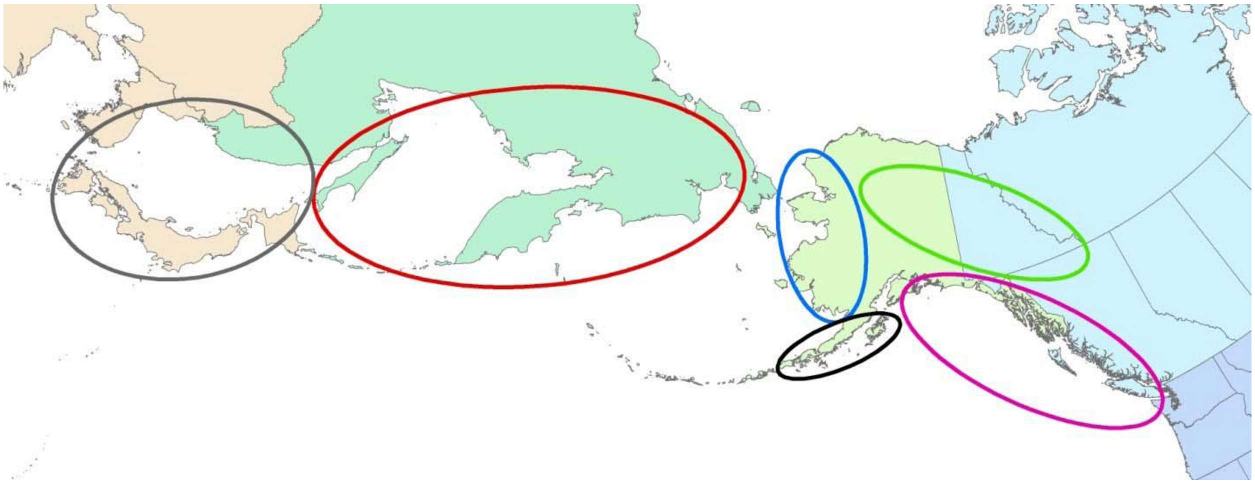


Figure ES-7. Six regional groupings of chum salmon populations used in the analysis including east Asia (grey), north Asia (red), coastal western Alaska (blue), upper/middle Yukon (green), southwest Alaska (black), and the Pacific Northwest (magenta). From Gray et al. 2010.

For this analysis, the genetic analysis was re-done (on the same sets of samples presented in the other studies—e.g., Guyon et al. 2010) but with the samples stratified temporally as from June-July or from August-October. The earlier genetic analyses presented to the Council, there appears to be a consistent pattern showing that Alaskan stocks are proportionately less common in bycatch later in the season compared to earlier. This re-stratification, along with careful accounting on the relative proportions of bycatch that occurred within years, confirms this pattern with Alaskan stocks being proportionately more common in the June-July period compared to later (Figure 3-16). The proportions of bycatch from the SE Alaska-BC-Washington region also decreased later in the season while proportions from Russia and Japan increased.

Relative impacts to individual river systems depend on where and when the bycatch occurs. This can add to the inter-annual variability in results for the same caps, closures, and allocations between sectors. On average (based on 2005-2009 data) approximately 12% of the AEQ is attributed to the coastal western Alaskan regional grouping while ~7% is attributed to the Upper Yukon (Fall chum). For the Southwest Alaska Peninsula stocks, the average AEQ over this period is ~2%, while for the combined PNW (including regions from Prince William Sound all the way to WA/OR), the average is 22%. Combined estimated Asian contribution is ~58% on average (for Russian stocks and Japanese stocks combined). Yearly estimates are presented in Chapter 3.

These proportions by year are applied to conservative run size estimates, where available, for Alaskan regional groupings to estimate an overall average impact rate of bycatch by region (Figure 5-92). Results indicate that the highest impact rate (chum salmon mortality due to the pollock fishery divided by run-size estimates) was less than 1.7% for the combined western Alaska stocks. For the Upper Yukon stock, the estimate of the impact was higher with a peak rate of 2.7% estimated on the run that returned in 2006 (Figure 5-92). For the SW Alaska region (taken to be from Area M) the estimate of impact rate was the lowest for any of the Alaska sub-regions. The average impact rate (2005-2009) by region (with ranges) was:

Coastal west Alaska	0.6%	(0.1% - 1.5%)
Upper Yukon	1.2%	(0.2% - 2.7%)
Combined WAK	0.7%	(0.1% - 1.5%)
Southwest Alaska	0.4%	(0.1% - 1.0%)

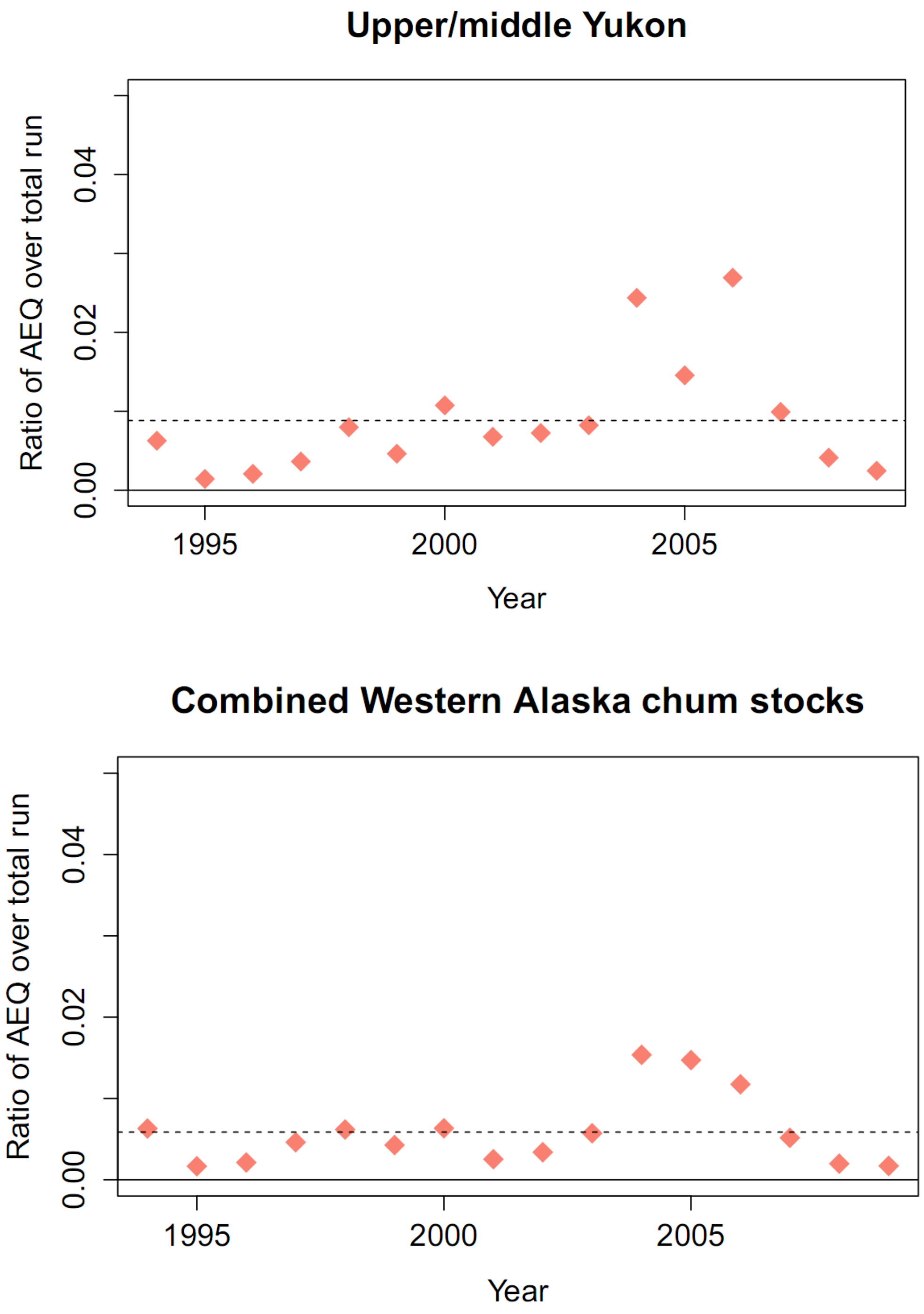


Figure ES-8. Estimated impact rates due to pollock fishery bycatch of chum salmon run sizes for Upper/middle Yukon (top) and for western Alaska stocks (coastal west Alaska stocks plus Upper/middle Yukon combined; bottom). Dashed horizontal line represents the mean value.

Under Alternative 2, the hard cap options, estimates are made by year of the number of salmon saved (in numbers as well as AEQ estimates) and compared to the actual amounts estimated under status quo under each cap and sector allocation scenario. The amount of salmon saved under each options varies considerably from year to year as well as by cap and sector allocation. The greatest number of salmon saved under Alternative 2 is 93% in the highest year (2005) for the most restrictive cap level considered (50,000). This contrasts with other years where no salmon would have been saved (given the assumptions) under the higher cap scenarios in years of both high and low bycatch. In years of low bycatch there is limited salmon savings under any cap and allocation scenario. Expected chum salmon saved for selected options under alternative 2 are presented in Table 5-80.

Table ES-11. Estimated proportion of Alaska chum salmon saved relative to AEQ mortality year for different **hard caps** and sector allocations by year for Alternative 2.

Sector allocation option	Hard Cap		
	50,000	200,000	353,000
2ii	80%	45%	21%
4ii	80%	50%	29%
6	81%	56%	43%

As previously noted, results for Alternative 3 the trigger cap and closure options are presented for scenarios over a range of hypothetical high and low bycatch years to provide contrast among the specified options rather than on actual historical bycatch levels. Results for the trigger cap levels and options themselves indicate that the resulting salmon savings are relatively insensitive to the cap levels and among the four different trigger application options. This insensitivity reflects the highly variable nature of chum salmon bycatch between years, and by seasons and areas rather than shortcomings of the closure design. Of the trigger application options, option 3 results in the highest percentage of salmon saved. However, this option results in lower amounts of salmon saved earlier in the B season when more of the bycatch is estimated to be of WAK origin. Overall savings of salmon under Alternative 3 ranged from 6-14% over all cap configurations and high and low bycatch years with sub-option 2a generally performing the best compared to the other options (i.e., greater levels of chum salmon PSC reductions; Table 5-86).

Table ES-12. Estimated relative reduction in chum salmon bycatch and diverted pollock catch by sector allocation (panels) and trigger cap levels for different trigger closure options.

2ii (sector allocation 1)

	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.6%	11.3%	12.5%	8.1%	8.6%	3.7%
Option 2	13.6%	11.4%	12.6%	8.5%	9.0%	4.3%
Option 2a	13.8%	12.0%	13.1%	9.1%	10.7%	5.0%
Option 3	13.2%	9.7%	10.9%	6.4%	5.9%	2.5%

4ii (sector allocation 2)

	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.1%	9.6%	12.8%	8.5%	9.9%	4.7%
Option 2	13.1%	10.1%	12.8%	8.9%	10.3%	5.3%
Option 2a	13.5%	10.8%	13.3%	9.6%	11.2%	5.8%
Option 3	11.9%	7.8%	11.6%	6.8%	6.6%	3.2%

6 (sector allocation 3)

	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.7%	11.9%	13.2%	9.3%	10.9%	6.1%
Option 2	13.7%	12.0%	13.2%	9.7%	11.1%	6.5%
Option 2a	13.7%	12.7%	13.4%	10.3%	11.7%	7.0%
Option 3	13.5%	10.3%	12.2%	7.7%	8.3%	4.5%

Under Alternative 4, with a fixed large-scale area closure imposed over the entire B season, the overall reduction in salmon bycatch is estimated to be approximately 36%, given the assumption that pollock fishing outside of the closure area remains viable (estimated with data from 2003-2010) and no fishing occurs in the closed area. However, as with status quo, participation under the RHS program is anticipated to remain at 100%, particularly with the greater incentive to participate under Alternative 4, , thus estimated impacts are likely best approximated by status quo.

Additional information on the relative salmon savings, AEQ and region of origin impacts under all of the alternatives is contained in Chapter 5.

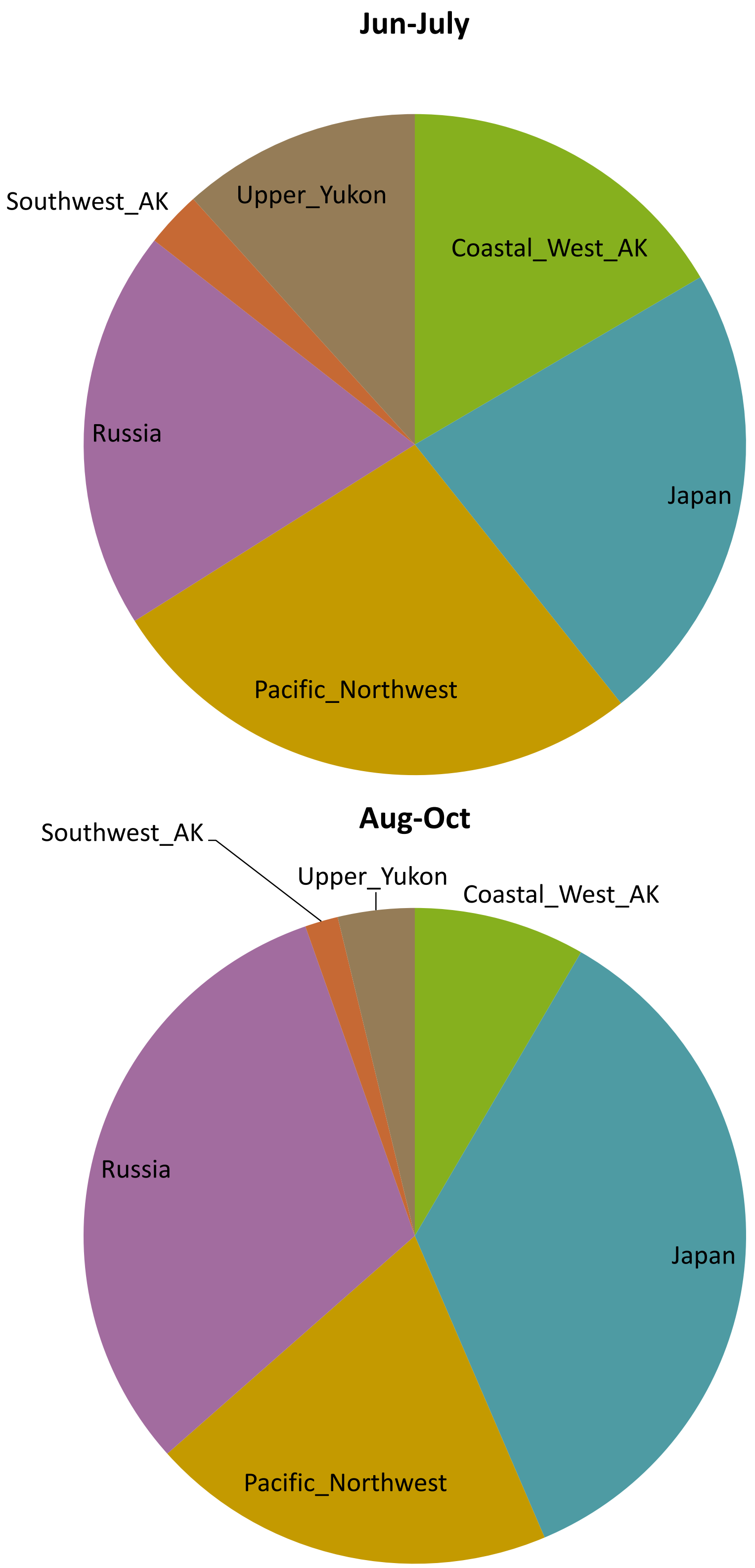


Figure ES-9. Average breakout of bycatch based on genetic analysis by early and late B-season strata, 2005-2009.

Chinook salmon

The pollock fishery catches both chum and Chinook salmon PSC in the B-season. The timing of this catch is dissimilar amongst the two species, with Chinook salmon caught in the latter part of the B season and chum salmon caught throughout the B season (Figure ES-10).

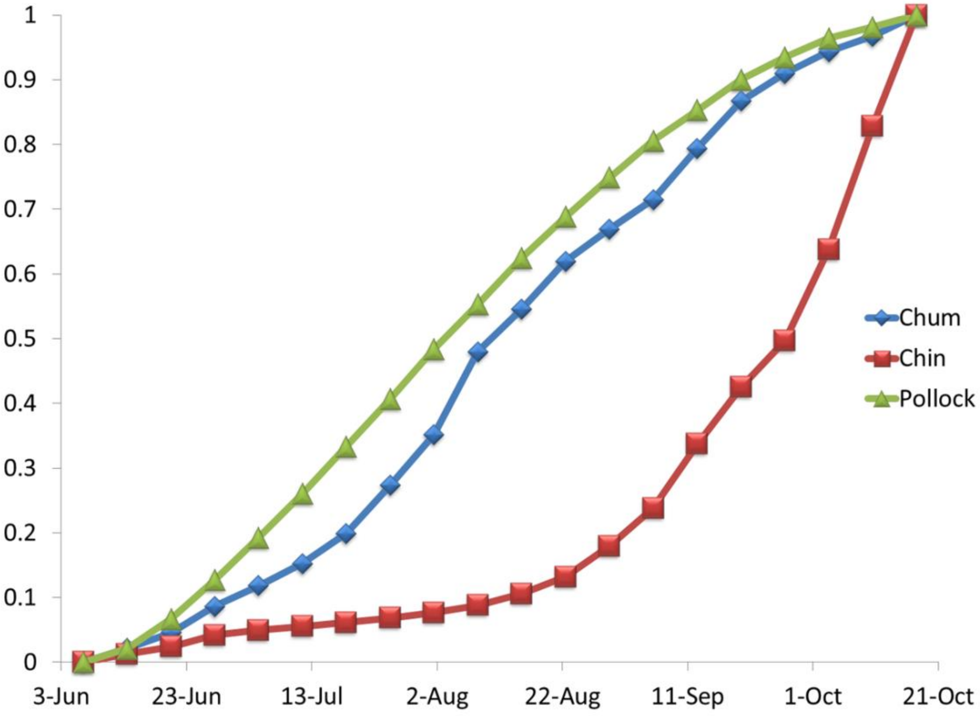


Figure ES-10. Mean relative values of pollock catch (triangles) compared with catch of chum (diamonds) and Chinook (squares) salmon species in the pollock fishery during the B-season.

Policy decisions for alternative management measures for chum must also consider the potential impact on the catch of Chinook salmon as a result of imposing additional management measures on the same pollock fishery. The 2011 A-season was the first season of management under the new bycatch management program implemented by Amendment 91. Incidental catch of Chinook salmon by the pollock fishery participants in the 2011 A-season indicated that pollock fishery participants remained well below their limits with a total A-season bycatch of 6,706 fish. This compares to Chinook salmon bycatch ranging from 7,661 fish in the A season of 2010 to 69,408 fish in the A season of 2007, thus Chinook bycatch in 2011 so far is much lower than in the recent 5 years.

For Alternative 2, hard caps for chum salmon, the impact on Chinook will likely result in lower levels of bycatch since for many years, the fishery is closed relatively early and Chinook bycatch tends to increase later in the B-season. Analysis of closure configurations under Alternative 3 indicates that many of the area closures benefit both chum and Chinook salmon savings. The early part of the season (June-July) on average tends to save a higher percentage of Chinook salmon compared to later for the different cap, sector splits, and trigger closure options. However, since the total Chinook bycatch is relatively low in the early period, the impact of the chum salmon trigger closures would tend to reduce Chinook bycatch by about 3% on average. Note that the variability about this result indicates that in some years, in particular years when high Chinook bycatch, the chum measures will make Chinook bycatch levels worse. Compared to the non-Chinook measures, the impact of lower cap levels on relative salmon savings was similar in direction (lower cap meaning more Chinook salmon saved) but not as beneficial. Additional information on the estimated impacts of chum management measures on Chinook salmon is contained in Chapter 6.

Economic Impacts of the Alternatives

The RIR provides an overview of the economic impacts of the alternatives in terms of **salmon saved** by imposing the proposed management measures as a reflection of the costs and benefits to salmon dependent subsistence, recreational, and commercial fisheries and communities. The RIR also summarizes the estimated cost of the alternatives on the directed pollock fishery and pollock fishery dependent communities. Detailed tables of salmon saved, forgone revenue, and revenue at risk are contained in the RIR and not repeated here.

The RIR analyzes the benefits of the estimated changes in chum salmon savings under the alternatives. The AEQ estimates represent the potential benefit in numbers of adult chum salmon that would have returned to aggregate regions as applicable in the years 2003 to 2010. These benefits would accrue within natal river systems of stock origin as returning adult fish that may return to spawn or be caught in subsistence, commercial, or sport fisheries. Exactly how those fish would be used is the fundamental question to answer in order to provide a balanced treatment of costs and benefits.

Measuring the potential economic benefit of chum salmon saved, in terms of effects on specific subsistence, commercial, sport, and personal use fisheries is difficult. The proportion of AEQ estimated chum salmon that might be taken in each of the various fisheries is a function of many variables, including overall run strength, subsistence management strategies, commercial management strategies, availability of commercial markets, the effect of weather on catch (e.g., high water), and potentially, on management of other salmon runs. Lacking estimates of the proportion of AEQ chum salmon that would be caught by each user group, it is not possible to estimate economic benefits in terms of gross revenues or other monetary values for those user groups due to changes in AEQ chum salmon estimated for each alternative

The proposed action is not designed to close the pollock fishery; it is intended to create incentives for pollock fishermen to avoid non-Chinook salmon. Thus, the impacts on the pollock industry are reported as potentially forgone gross revenue or revenue at risk, depending on alternative, and are not reported as industry losses of revenue. The RIR does not identify these estimates as lost revenue specifically because mitigation of the impacts via harvesting behavior changes are expected, as that is the point of incentivizing avoidance of PSC. The Council's intent is to incentivize non-Chinook salmon PSC avoidance in order to reduce it in all years of abundance, and the caps used in the potentially forgone gross revenue analysis is one part of the incentive. The implication is that the pollock industry will change behavior so that they do not face all of the potential forgone gross revenue, and/or revenue at risk estimated in the analysis, as direct losses in revenue due to direct reduction in pollock harvest.

While the hard caps (Alternative 2) have the potential effect of fishery closure and resulting forgone pollock fishery gross revenues, the triggered closures (Alternatives 3 and 4) do not directly create forgone earnings, but rather, they place revenue at risk of being forgone. When the closure is triggered, vessels must be relocated outside the closure areas and operators must attempt to catch their remaining allocation of pollock TAC outside the closure area. Thus, the revenue associated with any remaining allocation is placed at risk of not being earned, if the fishing outside the closure area is not sufficiently productive to offset any operational costs associated with relative harvesting inefficiencies outside the closure area.

The greatest adverse economic impact on the pollock fishery would have occurred in the highest PSC year (2005) and under the most restrictive PSC cap of 50,000 non-Chinook salmon where scenario 1 estimates are approximately $489 million would potentially have been forgone. That gross value is composed of $214 million from the CV sector, $206 million from the CP sector, $51million from the Mothership sector, and $19 million from CDQ pollock fisheries.

As is expected, as the hard cap amount increases, the adverse economic impacts on the pollock fisheries decrease, all else being equal. As the hard cap level is increased to 200,000 fish the potentially forgone revenue estimates are, as expected, lower and the hard cap is a binding constraint in fewer years. What is also apparent is that the potentially forgone revenue accrues mostly, an in some cases only, in the CV sector. This is simply a function of the CV sector having the highest proportion of non-Chinook PSC of all sectors. As the hard cap level is increased to 353,000 fish the potentially forgone revenue estimates continue to decline relative to the two lower caps and the impacts accrue mostly, an in some cases only, in the CV sector. As is the case of the 200,000 fish cap, this is simply a function of the CV sector having the highest proportion of non-Chinook PSC of all sectors.

Comparing the alternatives on the relative impact on chum salmon savings (in terms of AEQ) together with the relative change in pollock that would be diverted to areas outside of the closed areas suggests that relatively little benefit (in terms of bycatch reduction) is estimated by using low trigger cap levels. For example, computing averages over the different sector allocations and trigger options shows that the benefit for greater salmon savings at lower cap levels was much lower than the relative costs of redistributing pollock fishing effort.

There are several options for triggered area closures under Alternative 3. Summarizing years (2003-2010) and sectors suggests that a trigger closure under Alternative 3, option 3 results in the lowest reduction in bycatch for all sector splits and cap levels. Trigger closure option 2a, which was designed to improve early-season salmon savings in order to target a higher salmon savings during the portion of the season in which a higher relative percentage of the bycatch is of western Alaska stock, performed better than the other options in June-July, particularly for the high cap level. At the low trigger cap level and third sector allocation scheme, option 2a is estimated to perform similar to options 1 and 2. Option 3 performed poorly during the early period, since under this option, closures would generally occur later in the season since cap limits are based on season rather than monthly limits.

Under the alternatives to the status quo, fishermen would be expected to attempt to minimize losses associated with potentially forgone gross revenue and/or revenue placed at risk by altering their current operations. These reactions could include the following: (1) mitigating a triggered area closure by re-deploying fishing effort, using the same fishing gear and methods, to known adjacent fishing grounds that may be equally or only somewhat less productive (similar CPUE) than the fishing grounds lost to the salmon PSC minimization measure; (2) avoiding non-Chinook salmon PSC by re-deploying fishing effort to an area of unknown productivity and operational potential, using the identical fishing gear, in an exploratory mode; (3) switching to a different target fishery if possible; and (4) mitigating the risk of a hard cap induced closure by speeding up harvesting and processing activities (race for fish). Each of these strategies may have operational cost implications. While empirical data on operating cost structure at the vessel or plant level are not available, cost trends for key inputs may shed some light on the probable impacts of the fishing impact minimization alternatives on the pollock industry in the aggregate and on average.

Any regulatory action that requires an operator to alter his or her fishing pattern, whether in time or space, is likely to impose additional costs on that operator. The alternative non-Chinook salmon PSC management actions may affect the operating costs of the pollock fleet, compared to the status quo condition, with the degree of those effects necessarily dictated by the extent to which hard cap and/or triggered closures constrain harvests. The RIR addresses this issue in terms of both fixed and variable costs. Fixed costs tend to arise from investment decisions and variable costs arise from short-run production decisions. As the terms imply, fixed costs are those that do not change in the short run, no matter what the level of activity. Variable costs, on the other hand, are those costs that do change directly with the level of activity, recognizing that variable inputs must be used if production exceeds zero.

Clearly, upon attainment of a hard cap, some portion of TAC would remain unharvested, representing forgone gross revenue; however, triggered closures may increase the cost of fishing per unit of the pollock that continue to be caught. Based on information provided by the industry at public meetings and through individual contacts, as well as the professional judgment of the preparers of this RIR, seven categories of costs were defined for consideration, as follows:

- Increased travel costs
- Costs of learning new grounds or using new or modified gear (e.g. excluder devices)
- Costs of PSC avoidance measures, or (if these efforts are unsuccessful) premature closure due to excessive PSC
- Reduced pollock CPUE due to less concentrated target stocks;
- Potential gear conflicts
- Effects on processors (floating or shoreside) built for higher throughput
- Safety impacts

The RIR discusses specific safety-related issues that have been considered with respect to the alternatives. These include the following:

1. Fishing farther offshore,
2. Reduced profitability, and
3. Changes in risk.

Additional information on all of the categories of cost and safety-related issues are discussed in detail in the RIR.

Alternative 4 is essentially a rolling hotspot system, similar to the current approach under status quo, with a large area closure for those who do not participate. While impacts in terms of revenue at risk have been provided for Alternative 4 in the RIR, they are intended to identify the considerable incentive for participation in the rolling hotspot system. As such, it appears likely that most, if not all, vessel operators would be motivated to participate in a rolling hotspot system, thereby eliminating any potential revenue at risk under this alternative. As a result, it is not possible to predict whether any vessel may choose not to participate, and thereby have vessel specific revenue at risk, which would potentially generate shoreside value added “at risk” as well. Thus, the analysis does not provide that breakout as it would be inappropriate to imply that such a likelihood exists.

Other resources categories analyzed

The EA also evaluated the impact of alternative management measures for chum salmon on several different resources categories: pollock stocks, other marine resources (comprised of marine mammals, seabirds, habitat, ecosystem) and cumulative effects. Impacts of the alternatives for these categories are summarized below.

Pollock stocks

Chapter 4 analyzes the impacts of the alternatives on pollock stocks. Analysis of Alternatives 2, 3, and 4 indicate that these alternatives would make it more difficult to catch the full TAC for Bering Sea pollock compared to Alternative 1. Catching less pollock than authorized under the TAC would reduce the total catch of pollock and reduce the impact of fishing on the pollock stock. However, these alternatives are likely to result in fishermen shifting where they fish for pollock to avoid chum salmon bycatch. Changes in where pollock fishing occurs were shown to likely change the size—and by extension—age to younger smaller pollock which would potentially impact future ABC limits established for the pollock stocks.

The impact of Alternative 3 (triggered closures) on pollock fishing was evaluated in a similar way. The assumption that the pollock TAC may be fully harvested depends on the availability of pollock outside of triggered closures. The data show that in some years, the catch rate is consistently higher outside of the trigger area whereas in other years it is consistently lower for at-sea processors and inshore CVs and for the fleet as whole. The impact of a triggered area closure depends on when the closure occurs and the spatial characteristics of the pollock stock, which, based on this examination, appears to be highly variable between years. As with the evaluation of hard caps, under Alternatives 2 the same impacts under triggered closures (Alternative 3) would apply; it seems likely that the fleet would fish earlier in the summer season and would tend to fish in places farther away from the core fishing grounds north of Unimak Island (estimated average increased distance from port due to closures was about 8%). Both of these effects would result in catches of pollock that were considerably smaller and younger, less valuable age groups. This impact would, based on future assessments, likely result in smaller TACs since individual pollock sizes would smaller since they would miss the benefits from the summer-season growth.

Because this fishery is extensively monitored, the consequences of possibly catching smaller fish due to this alternative would be accounted for in the procedures for setting ABC and OFL. Namely, that as the “selectivity” of the fishery shifts, then the impact on allowable catch levels would be adjusted appropriately so as to avoid overfishing.

Other marine resources

The impacts of the alternative management measures on marine mammals, seabirds, habitat and the ecosystem are evaluated qualitatively based upon results of the quantitative analysis for chum, Chinook, pollock and economic considerations. Alternative 2, hard caps, is not likely to increase fishery interactions with any of these resources categories, and may result in fewer interactions compared to status quo since the pollock fishery is likely to be closed earlier in the B-season. Under area closures proposed under Alternatives 3 and 4, any closure of an area where marine mammals and seabirds are likely to interact with pollock fishing vessels would likely reduce the potential for incidental takes. The potential reduction would depend on the location and marine mammal species. Closures under Alternatives 3 and 4 would also minimize fishery interactions with the seafloor and benthic habitat.

Cumulative effects

The discussion of cumulative effects includes future actions that may affect the Bering Sea pollock fishery, the salmon caught as bycatch in that fishery, and the impacts of salmon bycatch on the resource components analyzed in this analysis. The future actions considered have been grouped in the following four categories: ecosystem-sensitive management, traditional management tools, actions by other Federal, State, and international agencies and private actions. Details on the actions contained in these categories and the activities considered are contained in Chapter 8.

This section considers the direct and indirect impacts of the proposed action when added to the impacts of past and present actions previously analyzed in other documents (incorporated by reference) and the impacts of the reasonably foreseeable future actions listed.

Policy considerations

In considering a preferred management approach, the Council will evaluate the range of alternatives and the estimated impacts biologically and economically (including impacts to subsistence, commercial, and recreational salmon fishing and commercial pollock fishing) of each alternative. Some comparative information is provided below to compare alternatives in terms of relative chum salmon saved, forgone pollock harvest, pollock revenue at risk (i.e., potentially unrealized economic gain due to closure areas), trade-offs in bycatch reductions for chum salmon compared with Chinook salmon, and relative benefits accrued from reductions in both species. At this time, it is difficult to predict pollock fleet behavior in the 2011 B-season under the first year of operation under Amendment 91, thus it is not possible to estimate how the Chinook salmon bycatch management measures will be affected by any new management measures imposed for chum salmon bycatch.

Comparison of chum salmon saved and forgone pollock harvest

Selection of a preferred alternative involves explicit consideration of trade-offs between the potential salmon saved and the forgone pollock catch, and of ways to maximize the amount of salmon saved and minimize the amount of forgone pollock.

As analyzed Chapters 4 and 5, the impacts of the alternatives on total bycatch numbers and forgone pollock would vary by year. This is due to the annual variability in the rate of chum salmon caught per ton of pollock and annual changes in chum salmon abundance and distribution in the Bering Sea. The RIR examines the relative cost of forgone pollock fishing under Alternative 2 and the revenue at risk under Alternative 3 as well as the potential benefits to subsistence, commercial, and recreational salmon fisheries.

In terms of cap and sector allocation options under Alternative 2, the lowest forgone pollock catches result in expected reductions of chum salmon bycatch by about 20 percent to 45 percent, depending on the sector allocation options (Figure ES-11). For hard cap scenarios that have the highest impact on forgone pollock catch levels, the sector allocation are estimated to have negligible additional improvements on chum salmon saved (Figure ES-11).

Under Alternative 3, options that require a greater proportion of pollock to be diverted elsewhere have diminishing benefits in terms of increased salmon savings (Figure ES-12). Option 2a generally outperforms the other options (i.e., greater reductions in chum salmon) given the same cap and allocation configurations. Option 3 has the lowest estimated levels of pollock diverted relative to the other options and allocation scenarios but also has a relatively low estimated level of salmon saved (Figure ES-12).

The implications of imposing Alternatives 2 or 3 and the associated options indicate that reducing bycatch levels and impacts to Alaskan chum salmon runs can be achieved, but improvements would be relative to the current estimated impacts which are already low (typically less than 1%). The extent that these measures, if enacted without a system like the current RHS program (analyzed under Alternative 1) are less well understood. It is clear that bycatch totals generally increase as run sizes increase. It is also clear that the effectiveness of triggered closure areas will vary from year to year due to the inherent variability and complexity of pollock and chum salmon seasonal and spatial distribution.

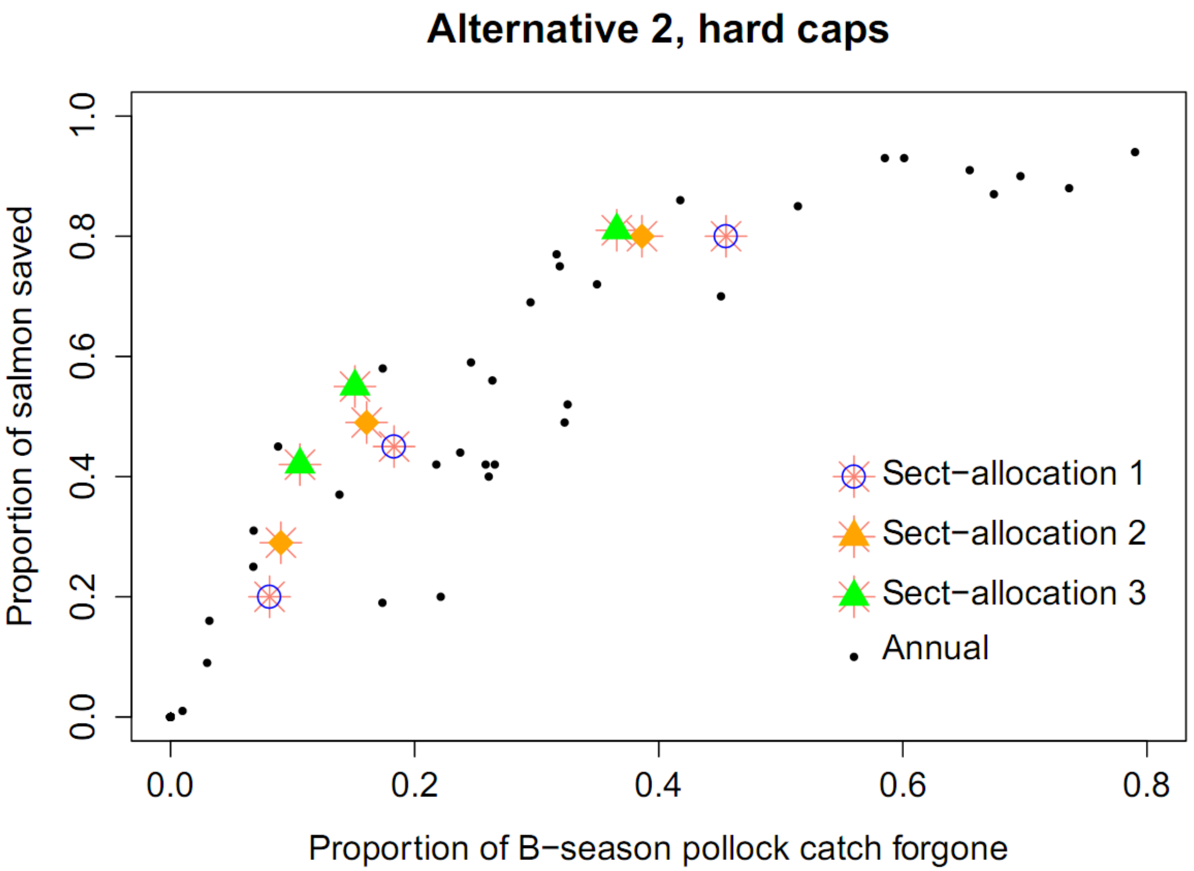


Figure ES-11. Expected (mean) trade-offs between B-season pollock forgone (horizontal axis) and relative salmon saved for **Alternative 2, hard caps** by sector allocation splits and three cap levels (50k chum, 200k chum, and 353k chum). Bullet points represent estimates from annual data (2003-2010).

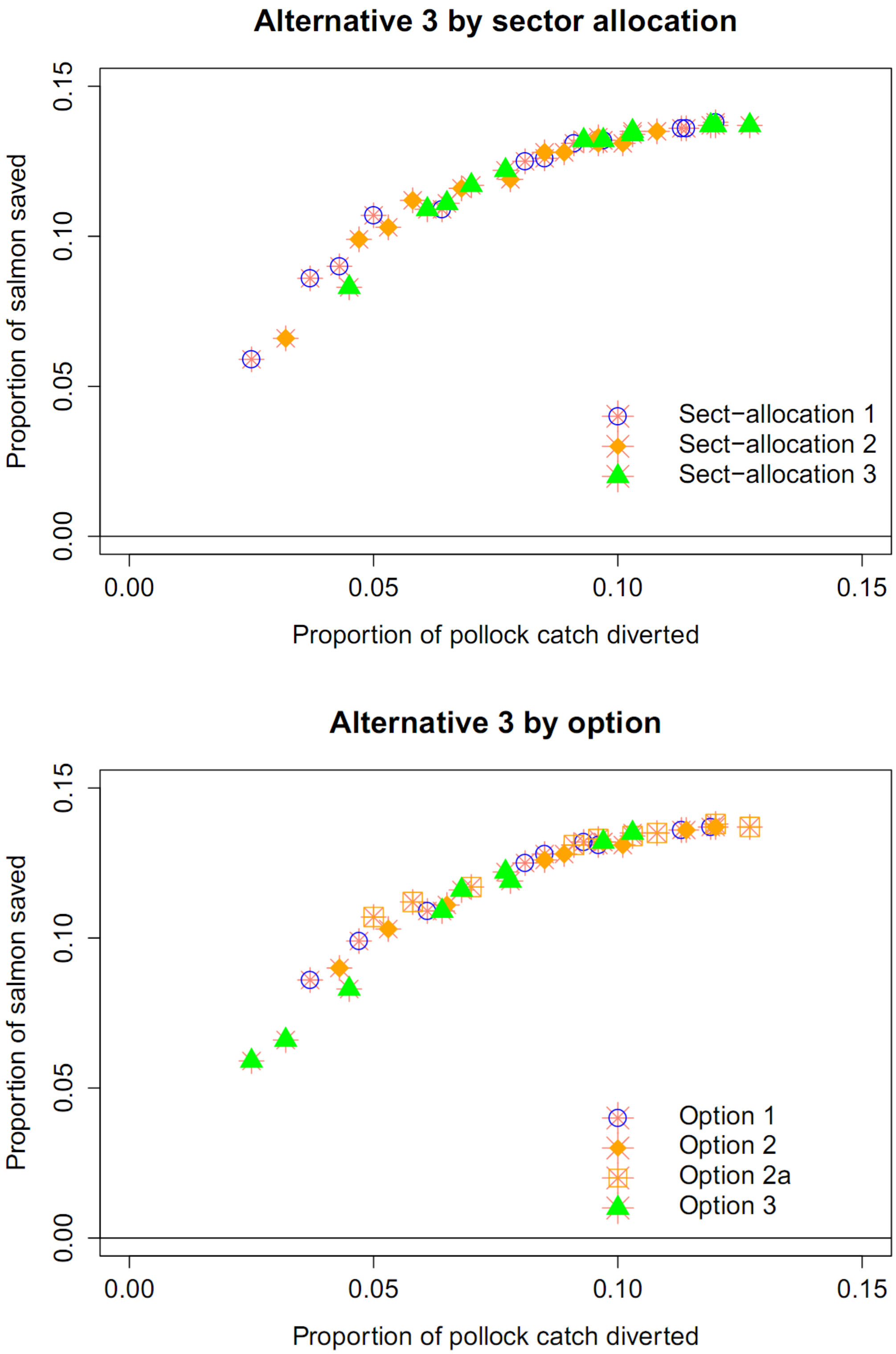


Figure ES-12. Expected (mean) trade-offs between B-season pollock forgone (horizontal axis) and relative salmon saved for **Alternative 3, triggered closures** by sector allocation splits (top) and by options (bottom) with three cap levels (25k chum, 75k chum, and 200k chum)**.**

Rural community outreach

One of the Council's policy priorities is to improve outreach and communication with Alaska Native entities, communities, and rural stakeholders in the development of fishery management actions.[6] The Council's Rural Community Outreach Committee met in August 2009 and recommended that the non-Chinook salmon bycatch issue be a priority for rural outreach, as did the Council's Salmon Bycatch Workgroup, and the Council agreed to undertake an outreach effort with affected community and Native stakeholders prior to and during the development of the draft analysis, well prior to final Council action.

The outreach plan for non-Chinook salmon bycatch management measures was developed by Council staff with input from NMFS, the Council, the Rural Community Outreach Committee, and affected stakeholders. It is intended to improve the Council's decision-making processes on the proposed action, as well as enable ongoing, two-way communication with Alaska Native and rural communities. The outreach plan for the proposed action is maintained and updated on the Council website.[7] The general components of the outreach plan include: several direct mailings to stakeholders prior to important steps in the process and/or Council meetings; rural community outreach meetings; additional outreach (statewide teleconference, radio/newspaper, press releases); and documentation of rural outreach meeting results. In addition, the draft analyses, associated documents, outreach materials, and powerpoint presentations, have been posted on the Council website as the process occurs.

While the outreach plan consists of several components, one of the most significant mechanisms for direct feedback from rural stakeholders has been outreach meetings or presentations to people that depend on salmon in rural communities in western and interior Alaska. The approach to the community outreach meetings was to work with established community representatives, Alaska Native entities, and Tribes within the affected regions, to attend annual or recurring regional meetings, in order to reach a broad group of stakeholders in the affected areas prior to the selection of a preferred alternative by the Council.

Council staff consulted with the coordinators of five of the Federal Subsistence Regional Advisory Councils (RACs), the Association of Village Council Presidents (AVCP), the Tanana Chiefs Conference (TCC), the Yukon River Drainage Fisheries Association (YRDFA), Kawerak, Inc., and the Yukon River Panel, in order to evaluate the potential for time on the agendas of their annual regional meetings.[8] In sum, two Council members and one to two staff analysts attended and presented the preliminary analysis of the alternatives for the proposed action at seven regional meetings, in addition to two meetings with the Yukon River Panel in Anchorage. The meetings were as follows:

Yukon River Panel: December 2010 and April 2011; Anchorage
Yukon River Drainage Fisheries Association annual meeting: February 14 – 17, 2011; Mountain Village
Bering Strait Regional Conference: Feb 22 – 24, 2011; Nome[9]
Yukon-Kuskokwim Delta Regional Advisory Council: February 23 – 24, 2011; St. Mary's
Eastern Interior Regional Advisory Council: March 1 – 2, 2011; Fairbanks
Western Interior Regional Advisory Council: March 1 – 2, 2011; Galena
Bristol Bay Regional Advisory Council: March 9 – 10, 2011; Naknek
Tanana Chiefs Conference annual meeting: March 15 – 19, 2011; Fairbanks

Council staff and members were available to answer questions, and staff documented the results of each meeting. In addition to input that could be incorporated into the impact analysis, the results of the

---

[6] This policy priority is identified in the Council's workplan resulting from the Programmatic SEIS.

[7] http://www.fakr.noaa.gov/npfmc/current_issues/bycatch/ChumOutreach1210.pdf.

[8] Schedule conflicts with Council meetings prevented Council members and staff from attending the October 2010 AVCP annual meeting and the February 2011 Seward Peninsula RAC meeting.

[9] NMFS staff presented the prepared information at this meeting, as Council staff could not get into Nome due to weather.

outreach meetings are provided in the form of an outreach report, included as a supplement to this EA/RIR/IRFA. Please reference the outreach report for details of the meetings, a summary of the input provided, and any formal resolutions resulting from the meetings attended.

TABLE OF CONTENTS

List of Tables

List of Figures

1 Introduction

This Environmental Assessment (EA) provides decision-makers and the public with an evaluation of the predicted environmental effects of alternative measures to minimize chum salmon prohibited species catch (PSC) in the Bering Sea pollock fishery. The Regulatory Impact Review (RIR) provides decision-makers and the public with an evaluation of the social and economic effects of these alternatives to addresses the requirements of Executive Order 12866, Executive Order 12898, and other applicable federal law. The EA/RIR serve as the central decision-making document for the Council to recommend changes in management via an Amendment to the Bering Sea Groundfish FMP to the Secretary of Commerce. The EA and RIR are intended to serve as the central decision-making documents for the Secretary of Commerce to approve, disapprove, or partially approve an amendment, and for the National Marine Fisheries Service (NMFS or NOAA Fisheries) to implement this amendment through federal regulations. This EA complies with the National Environmental Policy Act (NEPA). The RIR addresses the requirements of Executive Order 12866 and Executive Order 12898.

The Council developed the following problem statement for this analysis:

> *Magnuson-Stevens Act National Standards direct management Councils to balance achieving optimum yield with bycatch reduction as well as to minimize adverse impacts on fishery dependent communities. Non-Chinook salmon (primarily made up of chum salmon) prohibited species bycatch (PSC) in the Bering Sea pollock trawl fishery is of concern because chum salmon are an important stock for subsistence and commercial fisheries in Alaska. There is currently no limitation on the amount of non-Chinook PSC that can be taken in directed pollock trawl fisheries in the Bering Sea. The potential for high levels of chum salmon bycatch as well as long-term impacts of more moderate bycatch levels on conservation and abundance, may have adverse impacts on fishery dependent communities.*
>
> *Non-Chinook salmon PSC is managed under chum salmon savings areas and the voluntary Rolling Hotspot System (RHS). Hard caps, area closures, and possibly an enhanced RHS may be needed to ensure that non-Chinook PSC is limited and remains at a level that will minimize adverse impacts on fishery dependent communities. The Council should structure non-Chinook PSC management measures to provide incentive for the pollock trawl fleet to improve performance in avoiding non-Chinook salmon while achieving optimum yield from the directed fishery and objectives of the Amendment 91 Chinook salmon PSC management program. Non-Chinook salmon PSC reduction measures should focus, to the extent possible, on reducing impacts to Alaska chum salmon as a top priority.*

1.1 What is this Action?

The proposed action is to implement new management measures to minimize chum salmon bycatch in the Bering Sea pollock fishery. This EA analyzes alternative ways to manage chum salmon bycatch, including replacing the current Chum Salmon Savings Areas and rolling hotspot system intercooperative agreement (RHS ICA) in the Bering Sea with salmon PSC limits or new regulatory closures based on current salmon bycatch information. The alternatives represent a range of PSC management measures for analysis that assist the decision-makers and the public in determining the best alternative to meet the purpose and need for the action. The alternatives meet the purpose and need by presenting different ways to minimize chum salmon bycatch in the Bering Sea pollock fishery to the extent practicable while achieving optimum yield.

1.2 Purpose and Need for this Action

The purpose of chum salmon PSC management in the Bering Sea pollock fishery is to reduce chum salmon bycatch to the extent practicable, while achieving optimum yield. Minimizing chum salmon bycatch while achieving optimum yield is necessary to maintain a healthy marine ecosystem, ensure long-term conservation and abundance of chum salmon, provide maximum benefit to fishermen and communities that depend on chum salmon and pollock resources, and comply with the Magnuson-Stevens Act and other applicable federal law. National Standard 9 of the Magnuson-Stevens Act requires that conservation and management measures shall, to the extent practicable, minimize bycatch.

National Standard 1 of the Magnuson-Stevens Act requires that conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry. Section 3(33) of the MSA defines optimum yield to mean "the amount of fish which . . . (A) will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems; [and] (B) is prescribed as such on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factor . . . ." NMFS has established in regulations at 50 C.F.R. § 679.20(a)(1)(i) that the optimum yield for the Bering Sea Aleutian Island Management area is a range from 1.4 to 2.0 million metric tons (mt).

The BSAI FMP defines total allowable catch is the annual harvest limit for a stock or stock complex, derived from the acceptable biological catch by considering social and economic factors. NMFS's regulations at 50 C.F.R. § 679.20(a)(2) provide that the sum of the TACs so specified must be within the optimum yield range. The BSAI FMP provides further elaboration of the differences among optimum yield (OY), acceptable biological catch (ABC) and total allowable catch (TAC):

> In addition to definitional differences, OY differs from ABC and TAC in two practical respects. First, ABC and TAC are specified for each stock or stock complex within the "target species" and "other species" categories, whereas OY is specified for the groundfish fishery (comprising target species and other species categories) as a whole. Second, ABCs and TACs are specified annually whereas the OY range is constant. The sum of the stock-specific ABCs may fall within or outside of the OY range. If the sum of annual TACs falls outside the OY range, TACs must be adjusted or the FMP amended (BSAI FMP at 13).

Recognizing that salmon bycatch management measures precluding the pollock fishery from harvesting its entire TAC for any given year are not determinative of whether the BSAI groundfish fishery achieves optimum yield, providing the opportunity for the fleet to harvest the TAC in any given year is one aspect of achieving optimum yield in the long term.

For catch accounting and PSC limits 4 species of salmon (Sockeye, Coho, Pink and Chum) are aggregated into an 'other salmon' or non-Chinook salmon species category. Chum salmon comprises over 99.6% of the total catch in this category (Table 1-1).

Table 1-1 Composition of non-Chinook salmon prohibited species catch by species from 2001-2010. **Source:** NMFS catch accounting, extrapolated from sampled hauls only.

Year	sockeye	coho	pink	chum	Total	% chum
2001	12	173	9	51,001	51,195	99.6%
2002	2	80	43	66,244	66,369	99.8%
2003	29	24	72	138,772	138,897	99.9%
2004	13	139	107	352,780	353,039	99.9%
2005	11	28	134	505,801	505,974	100.0%
2006	11	34	235	221,965	222,245	99.9%
2007	3	139	39	75,249	75,430	99.8%
			Other "non-Chinook salmon"			
2008			78	9,472	9,550	99.2%
2009			260	27,250	27,510	99.1%
2010			82	9,407	9,489	99.1%

The majority of non-Chinook bycatch in the Bering Sea occurs in the pollock fishery. Historically, the contribution of non-Chinook bycatch from the pollock trawl fishery has ranged from a low of 88% of all bycatch to a high of >99.5% in 1993. Since 2002 bycatch of non-Chinook salmon in the pollock fishery has comprised over 95% of the total. Total catch of non-Chinook salmon in the pollock fishery reached an historic high in 2005 at 704,586 fish (Table 1-2). Bycatch of non-Chinook salmon in this fishery occurs almost exclusively in the B season. Previously the historic high was 242,000 in 1993 (prompting previous Council action to enact the Chum Salmon Savings Area (SSA). In recent years bycatch levels for chum salmon have been much lower than levels seen between 2003-2006, and in 2010 bycatch was approximately 13,000 fish.

Table 1-2 Non-Chinook (chum) salmon mortality in BSAI pollock directed fisheries 1991-2010. Note 2010 updated 1/14/11.

Year	Annual with CDQ	Annual without CDQ	Annual CDQ only	A season with CDQ	B season with CDQ	A season without CDQ	B season without CDQ	A season CDQ only	B season CDQ only
1991	Na	28,951	na	na	na	2,850	26,101	na	na
1992	Na	40,274	na	na	na	1,951	38,324	na	na
1993	Na	242,191	na	na	na	1,594	240,597	na	na
1994	92,672	81,508	11,165	3,991	88,681	3,682	77,825	309	10,856
1995	19,264	18,678	585	1,708	17,556	1,578	17,100	130	456
1996	77,236	74,977	2,259	222	77,014	177	74,800	45	2,214
1997	65,988	61,759	4,229	2,083	63,904	1,991	59,767	92	4,137
1998	64,042	63,127	915	4,002	60,040	3,914	59,213	88	827
1999	45,172	44,610	562	362	44,810	349	44,261	13	549
2000	58,571	56,867	1,704	213	58,358	148	56,719	65	1,639
2001	57,007	53,904	3,103	2,386	54,621	2,213	51,691	173	2,930
2002	80,782	77,178	3,604	1,377	79,404	1,356	75,821	21	3,583
2003	189,185	180,783	8,402	3,834	185,351	3,597	177,186	237	8,165
2004	440,459	430,271	10,188	422	440,037	395	429,876	27	10,161
2005	704,586	696,876	7,710	595	703,991	563	696,313	32	7,678
2006	309,644	308,430	1,214	1,326	308,318	1,260	307,170	66	1,148
2007	93,786	87,317	6,469	8,523	85,263	7,368	79,949	1,155	5,314
2008	15,142	14,717	425	319	14,823	246	14,471	73	352
2009	46,129	45,179	950	48	46,081	48	45,131	0	950
2010	13,306	12,789	517	48	13,258	48	12,741	0	517

Non-CDQ data for 1991-2002 from bsahalx.dbf Non-CDQ data for 2003-2009 from akfish_v_gg_pscnq_estimate CDQ data for 1992-1997 from bsahalx.dbf
CDQ data for 1998 from boatrate.dbf
CDQ data for 1999-2007 from akfish_v_cdq_catch_report_total_catch
CDQ data for 2008-2009 from akfish_v_gg_pscnq_estimate_cdq
A season - January 1 to June 10
B season - June 11 to December 31

Several management measures are currently used to reduce chum salmon bycatch in the Bering Sea pollock fishery. Chum salmon taken incidentally in groundfish fisheries are classified as prohibited species and, as such, must be either discarded or donated through the Prohibited Species Donation Program. In the mid-1990s, NMFS implemented regulations recommended by the Council to control the bycatch of chum salmon taken in the Bering Sea pollock fishery. These regulations established the Chum Salmon Savings Areas and mandated year-round accounting of chum salmon bycatch in the trawl fisheries. The savings area was adopted based on historic observed salmon bycatch rates and was designed to avoid areas with high levels of chum salmon bycatch.

The Chum Salmon Savings Area in the Bering Sea is a time-area closure designed to reduce overall non-Chinook salmon bycatch in the federal groundfish trawl fisheries. This time-area closure was adopted based on historically observed salmon bycatch rates and was designed to avoid areas and times of high non-Chinook salmon bycatch. The Chum Salmon Savings Area is closed to pollock fishing from August 1 through August 31 of each year. Additionally, if the prohibited species catch limit of 42,000 non-Chinook salmon are caught by vessels using trawl gear in the Catcher Vessel Operational Area during the period August 15 through October 14, the Chum Salmon Savings Area remains closed to directed fishing for pollock for the remainder of the period September 1 through October 14.

The Council started considering revisions to salmon bycatch management in 2004, when information from the fishing fleet indicated that it was experiencing increases in Chinook and chum salmon bycatch following the regulatory closure of the Chinook Salmon Savings Areas. This indicated that, contrary to the original intent of the savings area closures, Chinook and chum salmon bycatch rates appeared to be higher outside of the savings area than inside the area. While, upon closure, the non-CDQ fleet could no longer fish inside the Chinook and Chum Salmon Savings Area, vessels fishing on behalf of the CDQ groups were still able to fish inside the area because the CDQ groups had not yet reached their portion of the Chinook salmon prohibited species catch limit. Much higher salmon bycatch rates were reportedly encountered outside of the closure areas by the non-CDQ fleet than experienced by the CDQ vessels fishing inside. Further, the closure areas increased costs to the pollock fleet and processors.

To address this problem, the Council examined other means that were more flexible and adaptive to minimize salmon bycatch. The Council developed and recommended Amendment 84 to the BSAI FMP to implement in federal regulations the RHS ICA and an exemption to the Chinook and Chum Salmon Savings Areas for vessels that participated in the RHS ICA. In 2002, participants in the pollock fleet started the RHS ICA for Chinook and Chum salmon. The exemption to area closures for the RHS ICA was first implemented through an exempted fishing permit in 2006 and 2007 subsequently, in 2008, through Amendment 84 to the BSAI FMP. The RHS ICA was intended to increase the ability of pollock fishery participants to minimize salmon bycatch by giving them more flexibility to move fishing operations to avoid areas where they experience high rates of salmon bycatch.

The Council took separate action to minimize Chinook salmon bycatch in the Bering Sea pollock fishery under Amendment 91 to the BSAI Groundfish FMP. This management program implements sector and seasonal caps on the pollock fishery. In January 2011, the fishery began operating under Amendment 91 regulations. The fishery will operate under the regulations to implement Amendment 91 beginning in January 2011. Additional information on Amendment 91 and management and monitoring modifications as a result of this program are contained in Chapter 2.

The Council is now considering separate management actions to reduce bycatch of chum salmon in the Bering Sea pollock fishery.

1.3 The Action Area

The action area effectively covers the Bering Sea management area in the exclusive economic zone (EEZ), an area extending from 3 nm from the State of Alaska’s coastline seaward to 200 nm (4.8 km to 320 km). The Bering Sea EEZ has a southern boundary at 55° N. latitude from 170° W. longitude to the U.S.-Russian Convention line of 1867, a western boundary of the U.S.-Russian Convention Line of 1867, and a northern boundary at the Bering Strait, defined as a straight line from Cape Prince of Wales to Cape Dezhneva, Russia.

Impacts of the action may also occur outside the action area in the freshwater origins of the chum salmon caught as bycatch and in the chum salmon migration routes between their streams of origin and the Bering Sea. Chum salmon caught as bycatch in the Bering Sea pollock fishery may originate from Asia, Alaska, Canada, or the western United States.

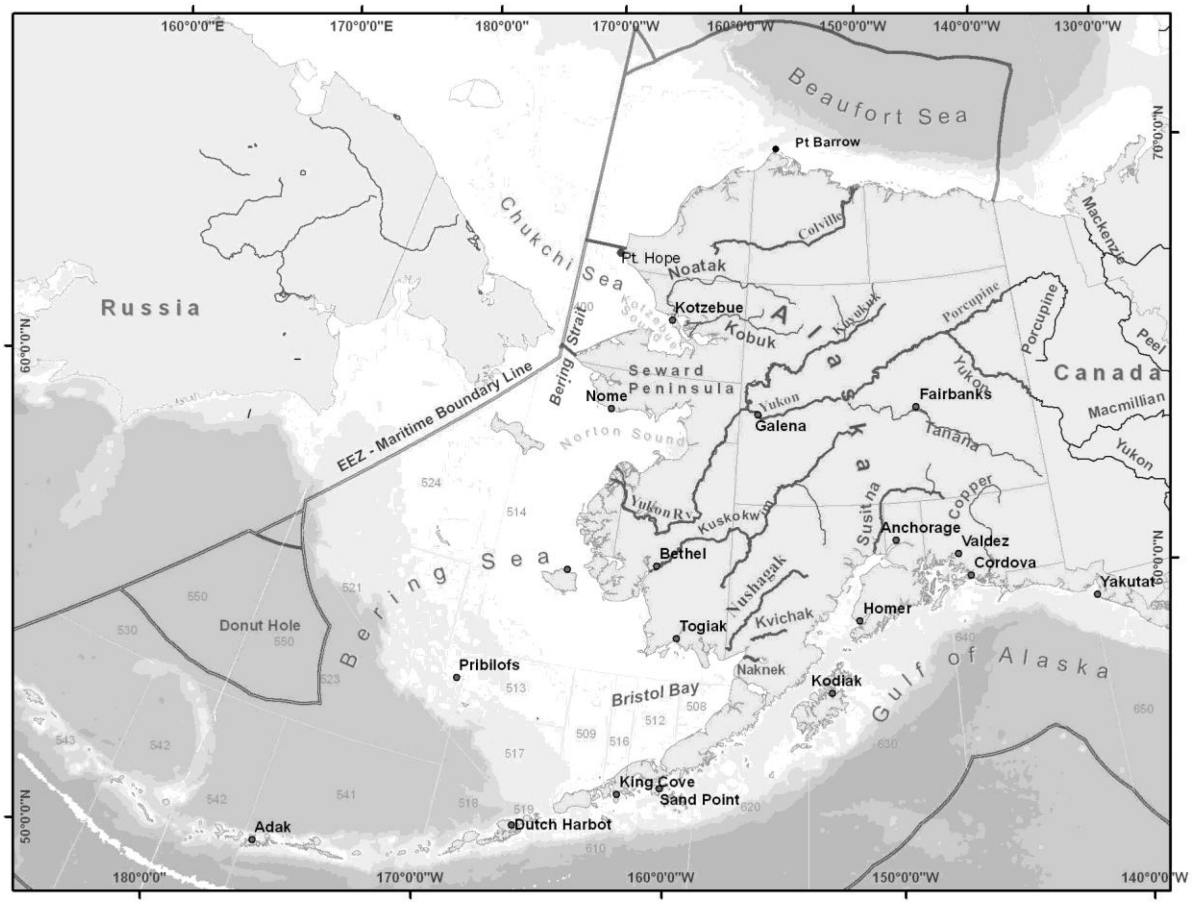


Figure 1-1 Map of the Bering Sea and major connected salmon producing rivers in Alaska and Northwest Canada

A comprehensive description of the action area is contained in previous EISs prepared for North Pacific fishery management actions. The description of the affected environment is incorporated by reference from Chapter 3 of the Programmatic Supplemental Environmental Impact Statement for the Alaska Groundfish Fisheries (PSEIS, NMFS 2004) and Chapter 3 of the Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska (EFH EIS, NMFS 2005a). These documents contain extensive information on the fishery management areas, marine resources, habitat, ecosystem, social, and economic parameters of the pollock fishery. Both of these public documents are available on the NMFS Alaska Region website.[10]

A large body of information exists on the life histories and general distribution of salmon in Alaska. The locations of many freshwater habitats used by salmon are described in documents organized and maintained by the Alaska Department of Fish & Game (ADF&G). Alaska Statute 16.05.871 requires ADF&G to specify the various streams that are important for spawning, rearing, or migration of anadromous fishes. This is accomplished through the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* (ADF&G 1998a) which lists water bodies documented to be used by anadromous fish, and the *Atlas to the Catalog of Waters Important for Spawning, Returning or Migration of Anadromous Fishes* (ADF&G 1998b), which shows locations of these waters and the

---

[10] http://alaskafisheries.noaa.gov/

species and life stages that use them. Additional information on salmon streams is available from the ADF&G website.[11]

1.4 The Bering Sea pollock fishery

Pollock is a commercially targeted species distributed in the North Pacific from Central California to the southern Sea of Japan. Currently, this species comprises a major portion of the BSAI finfish biomass and supports the largest single species fishery in the U.S. EEZ. The economic character of the fishery centers on the products produced from pollock: roe (eggs), surimi, and fillet products. In 2007, the total first wholesale gross value of retained pollock was estimated to be $1.248 billion. In 2008, the total value of pollock increased to an estimated $1.415 billion.

Within the BSAI management area, pollock is managed as three separate stocks: the Eastern Bering Sea, the Aleutian Islands region stock, and the Aleutian Basin or Bogoslof stock. The largest of these stocks, the Eastern Bering Sea stock, is the primary target of the pollock fishery. Since 1977, average annual catch of pollock in the Bering Sea has been 1.2 million tons while reaching a peak of catch of nearly 1.5 million tons in 2006.

Until 1998, the Bering Sea pollock fishery was managed as an open access fishery, commonly characterized as a “race for fish.” In 1998, however, Congress enacted the American Fisheries Act (AFA) to rationalize the fishery by limiting participation and allocating specific percentages of the Bering Sea directed pollock fishery total allowable catch (TAC) among the competing sectors of the fishery.

Sections 206(a) and (b) of the AFA establish the allocation of the Bering Sea pollock TAC among four AFA sectors. First, 10% of the Bering Sea pollock TAC is allocated to the CDQ Program. Then, NMFS reduces the remainder of the TAC by an amount of pollock that will be harvested as incidental catch in the non-pollock fisheries. In 2009, the incidental catch allowance for Bering Sea pollock was 29,340 mt. The remaining amount, after subtraction of the CDQ allocation and the incidental catch allowance, is called the directed fishing allowance. As required under the AFA, NMFS then allocates the directed fishing allowance among the three remaining AFA sectors (the “non-CDQ sectors”): 50% to the inshore catcher vessel (CV), 40% to the offshore catcher processor (CP), and 10% to the mothership sector (MS). Because the percentage of the TAC allocated to each of the four AFA sectors is specified in the AFA, transfer of pollock among the sectors is not allowed.

Pollock allocations to the AFA sectors are further divided into two seasons – 40% to the A season (January 20 to June 10) and the 60% to the B season (June 10 to November 1). NMFS may add any under harvest of a sector’s A season pollock allowance to the subsequent B season allowance. Typically, the fleet targets roe –bearing females in the A season and harvests the A season TAC by early April. The B season fishery focuses on pollock for filet and surimi markets and the fleet harvests most the B season TAC in September and October.

In addition to the required sector level allocations of pollock, the AFA allowed for the development of pollock industry cooperatives. Ten such cooperatives were developed as a result of the AFA: seven inshore cooperatives, two offshore cooperatives, and one mothership cooperative. These cooperatives are described below in more detail. All cooperatives are required to submit final annual written reports on fishing activity including prohibited species catch (PSC) on an area-by-area and vessel by vessel basis. NMFS and the Council are required by the AFA to release this information to the public.

---

[11] http://www.state.ak.us/adfg/habitat

1.4.1 Community Development Quota Program

The CDQ Program was established by the Council in 1992 to improve the social and economic conditions in western Alaska communities by facilitating their economic participation in the BSAI fisheries. The CDQ Program was developed to redistribute some of the BSAI fisheries' economic benefits to adjacent communities by allocating a portion of commercially important BSAI species including pollock to such communities. Their initial 7.5% allocation of pollock was expanded to 10% with the enactment of the AFA. These allocations are further allocated among the 6 CDQ groups: the Aleutian Pribilof Island Community Development Association (APICDA), the Bristol Bay Economic Development Corporation (BBEDC), the Central Bering Sea Fishermen's Association (CBSFA), the Coastal Villages Region Fund (CVRF), the Norton Sound Economic Development Corporation (NSEDC), and the Yukon Delta Fisheries Development Association (YDFDA). The percentage allocations of pollock among the six CDQ groups were approved by NMFS in 2005 based on recommendations from the State of Alaska. These percentage allocations are now the required allocations of pollock among the CDQ groups under section 305(i)(1)(B) of the Magnuson-Stevens Act. CDQ groups typically sell or lease their Bering Sea pollock allocations to various harvesting partners. The vessels harvesting CDQ pollock are the same vessels conducting AFA non-CDQ pollock harvesting. More detailed information on the CDQ Program is contained in the RIR.

1.4.2 Inshore catcher vessel sector

Each year, catcher vessels eligible to deliver pollock to the seven eligible AFA inshore processors may form cooperatives associated with a particular inshore processor. These catcher vessels are not required to join a cooperative and those that do not join a cooperative are managed by NMFS under the "inshore open access fishery." Usually, all inshore catcher vessels have joined one of seven inshore cooperatives. Annually, NMFS allocates the inshore sector's allocation of pollock among the inshore cooperatives and, if necessary, the inshore open access fishery. NMFS permits the inshore cooperatives, allocates pollock to them, and manages these allocations through a regulatory prohibition against an inshore cooperative exceeding its pollock allocation.

The inshore CV cooperatives are required to submit copies of their contracts to NMFS annually. These contracts must contain the information required in NMFS regulations, including information about the cooperative structure, vessels that are parties in the contract, and the primary inshore processor that will receive at least 90 percent of the pollock deliveries from these catcher vessels. Each catcher vessel in a cooperative must have an AFA permit with an inshore endorsement, a license limitation program permit authorizing the vessel to engage in trawl fishing for pollock in the Bering Sea, and no sanctions on the AFA or license limitation program permits. Although the contract requirements are governed by NMFS regulations, compliance with the provisions of the contract (primarily the 90 percent processor delivery requirements) are not enforced by NMFS, but are enforced through the private contractual arrangement of the cooperative.

Once an inshore cooperative's contract is approved by NMFS, the cooperative receives an annual pollock allocation based on the catch history of vessels listed in a cooperative contract. The annual pollock allocation for the inshore CV sector is divided up by applying a formula in the regulations which allocates catch to a cooperative or the inshore open access fishery according to the specific sum of the catch history for the vessels in the cooperative or the limited access fishery. Under § 679.62(a)(1), the individual catch history of each vessel is equal to the sum of inshore pollock landings from the vessel's best 2 of the 3 years 1995 through 1997, and includes landings to catcher/processors for vessels that made landings of 500 mt or more to catcher/processors from 1995 through 1997. Each year, fishing permits are issued to the inshore cooperative, with the permit application listing all cooperative member catcher vessels.

An inshore CV open access fishery could exist if vessels choose not to join a cooperative in a given year. In this case, the inshore CV pollock allocation would be partitioned to allow for an allocation to the limited access fishery. The TAC for the inshore open access fishery is based on the portion of total sector pollock catch associated with the vessels not participating in one of the inshore CV cooperatives.

1.4.3 Offshore catcher/processor cooperatives and mothership cooperatives

Separate allocations of the Bering Sea pollock TAC are made annually to the offshore CP sector and the mothership sector. These sector allocations of pollock are not further subdivided by NMFS among the vessels or companies participating in these sectors. However, through formation of cooperatives and under private contractual arrangement, participants in the offshore CP sector and the mothership sector further subdivide their respective pollock allocations among the participants in their sector. The purpose of these cooperatives is to manage the allocations made under the cooperative agreements to ensure that individual vessels and companies do not harvest more than their agreed upon share. The cooperatives also facilitate transfers of pollock among the cooperative members, enforcement of contract provisions, and participation in the VRHS ICA.

Two fishery cooperatives are authorized by the AFA to form in the offshore CP sector and the offshore catcher vessels sector. A single cooperative may form that includes both CPs and named offshore catcher vessels delivering to CPs, or the CP and CV may form separate cooperatives and enter into an inter-cooperative agreement to govern fishing for pollock in the offshore CP sector. The offshore CP sector elected to form two cooperatives. The Pollock Conservation Cooperative (PCC) was formed in 1999 and is made up of nineteen CPs that divide the sector’s overall pollock allocation. The AFA listed 20 eligible CPs by name and also allowed eligibility for any other CP that had harvested more than 2,000 metric tons of pollock in 1997 and was eligible for the license limitation program. One CP, the Ocean Peace, met the requirements for an “unlisted catcher/processor” under the AFA and is part of the offshore CP sector. The Ocean Peace fished for pollock from 1999 through 2001 and again in 2008. Under the requirements of the AFA, unlisted CPs may harvest up to 0.5% of the offshore CP sector’s allocation of pollock. The Ocean Peace is not part of the PCC.

The High Seas Catcher Cooperative (HSCC) consists of seven catcher vessels that formerly delivered pollock to CPs. These catcher vessels must either deliver to the PCC or lease their allocation to the PCC. The HSCC has elected to lease its pollock allocation to the PCC.

Catcher vessels delivering to motherships have formed a cooperative called the Mothership Fleet Cooperative (MFC). Under the AFA, fishery cooperatives are authorized to form in the mothership sector if at least 80 percent of the catcher vessels delivering to motherships enter into a fishery cooperative. The three motherships also are eligible to join the cooperative and retain a limited anti-trust exemption under the Fisherman’s Collective Marketing Act. The three motherships in this sector have not formed a separate cooperative and are not members of the MFC.

1.5 Public Participation

The EA and RIR are being developed with several opportunities for public participation. This section describes these avenues for public participation.

1.5.1 Scoping

Scoping is an early and open process for determining the scope of issues to be addressed in an EA or EIS and for identifying the significant issues related to the proposed action. A principal objective of scoping and public involvement process is to identify a range of reasonable of management alternatives that will delineate critical issues and provide a clear basis for distinguishing among those alternatives and selecting a preferred alternative. Through the notice of intent, we notified the public that a NEPA analysis and decision-making process for this proposed action has been initiated so that interested or affected people may participate and contribute to the final decision.

Scoping is the term used for involving the public in the NEPA process at its initial stages. Scoping is designed to provide an opportunity for the public, agencies, and other interest groups to provide input on potential issues associated with the proposed action. Scoping is used to identify the environmental issues related to the proposed action and identify alternatives to be considered in the analysis. Scoping is accomplished through written communications and consultations with agency officials, interested members of the public and organizations, Alaska Native representatives, and State and local governments.

The formal scoping period began with the publication of a Notice of Intent in the *Federal Register* on January 8, 2009 (74 FR 798). Public comments were due to NMFS by March 23, 2009. In the Notice of Intent, NMFS requested written comments from the public on the range of alternatives to be analyzed and on the environmental, social, and economic issues to be considered in the analysis. This scoping report summarizes issues and alternatives raised in public comments submitted during this scoping period.

Additionally, members of the public have the opportunity to comment during the Council process. The Council has noticed the public when it is scheduled to discuss non-Chinook salmon bycatch issues. The Council process, which involves regularly scheduled and noticed public Council meetings, ad-hoc industry meetings, and Council committee meetings, started before this formal scoping process and will continue after this formal scoping process is completed.

1.5.2 Summary of Alternatives and Issues Identified During Scoping

NMFS received 4 written comments from the public and interested parties.

1.5.2.1 Alternative management measures identified during scoping

The Council and NMFS will consider the alternatives identified during scoping in the analysis. The Council and NMFS will determine the range of alternatives to be analyzed that best accomplish the proposed action's purpose and need. The analysis describes the alternatives raised during scoping that were considered but not carried forward, and discuss the reasons for their elimination from further detailed study. Comments identified the following alternatives for consideration:

- Analyze a range of hard caps from 50,000 non-Chinook salmon to 400,000 non-Chinook salmon and their likely impacts to Western Alaska.
- The hard cap should be from 70,000 non-Chinook to 77,000 non-Chinook salmon.
- The hard cap should be less than or equal to 70,000 non-Chinook salmon because this amount appears to allow in-river escapement, subsistence harvest consistent with ANILCA, and Canadian border passage goals to be achieved, while providing for traditional in-river commercial fishing opportunities.
- Any pollock fishery management actions aimed at reducing salmon bycatch by altering time, area, and/or fishing methods must be used in conjunction with a hard cap threshold beyond which additional bycatch is prohibited.
- Develop a research and monitoring plan to identify information needed to establish an optimal bycatch level based on improved genetic stock-specific information.

1.5.2.2 Issues identified during scoping

The comments received through the scoping process identified the following issues. To the extent practicable and appropriate, the analysis will take these issues into account.

- NEPA mandates the preparation of an EIS because the proposed chum salmon bycatch measures would be a significant action because they are likely to be controversial and to have substantial environmental, social, and economic impacts.
- The purpose of the proposed action should be to reduce BSAI salmon bycatch to levels which facilitate and provide for healthy returns of in-river fish both in Alaska and the Yukon River in Canada. Healthy returns mean adequate escapement and sufficient opportunity to meet subsistence harvest needs. Healthy returns also would allow for the taking of additional fish for historical non-subsistence harvest and would allow the U.S. to meet its international treaty obligations to Canada.
- Evaluate the impacts of anticipate climate change and how changes to ocean temperatures are impacting oceanic circulation and nutrient flow, and how these changes affect salmon diet, competition, predation, and migration.
- Identifying salmon bycatch stock of origin and age at maturity would assist significantly in understanding the impact of pollock fishery bycatch to in-river salmon returns not only in Alaska but for Pacific Northwest threatened and endangered salmon stocks as well. Collecting samples of salmon from the pollock fishery bycatch could inform non-Chinook salmon management decisions in both marine and in-river fisheries.
- Relying on inaccurate data could make NMFS think there are more fish in the sea than there actually are

1.6 Tribal governments and Alaska Native Claims Settlement Act regional and village corporations

NMFS is obligated to consult and coordinate with Federally recognized tribal governments and Alaska Native Claims Settlement Act (ANCSA) regional and village corporations on a government-to-government basis pursuant to Executive Order 13175, the Executive Memorandum of April 29, 1994, on “Government-to-Government Relations with Native American Tribal Governments,” and Section 161 of the Consolidated Appropriations Act of 2004 (P.L. 108-199, 188 Stat. 452), as amended by Section 518 of the Consolidated Appropriations Act of 2005 (P.L. 108-447, 118 Stat. 3267).

As a first step in the consultation process, on January 16, 2009, NMFS mailed letters to approximately 660 Alaska tribal governments, ANCSA corporations, and related organizations providing information about the proposed action and analysis and soliciting consultation and coordination with interested tribal governments and ANCSA corporations. NMFS received 1 comment from a tribal government.

1.7 Cooperating Agencies

The Council for Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA emphasize agency cooperation early in the NEPA process. The State of Alaska Department of Fish and Game (ADF&G) is a cooperating agency and has agreed to participate in the development of this analysis and provide data, staff, and review for this analysis. ADF&G has an integral role in the development of this analysis because it manages the commercial salmon fisheries, collects and analyzes salmon biological information, and represents people who live in Western and Interior Alaska.

1.8 Community outreach

One of the Council’s policy priorities is to improve communication with and participation by Alaska Native and rural communities in the federal fisheries management process. The Council developed an outreach plan to solicit and obtain input on the proposed action from Alaska Natives, communities, and other affected stakeholders. This outreach effort, specific to chum salmon bycatch management, dovetails with the Council's overall community and Native stakeholder participation policy.

The Council's Rural Community Outreach Committee identified this action as an important project for outreach efforts to rural communities. An outreach plan was developed in late 2009 and is continually refined. The updated version is available here: http://www.fakr.noaa.gov/npfmc/current_issues/bycatch/ChumOutreach1010.pdf. The outreach plan includes attending several regional meetings in rural Alaska, as well as other meetings, in order to explain the proposed action, provide preliminary analysis, and receive direct feedback from rural communities prior to the final analysis. The majority of these meetings will occur in early 2011. A summary of verbal comments received during outreach meetings will be provided to the Council in the initial review draft analysis in June 2011.

1.9 Statutory Authority for this Action

Under the Magnuson-Stevens Act (16 USC 1801, et seq.), the United States has exclusive fishery management authority over all marine fishery resources found within the EEZ. The management of these marine resources is vested in the Secretary of Commerce (Secretary) and in the regional fishery management councils. In the Alaska Region, the Council has the responsibility for preparing FMPs and FMP amendments for the marine fisheries that require conservation and management, and for submitting its recommendations to the Secretary. Upon approval by the Secretary, NMFS is charged with carrying out the federal mandates of the Department of Commerce with regard to marine and anadromous fish.

The Bering Sea pollock fishery in the EEZ off Alaska is managed under the FMP for Groundfish of the Bering Sea and Aleutian Islands management area. The salmon bycatch management measures under consideration would amend this FMP and federal regulations at 50 CFR 679. Actions taken to amend FMPs or implement other regulations governing these fisheries must meet the requirements of federal law and regulations.

1.10 Relationship of this Action to Federal Laws, Policies, and Treaties

While NEPA is the primary law directing the preparation of this EA, a variety of other federal laws and policies require environmental, economic, and socioeconomic analyses of proposed federal actions. This section addresses the CEQ regulations, at 40 CFR 1502.2(d), that require an EA to state how alternatives considered in it and decisions based on it will or will not achieve the requirements of sections 101 and 102(1) of NEPA and other environmental laws and policies. This EA and RIR contain the required analysis of the proposed federal action and its alternatives to ensure that the action complies with these additional federal laws and executive orders:

- National Environmental Policy Act (NEPA)
- Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act)
- Endangered Species Act (ESA)
- Marine Mammal Protection Act (MMPA)
- Administrative Procedure Act (APA)
- Regulatory Flexibility Act (RFA)
- Information Quality Act (IQA)
- Coastal Zone Management Act (CZMA)
- Alaska National Interest Lands Conservation Act (ANILCA)
- American Fisheries Act (AFA)
- Executive Order 12866: Regulatory planning and review
- Executive Order 13175: Consultation and Coordination with Indian Tribal Governments
- Executive Order 12898: Environmental Justice

- Pacific Salmon Treaty and the Yukon River Agreement

The following provides details on the laws and executive orders directing this analysis. None of the alternatives under consideration threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

1.10.1 National Environmental Policy Act

NEPA establishes our national environmental policy, provides an interdisciplinary framework for environmental planning by federal agencies, and contains action-forcing procedures to ensure that federal decision-makers take environmental factors into account. NEPA does not require that the most environmentally desirable alternative be chosen, but does require that the environmental effects of all the alternatives be analyzed equally for the benefit of decision-makers and the public.

NEPA has two principal purposes:

1. To require federal agencies to evaluate the potential environmental effects of any major planned federal action, ensuring that public officials make well-informed decisions about the potential impacts.

2. To promote public awareness of potential impacts at the earliest planning stages of major federal actions by requiring federal agencies to prepare a detailed environmental evaluation for any major federal action significantly affecting the quality of the human environment.

NEPA requires an assessment of the biological, social, and economic consequences of fisheries management alternatives and provides that members of the public have an opportunity to participate in the decision-making process. In short, NEPA ensures that environmental information is available to government officials and the public before decisions are made and actions are taken.

Title II, Section 202 of NEPA (42 U.S.C. 4342) created the CEQ. The CEQ is responsible for, among other things, the development and oversight of regulations and procedures implementing NEPA. The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 CFR Part 1500) and require agencies to identify processes for issue scoping, for the consideration of alternatives, for developing evaluation procedures, for involving the public and reviewing public input, and for coordinating with other agencies—all of which are applicable to the Council's development of FMPs.

NOAA Administrative Order 216-6 describes NOAA's policies, requirements, and procedures for complying with NEPA and the implementing regulations issued by the CEQ. This Administrative Order provides comprehensive and specific procedural guidance to NMFS and the Council for preparing and adopting FMPs.

Federal fishery management actions subject to NEPA requirements include the approval of FMPs, FMP amendments, and regulations implementing FMPs. Such approval requires preparation of the appropriate NEPA analysis (Categorical Exclusion, Environmental Assessment, or EIS).

1.10.2 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Act authorizes the U.S. to manage its fishery resources in the EEZ. The management of these marine resources is vested in the Secretary and in regional fishery management councils. In the Alaska Region, the Council is responsible for preparing FMPs for marine fishery resources requiring conservation and management. NMFS is charged with carrying out the federal mandates with regard to marine fish. The NMFS Alaska Region and Alaska Fisheries Science Center research, draft, and review the management actions recommended by the Council. The Magnuson-Stevens Act established the required and discretionary provisions of an FMP and created ten National Standards to ensure that any FMP or FMP amendment is consistent with the Act

The Magnuson-Stevens Act emphasizes the need to protect fish habitat. Under the law, the Council has amended its FMPs to identify essential fish habitat (EFH). For any actions that may adversely impact EFH, the Magnuson-Stevens Act requires NMFS to provide recommendations to federal and state agencies for conserving and enhancing EFH. In line with NMFS policy of blending EFH assessments into existing environmental reviews, NMFS intends the analysis contained in Chapter 8 of this EIS to also serve as an EFH assessment.

The actions under examination in the EA and RIR are chum salmon bycatch minimization measures for the Bering Sea pollock fishery. While each FMP amendment must be comply with all ten national standards, National Standards 1 and 9 are directly guide the proposed action. National Standard 9 of the Magnuson-Stevens Act requires that conservation and management measures shall, to the extent practicable, minimize bycatch. National Standard 1 of the Magnuson-Stevens Act requires that conservation and management measures prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

1.10.3 Endangered Species Act (ESA)

The ESA is designed to conserve endangered and threatened species of fish, wildlife, and plants. The ESA is administered jointly by NMFS and the USFWS. With some exceptions, NMFS oversees cetaceans, seals and sea lions, marine and anadromous fish species, and marine plant species. USFWS oversees walrus, sea otter, seabird species, and terrestrial and freshwater wildlife and plant species.

The listing of a species as threatened or endangered is based on the biological health of that species. Threatened species are those likely to become endangered in the foreseeable future (16 U.S.C. 1532(20)). Endangered species are those in danger of becoming extinct throughout all or a significant portion of their range (16 U.S.C. 1532(6)). Species can be listed as endangered without first being listed as threatened.

Currently, with the listing of a species under the ESA, the critical habitat of the species must be designated to the maximum extent prudent and determinable (16 U.S.C. 1533(b)(6)(C)). The ESA defines critical habitat as those specific areas that are essential to the conservation of a listed species and that may be in need of special consideration. Federal agencies are prohibited from undertaking actions that destroy or adversely modify designated critical habitat.

Federal agencies have a mandate to conserve listed species and federal actions, activities or authorizations (hereafter referred to as federal actions) must be in compliance with the provisions of the ESA. Section 7 of the ESA provides a mechanism for consultation by the federal action agency with the appropriate expert agency (NMFS or USFWS). Informal consultations are conducted for federal actions that have no adverse affects on the listed species. The action agency can prepare a biological assessment to determine if the proposed action would adversely affect listed species or modify critical habitat. The biological assessment contains an analysis based on biological studies of the likely effects of the proposed action on the species or habitat.

Formal consultations, resulting in biological opinions, are conducted for federal actions that may have an adverse affect on the listed species. Through the biological opinion, a determination is made about whether the proposed action poses “jeopardy” or “no jeopardy” of extinction or adverse modification or destruction of designated critical habitat for the listed species. If the determination is that the proposed or on-going action will cause jeopardy or adverse modification of critical habitat, reasonable and prudent alternatives may be suggested which, if implemented, would modify the action to no longer pose the jeopardy of extinction or adverse modification to critical habitat for the listed species. These reasonable and prudent alternatives must be incorporated into the federal action if it is to proceed. A biological opinion with the conclusion of no jeopardy or adverse modification of critical habitat may contain conservation recommendations intended to further reduce the negative impacts to the listed species. These recommendations are advisory to the action agency (50 CFR 402.14(j)). If the likelihood exists of any take[12] occurring during promulgation of the action, an incidental take statement may be appended to a biological opinion to provide for the amount of take that is expected to occur from normal promulgation of the action. An incidental take statement is not the equivalent of a permit to take a listed species.

This EA contains pertinent information on the ESA-listed species that occur in the action area and that have been identified in previous consultations as potentially impacted by the Bering Sea pollock fishery. Analysis of the impacts of the alternatives is in the chapters addressing those resource components.

1.10.4 Marine Mammal Protection Act (MMPA)

Under the MMPA, NMFS has a responsibility to conserve marine mammals, specifically cetaceans and pinnipeds (other than walrus). The USFWS is responsible for sea otter, walrus, and polar bear. Congress found that certain species and stocks of marine mammals are or may be in danger of extinction or depletion due to human activities. Congress also declared that marine mammals are resources of great international significance.

The primary management objective of the MMPA is to maintain the health and stability of the marine ecosystem, with a goal of obtaining an optimum sustainable population of marine mammals within the carrying capacity of the habitat. The MMPA is intended to work in concert with the provisions of the ESA. The Secretary is required to give full consideration to all factors regarding regulations applicable to the "take" of marine mammals, including the conservation, development, and utilization of fishery resources, and the economic and technological feasibility of implementing the regulations. If a fishery affects a marine mammal population, the Council or NMFS may be requested to consider measures to mitigate adverse impacts. This EA analyzes the potential impacts of the pollock fishery and changes to the fishery under the alternatives on marine mammals.

1.10.5 Administrative Procedure Act (APA)

The APA requires federal agencies to notify the public before rule making and provide an opportunity to comment on proposed rules. General notice of proposed rule making must be published in the *Federal Register,* unless persons subject to the rule have actual notice of the rule. Proposed rules published in the *Federal Register* must include reference to the legal authority under which the rule is proposed and explain the nature of the proposal including a description of the proposed action, why it is being proposed, its intended effect, and any relevant regulatory history that provides the public with a well-informed basis for understanding and commenting on the proposal. The APA does not specify how much time the public must be given for prior notice and opportunity to comment; however, Section 304 (b) of the Magnuson-Stevens Act provides that proposed regulations that implement an FMP or FMP amendment, or that modify existing regulations, must have a public comment period of 15 to 60 days.

After the end of a comment period, the APA requires that comments received be summarized and responded to in the final rule notice. Further, the APA requires that the effective date of a final rule is no less than 30 days after its publication in the *Federal Register*. This delayed effectiveness, or "cooling off" period, is intended to give the affected public time to become aware of, and prepared to comply with the requirements of the rule. For fishery management regulations, the primary effect of the APA, in combination with the Magnuson-Stevens Act, NEPA, and other statutes, is to allow for public

---

[12] The term "take" under the ESA means "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" (16 U.S.C. § 1532(19)).

participation and input into the development of FMPs, FMP amendments, and regulations implementing FMPs. Regulations implementing the proposed salmon bycatch reduction measures will be published in the *Federal Register* in accordance with the APA and the Magnuson-Stevens Act.

1.10.6 Regulatory Flexibility Act (RFA)

The RFA requires federal agencies to consider the economic impact of their regulatory proposals on directly regulated small entities, analyze alternatives that minimize adverse economic impacts on this class of small entities, and make their analyses available for public comment. The RFA applies to a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions. The Small Business Administration has established size criteria for all major industry sectors in the United States, including fish harvesting and fish processing businesses.

The RFA applies to any regulatory actions for which prior notice and comment is required under the APA. After an agency begins regulatory development and determines that the RFA applies, unless an agency can certify that an action subject to the RFA will not have a significant economic impact on a substantial number of small entities, the agency must prepare an initial regulatory flexibility analysis (IRFA) to accompany a proposed rule. Based upon the IRFA, and received public comment, assuming it is still not possible to certify, the agency must prepare a final regulatory flexibility analysis (FRFA) to accompany the final rule. NMFS has published revised guidelines, dated August 16, 2000, for RFA analyses; they include criteria for determining if the action would have a significant impact on a substantial number of small entities.

The Analysis contains a draft IRFA that identifies the small entities directly regulated by the proposed action. The preamble to the proposed regulations that will be published in the *Federal Register* will contain the IRFA that evaluates the adverse impacts of this action on directly regulated small entities, in compliance with the RFA.

1.10.7 Information Quality Act (IQA)

The IQA directs the OMB to issue government-wide policy and procedural guidance to all federal agencies to ensure and maximize the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by federal agencies. The OMB's guidelines require agencies to develop their own guidelines for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by the agency. NOAA published its guidelines in September 2002.[13] Pursuant to the IQA and the NOAA guidelines, this information product has undergone a pre-dissemination review by NMFS, completed on November 30, 2009.

1.10.8 Coastal Zone Management Act (CZMA)

The CZMA is designed to encourage and assist states in developing coastal management programs, to coordinate State activities, and to safeguard regional and national interests in the coastal zone. Section 307(C) of the CZMA requires that any federal activity affecting the land or water or uses natural resources of a state's coastal zone be consistent with the state's approved coastal management program, to the maximum extent practicable.

A proposed fishery management action that requires an FMP amendment or implementing regulations must be assessed to determine whether it directly affects the coastal zone of a state with an approved coastal zone management program. If so, NMFS must provide the state agency having coastal zone management responsibility with a consistency determination for review at least 90 days before final action. Prior to implementation of the proposed action, NMFS will determine whether this action is

---

[13] http://www.noaanews.noaa.gov/stories/iq.htm

consistent to the maximum extent practicable with the enforceable policies of the approved coastal management program of the State of Alaska and submit this determination for review by the responsible state agency.

1.10.9 Alaska National Interest Lands Conservation Act (ANILCA)

Among other things, Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA) creates a priority for "subsistence uses" over the taking of fish and wildlife for other purposes on public lands (16 U.S.C. 3114). ANILCA also imposes obligations on federal agencies with respect to decisions affecting the use of public lands, including a requirement that they analyze the effects of those decisions on subsistence uses and needs (16 U.S.C. 3120).

ANILCA defines "public lands" as lands situated "in Alaska" which, after December 2, 1980, are federal lands, except those lands selected by or granted to the State of Alaska, lands selected by an Alaska Native Corporation under the Alaska Native Claims Settlement Act (ANCSA), and lands referred to in section 19(b) of ANCSA (16 U.S.C. 3102(3)).

The U.S. Supreme Court has ruled that ANILCA's use of "in Alaska" refers to the boundaries of the State of Alaska and concluded that ANILCA does not apply to the outer continental shelf (OCS) region (*Amoco Prod. Co. v. Village of Gambell*, 480 U.S. 531, 546-47 (1987)). The action area for Chinook salmon bycatch management is in the Bering Sea EEZ, which is in the OCS region.

Although ANILCA does not directly apply to the OCS region, NMFS aims to protect such uses pursuant to other laws, such as NEPA and the Magnuson-Stevens Act. The RIR evaluates the consequences of the proposed actions on subsistence uses. Thus NMFS and the Council remain committed to ensuring that federal fishery management actions consider the importance of subsistence uses of salmon and protecting such uses from any adverse consequences. One of the reasons NMFS and the Council have proposed implementing salmon bycatch reduction measures is to protect the interests of salmon subsistence users.

1.10.10 American Fisheries Act (AFA)

The AFA established a cooperative management program for the Bering Sea pollock fisheries. Among the purposes of the AFA was to tighten U.S. vessel ownership standards and to provide the pollock fleet the opportunity to conduct its fishery in a more economically rational manner while protecting non-AFA participants in other fisheries. Since the passage of the AFA, the Council has taken an active role in the development of management measures to implement the various provisions of the AFA. The AFA EIS was prepared to evaluate sweeping changes to the conservation and management program for the Bering Sea pollock fishery and to a lesser extent, the management programs for the other groundfish fisheries of the GOA and BSAI, the king and Tanner crab fisheries of the BSAI, and the scallop fishery off Alaska (NMFS 2002). Under the Magnuson-Stevens Act, the Council prepared Amendments 61/61/13/8 to implement the provisions of the AFA in the groundfish, crab, and scallop fisheries. Amendments 61/61/13/8 incorporated the relevant provisions of the AFA into the FMPs and established a comprehensive management program to implement the AFA. The EIS evaluated the environmental and economic effects of the management program that was implemented under these amendments, and developed scenarios of alternative management programs for comparative use. The AFA EIS is available on the NMFS Alaska Region website.[14]

NMFS published the final rule implementing the AFA on December 30, 2002 (67 FR 79692). The structure and provisions of the AFA constrain the types of measures that can be implemented to reduce

---

[14] http://www.alaskafisheries.noaa.gov/sustainablefisheries/afa/eis2002.pdf

salmon bycatch in the pollock fishery. The RIR contains a detailed discussion of the pollock fishery under the AFA and the relationship between the chum salmon bycatch management and the AFA.

1.10.11 Executive Order 12866: Regulatory planning and review

The purpose of Executive Order 12866, among other things, is to enhance planning and coordination with respect to new and existing regulations, and to make the regulatory process more accessible and open to the public. In addition, Executive Order 12866 requires agencies to take a deliberative, analytical approach to rule making, including assessment of costs and benefits of the intended regulations. For fisheries management purposes, it requires NMFS to (1) prepare a regulatory impact review (RIR) for all regulatory actions; (2) prepare a unified regulatory agenda twice a year to inform the public of the agency's expected regulatory actions; and (3) conduct a periodic review of existing regulations.

The purpose of an RIR is to assess the potential economic impacts of a proposed regulatory action. As such, it can be used to satisfy NEPA requirements and serve as a basis for determining whether a proposed rule will have a significant impact on a substantial number of small entities under the RFA. The RIR is frequently combined with an EA and an IRFA in a single document that addresses the analytical requirements of NEPA, RFA, and Executive Order 12866. Criteria for determining "significance" for Executive Order 12866 purposes, however, are different than those for determining "significance" for NEPA or RFA purposes. A "significant" rule under Executive Order 12866 is one that is likely to:

- Have an annual effect on the economy (of the nation) of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities;
- Create serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in Executive Order 12866.

Although fisheries management actions rarely have an annual effect on the national economy of $100 million or more or trigger any of the other criteria, the Secretary of Commerce with the Office of Management and Budget (OMB), makes the final determination of significance under this Executive Order, based in large measure on the analysis in the RIR. An action determined to be significant is subject to OMB review and clearance before its publication and implementation.

The RIR identifies economic impacts and assesses of costs and benefits of the proposed salmon bycatch reduction measures.

1.10.12 Executive Order 13175: Consultation and coordination with Indian tribal governments

Executive Order 13175 on consultation and coordination with Indian tribal governments establishes the requirement for regular and meaningful consultation and collaboration with Indian tribal governments in the development of federal regulatory practices that significantly or uniquely affect their communities; to reduce the imposition on unfunded mandates on Indian tribal governments; and to streamline the application process for and increase the availability of waivers to Indian tribal governments. This Executive Order requires federal agencies to have an effective process to involve and consult with representatives of Indian tribal governments in developing regulatory policies and prohibits regulations that impose substantial, direct compliance costs on Indian tribal communities.

Additionally, Congress extended the consultation requirements of Executive Order 13175 to Alaska Native corporations in Division H, Section 161 of the Consolidated Appropriations Act of 2004 (Public Law 108-199; 188 Stat. 452), as amended by Division H, Section 518 of the Consolidated Appropriations Act of 2005 (Public Law 108-447, 118 Stat. 3267). Public Law 108-199 states in Section 161 that "The Director of the Office of Management and Budget shall hereafter consult with Alaska Native corporations on the same basis as Indian tribes under Executive Order No. 13175." Public Law 108-447, in Section 518, amends Division H, Section 161 of Public Law 108-199 to replace Office of Management and Budget with all federal agencies.

1.10.13 Executive Order 12898: Environmental Justice

Executive Order 12898 requires that federal agencies make achieving environmental justice part of their mission by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low income populations in the United States. Salmon bycatch in the pollock fisheries impacts the in-river users of salmon in western and Interior Alaska, many of whom are Alaska Native. Additionally, a growing number of Alaska Natives participate in the pollock fisheries through the federal CDQ Program and, as a result, coastal native communities participating in the CDQ Program derive substantial economic benefits from the pollock fishery.

1.10.14 Pacific Salmon Treaty and the Yukon River Agreement

In 2002, the United States and Canada signed the Yukon River Agreement to the Pacific Salmon Treaty. The Yukon River Agreement states that the “Parties shall maintain efforts to increase the in-river run of Yukon River origin salmon by reducing marine catches and by-catches of Yukon River salmon. They shall further identify, quantify and undertake efforts to reduce these catches and by-catches” (Art. XV, Annex IV, Ch. 8, Cl. 12). The Yukon River Agreement also established the Yukon River Panel as an international advisory body to address the conservation, management, and harvest sharing of Canadian-origin salmon between the U.S. and Canada. This proposed action is an element of the Council’s efforts to reduce bycatch of salmon in the pollock fishery and ensure compliance with the Agreement. Additionally, in developing the alternatives under consideration, NMFS and the Council have considered the recommendations of the Yukon River Panel. This EA and RIR address the substantive issues involving the portion of chum salmon taken as bycatch in the Bering Sea pollock fishery that originated from the Yukon River and the impacts of salmon bycatch in the pollock fishery on returns of Chinook salmon to the Canadian portion of the Yukon River.

2 Description of Alternatives

This analysis is focused on alternative measures to minimize Chum (non-Chinook) salmon bycatch in the Bering Sea pollock fishery. This chapter provides a detailed description of the following four alternatives:

Alternative 1: Status Quo (No Action)

Alternative 2: Hard cap

Alternative 3: Triggered closures

Alternative 4: Triggered closure with RHS exemption

The alternatives analyzed in this EA and the RIR represent a complex suite of components, options, and suboptions. However, each of the alternatives involves a limit or "cap" on the number of Chinook salmon that may be caught in the Bering Sea pollock fishery and closure of all or a part of the Bering Sea to pollock fishing once the cap is reached. These closures would occur when a non-Chinook salmon bycatch cap was reached even if a portion of the pollock total allowable catch (TAC) has not yet been harvested. Alternatives 2 and 3 represent a change in management of the pollock fishery because if the non-Chinook salmon bycatch allocations are reached before the full harvest of the pollock allocation, then directed fishing for pollock must stop either BS-wide or in a specified area. Under Alternative 3, like Alternative 1, reaching the cap closes specific areas important to pollock fishing.

To best present the alternatives in comparative form, this chapter is organized into sections that describe in detail each alternative's components, options, and suboptions. To avoid unnecessary repetition, many aspects of the alternatives are presented in this chapter only, and cross-referenced later in the document as applicable.

This chapter also describes how management of the pollock fishery would change under each of the alternatives and how non-chinook salmon bycatch would be monitored. Estimated costs and the impacts of these changes on the pollock fishery are discussed in the RIR.

2.1 Alternative 1: Status Quo (No Action)

Alternative 1 retains the current program of Chum Salmon Savings Area (SSA) closures in the BS triggered by separate non-CDQ and CDQ non-chinook salmon prohibited species catch (PSC) limits, along with the exemption to these closures by pollock vessels participating in the Rolling Hot Spot intercooperative agreement (RHS ICA). The RHS ICA regulations were implemented in 2007 through Amendment 84 to the BSAI FMP. The regulations were revised in 2011 to remove those provisions of the ICA which were for Chinook bycatch management given the new program in place under Amendment 91. Closure of the SSA is designed to reduce the total amount of chum incidentally caught by closing areas with historically high levels of salmon bycatch. The RHS ICA operates in lieu of regulatory closures of the SSA and requires industry to identify and close areas of high salmon bycatch and move to other areas. Only vessels directed fishing for pollock are subject to the SSA closure and ICA regulations. The ICA for 2011 and the list of vessels participating in it are appended to this chapter (Chapter 2, appendix 1).

2.1.1 Chum Salmon Savings Area

Alternative 1 would keep the existing Chum SSA closures in effect (Figure 2-1). This area is closed to all trawling from August 1 through August 31. Additionally, if 42,000[15] 'other" salmon are caught in the Catcher Vessel Operational Area (CVOA) during the period August 15-October 14, the area remains

---

[15] This number is inclusive of the allocation to CDQ groups. Non-CDQ 'other salmon' limit is 37,506.

closed remainder of the period September 1 through October 14. As catcher processors are prohibited from fishing in the CVOA during the "B" season, unless they are participating in a CDQ fishery, only catcher vessels and CDQ fisheries are affected by the PSC limit.

This PSC limit is allocated among the non-CDQ pollock fisheries (89.3% or 37,506 salmon in 2011) and the CDQ Program (10.7% or 4,494 salmon). In the absence of an approved VRHS ICA described in Section 1.1.2, NMFS closes the Chum SSA to directed fishing for pollock from August 1-31 and additionally if either the non-CDQ or CDQ non-Chinook salmon PSC limit is triggered by vessels directed fishing for pollock in the Bering Sea. The Chum Salmon Savings Area was established in 1994 by emergency rule, and then formalized in the BSAI Groundfish FMP in 1995 under Amendment 35 (ADF&G 1995) (Figure 2-1).

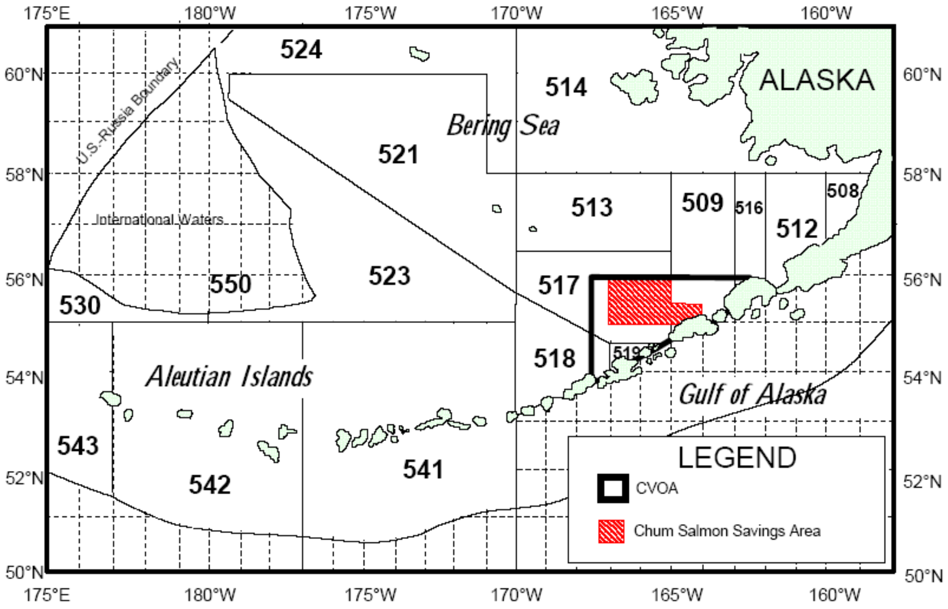


Figure 2-1 Chum Salmon Savings Area and Catcher Vessel Operational Area (CVOA)

2.1.1.1 PSC limits for the CDQ Program

Under the status quo, the CDQ Program receives allocations of 10.7 % of the Bering Sea non-Chinook salmon PSC limits as prohibited species quota (PSQ) reserves. A portion of the PSC limit (10.7%, or 4,494 non-Chinook salmon) is allocated to the CDQ Program as a PSQ reserve[16], while the remaining 37,506 non-Chinook salmon are available to the non-CDQ pollock fishery. NMFS further allocates the PSQ reserves among the six CDQ groups based on percentage allocations approved by NMFS on August 8, 2005. For non-Chinook salmon, the percentage allocations of the PSQ reserve among the CDQ groups are as follows:

Aleutian Pribilof Island Community Development Association (APICDA)	14%
Bristol Bay Economic Development Corporation (BBEDC)	21%
Central Bering Sea Fishermen's Association (CBSFA)	5%
Coastal Villages Region Fund (CVRF)	24%
Norton Sound Economic Development Corporation (NSEDC)	22%
Yukon Delta Fishery Development Corporation (YDFDC)	14%

---

[16] See 50 CFR 679.21(e)(3)(i)(A)(3)(i).

Unless exempted because of participation in the VRHS ICA, a CDQ group is prohibited from directed fishing for pollock in the Chinook salmon savings areas when that group's Chinook salmon PSQ is reached. NMFS does not issue fishery closures through rulemaking for the CDQ groups. All CDQ groups are participating in the VRHS ICA approved in 2010, so they currently are exempt from closure of the Chinook salmon savings area.

2.1.2 Rolling Hotspot System Intercooperative Agreement

Regulations implemented under Amendment 84 to the BSAI FMP exempt vessels directed fishing for pollock from closures of both the Chum and Chinook salmon savings areas if they participate in a RHS ICA approved by NMFS (NPFMC 2005). The fleet voluntarily started the RHS program in 2001 for chum salmon and in 2002 for Chinook salmon. The exemption to regulatory area closures for vessels that participated in the RHS was implemented in 2006 and 2007 through an exempted fishing permit. The Council developed Amendment 84 to attempt to resolve the bycatch problem through the AFA pollock cooperatives. These regulations were implemented in 2007. A RHS ICA was approved by NMFS in January 2010 for the 2011 fishing year (see Chapter 2, Appendix 2). All vessels and CDQ groups that are participating in the BS pollock fishery in 2011, except one vessel, participate in this ICA. The ICA was amended for the 2011 season to remove regulations related to the Chinook SSA (and all provisions under the ICA related to Chinook bycatch management) following implementation of Amendment 91.

The RHS provides real-time salmon bycatch information so that the fleet can avoid areas of high chum or Chinook salmon bycatch rates. Using a system of base bycatch rates, the ICA assigns vessels to certain tiers, based on bycatch rates relative to the base rate, and implements area closures for vessels in certain tiers. Monitoring and enforcement are carried out through private contractual arrangements.

Parties to the current RHS ICA include the AFA cooperatives, the CDQ groups, a third-party salmon bycatch data manager, and other entities with interests in Bering Sea salmon bycatch reduction. Federal regulations require the ICA to describe measures that parties to the agreement will take to monitor salmon bycatch and redirect fishing effort away from areas in which salmon bycatch rates are relatively high. It also must include intra-cooperative enforcement measures and various other regulatory conditions. The ICA data manager monitors salmon bycatch in the pollock fisheries and announces area closures for areas with relatively high salmon bycatch rates. The efficacy of closures and bycatch reduction measures must be reported to the Council annually.

Many modifications have been made to the ICAs for operation under this program since it was initially approved for exemption to SSAs under Amendment 84. A description of the structure of the program is provided in Sections 2.1.2.1–2.1.2.5 below. Details within each section note where changes to the ICA have occurred since 2006 (the voluntary agreement in place prior to that in regulation under Amendment 84).

The ICA is structured based upon a cooperatives' bycatch rate as compared with a pre-determined "Base Rate". Once the Base Rate is determined (see Section 2.1.2.1), all provisions for fleet behavior, closures and enforcement are based upon the relation of the cooperative's rate to the Base Rate. Tier assignments (Section 2.1.2.2) are calculated from the cooperatives' proportional bycatch rate to the Base Rate with higher tiers corresponding to higher bycatch rates. These tiers then determine how access to specific areas will be determined following designation of "hot spot" closures. These areas are then to be avoided by cooperatives in higher tiers.

2.1.2.1 Base Rate: calculation

The structure of the ICA is based upon cooperatives' bycatch rates in comparison with a calculated Base Rate established prior to the start of the season. The Base Rate (BR) is initially established as 0.19 (from June 10th to July 1st) in chum/mt of pollock harvest. Prior to the 2006 ICA, the BR was a season fixed rate of 0.062. This was based upon a roughly 80% of the 2003 season average and was established such that no unnecessary closures would be enacted in periods of low abundance[17]. Beginning July 1st the chum BR is subject to a weekly in-season adjustment each Friday (announced on Thursday) based on a 3 week rolling average of the fleet's overall chum bycatch rate.

2.1.2.2 Tier assignment based upon Base Rate

Once the Base Rate is established, cooperatives are placed into "tiers" based upon their percentage performance with respect to the base rate. Tier status is determined by a coop's "rolling two week" average bycatch rate. Closures are determined by Sea State based upon spatial information on "hot spot" bycatch areas.

Tier Assignment rates

- i. Tier 1 – cooperatives with bycatch rates less than 75% of Base Rate.
- ii. Tier 2 – cooperatives with bycatch rates equal to or greater than 75% of the Base Rate and equal to or less than 125% of the Base Rate.
- iii. Tier 3 – cooperatives with bycatch rates greater than 125% of the Base Rate.

2.1.2.3 Impacts of assignment to tier

Cooperatives are subject to savings closures based upon their tier assignments. Cooperatives assigned to Tier 1 are not constrained by savings closures. Cooperatives assigned to Tier 2 are subject to savings closures for 4 days; Friday at 6:00 pm to Tuesday at 6:00 pm. Cooperatives assigned to Tier 3 are subject to savings closures for 7 days; Friday at 6:00 pm to the following Friday at 6:00 pm.

Closure areas are rolling and are determined by Sea State based upon the bycatch rate within specified areas.

For "B" season, closures are determined according to the following criteria:

1. Savings Closures are based on the chum salmon bycatch and pollock harvest for the four to seven day period, depending on data quality, immediately preceding each closure announcement.
2. Chum salmon bycatch in an area must exceed the chum salmon Base Rate in order for the area to be eligible for a Savings Closure.
3. Pollock harvest in a potential Savings Closure area must be a minimum of 2% of the total fleet pollock harvest for the same time period in order to be eligible as a Savings Closure.
4. Current Savings Closures are exempt from the 2% minimum harvest rule described in item 3, above, and may continue as a Savings Closure if surrounding bycatch conditions indicate there has likely been no change in bycatch conditions for the area.
5. The Bering Sea will managed as 2 regions during the "B" season; a region east of 168° W. longitude (the Eastern Region) and a region west of 168° W. longitude (the Western Region).
6. Total Savings Closure area.

---

[17] A one-time inseason adjustment used to occur on September 1. This adjustment recalculated the Base Rate according to the average bycatch by members over the previous three week period (August 10-31).

   i. Chum salmon
      a. The Eastern Region Savings Closures may cover up to 3000 sq. miles. Note this was increased from 1000 sq. miles prior to Amendment 84.
      b. The Western Region Savings Closures may cover up to 1000 sq. miles.

7. There may be up to two Savings Closure areas at any one time within each region.
8. Closure areas will be described by a series of latitude and longitude coordinates and will be shaped as Sea State deems appropriate.
9. Sea State also provides additional non-binding hot-spot avoidance notices, outside of the savings closures, to the cooperatives as they occur throughout the season

One change from the previous ICA inclusive of Chinook bycatch management is the prioritization of Chinook closures over chum closures in the B season. Previously, within a single region Savings Closures must be either a chum closure or a Chinook closure, but not both. In the event Base Rates for both chum and Chinook are exceeded within a region during a week, the Savings Closure within that region was a Chinook closure. This was due to the elevated conservation concerns with respect to western Alaskan Chinook stocks. In those cases, Sea State issued a non-binding avoidance recommendation for the area of high chum bycatch.

2.1.2.4 "Vessel Performance Lists"

'Vessel Performance Lists' (formerly called "Dirty Twenty Lists") refer to lists which are published and made available to all members and include the 20 vessels with the highest chum (and previously Chinook) bycatch rates over the Base Rate. Prior to Amendment 84 this list reported the 20 vessels with the highest bycatch rate in excess of the Tier 1 rate. Lists are published by highest rate by week, highest rate for the past 2 weeks, and highest rates for the season-to-date. Only vessels with bycatch rates over the base rate appear on the list. Only vessels with more than 500 mt of groundfish catch are included in the season-to-date list. The season-to-date list was based on appearances on the weekly list. Accumulative points are assigned to vessels as they appear on the weekly list. Vessels in the number 1 slot on the weekly list receive 20 points, those in the number 2 slot receive 19 points and so on. The vessel's points are totaled each week and the vessels with the 20 highest scores appear on the seasonal list. A vessel must have harvested over 500 mt of pollock before being eligible for the seasonal list. Previously this was calculated as the vessel's number of appearances on the weekly list divided by the number of weeks fished in the B season. Note this season list is no longer part of the 2011 ICA.

2.1.2.5 RHS ICA monitoring

Monitoring and enforcement of the bycatch agreement is done by Sea State using the Base Rate as a trigger for Savings Area closures and determining the Tier Assignment of the vessel. Prior to Amendment 84 there was no enforcement monitoring by Sea State and enforcement was left to the individual cooperatives. VMS is the main tool for monitoring and enforcement. There are VMS requirements and fines for not complying. See Section 2.5 of this document (and section 5.f of the revised ICA) for a more detailed description of the RHS ICA monitoring considerations.

Penalties for savings closure violations as described in item H above are placed in a bank account designed for holding funds which are then used to fund research at the discretion of the cooperatives. Penalty money collected under the agreement is intended to be used in salmon stock identification research. To date the violation funds have been used to fund the Geiger-Pella project on sampling protocol (Geiger and Pella, 2009). The violation fund put in $25,000 and ADF&G put in the remainder. In 2010, $47,602 was given to UAF (Tony Gharrett) as matching funds with AKSSF money for a project entitled "Shared Chum Salmon Baseline Development Project". The remainder of the violation funds are awaiting an applicable project and have not yet been allocated.

A list of fines collected is contained in Table 2-1. The first violations occurred in 2005 before the both the EFP seasons and the implementation of Amendment 84. At that time the penalty for the first violation by a vessel in a year was 50% of the ex-vessel value of the pollock caught in the violating tow. Beginning in 2006 (the EFP and Amendment 84 years), first violations in year were set at $10,000, second violations were set at $15,000 and the third and subsequent violations in a year were set at $20,000. The Northern Hawk violation was a double-violation as the captain made two tows before he realized he was inside the closure area. There is currently a pending violation for the Hazel Lorraine from the 2010 B season. Additional information on that will be available in late spring 2011(J. Gruver, pers. comm).

Table 2-1 Enforcement violation fines incurred under the Rolling Hot Spot/ICA from 2005-2009

Salmon Savings Area Enforcement Violation Fine Summary 2005-2009			
2005			
Akutan	7/19/2005	Royal American	$1,700.00
Northern Victor	7/18/2005	Storm Petrel	$2,094.30
		Annual Total	$3,794.30
2006			
Akutan	10/20/2006	Golden Dawn	$10,000.00
Akutan	9/30/2006	Royal American	$10,000.00
Akutan	10/8/2006	Bristol Explorer	$10,000.00
Akutan	10/18/2006	Arctic Explorer	$10,000.00
		Annual Total	$40,000.00
2007			
Akutan	1/31/2007	Hazel Lorraine	$10,000.00
Arctic	10/8/2007	Ocean Explorer	$10,000.00
PCC	2/16/2007	Northern Hawk	$25,000.00
UniSea	9/11/2007	Nordic Star	$10,000.00
Westward	9/11/2007	Pacific Prince	$10,000.00
		Annual Total	$65,000.00
2009			
Akutan	11/2/2009	Predator	$10,000.00
		Annual Total	$10,000.00
		Total Enforcement Fines:	**$118,794.30**

2.1.2.6 Annual Performance Review

The inter-cooperative produces an annual report to the Council which contains the following:

1. Number of salmon taken by species and season.
2. Estimate number of salmon avoided as demonstrated by the movement of fishing effort away from salmon hot-spots.
3. A compliance/enforcement report which will include the results of an internal compliance audit and an external compliance audit if one has been done.
4. List of each vessels number of appearances on the weekly vessel performance lists (note this is a requirement of the AFA coop reports)..
5. Acknowledgement that the Agreement term has been extended for another year (maintaining the 3 year lifespan) and report any changes to the Agreement that were made at the time of the renewal.

An annual third party audit is also conducted to ensure compliance (or report on non-compliance) with the provisions of the ICA. The third party audit is made available to the public and the Council in conjunction with the annual performance review.

2.1.3 Amendment 91

The Council took final action on Amendment 91, Chinook salmon bycatch management measures in the Bering Sea pollock fishery in April 2009. The fishery is operating under rules to implement this program since January 2011. The final rule to implement Amendment 91 establishes two Chinook salmon PSC limits (60,000 Chinook salmon and 47,591 Chinook salmon) for the Bering Sea pollock fishery. For each PSC limit, NMFS will issue A season and B season Chinook salmon PSC allocations to the catcher/ processor sector, the mothership sector, the inshore cooperatives, and the CDQ groups. Chinook salmon allocations remaining from the A season can be used in the B season (‘‘rollover’’). Entities can transfer PSC allocations within a season and can also receive transfers of Chinook salmon PSC to cover overages (‘‘post-delivery transfers’’). NMFS will issue transferable allocations of the 60,000 Chinook salmon PSC limit to those sectors that participate in an incentive plan agreement (IPA) and remain in compliance with the performance standard. Sector and cooperative allocations would be reduced if members of the sector or cooperative decided not to participate in an IPA. Vessels and CDQ groups that do not participate in an IPA would fish under a restricted opt-out allocation of Chinook salmon. If a whole sector does not participate in an IPA, all members of that sector would fish under the optout allocation. NMFS changed the final rule to subtract a vessel’s opt-out allocation from a sector’s annual threshold amount in a method similar to the Council’s recommended method for determining the sector allocation under the 60,000

The IPA component is an innovative approach for fishery participants to design industry agreements with incentives for each vessel to avoid Chinook salmon bycatch at all times and thus reduce bycatch below the PSC limits. The rule establishes performance-based requirements for the IPAs. To ensure participants develop effective IPAs, this final rule requires that participants submit annual reports to the Council that evaluate whether the IPA is effective at providing incentives for vessels to avoid Chinook salmon at all times while fishing for pollock. The sector-level performance standard ensures that the IPA is effective and that sectors cannot fully harvest the Chinook salmon PSC allocations under the 60,000 Chinook salmon PSC limit in most years. Each year, each sector will be issued an annual threshold amount that represents that sector’s portion of 47,591 Chinook salmon. For a sector to continue to receive Chinook salmon PSC allocations under the 60,000 Chinook salmon PSC limit, that sector must not exceed its annual threshold amount 3 times within 7 consecutive years. If a sector fails this performance standard, it will permanently be allocated a portion of the 47,591 Chinook salmon PSC limit.

To improve the implementation of sector entities, NMFS modified the final rule to clarify that: (1) NMFS will authorize only one entity to represent the catcher/processor sector and only one entity to represent mothership sector; (2) under the 60,000 Chinook salmon PSC limit, the entity for each sector has to represent all IPA participating vessel owners in that sector; and (3) vessel owners in the catcher/processor sector and mothership sector must be a member of the sector entity to join an IPA.

NMFS will issue transferable allocations of the 47,591 Chinook salmon PSC limit to all sectors, cooperatives, and CDQ groups if no IPA is approved, or to the sectors that exceed the performance standard. Transferability of PSC allocations is expected to mitigate the variation in the encounter rates of Chinook salmon bycatch among sectors, CDQ groups, and cooperatives in a given season by allowing eligible participants to obtain a larger portion of the PSC limit in order to harvest their pollock allocation or to transfer surplus allocation to other entities. When a PSC allocation is reached, the affected sector, inshore cooperative, or CDQ group would have to stop fishing for pollock for the remainder of the season even if its pollock allocation had not been fully harvested.

The rule removes from regulations the 29,000 Chinook salmon PSC limit in the Bering Sea, the Chinook Salmon Savings Areas in the Bering Sea, exemption from Chinook Salmon Savings Area closures for participants in the RHS ICA, and Chinook salmon as a component of the VRHS ICA. This final rule does not change any regulations affecting the management of Chinook salmon in the Aleutian Islands or non-Chinook salmon in the BSAI.

IPAs were submitted and approved for all sectors for the 2011 fishing year. Thus NMFS will allocate sector and seasonal proportions of the 60,000 Chinook cap in 2011. Observer coverage and monitoring changes as a result of implementation of Amendment 91 will be implemented in 2011. These changes are summarized in Section 2.5.

2.1.4 2009 and 2010 pollock catch and non-Chinook (chum) salmon bycatch by vessel category

Vessel-specific salmon bycatch information currently exists for catcher/processors, motherships, and observed catcher vessels in the inshore sector. However, vessels in the 30 percent observer coverage category are a significant component of the inshore sector, in 2011 per observer coverage changes implemented under Amendment 91 this sector will be covered at 100%. However through 2010, when these vessels are not observed, salmon bycatch rates from other observed vessels are used to estimate the salmon bycatch associated with the pollock catch by the unobserved vessels (as discussed in Section 3.1.2).

Table 2-2 shows the estimated pollock catch and salmon bycatch in the AFA pollock fisheries in the Bering Sea in 2009, by fishery sector and vessel length class. Fifty-three of the vessels participating in the inshore sector in 2009 were in the 30 percent observer coverage category. These vessels caught approximately 22 percent of the pollock catch and an estimated 38 percent of the non-Chinook (chum) salmon bycatch.

Table 2-2 Number of vessels that participated in the 2009 AFA pollock fisheries, pollock catch, and estimated non-Chinook salmon bycatch, by vessel category

Vessel category	Number of Vessels	Pollock (mt)	Percent of Pollock Catch	Number of non-Chinook salmon	Percent of non-Chinook Salmon
Catcher/processor	15	281,603	40%	3,901	9%
Motherships	3	70,308	10%	1,733	4%
CV 60 ft.-125 ft.	53	152,649	22%	22,465	38%
CV ≥ 125 ft.	26	197,718	28%	17,070	38%
Total	97	702,278	100%	45,169	100%

Table 2-3 shows the estimated pollock catch and salmon bycatch in the AFA pollock fisheries in the Bering Sea in 2010, by fishery sector and vessel length class. Fifty-five of the vessels participating in the inshore sector in 2010 were in the 30 percent observer coverage category. These vessels caught approximately 22 percent of the pollock catch and an estimated 44 percent of the non-Chinook (chum) salmon bycatch.

Table 2-3 Number of vessels that participated in the 2010 AFA pollock fisheries, pollock catch, and estimated non-Chinook salmon bycatch, by vessel category

Vessel category	Number of Vessels	Pollock (mt)	Percent of Pollock Catch	Number of non-Chinook salmon	Percent of non-Chinook Salmon
Catcher/processor	15	353,326	50%	3,181	25%
Motherships*	2				
CV 60 ft.-125 ft.	55	153,322	22%	5,584	44%
CV ≥ 125 ft.	26	198,363	28%	4,024	31%
Total	98	705,010	100%	12,788	100%

*CPs and mothership sector harvests are combined for confidentiality reasons.

2.2 Alternative 2: Hard Cap

Alternative 2 would establish a hard cap to limit chum salmon bycatch in the pollock fishery. When the hard cap is reached all directed fishing for pollock must cease. Only those chum salmon caught by vessels participating in the directed fishery for pollock would accrue towards the cap, and fishery closures on attainment of the cap would apply only to directed fishing for pollock. Several different options as to the scale of management for the hard cap are provided under this alternative: at the fishery level (separate hard caps for the CDQ Program and the remaining three AFA sectors combined); at the sector level (each of the 4 sectors including the CDQ sector receive a sector level cap with the CDQ sector level cap allocated to the individual CDQ groups); and at the cooperative level (the inshore CV sector level cap is further subdivided and managed at the individual inshore cooperative level; Section 0).

Under this alternative, Component 1 requires selecting the hard cap. If the hard cap is apportioned by sector (under Component 2), options are provided for the subdivision. Options for sector transfers or reallocations are included in Component 3. Further subdivision of an inshore sector cap to individual inshore cooperatives is discussed under Component 4 (cooperative provisions).

If none of the options under the Components 2-4 are selected, the Alternative 2 hard cap would apply at the fishery level and would be divided between the CDQ and non-CDQ fisheries. The CDQ Program would receive an allocation of 10.7% of a fishery level hard cap. The CDQ Program allocation would be further allocated among the six CDQ groups based on percentage allocations currently in effect. Each CDQ group would be prohibited from exceeding its chum salmon cap. This prohibition would require the CDQ group to stop directed fishing for pollock once its cap was reached because further directed fishing for pollock would likely result in exceeding the cap.

The remaining 89.3% of a fishery level hard cap would be apportioned to the non-CDQ sectors (inshore CV sector, offshore CP sector, and mothership sector) combined. The inshore CV sector contains up to seven cooperatives, each composed of multiple fishing vessels associated with a specific inshore processor. There also is a possibility than an inshore open access sector could form, if one or more catcher vessels do not join an inshore cooperative. All bycatch of non-Chinook salmon by any vessel in any of these three AFA sectors would accrue against the fishery level hard cap, and once the cap was reached, NMFS would simultaneously prohibit directed fishing for pollock by all three of these sectors.

Under Alternative 2, existing regulations related to the non-Chinook salmon prohibited species catch limit of 42,000 salmon and triggered closures of the Chum salmon savings areas in the Bering Sea would be removed from 50 CFR part 679.21.

Per Council direction (June 2010), the impact of implementing specific cap levels for Alternative 2 was analyzed based on a subset of the range of cap levels, as indicated in the tables under each component and option.

2.2.1 Component 1: Setting the Hard Cap

Component 1 would establish the annual hard cap based upon a range of numbers as shown below. Component 1 sets the overall cap; this could be either applied at the pollock fishery level to the CDQ and non-CDQ fisheries (not allocated by sector within the non-CDQ sectors), or may be subdivided by sector (Component 2) and the inshore sector allocation further allocated among the inshore cooperatives (Component 4).

2.2.1.1 Range of numbers for a hard cap

Table 2-4 lists the range of numbers considered for the overall non-Chinook salmon hard caps, in numerical order, lowest to highest. As listed here, the CDQ Program of the fishery level cap would be allocated 10.7%, with the remainder to the combined non-CDQ fishery.

Table 2-4 Range of suboptions for hard cap for non-Chinook with allocations for CDQ Program (10.7%) and remainder for non-CDQ fishery (89.3 %)

	Non-Chinook	CDQ	Non-CDQ
i)	**50,000**	5,350	44,650
ii)	75,000	8,025	66,975
iii)	125,000	13,375	111,625
iv)	**200,000**	21,400	178,600
v)	300,000	32,100	267,900
vi)	**353,000**	37,771	315,229

For analytical purposes only, a subset of the cap numbers included in the six suboptions were used in this document to assess the impacts of operating under a given hard cap. This subset approximates the upper and lower endpoints of the suboption range, and a midpoint (**bolded**).

The cap numbers initially represented a range of rounded historical averages over different 3-, 5- and 10-year time periods ranging from 1997-2006. The Council chose to modify these averages based both on more recent year averages as well as downward adjustments that the Council made in their December 2009 motion (for complete Council motions from December 2009 and June 2010 see Appendix 1 to Chapter 2). For comparison, Table 2-5 shows the resulting change in these time periods for historical averaging by using the most recent time frame as opposed to averaging only from time frames 2006 and earlier.

Table 2-5 Comparison of historical averages using previous time frame (1997-2006) time periods with more recent (1997-2009) 3-, 5-, and 10-yr averages

Period (current alternative set)	Average (# of salmon)	Period	Average (# of salmon)
2004-2006	484,895	2007-2009	51,629
2002-2006	344,898	2005-2009	233,820
1997-2006	201,195	2000-2009	199,489
1997-2001	57,493		

2.2.2 Component 2: Sector Allocation

If this component is selected, the hard cap would be apportioned to the sector level. This would result in separate sector level caps for the CDQ sector, the inshore catcher vessel (CV) sector, the mothership sector, and the offshore catcher processor (CP) sector.

The bycatch of non-Chinook salmon would be counted on a sector level basis. If the total non-Chinook salmon bycatch in a non-CDQ sector reaches the cap for that sector, NMFS would close directed fishing for pollock by that sector for the remainder of the season. The remaining sectors may continue to fish until they reach their sector level cap. The CDQ Program would continue to be managed as the status quo, with further allocation of the CDQ salmon bycatch cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding its salmon bycatch cap.

For analytical purposes, a subset of the sector level cap options which provides the greatest contrast will be used for detailed analysis.

2.2.2.1 Option 1: Sector level caps based on pollock allocation under AFA

Option 1) 10% of the cap to the CDQ sector, and the remaining allocated as follows: 50% inshore CV sector; 10% for the mothership sector; and 40% for the offshore CP sector. This results in sector level caps of 45% inshore CV, 9% mothership and 36% offshore CP.

This option would set the sector level hard caps based on the percentage established for pollock allocations under the AFA. Application of these percentages results in the following range of sector level caps, based upon the range of caps in Component 1, Option 1 (Table 2-6).

2.2.2.2 Options 2-6: Historical average of non-Chinook salmon bycatch by sector and blended adjustment of pro-rata and historical

Under Option 2, sector level caps would be set for each sector based on a range of sector allocation percentages. Table 2-6 summarizes the range of sector allocations resulting from options 1-6 and suboptions under each.

Option 2) Historical average of percent bycatch by sector, based on:

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 3) Allocation based on 75% pro-rata and 25% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 4) Allocation based on 50% pro-rata and 50% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 5) Allocation based on 25% pro-rata and 75% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 6) Allocate 10.7% to CDQ, remainder divided 44.77% to Inshore CV, 8.77% to Mothership and 35.76% to Catcher Processors.

Table 2-6 Sector percentage allocations resulting from options 1-3. Note that percentage allocations under Option 6 for the remaining sections are not included at this time. The allocation included for analytical purposes are shown in **bold**.

Time Period for Average	Option	% historical: pro-rata	CDQ	Inshore CV	Mothership	Offshore CPs
NA (AFA)	1	0:100	10.0%	45.0%	9.0%	36.0%
2007-2009	2i	100:0	4.4%	75.6%	5.6%	14.4%
	3i	75:25	5.8%	67.9%	6.5%	19.8%
	4i	50:50	7.2%	60.3%	7.3%	25.2%
	5i	25:75	8.6%	52.6%	8.2%	30.6%
2005-2009	**2ii**	**100:0**	**3.4%**	**81.5%**	**4.0%**	**11.1%**
	3ii	75:25	5.0%	72.4%	5.3%	17.3%
	4ii	**50:50**	**6.7%**	**63.3%**	**6.5%**	**23.6%**
	5ii	25:75	8.3%	54.1%	7.8%	29.8%
2000-2009	2iii	100:0	4.4%	76.0%	6.2%	13.4%
	3iii	75:25	5.8%	68.3%	6.9%	19.1%
	4iii	50:50	7.2%	60.5%	7.6%	24.7%
	5iii	25:75	8.6%	52.8%	8.3%	30.4%
1997-2009	2iv	100:0	4.4%	74.2%	7.3%	14.1%
	3iv	75:25	5.8%	66.9%	7.8%	19.5%
	4iv	50:50	7.2%	59.6%	8.2%	25.0%
	5iv	25:75	8.6%	52.3%	8.6%	30.5%
suboption(10.7% to CDQ)	**6**	**NA**	**10.7%**	**44.77%**	**8.77%**	**35.76%**

For analysis the following range of sector allocations will be examined:

Option	**CDQ**	**Inshore CV**	**Mothership**	**CP**
2ii (sector allocation 1)	3.4%	81.5%	4.0%	11.1%
4ii (sector allocation 2)	6.7%	63.3%	6.5%	23.6%
Suboption (sector allocation 3)	10.7%	44.77%	8.77%	35.76%

Based on the cap levels noted under component 1 for analysis, the sector level caps under component 2 and the cooperative provisions under component 3 to be analyzed, the following shows the sector level caps to be evaluated in this analysis (Table 2-7). Note that cooperative level caps to the inshore CV sector will be analyzed qualitatively (see Section XXX for cooperative provisions and allocations).

Table 2-7 Alternative 2 non-Chinook salmon sector level caps for analysis (note sector level numbers refer to options as listed in Table 2-6 above)

Hard cap	Sector allocation	CDQ	CV	MS	CP
50,000	1	1,700	40,750	2,000	5,550
	2	3,350	31,650	3,250	11,800
	3	5,350	22,385	4,385	17,880
200,000	1	6,800	163,000	8,000	22,200
	2	13,400	126,600	13,000	47,200
	3	21,400	89,540	17,540	71,520
353,000	1	12,002	287,695	14,120	39,183
	2	23,651	223,449	22,945	83,308
	3	37,771	158,038	30,958	126,233

2.2.3 Component 3: Sector Transfer

The two options under this component may be selected only if the hard cap is apportioned among the sectors under Component 2. Options 1 and 2 are mutually exclusive, which means that either Option 1 to allow sector level transferable allocations or Option 2 to require NMFS to reapportion salmon bycatch from one sector to the other sectors in a season could be selected.

If sector level caps under Component 2 are selected, but not select Option 1 (transfers) or Option 2 (reallocations) under Component 3, the sector level cap would not change during the year and NMFS would close directed fishing for pollock once each sector reached its sector level cap. Because the CDQ sector level cap would be allocated to the CDQ groups, the CDQ caps would continue to be managed as they are under status quo, with further allocation of the non-Chinook salmon bycatch cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding is salmon bycatch allocation.

2.2.3.1 Option 1: Transferable salmon bycatch caps

Option 1) Allocate salmon bycatch caps to each sector and allow the entity representing each non-CDQ sector and the CDQ groups to transfer salmon bycatch cap among the sectors and CDQ groups.

To provide sectors and cooperatives more opportunity to fully use their pollock allocations, the ability to transfer sector level non-Chinook salmon caps could be implemented as part of Alternative 2. If sectors are issued transferable non-Chinook salmon caps, then these entities could request NMFS to move salmon bycatch cap amounts from one entity’s account to another entity’s account during a fishing season. Transferable caps would not constitute a “use privilege” and, under the suboptions, only a portion of the residual salmon bycatch cap may be transferred.

Suboption: Limit transfers to the following: a) 50%, b) 70%, or c) 90% of available salmon bycatch cap.

If a transferring entity had completed harvested its pollock without reaching its non-Chinook salmon bycatch cap, it could only transfer up to a specific percent of that salmon bycatch cap to another entity with pollock still remaining for harvest in that season. Under this circumstance, this transfer provision would mean that not all of the salmon bycatch cap would be available for use by entities other than the original recipient of the cap.

Transfers are voluntary requests to NMFS, initiated by the entity receiving a salmon bycatch cap, for NMFS to move a specific amount of a salmon bycatch cap from one entity's account to another entity's account.

Option 1 would require that each sector receiving a transferable salmon bycatch cap be represented by an entity that could:

- represent all vessels eligible to participate in the particular AFA sector and receive an amount of non-Chinook salmon bycatch cap on behalf of those vessels,
- be authorized by all members of the sector to transfer all or a portion of the sector's non-Chinook salmon bycatch cap to another sector or to receive a chum salmon bycatch cap transfer from another sector on behalf of the members of the sector,
- be responsible for any penalties assessed for exceeding the sector's non-Chinook salmon bycatch cap (i.e., have an agent for service of process with respect to all owners and operators of vessels that are members of the entity).

More information about the entities necessary to receive transferable non-Chinook salmon bycatch caps is in Section 1.2.5.3.

Once sector level salmon bycatch hard caps are allocated to an entity representing an AFA sector or to a CDQ group, each entity receiving a transferable cap would be prohibited from exceeding that cap. NMFS would report any overages of the cap to NOAA OLE for enforcement action.

2.2.3.2 Option 2: Reallocate unused salmon bycatch to other sectors

Option 2) NMFS manages the sector level caps for the non-CDQ sectors and would reallocate unused salmon bycatch caps to other sectors still fishing in a fishing season based on the proportion of pollock remaining for harvest.

A "reallocation" is a management action taken by NMFS to move salmon bycatch caps from one sector to the remaining sectors through a notice in the *Federal Register*. Reallocates are an alternative to transferable caps that allow one sector to voluntarily transfer unused salmon bycatch cap amounts to another sector.

Under this option, if a non-CDQ AFA sector has completed harvest of its pollock allocation without reaching its sector level bycatch cap, and sufficient salmon bycatch cap remains to be reallocated, NMFS would reallocate the unused amount of salmon bycatch cap to other AFA sectors, including CDQ groups. Any reallocation of salmon bycatch caps by NMFS would be based on the proportion each sector represented of the total amount of pollock remaining for harvest by all sectors through the end of the season. Successive reallocations would occur as each non-CDQ sector completes harvest of its pollock allocation.

The CDQ groups could receive reallocations of salmon bycatch caps from other sectors. However, because the CDQ groups will each receive a specific, transferable cap of salmon bycatch (as occurs under status quo), unused salmon bycatch caps would not be reallocated from an individual CDQ group to other CDQ groups or other AFA sectors. CDQ groups with unused salmon bycatch caps could transfer it to another CDQ group, as is currently allowed in the CDQ Program.

2.2.4 Component 4: Cooperative provisions

Options under this component may be selected only if sector level bycatch caps are set under Component 2. Component 4 would further subdivide the inshore CV sector level bycatch cap to the inshore cooperatives and the inshore open access fishery (if the inshore open access fishery exists in a particular year). Each inshore cooperative would manage its cap and would be required to stop directed fishing for pollock once the cooperative's cap is reached. NMFS would close the inshore open access fishery once that fishery's cap is reached.

The cap of salmon to the inshore CV cooperatives or to the inshore open access fishery would be based upon the proportion of total inshore CV sector pollock catch history associated with the vessels in the cooperative or inshore open access fishery, respectively. The annual pollock quota for this sector is allocated by applying a formula which allocates catch to a cooperative, or the inshore open access fishery, according to the sum of the catch history for the vessels in the cooperative or the inshore open access fishery, respectively. Under 50 CFR 679.62(e)(1), the individual catch history of each vessel is equal to the sum of inshore pollock landings from the vessel's best 2 out of 3 years from 1995 through 1997, and includes landings to catcher/processors for vessels that made landings of 500 mt or more in 1995, 1996, or 1997.

Each year, NMFS issues fishing permits to cooperatives based on the cooperative's permit application which lists all cooperative member catcher vessels. Fishing in the inshore open access fishery is possible should a vessel leave a cooperative, and the inshore CV pollock allocation allows for an allocation to an inshore open access fishery under these circumstances.

The range of inshore cooperative level caps in this analysis is based on the 2010 pollock allocations, and the options for the range for the inshore CV sector is based on Alternative 2 caps for analysis. All inshore sector CVs have been part of a cooperative since 2005 except two vessels in 2010. However, if this component is selected, regulations would accommodate allocations of the non-Chinook salmon bycatch cap to the inshore open access fishery, if, in the future, a vessel or vessels did not join a cooperative.

Table 2-8 Alternative 2 inshore catcher vessel sector non-Chinook salmon bycatch limits by cooperative based on 2010 pollock allocations

Hard cap	Sector Allocation	Akutan CV Assoc	Arctic Enterprise	Northern Victor Fleet	Peter Pan Fleet	Unalaska	Unisea Fleet	Westward Fleet	Open access AFA
2010 pollock allocation		32.02%	0.00%	9.38%	2.88%	10.49%	25.95%	18.49%	0.00%
50,000	1	13,050	0	3,822	1,172	4,276	10,576	7,534	0
	2	10,136	0	2,968	910	3,321	8,214	5,851	0
	3	7,169	0	2,099	644	2,349	5,810	4,139	0
200,000	1	52,199	0	15,286	4,688	17,104	42,305	30,135	0
	2	40,542	0	11,873	3,641	13,284	32,858	23,406	0
	3	28,674	0	8,397	2,575	9,395	23,239	16,554	0
353,000	1	92,131	0	26,980	8,274	30,188	74,668	53,189	0
	2	71,557	0	20,955	6,426	23,447	57,994	41,311	0
	3	50,610	0	14,821	4,545	16,583	41,017	29,218	0

2.2.4.1 Cooperative transfer options

These options would only apply if the sector level bycatch caps under Component 2 and the inshore CV sector level cap is further allocated among the inshore cooperatives and the inshore open access fishery (if the inshore open access fishery existed in a particular year) under Component 4. Option 1 or Option 2 or both could be selected.

When a salmon inshore cooperative cap is reached, the cooperative must stop fishing for pollock and may:

Option 1) Transfer (lease) its remaining pollock to another inshore cooperative for the remainder of the season or year. Allow inter-cooperative transfers of pollock to the degree currently authorized by the AFA.

Option 2) Transfer salmon bycatch cap amounts from other inshore cooperatives (industry initiated)

Suboption: Limit transfers to the following: a) 50%, b) 70%, or c) 90% of available salmon

2.3 Alternative 3: Triggered closures

Triggered closures are regulatory time and area closures when specific cap levels are reached. Once specific areas are closed, directed fishing for pollock could continue outside of the closure areas until either the pollock allocation is reached or the annual (November 1) closure date.

If the trigger cap is not further allocated among the non-CDQ sectors under Component 3, sector allocation, the CDQ sector would receive an allocation of 10.7 percent of the non-Chinook salmon trigger cap. This CDQ allocation would be further allocated among the six CDQ groups based on percentage allocations currently in effect. Each CDQ group would be prohibited from directed fishing for pollock inside the closure area(s) when that group's trigger cap is reached.

Under Alternative 3, existing regulations related to the non-Chinook salmon prohibited species catch limit of 42,000 salmon and triggered closures of the Chum salmon savings area in the Bering Sea would be removed from 50 CFR part 679.21 as well as regulations associated with the non-Chinook salmon elements of the VRHS ICA.

2.3.1 Component 1: Trigger cap formulation

Component 1 defines both how the overall cap level associated with the triggered area is defined (Component 1A) as well as how the monthly proportion or within-monthly limit is formulated (Component 1B).

2.3.1.1 Component 1A: Trigger cap levels:

Table 2-9 lists the range of numbers considered for the overall non-Chinook salmon hard caps, in numerical order, lowest to highest. As listed here, the CDQ sector allocation of the fishery level cap would be 10.7%, with the remainder apportioned to the combined non-CDQ fishery.

Table 2-9 Range of suboptions for trigger cap levels for non-Chinook with allocations for CDQ (10.7%) and remainder for non-CDQ fishery.

	Non-Chinook	CDQ	Non-CDQ
i)	**25,000**	2,675	22,325
ii)	50,000	5,350	44,650
iii)	**75,000**	8,025	66,975
iv)	125,000	13,375	111,625
v)	**200,000**	21,400	178,600

For analytical purposes only, a subset of the cap levels included in the six suboptions were used in this document to assess the impacts of operating under a given hard cap. This subset approximates the upper and lower endpoints of the suboption range, and a midpoint (**bolded**).

2.3.1.2 Component 1B: Trigger limit application:

Three options are considered for application of trigger caps (Component 1B) for area closure options

Option 1: Apply trigger to all non-Chinook bycatch (monthly proportion of cap)

Option 1 is to apply trigger to all chum bycatch, and to use the calculated cumulative monthly proportion of the cap to establish monthly threshold limits. Here the cumulative monthly proportion (as noted in Table 2-10 below) is used to establish threshold limits by month for the overall cap as selected under Component 1A. The cumulative monthly proportion was calculated by estimating the average per month over the years 2003-2010.

Table 2-10 Monthly proportion of non-Chinook salmon limit

Month	**Option 1** : monthly threshold cumulative proportion
June	11.1%
July	35.4%
August	66.5%
September	92.8%
October	100.0%

Option 2: Apply chum bycatch between specific dates (minimum of monthly proportion and 150% monthly historical proportion)

Under this option of Component 1B, “apply chum bycatch between specific dates”, the intent would be to specify a within monthly limit defined as the minimum of the monthly cumulative and 150% of monthly historical proportion[18]. The minimum of these two levels defines the within-month cap. Under this option of Component 1B, the monthly limit shown in Table 2-11 would be in effect.

---

[18] Note monthly limit should evaluate +/- 25% of monthly limit distribution

Table 2-11 Monthly proportion of chum salmon limit and within monthly proportion

	Option 2: monthly threshold and within monthly limit	
Month	Cumulative Proportion	Monthly proportion (if < cumulative)
June	11.1%	11.1%
July	35.4%	24.4%
August	66.5%	31.1%
September	92.8%	26.3%
October	100.0%	7.2%

Suboption (2a): Monthly trigger limit application that redistributes the monthly percentage such that trigger limits are lower in months where the chum salmon bycatch component is made up of relatively higher contribution from western Alaska.

This sub-option is intended to provide proportional within-season bycatch limits to account for the proportional contribution of western Alaskan chum salmon stocks. This trigger-cap adjustment option was developed given information indicating that the estimate of the proportion of chum salmon bycatch during the early (June-July) part of the B-season is higher for western Alaska stocks (WAK, which includes coastal western Alaska and fall run Yukon chum salmon) than later in the season (August-October). The rationale being that if the goal for a given trigger cap level, *C*, is to have the same relative savings of WAK chum salmon, then accounting for the proportional differences is required. For this option the cap for June and July would be adjusted further by the ratio *r*:

$$C_{Jun-Jul} = rC$$

$$r = \frac{p_{Aug-Oct}}{p_{Jun-Jul}}$$

where the *p* values represent the estimated proportion of the bycatch attributed as coming from WAK stocks based on analysis of genetic data (or potentially other sources).

Note that for this sub-option the ratio *r* may be periodically revised to reflect updated analyses on the regional origins of chum salmon in the bycatch. As described in Chapter 3, the genetic analyses indicate that the estimate for *r* based on samples from 2005-2009 is 0.565.

Option 3: single cap, no monthly limit[19]

Component 1B option 3 would indicate that a single (overall or sector-split) cap would be specified and bycatch would accrue toward it cumulatively over the season. When that cap was reached, the closure system as specified in component 4 would be enacted. There would be no additional monthly cap limit constraints as specified under components 1A and 1B. The areas to be closed would depend upon the timing of when the overall cap (or sector-specific proportion) was reached and would then continue monthly as specified under the closure system selected under component 4.

---

[19] Note this option was previously contained under Component 5 of June 2010 Council motion and has been merged for simplicity with the other timing and cap components under component 1. Previously this component read the following: *Component 5: Timing Option – Dates of Area Closure:*

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

b) Discrete small closures would close when a cap was attained and would close for the time period corresponding to periods of high historical bycatch.

The remaining component 'b' of the previous "Component 5" are contained already in Components 1A and 1B.

2.3.2 Component 2: Sector allocation

If this component is selected, the trigger cap would be apportioned to the sector level. This would result in separate sector level caps for the CDQ sector, the inshore catcher vessel (CV) sector, the mothership sector, and the offshore catcher processor (CP) sector.

The bycatch of Chum salmon would be counted on a sector level basis. If the total salmon bycatch in a non-CDQ sector reaches the cap for that sector, NMFS would close directed fishing for pollock by that sector in the specific areas (selected under Component 4) for the remainder of the season. The remaining sectors may continue to fish outside the closures until they reach their sector level cap. The CDQ allocations would continue to be managed as they are under the status quo, with further allocation of the CDQ salmon bycatch cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding its salmon bycatch allocation.

For analytical purposes, a subset of the sector allocation options which provides the greatest contrast will be used for detailed analysis.

2.3.2.1 Option 1: Sector allocation based on pollock allocation under AFA

Option 1) 10% of the cap to the CDQ sector, and the remaining allocated as follows: 50% inshore CV fleet; 10% for the mothership fleet; and 40% for the offshore CP fleet. This results in allocations of 45% inshore CV, 9% mothership and 36% offshore CP.

This option would set the sector level trigger caps based the percentage allocations established for pollock allocations under the AFA. Application of these percentages results in the following range of sector level caps, based upon the range of caps in Component 1, Option 1 (Table 2-12).

2.3.2.2 Option 2-6: Historical average of Chum salmon bycatch by sector and blended adjustment of pro-rata and historical

Under Option 2, sector level trigger caps would be set for each sector based on a range of sector allocation percentages.

Option 2) Historical average of percent bycatch by sector, based on:

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 3) Allocation based on 75% pro-rata and 25% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 4) Allocation based on 50% pro-rata and 50% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 5) Allocation based on 25% pro-rata and 75% historical

- i. 3-year (2007-2009)
- ii. 5-year (2005-2009)
- iii. 10-year (2000-2009)
- iv. 14-year (1997-2009)

Option 6) **Allocate 10.7% to CDQ, remainder divided 44.77% to Inshore CV, 8.77% to Mothership and 35.76% to Catcher Processors.**.

Table 2-12 summarizes the range of sector allocations resulting from options 1-6 and suboptions under each.

Table 2-12 Sector split percentage allocations resulting from options 1-6

Time Period for Average	Option	% historical: pro-rata	CDQ	Inshore CV	Mothership	Offshore CPs
NA (AFA)	1	0:100	10.0%	45.0%	9.0%	36.0%
2007-2009	2i	100:0	4.4%	75.6%	5.6%	14.4%
	3i	75:25	5.8%	67.9%	6.5%	19.8%
	4i	50:50	7.2%	60.3%	7.3%	25.2%
	5i	25:75	8.6%	52.6%	8.2%	30.6%
2005-2009	2ii	100:0	3.4%	81.5%	4.0%	11.1%
	3ii	75:25	5.0%	72.4%	5.3%	17.3%
	4ii	50:50	6.7%	63.3%	6.5%	23.6%
	5ii	25:75	8.3%	54.1%	7.8%	29.8%
2000-2009	2iii	100:0	4.4%	76.0%	6.2%	13.4%
	3iii	75:25	5.8%	68.3%	6.9%	19.1%
	4iii	50:50	7.2%	60.5%	7.6%	24.7%
	5iii	25:75	8.6%	52.8%	8.3%	30.4%
1997-2009	2iv	100:0	4.4%	74.2%	7.3%	14.1%
	3iv	75:25	5.8%	66.9%	7.8%	19.5%
	4iv	50:50	7.2%	59.6%	8.2%	25.0%
	5iv	25:75	8.6%	52.3%	8.6%	30.5%
Option 6(10.7% to CDQ)	6	NA	10.7%	44.77%	8.77%	35.76%

For analysis the following range of sector allocations will be examined:

Option	CDQ	Inshore CV	Mothership	CP
2ii (sector allocation 1)	3.4%	81.5%	4.0%	11.1%
4ii (sector allocation 2)	6.7%	63.3%	6.5%	23.6%
6 (sector allocation 3)	10.7%	44.77%	8.77%	35.76%

Based on the cap levels noted under component 1 for analysis, and the sector allocations under component 2 to be analyzed, the following shows the specific caps by sector to be evaluated in this analysis (Table 2-13 and Table 2-14).

Table 2-13 Chum salmon bycatch limits that would trigger monthly closures by sector under options 1-2. Optional monthly limits (option 2) are given in parenthesis. Note sector allocation numbers correspond to options listed in Table 2-14.

Sector Allocation	25,000 cap	CDQ	CV	MS	CP
1	June	90 (90)	2,250 (2,250)	110 (110)	310 (310)
	July	300 (300)	7,210 (7,210)	350 (350)	980 (980)
	August	570 (400)	13,560 (9,510)	670 (470)	1,850 (1,300)
	September	790 (340)	18,910 (8,030)	930 (390)	2,580 (1,090)
	October	850 (90)	20,380 (2,190)	1,000 (110)	2,780 (300)
2	June	180 (180)	1,710 (1,710)	180 (180)	640 (640)
	July	530 (520)	4,990 (4,920)	510 (510)	1,860 (1,830)
	August	1,070 (810)	10,070 (7,620)	1,030 (780)	3,760 (2,840)
	September	1,550 (720)	14,600 (6,790)	1,500 (700)	5,440 (2,530)
	October	1,680 (190)	15,830 (1,830)	1,630 (190)	5,900 (680)
3	June	290 (290)	1,210 (1,210)	240 (240)	970 (970)
	July	840 (830)	3,530 (3,480)	690 (680)	2,820 (2,780)
	August	1,700 (1,290)	7,130 (5,390)	1,400 (1,060)	5,690 (4,310)
	September	2,470 (1,150)	10,330 (4,800)	2,020 (940)	8,250 (3,840)
	October	2,680 (310)	11,190 (1,300)	2,190 (250)	8,940 (1,040)

Table 2-14 Chum salmon sector allocations of different trigger cap levels under option 3

Trigger cap	Sector allocation	CDQ	CV	MS	CP
25,000	1	850	20,375	1,000	2,775
	2	1,675	15,825	1,625	5,900
	3	2,675	11,192	2,193	8,940
50,000	1	1,700	40,750	2,000	5,550
	2	3,350	31,650	3,250	11,800
	3	5,350	22,385	4,385	17,880
200,000	1	6,800	163,000	8,000	22,200
	2	13,400	126,600	13,000	47,200
	3	21,400	89,540	17,540	71,520

2.3.2.3 Comparison of monthly limits under options 1, 2 and 3

Options 1-3 describe the mechanism by which the specific trigger limit (as selected under Component 1) is applied, which if reached enacts a series of closures, as described under Component 4. Under all three options, the closure system would be enacted for the remainder of the season should the cumulative total trigger by sector be reached. The distinction between the options is the progressively more restrictive within monthly limits imposed on either option 1 or 2 in addition to the cumulative cap. This section uses a specific cap and sector allocation example to demonstrate how the options differ in their application. For all options the area closure system example employed is the same. Component 4 describes the range of area closures under consideration based upon average historical bycatch percentages. Here Component 4B (50% historical bycatch) is selected for this example. The areas shown in Table 2-15 correspond to the closures indicated in Figure 2-3.

Table 2-15 Closure descriptions under Alternative 3, component 4b (50% historical bycatch closure system) for all three trigger application options. Note that within each month the closures are indicated by the CSSA number corresponding to the month and number of closure areas as indicated in Figure 2-3.

Month	Chum salmon savings area	Number of closure boxes
June	CSSA1	2
July	CSSA2	4
August	CSSA3	6
September	CSSA4	5
October	CSSA5	3

Option 1: Using the example of a 25,000 trigger cap limit sector allocation (1), the following tables indicate what the within monthly limit would be and which areas would close upon reaching that limit.

Table 2-16 Option 1 monthly proportion of cumulative total limits. If cumulative bycatch by a sector reaches the specific limit, during the specific month, then the area as indicated for that month will close for the remainder of the month. CSSA area numbers correspond to those listed in Table 2-15.

CDQ	CV	M	CP	Month	Area
90	2,250	110	310	June	CSSA1
300	7,210	350	980	July	CSSA2
570	13,560	670	1,850	August	CSSA3
790	18,910	930	2,580	September	CSSA4
850	**20,380**	**1,000**	**2,780**	October	CSSA5

Here the listed area will close for the month in which the sectors cap is reached. Those areas would then reopen at the end of the month. The next areas would remain open unless the cumulative bycatch by sector reaches the monthly limit. If bycatch reaches the monthly limit then the areas listed for that month will close for the remainder of the month. If in any month the cumulative total amount (listed in bold) is reached, then the CSSAs listed for each month would close according to their monthly schedule for the remainder of the season. In all cases there may be additional bycatch by sector outside of the CSSAs, however the sector whose limit has been reached will be prohibited from fishing in the CSSAs in each month in which the closure applies.

Option 2: Using the same example, Table 2-17 shows the monthly limits that would close the CSSA prior to reaching the limits as shown in Table 2-16.

Here the limits shown in Table 2-17 are in addition to the monthly cumulative limits shown in Table 2-16. For all sectors the monthly and cumulative amounts for June are equivalent (and for this sector allocation example they are equivalent in July as well). Should the within-monthly limit (Table 2-17) by sector be reached, regardless of the cumulative monthly limit not being reached, the CSSA would close for the remainder of the month. The following month, the CSSA would only close if the limit for that month was reached or if the cumulative bycatch reached the cumulative limits. As with option 1, if at any time the annual cumulative total (in bold) were reached, then the CSSAs would be enacted monthly for the remainder of the season and the sector or sectors reaching their limits would be prohibited from directed fishing for pollock within those areas in each month. As with option 1, bycatch by sector may continue to accrue outside of the CSSAs.

Table 2-17 Option 2 monthly proportion and within monthly limit. If prior to reaching the monthly amounts listed in Table 2-16 above, non-Chinook bycatch by sector in a given month reaches the following amount then the following areas close for the remainder of the month:

CDQ	CV	M	CP	MONTH	AREA
90	2,250	110	310	June	CSSA1
300	7,210	350	980	July	CSSA2
400	9,510	470	1,300	August	CSSA3
340	8,030	390	1,090	September	CSSA4
90	2,190	110	300	October	CSSA5

Option 3: For option 3 there is no monthly limit. Instead the bycatch accrues against the cumulative limit by sector only. Annual sector limits under the same total cap (25,000) and sector allocation example as shown for options 1 and 2 are as follows:

Table 2-18 Option 3 Seasonal cumulative limit. Sector specific cumulative trigger limits

CDQ	CV	M	CP
850	20,380	1,000	2,780

Here when the cumulative amount by sector is reached, the CSSA in the month in which the cap was reached will close for the remainder of the month and the CSSAs for all subsequent months through the end of the season will close as scheduled. No within monthly limit is applied in addition to the cumulative bycatch limit under this option. As with option 1 and 2, bycatch by sector may continue to accrue outside of the CSSAs.

2.3.3 Component 3: Cooperative Provisions

The two options under this component may be selected only if the trigger cap is apportioned among the sectors under Component 2. Options 1 and 2 are mutually exclusive, which means that either Option 1 to allow sector level transferable allocations or Option 2 to require NMFS to reallocate salmon bycatch from one sector to the other sectors could be selected.

If sector level caps under Component 2 are selected, but not select are Option 1 (transfers) or Option 2 (reallocations) under Component 3, the sector level cap would not change during the year and NMFS would close directed fishing for pollock in the specified area once each sector reached its sector level cap. Because the CDQ sector level cap would be allocated to the CDQ groups, the CDQ allocations would continue to be managed as they are under status quo, with further allocation of the salmon bycatch cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding is salmon bycatch allocation.

a) Allow allocation at the cooperative level for the inshore sector, and apply transfer rules (Component 3) at the cooperative level for the inshore sector.
    Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
        1) 50%
        2) 70%
        3) 90%
b) Allow NMFS to reallocate unused bycatch allocation to cooperatives that are still fishing.

2.3.4 Component 4: Area and Timing Options

Component 4 includes 3 options for a system of closure areas which change by month. Here options represent the overall estimated bycatch percentage represented historically by these regions on a monthly basis over the years 2003-2010.

d) Area closure groupings by month that represent 40% of historical bycatch.
e) Area closure groupings by month that represent 50%[20] of historical bycatch.
f) Area closure groupings by month that represent 60% of historical bycatch.

The following steps were used to determine which areas to be included in the area closures by size for each month.

1) Use criterion for ranking top 20 areas for each month (out of global top 20 areas)
2) Given the monthly ranking, compute the percentage of total chum
3) Use that to find the level amount of areas to close

Results area shown in Figure 2-2 to Figure 2-4 for each month associated with options a-c of Component 4.

Under the closure systems represented by Component 4, options a-c, the specified closures vary each month depending upon the selected historical bycatch percentage. Once a cap level and allocation as selected under components 1-3 are reached (by fishery, sector or cooperative depending upon the allocation level), the specified areas by month would close for the remainder of the month. At the end of the month, the areas would then reopen and if triggered (already based upon exceeding a cumulatively specified cap or within the subsequent month by triggering a within-month cap) new areas would close to those entities which exceeded their proportion of the cap the following month. In each month the areas to be closed are pre-specified but are not exactly the same from one month to the next. Under a cumulative cap scenario, once the cap is reached the closure system goes into place in every month for the remainder of the season. Further information on how the cap application corresponds to the closure system is contained in Section 2.3.2.3.

---

[20] The Council noted that the analysis should include quantitative analysis of the 50% closure options and qualitative analysis of the 40% and 60% closure options.

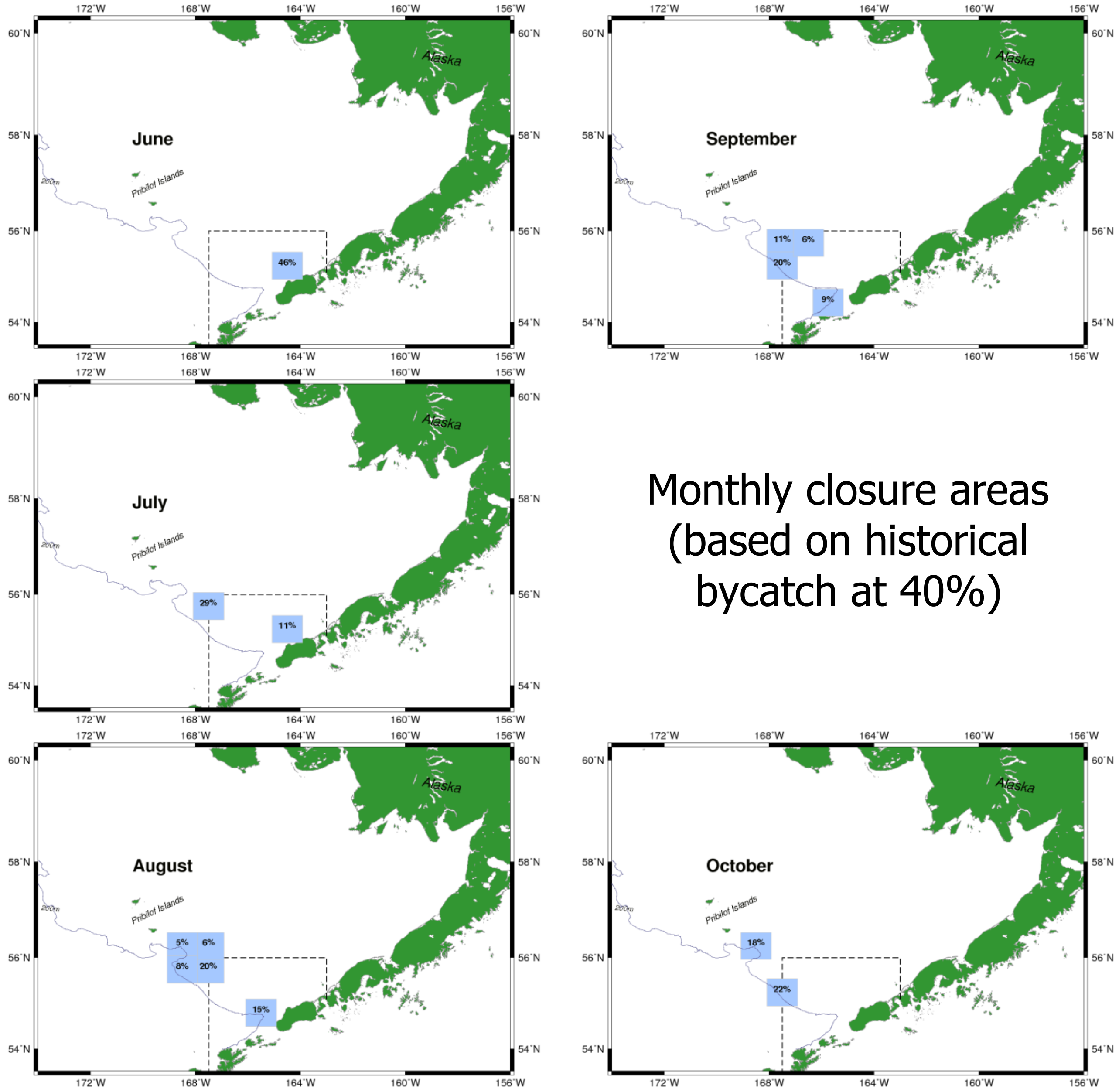


Figure 2-2 Monthly area closures based on ADFG areas that represented 40% of the historical chum salmon bycatch (within each month)

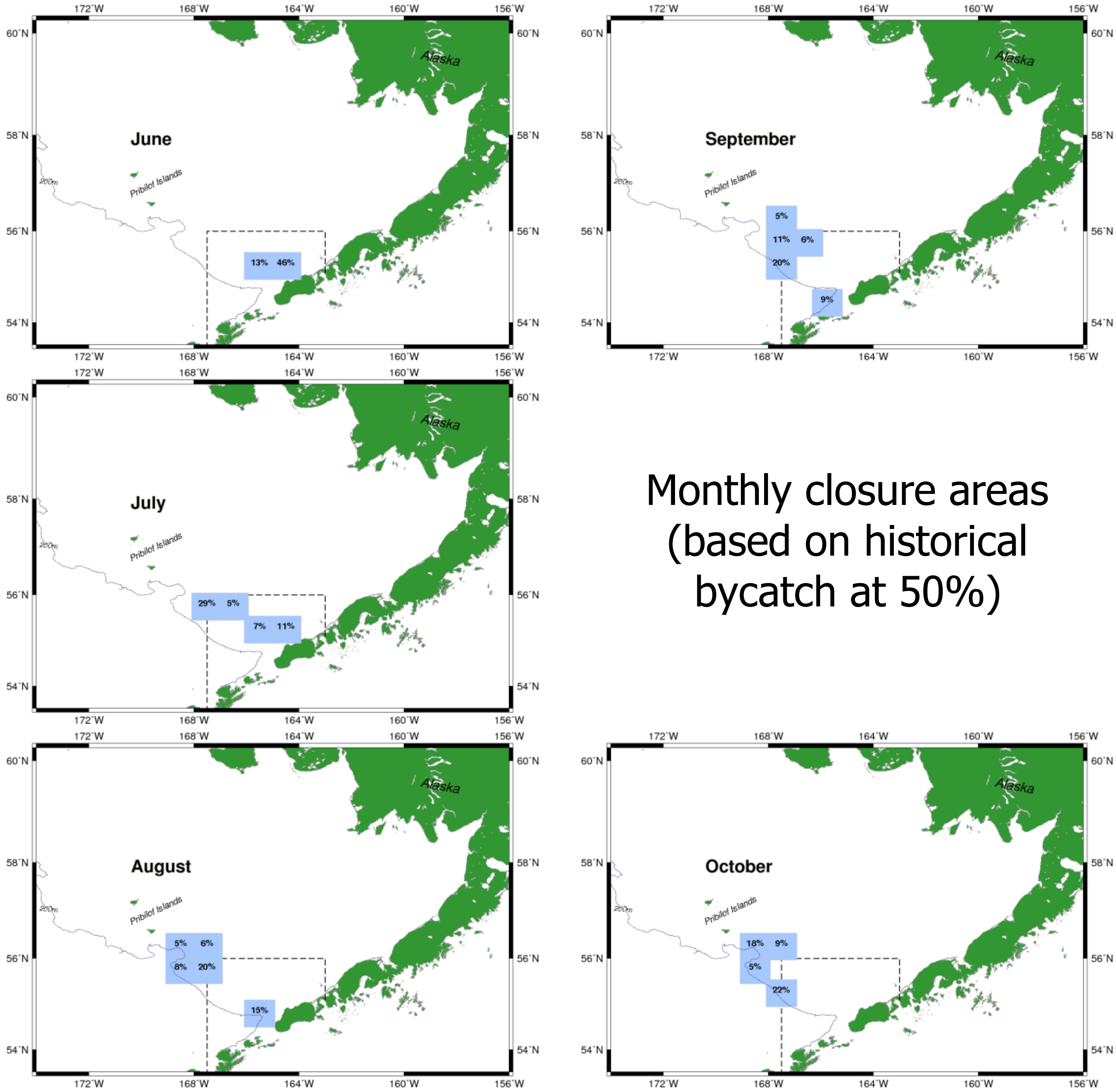
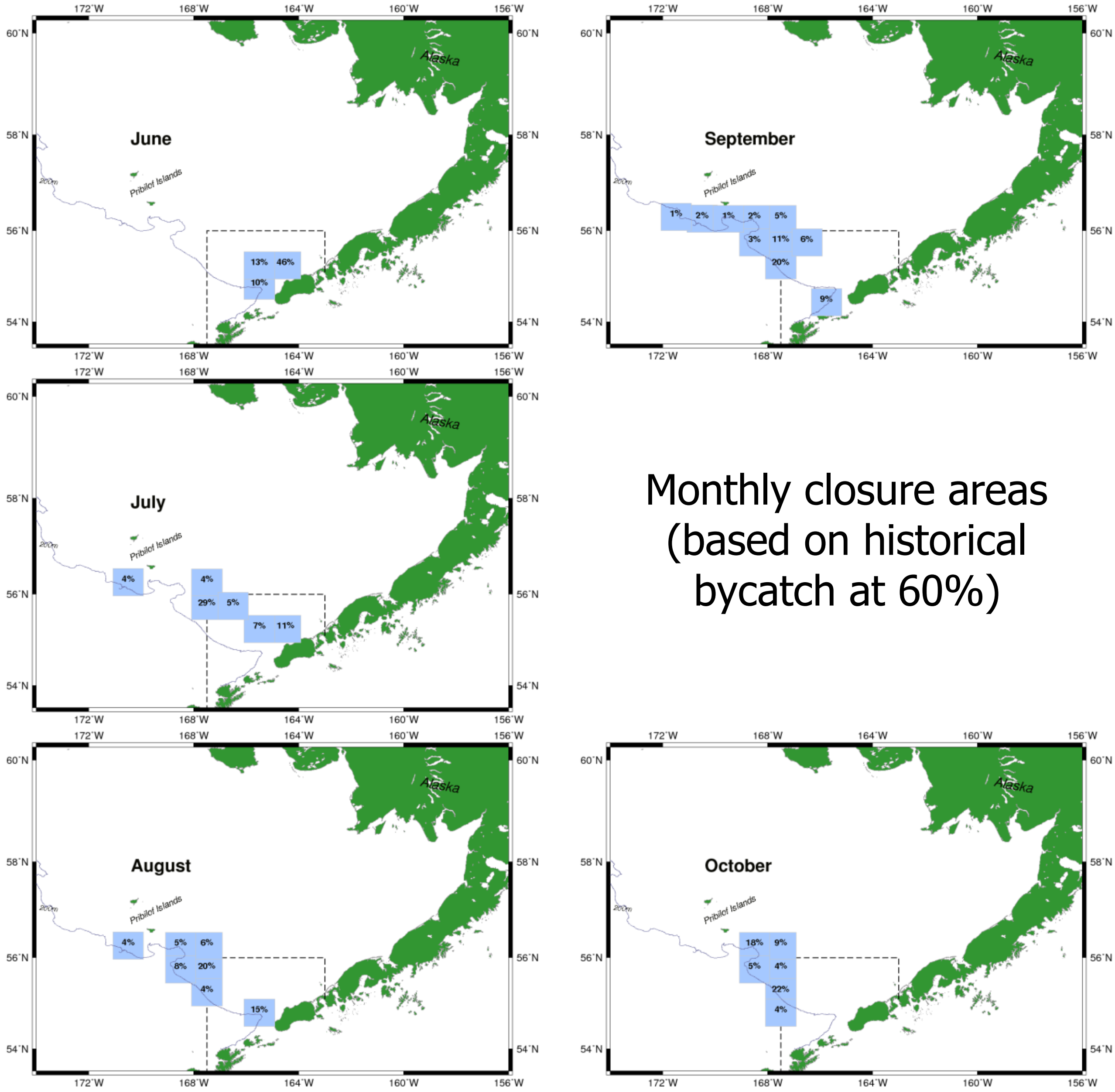


Figure 2-3 Monthly area closures based on ADFG areas that represented 50% of the historical chum salmon bycatch (within each month)



Monthly closure areas (based on historical bycatch at 60%)

Figure 2-4 Monthly area closures based on ADFG areas that represented 60% of the historical chum salmon bycatch (within each month)

2.4 Alternative 4-Closure with RHS exemption

Similar to status quo (rolling hot-spot (RHS) system in regulation), participants in a vessel-level (platform level for Mothership) RHS would be exempt from the regulatory closure system below. This closure represents a large area trigger closure encompassing 80% of historical bycatch (Figure 2-5). This closure would be fixed over the B-season unless the triggered closure option is selected. Sector allocation sub-options of the triggered cap are equivalent to those under Alternative 2.

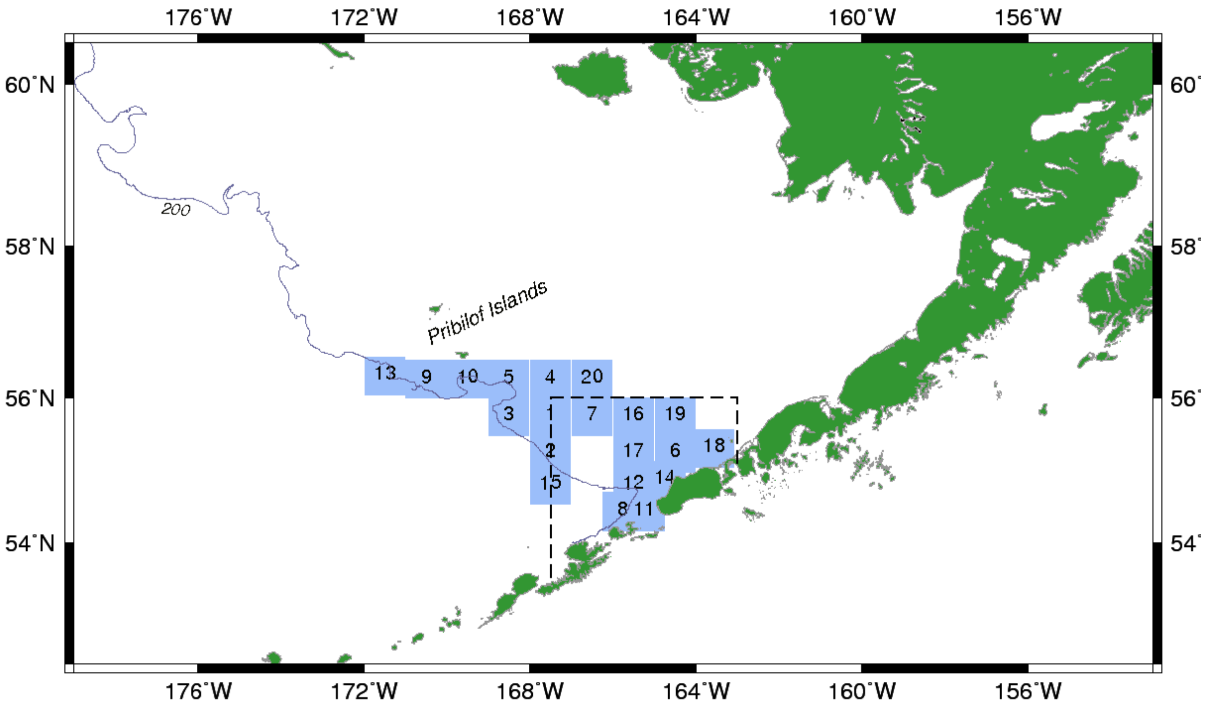


Figure 2-5 Large area closure based on ADFG areas that represented about 80% of the historical chum salmon bycatch

2.4.1 Option 1: Manage the area as a trigger area closure.

Under this option the closure as shown in Figure 2-5 would be in place as a fallback provision for all vessels not participating in an ICA if the following cap levels were reached:

Trigger cap options:
1a) 50,000
1b) 200,000

The trigger cap could be either applied at the pollock fishery level to the CDQ and non-CDQ fisheries (not allocated by sector within the non-CDQ sectors), or may be subdivided by sector according to the sector allocation suboptions below.

2.4.1.1 Suboption: Sector Allocation

If this suboption is selected, the trigger cap options under 1a and 1b would be apportioned to the sector level. This would result in separate sector level caps for the CDQ sector, the inshore catcher vessel (CV) sector, the mothership sector, and the offshore catcher processor (CP) sector.

The bycatch of chum salmon would be counted on at the sector level. Those sectors not participating in an ICA would be subject to the closure for the remainder of the season if their sector-level cap was reached. The remaining sectors (not participating in an ICA) may continue to fish until they reach their specific sector level cap. The CDQ allocations would continue to be managed as they are under the status quo, with further allocation of the CDQ salmon bycatch cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding its salmon bycatch allocation.

2.4.1.1.1 Sector allocation options

Sector allocations under this Alternative if selected are equivalent to the range of sector allocations under Alternative 2. Table 2-19 shows the range of sector allocations under consideration and the sub-set identified for analytical purposes.

Table 2-19 Sector percentage allocations resulting from options 1-6. Note that percentage allocations under Option 6 for the remaining sections are not included at this time. The allocation included for analytical purposes are shown in **bold**.

Time Period for Average	Option	% historical: pro-rata	CDQ	Inshore CV	Mothership	Offshore CPs
NA (AFA)	1	0:100	10.0%	45.0%	9.0%	36.0%
2007-2009	2i	100:0	4.4%	75.6%	5.6%	14.4%
	3i	75:25	5.8%	67.9%	6.5%	19.8%
	4i	50:50	7.2%	60.3%	7.3%	25.2%
	5i	25:75	8.6%	52.6%	8.2%	30.6%
2005-2009	**2ii**	**100:0**	**3.4%**	**81.5%**	**4.0%**	**11.1%**
	3ii	75:25	5.0%	72.4%	5.3%	17.3%
	4ii	**50:50**	**6.7%**	**63.3%**	**6.5%**	**23.6%**
	5ii	25:75	8.3%	54.1%	7.8%	29.8%
2000-2009	2iii	100:0	4.4%	76.0%	6.2%	13.4%
	3iii	75:25	5.8%	68.3%	6.9%	19.1%
	4iii	50:50	7.2%	60.5%	7.6%	24.7%
	5iii	25:75	8.6%	52.8%	8.3%	30.4%
1997-2009	2iv	100:0	4.4%	74.2%	7.3%	14.1%
	3iv	75:25	5.8%	66.9%	7.8%	19.5%
	4iv	50:50	7.2%	59.6%	8.2%	25.0%
	5iv	25:75	8.6%	52.3%	8.6%	30.5%
suboption(10.7% to CDQ)	**6**	**NA**	**10.7%**	**44.77%**	**8.77%**	**35.76%**

Analysis of trigger cap levels for this alternative will be treated similarly to the Alternative 2 subset of caps for analytical purposes (Table 2-20).

Table 2-20 Alternative 4 Option 1 chum salmon bycatch limits by sector for analysis (note sector allocation numbers refer to options as listed above)

Trigger cap	Sector allocation	CDQ	CV	MS	CP
50,000	1	1,700	40,750	2,000	5,550
	2	3,350	31,650	3,250	11,800
	3	5,350	22,385	4,385	17,880
200,000	1	6,800	163,000	8,000	22,200
	2	13,400	126,600	13,000	47,200
	3	21,400	89,540	17,540	71,520

2.5 Management, Monitoring, and Enforcement

2.5.1 Alternative 1: Status Quo

Alternative 1 retains the current program of Chum Salmon Savings Area (SSA) closures in the BS triggered by separate non-CDQ and CDQ chum salmon prohibited species catch (PSC) limits, along with the exemption to these closures by pollock vessels participating in the Rolling Hot Spot inter-cooperative agreement (RHS ICA). The RHS ICA regulations were revised in 2011 to remove those provisions of the ICA which were for Chinook bycatch management given the new program in place under Amendment 91.

2.5.1.1 Rolling Hot Spot Intercooperative Agreement (RHS ICA)

The RHS ICA operates in lieu of regulatory closures of the Chum SSA and requires industry to identify and close areas of high salmon bycatch and move to other areas. After June 10, Federal regulations require the ICA representative to notify its members and NMFS, on a weekly basis, where ICA chum salmon savings areas are located. Only vessels directed fishing for pollock are subject to the SSA closure and ICA regulations. Monitoring and enforcement of the bycatch agreement is done by Sea State using the Base Rate described in Federal regulations as a trigger for ICA chum salmon savings areas and determining Tier assignments for vessels. The tier assignments specify the duration for which vessels (including CDQ) and cooperatives are prohibited from fishing in an ICA closure area.

Sea State reports announcements to the members on Thursdays (weekly announcements) and Mondays (Savings closures updates). The Thursday announcements are effective at 6:00 pm on Friday and include the following:

1. Seasonal update on pollock harvest and salmon bycatch by sector.
2. Each cooperatives updated rolling 2-week bycatch rate for non-Chinook salmon and the associated tier status; closure start and stop times, and dates for each region; and number of closure days in each region.
3. The geographical extent of the ICA savings closure areas.
4. Bycatch rates for each statistical area fished
5. Updated list of the vessels with high non-Chinook salmon bycatch rates, known as the "Vessel Performance Lists."

Monday updates are effective at 6:00 pm Tuesday and include the following:

1. Seasonal update on pollock harvest and salmon bycatch by sector.
2. Updated geographical information about the savings closure areas.
3. Bycatch rates for each statistical area fished.
4. Reminder to vessels and cooperatives about their Tier status (where applicable).

Enforcement of the agreement is accomplished through legal agreements between all members. There are two tiers of legal agreements. The top tier is an agreement among the 9 Bering Sea pollock cooperatives that sets forth the Voluntary Rolling Hot Spot system terms and conditions (the Inter Cooperative Agreement). The second tier comprises the membership agreements of all 9 cooperatives. The terms and conditions of the Inter Cooperative Agreement are described above (and included in Appendix 2).

Cooperatives have 180 days to take action on the apparent violation of the ICA and submit a report of the action taken to all other cooperatives. Sea State and/or United Catcher Boats notify all other cooperatives, the CDQ Groups, the Association of Village Council Presidents (AVCA), Bering Sea Fisherman's Association (BSFA), Tanana Chiefs' Conference (TCC), and Yukon River Drainage Fisherman's Association (YRDFA) if the coop fails to take action and report within the 180 days; at that time the previously listed cooperatives and groups may pursue enforcement and penalty actions. Cooperatives failing to report the action taken on apparent ICA savings violations, either of their own accord or in response to actions taken by the other groups, will cause the coop to be in breach of the agreement.

Penalty amounts are fixed and specified in Federal regulations at 679.21(g)(E)(iv). The penalty amounts are paid by the vessel skipper. The amounts are increased with each subsequent violation as follows:

- 1st violation is $10,000.00

- 2nd violation is $15,000.00
- 3rd and subsequent violations in the same year is $20,000.00

The terms and conditions of the cooperative membership agreements that are specifically related to enforcement of the VRHS system are as follows:

A. Each member acknowledges that its vessel's operations are governed by the Inter-Cooperative Agreement, and agrees to comply with its terms, as they may be amended from time to time.

B. Each member authorizes the Board of Directors of its cooperative to take all actions and execute all documents necessary to give effect to the Inter-Cooperative Agreement.

C. Each member authorizes the Board of Directors of its cooperative to enforce the Inter Cooperative Agreement, and if the Board fails to do so within 180 days of receiving notice from Sea State that a cooperative member may have failed to comply with the Agreement, each member authorizes each of the Boards of Directors of each other pollock cooperative, each of the CDQ groups, Bering Sea Fishermen's Association, AVCP, TCC and Yukon River Drainage Fishermen's Association to individually or collectively take legal action to enforce the Inter Cooperative Agreement.

D. Each member releases to Sea State its VMS tacking data, its vessel log books and its plotter data for purposes of determining its compliance with the Inter-Cooperative Agreement, and agrees that in the event Sea State concludes that its vessel violated a RHS closure, Sea State may deliver any and all of such data to the Boards of Directors, the CDQ groups, BSFA, AVCP, TCC and YRDFA for purposes of enforcing the Agreement.

E. Each member agrees that the information contained in the records identified in item D, above, shall be presumed accurate absent a clear and compelling demonstration otherwise, and shall be presumed sufficient to determine its compliance with the Inter Cooperative Agreement.

F. Each member agrees that damages for violating the Inter-Cooperative Agreement shall apply on a strict liability basis, regardless of a member's lack of knowledge of the violation or intent to violate the agreement.

G. Each member agrees that actual damages for violating the agreement would be difficult to calculate, and therefore agrees to pay an amount per tow made in violation of the Interco-operative Agreement as the Board of Directors establishes from time to time as liquidated damages. Each member agrees to modify its skipper contracts to make its skipper(s) fully responsible for the liquidated damages that are assessed in connection with a breach of the agreement. Further, each member agrees that in the event a skipper fails to assume such assignment of liability, or in the event such assumption is deemed invalid, the member shall be liable for the full amount of such liquidated damages.

H. The current penalties for Savings Closure violations are $10,000 for the first violation in a year, $15,000 for a second violation in the same year as the first, and $20,000 for a third and subsequent violations in a year.

I. Each member agrees that in connection with any action taken to enforce the Inter-coop Agreement, the prevailing party shall be entitled to the costs and fees it incurs in connection with such action, including attorneys' fees.

J. Each member agrees that in addition to legal remedies, the Board of Directors of each cooperative, each of the CDQ groups, BSFA and YRDFA shall be entitled to injunctive relief in connection with the second and subsequent violations of the Inter-coop Agreement.

Penalties for savings closure violations as described in item H above are placed in a bank account designed for holding funds which are then used to fund research at the discretion of the cooperatives.

Penalty money collected under the agreement is intended to be used in salmon stock identification research.

Western Alaskan groups (YRDFA, TCC, AVCP and BSFA) are included in the agreement for compliance purposes. There are three primary means by which these groups are included in the ability to monitor and enforce the agreement. These are listed in items C, D and J, above. They have the legal ability to individually or collectively take legal action to enforce the agreement (item C). These groups also participate in the ability to request and obtain data from Sea State in cases where a violation of the cooperative agreement has occurred (item D). And finally, these groups are included in the ability to seek injunctive relief in the case of a violation of the agreement (item J).

2.5.1.2 Monitoring and observer requirements in BS pollock fishery

In 2011, Chinook salmon bycatch limits were implemented under Amendment 91 and placed new constraints on the Bering Sea pollock fishery, including the need to change observer sampling protocol to census salmon. Under this program, each entity (AFA sector, inshore cooperative, or CDQ group) that receives a transferable Chinook salmon bycatch allocation is prohibited from exceeding that allocation. Therefore, the Chinook bycatch limits, if reached, could prevent the full harvest of a pollock allocation to the AFA sectors, inshore cooperatives, or CDQ groups. Amendments 91 significantly increased the economic incentives to under report or misreport the amount of Chinook salmon bycatch or to discard or hide Chinook salmon before they can be counted by an observer. Thus, the monitoring requirements in the BS pollock fishery changed significantly in 2011 to enable Chinook salmon bycatch accounting.

The Monitoring of Chinook salmon bycatch allocations is accomplished through: (1) requirements for observer coverage for all vessels and processing plants; (2) salmon retention requirements; (3) specific areas to store and count all salmon; (4) video monitoring on at-sea processors; and (5) electronic reporting of salmon by species by haul or delivery. The monitoring was put into place to account for Chinook salmon; however, all species of salmon are counted using the same methods. So, while these provisions were put in place specifically to account for Chinook salmon, the methods are also applicable to non-Chinook salmon.

2.5.1.2.1 Catcher Vessels Delivering to Inshore Processors

Catcher vessels delivering pollock, including pollock CDQ, to inshore processors are required to retain all salmon of any species caught while directed fishing for pollock in the BS, and to deliver that salmon together with its pollock catch to an inshore processor with an approved catch monitoring and control plan (CMCP). No at-sea discard of salmon of any species may occur. Full retention of all salmon regardless of species is required because it is difficult to differentiate Chinook salmon from other species of salmon without direct identification by the observer. Identification of and counting of salmon occurs at the shoreside processing plant or on the floating processor where conditions for identification and counting of salmon can be better monitored and controlled.

Catcher vessels delivering to inshore processors are required to carry an observer at all times while directed fishing for pollock in the BS. Before the regulations were put in place for Amendment 91, observer coverage for catcher vessels was based on vessel length with one observer required at all times for vessels greater than 125 feet length overall (LOA) and an observer required for 30 percent of the fishing days for vessels between 60 feet and 125 feet LOA. Now, an observer is required on every catcher vessel, primarily to monitor compliance with the requirement to retain all salmon until delivery to the processing plant to ensure all salmon bycatch is not discarded at sea.

2.5.1.2.2 Inshore Processors

Each inshore processor that receives AFA or CDQ pollock is required to develop and operate under a NMFS-approved Catch Monitoring and Control Plan (CMCP). The original procedures established under the AFA for the CMCPs were designed to monitor the weighing of pollock at the inshore processing plants. Proper weighing of large volumes of a target species such as pollock require different conditions than does the proper sorting, identification, and counting of a more infrequently occurring bycatch species such as salmon. Salmon can be difficult to see, identify, and count amid the large volume of pollock. The factory areas of processing plants are large and complex. Preventing observers from seeing salmon that enter the factory area of the processing plant would not be difficult. Chinook salmon are difficult to differentiate from other species of salmon as they pass by the observer on the conveyor belt. The observer must examine each salmon to verify the species identification. Therefore, under Amendment 91, NMFS added the following requirements for the inshore processors to ensure that observers have access to all salmon bycatch prior to the fish being conveyed into the processing area of the plant:

a. Processors are prohibited from allowing salmon to pass from the area where catch is sorted and into the factory area of the processing plant;
b. the observer work station is required to be adjacent to the location where the observer counts all salmon and collects scientific data or biological information;
c. an observation area must provide a clear, unobstructed view of the salmon storage container to ensure no salmon of any species are removed without the observer’s knowledge observation area for the storage of salmon; and
d. all salmon of any species must be stored in a salmon storage container within view of the observer at all times during the offload.

Observers identify the species of each salmon, count each salmon, record the number of salmon by species on their data form, and transmit that information electronically to NMFS. The manager of the inshore processor is provided an opportunity to witness the count. The manager of the inshore processor also submits a salmon count for each salmon species by delivery to NMFS on landings reports. Landing report information is used by industry to track salmon catch.

2.5.1.2.3 Catcher/Processors and Motherships

Salmon bycatch monitoring on catcher/processors and catcher vessels delivering to motherships relies on requirements for two observers on each catcher/processor and mothership. NMFS uses a census, or a full count, of Chinook salmon bycatch in each haul by a catcher/processor and delivery by a catcher vessel to a mothership or catcher/processor as a basis for monitoring and enforcing the Chinook salmon bycatch allocations under Amendment 91. This eliminates the uncertainty associated with extrapolating from species composition samples to estimates of the total number of salmon caught in each haul and supports the level of precision and reliability that both the vessel owners and NMFS require to monitor and enforce Chinook salmon bycatch limits. However, in order to accomplish a reliable and accurate census on catcher/processors and motherships, conditions must exist to properly monitor that all of the salmon bycatch is retained and to provide the observer with the tools needed to identify, count, and report salmon bycatch by haul or delivery by catcher vessels. Chinook salmon are difficult to differentiate from other species of salmon as they pass by the observer on the conveyor belt. The observer must examine each salmon to verify the species identification. Therefore, the same monitoring measures that were put in place for Chinook salmon are also in effect for non-Chinook salmon.

The following requirements are in place to ensure that NMFS has accurate counts of salmon on catcher/processors and motherships:

(1) No salmon of any species are allowed to pass from the observer sample collection point and into the factory area of the catcher/processor or mothership;

(2) All salmon bycatch of any species must be retained until it is counted by an observer;
(3) Vessel crew must transport all salmon bycatch from each haul to an approved storage location adjacent to the observer sampling station so that the observer has free and unobstructed access to the salmon, and the salmon must remain within view of the observer from the observer sampling station at all times;
(4) The observer must be given the opportunity to count the salmon and take biological samples, even if this requires the vessel crew to stop sorting or processing catch until the counting and sampling is complete; and,
(5) The vessel owner must install a video system with a monitor in the observer sample station that provides views of all areas where salmon could be sorted from the catch and the secure location where salmon are stored.

Observers identify the species of each salmon, count each salmon, record the number of salmon by species on their data form, and transmit that information electronically to NMFS. The operator of the catcher/processor or mothership is provided an opportunity to witness the count. The vessel operator submits a count of each salmon species by delivery to NMFS on electronic logbooks or landings reports.

An owner of a catcher/processor is required to provide and maintain cameras, a monitor, and a digital video recording system for all areas where sorting and storage of salmon, prior to being counted by an observer, could occur. The video data must be maintained and made available to NMFS upon request for 120-days after the date the video is recorded. The video systems are also subject to approval by NMFS at the time of the observer sample station inspection. In order for the video system to be effective and ensure the observer has access to all salmon prior to entering the factory area, no salmon of any species would be allowed to pass the last point where sorting could occur.

2.5.1.3 Catch Accounting

With the implementation of Amendment 91, the rate-based estimation procedure for salmon caught in the BS pollock fishery was replaced by a census of all salmon. This census is used in CAS to enumerate non-Chinook salmon caught by all sectors in the BS pollock fishery. An advantage to using a census is that all non-Chinook PSC posted in CAS is assumed to be the entire “population” of salmon caught in the pollock fishery and is, by definition, distribution-free (no variance). Thus, information about vessel-specific incidental salmon catch is always obtained and represents all salmon caught during a fishing trip.

2.5.1.4 Electronic Logbook

Operators of catcher/processors participating in the BS pollock fishery are required to report in their logbook a count of all salmon bycatch, by species, for each haul. The logbook is required to be submitted to NMFS electronically so that the data are readily available to NMFS. The electronic logbooks replaces the paper logbooks which were required to be submitted by the operators of catcher/processors under § 679.5(c)(4). The electronic logbooks was added as an additional component to ‘‘eLandings,’’ the program through which the operators of catcher/processors currently submit their daily production reports.

The vessel operators are required to print out a copy of the electronic logbook and maintain it onboard the vessel. AFA catcher/processors or vessels harvesting CDQ pollock that are required to use an electronic logbook for their participation in the BS pollock fisheries are required to use this electronic logbook for the entire year for any other fishery in which they participate. Use of the electronic logbook all year for all fisheries is necessary to provide logbook information from a vessel to NMFS in a consistent format throughout the year for all fisheries in which that vessel participates.

Electronic logbooks are not required for AFA motherships or catcher vessels. Motherships already are required under § 679.5(e)(6) to submit daily an electronic landings report that includes a report of the number of salmon by species in each delivery by a catcher vessel. Electronic logbooks are also not required for catcher vessels delivering to inshore processors because the counting and reporting of the number of salmon by species in each delivery is done at the processing plant and reported by the inshore processor on landing reports (or "fish tickets").

2.5.2 Alternative 2: Hard Cap

Alternative 2 would establish a hard cap to limit non-Chinook salmon bycatch in the pollock fishery. When the hard cap is reached all directed fishing for pollock must cease. Only those non-Chinook salmon caught by vessels participating in the directed fishery for pollock would accrue towards the cap, and fishery closures on reaching the hard cap would apply only to directed fishing for pollock. Several different options as to the scale of management for the hard cap are provided under this alternative: at the fishery level (separate hard caps for the CDQ Program and the remaining three AFA sectors combined); at the sector level (each of the 4 sectors including the CDQ sector receive a sector level hard cap with the CDQ sector level hard cap allocated to the individual CDQ groups); and at the cooperative level.

The observer and monitoring requirements currently in place to account for Chinook salmon bycatch under Amendment 91 also enable NMFS to monitor non-Chinook salmon bycatch under a hard cap. Therefore, NMFS does not anticipate changes to observer requirements or additional monitoring provisions under the hard cap alternative. Catch accounting would rely on the information described under Status Quo with the additional complexity of tracking and facilitating transfers between entities if selected. Entity and other management implications associated with the components of Alternative 2 are discussed below.

2.5.2.1 Alternative 2, Component 1 & 2: Sector Allocations

If these components are selected, the hard cap would be allocated to the sector level. This would result in separate sector level hard caps for the CDQ sector, the inshore catcher vessel (CV) sector, the mothership sector, and the offshore catcher processor (CP) sector.

Depending on selections made for Components 3 and 4, the sector cap could be a quota allocation that a sector entity is prohibited from exceeding, or a hard cap that results in NMFS inseason managers closing the directed fishery for pollock when a hard cap is reached. Selection of a transfer option under Component 3 or Component 4 would prohibit entities from exceeding their quota allocation rather than NMFS closing directed fishing through a Federal register notice.

The bycatch of non-Chinook salmon would be counted on a sector level basis. If the total non-Chinook salmon bycatch in a non-CDQ sector reaches the hard cap for that sector, NMFS would close directed fishing for pollock by that sector for the remainder of the season. The remaining sectors may continue to fish until they reach their sector level hard cap. The CDQ Program would continue to be managed as the status quo, with further allocation of the CDQ non-Chinook salmon bycatch hard cap among the six CDQ groups, transferable allocations within the CDQ Program, and a prohibition against a CDQ group exceeding its salmon bycatch hard cap.

2.5.2.2 Alternative 2, Component 3: Sector Transfers

Component 3 includes options to allow sector level hard caps either to be transferred from one sector to another (Option 1) or reallocated (Option 2) from one sector to another. If Option 1 is chosen, the sector level hard caps would be issued to entities representing each sector as transferable allocations. Thus transfers of non-Chinook salmon bycatch allocations could occur between the catcher/processor sector, mothership sector, inshore sector, and CDQ groups.

Non-Chinook salmon transfers would be industry-initiated, whereas for reallocations NMFS would move an amount of a sector level hard cap from the sector that has stopped directed fishing for pollock to the sectors still fishing in a season. Both of these options have associated management implications that are discussed in the proceeding section.

If neither Option 1 or Option 2 were selected, *i.e.*, if Component 3 was not selected, each sector would have to stop directed fishing for pollock once its seasonal sector level hard cap was reached. There could be no movement of salmon bycatch hard cap allocations between the catcher/processor, mothership, inshore, or CDQ sectors. Without transfers or reallocations, prior to each sector's hard cap being reached, NMFS would close directed fishing for that sector with an inseason closure notice. The short delay associated with inseason closures would require NMFS to closely monitor pollock catch and salmon bycatch in order to project when a sector might reach its salmon bycatch hard cap. NMFS would use observer counts and the monitoring requirements put into place for Amendment 91 to determine the amount of salmon bycatch made by each sector.

2.5.2.2.1 Entities necessary to receive transferable allocations

The default assumption in this analysis is that entities that are already created to receive transferable allocation of Chinook under Amendment 91 would be the same for any allocation of non-Chinook salmon. The entity would have to be created by a contract among the group of eligible AFA participants in that sector who are receiving the transferable salmon bycatch allocation. If this is not the case, then additional issues with entity formation should be noted as follows:

Some pollock fishery participants already are recognized as entities by NMFS:

- Inshore cooperatives are entities recognized by NMFS through the pollock permitting process. They file contracts with NMFS and are issued permits for specific amounts of pollock. 50 CFR 679.7(k)(5)(ii) prohibits an inshore cooperative from exceeding its annual allocation of pollock.
- CDQ groups are entities recognized by NMFS to receive groundfish, halibut, crab, and PSQ reserves. 50 CFR 679.7(d)(5) prohibits a CDQ group from exceeding its groundfish, crab, and halibut PSC allocations. If a CDQ group receives a transferable salmon bycatch allocation, that allocation would be added to this list of prohibitions.

Transferable allocations must be issued to an entity that represents all members of the group eligible to receive the transferable allocation. The entity performs the following functions with NMFS:

- receives an allocation of a specific amount of salmon bycatch on behalf of all members of the entity;
- is authorized to transfer all or a portion of the entity's salmon bycatch allocation to another entity or receive a transfer from another entity (authorized to sign transfer request forms); and
- is responsible for any penalties assessed for exceeding the entity's salmon bycatch allocation (i.e., the entity must have an agent for service of process with respect to all owners and operators of vessels that are members of the entity).

Some AFA sectors are not recognized as entities by NMFS in the same sense as inshore cooperatives or CDQ groups because there has been no reason to require these groups to be entities to receive pollock allocations. These include the:

- AFA catcher/processor sector (which includes all members of the Pollock Conservation Cooperative (PCC), the seven catcher vessels named in the AFA, and the catcher/processor Ocean Peace). Non-transferable allocations of pollock made to this sector are required by the AFA and are made by NMFS through the annual groundfish harvest specifications. This fishery can be closed by NMFS through a *Federal Register* notice if the sector reaches its pollock allocation. In practice, the sector manages its pollock catch within allocations and NMFS has not had to issue pollock fishery closures.

- AFA mothership sector. This includes the three motherships named in the AFA: Excellence, Ocean Phoenix, and Golden Alaska and the catcher vessels permitted to deliver to these motherships. Non-transferable allocations of pollock are made to this sector as required by the AFA and made by NMFS through the annual groundfish harvest specifications. This fishery can be closed by NMFS through a *Federal Register* notice if the sector reaches its pollock allocation. In practice, the sector manages its pollock catch within allocations and NMFS has not had to issue pollock fishery closures.
- Inshore CV sector. While NMFS recognizes cooperatives as entities, the sector as whole does not have an entity. Non-Chinook salmon bycatch allocations would not be issued to the inshore cooperatives under Component 3 alone, so the inshore cooperatives and any catcher vessels not in a cooperative would have to create an umbrella entity that represented all participants in the inshore sector, if Component 4, cooperative allocations, is not chosen.

Existing contracts forming the PCC, the High Seas Catcher Vessel Cooperative, and the Mothership Cooperative could be modified to create the entities required to receive transferable bycatch allocations from NMFS or new entities (contracts) could be formed by the owners of these same vessels to address only NMFS's requirements to receive and transfer non-Chinook salmon bycatch allocations.

Each of the three sectors in the non-CDQ pollock fishery would incur some costs associated with establishing and maintaining the entity necessary for the sector as a whole to conduct non-Chinook salmon transfers, although this cost cannot be estimated at this time. Entities have been formulated in conjunction with Amendment 91 for 2011 for these sectors.

If members of the catcher/processor, mothership, or inshore sectors are unable to form their respective entities to accept their share of the transferable salmon bycatch allocations, then these sectors would fish under a sector level cap. NMFS would manage the sector level caps with directed fishery closures that would apply to all members of the sector once the sector's non-Chinook salmon sector level cap was reached.

2.5.2.2.2 Conducting transfers

A non-Chinook salmon bycatch transfer between different entities in the pollock fishery would require NMFS approval before the transaction could be completed. Per existing agency practice with other fishery programs with transferrable allocations, NMFS would review the transferring entities catch record to ensure sufficient amounts of salmon bycatch hard cap allocation was available to transfer. NMFS has developed the internal processes that allow quota share and allocation holders in various Alaska fisheries to conduct transfers through the NMFS web site. Such a process would be extended to transferable non-Chinook salmon bycatch allocations. The transfer process would be conducted through an online web site that allows entities to log onto a secure NMFS web site and make a salmon bycatch allocation transfer. Online transfers would probably reduce the amount of oversight required by NMFS. The costs for an online system would depend on how much modification would be necessary for this action, but could be shared with other fishery management programs. Another advantage to the online system is that transfers are almost instantaneous. By contrast, paper-based transfers take up to 3 business days to process. The cost of preparing transfer requests could be shared by the transferring entities, since each party to a transfer would have some cost associated with a transfer transaction.

The non-Chinook salmon hard cap that is allocated to the CDQ sector would continue to be subdivided into CDQ group allocations. Each CDQ group allocation may be transferred between CDQ groups as well as between the other three AFA sectors under Component 3. NMFS regulations describe the process to transfer allocations between CDQ groups. This process requires each group involved in the transfer to complete a transfer request and submit it to NMFS for review. If the remaining amount of salmon bycatch quota is sufficient, NMFS debits the transferring CDQ group's salmon account and credits the receiving group's salmon account, per the amount requested.

Option 1 increases the complexity of the changes that would be required to be made to NMFS's catch accounting, since it involves both sector level caps and transferable allocations. Transfer provisions would require accounts to be established for entities that receive salmon allocations, including designing accounts that enable NMFS to track and archive transfers and changes in cooperative structure. Transfers between entities would require receipt of transfer information and readjustment of accounts for the transferor and transferee. These management structures have already been put into place for Chinook salmon in conjunction with Amendment 91.

2.5.2.2.3 NMFS reallocations of sector level caps

Reallocations would be selected if a hard cap or a trigger cap for salmon bycatch is allocated among the AFA sectors, but either:

- salmon bycatch caps are not transferable among the sectors, or
- the non-CDQ sectors cannot form the entity necessary to allow transferability of salmon bycatch among the sectors.

Under Component 3 (sector transfers), either Option 1 (to allow transferable salmon bycatch hard caps) or Option 2 (to have NMFS manage reallocations of unused salmon bycatch allocations among the sectors, inshore cooperatives, or CDQ groups) could be selected.

Reallocations refer to an action that NMFS would take to move salmon bycatch caps that remain in a season after a sector had stopped directed fishing for pollock to another AFA sector, CDQ sector, or the inshore open access fishery. For example, if the catcher/processor sector completed harvest of its pollock allocation, but still had some remaining salmon bycatch hard cap, and if the mothership sector, inshore sector, and CDQ sector had remaining pollock, NMFS would reallocate the catcher/processor sector's remaining non-Chinook salmon allocation to the other pollock sectors. This is portrayed in the following table, in which there are 1,000 non-Chinook salmon bycatch hard cap allocation remaining in the catcher/processor sector level hard cap.

Table 2-21. Example of a non-Chinook salmon bycatch sector level cap reallocation to remaining sectors from catcher/processor sector level hard cap

Sector	Pollock remaining	Percent of total pollock remaining	Reallocation of 1,000 salmon
Inshore	20,000 mt	77	770
Mothership	5,000 mt	20	200
CDQ Program	1,000 mt	3	30
Total	26,000 mt	100	1,000

Reallocations of non-Chinook salmon bycatch hard caps among AFA sectors could include the CDQ sector as a recipient of reallocations. Any salmon bycatch hard cap reallocated to the CDQ sector during a year would be further allocated among the CDQ groups, based on each group's percentage allocation of salmon bycatch. However, reallocations from the CDQ sector to other AFA sectors are not practicable under the current allocative structure of the CDQ sector. A percentage of the current salmon PSC limits currently are allocated to the CDQ sector. These PSC allocations are then further allocated among the six

CDQ groups as transferable salmon PSQ. Therefore, once allocated among the CDQ groups, NMFS could not reallocate salmon bycatch from one or more CDQ groups through a reallocation.

Regulatory guidelines would be needed to allow NMFS to reallocate salmon bycatch . For example, the following process could be used for reallocations:

> *If, during a fishing season, the Regional Administrator determines that a non-CDQ AFA sector has completed harvest of its pollock allocation without reaching its sector level hard cap and sufficient salmon bycatch hard cap remains to be reallocated, the Regional Administrator would reallocate the projected unused amount of salmon bycatch hard cap to other AFA sectors (including CDQ), through notification in the Federal Register. Any reallocation of salmon bycatch hard cap by the Regional Administrator would be based on the proportion each sector represents of the total amount of pollock remaining for harvest by all sectors through the end of the season. Successive reallocation actions would occur as each sector completes harvest of its pollock allocation.*

2.5.3 Alternative 3: Triggered closures

Alternative 3 focuses on closing specific areas to directed fishing for pollock once a salmon bycatch allocation is reached. This is similar to how the existing salmon savings area system closure functions, although the components and options associated with triggered closures are much more complicated than the status quo. Alternative 3 embodies many similar implementation requirements as Alternative 2, such as the establishment of caps and subsequent allocations of the caps to the AFA sectors, inshore cooperatives, and CDQ groups. Thus, the monitoring and management issues described for Alternative 2 are applicable to Alternative 3 as well.

Area closures under Alternative 3 are considerably more complex than those under status quo. Multiple areas are used in each month with caps by sector or cooperative and potentially triggered within each month for the remainder of the month. Closure notices would be announced for a sector or cooperative as soon as they reach their monthly allocation of the B season cap notifying them that they must cease directed fishing for pollock within the specific areas for the remainder of the month. At the end of the month the areas re-open and then depending upon whether a monthly limit or a cumulative limit have been reached by a sector directed fishing for pollock may resume in those areas while other specific areas would close.

The Coast Guard has identified at-sea enforcement issues related to aerial surveillance for enforcing trawl closures. They note some issues in distinguishing between pelagic and non-pelagic trawl gear. This alternative would restrict only vessels using pelagic trawl gear (if their sector or cooperative level cap was reached) from directed fishing for pollock within the area closures. All directed fishing for pollock in the Bering Sea uses pelagic trawl gear only.

Due to the size of the Alaska region and the number of enforcement assets available, one of the most effective means of surveillance is by aircraft. While an aircraft can identify the type of vessel (e.g. long line, trawl, seine, pot, etc.), there is no way for aircraft to readily identify whether a trawl vessel is using pelagic or non-pelagic trawl gear.

Because of these definitions, the only time an aircraft would be able to determine whether a vessel was using pelagic or non-pelagic trawl gear would be if they witnessed a haul back and noted chafing gear on the foot rope or roller gear. By definition, this would make the vessel a non-pelagic trawler. All other definitions used to identify whether a vessel is using pelagic or non-pelagic trawl gear must be conducted by a boarding team on the vessel.

Component 1b, Options 1 and 2 would greatly complicate NMFS management due to the monthly trigger caps. The current census data collection program is highly responsive to management needs and provides timely data, especially considering the logistics of the sectors and variation in operation type. However, even with this highly responsive system, monthly caps result in very short time periods for NMFS to monitor and insure a timely trigger area closure. NMFS would need to project non-Chinook salmon harvest during the week required to publish a Federal register notice and get census information. These projections may result in a trigger closure being made prior to or after the cap being reached.

Note that other management and enforcement issues with this alternative may be included after initial review.

2.5.4 Alternative 4: Closure with RHS exemption

Similar to status quo (rolling hot-spot (RHS) system in regulation), participants in a vessel-level (platform level for Mothership) RHS would be exempt from the regulatory closure system. This closure represents a large area closure encompassing 80% of historical bycatch (Figure 2-5). This closure would be fixed over the B-season unless the triggered closure option is selected. Sector allocation sub-options of the triggered cap are equivalent to those under Alternative 2.

Monitoring and enforcement of this Alternative is similar to Status Quo in which ICA members manage under the RHS and NMFS closes the trigger area for non-ICA members. Monitoring and enforcement of the bycatch agreement under this alternative is done by Sea State using the Base Rate as a trigger for savings area closures and determining the Tier Assignment of the vessel. Issues associated with management and monitoring by Sea State are contained under Alternative 1 (see Section 2.1.2.5). Enforcement of the area closure for non-ICA members could be done using a variety of sources including catch information, VMS, and US Coast Guard resources. The at-sea enforcement issues identified in Alternative 3 also apply to this alternative.

Additional information on specific management and monitoring concerns regarding this alternative may be incorporated after initial review.

2.6 Alternatives considered and eliminated from further analysis

The alternatives in this analysis were developed through a public Council and stakeholder process. Many issues were aired and other possible management options, or points within the range of the options, were considered. Through an iterative process, the Council arrived at an draft suite of management options that best suit the problem statement, that represent a reasonable range of alternatives and options, and also represent a reasonable combination of management measures that can be analyzed and used for decision-making. These alternatives may still be modified by the Council in iterative reviews of this analysis. Currently the analysis is scheduled for initial review in June. It is anticipated that some modification of the suite of alternatives may occur at initial review and initial review. The Council may select a preliminary preferred alternative (PPA) at initial review in June and will select a preferred alternative (PA) at final action that may or may not comport with the PPA.

The Council and NMFS also concurrently held a formal scoping period which provided another forum for the public to provide input to the development of alternatives. A scoping report was provided which summarized the comments for the Council. Chapter 1 includes a detailed discussion of the issues raised in scoping, which is referenced but not repeated here.

This section discusses the Council's process for developing alternatives, and those alternatives that were originally discussed at the Council level and through the Council's Salmon Bycatch Workgroup, but which, for the reasons noted below, were not analyzed in detail.

The Council, in February 2007, established a Salmon Bycatch Workgroup (SBW) committee, comprising of members representing the interests of western Alaska (4 members) and of the pollock industry (4 members). This committee had two Chairs, one from each of the major interest groups represented in its membership. The Council later (June 2007) appointed an additional member from the Alaska Board of Fisheries (BOF). The Council requested that the SBW provide recommendations to the Council regarding appropriate salmon cap levels, by species (Chinook and chum or 'other' salmon), to be considered for the pollock fishery, as well as to work with staff to provide additional review of and recommendations for the development of alternatives for analysis.

The SBW met 5 times, in March 2007, May 2007, August 2007, November 2007 and January 2009. These meetings were open to the public and noticed in the Federal Register accordingly. Following each meeting, a report was compiled representing the recommendations and discussions by the committee, and provided to the Council at its subsequent meeting (April 2007, June 2007, October 2007, December 2007, February 2009). In the spring of 2009 the Council bifurcated the analyses of chum and Chinook management measures and prioritized the analysis of Chinook management measures. Final action on Chinook management measures was taken by the Council in April 2009 (Amendment 91). The fishery is operating under the Amendment 91 regulations beginning in January 2011.

The Council refined alternatives for chum salmon management measures in December 2009 and June 2010 (see Council motions in Appendix 1 to this Chapter). Modifications included changing the range of numbers for cap considerations and adopting the area closures under consideration in Alternative 3. Further modification of alternatives may occur iteratively in the course of finalizing the analysis prior to final action.

3 Methodology for Impact Analysis

The following description of the methodology attempts to outline the scientific basis to aid decision-makers and the public. The chapter presents the approach used to evaluate the impacts of alternatives on pollock catch (Chapter 4), Chum salmon (Chapter 5), Chinook salmon (Chapter 6) and the economic impacts (RIR). For the remaining resource categories considered in this analysis, marine mammals, seabirds, other groundfish, EFH, ecosystem relationships, and environmental justice, impacts of the alternatives were evaluated largely qualitatively based on results and trends from the quantitative analysis. Emphasis was placed on carrying forward estimates of uncertainties and interpretation of different assumptions.

3.1 Estimating Chum salmon bycatch in the pollock fishery

Overall, salmon bycatch levels are estimated based on extensive observer coverage using the NMFS Catch Accounting System (CAS). For the pollock fishery, the vast majority of tows are observed either directly at sea or at offloading locations aboard motherships or at shore-based processing plants. The observer data is used to allow inseason managers to evaluate when to open and close all groundfish fisheries based on bycatch levels of prohibited species, such as salmon and halibut, and catch levels of target groundfish species. The process of using observer data (in addition to other landings information) to set fishery season length relies on assuming that catch and bycatch rate information collected by observers is similar to catch and bycatch rates by unobserved fishing vessels. Data from observed vessels and processors is extrapolated to catch made by unobserved vessels.

The sampling intensity for salmon bycatch in the pollock fishery is very high in order to reduce the severity of potential sampling issues and to satisfy the demands of inseason management. Because sampling fractions are high for the pollock fishery, uncertainty associated with the magnitude of salmon bycatch is relatively low. Statistically rigorous estimators have been developed that suggest that for the Eastern Bering Sea pollock fishery, the levels of salmon bycatch are precisely estimated with coefficients of variation of around 5 percent (Miller 2005[21]). This indicates that, assuming that the observed fishing operations are unbiased relative to unobserved operations, the total salmon bycatch levels are precisely estimated for the fleet as a whole. Imprecision of the estimates of total annual Chinook salmon bycatch is considered negligible.

3.1.1 Monitoring Catcher/processors and motherships

Catcher/processors and motherships are required to carry two NMFS-certified observers during each fishing day. These vessels must also have an observer sampling station and a motion-compensated flow scale, which is used to weigh all catch in each haul. The observer sampling station is required to include a table, motion compensated platform scale, and other monitoring tools to assist observers in sampling. Each observer covers a 12 hour shift and all hauls are observed unless an observer is unable to sample (*e.g.,* due to illness or injury).

Estimates of the weight of each species in the catch are derived from sampling. A sample is a specific portion of the haul that is removed and examined by the observer. Catch in the sample is sorted by species, identified, and weighed by the observer. Species counts also are obtained for non-predominant species. Observer samples are collected using random sampling techniques to the extent possible on

---

[21] Miller's dissertation represents a thorough presentation of statistically sound methodology that accurately characterizes low variation in salmon bycatch estimates. However, NMFS recognizes the differences between its estimates and those presented in Miller 2005. See FEIS for Chinook salmon for details.

commercial fishing vessels. Observer samples are extrapolated to the haul level under the assumption that sample composition represents the composition of an entire haul. The sample proportion of each haul in the pollock fishery is relatively high because catch is generally not diverse and excellent sampling tools, such as flow scales and observer sample stations, are available.

Sampling for salmon is conducted as part of the overall species composition sampling for each haul. The observer collects and records information about the number of salmon in each sample and the total weight of each haul. NMFS estimates the total number of salmon in each haul by extrapolating the number of salmon in the species composition samples to the total haul weight. In the rare case that an observer on an AFA catcher/processor or mothership is unable to sample a haul for species composition, NMFS applies species composition information from observed hauls to non-observed hauls.

Catcher vessels deliver unsorted catch to the three motherships that participate in the AFA pollock fisheries. NMFS does not require these catcher vessels to carry observers because catch is not removed from the trawl’s codend (the detachable end of the trawl net where catch accumulates) prior to it being transferred to the mothership. Observer sampling occurs on the mothership following the same estimation processes and monitoring protocols that are described above for catcher/processors.

While regulations require vessel personnel to retain salmon until sampled by an observer, salmon that are retained by catcher/processor and mothership crew outside of the observer’s sample are not included in the observer’s samples and are not used to estimate the total number of salmon caught. However, observers examine these salmon for coded-wire tags and may collect biological samples.

3.1.2 Monitoring catcher vessels delivering to shoreside processors or stationary floating processors

Catcher vessels in the inshore sector are required to carry observers based on vessel length.

> <u>Catcher vessels 125 feet in length or greater</u> are required to carry an observer during all of their fishing days (100 percent coverage).
>
> <u>Catcher vessels greater than 60 feet in length and up to 125 feet in length</u> are required to carry an observer at least 30 percent of their fishing days in each calendar quarter, and during at least one fishing trip in each target fishery category (30 percent coverage).
>
> <u>Catcher vessels less than 60 feet in length</u> are not required to carry an observer. However, no vessels in this length category participate in the Bering Sea pollock fisheries.

Observers sample hauls onboard the catcher vessels to collect species composition and biological information. Observers use a random sampling methodology that requires observers to take multiple, equal sized, samples from throughout the haul to obtain a sample size of approximately 300 kilograms. Catch from catcher vessels delivering to shoreside processing plants or floating processors generally is either dumped or mechanically pumped from a codend (i.e., the end of the trawl net where catch accumulates) directly into recirculating seawater (RSW) tanks. Observers attempt to obtain random, species composition samples by collecting small amounts of catch as it flows from the codend to the RSW tanks.

This particular collection method is difficult and dangerous, as observers must obtain a relatively small amount of fish from the catch flowing out of the codend as it is emptied into the RSW tanks. A large codend may contain over 100 mt of fish. This sampling is typically done on-deck, where the observer is exposed to the elements and subject to the operational hazards associated with the vessel crew’s hauling, lifting, and emptying of the codend into the large hatches leading to the tanks. In contrast, the sampling methods used on catcher/processors and motherships allow observers to collect larger samples under more controlled conditions. On these vessels, the observer is able to collect samples downstream of the fish holding tanks, just prior to the catch sorting area that precedes the fish processing equipment. Additionally, the observer is below decks and has access to catch weighing scales and an observer sampling station.

Because the composition of catch in the pollock fishery is almost 100 percent pollock, species composition sampling generally works well for common species. However, for uncommon species such as salmon, a larger sample size is desired; however, large sample sizes are generally not logistically possible on the catcher vessels. Instead, estimates of salmon bycatch by catcher vessels are based on a full count or census of the salmon bycatch at the shoreside processing plant or stationary floating processor whenever possible.

Vessel operators are prohibited from discarding salmon at sea until the number of salmon has been determined by an observer, either on the vessel or at the processing plant, and the collection of any scientific data or biological samples from the salmon has been completed. Few salmon are reported discarded at sea by observed catcher vessels. However, any salmon reported as discarded at sea by the observer are added into the observer's count of salmon at the processing plant. Unlawful discard of salmon at sea may also subject a vessel operator to enforcement action.

3.1.3 Monitoring shoreside processors

AFA inshore processors are required to provide an observer for each 12 consecutive hour period of each calendar day during which the processor takes delivery of, or processes, groundfish harvested by a vessel directed fishing for pollock in the Bering Sea. NMFS regulates plant monitoring through a permitting process. Each plant that receives AFA pollock is required to develop and operate under a NMFS-approved catch monitoring and control plan (CMCP). Monitoring standards for CMCP are described in regulation at 50 CFR 679.28(g).

These monitoring standards detail the flow of fish from the vessel to the plant ensuring all groundfish delivered are sorted and weighed by species. CMCPs include descriptions and diagram of the flow of catch from the vessel to the plant, scales for weighing catch, and accommodations for observations. Depending on the plant, observers will physically remove all salmon from the flow of fish before the scale as it is conveyed into the plant, or supervise the removal of salmon by plant personnel. Observers assigned to the processing plant are responsible for reading the CMCPs and verifying the plant is following the plan laid out in the CMCP. Vessel observers complete the majority of a salmon census during an offload, with the plant observer providing breaks during long offloads.

One performance standard required in CMCPs is that all catch must be sorted and weighed by species. The CMCP must describe the order in which sorting and weighing processes take place. Processors meet this performance standard in different ways. Some processors choose to weigh all of the catch prior to sorting and then deduct the weight of non-pollock catch in order to obtain the weight of pollock. Other processors choose to sort the catch prior to weighing and obtain the weight of pollock directly. No matter how the weight of pollock is obtained, it will only be accurate if bycatch is effectively sorted, and methods must be in place to minimize the amount of bycatch that makes it past the sorters into the factory. CMCPs were not designed to track individual fish throughout the shoreside processing plant and the focus of the performance standards is on monitoring the large volumes of species such as pollock, not on monitoring small quantities of bycatch. Currently, the practice of deducting bycatch from the total catch weight of pollock provides an incentive for processors to report bycatch, including salmon.

3.1.4 Salmon accounting at shoreside processors

When a catcher vessel offloads at the dock, prohibited species such as crab, salmon, and halibut are identified and enumerated by the vessel observer during the offload. The observer monitors the offload and, with the assistance of the plant's processing crew, attempts to remove all salmon from the catch. Salmon that are missed during sorting will end up in the processing facility, which requires special treatment by the plant and the observers to ensure they are counted. These "after-scale" salmon (so called because they were initially weighed along with pollock) creates tracking difficulties for the plant and the observer.

Although after scale salmon are required to be given to an observer, there is no direct observation of salmon once they are moved past the observer and into the plant. Observers currently record after scale salmon as if they had collected them. However, such salmon can better be characterized as plant reported information. Further complications in plant based salmon accounting occur when multiple vessels are delivering simultaneously, making it difficult or impossible to determine which vessel's trip these salmon should be assigned to. Currently, plant personnel are very cooperative with saving after-scale salmon for observers at this stage of sampling and after scale salmon numbers are relatively low. However, if management measures create incentives for not reporting salmon, this reportedly high level of cooperation could be reduced. Additionally, complications occur when multiple vessels are delivering in quick succession to a plant because it is often impossible to assign salmon to a vessel.

3.1.5 NMFS Catch Accounting System

NMFS determines the number of non-Chinook salmon caught as bycatch in the Bering Sea pollock fishery using the NMFS's CAS. The CAS was developed to receive catch reports from multiple sources, evaluate data for duplication or errors, estimate the total catch by species or species category, and determine the appropriate "bin" or account to attribute the catch. Historically, these accounts have been established to mirror the myriad combinations of gear, area, sector, and season that are established in the annual groundfish harvest specifications. In general, the degree to which a seasonal or annual allocation requires active NMFS management is often inversely related to the size of the allocation. Typically, the smaller the catch limit, the more intensive the management required to ensure that it is not exceeded.

The CAS account structure is different for each major regulatory program, such as the Amendment 80 Program, the GOA Rockfish Program, the AFA pollock fishery, and the CDQ Program. For example, separate accounts are used to monitor Atka mackerel caught by Amendment 80 vessels and non-Amendment 80 vessels. To monitor this catch, accounts are created for all Atka mackerel caught, separate accounts if the vessel is in a cooperative or limited access sector, separate accounts for fish caught in or outside special harvest limit areas, and finally, seasonal accounts for all scenarios combined. This results in 10 separate accounts that had to be created by programmers for use by NMFS fisheries managers.

The AFSC's Fisheries Monitoring and Analysis Division provides observer data about groundfish catch and salmon bycatch, including expanded information to NMFS. NMFS estimates salmon bycatch for unobserved catcher vessels using algorithms implemented in its CAS. The haul-specific observer information is used by the CAS to create salmon bycatch rates from observed vessels that are applied to total groundfish catch in each delivery (trip level) by an unobserved vessel. The rate is calculated using the observed salmon bycatch divided by the groundfish weight, which results in a measure of salmon per metric ton of groundfish caught. Salmon bycatch rates are calculated separately for Chinook salmon and non-Chinook salmon.

The CAS is programmed to extrapolate information from observed vessels to unobserved vessels by matching the type of information available from observed vessels with that of an unobserved vessel.

Surrogate bycatch rates are applied using the most closely available data from an observed catcher vessel by:

- processing sector (in this case, inshore sector)
- week ending date,
- fishery (pollock),
- gear (pelagic trawl),
- trip target,
- special area (such as the catcher vessel operational area), and
- federal reporting area.

If no data are available for an observed vessel within the same sector, then rates will be applied based on observer data from vessels in all sectors in the target fishery. If observer data are not available from the same week, then a three-week moving average (if the reporting area or special area is the same) or three-month moving average (if data with the same reporting or special areas are not available) is applied. Similarly, if data from the same Federal reporting area is not available, then observer data from the pollock fishery in the Bering Sea, as a whole, will be applied. However, this latter methodology is rarely used. NMFS generally receives adequate information to calculate bycatch rates for observed vessels that operate in a similar time and place as the unobserved catcher vessels.

The CAS methodology used to estimate prohibited species catch is the same for the inshore and offshore sectors; however, the methodology to obtain haul-specific estimates is different between the sectors. The offshore sector relies on robust sampling methods and the inshore sector uses a census approach.

Estimates of salmon, crab, and halibut bycatch for catcher processors and motherships in the pollock fishery rely on at-sea sampling. To estimate the bycatch of these species, at-sea observers take several "within haul" samples that are extrapolate to obtain an estimate of specie-specific catch for a sampled haul. The haul-specific estimate is used by CAS to calculate a bycatch rate that is applied to unobserved hauls. Thus, there are several levels of estimation: (1) from sample to haul, (2) sampled hauls to unsampled hauls within a trip, and potentially, (3) sampled hauls to unsampled hauls between vessels.

The extrapolation method for prohibited species, such as halibut, salmon, and crab are the same for observed vessels in the inshore pollock sector. Sampling of prohibited species for this sector is conducted by observers both at-sea and shoreside. The majority of catch is assessed by observers when a vessel offloads catch at a plant (shoreside). During an offload, observers count all prohibited species as they are removed from the vessel. Prohibited species catch that is discarded at-sea is assessed by onboard observers. The total amount of prohibited species at-sea discard is added to the shoreside census information to obtain a total amount of specie-specific discard for a trip. NMFS uses the total discard information (inshore discards plus at-sea discards) to create a bycatch rate that is applied to unobserved vessels. The catch accounting system uses the shoreside information for salmon bycatch only if the offloading vessel also had an observer onboard. As a result, only salmon bycatch data from observed trips are used when calculating a bycatch rate.

3.2 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 2010 under the different alternatives. The years 2003 to 2010 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 2003-2010. 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 2003-2010 data.

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.

3.2.1 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.

3.2.1.1 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 3-1). 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 3-2). 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 3-1 and Table 3-2). 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 3-3) 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 3-4). 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 3-3). 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 3-4).

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 3-5). Also apparent in these data are the differences in size frequency by sex with males consistently bigger than females (Stram and Ianelli 2009).

Table 3-1. 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 3-2. 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 3-3. 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 3-4. 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

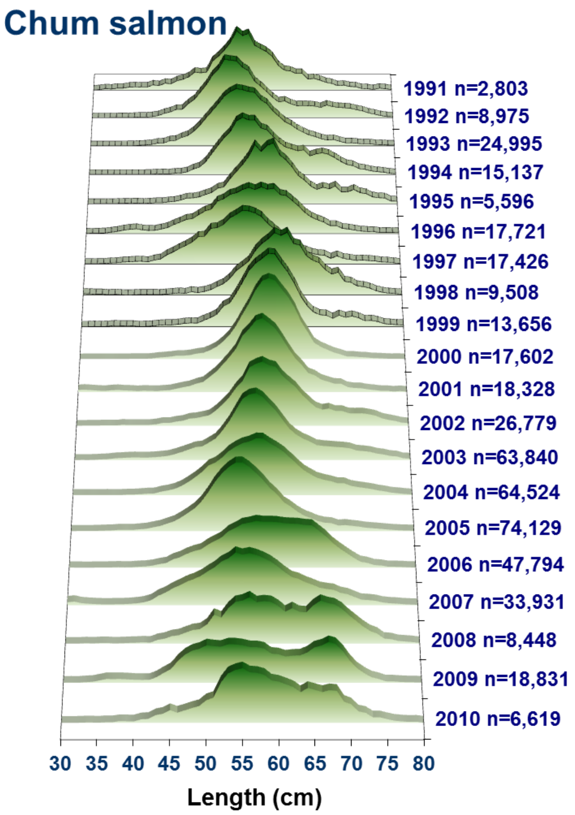


Figure 3-1. Chum salmon length frequency from the eastern Bering Sea pollock fishery, 1991-2010.

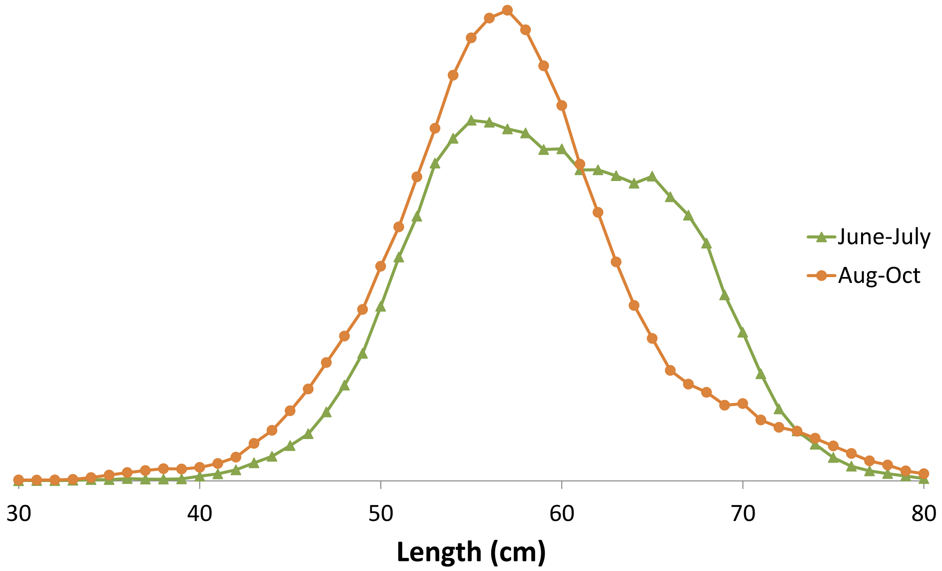


Figure 3-2. Aggregated chum length frequency from the eastern Bering Sea pollock fishery by period within the B-season, 1991-2010.

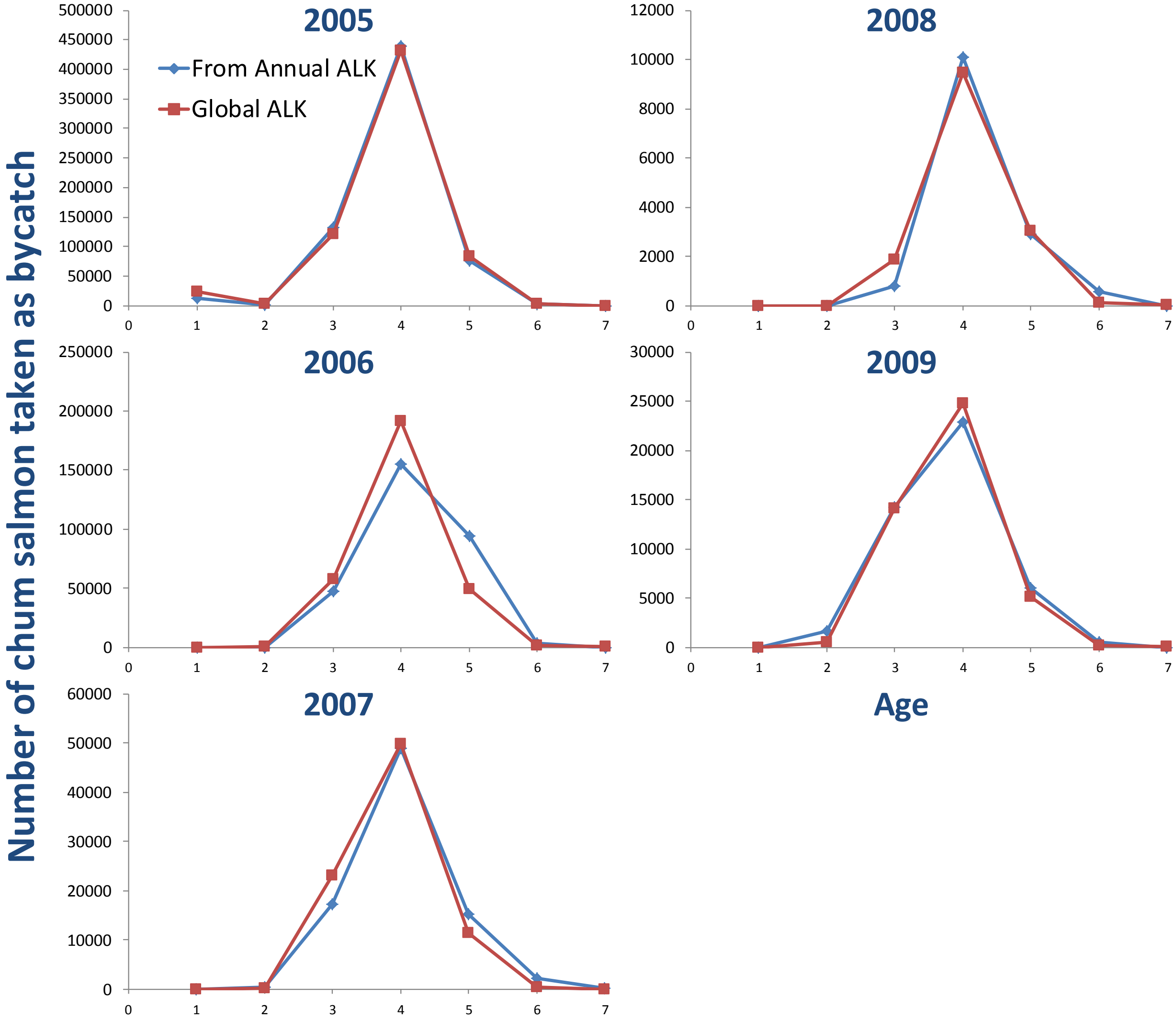


Figure 3-3. Estimated chum bycatch at age as estimated by using the combined-year stratified age-length key compared to estimates from annually varying stratified age-length keys, 2005-2009.

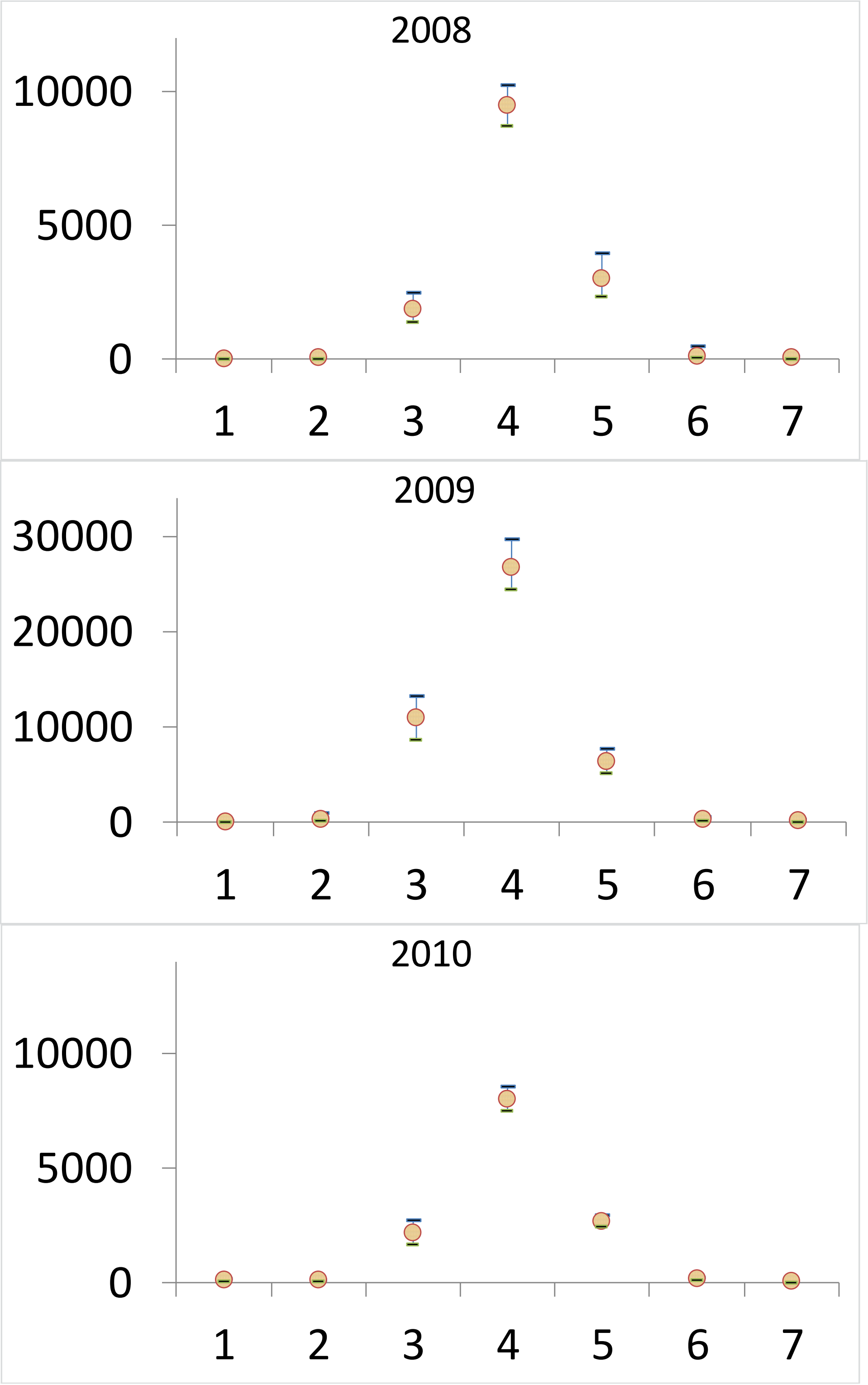


Figure 3-4. Examples of estimated chum bycatch at age and bootstrap quantiles (0.05 and 0.95) by using stratified age-length keys, 2008-2010.

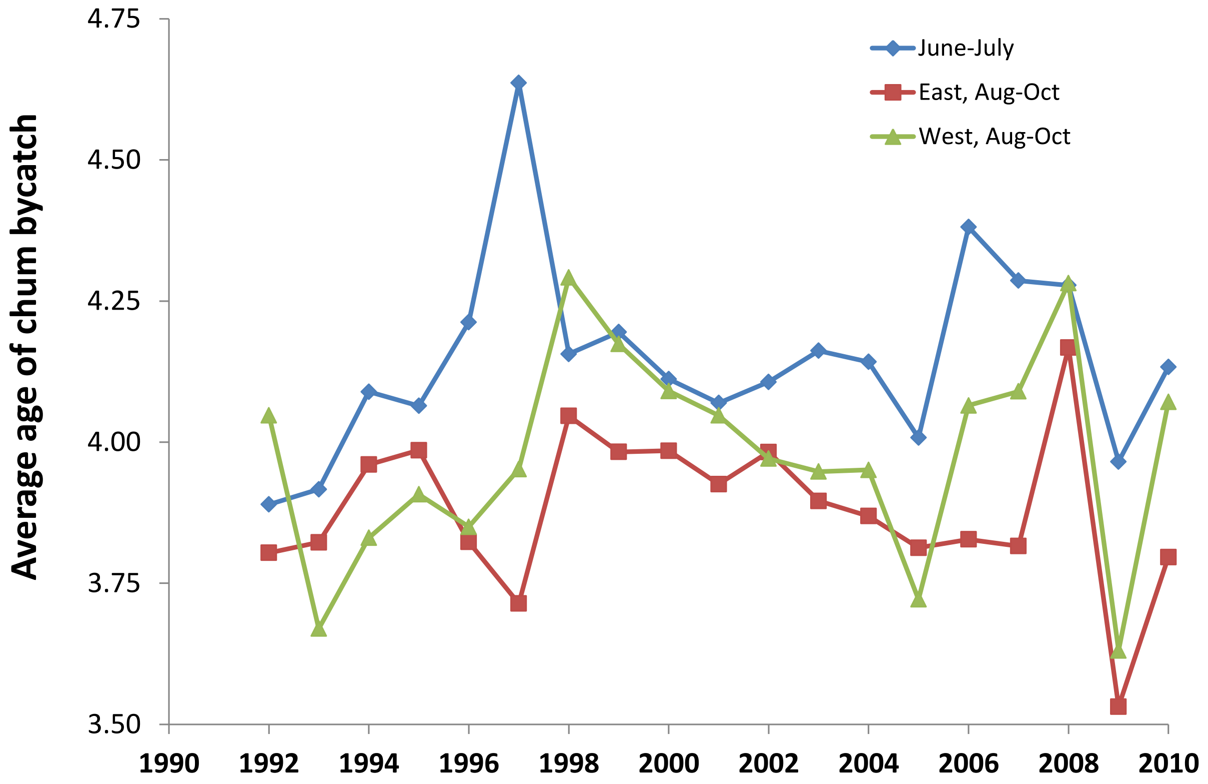


Figure 3-5. Stratified estimates of average age (years) of chum bycatch based on catch-at-age estimates from NMFS observer collected length frequencies and age determinations, 1991-2010.

3.2.1.2 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:

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

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:

$$
\begin{aligned}
AEQ_t = \sum_{a=3}^{7} & c_{t,a}\gamma_a + \\
& \gamma_4\left(1-\gamma_3\right)s_3c_{t-1,3} + \\
& \gamma_5\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4c_{t-2,3} + \\
& \gamma_6\left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4s_5c_{t-3,3} + \\
& \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4s_5s_6c_{t-4,3} + \\
\\
& \gamma_5\left(1-\gamma_4\right)s_4c_{t-1,4} + \\
& \gamma_6\left(1-\gamma_5\right)\left(1-\gamma_4\right)s_4s_5c_{t-2,4} + \\
& \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right)s_4s_5s_6c_{t-3,4} + \\
\\
& \gamma_6\left(1-\gamma_5\right)s_5c_{t-1,5} + \\
& \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)s_5s_6c_{t-2,5} + \\
\\
& \gamma_7\left(1-\gamma_6\right)s_6c_{t-1,6}
\end{aligned}
\qquad (2)
$$

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 3-6. 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 3-5). Note that there is a distinction between the distribution of mature age salmon found in rivers (Table 3-5) 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 $S_{t,k}$):

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

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:

$$\dot{p}_{\mathrm{k}} \sim \mathrm{B}(\alpha_{\mathrm{k}}, \beta_{\mathrm{k}}) \tag{6}$$

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).

The pattern of bycatch relative to AEQ is variable and relatively insensitive to mortality assumptions (Figure 3-7). 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 3-8).

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 3-7). 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 3-7). The application of these results to the genetic stock identification derived from sampling is presented in the next section.

Table 3-5. 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 3-6 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 3-7 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.

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	440,459	325,945	292,873	377,794	2001	631,926
2005	704,586	567,893	501,585	671,478	2002	285,480
2006	309,644	419,542	335,831	591,359	2003	97,814
2007	93,786	150,434	116,769	214,919	2004	37,342
2008	15,157	45,958	34,578	70,315	2005	31,239
2009	46,129	36,435	31,402	43,711	2006	16,959
2010	13,294	21,765	15,983	32,509		
2011		*4,979*	*3,441*	*9,007*		
2012		*464*	*183*	*1,042*		

$$AEQ_t = \overbrace{\sum_{a=3}^{7} c_{t,a}\gamma_a}^{\text{The sum over ages of catch in year } t \text{ that would have returned in that year}} + \text{Fish caught in earlier years that would have survived:}$$

$$\begin{array}{l}\text{The catch of}\\ \text{age 3 salmon in}\\ \text{previous years}\\ \text{that survived}\\ \text{and had not}\\ \text{returned in}\\ \text{earlier years}\end{array}\left\{\begin{array}{l}\gamma_4\left(1-\gamma_3\right)s_3c_{t-1,3}+\\ \gamma_5\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4c_{t-2,3}+\\ \gamma_6\left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4s_5c_{t-3,3}+\\ \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right)\left(1-\gamma_3\right)s_3s_4s_5s_6c_{t-4,3}+\end{array}\right.$$

$$\begin{array}{l}\text{The catch of}\\ \text{age 4 salmon in}\\ \text{previous years}\\ \text{that survived}\\ \text{and had not}\\ \text{returned in}\\ \text{earlier years}\end{array}\left\{\begin{array}{l}\gamma_5\left(1-\gamma_4\right)s_4c_{t-1,4}+\\ \gamma_6\left(1-\gamma_5\right)\left(1-\gamma_4\right)s_4s_5c_{t-2,4}+\\ \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)\left(1-\gamma_4\right)s_4s_5s_6c_{t-3,4}+\end{array}\right.$$

$$\begin{array}{l}\text{The catch of}\\ \text{age 5 salmon...}\end{array}\left\{\begin{array}{l}\gamma_6\left(1-\gamma_5\right)s_5c_{t-1,5}+\\ \gamma_7\left(1-\gamma_6\right)\left(1-\gamma_5\right)s_5s_6c_{t-2,5}+\end{array}\right.$$

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

Figure 3-6. Explanatory schematic of main AEQ equation. Symbols are defined in text.

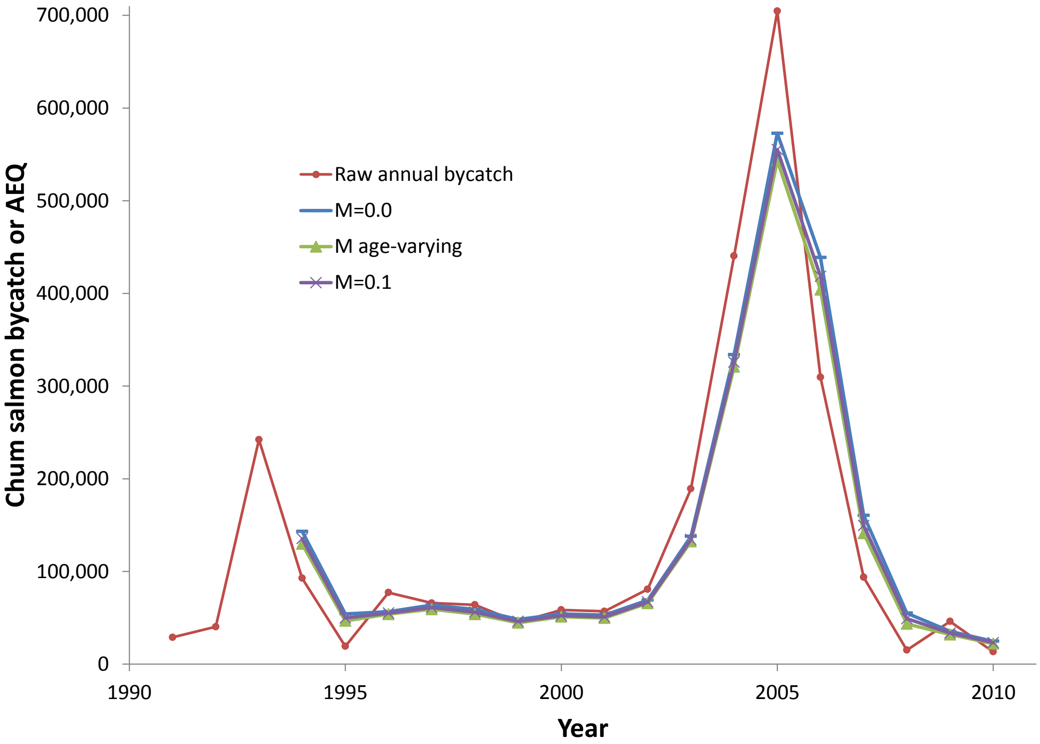


Figure 3-7. Estimated chum bycatch age-equivalent (AEQ) chum bycatch for three different assumptions about oceanic natural mortality rates compared to the annual tally

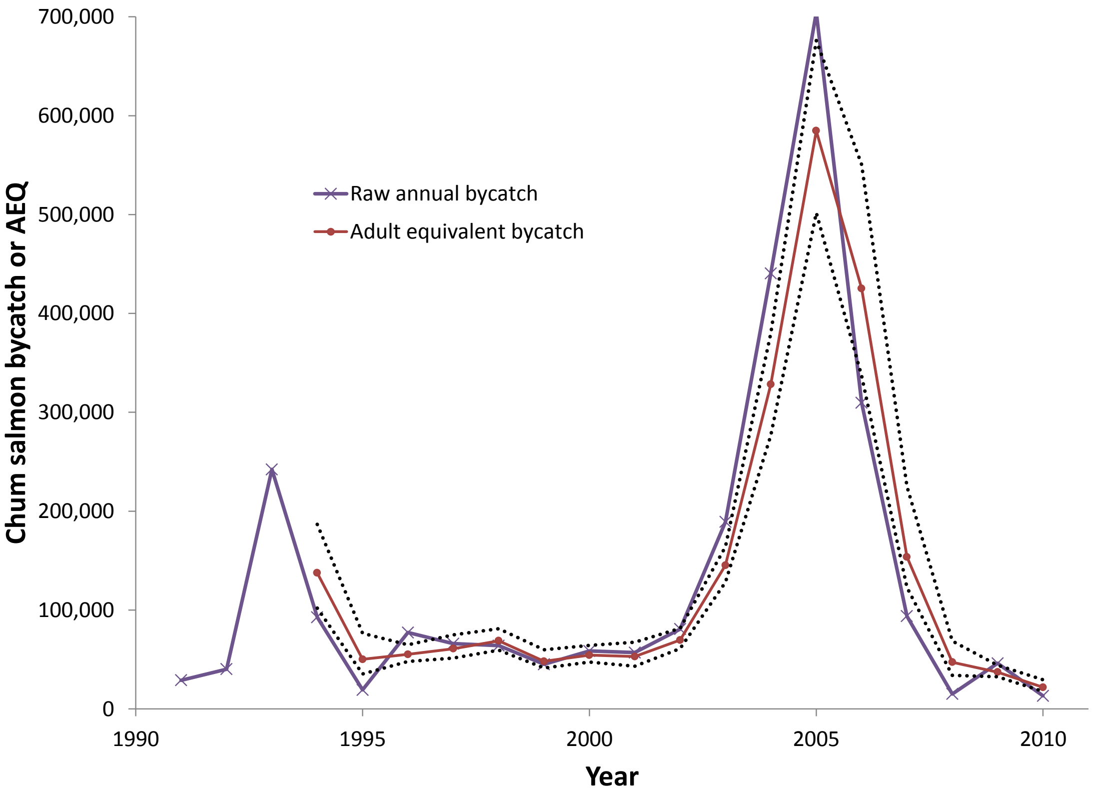


Figure 3-8. Estimated chum bycatch age-equivalent (AEQ) chum bycatch with stochastic (CV=0.4) age-specific oceanic natural mortality scenario 2 and rates compared to the annual tally. Dashed lines represent 5th and 95th percentiles based on 100 simulations.

3.2.2 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 3-9). Individual populations from each region are identified in Table 3-8. 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

$$\hat{y}_{i,j,k} = N_{i,j}\hat{p}_{i,j,k} \qquad (1)$$

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):

$$L = \frac{N!}{y_1! \cdots y_K!} p_1^{y_1} \cdots p_K^{y_K} \qquad (2)$$

$$L = \left(2\pi\right)^{-\frac{K}{2}} \left|\mathbf{\Sigma}\right|^{-\frac{1}{2}} e^{-\frac{1}{2}(\mathbf{p}-\hat{\mathbf{p}})' \mathbf{\Sigma}^{-1} (\mathbf{p}-\hat{\mathbf{p}})} \qquad (3)$$

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*:

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

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 3-9). 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. 2).

Results show that sample size affects the precision of estimates for a particular stock of interest within a stratum (Figure 3-10). 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 3-11).

Genetics results were compiled based on sampling schemes that were sub-optimal for minimizing variance (Table 3-10). 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 3-11). 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.

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

$$ESE_k = ESE_{k,fishery} + ESE_{k,genetic} \qquad (4)$$

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 ($\tilde{N}$):

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

$$\tilde{N} = \hat{p}_k\left(1-\hat{p}_k\right)\operatorname{var}\left(\hat{p}_k\right)^{-1} \qquad (5)$$

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 3-12). 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 3-13). Also, there were differences in relative terms between the number hauls and the number of fish used for genetics over time (Figure 3-14).

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 3-12). 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 3-15). 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 3-16).

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 3-17). 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 3-18). 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 focus 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 3-19). Note that the variance due to the year effect is inflated and thus has the desired property of estimation "outside of sampled" years.

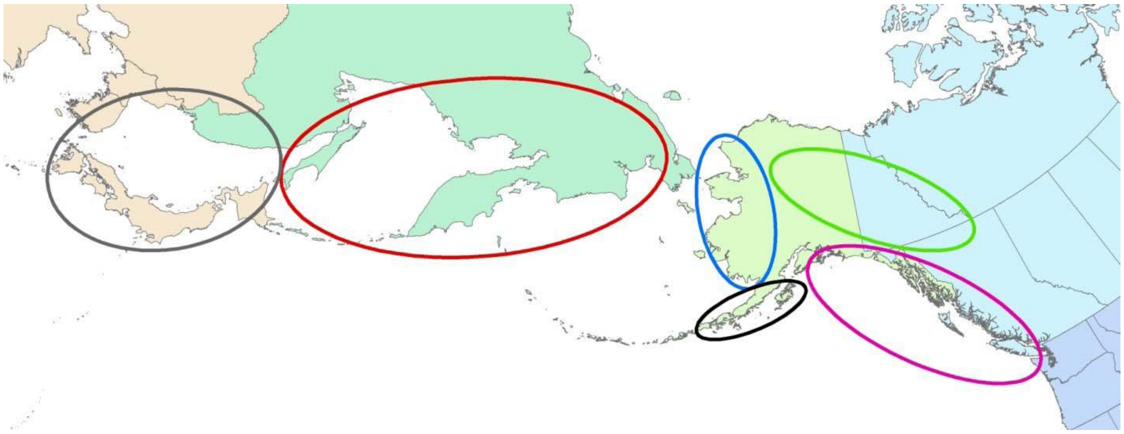


Figure 3-9. Six regional groupings of chum salmon populations used in the analysis including east Asia (grey), north Asia (red), coastal western Alaska (blue), upper/middle Yukon (green), southwest Alaska (black), and the Pacific Northwest (magenta). From Gray et al. 2010.

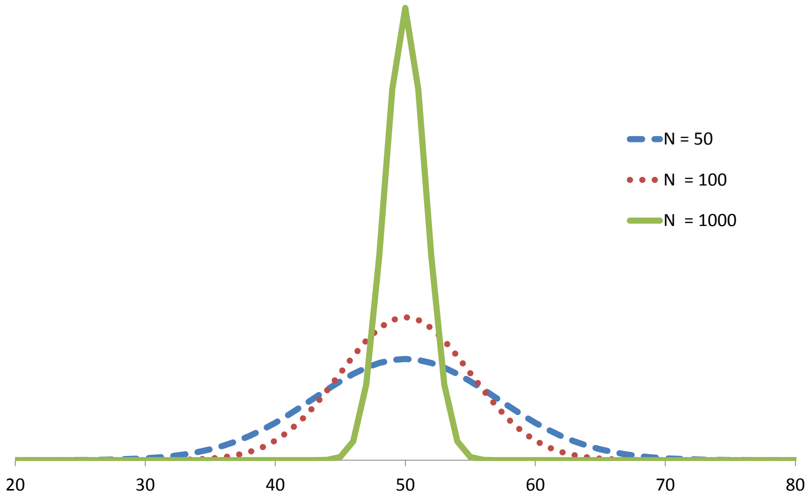


Figure 3-10. Example distributions for different effective sample sizes where the proportion for this example stock composition estimate is 0.5 applied to 100 chum salmon in the bycatch. *Note: this is an illustrative example to evaluate model behavior.*

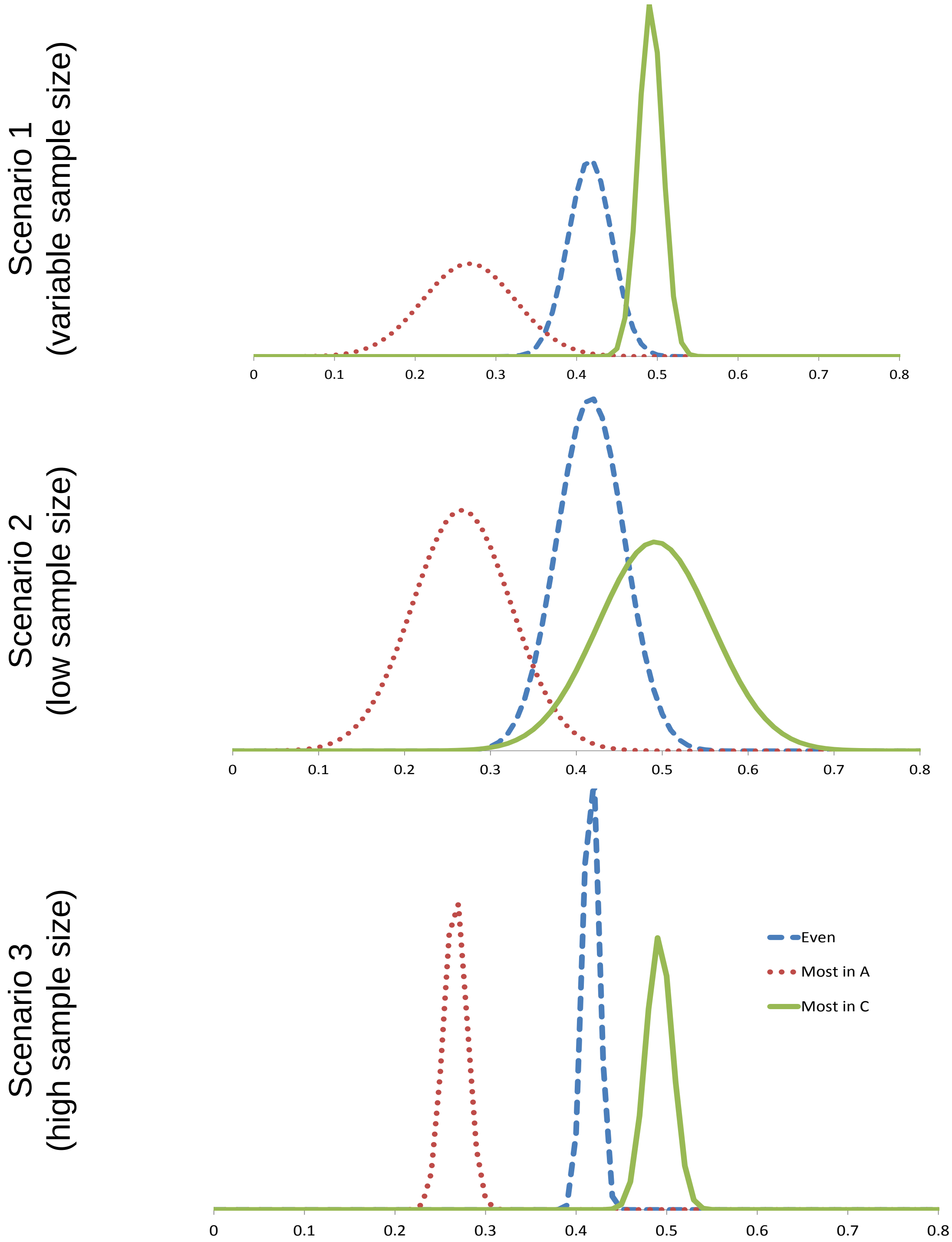


Figure 3-11. Example results of bycatch proportions assuming different bycatch levels within strata (dotted, dashed and solid lines) and different sample size configurations (scenarios 1-3). Each distribution is the integrated (variance weighted) estimate over all strata. *Note: this is an illustrative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

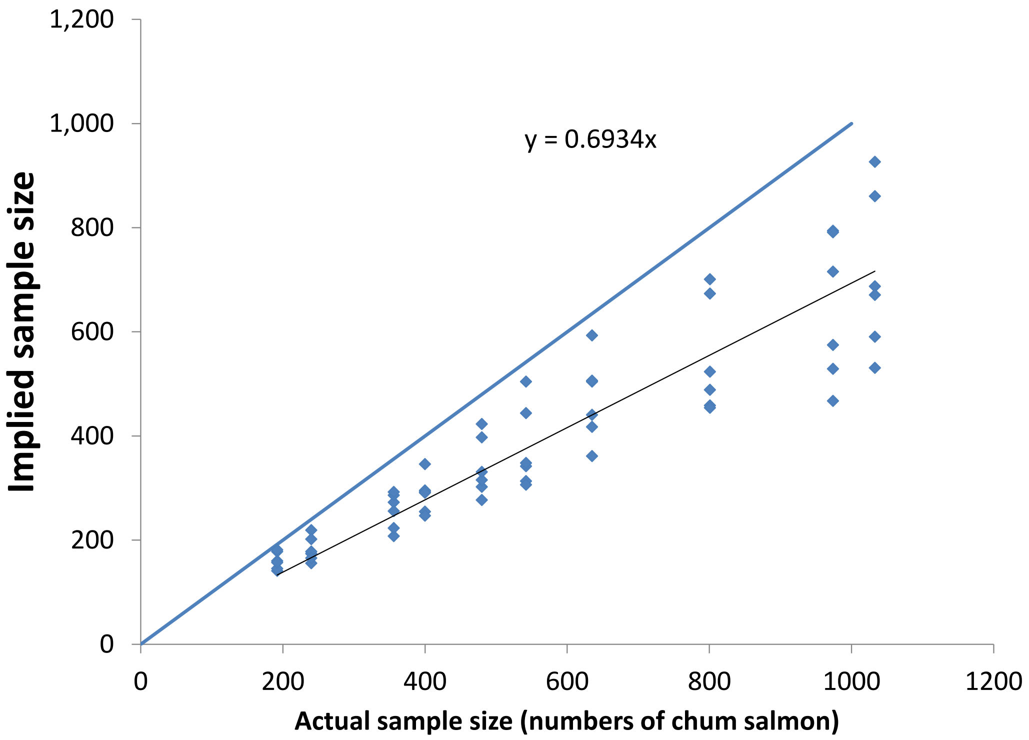


Figure 3-12. Comparison of the implied sample size (as derived from the estimated proportions and variances from the genetic samples) to the actual sample size, 2005-2009 data. Thick diagonal line represents the 1 to 1 line and the thin line represents the fit to the points.

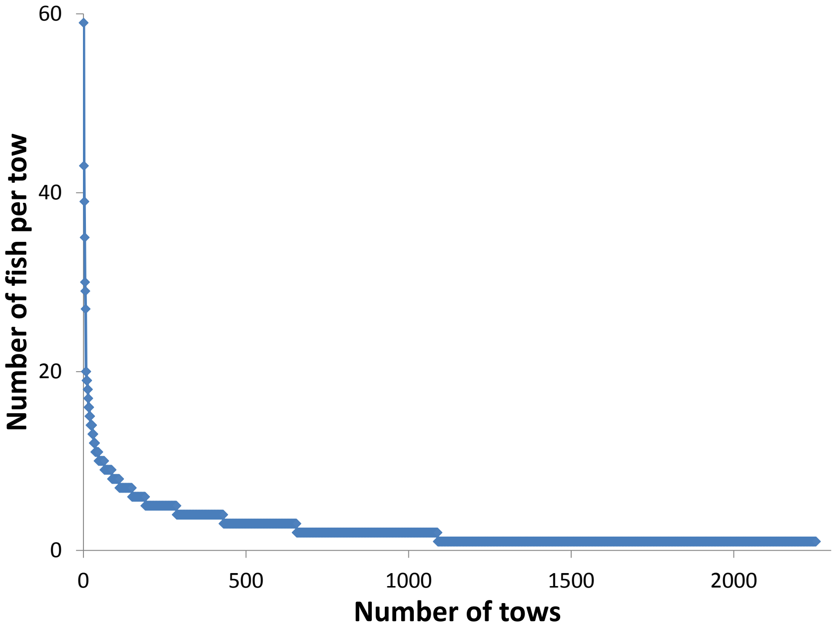


Figure 3-13. Number of B-season chum salmon per tow (trawl fishing operation) from which samples were obtained for genetic analysis compared to the number of tows, 2005-2009.

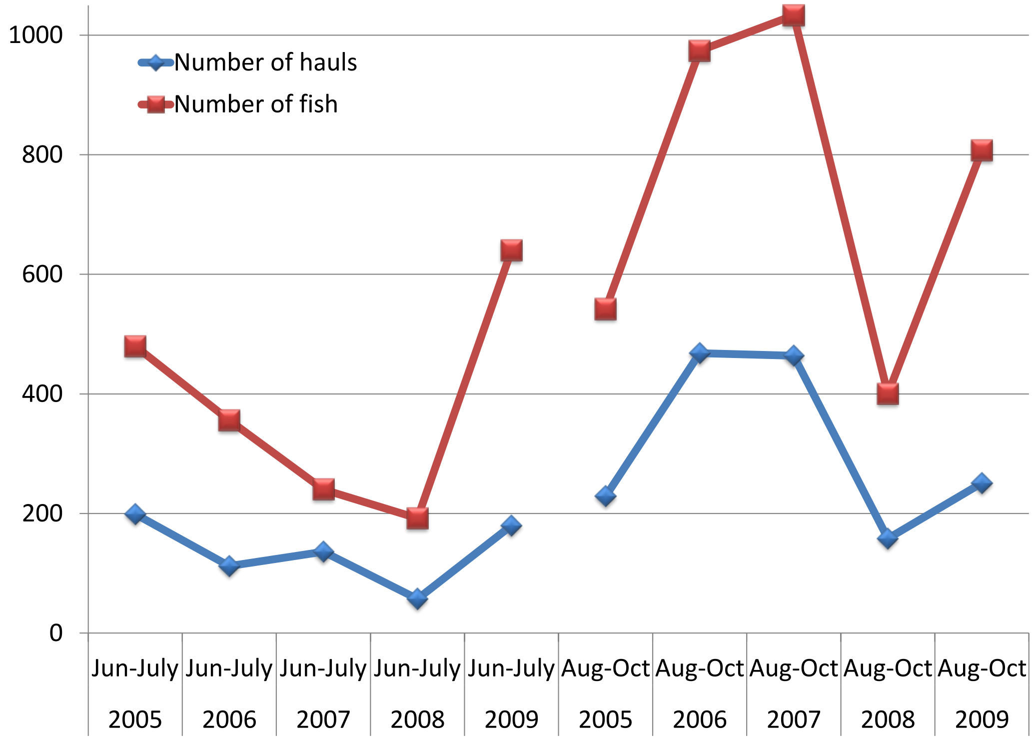


Figure 3-14. Number of fish and number of hauls from which samples were obtained for genetic analysis by early and late B-season strata, 2005-2009.

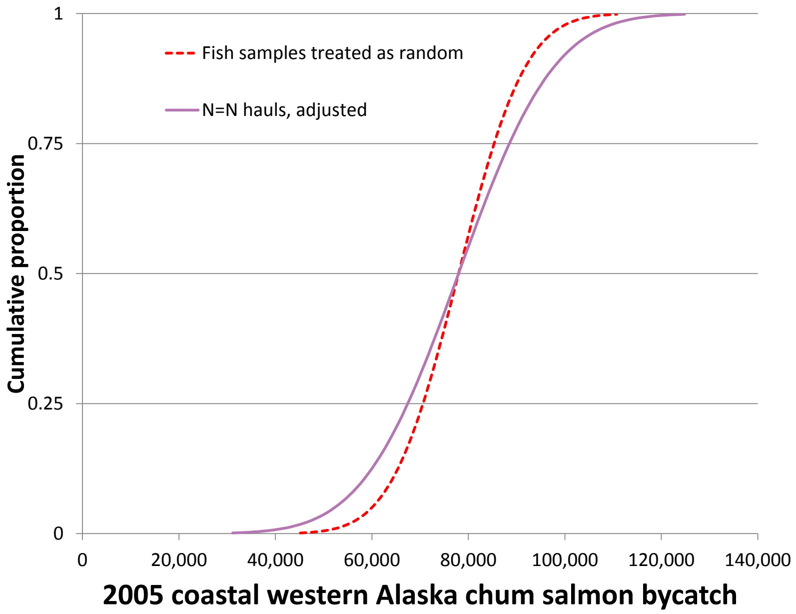


Figure 3-15. Cumulative probability of using the default estimate of uncertainty from the genetic results for chum salmon bycatch (dashed line) compared with that where an adjustment to reflect variable sampling schemes is included (solid line).

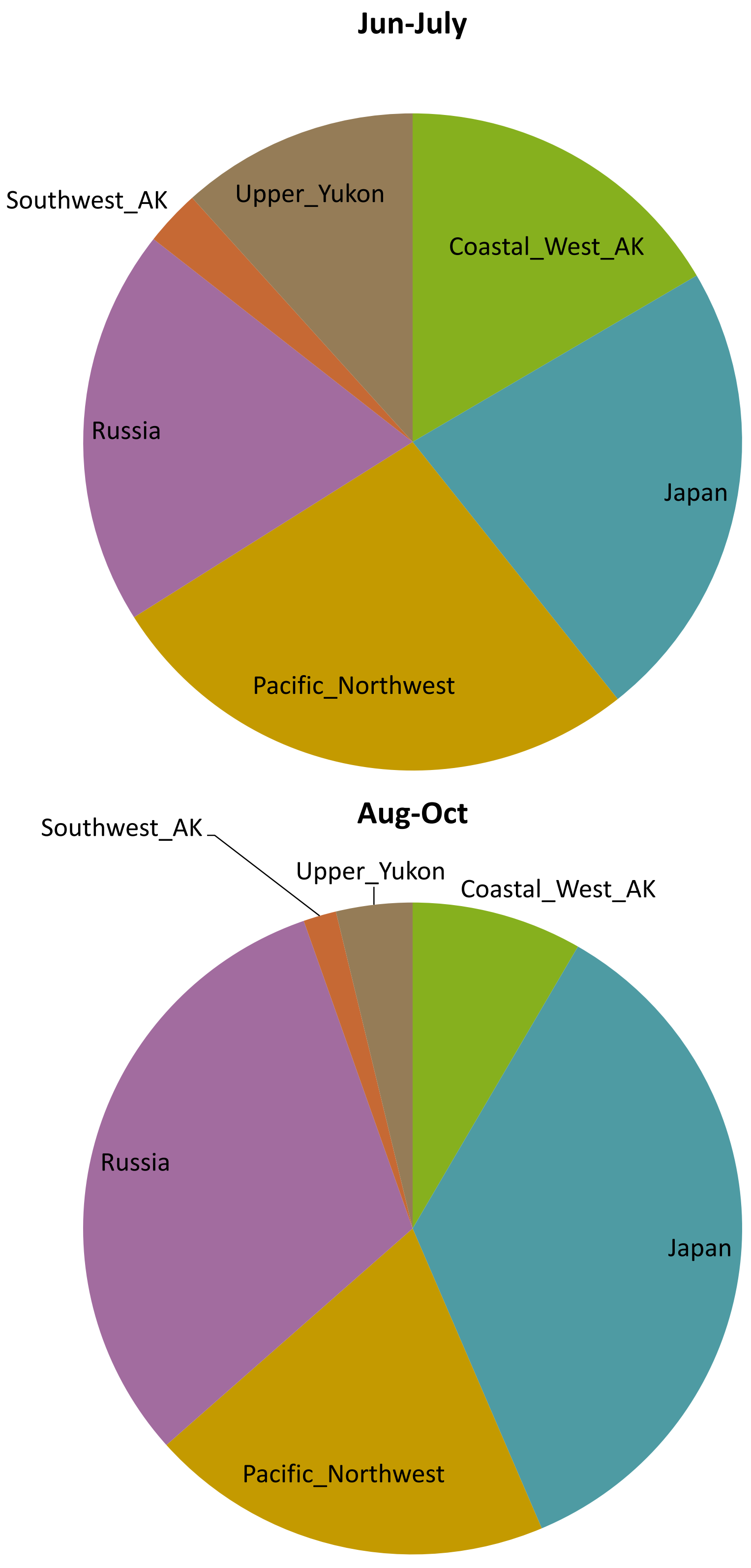


Figure 3-16. Average breakout of bycatch based on genetic analysis by early and late B-season strata, 2005-2009.

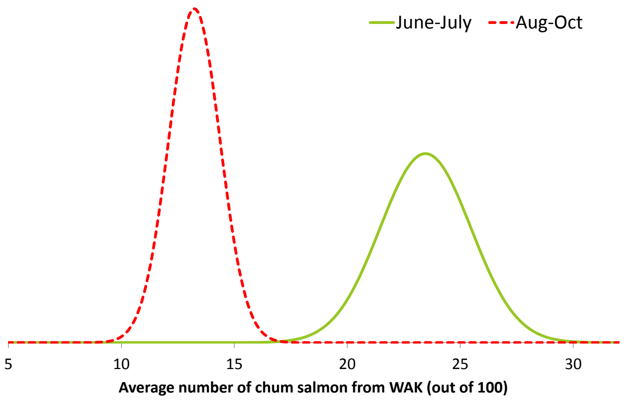


Figure 3-17. Genetic results showing the distribution of the mean WAK (coastal western Alaska and Upper Yukon combined) chum salmon in the bycatch for the early (June-July) compared to the late (Aug-Oct) B-season based on genetic data from 2005-2009.

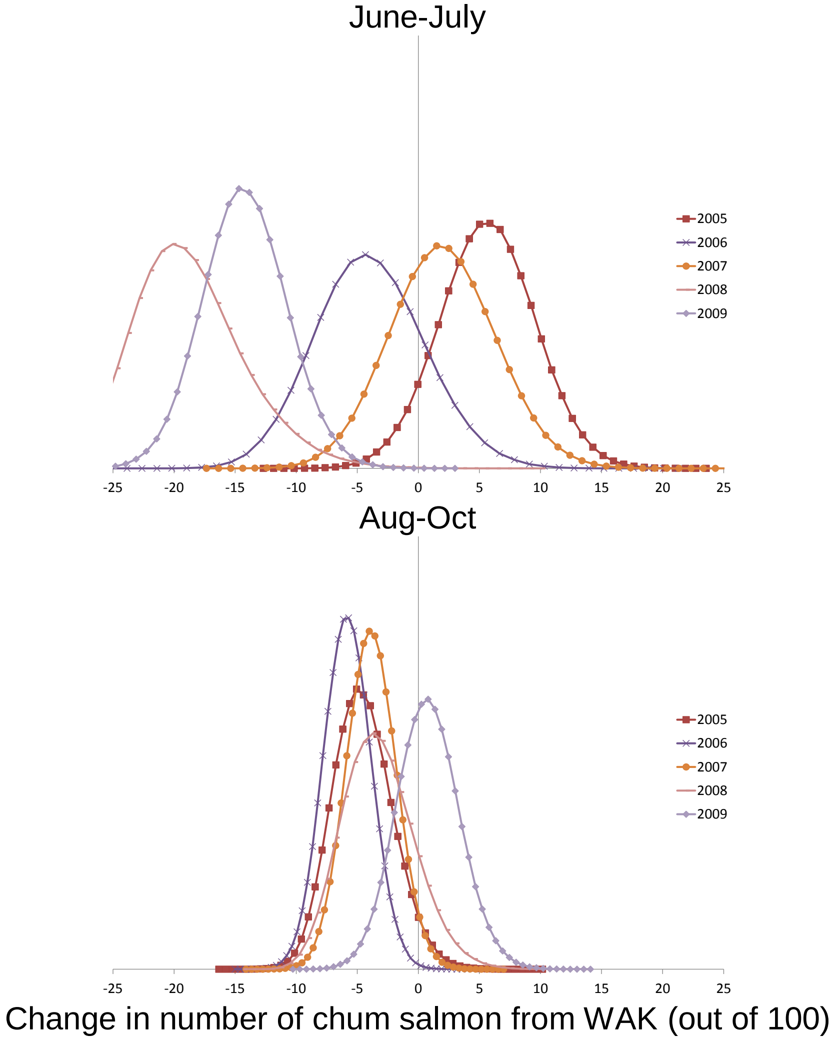


Figure 3-18. Genetics results showing the distribution of the mean WAK (coastal western Alaska and Upper Yukon combined) chum salmon in the bycatch for the early (June-July) compared to the late (Aug-Oct) B-season based on genetics data from 2005-2009.

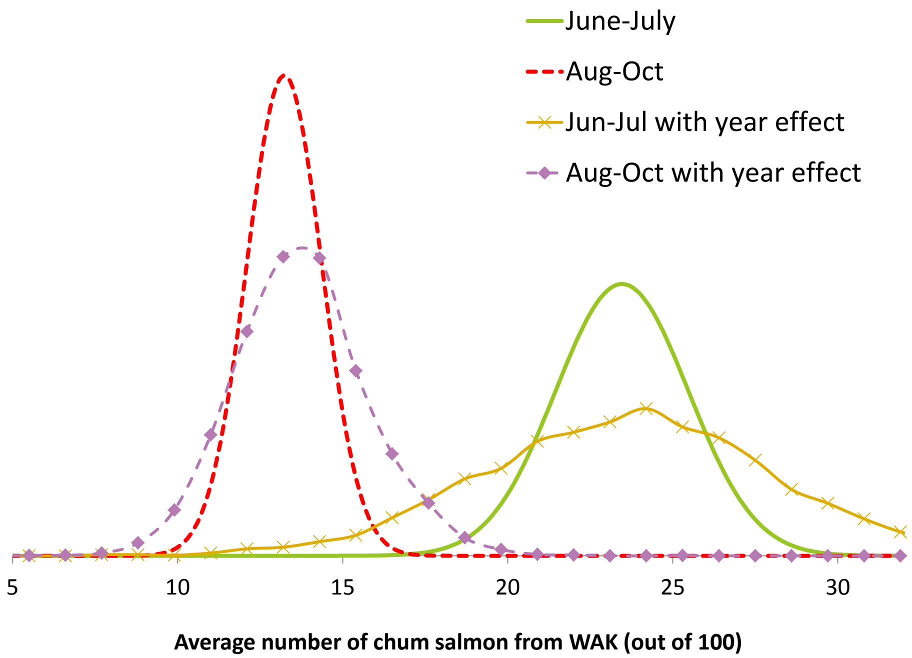


Figure 3-19. Comparison of the mean proportion of chum salmon bycatch originating from WAK (including upper Yukon) during early and late B-season and with the additional uncertainty due to year-effect variability.

Table 3-8. 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 3-9. 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 3-10. 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 3-11. 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 3-12. 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).

Coastal West Alaska		Aug-Oct
Multinomial, N= fish	CV	
2005	9%	14%
2006	13%	13%
2007	19%	10%
2008	32%	17%
2009	11%	9%
Multivariate normal, Covariance		
2005	11%	18%
2006	17%	17%
2007	23%	14%
2008	37%	21%
2009	14%	12%
Multinomial, N=hauls		
2005	13%	30%
2006	22%	52%
2007	22%	21%
2008	21%	16%
2009	22%	16%
Multinomial, N=hauls adjusted		
2005	**16%**	**36%**
2006	**26%**	**62%**
2007	**26%**	**26%**
2008	**25%**	**19%**
2009	**27%**	**19%**

Table 3-13. 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

3.2.3 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 3-13). The impact of the correction due to the lag is illustrated in Figure 3-20. 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.

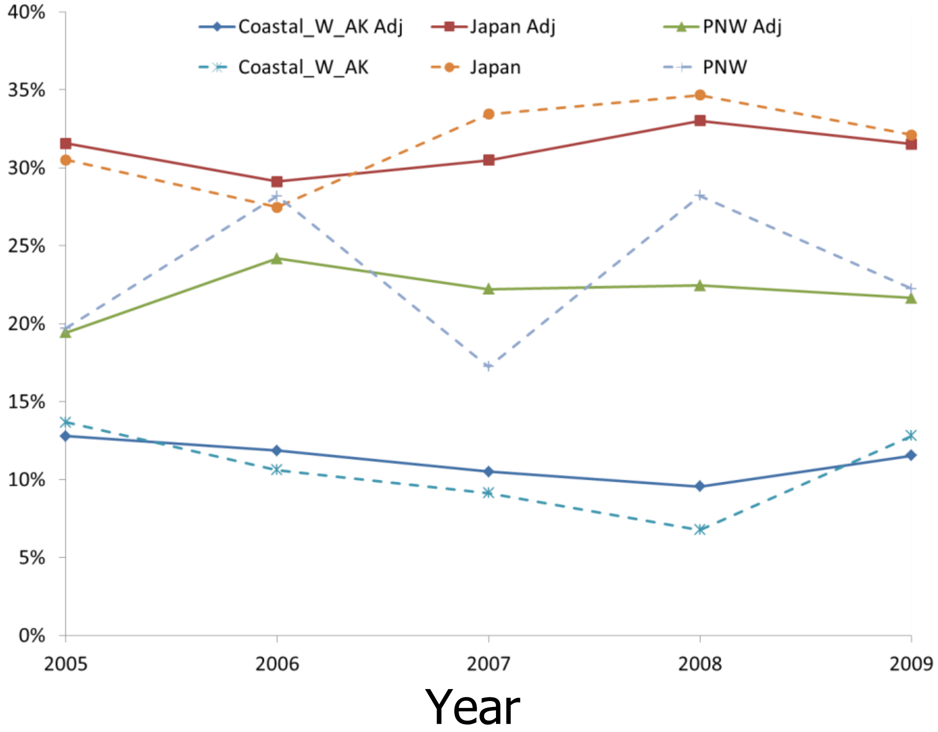


Figure 3-20. Comparison of the annual proportion of B-season chum salmon bycatch originating from different regions by year using the annual genetics results compared with the lag-corrected values (Adj).

3.3 Approach to evaluate Status Quo/RHS program

A separate analysis was completed estimating the efficacy of the RHS program 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.

3.4 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.

3.5 Evaluating Alternative 3, 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 2003-2010 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 1, 2, 2a, and 3 under component 1b). The analysis focused on the historical period from 2003-2010 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 1,152 values to display. Consequently, results for the 50% level of trigger areas only (Figure 2-3) is shown.

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.

Initial evaluations using these data showed that the resolution to distinguish among the trigger options (1, 2, 2a, and 3) was poor due to the magnitude of the bycatch in many of the years. To resolve this problem, 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 8 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 steady shift in fishing patterns (due to the relative abundance of pollock) has occurred through this period with higher proportions of pollock taken west of the Pribilof Islands than in most years.

Within-season patterns are also illustrated by cap, sector split, and trigger option. 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). For analysis of options under alternative 3, the key statistic for evaluating relative salmon saved is based on a "*prototypical"* year—i.e., the expected salmon saved under different levels of AEQ mortality due to bycatch.

3.6 Alternative 4 closure with VRHS exemption

This alternative was evaluated using the same approach described in the above section except that closed areas were imposed for the entire B-season for the historical years. That is, the database records with fishing that occurred within the large-area closure were "redirected" outside of the closed areas and assumed to catch pollock and other PSC species (Chinook and chum) at the sector-specific rates observed outside of the closures. As before, likely behavioral changes by the fleet under this scenario are unknown and consequently ignored for this analysis.

4 Walleye pollock

4.1 Overview of pollock biology and distribution

Overview information in this section is extracted from Ianelli et al. (2010). Other information on pollock may be found at the NMFS website, www.afsc.noaa.gov/refm.

Walleye pollock, *Theragra chalcogramma*, are a member of the order Gadiformes and family Gadidae. They are a semidemersal, schooling species that are generally found at depths from 30 to 300 meters but have been recorded at depths as low as 950 meters (Mecklenburg *et al.* 2002). Pollock are usually concentrated on the outer shelf and slope of coastal waters but may utilize a wide variety of habitats as nearshore seagrass beds (Sogard and Olla 1993). Their distribution extends from the waters of the North Pacific Ocean off Carmel, California throughout the Gulf of Alaska in the eastern Pacific Ocean, across the North Pacific Ocean including the Bering Sea, Chukchi Sea, and Aleutian Islands, and in the western Pacific Ocean from the Sea of Japan north to the Sea of Okhotsk in the western Pacific Ocean (Mecklenburg *et al.* 2002, Hart 1973).

Adult pollock are visual, opportunistic feeders that diet on euphausiids, copepods, and fish, with a majority of their diet from juvenile pollock (National Research Council 1996). In the eastern Bering Sea, cannibalism is the greatest source of mortality for juvenile pollock (Livingston 1989), but cannibalism is not prevalent in the Gulf of Alaska (GOA) (Bailey *et al.* 1999). Juvenile pollock reach sexual maturity and recruit to the fishery at about age four at lengths of 40 to 45 centimeters (Wespestad 1993). Most pollock populations spawn at consistent times and consistent locations each year, most often in sea valleys, canyons, deep water, or the outer margins of the continental shelf during late winter and early spring (Bailey *et al*. 1999). In the eastern Bering Sea, spawning occurs over the southeastern slope and shelf from March through June and over the northwest slope and shelf from June through August (Hinckley 1987). The main spawning location is on the southeastern shelf while the main rearing ground location is on the northeastern shelf (Ianelli 2010).

For management purposes, pollock in the U.S. waters of the Bering Sea are divided into three stocks: the eastern Bering Sea stock, the Aleutian Islands stock, and the Central Bering Sea-Bogoslof Island stock (Ianelli *et al.* 2007). The extent to which pollock migrate across the boundaries of these three areas, across the boundaries of the Bering Sea U.S. EEZ and the Russian EZZ, and seasonally within the eastern Bering Sea is unclear. General migratory movements of adult pollock on and off the eastern Bering Sea shelf tend to follow a pattern of movement to the outer shelf edge and deep water in the winter months, to spawning areas in the springtime, and to the outer and central shelf during the summer months to feed (Smith 1981).

Japanese mark-recapture studies during the summer/autumn feeding seasons have revealed that pollock migrate across the Bering Sea (Dawson 1989) suggesting the interchange of pollock between Russian and U.S. waters. There are concerns that Russian fisheries may be harvesting U.S. managed pollock stocks resulting in a higher fishing mortality. Although the few tagging studies in the Bering Sea have not provided information on spawning migrations, homing to specific spawning sites, and the characteristic of migrating populations as schools or individuals, tagging studies around Japan have been more informative. Mark-recapture studies in which pollock were tagged during the spawning season (April) in Japanese waters revealed migrations for spawning site fidelity, but diffuse mixing during the summer feeding season (Tsuji 1989).

4.1.1 Food habits/ecological role

In North American waters, pollock are most prevalent in the eastern Bering Sea. Because of their large biomass, pollock provide an important food source for other fishes, marine mammals as Steller sea lions (*Eumetopias jubatus*), northern fur seals (*Callorhinus ursinus*), and fin whales (*Balaenoptera physalus*), and marine birds as the northern fulmars (*Fulmarus glacialis*), kittiwakes (*Rissa tridactyla, Rissa brevirostris*), murres (*Uria aalge, Uria lomvia*), and puffins (*Fratercula corniculata, Lunda cirrhata*) (Kajimura and Fowler 1984). These predator-prey relationships between pollock and other organisms are an integral part of the balance that makes the eastern Bering Sea one of the most highly productive environments in the world.

In comparisons of the Western Bering Sea (WBS) with the Eastern Bering Sea using mass-balance food-web models based on 1980-85 summer diet data, Aydin et al. (2002) found that the production in these two systems is quite different. On a per-unit-area measure, the western Bering Sea has higher productivity than the EBS. Also, the pathways of this productivity are different with much of the energy flowing through epifaunal species (e.g., sea urchins and brittlestars) in the WBS whereas for the EBS, crab and flatfish species play a similar role. In both regions, the keystone species in 1980-85 were pollock and Pacific cod. This study showed that the food web estimated for the EBS ecosystem appears to be relatively mature due to the large number of interconnections among species. In a more recent study based on 1990-93 diet data (see Boldt et al. 2007 for methods), pollock remain in a central role in the ecosystem. The diet of pollock is similar between adults and juveniles with the exception that adults become more piscivorous (with consumption of pollock by adult pollock representing their third largest prey item). In terms of magnitude, pollock cannibalism may account for 2.5 million t to nearly 5 million t of pollock consumed (based on uncertainties in diet percentage and total consumption rate).

Regarding specific small-scale ecosystems of the EBS, Ciannelli et al. (2004) presented an application of an ecosystem model scaled to data available around the Pribilof Islands region. They applied bioenergetics and foraging theory to characterize the spatial extent of this ecosystem. They compared energy balance, from a food web model relevant to the foraging range of northern fur seals and found that a range of 100 nautical mile radius encloses the area of highest energy balance representing about 50% of the observed foraging range for lactating fur seals. This suggests that fur seals depend on areas outside the energetic balance region. This study develops a method for evaluating the shape and extent of a key ecosystem in the EBS (i.e., the Pribilof Islands). Subsequent studies have examined spatial and temporal patterns of age zero pollock in this region and showed that densities are highly variable (Winter et al. 2005, Swartzman et al. 2005).

The impact of predation by species other than pollock may have shifted in recent years. In particular, the increasing population of arrowtooth flounder in the Bering Sea is a concern, especially considering the large predation caused by these flatfish in the Gulf of Alaska. Overall, the total non-cannibal groundfish predator biomass has gone down in the Bering Sea according to current stock assessments, with the drop of Pacific cod in the 1980s exceeding the rise of arrowtooth in terms of biomass (e.g., Fig. 4 in Boldt 2007). This also represents a shift in the age of predation, with arrowtooth flounder consuming primarily age-2 pollock, while Pacific cod primarily consume larger pollock. However, the dynamics of this predation interaction may be quite different than in the Gulf of Alaska. A comparison of 1990-94 natural mortality by predator for arrowtooth flounder in the Bering Sea and the Gulf of Alaska shows that they are truly a top predator in the Gulf of Alaska. In the Bering Sea, pollock, skates, and sharks all prey on arrowtooth flounder, giving the species a relatively high predation mortality.

The predation on small arrowtooth flounder by large pollock gives rise to a specific concern for the Bering pollock stock. Walters and Kitchell (2001) describe a predator/prey system called “cultivation/depensation” whereby a species such as pollock “cultivates” its young by preying on species that would eat its young (for example, arrowtooth flounder). If these interactions are strong, the removal of the large pollock may lead to an accelerated decline, as the control it exerts on predators of its recruits is removed—this has been cited as a cause for a decline of cod in the Baltic Sea in the presence of herring feeding on cod young (Walters and Kitchell 2001). In situations like this, it is possible that predator culling (e.g., removing arrowtooth) may not have a strong effect towards controlling predation compared to applying additional caution to pollock harvest and thus preserving this natural control. At the moment, this concern for Bering Sea pollock is qualitative; work on extending a detailed, age-structured, multispecies statistical model (e.g., MSM; Jurado-Molina et al. 2005) to more completely model this complex interaction for pollock and arrowtooth flounder is continuing.

4.1.2 Groundfish Fisheries

Pollock continues to represent over 40% of the global whitefish production with the market disposition split fairly evenly between fillets, whole (head and gutted), and surimi. An important component of the commercial production is the sale of roe from pre-spawning pollock. Pollock are considered a relatively fast growing and short-lived species and currently represents a major biological component of the Bering Sea ecosystem.

In the U.S. portion of the Bering Sea three stocks of pollock are identified for management purposes. These are: Eastern Bering Sea which consists of pollock occurring on the Eastern Bering Sea shelf from Unimak Pass to the U.S.-Russia Convention line; the Aleutian Islands Region encompassing the Aleutian Islands shelf region from 170°W to the U.S.-Russia Convention line; and the Central Bering Sea—Bogoslof Island pollock. These three management stocks undoubtedly have some degree of exchange. The Bogoslof stock forms a distinct spawning aggregation that has some connection with the deep water region of the Aleutian Basin. In the Russian EEZ, pollock are considered to form two stocks, a western Bering Sea stock centered in the Gulf of Olyutorski, and a northern stock located along the Navarin shelf from 171°E to the U.S.- Russia Convention line. There is some indication (based on contiguous surveys) that the fishery in the northern region may be a mixture of Eastern and western Bering Sea pollock with the former predominant. Bailey et al. (1999) present a thorough review of population structure of pollock throughout the north Pacific region. Genetic differentiation using microsatellite methods suggest that populations from across the North Pacific Ocean and Bering Sea were similar. However, weak differences were significant on large geographical scales and conform to an isolation-by-distance pattern (O’Reilly and Canino, 2004; Canino et al. 2005).

From 1954 to 1963, pollock were harvested at low levels in the Eastern Bering Sea and directed foreign fisheries began in 1964. Catches increased rapidly during the late 1960s and reached a peak in 1970-75 when they ranged from 1.3 to 1.9 million t annually. Following a peak catch of 1.9 million t in 1972, catches were reduced through bilateral agreements with Japan and the USSR.

Since the advent of the U.S. EEZ in 1977 the annual average Eastern Bering Sea pollock catch has been 1.2 million t and has ranged from 0.9 million t in 1987 to nearly 1.5 million t in recent years. Stock biomass has apparently ranged from a low of 4-5 million t to highs of 10-12 million t (Figure 4-1). United States vessels began fishing for pollock in 1980 and by 1987 they were able to take 99% of the quota. Since 1988, only U.S. vessels have been operating in this fishery. By 1991, the current NMFS observer program for north Pacific groundfish-fisheries was in place. In recent years, the proportion of catch taken west of 170°W has grown.

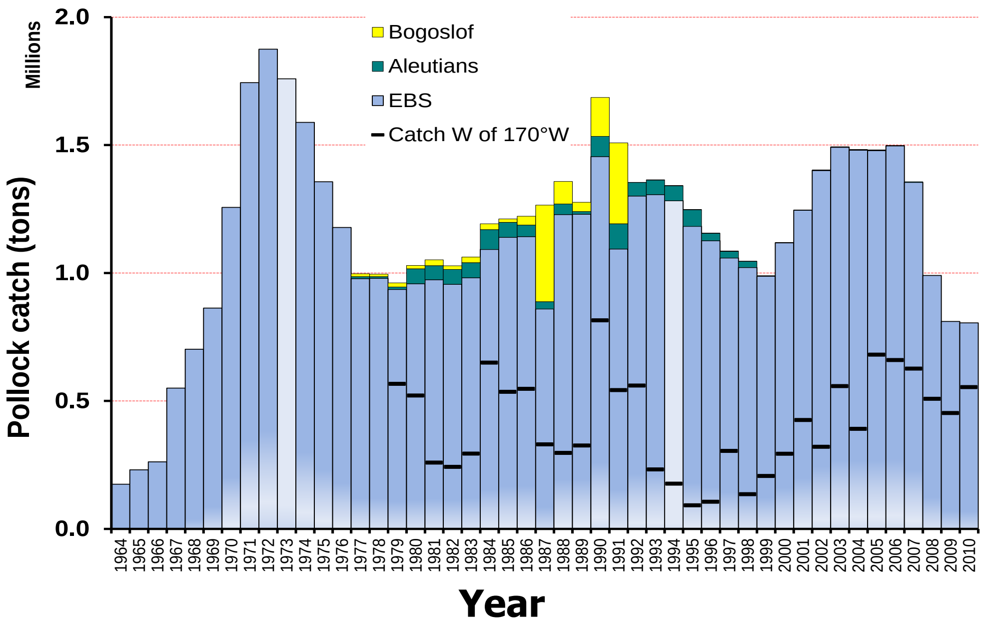


Figure 4-1. Alaska pollock catch estimates from the Eastern Bering Sea, Aleutian Islands, and Bogoslof Island regions, 1964-2010. The 2010 value is based on expected totals for the year.

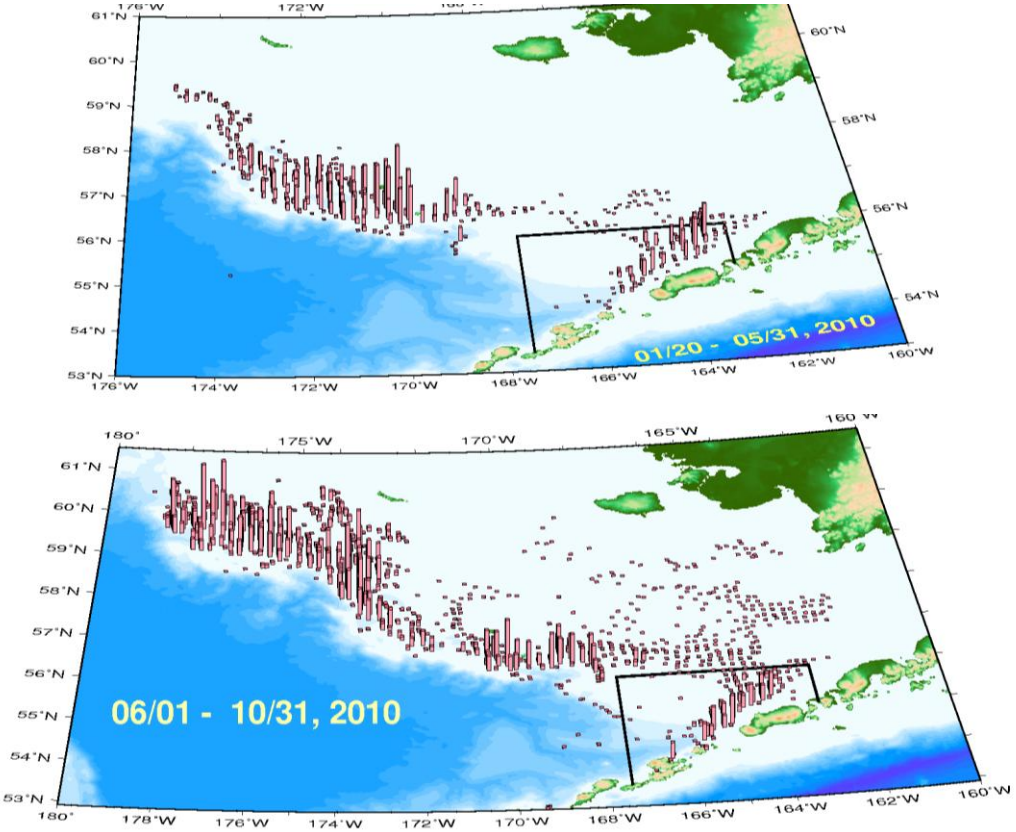


Figure 4-2. Alaska pollock 2010 catch distribution during the winter (top) and summer-fall (bottom).

4.1.3 NMFS surveys and stock assessment

The NMFS conducts bottom trawl surveys annually and echo-integration trawl surveys every other year. Both occur during summer months and provide a synoptic overview of relative densities of adult and pre-recruit pollock (Figure 4-3).

Extensive observer sampling is conducted and a complete assessment is done each year for evaluating stock status and to form the basis of catch recommendations. The most recent assessment shows a declining biomass since 2003 due to a period of below-average recruitment which has subsequently improved since 2008 and is estimated to be above the target spawning level in 2011 (Figure 4-4; Ianelli et al. 2010). Due to the decline, catch was restricted to about 800 thousand tons in 2009 and 2010 whereas catch averaged 1.463 million tons from 2002-2005. The effect of these catches is closely monitored by resource assessment surveys and an extensive fishery observer program.

The assessment reporting process involves reviews done by the Council through the Groundfish Plan Team (which meet on assessment issues twice per year). The Plan Team prepares a summary report of the assessment as the introduction to the Stock Assessment and Fishery Evaluation (SAFE) report which contains separate chapters for each stock or stock complex. These are posted on the internet and can be obtained at http://www.afsc.noaa.gov/REFM/stocks/assessments.htm. Preliminary drafts are presented to the Council in early December where the SSC reviews the documents and makes final ABC recommendations. As part of the review process, the SSC formally provides feedback on aspects of research and improvements on assessments for the coming year. The SSC ABC recommendation is forwarded to the Council where the value represents an upper limit of where the TAC may be set.

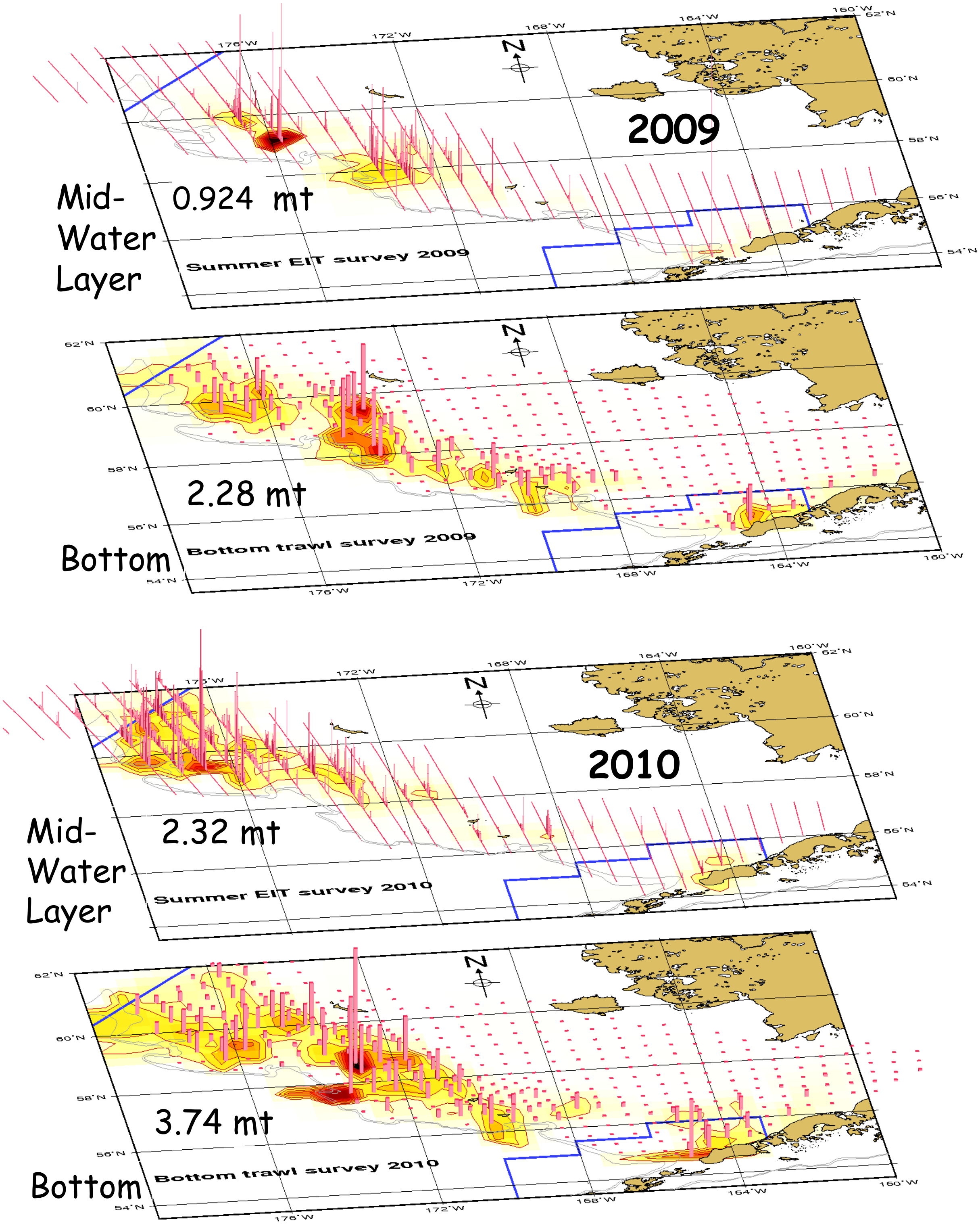


Figure 4-3. Echo-integration trawl and bottom trawl survey results for 2009 and 2010. Vertical lines represent biomass of pollock as observed in the different surveys.

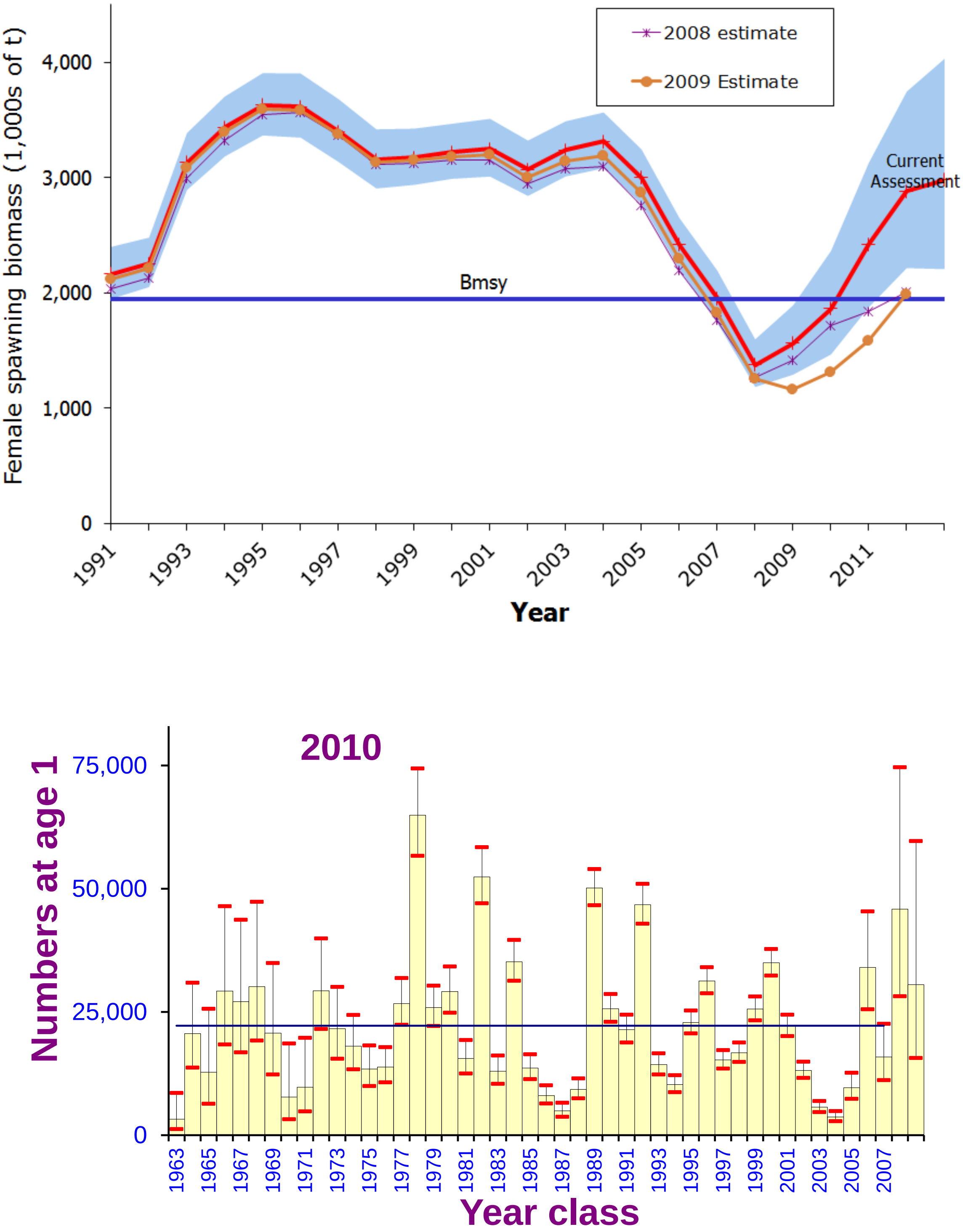


Figure 4-4. Estimated age female spawning EBS mid-year pollock biomass, 1978-2010 (top; with previous year's estimates) and age-1 year-class strengths (bottom panel). Approximate upper and lower 95% confidence limits are shown by shadings and error bars.

4.2 Impact of alternatives on the fishery

Note that significance criteria will be developed and incorporated into the impact analysis for the public review draft in order to evaluate the significance of the impacts of the alternative management measures on pollock stocks.

4.2.1 Alternative 2, hard caps

The amount of pollock catch that would have been forgone was compared with the total actual pollock to evaluate the impact of different sector-split hard caps. **This method ignores the fact that the fleet would likely have taken measures to avoid reaching a cap in any given year.** Nonetheless, all hard caps show that all sectors would have forgone high levels of pollock catch at most cap levels (Table 4-1 and Table 4-2). The sector most affected is the shore-based catcher vessels (CVs), particularly for the 50,000 chum salmon hard cap and the third sector allocation scheme evaluated (Table 4-1; Table 4-2). For the first sector allocation scheme the impact on the at-sea catcher processors was highest, particularly in 2004. Since the impacts for hard caps are quite high (based on historical data in terms of tonnages of pollock), the effort required to avoid chum in such years would additionally increase the costs of fishing. Also, the estimated week of closure in some years was quite early (Table 4-3). Summing hypothetical forgone pollock over sectors, the amount varies considerably between years (Table 4-4) ranging from no pollock forgone to over 79% for the low cap option in 2005.

Table 4-1. Estimated forgone pollock (in metric tons) by sector and year under 3 different allocation schemes and hard caps for 2003-2010 for the B season.

2ii (sector allocation 1)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	33,922	67,813	41,054	194,749			8,602					
2004	74,003	297,215	56,625	191,669	25,223	226,957	9,645	74,207		121,849		24,294
2005	28,754	282,067	68,887	286,835	12,031	105,591	24,481	238,309		68,329	5,682	198,357
2006		223,513		345,480				219,952				
2007	16,499	87,759	24,022	61,265								
2008												
2009												
2010												

4ii (sector allocation 2)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	12,123	24,505	21,285	219,190				26,102				
2004	51,821	286,356	47,524	200,289		121,849		85,320				57,095
2005	23,251	127,176	67,599	288,958		61,230	10,990	248,833				222,456
2006		88,107		345,480				274,460				186,756
2007	13,793	66,786	18,204	75,480								
2008												
2009				14,871								
2010												

6 (sector allocation 3)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003			17,586	247,525				59,213				
2004	36,141	264,379	33,932	216,497		15,896		130,440				74,207
2005	19,168	113,149	64,848	296,493				266,815				248,833
2006				352,310				307,173				224,129
2007	4,717	48,965	6,498	99,701								
2008												
2009				64,572								
2010												

Table 4-2. Estimated forgone pollock (relative to estimated catches) by sector and year under 3 different allocation schemes and hard caps for 2003-2010 for the B season.

2ii (sector allocation 1)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	41%	21%	57%	50%			12%					
2004	79%	97%	77%	52%	27%	74%	13%	20%		40%		7%
2005	30%	92%	90%	78%	13%	35%	32%	65%		22%	7%	54%
2006		71%		95%				60%				
2007	20%	31%	36%	20%								
2008												
2009												
2010												

4ii (sector allocation 2)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	15%	8%	29%	56%				7%				
2004	55%	93%	65%	55%		40%		23%				16%
2005	25%	42%	88%	79%		20%	14%	68%				61%
2006		28%		95%				75%				51%
2007	17%	24%	28%	25%								
2008												
2009				7%								
2010												

6 (sector allocation 3)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003			24%	64%				15%				
2004	39%	86%	46%	59%		5%		36%				20%
2005	20%	37%	85%	81%				73%				68%
2006				97%				84%				61%
2007	6%	17%	10%	33%								
2008												
2009				31%								
2010												

Table 4-3. Estimated week of sector-specific pollock fishery closures due to hypothetical hard caps (column sections) for three different allocation schemes (row sections) for the B season (2003-2010). A blank cell indicates that the fishery would have remained open.

2ii (sector allocation 1)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	13-Sep	23-Aug	16-Aug	16-Aug			27-Sep					
2004	15-Aug	20-Jun	18-Jul	8-Aug	19-Sep	11-Jul	26-Sep	12-Sep		8-Aug		3-Oct
2005	16-Aug	28-Jun	28-Jun	12-Jul	13-Sep	23-Aug	23-Aug	26-Jul		6-Sep	27-Sep	2-Aug
2006		26-Jul		14-Jun				2-Aug				
2007	23-Aug	23-Aug	23-Aug	13-Sep								
2008												
2009												
2010												

4ii (sector allocation 2)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	27-Sep	13-Sep	6-Sep	9-Aug				4-Oct				
2004	5-Sep	20-Jun	1-Aug	8-Aug		8-Aug		5-Sep				19-Sep
2005	23-Aug	16-Aug	28-Jun	12-Jul		6-Sep	20-Sep	19-Jul				26-Jul
2006		6-Sep		14-Jun				12-Jul				9-Aug
2007	30-Aug	30-Aug	30-Aug	6-Sep								
2008												
2009				6-Sep								
2010												

6 (sector allocation 3)

Cap:	**50,000**				**200,000**				**353,000**			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003			6-Sep	2-Aug				20-Sep				
2004	12-Sep	27-Jun	29-Aug	1-Aug		12-Sep		29-Aug				12-Sep
2005	30-Aug	23-Aug	5-Jul	5-Jul				19-Jul				19-Jul
2006				14-Jun				28-Jun				2-Aug
2007	4-Oct	6-Sep	27-Sep	23-Aug								
2008												
2009				2-Aug								
2010												

Table 4-4. Hypothetical forgone pollock (percent) based on closures due to hard caps (column sections) for three different allocation schemes (row sections) for the B season (2003-2010 and relative for all years combined).

2ii (sector allocation 1)	50,000	200,000	353,000
2003	35%	1%	0%
2004	74%	40%	17%
2005	79%	45%	32%
2006	67%	26%	0%
2007	26%	0%	0%
2008	0%	0%	0%
2009	0%	0%	0%
2010	0%	0%	0%
All years	46%	18%	8%
4ii (sector allocation 2)	**50,000**	**200,000**	**353,000**
2003	32%	3%	0%
2004	70%	25%	7%
2005	60%	38%	26%
2006	51%	33%	22%
2007	24%	0%	0%
2008	0%	0%	0%
2009	3%	0%	0%
2010	0%	0%	0%
All years	39%	16%	9%
6i (sector allocation 3)	**50,000**	**200,000**	**353,000**
2003	31%	7%	0%
2004	65%	17%	9%
2005	59%	32%	30%
2006	42%	36%	27%
2007	22%	0%	0%
2008	0%	0%	0%
2009	14%	0%	0%
2010	0%	0%	0%
All years	37%	15%	11%

4.2.2 Alternative 3, trigger closures

4.2.2.1 Components selected for analysis

As presented in the methods section, a reduced range of options and components were selective for analysis. Shown annually, there is a fair amount of variability between sectors for a given allocation scheme, cap, and trigger option (Table 4-5 through Table 4-8). Integrated results over years and sectors to compare the relative impact of the options on the pollock fishery show that the lower cap levels and sector allocation scheme 3 have the largest impact on the pollock fishery (Table 4-9). In terms of potential tons of pollock that would be diverted, Option 2a appears to have the lowest impact on pollock fishing among the other trigger closure options given cap and sector allocation scheme (Table 4-10).

4.2.2.2 Area closures other than 50% of historical bycatch

Options for closures that include 40% of the historical chum bycatch and 60% are anticipated to result in proportionally less and more (respectively) amount of pollock fishing that would be diverted from traditional regions.

Additionally, alternative cap levels and sector splits as presented in Chapter 2 fall within the ranges of those analyzed hence could be evaluated in a relative sense.

Table 4-5. Relative amount of pollock fishing (in percentages of pollock catch biomass) that would be diverted from historical fishing grounds by sector allocation (panels) and trigger cap levels for **Option 1.**

	25,000				**75,000**				**200,000**			
2ii (sector allocation 1)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	16.3%	1.5%	11.8%	36.4%	11.3%	1.2%	8.5%	23.7%	1.7%	0.7%	4.1%	6.9%
2004	2.2%	3.5%	11.6%	19.8%	0.6%	3.0%	5.0%	11.8%	0.3%	1.9%	0.1%	2.9%
2005	0.0%	0.0%	9.5%	35.1%	0.0%	0.0%	3.6%	26.3%	0.0%	0.0%	0.3%	14.1%
2006	0.0%	0.7%	0.0%	21.4%	0.0%	0.4%	0.0%	19.2%	0.0%	0.0%	0.0%	13.1%
2007	0.3%	1.1%	0.1%	8.4%	0.3%	1.0%	0.1%	5.6%	0.3%	0.8%	0.0%	3.0%
2008	0.1%	0.1%	0.0%	21.1%	0.1%	0.1%	0.0%	17.7%	0.0%	0.1%	0.0%	9.6%
2009	0.0%	0.0%	2.1%	15.2%	0.0%	0.0%	1.4%	8.9%	0.0%	0.0%	0.4%	1.9%
2010	0.0%	0.0%	14.7%	16.2%	0.0%	0.0%	13.4%	12.4%	0.0%	0.0%	10.3%	5.7%
	2.6%	1.0%	6.4%	23.0%	1.7%	0.8%	3.8%	16.6%	0.3%	0.5%	1.6%	7.6%
4ii (sector allocation 2)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	13.9%	1.4%	11.1%	38.7%	4.8%	0.9%	5.1%	27.4%	0.0%	0.0%	2.6%	11.9%
2004	1.4%	3.3%	8.3%	20.7%	0.3%	2.3%	2.4%	14.3%	0.0%	0.7%	0.0%	5.4%
2005	0.0%	0.0%	7.5%	36.6%	0.0%	0.0%	0.5%	27.5%	0.0%	0.0%	0.2%	18.1%
2006	0.0%	0.5%	0.0%	21.6%	0.0%	0.1%	0.0%	19.6%	0.0%	0.0%	0.0%	15.5%
2007	0.3%	1.0%	0.1%	8.7%	0.3%	0.8%	0.1%	6.4%	0.2%	0.6%	0.0%	3.8%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.1%	0.0%	19.1%	0.0%	0.0%	0.0%	12.4%
2009	0.0%	0.0%	1.9%	16.0%	0.0%	0.0%	0.8%	9.8%	0.0%	0.0%	0.1%	3.6%
2010	0.0%	0.0%	14.4%	16.7%	0.0%	0.0%	11.7%	13.6%	0.0%	0.0%	7.8%	8.2%
	2.2%	0.9%	5.4%	23.9%	0.8%	0.6%	2.3%	18.2%	0.0%	0.2%	1.1%	10.4%
6 (sector allocation 3)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	11.3%	1.2%	10.1%	41.6%	1.4%	0.6%	4.7%	31.8%	0.0%	0.0%	1.1%	18.6%
2004	0.6%	3.0%	6.4%	22.0%	0.2%	1.4%	0.4%	16.5%	0.0%	0.1%	0.0%	8.3%
2005	0.0%	0.0%	5.9%	39.0%	0.0%	0.0%	0.4%	31.6%	0.0%	0.0%	0.1%	22.3%
2006	0.0%	0.3%	0.0%	21.6%	0.0%	0.0%	0.0%	20.7%	0.0%	0.0%	0.0%	17.2%
2007	0.3%	1.0%	0.1%	9.7%	0.3%	0.7%	0.1%	7.1%	0.1%	0.4%	0.0%	5.1%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.0%	0.0%	19.8%	0.0%	0.0%	0.0%	15.3%
2009	0.0%	0.0%	1.7%	17.6%	0.0%	0.0%	0.4%	12.4%	0.0%	0.0%	0.0%	6.7%
2010	0.0%	0.0%	14.1%	16.8%	0.0%	0.0%	10.8%	14.7%	0.0%	0.0%	6.5%	10.7%
	1.7%	0.8%	4.7%	25.2%	0.3%	0.4%	1.8%	20.5%	0.0%	0.1%	0.7%	13.7%

Table 4-6. Relative amount of pollock fishing (in percentages of pollock catch biomass) that would be diverted from historical fishing grounds by sector allocation (panels) and trigger cap levels for **Option 2.**

	25,000				**75,000**				**200,000**			
	2ii (sector allocation 1)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	17.1%	1.5%	11.9%	37.6%	13.9%	1.2%	8.8%	27.3%	7.7%	0.8%	4.7%	12.4%
2004	2.3%	3.5%	11.6%	20.6%	1.1%	3.0%	5.0%	14.4%	0.4%	1.9%	0.2%	4.9%
2005	0.0%	0.0%	9.5%	35.1%	0.0%	0.0%	3.6%	26.3%	0.0%	0.0%	0.3%	14.9%
2006	0.0%	0.7%	0.0%	21.4%	0.0%	0.4%	0.0%	19.2%	0.0%	0.0%	0.0%	13.1%
2007	0.3%	1.1%	0.1%	8.4%	0.3%	1.0%	0.1%	5.7%	0.3%	0.8%	0.0%	3.1%
2008	0.1%	0.1%	0.0%	21.1%	0.1%	0.1%	0.0%	17.7%	0.0%	0.1%	0.0%	9.6%
2009	0.0%	0.0%	2.1%	15.2%	0.0%	0.0%	1.4%	9.0%	0.0%	0.0%	0.4%	2.0%
2010	0.0%	0.0%	14.7%	16.2%	0.0%	0.0%	13.4%	12.4%	0.0%	0.0%	10.3%	5.7%
	2.8%	1.0%	6.4%	23.3%	2.1%	0.8%	3.8%	17.5%	1.2%	0.5%	1.7%	8.9%
	4ii (sector allocation 2)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.7%	1.4%	11.1%	40.4%	9.7%	0.9%	5.6%	30.5%	1.7%	0.1%	3.8%	17.1%
2004	1.6%	3.3%	8.3%	21.7%	0.4%	2.3%	2.5%	16.4%	0.2%	0.7%	0.1%	7.2%
2005	0.0%	0.0%	7.5%	36.6%	0.0%	0.0%	0.5%	27.5%	0.0%	0.0%	0.2%	18.6%
2006	0.0%	0.5%	0.0%	21.6%	0.0%	0.1%	0.0%	19.6%	0.0%	0.0%	0.0%	15.5%
2007	0.3%	1.0%	0.1%	8.7%	0.3%	0.8%	0.1%	6.4%	0.2%	0.6%	0.0%	3.9%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.1%	0.0%	19.1%	0.0%	0.0%	0.0%	12.4%
2009	0.0%	0.0%	1.9%	16.0%	0.0%	0.0%	0.8%	9.8%	0.0%	0.0%	0.1%	3.7%
2010	0.0%	0.0%	14.4%	16.7%	0.0%	0.0%	11.7%	13.6%	0.0%	0.0%	7.8%	8.2%
	2.5%	0.9%	5.4%	24.3%	1.5%	0.6%	2.3%	19.0%	0.3%	0.2%	1.3%	11.6%
	6 (sector allocation 3)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	13.9%	1.2%	10.4%	41.6%	5.3%	0.6%	5.3%	33.8%	0.7%	0.0%	2.8%	22.0%
2004	0.9%	3.0%	6.4%	22.4%	0.4%	1.4%	0.4%	18.6%	0.0%	0.1%	0.0%	10.8%
2005	0.0%	0.0%	5.9%	39.0%	0.0%	0.0%	0.4%	31.9%	0.0%	0.0%	0.1%	22.4%
2006	0.0%	0.3%	0.0%	21.6%	0.0%	0.0%	0.0%	20.7%	0.0%	0.0%	0.0%	17.2%
2007	0.3%	1.0%	0.1%	9.7%	0.3%	0.7%	0.1%	7.1%	0.1%	0.4%	0.0%	5.2%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.0%	0.0%	19.8%	0.0%	0.0%	0.0%	15.3%
2009	0.0%	0.0%	1.7%	17.6%	0.0%	0.0%	0.4%	12.5%	0.0%	0.0%	0.0%	6.7%
2010	0.0%	0.0%	14.1%	16.8%	0.0%	0.0%	10.8%	14.7%	0.0%	0.0%	6.5%	10.7%
	2.1%	0.8%	4.7%	25.3%	0.8%	0.4%	1.9%	21.1%	0.1%	0.1%	1.0%	14.6%

Table 4-7. Relative amount of pollock fishing (in percentages of pollock catch biomass) that would be diverted from historical fishing grounds by sector allocation (panels) and trigger cap levels for **Option 2a.**

	25,000				**75,000**				**200,000**			
2ii (sector allocation 1)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	17.1%	1.5%	12.5%	39.9%	13.9%	1.2%	10.7%	28.0%	7.7%	0.8%	5.4%	12.4%
2004	2.6%	3.5%	14.4%	20.9%	1.5%	3.0%	7.5%	14.4%	0.4%	1.9%	2.8%	4.9%
2005	0.3%	0.0%	10.7%	37.9%	0.0%	0.0%	6.8%	29.0%	0.0%	0.0%	0.7%	16.4%
2006	0.1%	0.8%	0.0%	21.4%	0.0%	0.6%	0.0%	19.4%	0.0%	0.1%	0.0%	14.6%
2007	0.3%	1.1%	0.1%	9.4%	0.3%	1.0%	0.1%	5.9%	0.3%	0.8%	0.0%	3.3%
2008	0.1%	0.1%	0.0%	21.2%	0.1%	0.1%	0.0%	18.8%	0.0%	0.1%	0.0%	12.8%
2009	0.0%	0.0%	2.1%	17.6%	0.0%	0.0%	1.7%	11.8%	0.0%	0.0%	0.7%	6.0%
2010	0.0%	0.0%	14.8%	16.4%	0.0%	0.0%	14.4%	13.3%	0.0%	0.0%	12.4%	7.8%
	2.9%	1.0%	7.1%	24.5%	2.2%	0.9%	5.1%	18.5%	1.2%	0.5%	2.4%	10.2%
4ii (sector allocation 2)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.7%	1.4%	11.8%	41.9%	9.7%	0.9%	8.0%	31.3%	1.7%	0.1%	3.8%	17.1%
2004	2.0%	3.3%	11.8%	22.8%	0.4%	2.3%	5.3%	16.4%	0.2%	0.7%	0.1%	7.2%
2005	0.0%	0.0%	9.5%	39.8%	0.0%	0.0%	4.0%	31.3%	0.0%	0.0%	0.3%	19.9%
2006	0.0%	0.7%	0.0%	21.6%	0.0%	0.3%	0.0%	20.1%	0.0%	0.0%	0.0%	16.5%
2007	0.3%	1.0%	0.1%	10.3%	0.3%	0.8%	0.1%	6.8%	0.2%	0.6%	0.0%	4.0%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.1%	0.0%	19.7%	0.0%	0.0%	0.0%	15.2%
2009	0.0%	0.0%	2.1%	18.3%	0.0%	0.0%	1.4%	13.9%	0.0%	0.0%	0.4%	7.4%
2010	0.0%	0.0%	14.8%	16.7%	0.0%	0.0%	13.4%	14.5%	0.0%	0.0%	10.4%	9.5%
	2.5%	1.0%	6.4%	25.6%	1.5%	0.6%	3.8%	20.3%	0.3%	0.2%	1.5%	12.7%
6 (sector allocation 3)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	13.9%	1.2%	11.7%	43.1%	5.3%	0.6%	6.6%	35.3%	0.0%	0.0%	1.1%	18.9%
2004	1.2%	3.0%	10.3%	24.5%	0.4%	1.6%	3.9%	18.6%	0.0%	0.1%	0.0%	8.3%
2005	0.0%	0.0%	8.3%	41.7%	0.0%	0.0%	1.8%	34.9%	0.0%	0.0%	0.3%	24.3%
2006	0.0%	0.6%	0.0%	21.6%	0.0%	0.1%	0.0%	21.1%	0.0%	0.0%	0.0%	17.9%
2007	0.3%	1.0%	0.1%	11.3%	0.3%	0.7%	0.1%	7.4%	0.1%	0.4%	0.0%	5.3%
2008	0.1%	0.1%	0.0%	21.5%	0.0%	0.0%	0.0%	20.6%	0.0%	0.0%	0.0%	17.0%
2009	0.0%	0.0%	1.9%	19.8%	0.0%	0.0%	1.0%	15.1%	0.0%	0.0%	0.3%	9.3%
2010	0.0%	0.0%	14.5%	16.8%	0.0%	0.0%	12.8%	15.4%	0.0%	0.0%	9.1%	11.6%
	2.2%	0.9%	5.9%	26.6%	0.8%	0.4%	3.0%	22.3%	0.0%	0.1%	1.0%	14.7%

Table 4-8. Relative amount of pollock fishing (in percentages of pollock catch biomass) that would be diverted from historical fishing grounds by sector allocation (panels) and trigger cap levels for **Option 3.**

	25,000				**75,000**				**200,000**			
	2ii (sector allocation 1)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	16.3%	1.5%	9.3%	34.9%	11.3%	1.2%	5.9%	23.0%	1.7%	0.7%	4.1%	5.5%
2004	1.6%	3.5%	6.1%	19.0%	0.6%	3.0%	0.4%	10.0%	0.3%	1.9%	0.1%	2.9%
2005	0.0%	0.0%	5.0%	29.4%	0.0%	0.0%	1.2%	23.5%	0.0%	0.0%	0.0%	11.5%
2006	0.0%	0.6%	0.0%	18.6%	0.0%	0.1%	0.0%	12.9%	0.0%	0.0%	0.0%	6.5%
2007	0.3%	1.1%	0.1%	7.8%	0.3%	1.0%	0.1%	5.3%	0.3%	0.8%	0.0%	3.0%
2008	0.1%	0.1%	0.0%	15.2%	0.1%	0.1%	0.0%	7.8%	0.0%	0.1%	0.0%	2.5%
2009	0.0%	0.0%	2.0%	8.3%	0.0%	0.0%	1.3%	3.6%	0.0%	0.0%	0.1%	1.5%
2010	0.0%	0.0%	12.0%	13.5%	0.0%	0.0%	9.9%	9.1%	0.0%	0.0%	6.0%	3.7%
	2.6%	1.0%	4.2%	19.9%	1.7%	0.8%	2.1%	13.1%	0.3%	0.5%	1.1%	5.1%
	4ii (sector allocation 2)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	13.9%	1.4%	6.8%	35.5%	4.8%	0.9%	5.1%	25.9%	0.0%	0.0%	2.6%	9.4%
2004	1.1%	3.3%	3.8%	20.3%	0.3%	2.3%	0.2%	12.4%	0.0%	0.7%	0.0%	4.6%
2005	0.0%	0.0%	3.5%	30.2%	0.0%	0.0%	0.0%	24.9%	0.0%	0.0%	0.0%	14.9%
2006	0.0%	0.3%	0.0%	19.4%	0.0%	0.0%	0.0%	13.9%	0.0%	0.0%	0.0%	8.5%
2007	0.3%	1.0%	0.1%	8.2%	0.3%	0.8%	0.1%	6.0%	0.2%	0.5%	0.0%	3.7%
2008	0.1%	0.1%	0.0%	17.1%	0.0%	0.1%	0.0%	9.0%	0.0%	0.0%	0.0%	4.1%
2009	0.0%	0.0%	1.9%	8.8%	0.0%	0.0%	0.7%	4.5%	0.0%	0.0%	0.0%	1.9%
2010	0.0%	0.0%	11.1%	14.3%	0.0%	0.0%	8.4%	10.4%	0.0%	0.0%	2.8%	5.2%
	2.2%	0.9%	3.2%	20.7%	0.8%	0.6%	1.6%	14.6%	0.0%	0.2%	0.6%	7.1%
	6 (sector allocation 3)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	11.3%	1.2%	6.4%	38.5%	1.4%	0.6%	4.7%	30.4%	0.0%	0.0%	1.1%	16.4%
2004	0.6%	3.0%	2.0%	20.9%	0.2%	1.4%	0.1%	14.8%	0.0%	0.1%	0.0%	7.0%
2005	0.0%	0.0%	2.4%	31.3%	0.0%	0.0%	0.0%	27.4%	0.0%	0.0%	0.0%	19.3%
2006	0.0%	0.1%	0.0%	20.2%	0.0%	0.0%	0.0%	16.0%	0.0%	0.0%	0.0%	10.5%
2007	0.3%	1.0%	0.1%	8.7%	0.3%	0.7%	0.1%	6.5%	0.1%	0.3%	0.0%	4.9%
2008	0.1%	0.1%	0.0%	18.4%	0.0%	0.0%	0.0%	11.0%	0.0%	0.0%	0.0%	5.6%
2009	0.0%	0.0%	1.6%	11.3%	0.0%	0.0%	0.3%	5.8%	0.0%	0.0%	0.0%	2.4%
2010	0.0%	0.0%	10.0%	15.3%	0.0%	0.0%	6.8%	11.5%	0.0%	0.0%	1.3%	7.6%
	1.7%	0.8%	2.6%	22.1%	0.3%	0.4%	1.3%	16.9%	0.0%	0.1%	0.3%	10.1%

Table 4-9. Average proportion of pollock catch that would be estimated to be diverted from closed areas for different cap, sector allocations, and trigger options summarizing over years and sectors.

	Cap		
2ii (sector allocation 1)	25,000	75,000	200,000
Option 1	11.3%	8.1%	3.7%
Option 2	11.4%	8.5%	4.3%
Option 2a	9.7%	6.4%	2.5%
Option 3	12.0%	9.1%	5.0%
4ii (sector allocation 2)	25,000	75,000	200,000
Option 1	9.6%	8.5%	4.7%
Option 2	10.1%	8.9%	5.3%
Option 2a	7.8%	6.8%	3.2%
Option 3	10.8%	9.6%	5.8%
6 (sector allocation 3)	25,000	75,000	200,000
Option 1	11.9%	9.3%	6.1%
Option 2	12.0%	9.7%	6.5%
Option 2a	10.3%	7.7%	4.5%
Option 3	12.7%	10.3%	7.0%

Table 4-10. Amount of pollock catch that is estimated to be diverted from closed areas for different cap, sector allocations, and **trigger** options summing over years (2003-2010) and sectors for Alternative 3.

	Cap		
2ii (sector allocation 1)	25,000	75,000	200,000
Option 1	656,650	470,808	214,922
Option 2	665,230	498,290	254,013
Option 2a	699,395	531,389	291,791
Option 3	564,907	371,748	148,428
4ii (sector allocation 2)	25,000	75,000	200,000
Option 1	670,559	493,091	276,087
Option 2	682,565	518,093	385,043
Option 2a	721,676	560,185	411,786
Option 3	577,255	398,927	250,736
6 (sector allocation 3)	25,000	75,000	200,000
Option 1	693,978	540,523	355,408
Option 2	698,751	562,214	363,276
Option 2a	740,021	597,951	363,947
Option 3	602,365	446,560	266,632

4.2.2.3 Effect of chum closures on size distribution of pollock

As with the evaluation of hard caps presented above, the same impacts under triggered closures would apply. Namely that it seems likely that the fleet would fish earlier in the summer season and would tend to fish in places further away from the core fishing grounds north of Unimak Island. Both of these effects have would appear to result in catches of pollock that were considerably smaller in mean sizes-at-age. NMFS at-sea observer length frequency data of pollock fishery was compiled inside of candidate chum closure areas (which vary by month based on the 50% closure scenario) and compared to length frequency outside of the areas based 1999-2010 for the months June-October (Table 4-11). The length frequency distribution for pollock found outside these areas is substantially smaller with a mean length of 45.7 cm outside compared to 49.4 cm inside area closures (Figure 4-5). The implication of this difference is that based on mean B-season fishery weights at length, inside the closure areas would require about 1,078 individual pollock to make up one ton of catch whereas outside the closure areas, 24% more pollock (or 1,334 pollock) would be required to make up one ton of pollock catch.

Because this fishery is extensively monitored, the consequences of possibly catching smaller fish due to this alternative would be accounted for in the procedures for setting ABC and OFL. Namely, that as the "selectivity" of the fishery shifts, then the impact on allowable catch levels would be adjusted appropriately so as to avoid overfishing.

4.2.2.4 Pollock fishery inside and outside of closure areas

Analysis of the 33 months from 2003-2010 B-season data, the trigger closure areas (at 50% level) resulted in 11 months having *worse* fishing outside of the areas (outside CPUE is 80% on average of CPUE inside) for **shore-based catcher vessels**. The other 22 months (two thirds of the data) fishing by this sector was *better* outside of the closure areas (outside closure areas was 143% better than inside). Note that this approach assumes homogeneity among vessels fishing inside and outside of closure areas since vessel effects were ignored.

For **at-sea catcher processors**, 22 months of 2003-2010 for B-season data were available for this comparison. Using the 50% trigger closure areas, only 4 of these months had *worse* fishing outside of the areas (outside CPUE is 66% on average of CPUE inside). The other 17 months (77% of the time) fishing was *better* outside of the closure areas (outside closure area was 184% better than inside).

Computing a mean distance (from a point about mid-way between Akutan and Dutch harbor (54°N 166.2°W) for all shore-based catcher-vessels can provide some insights on the potential effect of enacting the monthly closures using historical data. For example, the differences in distance due to closures indicate a 7% increase distance from "port" based on 2003-2010 data (Figure 4-6). By month, the apparent effect of closures becomes greater later in the B-season (Table 4-12). This suggests another intuitive impact on the pollock fishery (i.e., that area closures will likely result in increased fuel costs and travel times).

Table 4-11. Sample sizes for EBS pollock length data by month and inside or outside of chum trigger closure areas (50% scenario), 1999-2010; NMFS chum salmon observer data.

	Outside	Inside	Total
June	3,667,166	63,083	3,730,249
July	9,008,970	321,473	9,330,443
August	9,624,126	622,298	10,246,424
September	6,901,719	456,955	7,358,674
October	2,779,714	447,130	3,226,844
Total	31,981,695	1,910,939	33,892,634

Table 4-12. Mean distance of shore-based catcher vessels from 54°N 166.2°W by B-season month with monthly closures (2nd column) and without (3rd column) and expressed as a ratio of difference with closures divided by mean distance without closures (4th column), 2003-2010.

Month	Average distance with closure (km)	Average distance from data (no closures; km)	Change in distance relative to no closure
June	217	217	0%
July	332	326	2%
August	395	362	9%
September	373	343	9%
October	366	305	20%
Overall	343	320	7%

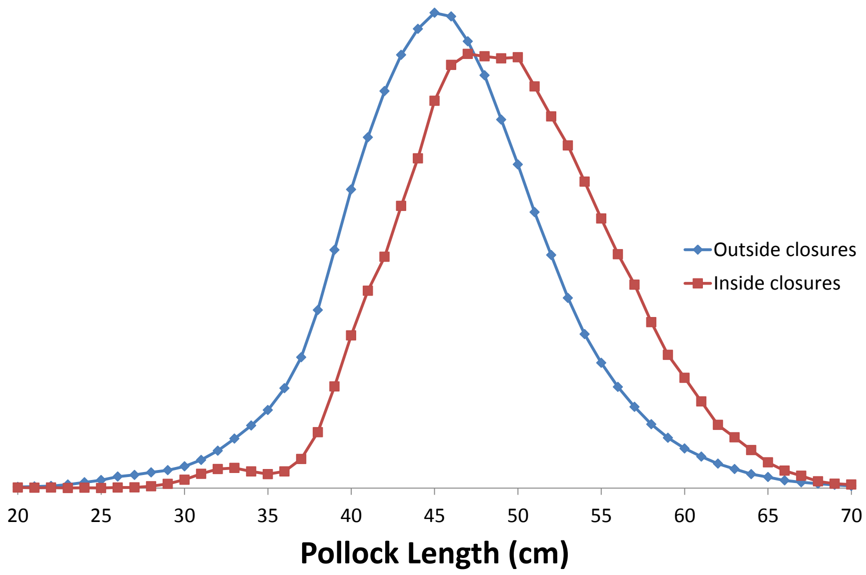


Figure 4-5. Walleye pollock length frequency inside of candidate chum closure areas (which vary by month based on the 50% closure scenario) compared to length frequency outside of the areas based on NMFS observer data from 1999-2010 for the months June-October.

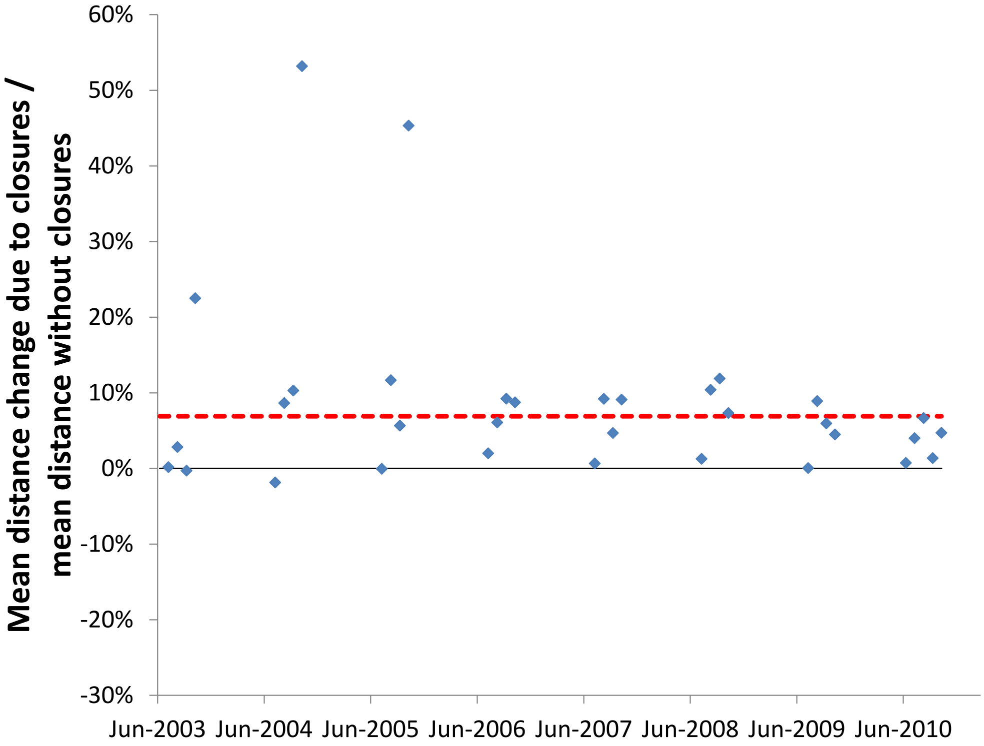


Figure 4-6. Mean distance of all shore-based catcher vessels from 54°N 166.2°W by B-season month expressed as a ratio of difference with closures divided by mean distance without closures, 2003-2010. Dashed line represents overall mean of 7% (i.e., closures result in average increased distance from port by about 7%.

4.2.3 Alternative 4, closures with VRHS exemption

Under this alternative, the impact on fishing for participants outside of the VRHS exemption is anticipated to be costly and the likelihood of forgone pollock is considerable. For example, the average amount of B-season pollock catch that would be diverted to outside the large closure area is 70% for shore-based catcher vessels and fleet-wide is 48% (Table 4-12). As expected, vessels having to adhere to the large area closures would be required to travel nearly twice as far (Figure 4-7).

Table 4-13. Catch proportions (top section) and estimated total sector-specific tonnages (bottom section) of pollock that could (presumably) be diverted from the large area closure for Alternative 4, 2003-2010.

Proportion	CDQ	CP	M	CV	All fleet
2003	62%	24%	58%	90%	60%
2004	49%	32%	55%	86%	60%
2005	32%	39%	40%	81%	56%
2006	29%	29%	25%	70%	47%
2007	26%	27%	31%	55%	39%
2008	12%	12%	14%	43%	26%
2009	30%	26%	26%	45%	35%
2010	14%	35%	41%	60%	44%
Total	34%	29%	38%	70%	48%
Tons diverted	CDQ	CP	M	CV	All fleet
2003	85,100	130,137	69,576	584,757	869,569
2004	76,794	164,848	67,712	525,382	834,736
2005	49,933	197,205	51,125	492,978	791,241
2006	44,156	154,779	30,976	425,350	655,261
2007	35,424	128,227	33,672	281,740	479,063
2008	12,450	39,692	11,063	179,027	242,233
2009	24,745	72,566	18,158	154,918	270,386
2010	11,047	98,633	28,561	209,096	347,337
Total	339,650	986,087	310,843	2,853,248	4,489,827

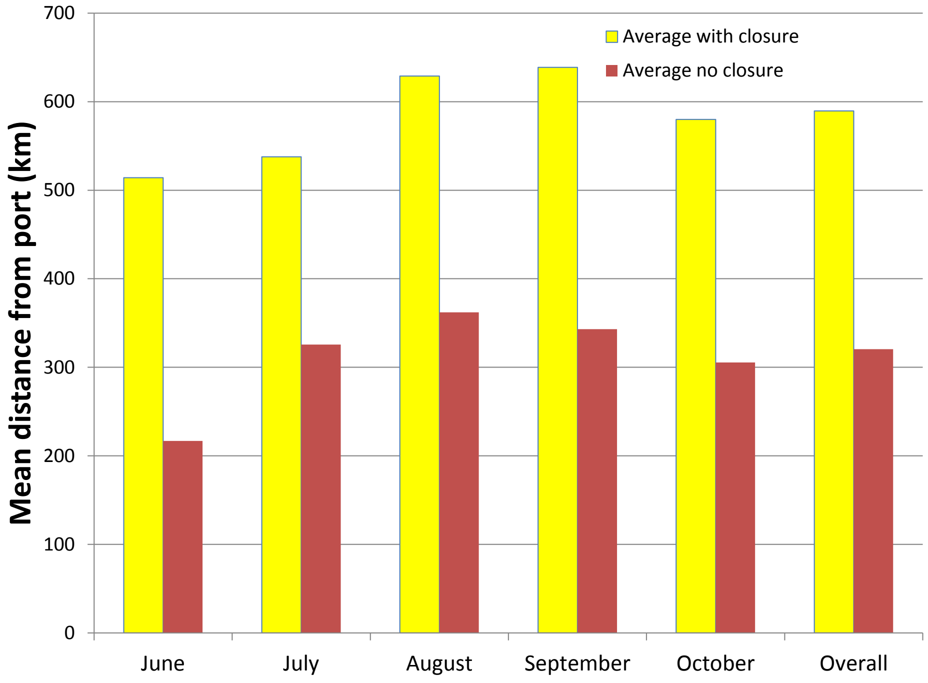


Figure 4-7. Mean distance of all shore-based catcher vessels from 54°N 166.2°W by B-season month, 2003-2010 for Alternative 4 large area closures.

5 Chum Salmon

5.1 Overview of Chum salmon biology and distribution

Information on chum salmon may be found at the ADF&G website: www.adfg.state.ak.us/pubs/notebook/fish/chum.php.

Chum salmon have the widest distribution of any of the Pacific salmon species. They range south to the Sacramento River in California and the island of Kyushu in the Sea of Japan. In the north they range east in the Arctic Ocean to the Mackenzie River in Canada and west to the Lena River in Siberia.

Chum salmon often spawn in small side channels and other areas of large rivers where upwelling springs provide excellent conditions for egg survival. They also spawn in many of the same places as do pink salmon (i.e., small streams and intertidal zones). Some chum in the Yukon River travel over 2,000 miles to spawn in the Yukon Territory. These have the brightest color and possess the highest oil content of any chum salmon when they begin their upstream journey. Chum salmon spawning is typical of Pacific salmon with the eggs deposited in redds located primarily in upwelling spring areas of streams.

Chum salmon do not have a period of freshwater residence after emergence of the fry as do Chinook, coho, and sockeye salmon. Chum fry feed on small insects in the stream and estuary before forming into schools in salt water where their diet usually consists of zooplankton. By fall they move out into the Bering Sea and Gulf of Alaska where they spend two or more of the winters of their three to six year lives. In southeastern Alaska most chum salmon mature at four years of age, although there is considerable variation in age at maturity between streams. There is also a higher percentage of chums in the northern areas of the state. Chum salmon vary in size from four to over thirty pounds, but usually range from seven to eighteen pounds, with females generally smaller than males.

Chum salmon are the most abundant commercially harvested salmon species in arctic, northwestern, and Interior Alaska. They are known locally as ‘dog salmon’ and are an important year-round source of fresh and dried fish for subsistence and personal use purposes, but are of relatively less importance in other areas of the state. Sport fishermen generally capture chum salmon incidental to fishing for other Pacific salmon in either fresh or salt water. After entering fresh water, chums are most often prepared as smoked product. In the commercial fishery, most chum salmon are caught by purse seines and drift gillnets, but troll gear and set gillnets harvest a portion of the catch as well. In many areas they have been harvested incidental to the catch of pink salmon. The development of markets for ikura (roe) and fresh and frozen chum in Japan and northern Europe has increased their demand.

Because chum salmon are generally caught incidental to other species, catches may not be good indicators of abundance. In recent years chum salmon catch in many areas has been depressed by low prices. Directed chum salmon fisheries occur in Arctic-Yukon-Kuskokwim area and on hatchery runs in Prince William Sound and Southeast Alaska. Chum salmon runs to Arctic-Yukon-Kuskokwim Rivers appear to be cyclical or volatile; data suggests that most areas are improving following a major decline in the late 1990s and early 2000. Chum salmon in Northern Norton Sound continue to be managed as a stock of concern.

5.1.1 Food habits/ecological role

Chum salmon diet composition in summer is primarily euphausids and pteropods with some smaller amounts of amphipods, squid, fish, and gelatinous zooplankton. Chum from the shelf region contained a higher proportion of pteropods than the other regions while Aleutian Islands chum salmon contained higher proportions of euphausids and amphipods. Basin chum salmon samples had higher amounts of fish and gelatinous zooplankton. Fish prey species consumed in the basin included northern lampfish and juvenile Atka mackerel, sculpins, and flatfish while shelf samples consumed juvenile rockfish, sablefish, and pollock.

5.1.2 Hatchery releases

5.1.2.1 Pacific Rim

Commercial salmon fisheries exist around the Pacific Rim with most countries releasing salmon fry in varying amounts by species. The North Pacific Anadromous Fish Commission summarizes information on hatchery releases by country and by area where available. Reports submitted to the NPAFC were used to summarize hatchery information by Country and by US state below (Table 5-1, Table 5-2). For more information see the following: Russia (Anon., 2007; TINRO-centre 2008; 2006; 2005); Canada (Cook and Irvine, 2007); USA (Josephson 2008; 2007; Eggers, 2006; 2005; Bartlett, 2008, 2007; 2006; 2005); Korea (SRT 2008, 2007, 2006, 2005). Chum salmon hatchery releases by country are shown below in Table 5-2 .

For chum salmon, Japanese hatchery releases far exceed releases by any other Pacific Rim country. This is followed by the US and Russia. A further break-out of hatchery releases by area in the US show that the majority of chum salmon fry releases occur in the Alaska region (Table 5-2).

Combined Asian hatchery releases in 2009 (Russia, Japan, Korea) account for 78% of the total releases while Alaskan chum releases account for 18% of the total releases. Chum enhancement projects in Alaska are not active in the AYK region.

Table 5-1 Hatchery releases of juvenile chum salmon in millions of fish.

Year	Russia	Japan	Korea	Canada	US	Total
1999	278.7	1,867.9	21.5	172.0	520.8	2,860.9
2000	326.1	1,817.4	19.0	124.1	546.5	2,833.1
2001	316.0	1,831.2	5.3	75.8	493.8	2,722.1
2002	306.8	1,851.6	10.5	155.3	507.2	2,831.4
2003	363.2	1,840.6	14.7	136.7	496.3	2,851.5
2004	363.1	1,817.0	12.9	105.2	630.2	2,928.4
2005	387.3	1,844.0	10.9	131.8	596.9	2,970.9
2006	344.3	1,858.0	7.3	107.1	578.8	2,895.5
2007	350.4	1,870.0	13.8	142.0	653.3	3,029.5
2008	508.0	1,888.0	16.6	82.0	604.0	3,098.6
2009	523.3	1,808.4	5.84	78.9	577.7	2,994.1

Table 5-2 U.S. west coast hatchery releases of juvenile chum salmon in millions of fish.

Year	Alaska	Washington	Oregon	California	Idaho	Combined WA/OR/CA/ID	Total
1999	460.9	59.9	0	0	0		520.8
2000	507.7	38.8	0	0	0		546.5
2001	465.4	28.4	0	0	0		493.8
2002	450.8	56.4	0	0	0		507.2
2003	435.6	60.7	0	0	0		496.3
2004	578.5					51.7	630.2
2005	549.0					47.9	596.9
2006	541.2					37.6	578.8
2007	604.7	48.6	0	0	0	48.6	653.3
2008	567.5					36.0	603.5
2009	551.7					25.5	577

A portion of hatchery fish have thermally marked otoliths (Table 5-3). In 2009 approximately 11% of the combined Asian (Japan, Korea, Russia) releases were thermally marked while for the USA, 79% were thermally marked. Of the USA hatchery released that are marked, over 99% of those are from Alaska with a very small proportion <1% from the combined states of Washington, Oregon, California and Idaho. Currently otoliths are not collected in the groundfish observer program for salmon species thus cataloguing the proportion of chum that are of hatchery origin in the bycatch is not possible at this time.

Table 5-3 Number of otolith marked chum salmon (numbers of fish) released from Pacific Rim hatcheries 2009-2010 (note 2010 data are preliminary). Source NPAFC.

Year	Russia	Japan	Korea	Canada	US	Total
2009	94,798,986	155,807,000	1,200,000	9,608,610	456,760,215	718,174,811
2010	288,120,000	152,865,000	6,500,000	8,300,000	591,077,800	1,046,862,800

5.1.2.2 Alaska

Hatchery-produced salmon are harvested in traditional common property fisheries, common property hatchery terminal area fisheries, and in private hatchery cost recovery fisheries. As enhanced fish enter terminal areas near hatchery release sites, fishery management is focused on the harvest of hatchery-produced surplus returns. In several locations terminal harvest areas (THAs) must be managed in cooperation with hatchery organizations to provide for broodstock needs and cost recovery harvests. Harvests in hatchery Special Harvest Areas (SHAs) are opened so hatchery operators can harvest returning fish to pay for operating costs and to reserve sufficient broodstock to provide for egg take goals. For some terminal locations only cost recovery harvest takes place; for some locations both common property and cost recovery harvests occur; at other locations only common property harvests occur.

Most hatchery fish harvested in terminal areas are segregated from wild stocks while common property fisheries harvest hatchery fish in mixed-stock fisheries during their migration to terminal areas. Hatchery operators are required to provide ADF&G with estimates of the total number of chum salmon harvested each year. The methods used to estimate harvests in mixed-stock fisheries vary from comprehensive thermal mark sampling to best estimates based on consultation with ADF&G management biologist and hatchery operators. Harvest estimates of wild chum salmon are based on estimates of the harvest of hatchery fish (i.e., subtracting the estimated contribution of hatchery fish to the common property fisheries from the total commercial harvest of chum salmon). More detail on local hatcheries is provided as a component in each of the regional management area sections below.

5.1.3 BASIS surveys

The Bering-Aleutian Salmon International Survey (BASIS) is an NPAFC-coordinated program of pelagic ecosystem research on salmon and forage fish in the Bering Sea. Shelf-wide surveys have been conducted beginning in 2006 on the eastern Bering Sea shelf (Helle et al 2007). A major goal of this program is to understand how changes in the ocean conditions affect the survival, growth, distribution, and migration of salmon in the Bering Sea. Research vessels from U.S. (F/V Sea Storm, F/V Northwest Explorer), Japan (R/V Kaiyo Maru, R/V Wakatake Maru), and Russia (R/V TINRO), have participated in synoptic BASIS research surveys in Bering Sea since in 2002 (NPAFC 2001).

The primary findings from the past 5 years (2002–2006) indicate that there are special variations in distribution among species: juvenile coho and Chinook salmon tend to be distributed nearshore and juvenile sockeye, chum, and pink salmon tended to be distributed further offshore. In general, juvenile salmon were largest during 2002 and 2003 and smallest during 2006, particularly in the northeast Bering Sea region. Fish, including age-0 pollock and Pacific sand lance were important components of the diets for all species of juvenile salmon in some years; however, annual comparisons of juvenile salmon diets indicated a shift in primary prey for many of the salmon species during 2006 in both the northeast and southeast Bering Sea regions. In addition, the average catch per unit effort of juvenile salmon fell sharply during 2006 in the southeast Bering Sea region. It is speculated that spring sea surface temperatures on the eastern Bering Sea shelf likely impact growth rate of juvenile western Alaska salmon through bottom-up control in the ecosystem. Cold spring SSTs lead to lower growth and marine survival rates for juvenile western Alaska salmon, while warm spring SSTs have the opposite effect (NPAFC 2001).

Figure 5-1 shows the relative abundance of juvenile salmon in the Northern Shelf Region of the Bering Sea as determined by the U.S. BASIS cruises from 2002 to 2007. The very low numbers of chum juveniles in 2004 may explain the relatively low chum salmon bycatch in the BSAI groundfish fishery in 2007. The numbers of juvenile chum salmon appear to be rebounding in 2006 and 2007 (Chris Kondzela, AFSC, personal communication).

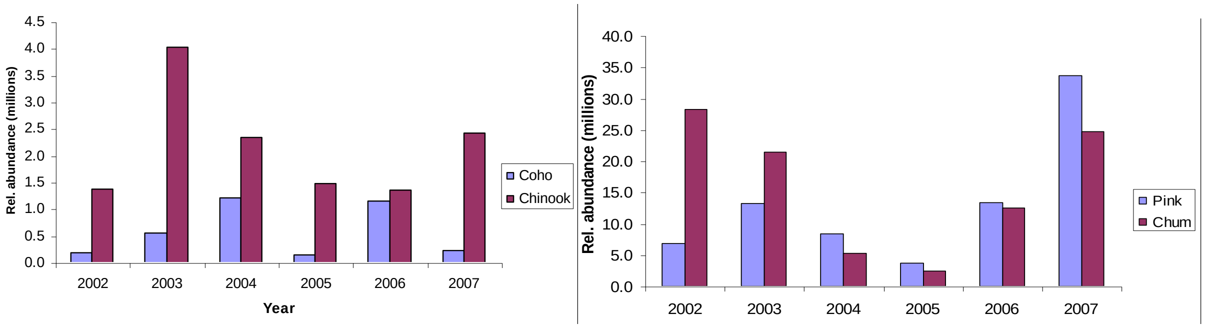


Figure 5-1 Relative abundance of juvenile salmon in the Northern Shelf Region (60°N-64°N latitude) of the U.S. BASIS survey, 2002-2007. *Source: Chris Kondzela, NMFS AFSC.*

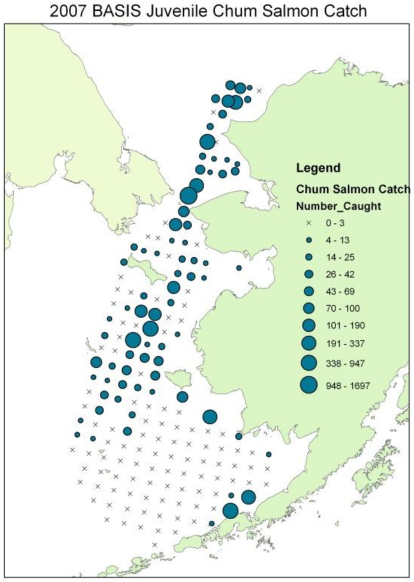


Figure 5-2 U .S. BASIS juvenile Chum salmon catches in 2007. Source: Chris Kondzela, AFSC

Stock mixtures of salmon from BASIS surveys in the Bering Sea have provided new information on oceanic migration and distribution of regional stock groups in the Bering Sea. Recent results from Japanese surveys indicate that 81% of the immature chum salmon in the Bering Sea basin were from Asian (Russia and Japan) populations during August-September in 2002. Results from U.S. surveys on the Bering Sea shelf and Aleutian chain indicate considerable spatial variation in stock mixtures; however, when pooled over location mixtures were very similar to mixtures present in the basin with 80% of the immature chum salmon from Asian populations. Immature chum salmon from western Alaska comprised 2% and 8% of immature chum salmon on the southern Bering Sea shelf and northern Bering Sea shelf, respectively. Stock mixtures of juvenile chum salmon have identified where migratory routes of western Alaska and Russian chum salmon stocks overlap and has helped identify the contribution of Russian stocks to the total biomass of juvenile chum salmon on the eastern Bering Sea shelf (JTC 2008).

During the June-July 2005 BASIS survey chum salmon was the most dominant fish species in upper epipelagic layer in the survey area (52 % from overall fish biomass estimates; NPAFC 2006). Chum salmon was a dominant Pacific salmon species in terms of its quantity (46% from overall Pacific salmon quantity). The rate of chum salmon occurrence in trawl catches was highest (92%) among all fish species (NPAFC 2006). During the survey period age 0.1 chum salmon has just started entering Bering Sea along the major pathway of Central Bering Sea Current. Age 0.2 chum salmon was distributed in the Aleutian and Commander Basins. This age group of chum salmon migrated into the Russian EEZ earlier than 0.1 along the major pathway of Central Bering Sea Current (NPAFC 2006). Near Navarin Cape and Kronotsky Capes age 0.2 chum was most proximate to the shore as compared with other areas (NPAFC 2006). Large-size (FL>53 cm) immature chum salmon was numerous in the northwestern Aleutian Basin and Navarin Shelf area (NPAFC 2006). Age 0.3 and higher was distributed almost throughout entire survey area (rate of occurrence in catches – 73%), except for inshore areas (NPAFC 2006). Maturing chum salmon individuals were noted in a high percentage of trawl catches (87 %). The overall biomass of chum salmon in the survey areas was estimated as 311.59 thousand tons (49% - immature and 51% - mature chum). Overall quantity estimates were 138.96 million individuals (57% - immature and 43% - mature chum salmon) (NPAFC 2006)

In 2007, the U.S. BASIS program sampled in the Bering Straits and the Chukchi Sea, and found water temperatures warmer than in the Bering Sea. Substantial numbers of juvenile pink and chum salmon were caught that were larger than those caught south of the Bering Straits. Juvenile chum salmon in this area and from the Chukchi Sea may also originate from the Yukon River (JTC 2008).

Genetic evaluations were recently completed on chum salmon samples from the 2006 and 2007 summer and fall BASIS cruises (McCraney et al. 2010; Figure 5-3 and Figure 5-4). Substantial differences were found in the stock composition of chum salmon between the continental slope and northern shelf environments compared with the southern continental shelf in the eastern Bering Sea, with more consistent stock composition in former and limited inter-annual variability while substantial inter-annual variability was found in the southern continental shelf region. The continental slope and northern shelf environments were dominated by Asian stocks while the southern continental shelf was dominated by North American stocks (McCraney et al. 2010).

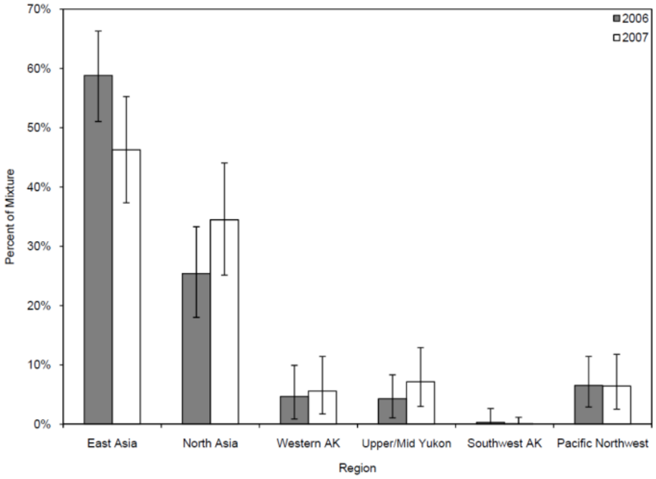


Figure 5-3 Stock composition of chum salmon in the north shelf habitat of the Bering Sea from 2006-07, as estimated by microsatellites. Error bars indicate 95% credible intervals. From McCraney et al. 2010.

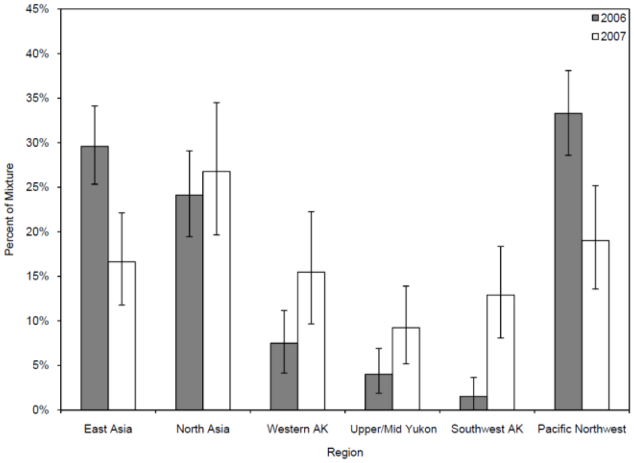


Figure 5-4 Stock composition of chum salmon in the south shelf habitat of the Bering Sea from 2006-07, as estimated by microsatellites. Error bars indicate 95% credible intervals. from McCraney et al. 2010

The BASIS program is now moving into BASIS Phase II, building upon the work undergone in BASIS Phase I. Some of the main findings of Phase I included research indicating that the observed (2002-2006) shift in increased salmon returns to western Alaska was related to increased carrying capacity for juvenile salmon in the eastern and western Bering Sea (Farley and Moss in review; Farley and Trudel in review; Gritsenko et al. in review). Despite the increase in oceanic salmon abundance, salmon carrying capacity in offshore regions of the Bering Sea also appeared to be sufficient for the growth of immature salmon (Azumaya et al. 2008).

BASIS phase II is intended to be a 5-year (2009-2013) program of field, laboratory and computer modeling research combined with previous field efforts for better tracking of longer-lived salmon species (sockeye, chum and Chinook) through a complete Bering Sea production cycle (NPAFC 2009). This will ideally enable a clearer understanding of salmon carrying capacity in the Bering Sea (NPAFC 2009).

5.1.4 Migration corridors

BASIS surveys have established that the distribution and migration pathways of western Alaska juvenile salmon vary by species. Farley et al. (2006; Figure 5-5) reported on the distribution and movement patterns of main species in this region. The Yukon River salmon stocks are distributed along the western Alaska coast from the Yukon River to latitude 60ºN. Kuskokwim River salmon stocks are generally distributed south of latitude 60ºN from the Kuskokwim River to longitude 175ºW. Bristol Bay stocks are generally distributed within the middle domain between the Alaska Peninsula and latitude 60ºN and from Bristol Bay to longitude 175ºW. The seaward migration from natal freshwater river systems is south and east away from the Yukon River for Yukon River chum salmon, to the east and south away from the Kuskokwim River for Kuskokwim River chum, Chinook, and coho salmon, and east away from Bristol Bay river systems for Bristol Bay sockeye salmon stocks.

Previous reports have studied seasonal migration patterns of Asian and North American chum salmon in the Bering Sea (Fredin et al. 1977). These show distinct differences in the Bering Sea based upon immature and maturing fish in migratory patterns between North American and Asian origin stocks (Figure 5-6), however data used to estimate these migration trends is dated (1950-1960s) (Myers et al 2006).

Studies specific to Japanese hatchery chum salmon used genetic stock identification to model migration routes for Japanese chum in the Bering Sea over several years (Figure 5-7). Urawa (2000; 2003) estimated that Japanese chum hatchery fish begin to migrate into the Bering Sea in their second summer/fall, migrating south and east late in the fall to the Gulf of Alaska to spend their second winter. In subsequent years they then migrate between feeding grounds in the Bering Sea and Gulf of Alaska in summer and fall prior to returning as maturing fish to Japan via the western Bering Sea (Urawa 2000; 2003).

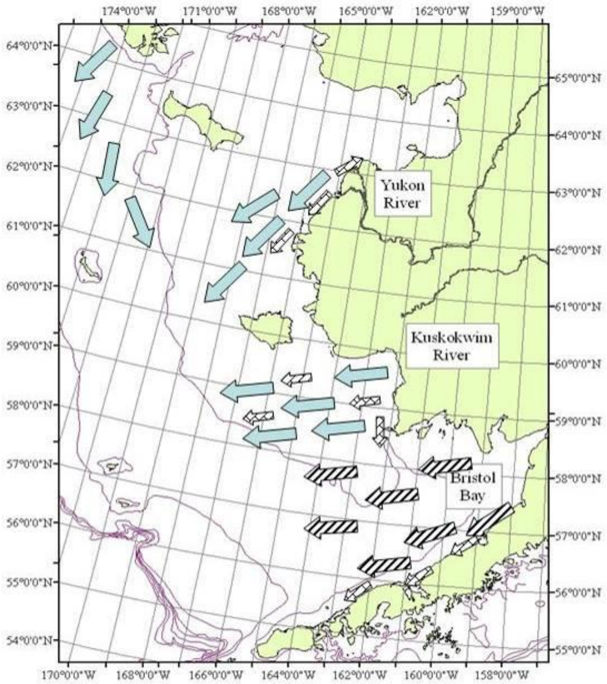


Figure 5-5. Seaward migration pathways for juvenile chum (solid arrow), sockeye (slashed line arrow), coho, and Chinook (boxed line arrow) salmon along the eastern Bering Sea shelf, August through October. *Source: Farley et al 2007.*

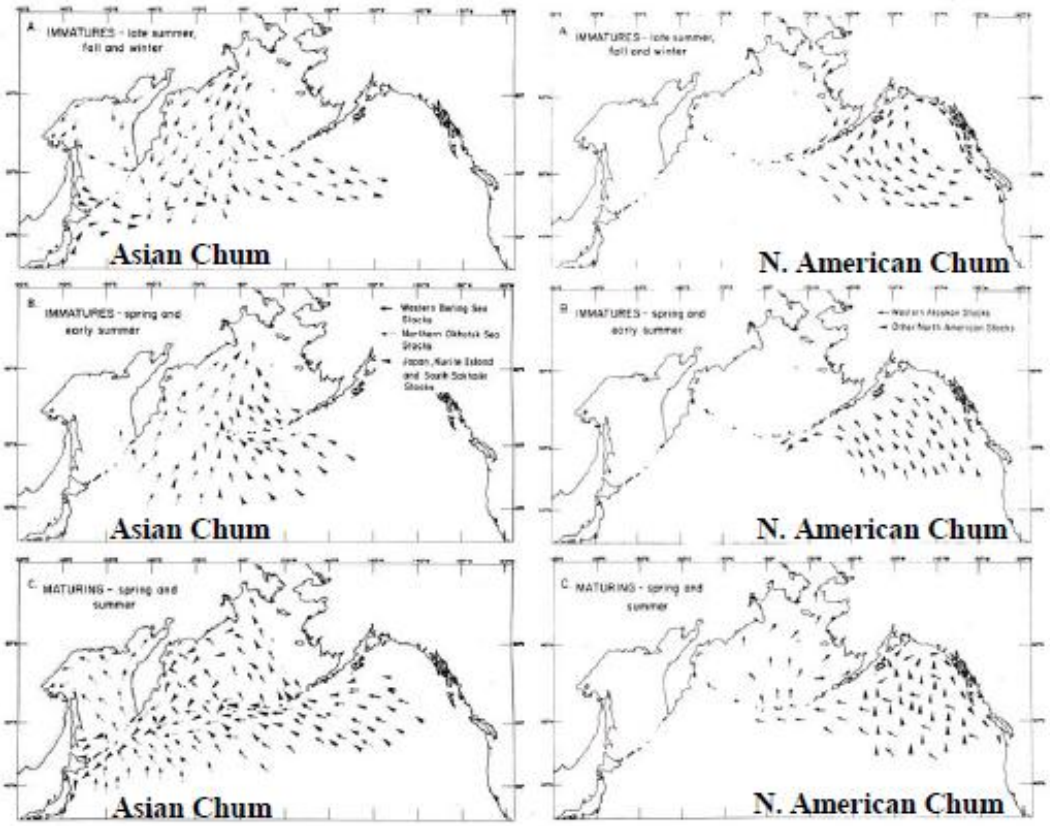


Figure 5-6. Models of seasonal ocean migration patterns of Asian and North American chum salmon. Arrows indicate direction of movement of immatures in later summer, fall and winter (top panels), immatures in spring and early summer (center panels), and maturing fish in spring and summer (bottom panels). Source: Fredin et al 1977.

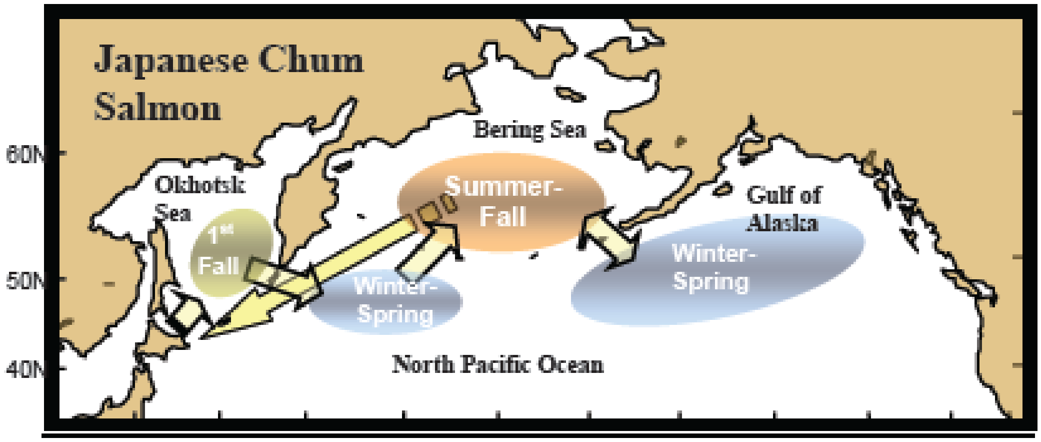


Figure 5-7. Model for Japanese hatchery chum salmon as estimated by genetic stock identification (Urawa 2000; 2003).

5.2 Chum salmon assessment overview by major river system or region in western Alaska

5.2.1 Management of salmon stocks

The Alaska State Constitution, Article VII, Section 4, states that “Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial users.” In 2000, the Alaska Board of Fisheries (board) adopted the Sustainable Salmon Fisheries Policy (SSFP) for Alaska, codified in 5 AAC 39.222. The SSFP defines sustained yield to mean an average annual yield that results from a level of salmon escapement that can be maintained on a continuing basis; a wide range of average annual yield levels is sustainable and a wide range of annual escapement levels can produce sustained yields (5 AAC 39.222(f)(38)).

The SSFP contains five fundamental principles for sustainable salmon management, each with criteria that will be used by ADF&G and the board to evaluate the health of the state’s salmon fisheries and address any conservation issues and problems as they arise. These principles are (5 AAC 39.222(c)(1-5):

- Wild salmon populations and their habitats must be protected to maintain resource productivity;
- Fisheries shall be managed to allow escapements within ranges necessary to conserve and sustain potential salmon production and maintain normal ecosystem functioning;
- Effective salmon management systems should be established and applied to regulate human activities that affect salmon;
- Public support and involvement for sustained use and protection of salmon resources must be maintained;
- In the face of uncertainty, salmon stocks, fisheries, artificial propagation, and essential habitats must be managed conservatively.

This policy requires that ADF&G describe the extent salmon fisheries and their habitats conform to explicit principles and criteria. In response to these reports the board must review fishery management plans or create new ones. If a salmon stock concern is identified in the course of review, the management plan will contain measures, including needed research, habitat improvements, or new regulations, to address the concern.

A healthy salmon stock is defined as a stock of salmon that has annual runs typically of a size to meet escapement goals and a potential harvestable surplus to support optimum or maximum yield. In contrast, a depleted salmon stock means a salmon stock for which there is a conservation concern. Further, a stock of concern is defined as a stock of salmon for which there is a yield, management, or conservation concern (5 AAC 39.222(f)(16)(7)(35)). Yield concerns arise from a chronic inability to maintain expected yields or harvestable surpluses above escapement needs. Management concerns are precipitated by a chronic failure to maintain escapements within the bounds, or above the lower bound of an established goal. A conservation concern may arise from a failure to maintain escapements above a sustained escapement threshold (defined below).

Escapement is defined as the annual estimated size of the spawning salmon stock. Quality of the escapement may be determined not only by numbers of spawners, but also by factors such as sex ratio, age composition, temporal entry into the system, and spatial distribution within salmon spawning habitat ((5 AAC 39.222(f)(10)). Scientifically defensible salmon escapement goals are a central tenet of fisheries management in Alaska. It is the responsibility of ADF&G to document, establish, and review escapement goals, prepare scientific analyses in support of goals, notify the public when goals are established or modified, and notify the board of allocative implications associated with escapement goals.

The key definitions contained in the SSFP with regard to scientifically defensible escapement goals and resulting management actions are: biological escapement goal, optimal escapement goal, sustainable escapement goal, and sustained escapement threshold. Biological escapement goal (BEG) means the escapement that provides the greatest potential for maximum sustained yield. BEG will be the primary management objective for the escapement unless an optimal escapement or inriver run goal has been adopted. BEG will be developed from the best available biological information and should be scientifically defensible on the basis of available biological information. BEG will be determined by ADF&G and will be expressed as a range based on factors such as salmon stock productivity and data uncertainty (5 AAC 39.222(f)(3)).

Sustainable escapement goal (SEG) means a level of escapement, indicated by an index or an escapement estimate, which is known to provide for sustained yield over a five to ten year period. An SEG is used in situations where a BEG cannot be estimated or managed for. The SEG is the primary management objective for the escapement, unless an optimal escapement or inriver run goal has been adopted by the board. The SEG will be developed from the best available biological information and should be scientifically defensible on the basis of that information. The SEG will be stated as a range (SEG Range) or a lower bound (Lower Bound SEG) that takes into account data uncertainty. The SEG will be determined by ADF&G and the department will seek to maintain escapements within the bounds of the SEG Range or above the level of a lower Bound SEG (5 AAC 39.222(f)(36)).

Sustained escapement threshold means a threshold level of escapement, below which the ability of the salmon stock to sustain itself is jeopardized. In practice, SET can be estimated based on lower ranges of historical escapement levels, for which the salmon stock has consistently demonstrated the ability to sustain itself. The SET is lower than the lower bound of the BEG and also lower than the lower bound of the SEG. The SET is established by ADF&G in consultation with the board for salmon stocks of management or conservation concern (5 AAC 39.222(f)(39)).

Optimal escapement goal (OEG) means a specific management objective for salmon escapement that considers biological and allocative factors and may differ from the SEG or BEG. An OEG will be sustainable and may be expressed as a range with the lower bound above the level of SET (5 AAC 39.222(f)(25)).

The Policy for Statewide Salmon Escapement Goals is codified in 5 AAC 39.223. In this policy, the board recognizes ADF&G’s responsibility to document existing salmon escapement goals; to establish BEGs, SEGs, and SETs; to prepare scientific analyses with supporting data for new escapement goals or to modify existing ones; and to notify the public of its actions. The Policy for Statewide Salmon Escapement Goals further requires that BEGs be established for salmon stocks for which the department can reliably enumerate escapement levels, as well as total annual returns. Biological escapement goals, therefore, require accurate knowledge of catch and escapement by age class. Given such measures taken by ADF&G, the board will take regulatory actions as may be necessary to address allocation issues arising from new or modified escapement goals and determine the appropriateness of establishing an OEG. In conjunction with the SSFP, this policy recognizes that the establishment of salmon escapement goals is the responsibility of both the board and ADF&G.

5.2.1.1 Chum salmon escapement

Stock-specific harvest information is not available for the vast majority of wild chum salmon stocks in Alaska, which are predominantly harvested in mixed stock fisheries far from their spawning grounds.

Chum salmon are mostly harvested incidental to other salmon species in common property fisheries that are managed based on abundance of the target species. For example, summer-run chum salmon stocks in Southeast Alaska are harvested incidentally in directed pink salmon purse seine fisheries. The increase in the pink salmon population has masked the abundance of chum salmon and greatly limited ADF&G's ability to estimate numbers of chum salmon in many or most streams in Alaska.

Chum salmon escapement estimates are made using a variety of methods including aerial surveys, foot surveys, and weir counts. Estimating chum salmon escapements using aerial observations is more difficult than estimating escapements of other species of salmon. Chum salmon migrate into small sloughs and side creeks as well as into major river systems, and may also occupy more turbid systems, making observations difficult.

Available information for most chum salmon stocks in Alaska fits into the "fair" or "poor" categories as defined by Bue and Hasbrouck (*unpublished*)[22], primarily due to lack of stock-specific harvest information, estimates of total escapement, or estimates of return by age. A fair category determination is made when escapement is estimated or indexed and harvest is estimated with reasonably good accuracy but precision lacking for one if not both; no age data exists and/or data is insufficient to estimate total return and construct brood tables. A poor category determination is made when escapement is indexed (e.g., single foot/aerial survey) such that the index provides a fairly reliable measure of escapement but no harvest and age data is available.

5.2.2 Western chum salmon stocks and chum salmon stocks in western Alaska

5.2.2.1 Bristol Bay

The Bristol Bay management area includes all coastal and inland waters east of a line from Cape Newenham to Cape Menshikof (Figure 5-8). The area includes nine major river systems: Ugashik, Egegik, Naknek, Alagnak (Branch), Kvichak, Nushagak, Wood, Igushik, and Togiak. Collectively, these rivers are home to the largest commercial sockeye salmon fishery in the world. 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 Bristol Bay area is divided into 5 management districts (Ugashik, Egegik, Naknek-Kvichak, Nushagak, and Togiak) that correspond to the major river drainages. 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.

---

[22] 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.

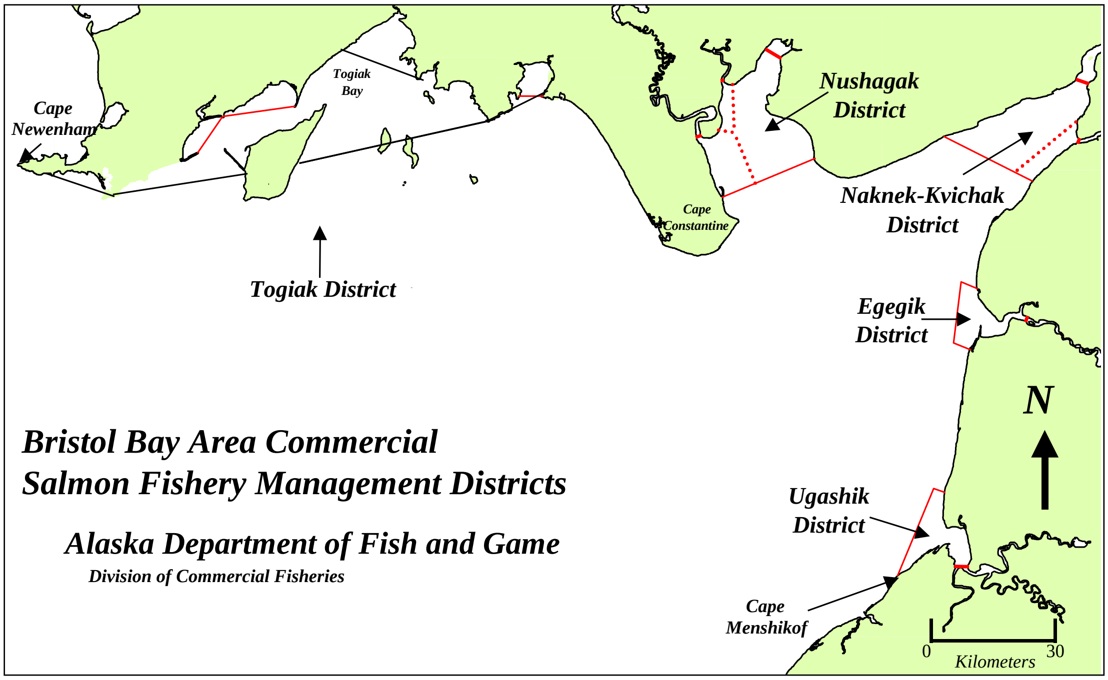


Figure 5-8. Bristol Bay area commercial fisheries salmon management districts

The five species of Pacific salmon found in Bristol Bay are the focus of major commercial, subsistence, and sport fisheries. Annual commercial catches for the most recent 20-year span (1990–2009) average nearly 25.7 million sockeye, 64,900 Chinook, 947,000 chum, 97,000 coho, and 170,000 (even-years only) pink salmon (Morstad et al. 2010). Since 1990, the value of the commercial salmon harvest in Bristol Bay has averaged $120.70 million, with sockeye salmon being the most valuable, worth an average $118.6 million. Subsistence catches are comprised primarily of sockeye salmon and average approximately 142,000 fish. Sport fisheries harvest all species of salmon, with most effort directed toward Chinook and coho salmon stocks.

Management of the commercial fisheries in Bristol Bay is primarily focused on sockeye salmon. Discrete stocks are managed 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. There are 1,863 drift gillnet permits and 981 set gillnet permits in Bristol Bay.

Chum salmon are harvested incidentally to sockeye salmon. The total commercial harvest in Bristol Bay was 1.40 million chum salmon in 2009 (Morstad et al 2010). This was 38% more than the 20-year average of 946,000 chum salmon. Approximately half of the commercial chum salmon harvest occurs in the Nushagak District with the reminder split between Togiak, Naknek-Kvichak, Egegik, and Ugashik Districts.

5.2.2.1.1 Nushagak River

Stock Size

The largest run of chum salmon in Bristol Bay occurs in the Nushagak River. The 2009 total run of chum salmon to the Nushagak River was 1,213,821 (). The total run was 421,878 (53%) more than the recent

20-year (1989-2008) average of 791,943 and 28% more than the recent 10-year (1999-2008) average of 947,042 (Table 5-4).

Escapement

Chum salmon are enumerated in the Nushagak River using Dual Frequency Identification (DIDSON) sonar. The spawning escapement in the Nushagak River was 438,481 chum salmon in 2009 (Table 5-5). 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 1989 (Table 5-5).

Harvest & Exploitation Rate

A total of 775,340 chum salmon were harvested in the commercial fishery of the Nushagak District in 2009. 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 2009 commercial harvest of chum salmon was 61% higher than the 20-year average of 481,481 and 31% higher than the 10-year average of 591,806. The exploitation rate in 2009 was 64%, which was 5% higher than both the 10-year and 20-year averages. The commercial harvest in 2009 was one of largest harvests of chum salmon in the Nushagak District since 1966; only harvests in 2005, 2006 and 2007 have been larger.

2010 Summary

The 2010 total Bristol Bay chum salmon harvest was approximately 1.09 million (Salomone et al. 2011). Naknek-Kvichak and Ugashik Districts produced harvests above their 20-year averages while Egegik, Nushagak and Togiak Districts produced less chum salmon that their 20-year averages. The Nushagak District was the largest producer of chum salmon, where over 509,000 were harvested.

Age Composition/Maturity

The 2009 age composition of the total run was 2% (19,082) age-0.2, 61% (736,745) age-0.3, 37% (453,785) age-0.4, and <1% (4,208) age-0.5%. The 2009 age composition is similar to what we have observed historically for Chum salmon in the Nushagak River. Age-0.3 fish have comprised the majority of the production of chum salmon in the Nushagak River (Table 5-5).

Table 5-4. Commercial harvest, spawning escapement, total run and exploitation rate of Nushagak River chum salmon, 1989–2009.

Year	Harvest[a]	Escapement[b]	Total Run	Exploitation
1989	523,910	377,512	901,422	58%
1990	375,361	329,793	705,154	53%
1991	463,780	252,436	716,216	65%
1992	398,691	302,678	701,369	57%
1993	505,799	217,230	723,029	70%
1994	328,260	378,928	707,188	46%
1995	390,158	212,612	602,770	65%
1996	331,414	225,029	556,443	60%
1997	185,635	61,456	247,091	75%
1998	208,551	299,215	507,766	41%
1999	170,795	242,312	413,107	41%
2000	114,454	141,324	255,778	45%
2001	526,602	564,724	1,091,326	48%
2002	276,845	419,964	696,809	40%
2003	740,311	295,413	1,035,724	71%
2004	477,370	283,811	761,181	63%
2005	966,050	456,025	1,422,075	68%
2006	1,150,880	661,002	1,811,882	64%
2007	953,282	161,483	1,114,765	86%
2008	541,469	326,300	867,769	62%
Last 20	481,481	310,462	791,943	59%
Last 10	591,806	355,236	947,042	59%
Last 5	817,810	377,724	1,195,534	68%
Last 3	881,877	382,928	1,264,805	70%
Min	114,454	61,456	247,091	40%
Max	1,150,880	661,002	1,811,882	86%
2009	775,340	438,481	1,213,821	64%

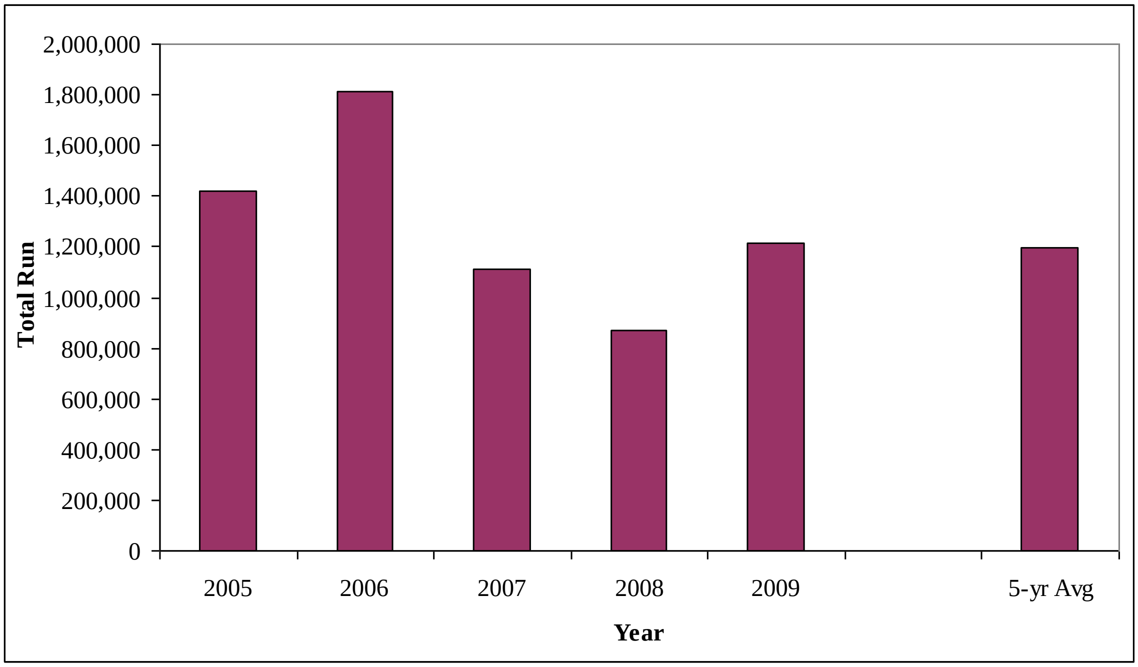


Figure 5-9. Total chum salmon run, Nushagak River, 2005-2009 with 5-year average. 2009 data are preliminary.

Table 5-5. Nushagak River chum salmon escapement and return by brood year, 1974–2009.

				Return[a] by Age Class															
Brood Year		Escapement		0.2		0.3		0.4		1.3		0.5		1.4		Total		R/S	
1974	b				b		b		b	0				0			c		
1975	b				b		b	17,771		0		11,602		0			c		
1976	b				b	1,436,331		343,806		0		14,633		0		1,794,770	c		
1977	b			196,828		581,222		372,808		0		135,772		0		1,286,630	c		
1978	b			35,513		295,832		516,886		0		17,619		0		865,850	c		
1979	b			7,544		265,589		136,716		0		1,755		0		411,604	c		
1980	e,f	969,000	g	15,813		1,041,451		126,114		0		933		0		1,184,311		1.22	
1981	e,f	177,000	g	16,328		420,953		107,737		0		11,713		0		556,731		3.15	
1982	e,f	256,000	g	135,918		577,903		328,472		0		7,165		0		1,049,458		4.1	
1983	e	164,000	g	1,480		210,647		212,349		0		5,538		0		430,014		2.62	
1984	e	362,000	g	0		305,950		152,642		0		1,117		0		459,709		1.27	
1985	e	288,000	g	31,177		663,150		184,098		0		1,384		0		879,809		3.05	
1986	e	200,300	g	2,337		448,869		239,892		0		1,708		0		692,806		3.46	
1987		147,433	h	2,161		463,300		304,142		0		27,670		0		797,273		5.41	
1988		186,418	h	13,443		309,174		409,756		0		19,960		0		752,333		4.04	
1989		377,512	h	688		284,424		427,478		0		32,432		0		745,022		1.97	
1990		329,793	h	1,179		258,707		236,663		0		5,079		0		501,628		1.52	
1991		252,436	h,i	1,050		296,267		144,219		0		959		0		442,495		1.75	
1992		302,678	h,i	37,408		406,376		84,028		0		2,991		0		530,803		1.75	
1993		217,230	h	769		160,857		74,492		0		3,476		0		239,594		1.1	
1994		378,928	h	1,232		425,824		146,150		377		56,189		0		629,772		1.66	
1995		212,612	h	4,459		263,104		109,670		0		0		0		377,233		1.77	
1996		225,029	h	0		77,560		188,397		0		4,941		0		270,898		1.2	
1997		61,456	h	12,359		899,278		241,545		1,235		4,350		1,186		1,159,953		18.87	
1998		299,215	h	3,651		410,040		153,572		10,677		539		0		578,479		1.93	
1999		242,312	h	39,048		861,720		384,456		0		2,821		0		1,288,045		5.32	
2000		141,324	h	4,219		297,237		177,157		0		9,851		0		488,465		3.46	
2001		564,724	h	78,950		1,241,318		670,277		1,481		12,159		0		2,004,185		3.55	
2002		419,964	h	780		1,111,017		573,389		0		16,262		0		1,701,448		4.05	
2002		419,964	h	780		1,111,017		573,389		0		16,262		0		1,701,448		4.05	
2003		295,413	h	19,255		525,542		338,534		0		4,208	j	0	j	887,539	c		
2004		283,811	h	3,675		499,671		453,785	j	0	j		c		c	957,131	c		
2005		456,025	h	13,305		736,745	j		c		c		c		c	750,050	c		
2006		661,002	h	19,082	j		c		c		c		c		c	19,082	c		d
2007		161,483	h		c		c		c		c		c		c	0	c		d
2008		326,300	h																d
2009		438,481	h																d

continued--

Table 5-5 continued

Brood Year	Escapement	Return[a] by Age Class						Total	R/S
		0.2	0.3	0.4	1.3	0.5	1.4		
1980-2002		2%	64%	32%	0%	1%	0%	100%	
Average	294,581	17,585	497,179	246,813	599	9,967	52	772,194	3.4
Median	252,436	3,651	410,040	188,397	0	4,941	0	629,772	2.62
Minimum	61,456	0	77,560	74,492	0	0	0	239,594	1.1
Maximum	969,000	135,918	1,241,318	670,277	10,677	56,189	1,186	2,004,185	18.87

a Return = commercial catch plus escapement estimate. Source: ADF&G Bristol Bay salmon catch & escapement reports, 1980-1998.

b Nushagak chum data not included in annual catch & escapement reports prior to 1980.

c Incomplete returns from brood year escapement.

d Insufficient data to preform this calculation.

e The commercial chum catch statistics for these years were reported as Nushagak-Igushik District totals.

f The chum escapement statistics for these years were reported as Nushagak-Mulchatna River totals.

g These escapement numbers may also include aerial survey estimates. Miller (1996) reports lower Nushagak River chum escapements for these years in his Nushagak River sonar report.

h This Nushagak River chum escapement was derived from Portage Creek sonar.

I Miller (1996) revised the 1991 and 1992 chum escapement estimates to 287,281 and 302,858 respectively.

j Estimate based on 2009 preliminary return numbers.

5.2.3 Kuskokwim Area

The Kuskokwim Salmon Management Area encompasses the Kuskokwim River drainage and all waters of Alaska that flow into the Bering Sea between Cape Newenham and the Naskonat Peninsula, including Nelson, Nunivak, and St. Matthew Islands. Subsistence and sport fishing for salmon can occur throughout the area but commercial salmon fishing is restricted to four discrete districts: two within the Kuskokwim River and two in marine waters of Kuskokwim Bay (see Figure 5-10).

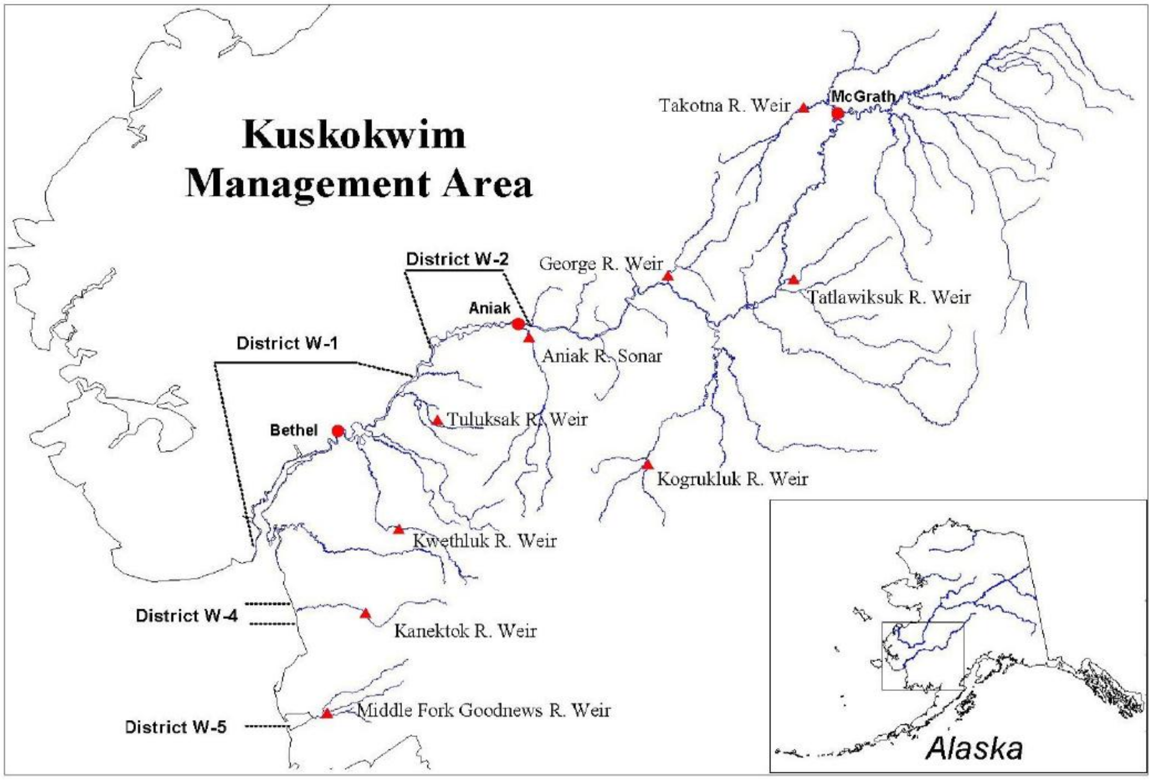


Figure 5-10. Map of Kuskokwim River Alaska, showing the distribution of commercial harvest areas and escapement monitoring sites.

5.2.3.1.1 Kuskokwim River

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 5-10). 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 (Figure 1). 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 (Whitmore et al 2008). Subdistrict 1-A is that portion of District 1 upstream (“above”) Bethel (rkm 106) and subdistrict 1-B is downstream (“below”) of Bethel. 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 (Whitmore et al 2008). 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.

5.2.3.1.2 Kuskokwim River chum

Introduction

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).

Stock Assessment Background

Escapement

Escapement monitoring is limited to summer chum salmon and occurs on seven tributaries: six employing weirs and one sonar (Table 5-6). 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 (Figure 5-11). 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 5-6. Kuskokwim River chum salmon escapement by projects, 1975-2009.

	Escapement Project						
Year	Kwethluk R. Weir	Tuluksak R. Weir	Aniak R. Sonar	George R. Weir	Kogrukluk R. Weir	Tatlawiksuk R. Weir	Takotna R. Weir
1975							
1976					8,117		
1977							
1978					48,125		
1979					18,599		
1980			1,600,032				
1981			646,849		57,374		
1982			529,758		61,859		
1983			166,452				
1984			317,688		41,484		
1985			273,306		15,005		
1986			219,770		14,693		
1987			204,834				
1988			485,077		39,543		
1989			295,993		39,547		
1990			246,813		26,765		
1991	30,595	7,675	366,687		24,188		
1992		11,183	87,467		34,104		
1993		13,804	15,278		31,901		
1994		15,724	474,356		46,635		
1995					31,265		
1996			402,195	19,393 [a]	48,478		2,872
1997	10,659		289,654	5,907 [a]	7,958		1,779
1998			351,792		36,441		
1999			214,429	11,552 [a]	13,820	9,599 [a]	
2000	11,691		177,384	3,492 [a]	11,491	7,044 [a]	1,254
2001		19,321	408,830	11,601 [a]	30,570	23,718 [a]	5,414
2002	35,854	9,958	472,346	6,543	51,570	24,542	4,377
2003	41,812	11,724	477,544	33,666	23,413		3,393
2004	38,646 [a]	11,796	673,445	14,409 [a]	24,201 [a]	21,245	1,630
2005		35,696	1,173,155	14,828	197,723	55,720	6,467
2006	47,489	25,648	1,108,626	41,467	176,508	32,301	12,613
2007	57,230	17,286	699,178	55,842	49,505	83,246	8,900
2008	20,048	12,518	427,911	29,978	44,978	30,896	5,691
2009	32,028	13,658	479,531	7,941	84,940	19,975	2,487

[a] Escapement was adjusted to account for inoperable periods.

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). These goals have been annually achieved or exceeded in all but one of the last 10 years (Figure 5-12, Figure 5-13). Escapement goals have not been established at the five other locations where chum salmon escapements are currently being monitored. Escapement goals mentioned in this report focus on those goals established prior to the 2010 Board of Fisheries cycle.

Maturity

Age composition of Kuskokwim River chum salmon is estimated for the commercial fishery and escapements through scale sampling (Molyneaux et al. 2009). The compositions tend to be similar, but they are not combined to provide age compositions estimates of the total run. Table 5-7 describes average maturity schedule based on the District 1 commercial fishery.

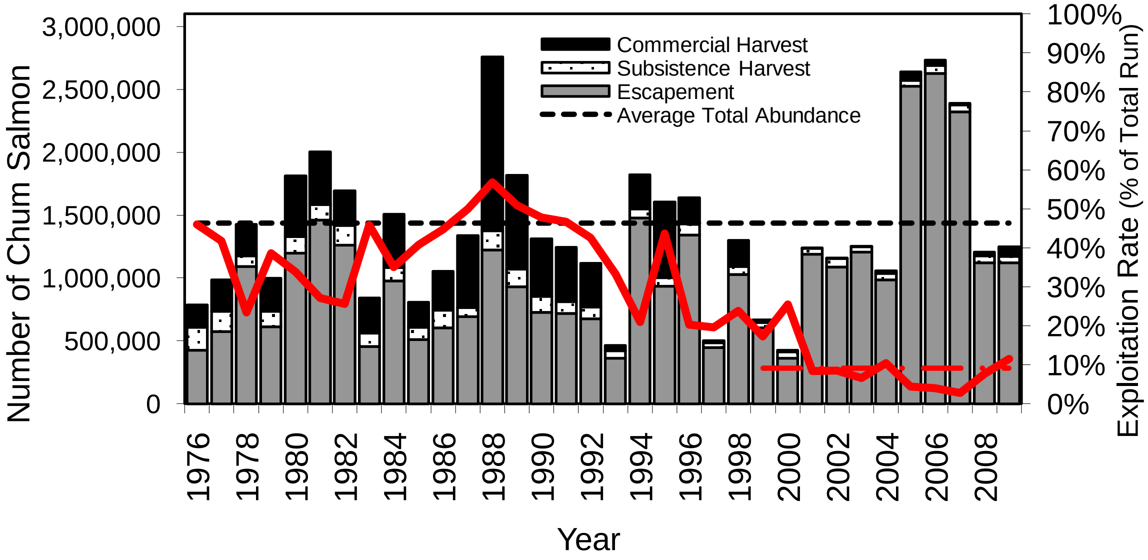


Figure 5-11. Draft Kuskokwim River chum salmon run reconstruction 1976-2009, showing total annual abundance and exploitation rates based on Bue et al. 2009.

Current escapement goals for Kuskokwim River chum salmon stocks are as follows:

		Current Escapement Goal		
Stock Unit	Enumeration Method	Goal	Type	Year Established
Chum Salmon				
Aniak River	Sonar	220,000–480,000	SEG	2007
Kogrukluk River	Weir	15,000–49,000	SEG	2005

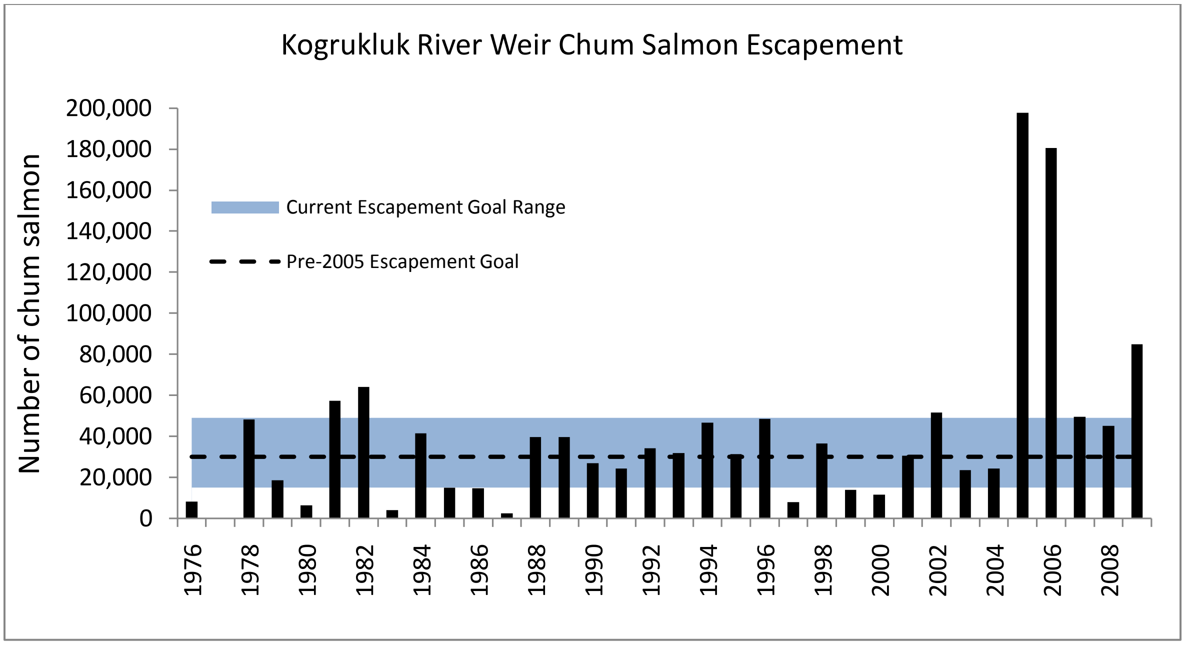


Figure 5-12. Chum salmon escapement at Kogrukluk River weir, 1976-2009 with escapement goal range (15,000 - 49,000) adopted in 2005, and the minimum escapement goal (30,000) used from 1983 to 2004.

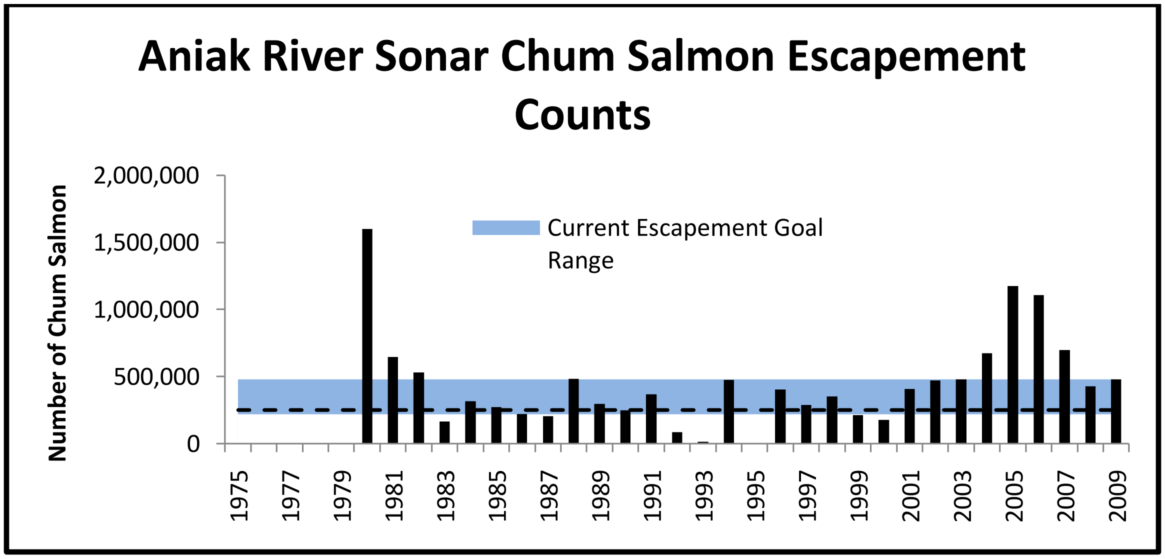


Figure 5-13. Chum salmon escapement index at the Aniak River Sonar site, 1980-2009 with the escapement goal range (220,000-480,000) adopted in 2007, and the minimum escapement goal (250,000) used from 1983 to 2004.

Table 5-7. Average age structure of Kuskokwim River chum salmon, as identified from the commercial harvest (Molyneaux et al. 2009).

	Age Class				
	3	4	5	6	7
Proportion of harvest	0.02	0.65	0.32	0.01	0.00

Harvest and Exploitation

Historically, Kuskokwim River chum salmon, though an important subsistence species, have been primarily targeted for commercial harvest (Figure 5-14). 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. Average annual subsistence harvest is approximately 50,000 chum salmon (Figure 5-14), and harvest has been within or above the Amount Necessary for Subsistence every year since 1990. 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 5-11; Bue et al. 2008). Through the mid-1990s exploitation rates likely ranged between 20% and 60%.

2010 Summary

Chum salmon escapements were evaluated through enumeration at weirs on seven tributary streams and a tributary sonar project on the Aniak River. Chum salmon escapements in 2010 ranged from above average to below average at all monitored locations. Chum salmon escapement to the Kogrukluk River exceeded the upper end of the escapement goal, and the Aniak River achieved the upper end of the escapement goal range. Chum salmon run timing was normal.

Commercial harvest on the Kuskokwim River in 2010 was 93,148 chum salmon, which was the largest harvest since 1998. Catch rates were average to above average from late June through July. Subsistence fishing was allowed seven days a week throughout the summer with the exception of closed periods six hours before, during, and three hours after commercial fishing periods in June, July, and August. Subsistence harvest in the Lower Kuskokwim River was normal for chum salmon. However, many subsistence fishermen reported difficulties with drying and preserving their harvests as a result of the wet and cool weather conditions that persisted throughout the summer.

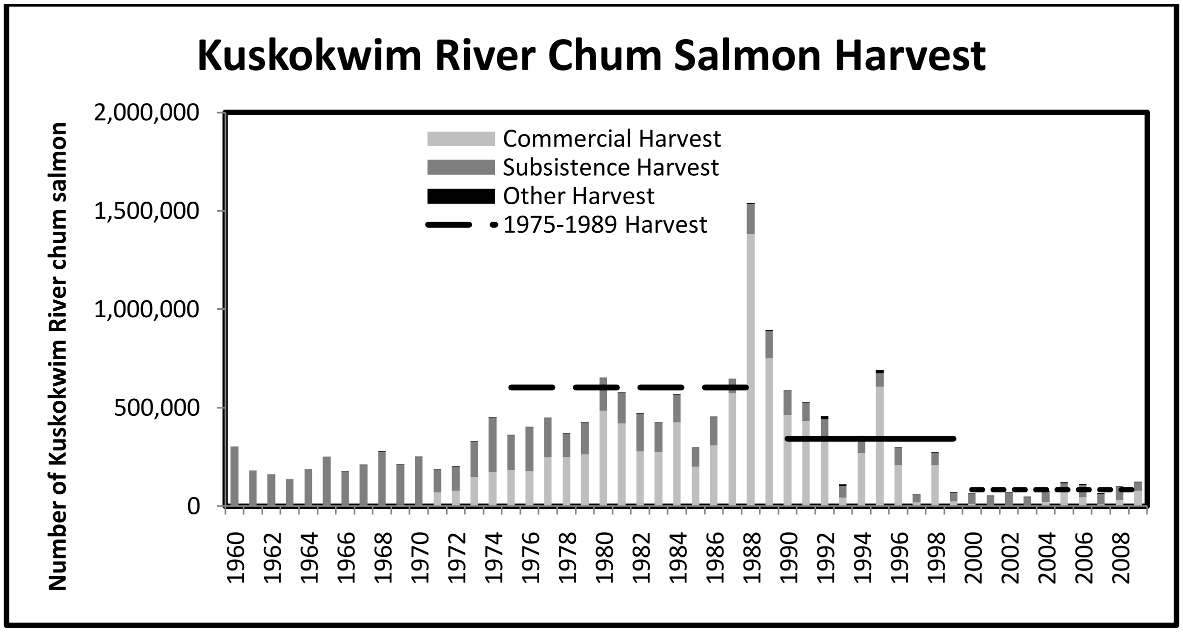


Figure 5-14. Kuskokwim River chum salmon harvest, from commercial, subsistence, test, and sport fisheries, 1960-2009, with approximately decadal average harvest ranges.

Outlook

The Kuskokwim River has no formal forecast for salmon returns. Broad expectations are developed based on parent-year escapements and recent year trends. The 2011 chum salmon returns are expected to exceed the 2010 abundance with an anticipated available surplus of 300,000 chum salmon.

5.2.3.2 Kuskokwim Bay

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 has two commercial salmon fishing districts. District 4 extends from the northern-most edge of the mouth of Weelung Creek to the southern-most tip of the south mouth of Arolik River, and 3 miles from the coast into Kuskokwim Bay (Figure 5-15). The Kanektok and Arolik Rivers are the main spawning tributaries in District 4. District 5 extends east of a line from ADF&G regulatory markers located approximately 2 miles south and 2 miles north on the seaward side of the entrance of Goodnews Bay and east to a line between the mouth of Ukfigag Creek to the mouth of the Tunulik River (Figure 5-16). The Goodnews River drainage is the main spawning tributary in District 5 with the Middle and North Forks of the Goodnews River contributing the majority of salmon production.

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.

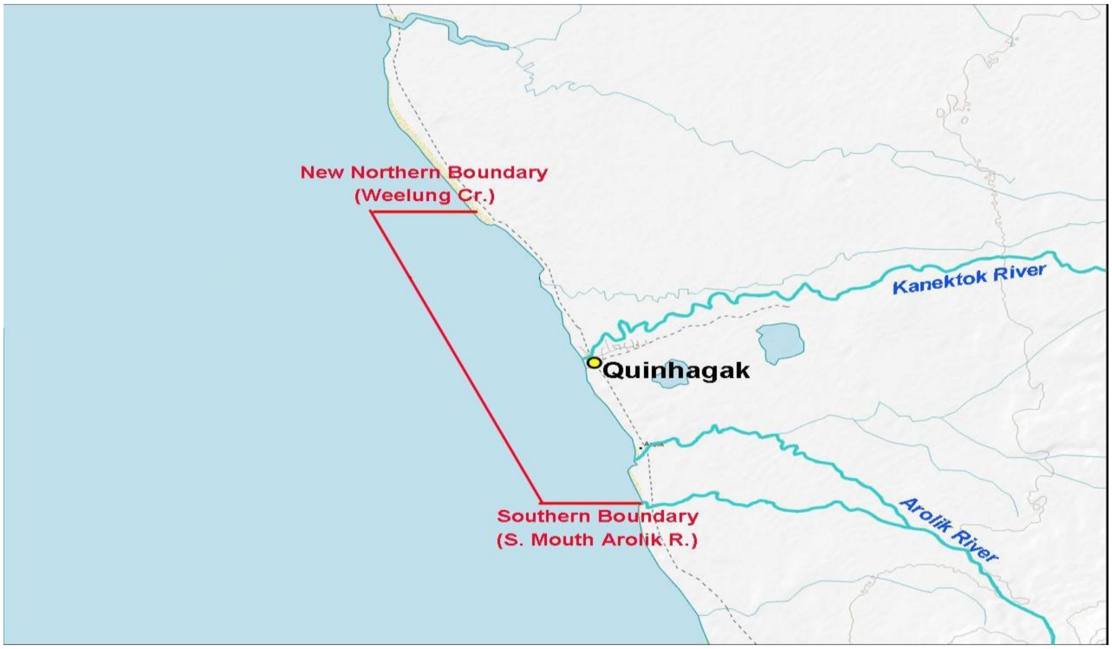


Figure 5-15. District 4 commercial fishing boundaries, Kuskokwim Bay, Alaska.

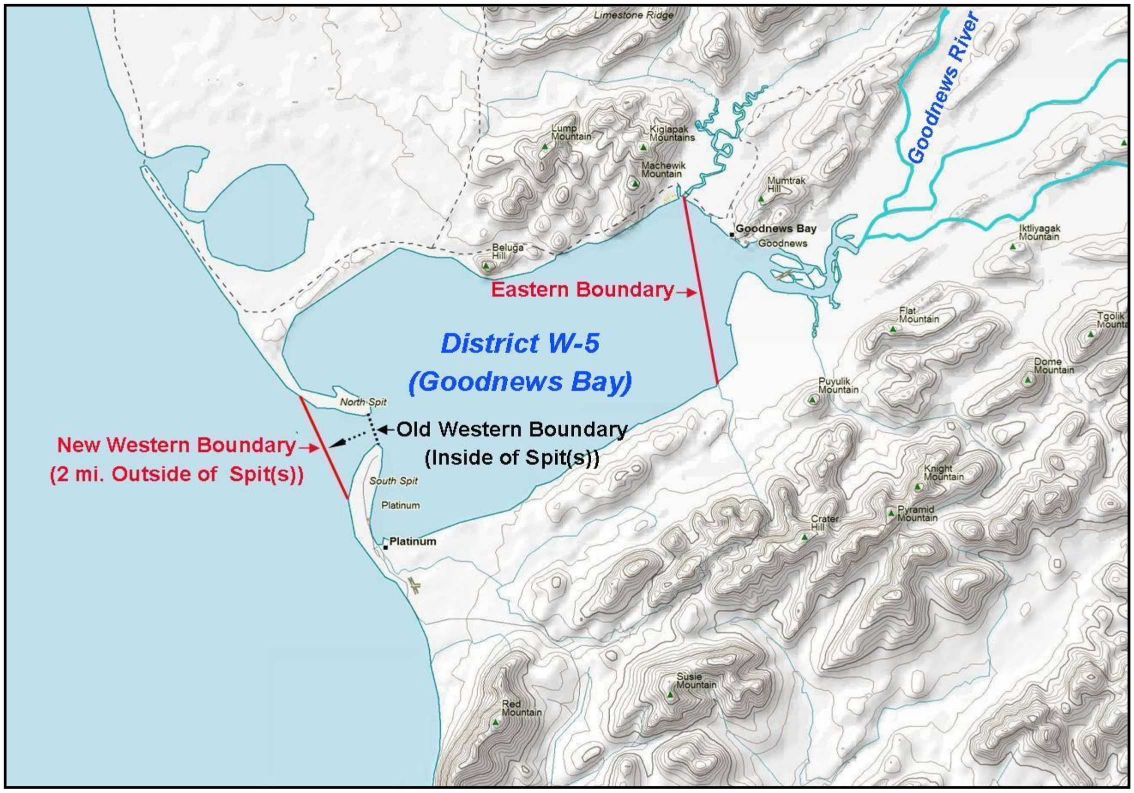


Figure 5-16. District 5 commercial fishing boundaries, Kuskokwim Bay, Alaska.

5.2.3.2.1 Kuskokwim Bay chum

Introduction

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.

Stock Assessment Background

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 (Figure 5-17, Figure 5-18). Since 2005 at Kanektok weir, escapement estimates have ranged from 51,652 to 133,215 (Table 5-8). Since 2005 at Middle Fork Goodnews River weir, escapement estimates have ranged from 19,715 to 54,699 (Table 5-8). Aerial surveys for chum salmon have not been flown since 2004.

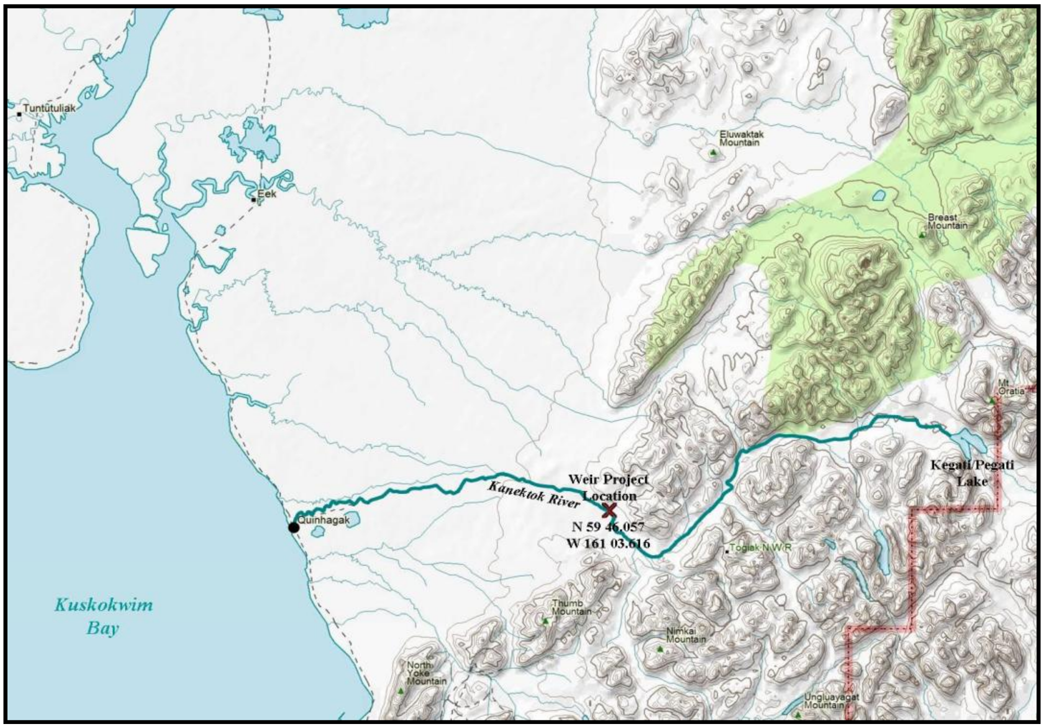


Figure 5-17. Kanektok River drainage and weir location, Kuskokwim Bay, Alaska.

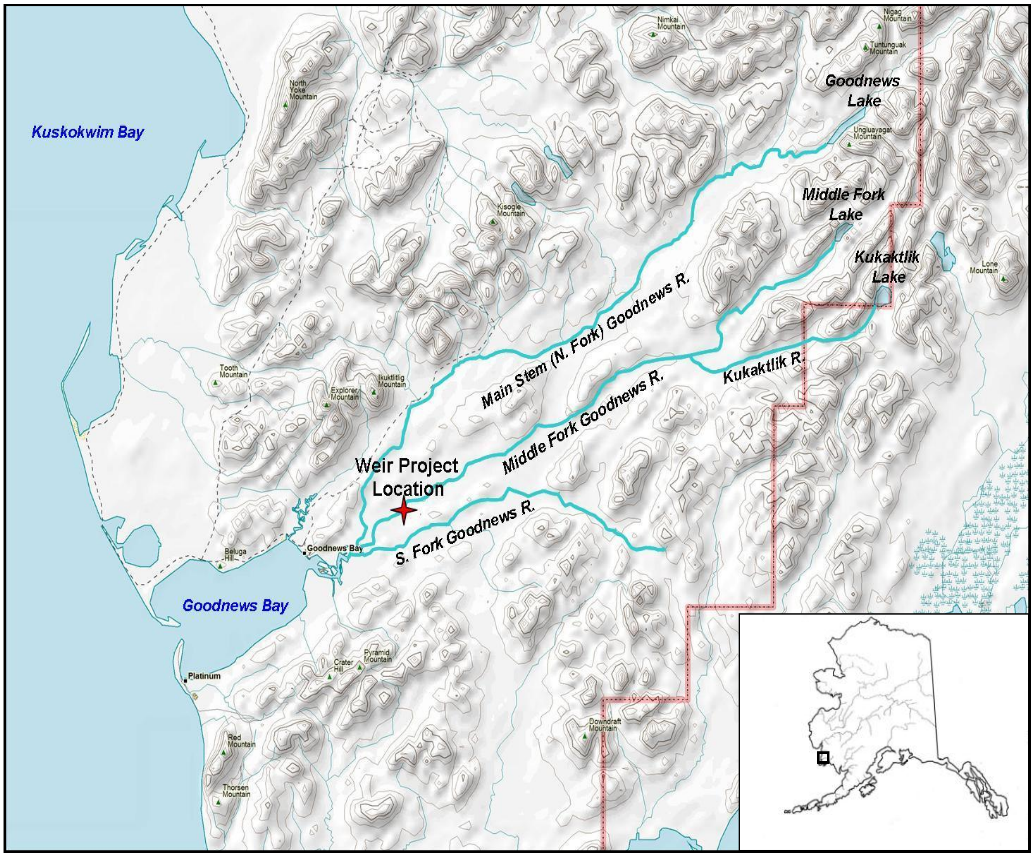


Figure 5-18. Goodnews River drainage and weir location, Kuskokwim Bay, Alaska.

Table 5-8. Chum salmon escapement at monitoring projects, Kuskokwim Bay, 1981-2009

Year	Middle Fork Goondews 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]

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

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

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

[d] Prior to 1991 escapment was estimated at Middle Fork 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 5-19).

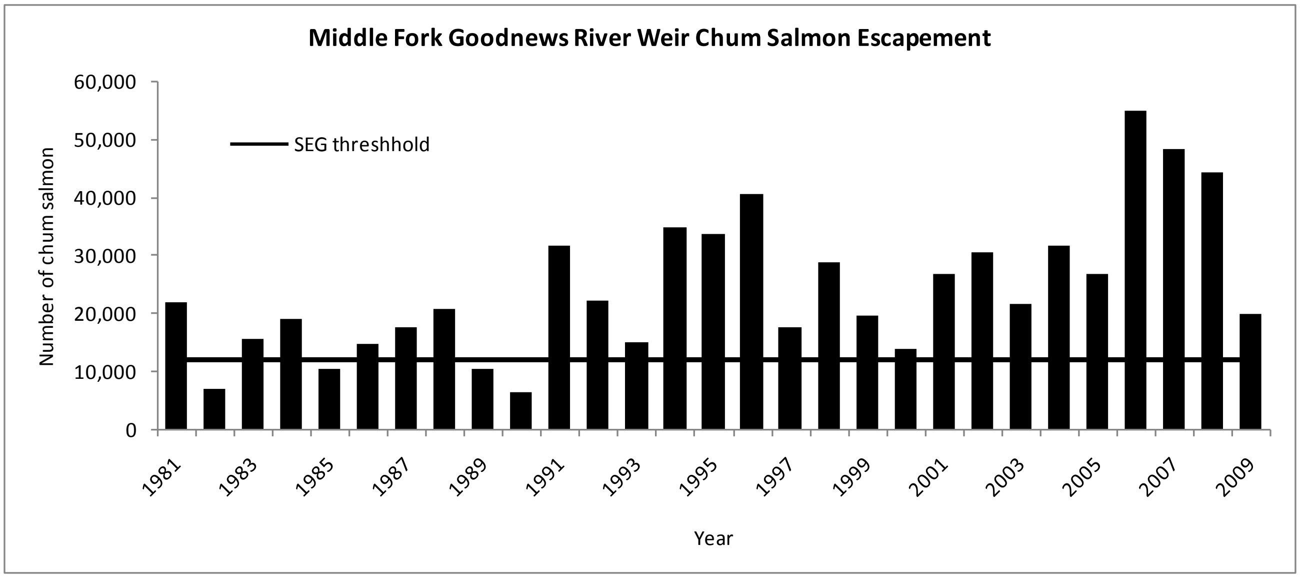


Figure 5-19. Chum salmon escapement, Middle Fork Goodnews River weir, Kuskokwim Bay, 1981-2009.

Maturity

Kuskokwim Bay chum salmon age composition is estimated through scale sampling in Districts 4 and 5 commercial fisheries and at the escapement projects (Table 5-9).

Table 5-9. Age composition of commercially harvested chum salmon, Kuskokwim Bay, 2009.

	Age Class				
	0.2	0.3	0.4	0.5	0.6
District 4 (Quinhagak)	0.02	0.60	0.37	0.02	0.00
District 5 (Goodnews Bay)	0.01	0.51	0.47	0.01	0.00

Harvest and Exploitation

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 5-20). The 2009 harvest of 91,158 chum salmon in District 4 was the highest on record and 121% above the historical average (1981-2008) of 41,256 fish. The 2009 commercial harvest of 16,985 chum salmon in District 5 was 38% above the historical average (1981-2008) of 12,304 fish (Table 5-10).

2010 Summary

Subsistence fishing was allowed seven days per week throughout the season with the exception of closed periods 16 hours before, during, and six hours after commercial fishing periods. These closures were reduced to eight hours before, during, and six hours after commercial fishing periods beginning July 13. Subsistence harvests in 2010 were described as adequate and amounts necessary for subsistence use is expected to have been achieved

Commercial chum salmon harvests were above average with 106,610 chum salmon harvested in the Quinhagak District and 26,914 chum salmon in the Goodnews Bay District. The escapement goal threshold for chum salmon was achieved on the Middle Fork of the Goodnews River.

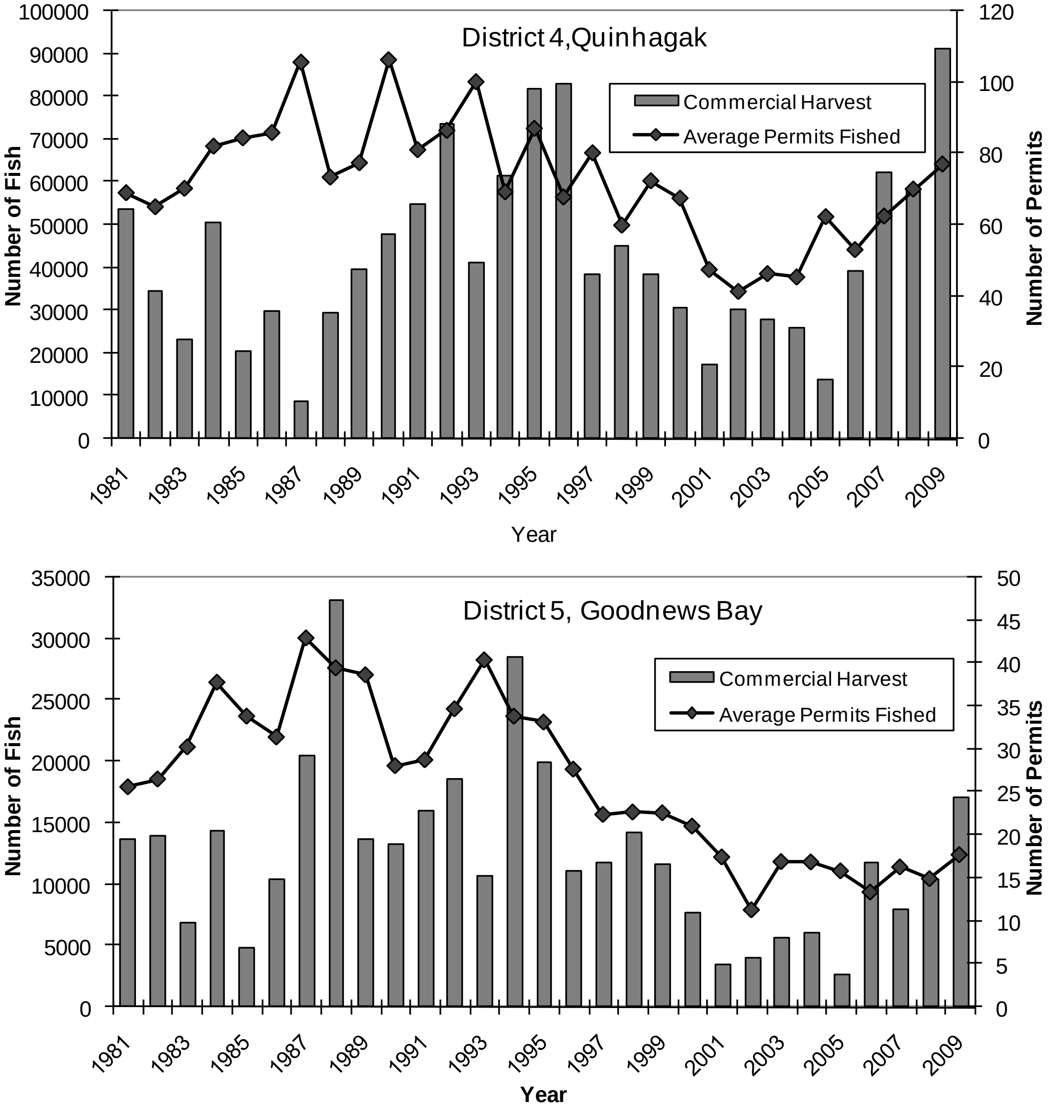


Figure 5-20. Commercial harvest of chum salmon and fishing effort, Districts 4 and 5, Kuskokwim Bay, 1981-2009.

Table 5-10. Commercial harvest of chum salmon by district, Kuskokwim Bay, 1981-2009.

Year	District 4	District 5
1981	53,334	13,642
1982	34,346	13,829
1983	23,090	6,766
1984	50,422	14,340
1985	20,418	4,784
1986	29,700	10,356
1987	8,557	20,381
1988	29,247	33,059
1989	39,395	13,622
1990	47,717	13,194
1991	54,493	15,892
1992	73,383	18,520
1993	40,924	10,657
1994	61,301	28,477
1995	81,462	19,832
1996	83,005	11,093
1997	38,435	11,729
1998	45,095	14,155
1999	38,091	11,562
2000	30,553	7,450
2001	17,209	3,412
2002	29,319	3,799
2003	27,868	5,593
2004	25,850	5,965
2005	13,529	2,568
2006	39,151	11,568
2007	62,232	7,853
2008	57,033	10,408
2009	91,158	16,985
Historical Average (1981-2009)	42,976	12,465

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.

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.

Outlook

The Kuskokwim Bay has no formal forecast for salmon returns. Broad expectations are developed based on parent-year escapements and recent year trends. The 2011 chum salmon runs are expected to be similar to the abundance observed in 2010. Anticipated available surplus for commercial harvest is expected to range from 90,000 to 140,000 chum salmon.

See Appendix A for the 2010 Kuskokwim Bay salmon outlook and management plan.
Add Kuskokwim Bay chum EA final.doc appendix A.

5.2.4 Yukon River

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 5-21). 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.

Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, and coho *O. kisutch* salmon are the target species harvested in Yukon River commercial, subsistence, personal use, and sport fisheries. 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. 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.

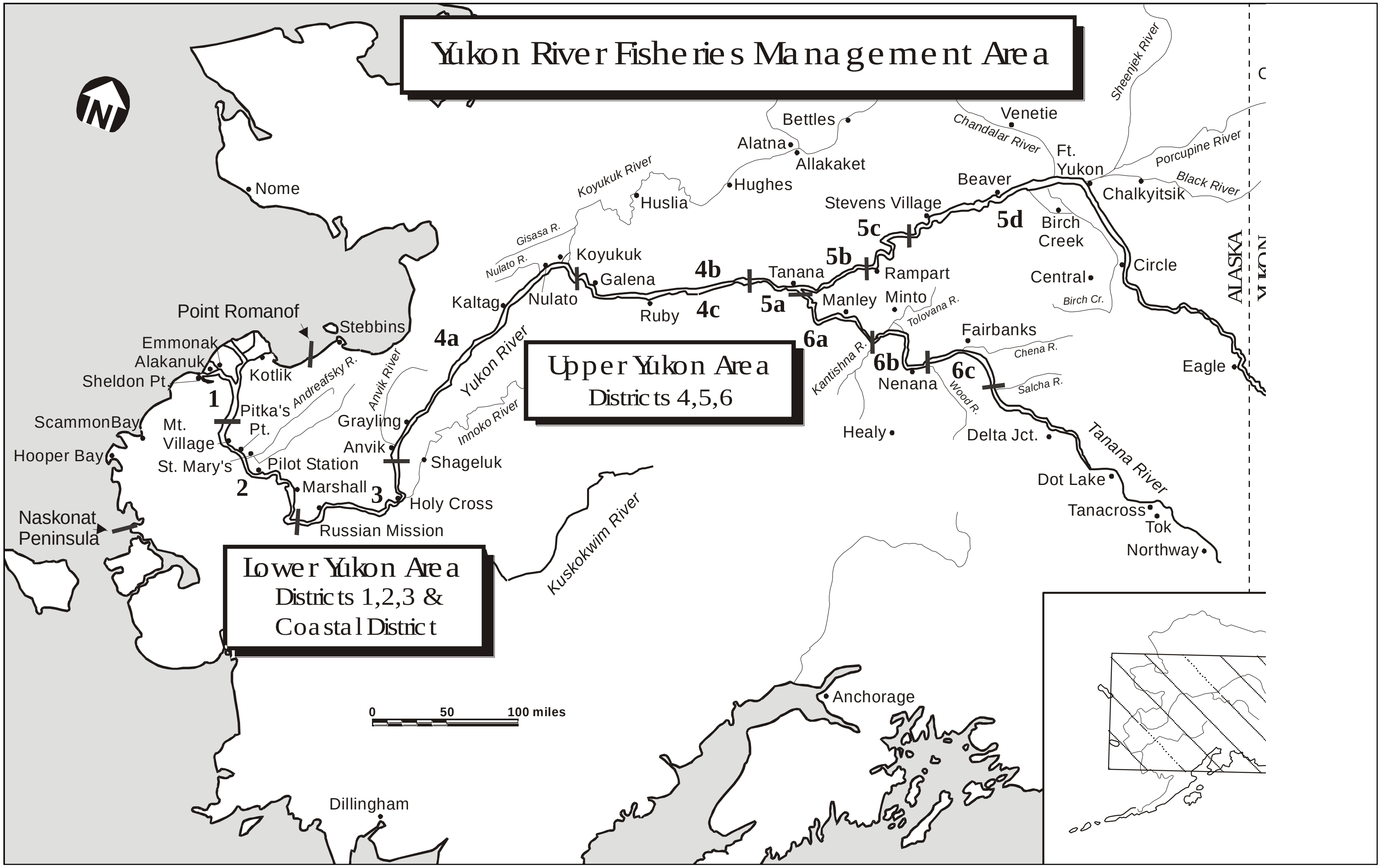


Figure 5-21. Alaska portion of the Yukon River drainage showing communities and fishing districts.

5.2.4.1 Summer run

In response to the guidelines established in the SSFP (5 AAC 39.222(f)(21)), the BOF classified Yukon River summer chum salmon stock as a management concern at its September 2000 work session. 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. This report focuses on the recent 5-year period prior to the January 2010 BOF cycle meeting.

Stock Assessment Background

Escapement

Most summer chum salmon spawn in the Yukon River drainage downstream of and within the Tanana River drainage (Figure 5-21). 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 5-22). 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 5-22).

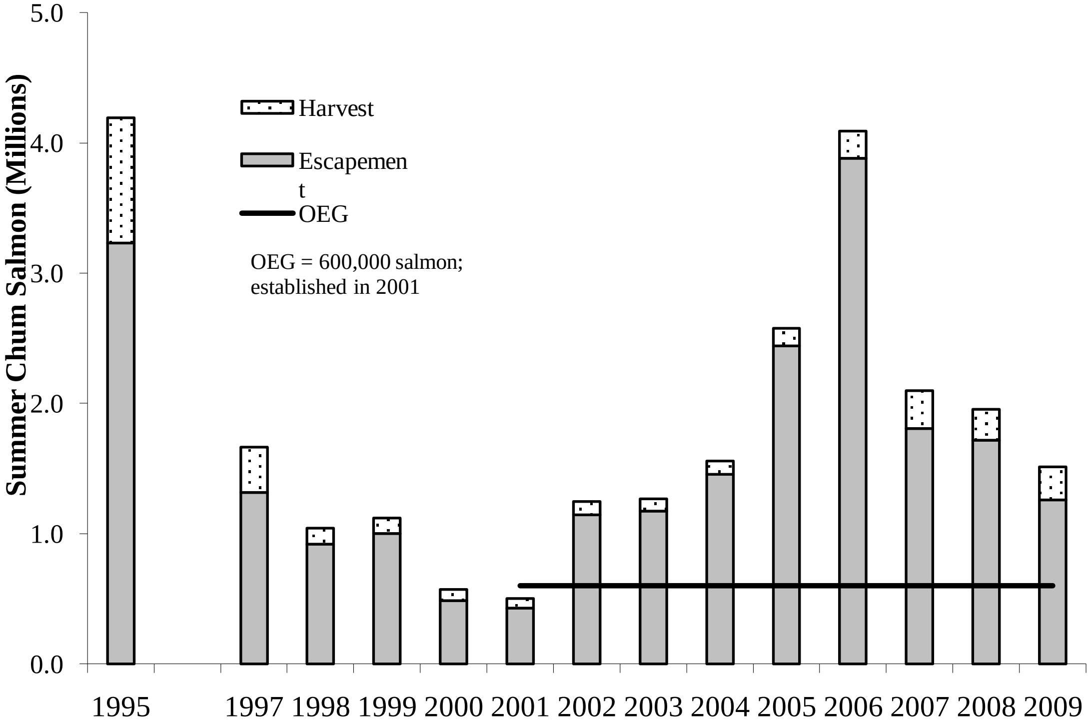


Figure 5-22. Estimated total annual runs of summer chum salmon by harvest and escapement and drainage-wide OEG, Yukon River, 1995 and 1997-2009. Data are unavailable for 1996.

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 5-11). 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 5-11. Yukon River drainage summer chum salmon management plan overview. Note: This management plan was modified at the 2010 Board of Fisheries cycle meeting.

	Required Management Actions Summer Chum Salmon-Directed Fisheries			
Projected Run Size [a]	Commercial	Personal Use	Sport	Subsistence
600,000 or Less	Closure	Closure	Closure	Closure [b]
600,000 to 700,000	Closure	Closure	Closure	Possible Restrictions [c]
700,001 to 1,000,000	Restrictions [d]	Restrictions [e]	Restrictions [e]	Normal Fishing Schedules
Greater Than 1,000,000	Open [f]	Open	Open	Normal Fishing

[a] 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 assess the run size.

[b] The department may, by emergency order, open subsistence chum salmon directed fisheries where indicators show that the escapement goal(s) in that area will be achieved.

[c] The department shall manage the fishery to achieve drainage wide escapement of no less than 600,000 summer chum salmon, except that the department may, by emergency order, open a less restrictive directed subsistence summer chum fishery in areas that indicator(s) show that the escapement goal(s) in that area will be achieved.

[d] The department may, by emergency order, open commercial fishing in areas that show the escapement goal(s) in that area will be achieved.

[e] The department may, by emergency order, open personal use and sport fishing in areas that indicator(s) show the escapement goal(s) in that area will be achieved.

[f] The department may open a drainage-wide commercial fishery with the harvestable surplus distributed by district or subdistrict in proportion to the guideline harvest levels established in 5 AAC 05.362. (f) and (g).

From 2001 – 2009 there were two established BEGs for summer chum salmon in the Yukon River drainage. The BEG range for 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 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 (Figure 5-23). Assessment of annual escapements has occurred in 22 of 29 years since 1981 in East Fork Andreafsky River with the BEG met or exceeded in 12 out of 22 years (54%), and last met in 2007 (Figure 5-23).

Recent BEGs for Yukon River summer chum salmon are as follows:

Stream (Project Type)	Current Goal	Type of Goal
East Fork Andreafsky River (Weir)	60,000 –300,000	BEG
Anvik River Index (Sonar)	350,000–700,000	BEG

Note: East Fork Andreafsky escapement goal was adjusted to an SEG threshold of >40,000 in the 2010 BOF cycle.

Table 5-12. Yukon River summer chum salmon historical escapement 1980-2009, and Pilot Station sonar passage estimates 1995 and 1997-2009 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]
2005-2009 avg.	2,176,930	51,612	508,967	n/a	n/a	108,533	n/a	130,761
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 5-23). 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 5-23) that failed to replace themselves (recruits per spawner (R/S) <1.0; Clark and Sandone 2001).

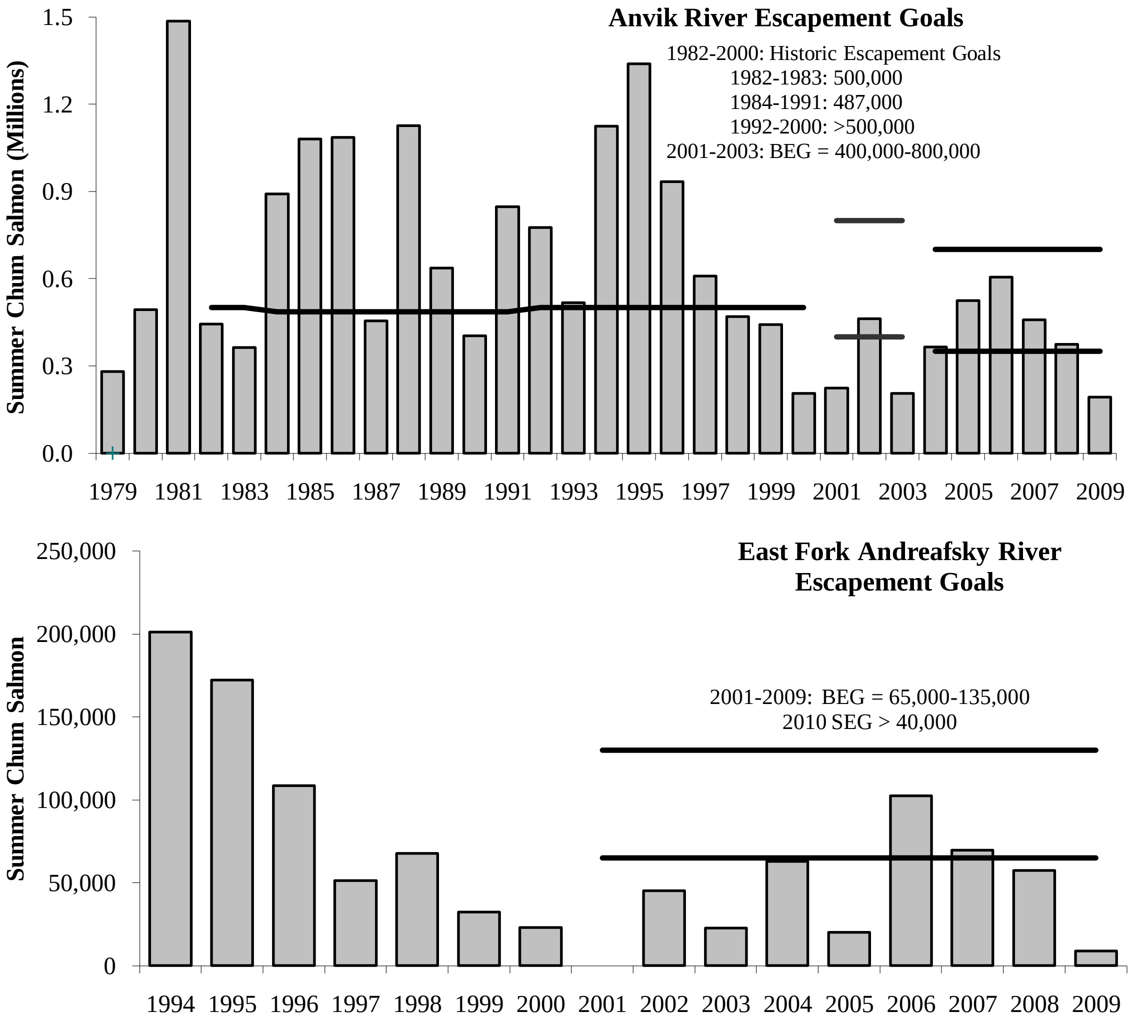


Figure 5-23. Summer chum salmon escapement estimates and escapement goals for Anvik River sonar (1979-2009), and E.F. Andreafsky River weir (1994-2009).

Stock composition of Yukon River summer chum runs has been in flux over the last decade. 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 twice, in 2006 and 2007, since 2002 (Figure 5-23). 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.

Maturity

While data are not available to estimate the age composition of the overall Yukon River summer chum salmon return, data are available for the Anvik River. Since the Anvik River represents approximately 25% of the overall run in recent years, it is believed that it is likely representative of the overall population. The 2000-2009 average age composition for the Anvik River is dominated by age-4 fish.

	Age Class				
	3	4	5	6	7
Proportion	0.014	0.529	0.427	0.031	1.00E-04

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 5-24). The recent 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.

2010 Summary

Inseason run strength assessment of summer chum salmon was based on the lower river test fisheries (LYTF) at Emmonak and Mountain Village, the Pilot Station sonar, and subsistence fishermen catch reports. Management decisions regarding summer chum salmon were delayed until the third quarter point in the Chinook salmon run at LYTF, just after the peak of the summer chum salmon run. A total run size of 1.4 million chum salmon was projected. A short commercial fishing period was announced for June 26 in District 1, with nets restricted to six-inch maximum mesh size. Test fishery information prior to the commercial opening indicated a drop in the summer chum salmon entering the river, so the opening was delayed until June 28 to avoid over-harvesting Chinook salmon. A total of 30,295 chum salmon were harvested during the first opening. Fishing was again delayed until July 1 when the commercial fishery resumed on a more regular schedule for Districts 1 and 2.

The department scheduled eight commercial fishing periods targeting summer chum salmon in District 1 and seven in District 2. The harvest from both Districts is 183,215 summer chum salmon, which is 181% above the 2000 - 2009 average harvest of 65,143 fish.

A summer chum salmon directed commercial fishery in Subdistrict 4-A opened on July 7. Subsistence salmon fishing periods were not altered by commercial salmon fishing periods. Chinook salmon were kept for subsistence use. The harvest in 4-A is 44,207 summer chum salmon.

District 6 was managed using inseason assessment information provided by projects operated in the Tanana River drainage. Based on the available surplus and market interest, the first commercial fishing period occurred on July 19. There were a total of seven commercial fishing periods targeting chum salmon in District 6 with a total harvest of 5,466 summer chum salmon.

The total Yukon Area commercial harvest was 232,888 summer chum salmon, which is 195% above the 2000-2009 average harvest.

Summer chum salmon escapements were variable, but most tributaries experienced good escapements. East Fork Andreafsky SEG and Anvik BEG were met. Salcha River escapement, however, was approximately 7,000 fish less than expected. The Pilot Station sonar summer chum passage estimate through July 18 was 1,327,581 fish, and the reconstructed run size for 2010 is approximately 1.6 million fish.

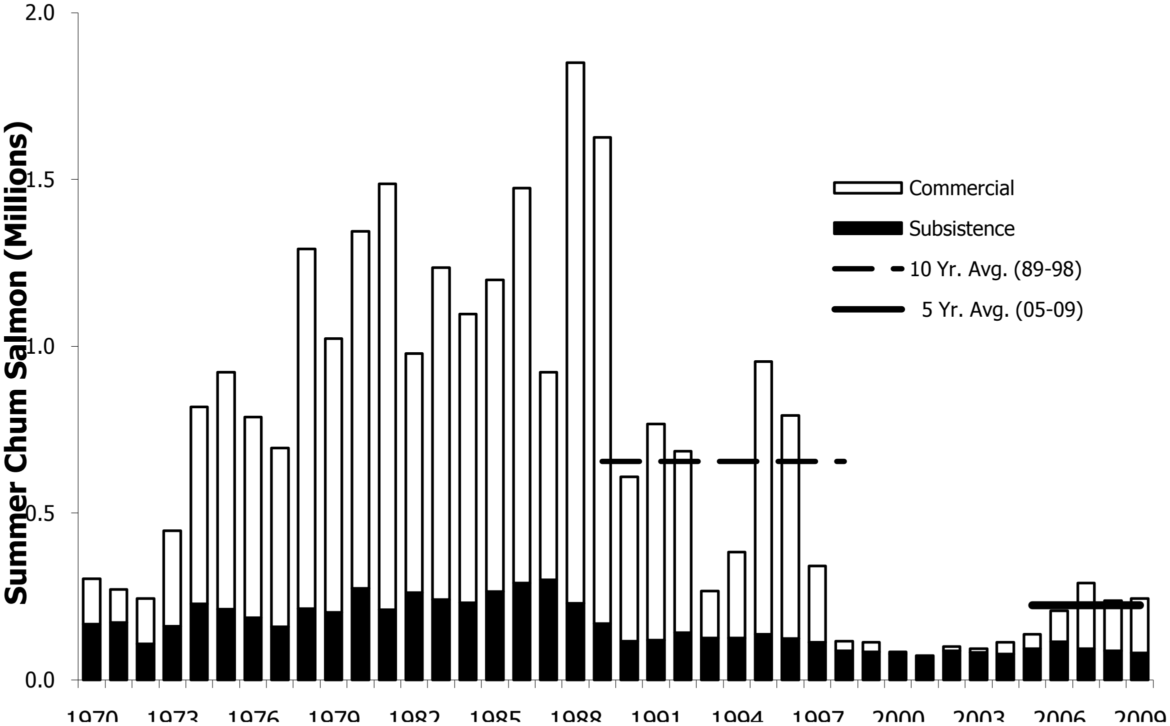


Figure 5-24. Yukon River summer chum salmon subsistence and commercial harvests from 1970 to 2009, compared to the 1989–1998 average (approximately 665,100 fish) and the 2005–2009 average (226,994 fish).

Exploitation Rates

Annual total run estimates can be coupled with total inriver utilization to estimate exploitation rates exerted on Yukon River summer chum salmon for the years 1995 and 1997–2009 (Figure 5-25). Total exploitation rates exerted by Yukon River fisheries on summer chum salmon over 14 years averaged about 12.2%, ranging from as high as 23.0% in 1995 to as low as 4.3% in 2006. Note that both these years had run sizes in excess of 4.0 million fish. Exploitation rates on the 2 lowest runs, approximately 550,000 fish, in 2000 and 2001, were 15.1% and 13.1%, respectively (Figure 5-25). Exploitation rates have been increasing slightly since 2007 owing to increased market interest; however, these harvest rates are low in comparison to exploitation rates exerted on most Alaska salmon populations and primarily reflect the lack of commercial markets.

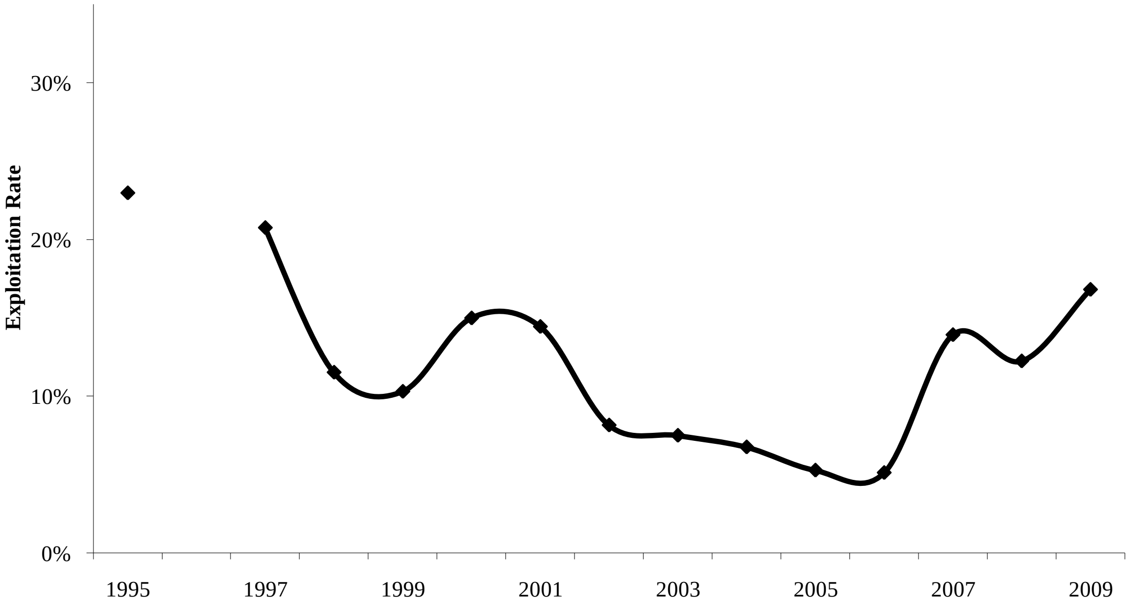


Figure 5-25. Approximate exploitation rates on Yukon River summer chum salmon stocks, 1995 and 1997–2009. Data are unavailable for 1996.

Outlook

It is expected that the total run in the Yukon River will be approximately 1.3 – 1.6 million fish, similar to the 2010 run. If inseason indicators of run strength suggest sufficient abundance exists to allow for a commercial fishery, the commercially harvestable surplus in Alaska could range from 300,000 to 600,000 summer chum salmon. The actual commercial harvest of summer chum salmon in 2011 will likely be affected by a potentially poor Chinook salmon run, as Chinook salmon are incidentally harvested in summer chum salmon-directed fisheries.

5.2.4.2 Fall run

In response to guidelines established in the SSFP (5 AAC 39.222(f)(21)), the BOF classified Yukon River fall chum salmon as a stock of yield concern and classified Toklat and Fishing Branch rivers fall chum salmon as stocks of management concerns at its September 2000 work session. 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.

Stock Assessment Background

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 5-26). 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 5-13). 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. This report focuses on the recent 5-year period prior to the January 2010 Board of Fisheries cycle meeting.

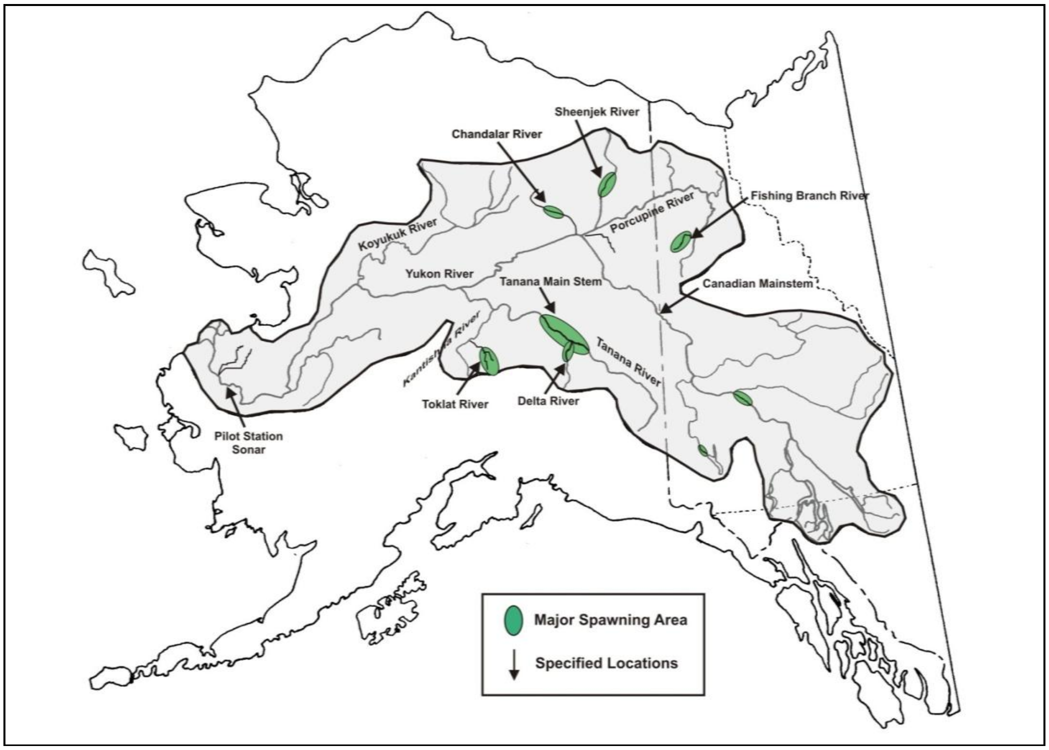


Figure 5-26. Map showing major spawning areas of fall chum salmon in Alaska and Canada.

Table 5-13. Yukon River drainage fall chum salmon management plan, 5AAC 01.249, 2009.

Run Size Estimate [b]	Recommended Management Action Fall Chum Salmon Directed Fisheries [a]				Targeted Drainagewide
(Point Estimate)	Commercial	Personal Use	Sport	Subsistence	Escapement
300,000 or Less	Closure	Closure	Closure	Closure [c]	
300,001 to 500,000	Closure	Closure [c]	Closure [c]	Possible Restrictions [c, d]	300,000 to 600,000
500,001 to 600,000	Restrictions [c]	Open	Open	Pre-2001 Fishing Schedules	
Greater Than 600,000	Open [e]	Open	Open	Pre-2001 Fishing Schedules	

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

[a] Considerations for the Toklat River and 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.

[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.

[e] Drainagewide commercial fisheries may be open and the harvestable surplus above 600,000 fall chum salmon will be distributed by district or subdistrict (in proportion to the guidelines harvest levels established in 5 AAC 05.365 and 5 AAC 05.367).

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 Mt. 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 (Table 5-14) 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 (Table 5-14, Figure 5-27). 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.

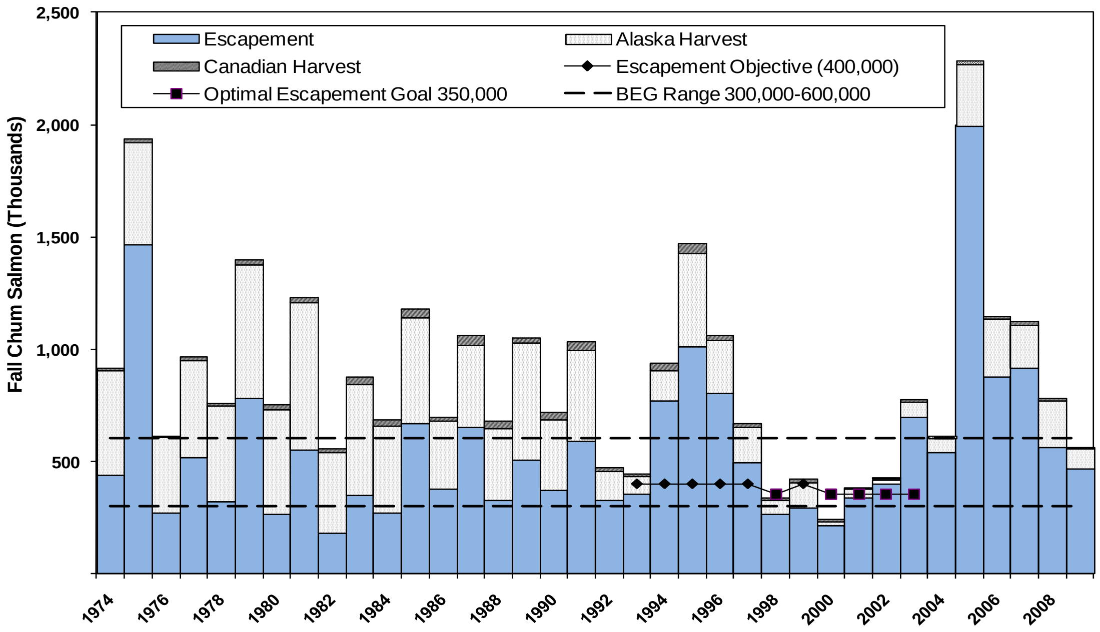


Figure 5-27. Total run reconstruction based on estimated harvest and escapement of fall chum salmon, Yukon River drainage, 1974–2008 with the 2009 run size estimate.

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.

Table 5-14. Fall chum salmon estimated brood year production and return per spawner estimates, Yukon Area, 1974–2009.

	(P)			Estimated Brood Year Return								(R)	(R/P)
Estimated Annual Totals				Number of Salmon [a]				Percent				Total Brood	Return/
Year	Escapement [b]	Catch	Return	Age 3	Age 4	Age 5	Age 6	Age 3	Age 4	Age 5	Age 6	Year Return[a]	Spawner
1974	436,485	478,875	915,360	91,751	497,755	68,693	0	0.139	0.756	0.104	0.000	658,199	1.51
1975	1,465,213	473,062	1,938,275	150,451	1,225,440	61,401	123	0.105	0.853	0.043	0.000	1,437,415	0.98
1976	268,841	339,043	607,884	102,062	587,479	137,039	4,316	0.123	0.707	0.165	0.005	830,895	3.09
1977	514,843	447,918	962,761	102,660	1,075,198	175,688	4,189	0.076	0.792	0.129	0.003	1,357,735	2.64
1978	320,487	434,030	754,517	22,222	332,230	90,580	0	0.050	0.747	0.204	0.000	445,032	1.39
1979	780,818	615,377	1,396,195	41,114	769,496	274,311	3,894	0.038	0.707	0.252	0.004	1,088,814	1.39
1980	263,167	488,373	751,540	8,377	362,199	208,962	3,125	0.014	0.622	0.359	0.005	582,663	2.21
1981	551,192	683,391	1,234,583	45,855	955,725	278,386	8,888	0.036	0.742	0.216	0.007	1,288,853	2.34
1982	179,828	373,519	553,347	11,327	400,323	166,754	679	0.020	0.691	0.288	0.001	579,083	3.22
1983	347,157	525,485	872,642	12,569	875,355	223,468	2,313	0.011	0.786	0.201	0.002	1,113,704	3.21
1984	270,042	412,323	682,365	7,089	408,040	174,207	8,516	0.012	0.683	0.291	0.014	597,852	2.21
1985	664,426	515,481	1,179,907	46,635	874,819	270,984	3,194	0.039	0.732	0.227	0.003	1,195,632	1.80
1986	376,374	318,028	694,402	0	429,749	368,513	4,353	0.000	0.535	0.459	0.005	802,614	2.13
1987	651,943	406,143	1,058,086	12,413	617,519	290,767	7,720	0.013	0.665	0.313	0.008	928,418	1.42
1988	325,137	353,685	678,822	41,003	175,236	152,368	10,894 [c]	0.108	0.462	0.401	0.029	379,501	1.17
1989	506,173	545,166	1,051,339	2,744	282,905	345,136 [c]	20,290	0.004	0.435	0.530	0.031	651,075	1.29
1990	369,654	352,007	721,661	710	579,452 [c]	418,448	30,449	0.001	0.563	0.407	0.030	1,029,059	2.78
1991	591,132	439,096	1,030,228	3,663 [c]	1,024,800	369,103	12,167	0.003	0.727	0.262	0.009	1,409,733	2.38
1992	324,253	148,846	473,099	6,763	653,648	197,073	3,907	0.008	0.759	0.229	0.005	861,392	2.66
1993	352,688	91,015	443,703	7,745	451,327	102,420	3,235	0.014	0.799	0.181	0.006	564,727	1.60
1994	769,920	169,225	939,145	4,322	225,243	149,527	1,603 [c]	0.011	0.592	0.393	0.004	380,695	0.49

-continued-

Table 5-14 continued

	(P)			Estimated Brood Year Return								(R)	(R/P)
Estimated Annual Totals				Number of Salmon				Percent				Total Brood	Return
Year	Escapement	Catch	Return	Age 3	Age 4	Age 5	Age 6	Age 3	Age 4	Age 5	Age 6	Year Return	Spawner
1995	1,009,155	461,147	1,470,302	2,371	266,955	68,918 [c]	383	0.007	0.788	0.204	0.001	338,627	0.34
1996	800,022	260,923	1,060,945	420	165,691 [c]	136,906	8,295	0.001	0.532	0.440	0.027	311,312	0.39
1997	494,831	170,059	664,890	3,087 [c]	244,801	118,343	3,332	0.008	0.662	0.320	0.009	369,563	0.75
1998	263,121	70,820	333,941	651	269,653	57,962	6,694	0.002	0.805	0.173	0.020	334,960	1.27
1999	288,962	131,175	420,137	29,097	705,152	174,424	13,720	0.032	0.764	0.189	0.015	922,392	3.19
2000	210,756	28,543	239,299	8,446	297,012	115,478	0	0.020	0.706	0.274	0.000	420,937	2.00
2001	337,765	44,976	382,741	136,038	2,157,498	675,688	33,955	0.045	0.718	0.225	0.011	3,003,179	8.89
2002	397,977	27,411	425,388	0	444,507	239,154	13,067	0.000	0.638	0.343	0.019	696,728	1.75
2003	695,363	79,529	774,892	24,263	858,714	434,639	16,010	0.018	0.644	0.326	0.012	1,333,626	1.92
2004	537,873	76,296	614,169	0	332,454	145,202	7,377	0.000	0.685	0.299		485,033 [d]	>0.90
2005	1,996,513	290,183	2,286,696	2,269	370,342	150,844						523,455 [e]	>0.26
2006	873,987	270,471	1,144,458	24,349									
2007	928,430	203,393	1,131,823										
2008	564,482	217,947	782,429										
2009	462,583	93,319	555,902										
2009 Avg.	560,878	306,563	867,441										
	494,258	All Brood Years (1974–2003)		30,862	607,131	218,178	7,644	0.0319	0.6870	0.2716	0.0095	863,814	2.08
	371,738	Even Brood Years (1974–2003)		20,343	388,548	178,778	6,393	0.0340	0.6531	0.3020	0.0109	594,062	1.89
	616,777	Odd Brood Years (1974–2003)		41,380	825,714	257,578	8,894	0.0299	0.7209	0.2412	0.0080	1,133,566	2.28

[a] The estimated number of salmon which returned are based upon annual age composition observed in lower Yukon test nets each year, weighted by test fish CPUE.

[b] Contrast in escapement data is 11.10.

[c] Based upon expanded test fish age composition estimates for years in which the test fishery terminated early (both in 1994 and 2000).

[d] Brood year return for 3, 4, and 5 year fish, indicate that production (R/P) from brood year 2004 was at least 0.90. Recruits estimated for incomplete brood year.

[e] Brood year return for 3 and 4 year fish, indicate that production (R/P) from brood year 2005 was at least 0.26. Recruits estimated for incomplete brood year.

Escapement goals

Current BEGs and SEGs for Yukon River fall chum salmon are as follows:

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
Toklat River (foot survey)	15,000–33,000	Eliminated
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
Canadian Upper Yukon River (sonar)	>80,000[a]	IMEG[b]
Fishing Branch River (weir)	50,000–120,000[a]	IMEG[b]

[a] U.S./Canada escapement goals based on Yukon Salmon Agreement.

[b] Interim Management Escapement Goals (IMEG) are set by the U.S./Canada Panel. The current IMEG for Fishing Branch River is 22,000 to 49,000 fall chum salmon through 2010.

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 (Figure 5-27).

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 5-15 and Figure 5-28). 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 5-15 and Figure 5-29).

Table 5-15. Fall chum salmon passage estimates and escapement estimates for selected spawning areas, Yukon River drainage, 1971–2009.

	Alaska									
	Yukon	Tanana River Drainage					Upper Yukon River Drainage		Canada	
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 5-15 continued.

	Alaska								Canada	
	Yukon	Tanana River Drainage					Upper Yukon River Drainage			
Year	River M115 instem 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]
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
2009 [ab]	240,449	-	-	13,492		-	-	54,126 [q]	25,828 [aa]	92,626
Five Year Average	828,748	N/A	86,899	19,469	6,581	300,412	286,977	153,669	46,379	226,193
BEG Range		15,000	N/A	6,000	N/A	46,000 [ac]	74,000	50,000	27,000	60,000
		33,000		13,000		103,000	152,000	104,000	56,000	129,000
Drainagewide BEG						Treaty Negotiated Interim Objectives:			50,000-120,000	>80,000
300,000-600,000					Yukon River Panel Negotiated Objectives for 2008-2010:				22,000-49,000	

-continued-

Table 5-15 continued.

Note: Latest table revision September 9, 2010.

[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 5-15 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.

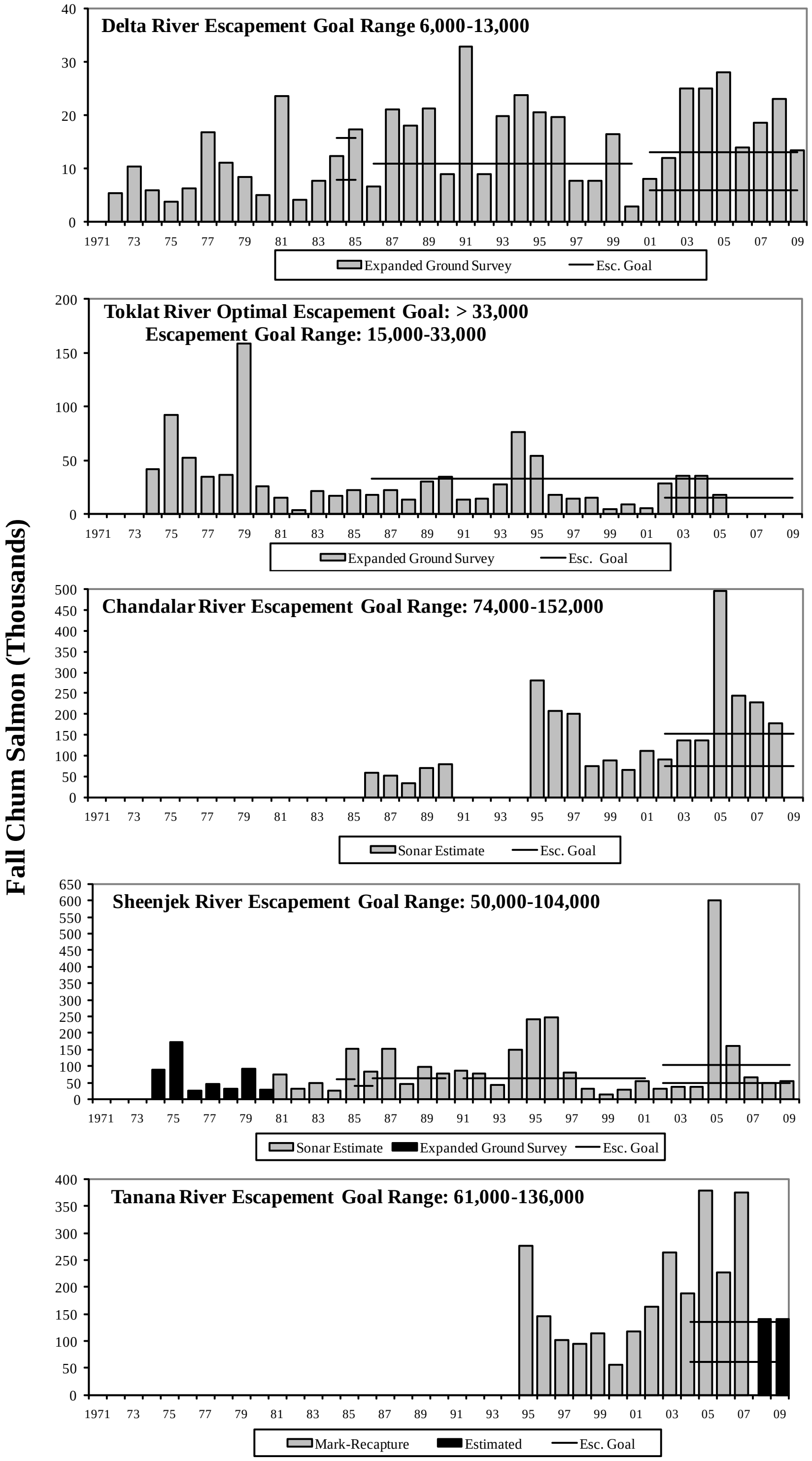


Figure 5-28 Fall chum salmon escapement estimates for selected spawning areas in the Alaskan portion of the Yukon River drainage, 1971-2009. Horizontal lines represent escapement goals or ranges. Note: vertical scale is variable

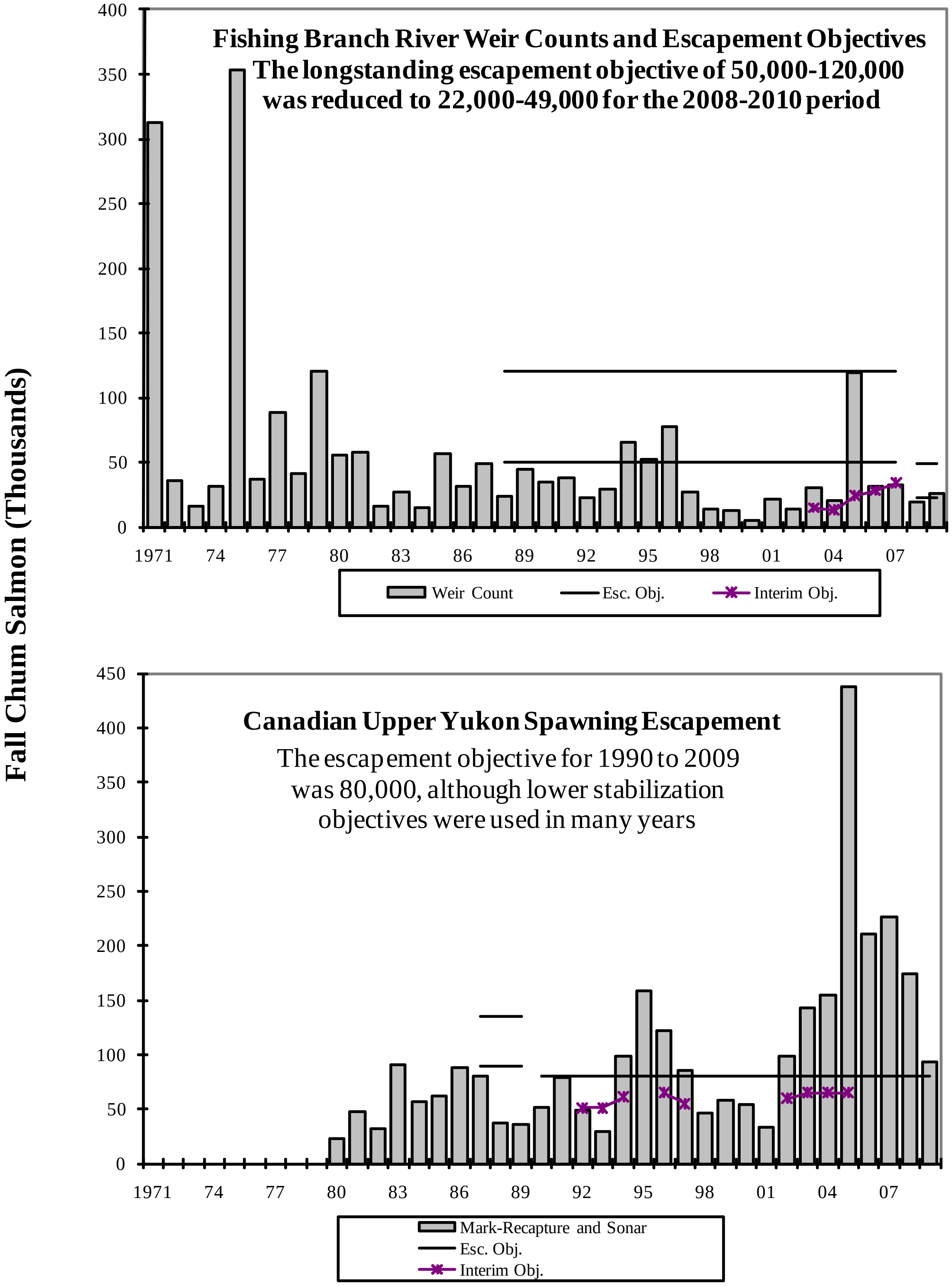


Figure 5-29 Chum salmon spawning escapement estimates for Canadian portion of the Yukon River drainage, 1971-2009. Sonar estimates were used in 2008 and 2009. Horizontal lines represent escapement goal objectives or ranges. The interim stabilization or rebuilding objectives are also shown.

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 5-18, Figure 5-29). 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[23] 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 5-18 and Figure 5-28). 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.

Maturity

Annual inseason estimates of fall chum salmon age composition since 1977 are derived by the following sources: Inseason estimates of age prior to 1981 are based on fish sampled at Emmonak from 6" commercial gillnet catches. Estimates of age from 1981 to 2000 are based on 6" set gillnet test fish catches at Big Eddy and Middle Mouth sites (LYTF), in 2001 fishing gear was changed to 6" drift gillnets. All test fishery age composition data were weighted by daily CPUE from 1981 through 2009. Because of low sample sizes obtained in the normal operations of LYTF in 2009 (due to difficulty catching fall chum salmon) samples were supplemented by an extra drift site in Big Eddy and from the Mountain Village test fishery. Estimates for 1994 and 2000 were obtained by apportioning daily CPUE among ages, fitting age specific run timing curves to each age, and extending the curves to the end of the season since the projects were terminated early due to the poor returns. Estimated annual age composition from 1977 through 2009 has averaged approximately 4% age-3, 68% age-4, 27% age-5, and less than 1% age-6.

Age composition from 1974 through 2003 is used to estimate age structure of brood year returns (Table 5-17). Additionally, recruits are estimated from 2004 (age-6) and 2005 (age-5) brood year returns. Although the overall proportion of age-4 and age-5 fish combined varies little among brood year returns, (averaging approximately 95% annually), there is a change in the proportion of these age groups between even and odd-numbered brood year returns. For example, age-4 fish averaged approximately 72% of returns from odd-numbered brood years between 1974 and 2003, whereas only 65% from even-numbered brood years. By comparison, returning age-5 fish averaged approximately 24% from odd-numbered brood year returns and 30% from even-numbered brood years. The 2001 brood year had extremely good marine survival as evidenced by the large return of each age class from age-3 returns in 2004 through age-6 returns in 2007.

---

[23] 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.

However, age-4 component that retuned from the 2005 brood year was much lower than would be expected if the return had actually produced a run commensurate with the large escapement.

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.

2010 Summary

The fall season began by regulation on July 16. At that time, fall chum salmon abundance was projected to be 600,000 fish based upon the abundance of the proceeding summer chum salmon run. That level of abundance would be adequate to meet escapement needs and provide for normal subsistence harvest. At the beginning of the fall season, subsistence fishing in Districts 1, 2, 3, and Subdistrict 5-D were open seven days a week, 24 hours a day while District 4 and Subdistricts 5-A, 5-B, and 5-C were open on a five days a week schedule. Due to high water levels and debris which hindered subsistence fishing efforts early in the season, District 4 and Subdistricts 5-A, 5-B, and 5-C were moved to a seven days a week schedule to provide more opportunity.

In mid-August, management of fall chum shifted from using the preseason projection to inseason assessment. The Pilot Station sonar indicated a weaker fall chum salmon run than anticipated with projections less than 400,000 fish. As a result, the department placed mainriver districts (excluding Subdistrict 5-D) on the regulatory windowed schedule and commercial fishing for chum salmon was not allowed. In March 2010, the Yukon River Panel agreed to a new Interim Management Escapement Goal range of 70,000 – 104,000 for the Canadian mainstem fall chum salmon stock. Concerns about meeting the lower end of the Canadian border objective (escapement goal plus a Canadian harvest share agreement) resulted in further subsistence restrictions until it became apparent in early September that the lower end of the Canadian border passage goal was going to be met. At that point, subsistence schedules in the mainriver districts were liberalized.

A limited late season coho salmon directed commercial fishery was prosecuted in Districts 1 and 2, and a limited salmon directed commercial fishery was prosecuted in District 6. There were two commercial periods in District 1, one period in District 2, and three periods in District 6. The 2010 total commercial harvest for the Yukon River fall season in the Alaskan portion of the drainage was 2,550 fall chum salmon, which is well below the most recent five and 10-year averages and among the lowest on record.

The preliminary 2010 fall chum salmon run size is estimated to be approximately 450,000 to 500,000, below the preseason forecast of 552,000 to 828,000 salmon. The distribution of tributary stock escapements was not uniform and some goals and management objectives were not achieved within the Porcupine River drainage including the Sheenjek and Fishing Branch river systems while goals for the Chandalar River, Canadian Mainstem, Delta and Tanana rivers, were achieved.

Exploitation Rates

Annual total run estimates can be coupled with total inriver harvests to estimate exploitation rates exerted on fall chum salmon for 1974–2009 (Figure 5-30). Total exploitation rates exerted by Yukon River fisheries on fall chum salmon over 36 years averaged about 17.4%, ranging from as high as 67.5% in 1982 to as low as 6.4% in 2002. Exploitation rates on 2 of the lowest runs, approximately 239,000 fish, in 2000 and 383,000 fish in 2001 were 11.9% and 11.7%, respectively. Exploitation rates have been increasing slightly since 2002 with improvements in run size and reestablishment of market interest; however, current exploitation rates are much lower than historical rates (averaging 51% pre-1992 to an average of 20% post-1991), partly due to highly variable and unpredictable runs occurring in the last two decades.

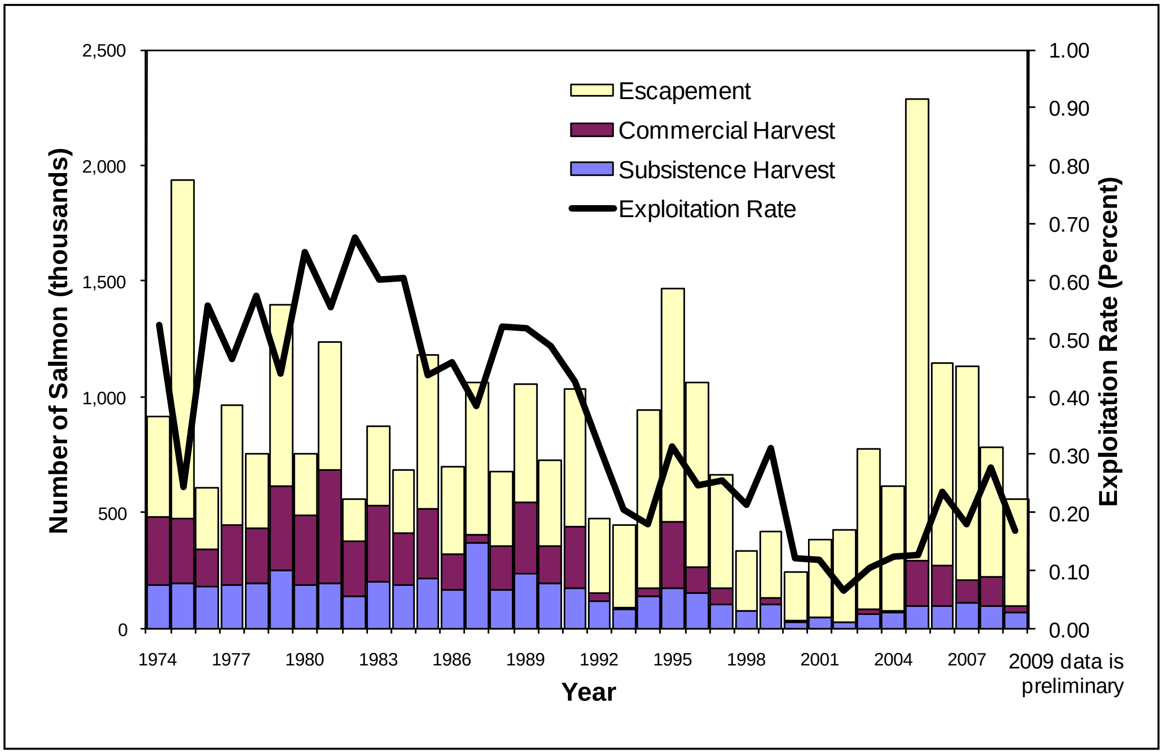


Figure 5-30 Estimated fall chum salmon harvest and escapement with exploitation rate, Yukon Area, 1974–2009.

Yields based on brood return from individual escapements have also become highly variable in the last two decades (Figure 5-31). 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 5-30). 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 5-30). With the exception of 1995, fall chum salmon commercial harvests (Figure 5-30) 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.

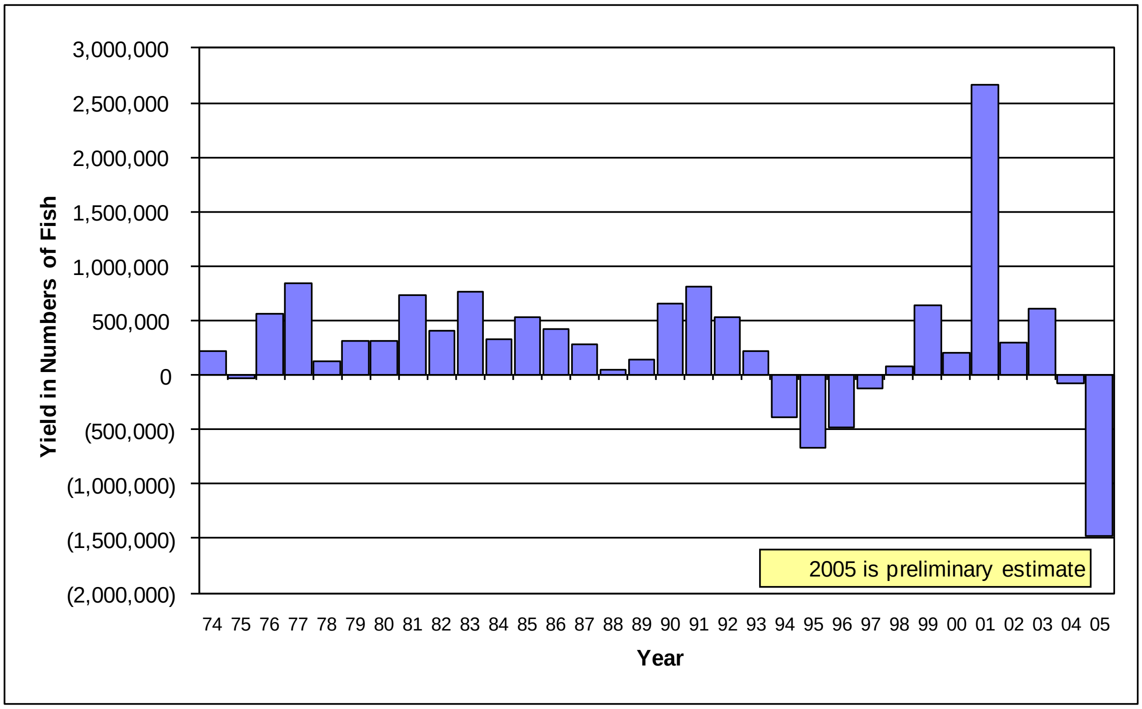


Figure 5-31. Yields of fall chum salmon based on parent year escapements and resulting brood year returns, 1974-2005.

Outlook

The 2011 run size projection is expressed as a range from 605,000 to 870,000 fall chum salmon. This projected run size is below average for odd-numbered year returns. It is anticipated that escapement goals will be met while supporting normal subsistence fishing activities. Based on the preseason outlook, the commercial harvest would be between 50,000 and 300,000 fall chum salmon. However, commercial harvestable surpluses will have to be determined inseason and opportunity provided where commercial ventures exist.

5.2.5 Norton Sound

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, Unalakleet (Figure 5-32). 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.

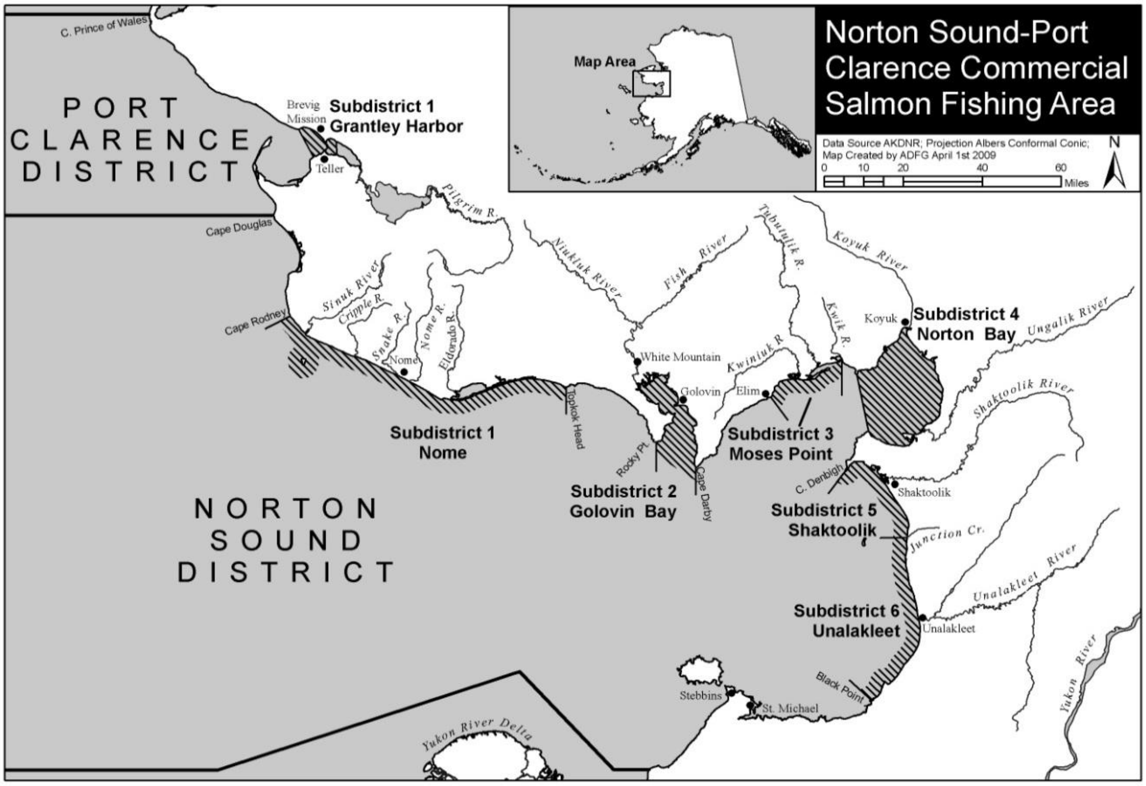


Figure 5-32. Norton Sound commercial salmon fishing districts and subdistricts.

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.

5.2.5.1 Northern Norton Sound chum salmon

5.2.5.1.1 Introduction

Northern Norton Sound includes Subdistricts 1, 2, and 3 (Figure 5-32). 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 92005 – 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.

5.2.5.1.2 Stock Assessment Background

Escapement

The Subdistrict 1 BEG was achieved or exceeded from 2005–2008 and fell short of the goal in 2009 (Figure 5-33). During this same time period (2005–2009), the SEG was achieved or exceeded for 3 of 5 years at Nome and Snake Rivers (Table 5-16, Figure 5-34, Figure 5-35), and 4 of 5 years at Eldorado River (Table 5-16, Figure 5-36). Comparing escapements during 2005–2009 to the escapement goals established in 2001 shows there has not been a chronic inability to meet escapement goals.

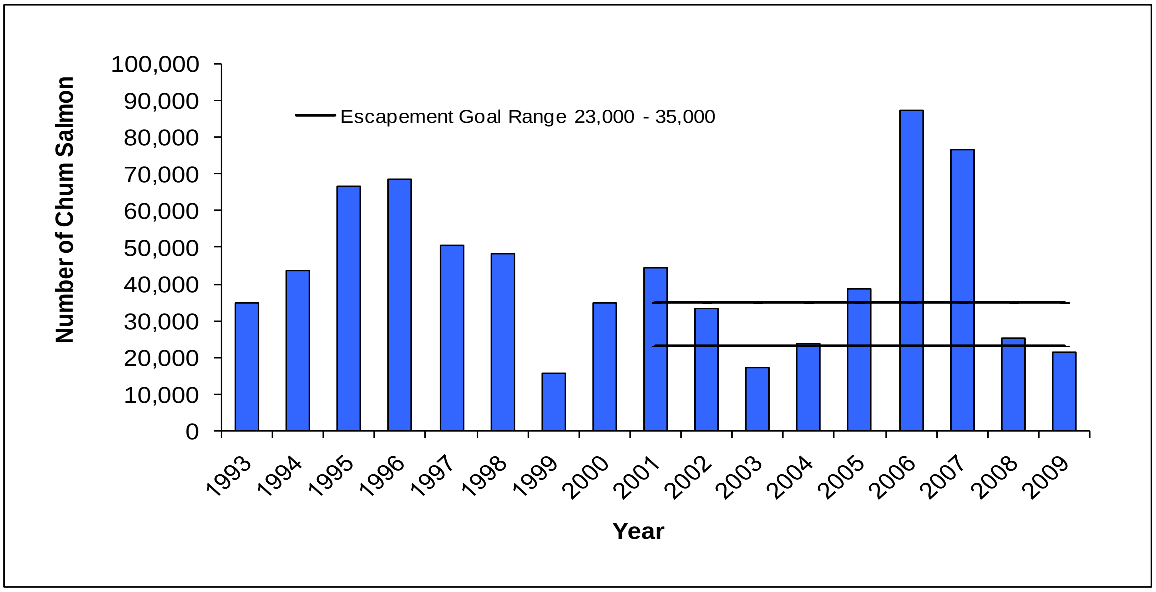


Figure 5-33. Subdistrict 1estimated chum salmon escapement, 1993–2009, and in relation to the biological escapement goal range, 2001–2009.

Table 5-16. Subdistrict 1 chum salmon escapement, 1993–2009.

Year	Solomon River [a]	Bonanza River [a]	Flambeau River [a]	Sinuk River [a]	Eldorado River [b]	Snake River [c]	Nome River [d]	Subdistrict Total
1993	2,525	3,007	6,103	6,052	9,048	2,115	5,925	34,775
1994	1,066	5,178	12,889	4,905	13,202	3,519	2,893	43,652
1995	2,106	11,182	16,474	9,464	18,955	4,395	5,093	67,669
1996	2,141	7,049	13,613	6,658	32,970	2,772	3,339	68,542
1997	2,111	4,140	9,455	9,212	14,302	6,184	5,147	50,551
1998	925	4,552	9,129	6,720	13,808	11,067	1,930	48,131
1999	637	2,304	637	6,370	4,218	484	1,048	15,698
2000	1,294	4,876	3,947	7,198	11,617	1,911	4,056	34,899
2001	1,949	4,745	10,465	10,718	11,635	2,182	2,859	44,553
2002	2,150	3,199	6,804	6,333	10,243	2,776	1,720	33,225
2003	806	1,664	3,380	3,482	3,591	2,201	1,957	17,081
2004	1,436	2,166	7,667	3,197	3,273	2,145	3,903	23,787
2005	1,914	5,534	7,692	4,710	10,426	2,948	5,584	38,808
2006	2,062	708	27,828	4,834	41,985	4,128	5,677	87,222
2007	3,469	8,491	12,006	16,481	21,312	8,147	7,084	76,990
2008 [e]	1,000	1,000	11,618	1,000	6,746	1,244	2,607	25,215
2009	918	6,744	4,075	2,232	4,943	891	1,565	21,368
2005-2009 avg.	1,873	4,495	12,644	5,851	17,082	3,472	4,503	49,921
2000-2009 avg.	1,700	3,913	9,548	6,019	12,577	2,857	3,701	40,315

[a] The Bonanza, Flambeau, Sinuk and Solomon Rivers escapement estimate is obtained by expanded aerial survey counts and expanding by calculation from Clark, J.H. 2001.

[b] The Eldorado River escapement estimate is the same method as in Clark, J.H. 2001 for 1993-1996. From 1997 - 2002 escapement estimates are from counting tower and from 2003-2009 by weir.

[c] The Snake River escapement estimate is the same method as in Clark, J.H. 2001 for 1993-1994. From 1995 - 2002 escapement estimates are from counting tower and from 2003-2009 by weir.

[d] The Nome River escapement estimate is the same method as in Clark, J.H. 2001 for 1993. From 1994-1995 escapement estimates are from counting tower and from 1996 – 2009 by weir.

[e] A huge pink salmon run prevented surveyors from estimating chum salmon in the Solomon, Bonanza and Sinuk rivers; escapement was conservatively listed at 1,000 chum salmon for each river, but based

on historical data was likely higher.

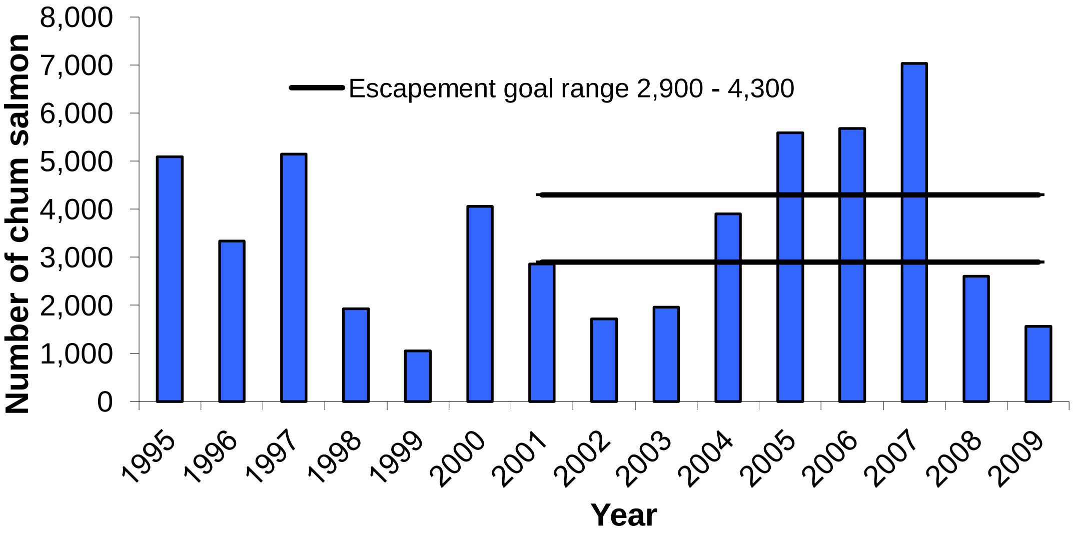


Figure 5-34. Nome River estimated chum salmon escapement, 1995–2009, and in relation to the sustainable escapement goal, 2001–2009.

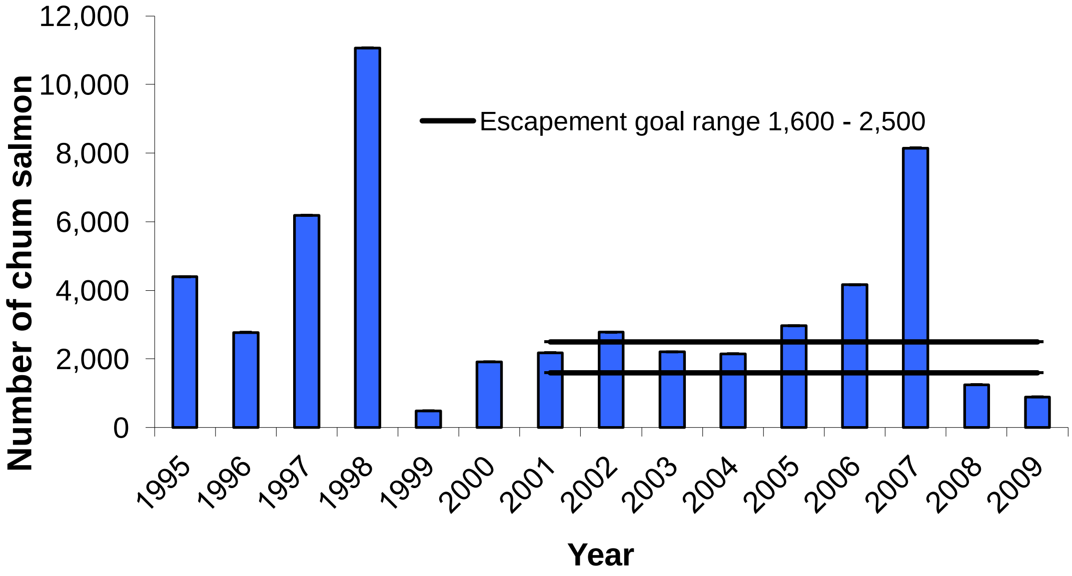


Figure 5-35. Snake River estimated chum salmon escapement,1995–2009, and in relation to the sustainable escapement goal, 2001–2009.

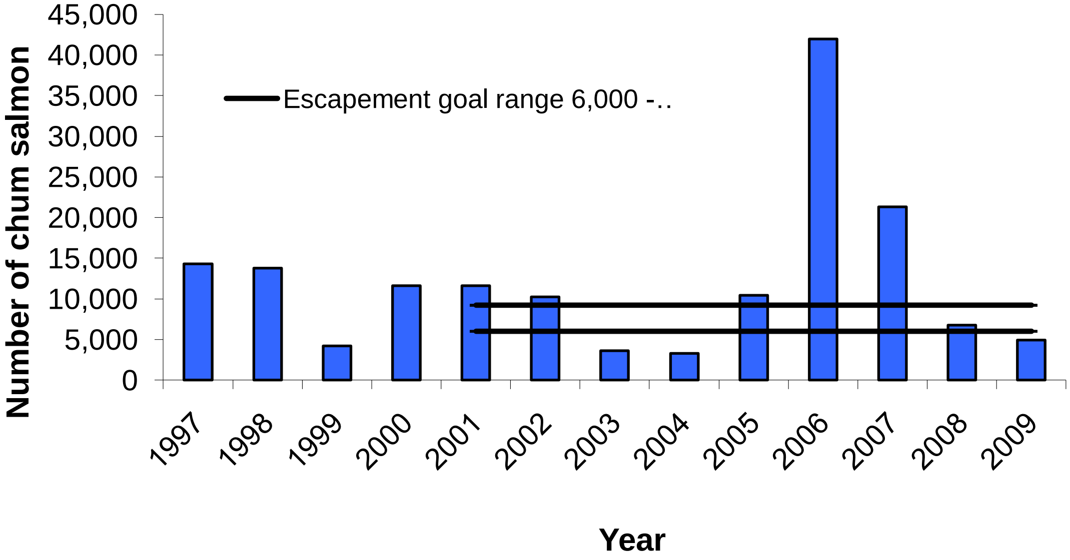


Figure 5-36. Eldorado River estimated chum salmon escapement, 1997–2009, and in relation to the sustainable escapement goal, 2001–2009.

Niukluk River in Subdistrict 2 exceeded the SEG in 2007, and was close to the goal in 2006. There has been a decreasing trend in escapement since the project was established in 1995 (Table 5-17, Figure 5-37).

Table 5-17. Historical salmon migration passed Niukluk River counting tower, 1995–2009.

Year	Operating period	Chum	Pink	Chinook	Coho
1995	June 29 - Sept 12	86,332	17,088	123	4,713
1996	June 23 - Sept 12	80,178	1,154,922	243	12,781
1997	June 28 - Sept 09	57,305	10,468	259	3,994
1998	July 04 - Aug 09	45,588	1,624,438	260	840
1999	June 04 - Sept 04	35,239	20,351	40	4,260
2000	July 04 - Aug 27	29,573	961,603	48	11,382
2001	July 10 - Sept 08	30,662	41,625	30	3,468
2002	June 25 - Sept 10	35,307	645,141	621	7,391
2003	June 25 - Sept 10	20,018	75,855	179	1,282
2004	June 25 - Sept 08	10,770	975,895	141	2,064
2005	June 28 - Sept 09	25,598	270,424	41	2,727
2006	June 26 - Sept 08	29,199	1,371,919	39	11,169
2007	July 01 - Sept 04	50,994	43,617	30	3,498
2008	July 01 - Sept 06	12,078	669,234	33	13,779
2009	July 03 - Sept 02	15,879	24,204	204	6,861
2005-2009 avg.		26,750	475,880	69	7,607

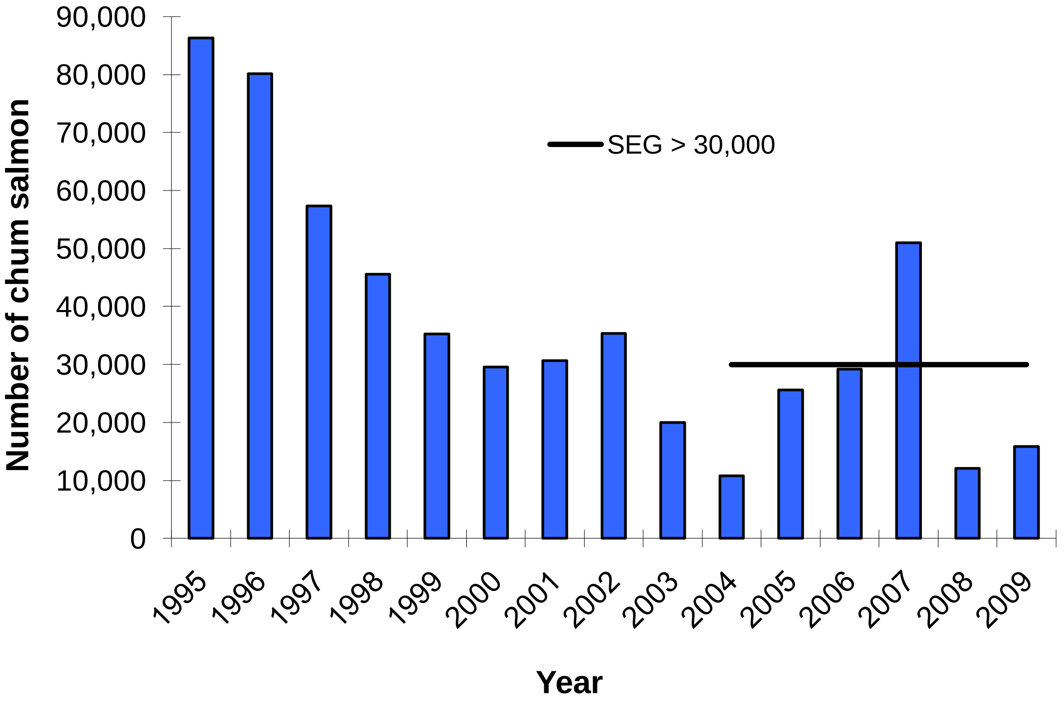


Figure 5-37. Niukluk River estimated chum slamon escapement, 1995–2009, and in relation to the sustainable escapement goal, 2004–2009.

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 3 of the 5 recent years (2005–2009) (Table 5-18, Figure 5-38). The SEG for the Tubutulik chum salmon stock is 9,200 to 18,400 chum salmon as assessed by aerial surveys. 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 2009 counted 3,161 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.

Table 5-18. Historical salmon migration passed Kwiniuk counting tower, 1965–2009.

Year	Chum	Pink	Chinook	Coho
1965	32,861	8,668	19	
1966	32,786	10,629	7	
1967	26,661	3,587	13	
1968	19,976	129,052	27	
1969	19,687	56,683	12	
1970	66,604	226,831		
1971	38,679	16,634		
1972	30,686	62,461	65	
1973	28,029	37,070	57	
1974	35,161	39,375	62	
1975	14,049	55,293	44	
1976	8,508	35,226	12	
1977	21,798	47,934		
1978	11,049	70,148		
1979	12,355	167,492	107	
1980	19,374	319,363	177	
1981	34,565	566,534	136	
1982	44,099	469,674	138	
1983	56,907	251,965	267	
1984	54,043	736,544	736 [a]	
1985	9,013	18,237	955	
1986	24,700	241,446	654	
1987	16,133	5,566	317	
1988	13,303	187,907	321	
1989	14,529	27,488	248	
1990	13,957	416,512	900	
1991	19,801	53,499	708	
1992	12,077	1,464,716	479	
1993	15,824	43,063	600	
1994	33,012	2,303,114	625	2,547
1995	42,500	17,511	498	114
1996	28,493	907,893	577	461
1997	20,119	9,535	974	
1998	24,247	655,934	303	
1999	8,763	607	116	
2000	12,879	750,173	144	41
2001	16,598	8,423	261	9,532
2002	37,995	1,114,410	778	6,459
2003	12,123	22,329	744	5,490
2004	10,362	3,054,684	663	11,240
2005	12,083	341,048	342	12,950
2006	39,519	1,347,090	195	22,341
2007	27,756	54,255	258	9,429
2008	9,462	1,442,246	237	10,461
2009	8,733	42,957	444	8,563
2005-2009 avg.	19,511	645,519	295	12,749

[a] Chinook salmon counts from 1965-1984 were not expanded; counts in 1985 and after were expanded

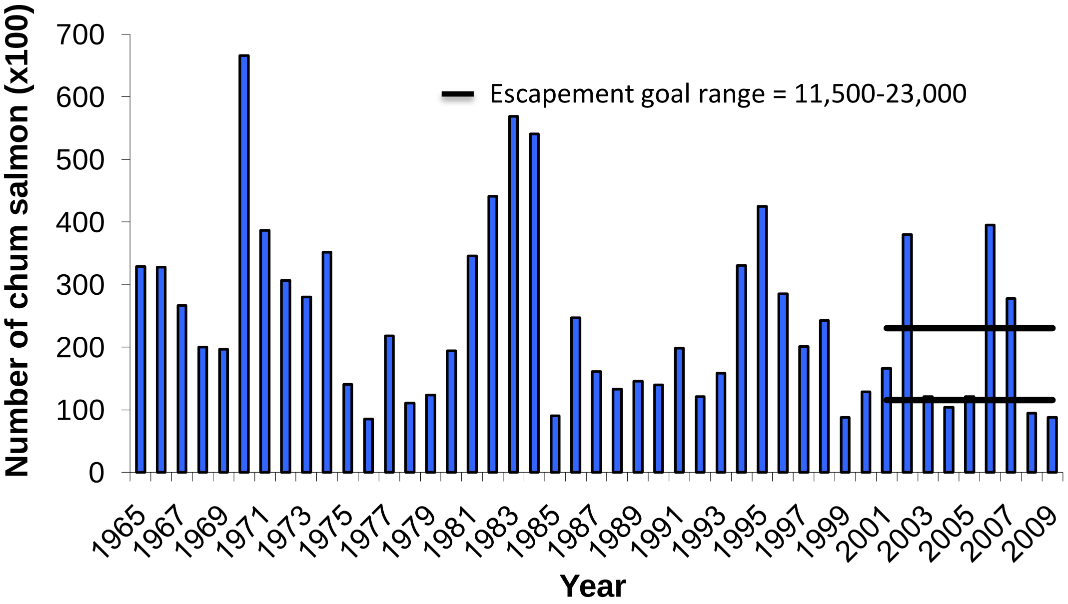


Figure 5-38. Kwiniuk River estimated chum salmon escapement, 1965–2009, and in relation to the optimal escapement goal range, 2001–2009.

Escapement Goals

Current Subdistrict 1 SEGs and district-wide BEG are as follows:

River	Enumeration Method	Goal	Type
Eldorado River	Weir	6,000-9,200	SEG
Nome River	Weir	2,900-4,300	SEG
Snake River	Weir	1,600-2,500	SEG
Subdistrict 1	Multiple	23,000-35,000	BEG

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.

Maturity

In Subdistrict 1, the Nome, Snake, and Eldorado rivers have had age, sex, and length (ASL) data collected consistently from escapements since 2001. The 9-year average (2001–2009) age composition of escapement is dominated by 4 and 5-year old chum salmon.

	Age				
River	0.2	0.3	0.4	0.5	0.6
Nome River	0.026	0.530	0.412	0.031	5.56E-04
Snake River	0.016	0.537	0.410	0.037	0.00E+00
Eldorado River	0.027	0.520	0.424	0.029	4.44E-04

In Subdistrict 2, the Niukluk River escapement has been monitored since 1995. The 10-year (2000–2009) average age composition of escapement is dominated by 4 and 5-year old chum salmon.

	Age				
	0.2	0.3	0.4	0.5	0.6
Niukluk River	0.024	0.521	0.428	0.026	2.510E-04

In Subdistrict 3, the Kwiniuk River escapement has been monitored since 1965. The 10-year (2000–2009) average age composition is dominated by 4 and 5-year old chum salmon.

	Age				
	0.2	0.3	0.4	0.5	0.6
Kwiniuk River	0.051	0.490	0.441	0.019	0.000

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 5-39). The average subsistence harvest of 1,636 chum salmon for 1990–2009 was less than one half the average subsistence harvests of 4,645 chum salmon for the previous twenty years (1970–1989). 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.

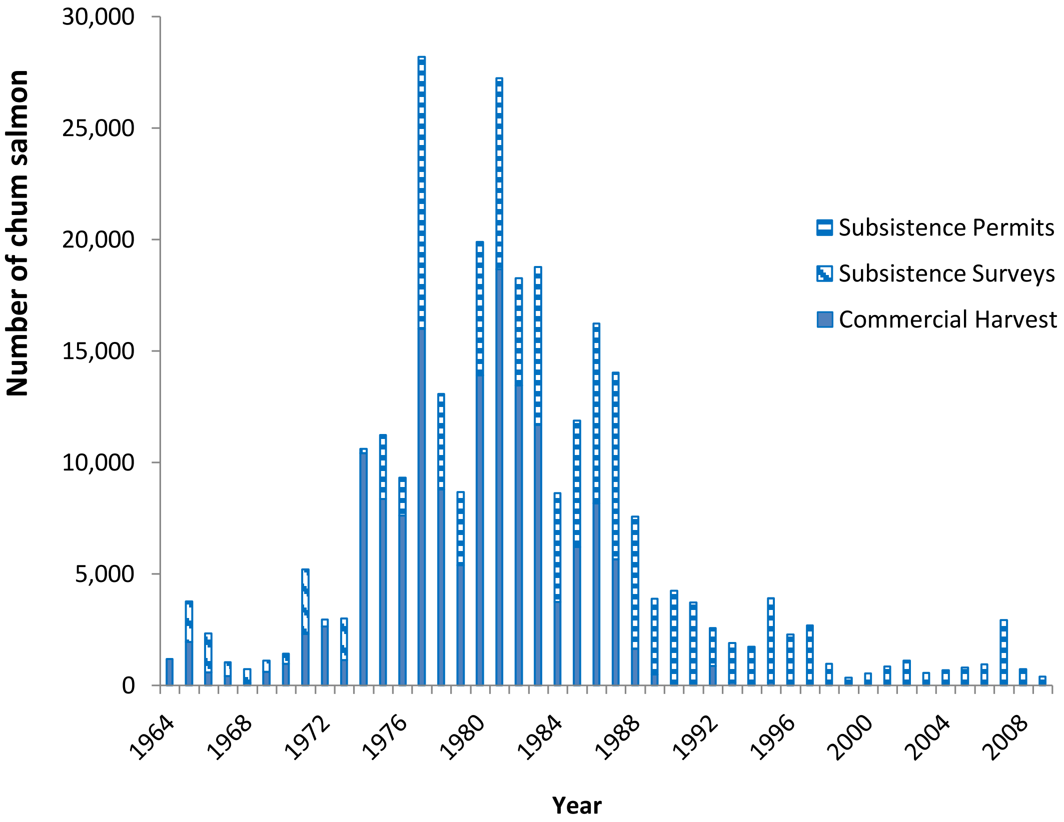


Figure 5-39. Subdistrict 1 commercial and subsistence chum salmon harvest, 1964–2009.

In Subdistricts 2 and 3, chum salmon subsistence harvests in the 2000s have been very minimal. In Subdistrict 2, chum salmon harvests averaged 1,767 fish from 2005 through 2009, only slightly more than one half the previous 10-year (1995–2004) average subsistence harvest of 3,237 chum salmon (Figure 5-40). In Subdistrict 3, an average of 1,216 chum salmon were harvested for subsistence from 2005 through 2009, slightly less than the previous 10-year (1995–2004) average subsistence harvest of 1,617 chum salmon (Figure 5-41). In most years since 2003, chum salmon runs have been insufficient to allow for a commercial harvest in Subdistricts 2 and 3. However, in 2007 there was a large surplus of chum salmon, but the buyer was only able to purchase fish in Subdistrict 3.

2010 Summary

Commercial chum salmon catches in Northern Norton Sound totaled 40,665 fish harvested in 2010. Subdistricts 2 and 3 had the highest chum salmon harvest in each subdistrict in over 20 years. The department’s longest operational salmon escapement monitoring project in Norton Sound at Kwiniuk River had the highest chum salmon escapement (71,388) in the 46-year history of the counting tower project.

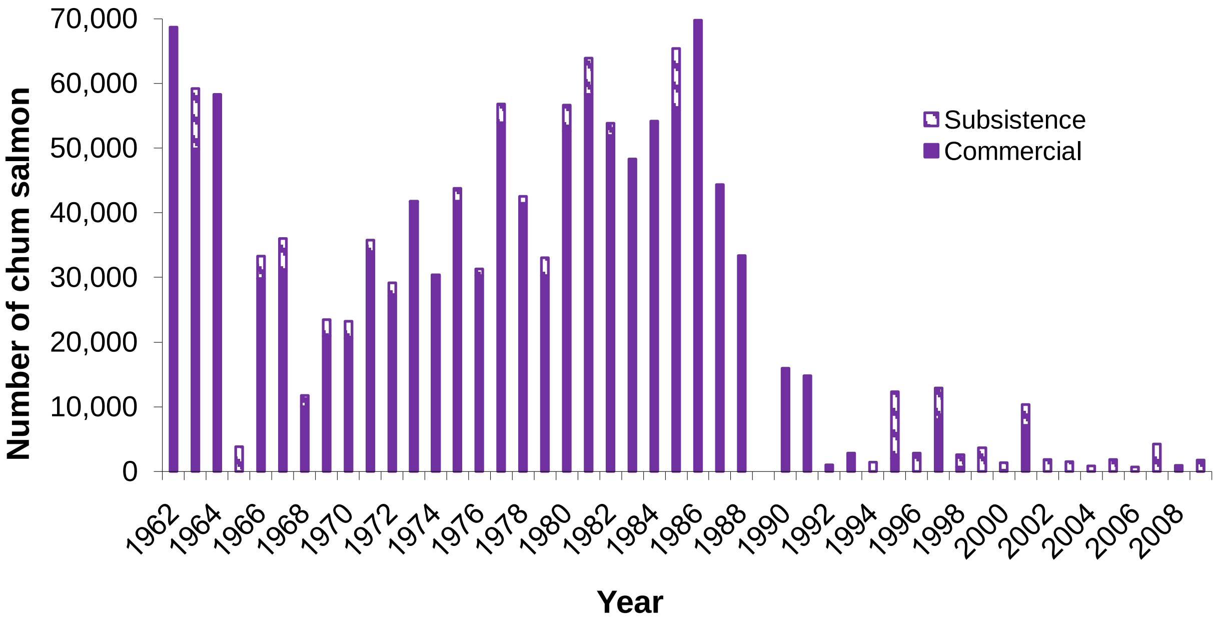


Figure 5-40. Subdistrict 2 commercial and subsistence chum salmon harvest, 1961–2009.

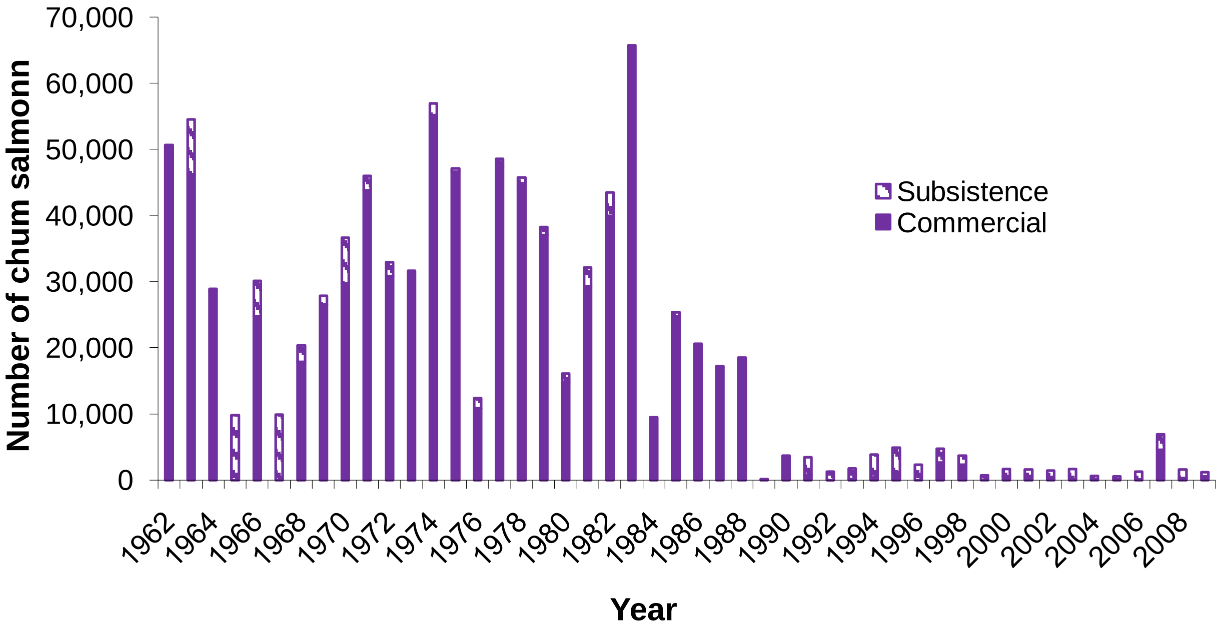


Figure 5-41. Subdistrict 3 commercial and subsistence chum salmon harvest, 1962–2009.

Exploitation Rates

Exploitation rates in Subdistrict 1 have declined since the early 1990s (Figure 5-42) and dropped from an average of 3.5% (1993–2004) to an average of 2.3% in the last 5 years (2005–2009). In Subdistrict 2, the exploitation rate has been more consistent in the 2000s then earlier years and has been trending up since 2007 (Figure 5-42) yet it has dropped from an average of 3.1% (1995–2004) to an average of 2.1% (2004–2009). The exploitation rate in Subdistrict 3 peaked in the late 1990s and has been decreasing since (Figure 5-42) with an average exploitation rate of 2.5% (2005–2009) down from 3.8% (1994–2004). These harvest rates are low in comparison to exploitation rates exerted on most Alaska salmon populations and primarily reflect low runs and lack of commercial markets during larger runs.

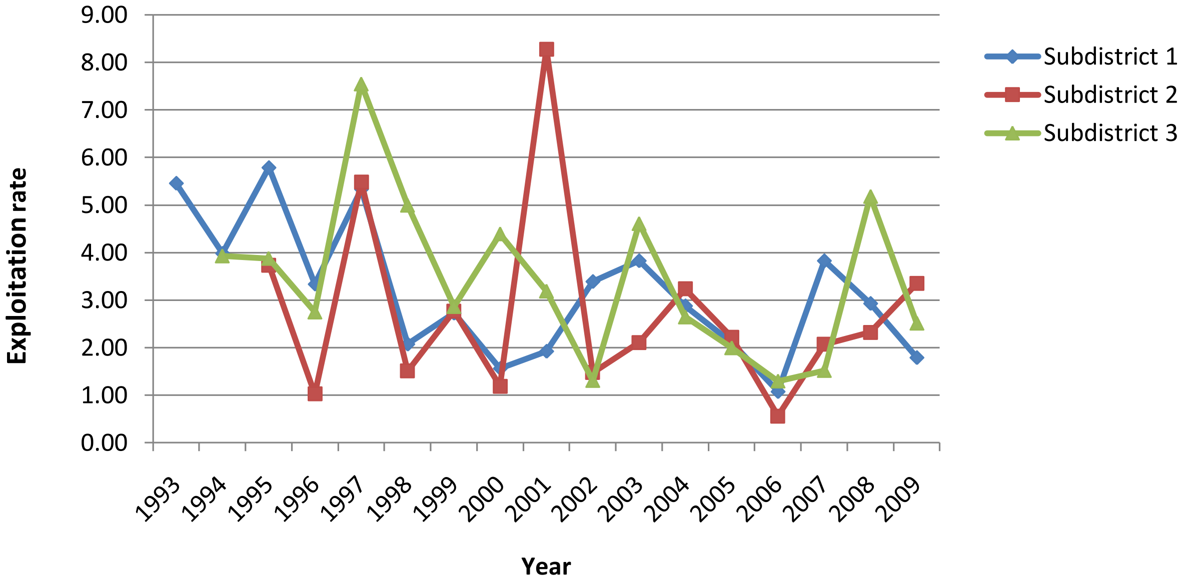


Figure 5-42. Exploitation rates in Subdistrict 1, 1993–2009; Subdistrict 2, 1995–2009; and Subdistrict 3, 1994–2009.

Outlook

Norton Sound Subdistricts 1–3 have no formal forecast for salmon returns. Broad expectations are developed based on parent-year escapements and recent year trends.

Processing capacity and management for anticipated low Chinook salmon abundance may result in chum salmon harvests that are lower than the outlook projections. Currently, Northern Norton Sound chum salmon stocks are classified as stocks of yield concern under the Sustainable Salmon Fisheries Policy. The estimated projected commercial harvest in 2011 is 90,000–120,000 fish for all subdistricts (1–6) combined in Norton Sound..

5.2.5.2 Eastern Norton Sound chum salmon

Eastern Norton Sound includes Subdistricts 4, 5, and 6 (Figure 5-32) 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.

Stock Assessment Background

Escapement

There are no escapement monitoring programs in Subdistricts 4 and 5. The historical average escapement as enumerated at the North River counting tower is 6,232 chum salmon and this has been exceeded 5 times in the last ten years (Table 5-19). 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 recent 5-year average (2005–2009) drainage-wide chum salmon escapement estimate of 69,591 chum salmon was 41% above the previous 9-year average (1996–2004) escapement estimate of 49,328 chum salmon (Table 5-20). Additionally, the number of chum salmon caught in 2008 and 2009 in the Unalakleet River test fishery was higher than in any other years over the 25 years the project has been operating (Table 5-21).

Table 5-19. Historical salmon migration passed North River counting tower, 1972–2009.

Year	Operating Period	Chum	Pink	Chinook	Coho
1972	July 07-July 28	2,332	54,934	561	
1973	June 29-July 23	4,334	26,542	298	
1974	June 25-July 17	826	143,789	196	
1984	June 25-July 28	2,915	458,387	2,844	
1985	June 27-Aug 31	4,567	4,360	1,426	2,045
1986	June 25-July 18	3,738	236,487	1,613	
1996	June 16-July 25	9,789	332,539	1,197	1,229
1997	June 16-Aug 21	6,904	127,926	4,185	5,768
1998	June 15-Aug 12	1,526	74,045	2,100	3,361
1999	June 30-Aug 31	5,600	48,993	1,639	4,792
2000	June 17-Aug 12	4,971	69,703	1,046	6,959
2001	July 05-Sept 15	6,515	24,737	1,337	12,383
2002	June 19-Aug 29	5,918	321,756	1,484	2,966
2003	June 15-Sept 13	9,859	280,212	1,452	5,837
2004	June 15-Sept 14	10,036	1,162,978	1,125	11,187
2005	June 15-Sept 15	11,984	1,670,934	1,015	19,189
2006	June 18-Sept 11	5,385	2,169,890	906	9,835
2007	June 16-Sept 05	8,151	580,929	1,948	19,965
2008	June 19-Sept 13	9,502	240,286	903	15,648
2009	June 19-Sept 11	9,783	189,939	2,352	22,266

Table 5-20. Historical salmon catches in the Unalakleet set gillnet test fishery, 1985–2009

		Chinook		Chum		Coho	
Year	Dates of Operation	Total Catch	Midpoint Date	Total Catch	Midpoint Date	Total Catch	Midpoint Date
1985	6/05-9/21	193	7/08	916	7/10	206	8/21
1986	6/17-9/10	52	6/26	1,063	7/23	163	8/18
1987	6/20-9/08	52	7/07	707	7/22	149	8/27
1988	6/20-9/12	15	6/27	662	7/25	216	8/12
1989	6/13-9/12	50	6/19	856	7/11	232	8/16
1990	6/15-9/13	43	6/20	383	7/14	284	8/21
1991	6/10-9/10	36	6/24	834	7/27	177	8/26
1992	6/27-9/08	25	7/12	976	7/12	455	8/12
1993	6/08-9/08	94	6/26	700	7/29	156	8/24
1994	6/16-9/07	35	6/22	949	7/02	297	8/22
1995	6/05-9/11	99	6/20	1,212	7/11	213	8/14
1996	6/05-9/11	138	6/14	1,635	7/06	717	8/06
1997	6/05-9/10	202	6/27	832	7/16	197	8/12
1998	6/05-9/09	110	7/07	535	7/18	220	8/17
1999	6/05-9/08	63	7/08	1,022	7/27	206	8/23
2000	6/05-9/08	61	6/28	1,075	7/18	257	8/16
2001	6/15-9/07	79	7/04	645	7/09	219	8/15
2002	6/05-9/08	44	6/26	852	7/08	394	8/25
2003	6/02-9/08	25	7/02	458	7/30	267	8/24
2004	6/02-9/10	29	7/01	976	7/17	829	8/15
2005	6/04-9/08	78	6/23	1,209	7/10	1,080	8/19
2006	6/08-9/14	79	6/30	1,482	7/01	1,738	8/16
2007	6/04-9/09	96	6/29	978	7/15	1,087	8/06
2008	6/09-9/13	123	7/07	1,932	7/18	1,988	8/15
2009	6/08-9/11	135	6/28	1,687	7/18	2,104	8/18

Table 5-21. Estimated chum salmon escapement, total harvest, and total run compared to exploitation rates, Unalakleet River, 1984–1986, 1996–2009.

	Escapement		Total		
Year	North River	Unalakleet R. Drainage[a]	Harvest [b]	Estimated Run Size	Exploitation Rate Percent
1984	2,915	21,123	46,665	67,788	68.8
1985	4,567	33,094	27,079	60,173	45.0
1986	3,738	27,087	30,239 [c]	57,326	52.7
1996 [d]	9,789	70,935	11,596	89,677	12.9
1997	6,904	50,029	18,742	59,277	31.6
1998	1,526	11,058	9,248	20,450	45.2
1999	5,600	40,580	9,392	46,280	20.3
2000	4,971	36,022	5,700	40,452	14.1
2001	6,515	47,210	4,430	51,426	8.6
2002	5,918	42,884	4,216	47,744	8.8
2003	9,859	71,442	4,860	78,520	6.2
2004	10,036	73,794	7,078	79,646	8.9
2005	11,984	118,653	5,852	128,086	4.6
2006	5,397	30,492	9,433	44,337	21.3
2007	8,151	59,066	13,845	79,519	17.4
2008	9,502	68,855	20,453	68,855	29.7
2009	9,783	70,891	23,614	94,505	25.0
Previous 9-yr Avg.	6,791	49,328	8,362	57,052	17.4
2005-2009 Avg.	8,963	69,591	14,639	83,060	19.6

[a] Drainage-wide escapement estimates for the 2004-2006 seasons calculated by expanding tower counts by North River proportional abundance estimates determined from radiotelemetry (0.136, 0.101, and 0.177, respectively). Drainage-wide escapements estimated for all other years by expanding tower counts by the average proportion (0.138) of chum salmon migrating into the North River, 2004-2006 (Estensen & Balland, *in prep*).

[b] Harvest includes commercial, subsistence, sport and Unalakleet River test fishery catches from 1984-1986 and 1996-2009.

[c] Subsistence harvest data unavailable in 1986 and was estimated by averaging subsistence harvest from 1981-1985.

[d] North River Tower not operational from 1987-1995.

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.

Maturity

The age composition of chum salmon in Subdistrict 5 was calculated from commercial fisheries in 2002, 2004, 2006, and 2007–2009. The commercial fisheries are dominated by age-4 chum salmon.

	Age				
	0.2	0.3	0.4	0.5	0.6
Commercial	0.064	0.463	0.437	0.045	0.000

In Subdistrict 6, age composition is determined by age, sex, and length data collected during the test fishery and the commercial fisheries. The test fishery is dominated by 5-year old chum salmon while the commercial fishery is predominantly 4-year old chum salmon. The disparity of age between the test fishery and the commercial catch may highlight a bias in fishing gear; the 5 7/8-inch mesh deployed in the test fishery preferentially selects large male chum salmon in the 5 and 6-year old age classes.

	Age				
	0.2	0.3	0.4	0.5	0.6
Test Fish	0.022	0.445	0.499	0.034	0.001
Commercial	0.024	0.535	0.415	0.027	0.000

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 in 2008 and 2009. Commercial chum salmon fishing has only occurred 6 times since 1987 and the harvest of 1,850 chum salmon in 2009 was the highest since 1988 (Table 5-22). A total of 7 permits holders participated at some time during the 2009 season compared to 4 permit holders in 2008. Subsistence harvest in Subdistrict 4 was not assessed from 2004–2007 but shows a slight decreasing trend with an average harvest of 4,826 chum salmon in the 1990s to an average harvest of 3,840 chum salmon in the 2000s (Table 5-22).

Table 5-22. Commercial and subsistence salmon catch by species, by year in Subdistrict 4, Norton Sound District, 1962-2009.

Year	Commercial	Subsistence
1962	24380	-
1963	12469	-
1964	5916	-
1965	-	3032
1966	-	3612
1967	-	2945
1968	-	1872
1969	3974	3855
1970		3500
1971	-	2619
1972	7799	2022
1973	4672	130
1974	3826	900
1975	17385	361
1976	7161	236
1977	13563	2055
1978	21973	1060
1979	15599	1400
1980	7855	1132
1981	3111	3515
1982	7128	2485
1983	17157	[a]
1984	3442	[a]
1985	9948	[a]
1986	1994	[a]
1987	3586	[a]
1988	7521	[a]
1989	-	[a]
1990	0	[a]
1991	0	[a]
1992	1787	[a]
1993	1378	[a]
1994 [b]	0	4581
1995 [b]	0	5828
1996 [b]	0	4161
1997 [b]	531	4040
1998 [b]	0	6192
1999 [b]	0	4153
2000 [b]	0	4714
2001 [b]	0	4445
2002 [b]	0	3971
2003 [b]	0	3397
2004	0	[a]
2005	0	[a]
2006	0	[a]
2007	0	[a]
2008	507	3330
2009	1850	3183

[a] Subsistence surveys were not conducted.

[b] Subsistence harvests were estimated from Division of Subsistence surveys.

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 2009 commercial harvest was 10,915 chum salmon, well above the recent 5-year (2004–2008) average of 3,520 fish (Figure 5-43).

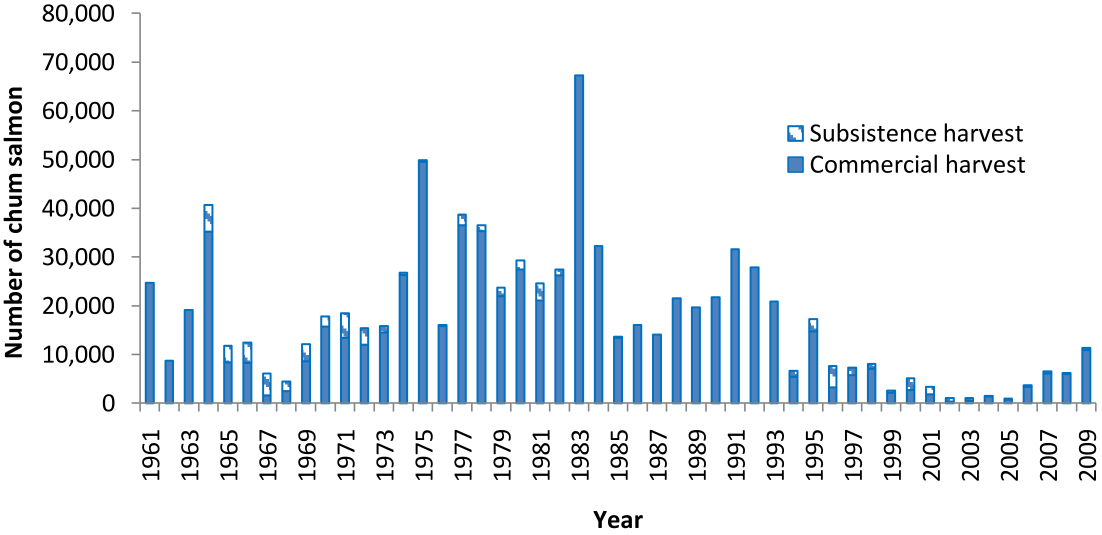


Figure 5-43. Commercial and subsistence chum salmon harvest in Subdistrict 5, 1961–2009.

In Subdistrict 6, commercial harvest is also showing an increase since 2006. The commercial harvest in 2009 of 20,647 chum salmon was well above the most recent 5-year (2004–2008) average of 8,855 fish. Subsistence harvest has remained relatively consistent since 2004 but has decreased slightly with an average harvest of 2,668 chum salmon in the 2000s down from an average of 3,557 chum salmon harvested in the 1990s (Figure 5-44).

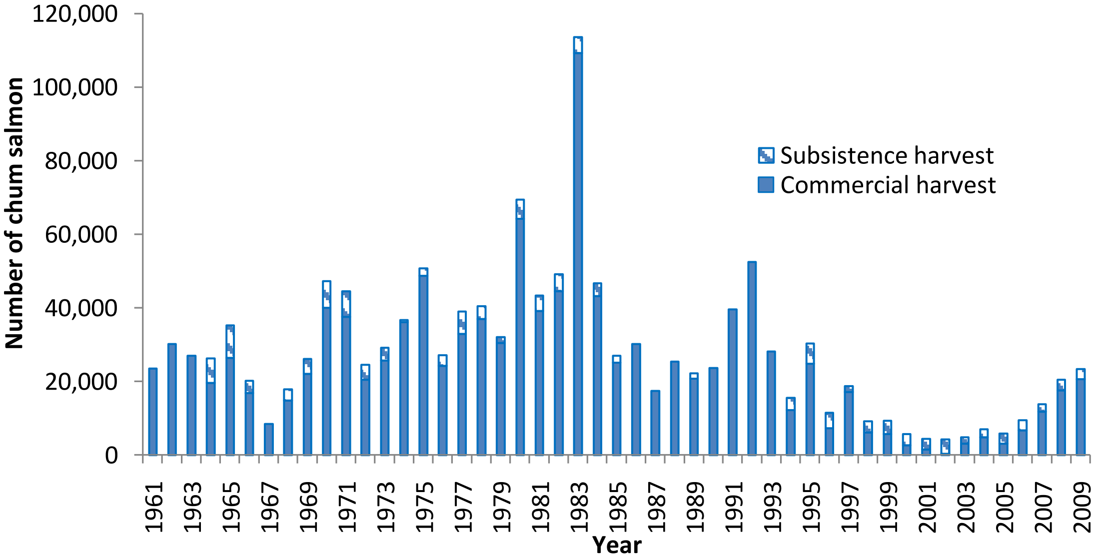


Figure 5-44. Commercial and subsistence chum salmon harvest in Subdistrict 6, 1961–2009.

Exploitation Rates

There are no complete escapement estimates for Subdistricts 4 and 5, hence it is not possible to calculate exploitation rates for these subdistricts. The exploitation rate of chum salmon in Subdistrict 6 is calculated using the drainage-wide escapement estimate and harvest. There is an increasing trend in exploitation since the early 2000s yet it is still well below the 1998 exploitation rate of 45% (Figure 5-45).

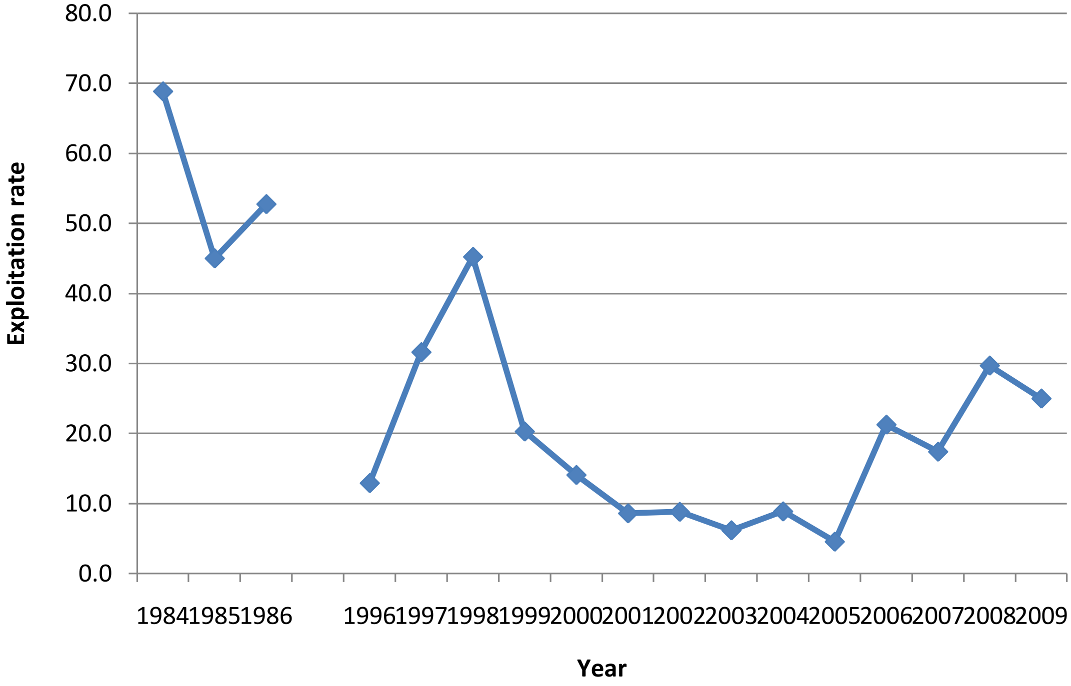


Figure 5-45. Exploitation rate of chum salmon in Subdistrict 6, Norton Sound, 1984–2009. Note: No data are available for 1987–1995.

2010 Summary

Commercial chum salmon catches in Eastern Norton Sound totaled 77,078 fish in 2010, well above the long-term average of 49,259 fish. Subdistricts 4 and 5 had the highest chum salmon harvest in each subdistrict in over 20 years, and Subdistrict 6 had the highest chum salmon harvest in 18 years. Additionally, the department's Unalakleet River test fishery had the highest chum salmon catch index in its 26-year project history.

Outlook

ADF&G does not produce formal run forecasts for most salmon runs in the AYK Region. Processing capacity and management for anticipated low Chinook salmon abundance may result in chum salmon harvests that are lower than the outlook projections. Currently, the estimated projected chum salmon commercial harvest for all subdistricts (1-6) in Norton Sound is 90,000 – 120,000 fish.

5.2.6 Kotzebue

Kotzebue Sound District encompasses all waters from Point Hope to Cape Prince of Wales, including those waters draining into the Chukchi Sea (Figure 5-46). 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.

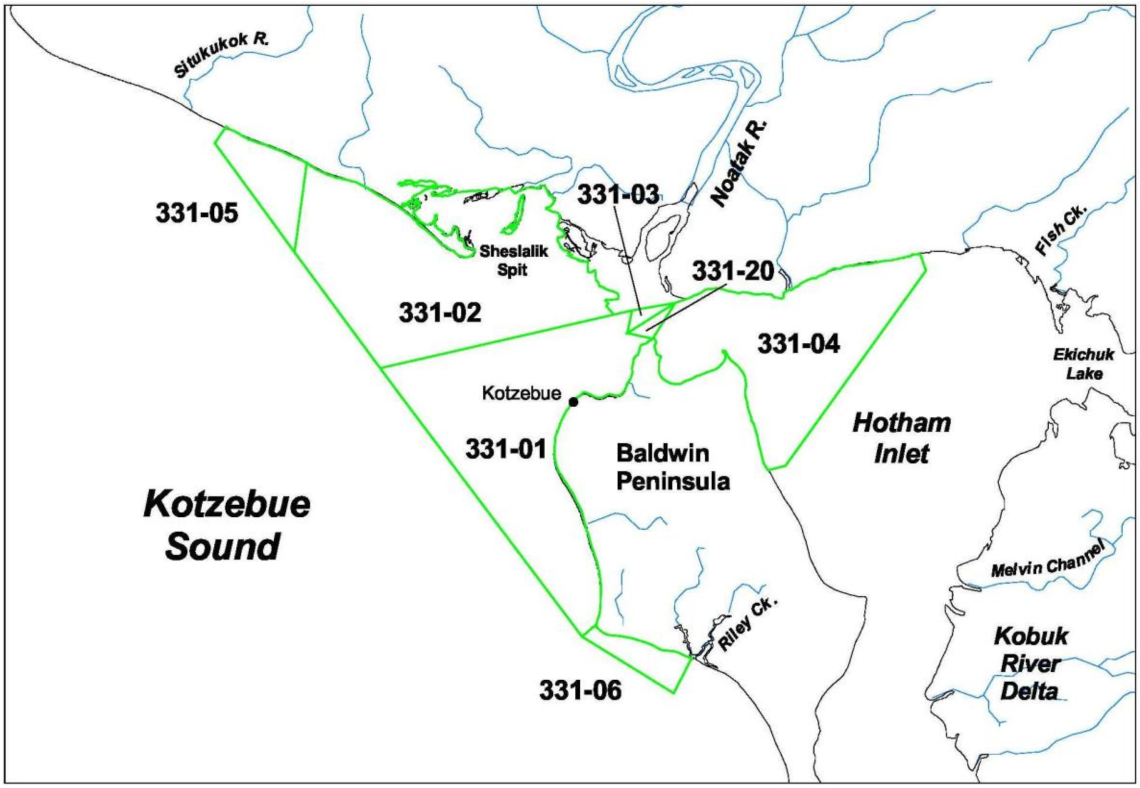


Figure 5-46. Kotzebue Sound commercial fishing subdistricts.

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 5-46). Commercial fishing began in 1962 primarily harvesting chum salmon, and in recent years has been limited by processing capacity

Subsistence salmon fishing in Kotzebue Sound District is important, but fish abundance and fishing activities vary between communities. Along the Noatak and Kobuk Rivers where chum salmon runs are strong, household subsistence activities in middle and late summer revolve around catching, drying, and storing salmon. In southern Kotzebue Sound other fish species may be taken for subsistence because salmon are not abundant.

Stock Assessment Background

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 5-47).

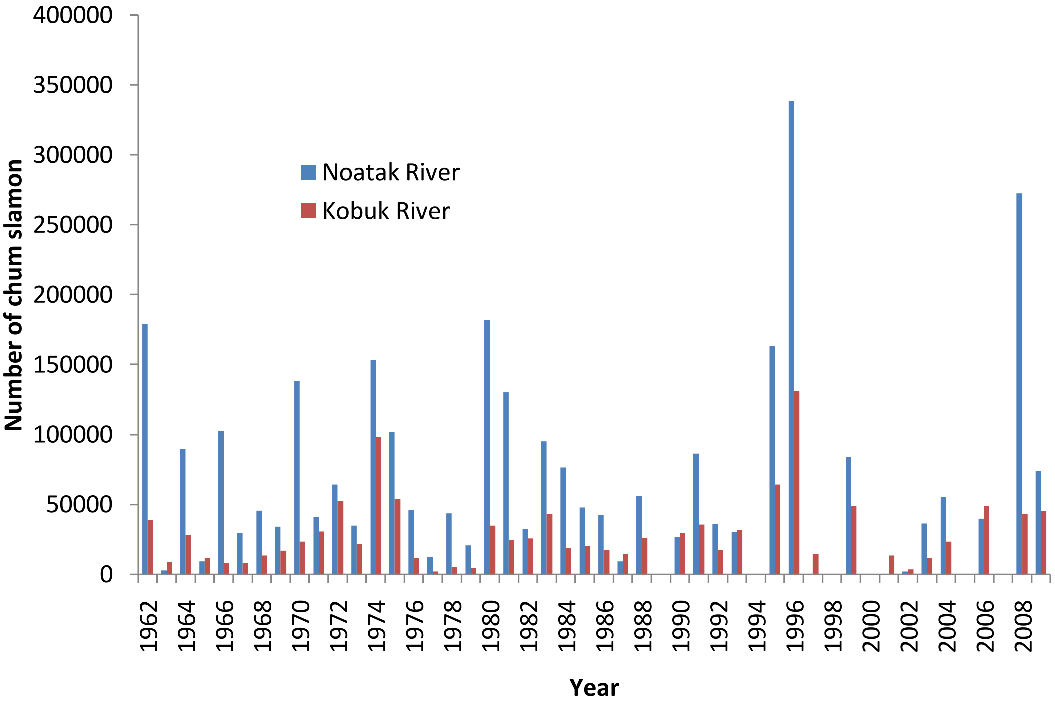


Figure 5-47. Chum salmon escapement in to the Noatak and Kobuk River drainages in Kotzebue Sound District determined by aerial surveys, 1962–2009. Note: Foot surveys were conducted in 1962 and 1968; blanks represent years with no surveys or poor survey conditions.

Escapement Goals

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

Maturity

The age composition of chum salmon from the Noatak River is obtained from a yearly test fishery. The average age composition (2001-2009) is dominated by 4-year old chum salmon.

	Age				
	0.2	0.3	0.4	0.5	0.6
Noatak River	0.064	0.605	0.290	0.035	0.006

The age composition for the Kobuk River is obtained from a test fishery conducted about 75 miles from the mouth. The 2002-2009 average age composition is predominantly ag-3 chum salmon.

	Age				
	0.2	0.3	0.4	0.5	0.6
Kobuk River	0.099	0.476	0.369	0.054	0.002

Age composition is also determined for the commercial chum fishery in Kotzebue Sound District. The 2003-2009 average age composition for the commercial fishery is dominated by 4-year old chum salmon.

	Age					
	0.2	0.3	0.4	0.5	0.6	0.7
Commercial	0.051	0.544	0.357	0.045	0.002	0.001

Harvest

Commercial harvest in Kotzebue Sound District has been limited because of processor capacity and lacked a local buyer in 2002–2003. The 2009 harvest of 187,000 chum salmon was well above the average harvest of 119,000 for the 2000–2008 time period, but is still well below harvests in the 1980s, which averaged close to 300,000 fish. The number of fishing permits is also rebounding slightly with 62, the highest number since 2001 (Figure 5-48). Subsistence harvest is not available beyond 2004.

<u>2010 Summary</u>

The overall chum salmon run to Kotzebue Sound in 2010 was estimated to be above average to well above average based on commercial harvest rates, subsistence fishermen reports, and the Kobuk test fish index being the fifth best in the 18-year project history. The commercial harvest of 270,343 chum salmon was the highest since 1995.

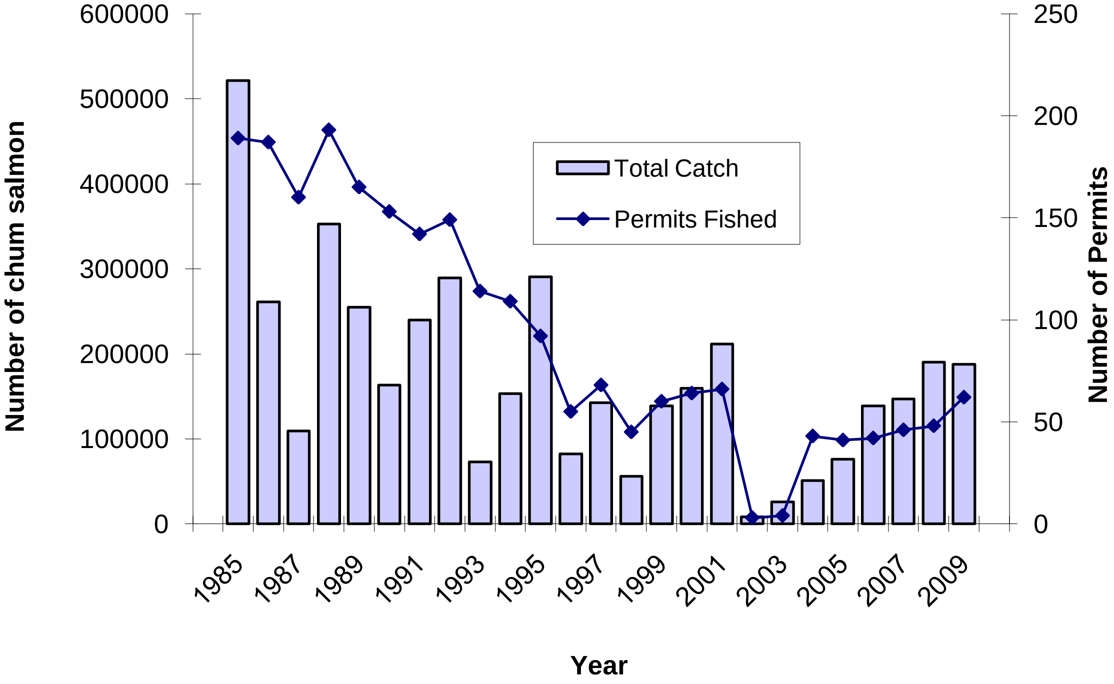


Figure 5-48. Kotzebue Sound commercial chum salmon harvest and permit fished, 1985–2009.

Exploitation Rates

There are no complete escapement estimates for the Kotzebue Sounds District; hence, it is not possible to calculate exploitation rates.

Outlook

Kotzebue Sound chum salmon fisheries have no formal forecast for salmon returns. Broad expectations are developed based on parent-year escapements and recent year trends.

ADF&G does not produce formal run forecasts for most salmon runs in the AYK Region. In general, processing capacity and management for anticipated low Chinook salmon abundance may result in chum salmon harvests that are lower than the outlook projections, in the AYK region. The estimated projected run size for chum salmon in Kotzebue Sound is 230,000–260,000 fish.

5.2.7 Alaska Peninsula/Area M

The Alaska Peninsula Area (Area M) includes the waters of Alaska on the north side of the Alaska Peninsula, southwest of a line from Cape Menshikof (57º 28.34' N. lat., 157º 55.84' W. long.) to Cape Newenham (58º 39.00' N. lat., 162º W. long.) and east of the longitude of Cape Sarichef Light (164º 55.70' W. long.) and on the south side of the Alaska Peninsula, from a line extending from Scotch Cap through the easternmost tip of Ugamak Island to a line extending 135º southeast from Kupreanof Point (55º 33.98' N. lat., 159 º 35.88' W. long.; Figure 5-49). Area M is further divided into two management areas, the North Alaska management area and the South Alaska management area. The two management areas will be summarized separately.

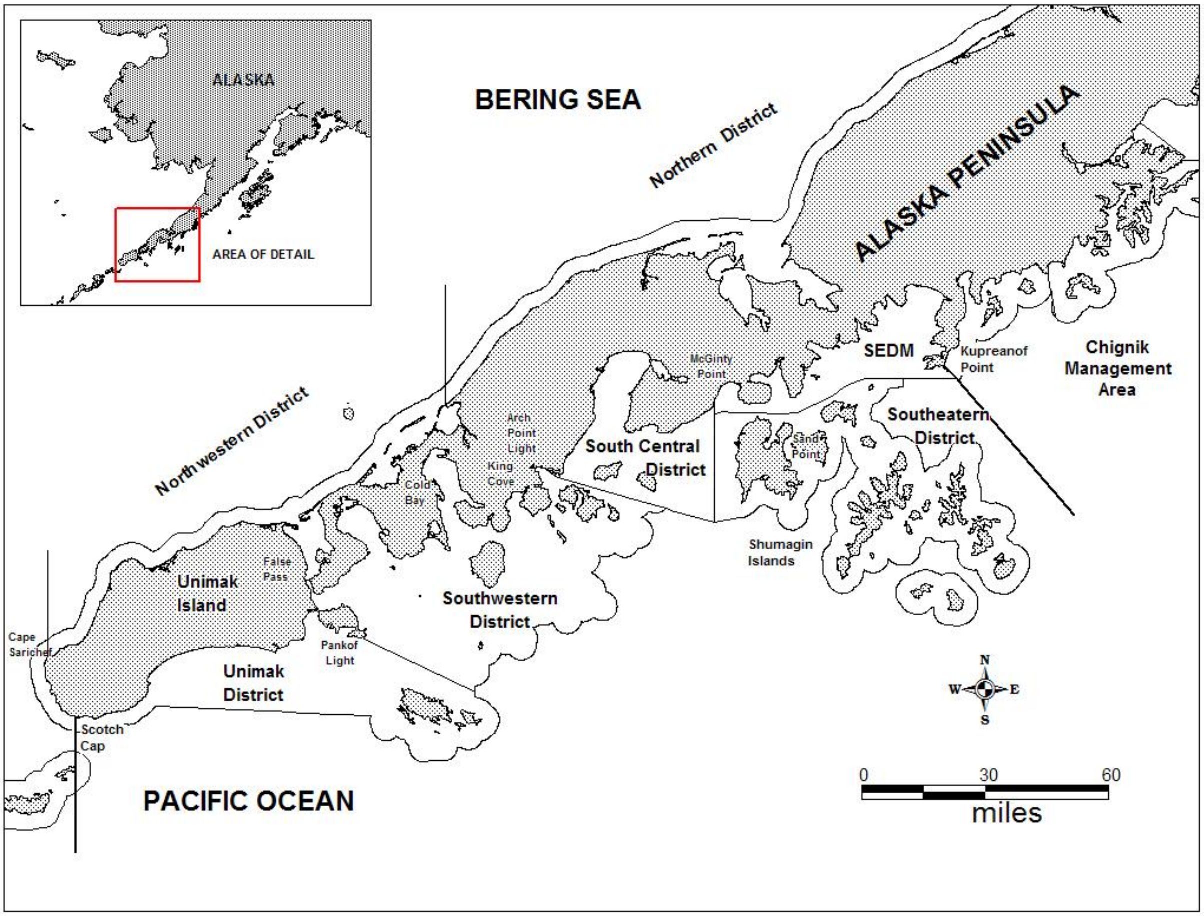


Figure 5-49. Alaska Peninsula/Area M identifying commercial salmon fishing districts.

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 (Table 5-23). 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.

Table 5-23. Area M chum salmon escapements by year and district, 1979-2009.

	Area M Salmon Management Districts						
Year	Northern	Northwestern	Unimak	Southwestern	Southeastern	South Central	Total
1979	114,900	190,400	500	107,900	134,100	168,600	716,400
1980	364,200	405,300	1,000	119,800	118,800	122,800	1,131,900
1981	276,400	264,600	100	146,700	118,400	116,100	922,300
1982	267,500	190,200	0	183,900	73,900	129,100	844,600
1983	199,100	193,500	0	117,600	160,400	168,500	839,100
1984	409,300	460,900	0	253,700	251,000	195,000	1,569,900
1985	123,900	220,400	0	218,800	112,300	172,400	847,800
1986	77,900	165,700	400	331,477	130,816	105,774	812,067
1987	161,400	341,500	493	327,910	154,207	169,267	1,154,777
1988	144,100	356,200	1,313	271,446	90,397	225,623	1,089,079
1989	102,300	110,000	321	144,034	103,997	94,107	554,759
1990	115,600	110,900	710	181,897	125,813	137,082	672,002
1991	81,500	221,800	540	278,929	276,545	170,262	1,029,576
1992	136,400	215,300	170	162,923	224,399	138,482	877,674
1993	183,400	219,000	1,070	300,251	40,632	211,293	955,646
1994	230,800	249,400	1,190	403,233	69,291	216,690	1,170,604
1995	347,800	408,300	736	556,707	127,150	295,161	1,735,854
1996	436,400	386,700	800	302,100	133,600	173,800	1,433,400
1997	161,000	227,200	3,300	263,700	267,650	274,400	1,197,250
1998	380,400	349,100	500	351,410	246,025	1,444,300	2,771,735
1999	299,500	366,800	1,000	388,130	82,550	253,500	1,391,480
2000	338,900	249,200	800	257,225	179,950	84,100	1,110,175
2001	285,900	520,026	400	277,021	318,300	155,500	1,557,147
2002	262,800	438,939	1,200	268,000	204,150	129,400	1,304,489
2003	214,660	252,577	200	193,030	218,810	79,000	958,277
2004	139,350	302,078	400	180,000	367,200	184,800	1,173,828
2005	103,675	226,582	4,200	317,910	412,500	235,700	1,300,567
2006	382,583	232,848	7,915	231,935	405,300	119,600	1,380,181
2007	243,334	431,456	1,200	398,010	201,451	126,000	1,401,451
2008	228,537	176,550	2,800	171,250	277,450	140,450	997,037
2009	154,131	84,460	1,400	385,730	106,500	18,600	750,821
1999-2008 Average	249,924	319,706	2,012	268,251	266,766	150,805	1,257,463

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 (Figure 5-49). In 2009, the Northern District chum salmon escapement goal (119,600 to 239,200 fish; Honnold et al. 2007) was met when 154,131 fish were documented in Northern District streams (Table 5-23; Figure 5-50). The Northwestern District chum salmon escapement of 84,460 fish did not meet the goal of 100,000 to 215,000 fish, and was below the previous ten year average of 319,706 fish (Table 5-23; Figure 5-51; Honnold et al. 2007). The total North Alaska Peninsula estimated chum salmon escapement of 238,591 was below the previous ten year average of 569,630 fish.

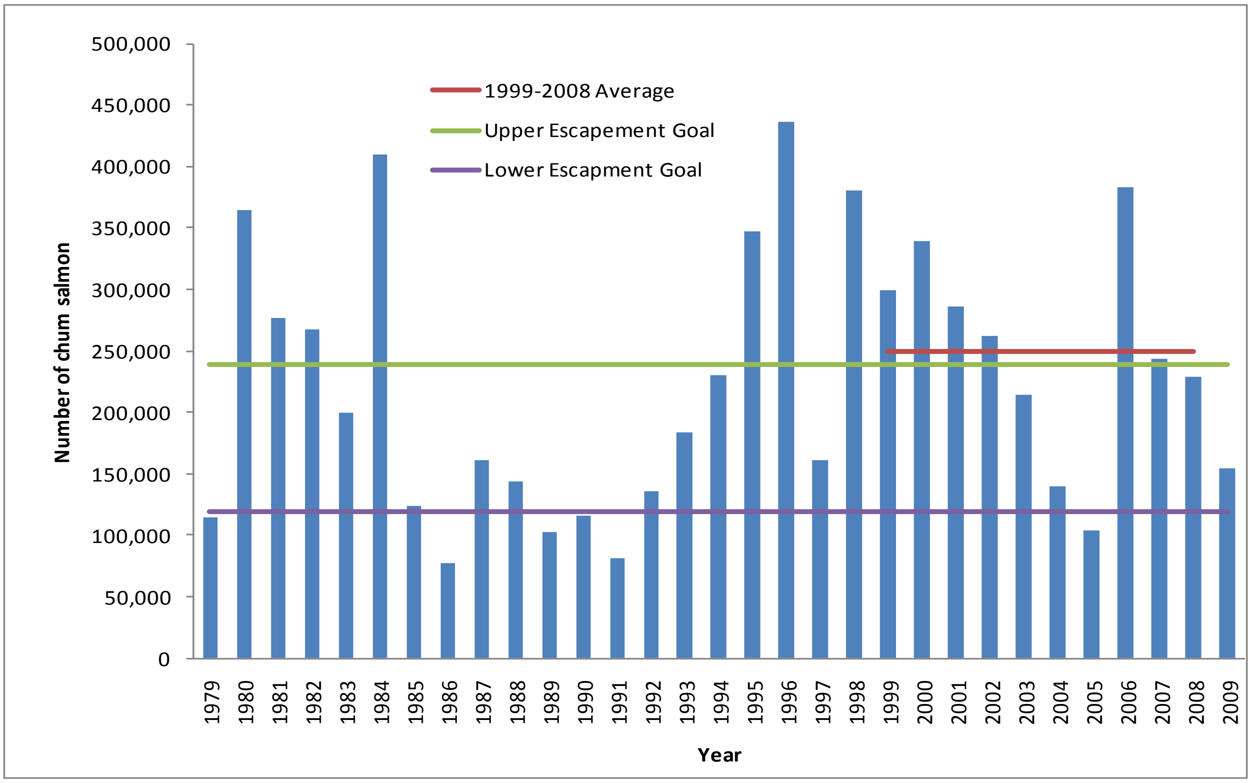


Figure 5-50. Northern District chum salmon escapement with comparison of upper and lower escapement goal and 10 year average, 1979-2009.

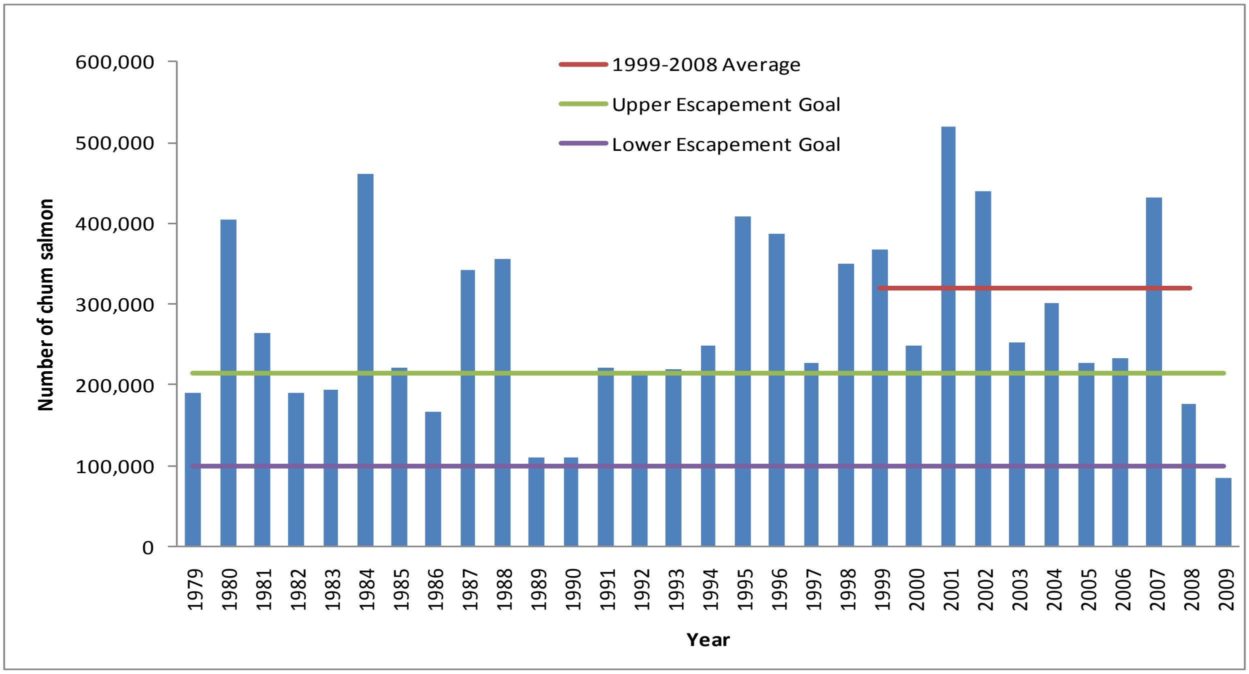


Figure 5-51. Northwestern District chum salmon escapement with comparison of upper and lower escapement goal and 10 year average, 1979-2009.

South Peninsula Chum salmon Escapement

Chum salmon are managed on district-wide SEGs of 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. 2007).

In 2009, chum salmon escapement in the Unimak District was 1,400 fish and was the only district to exceed its SEG (; Figure 5-52). Chum salmon escapement was within the established SEG for the Southeastern District (106,500; Figure 5-53) and the Southwestern District of (385,730 fish; Figure 5-54). The South Central District chum salmon escapement of 18,600 fish was below the SEG (Figure 5-55). South Peninsula total indexed chum salmon escapement of 512,230 fish was within the combined escapement goal range of 330,400 to 659,200 fish.

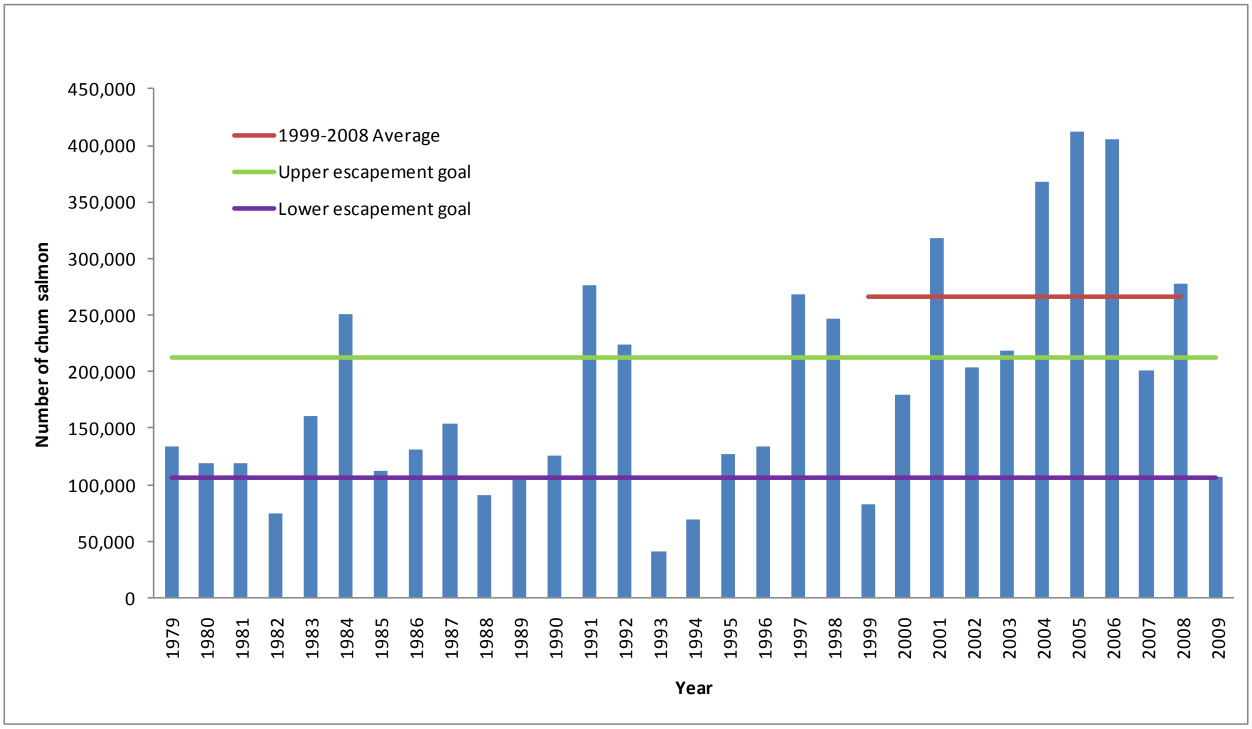


Figure 5-52. Unimak District chum salmon escapement including the lower escapement goal and 10-year average, 1979-2009.

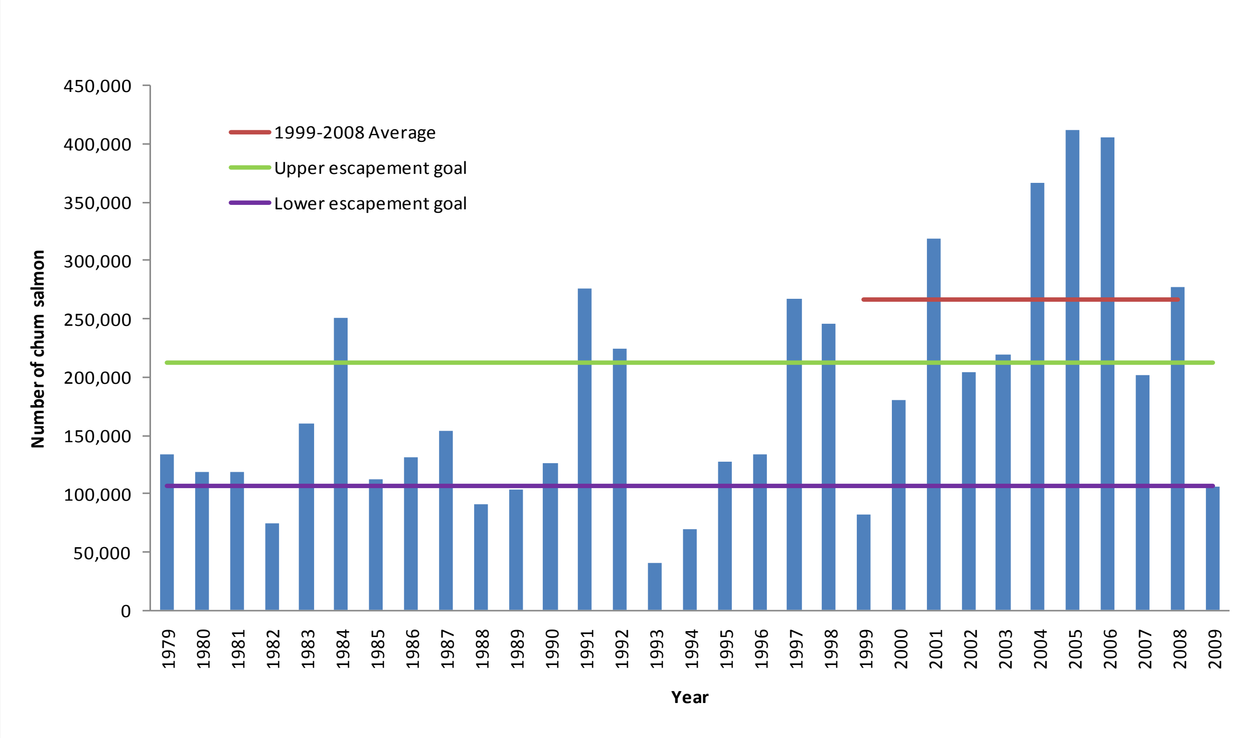


Figure 5-53. Southeastern District chum salmon escapement including the lower and upper escapement goal and 10-year average, 1979-2009.

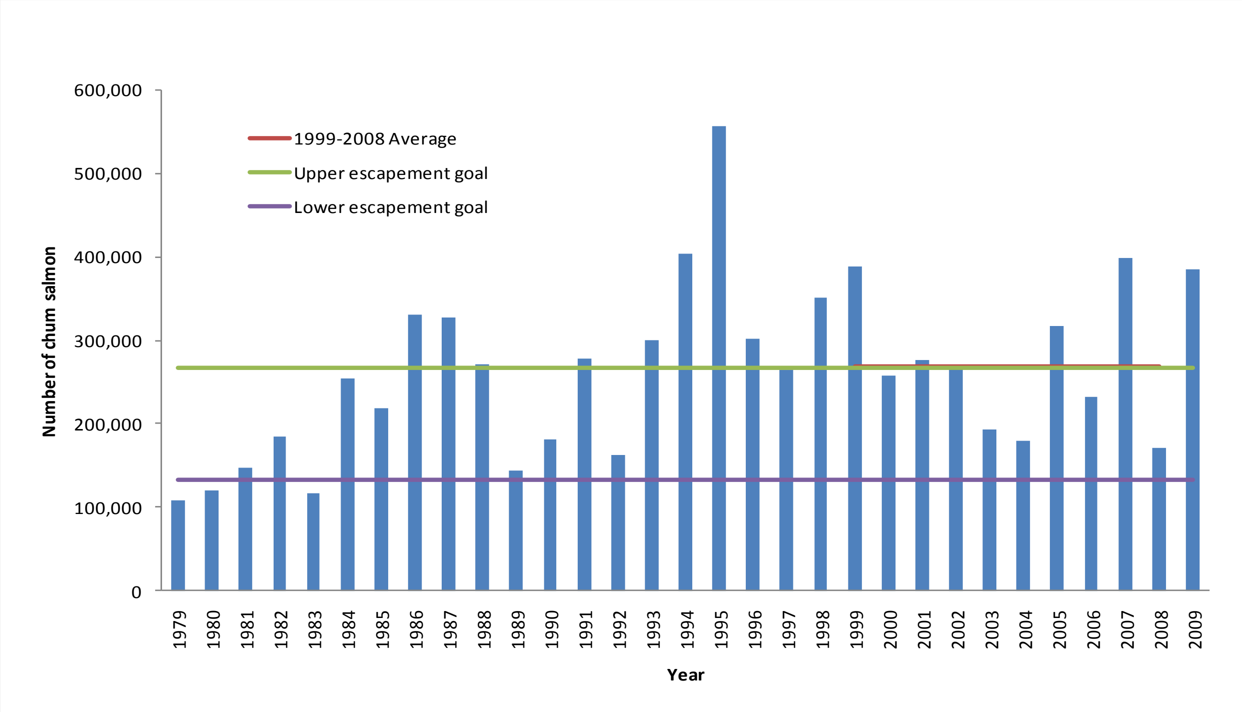


Figure 5-54. Southwestern District chum salmon escapement including the lower and upper escapement goal and 10-year average, 1979-2009.

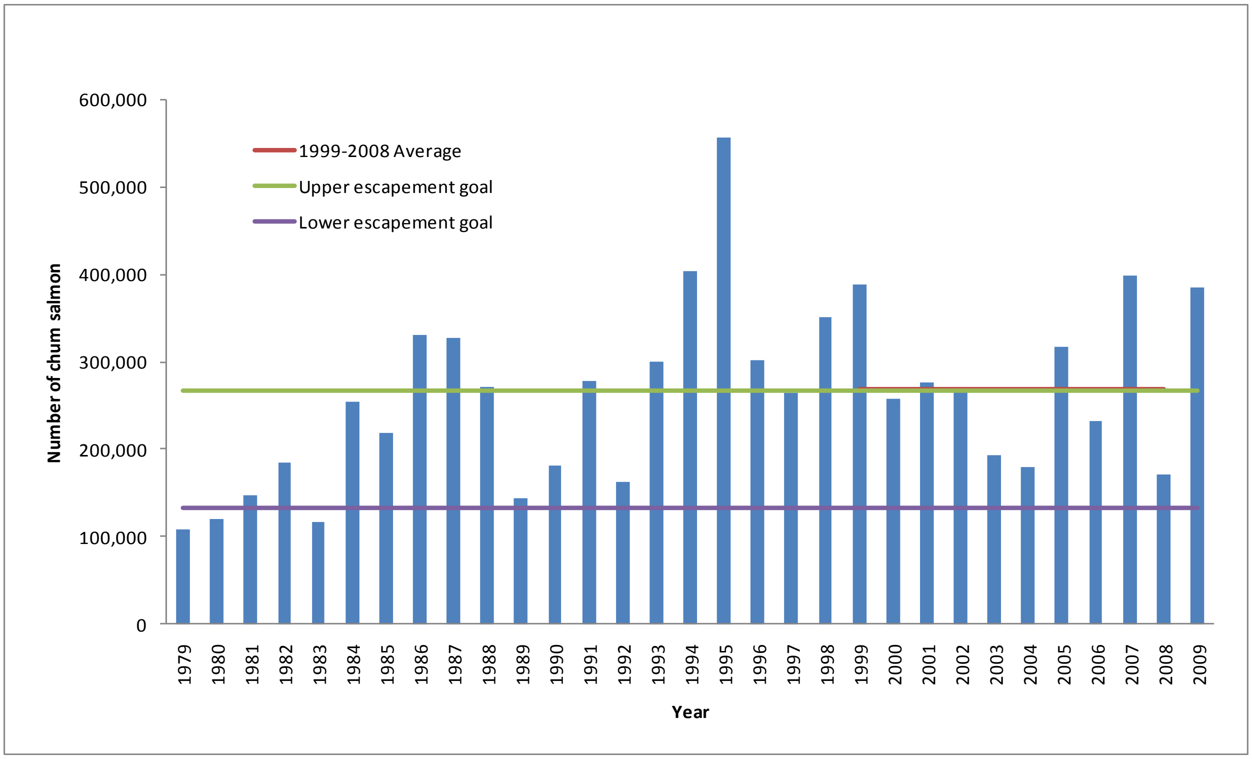


Figure 5-55. South Central District chum salmon escapement including the lower and upper escapement goal and 10 year average, 1979-2009.

Area M Commercial Chum Salmon Fishery

In 2009, 54 of the 119 available seine, 143 of 162 available drift gillnet, and 91 of 113 available set gillnet Area M permits were fished. Overall effort by the different gear groups was similar to the most recent ten year average. In 2009, the Alaska Peninsula Area commercial chum salmon harvest totaled 1,786,713 fish which was higher than the 1999-2008 average harvest of 939,588 (Table 5-24; Hartill and Keyes 2010).

The 2010 total Area M chum salmon harvest was approximately 1.05 million which was slightly above the recent 10-year average.

Table 5-24. Area M chum salmon harvest by year and district, 1979-2009.

Area M Salmon Management Districts							
Year	North	Northwest	Southeastern	South Central	Southwestern	Unimak	Total
1979	35,371	30,340	215,955	105,650	128,431	33,145	548,892
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
1999-2008 Average	48,594	46,978	409,176	68,616	257,085	109,140	939,588

North Alaska Peninsula

The 2009 North Alaska Peninsula chum salmon harvest of 105,994 fish was above the 1999-2008 average harvest of 95,572 fish. In the Northern District, the chum salmon harvest of 51,825 fish was just above the 1999-2008 average of 48,594 fish (Figure 5-56). The remaining 54,169 chum salmon were harvested in the Northwestern District, which was also above the previous ten-year average of 46,978 fish (Figure 5-57). In 2009, the chum salmon harvested in the Northern District were caught incidentally during sockeye salmon fisheries, while in the Northwestern District the majority of the chum salmon harvest was from directed fisheries (Hartill and Murphy 2010).

2010 summary

The total commercial harvest for the North Alaska Peninsula fishery was 259,063 chum salmon. 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 2010, the North Alaska Peninsula harvest of chum salmon was above the previous 10-year (2000–2009) average.

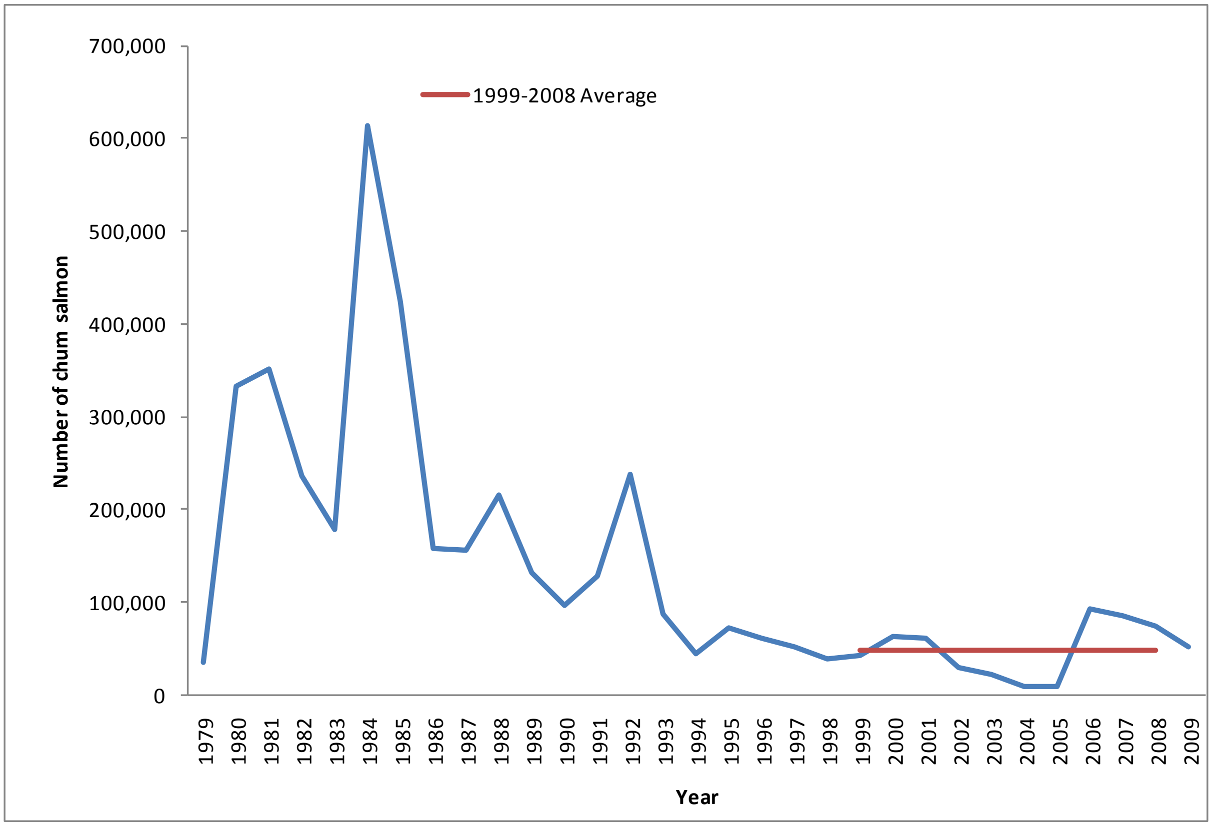


Figure 5-56. Northern District chum salmon harvest and 10-year average, 1979-2009.

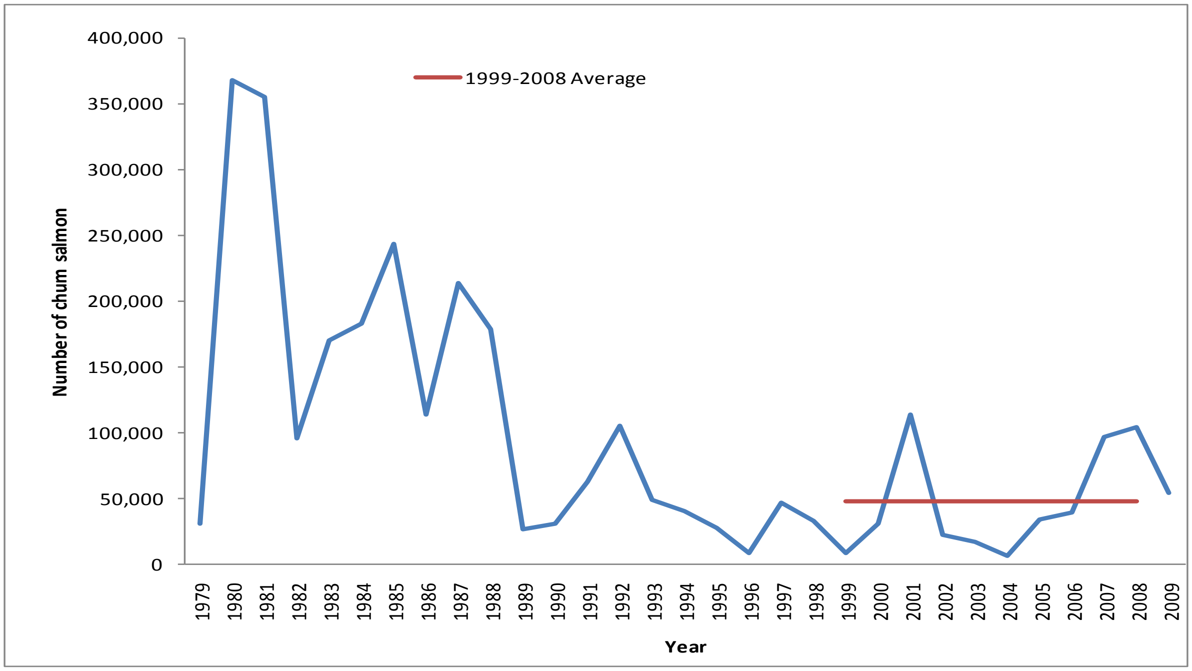


Figure 5-57. Northwestern District chum salmon harvest and 10-year average, 1979-2009

South Alaska Peninsula

The 2009 South Alaska Peninsula chum salmon harvest of 1,680,719 fish was well above the 1999-2008 average harvest of 844,017 fish. In the Southeastern District, the chum salmon harvest of 866,938 fish was above the 1999-2008 average of 409,176 fish (Figure 5-58). For the South Central District a total of 77,233 chum salmon were harvested which was slightly above the previous ten year average of 68,616 fish (Table 5-24; Figure 5-59). Fishermen in the Southwest District harvested 605,457 chum salmon which was higher than the 1999-2008 average harvest of 257,085 fish (Figure 5-60). A total of 131,091 chum salmon were harvest in the Unimak District, which was also above the previous ten-year average of 109,140 fish (Figure 5-61; Poetter et al).

2010 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 271,700 fish. The total commercial harvest for the South Peninsula post-June fishery (excluding the Southeastern District mainland) was 444,245 chum salmon. The Southeastern District Mainland section had a total harvest after June 18 of 74,186 chum salmon. Commercial salmon fishing did not take place from August 4-6 through September 14 in the South Alaska Peninsula due to low escapements of both pink and chum salmon. Chum salmon indexed total escapement (291,912) was below the escapement goal range (330,400–660,800).

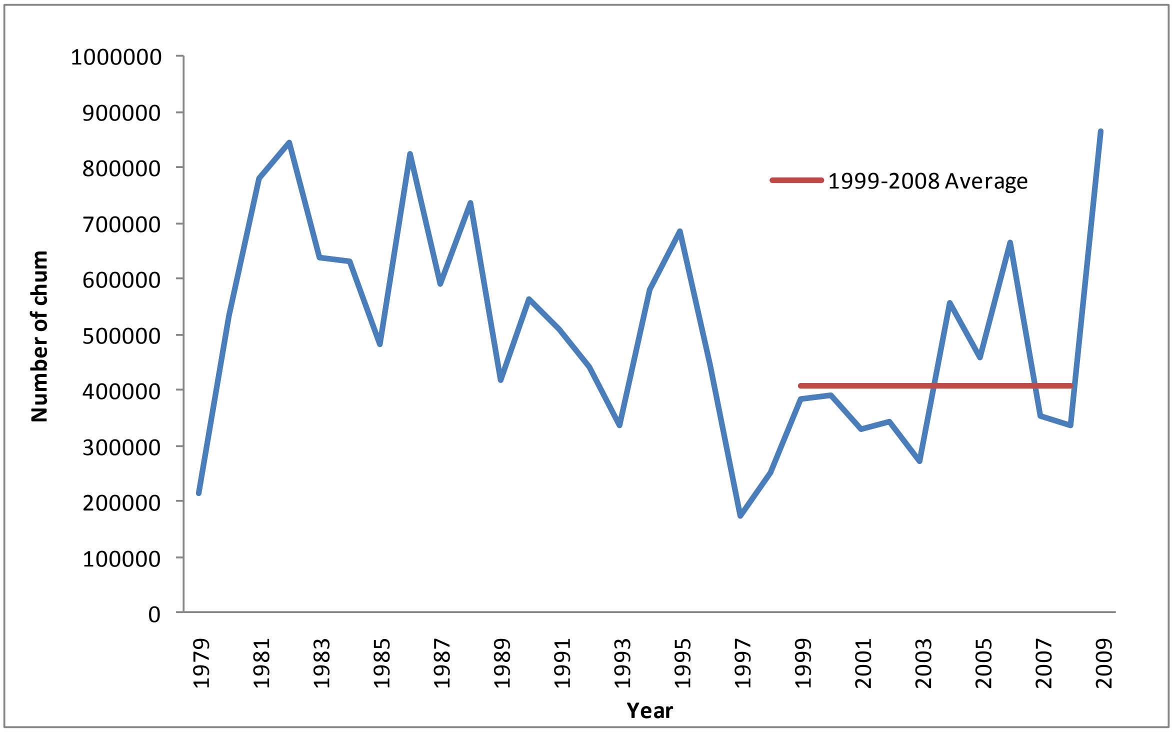


Figure 5-58. Southeastern District chum salmon harvest and 10-year average, 1979-2009

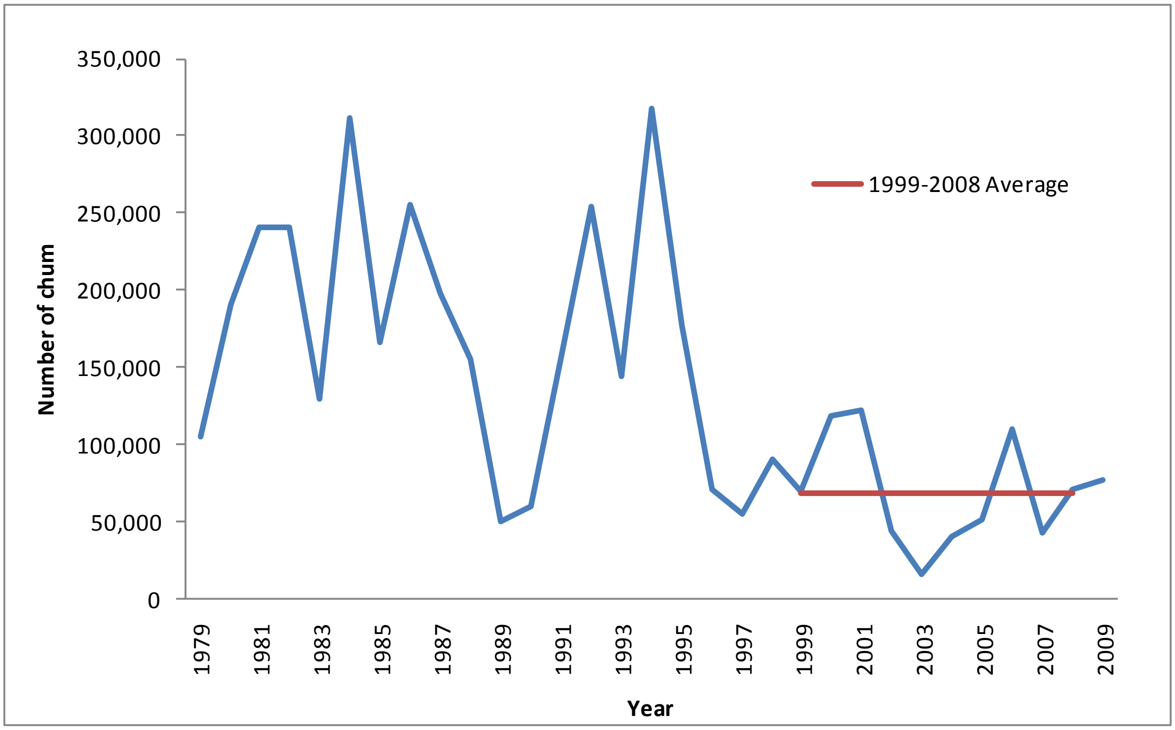


Figure 5-59. South Central District chum salmon harvest and 10-year average, 1979-2009

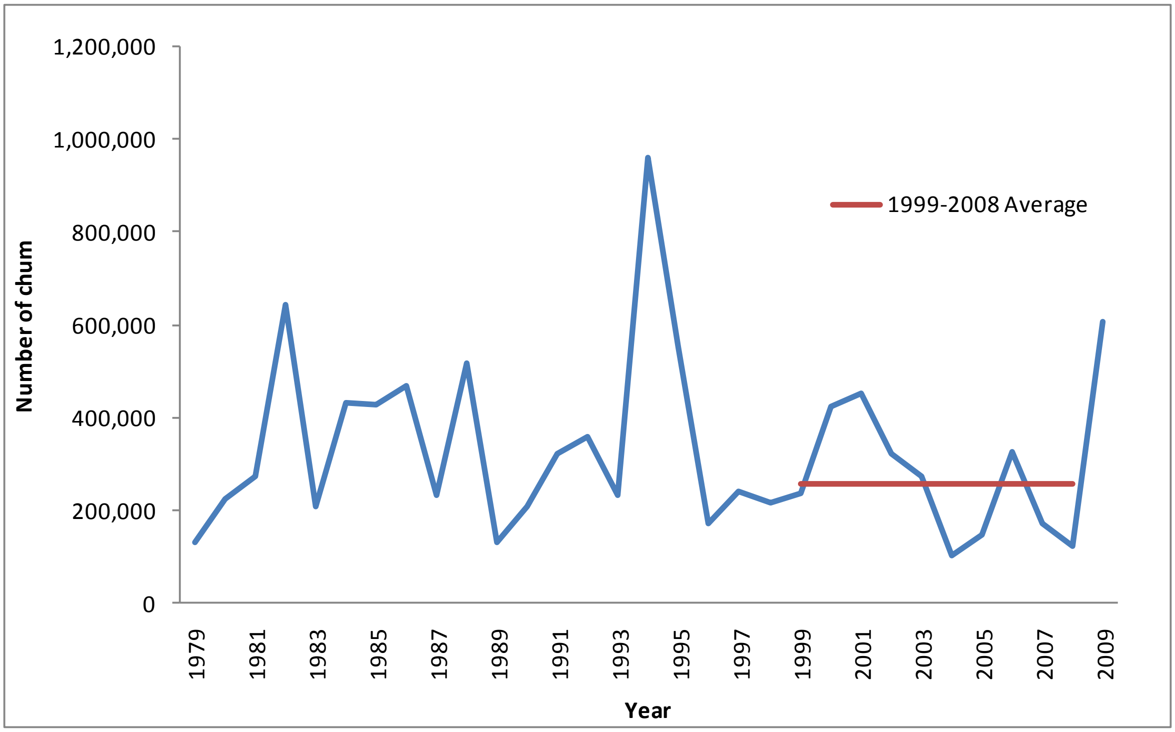


Figure 5-60. Southwestern District chum salmon harvest and 10-year average, 1979-2009

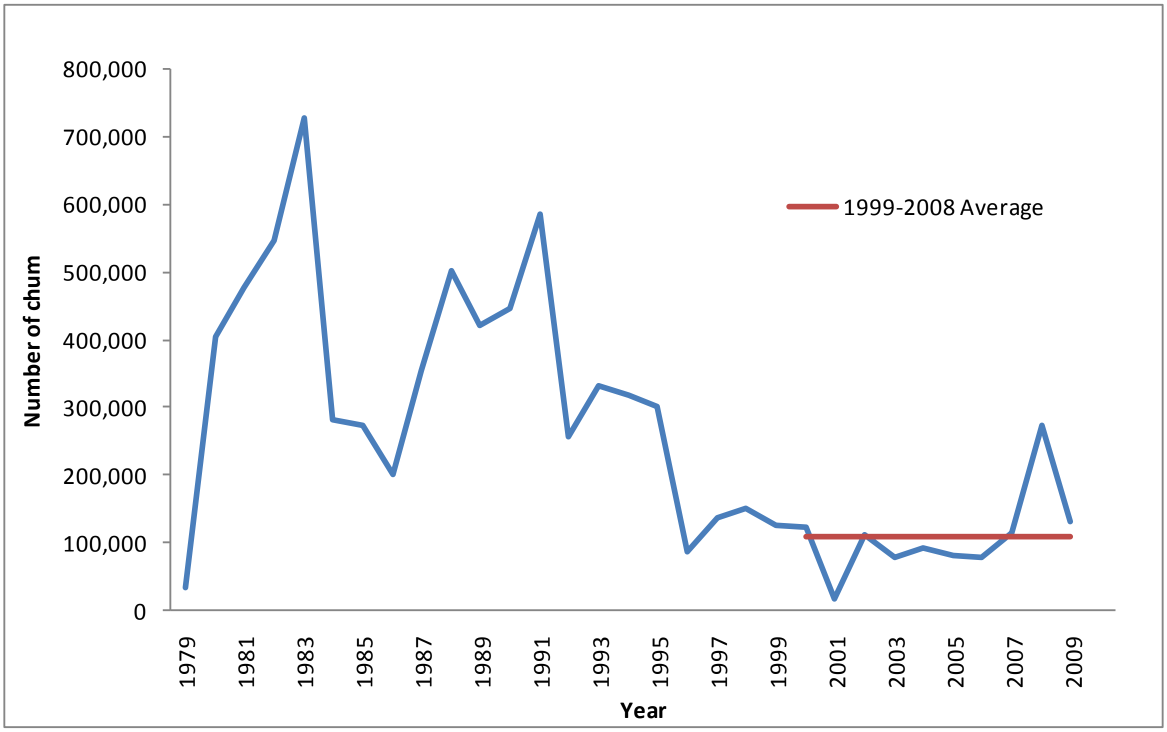


Figure 5-61. Unimak District chum salmon harvest and 10-year average, 1979-2009

Outlook

The Area M districts have no formal forecast for salmon returns. Broad expectations are developed based on parent-year escapements and recent year trends. The 2011 outlook and management plan will be available spring 2011.

5.2.8 Statewide summary for major western Alaska stocks

Western Alaska includes the Alaska Peninsula, Bristol Bay, Kuskokwim, Yukon, Norton Sound, and Kotzebue Sound management areas. Nushagak, Kuskokwim, Yukon, Unalakleet, and Kobuk rivers comprise the chum salmon index stocks for this region along with Kuskokwim Bay and Norton Sound stocks. Western Alaska chum salmon stocks declined sharply in the late 1990s through the early 2000s, rebuilt rapidly with record and near record runs in the mid 2000s, and abundance has been variable since 2007.

In 2010, all stocks exhibited average to above average abundance except for the South Alaska Peninsula stocks and Yukon River fall chum salmon, which were below average. Subsistence restrictions were implemented on the Yukon River fall chum run and six of eight escapement goals were achieved. Two of the four escapement goals in the South Alaska Peninsula were not achieved and the area was closed to commercial fishing from August 4 through September 14 due to low escapements of both pink and chum salmon. Norton Sound 2010 chum salmon runs were some of the strongest on record. More southerly stocks in Kuskokwim Bay and Nushagak River showed above average runs from 2008–2010 and the most northerly stocks in Noatak and Kobuk rivers were also above average.

Commercial fisheries occurred in most areas of western Alaska in 2010. North Alaska Peninsula, Norton Sound, and Kuskokwim Bay had some of the largest chum salmon commercial harvests on record. Two Yukon River (summer run) and Kuskokwim River chum salmon harvests were more modest owing to potential for incidental harvest of weak Chinook salmon stocks and limited processing capacity in the Kuskokwim River. Generally, these were the largest commercial harvests since 1998 for most of western Alaska, and in Norton Sound, since 1986. Commercial fisheries targeting Yukon River fall chum salmon were limited to a late season terminal fishery in the Tanana River, as some restrictions were placed on subsistence fisheries and the sport fishery was closed.

Overall, chum salmon escapement goals were easily achieved throughout western Alaska in 2010 (Table 5-51).

5.3 Chum salmon assessment overview for stock groupings outside western Alaska

5.3.1 Cook Inlet

5.3.1.1 Upper Cook Inlet

5.3.1.1.1 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 5-62). 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.

Figure 5-62. Upper Cook Inlet Management Area showing Northern and Central commercial fishing districts.

5.3.1.1.2 Commercial Chum Salmon Harvest

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.

In 2010, approximately 229,000 chum salmon were harvested by UCI commercial fishermen, which represented the second largest catch in the past 15 years. This harvest was nearly 116% more than the previous 10-year average annual harvest of 106,000 fish, yet more than 50% less than the average annual harvest of 458,000 fish taken from 1966-2009 (Figure 5-63). Assessing chum salmon stocks based on recent harvest trends is suspect, at best. 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 (Shields 2010).

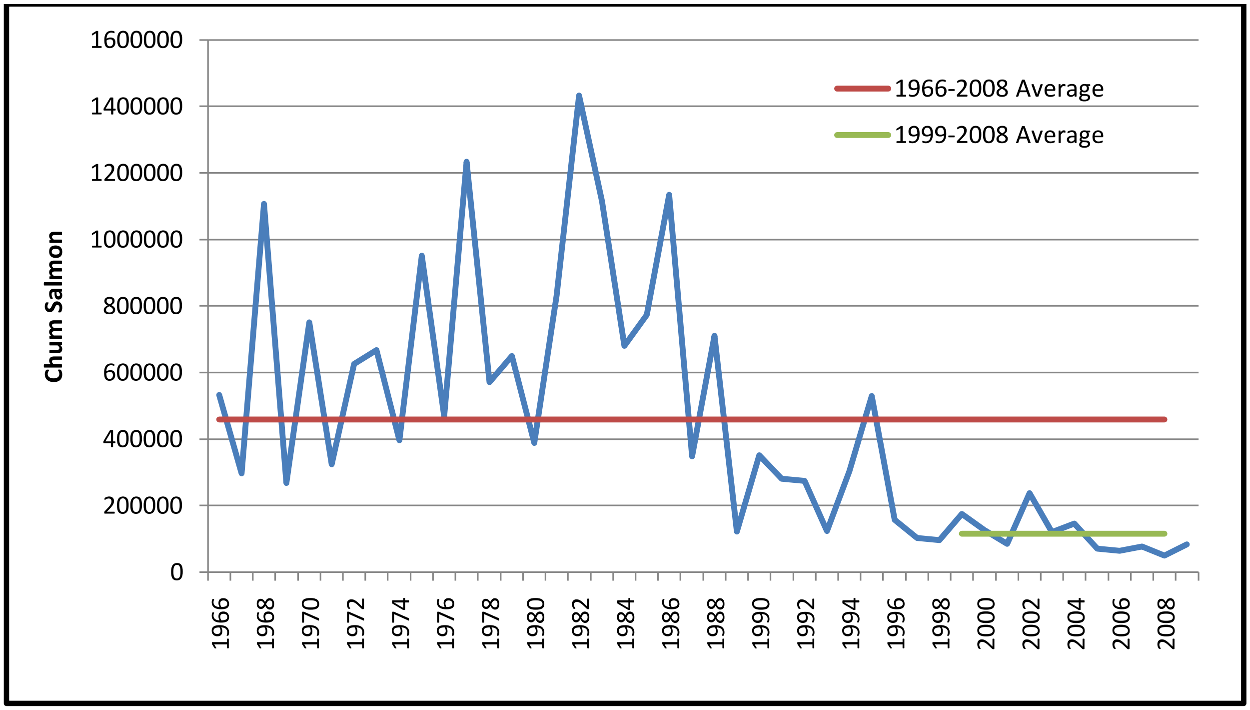


Figure 5-63. Upper Cook Inlet commercial chum salmon harvest, 1966-2009.

As shown in Table 5-25, 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.

Table 5-25. Upper Cook Inlet commercial chum salmon harvest by district and gear type, 2010

Gear	District	Subdistrict	Permits	Chum Salmon
Drift	Central	All	378	216,985
Setnet	Central	Upper	329	3,035
		Kalgin Is.	29	1,525
		Chinitna	<4	272
		Western	26	3,148
		Kustatan	10	2
		All	380	7,982
	Northern	General	60	3,179
		Eastern	31	524
		All	86	3,703
Seine	All		-	-
Total			846	228,670

5.3.1.1.3 Chum Salmon Escapement

Evaluation of chum salmon runs in UCI is made difficult because of the lack of information other than commercial harvest data. 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 (Table 5-28).

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. These actions have included: (1) significant reductions in the offshore drift gillnet and Northern District set gillnet fisheries to conserve Yentna River sockeye salmon; (2) adoption of the Northern District Salmon Management Plan (5 AAC 21.358), which states that its primary purpose is to minimize the harvest of coho salmon bound for the Northern District; (3) the lack of a directed chum salmon fishery in Chinitna Bay; and (4) harvest avoidance by the drift fishery as a result of lower prices being paid for chum salmon than for sockeye salmon. Other than the aerial census counts in Chinitna Bay, most of the sporadic chum salmon data available to assess annual runs can at best be used to make very general conclusions (i.e., the run was below average, average, or above average). The commercial chum salmon harvest in 2009 was better than the previous few years, but the UCI chum salmon run was still considered below average. It appears the 2010 chum salmon run, however, was above average. This characterization was corroborated by commercial harvest data, as well as catches in the offshore test fish (OTF) project, and aerial census escapement counts from Chinitna Bay. The 2010 OTF cumulative chum salmon CPUE of 737 was the second largest CPUE in the OTF project history. The peak aerial chum salmon census in Chinitna Bay of nearly 16,000 fish was the third largest estimate of escapement there since 1971. Based on a 2002 marine tagging study, which estimated the UCI commercial fishing exploitation rate on chum salmon at only 6%, and considering the escapement objective in Chinitna Bay has been consistently achieved, these limited data reveal no immediate concerns for UCI chum salmon stocks.

5.3.1.1.4 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 (except Chinook salmon, which must be released) for each additional member. The preliminary subsistence harvest for 2009 from Tyonek was two chum salmon and for the Yentna River drainage was six chum salmon (Table 5-26).

Educational fisheries in UCI first began in 1989. The total harvest from all salmon species educational fisheries in 2009 was 9,397 fish, which was the largest harvest ever recorded since the educational fisheries began. The average annual educational harvest from 1994 through 2009 has been approximately 6,008 fish. The 2009 education chum salmon harvest in UCI was 36 fish (Table 5-26).

As with the subsistence fishery, permit holders in the personal use fishery are allowed to harvest 25 salmon with an additional 10 salmon (except Chinook) for each household member. Personal use fishing takes places primarily with dip nets in the Kenai, Kasilof, and Beluga (senior citizens only) Rivers and in some years at Fish Creek. A personal use fishery with set gillnets also takes place in salt water at the mouth of the Kasilof River (Table 5-26).

Table 5-26. Upper Cook Inlet subsistence, educational, and personal use chum salmon harvest, 1998-2010.

Year	Chum Salmon 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	52
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

5.3.1.1.5 2011 Upper Cook Inlet Chum Salmon Forecast

Very little information is available on which to base outlooks for the commercial harvests of chum salmon in UCI. Using recent harvest trends and factoring in the expected intensity of the sockeye-based fishery, ADF&G forecasted a 2011 chum salmon harvest of approximately 101,000 fish.

5.3.1.2 Lower Cook Inlet

5.3.1.2.1 Description of Management Area

The Lower Cook Inlet (LCI) management area, comprised of all waters west of the longitude of Cape Fairfield, north of the latitude of Cape Douglas, and south of the latitude of Anchor Point, is divided into five commercial salmon fishing districts (Figure 5-64). 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.

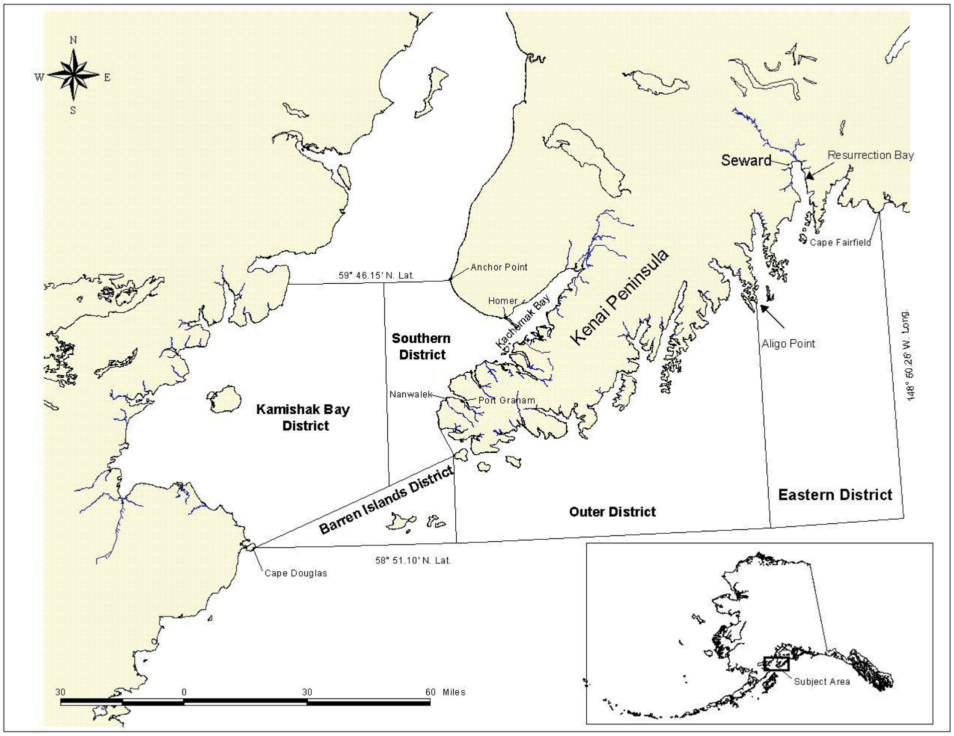


Figure 5-64. Lower Cook Inlet Management Area showing the five management districts.

Several hatchery facilities occur in Lower Cook Inlet and while salmon fisheries enhancement continues to play a major role in LCI salmon production as it has over the past three decades, 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.

Commercial Chum Salmon Harvest

The cumulative 2010 LCI all-species commercial salmon harvest of slightly more than 468,000 fish was the lowest for the management are in 35 years and was characterized by below 10-year average harvests of all salmon species except chum salmon. Commercial harvests in 2010 of chum salmon, at nearly 95,000 fish, were slightly greater than the recent 10-year average (87,000 fish) but almost double the 20-year average (48,600 fish) (Figure 5-65).

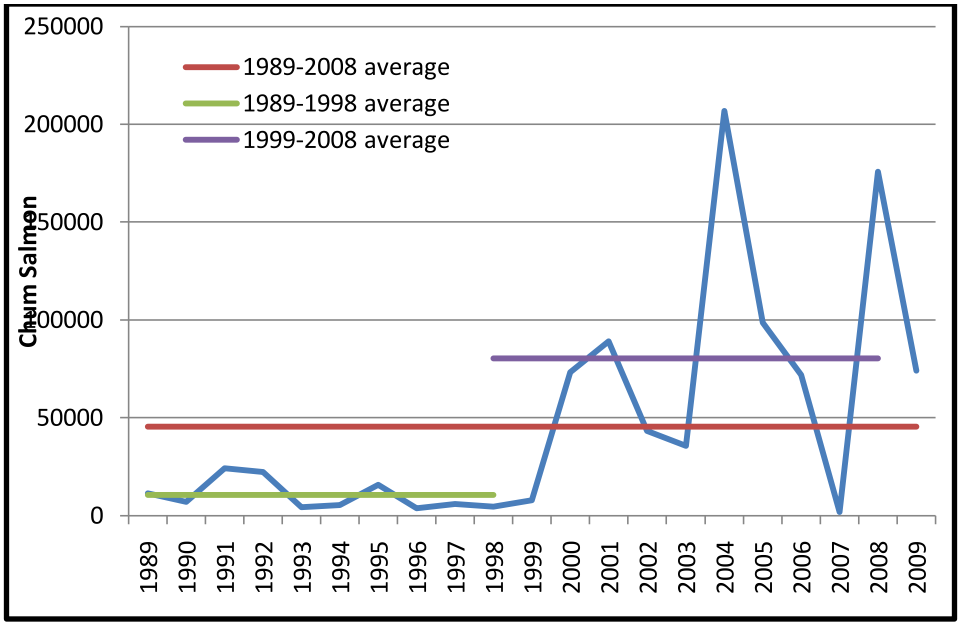


Figure 5-65. Lower Cook Inlet commercial chum salmon harvest for all gear and harvest types, 1990-2010.

After a disappointingly weak chum salmon season in 2007, chum salmon runs have since rebounded and were a major bright spot for the LCI area in 2010, marking the tenth season out of the past eleven that produced relatively strong chum runs coupled with moderate to good catches. The 2010 chum salmon harvest was the fourth highest for the species in LCI during the past two decades and exceeded the average harvest over the past 10 years by about 9%. The LCI area-wide commercial chum salmon harvest for the 2010 season was dominated by seine catches from Kamishak Bay District, on the west side of the management area, at three-fourths of the total, followed by seine catches in the Outer District (24%), with set gillnet catches in the Southern District accounting for the remaining 2% (Table 5-27).

Table 5-27. Commercial and hatchery chum salmon catches by district and gear type, 2010. Note: Figures for 2010 do not include a very small number or fish caught during commercial fishing but not sold (i.e., retained for personal use).

District	Harvest Type	Gear Type	Chum Salmon
Southern	Commercial	Set Gillnet	1,503
		Purse Seine	-
	Hatchery	Purse Seine	4
		Total	1,507
Outer	Commercial	Purse Seine	22,463
Eastern	Commercial	Purse Seine	-
	Hatchery	Purse Seine	-
		Weir	-
Kamishak Bay	Commercial	Purse Seine	70,785
	Hatchery	Purse Seine	-
		Total	70,785
LCI Total			94,755
1990-2009 Average			48,550

Chum Salmon 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 2010, escapements into most LCI chum salmon systems were sufficient to achieve SEG goals, with the exception of McNeil river in Kamishak Bay District and Island Creek in the Outer District (Table 5-28).

Subsistence and Personal Use Chum Salmon Harvest[24]

Subsistence and personal use chum salmon fisheries occur primarily in the Southern District of LCI in Nanwalek/Port Graham, and Seldovia. One of LCI's two subsistence salmon fisheries during 2010 occurred near the villages of Nanwalek (formerly English Bay) and Port Graham, located approximately 21 nautical miles southwest of Homer on the south side of Kachemak Bay. Gear in this fishery is limited to set gillnets. 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") Bay, located about seven nautical miles south of English Bay, targeting non-local stocks of Chinook salmon as well as local stocks of chum salmon. In 2010, Port Graham subsistence fishermen reported a harvest of 37 chum salmon out of a total 331 salmon. Nanwalek subsistence fishermen in 2010 reported 271 chum salmon harvested out of a total 4,139 salmon.

2011 Lower Cook Inlet Chum Salmon Forecast

Preliminary commercial harvest forecasts for Lower Cook Inlet chum salmon are expected to total up to 49,000 fish in 2011. However, no formal forecasts are prepared for this species, and these projections are based strictly on annual average harvests in LCI since 1989.

---

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

Table 5-28. Estimated chum salmon escapements in thousands of fish for the major spawning systems of Lower Cook Inlet, 1990 - 2010.

Year	Port Graham	Dogfish Lagoon	Rocky River	Pt. Dick Head	Island Creek	Big Kamishak	Little Kamishak	McNeil River	Bruin Bay	Ursus Cove	Cotton-wood	Iniskin Bay	Total
1990	2.6	1.0	0.8	1.1	2.3	2.5	7.9	8.0	4.0	3.8	4.3	8.4	46.7
1991	1.1	3.1	---	7.4	17.3	8.7	8.4	10.0	6.0	1.3	7.7	8.3	79.3
1992	1.4	0.8	1.7	5.4	6.7	4.5	7.1	19.2	8.5	1.7	6.1	3.4	66.5
1993	2.5	5.4	0.1	2.5	3.6	9.1	6.3	17.4	6.0	7.7	12.0	8.0	78.8
1994	5.2	11.3	1.9	3.5	8.8	---	9.0	15.0	6.1	6.2	10.2	18.9	96.1
1995	3.8	4.2	5.1	3.3	7.7	[a]	[a]	14.4	6.6	11.1	15.4	22.7	90.9
1996	3.7	6.7	2.0	2.3	6.9	11.1	4.4	16.1	14.9	7.6	16.1	7.8	99.6
1997	4.1	12.7	1.1	1.9	5.2	---	---	27.5	8.8	6.2	5.6	15.4	88.5
1998	5.1	9.8	0.7	1.8	3.4	7.1	9.7	23.5	9.4	4.6	2.3	18.6	96.0
1999	6.6	18.8	5.4	2.9	16.4	11.6	8.9	13.5	10.3	21.0	12.0	23.3	150.7
2000	11.4	19.6	4.2	3.4	12.1	45.3	26.9	18.6	13.6	41.7	24.1	23.6	244.5
2001	6.0	6.1	3.0	1.8	6.3	36.3	27.2	17.0	21.8	37.7	15.9	13.8	192.9
2002	5.3	10.1	5.7	12.3	15.3	17.4	16.4	11.3	9.9	17.1	42.2	28.5	191.6
2003	2.9	13.3	5.5	5.6	16.3	16.4	22.2	23.3	13.1	30.4	72.8	18.7	240.5
2004	1.2	3.6	17.2	8.6	15.1	57.9	45.3	11.2	15.9	16.0	16.3	22.0	230.3
2005	0.7	2.7	6.1	4.8	20.7	25.7	12.1	17.4	21.2	12.2	17.9	16.5	158.0
2006	2.2	5.4	11.2	2.8	5.6	58.2	42.9	28.2	7.0	15.7	13.2	15.6	208.1
2007	1.9	4.9	1.6	2.8	3.1	14.8	15.6	13.6	3.1	20.9	12.5	5.3	100.0
2008	1.8	6.2	3.8	11.8	12.9	4.5	21.3	9.8	17.5	6.5	11.6	20.0	130.0
2009	1.0	4.4	2.5	5.6	9.3	15.0	4.2	18.8	10.1	12.9	19.4	30.8	140.3
2010	1.4	12.7	1.3	2.4	3.4	[a]	18.4	10.5	6.2	11.8	15.8	19.3	103.2
20-Year Avg.	3.5	7.5	4.2	4.6	9.8	20.4	16.4	16.7	10.7	14.1	16.9	16.5	141.2
1990–1999 Avg.	3.6	7.4	2.1	3.2	7.8	7.8	7.7	16.5	8.1	7.1	9.2	13.5	93.9
2000–2009 Avg.	3.4	7.6	6.1	5.9	11.7	29.1	23.4	16.9	13.3	21.1	24.6	19.5	182.8
Sustainable Esc. Goal[b]	1.45–4.8	3.35–9.15	1.2–5.4	1.9–4.45	6.4–15.6	9.35–24.0	6.55–23.8	24.0–48.0	6.0 –10.25	6.05–9.85	5.75–12.0	7.85– 13.7	69.6 –158.75

Note: Escapement estimates are derived from periodic ground surveys with stream life factors applied, or from periodic aerial surveys. Aerial survey estimates after 1990 incorporate stream life factors; prior to 1990, aerial estimates are peak aerial survey counts adjusted for survey conditions and time of surveys.

[a] Insufficient data to generate escapement estimates.

[b] New sustainable escapement goals (SEG's) implemented for the first time beginning with the 2002 season, except for McNeil River, which was revised in 2007 and implemented beginning with the 2008 season.

5.3.1.3 Prince William Sound

5.3.1.3.1 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 5-66, Figure 5-67). 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.

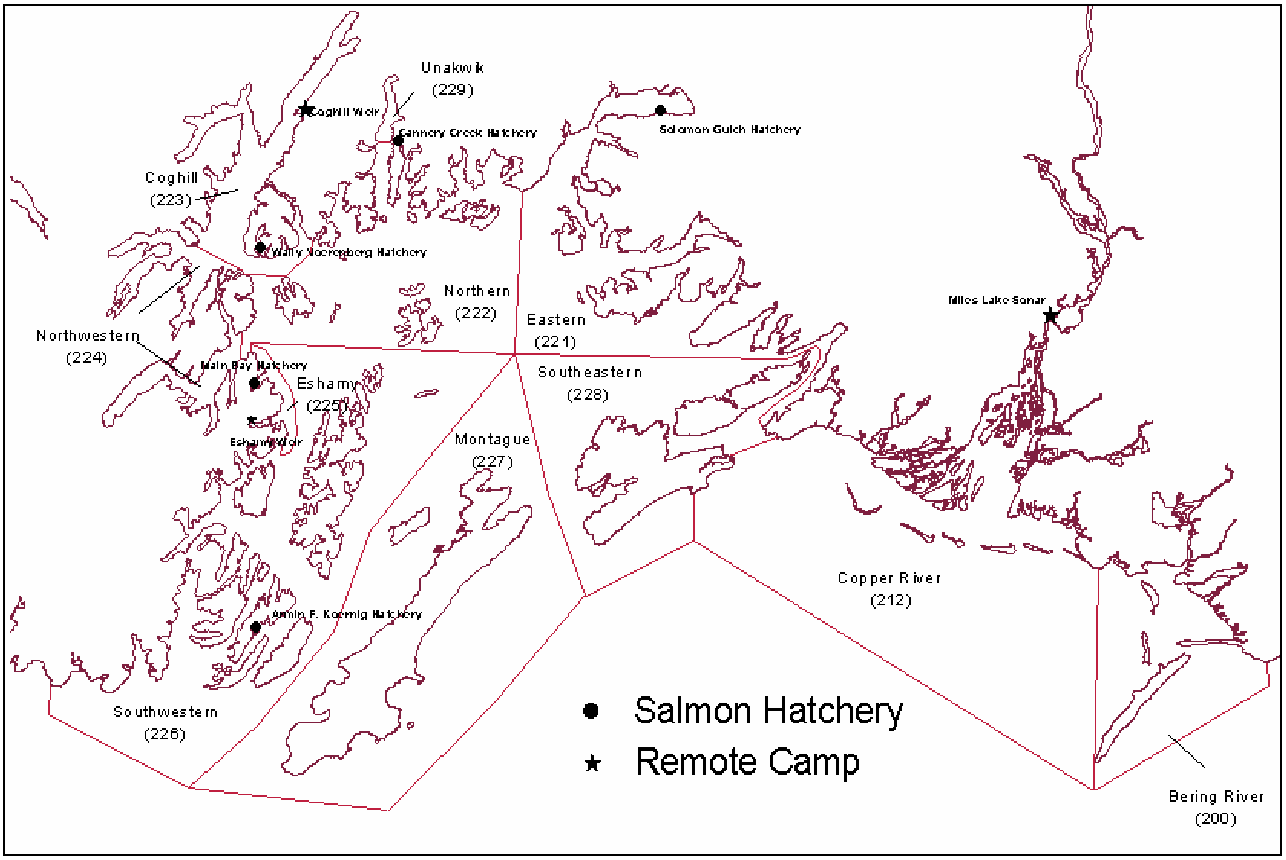


Figure 5-66. Prince William Sound Management Area showing commercial fishing districts, salmon hatcheries, weir locations, and Miles Lake sonar camp (Copper River district).

The salmon management area is divided into 11 districts (see Figure 5-66 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 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.

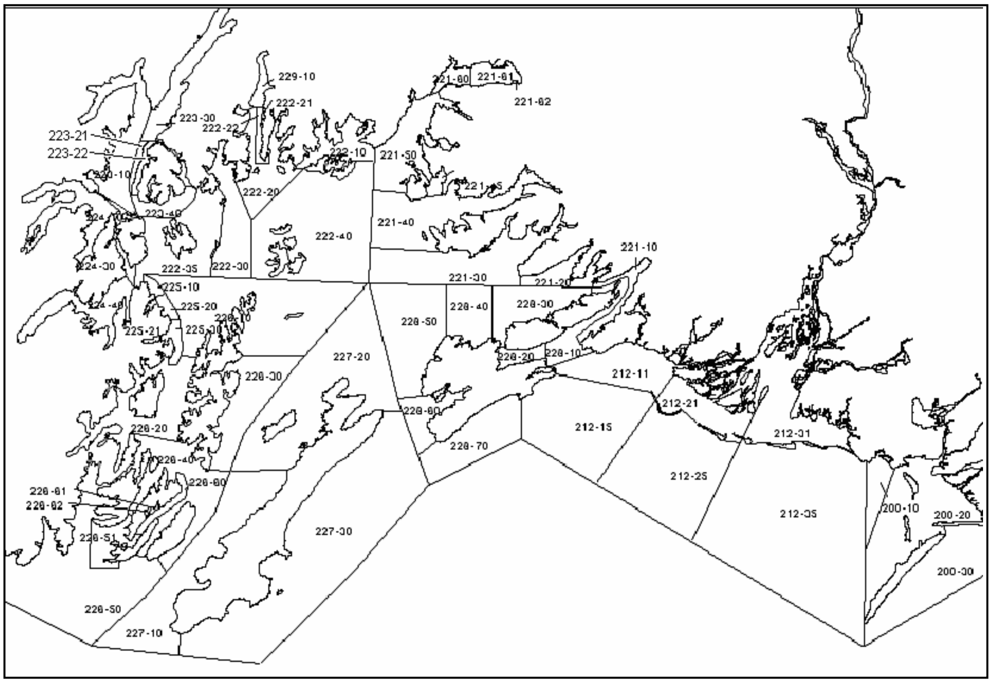


Figure 5-67. Prince William Sound Area showing commercial fishing districts and statistical reporting areas.

5.3.1.3.2 Commercial Chum Salmon Harvest

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.

The 2009 Prince William Sound Area total commercial salmon harvest was 24.0 million fish, of which 3.2 million were chum salmon (Figure 5-68). Contributions from thermal mark sampling indicate >90% of the 2009 chum salmon commercial harvest was hatchery production from PWSAC. The 2009 preseason forecast for chum salmon in PWS was 4.6 million fish. The chum salmon common property fishery (CPF) harvest was 2.6 million fish, which was 1.1 million fish below the preseason forecast. Based on ADF&G’s 2009 wild chum salmon forecast of 376,000 fish, there was a potential CPF harvest of 176,000 wild chum salmon. The 2009 purse seine common property fishery harvest of 269,000 chum salmon was composed of approximately 4% wild and 96% hatchery fish. The drift gillnet common property fishery harvest was 2.3 million chum salmon, which was above the five year average of 1.1 million fish. PWSAC forecasted a 2009 run of 2.8 million chum salmon to Wally Noerenberg Hatchery, 1 million chum salmon to Port Chalmers, and 409,000 chum salmon to Armin F. Koernig Hatchery. For the Port Chalmers subdistrict, 2009 was the first year that drift gillnet gear was given access to this area. Approximately 1% of the chum salmon harvested in Port Chalmers were of wild stock origin. PWSAC harvested 604,625 chum salmon for cost recovery and 151,835 chum salmon for broodstock requirements.

5.3.1.3.3 2010 Summary

The 2010 chum salmon total run forecast for Prince William Sound was 3.4 million. The majority of the forecast, 3.0 million, were of hatchery origin. The common property fishery harvest was 3.6 million, 1.2 million above the preseason forecast. The total wild stock chum salmon escapement lagged behind anticipated aerial survey indices early in the season, with escapement ahead of anticipated in all but the Eastern District by the end of the season.

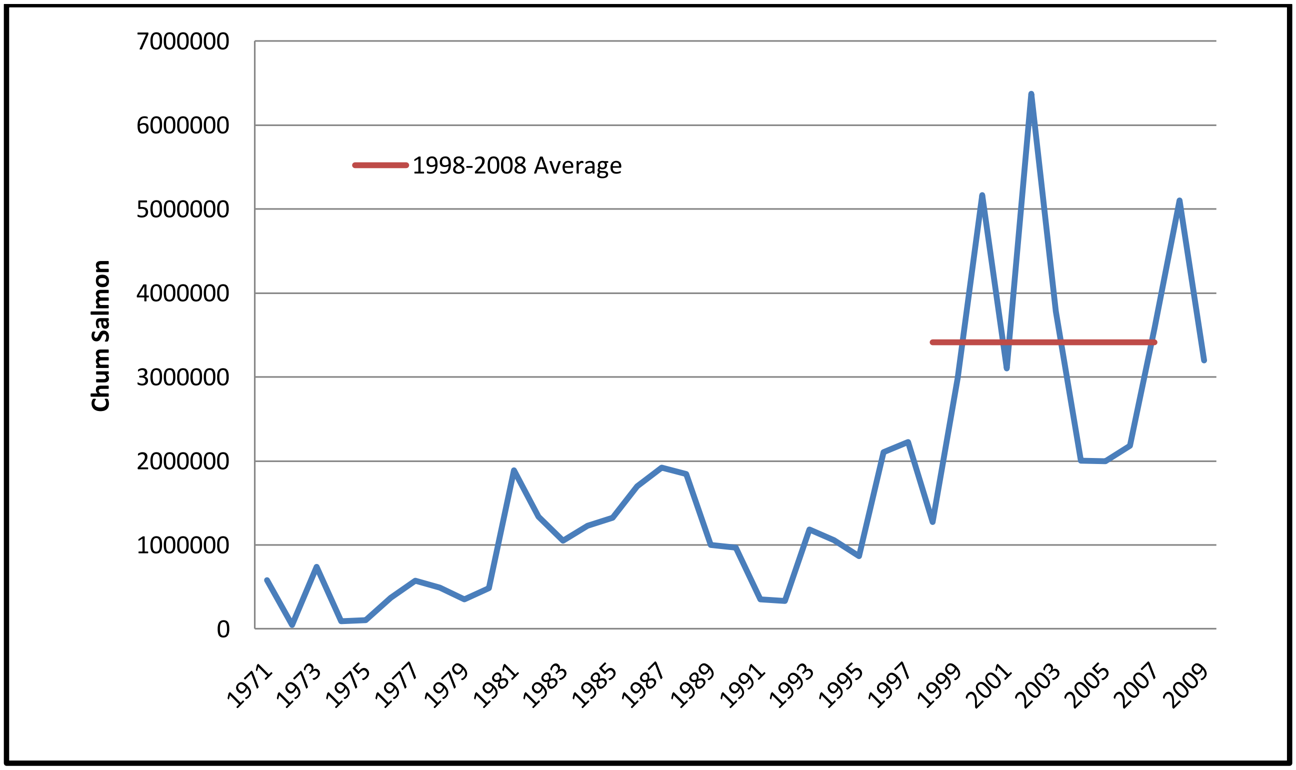


Figure 5-68. Total commercial chum salmon harvest by all gear types in Prince William Sound, 1971-2009.

The 2008 PWS Area commercial salmon harvest was 49.3 million fish, which included 5.1 million chum salmon. During this season, hatchery runs of chum salmon were above forecast levels. Of the 5.1 million chum salmon harvested, 95% (4.8 million fish) were produced by PWSAC. The 2008 chum salmon total run forecast in Prince William Sound was 3.8 million fish. The majority of the forecast (88%) was expected PWSAC hatchery production. Enhanced chum salmon returns to WNH, Port Chalmers, and AFK were forecast to be 2.3 million fish, 787,000 fish, and 309,000 fish respectively. Of that forecast, PWSAC's projection for cost recovery and broodstock requirements was approximately 842,000 fish (45%) of the 2.3 million, leaving 1.4 million chum salmon for the common property fishery (CPF). Based on ADF&G's wild chum salmon forecast of 446,000 fish, there was a potential common property harvest of 246,000 wild chum salmon. The total CPF chum salmon harvest for all three gear types was 1.7 million fish. Table 1 summarizes the commercial chum salmon harvest for PWS (2007–2009) by gear type and district.

The 2007 PWS Area commercial salmon harvest was 70.6 million fish, which included 3.6 million chum salmon. During this season, hatchery runs of chum salmon were above forecast levels. Of the 3.6 million chum salmon harvested, 96% (3.4 million fish) were produced by PWSAC. The 2007 chum salmon forecast in Prince William Sound was 3.4 million fish. The majority of that forecast (84%) was expected

PWSAC hatchery production. Enhanced chum salmon returns to WNH, Port Chalmers, and AFK were forecast to be 1.9 million fish, 625,000 fish, and 404,000 fish respectively. Of that forecast, PWSAC's projection for cost recovery and broodstock requirements was approximately 844,000 fish (45%) of the 2.9 million, leaving 1.1 million chum salmon for the common property fishery (CPF). Based on ADF&G's wild chum salmon forecast of 454,000 fish, there was a potential common property harvest of 254,000 wild chum salmon. The total CPF chum salmon harvest for all three gear types was 1.5 million fish.

Table 5-29. Prince William Sound Management Area commercial chum salmon harvest by gear type and district, 2007-2009.

District	2009 Chum Salmon	2008 Chum Salmon	2007 Chum Salmon
Eastern	4,752	20,808	81,077
Northern	15,234	38,525	9,901
Coghill	12,926	9,358	465,448
Southwestern	233,661	517,449	42,445
Montague	-	1,233,909	741,020
Southeastern	2,887	0	13,997
Unakwik	10	0	4
Purse Seine	269,470	1,820,049	1,353,892
Bering River	5	1	1
Copper River	8,629	1,330	9,657
Coghill	1,323,728	2,308,231	1,009,377
Eshamy	286,361	251,493	81,410
Montague	672,918	-	-
Unakwik	374	58	222
Drift Gillnet	2,292,015	2,561,113	1,100,667
Eshamy	50,748	53,627	24,651
Set Gillnet	50,748	53,627	24,651
Solomon Gulch	3,916	-	-
Cannery Creek	-	-	-
Wally Noerenberg	604,625	641,332	920,198
Main Bay	-	-	5,269
Armin F. Koernig	-	-	174,263
Hatchery	608,541	641,332	1,099,730
Educational Permit	-	-	20
Personal Use	67	14	102
Donated Fish	-	-	6
Misc.	67	14	128
Prince William Sound Total	3,220,841	5,076,135	3,579,068

PWSAC amended their initial 2007 WNH chum salmon cost recovery goal from 655,000 fish to 795,000 fish because the average fish weight was smaller than anticipated. PWSAC subsequently reported a chum salmon cost recovery harvest of 920,198 fish and a broodstock harvest of 173,452 fish, exceeding the inseason amended cost recovery goal by approximately 125,000 fish. ADF&G sought explanation as to why the cost recovery goal was exceeded, but did not receive a response from PWSAC staff.

5.3.1.3.4 *Chum Salmon Escapement*

The general purse seine districts are managed to achieve wild chum SEGs by district and allow for the orderly harvest of surplus wild and hatchery stocks. Escapement of chum salmon is monitored through the season by weekly aerial surveys of 208 index streams. 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.

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. The 2009 total PWS chum salmon escapement of approximately 180,000 fish in districts with SEGs was almost double the SEG lower bound of 91,000. SEGs in PWS were met in each of the districts with established goals each year since 2006 (Table 5-30). 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.

Table 5-30. Prince William Sound chum salmon escapement goals and escapements, 2001-2009.

				Chum Salmon Escapement								
Upper	Type	Year Implemented	Enumeration Method	2001	2002	2003	2004	2005	2006	2007	2008	2009
	lower-bound SEG	2006	Multiple Aerial Surveys	198,683	94,046	198,921	108,833	113,135	109,403	123,814	74,740	55,219
	lower-bound SEG	2006	Multiple Aerial Surveys	75,473	30,531	44,272	42,456	30,657	52,039	49,669	38,791	37,358
	lower-bound SEG	2006	Multiple Aerial Surveys	13,388	7,430	19,729	9,685	11,979	15,900	14,052	39,660	36,724
	lower-bound SEG	2006	Multiple Aerial Surveys	6,373	16,194	12,736	10,371	12,696	25,860	10,778	28,051	34,290
	lower-bound SEG	2006	Multiple Aerial Surveys	37,526	104,906	116,131	42,344	25,547	26,739	60,464	21,614	16,453

scapement fell below stated goals. Yellow-shaded cells indicate escapement goals were met. Green-shaded cells indicate escapement goals were
cate no official escapement goal for that particular year. Shaded cells are based upon the escapement goal in place at the time of enumeration for salmon stocks
t goal provided.

5.3.1.3.5 *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 5-31). 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 5-31. Chum salmon harvest and effort in the Tatilek and Chenega subsistence fisheries, 1988-2009.

	Tatitlek				Chenega		
Year	Permits Issued	Chum Salmon	Total	Year	Permits Issued	Chum Salmon	Total
1988	17	245	811	1988	10	294	604
1989	14	43	837	1989	8	180	1,056
1990	13	4	260	1990	7	2	64
1991	17	28	1,439	1991	12	53	638
1992	16	49	891	1992	14	99	962
1993	18	74	1,217	1993	22	124	1,293
1994	14	70	313	1994	16	161	837
1995	15			1995	10	41	329
1996	6	0	38	1996	7	46	315
1997	6	54	206	1997	5	272	649
1998	11	28	355	1998	4	119	331
1999	17	31	947	1999	14	101	887
2000	12	40	688	2000	12	143	646
2001	14	12	416	2001	16	146	454
2002	19	36	575	2002	10	60	418
2003	15	12	298	2003	13	147	677
2004	18	28	713	2004	8	84	722
2005	16	16	600	2005	13	174	908
2006	12	25	81	2006	11	111	299
2007	14	unknown	unknown	2007	4	55	381
2008	2	0	60	2008	15	30	276
2009	12	0	301	2009	4	84	285
2000-2009 average	13	19	415	2000-2009 average	11	103	507

5.3.1.3.6 2011 Prince William Sound Chum Salmon Forecast

The 2011 chum salmon total run forecast for the Prince William Sound Management Area is 3.9 million fish, the majority of which (3.5 million) would be from Prince William Sound Aquaculture Corporation hatchery production. The early run of chum salmon to WNH was forecast by PWSAC to be 2.6 million fish, (Table 5-32). PWSAC forecasted 280,000 chum salmon to AFK and 624,000 chum salmon to Port Chalmers. Based upon ADF&G's wild chum salmon forecast of 400,000 fish (range 390,000-410,000), there is a potential common property harvest of 200,000 wild chum salmon (range 190,000-210,000).

Table 5-32. Prince William Sound chum salmon return estimate, 2011.

Natural Stocks	400,000
Hatchery Stocks	
Wally Noerenberg	2,612,000
Armin F. Koernig	280,000
Port Chalmers	624,000
Natural & Hatchery	3,916,000

5.3.2 Kodiak, Chignik, and the Aleutian Islands areas

For purposes of salmon management, the State of Alaska groups the Alaska Peninsula, Aleutian Islands, and Atka-Amlia Management Areas collectively into a single management region. This region is often referred to as Management Areas M & F, which is divided into four subareas: (1) the North Peninsula, consisting of Bering Sea waters extending west from Cape Menshikof to Cape Sarichef on Unimak Island; (2) the South Peninsula, consisting of Pacific Ocean coastal waters extending west of Kupreanof Point to Scotch Cap on Unimak Island; (3) the Aleutian Islands, consisting of the Bering Sea and Pacific Ocean waters of the Aleutian Islands west of Unimak Island and exclusive of the Atka-Amlia Management Area; and (4) the Atka-Amlia Management Area, also known as Area F, consisting of Bering Sea and Pacific Ocean waters extending west of Seguam Pass and east of Atka Pass. In this document, the Aleutian Islands and Atka-Amlia Management Areas (see Section 5.3.3.3 below) are treated separately from the Alaska Peninsula (refer to Section 5.2.7), which is being considered as a separate salmon stock grouping in western Alaska.

5.3.2.1 Kodiak

5.3.2.1.1 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 5-69). 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.

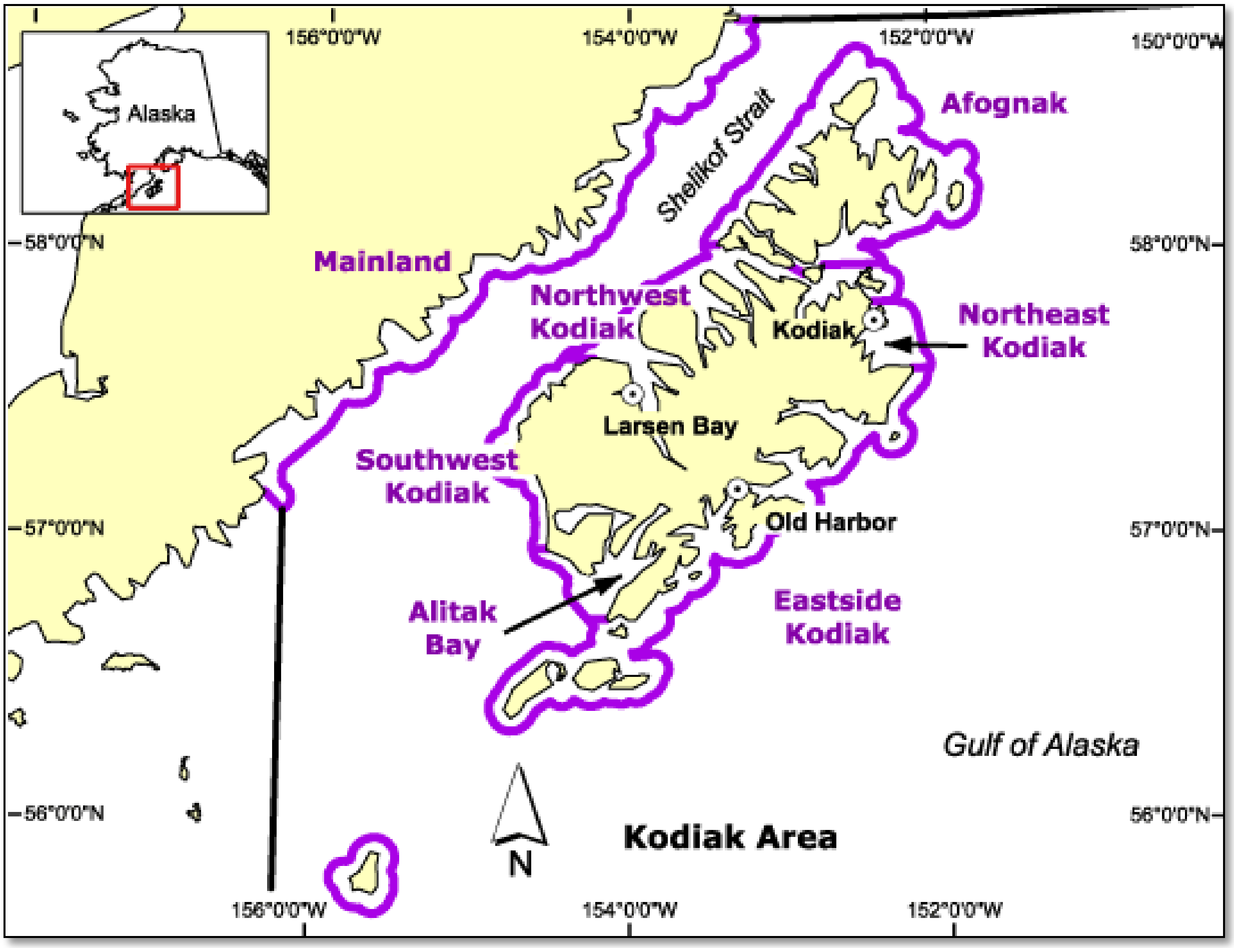


Figure 5-69. Kodiak Management Area identifying commercial salmon fishing districts.

Salmon migration or spawning has been documented in approximately 750 streams within the KMA. Of these, 415 streams have been documented to support yearly spawning populations of salmon while the remaining 335 are small streams used by pink salmon in years with very large returns. Chum salmon stocks are found in approximately 179 streams within the KMA (Table 5-33). Of the total number of streams, 97 are located in the Mainland District (on the Alaska Peninsula), while the remainder are located in the Kodiak Archipelago (in the Afognak, Northwest Kodiak, Southwest Kodiak, Alitak, Eastside Kodiak and Northeast Kodiak districts).

Table 5-33. 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	92	9
Northwest Kodiak	67	22
Southwest Kodiak	11	6
Alitak	30	15
Eastside Kodiak	91	54
Northeast Kodiak	27	12
Mainland	97	61
Total	415	179

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.

5.3.2.1.2 Commercial Chum Salmon Fishery

Commercial fishing effort was low during the 2009 commercial salmon fishing season (although increased slightly from 2008) with only 291 of 608 eligible permits making commercial landings. 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. By gear type, a total of 132 set gillnet, 158 purse seine, and one beach seine permit holder(s) fished in 2009. During 2009 set gillnet permit holder participation was lower than in 2008 while purse seine permit holder participation was higher than in 2008; however, participation in both gear types was below the previous 10-year (1999-2008) average. Purse seine fishermen accounted for 93% of the total number of salmon harvested in the KMA while set gillnet fishermen accounted for the remaining 7% of the total (Dinnocenzo et al., 2010).

For 2009, there was a projected all-species salmon harvest of 24,666,992 fish. A total of 30,627,685 salmon were actually harvested in the 2009 KMA commercial salmon fisheries, which included a total of 955,808 chum salmon. Commercial harvests of chum salmon exceeded projections of 623,000 fish and were slightly above the 1999-2008 average of 928,203 fish (Figure 5-70). Westside fisheries harvested 262,614 chum salmon, which was above the forecast of 197,819 fish; Eastside/North end Kodiak fishery harvest totaled 355,205 chum salmon, well above the forecast of 149,703 fish; and Mainland District catches totaled 121,807 chum salmon, close to the forecast of 104,387 fish (Table 5-34).

5.3.2.1.3 2010 Summary

The chum salmon harvest of 734,806 fish was well below the forecast of 1.02 million and below the 2000 to 2009 average of 932,402 fish. The eastside and the north end of Kodiak Island accounted for 136,434 chum salmon. Kitoi Bay Hatchery chum salmon production was weaker than expected, with 191,284 harvested, below the 2010 forecast of 273,668 fish.

Table 5-34. Projected vs. actual 2009 commercial chum salmon harvest for Kodiak Management Area.

	2009 Harvest	
Fishery	Projection	Actual
Afognak	20,328	50,386
Westside Kodiak	197,819	262,614
Alitak District	32,763	72,497
Eastside/Northend Kodiak	149,703	355,205
Mainland District	104,387	121,807
Total	505,000	862,509

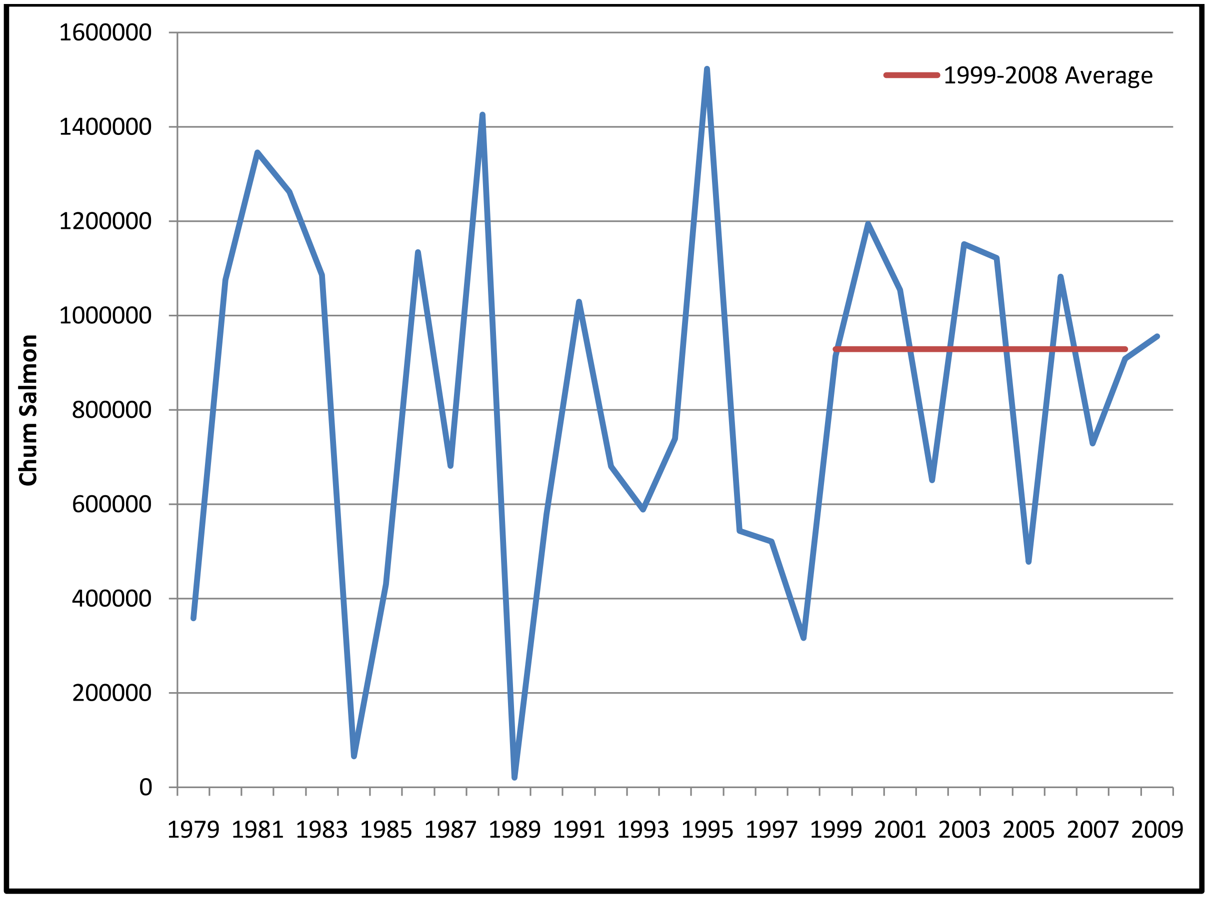


Figure 5-70. Commercial chum salmon harvest in the Kodiak Management Area, 1979-2009. Note: Average does not include 1989, when commercial fisheries were severely limited due to the M/V Exxon Valdez oil spill.

The recent ten year (1999-2008) average supplemental production from KRAA has included an estimated 202,857 chum salmon. The commercial chum salmon harvest attributed to the Kitoi Bay Hatchery of 93,299 fish was less than the forecast of 118,000 fish.

5.3.2.1.4 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 2009 chum salmon escapement in the Mainland District was 83,106 fish, not achieving the minimum goal of 104,000 fish. The chum salmon escapement for the Kodiak Archipelago of 210,039 fish exceeded the minimum goal of 151,000 fish (Table 5-38). Total 2009 escapement of chum salmon in the KMA was 293,145 fish.

The majority of the 2009 chum salmon escapement was estimated from aerial surveys, with less than 1% counted through weirs. Aerial surveys were conducted on several major KMA chum salmon systems along Kodiak Island's west side and in the Mainland District, mostly surveys of bays and streams from fixed-wing aircraft. 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

Overall chum salmon escapement of 300,285 fish was below the recent 10-year average of 473,392 fish. Escapement goals have been established in Kodiak Archipelago and the Mainland. The escapement in the Kodiak Archipelago was above the escapement goal of 151,000 fish with an estimate of 155,570 and the Mainland District escapement of 144,715 was also above the escapement goal of 104,000 chum salmon.

5.3.2.1.5 Subsistence Chum Salmon Harvest

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.

5.3.2.1.6 The 2009 reported subsistence harvest of 29,716 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 36,414 fish annually for the 10-year period 2000-2009 (2011 Chum Salmon Forecast

The 2011 preseason forecast for the Kodiak Management Area projected a harvest of 1,139,578 chum salmon out of a total all-species salmon harvest of 32,885,854 fish. Of this total, the KRAA forecasted the harvest of chum salmon returning to the Kitoi Bay Hatchery to be approximately 411,000 fish (Table 5-36).

Table 5-35). Chum salmon have only accounted for 1% of the recent 10-year average harvest (363 fish per year).

5.3.2.1.7 2011 Chum Salmon Forecast

The 2011 preseason forecast for the Kodiak Management Area projected a harvest of 1,139,578 chum salmon out of a total all-species salmon harvest of 32,885,854 fish. Of this total, the KRAA forecasted the harvest of chum salmon returning to the Kitoi Bay Hatchery to be approximately 411,000 fish (Table 5-36).

Table 5-35. Number of subsistence permits issued and estimated subsistence salmon harvest for the Kodiak Management Area, 2000-2009.

Year	Permits Issued	Chum Salmon	Total All Salmon
2000	1,711	375	39,753
2001	2,378	427	41,656
2002	2,277	350	42,622
2003	2,272	388	40,698
2004	2,241	261	38,403
2005	2,290	592	38,743
2006	2,095	441	32,173
2007	2,096	266	32,429
2008	2,037	186	27,947
2009	1,926	345	29,716

Table 5-36. Projected commercial chum salmon harvest for the Kodiak Management Area, 2011.

Fishery	2011 Projection
Kitoi Bay Hatchery	411,000
Afognak (wild)	36,446
Westside Kodiak	221,945
Alitak District	52,972
Eastside/Northend Kodiak	267,112
Mainland District	150,102
Total	1,139,578

5.3.2.2 Chignik

5.3.2.2.1 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 5-71). 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. The CMA is also known as Area L.

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.

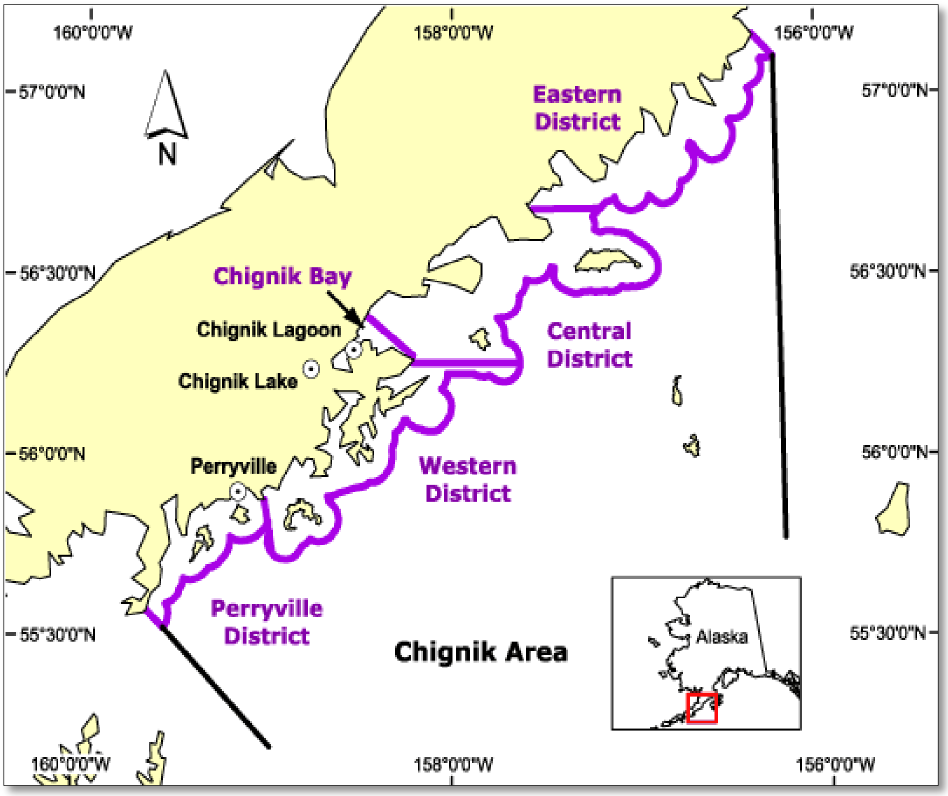


Figure 5-71. Chignik Management Area identifying the five commercial salmon fishing districts.

5.3.2.2.2 *Commercial Chum Salmon Harvest*

A total of 256,425 chum salmon were harvested in 2009, which (as with 2008) was higher than the five and ten year average harvests (Figure 5-72). The majority of the chum harvest in 2009 took place in the Western District, although the Central and Eastern districts also yielded substantial catches (Table 5-37). Purse and hand purse seines are the only legal commercial salmon fishing gear within the CMA. A total of 209,325 chum salmon were harvested from the CMA during 2008. The majority of the 2008 chum salmon harvest occurred in the Eastern and Western districts during August.

A total of 581,329 chum salmon were commercially harvested in 2010, which was the highest catch since accurate harvest records began in 1954. The majority of the chum salmon harvest in 2010 took place in the Central District, although the Western and Eastern districts also yielded substantial catches. Most chum salmon were harvested between late June and mid-August.

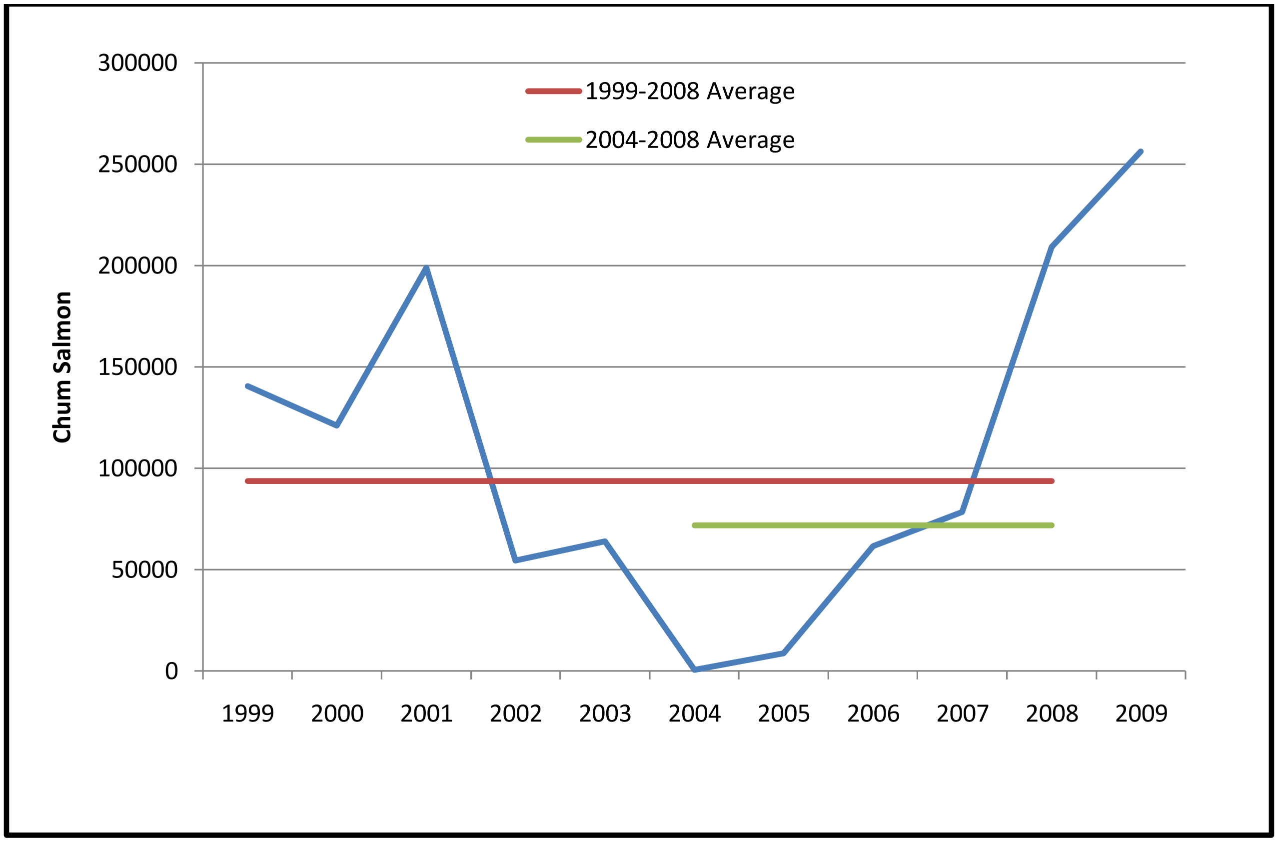


Figure 5-72. Commercial chum salmon harvest in the Chignik Management Area, 1999-2009.

Table 5-37. Chignik Management Area commercial chum salmon harvest by district, 1999-2009.

	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

Chum Salmon Escapement

Salmon escapements in the CMA are enumerated through the use of a weir on the Chignik River, and the escapement goal is an aggregate, area-wide LB SEG. After the latest review of escapement goals for the Chignik Management Area in 2007 (Witteveen et al. 2007), this LB SEG was changed from 50,400 to

57,400, effective beginning in 2008. This LB SEG was exceeded in both 2008 (197,259 chum salmon) and 2009 (214,959 chum salmon).

The 2010 Chignik River chum salmon escapement was 95, which was below average for the Chignik River. Chum salmon escapements to other CMA streams were estimated via aerial survey and summarized by district. The SEG of all districts combined (57,400) was exceeded with an estimated total peak escapement of 177,220 fish.

Table 5-38. Chignik and Kodiak area chum salmon escapement goals and escapements, 2001-2009.

				Chum Salmon Escapement								
Upper	Type	Year Implemented	Enumeration Method	2001	2002	2003	2004	2005	2006	2007	2008	2009
	lower-bound SEG	2008	Weir Count and Aerial Survey	550,800	235,634	300,325	349,518	38,700	93,489	238,098	197,259	214,959

				Chum Salmon Escapement								
Upper	Type	Year Implemented	Enumeration Method	2001	2002	2003	2004	2005	2006	2007	2008	2009
	lower-bound SEG	2008	Weir Count and Aerial Survey	294,700	197,175	114,750	364,395	37,500	346,140	87,350	122,425	83,106
	lower-bound SEG	2008	Weir Count and Aerial Survey	263,225	333,416	265,773	168,696	206,755	441,409	206,992	101,482	210,039

scapement fell below stated goals. Yellow-shaded cells indicate escapement goals were met. Cells with no color indicate no official escapement goal for

based upon the escapement goal in place at the time of enumeration for salmon stocks rather than the most recent escapement goal provided.

Subsistence Chum Salmon Harvest[25]

In 2009, ADF&G issued 95 subsistence fishing permits in the CMA. Based on the 82 permits returned to ADF&G Division of Subsistence, the estimated subsistence harvest totaled 8,907 salmon, which included only 137 chum salmon. This harvest was lower than the previous five and 10-year subsistence harvest averages of 264 chum salmon and 223 chum salmon, respectively (Table 5-39). Sockeye salmon comprise the majority of the subsistence harvest in CMA.

Table 5-39. Number of subsistence permits issued and estimated subsistence salmon harvest for the Chignik Management Area, 1999-2009.

Year	Permits Issued	Chum Salmon	Total All Salmon
1999	106	136	12,289
2000	130	517	13,228
2001	135	213	13,663
2002	120	23	11,980
2003	146	286	15,395
2004	104	202	10,357
2005	119	353	11,590
2006	113	275	11,186
2007	128	165	13,372
2008	89	57	8,783
2009	95	137	8,907

2010 Chum Salmon Forecast[26]

Harvest projections for chum salmon in the CMA for 2010 were generated by averaging the last four fishery years (2006-2009). The 2010 projected chum salmon harvest was 151,000 fish. Historically, the Western and Perryville districts provided the largest proportion of the commercial harvest.

5.3.3 Aleutian Islands

5.3.3.1 The Aleutians Islands and Atka-Amlia Management Area

The Aleutian Islands Management Area (AIMA) includes waters west of Cape Sarichef Light and Scotch Cap (both located on Unimak Island), and the Pribilof Islands (Figure 5-73). The AIMA is one of three subareas comprising Area M, the other two of which are the North and South Alaska Peninsula management areas (Hartill 2009) 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 5-73) and is also known as Area F.

---

[25] There is no reported information on educational or personal use salmon fisheries in the Chignik Management Area.

[26] Forecasts for the 2011 fishery are not yet available.

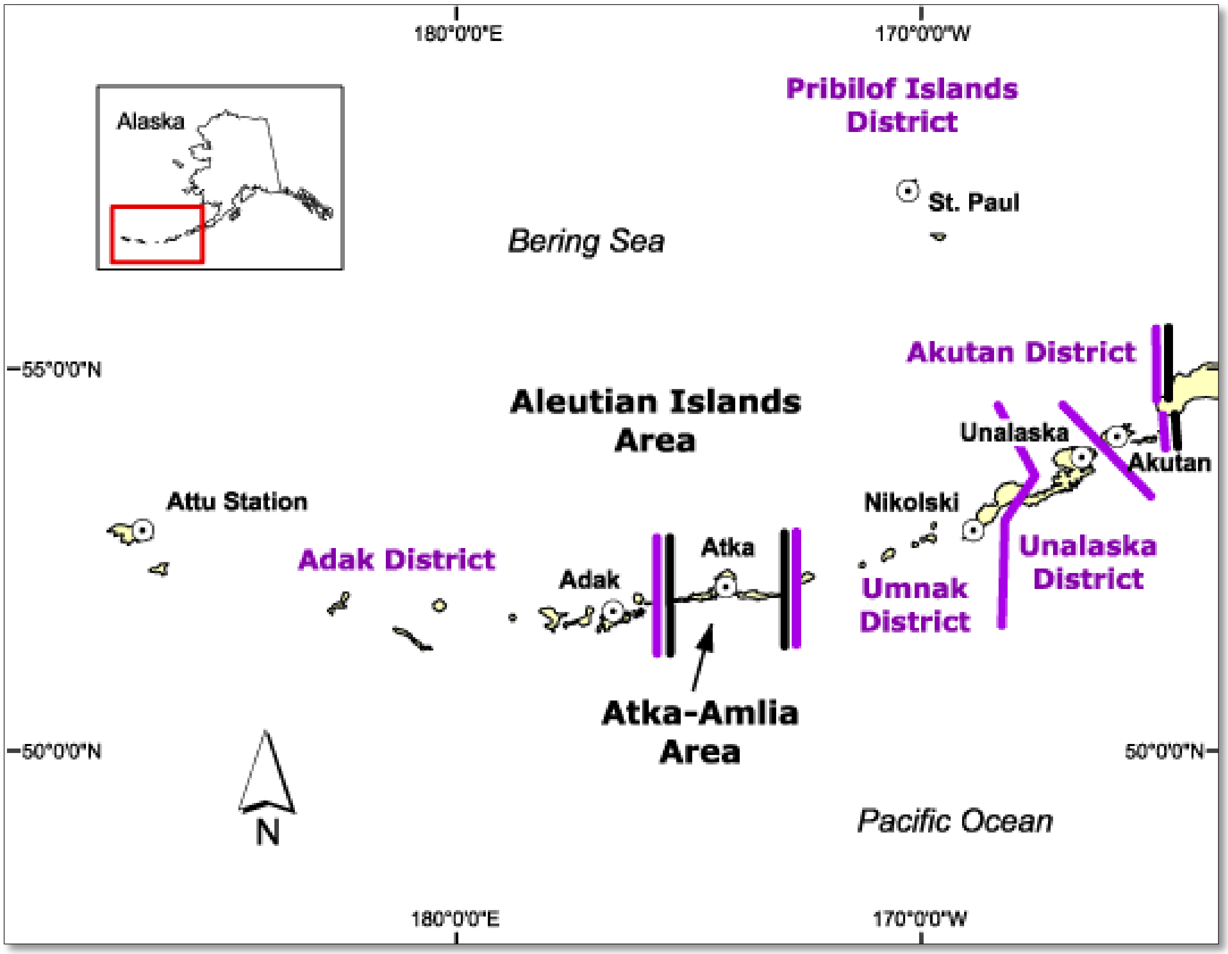


Figure 5-73. The Aleutian Islands and Atka-Amlia Islands management areas.

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.

Commercial Chum Salmon Harvest

Purse seines, hand purse seines, and beach seines are the only legal gear types allowed to fish for salmon in the Aleutian Islands Management Area. Small commercial harvests occurred in the Atka-Amlia Islands Management Area between 1992 and 1996 with no commercial effort since that time. Interest in this fishery diminished due to lack of markets, high processing costs, and low volumes of fish.

Table 5-40. 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	*	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

* Confidentiality rules prohibit the release of information for 1985, 1991, 2000, and 2007.

In total 2,005 chum salmon were harvested in the commercial fishery in the Aleutian Islands Management Area in 2009 (Table 5-40), 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 5-41).

Table 5-41. 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

Chum Salmon Escapement

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.

Subsistence Chum Salmon Harvest[27]

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.

A total of 215 subsistence permits were issued for the Unalaska District in 2009, which was 11 permits more than in 2008 and 14 permits more than the average from 2004 through 2008. The total estimated harvest of 4,513 salmon in 2009 was more than the estimated 2008 catch of 3,243 fish, and 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 5-42).

Table 5-42. Estimated chum salmon subsistence harvest in the Aleutian Islands and Atka-Amlia Management Area, 1985-2009.

Year	Permits Issued	Chum Salmon
1985	65	20
1986	121	375
1987	81	151
1988	74	83
1989	70	36
1990	94	100
1991	89	45
1992	144	11
1993	137	136
1994	15	48
1995	159	23
1996	189	49
1997	218	110
1998	206	26
1999	208	13
2000	205	24
2001	201	100
2002	226	63
2003	220	41
2004	207	26
2005	207	15
2006	193	92
2007	171	36
2008	195	115
2009	205	182

---

[27] There is no reported information on educational or personal use salmon fisheries in the Aleutian Islands and Atka-Amlia Management Areas.

5.3.4 Southeast Alaska and Yakutat

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 5-74). 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 (Figure 5-75). 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 5-76).

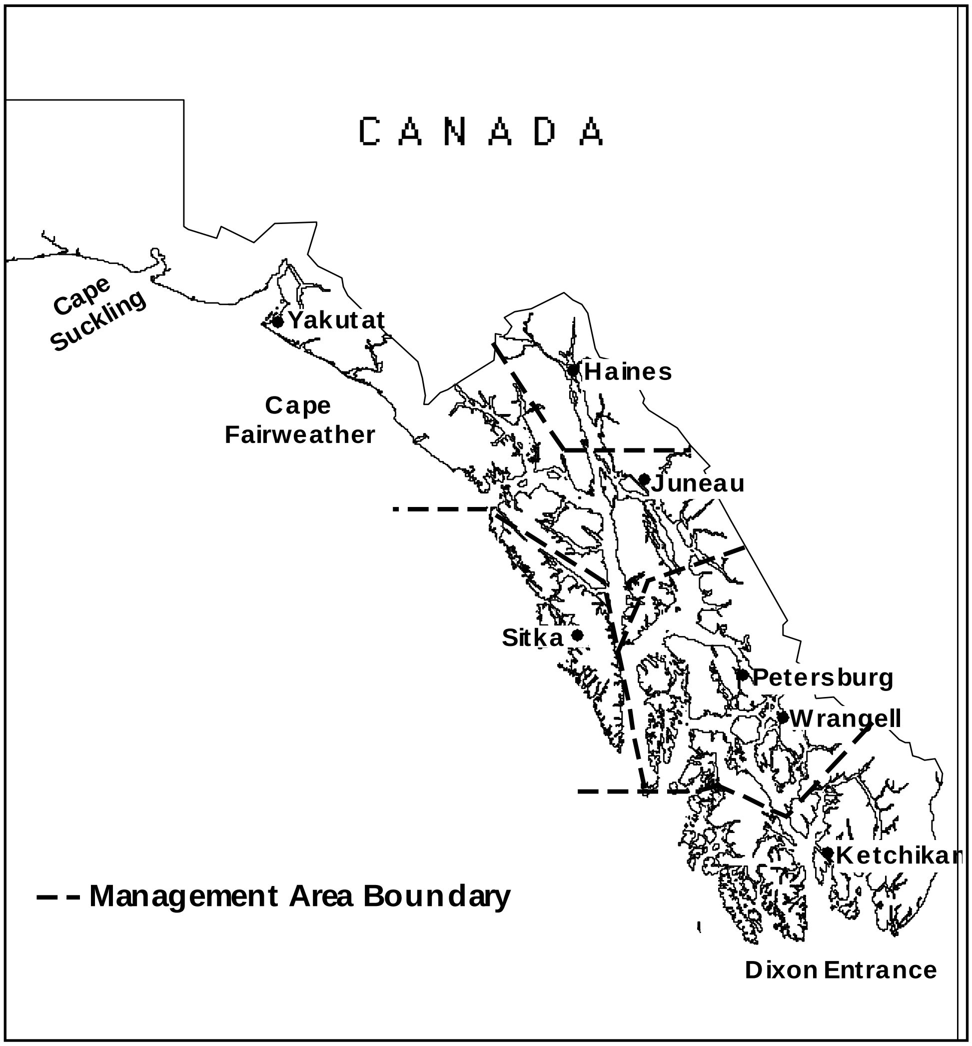


Figure 5-74. The Southeast Alaska/Yakutat Region (Region I) consists of Alaska waters between Cape Suckling on the north and Dixon Entrance on the south. Troll fisheries are managed regionally, and drift gillnet, set net, and purse seine fisheries are managed by area offices in Ketchikan, Petersburg/Wrangell, Sitka, Juneau, Haines, and Yakutat.

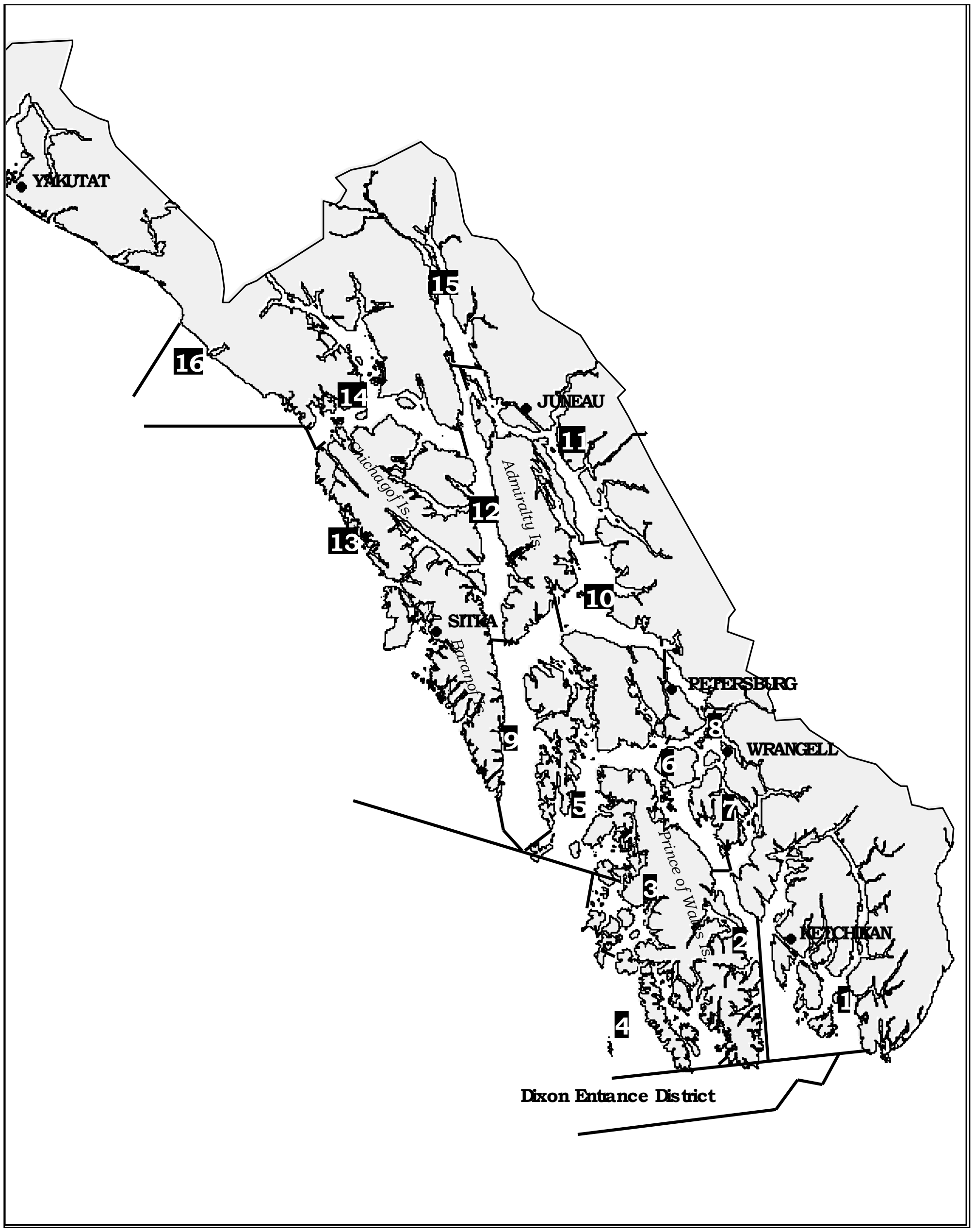


Figure 5-75. Boundaries for regulatory districts 1 to 16, as well as Dixon Entrance district, within Southeast Alaska.

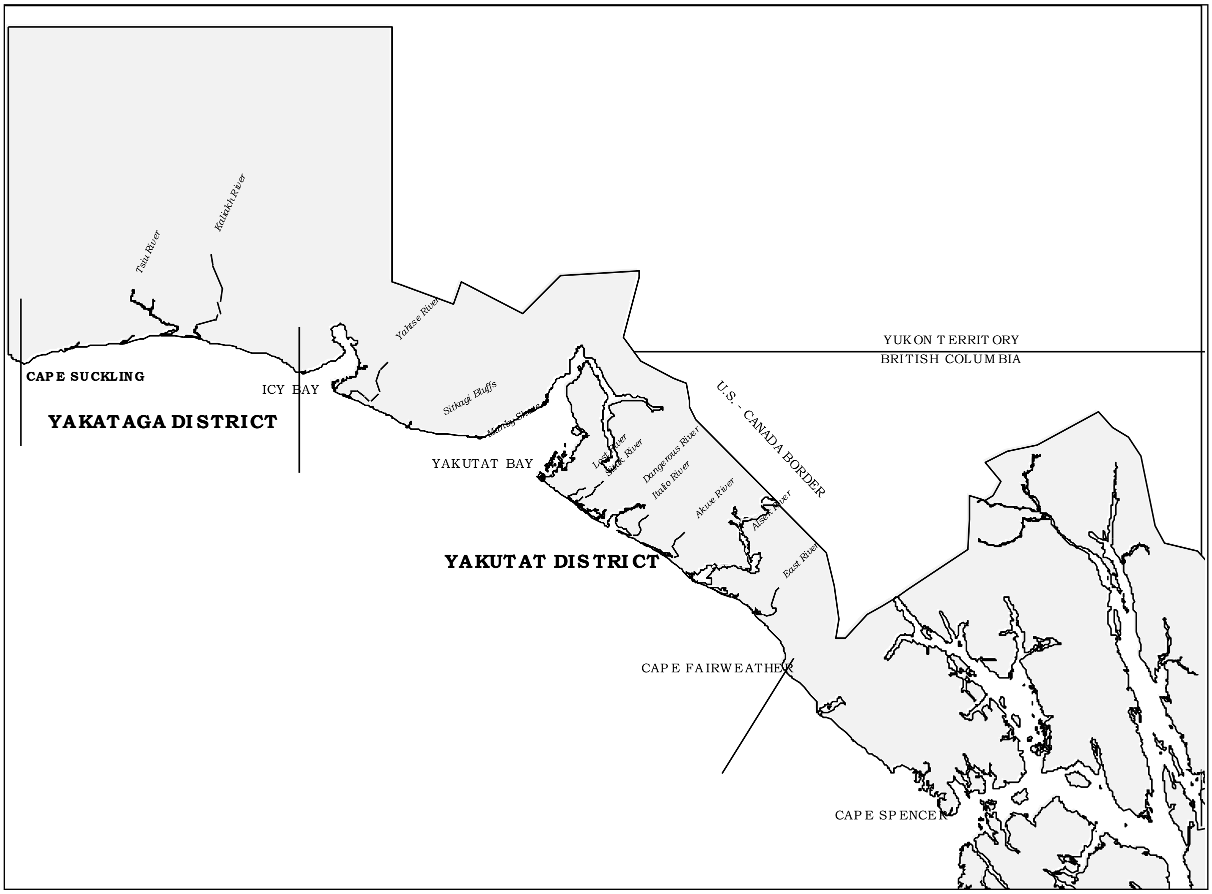


Figure 5-76. Boundaries for Yakutat and Yakataga regulatory districts, within the Yakutat management area (Registration Area D).

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).

5.3.4.1.1 Commercial Chum Salmon Harvest

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. Prior to 2006 these reports were combined annually into the Commercial, Personal Use, and Subsistence Salmon Fisheries: Report to the Alaska Board of 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). Approximately 51.6 million salmon were commercially harvested (including hatchery cost recovery) in the combined Southeast Alaska/Yakutat Region in 2009. The total common property commercial harvest was 45.5 million, 88% of total harvests, excluding cost recovery and Annette Island harvests (fishery data for 2009 were reported by Tingley and Davidson 2010). A total of 1,915 permit holders participated in the common property commercial salmon season in 2009, a slight increase from 2008 effort levels. Salmon harvests (in numbers of fish) by gear type for 2009 included 44.4 million by purse seine, 4.3 million by drift gillnet, 0.3 million by set net, and 2.2 million by hand and power troll.

Since the mid-1970s, salmon harvests in Region I have generally increased with a record harvest of chum salmon occurring in 1996. The various salmon fisheries in the region are well-established and the distribution of harvests between fisheries has changed little comparing the recent year, the recent 10-year average, or the long term average since 1962. The exception is that private hatchery cost recovery harvests, which only began in 1980, now account for a larger proportion of overall harvests. Harvests of chum salmon increased as new hatchery production began in the mid-1980s and in recent years the majority of chum salmon harvests in the region are attributable to hatchery production. In 1980, hatchery operators in Southeast Alaska released 8.7 million chum salmon fry at eight locations; by 2007, this number had risen to 454 million fry released at 22 locations.

The total harvest of 9.7 million chum salmon in 2009 was slightly higher than the preceding year and 89% of the recent 10-year average of 10.8 million (Table 5-43, Figure 5-77). Hatchery-produced chum salmon accounted for 88% of the chum harvested in Southeast Alaska common property fisheries (White 2010) and 92% of the total chum salmon harvested in Southeast Alaska (Figure 5-78). The 2009 chum salmon harvest made up 19% of the all-salmon species harvest and was above the long-term average from 1962-2008. For 2009, purse seiners harvested 3.5 million (36%) chum salmon, drift gillnetters accounted for 2.7 million (28%) chum salmon and 2.9 million (30%) chum salmon were taken in the hatchery cost recovery fisheries (Table 5-44).

The total commercial chum salmon harvest was 9.5 million in 2010, well above the long-term average harvest of 5.3 million. A large portion of chum salmon harvests in the region resulted from hatchery production, including harvest outside of terminal areas as hatchery returns pass through traditional fisheries. Wild summer chum salmon escapements, based on three recently established sustainable escapement goal thresholds, were below goal in Southern Southeast and Northern Southeast Inside areas, but reached the goal for the Northern Southeast Outside area. Fall chum salmon escapements were good in most systems monitored.

Table 5-43. Southeast Alaska and Yakutat Area total chum salmon harvest and percentage of all salmon species harvest, 1980-2009.

Year	Chum Salmon	Percentage
1980	1,642,938	9%
1981	837,240	4%
1982	1,330,219	5%
1983	1,170,126	3%
1984	4,084,200	13%
1985	3,275,417	5%
1986	3,358,992	6%
1987	2,721,661	17%
1988	3,535,591	20%
1989	1,968,894	3%
1990	2,217,895	6%
1991	3,336,043	5%
1992	4,936,515	11%
1993	7,879,868	11%
1994	10,403,085	14%
1995	11,225,693	17%
1996	16,043,397	18%
1997	11,789,139	26%
1998	15,695,285	25%
1999	14,930,932	15%
2000	15,910,909	40%
2001	8,754,416	11%
2002	7,455,007	13%
2003	11,115,085	16%
2004	11,371,623	18%
2005	6,427,530	9%
2006	14,002,610	47%
2007	9,416,164	16%
2008	9,065,156	32%
2009	9,660,364	19%
1962-2008 Avg.	5,229,792	13%
1998-2008 Avg.	10,844,947	22%

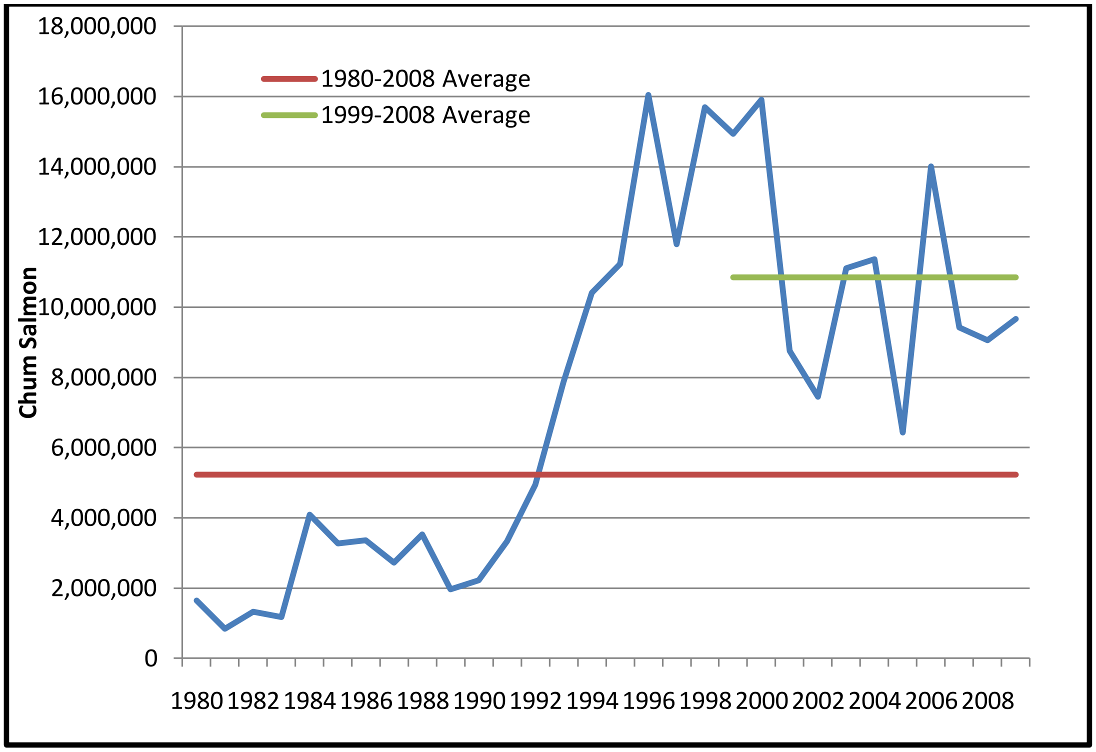


Figure 5-77. Southeast Alaska and Yakutat Area total chum salmon harvest and percentage of total, 1980-2009.

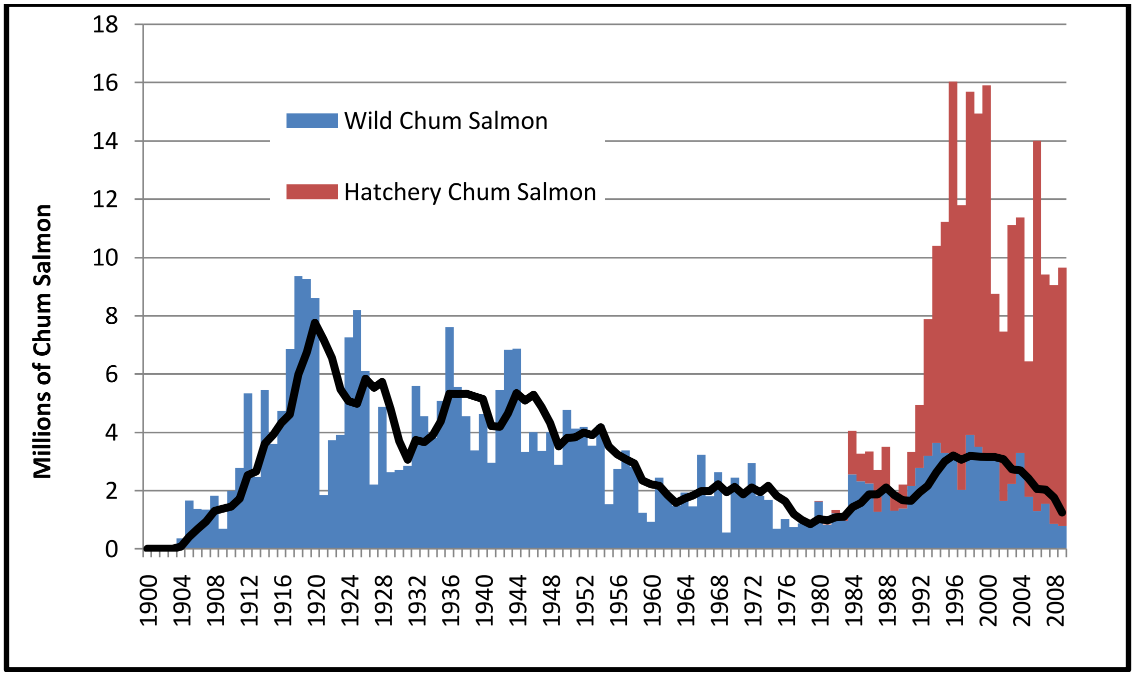


Figure 5-78. Southeast Alaska total chum salmon harvest including estimated hatchery contribution, 1900-2009.

Table 5-44. Southeast Alaska and Yakutat Area commercial chum salmon harvest by fishery, 2009.

Fishery	Chum Salmon	Percentage
Purse Seine	3,502,998	36%
Drift Gillnet	2,729,966	28%
Set Gillnet	871	<1%
Troll	342,866	4%
Annette Island	158,637	2%
Hatchery Cost Recovery	2,912,641	30%
Miscellaneous	12,385	<1%
Total	9,660,364	

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

In 2009, of the 51.6 million total all-gear, all-species salmon harvest, 81% were harvested in traditional fisheries, 7% in THA fisheries, and 8% in hatchery cost recovery fisheries. Of the 9.7 million chum harvested in 2009, 38% were harvested in traditional areas, 30% were harvested in hatchery THAs, and 30% were harvested in cost recovery fisheries. The estimated hatchery contribution of chum salmon to the common property seine harvest for 2009 was 87%, or 3.1 million fish. Total combined hatchery contributions estimated by NSRAA, SSRAA, and DIPAC to the common property drift gillnet fisheries was 95%, or 2.6 million chum salmon.
Hatchery cost recovery harvests in 2009 totalled approximately 4.0 million fish (all species combined), 84% of the recent 10-year average harvest of 4.8 million. The harvest included 2.9 million chum salmon. Chum salmon made up 73% of the total cost recovery harvest in the region in numbers of fish and was 15% below the recent 10-year average harvest of 3.4 million. Chum salmon cost recovery harvests were conducted by SSRAA (761,000), DIPAC (1,588,000), NSRAA (446,000), AKI (38,000), and SJC (17,000). No cost recovery harvests were reported by KAKE or MIC.

Southeast Alaska Commercial Purse Seine and Drift Gillnet Fisheries

During the 2009 purse seine fishery, 379 permits were issued and 269 permits were fished. Effort in 2009 increased greatly over the 213 permits fished in 2008 (the second lowest effort on record) and was the greatest since 273 permits were fished in 2002.

In 2009, the total harvest by purse seine gear was 44.4 million salmon (all species combined) of which the total common property purse seine harvest was 39.1 million salmon. Common property fisheries include traditional wild stock fisheries and terminal harvest area (THA) fisheries where fishermen compete to harvest surplus returns. Common property purse seine harvests for 2009 included 36.2 million fish in traditional areas and 2.8 million fish in hatchery terminal areas. The total common property purse seine harvest included approximately 3.5 million chum salmon. On average, the common property purse seine harvests since 1962 account for 69% of chum salmon harvests in the region.

Historically, the total purse seine fishery in Southeast Alaska has accounted for approximately 82% of the total commercial common property 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. Common property purse seine harvests for all salmon species (except Chinook salmon) were below the recent 10-year average. The chum salmon harvest for 2009 was 71% of the recent 10-year average harvest of 5.0 million fish. Cost recovery seine harvests to support privately operated salmon enhancement programs totaled 3.6 million, of which 75% were chum salmon. Seine harvests reported by the Annette Island Reservation[28] totaled 1.7 million fish (all species) which included approximately 38,500 chum salmon. Miscellaneous harvests of 41,000 salmon include test fisheries authorized by the department as well as illegally harvested fish, later confiscated by the Alaska Wildlife Troopers.

Of the 44.4 million salmon harvested by purse seine gear in 2009, 28.4 million were harvested in Southern Southeast districts and 16.0 million were harvested in Northern Southeast districts. Purse seine fishing in Northern Southeast Alaska includes the fisheries that occur in Districts 9 through 14. For 2009, traditional and THA purse seine harvests in Northern Southeast Alaska totaled 13.1 million fish, and included 2.4 million chum salmon (Table 5-45, Figure 5-79). The harvest of chum salmon was above the long-term average but below the most recent 10-year average harvests. The 2009 harvest of chum salmon in Northern Southeast Alaska was 79% of the recent 10-year average harvest of 3.3 million.

Purse seine fishing in southern Southeast Alaska occurs in Districts 1 through 7. In 2009, the common property purse seine harvest (traditional and THA) in southern Southeast Alaska totaled 25.9 million fish. The harvest included 1.1 million chum salmon (Table 5-45, Figure 5-79). The harvest of chum salmon was 65% of the recent 10-year average in 2009.

---

[28] 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 5-45. Southeast Alaska annual commercial, common property, purse seine chum salmon harvest (from traditional and terminal areas), 1980-2009.

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	3,043,032	1,242,118	1,800,914
2008	3,215,231	2,332,622	882,609
2009	3,502,998	2,427,762	1,075,236
1999-2008 Avg.	4,950,705	3,282,736	1,667,968

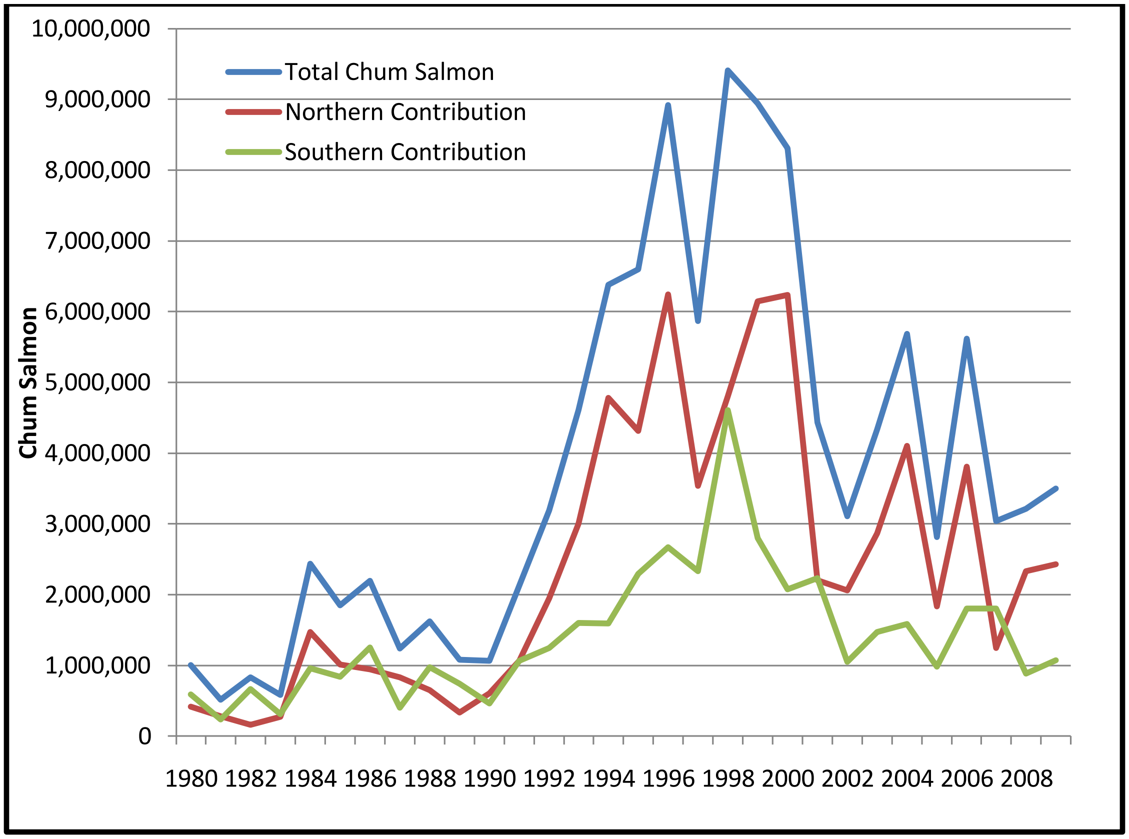


Figure 5-79. Southeast Alaska annual commercial, common property, purse seine chum salmon harvest (from traditional and terminal areas), 1980-2009.

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). During the 2009 drift gillnet fishery, 474 permits were issued and 408 permits were fished; a slight increase over the 10-year average of 391 permits fished. The 2009 drift gillnet common property fisheries (traditional and THA) harvested 4.0 million salmon (all species combined). The total common property drift gillnet harvest included approximately 2.7 million chum salmon (68% of the harvest) (Table 5-46, Figure 5-80). The chum salmon harvest was 31% above the recent 10-year average harvest of 2.1 million fish. Common property harvests included 2.2 million chum salmon in traditional fisheries and 0.5 million fish in hatchery terminal areas. Cost recovery harvests by drift gillnet gear were minimal. Drift gillnet harvests from the Annette Island Reservation were 272,000 salmon (all species combined), which included approximately 120,000 chum salmon.

Table 5-46. Southeast Alaska total commercial, common property, drift gillnet chum salmon harvest (from traditional and terminal areas), 1980-2009.

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
1999-2008 Avg.	2,079,969

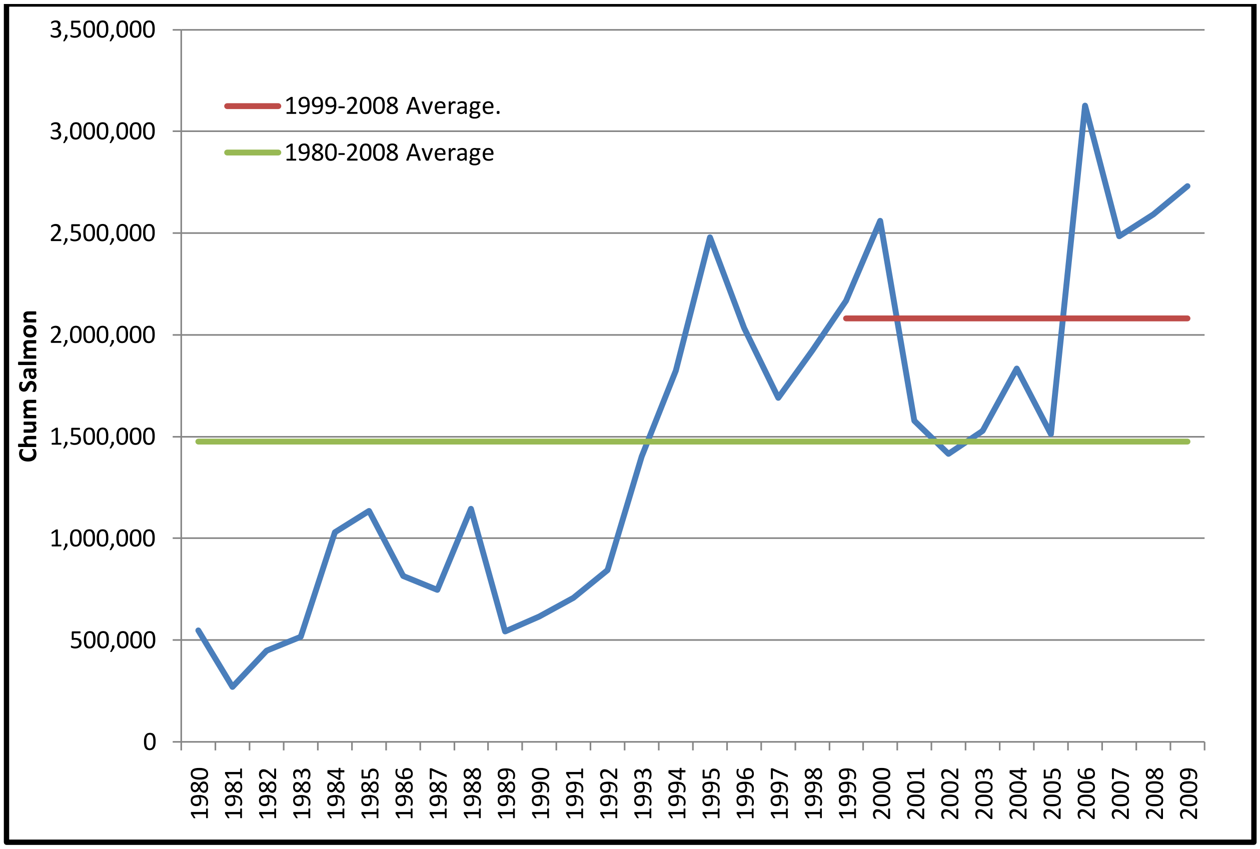


Figure 5-80. Southeast Alaska total commercial, common property, drift gillnet chum salmon harvest (from traditional and terminal areas), 1980-2009.

Yakutat Set Gillnet Fishery

In Registration Area D, 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. Of the 167 Yakutat set gillnet permits, 123 were active for the 2009 season, compared to the recent 10-year average of 114 permits fished.

The Yakutat set gillnet fishery produced a cumulative harvest of 319,000 salmon (all species combined), which was nearly equal to the recent 10-year average of 320,000 salmon. The chum salmon harvest of 871 fish was 88% of the recent 10-year average (Table 5-47). 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 (as well as the sockeye salmon run) in the East River declined in the early 1990s, probably due to changes in habitat (see Clark et al. 2003). A total of 275 chum salmon were harvested in the East River fishery in 2009. In addition, chum salmon were also harvested in the Situk-Ahrnklin Inlet (147 fish; 89% of the recent 10-year average) and Yakutat Bay (353 fish; 35% of the recent 10-year average).

Table 5-47. Commercial chum salmon harvest in the Yakutat area set gillnet fishery, 1998-2009.

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
1999-2008 Avg.	990

Southeast Alaska/Yakutat Troll Fishery

The commercial troll fishery in Southeast Alaska and Yakutat (Region 1) 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 2.1 million salmon were harvested in the 2009 Southeast Alaska/Yakutat troll fishery (common property and terminal areas) by 748 power troll and 367 hand troll permit holders. The harvest included 343,000 chum salmon landed, of which 5,300 chum salmon (1.5%) were taken by hand troll gear and 338,000 chum salmon (98.5%) by power troll gear. A total of 748 chum salmon were reported as harvested outside state waters in the EEZ.

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, when for the first time over 1 million chum salmon returned to the NSRAA Hidden Falls hatchery, located on eastern Baranof Island. In 1993, the NSRAA Medvejie/Deep Inlet facility near Sitka saw a return of over 1.0 million chum and the troll chum salmon harvest increased to over 500,000 fish. Since that time, trollers have targeted chum and, with the exception of 1999 and 2008, the annual troll harvest of chum salmon outside of terminal harvest areas has been consistently greater than 100,000 fish (Table 5-48, Figure 5-81). In 2009, trollers harvested a total of 109,000 chum salmon in Sitka Sound. The majority (66,000) were harvested during the general summer fishery in Sitka Sound/Eastern Channel, with peak harvests occurring during the first 2 weeks of August. Trollers also harvested 40,300 chum salmon in Eastern Channel during the August troll closure and 2,700 chum salmon in the Deep Inlet THA.

Currently, trollers are allowed to fish in the Neets Bay THA only in years in which a surplus above SSRAA's broodstock and cost recovery needs is identified. In 2009, trollers harvested 186,000 chum salmon in the Neets Bay THA from July 1–17. Trollers also harvested 26,000 chum salmon in West Behm Canal, adjacent to the Neets Bay THA, with the majority taken during the two weeks following the closure of the THA. A total of 213,000 chum salmon were harvested by trollers in Neets Bay and West Behm Canal.

Table 5-48. Southeast Alaska/Yakutat Region commercial troll (common property) chum salmon harvest, 1980-2009.

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	78,990
1993	525,138	34,449	490,689
1994	330,376	32,061	298,315
1995	277,453	21,282	256,171
1996	406,244	53,646	352,598
1997	312,042	20,042	292,000
1998	117,642	2,051	115,591
1999	74,672	583	74,089
2000	478,144	6,427	471,717
2001	467,830	12,480	455,350
2002	117,672	578	117,094
2003	286,410	3,095	283,315
2004	161,070	861	160,209
2005	165,393	418	164,975
2006	143,030	437	142,593
2007	185,800	1,385	184,415
2008	56,175	735	55,440
2009	299,593	4374	295,219
1999-2008 Avg.	213,620	2,700	210,920

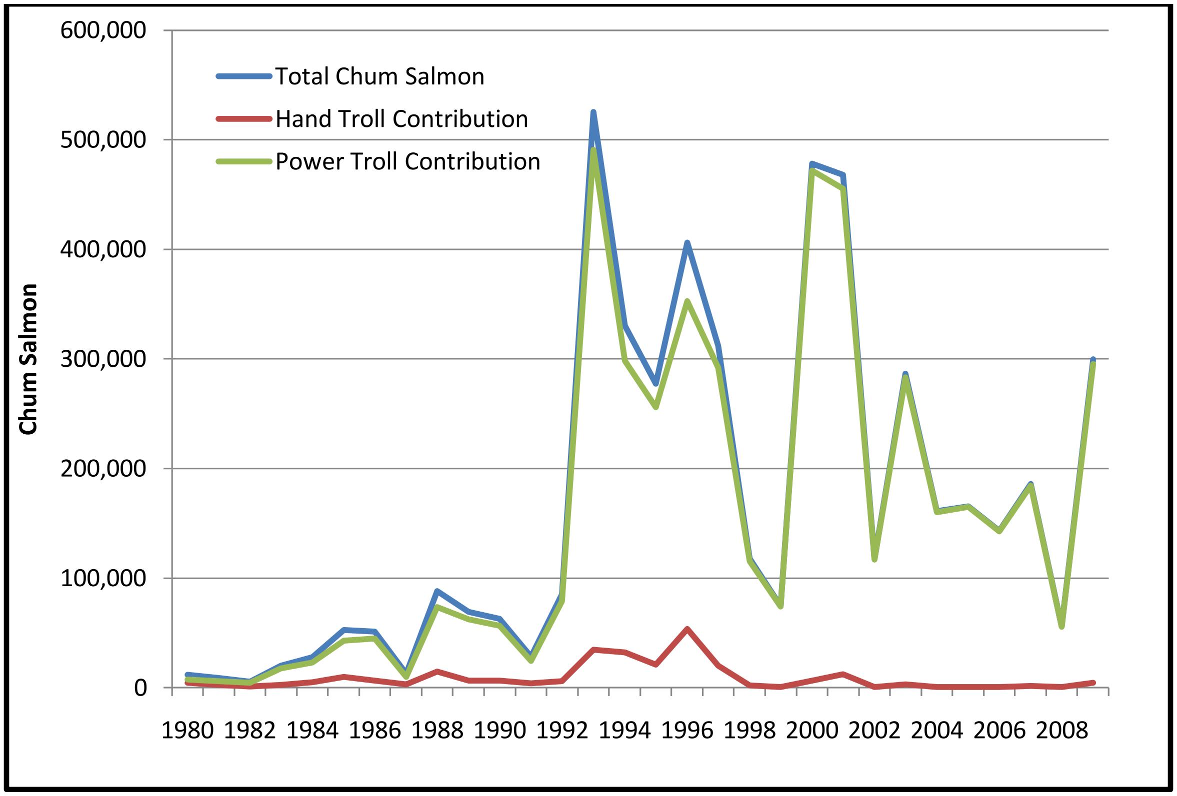


Figure 5-81. Southeast Alaska/Yakutat Region commercial troll (common property) chum salmon harvest, 1980-2009.

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, two large, glacial, mainland river systems. 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 in Southern Southeast, Northern Southeast Inside, and Northern Southeast Outside subregions. The abundance of summer-run chum salmon has increased since the early 1970s and escapement indices have been stable or increasing since 1980. However, the 2008 and 2009 summer chum salmon runs in Southeast Alaska were generally weak, with observed escapements below the recommended goals for the Northern Inside and Southern aggregates. Summer chum salmon runs were notably poor over most of the region in 2009.

For fall runs that support, or have supported, a directed fishery, stocks were divided into five aggregates in Cholmondeley Sound, Port Camden, Security Bay, Excursion Inlet, and Chilkat River areas. The abundance of fall-run chum salmon has decreased from the high levels observed from the 1960s to the early 1970s; however, 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 2008 were generally within or above escapement goals. In 2009, with the exception of Port Camden and Excursion Inlet, fall runs performed better with respect to escapement goals than summer runs, particularly in the Chilkat River. It should be noted that allozyme studies by Kondzela et al. (1994), Phelps et al. (1994), and Wilmot et al. (1994) suggested that run-timing is an isolating mechanism for chum salmon populations: "reproductive isolation between summer-run and fall-run chum salmon is an important component of the genetic diversity of this species" (Phelps et al. 1994).

Table 5-49. Southeast Alaska chum salmon escapement goals and escapements, 2001-2009.

ange				Chum Salmon Escapement								
pper	Type	Year Implemented	Enumeration Method	2001	2002	2003	2004	2005	2006	2007	2008	2009
	lower-bound SEG	2009	Aerial Survey	125,000	55,000	66,000	74,000	66,000	76,000	132,000	13,000	41,000
	lower-bound SEG	2009	Aerial Survey	229,000	397,000	210,000	242,000	185,000	282,000	149,000	99,000	107,000
	lower-bound SEG	2009	Aerial Survey	58,000	19,000	30,000	86,000	77,000	57,000	34,000	46,000	15,000
8,000	SEG	2009	Aerial Survey	45,000	39,000	75,000	60,000	15,000	54,000	18,000	49,500	39,000
,000	SEG	2009	Aerial Survey	n/a	450	676	3,300	2,110	2,420	505	1,400	1,711
5,000	SEG	2009	Aerial Survey	3,500	6,000	8,700	13,100	2,750	15,000	54,000	11,700	5,100
8,000	SEG	2009	Aerial Survey	17,750	4,680	6,300	5,200	1,100	2,203	6,000	8,000	1,400
70,000	SEG	2009	Mark-recapture, fish wheel	312,000	206,000	166,000	310,000	202,000	704,000	331,000	451,000	337,000

scapement fell below stated goals. Yellow-shaded cells indicate escapement goals were met. Green-shaded cells indicate escapement goals were exceeded.
icial escapement goal for that particular year. Shaded cells are based upon the escapement goal in place at the time of enumeration for salmon stocks rather than the
.

Subsistence Chum Salmon Harvest

A total of 3,427 subsistence permits were issued in Southeast Alaska in 2009: 3,294 in Registration Area A, and 133 subsistence permits in the Yakutat area, Registration Area D. Of that total, 3,107 permits were returned, with a total reported subsistence harvest of 52,550 fish, of which only 1,714 (3%) were chum salmon. Those numbers are slightly below the 10-year average of 2,356 chum salmon (average 4% of total harvest). Sockeye salmon make up 85% of the annual subsistence harvest in Southeast Alaska.

Table 5-50. Number of subsistence permits issued and returned, and reported chum salmon subsistence harvest in Southeast Alaska, 1999–2009.

Year	Permits Issued	Permits Returned	Total Fish Harvested	Reported Chum Harvest	Proportion Chum
1999	4,308	3,709	59,766	4,356	7%
2000	3,771	3,198	54,384	2,981	5%
2001	3,609	3,122	59,340	3,308	6%
2002	3,328	2,785	58,142	1,846	3%
2003	3,597	2,956	67,156	3,207	5%
2004	3,703	3,294	63,105	2,748	4%
2005	3,315	2,799	42,836	1,636	4%
2006	3,406	2,810	53,941	1,526	3%
2007	3,161	2,802	41,863	628	2%
2008	3,153	2,823	43,482	1,325	3%
2009	3,427	3,107	52,550	1,714	3%
1999-2008 Avg.	3,535	3,030	54,402	2,356	4%

2010 Chum Salmon Forecast

The projection for chum salmon harvest in 2010 was for a total of 9.4 million chum salmon, of which 7.3 million were hatchery fish and 2.1 million were wild fish (Eggers et al. 2010). The projection for hatchery fish are provided by the hatchery operators, while the projection for wild fish is simply the 5-year running average of past harvests of wild chum salmon.

5.3.5 Statewide summary for other Alaska stocks

Chum salmon stocks in areas outside of western Alaska include those found in the Aleutian Islands, Kodiak, Chignik, Upper Cook Inlet, Lower Cook Inlet, Prince William Sound, and Southeast Alaska. Escapement goals are generally comprised of stock-aggregate goals from several individual index streams. There is no escapement goal or chum salmon escapement surveys in the Aleutian Islands area.

In 2010, average escapement was achieved in Chignik, Prince William Sound, and Lower Cook Inlet areas. Below average escapement occurred in Kodiak and Southeast Alaska. There is only one chum salmon escapement goal in Upper Cook Inlet and the upper range of that goal was exceeded in 2010. Although spawning escapement goals were met in most of the Lower Cook Inlet streams, escapement into McNeil River failed to reach the lower goal for the sixteenth time in the past 21 years despite the continued ban on targeted commercial fishing.

Commercial fisheries occurred in all areas with above average harvests for chum salmon in Chignik, Upper Cook Inlet, Lower Cook Inlet, and Prince William Sound areas. Kodiak chum salmon harvests were below the most recent 10-year average.

Table 5-51. Over view of Alaskan chum salmon stock performance, 2010.

Chum salmon stock	Total run size?	Escapement goals met?[1]	Subsistence fishery?	Commercial fishery?	Sport fishery?	Stock of concern?
Bristol Bay	Above average	1 of 1	Yes	Yes	Yes	No
Kuskokwim Bay	Above average	2 of 2	Yes	Yes	Yes	No
Kuskokwim River	Average	2 of 2	Yes	Yes	Yes	Yield concern discontinued 2007
Yukon River summer run	Average	2 of 2	Yes	Yes, but limited by low Chinook	Yes	Management concern discontinued 2007
Yukon River fall run	Below average	6 of 8	Restrictions	Limited season (Tanana River)	No	Yield concern discontinued 2007
Eastern Norton Sound	Above average	1 of 1	Yes	Yes	Yes	No
Northern Norton Sound	Above average	7 of 7	Yes	Yes	Yes, except for Nome Subdistrict	Yield concern (since 2000)
Kotzebue	Above average	6 of 6	Yes	Yes	Yes	No
North Peninsula	Average	2 of 2	Yes	Yes	Yes	No
South Peninsula	Below average	2 of 4	Yes	Yes	Yes	No
Aleutian Islands	n/a	n/a	Yes	Yes	Yes	No
Kodiak	Below average	2 of 2	Yes	Yes	Yes	No
Chignik	Average	1 of 1	Yes	Yes	Yes	No
Upper Cook Inlet	Above average	1 of 1	Yes	Yes	Yes	No
Lower Cook Inlet	Average	9 of 12	Yes	Yes	Yes	No
Prince William Sound	Average	5 of 5	Yes	Yes	Yes	No
Southeast	Below average	6 of 8	Yes	Yes	Yes	No

[1] Some aerial survey-based escapement goals were not assessed due to inclement weather or poor survey conditions.

5.4 Impacts on chum salmon

Note that significance criteria will be developed and incorporated into the impact analysis for the public review draft in order to evaluate the significance of the impacts of the alternative management measures on chum salmon stocks.

5.4.1 Pollock fishery bycatch of Chum salmon under Alternative 1

The majority of non-Chinook bycatch in the Bering Sea occurs in the pollock fishery. Historically, the contribution of non-Chinook bycatch from the pollock trawl fishery has ranged from a low of 88% of all bycatch to a high of >99.5% in 1993. Since 2005 the pollock fishery contribution to the total non-Chinook bycatch has ranged from 88% in 2010 to 99.3% in 2005. Total catch of non-Chinook salmon in the pollock fishery reached an historic high in 2005 at 705,963 fish (Table 5-52). Bycatch of non-Chinook salmon in this fishery occurs almost exclusively in the B season.

Table 5-52. Non-Chinook (chum) salmon mortality in BSAI pollock directed fisheries 1991-2010. Note 2010 updated 1/14/11.

Year	Annual with CDQ	Annual without CDQ	Annual CDQ only	A season with CDQ	B season with CDQ	A season without CDQ	B season without CDQ	A season CDQ only	B season CDQ only
1991	Na	28,951	na	na	na	2,850	26,101	na	na
1992	Na	40,274	na	na	na	1,951	38,324	na	na
1993	Na	242,191	na	na	na	1,594	240,597	na	na
1994	92,672	81,508	11,165	3,991	88,681	3,682	77,825	309	10,856
1995	19,264	18,678	585	1,708	17,556	1,578	17,100	130	456
1996	77,236	74,977	2,259	222	77,014	177	74,800	45	2,214
1997	65,988	61,759	4,229	2,083	63,904	1,991	59,767	92	4,137
1998	64,042	63,127	915	4,002	60,040	3,914	59,213	88	827
1999	45,172	44,610	562	362	44,810	349	44,261	13	549
2000	58,571	56,867	1,704	213	58,358	148	56,719	65	1,639
2001	57,007	53,904	3,103	2,386	54,621	2,213	51,691	173	2,930
2002	80,782	77,178	3,604	1,377	79,404	1,356	75,821	21	3,583
2003	189,185	180,783	8,402	3,834	185,351	3,597	177,186	237	8,165
2004	440,459	430,271	10,188	422	440,037	395	429,876	27	10,161
2005	704,586	696,876	7,710	595	703,991	563	696,313	32	7,678
2006	309,644	308,430	1,214	1,326	308,318	1,260	307,170	66	1,148
2007	93,786	87,317	6,469	8,523	85,263	7,368	79,949	1,155	5,314
2008	15,142	14,717	425	319	14,823	246	14,471	73	352
2009	46,129	45,179	950	48	46,081	48	45,131	0	950
2010	13,306	12,789	517	48	13,258	48	12,741	0	517

Non-CDQ data for 1991-2002 from bsahalx.dbf Non-CDQ data for 2003-2009 from akfish_v_gg_pscnq_estimate
CDQ data for 1992-1997 from bsahalx.dbf
CDQ data for 1998 from boatrate.dbf
CDQ data for 1999-2007 from akfish_v_cdq_catch_report_total_catch
CDQ data for 2008-2009 from akfish_v_gg_pscnq_estimate_cdq
A season - January 1 to June 10
B season - June 11 to December 31

Bycatch rates for chum salmon (chum salmon/t of pollock) from 1991-2010 are shown in Figure 5-82. Currently the Chum Salmon Savings Area as shown in Figure 5-82 is invoked in the month of August annually and when triggered in September. However, starting in 2006, the fleet has been exempt from these closures because of their participation in the salmon bycatch reduction intercooperative agreement, which was implemented in 2006 (under an exempted fishing permit) and in regulation in 2007 under Amendment 84.

Bycatch by sector from 1997-2009 is summarized in Table 5-53. Annual percentage contribution to the total amount by year and sector (non-CDQ) from 1997-2009 is summarized in Table 5-54.

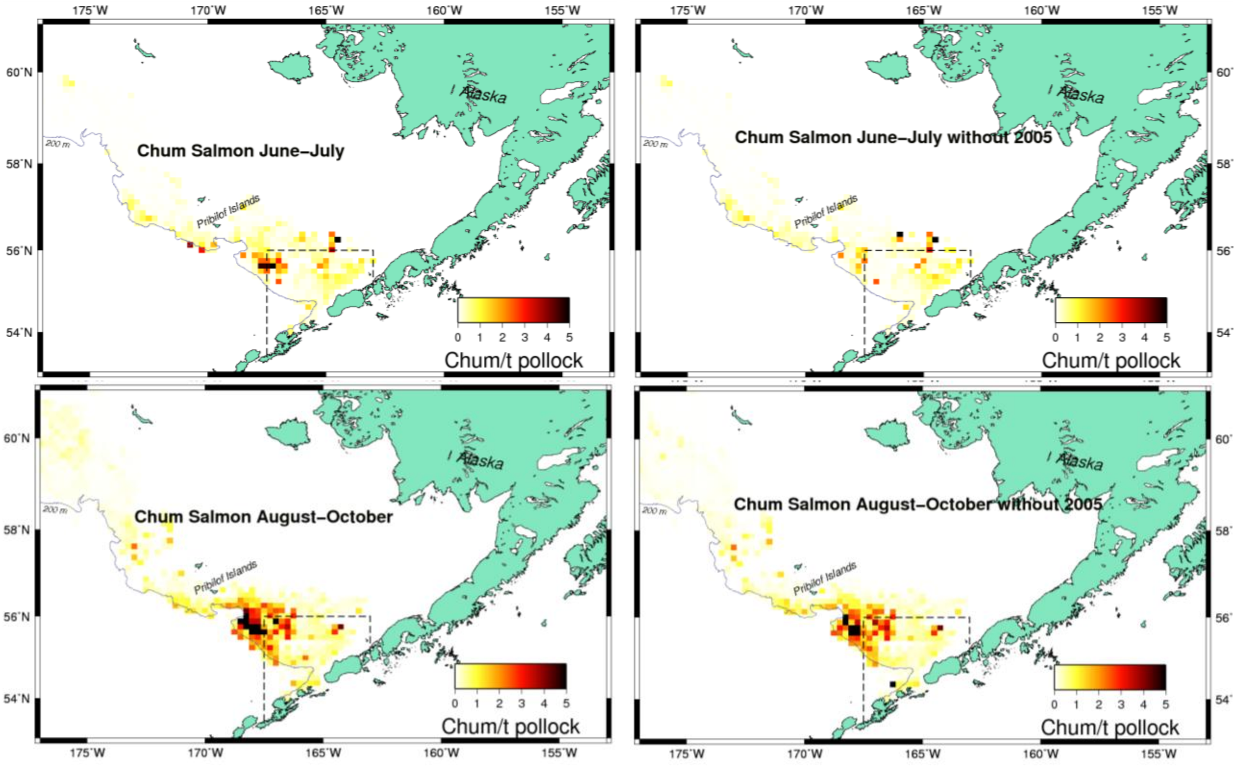


Figure 5-82. Chum salmon bycatch rates (numbers per t of pollock) for 2003-2010 data (left panels) and with the 2005 data omitted (right panels) by months within the B-season. Catcher Vessel Operational Area (CVOA) is represented by dashed line.

Table 5-53. Non-Chinook bycatch in the EBS pollock trawl fishery 1997-2009 by sector. CP = catcher processor, M= Mothership, S = Shoreside catcher vessel fleet. CDQ where available is listed separately by the sector in which the salmon was caught. For confidentiality reasons CDQ catch by sector since 2008 cannot be listed separately. 2009 data through 10/10/09 Source NMFS catch accounting

Year	CP	M	S	CDQ(total)	Total
1997	23,131	15,018	23,610	4,229	65,988
1998	8,119	6,750	49,173	0	64,042
1999	2,312	212	42,087	661	45,271
2000	4,930	509	51,428	1,704	58,571
2001	20,356	8,495	25,052	3,103	57,007
2002	9,303	13,873	54,002	3,474	80,652
2003	22,831	11,895	152,053	8,356	195,135
2004	76,159	13,330	347,940	10,197	447,626
2005	63,266	15,314	619,691	7,693	705,963
2006	18,180	2,013	289,150	1,202	310,545
2007	27,245	5,427	54,920	6,480	94,071
2008	1,562	641	12,512	425	15,140
2009	3,878	1,733	39,412	950	45,973

Table 5-54. Percent of total annual non-Chinook salmon catch by sector by year 1997-2009 (CDQ not included in sector totals) CP = catcher processor, M= Mothership, S = Shoreside catcher vessel fleet.

Year	CP	M	S
1997	35%	23%	36%
1998	13%	11%	77%
1999	5%	0%	93%
2000	8%	1%	88%
2001	36%	15%	44%
2002	12%	17%	67%
2003	12%	6%	78%
2004	17%	3%	78%
2005	9%	2%	88%
2006	6%	1%	93%
2007	29%	6%	58%
2008	10%	1%	83%
2009	8%	2%	86%

5.4.1.1 Bycatch under RHS/Inter-cooperative Agreement

This analysis provides an evaluation of the status quo chum PSC reduction measures[29]. 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 it 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 and June 2010.

Since 2001, there has been an 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 Section 2.1.2. 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[30], 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 creates a "hard cap" for Chinook salmon beginning in 2011.

The three panes of Figure 5-83 show the locations of RHS closures in the Bering Sea at different points in the B Season from 2003-2010 (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.

---

[29] 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.

[30] 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.

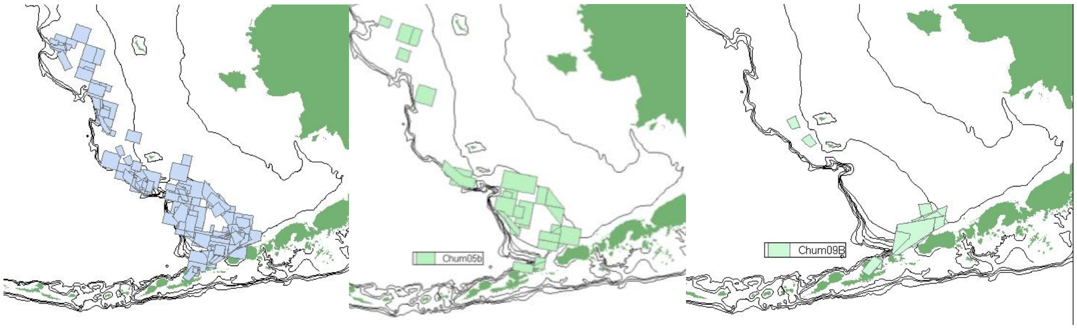


Figure 5-83. RHS B Season Closures 2003-2010 (left), 2005B (center) and 2009B (right)

As described in section 2.1.2, the rolling hotspot program 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 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 2.1.2also facilitates more informed decision-making, though how this affects behavior is difficult to measure.

5.4.1.2 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. 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
- Presentation of summary findings
- Appendix: RHS B-Season Closure Periods 2003-2009.

5.4.1.2.1 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 be able to assess the impact of closures being imposed, while at the same time minimizing double counting of sequential and overlapping closures.

5.4.1.2.2 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 the 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 2003-2010. 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).

Table 5-55. 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

* 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.

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 in 2008-2010 (Table 5-56).

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 5-57). 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.

Vessels that fished in a closure area before the closure also fished elsewhere to differing degrees by year and sector (Table 5-58). 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. Tier 3 vessels are prohibited from fishing in closures for 7 days. Nonetheless, vessels will often leave 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 apply to all vessels.

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 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.

The Chum PSC rates of Tier 1 and Tier 2 vessels legally fishing inside of RHS closures after they are implemented shows that approximately 5 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 5-59). 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 2003-2010 for Tier 1 & 2 vessels fishing inside closures was 0.47 chum/t. At the same time, the rate outside the closures was 0.65. For other sectors, the Chum PSC rate was 0.23 inside versus 0.9 outside. For Chinook PSC, the average rate for CVs fishing in the closures over the period was 0.086 versus 0.082 outside. For other sectors, the rate was 0.03 versus 0.10. The relatively small amount of fishing that occurs in the areas can make these rates quite variable from year to year.

Table 5-56. Days per Month with Chum or Chinook Closures in Place

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

Table 5-57. Average percent of total Chum, Chinook, and Pollock caught in RHS Closures during the 5 days before each closure, 2003-2010

	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%	1%	1%
2007	11%	19%	7%	30%	22%	5%
2008	29%	52%	11%	2%	6%	0%
2009	33%	18%	13%	9%	18%	2%
2010	33%	47%	9%	13%	35%	2%

Table 5-58. For Vessels that fished in the RHS during the 5 days before closures, % of their pollock caught in the RHS Area during that 5 day period by Sector and Year

Year	CV % in RHS	CP/MS % in RHS
2003	49%	28%
2004	37%	17%
2005	45%	30%
2006	39%	17%
2007	45%	31%
2008	63%	15%
2009	51%	26%
2010	57%	17%

Table 5-59 Activity inside RHS Closures by Tier 1 & 2 Vessels.

Year	CV	% Chum In	Chum In RHS	Chum Out RHS	Chum Rate In	Chum Rate Out	% Pollock In	Pollock In (t)	Pollock Out (t)
2003	CV	5.2%	4,445	80,887	0.168	0.433	14.1%	26,394	186,616
2004	CV	2.7%	4,161	148,498	0.573	0.875	4.3%	7,261	169,661
2005	CV	1.4%	5,644	384,980	0.990	1.812	2.7%	5,700	212,409
2006	CV	2.3%	3,696	158,589	1.673	0.634	0.9%	2,209	250,166
2007	CV	13.1%	4,061	26,921	0.751	0.170	3.4%	5,405	158,011
2008	CV	13.6%	710	4,506	0.154	0.039	4.0%	4,600	115,060
2009	CV	19.6%	4,076	16,699	0.654	0.183	6.8%	6,229	91,107
2010	CV	12.0%	542	3,955	0.688	0.043	0.8%	788	92,820
2003	CP/MS/CDQ	0.8%	290	35,311	0.133	0.108	0.7%	2,177	326,201
2004	CP/MS/CDQ	*	*	64,513	0.935	0.187	*	*	344,340
2005	CP/MS/CDQ	1.5%	898	58,923	0.817	0.142	0.3%	1,100	414,048
2006	CP/MS/CDQ	0.0%		18,985	-	0.040			473,228
2007	CP/MS/CDQ	1.3%	396	30,142	0.117	0.085	1.0%	3,394	353,850
2008	CP/MS/CDQ	0.5%	*	1,900	*	0.007	*	*	255,459
2009	CP/MS/CDQ	0.1%	4	4,747	0.023	0.025	0.1%	171	193,012
2010	CP/MS/CDQ	1.6%	35	2,142	0.059	0.014	0.4%	602	155,534
2003-10	CP/MS/CDQ	0.8%	1,709	216,663	0.225	0.086	0.3%	7,587	2,515,671
Avg/Total	CV	3.2%	27,336	825,035	0.467	0.647	4.6%	58,585	1,275,850

5.4.1.2.3 Evaluating and quantifying impacts of the RHS system

How does this translate into 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.

Some RHS closure areas 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 closures, it's possible that 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 bycatch reduction is unlikely to be very large.

The analysis of the closures below suggests, as one would expect, that the largest benefit, on average, accrues immediately following closure implementation.

There are inherent limitations in analyzing precisely how well the RHS system works at any given time. There were times when closures were put in place or left in place for long periods where there may have been substantial salmon avoided or saved but there is no way to demonstrate this beyond looking at average variation in the fishery. 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 bycatch that would have occurred, either because salmon bycatch 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 bycatch than if they had remained in the closure.

5.4.1.2.4 The impact of RHS closures on observed PSC levels

Figure 5-84 displays the observer-derived chum PSC rates, by day for 2003-2010. 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 2003-2010.

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.

To evaluate the success of the hotspot system, we estimate the change in the overall PSC rate for the entire fishery at the time that closures are 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.

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 attempt to measure the change in chum PSC that occurs when closures are implemented.

5.4.1.2.5 Before-after RHS closure comparison of changes in average chum PSC rates

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.[31] 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

---

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

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.

While there are long-term trends of PSC within a season that may be impacted by closures that this analysis considers by examining the pre-RHS period, it is difficult to separate these trends from the repeated "treatments" imposed by the RHS closures when RHS closures are in place. However, 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.

There is, on average, a drop in PSC rate in the days immediately following the implementation of RHS chum closures (Table 5-60). However, the standard deviations are large. A Mann-Whitney-Wilcoxon rank sum test indicates that the means of chum bycatch 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. However, comparing rates for the 5 days before and 5 days after 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.[32]

---

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

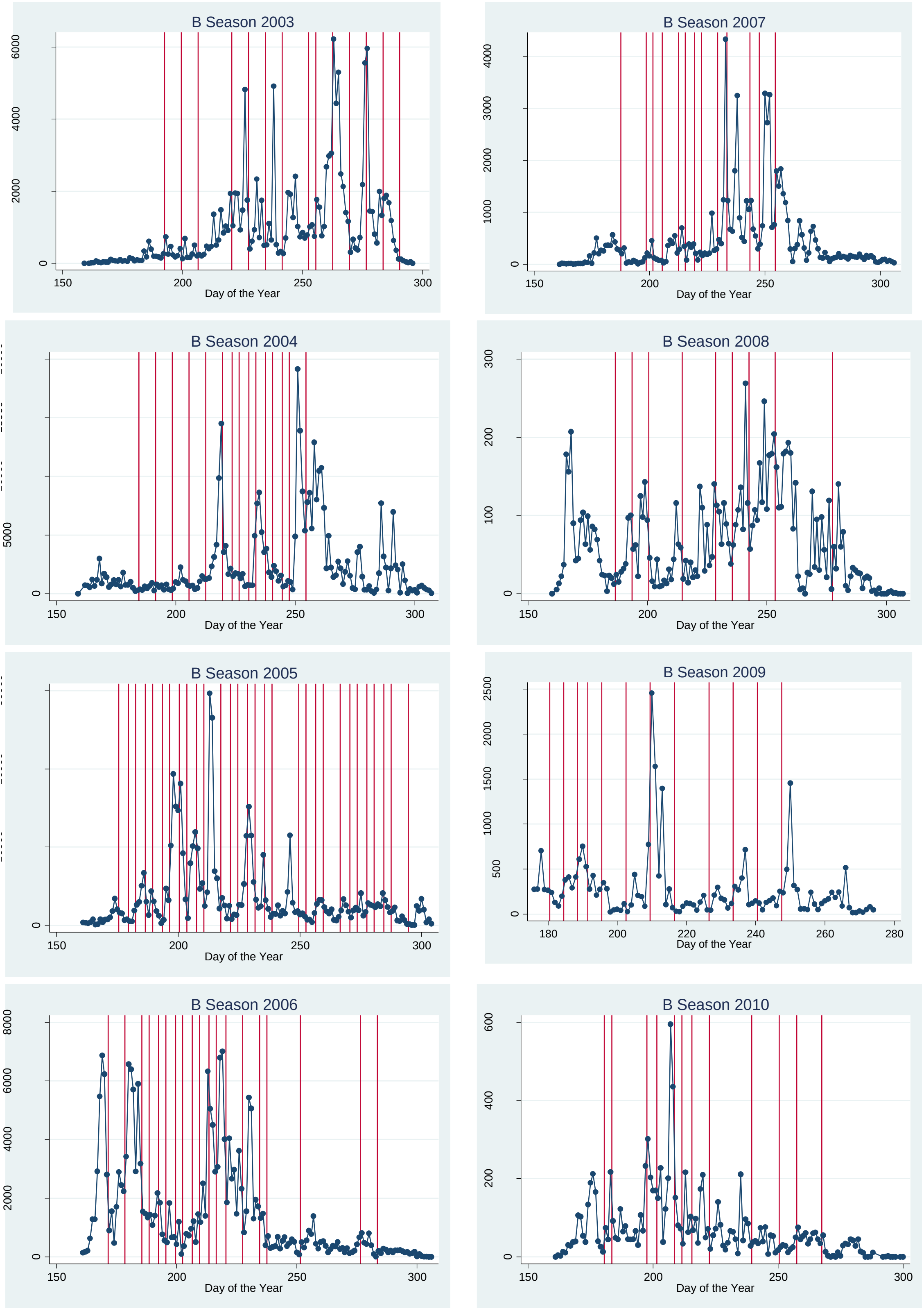


Figure 5-84. Chum PSC by day of the year, B-Seasons, 2003 – 2010. Vertical lines represent days a closure took place.

Table 5-60. Average chum PSC rate for the 5 days before and after Chum RHS closure periods, 2003-2010 B Seasons. Note that the negative numbers represent the days before the closures, with "-1," for example, representing hauls deployed from 0 to 24 hours before the closure was put in place.

		Mean Chum rate	Std. Dev.	Hauls
Days Before Closure	-5	0.393	1.71	8,902
	-4	0.464	2.11	8,984
	-3	0.412	1.72	8,811
	-2	0.38	1.48	8,754
	-1	0.425	2.07	8,543
Days After Closure	1	0.355	1.82	8,743
	2	0.375	1.67	8,860
	3	0.394	1.72	8,619
	4	0.465	1.98	8,861
	5	0.416	1.77	8,728
	Total	0.408	1.81	87,805

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 significant evidence that the observed impact measured at the time of closure implementation is due to the presence of closure areas.

Figure 5-85 displays the average chum PSC rates for the three days before and after chum closures are implemented. The pre-RHS analysis, below, provides a means to estimating the total salmon saved. Details on this method are discussed below.

Table 5-61 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 1/8 as much data at the annual level as in the aggregate comparison, several large increases in PSC after a closure have 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.

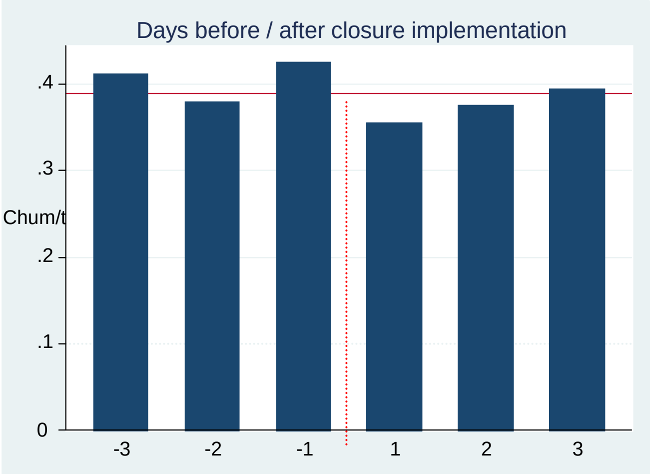


Figure 5-85. Chum PSC / MT Before & After Closures Implementation

Table 5-61. Average chum PSC rate for the 3 days before and after Chum RHS closure periods, Individual Years, 2003-2010

	Year									
Days Before/ After RHS	2003	2004	2005	2006	2007	2008	2009	2010	Total	Average
-3	0.239	0.486	0.863	0.497	0.141	0.03	0.104	0.058	0.439	
-2	0.254	0.386	0.782	0.529	0.128	0.059	0.095	0.056	0.403	
-1	0.285	0.465	0.841	0.544	0.176	0.053	0.127	0.054	0.453	0.406
1	0.39	0.311	0.713	0.351	0.147	0.066	0.192	0.035	0.379	
2	0.227	0.386	0.754	0.423	0.133	0.027	0.205	0.125	0.393	
3	0.242	0.418	0.822	0.473	0.199	0.033	0.142	0.033	0.419	0.375
Total	0.273	0.408	0.796	0.467	0.154	0.045	0.144	0.06	0.39	

5.4.1.3 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.

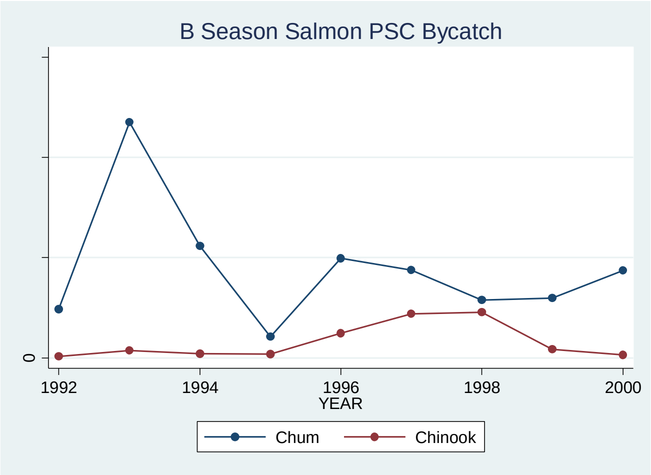


Figure 5-86. Salmon PSC catch by Bering sea pollock fishery, 1992-2000.

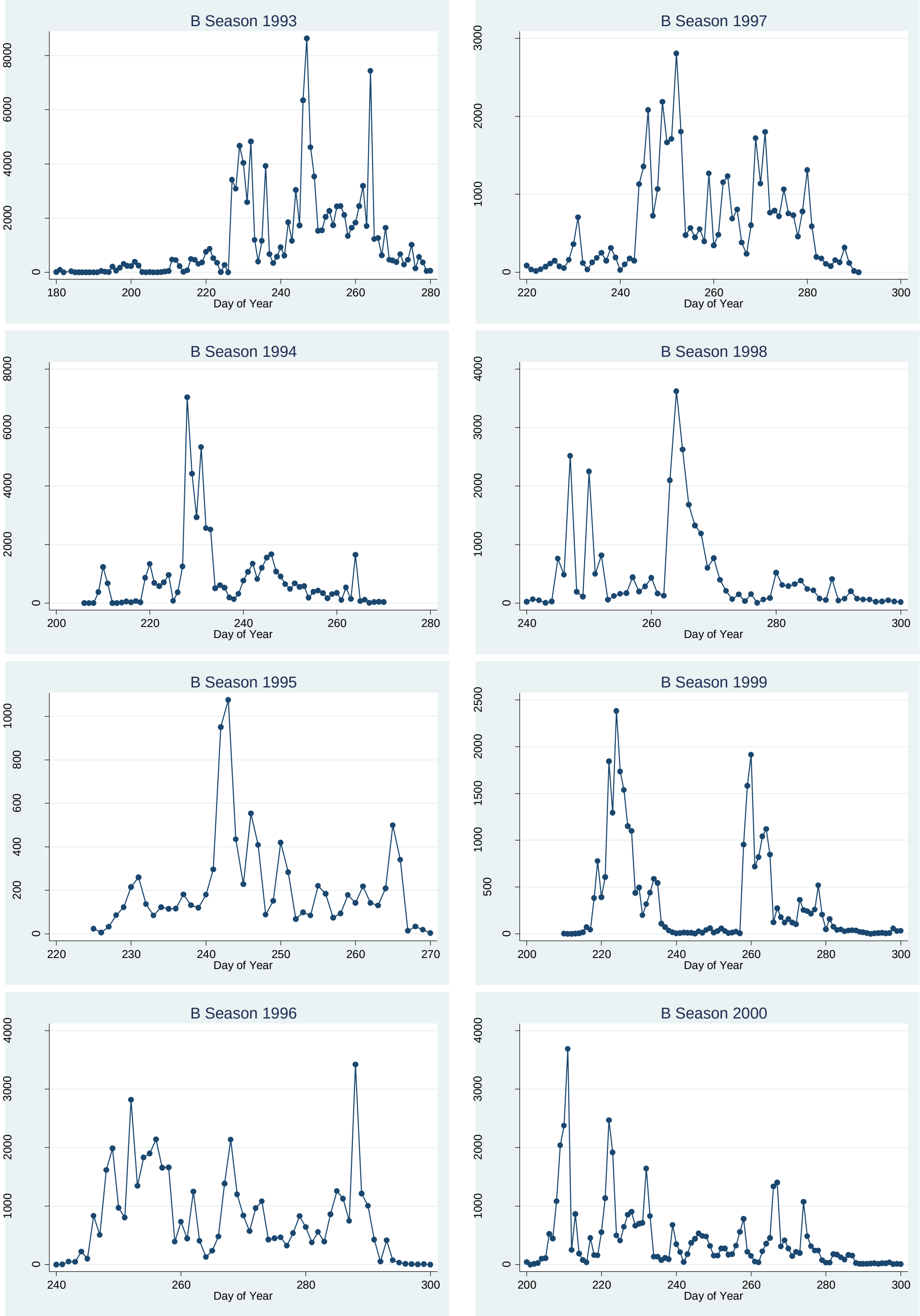


Figure 5-87. Daily chum salmon PSC in the Bering Sea pollock fishery, 1993-2000.

5.4.1.3.1 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 5-62. 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

5.4.1.3.2 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 5-63. 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 5-64. 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 5-65. 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 5-66. 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%

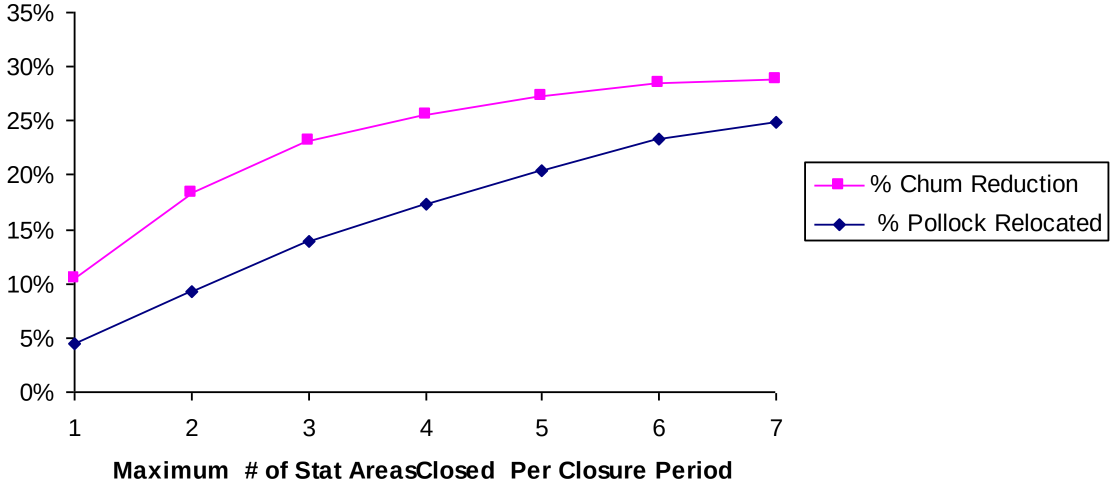


Figure 5-88. Percentage reduction in Chum bycatch and pollock reallocated with different sized closures.

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.[33] 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.

---

[33] 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 5-67. 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 5-89 illustrates how the effectiveness of closures declines in a near-linear fashion as the information delay in information gets larger.

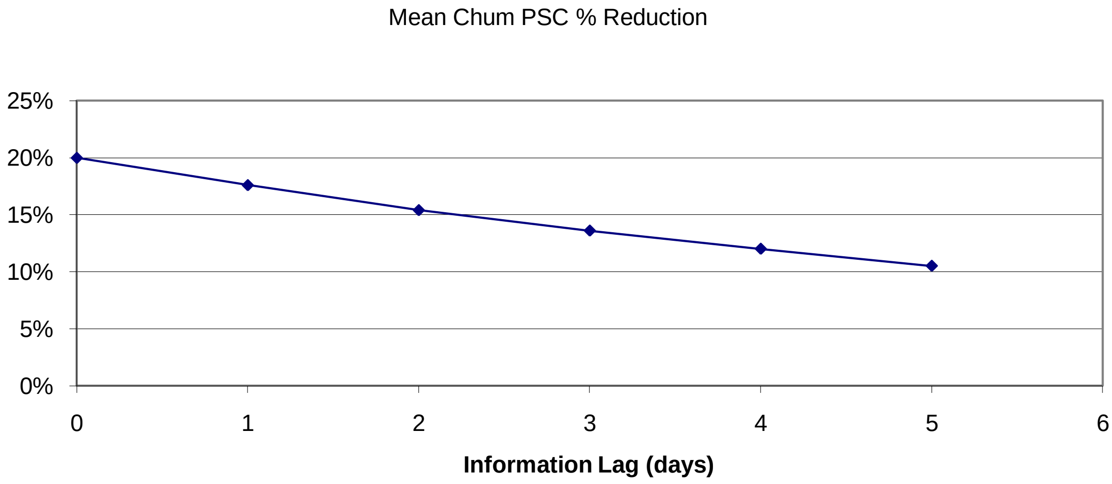


Figure 5-89. Impact on chum PSC reduction efficacy of a lag in information in implementing closures

5.4.1.3.3 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*-2010 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 2003-2010 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.

5.4.1.4 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 following table suggests they are actually higher than average.

Table 5-68. Relative chum and Chinook bycatch rates of vessels that fished in RHS areas compared to those that did not, before and after RHS closures

	Vessels NOT in clousure in 5 days before							Vessels inside clousure in 5 days before								
Year	CV	Chum	Chin	PollWt	Duration	Chum Rate	Chin Rate	Chum	Chin	PollWt	Duration	Chum Rate	Chin Rate	Rate Ratio Chum Vessels in/out	Rate Ratio Chin Vessels in/out
2003	0	25,599	3,314	215,914	9,587	0.12	0.02	3,094	544	32,759	1,493	0.094	0.017	0.80	
2004	0	47,614	3,530	290,799	12,528	0.16	0.01	9,484	362	57,648	2,282	0.165	0.006	1.00	0.52
2005	0	52,513	4,678	471,659	16,517	0.11	0.01	15,346	786	54,292	2,613	0.283	0.014	2.54	1.46
2006	0	12,859	864	393,263	17,753	0.03	0.00	2,439	63	22,422	1,008	0.109	0.003	3.33	1.28
2007	0	12,528	1,087	222,123	11,224	0.06	0.00	11,216	1,320	56,714	3,525	0.198	0.023	3.51	4.76
2008	0	811	156	117,060	10,234	0.01	0.00	3	-	2,264	240	0.001	0.000	0.19	0.00
2009	0	3,186	233	154,305	10,621	0.02	0.00	356	14	6,973	740	0.051	0.002	2.47	1.33
2010	0	2,089	35	122,142	5,508	0.02	0.00	235	4	13,443	1,093	0.017	0.000	1.02	1.04
2003	1	46,444	3,720	98,315	6,277	0.47	0.04	11,795	524	51,369	2,808	0.230	0.010	0.49	0.27
2004	1	113,920	3,588	149,157	11,235	0.76	0.02	38,562	1,135	32,798	2,724	1.176	0.035	1.54	1.44
2005	1	368,953	22,096	219,746	19,565	1.68	0.10	120,726	4,835	61,753	4,609	1.955	0.078	1.16	0.78
2006	1	93,970	5,127	146,398	12,582	0.64	0.04	64,825	911	44,142	4,770	1.469	0.021	2.29	0.59
2007	1	18,069	2,602	96,863	10,214	0.19	0.03	3,937	822	12,381	1,836	0.318	0.066	1.70	2.47
2008	1	2,010	481	56,480	8,060	0.04	0.01	541	72	4,688	927	0.115	0.015	3.24	1.80
2009	1	11,537	244	68,645	6,410	0.17	0.00	6,445	70	14,887	1,979	0.433	0.005	2.58	1.32
2010	1	2,550	536	70,181	5,511	0.04	0.01	383	55	9,019	982	0.042	0.006	1.17	0.80
CPMS		157,199	13,897	1,987,264	93,972	0.08	0.007	42,173	3,093	246,516	12,994	0.171	0.013	**2.16**	1.79
CV		657,453	38,394	905,784	79,855	0.73	0.042	247,214	8,424	231,038	20,636	1.070	0.036	**1.47**	0.86

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. 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. [34] 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.

---

[34] 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 5-69. 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.

Table 5-70. 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.

5.4.1.5 How do Chinook and chum PSC closures interact?

The pre-RHS historical simulation analysis suggests that targeting Chinook and chum reduction is in general complementary.

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. 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 RHS closures is, in general, complementary.

5.4.1.6 **Observable economic impacts of the RHS closures**

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

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

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

5.4.1.7 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 5-71. Chum Salmon Savings Area (CSSA) dates in place

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 so the closure could not be triggered (Mary Furuness, pers. comm.).

An examination of the rates in and out of the chumSSA 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 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 5-72. Chum salmon PSC rates by Month & Year, In and Out of the Chum SSA

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

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

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

The IPAs are different for each sector but all provide a mandate that vessels stay below the sector-specific hard cap. In addition to other measures, a Rolling Hotspot Program (RHS) for Chinook PSC is part of the Catcher Processor and CDQ IPAs. Thus there may be closures in place for Chinook PSC as well as any fixed or rolling closures intended for chum avoidance.

How will these measures interact with current or potential future chum PSC avoidance measures? The presence of the Amendment 91 measures mean that fixed or hotspot chum closures have the *potential* to be more expensive for the fleet and lead to higher Chinook PSC. Similarly, the Chinook PSC measures could make it more costly and/or difficult for vessels to avoid high chum PSC area. If a vessel exceeds its available Chinook salmon PSC and is unable to obtain access to additional PSC, then it will be unable to continue to fish for pollock in a given year. Similarly, there is the potential that vessels would be forced by chum area closures to fish in high Chinook areas if low Chinook PSC fishing grounds are closed by chum closures. It should be noted that vessels can also choose to not fish for periods of time which will reduce the likelihood of a short-term closure “forcing” vessels to fish in high Chinook areas. The length of time a closure is in place will impact vessels’ financial ability to do this and in general this is a costly decision for a vessel to have to make. However, as discussed above, Chinook and chum PSC are positively correlated from 2003-2010 and the pre-RHS analysis also suggests that on average targeting low bycatch of one species is likely to reduce bycatch of the other species.

SeaState carefully weighs the need to reduce PSC of both species in its decision making. Any type of fixed closure system would eliminate this flexibility, which is also the case with the current Chum Salmon Savings Area. As discussed above, in general high chum and Chinook PSC areas that become RHS closures tend to be correlated.

Figure 5-90 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.

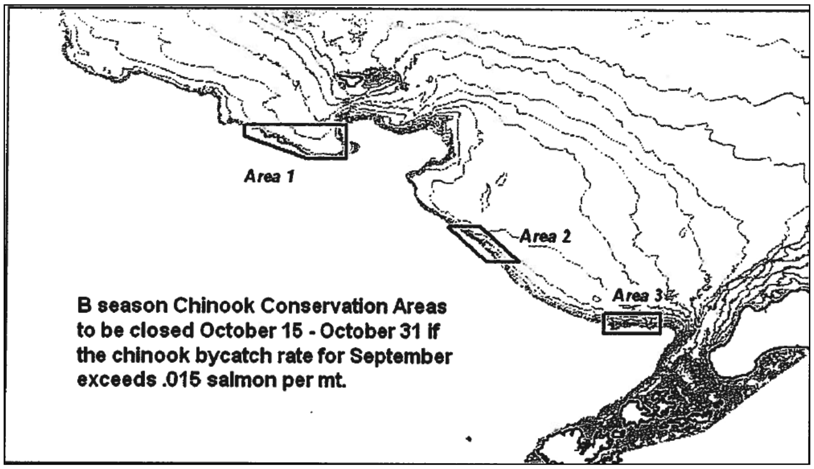


Figure 5-90. 2011 Amendment 91 IPA B Season Chinook Conservation Area

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 2003-2009.

Table 5-73. Number of hauls, Chum, and Chinook inside and outside the Amendment 91 B-Season Chinook Conservation Area by Sector and Year, 2003-2009

Sector	In BCCA?	Year	Hauls	ChumNum	ChinNum	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.

5.4.1.9 **The Dirty 20 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. There is no financial penalty to being on the list, but vessel operators report that there are social pressures connected to being on the list. According to conversations with several vessel captains, captains will give other captains a hard time for being on the list and one person regularly on the list expressed feeling very bad about it. The list has been refined over time so that both seasonal and recent activity list are published in SeaState reports for both Chinook and non-Chinook salmon. It is difficult to assess how much of a difference the list has made, but it provides transparency to the fleet about who is and is not avoiding PSC and establishes a social norm in which vessels are publicly labeled as “dirty” for having high salmon PSC.

5.4.1.10 Additional Flexibilities of RHS System

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

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

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

Figure 5-91, below, shows the overlapping closures that were put in place from mid-August to early-October, 2009. This was a low PSC period but the closures were repeatedly moved to close areas with the highest PSC at the time.

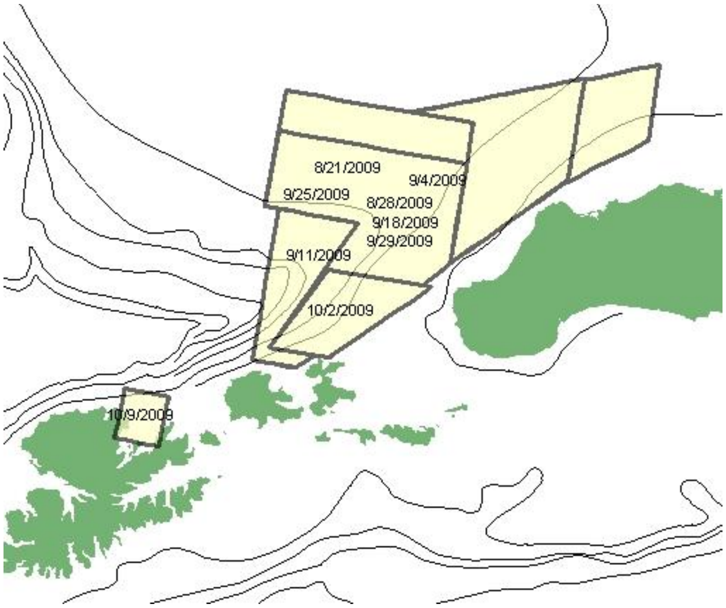


Figure 5-91. Shifts in late summer 2009 Closures illustrate SeaState efforts and ability to adjust to changing PSC hotspots

5.4.1.11 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 ever 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 this analysis include:

- From 2003-2010, comparing chum bycatch rates in the 1-3 days following RHS closures are approximately 8 percent lower
- Annual average chum PSC in the 5-days before closures were imposed from 2003-2010 ranged from 11-33 percent for CVs and from 2-30 percent for other sectors, with the majority of years being in the upper end of this range. The average percentage of pollock range from 7-21 percent for CVs and was less than 5 percent for other sectors.
- Evaluating the 1993-2000, an RHS-like system would likely have reduced chum bycatch by 9-22 percent on average with about 4-10% percent of pollock fishing have been relocated to other areas.
- The pre-RHS analysis suggest that often ‘what’s good for chum is good for Chinook’ with the range of Chinook savings as 6-14 percent per year.

Secondarily, this work indicates

- Based on 1993-2000 data, large closures reduce salmon PSC more but at the cost of moving additional pollock. Also, closures based on the most recent information possible leads to larger average reductions and relatively small base rates appear on average to be more effective.
- The “tier system” of the RHS program allows cooperatives with low PSC relative to the base rate to fish inside closed areas. This provides some incentive for cooperatives to have lower chum PSC rates in order to be able to fish in closed areas. 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.
- 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 trigger this area could be actually increase chum PSC.

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.
- The system can adapt with new information. For example, from the 8/27/07 SeaState report – “It would be particularly useful to know if there is a temperature front associated with higher or lower PSC, as there was further up on the shelf.”
- Through regular reporting to the Council and independent audits of potential violations, there is transparency in whether vessels adhere to closures. The number of violations of the closures has been very limited and seemingly generally due to mistakes by vessel operators.

Several potential limitations to the RHS system can also be noted which suggest options for program change:

- The restrictions of the chum RHS system constrain the maximum areas to be closed in a manner that this analysis suggests may be limiting at times.
- While the RHS system successfully reduces PSC by closing the highest-PSC areas to fishing, individual incentives to avoid PSC appear to be relatively small. At periods of wide-spread abundance such as 2005, vessel operators may still choose to fish in high PSC areas without direct economic consequences. The Amendment 91 Chinook rolling hotspot program is based on *individual* rather than cooperative PSC rates which provides a means to provide additional incentives to reduce PSC rates within a hotspot program.

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

5.4.2 AEQ and region of origin impacts under Alternative 1

Applying the AEQ results to the available genetics data requires careful consideration of time and area of genetics sampling relative to actual bycatch. For example, should genetics sampling under-represent an area of high bycatch, then the appropriate ratios must be applied to obtain an unbiased representation of the bycatch by stock of origin. The methods used to estimate stock composition and attempt to correct for potential biases are presented in section 3.2.2.

Results indicate that on average (2005-2009 data) 11% of the AEQ came from coastal western Alaska systems and about 6% of the total bycatch mortality is attributed to the Upper Yukon fall run of chum salmon (Table 3-13). Applying these proportions to conservative run size estimates (compiled from section 5 and omitting systems which were missing run-size information; Table 5-74) indicates that the highest impact rate (chum salmon mortality due to the pollock fishery divided by run-size estimates) was less than 1.7% for the combined western Alaska stocks (Table 5-75). In only three out of 16 years was the impact rate estimated to be higher than 0.7% (Table 5-75). For the Upper Yukon stock, the estimate of the impact is higher with a peak rate of 2.7% estimated on the run that returned in 2006 (with upper 95% confidence bound at 3.67%; Table 5-75 and Figure 5-92). For the SW Alaska region (taken to be from Area M) the estimate of impact rate is the lowest for any of the Alaska sub-regions. The average impact rate (2005-2009) by region (with ranges over this period):

Coastal west Alaska	0.6%	(0.1% - 1.5%)
Upper Yukon	1.2%	(0.2% - 2.7%)
Combined WAK	0.7%	(0.1% - 1.5%)
Southwest Alaska	0.4%	(0.1% - 1.0%)

These impact rates would be the de facto values that might be applicable to sub-regions (or individual rivers). The historical information on stock identification at finer scales is limiting due both to the sampling and to the resolution of the genetic methods used. Overall, comparing AEQ mortality due to bycatch of chum salmon to run sizes and suggests a variable relationship (Figure 5-93). These results indicate even with uncertainties considered, that bycatch of western Alaska chum salmon is likely most affected by the magnitude of returns (Figure 5-94). Sensitivity of impact-rate uncertainty to alternative assumptions about underlying variability indicates that assumed run-size CV has a large impact followed by the precision of genetic analysis whereas uncertainty in AEQ survival rate had a relatively minor effect (Figure 5-95).

For comparison purposes, any of the alternatives which would reduce non-Chinook salmon bycatch would be affecting the impact rates to Alaska systems shown above.

Table 5-74. Estimates of chum salmon run sizes by broad regions, 1991-2009. WAK includes coastal western Alaska and Upper Yukon (Fall run). These values only include regions where estimates were available and may be considered conservative. See section 5 for details and derivation on stocks from these regions. For impact rates and uncertainty, a coefficient of variation of 10% was assumed for these estimates.

	WAK run size	Coastal WAK	Upper Yukon	SW Alaska (Area M)
1991	3,051,585	2,021,357	1,030,228	1,029,576
1992	2,324,051	1,850,952	473,099	877,674
1993	1,893,485	1,449,782	443,703	955,646
1994	2,918,361	1,979,216	939,145	1,170,604
1995	4,009,752	2,539,450	1,470,302	1,735,854
1996	3,403,884	2,342,939	1,060,945	1,433,400
1997	1,736,543	1,071,653	664,890	1,197,250
1998	1,428,365	1,094,424	333,941	2,771,735
1999	1,512,520	1,092,383	420,137	1,391,480
2000	1,207,211	967,912	239,299	1,110,175
2001	3,053,952	2,671,211	382,741	1,557,147
2002	2,840,937	2,415,549	425,388	1,304,489
2003	3,488,094	2,713,202	774,892	958,277
2004	3,004,884	2,390,715	614,169	1,173,828
2005	7,206,714	4,920,018	2,286,696	1,300,567
2006	6,891,139	5,746,681	1,144,458	1,380,181
2007	5,327,156	4,195,333	1,131,823	1,401,451
2008	3,715,641	2,933,212	782,429	997,037
2009	3,403,125	2,843,270	559,855	750,821
Median	3,051,585	2,390,715	664,890	1,197,250

Table 5-75. Estimated median impact of the pollock fishery (based on regional AEQ estimates from Table 3-13) on chum salmon assuming run size estimates presented in Table 5-74 (with an assumed 10% CV) by broad regions, 1994-2009. WAK includes coastal western Alaska and Upper Yukon (Fall run). Italicized values are extrapolated from 2005-2009 stratum-specific mean bycatch stock composition estimates and as such have higher levels of uncertainty. They do account for the amount of bycatch that occurred within each stratum and the estimates of total run strength. Values in parentheses are the 5th and 95th percentile from the integrated combined AEQ-Genetic-run-size uncertainty model.

	Coastal WAK	Upper Yukon	WAK (coastal + Upper Yukon)	SW Alaska
1994	*0.62% (0.43%, 0.88%)*	*0.61% (0.39%, 0.93%)*	*0.62% (0.45%, 0.83%)*	*0.11% (0.00%, 0.27%)*
1995	*0.18% (0.12%, 0.25%)*	*0.14% (0.08%, 0.22%)*	*0.16% (0.11%, 0.23%)*	*0.03% (0.00%, 0.07%)*
1996	*0.21% (0.15%, 0.29%)*	*0.20% (0.12%, 0.31%)*	*0.21% (0.15%, 0.28%)*	*0.04% (0.00%, 0.09%)*
1997	*0.51% (0.35%, 0.72%)*	*0.35% (0.21%, 0.56%)*	*0.46% (0.33%, 0.61%)*	*0.05% (0.00%, 0.13%)*
1998	*0.55% (0.38%, 0.78%)*	*0.78% (0.46%, 1.23%)*	*0.61% (0.44%, 0.82%)*	*0.02% (0.00%, 0.06%)*
1999	*0.40% (0.28%, 0.56%)*	*0.45% (0.27%, 0.71%)*	*0.42% (0.30%, 0.57%)*	*0.04% (0.00%, 0.08%)*
2000	*0.52% (0.37%, 0.70%)*	*1.05% (0.70%, 1.53%)*	*0.63% (0.48%, 0.81%)*	*0.04% (0.00%, 0.10%)*
2001	*0.19% (0.13%, 0.26%)*	*0.67% (0.43%, 0.96%)*	*0.25% (0.19%, 0.32%)*	*0.03% (0.00%, 0.07%)*
2002	*0.27% (0.19%, 0.37%)*	*0.70% (0.45%, 1.05%)*	*0.34% (0.25%, 0.44%)*	*0.05% (0.00%, 0.12%)*
2003	*0.49% (0.35%, 0.66%)*	*0.80% (0.52%, 1.20%)*	*0.57% (0.43%, 0.74%)*	*0.14% (0.00%, 0.34%)*
2004	*1.28% (0.92%, 1.74%)*	*2.40% (1.59%, 3.42%)*	*1.52% (1.14%, 1.98%)*	*0.25% (0.00%, 0.62%)*
2005	1.47% (1.11%, 1.92%)	1.42% (0.98%, 2.03%)	1.45% (1.15%, 1.85%)	0.81% (0.39%, 1.47%)
2006	0.86% (0.63%, 1.16%)	2.65% (1.87%, 3.67%)	1.16% (0.90%, 1.49%)	0.45% (0.25%, 0.75%)
2007	0.38% (0.28%, 0.51%)	0.98% (0.70%, 1.35%)	0.51% (0.39%, 0.66%)	0.09% (0.05%, 0.17%)
2008	0.14% (0.10%, 0.19%)	0.40% (0.29%, 0.57%)	0.19% (0.14%, 0.26%)	0.02% (0.01%, 0.07%)
2009	0.15% (0.12%, 0.20%)	0.24% (0.15%, 0.36%)	0.17% (0.13%, 0.22%)	0.18% (0.10%, 0.29%)

Table 5-76. Estimated historical adult equivalent mortality (AEQ) due to pollock fishery bycatch by river system with upper 95% confidence value shown in parenthesis.

	Coastal WAK		Upper Yukon		WAK (coastal WAK + Upper Yukon)		SW Alaska	
1994	12,543	(16,781)	5,903	(8,533)	18,446	(23,556)	2,542	(3,062)
1995	4,502	(6,327)	2,063	(3,137)	6,566	(8,827)	904	(1,164)
1996	5,014	(6,582)	2,206	(3,258)	7,220	(9,042)	992	(1,297)
1997	5,587	(7,430)	2,435	(3,625)	8,022	(10,219)	1,102	(1,463)
1998	6,171	(8,192)	2,676	(3,993)	8,847	(11,215)	1,215	(1,628)
1999	4,473	(5,945)	1,950	(2,917)	6,424	(8,122)	882	(1,187)
2000	5,100	(6,513)	2,604	(3,542)	7,704	(9,321)	1,066	(1,114)
2001	5,104	(6,551)	2,589	(3,551)	7,693	(9,391)	1,064	(1,121)
2002	6,558	(8,551)	3,081	(4,363)	9,639	(11,975)	1,328	(1,598)
2003	13,483	(17,424)	6,443	(9,056)	19,926	(24,398)	2,748	(3,185)
2004	31,261	(40,162)	15,401	(21,263)	46,663	(56,804)	6,446	(7,116)
2005	72,610	(90,760)	34,095	(46,314)	106,700	(127,475)	13,401	(18,805)
2006	49,776	(63,817)	31,440	(41,961)	81,216	(98,710)	8,562	(10,148)
2007	15,815	(20,688)	11,056	(14,803)	26,871	(33,648)	2,362	(2,334)
2008	4,048	(5,401)	3,104	(4,291)	7,152	(9,311)	708	(708)
2009	4,332	(5,442)	1,429	(1,990)	5,761	(7,000)	1,396	(2,133)
Mean	15,399	(19,785)	8,030	(11,037)	23,428	(28,688)	2,920	(3,629)

	AK-BC-WA		Japan		Russia		Total	
1994	24,165	(30,615)	48,440	(57,492)	40,967	(48,726)	133,219	(152,151)
1995	8,561	(11,587)	17,696	(22,271)	14,973	(18,880)	48,344	(59,264)
1996	9,341	(11,770)	20,019	(22,697)	16,966	(19,226)	54,095	(56,750)
1997	10,349	(13,243)	22,390	(25,839)	18,983	(22,068)	60,389	(65,922)
1998	11,424	(14,610)	24,851	(28,604)	21,096	(24,223)	66,880	(72,697)
1999	8,268	(10,641)	17,934	(20,963)	15,218	(17,802)	48,382	(53,725)
2000	10,233	(12,418)	18,610	(21,088)	15,726	(17,786)	52,723	(56,157)
2001	10,217	(12,501)	18,737	(21,357)	15,794	(18,119)	52,932	(57,173)
2002	12,619	(15,616)	25,249	(28,649)	21,373	(24,273)	69,493	(73,947)
2003	26,174	(32,180)	51,308	(57,835)	43,424	(48,861)	142,273	(148,123)
2004	61,564	(75,071)	116,730	(131,388)	98,520	(111,321)	326,777	(340,222)
2005	111,183	(132,586)	180,100	(206,071)	159,038	(185,105)	569,091	(602,556)
2006	102,437	(119,942)	122,723	(145,114)	106,237	(126,746)	419,286	(469,973)
2007	33,814	(41,702)	46,217	(55,548)	42,483	(50,542)	150,676	(177,152)
2008	10,507	(13,133)	15,332	(18,819)	13,105	(16,472)	46,493	(56,519)
2009	8,109	(9,526)	12,012	(13,732)	9,325	(10,871)	36,520	(39,747)
Mean	28,685	(34,821)	47,397	(54,842)	40,827	(47,564)	142,348	(155,130)

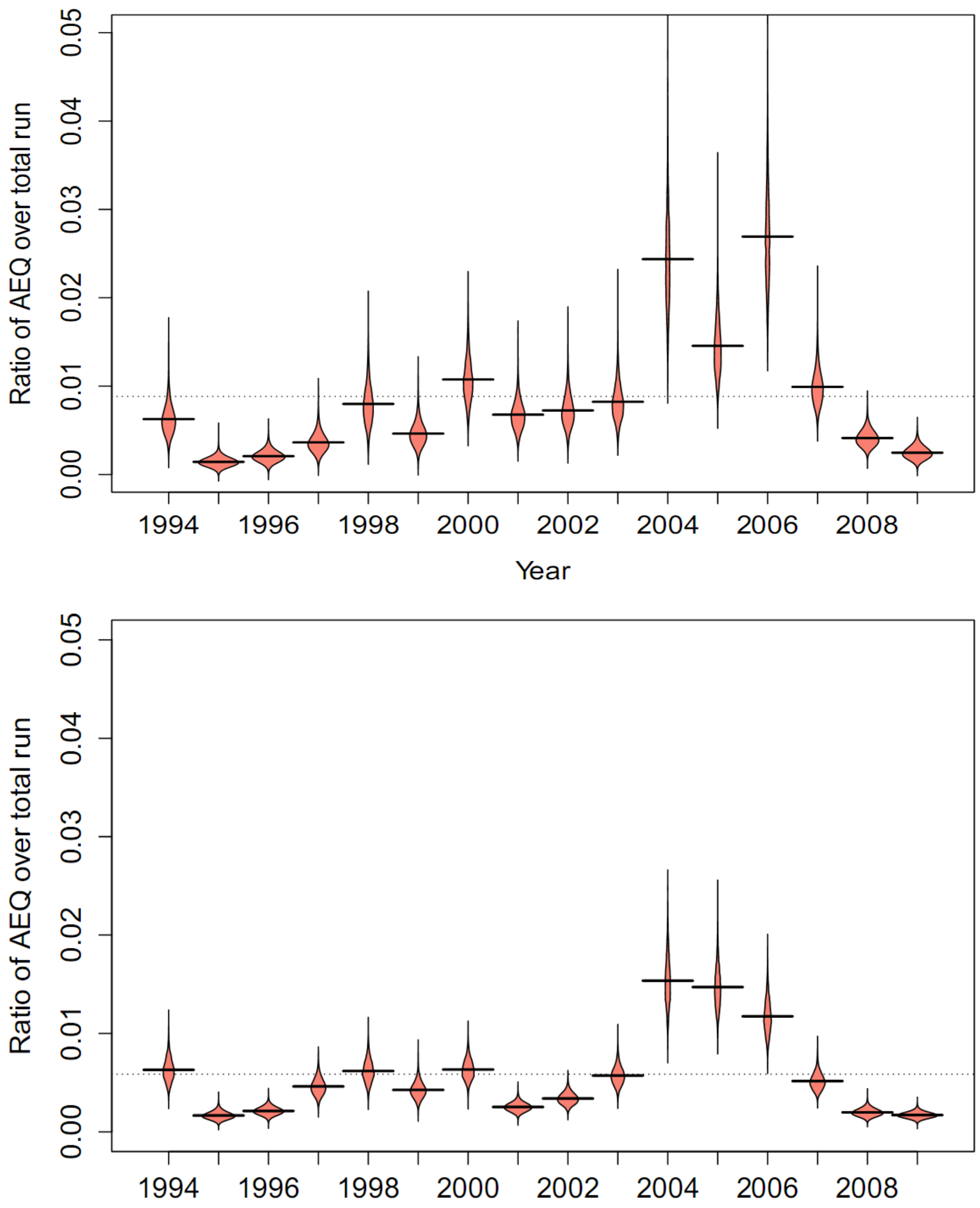


Figure 5-92. Estimated impact rates due to pollock fishery bycatch of chum salmon run sizes for Upper Yukon (top) and for western Alaska stocks (coastal west Alaska stocks plus Upper Yukon combined; bottom). Shapes represent relative probabilities based on the marginal distributions approximated by MCMC integration with uncertainty in run strength (10% CV), AEQ mortality, sampling, and genetic classification errors.

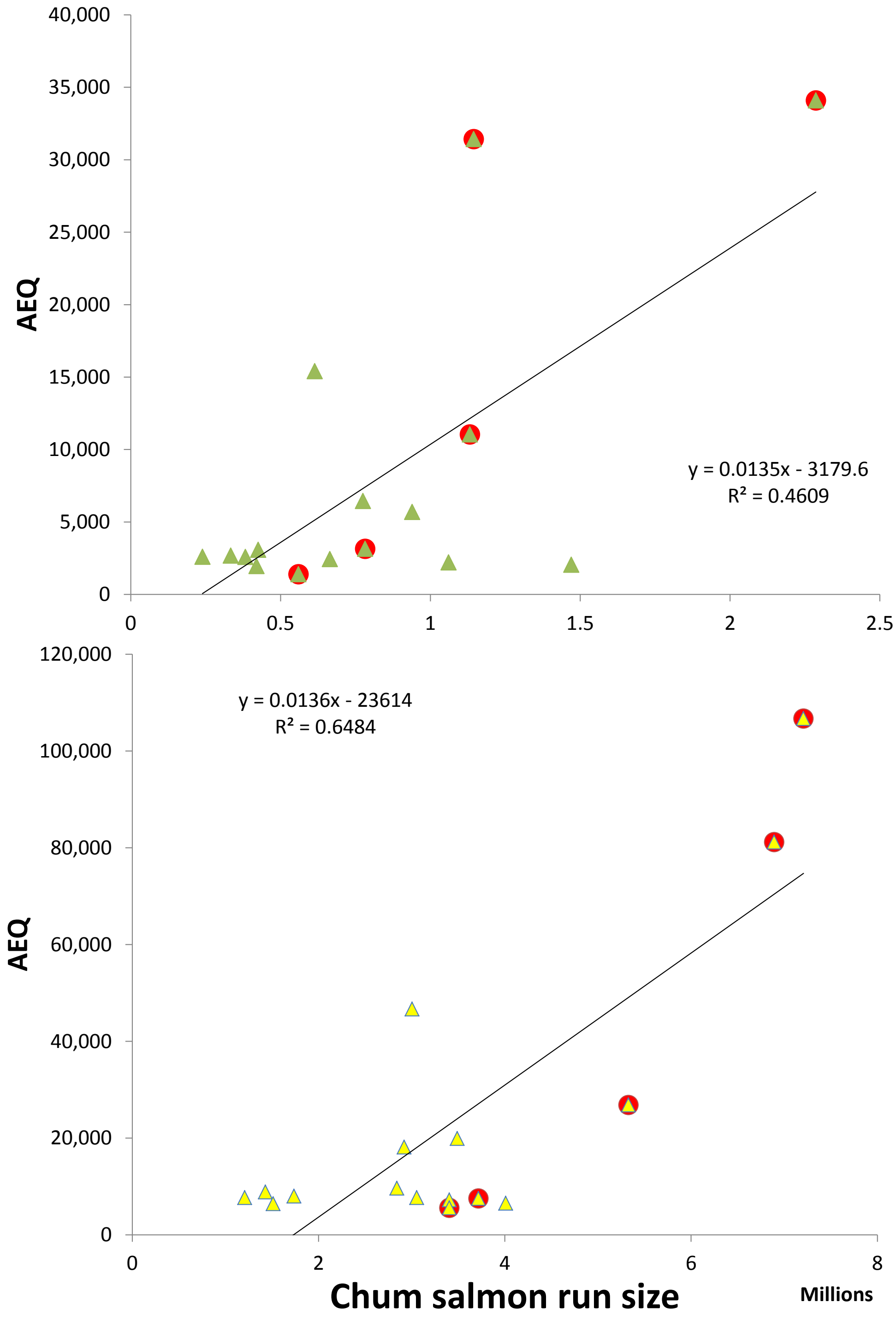


Figure 5-93. AEQ results compared to chum salmon run sizes for Upper Yukon (top) and for western Alaska stocks (coastal west Alaska stocks plus Upper Yukon combined; bottom). Filled circles represent data from years where genetics data were available and applied directly. Other points are based on mean bycatch stock composition proportions within strata and are thus more uncertain.

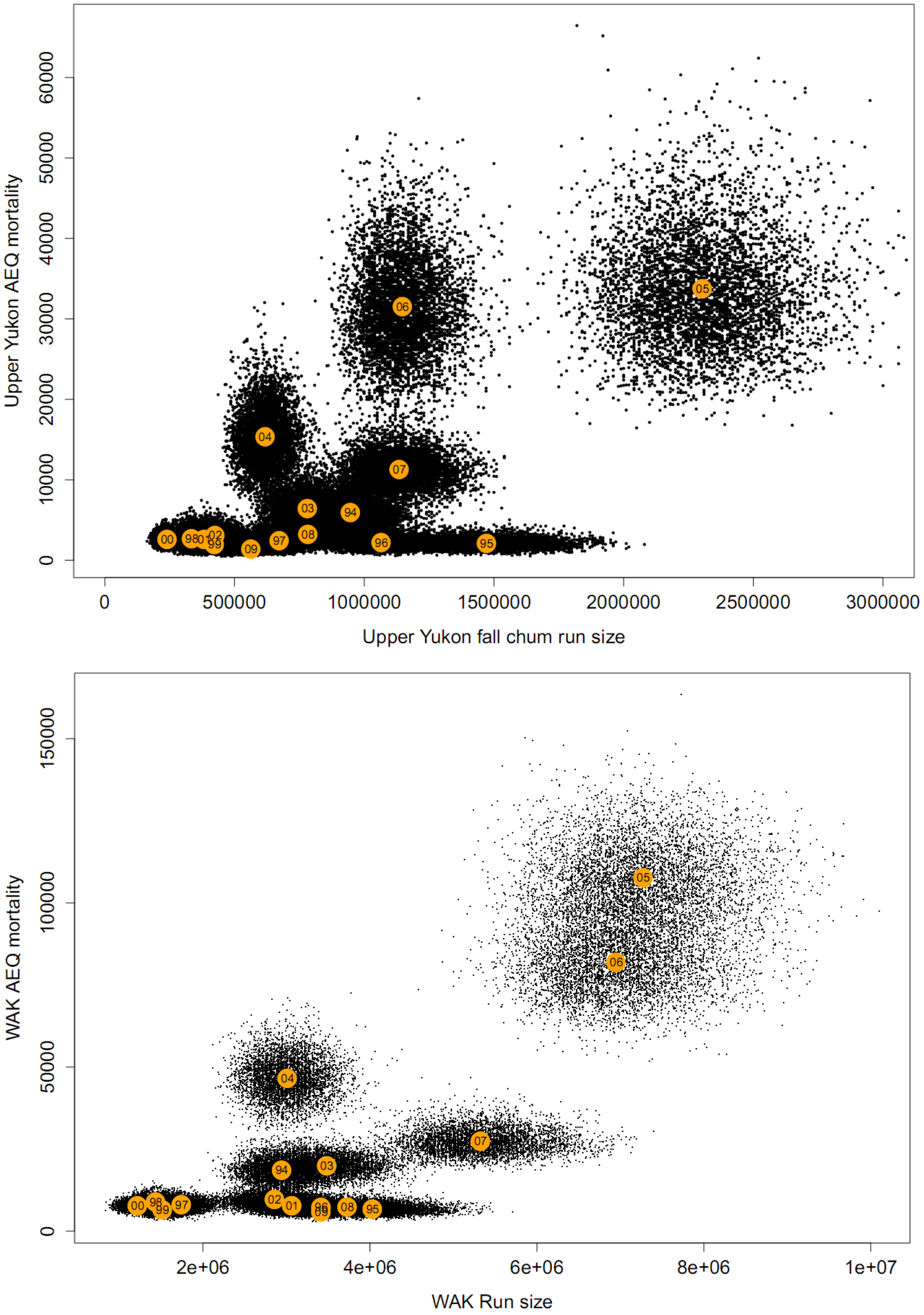


Figure 5-94. Estimated AEQ results compared to chum salmon run sizes for Upper Yukon (top) and for western Alaska stocks (coastal west Alaska stocks plus Upper Yukon combined; bottom). Circles represent mean estimates by year and concentrations of points represent relative density (probability) from the MCMC integration over uncertainty in run strength (10% CV), AEQ mortality, sampling, and genetic classification errors.

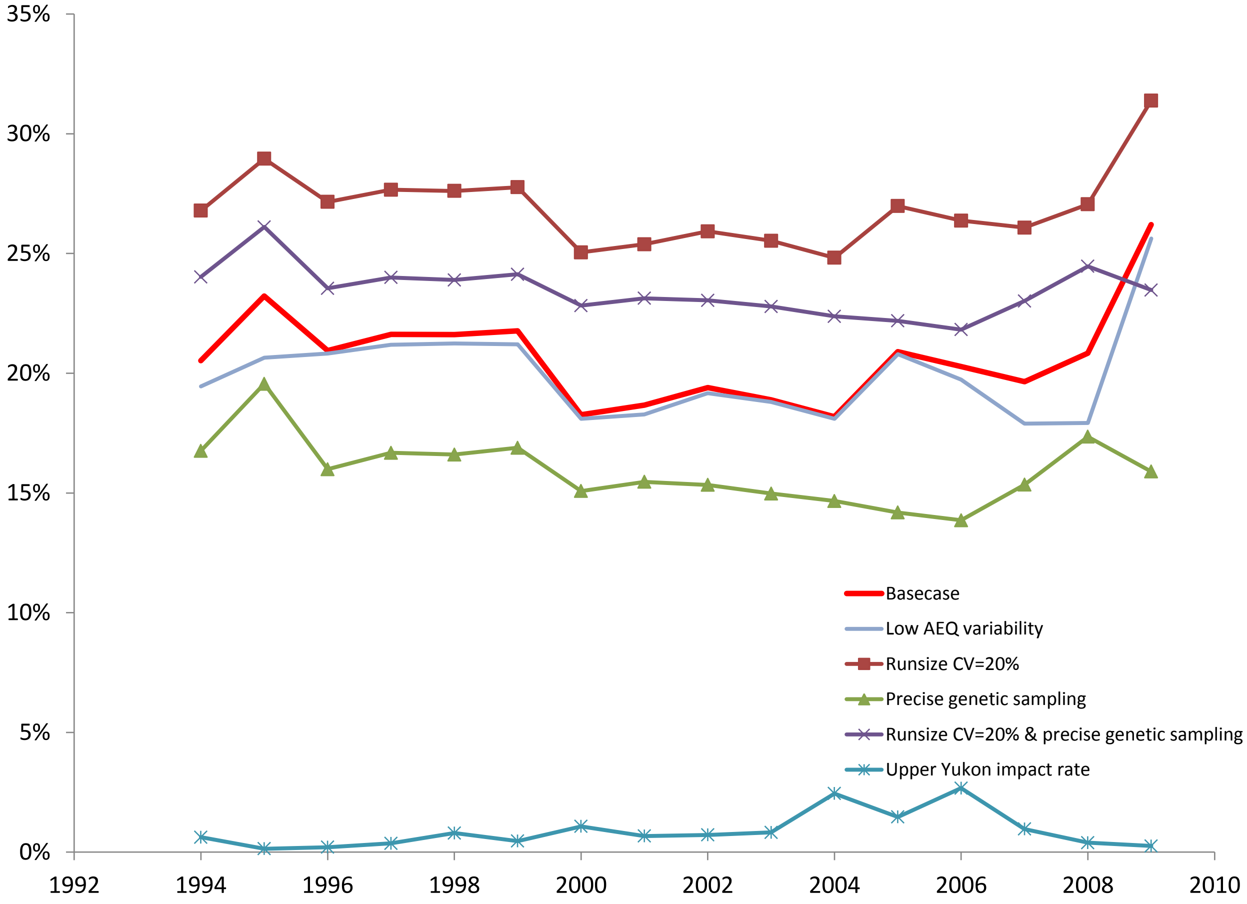


Figure 5-95 Example sensitivity analysis of impact rate uncertainty (CV of Upper Yukon impact rate—AEQ mortality divided by total run size estimate) to AEQ survival rate, run-size, and genetic sampling variability. Note for the basecase scenario AEQ survival was assigned a 20% CV and a 10% CV was assumed for run size estimates.

5.4.3 Alternative 2, hard caps

Under the analyzed options for the hard caps and sector allocations, the numbers of salmon saved is quite high for some years and varies by sector (Table 5-77 and Table 5-78). Over all sectors, the numbers of chum salmon saved is particularly high for the low cap options in both total numbers and in proportions and varies considerably between years (Table 5-79). The previous section presented the dates when sector specific closures would have occurred (Table 4-3). The sector specific splits are similar at low cap levels but diverge at the higher cap levels with sector allocation 2ii providing lower chum salmon savings (Table 5-80). The estimated impact on chum salmon AEQ would be proportional to the values presented in

Table 5-78. For example, given the AEQ for all of western Alaska based on genetic analysis for 2003-2009 about 294,000 total chum salmon were intercepted by the pollock fishery. Hard cap and sector-allocation options hypothetically would have reduced that amount by values ranging from 61,000 to 240,000 chum salmon (all years combined; Table 5-81).

Table 5-77. Estimated non-Chinook salmon saved by sector and year under 3 different allocation schemes and hard caps for 2003-2010 for the B season. Note that these apply only to the bycatch totals by year (without taking into account adult equivalent chum mortality).

2ii (sector allocation 1)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	2,525	12,460	8,486	102,571			2,528					
2004	9,341	69,811	8,532	289,078	4,235	53,557	2,804	189,933		38,904		41,944
2005	6,875	56,267	13,115	531,651	2,202	41,678	7,139	402,354		24,064	968	295,269
2006		11,644		250,957				121,110				
2007	3,956	17,763	2,922	10,515								
2008												
2009												
2010												

4ii (sector allocation 2)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	1,744	5,993	7,209	116,181				16,581				
2004	7,715	63,570	7,548	303,631		38,904		213,212				108,270
2005	5,574	50,116	12,109	533,918		14,553	2,386	448,380				362,173
2006		5,404		250,957				156,684				59,741
2007	3,469	10,658	1,981	20,318								
2008												
2009				7,482								
2010												

6 (sector allocation 3)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003			6,574	128,019				53,732				
2004	6,091	57,528	6,183	318,339		4,551		240,812				189,933
2005	3,566	44,336	11,091	542,285				497,897				448,380
2006				259,499				192,671				127,045
2007	239	5,173	595	28,773								
2008												
2009				16,615								
2010												

Table 5-78. Estimated non-Chinook salmon saved (relative to actual estimates) by sector and year under 3 different allocation schemes and **hard caps** for 2003-2010 for the B season in proportions.

2ii (sector allocation 1)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	60%	70%	81%	72%			24%					
2004	85%	93%	81%	88%	39%	71%	27%	58%		52%		13%
2005	82%	91%	87%	94%	26%	68%	47%	71%		39%	6%	52%
2006		68%		89%				43%				
2007	71%	81%	59%	21%								
2008												
2009												
2010												

4ii (sector allocation 2)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003	42%	34%	69%	81%				12%				
2004	70%	84%	72%	92%		52%		65%				33%
2005	66%	81%	80%	95%		24%	16%	79%				64%
2006		32%		89%				56%				21%
2007	62%	48%	40%	40%								
2008												
2009				19%								
2010												

6 (sector allocation 3)

Cap:	50,000				200,000				353,000			
	CDQ	CP	M	CV	CDQ	CP	M	CV	CDQ	CP	M	CV
2003			63%	90%				38%				
2004	56%	76%	59%	97%		6%		73%				58%
2005	42%	72%	74%	96%				88%				79%
2006				92%				68%				45%
2007	4%	24%	12%	56%								
2008												
2009				43%								
2010												

Table 5-79. Estimated total chum salmon saved (from all sources; top section) relative to AEQ mortality for different hypothetical **hard caps** and sector allocations by year for Alternative 2. Proportions of hypothetical salmon saved are shown in the bottom section.

	50,000			200,000			353,000		
Total	2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	103,245	107,424	110,247	2,087	13,584	43,997	0	0	0
2004	291,794	296,197	300,599	194,034	195,262	190,041	62,599	83,840	147,100
2005	533,858	528,411	528,027	398,156	408,631	437,236	281,275	318,051	393,771
2006	366,423	357,716	362,094	168,975	218,610	268,831	0	83,376	177,282
2007	63,800	66,111	63,150	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0	0
2009	0	6,032	13,422	0	0	0	0	0	0
Total	1,359,119	1,361,891	1,377,540	763,252	836,087	940,105	343,875	485,266	718,153
	50,000			200,000			353,000		
Proportion	2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	72%	75%	77%	1%	9%	31%	0%	0%	0%
2004	88%	90%	91%	59%	59%	58%	19%	25%	45%
2005	94%	93%	93%	70%	72%	77%	49%	56%	69%
2006	87%	85%	86%	40%	52%	64%	0%	20%	42%
2007	42%	44%	42%	0%	0%	0%	0%	0%	0%
2008	0%	0%	0%	0%	0%	0%	0%	0%	0%
2009	0%	16%	37%	0%	0%	0%	0%	0%	0%
Total	80%	80%	81%	45%	49%	55%	20%	29%	42%

Table 5-80. Estimated proportion of Alaska chum salmon saved relative to AEQ mortality year different **hard caps** and sector allocations by year for Alternative 2.

Sector allocation option	Hard Cap		
	50,000	200,000	353,000
2ii	80%	45%	21%
4ii	80%	50%	29%
6	81%	56%	43%

Table 5-81. Estimated numbers of Alaska chum salmon saved relative to AEQ mortality year (2^{nd} column, shaded) for different **hard caps** and sector allocations by year. Note that AEQ WAK is the sum of “coastal WAK” and Upper Yukon.

		50,000			**200,000**			**353,000**		
WAK		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	19,926	14,329	14,908	15,302	287	1,885	6,109			
2004	46,663	41,272	41,896	42,518	27,444	27,617	26,878	8,856	11,860	20,806
2005	106,700	99,860	98,843	98,770	74,475	76,437	81,788	52,615	59,493	73,654
2006	81,216	70,656	68,977	69,821	32,586	42,158	51,840		16,074	34,183
2007	26,871	11,301	11,709	11,180						
2008	7,152									
2009	5,761		951	2,111						
Total	294,289	237,418	237,283	239,703	134,792	148,097	166,615	61,471	87,428	128,643

		50,000			**200,000**			**353,000**		
Coastal WAK		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	13,483	9,696	10,088	10,354	194.1996	1,275	4,134			
2004	31,261	27,649	28,067	28,484	18,386	18,501	18,006	5,933	7,945	13,939
2005	72,610	67,955	67,263	67,214	50,681	52,016	55,657	35,805	40,485	50,122
2006	49,776	43,304	42,275	42,792	19,971	25,838	31,772		9,852	20,950
2007	15,815	6,651	6,891	6,580						
2008	4,048									
2009	4,332		715	1,587						
Total	191,325	155,256	155,300	157,011	89,232	97,631	109,569	41,738	58,282	85,011

		50,000			**200,000**			**353,000**		
Upper Yukon		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	6,443	4,633	4,820	4,948	93	610	1,975			
2004	15,402	13,623	13,829	14,034	9,058	9,116	8,872	2,923	3,915	6,867
2005	34,090	31,905	31,580	31,556	23,794	24,421	26,131	16,810	19,008	23,532
2006	31,440	27,352	26,702	27,029	12,615	16,320	20,068	0	6,223	13,233
2007	11,056	4,650	4,818	4,600						
2008	3,104									
2009	1,429		236	524						
Total	102,964	82,162	81,983	82,692	45,560	50,466	57,046	19,733	29,146	43,632

Table 5-81 (continued) Estimated numbers of Alaska chum salmon saved relative to AEQ mortality year (2nd column, shaded) for different **hard caps** and sector allocations by year. Note that Asia is the sum of Russian plus Japan origin chum salmon.

SW AK		**50,000**			**200,000**			**353,000**		
		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	2,748	1,976	2,056	2,110	40	260	842			
2004	6,446	5,701	5,787	5,873	3,791	3,815	3,713	1,223	1,638	2,874
2005	13,401	12,542	12,414	12,405	9,354	9,600	10,272	6,608	7,472	9,251
2006	8,562	7,449	7,272	7,361	3,435	4,444	5,465		1,695	3,604
2007	2,362	993	1,029	983						
2008	708									
2009	1,396		230	512						
Total	35,623	28,661	28,789	29,244	16,620	18,119	20,293	7,832	10,805	15,729

AK-BC-WA		**50,000**			**200,000**			**353,000**		
		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	26,174	18,821	19,583	20,097	381	2,476	8,020	0	0	0
2004	61,564	54,449	55,270	56,092	36,207	36,436	35,462	11,681	15,644	27,449
2005	111,183	104,056	102,994	102,920	77,607	79,648	85,223	54,824	61,992	76,752
2006	102,437	89,121	87,003	88,068	41,097	53,169	65,384	0	20,279	43,119
2007	33,814	14,216	14,731	14,073	0	0	0	0	0	0
2008	10506.5	0	0	0	0	0	0	0	0	0
2009	8,109	0	1,336	2,974	0	0	0	0	0	0
Total	353,788	280,663	280,918	284,223	155,291	171,729	194,089	66,505	97,916	147,320

Asia		**50,000**			**200,000**			**353,000**		
		2ii	4ii	6	2ii	4ii	6	2ii	4ii	6
2003	94,732	68,119	70,877	72,738	1378.927	8963.027	29026.42	0	0	0
2004	215,250	190,372	193,244	196,116	126,592	127,393	123,987	40,839	54,697	95,971
2005	339,138	317,399	314,160	313,932	236,721	242,946	259,953	167,228	189,093	234,114
2006	228,960	199,197	194,464	196,844	91,857	118,839	146,142	0	45,327	96,376
2007	88,699	37289.8	38,642	36914.27	0	0	0	0	0	0
2008	28,437	0	0	0	0	0	0	0	0	0
2009	21,337	0	3515.331	7825.432	0	0	0	0	0	0
Total	1,016,553	812,377	814,902	824,370	456,549	498,142	559,108	208,067	289,117	426,461

5.4.4 Alternative 3, Triggered closures

The estimated relative annual and sector-specific relative impacts for Options 1, 2, 2a, and 3 are presented in Table 5-82 through Table 5-85. In some years for some sectors results show that the benefits of saving non-Chinook salmon are negative—this means in that year for those vessels the bycatch data outside closure regions were ineffective.

Comparing the alternatives on the relative impact on chum salmon savings (in terms of AEQ) together with the relative change in pollock that would be diverted to areas outside of the closed area suggests that relatively little benefit (in terms of bycatch reduction) is estimated by using low trigger cap levels (Table 5-86). For example, computing averages from Table 5-86 over the different sector allocations and trigger options shows that the benefit for greater salmon savings was at lower cap levels was much lower than the relative costs of redistributing pollock fishing effort (Figure 5-96).

Since results from genetic analysis indicate that proportionately more western Alaska chum salmon occur during the early part of the season (June-July) compared to later in the B season (August-October), then the relative benefit of reducing salmon bycatch is worth examining. Summarizing years (2003-2010) and sectors suggests that trigger option 3 results in the lowest reduction in bycatch for all sector splits and cap levels (Table 5-87). Trigger option 2a which was designed to improve early-season salmon savings performed better than the other options in June-July, particularly for the high cap level (Table 5-87). At the low trigger cap level and third sector allocation scheme, option 2a performs similarly to options 1 and 2. Option 3 unsurprisingly performed poorly during the early period since under this option, closures would generally occur later in the season since cap limits are based on season rather than monthly limits.

To evaluate the putative benefits of different alternatives to western Alaska chum salmon, absolute numbers of salmon saved were computed assuming the highest AEQ mortality year (106,700 chum for western Alaska in 2005) and assuming an average AEQ year (23,428 chum salmon; Table 5-89). For contrast, values in parentheses on this table assume the proportion of chum bycatch in June-July was 42% (the proportion observed in 2009) whereas the main numbers were computed using an average proportion of June-July bycatch (12% based on 1991-2009 data). Note that this approach differs from the hard cap analysis where different years were evaluated under different fishery closure options. Evaluating individual historical years with triggered closures is inappropriate since initial evaluations using these data showed that the resolution to distinguish among the trigger options (1, 2, 2a, and 3) was poor. As noted in the methods section, the approach for triggered closures required computing the annual proportion of week-area chum bycatch and using a range of alternative chum bycatch levels to obtain proportional changes in salmon bycatch. This provided the resolution to distinguish trigger closure scenarios that might apply for future scenarios of spatio-temporal bycatch patterns. To the extent that other regions were able to be broken out, the Alaska systems are presented in Table 5-90 through Table 5-92.

Both the total western Alaska AEQ values and the amount of salmon saved by alternative are quite small compared to total run size estimates for these rivers that have averaged 3.45 million fish (and had a maximum of 7.21 million in 2005). Similarly, Table 5-90 through Table 5-92 provide salmon savings under the highest AEQ salmon year compared to the averages for the component Alaskan chum salmon stocks (given the ability of genetic analysis to resolve river of origins).

Table 5-82. Relative reduction in chum salmon bycatch by sector allocation (panels) and trigger cap levels for **Option 1.**

	25,000				**75,000**				**200,000**			
	2ii (sector allocation 1)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.2%	9.1%	10.3%	10.3%	15.4%	8.9%	10.1%	7.7%	20.7%	7.4%	9.2%	5.5%
2004	2.9%	21.3%	-0.6%	14.2%	-0.2%	21.0%	2.1%	14.5%	-0.7%	19.2%	1.0%	10.2%
2005	0.0%	0.3%	-3.7%	18.3%	0.0%	0.0%	-0.6%	16.7%	0.0%	0.0%	1.3%	11.9%
2006	0.0%	4.3%	0.1%	25.9%	0.0%	3.0%	0.0%	25.1%	0.0%	0.0%	0.0%	19.9%
2007	0.3%	4.2%	0.1%	1.3%	0.3%	4.1%	0.1%	0.9%	0.3%	4.0%	0.1%	0.2%
2008	1.6%	2.1%	0.0%	13.9%	1.3%	2.0%	0.0%	13.1%	0.0%	1.5%	0.0%	6.6%
2009	0.0%	0.0%	17.7%	16.4%	0.0%	0.0%	16.1%	14.5%	0.0%	0.0%	9.0%	8.1%
2010	0.0%	0.0%	5.8%	20.6%	0.0%	0.0%	5.8%	17.6%	0.0%	0.0%	5.5%	10.9%
	2.3%	6.1%	4.9%	15.7%	1.9%	5.9%	5.1%	14.4%	2.3%	5.2%	4.2%	9.6%
	4ii (sector allocation 2)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	8.9%	10.3%	10.5%	17.6%	8.1%	9.8%	8.2%	0.0%	1.5%	7.7%	6.4%
2004	1.9%	21.1%	0.6%	14.1%	-0.8%	19.4%	1.8%	14.6%	0.0%	8.8%	0.0%	12.4%
2005	0.0%	0.1%	-2.8%	18.5%	0.0%	0.0%	1.5%	17.4%	0.0%	0.0%	0.8%	13.6%
2006	0.0%	3.8%	0.1%	25.9%	0.0%	0.8%	0.0%	25.5%	0.0%	0.0%	0.0%	22.4%
2007	0.3%	4.2%	0.1%	1.4%	0.3%	4.0%	0.1%	1.0%	0.3%	3.2%	0.1%	0.6%
2008	1.5%	2.0%	0.0%	14.0%	0.6%	1.7%	0.0%	13.5%	0.0%	0.0%	0.0%	9.8%
2009	0.0%	0.0%	17.3%	16.5%	0.0%	0.0%	12.9%	15.0%	0.0%	0.0%	4.3%	10.9%
2010	0.0%	0.0%	5.8%	20.7%	0.0%	0.0%	5.8%	18.4%	0.0%	0.0%	4.5%	14.3%
	2.2%	6.0%	5.0%	15.8%	2.0%	5.3%	4.9%	14.8%	0.1%	2.5%	3.0%	11.8%
	6 (sector allocation 3)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.2%	8.9%	10.3%	10.6%	17.6%	6.7%	9.6%	9.3%	0.0%	0.0%	5.6%	6.8%
2004	-0.2%	21.0%	2.1%	14.0%	-0.5%	17.9%	1.6%	14.8%	0.0%	0.5%	0.0%	14.5%
2005	0.0%	0.0%	-2.1%	18.5%	0.0%	0.0%	1.4%	18.1%	0.0%	0.0%	0.3%	15.3%
2006	0.0%	2.7%	0.0%	25.9%	0.0%	0.0%	0.0%	25.7%	0.0%	0.0%	0.0%	24.0%
2007	0.3%	4.1%	0.1%	1.6%	0.3%	3.8%	0.1%	0.9%	0.2%	1.7%	0.1%	0.9%
2008	1.3%	2.0%	0.0%	14.0%	0.0%	1.0%	0.0%	13.6%	0.0%	0.0%	0.0%	11.8%
2009	0.0%	0.0%	17.0%	16.7%	0.0%	0.0%	10.2%	15.7%	0.0%	0.0%	0.0%	13.0%
2010	0.0%	0.0%	5.8%	20.8%	0.0%	0.0%	5.7%	19.8%	0.0%	0.0%	3.9%	16.6%
	1.9%	5.8%	5.2%	15.8%	2.0%	4.8%	4.5%	15.3%	0.1%	0.5%	2.0%	13.4%

Table 5-83. Relative reduction in chum salmon bycatch by sector allocation (panels) and trigger cap levels for **Option 2.**

	25,000				75,000				200,000			
	2ii (sector allocation 1)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.0%	9.1%	10.3%	10.3%	15.4%	8.9%	10.2%	7.8%	18.5%	8.1%	9.5%	5.3%
2004	3.1%	21.3%	-0.6%	14.1%	1.4%	21.0%	2.2%	14.8%	-0.8%	19.2%	1.8%	13.1%
2005	0.0%	0.3%	-3.7%	18.3%	0.0%	0.0%	-0.6%	16.7%	0.0%	0.0%	1.3%	12.0%
2006	0.0%	4.3%	0.1%	25.9%	0.0%	3.0%	0.0%	25.1%	0.0%	0.0%	0.0%	19.9%
2007	0.3%	4.2%	0.1%	1.3%	0.3%	4.2%	0.1%	1.0%	0.3%	4.1%	0.1%	0.7%
2008	1.6%	2.1%	0.0%	13.9%	1.3%	2.0%	0.0%	13.1%	0.0%	1.5%	0.0%	6.6%
2009	0.0%	0.0%	17.7%	16.4%	0.0%	0.0%	16.1%	14.5%	0.0%	0.0%	9.0%	8.2%
2010	0.0%	0.0%	5.8%	20.6%	0.0%	0.0%	5.8%	17.6%	0.0%	0.0%	5.5%	10.9%
	2.3%	6.1%	4.9%	15.7%	2.1%	5.9%	5.2%	14.4%	2.0%	5.3%	4.3%	10.0%
	4ii (sector allocation 2)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	9.1%	10.3%	10.5%	16.5%	8.6%	10.0%	8.4%	20.7%	5.3%	8.8%	6.1%
2004	2.2%	21.1%	0.7%	13.9%	-0.9%	19.4%	2.1%	14.6%	-0.6%	9.1%	1.2%	14.4%
2005	0.0%	0.1%	-2.8%	18.5%	0.0%	0.0%	1.5%	17.4%	0.0%	0.0%	0.8%	13.7%
2006	0.0%	3.8%	0.1%	25.9%	0.0%	0.8%	0.0%	25.5%	0.0%	0.0%	0.0%	22.4%
2007	0.3%	4.2%	0.1%	1.4%	0.3%	4.1%	0.1%	1.0%	0.3%	3.5%	0.1%	1.0%
2008	1.5%	2.1%	0.0%	14.0%	0.6%	1.7%	0.0%	13.5%	0.0%	0.0%	0.0%	9.8%
2009	0.0%	0.0%	17.3%	16.5%	0.0%	0.0%	12.9%	15.0%	0.0%	0.0%	4.3%	10.9%
2010	0.0%	0.0%	5.8%	20.7%	0.0%	0.0%	5.8%	18.4%	0.0%	0.0%	4.5%	14.3%
	2.3%	6.0%	5.1%	15.8%	1.9%	5.4%	4.9%	14.8%	2.3%	3.0%	3.3%	12.1%
	6 (sector allocation 3)											
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	8.9%	10.3%	10.6%	18.7%	8.1%	9.9%	9.4%	9.8%	1.6%	7.6%	6.9%
2004	0.9%	21.0%	2.1%	13.9%	-0.8%	17.9%	1.9%	14.4%	0.0%	0.9%	0.7%	14.6%
2005	0.0%	0.0%	-2.1%	18.5%	0.0%	0.0%	1.4%	18.0%	0.0%	0.0%	0.3%	15.3%
2006	0.0%	2.7%	0.0%	25.9%	0.0%	0.0%	0.0%	25.7%	0.0%	0.0%	0.0%	24.0%
2007	0.3%	4.2%	0.1%	1.6%	0.3%	4.0%	0.1%	0.9%	0.2%	2.7%	0.1%	1.0%
2008	1.3%	2.0%	0.0%	14.0%	0.0%	1.1%	0.0%	13.6%	0.0%	0.0%	0.0%	11.8%
2009	0.0%	0.0%	17.0%	16.7%	0.0%	0.0%	10.2%	15.7%	0.0%	0.0%	0.0%	13.1%
2010	0.0%	0.0%	5.8%	20.8%	0.0%	0.0%	5.7%	19.8%	0.0%	0.0%	3.9%	16.6%
	2.1%	5.9%	5.2%	15.8%	2.1%	5.0%	4.5%	15.3%	1.1%	1.0%	2.4%	13.5%

Table 5-84. Relative reduction in chum salmon bycatch by sector allocation (panels) and trigger cap levels for **Option 2a.**

	25,000				**75,000**				**200,000**			
2ii (sector allocation 1)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.0%	9.1%	10.3%	10.3%	15.4%	8.9%	10.2%	8.3%	18.5%	8.1%	9.5%	5.3%
2004	3.2%	21.3%	-0.9%	14.1%	1.6%	21.0%	1.2%	14.8%	-0.8%	19.3%	1.6%	13.1%
2005	0.4%	0.3%	-4.0%	18.6%	0.0%	0.0%	-2.5%	17.8%	0.0%	0.0%	1.8%	14.7%
2006	0.5%	4.5%	0.1%	25.9%	0.0%	4.0%	0.0%	25.2%	0.0%	1.4%	0.0%	20.8%
2007	0.3%	4.2%	0.1%	1.6%	0.3%	4.2%	0.1%	1.3%	0.3%	4.1%	0.1%	0.7%
2008	1.6%	2.1%	0.0%	14.0%	1.3%	2.0%	0.0%	13.4%	0.0%	1.5%	0.0%	10.8%
2009	0.0%	0.0%	17.7%	16.7%	0.0%	0.0%	17.0%	15.5%	0.0%	0.0%	12.7%	11.9%
2010	0.0%	0.0%	5.8%	20.7%	0.0%	0.0%	5.8%	19.3%	0.0%	0.0%	5.9%	15.9%
	2.4%	6.1%	4.9%	15.8%	2.2%	5.9%	5.1%	15.0%	2.0%	5.4%	4.8%	12.1%
4ii (sector allocation 2)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	9.1%	10.3%	10.5%	16.5%	8.6%	10.1%	8.7%	20.7%	5.3%	8.8%	6.1%
2004	2.5%	21.1%	-0.5%	14.0%	-0.9%	19.5%	1.9%	14.6%	-0.6%	9.2%	1.2%	14.4%
2005	0.0%	0.1%	-3.6%	18.6%	0.0%	0.0%	-0.9%	18.1%	0.0%	0.0%	1.3%	15.4%
2006	0.0%	4.2%	0.1%	25.9%	0.0%	2.3%	0.0%	25.5%	0.0%	0.0%	0.0%	22.8%
2007	0.3%	4.2%	0.1%	1.6%	0.3%	4.1%	0.1%	1.6%	0.3%	3.5%	0.1%	0.9%
2008	1.5%	2.1%	0.0%	14.0%	0.6%	1.7%	0.0%	13.7%	0.0%	0.0%	0.0%	11.8%
2009	0.0%	0.0%	17.7%	16.7%	0.0%	0.0%	16.1%	16.1%	0.0%	0.0%	10.2%	13.5%
2010	0.0%	0.0%	5.8%	20.8%	0.0%	0.0%	5.8%	19.9%	0.0%	0.0%	5.6%	16.4%
	2.3%	6.0%	5.0%	15.9%	1.9%	5.5%	5.1%	15.3%	2.3%	3.0%	4.2%	13.2%
6 (sector allocation 3)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	8.9%	10.3%	10.6%	18.7%	8.1%	9.9%	9.5%	0.0%	0.0%	5.6%	7.1%
2004	1.0%	21.0%	-0.3%	13.9%	-0.8%	17.9%	1.6%	14.4%	0.0%	0.5%	0.0%	14.5%
2005	0.0%	0.0%	-3.2%	18.4%	0.0%	0.0%	1.3%	18.4%	0.0%	0.0%	1.1%	16.9%
2006	0.0%	4.0%	0.0%	25.9%	0.0%	1.1%	0.0%	25.8%	0.0%	0.0%	0.0%	24.2%
2007	0.3%	4.2%	0.1%	1.6%	0.3%	4.0%	0.1%	1.5%	0.2%	1.7%	0.1%	0.9%
2008	1.3%	2.0%	0.0%	14.0%	0.0%	1.1%	0.0%	13.8%	0.0%	0.0%	0.0%	12.7%
2009	0.0%	0.0%	17.5%	16.7%	0.0%	0.0%	14.4%	16.3%	0.0%	0.0%	7.7%	14.5%
2010	0.0%	0.0%	5.8%	20.8%	0.0%	0.0%	5.8%	20.4%	0.0%	0.0%	5.1%	18.1%
	2.1%	5.9%	5.0%	15.8%	2.1%	5.0%	5.0%	15.6%	0.1%	0.5%	3.2%	14.2%

Table 5-85. Relative reduction in chum salmon bycatch by sector allocation (panels) and trigger cap levels for **Option 3.**

	25,000				**75,000**				**200,000**			
2ii (sector allocation 1)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.2%	9.1%	10.3%	10.0%	15.4%	8.9%	10.1%	7.6%	20.7%	7.4%	9.2%	5.5%
2004	2.3%	21.3%	2.1%	14.2%	-0.2%	21.0%	2.4%	14.5%	-0.7%	19.2%	1.0%	10.0%
2005	0.0%	0.3%	1.8%	17.6%	0.0%	0.0%	0.7%	13.7%	0.0%	0.0%	0.0%	6.6%
2006	0.0%	4.0%	0.1%	25.6%	0.0%	0.8%	0.0%	23.3%	0.0%	0.0%	0.0%	14.7%
2007	0.3%	4.2%	0.1%	1.2%	0.3%	4.1%	0.1%	1.0%	0.3%	3.8%	0.1%	0.0%
2008	1.6%	2.1%	0.0%	13.1%	1.3%	2.0%	0.0%	10.0%	0.0%	1.4%	0.0%	3.5%
2009	0.0%	0.0%	17.5%	15.2%	0.0%	0.0%	15.0%	10.8%	0.0%	0.0%	4.3%	3.6%
2010	0.0%	0.0%	5.6%	19.4%	0.0%	0.0%	5.0%	14.0%	0.0%	0.0%	3.7%	3.7%
	2.3%	6.1%	5.5%	15.1%	1.9%	5.7%	4.9%	12.4%	2.3%	5.1%	3.1%	6.3%
4ii (sector allocation 2)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.4%	8.9%	10.2%	10.2%	17.6%	8.1%	9.9%	7.8%	0.0%	1.5%	7.7%	6.7%
2004	1.8%	21.1%	2.2%	14.2%	-0.8%	19.4%	1.9%	14.5%	0.0%	8.8%	0.0%	11.7%
2005	0.0%	0.1%	1.2%	18.0%	0.0%	0.0%	0.0%	15.1%	0.0%	0.0%	0.0%	7.5%
2006	0.0%	2.4%	0.1%	25.7%	0.0%	0.0%	0.0%	24.2%	0.0%	0.0%	0.0%	17.6%
2007	0.3%	4.2%	0.1%	1.4%	0.3%	4.0%	0.1%	1.0%	0.3%	2.4%	0.1%	0.6%
2008	1.5%	2.0%	0.0%	13.4%	0.6%	1.7%	0.0%	11.2%	0.0%	0.0%	0.0%	5.8%
2009	0.0%	0.0%	17.3%	15.4%	0.0%	0.0%	10.9%	12.6%	0.0%	0.0%	0.0%	4.8%
2010	0.0%	0.0%	5.2%	19.7%	0.0%	0.0%	4.7%	15.6%	0.0%	0.0%	1.9%	4.7%
	2.2%	5.9%	5.3%	15.3%	2.0%	5.3%	4.3%	13.3%	0.1%	2.3%	1.8%	7.8%
6 (sector allocation 3)												
	CDQ	CP	MS	CV	CDQ	CP	MS	CV	CDQ	CP	MS	CV
2003	15.2%	8.9%	10.2%	10.5%	17.6%	6.7%	9.6%	8.7%	0.0%	0.0%	5.6%	7.1%
2004	-0.2%	21.0%	2.3%	14.0%	-0.5%	17.8%	1.5%	15.2%	0.0%	0.5%	0.0%	13.3%
2005	0.0%	0.0%	0.8%	18.2%	0.0%	0.0%	0.0%	16.0%	0.0%	0.0%	0.0%	10.0%
2006	0.0%	0.8%	0.0%	25.8%	0.0%	0.0%	0.0%	24.9%	0.0%	0.0%	0.0%	20.7%
2007	0.3%	4.1%	0.1%	1.6%	0.3%	3.5%	0.1%	0.6%	0.2%	0.5%	0.1%	0.9%
2008	1.3%	2.0%	0.0%	13.7%	0.0%	1.0%	0.0%	12.1%	0.0%	0.0%	0.0%	7.7%
2009	0.0%	0.0%	16.5%	15.9%	0.0%	0.0%	7.7%	14.0%	0.0%	0.0%	0.0%	7.6%
2010	0.0%	0.0%	5.1%	20.3%	0.0%	0.0%	4.1%	18.0%	0.0%	0.0%	0.7%	11.0%
	1.9%	5.7%	5.2%	15.6%	2.0%	4.7%	3.7%	14.2%	0.1%	0.2%	1.2%	10.2%

Table 5-86. Estimated relative reduction in chum salmon bycatch and diverted pollock catch by sector allocation (panels) and trigger cap levels for different trigger closure options.

2ii (sector allocation 1)	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.6%	11.3%	12.5%	8.1%	8.6%	3.7%
Option 2	13.6%	11.4%	12.6%	8.5%	9.0%	4.3%
Option 2a	13.8%	12.0%	13.1%	9.1%	10.7%	5.0%
Option 3	13.2%	9.7%	10.9%	6.4%	5.9%	2.5%
4ii (sector allocation 2)						
	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.1%	9.6%	12.8%	8.5%	9.9%	4.7%
Option 2	13.1%	10.1%	12.8%	8.9%	10.3%	5.3%
Option 2a	13.5%	10.8%	13.3%	9.6%	11.2%	5.8%
Option 3	11.9%	7.8%	11.6%	6.8%	6.6%	3.2%
6 (sector allocation 3)						
	25,000		75,000		200,000	
	Chum	Pollock	Chum	Pollock	Chum	Pollock
Option 1	13.7%	11.9%	13.2%	9.3%	10.9%	6.1%
Option 2	13.7%	12.0%	13.2%	9.7%	11.1%	6.5%
Option 2a	13.7%	12.7%	13.4%	10.3%	11.7%	7.0%
Option 3	13.5%	10.3%	12.2%	7.7%	8.3%	4.5%

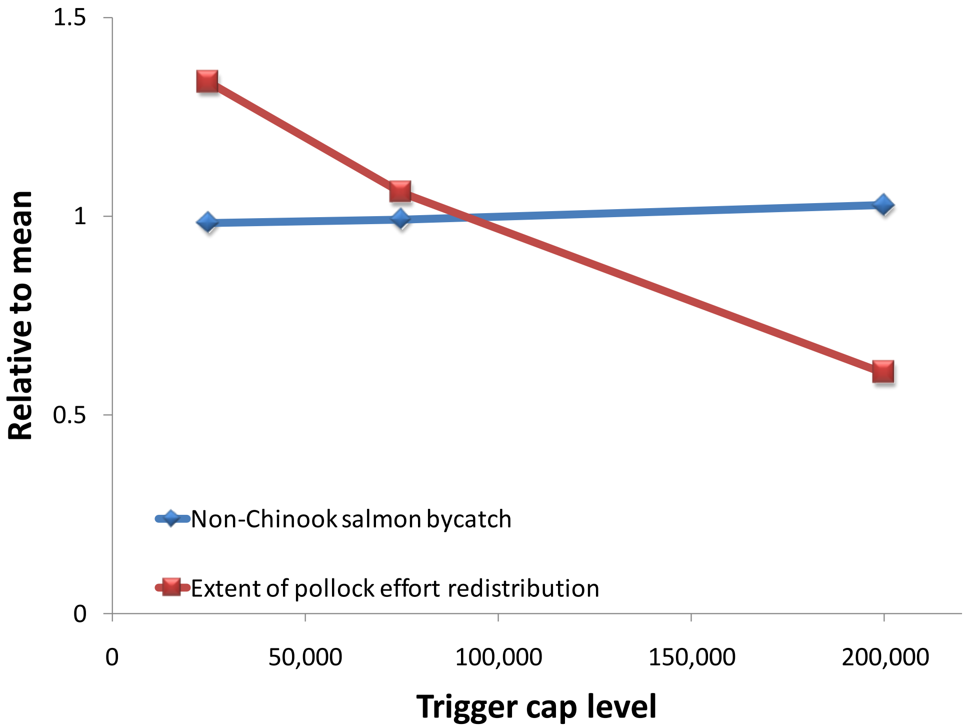


Figure 5-96. Relative change of salmon bycatch and pollock effort redistribution by trigger cap levels where the values represent averages over all other analyzed years, sector splits, and options normalized to have a mean of 1.0. Lower values are "better".

Table 5-87. Estimated seasonal (June-July and August-October) differences in the relative amount of non-Chinook salmon bycatch reductions (in numbers) by sector allocation (panels), trigger cap levels, and trigger closure options**.**

	25,000		**75,000**		**200,000**	
	2ii (sector allocation 1)					
	June-July	**Aug-Oct**	**June-July**	**Aug-Oct**	**June-July**	**Aug-Oct**
Option 1	21.1%	10.6%	18.3%	10.1%	10.4%	7.9%
Option 2	21.1%	10.5%	18.3%	10.2%	10.4%	8.4%
Option 2a	21.5%	10.5%	20.0%	10.2%	16.2%	8.4%
Option 3	19.5%	10.6%	12.8%	10.1%	1.3%	7.8%
	4ii (sector allocation 2)					
	June-July	**Aug-Oct**	**June-July**	**Aug-Oct**	**June-July**	**Aug-Oct**
Option 1	21.3%	10.5%	19.1%	10.2%	13.9%	8.3%
Option 2	21.3%	10.5%	19.1%	10.2%	13.9%	8.8%
Option 2a	21.5%	10.5%	20.6%	10.2%	17.1%	8.8%
Option 3	20.0%	10.6%	15.0%	10.2%	3.0%	8.2%
	6 (sector allocation 3)					
	June-July	**Aug-Oct**	**June-July**	**Aug-Oct**	**June-July**	**Aug-Oct**
Option 1	21.5%	10.5%	20.1%	10.3%	16.3%	8.7%
Option 2	21.5%	10.5%	20.1%	10.3%	16.3%	8.9%
Option 2a	21.5%	10.5%	21.1%	10.3%	18.6%	8.7%
Option 3	20.7%	10.5%	16.9%	10.3%	7.8%	8.5%

Table 5-88. Estimated numbers of chum salmon saved in prototypical years (all regions combined) by: 1) assuming the highest AEQ mortality year (569,091chum; top section), and 2) assuming an average AEQ year (142,348 chum salmon; bottom section) for different cap, sector levels, and trigger options. Values assume an average proportion of bycatch occurred in June-July (12%) whereas numbers in parentheses assume that the proportion of June-July chum bycatch was 42% (the highest proportion observed on record).

Highest AEQ mortality (569,091 chum)

	25,000	**75,000**	**200,000**
2ii (sector allocation 1)			
Option 1	67,567 (85,545)	63,135 (77,175)	46,683 (50,963)
Option 2	67,067 (85,216)	63,635 (77,504)	49,183 (52,608)
Option 2a	67,343 (86,177)	64,808 (81,587)	53,185 (66,539)
Option 3	66,463 (81,702)	59,341 (63,964)	39,905 (28,776)
4ii (sector allocation 2)			
Option 1	67,205 (85,696)	64,187 (79,425)	51,098 (60,686)
Option 2	67,205 (85,696)	64,187 (79,425)	53,598 (62,330)
Option 2a	67,343 (86,177)	65,222 (83,028)	55,806 (70,017)
Option 3	66,808 (82,903)	61,359 (69,577)	43,078 (34,175)
6 (sector allocation 3)			
Option 1	67,343 (86,177)	65,377 (82,156)	54,754 (67,766)
Option 2	67,343 (86,177)	65,377 (82,156)	55,754 (68,424)
Option 2a	67,343 (86,177)	66,067 (84,558)	56,341 (73,291)
Option 3	66,791 (84,255)	63,170 (74,470)	47,890 (46,691)

Average AEQ mortality (142,348 chum)

	25,000	**75,000**	**200,000**
2ii (sector allocation 1)			
Option 1	16,901 (21,398)	15,792 (19,304)	11,677 (12,748)
Option 2	16,776 (21,315)	15,917 (19,386)	12,302 (13,159)
Option 2a	16,845 (21,556)	16,211 (20,408)	13,303 (16,644)
Option 3	16,625 (20,436)	14,843 (15,999)	9,982 (7,198)
4ii (sector allocation 2)			
Option 1	16,810 (21,435)	16,055 (19,867)	12,781 (15,180)
Option 2	16,810 (21,435)	16,055 (19,867)	13,407 (15,591)
Option 2a	16,845 (21,556)	16,314 (20,768)	13,959 (17,513)
Option 3	16,711 (20,737)	15,348 (17,403)	10,775 (8,548)
6 (sector allocation 3)			
Option 1	16,845 (21,556)	16,353 (20,550)	13,696 (16,951)
Option 2	16,845 (21,556)	16,353 (20,550)	13,946 (17,115)
Option 2a	16,845 (21,556)	16,526 (21,151)	14,093 (18,332)
Option 3	16,707 (21,075)	15,801 (18,627)	11,979 (11,679)

Table 5-89. Estimated numbers of **western Alaska** (Upper Yukon plus coastal west Alaska) chum salmon saved in prototypical years: 1) assuming the highest AEQ mortality year (106,700 chum; top section), and 2) assuming an average AEQ year (23,428 chum salmon; bottom section) for different cap, sector levels, and trigger options. Values assume an average proportion of bycatch occurred in June-July (12%) whereas numbers in parentheses assume that the proportion of June-July chum bycatch was 42% (the highest proportion observed on record).

Highest AEQ mortality (106,700 chum)

	25,000		**75,000**		**200,000**	
2ii (sector allocation 1)						
Option 1	12,668	(16,039)	11,837	(14,470)	8,753	(9,555)
Option 2	12,575	(15,977)	11,931	(14,531)	9,221	(9,864)
Option 2a	12,626	(16,157)	12,151	(15,297)	9,972	(12,476)
Option 3	12,461	(15,318)	11,126	(11,993)	7,482	(5,395)
4ii (sector allocation 2)						
Option 1	12,600	(16,067)	12,035	(14,892)	9,580	(11,378)
Option 2	12,600	(16,067)	12,035	(14,892)	10,049	(11,686)
Option 2a	12,626	(16,157)	12,229	(15,567)	10,463	(13,128)
Option 3	12,526	(15,544)	11,504	(13,045)	8,077	(6,408)
6 (sector allocation 3)						
Option 1	12,626	(16,157)	12,258	(15,404)	10,266	(12,706)
Option 2	12,626	(16,157)	12,258	(15,404)	10,453	(12,829)
Option 2a	12,626	(16,157)	12,387	(15,854)	10,563	(13,741)
Option 3	12,523	(15,797)	11,844	(13,962)	8,979	(8,754)

Average AEQ mortality (23,428 chum)

	25,000		**75,000**		**200,000**	
2ii (sector allocation 1)						
Option 1	2,782	(3,522)	2,599	(3,177)	1,922	(2,098)
Option 2	2,761	(3,508)	2,620	(3,191)	2,025	(2,166)
Option 2a	2,772	(3,548)	2,668	(3,359)	2,189	(2,739)
Option 3	2,736	(3,363)	2,443	(2,633)	1,643	(1,185)
4ii (sector allocation 2)						
Option 1	2,767	(3,528)	2,642	(3,270)	2,104	(2,498)
Option 2	2,767	(3,528)	2,642	(3,270)	2,207	(2,566)
Option 2a	2,772	(3,548)	2,685	(3,418)	2,297	(2,882)
Option 3	2,750	(3,413)	2,526	(2,864)	1,773	(1,407)
6 (sector allocation 3)						
Option 1	2,772	(3,548)	2,691	(3,382)	2,254	(2,790)
Option 2	2,772	(3,548)	2,691	(3,382)	2,295	(2,817)
Option 2a	2,772	(3,548)	2,720	(3,481)	2,319	(3,017)
Option 3	2,750	(3,469)	2,601	(3,066)	1,972	(1,922)

Table 5-90. Estimated numbers of **coastal western Alaska** chum salmon saved in prototypical years: 1) assuming the highest AEQ mortality year (72,610 chum; top section) and 2) assuming an average AEQ year (15,399 chum salmon; bottom section) for different cap, sector levels, and trigger options. Values assume an average proportion of bycatch occurred in June-July (12%) whereas numbers in parentheses assume that the proportion of June-July chum bycatch was 42% (the highest proportion observed on record).

Highest AEQ mortality (72,610 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	8,621	(10,915)	8,055	(9,847)	5,956	(6,502)
Option 2	8,557	(10,872)	8,119	(9,888)	6,275	(6,713)
Option 2a	8,592	(10,995)	8,269	(10,410)	6,786	(8,490)
Option 3	8,480	(10,424)	7,571	(8,161)	5,092	(3,671)
4ii (sector allocation 2)						
Option 1	8,574	(10,934)	8,190	(10,134)	6,519	(7,743)
Option 2	8,574	(10,934)	8,190	(10,134)	6,838	(7,952)
Option 2a	8,592	(10,995)	8,322	(10,593)	7,120	(8,934)
Option 3	8,524	(10,578)	7,829	(8,877)	5,496	(4,361)
6 (sector allocation 3)						
Option 1	8,592	(10,995)	8,342	(10,483)	6,986	(8,647)
Option 2	8,592	(10,995)	8,342	(10,483)	7,113	(8,730)
Option 2a	8,592	(10,995)	8,429	(10,789)	7,188	(9,351)
Option 3	8,522	(10,750)	8,060	(9,501)	6,110	(5,957)

Average AEQ mortality (15,399 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	1,829	(2,315)	1,708	(2,088)	1,263	(1,379)
Option 2	1,815	(2,306)	1,722	(2,097)	1,331	(1,424)
Option 2a	1,822	(2,332)	1,754	(2,208)	1,439	(1,800)
Option 3	1,798	(2,210)	1,606	(1,731)	1,080	(779)
4ii (sector allocation 2)						
Option 1	1,819	(2,319)	1,737	(2,149)	1,383	(1,642)
Option 2	1,819	(2,319)	1,737	(2,149)	1,451	(1,687)
Option 2a	1,822	(2,332)	1,765	(2,247)	1,510	(1,894)
Option 3	1,808	(2,243)	1,660	(1,882)	1,165	(925)
6 (sector allocation 3)						
Option 1	1,822	(2,332)	1,769	(2,223)	1,482	(1,834)
Option 2	1,822	(2,332)	1,769	(2,223)	1,508	(1,852)
Option 2a	1,822	(2,332)	1,788	(2,288)	1,524	(1,983)
Option 3	1,808	(2,280)	1,710	(2,015)	1,296	(1,263)

Table 5-91. Estimated numbers of **Upper Yukon (fall)** chum salmon saved in prototypical years: 1) assuming the highest AEQ mortality year (34,095 chum; top section) and 2) assuming an average AEQ year (8,030 chum salmon; bottom section) for different cap, sector levels, and trigger options. Values assume an average proportion of bycatch occurred in June-July (12%) whereas numbers in parentheses assume that the proportion of June-July chum bycatch was 42% (the highest proportion observed on record).

Highest AEQ mortality (34,095 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	4,048	(5,125)	3,782	(4,624)	2,797	(3,053)
Option 2	4,018	(5,105)	3,812	(4,643)	2,946	(3,152)
Option 2a	4,035	(5,163)	3,883	(4,888)	3,186	(3,987)
Option 3	3,982	(4,895)	3,555	(3,832)	2,391	(1,724)
4ii (sector allocation 2)						
Option 1	4,026	(5,134)	3,846	(4,759)	3,061	(3,636)
Option 2	4,026	(5,134)	3,846	(4,759)	3,211	(3,734)
Option 2a	4,035	(5,163)	3,908	(4,974)	3,343	(4,195)
Option 3	4,003	(4,967)	3,676	(4,168)	2,581	(2,048)
6 (sector allocation 3)						
Option 1	4,035	(5,163)	3,917	(4,922)	3,280	(4,060)
Option 2	4,035	(5,163)	3,917	(4,922)	3,340	(4,099)
Option 2a	4,035	(5,163)	3,958	(5,066)	3,375	(4,391)
Option 3	4,002	(5,048)	3,785	(4,461)	2,869	(2,797)

Average AEQ mortality (8,030 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	954	(1,207)	891	(1,089)	659	(719)
Option 2	946	(1,202)	898	(1,094)	694	(742)
Option 2a	950	(1,216)	914	(1,151)	750	(939)
Option 3	938	(1,153)	837	(902)	563	(406)
4ii (sector allocation 2)						
Option 1	948	(1,209)	906	(1,121)	721	(856)
Option 2	948	(1,209)	906	(1,121)	756	(880)
Option 2a	950	(1,216)	920	(1,172)	787	(988)
Option 3	943	(1,170)	866	(982)	608	(482)
6 (sector allocation 3)						
Option 1	950	(1,216)	922	(1,159)	773	(956)
Option 2	950	(1,216)	922	(1,159)	787	(966)
Option 2a	950	(1,216)	932	(1,193)	795	(1,034)
Option 3	943	(1,189)	891	(1,051)	676	(659)

Table 5-92. Estimated numbers of **south western Alaska** chum salmon saved in prototypical years: 1) assuming the highest AEQ mortality year (13,401 chum; top section) and assuming an average AEQ year (2,920 chum salmon; bottom section) for different cap, sector levels, and trigger options. Values assume an average proportion of bycatch occurred in June-July (12%) whereas numbers in parentheses assume that the proportion of June-July chum bycatch was 42% (the highest proportion observed on record).

Highest AEQ mortality (13,401 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	1,591	(2,014)	1,487	(1,817)	1,099	(1,200)
Option 2	1,579	(2,007)	1,498	(1,825)	1,158	(1,239)
Option 2a	1,586	(2,029)	1,526	(1,921)	1,252	(1,567)
Option 3	1,565	(1,924)	1,397	(1,506)	940	(678)
4ii (sector allocation 2)						
Option 1	1,582	(2,018)	1,512	(1,870)	1,203	(1,429)
Option 2	1,582	(2,018)	1,512	(1,870)	1,262	(1,468)
Option 2a	1,586	(2,029)	1,536	(1,955)	1,314	(1,649)
Option 3	1,573	(1,952)	1,445	(1,638)	1,014	(805)
6 (sector allocation 3)						
Option 1	1,586	(2,029)	1,540	(1,935)	1,289	(1,596)
Option 2	1,586	(2,029)	1,540	(1,935)	1,313	(1,611)
Option 2a	1,586	(2,029)	1,556	(1,991)	1,327	(1,726)
Option 3	1,573	(1,984)	1,488	(1,754)	1,128	(1,099)

Average AEQ mortality (2,920 chum)

	25,000		75,000		200,000	
2ii (sector allocation 1)						
Option 1	347	(439)	324	(396)	240	(261)
Option 2	344	(437)	327	(398)	252	(270)
Option 2a	345	(442)	333	(419)	273	(341)
Option 3	341	(419)	304	(328)	205	(148)
4ii (sector allocation 2)						
Option 1	345	(440)	329	(408)	262	(311)
Option 2	345	(440)	329	(408)	275	(320)
Option 2a	345	(442)	335	(426)	286	(359)
Option 3	343	(425)	315	(357)	221	(175)
6 (sector allocation 3)						
Option 1	345	(442)	335	(422)	281	(348)
Option 2	345	(442)	335	(422)	286	(351)
Option 2a	345	(442)	339	(434)	289	(376)
Option 3	343	(432)	324	(382)	246	(240)

5.4.5 Alternative 4, voluntary program with large area closure

Under this alternative, the analysis consists of examining the impact of having the large area closures in place for the entire B season. The options (i.e., using sector splits and trigger caps) are inferred from results where the hard cap occurred since the two cap levels and three sector splits are included from that application. Results of the closure being in place (as imposed on the same database constructed for analysis in the trigger closure section) for the entire B season shows that overall, the expected reduction in chum salmon bycatch would be 36% given the assumption that pollock fishing would remain viable outside of the closure area to the extent that it was during the period 2003-2010 (Table 5-93). These results reflect the spatial variability over time and suggest that some years will have greater impact than others on the raw totals of salmon saved (ignoring run size impacts).

With the cap levels of 50,000, and 200,000 chum and sector levels, the closure sequence is expected to be similar in pattern to what was shown under Alternative 2 (e.g., Table 5-81).

Table 5-93. Sector-specific estimated proportion of chum salmon bycatch (and by extension, AEQ mortality) reduction that would hypothetically have occurred had the large area closure for Alternative 4 been in place, 2003-2010.

Year	CDQ	CP	MS	CV	Mean
2003	21%	53%	24%	12%	17%
2004	52%	70%	42%	13%	25%
2005	28%	44%	47%	15%	18%
2006	69%	75%	77%	22%	25%
2007	50%	65%	64%	48%	53%
2008	92%	85%	88%	45%	52%
2009	49%	73%	67%	56%	58%
2010	84%	64%	47%	30%	39%
Mean	57%	66%	54%	30%	36%

5.4.6 Comparison of Alternatives

Estimates of historical bycatch represent actual numbers of chum salmon taken and include benefits of existing management measures. The status quo analysis estimates are provided to understand the effectiveness of the current system relative to one which lacked any salmon bycatch avoidance program. The reduction due to this program is estimated to range from 4-28% based on estimation of imposing the system in years prior to its operation. Comparing alternatives against status quo requires understanding that the relative benefits are in addition to the current status quo measures.

Relative impacts of bycatch to individual river systems depend on where and when the bycatch occurs. This can add to the inter-annual variability in results for the same caps, closures, and allocations between sectors. On average (based on 2005-2009 data) approximately 12% of the AEQ is attributed to the coastal western Alaskan regional grouping while ~7% is attributed to the Upper Yukon (Fall chum). For the Southwest Alaska Peninsula stocks, the average AEQ over this period is ~2%, while for the combined PNW (including regions from Prince William Sound all the way to WA/OR), the average is 22%. Combined estimated Asian contribution is ~58% on average (for Russian stocks and Japanese stocks combined).

Combining these results with conservative estimates of run sizes where available for the aggregate coastal western Alaska stocks indicate that the highest impact rate (chum salmon mortality due to the pollock fishery divided by run-size estimates) was less than 1.7% for the combined western Alaska stocks.

Under Alternative 2, the hard cap options, estimates are made by year of the number of salmon saved (in numbers as well as AEQ estimates) and compared to the actual amounts estimated under status quo under each cap and sector allocation scenario. The amount of salmon saved under each options varies considerably from year to year as well as by cap and sector allocation. The greatest number of salmon saved under Alternative 2 is 93% in the highest year (2005) for the most restrictive cap level considered

(50,000). This contrasts with other years where no salmon would have been saved (given the assumptions) under the higher cap scenarios in years of both high and low bycatch. In years of low bycatch there is limited salmon savings under any cap and allocation scenario.

Triggered closures are effective at reducing chum bycatch (by about 12% on average depending on configuration but as high as 21% for some sectors in some years). Triggered closure areas are relatively insensitive to the magnitude of the cap level that triggers closures. This insensitivity reflects the highly variable nature of chum salmon bycatch between years, and by seasons and areas rather than shortcomings of the closure design. Of the trigger application options, option 3 results in the highest percentage of salmon saved. However, this option results in lower amounts of salmon saved earlier in the B season when more of the bycatch is estimated to be of WAK origin. Overall savings of salmon under Alternative 3 ranged from 6-14% over all cap configurations and high and low bycatch years with sub-option 2a generally performing the best compared to the other options (i.e., greater levels of chum salmon PSC reductions).

Under Alternative 4, with a fixed large-scale area closure imposed over the entire B season, the overall reduction in salmon bycatch is estimated to be approximately 36%, given the assumption that pollock fishing outside of the closure area remains viable (estimated with data from 2003-2010) and no fishing occurs in the closed area. However, as with status quo, participation under the RHS program is anticipated to remain at 100%, particularly with the greater incentive to participate under Alternative 4, , thus estimated impacts are likely best approximated by status quo.

6 Chinook salmon

Seasonal bycatch totals are presented in Table 6-4 and by pollock fishing sector in Table 6-5.

6.1 Overview of Chinook salmon biology and distribution

Overview information in this section is extracted from Delaney (1994). Other information on Chinook salmon may be found at the ADF&G website, http://www.cf.adfg.state.ak.us/geninfo/finfish/salmon/salmhome.php.

The Chinook salmon (*Oncorhynchus tshawytscha*) is the largest of all Pacific salmon, with weights of individual fish commonly exceeding 30 pounds. In North America, Chinook salmon range from the Monterey Bay area of California to the Chukchi Sea area of Alaska. In Alaska, it is abundant from the southeastern panhandle to the Yukon River. Major populations return to the Yukon, Kuskokwim, Nushagak, Susitna, Kenai, Copper, Alsek, Taku, and Stikine rivers. Important runs also occur in many smaller streams.

Like all species of Pacific salmon, Chinook salmon are anadromous. They hatch in fresh water, spend part of their life in the ocean, and then spawn in fresh water. All Chinooks die after spawning. Chinook salmon may become sexually mature from their second through seventh year, and as a result, fish in any spawning run may vary greatly in size. For example, a mature 3-year-old will probably weigh less than 4 pounds, while a mature 7-year-old may exceed 50 pounds. Females tend to be older than males at maturity. In many spawning runs, males outnumber females in all but the 6- and 7-year age groups. Small Chinooks that mature after spending only one winter in the ocean are commonly referred to as "jacks" and are usually males. Alaska streams normally receive a single run of Chinook salmon in the period from May through July.

Chinook salmon migrate through coastal areas as juveniles and returning adults; however, immature Chinook salmon undergo extensive migrations and can be found inshore and offshore throughout the North Pacific and Bering Sea. In summer, Chinook salmon concentrate around the Aleutian Islands and in the western Gulf of Alaska (Eggers 2004).

Juvenile Chinook salmon in freshwater feed on plankton and then later eat insects. In the ocean, they eat a variety of organisms including herring, pilchard, sand lance, squid, and crustaceans. Salmon grow rapidly in the ocean and often double their weight during a single summer season.

North Pacific Chinook salmon are the subject of commercial, subsistence, personal use, and sport fisheries, as discussed in more detail in Chapters 9 and 10. The majority of the Alaska commercial catch is made in Southeast Alaska, Bristol Bay, and the Arctic-Yukon-Kuskokwim areas. Fish taken commercially average about 18 pounds. The majority of the catch is made with troll gear and gillnets. Approximately 90 percent of the subsistence harvest is taken in the Yukon and Kuskokwim rivers.

The Chinook salmon is perhaps the most highly prized sport fish in Alaska and is extensively fished by anglers in the Southeast and Cook Inlet areas. The sport fishing harvest of Chinook salmon is over 76,000 annually, with Cook Inlet and adjacent watersheds contributing over half of the catch.

Unlike “other salmon” species, Chinook salmon rear in inshore marine waters and are, therefore, available to commercial and sport fishermen all year.

6.1.1 Food habits/ecological role

Western Alaskan salmon runs experienced dramatic declines from 1998 through 2002 with a record low in stocks in 2000. Weak runs during this time period have been attributed to reduced productivity in the marine environment rather than an indication of low levels of parent year escapements (Bue and Lingnau 2005). Recent Bering-Aleutian Salmon International Survey (BASIS) evaluations have examined the food habits from Pacific salmon in the Bering Sea in an attempt to evaluate potential interactions between salmon species as well as their dependence upon oceanographic conditions for survival.

Ocean salmon feeding ecology is highlighted by the BASIS program given the evidence that salmon are food limited during their offshore migrations in the North Pacific and Bering Sea (Rogers 1980; Rogers and Ruggerone 1993; Aydin et al. 2000, Kaeriyama et al. 2000). Increases in salmon abundance in North America and Asian stocks have been correlated to decreases in body size of adult salmon which may indicate a limit to the carrying capacity of salmon in the ocean (Kaeriyama 1989; Ishida et al. 1993; Helle and Hoffman 1995; Bigler et al. 1996; Ruggerone et al. 2003). International high seas research results suggest that inter and intra-specific competition for food and density-dependant growth effects occur primarily among older age groups of salmon particularly when stocks from different geographic regions in the Pacific Rim mix and feed in offshore waters (Ishida et al. 1993; Ishida et al 1995; Tadokoro et al. 1996; Walker et al. 1998; Azumaya and Ishida 2000; Bugaev et al. 2001; Davis 2003; Ruggerone et al. 2003).

Results of a fall study to evaluate food habits data in 2002 indicated Chinook salmon consumed predominantly small nekton and did not overlap their diets with sockeye and chum (Davis et al. 2004). Shifts in prey composition of salmon species between seasons, habitats and among salmon age groups were attributed to changes in prey availability (Davis et al. 2004).

Stomach sample analysis of ocean age .1 and .2 fish from basin and shelf area Chinook salmon indicated that their prey composition was more limited than chum salmon (Davis et al. 2004). This particular study did not collect many ocean age .3 or .4 Chinook, although those collected were located predominantly in the basin (Davis et al. 2004). Summer Chinook samples contained high volumes of euphausiids, squid and fish while fall stomach samples in the same area contained primarily squid and some fish (Davis et al. 2004). The composition of fish in salmon diets varied with area with prey species in the basin primarily northern lamp fish, rockfish, Atka mackerel, Pollock, sculpin and flatfish while shelf samples contained more herring, capelin, Pollock, rockfish and sablefish (Davis et al. 2004). Squid was an important prey species for ocean age .1, .2, and .3 Chinook in summer and fall (Davis et al. 2004). The proportion of fish was higher in summer than fall as was the relative proportion of euphausiids (Davis et al. 2004). The proportion of squid in Chinook stomach contents was larger during the summer in years (even numbered) when there was a scarcity of pink salmon in the basin (Davis et al. 2004).

Results from the Bering Sea shelf on diet overlap in 2002 indicated that the overlap between chum and Chinook salmon was moderate (30%), with fish constituting the largest prey category, results were similar in the basin (Davis et al. 2004). However notably on the shelf, both chum and Chinook consumed juvenile walleye pollock, with Chinook salmon consuming somewhat larger (60-190 mm SL) than those consumed by chum salmon (45-95 mm SL) (Davis et al. 2004). Other fish consumed by Chinook salmon included herring and capelin while chum salmon stomach contents also included sablefish and juvenile rockfish (Davis et al. 2004).

General results from the study found that immature chum are primarily predators of macrozooplankton while Chinook tend to prey on small nektonic prey such as fish and squid (Davis et al. 2004). Prey compositions shifts between species and between seasons in different habitats and a seasonal reduction in diversity occurs in both chum and Chinook diets from summer to fall (Davis et al. 2004). Reduction in prey diversity was noted to be caused by changes in prey availability due to distribution shifts, abundance changes or progression of life-history changes which could be the result of seasonal shift in environmental factors such as changes in water temperature and other factors (Davis et al. 2004).

Davis et al. (2004) found that diet overlap estimates between Chinook and sockeye salmon and Chinook and chum salmon were lower than the estimates obtained for sockeye and chum salmon, suggesting a relatively low level of inter-specific food competition between immature Chinook and immature sockeye or chum salmon in the Bering Sea because Chinook salmon were more specialized consumers. In addition, the relatively low abundance of immature Chinook salmon compared to other species may serve to reduce intra-specific competition at sea. Consumption of nektonic organisms (fish and squid) may be efficient because they are relatively large bodied and contain a higher caloric density than zooplankton, such as pteropods and amphipods (Tadokoro et al. 1996, Davis et al. 1998). However, the energetic investment required of Chinook to capture actively swimming prey is large, and if fish and squid prey abundance are reduced, a smaller proportion of ingested energy will be available for salmon growth (Davis et al. 1998). Davis et al. (2004) hypothesized that inter- and intra-specific competition in the Bering Sea could negatively affect the growth of chum and Chinook salmon, particularly during spring and summer in odd-numbered years, when the distribution of Asian and North American salmon stocks overlap. Decreased growth could lead to reduction in salmon survival by increasing predation (Ruggerone et al. 2003), decreasing lipid storage to the point of insufficiency to sustain the salmon through winter when consumption rates are low (Nomura et al. 2002), and increasing susceptibility to parasites and disease due to poor salmon nutritional condition.

6.1.2 Hatchery releases

Commercial salmon fisheries exist around the Pacific Rim with most countries releasing salmon fry in varying amounts by species. The North Pacific Anadromous Fish Commission summarizes information on hatchery releases by country and by area where available. Reports submitted to the NPAFC were used to summarize hatchery information by Country and by US state below (Table 6-1, Table 6-2). For more information see the following: Russia (Akinicheva et al. 2008; Anon. 2007; TINRO-centre 2006, 2005); Canada (Cook et al. 2008); USA (Josephson 2008; Josephson 2007; Eggers 2006, 2005; Bartlett 2007, 2006, 2005).

Chinook salmon hatchery releases by country are shown below in Table 6-1. There are no hatchery releases of Chinook salmon in Japan and Korea and only a limited number in Russia.

Table 6-1 Hatchery releases of juvenile Chinook salmon, in millions of fish

Year	Russia	Japan	Korea	Canada	USA	TOTAL
1999	0.6	-	-	54.4	208.1	263.1
2000	0.5	-	-	53.0	209.5	263.0
2001	0.5	-	-	45.5	212.1	258.1
2002	0.3	-	-	52.8	222.1	275.2
2003	0.7	-	-	50.2	210.6	261.5
2004	1.17	-	-	49.8	173.6	224.6
2005	0.84	-	-	43.5	184.0	228.3
2006	0.78	-	-	40.9	181.2	223.7
2007	0.78	-	-	44.6	182.2	227.6
2008	1.0			38.0	198.4	237.4
2009	0.78	-	-	41.63	111.5	153.92

For Chinook salmon fry, the United States has the highest number of annual releases (80% of total in 2007), followed by Canada (~20%). In Canada, enhancement projects have been on-going since 1977 with approximately 300 different projects for all salmon species (Cook and Irvine 2007). Maximum production for Chinook releases was reached in 1991 with 66 million fish in that year (Cook and Irvine 2007). Releases of Chinook in 2006 occurred in the following regions: Yukon and Transboundary River, Skeena River, North Coast, Central Coast, West Coast and Vancouver Island, Johnstone Strait, Straits of Georgia, and the Lower and Upper Fraser rivers. Of these the highest numbers were released in the West Coast Straits of Georgia (20 million fish) followed by Vancouver Island area (12.4 million fish) the Lower Fraser River (3.3 million fish) (Cook and Irvine 2007).

Of the US releases however, a breakout by area shows that the highest numbers are coming from the State of Washington (63% in 2007), followed by California (19% in 2007), and then Oregon (7% in 2007) (Table 6-2). Hatcheries in Alaska are located in southcentral and southeast Alaska; there are no enhancement efforts for the AYK region. Since 2004 the number of hatcheries has ranged from 33 (2004–2005) to 31 (2006) with the majority of hatcheries (18–22) located in southeast Alaska, while 11 hatcheries are in Cook Inlet and 2 in Kodiak (Eggers 2005, 2006; Josephson 2007).

Table 6-2 USA west coast hatchery releases of juvenile Chinook salmon, in millions of fish

Year	Alaska	Washington	Oregon	California	Idaho	WA/OR/CA/ID (combined)	TOTAL
1999	8.0	114.5	30.5	45.4	9.7		208.1
2000	9.2	117.4	32.3	43.8	6.8		209.5
2001	9.9	123.5	28.4	45.0	5.4		212.1
2002	8.4					213.6	222.0
2003	9.3					201.3	210.6
2004	9.35	118.2	17.0	27.4	1.7	164.2	173.6
2005	9.46	117.7	19.2	28.8	8.7	174.5	184.0
2006	10.2	110.5	19.2	29.4	12.0	171.0	181.2
2007	10.5	114.5	13.2	34.8	9.2	171.7	182.2
2008	11.4					187.0	198.4
2009	10.5					101.00	111.5

6.1 Chinook salmon assessment overview by river system or region (update for 2010)

This section provides a brief overview of the status of western Alaskan Chinook salmon stocks. Western Alaska includes the Bristol Bay, Kuskokwim, Yukon, and Norton Sound management areas. Nushagak, Goodnews, Kanektok, Kuskokwim, Yukon, and Unalakleet rivers comprise the Chinook salmon index stocks for this region. Comprehensive information by region can be found in the environmental impact statement prepared for the Bering Sea Chinook Salmon Bycatch Management action by the Council (NPFMC/NOAA 2009) and is incorporated by reference. The EIS can be downloaded online at: http://www.fakr.noaa.gov/sustainablefisheries/bycatch/salmon/chinook/feis/eis_1209.pdf

The Alaska Board of Fisheries (board) designated the Yukon and Kuskokwim river stocks as a "Yield Concern" in September 2000 based on a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above each stock's escapement needs (Table 6-3). In January 2004, the board also designated Chinook salmon in Subdistricts 5 (Shaktoolik) and 6 (Unalakleet) of Norton Sound as a "Yield Concern". Based on improved abundance, that designation was lifted for Kuskokwim River stocks in January 2007, but remained for the Yukon River and Subdistricts 5 (Shaktoolik) and 6 (Unalakleet) of Norton Sound. The Alaska Department of Fish and Game (department) recommended and the board concurred in continuing these designations at the 2010 board meeting.

In general, these western Alaska Chinook salmon stocks declined sharply in 2007 and remained low in 2008–2010. For the more northerly of these stocks, the 2008 Chinook salmon run was one of the poorest on record. On the heels of the below average 2007–2009 Chinook salmon runs in western Alaska, management of the 2010 fisheries was conservative. All of the Chinook salmon runs to western Alaska started late and most were four to six days late in run timing. The late run combined with inclement weather in early June resulted in a delayed start to most fisheries. No directed Chinook salmon commercial fisheries occurred in the Yukon River, Kuskokwim River, or in Norton Sound in 2010, and only small commercial fisheries occurred in the Nushagak and Kuskokwim Bay (Table 6-3). Sport fisheries were restricted or closed in the Nushagak River, Yukon (Chena River), Kuskokwim (Kwethluk and Tuluksak rivers), and Unalakleet and Shaktoolik rivers of Norton Sound Area. More significantly, subsistence fisheries in the Nushagak River, two tributaries of the Kuskokwim River (Kwethluk and Tuluksak rivers; USFWS federal closure), and Norton Sound (Unalakleet and Shaktoolik rivers) were restricted or closed. In spite of conservative management strategies, which in some cases were at great cost to the people who rely on these resources for food and income, few escapement goals were achieved in western Alaska.

An overview of Chinook stock performance across the State including regions outside of western Alaska is also shown in Table 6-3.

Table 6-3 Overview of Alaskan Chinook salmon stock performance, 2010.

Chinook salmon stock	Total run size?	Escapement goals met?[a]	Subsistence fishery?	Commercial fishery?	Sport fishery?	Stock of concern?
Bristol Bay	Poor	0 of 1[b] (4 not surveyed)	Restricted on Nushagak	Limited in Nushagak District	Restricted, closed on Nushagak	No
Kuskokwim	Poor	3 of 7 (7 not surveyed)	Yes, 2 tributaries closed	None on Kuskokwim River, limited in Bay	2 tributaries closed	No
Yukon	Poor	3 of 7	Yes	No directed, some incidental take with chum	1 Tributary closed	Yield
Norton Sound	Poor	1 of 3 (2 not surveyed)	Yes, with restrictions	No	No	Yield
Alaska Peninsula	Below average	1 of 1	Yes	Yes	Yes	No
Kodiak	Below average	1 of 2	Karluk closed	Restricted in Karluk and Ayakulik areas	Karluk closed	Management
Chignik	Average	1 of 1	Yes	Yes	Yes	No
Upper Cook Inlet	Below average	4 of 19 (2 not surveyed)	Yes	Restricted in Northern District	Various restrictions	6 stocks of concern
Lower Cook Inlet	Below average	2 of 3	Yes	Yes	Yes	No
Prince William Sound	Below average	0 of 1	Yes	Yes	Yes	No
Southeast	Average	9 of 11	Yes	Yes	Yes	No

[a] Some aerial survey-based escapement goals were not assessed due to inclement weather or poor survey conditions, therefore we do not know if the escapement goals were met for these systems.

[b] The Chinook salmon escapement goal was not met on the Nushagak River in 2010.

6.1.1 Pollock fishery bycatch of Chinook salmon under alternatives

Note that significance criteria will be developed and incorporated into the impact analysis for the public review draft in order to evaluate the significance of the impacts of the alternative management measures on Chinook salmon stocks.

Seasonal bycatch totals are presented in Table 6-4 and by pollock fishing sector in Table 6-5. For evaluating impacts, it is necessary to translate how different catch restrictions may affect salmon stocks. For these analyses, the adult-equivalency (AEQ) of the bycatch was estimated. This is distinguished from the annual bycatch numbers that are recorded by observers and tallied in each year for management purposes. Not all Chinook that is caught as bycatch would otherwise have survived to return as an adult to its spawning stream. The AEQ methodology applies the extensive observer datasets on the length frequencies of Chinook salmon caught in the pollock fishery and convert these to ages, appropriately accounting for the time of year that catch occurred. The age data is coupled with information on the proportion of salmon that return to different river systems at various ages, and the bycatch-at-age data is used to pro-rate how any given year of bycatch affects future potential spawning runs of salmon. General results suggest that for Chinook salmon, the AEQ estimates are variable with the impact on run sizes (due to bycatch) showing a lagged effect (Fig. 6-1).

Based on analyses presented in the FEIS (Anon. 2010) the adult equivalent mortality due to bycatch (AEQ) for coastal western Alaska Chinook stocks ranged from below 10,000 to about 45,000 Chinook salmon during 1993-2007 (Fig. 6-2).

6.1.2 Trade-offs between management of Chinook bycatch and chum bycatch management measures

For Alternative 2, hard caps for chum salmon, the impact on Chinook will likely result in lower levels of bycatch since for many years, the fishery is closed relatively early and Chinook bycatch tends to increase later in the B-season (Anon 2010).

For Alternative 3, monthly triggered area closures to designed to reduce chum salmon bycatch generally tends to result in closing areas that also have had Chinook bycatch (Figure 6-3). Using the same methodology as for chum bycatch, the annual expected change (based on historical spatio-temporal patterns) for years is variable, with some sectors in some years being diverted to areas which would have resulted in higher than observed Chinook bycatch levels (negative shaded values, Table 6-6). The early part of the season (June-July) on average tends to save a higher percentage of Chinook salmon compared to later for the different cap, sector splits, and trigger closure options (Table 6-7). However, since the total Chinook bycatch is relatively low in the early period, the impact of the chum salmon trigger closures would tend to reduce Chinook bycatch by about 3% on average (Table 6-8). Note that the variability about this result indicates that in some years, in particular years when high Chinook bycatch, the chum measures will make Chinook bycatch levels worse. Compared to the non-Chinook measures, the impact of lower cap levels on relative salmon savings was similar in direction (lower cap meaning more Chinook salmon saved) but not as beneficial (Figure 6-4).

Table 6-4. Chinook salmon bycatch from the pollock fishery, 1991-2011 (April 16, 2011) by season.

Year	A-season	B-Season	Total
1991	38,791	2,114	40,906
1992	25,691	10,259	35,950
1993	17,264	21,252	38,516
1994	28,451	4,686	33,136
1995	10,579	4,405	14,984
1996	36,068	19,554	55,623
1997	10,935	33,973	44,909
1998	15,193	36,130	51,322
1999	6,352	5,627	11,978
2000	3,422	1,539	4,961
2001	18,484	14,961	33,444
2002	21,794	12,701	34,495
2003	32,609	12,977	45,586
2004	23,093	28,603	51,696
2005	27,331	40,030	67,361
2006	58,391	24,305	82,695
2007	69,408	52,349	121,757
2008	16,679	4,856	21,535
2009	9,688	2,736	12,424
2010	7,661	2,076	9,737
2011	6,994		6,994

Table 6-5 Chinook bycatch by sector for the Bering Sea pollock fleet, 1991-2011.

		A-season		A		B-season		B	Annual
YEAR	M	P	S	Total	M	P	S	Total	Total
1991	9,001	17,645	10,192	36,838	152	397	1,667	2,216	39,054
1992	4,057	12,631	6,725	23,413	1,766	6,889	1,604	10,259	33,672
1993	3,529	8,869	3,017	15,415	6,657	11,932	2,615	21,204	36,619
1994	1,790	17,149	8,346	27,285	572	2,826	1,207	4,605	31,890
1995	971	5,971	2,040	8,982	667	2,973	781	4,421	13,403
1996	5,481	15,276	15,228	35,985	6,322	3,222	9,944	19,488	55,472
1997	1,561	3,832	4,954	10,347	5,702	5,721	22,550	33,973	44,320
1998	4,284	6,500	4,334	15,118	6,361	2,547	27,218	36,127	51,244
1999	554	2,694	3,103	6,352	374	2,590	2,662	5,627	11,978
2000	19	2,525	878	3,422	253	568	717	1,539	4,961
2001	1,664	8,264	8,555	18,484	1,319	9,863	3,779	14,961	33,444
2002	1,976	9,481	10,336	21,794	1,755	1,386	9,560	12,701	34,495
2003	2,892	14,428	16,488	33,808	1,940	4,044	7,202	13,185	46,993
2004	2,092	9,492	12,376	23,961	2,076	4,289	23,701	30,067	54,028
2005	2,111	11,421	14,097	27,630	888	4,343	34,986	40,217	67,847
2006	5,408	17,306	36,039	58,753	200	1,551	22,654	24,405	83,159
2007	5,860	27,943	35,458	69,261	3,544	7,148	41,751	52,443	121,704
2008				16,679				4,856	21,535
2009				9,688				2,736	12,424
2010				7,661				2,076	9,737
2011				6,994					6,994

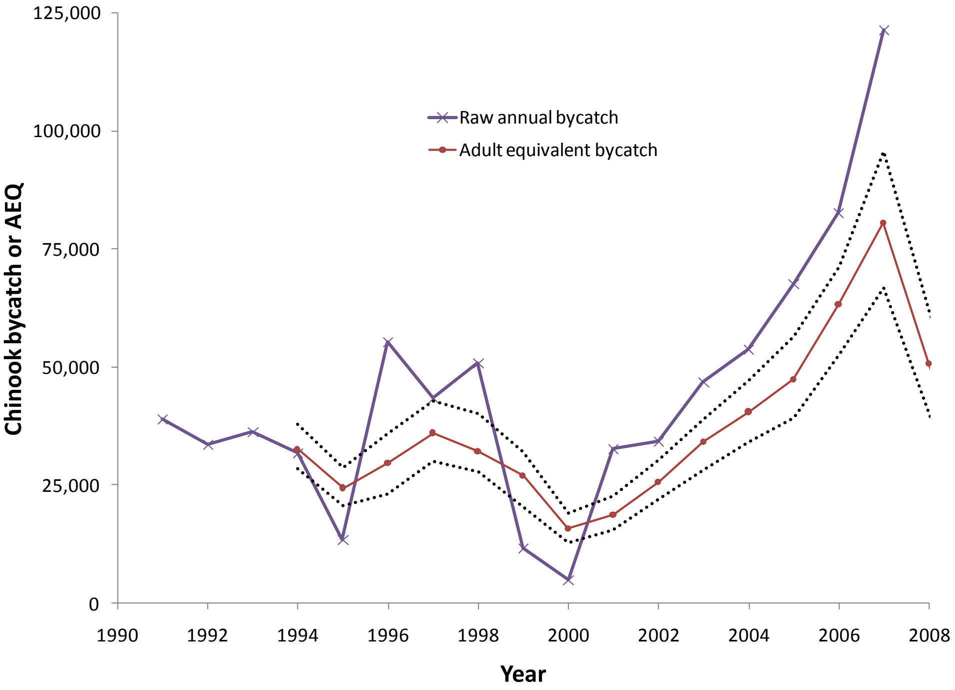


Fig. 6-1 Time series of Chinook actual and adult equivalent bycatch from the pollock fishery, 1991-2007 (2008 raw annual bycatch also indicated separately). The dotted lines represent the uncertainty of the AEQ estimate, due to the combined variability of ocean mortality, maturation rate, and age composition of bycatch estimates (From Anon 2010).

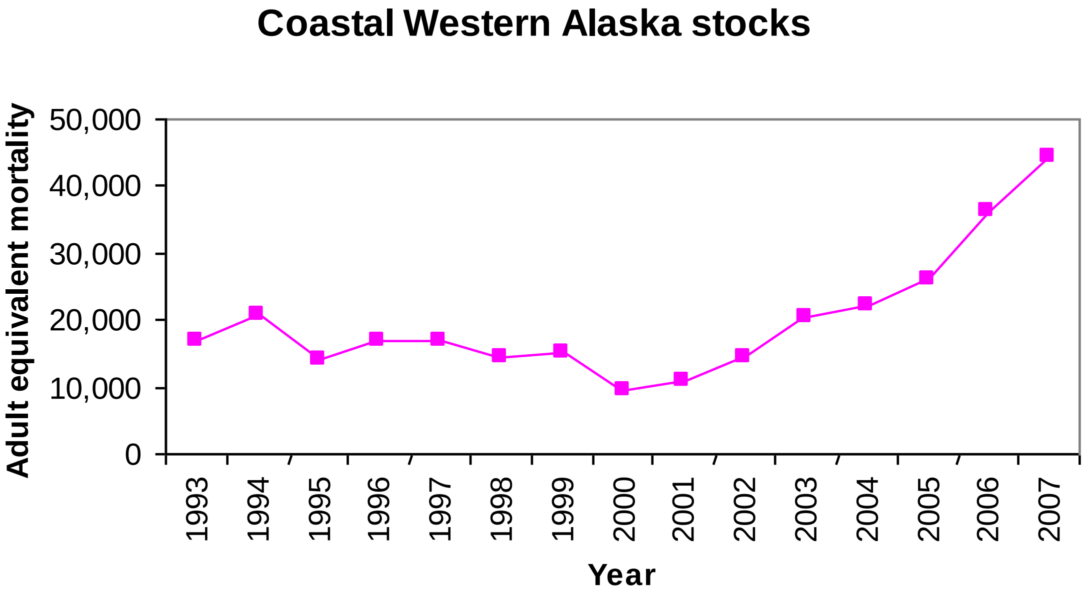


Fig. 6-2 Annual estimated pollock fishery adult equivalent removals on stocks from the Coastal western Alaska returns, 1993-2007.

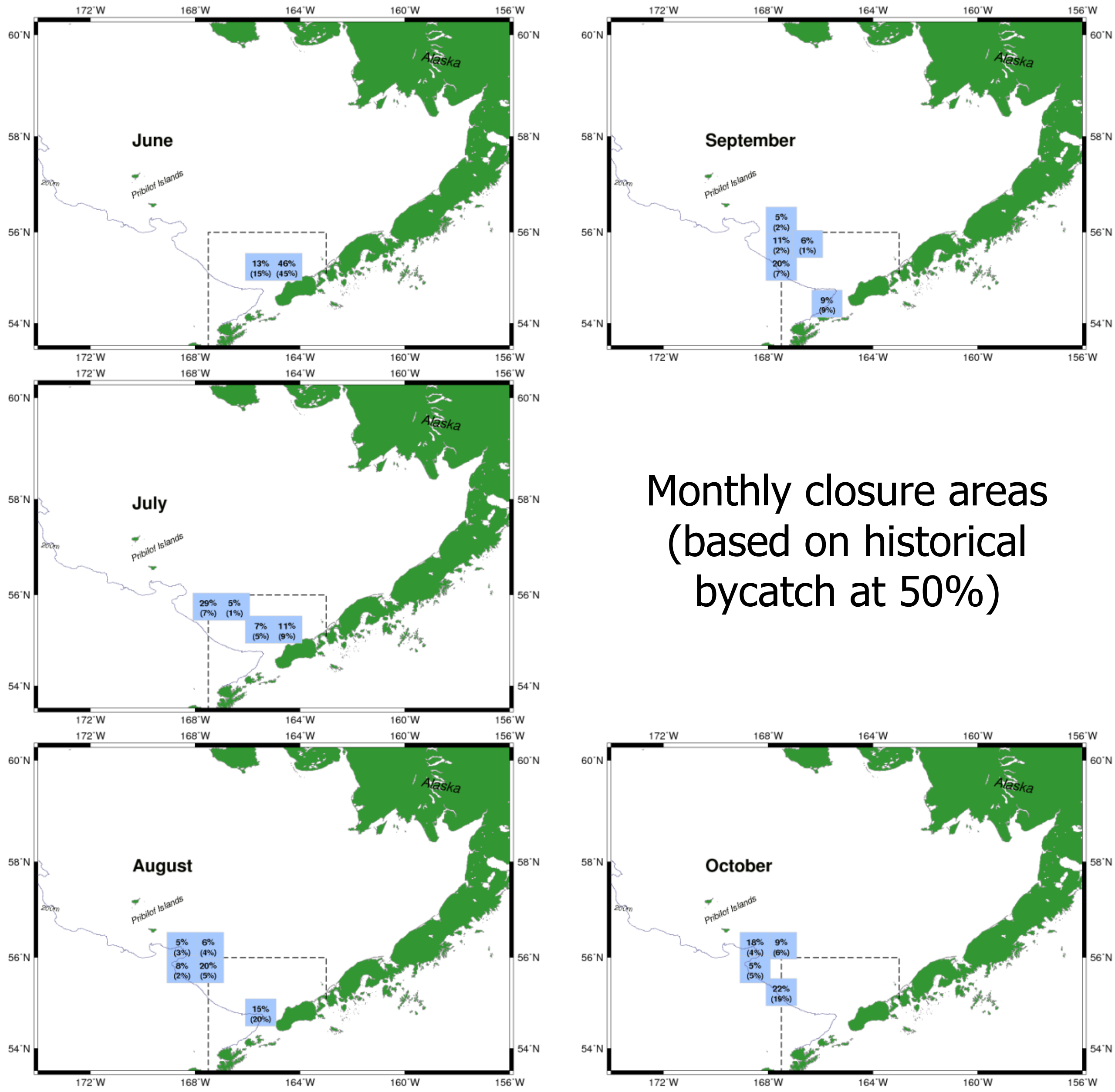


Figure 6-3 Monthly area closures based on ADFG areas that represented 50% of the historical chum bycatch (within each month). Values in parentheses are the proportion of Chinook salmon bycatch that occurred historically (2003-2010).

Table 6-6. Example expected percentage reduction in Chinook bycatch for triggered closures for a cap of 75,000 chum under the sector allocation scheme 2 by year and trigger closure options. Shaded cells represent instances of negative values (i.e., Chinook bycatch would have increased with triggered closure scheme in effect).

Cap=75,000		4ii (sector allocation 2)			
Option 1	CDQ	CP	MS	CV	All Sectors
2003	3.0%	2.4%	2.4%	-6.5%	-0.2%
2004	0.0%	4.3%	-1.7%	7.1%	1.0%
2005	0.0%	0.0%	1.0%	13.4%	2.5%
2006	0.0%	0.3%	0.0%	6.8%	1.0%
2007	-0.7%	4.0%	0.2%	-8.4%	-1.7%
2008	-0.3%	2.2%	0.0%	2.7%	0.1%
2009	0.0%	0.0%	0.1%	11.3%	0.2%
2010	-	0.0%	9.2%	5.5%	0.1%
Option 2	CDQ	CP	MS	CV	All Sectors
2003	3.6%	2.6%	2.7%	-6.4%	-0.2%
2004	0.0%	4.3%	-2.4%	7.7%	1.0%
2005	0.0%	0.0%	1.0%	13.4%	2.5%
2006	0.0%	0.3%	0.0%	6.8%	1.0%
2007	-0.7%	4.1%	0.2%	-8.4%	-1.7%
2008	-0.3%	2.2%	0.0%	2.7%	0.1%
2009	0.0%	0.0%	0.1%	11.3%	0.2%
2010	-	0.0%	9.2%	5.5%	0.1%
Option 2a	CDQ	CP	MS	CV	All Sectors
2003	3.6%	2.6%	2.6%	-6.4%	-0.2%
2004	0.0%	4.4%	-2.2%	7.7%	1.0%
2005	0.0%	0.0%	0.3%	13.4%	2.5%
2006	0.0%	1.0%	0.0%	6.8%	1.0%
2007	-0.7%	4.1%	0.2%	-8.4%	-1.7%
2008	-0.3%	2.2%	0.0%	2.8%	0.1%
2009	0.0%	0.0%	1.0%	15.4%	0.3%
2010	-	0.0%	7.6%	6.2%	0.1%
Option 3					
2003	3.0%	2.4%	2.4%	-6.6%	-0.2%
2004	0.0%	4.3%	-1.8%	7.0%	0.9%
2005	0.0%	0.0%	0.0%	13.4%	2.5%
2006	0.0%	0.0%	0.0%	6.7%	1.0%
2007	-0.7%	4.0%	0.2%	-8.4%	-1.7%
2008	-0.3%	2.2%	0.0%	2.2%	0.1%
2009	0.0%	0.0%	0.3%	0.7%	0.0%
2010	-	0.0%	1.8%	1.6%	0.0%

Table 6-7. Percentage reduction in Chinook bycatch expected for triggered closures for different chum salmon caps (top row), sector allocation schemes, and trigger closure options integrated over years and sectors by sub-season.

Cap:	**25,000**		**75,000**		**200,000**	
2ii (sector allocation 1)	June-July	Aug-Oct	June-July	Aug-Oct	June-July	Aug-Oct
Option 1	7.4%	3.1%	5.3%	3.0%	2.0%	2.4%
Option 2	7.4%	3.1%	5.3%	3.0%	2.0%	2.6%
Option 2a	8.0%	3.1%	6.4%	3.0%	4.2%	2.6%
Option 3	3.2%	3.1%	1.4%	3.0%	0.1%	2.4%
4ii (sector allocation 2)	June-July	Aug-Oct	June-July	Aug-Oct	June-July	Aug-Oct
Option 1	7.4%	3.0%	5.6%	2.7%	2.5%	2.4%
Option 2	7.4%	3.1%	5.6%	2.8%	2.5%	2.6%
Option 2a	7.9%	3.1%	6.8%	2.8%	4.5%	2.6%
Option 3	3.1%	3.0%	1.6%	2.7%	0.3%	2.4%
6 (sector allocation 3)	June-July	Aug-Oct	June-July	Aug-Oct	June-July	Aug-Oct
Option 1	7.7%	3.0%	6.1%	3.1%	3.9%	2.3%
Option 2	7.7%	3.0%	6.1%	3.2%	3.9%	2.4%
Option 2a	7.9%	3.0%	6.9%	3.2%	5.3%	2.4%
Option 3	4.3%	3.0%	1.9%	3.1%	0.7%	2.3%

Table 6-8. Percentage reduction in Chinook bycatch expected for triggered closures for different chum salmon caps (top row), sector allocation schemes, and trigger closure options integrated over years and sectors.

	25,000	75,000	200,000
2ii (sector allocation 1)			
Option 1	3.4%	3.2%	2.4%
Option 2	3.4%	3.2%	2.6%
Option 2a	3.4%	3.3%	2.7%
Option 3	3.1%	2.9%	2.2%
4ii (sector allocation 2)			
Option 1	3.3%	2.9%	2.4%
Option 2	3.3%	3.0%	2.6%
Option 2a	3.4%	3.1%	2.7%
Option 3	3.0%	2.6%	2.2%
6 (sector allocation 3)			
Option 1	3.3%	3.3%	2.5%
Option 2	3.3%	3.4%	2.5%
Option 2a	3.4%	3.4%	2.6%
Option 3	3.1%	3.0%	2.2%

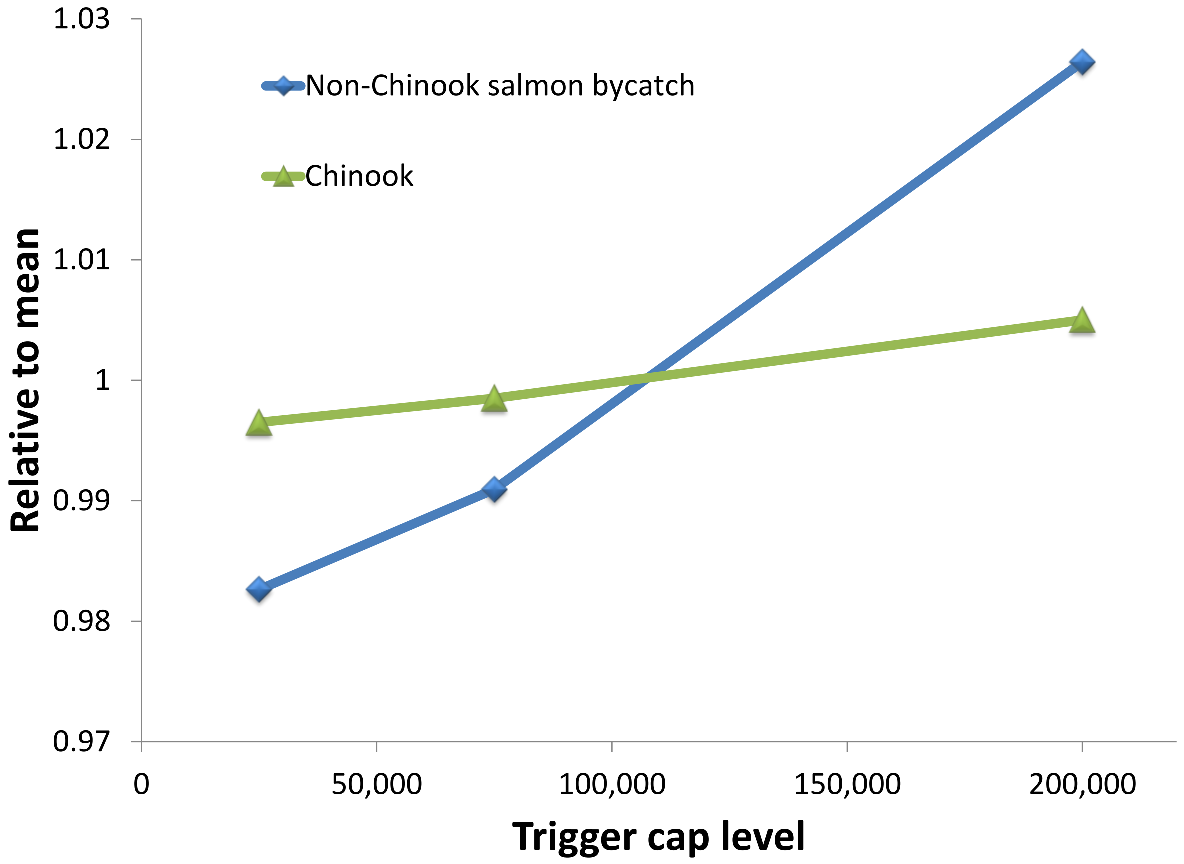


Figure 6-4 Comparison of relative benefit of different trigger cap levels for non-Chinook salmon and Chinook salmon when averaged over the other factors. **Note that lower values represent more salmon saved.**

7 Other Marine Resources

The Bering Sea pollock fishery, and potential changes to the prosecution of the pollock fishery to reduce salmon bycatch under the alternatives, impacts other fish species, marine mammals, seabirds, and essential fish habitat. This chapter analyses the impacts to these other marine resources.

Note that significance criteria will be developed and incorporated into the impact analysis for the public review draft in order to evaluate the significance of the impacts of the alternative management measures on each of these other marine resource categories.

7.1 Other fish species

Vessels participating in the directed pollock fishery catch other groundfish species incidentally while targeting pollock. Incidental catch levels in the pollock fishery, however, are low. The most common species in the incidental catch is Pacific cod, flathead sole, jellyfish, skates and yellowfin sole (Table 7-1, Table 7-2). Other flatfish and rockfish species, halibut, various shark species, jellyfish, and grenadiers are also incidentally caught in the fishery in lesser amounts.

Table 7-1 Bycatch estimates (t) of non-target species caught in the BSAI directed pollock fishery, 1997-2002 based on observer data, 2003-2010 based on observer data as processed through the catch accounting system (NMFS Regional Office, Juneau, Alaska).

Group	1997	1998	1999	2000	2001	2002
Jellyfish	6,632	6,129	6,176	9,361	3,095	1,530
Squid	1,487	1,210	474	379	1,776	1,708
Skates	348	406	376	598	628	870
Misc Fish	207	134	156	236	156	134
Sculpins	109	188	67	185	199	199
Sleeper shark	105	74	77	104	206	149
Smelts	19.5	30.2	38.7	48.7	72.5	15.3
Grenadiers	19.7	34.9	79.4	33.2	11.6	6.5
Salmon shark	6.6	15.2	24.7	19.5	22.5	27.5
Starfish	6.5	57.7	6.8	6.2	12.8	17.4
Shark	15.6	45.4	10.3	0.1	2.3	2.3
Benthic inverts.	2.5	26.3	7.4	1.7	0.6	2.1
Sponges	0.8	21	2.4	0.2	2.1	0.3
Octopus	1	4.7	0.4	0.8	4.8	8.1
Crabs	1	8.2	0.8	0.5	1.8	1.5
Anemone	2.6	1.8	0.3	5.8	0.1	0.6
Tunicate	0.1	1.5	1.5	0.4	3.7	3.8
Unident. inverts	0.2	2.9	0.1	4.4	0.1	0.2
Echinoderms	0.8	2.6	0.1	0	0.2	0.1
Sea pen/whip	0.1	0.2	0.5	0.9	1.5	2.1
Other	0.8	2.9	1.1	0.8	1.2	3.7

Table 7-1 Bycatch estimates (t) of non-target species caught in the BSAI directed pollock fishery, 1997-2002 based on observer data, 2003-2010 based on observer data as processed through the catch accounting system (NMFS Regional Office, Juneau, Alaska). (Continued)

Group	2003	2004	2005	2006	2007	2008	2009	2010
Jellyfish	5,592	6,495	5,084	2,657	2,156	3,722	3,731	2,174
Skates	462	829	693	1,258	1,182	2,301	1,635	1,076
Squid	952	717	699	893	962	374	119	77
Sharks	191	186	163	506	214	114	92	24
Sculpins	92	141	140	171	161	254	153	157
Eulachon	2	19	9	87	101	2	2	1
Eelpouts	1	1	1	21	119	7	2	0
Sea stars	89	7	10	11	5	7	5	5
Grenadier	20	10	9	9	11	4	1	1
Other osmerids	7	2	3	5	37	2	0	0
Octopus	9	3	1	2	4	3	4	1
Lanternfish	0	0	0	10	6	1	0	0
Sea pens, whips	1	1	2	2	4	1	2	2
Birds	0	0	2	0	1	0	0	0
Capelin	0	0	0	2	1	0	0	0
Other fish	98	88	147	140	198	102	59	134
Other invertebrates	2	2	11	5	6	7	2	2

Table 7-2 Bycatch estimates (t) of other target species caught in the BSAI directed pollock fishery, 1997-2010 based on then NMFS Alaska Regional Office reports from observers (*2010 data are preliminary*).

	Pacific Cod	Flathead Sole	Rock Sole	Yellowfin Sole	Arrowtooth Flounder	Pacific Ocean Perch	Atka Mackerel	Sablefish	Greenland Turbot	Alaska Plaice	All other	Total
1997	8,262	2,350	1,522	606	985	428	83	2	123	1	879	15,241
1998	6,559	2,118	779	1,762	1,762	682	91	2	178	14	805	14,751
1999	3,220	1,885	1,058	350	273	121	161	7	30	3	249	7,357
2000	3,432	2,510	2,688	1,466	979	22	2	12	52	147	306	11,615
2001	3,878	2,199	1,673	594	529	574	41	21	68	14	505	10,098
2002	5,925	1,843	1,885	768	606	544	221	34	70	50	267	12,214
2003	5,968	1,740	1,419	210	618	935	762	48	40	7	67	11,814
2004	6,437	2,105	2,554	841	557	393	1,051	17	18	8	120	14,100
2005	7,413	2,352	1,125	63	651	652	677	11	31	45	125	13,145
2006	7,285	2,861	1,361	256	1,088	737	789	9	65	11	152	14,612
2007	5,627	4,228	510	86	2,794	624	315	12	107	3	188	14,494
2008	6,761	4,209	1,964	405	1,364	336	15	2	82	30	39	15,205
2009	7,876	4,652	7,534	269	2,143	114	25	2	44	176	25	22,861
2010	6,902	4,333	2,220	1,017	1,414	230	55	2	23	109	22	16,326
Average	6,110	2,813	2,021	621	1,126	457	306	13	67	44	268	13,845

The effects of the EBS pollock fishery on fish species that are caught incidentally has most recently been analyzed in the Alaska Groundfish Fisheries Harvest Specifications EIS (NMFS 2007) as well as analyzed in the Chinook Salmon Bycatch Measures EIS (NPFMC/NMFS 2009). The harvest specifications analysis concludes that under the status quo, the neither the level of mortality nor the spatial and temporal impacts of fishing are likely to jeopardize the sustainability of the target and nontarget fish populations while the Chinook EIS concluded that none of the proposed alternative measures, neither hard caps nor area closures (similar to ones examined here) would jeopardize the sustainability of target and nontarget fish populations either.

Alternative 2 would establish a hard cap that limits bycatch of chum salmon in the EBS pollock fishery. A lower hard cap may result in the pollock fishery closing before the TAC is reached, which may reduce impacts of this fishery on incidental catch species. A higher hard cap may allow for pollock fishing at current levels, and impacts would likely be similar to the status quo fishery. Fishing pressure on incidental catch species is unlikely to increase under Alternative 2, therefore the impacts are likely insignificant compared to the status quo.

The Alternative 2 hard caps, to the extent that they prevent the pollock fleet from harvesting the pollock TAC and therefore reduce pollock fishing effort, would reduce the pollock fisheries impacts on forage fish from Alternative 1. Depending on the extent vessels move to avoid salmon bycatch or as pollock catch rates decrease, pollock trawling effort may increase even if the fishery is eventually closed due to a hard cap.

The Alternative 3 trigger closures would close identified areas by month when a specific cap level is reached by fishery or sector. The area closure would reduce the pollock fisheries impacts to ecosystem component species in the closed area, but it would increase the fishing effort and therefore the impacts in the adjoining areas. Since the total amount of pollock harvested and the total effort would not change under Alternative 3, it is reasonable to conclude that the overall impacts on ecosystem component species and incidental catch of other fish species would be similar to Alternative 1. As with Alternative 2, fishing effort may increase as vessels move to avoid salmon bycatch or as pollock catch rates decrease.

Alternative 4 proposes a large-scale fixed or triggered closure as a back-stop mechanism to encourage participation in the RHS program for bycatch reduction. Given that there is 100% participation by the fleet in the current RHS program it is reasonable to assume that under this alternative the incentive to remain in the program would be strong enough to continue to maintain 100% participation. Thus the impacts of this alternative on incidental catch of other fish species would be similar to status quo.

7.2 Marine Mammals

7.2.1 Status of Marine Mammals

The Bering Sea supports one of the richest assemblages of marine mammals in the world. Twenty-five species are present from the orders Pinnipedia (seals, sea lion, and walrus), other Carnivora (sea otter and polar bear), and Cetacea (whales, dolphins, and porpoises). Marine mammals occur in diverse habitats, including deep oceanic waters, the continental slope, the continental shelf (Lowry et al. 1982), sea ice, shores and rocks, and nearshore waters. The PSEIS (NMFS 2004) describes the range, habitat, diet, abundance, and population status for marine mammals.

The most recent marine mammal stock assessment reports (SARs) for strategic BSAI marine mammals stocks (Steller sea lions, northern fur seals, harbor porpoise, North Pacific right whales, humpback whales, sperm whales, fin whales and bowhead whales) were completed in 2008 based on a review of data available through 2006 (Angliss and Outlaw 2008). Northern elephant seals, and marine mammals under U. S. Fish and Wildlife Service (USFWS) jurisdiction (polar bear, walrus, and sea otters), were assessed in 2002 (Angliss and Outlaw 2008). The most recent stock assessment of Pacific walrus was completed in May 2009 (URL: http://alaska.fws.gov/fisheries/mmm/stock/DraftPacificWalrusSAR.pdf). The information from NMFS 2004 and Angliss and Outlaw 2006, 2007, and 2008 and the walrus stock assessment is incorporated by reference to this EIS. The SARs provide population estimates, population trends, and estimates of the potential biological removal (PBR) levels for each stock. The SARs also identify potential causes of mortality and whether the stock is considered a strategic stock under the MMPA. The SARs are available on the Protected Resources Division web site at http://www.nmfs.noaa.gov/pr/sars/region.htm.

The Alaska Groundfish Harvest Specifications EIS provides information on the effects of the groundfish fisheries on marine mammals (NMFS 2007a). Direct and indirect interactions between marine mammals and groundfish fishing vessels may occur due to overlap in the size and species of groundfish harvested in the fisheries that are also important marine mammal prey, and due to temporal and spatial overlap in marine mammal occurrence and commercial fishing activities. This discussion focuses on those marine mammals that may interact or be affected by the pollock pelagic trawl fishery in the Bering Sea. These species are listed in Table 7-3 and Table 7-4. Marine mammals species listed in Table 7-5 and bearded and ringed seals are taken incidentally in the BSAI pollock trawl fishery based on the List of Fisheries (LOF) for 2008 (72 FR 66048, November 27, 2007) and based on information from the National Marine Mammal Laboratory. No changes in species taken by Alaska fisheries are proposed in the LOF for 2009 (73 FR 33760, June 13, 2008).

Table 7-3 Status of Pinniped stocks potentially affected by the Bering Sea pollock fishery

Pinnipedia species and stock	***Status under the ESA***	***Status under the MMPA***	***Population Trends***	***Distribution in action area***
Steller sea lion - Western and Eastern Distinct Population Segment (DPS)	Endangered (W) Threatened (E)	Depleted & a strategic stock	For the western DPS, regional increases in counts in trend sites of some areas have been offset by decreased counts in other areas so that the overall population of the western DPS appears to have stabilized (Fritz et al. 2008). The eastern DPS is steadily increasing and has been recommended to delisting consideration (NMFS 2008).	Western DPS inhabits Alaska waters from Prince William Sound westward to the end of the Aleutian Island chain and into Russian waters. Eastern DPS inhabit waters east of Prince Williams Sound to Dixon Entrance. Occur throughout AK waters, terrestrial haulouts and rookeries on Pribilof Is., Aleutian Is., St. Lawrence Is. And off mainland. Use marine areas for foraging. Critical habitat designated around major rookeries and haulouts and foraging areas.
Northern fur seal – Eastern Pacific	None	Depleted & a strategic stock	Recent pup counts show a continuing decline in the number of pups surviving in the Pribilof Islands. NMFS researchers found an approximately 9% decrease in the number of pups born between 2004 and 2006. The pup estimate decreased most sharply on Saint Paul Island.	Fur seals occur throughout Alaska waters, but their main rookeries are located in the Bering Sea on Bogoslof Island and the Pribilof Islands. Approximately 55% of the worldwide abundance of fur seals is found on the Pribilof Islands (NMFS 2007b). Forages in the pelagic area of the Bering Sea during summer breeding season, but most leave the Bering Sea in the fall to spend winter and spring in the N. Pacific.
Harbor seal – Gulf of Alaska Bering Sea	None	None	Moderate to large population declines have occurred in the Bering Sea and Gulf of Alaska stocks.	GOA stock found primarily in the coastal waters and may cross over into the Bering Sea coastal waters between islands. Bering Sea stock found primarily around the inner continental shelf between Nunivak Island and Bristol Bay and near the Pribilof Islands.
Ringed seal – Alaska	Status under review	None	Reliable data on population trends are unavailable.	Found in the northern Bering Sea from Bristol Bay to north of St. George Island and occupy ice (Figure 7-3).
Bearded seal – Alaska	Status under review	None	Reliable data on population trends are unavailable.	Found in the northern Bering Sea from Bristol Bay to north of St. George Island and inhabit areas of water less than 200 m that are seasonally ice covered (Figure 7-3).
Ribbon seal – Alaska	None	None	Reliable data on population trends are unavailable.	Found throughout the offshore Bering Sea waters (Figure 7-3).
Spotted seal - Alaska	Status under review	None	Reliable data on population trends are unavailable.	Found throughout the Bering Sea waters (Figure 7-3).
Pacific Walrus	Status under review	Strategic	Population trends are unknown. Population size estimated from a 2006 ice survey is 15,164 animals, but this is considered a low estimate. Further analysis is being conducted on the 2006 survey to refine the population estimate.	Occur primarily is shelf waters of the Bering Sea. Primarily males stay in the Bering Sea in the summer. Major haulout sites are in Round Island in Bristol Bay and on Cape Seniavin on the north side of the Alaska Peninsula.

Source: Angliss and Outlaw 2008 and List of Fisheries for 2008 (72 FR 66048).
Northern fur seal pup data available from http://www.fakr.noaa.gov/newsreleases/2007/fursealpups020207.htm.
Pacific Walrus information available from http://alaska.fws.gov/fisheries/mmm/stock/DraftPacificWalrusSAR.pdf.

Table 7-4 Status of Cetacea stocks potentially affected by the Bering Sea pollock fishery. Source: Angliss and Outlaw 2008 and List of Fisheries for 2008 (72 FR 66048). North Pacific right whale included based on NMFS 2006 and Salveson 2008 www.nmfs.noaa.gov/pr/species/mammals/cetaceans/spermwhale.htm

Cetacea species and stock	***Status under the ESA***	***Status under the MMPA***	***Population Trends***	***Distribution in action area***
Killer whale – AT1 Transient; Eastern North Pacific GOA, AI, and BS transient; West Coast transient; and Eastern North Pacific Alaska Resident	None	AT1 Transient – Depleted & a strategic stock	AT1 group has been reduced to at least 50% of its 1984 level of 22 animals, and has likely been reduced to 32% of its 1998 level of 7 animals. Unknown abundance for the eastern North Pacific Alaska resident; West Coast transient; and Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea transient stocks. The min. abundance estimates for the Eastern North Pacific Alaska Resident and West coast transient stocks are likely underestimated because new whales recently found in the Alaskan waters.	Transient-type killer whales from the Aleutian Islands and Bering Sea are considered to be part of a single population that includes Gulf of Alaska transients. Killer whales are seen in the northern Bering Sea and Beaufort Sea, but little is known about these whales.
Dall's porpoise – Alaska	None	None	Reliable data on population trends are unavailable.	Found offshore waters from coastal western Alaska to Bering Sea.
Humpback whale- Western North Pacific Central North Pacific	Endangered	Depleted & a strategic stock	Reliable data on population trends are unavailable for the western North Pacific stock. Central North Pacific stock thought to be increasing. The status of the stocks in relation to optimal sustainable population (OSP) is unknown.	W. Pacific and C. North Pacific stocks occur in Alaskan waters and may mingle in the North Pacific feeding area shown in Figure 7-2. Humpback whales in the Bering Sea identity to western or Central North Pacific stocks, or to a separate, unnamed is stock difficult.
North Pacific right whale Eastern North Pacific	Endangered	Depleted strategic stock	Abundance not known, stock is considered to represent only a small fraction of its pre-commercial whaling abundance.	See Figure 7-4 for distribution and designated critical habitat.
Fin whale – Northeast Pacific	Endangered	Depleted & a strategic stock	Abundance may be increasing but surveys only provide information for portions of the stock in the central-eastern and southeastern Bering and coastal waters of the Aleutian Islands and the Alaska Peninsula, and much of the North Pacific range has not been surveyed.	Found in the Bering Sea and coastal waters of the Aleutian Islands and Alaska Peninsula. Most sightings in the central-eastern Bering Sea occur in a high productivity zone on the shelf break (Figure 7-1).
Minke whale - Alaska	None	None	Considered common but abundance not known and uncertainty exists regarding the stock structure.	Common in the Bering and Chukchi Seas and in the inshore waters of the GOA.
Sperm Whale – North Pacific	Endangered	Depleted & a strategic stock	Abundance and population trends in Alaska waters are unknown.	Inhabit waters 600 m or more depth, south of 62°N lat. Males inhabit Bering Sea in summer.
Gray Whale – Easter North Pacific	None	None	Minimum population estimate is 17,752 animals. Increasing populations in the 1990's but below carrying capacity.	Most spend summers in the shallow waters of the northern Bering Sea and Arctic Ocean. Winters spent along the Pacific coast near Baja California.
Beluga Whale – Bristol Bay, Eastern Bering Sea, Cook Inlet, and eastern Chukchi Sea	None for all stocks except Cook Inlet, which are endangered	None	Abundance estimate is 3,710 animals and trend stable for the eastern Chuckchi Sea stock. Min. population estimate for the eastern Bering Sea stock is 14,898 animals and trend is unknown. The min. population estimate for the Bristol Bay stock is 1,619 animals and trend is stable and may be increasing. For Cook Inlet Belugas, estimated decline of 71 percent in 30 years with 375 animals estimated in 2008.	Summer in the Arctic Ocean and Bering Sea coastal waters, and winter in the Bering Sea in offshore waters associated with pack ice. Cook Inlet belugas remain in Cook Inlet year round, but eat salmon that occur in the Bering Sea and are taken as bycatch.

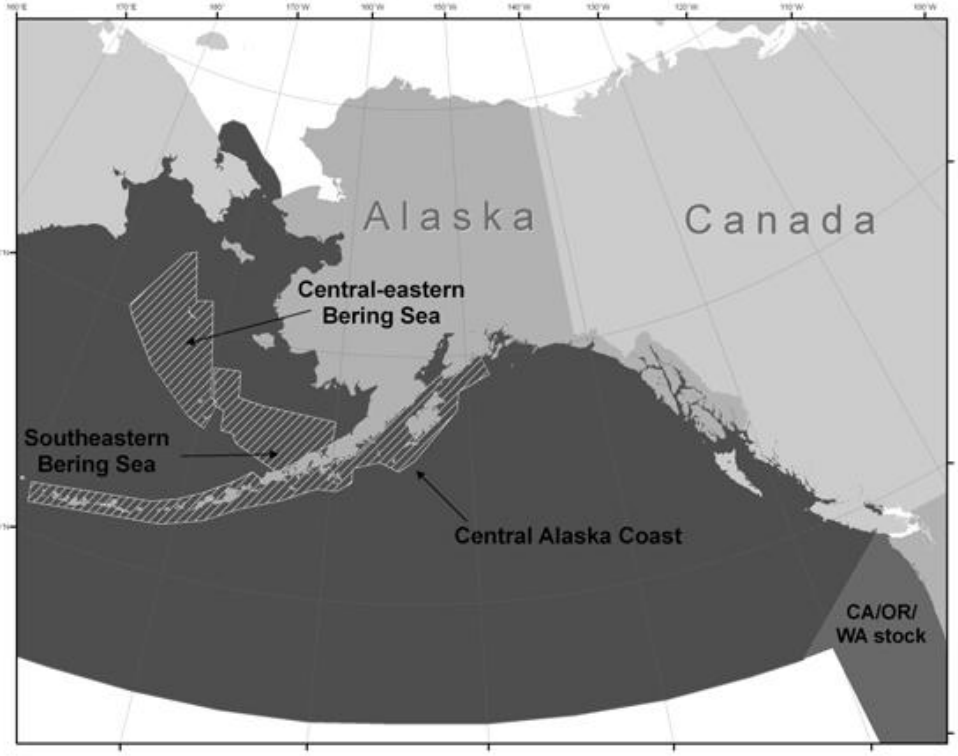


Figure 7-1. Fin whale distribution and survey areas in lined locations (Angliss and Outlaw 2008)

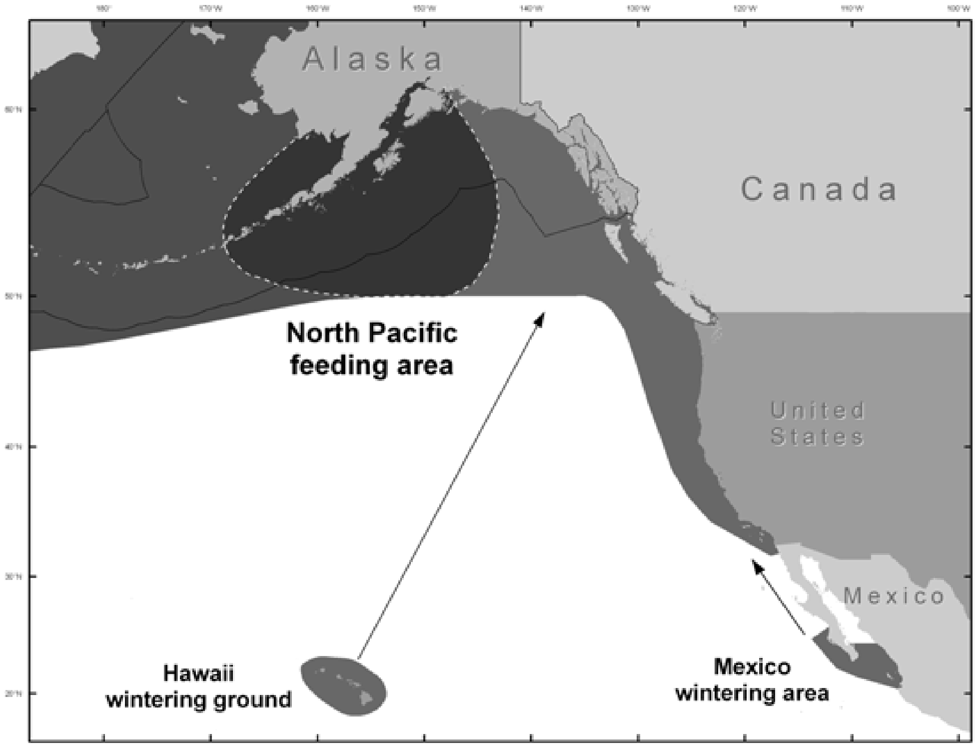


Figure 7-2. Feeding area of humpback whales (Angliss and Outlaw 2008). Shaded area shows overlap of Central and western North Pacific humpback whale stocks.

7.2.2 ESA Consultations for Marine Mammals

For Bering Sea marine mammals, ESA Section 7 consultations have been completed for all ESA-listed marine mammals (NMFS 2000 and NMFS 2001). The Alaska Groundfish Harvest Specifications EIS provides a detailed description of the status of ESA Section 7 consultations through December 2006 (Section 8.2 of NMFS 2007a). This section provides information on Section 7 consultations that have taken place since that document was published.

7.2.2.1 Steller Sea Lions

The Steller sea lion has been listed as threatened under the ESA since 1990. In 1997, the population was split into two stocks or distinct population segments (DPS) based on genetic and demographic dissimilarities Because of a pattern of continued decline, the western DPS was listed as endangered on May 5, 1997 (62 FR 30772), while the eastern DPS remains listed as threatened. NMFS is currently considering delisting the eastern DPS (75 FR 77602, December 13, 2010). The western DPS inhabits an area of Alaska approximately from Prince William Sound westward to the end of the Aleutian Island chain and into Russian waters (west of 144° W longitude).

In 2006, NMFS reinitiated a FMP-level Section 7 consultation on the effects of the groundfish fisheries on Steller sea lions, humpback whales, and sperm whales to consider new information on these species and their interactions with the fisheries (NMFS 2006a). A draft Biological Opinion (BiOp) was released in July 2010 (NMFS 2010a). The draft opinion found that the effects of the groundfish fisheries may be likely to jeopardize the continued existence of Steller sea lions and adversely modify designated critical habitat (JAM). The draft BiOp also found that the groundfish fisheries were not likely to jeopardize the continued existence of humpback or sperm whales. Because the draft BiOp found that the groundfish fisheries may cause JAM for Steller sea lions, a reasonable and prudent alternative (RPA) was included. The final BiOp was released in November 2010, and NMFS implemented the Steller sea lion protection measures in the RPA on January 1, 2011 (NMFS 2010b) by interim final rule (75 FR 77535, December 13, 2010, corrected 75 FR 81921, December 29, 2010). The RPA did not change the Steller sea lion protection measures in the EBS. Incidental take statements for Steller sea lions, humpback whales, fin whales, and sperm whales were completed on February 10, 2011 (Balsiger 2011).

A detailed discussion of Steller sea lion population trends in the WDPS is included in the most recent Biological Opinion (NMFS 2010b) and is summarized here. Based on non-pup counts of Steller sea lions on trend sites throughout the range of the WDPS the overall population trend for the WDPS of Steller sea lions is stable and may be increasing, but the trend is not statistically significant. The number of non-pups counted at trend sites increased by12% between 2000 and 2008. However, counts increased by only 1% between 2004 and 2008 (DeMaster 2009). Population trends differ across the range of the WDPS. Non-pup counts have declined in the Aleutian Islands, with the decline being most severe in the west and becoming less of a decline towards the east (7% decline in Area 543, 1% to 4% decline in Areas 542 and 541; NMFS 2010b). Pup and non-pup counts in the remainder of the WDPS range are either stable or increasing, ranging from 0% to 5% increases in population growth from 2000 to 2008 (NMFS 2010b).

7.2.2.2 Ice Seals

In December 2007, NMFS was petitioned by the Center for Biological Diversity (CBD) to list ribbon seals as endangered or threatened under the ESA (CBD 2007). This petition is based on the dependence of this species on sea ice and the loss of sea ice due to global climate change. The petition presents information on (1) global warming which is resulting in the rapid melt of the seals' sea-ice habitat; (2) high harvest levels allowed by the Russian Federation; (3) current oil and gas development; (4) rising contaminant levels in the Arctic; and (5) bycatch mortality and competition for prey resources from commercial fisheries. NMFS determined that the petition presented substantial information that a listing may be warranted and started a status review of the species to determine whether listing is warranted (73 FR 16617, March 28, 2008). Detailed information on the biology, distribution and potential threats on ribbon seals is contained in CBD 2007.

NMFS determined that the listing is not warranted at this time due to modeling of future sea ice extent and population estimates (73 FR 79822, December 30, 2008). On March 31, 2009, the CBD and Greenpeace filed a 60 day notice of intent to sue NMFS for failing to propose listing ribbon seals under the ESA. The CBD and Greenpeace filed a complaint for declaratory and injunctive relief on September 3, 2009, asking for the 12-month finding to be remanded.

On May 28, 2008, the CBD petitioned NMFS to list ringed, bearded, and spotted seals under the ESA due to threats to the species from (1) global warming, (2) high harvest levels allowed by the Russian Federation, (3) oil and gas exploration and development, (4) rising contaminant levels in the Arctic, and (5) bycatch mortality and competition for prey resources from commercial fisheries (CBD 2008a). NMFS has initiated the status review for ringed, bearded, and spotted seals (73 FR 51615, September 4, 2008). Pursuant to a court settlement, NMFS completed the status review and issued a 12-month finding on October 15, 2009 for the spotted seal (74 FR 53683, October 20, 2009). NMFS determined that the status of the stocks of spotted seals occurring in Alaska indicated that no listing was needed. On December 10, 2010, NMFS completed its status reviews of ringed and bearded seals. The agency proposed listing four subspecies of ringed seals found in the Arctic Basin (including the Bering Sea) and the North Atlantic as threatened, and two distinct population segments (DPS) of bearded seals as threatened under the Endangered Species Act. The populations of bearded seal proposed for listing occur in the Bering Sea and Okhotsk Sea. Listing of ringed or bearded seals would require ESA consultation on federal actions that may adversely affect them or any designated critical habitat.

The National Marine Mammal Laboratory surveyed ice seals during April through June 2007 from the USGC vessel Healy in the Bering Sea. Figure 7-3 shows the abundance and distribution of bearded, ribbon, and spotted seals over the survey area. Satellite tagged ribbon and spotted seals from late spring through July showed that the animals mostly stayed in the Bering Sea south and west of St. Matthews Island with a few animals traveling north through the Bering Strait (Boveng, et. al. 2008).

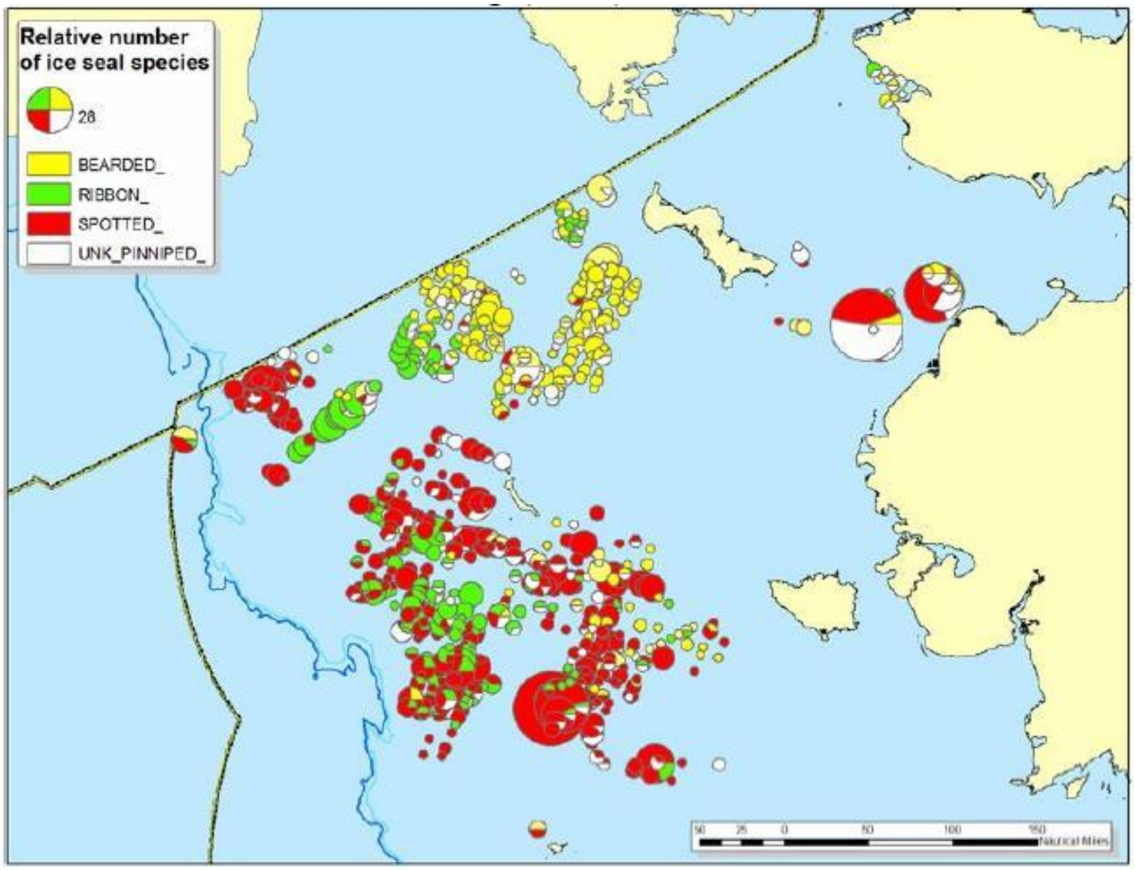


Figure 7-3. Ice seal survey during Healy cruises in summer in Bering Sea 2007 (Cameron and Boveng 2007)

7.2.2.3 North Pacific Right Whale

Due to the recent revision of the species designation for the northern right whale (73 FR 12024, March 6, 2008) and designation of critical habitat (73 FR 19000, April 8, 2008), the NMFS Alaska Region Sustainable Fisheries Division reinitiated ESA section 7 consultation on the effects of the Alaska groundfish fisheries on the North Pacific right whale (*Eubalaena japonica)*, and its designated critical habitat, as required by 50 CFR 402.16 (Salveson 2008). The new species designation is effective April 7, 2008, and the new critical habitat designation is effective May 8, 2008. Groundfish fisheries are conducted in the North Pacific right whale designated critical habitat areas in the Bering Sea and Gulf of Alaska (Figure 7-4). Details of the potential impact analysis for the North Pacific right whale are in the biological assessment (NMFS 2006). The recent species and critical habitat designations are necessary to address the recognition of two northern hemisphere right whale species, the North Atlantic and the North Pacific. These new designations do not change the expected impacts of fisheries on the right whales occurring in the Pacific. The previous finding that Alaska fisheries are not likely to adversely affect the species or designated critical habitat (Brix 2006) is not likely to change for the status quo fishery. The consultation concluded that the Alaska groundfish fisheries were not likely to adversely affect north Pacific right whales or their designated critical habitat.

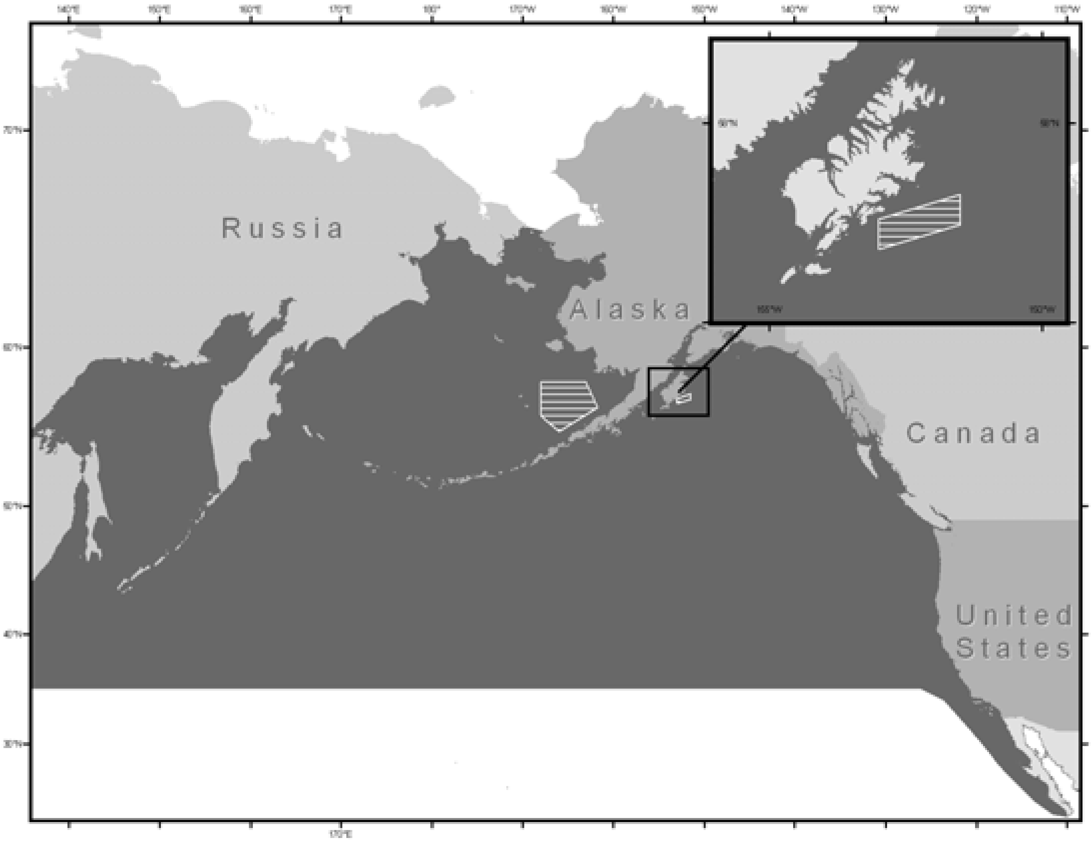


Figure 7-4. North Pacific right whale distribution and critical habitat shown in lined boxes. (Angliss and Outlaw 2008)

7.2.2.4 Pacific Walrus

Management of the Pacific walrus is under the jurisdiction of the USFWS. They occur in the shelf waters of the Bering and Chukchi Sea and some attempts at population estimates range from 200,000 to 246,000 animals (USFWS 2002a). No reliable population estimates or trends are available. In April 2006, federal and state agencies conducted satellite tagging and aerial surveys of walrus in the Bering Sea to develop an abundance estimate (http://alaska.usgs.gov/science/biology/walrus/2006_tagging.html). The shallow productive waters of the Northern Aleutian Basin support some of the largest concentrations of Pacific walruses in the world. Large breeding aggregations form in late winter in the broken pack ice of northern Bristol Bay. Females and dependent young migrate out of the region in spring, following the retreating pack-ice to summer feeding areas in the Chukchi Sea. Thousands of primarily adult male walruses remain in the Bristol Bay region through the ice free season, foraging on rich beds of benthic invertebrates and resting at isolated coastal haulout sites. The most heavily used coastal haulouts in Bristol Bay are located at Round Island (Walrus Islands State Game Sanctuary), Cape Peirce and Cape Newenham (Togiak National Wildlife Refuge), and Cape Seniavin on the Alaska Peninsula. Less consistently used haulout sites are found at Cape Constantine, Amak Island, Big Twin Island, Crooked Island, High Island, and Hagemeister Island. Walruses have also occasionally been observed at isolated beaches near Port Moller, Port Heiden, and Egegik Bay. In summer 1982, adult male walruses were observed using haulouts and foraging areas on the east end of St. Matthew Island (Irons 1983). Hauling out and foraging at St. Matthew Island by adult males has not been observed in the past 15 to 20 years (Dr. Chadwick Jay, personal communication, U.S. Geological Survey, June 10, 2009). Adult males may transit through areas near St. Matthew Island in the fall as they move north towards the females, but the concentration of migration is generally further east (Dr. Chadwick Jay, personal communication, U.S. Geological Survey, June 10, 2009). Females and juveniles may forage near St. Matthew Island in the winter depending on the extent of sea ice and open leads or polynyas.

The number of walruses attending coastal haulout sites in northern Bristol Bay (Round Island, Cape Peirce, and Cape Newenham) has declined in recent years, while the number of animals using haulouts along the Alaska Peninsula (principally at Cape Seniavin) has increased. On February 7, 2008, the Center for Biological Diversity petitioned the USFWS to list Pacific walrus under the ESA because of the impact of global warming in the sea ice habitat (CBD 2008). On December 3, 2008, the CBD filed suit against the USFWS for failing to act on the petition (http://www.biologicaldiversity.org/news/ press releases/2008/pacific-walrus-12-03-2008.html). On May 18, 2009 the USFWS agreed to complete the review of the petition by September 10, 2009, in a settlement with the CBD. On September 8, 2009, the USFWS announced that the CBD petition presents substantial scientific or commercial information indicating that adding Pacific walrus to the federal list of threatened and endangered species may be warranted.

On February 10, 2011, the USFWS released its 12-month finding on a petition to list the Pacific walrus (*Odobenus rosmarus divergens*) as endangered or threatened under the ESA. The USFWS found that listing the Pacific walrus as threatened or endangered is warranted but precluded at this time by higher priority actions under the ESA. Therefore, the agency has added Pacific walrus to the candidate species list. As priorities allow, the USFWS will develop a proposed rule to list the Pacific walrus. Release of the proposed rule would be followed by a public comment period, after which the agency would make a final determination on listing. The USFWS would likely identify critical habitat during development of the proposed rule.

7.2.3 Existing Management Measures to Mitigate Fishing Impacts on Marine Mammals

The most recent action that will provide protection to some marine mammals in the Bering Sea is the approval of the Fishery Management Plan for Fish Resources of the Arctic Management Area. This plan was approved on August 17, 2009 and implementing regulations are scheduled by the end of 2009. This plan initially prohibits commercial fishing in the Arctic Management Area until information is available to support sustainable fisheries management. This action would prevent the potential adverse effects of unregulated commercial fishing activities on marine mammal species. Several of these species occur in both the Arctic Management Area and in the Bering Sea (e. g., bowhead whales, gray whales, walrus, and ice seals).

Throughout the 1990s, particularly after critical habitat was designated, various closures of areas around rookeries, haulouts, and some offshore foraging areas were designated. These closures affect commercial harvests of pollock, Pacific cod, and Atka mackerel, which are important components of the WDPS of Steller sea lion diet. In 2001, a Biological Opinion was released that provided protection measures that would not jeopardize the continued existence of the Steller sea lion or adversely modify its designated critical habitat; that opinion was supplemented in 2003, and after court challenge, these protection measures remain in effect today (NMFS 2001, Appendix A).

In the BS, extensive closures are in place for Steller sea lions including no transit zones and closures of critical habitat around rookeries and haulouts. Pollock is an important prey species for Steller sea lions (NMFS 2010b). The Bering Sea subarea has several pollock fishery closures in place for Steller sea lion protection including no transit zones, closures around rookeries and haulouts, the Bogoslof foraging area closure, and the Steller Sea Lion Conservation Area (Figure 7-5). The proposed action would not change the closures associated with the five Bering Sea Steller sea lion sites located at Sea lion Rock, Bogoslof Island/Fire Island, Adugak Island, Pribilof Islands, and Walrus Islands and with the Bogoslof Foraging Area. The harvest of pollock in the Bering Sea subarea is temporally dispersed (§§ 679.20 and 679.23) and spatially dispersed through area closures (§ 679.22). Based on the most recent completed biological opinion, these harvest restrictions on the pollock fishery decrease the likelihood of disturbance, incidental take, and competition for prey to ensure the groundfish fisheries do not jeopardize the continued existence or adversely modify the designated critical habitat of Steller sea lions (NMFS 2000, NMFS 2001, and NMFS 2010b). A detailed analysis of the effects of these protection measures is provided in the Steller Sea Lion Protection Measures Final Supplemental EIS (NMFS 2001).

Figure 7-5 also shows the other areas closed to pollock fishing. The Nearshore Bristol Bay Trawl Closure prohibits pollock vessels from fishing in Bristol Bay. The Pribilof Island Area Habitat Conservation Zone prevents pollock trawling at all times in the area around the Pribilof Islands. The walrus protection areas around Round Island and The Twins, are closed from April 1 through September 30 to pollock vessels.

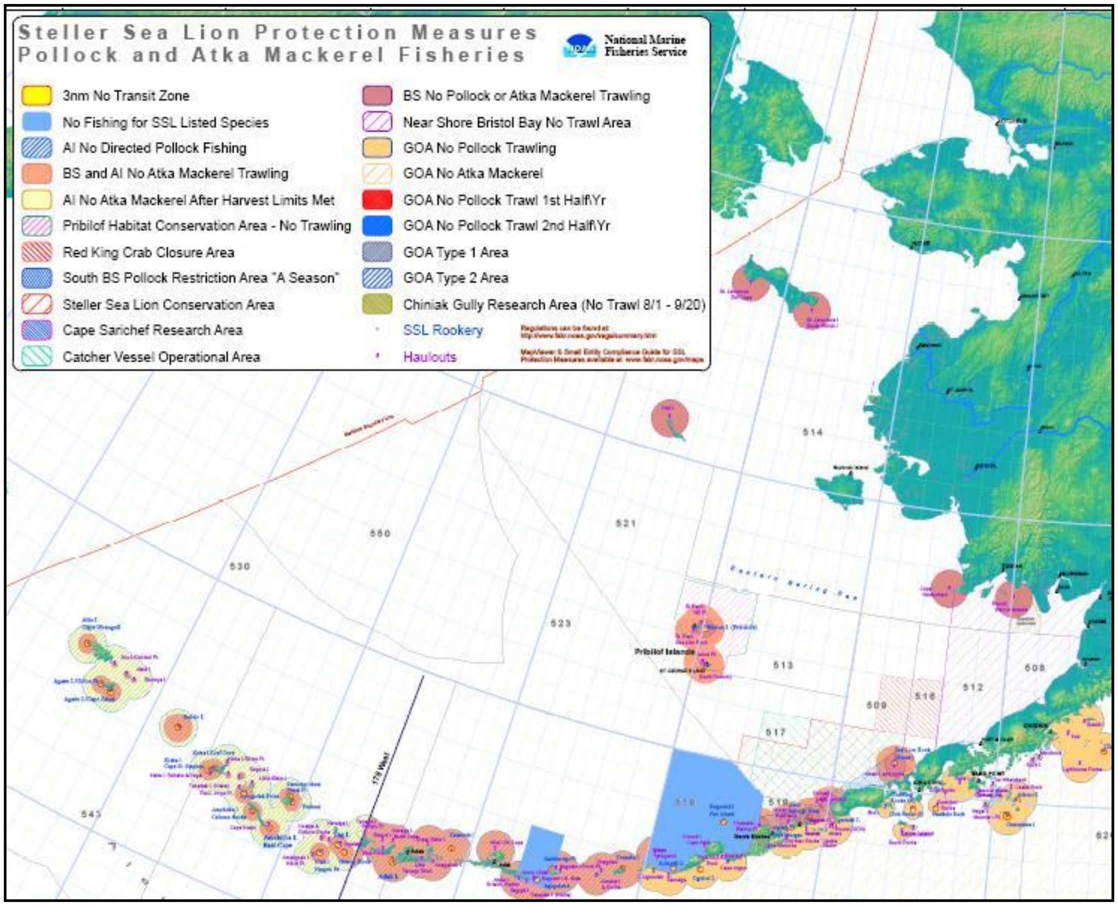


Figure 7-5. Pollock Fishery Restrictions Including Steller Sea Lion Protection Areas of the Bering Sea Subarea. (Details of these closures are available through the NMFS Alaska Region website at http://alaskafisheries.noaa.gov/protectedresources/stellers/maps/Pollock_Atka0105.pdf).

7.2.4 Incidental Take Effects

The Alaska Groundfish Harvest Specifications EIS contains a detailed description of the effects of the groundfish fisheries on marine mammals (Chapter 8 of NMFS 2007a) and is incorporated by reference. Potential take in the groundfish fisheries is well below the potential biological removal (PBR) for all marine mammals which have a PBR determined, except killer whales and humpback whales. This means that predicted take would be below the maximum number of animals that may be removed from these marine mammal stocks while allowing the stocks to reach or maintain their OSP. Table 7-5 lists the species of marine mammals taken in the BSAI pollock fishery as published in the List of Fisheries for 2008. Table 7-5 provides more detail on the levels of take based on the most recent SARs (Angliss and Outlaw 2008, 2007, and 2006). The BSAI pollock fishery is a Category II fishery because it has annual mortality and serious injury of a marine mammal stock greater than 1% and less than 50% of the PBR level (72 FR 66048, November 27, 2007 and 73 FR 33760, June 13, 2008). Overall, very few marine mammals are reported taken in the Bering Sea pollock fishery.

Table 7-5. Category II BSAI Pollock Fishery with documented marine mammal takes from the List of Fisheries for 2008 (72 FR 66048, November 27, 2007)

Fishery	**Marine Mammal Stocks Taken**
Category II	
BSAI pollock trawl	Dall's porpoise, AK Harbor seal, Bering Sea Killer whale, Eastern North Pacific, GOA, Aleutian Islands, and Bering Sea transient Steller sea lions, western U. S Humpback whale, Central and western N. Pacific Minke whale, AK Ribbon seal, AK Spotted seal, AK

Based on the most recent information, the potential incidental take of marine mammals is limited to the species taken by the BSAI pollock trawl fishery listed in Table 7-5, plus bearded and ringed seals. Bearded seals have experienced recent incidental take (NMML, James Thomason, pers. comm., April 28, 2008). Northern fur seals, spotted seals, harbor seals, resident killer whales, humpback whales, and fin whales have not been reported taken in the BSAI pollock trawl fishery between 2000 and 2004; and therefore, these species have zero mortality as show in Table 7-6. Perez unpublished report documents bearded seal and a fin whale take in 2006. Perez (2007) reports takes of bearded seal in 1999. Table 7-5 is based on the List of Fisheries for 2008, which is based on all previously reported injury or mortality. Table 7-6 is based on the 2007 stock assessment reports (SARs), which use the previous 5 years of reported serious injury or mortality. Due to an error, ringed seals should be listed in the List of Fisheries for 2008 and will be added in the next version (Robyn Angliss, National Marine Mammal Laboratory, personal communication 4/28/08). Because the List of Fisheries includes all reported listings of injury, several species appear on the 2008 List of Fisheries as taken in the pollock fishery even though the recent SARs show these species are not reported taken in the pollock fishery. These species include humpback whales, harbor seals, Eastern North Pacific Alaska resident killer whales, and spotted seal. Bearded seals and a fin whale were taken in the pollock fishery in 2006, and this information has not yet been added to the List of Fisheries or the SAR report for this species (Table 7-7).

Table 7-6. Estimated mean annual mortality of marine mammals from observed BSAI pollock fishery compared to the total mean annual human-caused mortality and potential biological removal. Mean annual mortality is expressed in number of animals and includes both incidental takes and entanglements. The averages are from the most recent 5 years of data since the last SAR update, which may vary by stock. Groundfish fisheries mortality calculated based on Angliss and Outlaw (2008).

Marine Mammal Species and Stock	5 years of data used to calculate total mean annual human-caused mortality	Mean annual mortality, from BSAI pollock fishery	Total mean annual human-caused mortality*	Potential Biological Removal (PBR)
**Steller sea lions (western)	2001-2005	2.58	215.6	234
Northern fur seal	2001-2005	0.21	704	15,262
Harbor seal (BS)	2000-2004	0	176.2	603
Harbor seal (AI)	2000-2004	0	820	1334
Spotted seal	2000-2004	0	5,265	Undetermined
Ringed seal	2000-2004	0.71	9,568	Undetermined
Ribbon seal	2000-2004	0.2	194	Undetermined
Killer whale Eastern North Pacific AK resident	2000-2004	0	1.5	11.2
Killer whale, Eastern North Pacific Northern resident	2000-2004	0	0	2.16
Killer whale, GOA, BSAI transient	2000-2004	0.41	0.4	3.1
Dall's porpoise	2000-2004	1.89	30	Undetermined
**Humpback whale, Western North Pacific	2001-2005	0	0.2	1.3
**Humpback whale, Central North Pacific	2001-2005	0	5.0	12.9
Minke whale, Alaska	2000-2004	0.3	0.3	Undetermined
**Fin whale, Northeast Pacific	2001-2005	0	0	11.4
Pacific walrus	2002-2006	2.66	4,963-5,460	

* Does not include research mortality. Other human-caused mortality is predominantly subsistence harvests for seals and sea lions.

** ESA-listed stock

Table 7-7 shows the months and locations when incidental takes of marine mammals occurred in 2003, 2004, 2005, and 2006. It is not possible to determine any seasonality to the incidental takes of killer whales, fur seals, or fin whales since only one occurrence for each is reported during this time period. It appears that Dall's porpoise may be more likely taken in July and bearded seals may be more likely taken in September and October. Steller sea lions appear to be taken in the A and B pollock fishing seasons, mostly in January through March and in September. Based on the very limited data in Table 7-7, bearded seals were primarily taken in the northern portion of the eastern Bering Sea. Killer whale, Dall's porpoise, and fin whale appear to be taken in the area along the shelf break. Steller sea lions appear to be taken primarily in the southern portion of the eastern Bering Sea and northwest of the Pribilof Islands.

Table 7-7. Marine Mammals taken in the pollock fishery in 2003, 2004, 2005, and 2006. Locations correspond to the areas depicted in Figure 7-5 (Sources: National Marine Mammal Laboratory 4-28-08 and the North Pacific Groundfish Observer Program 10-31-08)

SPECIES	DATE	LOCATION
Killer whale	20-Mar-03	Area 521
Dall’s porpoise	20-Jul-04	Area 521
Steller sea lion	15-Jul-04	Area 513
Steller sea lion	3-Feb-05	Area 509
Steller sea lion	3-Mar-05	Area 521
Steller sea lion	5-Mar-05	Area 521
Steller sea lion	5-Sep-05	Area 521
Northern fur seal	29-Jun-05	Area 521
Steller sea lion	27-Jan-06	Area 509
Steller sea lion	30-Jan-06	Area 509
Steller sea lion	5-Feb-06	Area 509
Steller sea lion	6-Mar-06	Area 509
Steller sea lion	15-Sep-06	Area 521
Steller sea lion	18-Sep-06	Area 509
Bearded seal	6-Sep-06	Area 524
Bearded seal	18-Oct-06	Area 524
Fin whale	16-Aug-06	Area 521
Dall’s porpoise	26-Jul-06	Area 517

7.2.4.1 Alternative 1: Status Quo

The effects of the status quo fisheries on the incidental takes of marine mammals are detailed in the 2007 harvest specifications EIS (NMFS 2007a) and the Chinook Salmon Bycatch Management Measures EIS (NPFMC/NMFS 2009). Except for minke whales, the potential take of marine mammals in the pollock fishery is well below the PBRs or a very small portion of the overall human caused mortality for those species without a PBR determination (Table 7-6). A PBR for bearded seals is not available, but human caused mortality through hunting is estimated at 6,788 animals per year (Angliss and Outlaw 2007). The take of minke whales appears to be a very rare event considering no takes are reported for the pollock fishery in Table 7-7. Because of the broad distribution and common occurrence of minke whales in the Bering Sea, it is not likely that the potential incidental take by pollock fishery would have an impact on this stock.

7.2.4.2 Alternative 2: Hard Cap

Imposing hard caps on the pollock fishery and the impact this could have on fishing pressures was also examined in the Chinook Bycatch Management Measures EIS (NPFMC/NMFS 2009). The range of hard caps under Alternative 2 may result in different potentials for incidental takes of marine mammals. The lower hard caps may result in stopping the pollock fishery in the Bering Sea earlier which would reduce the potential for incidental takes in fishing areas where marine mammals may interact with pollock fishing vessels.

The options for sector allocations and transfers, and cooperative provisions affect the management and distribution of the cap across the sectors. These options are not likely to have any effect on pollock fishing in a manner that would change the potential for incidental takes of marine mammals since the overall quantity of pollock fishing and potential for interaction with marine mammals is not changed by the allocations, transfers, and cooperative provisions.

7.2.4.3 Alternative 3: Triggered Closures

A closure of an area where marine mammals are likely to interact with pollock fishing vessels would likely reduce the potential for incidental takes. The potential reduction would depend on the location and marine mammal species. A number of marine mammal species have been taken in northern waters of the Bering Sea (Table 7-7). Fishing under any of the alternatives and options would require vessels to comply with Steller sea lion protection measures and the Pribilof Island Area Habitat Conservation Zone, reducing the potential for interaction with Steller sea lions and northern fur seals in these areas. A large portion of the closures are located in the southern part of the Bering Sea where Steller sea lions are more likely to be encountered. These closures for salmon also may reduce the potential for incidental takes of Steller sea lions in the closure locations.

7.2.4.4 Alternative 4

Alternative 4 proposes a large-scale fixed or triggered closure as a back-stop mechanism to encourage participation in the RHS program for bycatch reduction. Given that there is 100% participation by the fleet in the current RHS program it is reasonable to assume that under this alternative the incentive to remain in the program would be strong enough to continue to maintain 100% participation. Thus the impacts of this alternative on incidental catch of marine mammals would be similar to status quo.

7.2.5 Prey Species Effects

Table 7-8 shows the Bering Sea marine mammals that may be impacted by the pollock fishery and their prey species. Pollock and salmon prey are in **bold**.

Table 7-8 Bering Sea Marine Mammal Prey

Species	Prey
Fin whale	Zooplankton, squid, fish (herring, cod, capelin, and **pollock**), and cephalopods
Humpback whale	Zooplankton, schooling fish (**pollock**, herring, capelin, saffron cod, sand lance, Arctic cod, and **salmon** species)
Gray whale	Benthic invertebrates
Sperm whale	Mostly squid, some fish, shrimp, sharks, skates, and crab (up to 1,000 m depth)
Minke whale	Pelagic schooling fish (herring and **pollock**)
Beluga whale	Wide variety invertebrates and fish including **salmon and pollock**
Killer whale	(transient) Marine mammals and (resident) fish (including herring, halibut, **salmon,** and cod)
Dall's porpoise	hake, squid, lanternfish, anchovy, sardines, and small schooling fish.
Pacific walrus	Benthic invertebrates (primarily mollusks), occasionally seals and birds
Bearded seal	Primarily crab, shrimp, and mollusks; some fish (Arctic cod, saffron cod, sculpin, and **pollock**)
Spotted seal	Primarily pelagic and nearshore fish (**pollock and salmon**), occasionally cephalopods and crustaceans
Ringed seal	Primarily Arctic cod, saffron cod, herring and smelt in fall in winter and fish and fish and crustaceans in summer and spring
Ribbon seal	Arctic and saffron cods, **pollock**, capelin, eelpouts, sculpin and flatfish, crustaceans and cephalopods
Northern fur seal	**Pollock**, squid, and bathylagid fish (northern smoothtongue*)*, herring, **salmon,** and capelin. (Females at Bogoslof eat primarily squid and bathylagid fish and less pollock than in the Pribilofs, and salmon irregularly.)
Harbor seal	crustaceans, squid, fish, and mollusks
Steller sea lion	**pollock**, Atka mackerel, Pacific herring, Capelin, Pacific sand lance, Pacific cod, and **salmon**

Sources: NOAA 1988; NMFS 2004; NMFS 2007b; Nemoto 1959; Tomilin 1957; Lowry et al. 1980; Kawamura 1980; http://www.afsc.noaa.gov/nmml/education/cetaceans/sperm.php; Rolf Ream, NMML personal communication, September 26, 2008; and http://www.adfg.state.ak.us/pubs/notebook/marine/orca.php

Nine of the 16 species listed in Table 7-8 are documented to eat pollock, and six of the marine mammals listed eat salmon. Salmon is primarily a summer prey species for Steller sea lions (NMFS 2001), resident killer whales (NMFS 2004), spotted seals (CBD 2008a), beluga whales (NMFS 2008), and northern fur seals (NMFS 2007b). Steller sea lions, ribbon seals, and northern fur seals depend on pollock as a principal prey species (NMFS 2007a, 2007b and http://www.adfg.state.ak.us/pubs/notebook/marine/rib-seal.php). Spotted seals eat pollock mainly in the winter and spring, and eat salmon in the summer (CBD 2008).

Several marine mammals do not primarily depend on pollock or salmon but may be impacted indirectly by any effects that the pelagic trawl gear may have on the benthic habitat where marine mammals are dependent on benthic prey. These species include gray, beluga, and sperm whales; bearded, spotted, ringed, ribbon, and harbor seals; and walrus. Whether the benthic prey dependent species are indirectly affected by pollock fishing will depend on the effects of the pollock fishing on the benthos and whether the marine mammal forages on benthic species in the impacted area and their dependence on the benthic prey. The EFH EIS provides a description of the effects of pollock fishing on bottom habitat in the Appendix (NMFS 2005a), including the effects of the pollock fishery on the Bering Sea slope and shelf. Pollock trawl gear is known to contact the bottom and may impact benthic habitat. The fisheries effects analysis in the EFH EIS determined that the long term effects indices for pollock fishing on sand/mud and slope biostructure in the Bering Sea were much larger than the effects from other fisheries conducted in the Bering Sea, especially on the slope (Table 8.2-10 in NMFS 2005a)

Table 7-10 shows the marine mammals that may depend on benthic prey and the known depths of diving and Bering Sea locations. Most pollock fishing is conducted in waters greater than 50 m and less than 200 m (Figure 4-2). Diving activity may be associated with foraging.

Table 7-9. Listing of Benthic Dependent Marine Mammals and Location and Diving Depths in the Bering Sea

Species	Depth of Diving and location
Bearded seal	Occur in waters < 200 m, at least 20 nm from shore during spring and summer (Figure 7-4)
Ringed seal	Usually shallow but can dive up to 500 m. Throughout pack ice.
Ribbon seal	Mostly dive < 150 m on shelf, deeper off shore. Shelf and slope areas
Spotted seal	Up to 300 m. Coastal habitats in summer and fall and ice edge in winter
Harbor seal	Up to 183 m. Generally coastal
Pacific walrus	Usually in waters < 100 m. Shelf area, concentrated SW of St. Lawrence Island and in Nunivak Island/Bristol Bay area
Gray whale	< 60 m waters, coastal and shelf area.
Beluga whale	6-30 m, shelf area and nearshore estuaries and river mouths
Sperm whale	Up to 1,000 m, but generally in waters > 600 m

Sources: http://www.adfg.state.ak.us/pubs/notebook/marine/harseal.php, http://www.afsc.noaa.gov/nmml/species/species_ribbon.php, http://www.adfg.state.ak.us/pubs/notebook/marine/rib-seal.php, Burns et al. 1981, Angliss and Outlaw 2008, Angliss and Outlaw 2007, http://www.adfg.state.ak.us/pubs/notebook/marine/gray.php, http://alaska.fws.gov/fisheries/mmm/walrus/nhistory.htm, and http://www.adfg.state.ak.us/pubs/notebook/marine/beluga.php

Sperm whales are not likely to be affected by any potential impacts on benthic habitat from pollock fishing because they generally occur in deeper waters than where the pollock fishery is conducted (Figure 7-6). Harbor seals also are less likely to have any benthic habitat affected by the pollock fishery because they occur primarily along the coast where pollock fishing is not conducted. Pacific walrus are unlikely to have benthic habitat affected by the pollock fishery because they occur in shelf waters to the west of slope and out of the area where pollock fishing occurs. Beluga whales generally dive shallower than the locations where pollock fishing occurs. The pollock fishery in the SE Bering Sea occurs in an area between 100 m and 50 m deep which may overlap with a portion of the gray whale feeding area. Gray whales feed primarily in the northern and western area of the Bering and Chukchi Seas in the summer toward St. Lawrence Island after traveling along the coast past Nunivak Island (http://www.adfg.state.ak.us/pubs/notebook/marine/gray.php). Pollock fishing is not likely to have an impact on gray whales considering the extensive area of the Bering Sea under 60 m depth that is not fished for pollock and the areas of pollock fishing compared to the areas of gray whale migration and feeding.

Ice seals are most likely of the marine mammals listed in Table 7-9 to potentially have benthic prey affected by the pollock fishery because of their overlap with the location and depth of the pollock fishery. Ice seals use ice in areas of the Bering Sea where fishing is conducted during ice free conditions. Bearded seals have been incidentally taken in area 524 by the pollock fishery (Table 7-7) and may use benthic habitat for feeding in locations where pollock fishing has occurred. Ribbon and spotted seals are probably less likely to be affected by any benthic prey disturbance compared to the other ice seals due to pollock being their primary prey.

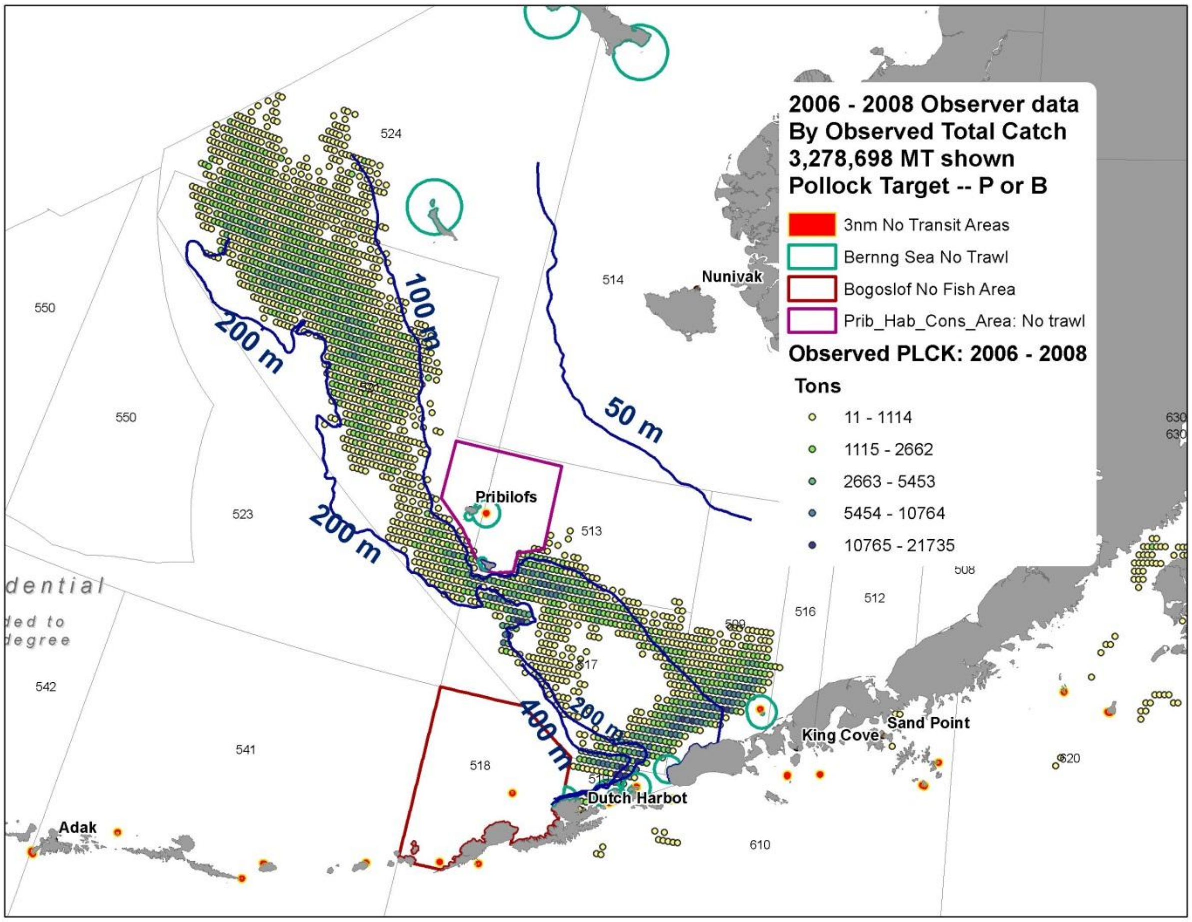


Figure 7-6. 2006-2008 Observed pollock harvest and bathymetry of the Bering Sea (Steve Lewis, NMFS Analytical Team, October 5, 2008)

The Alaska Groundfish Harvest Specifications EIS determined that competition for key prey species under the status quo fishery is not likely to constrain foraging success of marine mammal species or cause population declines (NMFS 2007a). The exceptions to this are northern fur seals and Steller sea lions which potentially compete for principal prey with the groundfish fisheries (NMFS 2001, 2007b). The introduction to this section reviewed the marine mammal species prey and the potential impacts of the pollock fishery on benthic habitat that supports marine mammal prey. Ice seals were the only species that may depend on benthic habitat for prey that could be potentially impacted by the pollock fishery. The following provides additional information regarding Steller sea lions and northern fur seals potential competitions with the pollock fishery.

7.2.5.1 Alternative 1: Status Quo

7.2.5.1.1 Northern Fur Seals

The Northern Fur Seal Conservation Plan recommends gathering information on the effects of the fisheries on fur seal prey, including measuring and modeling effects of fishing on prey (both commercial and noncommercial) composition, distribution, abundance, and schooling behavior, and evaluate existing fisheries closures and protected areas (NMFS 2007b). The Alaska Groundfish Harvest Specifications EIS analyzed the effects of the groundfish fisheries on fur seal prey (Section 8.3.2 of NMFS 2007a). The EIS for the annual subsistence harvest of fur seals determined that the groundfish fisheries in combination with the subsistence harvest may have a conditional cumulative effect on prey availability if the fisheries were to become further concentrated spatially or temporally in fur seal habitat, especially during June through August (NMFS 2005b).

Migration of fur seals is described in detail in the Conservation Plan for the Eastern Pacific stock of Northern Fur Seal (NMFS 2007b). Northern fur seals begin to return to the breeding islands from their pelagic winter foraging in the spring of each year. Adult males arrive first and establish territories on the breeding rookeries. On the Pribilof Islands they arrive in descending order by age, beginning in early May. The youngest males may not return to the breeding areas until mid-August or later. Some yearlings arrive as late as September or October; however, most remain at sea. The older pregnant females arrive about mid-June; the peak of pupping occurs in early July. Pups leave the islands in early November after the older animals have left. Fur seals migrate during early winter through the Eastern Aleutian Islands into the North Pacific Ocean then into the waters off the coasts of British Columbia, Washington, Oregon, and California.

Based on scat sampling of female fur seals in July through September, the hydrographic domains for salmon prey include inner, middle, and outer shelves; and the oceanic domain (Zeppelin and Ream 2006 and Figure 7-7). Female fur seal foraging locations are dependent on the rookery location for animals using St. George and St. Paul Island rookeries (Zeppelin and Ream 2006). Fur seals from St. George appear to be more dependent on salmon than fur seals from St. Paul. Frequency of occurrence of salmon in scat samples from St. George is 10 to 19% of the samples, while salmon occurs in 3% to 12% of the samples from St. Paul, with only 2 of the 11 rookeries sampled having more than 10% frequency of occurrence (Zeppelin and Ream 2006). Because of this site specific salmon foraging behavior, any harvest of salmon by the pollock fishery that may compete with female fur seals is likely to have more of an impact on fur seals using St. George Island rookeries compared to fur seals using St. Paul Island. Competition with the pollock fishery is less likely for females using the Bogoslof Island rookery as these animals eat primarily squid and northern smooth tongue and are less likely to take foraging trips outside of the Bogoslof Foraging Area closure for the pollock fishery (Rolf Ream, NMML, pers. comm., September 26, 2008).

For northern fur seals, pollock is particularly important around the Pribilof Islands and other inshore areas from July to September and is their principal prey species based on scat and spew analyses (NMFS 2007b; Gudmundson et al. 2006; Zeppelin and Ream 2006). Adult pollock were most frequently found in the stomachs of fur seals collected over the outer domain of the continental shelf, while juvenile pollock were found in seals collected both over the midshelf and outer domain (NMFS 2005b) (Figure 7-7). Based on female fur seal scat samples from St. George and St. Paul Islands, pollock prey for fur seals from July through September come from the hydrographic domains of the middle and outer shelf regions (Zeppelin and Ream 2006). Pollock occurred in 64% to 84% of the fur seal scat samples from St. Paul Island, and in 43% to 70% of the samples from St. George Island (Zeppelin and Ream 2006). In the summer of 1999 and 2000, spew samples from St. George showed a frequency of occurrence for pollock in 36.8% of the samples compared to 60% occurrence in the scat samples (Gudmundson et al. 2006). No difference was seen for the frequencies of occurrence for pollock in scat and spew samples from St. Paul Island which were both around 70%.

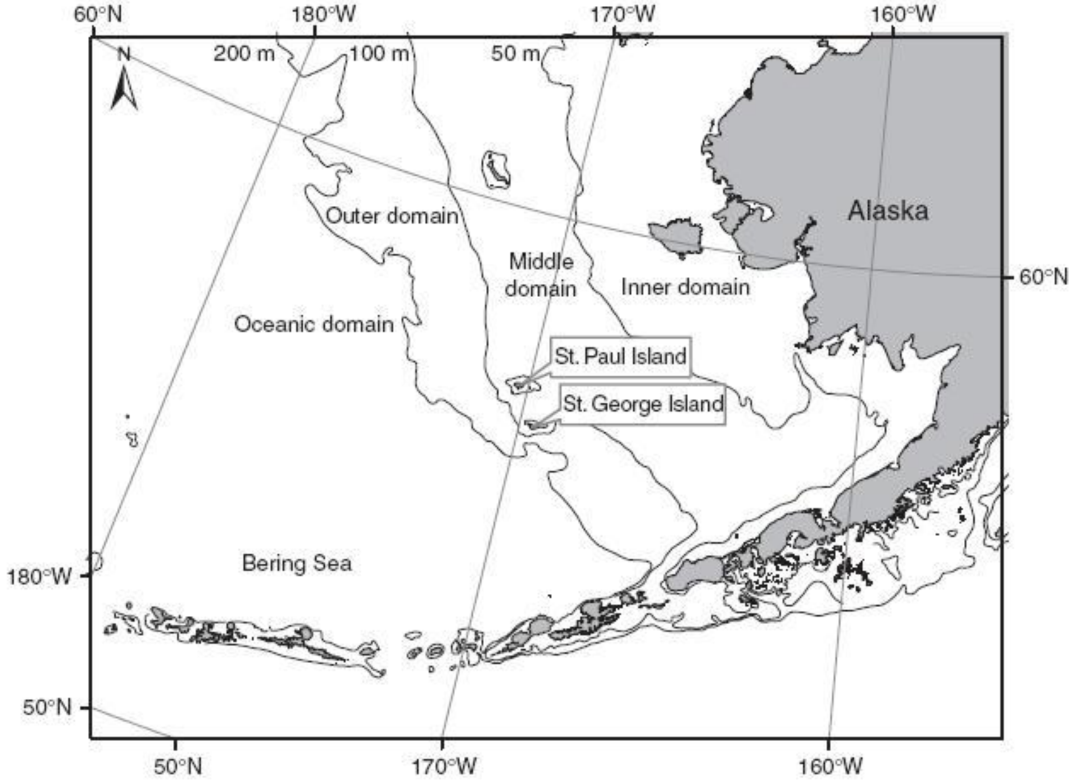


Figure 7-7. Bering Sea Hydrographic Domains. Represents the Bering Sea areas where fur seal prey may occur (Zeppelin and Ream 2006)

Fur seal use of pelagic habitat across years or seasons is not clearly understood, but is beginning to be investigated (NMFS 2007b). The subpolar continental shelf and shelf break from the Bering Sea to California are known feeding grounds for fur seals while at sea. It has been suggested that the highest fur seal densities in the open ocean occur in association with major oceanographic frontal features such as sea mounts, valleys, canyons, and along the continental shelf break (Lander and Kajimura 1982; Kajimura 1984; Loughlin et al. 1999). This area overlaps with the location of the pollock fishery (Figure 7-7).

7.2.5.1.2 Steller sea lions

Analysis of diet data for Steller sea lions in the Bering Sea includes scats collected at haulouts and rookeries along the eastern portion of the Aleutian Island chain and Bogoslof/Fire Island. Pollock appear to be a major component of the Steller sea lion diet for animals using Bogoslof/Fire Island and the Akutan sites, present in 54% of the samples collected in the summer and 59% winter samples (Sinclair and Zeppelin 2002). Based on diet analysis, Steller sea lions at Akutan sites appear to depend on pollock more in the winter than the summer (Figure 3 in Trites et al. 2007). No Steller sea lion diet analysis is available from haulouts in the northern Bering Sea. Pollock occurred in more than 36% of the stomach samples taken from Steller sea lion on the Pribilof Islands in the 1980s (NMFS 2008). Pollock occurred in 100% of the samples from Steller sea lions taken at sea in the winter of 1981 in an area between the Pribilof and St. Matthew Islands (Caulkins 1998).

Sea lions eat salmon primarily in May where salmon congregate for migration (Lowell Fritz, National Marine Mammals Laboratory, pers. comm. February 14, 2008). Diet analysis from the Akutan area indicated that Steller sea lions may be more dependent on salmon in the summer than in the winter (Figure 3 in Trites et al. 2007). Scat and spew samples of fur seals collected between July and September on St. George and St. Paul Islands show salmon as part of the diet (Gudmundson et al. 2006; and Zeppelin and Ream 2006). Spew samples show a greater frequency of occurrence of salmon than scat samples for both islands (Gudmundson et al. 2006) so the use of scat samples for salmon occurrence in fur seals may underestimate the importance of salmon for prey.

7.2.5.1.3 Other direct impacts on marine mammal prey

Killer whales eat salmon that are migrating to spawning streams in nearshore waters (NMFS 2004). The impact of the pollock fishery on prey for resident killer whales would be only in the interception of salmon that would have been eaten by killer whales.

Spotted seals forage on pelagic fish and nearshore species, including pollock and salmon. Sampling of spotted seals in the Bering Sea coastal area in September through October showed salmon in the diet (Lowry et al. 2000). Juvenile pollock are important prey species for ribbon seals. Pollock occurred in approximately 80% of the scat samples collected from ribbon seals in 2006 and 2007 (Ziel et al. 2008). Juvenile pollock are also important prey species for spotted seals. Pollock occurred in approximately 40% of the scat samples collected from spotted seals in 2006 and 2007 (Ziel et al. 2008).

Of the ice seals, ribbon seals appear to be more dependent on pollock and may be directly impacted by pollock harvests in locations where ribbon seals may forage during summer months. Bearded seals feed primarily on benthic invertebrates (Lowry et al. 1980a) and schooling fish and invertebrates in the vicinity of St. Matthew Island (Antonelis et al. 1994). Ringed seals eat primarily Arctic and saffron cod and epibenthic and pelagic crustaceans (Lowry et al. 1980b).

Beluga whales are not likely to compete with the pollock fishery for pollock because their occurrence does not overlap with pollock fishery locations (Figure 7-7 and Table 7-9).

Minke, fin, and humpback whales potentially compete with the pollock fishery for pollock because of the overlap of their occurrence with the location of the pollock fishery in the Bering Sea. Fin and humpback whales have a more diverse diet than minke whales and therefore may have less potential to be affected by any competition (Table 7-8). An area of overlap for feeding humpback whale stocks occurs in the southeastern Bering Sea where the pollock fishery occurs (Figure 4-2). The area of distribution and surveys for fin whales is in the same slope area as the pollock fishery (Figure 4-3).

7.2.5.2 Alternative 2: Hard Caps

A hard cap on the amount of salmon taken in the pollock fishery could benefit Steller sea lions, resident killer whales, spotted seals, ribbon seals, and northern fur seals if the cap prevents harvest of salmon and pollock that these species prey upon. If the hard cap results in additional fishing effort in less productive pollock areas with less salmon bycatch, the shifting of the fleet may allow for additional pollock being available as prey in those areas where salmon is concentrated, if these areas are also used by Steller sea lions, spotted seals, ribbon seals, and northern fur seals for foraging. The higher hard cap would be less constraining on the fishery and would likely result in effects on prey availability similar to the status quo. Lower hard caps would be more constraining on the fishery, making more salmon available for prey for Steller sea lions, northern fur seals, spotted seals, and resident killer whales, and may allow for more pollock prey if the fishery is closed before reaching its pollock TAC.

The more restrictive caps may result in smaller pollock being taken by the pollock fishery, as described in Chapter 4. It is not clear how much smaller the pollock would be. Since 2003, the pollock fishery tends to harvest pollock that are less than 60 cm and greater than 30 cm in the Bering Sea (NPFMC 2007). Steller sea lions and northern fur seals tend to prey on whatever size of pollock is most abundant at the time of foraging (Fritz et al. 1995). In years with one or more large recently spawned year classes, Steller sea lions and fur seals consume primarily juvenile pollock (Pitcher 1981, Calkins 1998, Zeppelin et al. 2004, and Sinclair et al. 1994). As large year classes of pollock age and grow, they will continue to be targeted by sea lions and fur seals particularly if the size of subsequent year classes is small. As a consequence, overlap between fisheries (that generally take large pollock) and pinnipeds in the size of pollock consumed will change depending on the age structure of pollock. Juvenile Steller sea lions are more likely to successfully forage on smaller rather than larger pollock. Taking smaller pollock may increase the potential for the fishery to compete with juvenile Steller sea lions for pollock, and may increase the estimated overlap between the fishery and juvenile Steller sea lions for pollock prey size. Whether competition would occur depends on the abundance of the size of prey targeted by the sea lions. Steller sea lions tend to prey more on juvenile pollock in the summer on haulouts than in the winter or in the summer on rookeries (Zeppelin et al. 2004). For the year of data analyzed, the overlap between the size of pollock taken in the fishery and those used as prey by Steller sea lions in the winter and summer is 56% and 61%, respectively (Zeppelin et al. 2004). Harvesting smaller pollock in the early B season may have more of a potential for competition for juvenile Steller sea lions using haulouts in the summer compared to animals at rookeries and in the winter.

All pollock recovered from the scat sampling for spotted and ribbon seals in 2006 and 2007 were well below 20 cm in length (range 5-22.7 cm) (Ziel et al. 2008). It is not clear if this size of pollock was eaten because it was the size that could easily be captured or it was the most abundant size available for foraging. It is not likely the shifting of the pollock fishery to smaller fish would result in fish less than 20 cm in length being taken and therefore, competition with ribbon and spotted seals is not likely if they are targeting these smaller fish, regardless of abundance.

The options for sector allocations, sector transfers, and cooperative provisions affect the management and distribution of the cap across the sectors and are not likely to have any overall effect on pollock fishing that would change the potential competition for prey species between the pollock fishery and marine mammals. Options that allocate more chum salmon bycatch to the CV sector compared to the offshore sector would result in more harvest of pollock in the southern part of the Bering Sea where more Steller sea lions are located compared to the northern Bering Sea where northern fur seals and spotted seals may be foraging. This may result in more potential for competition for salmon and pollock prey for Steller sea lions than for northern fur seals or spotted seals. The Steller sea lion protection measures were designed to mitigate competition between the fisheries and Steller sea lions. This may reduce any potential for increased competition for prey if allocating higher portions of the salmon caps to the CV sector would result in more fishing in the southern Bering Sea.

7.2.5.3 Alternative 3: Triggered Closures

A pollock fishery closure of an area where Steller sea lions, humpback whales, spotted seals, or northern fur seals are likely to compete with pollock fishing vessels would likely reduce the potential for competition for prey resources (pollock and salmon). Occurrences of fin and minke whales are more widespread in the Bering Sea and therefore, they are less likely to be affected by the triggered closures. The potential reduction in competition would depend on the foraging locations and prey species for Steller sea lions, humpback whales, spotted seals, and northern fur seals and on the timing of the foraging activity and fishing.

Based on stomach samples collected in the 1980s, Steller sea lions may not depend on salmon as prey in the areas of the Pribilof Islands and northern Bering Sea (NMFS 2008). No salmon was detected in stomach samples from these areas. Steller sea lions appear to use salmon resources in the southern portion of the Bering Sea based on scat sampling near Akutan and Bogoslof Island (Figure 3 in Trites et al. 2007). Salmon area closures in the northern portion of the Bering Sea are not likely to have any effect on salmon prey resources for Steller sea lions and spotted seals, because there is no evidence of the sea lions or spotted seals eating salmon in the northern portion of the Bering Sea.

For fur seals, spotted seals, and Steller sea lions, closing the salmon areas in the northern portion of the Bering Sea may only provide a localized benefit for reducing competition for pollock in the closure area. The overall availability of pollock as prey is not likely to change given the existing closure areas and the pollock fleet’s likely ability to still harvest its TAC.

7.2.6 Disturbance Effects

7.2.6.1 Alternative 1: Status Quo

The Alaska Groundfish Harvest Specifications EIS analyzed the potential disturbance of marine mammals by the groundfish fisheries (Section 8.3.3 of NMFS 2007a). The EIS concluded that the status quo fishery does not cause disturbance to marine mammals that may cause population level effects, and fishery closures exist to limit the potential interaction between the fishing vessels and marine mammals.

7.2.6.2 Alternative 2: Hard Cap

The effects on the disturbance of marine mammals by the proposed hard caps would be similar to the effects of these hard caps on the potential for incidental takes. If the pollock fishery reduces fishing activity because of reaching a hard cap, then less potential exists for disturbance of marine mammals. If the pollock fishery increases the duration of fishing in areas with lower concentrations of pollock to avoid areas of high salmon bycatch, there may be more potential for disturbance if this increased fishing activity overlaps with areas used by marine mammals. Fishing under the higher hard cap is likely similar to status quo because it is less constraining than fishing under the lower caps and less likely to cause a change in fishing activities.

7.2.6.3 Alternative 3: Triggered Closures

The potential effects of the trigger closures depend on the presence of marine mammals in the closure area and the timing of the closure. The Bering Sea harbor seal stock is not likely to occur in most of the areas proposed for closure; and therefore, is not likely to be disturbed by the pollock fishery restrictions in these areas. The Gulf of Alaska stock of harbor seals may cross over into the Bering Sea within the southern waters and may experience less potential for disturbance.

The monthly closures would include portions of waters south of St. George Island, which are currently open to pollock fishing, exclusive of the Steller sea lion protection areas and the Pribilof Island Area Habitat Conservation Zone. Closure of these waters would reduce the potential for disturbance of Steller sea lions and fur seals located at St. George Island that may use waters south of St. George.

The southern portion of the salmon closures for the B season overlap with a portion of North Pacific right whale designated critical habitat (73 FR 19000, April 8, 2008 and Figure 7-4). Any closures of these areas that overlap with the right whale critical habitat may reduce the potential for disturbance from pollock fishing vessels to foraging whales.

Closures may also be beneficial to humpback whales and fin whales. If the southern portion of the salmon closures are triggered, pollock fishing vessels would not be present in the portion of this salmon closure area that overlaps with the humpback whale feeding area, therefore reducing the potential for disturbance of foraging humpback whales and may reduce the potential for pollock fishing vessel to disturb fin whales if the closures occur at the same time that fin whales are likely to be in these closure areas.

All the ice seals occur in the northern portion of the Bering Sea where some salmon closures would occur and may experience less potential for disturbance if the pollock fishery is closed out of these salmon closure areas at the same time ice seals may be present. Ribbon and spotted seals are more widely distributed in the Bering Sea and may experience less potential for disturbance by pollock fishing vessels if they occur in any of the salmon closure area when the pollock fishery is prohibited. Ribbon seals likely migrate into the Chukchi Sea in summer (Angliss and Outlaw 2008). Bearded and ringed seals are located in the northern portion of the Bering Sea (Angliss and Outlaw 2007) outside of the closure areas Ringed seals remain in contact with the ice most of the year (Angliss and Outlaw 2007). Because of their distribution, the salmon area closures in the southern portion of the Bering Sea are not as likely to have an effect on bearded, ringed, and ribbon seals. These stocks may benefit from the northern closures by potentially less disturbance from pollock vessels where the closures occur and these seals may be present. Bearded, ribbon, and ringed seals are not likely to occur in the closure areas and are therefore not likely to be affected by these portions of salmon closures under Alternative 3.

During spring, spotted seals tend to prefer small ice floes (i.e., < 20 m in diameter), and inhabit mainly the southern margin of the ice, with movement to coastal habitats after the retreat of the sea ice (Fay 1974, Shaughnessy and Fay 1977, Simpkins et al. 2003). In summer and fall, spotted seals use coastal haulouts regularly, and may be found as far north as 69-72 degrees N latitude in the Chukchi and Beaufort Seas (Porsild 1945, Shaughnessy and Fay 1977). To the south, along the west coast of Alaska, spotted seals are known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands (Angliss and Outlaw 2007). Spotted seals may occur in all of the areas considered for closing under Alternative 3 and may have less potential for disturbance by pollock fishing vessels if they occur in these areas when the pollock fishery is prohibited.

Dall’s porpoise have been encountered by the pollock fishery mostly in the northern shelf break area of the Bering Sea (Table 7-7) and therefore are more likely to be affected by closures in the northern portion of the Bering Sea. If Dall’s porpoise occur in these closure areas, then prohibiting the pollock fishery in the salmon closure areas under Alternative 3 may reduce the potential for disturbance.

Minke and killer whales occurring in the closure areas would have less potential for disturbance when the pollock fishery is prohibited in these areas.

Humpback whales that use the feeding area in the southern portion of the Bering Sea may have less potential for disturbance by pollock vessels(Figure 4-2) Fin whales appear to gather in the northern portion of the Bering Sea (Figure 7-1). Fin whales occurring in this northern area may encounter less disturbance by pollock fishing vessels if the whales are present in the closure areas when the pollock fishery is prohibited. The potential benefit to the stock of fewer disturbances is likely greater for whales in this northern area compared to whales in the southern portion of the Bering Sea, where they are less numerous (Angliss and Outlaw 2008).

7.2.7 Alternative 4

Alternative 4 proposes a large-scale fixed or triggered closure as a back-stop mechanism to encourage participation in the RHS program for bycatch reduction. Given that there is 100% participation by the fleet in the current RHS program it is reasonable to assume that under this alternative the incentive to remain in the program would be strong enough to continue to maintain 100% participation. Thus the impacts of this alternative on marine mammals would be similar to status quo.

7.3 Seabirds

7.3.1 Seabird Resources in the Bering Sea

Thirty-eight species of seabirds breed in Alaska. Breeding populations are estimated to contain 36 million individual birds in Alaska, and total population size (including subadults and nonbreeders) is estimated to be approximately 30% higher. Five additional species that breed elsewhere but occur in Alaskan waters during the summer months contribute another 30 million birds.

As noted in the PSEIS, seabird life history includes low reproductive rates, low adult mortality rates, long life span, and delayed sexual maturity. These traits make seabird populations extremely sensitive to changes in adult survival and less sensitive to fluctuations in reproductive effort. The problem with attributing population changes to specific impacts is that, because seabirds are long-lived animals, it may take years or decades before relatively small changes in survival rates result in observable impacts on the breeding population.

Table 7-10. Seabird species in the BSAI (NMFS 2004)

Albatrosses - Black-footed, Short-tailed, Laysan
Northern fulmar
Shearwaters - Short-tailed, Sooty
Storm petrels - Leach’s, Fork-tailed
Cormorants - Pelagic, Red-faced, Double-crested
Gulls - Glaucous-winged, Glaucous, Herring. Mew, Bonaparte’s Sabine, Ivory
Murres - Common, Thick-billed
Jaegers - Long-tailed, Parasitic, Pomarine
Guillemots - Black, Pigeon
Eiders - Common, King, Spectacled, Steller’s
Murrelets - Marbled, Kittlitz’s, Ancient
Kittiwakes - Black-legged, Red-legged
Auklets - Cassin’s, Parakeet, Least, Whiskered, Crested
Terns - Arctic, Aleutian
Puffins - Rhinoceros, Horned, Tufted

More information on seabirds in Alaska’s EEZ may be found in several NMFS, Council, and USFWS documents:

- The URL for the USFWS Migratory Bird Management program is at: http://alaska.fws.gov/mbsp/mbm/index.htm
- Section 3.7 of the PSEIS (NMFS 2004a) provides background on seabirds in the action area and their interactions with the fisheries. This may be accessed at http://www.fakr.noaa.gov/sustainablefisheries/seis/final062004/Chaps/chpt_3/chpt_3_7.pdf
- The annual Ecosystems Considerations chapter of the SAFE reports has a chapter on seabirds. Back issues of the Ecosystem SAFE reports may be accessed at http://www.afsc.noaa.gov/REFM/REEM/Assess/Default.htm.
- The Seabird Fishery Interaction Research webpage of the Alaska Fisheries Science Center http://www.afsc.noaa.gov/refm/reem/Seabirds/Default.htm

- The NMFS Alaska Region's Seabird Incidental Take Reduction webpage: http://www.fakr.noaa.gov/protectedresources/seabirds.html
- The BSAI and GOA Groundfish FMPs each contain an "Appendix I" dealing with marine mammal and seabird populations that interact with the fisheries. The FMPs may be accessed from the Council's home page at http://www.fakr.noaa.gov/npfmc/default.htm
- Washington Sea Grant has several publications on seabird takes, and technologies and practices for reducing them: http://www.wsg.washington.edu/publications/online/index.html
- The seabird component of the environment affected by the groundfish FMPs is described in detail in Section 3.7 of the PSEIS (NMFS 2004a).
- Seabirds and fishery impacts are also described in Chapter 9 of the Alaska Groundfish Harvest Specifications EIS (NMFS 2007a).

7.3.2 ESA-Listed Seabirds in the Bering Sea

Several species of conservation concern occur in the EBS. Short-tailed albatross is listed as endangered under the ESA, and Steller's eider and spectacled eider are listed as threatened. Kittlitz's Murrelet is a candidate species for listing under the ESA, and the U.S. Fish and Wildlife Service (USFWS) is currently working on a 12-month finding for Black-footed albatross. The red-legged kittiwake is a species of conservation concern due to recent population declines.

7.3.2.1 Short-tailed albatross

Short-tailed albatross (*Phoebastria albatrus*) is currently listed as endangered under the ESA. Short-tailed albatross populations were decimated by hunters and volcanic activity at nesting sites in the early 1900s, and the species was reported to be extinct in 1949. In recent years, the population has recovered at a 7% to 8% annual rate. The world population of short-tailed albatross in 2009 was estimated at 3,000 birds. The majority of nesting occurs on Torishima Island in Japan, where an active volcano threatens the colony. No critical habitat has been designated for the short-tailed albatross in the United States, because the population growth rate does not appear to be limited by marine habitat loss (NMFS 2004b). Short-tailed albatross feeding grounds are continental shelf breaks and areas of upwelling and high productivity. Short-tailed albatross are surface feeders, foraging on squid and forage fish.

7.3.2.2 Steller's eider and spectacled eider

Both Steller's eider (*Polysticta stelleri)* and spectacled eider (*Somateria fishcheri)* are listed as threatened under the ESA. While designated critical habitat for both of these species does overlap with fishing grounds, there has never been an observed take of either of these species off Alaska (USFWS 2003a and 2003b, NMFS 2008), and no take estimates are produced by AFSC. Therefore, impacts to Steller's and spectacled eiders are not analyzed in this document.

7.3.2.3 Black-footed albatross

The black-footed albatross (*Phoebastria nigripes*) is a species of concern because some of the major colony population counts may be decreasing or are of unknown status. World population estimates range from 275,000 to 327,753 individuals (Brooke 2004), with a total breeding population of 61,700 pairs (Arata et al. 2009). In 2004, a petition was filed to list the black-footed albatross under the ESA. USFWS found that the petition was warranted and is currently working on a 12-month finding. Naughton et al (2007) published a conservation plan for Laysan and black-footed albatrosses that lists fisheries bycatch as the most significant source of mortality for both species, but notes that bycatch off Alaska is a small fraction of the worldwide bycatch of these species. There have not been reported takes of black-footed albatross with trawl gear in Alaska.

7.3.2.4 Kittlitz's murrelet

Kittlitz's murrelet (*Brachyramphus brevirostris*) is a small diving seabird that forages in shallow waters for capelin, Pacific sandlance, zooplankton, and other invertebrates. It feeds near glaciers, icebergs, and outflows of glacial streams, sometimes nesting up to 45 miles inland on rugged mountains near glaciers. Most recent population estimates indicate that it has the smallest population of any seabird considered a regular breeder in Alaska (9,000 to 25,000 birds). This species appears to have undergone significant population declines in several of its core population centers. USFWS believes that glacial retreat and oceanic regime shifts are the factors that are most likely causing population-level declines in this species. Kittlitz's murrelet is currently a candidate species for listing under the ESA. No Kittlitz's murrelets were reported taken in the observed groundfish fisheries between 1993 and 2001 (NMFS 2004a).

7.3.2.5 Red-legged kittiwake

The red-legged kittiwake (*Rissa brevirostris*) is a small gull that breeds at only a few locations in the world, all of which are in the Bering Sea (USFWS 2006). Eighty percent of its worldwide population nests at St. George Island, with the remainder nesting at St. Paul, the Otter Islands, Bogoslof and Buldir Islands. The total population is estimated at around 209,000 birds (USFWS 2006). They are listed as a USFWS bird of conservation concern because recent severe population declines remain unexplained (NMFS 2004b), but could be due to irregular food supplies in the Pribilof Islands. Red-legged kittiwakes are present in the eastern Bering Sea, but do not interact regularly with the Bering Sea fisheries.

7.3.3 Status of ESA Consultations on Groundfish and Halibut Fisheries

USFWS has primary responsibility for managing seabirds and has evaluated effects of the BSAI and GOA FMPs and the harvest specifications process on currently listed species in two Biological Opinions (USFWS 2003a and 2003b). Both Biological Opinions concluded that the groundfish fisheries off Alaska, including the EBS pollock fishery, are unlikely to jeopardize populations of listed species or adversely modify or destroy critical habitat for listed species. The current population status, life history, population biology, and foraging ecology of these species, as well as a history of ESA Section 7 consultations and NMFS actions carried out as a result of those consultations are described in detail in section 3.7 of the PSEIS (NMFS 2004a).

In 1997, NMFS initiated a Section 7 consultation with USFWS on the effects of the Pacific halibut fishery off Alaska on the short-tailed albatross. USFWS issued a Biological Opinion in 1998 that concluded that the Pacific halibut fishery off Alaska was not likely to jeopardize the continued existence of the short-tailed albatross. USFWS issued an Incidental Take Statement of two short-tailed albatross in a 2-year period (e.g., 1998/1999, 2000/2001, 2002/2003), reflecting what the agency anticipated the incidental take could be from the fishery action. Under the authority of ESA, USFWS identified non-discretionary reasonable and prudent measures that NMFS must implement to minimize the impacts of any incidental take.

Two updated USFWS biological opinions were published in 2003:

- Section 7 Consultation - Biological Opinion on the Effects of the Total Allowable Catch-Setting Process for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fisheries to the Endangered Short-tailed Albatross (*Phoebastria albatrus*) and Threatened Steller's Eider (*Polysticta stelleri*) (USFWS 2003b).
- Section 7 Consultation - Programmatic Biological Opinion on the Effects of the Fishery Management Plans for the Gulf of Alaska and Bering Sea/Aleutian Islands Groundfish Fisheries on the Endangered Short-tailed Albatross (*Phoebastria albatrus*) and Threatened Steller's Eider (*Polysticta stelleri*) (USFWS 2003a).

Although USFWS has determined that the short-tailed albatross is adversely affected by hook-and-line Pacific halibut and groundfish fisheries off Alaska, both USFWS opinions concurred with NMFS and concluded that the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands Management Area (BSAI) fishery actions are not likely to jeopardize the continued existence of the short-tailed albatross or Steller's eider or result in adverse modification of Steller's eider critical habitat. USFWS also concluded that these fisheries are not likely to adversely affect the threatened spectacled eider. The Biological Opinion on the TAC-setting process updated incidental take limits to—

- four short-tailed albatross taken every 2 years in the hook-and-line groundfish fishery off Alaska, and
- two short-tailed albatross taken in the groundfish trawl fishery off Alaska while the biological opinion is in effect (approximately 5 years).

These incidental take limits are in addition to the previous take limit set in 1998 for the Pacific halibut hook-and-line fishery off Alaska of two short-tailed albatross in a 2-year period. The 2003 Biological Opinion on the TAC-setting process also included mandatory terms and conditions that NMFS must follow in order to be in compliance with the ESA. These include implementation of seabird deterrent measures, outreach and training of fishing crews on proper deterrence techniques, training observers in seabird identification, and retention of all seabird carcasses until observers can identify and record takes, continued analysis and publication of estimated incidental take in the fisheries, collection of information regarding the efficacy of seabird protection measures, cooperation in reporting sightings of short-tailed albatross, and continued research and reporting on the incidental take of short-tailed albatross in trawl gear.

USFWS also released a short-tailed albatross recovery plan in September 2008 (USFWS 2008). This recovery plan describes site-specific actions necessary to achieve conservation and survival of the species, downlisting and delisting criteria, and estimates of time and cost required to implement the recovery plan. Because the primary threat to the species recovery is the possibility of an eruption of Torishima Island, the most important recovery actions include monitoring the population and managing habitat on Torishima Island, establishing two or more breeding colonies on non-volcanic islands, monitoring the Senkaku population, and conducting telemetry and other research and outreach. Translocation of chicks to new colonies has begun. USFWS estimates that short-tailed albatross may be delisted in the year 2030, if new colony establishment is successful.

7.3.4 Short-tailed albatross distribution and interactions with Alaska fisheries

7.3.4.1 *Satellite Tracking of Short-tailed Albatross*

USFWS and Oregon State University placed 52 satellite tags on Laysan, black-footed, and short-tailed albatrosses in the central Aleutian Islands to study movement patterns of the birds in relation to commercial fishing activity and other environmental variables. From 2002 to 2006, 21 individual short-tailed albatrosses (representing about 1% of the entire population) were tagged, including adults, sub-adults, and hatch-year birds. During the non-breeding season, short-tailed albatross ranged along the Pacific Rim from southern Japan through Alaska and Russia to northern California, primarily along continental shelf margins (Suryan et al. 2006).

Eleven of the 14 birds had sufficient data to analyze movements within Alaska. Within Alaska, albatrosses spent varying amounts of time among NMFS reporting areas, with six of the areas (521, 524, 541, 542, 543, 610) being the most frequently used (Suryan et al. 2006). Non-breeding albatross concentrate foraging in oceanic areas characterized by gradients in topography and water column productivity. The primary hot spots for short-tailed albatrosses in the Northwest Pacific Ocean and Bering Sea occur where a variety of underlying physical processes enhance biological productivity or prey aggregations. The Aleutian Islands, in particular, were a primary foraging destination for short-tailed albatrosses.

7.3.4.2 *Short-tailed Albatross Takes in Alaska Fisheries*

Table 6-2 lists the short-tailed albatrosses reported taken in Alaska fisheries since 1983. With the exception of one take in the Western GOA, all takes occurred along the shelf break in the Bering Sea. The Western GOA take was in the hook-and-line halibut fishery. No takes were reported from 1999 through 2009. No takes with trawl gear have been reported. While the incidental take statement take limits for short-tailed albatross have never been met or exceeded, two short-tailed albatrosses were taken in the BSAI hook-and-line Pacific cod fishery in 2010 (Table 6-2 and Figure 6-3). NMFS is working closely with industry and the observer program to understand the specific circumstances of these incidents.

Table 7-11. Reported takes of short-tailed albatross in Alaska fisheries.

Date of take	Location	Fishery	Age when taken
July 1983	BS	brown crab	juvenile (4 mos)
1 Oct 87	GOA	halibut	juvenile (6 mos)
28 Aug 95	EAI	hook-and-line	sub-adult (16 mos)
8 Oct 95	BS	hook-and-line	sub-adult
27 Sept 96	BS	hook-and-line	sub-adult (5 yrs)
21 Sept 98	BS	Pacific cod hook-and-line	adult (8 yrs)
28 Sept 98	BS	Pacific cod hook-and-line	sub-adult
27 Aug 2010	BS	Pacific cod hook-and-line	Sub-adult (7 yrs 10 mos)
14 Sept 2010	BS	Pacific cod hook-and-line	Sub-adult (3 yrs 10 mos)

Source: AFSC.

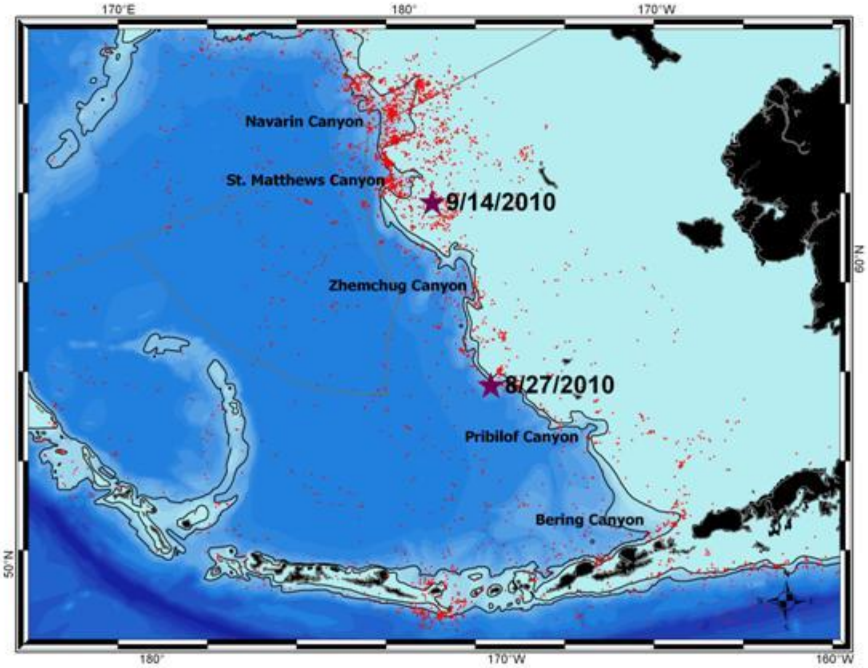


Figure 7-2. Map of two recent short-tailed albatross takes in Alaska hook-and-line fisheries (purple stars). Red dots indicate satellite tagging data from birds tagged between 2001-2010.

Credits: Yamashina Institute for Ornithology, Oregon State University, U.S. Fish and Wildlife Service, and Ministry of Environment Japan.

7.3.5 Seabird Interactions with Alaska Groundfish Trawl Fisheries

The impacts of the Alaska groundfish fisheries on seabirds were analyzed in the Alaska Harvest Specifications EIS (NMFS 2007). That document evaluates the impacts of the alternative harvest strategies on seabird takes, prey availability, and seabird ability to exploit benthic habitat. The focus of this analysis is similar, as any changes to the pollock fishery in the Bering Sea could change the potential for direct take of seabirds. Potential changes in prey availability (seabird prey species caught in the pollock trawl fishery) and disruption of bottom habitat via the intermittent contact with non-pelagic trawl gear under different levels of harvest are discussed in NMFS (2007). These changes would be closely associated with changes in take levels because of the nature of the alternatives using caps and spatial restrictions. Therefore, all impacts are addressed by focusing on potential changes in seabird takes.

Seabirds can interact with trawl fishing vessels in several ways. Birds foraging at the water surface or in the water column are sometimes caught in the trawl net as it is brought back on board. In addition to being caught in the fishing nets of trawl vessels, some species strike cables attached to the infrastructure of vessels or collide with the infrastructure itself. Large winged birds such as albatrosses are most susceptible to mortalities from trawl-cable strikes (CCAMLR 2006a). Third wire cables have been prohibited in some southern hemisphere fisheries since the early 1990s due to substantial albatross mortality from cable strikes. No short-tailed albatross or black-footed albatross have been observed taken with trawl gear in Alaska fisheries, but mortalities to Laysan albatrosses have been observed.

There are presently no standardized observer data on seabird mortality from trawl third wire collisions in Alaskan waters. To date, there have been no observer reports of short-tailed albatross striking trawl vessels or gear. The probability of short-tailed albatross collisions with third wires or other trawl vessel gear in Alaskan waters cannot be assessed; however, given the available observer information and the observed at-sea locations of short-tailed albatrosses relative to trawling effort, the possibility of such collisions cannot be completely discounted. USFWS issued an incidental take statement of two short-tailed albatross every 5 years for the trawl groundfish fisheries off Alaska (USFWS 2003).

7.3.5.1 Alternative 1 Status Quo

The effects of the status quo fisheries on incidental takes of seabirds are detailed in the 2007 harvest specifications EIS (NMFS 2007). Figure 7-8 shows the seabird species taken as bycatch in the Bering Sea trawl fisheries reported by fisheries observers from 2002-2006. This includes trawl fisheries for pollock, Pacific cod, Atka mackerel, rockfish, and flatfish. The high number of unidentified seabirds was influenced by one haul in the Pacific cod fishery in 2006 that occurred in NMFS Area 517. AFSC 2006 estimates of seabird bycatch in the pollock fishery are listed in Table 7-12. In 2006, the pollock fishery accounted for only 12.8% of the total trawl seabird bycatch. It accounted for 61.7% of trawl seabird bycatch in 2005. These take estimates are small in comparison to seabird population estimates, and under the status quo alternative, it is reasonable to conclude that the impacts would continue to be similar. However, observers are not able to monitor all seabird mortality associated with trawl vessels. Several research projects are currently underway to provide more information on these interactions.

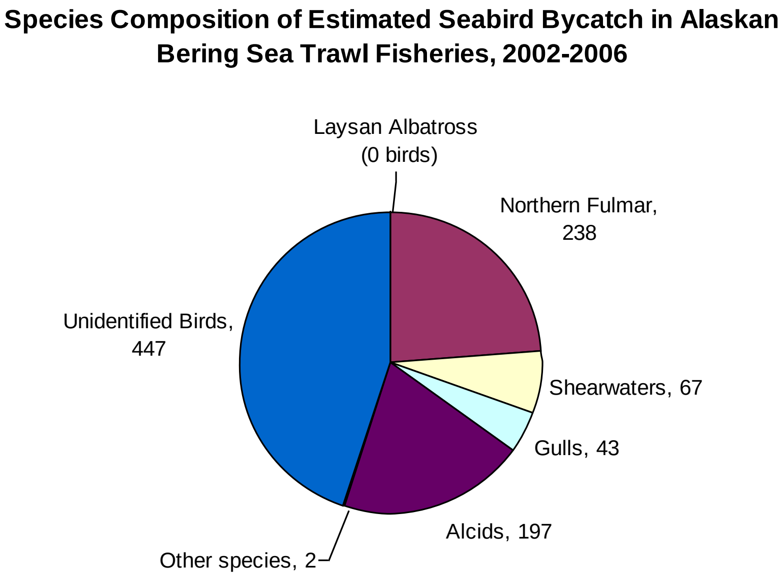


Figure 7-8. Bycatch composition of seabirds in the Bering Sea trawl fisheries, 2002-2006 (from AFSC)

Table 7-12. Estimates of seabird bycatch in the pollock fishery, 2006

Species	Point Estimate	95% Confidence Interval
Laysan Albatross	2	1-34
Northern Fulmar	335	286-393
Shearwater species	20	12-35
Unidentified Procellarids	2	1-5
Alcid species	3	1-12
Unidentified species	6	2-16

Source: Data from AFSC. All other species are estimated at zero takes.

Dietrich and Melvin (2007) report observed warp hours from June - August pollock trawl fisheries in 2004 (Figure 7-9 and Figure 7-10) and summer albatross sightings. A warp hour is a measure of effort used to indicate potential for bird interaction. The warp line is part of the trawl gear that interacts with seabirds. While the vessel is trawling and has its warp lines out, each hour that passes would be one warp hour. In 2004, overlap was high along the shelf break for Laysan albatross and northwest of Zhemchug Canyon for short-tailed albatross. In 2005 overlap was minimal with only two black-footed albatross and one short-tailed albatross. The authors are careful to point out that overlap does not necessarily imply interaction, only the potential for interaction.

Figure 7-5 shows the current spatial restrictions on the pollock trawl fishery in the Bering Sea and Aleutian Islands. Steller sea lion haulouts near the Pribilof, St. Lawrence, St. Matthew, Walrus, and Round Islands are protected out to various distances by closing those waters to pollock fishing (and other fisheries). Additionally, restrictions on fishing activities in Bristol Bay, the Bogoslof area, and the CVOA further spatially restrict the pollock fishery. These closures decrease the potential for interaction with birds in these areas and would not change under the status quo alternative.

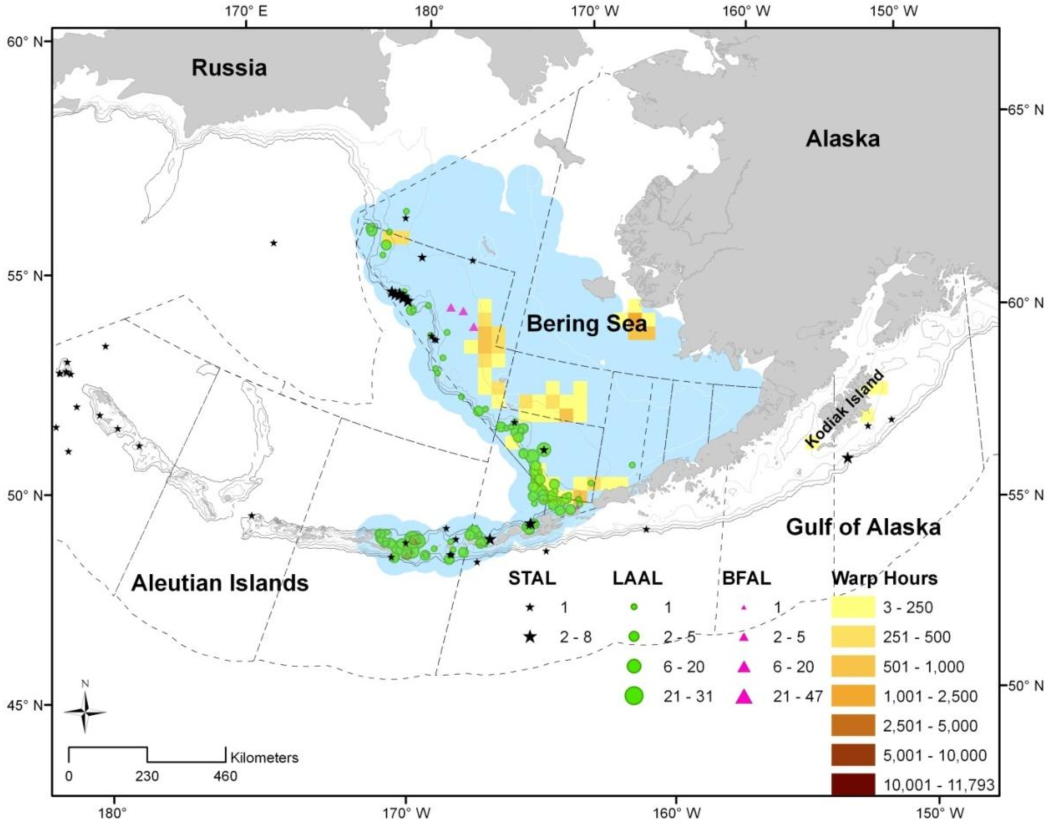


Figure 7-9. Spatial distribution of warp hours in the pollock trawl fishery and albatross sightings, 2004. Figure used with permission (Dietrich and Melvin 2007)

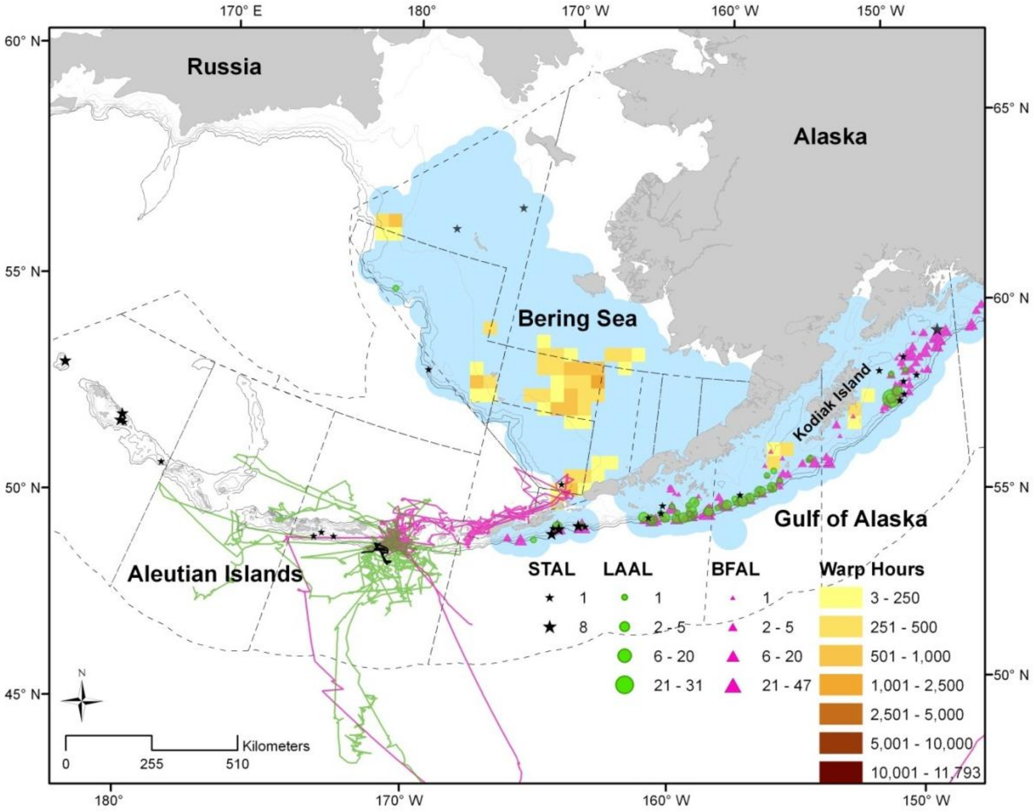


Figure 7-10. Spatial distribution of warp hours in the pollock trawl fishery and albatross sightings, 2005. Figure used with permission (Dietrich and Melvin 2007)

7.3.5.2 Alternative 2 Hard Cap

The range of hard caps under Alternative 2 offer a range of potential for incidental takes of seabirds. The lower hard caps may preclude pollock fishing in the Bering Sea at some point in the fishing season, which would reduce the potential for incidental takes in fishing areas that overlap with seabird distributions after the cap is reached. The higher hard caps would allow for more pollock fishing and more potential interaction and incidental takes of seabird species than the lower caps but would close the fishery sooner than under status quo which would reduce the potential overall.

7.3.5.3 Alternative 3 Triggered Closures

The potential effects of the trigger closures depend on the presence of seabirds in the closure areas and the timing of the closures. If Alternative 3 results in the closure of areas where interactions between pollock trawl vessels and seabirds are more likely to occur, it would reduce the potential for incidental takes of seabirds.

7.3.5.4 Alternative 4

Alternative 4 proposes a large-scale fixed or triggered closure as a back-stop mechanism to encourage participation in the RHS program for bycatch reduction. Given that there is 100% participation by the fleet in the current RHS program it is reasonable to assume that under this alternative the incentive to remain in the program would be strong enough to continue to maintain 100% participation. Thus the impacts of this alternative on incidental catch of seabird species would be similar to status quo.

7.3.6 Conclusions

Many seabird species utilize the marine habitat of the Bering Sea. Several species of conservation concern and many other species could potentially interact with trawl cables. The AFSC estimates of takes are small relative to seabird population total estimates, however, those estimates do not include cable-related trawl mortalities. Recent modeling suggests that even if there were to be a large increase in trawl cable incidental takes of short-tailed albatross (the only seabird listed as endangered under the ESA), it would have negligible effects on the recovery of the species.

7.4 Essential Fish Habitat

This section addresses the mandatory requirements for an essential fish habitat (EFH) assessment enumerated in the final rule (67 FR 2343, January 17, 2002) implementing the EFH provisions of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267). Importantly, an EFH assessment is required for any federal action that may adversely affect EFH. The mandatory requirements for an EFH assessment are:

- a description of the action;
- an analysis of the potential adverse effects of the action on EFH and the managed species;
- the Federal agency's conclusions regarding the effects of the action on EFH; and
- proposed mitigation, if applicable.

An EFH assessment may incorporate by reference other relevant environmental assessment documents, such as a Biological Assessment, a NEPA document, or another EFH assessment prepared for a similar action.

The Magnuson-Stevens Act defines EFH as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of EFH, the EFH regulations at 50 CFR 600.10 specify that "waters" include aquatic areas that are used by fish and their associated physical, chemical, and biological properties, and may include areas historically used by fish where appropriate; "substrate" includes sediments, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' entire life cycle.

The criterion for analyzing effects on habitat is derived from the requirement at 50 CFR 600.815(a)(2)(ii) that NMFS must determine whether fishing adversely affects EFH in a manner that is "more than minimal and not temporary in nature." This standard determines whether actions are required to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable.

The final rule for EFH (67 FR 2343; January 17, 2002) does not define minimal and temporary, although the preamble to the rule states, "Temporary impacts are those that are limited in duration and that allow the particular environment to recover without measurable impact. Minimal impacts are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions" (67 FR 2354).

In 2005, NMFS and the Council completed the EIS for EFH Identification and Conservation in Alaska (EFH EIS; NMFS 2005). The EFH EIS provided a thorough analysis of alternatives and environmental consequences for amending the Council's FMPs to include EFH information pursuant to Section 303(a)(7) of the Magnuson-Stevens Act and 50 CFR 600.815(a). Specifically, the EFH EIS examined three actions: (1) describing and identifying EFH for Council managed fisheries, (2) adopting an approach to identify HAPC within EFH, and (3) minimizing to the extent practicable the adverse effects of

Council-managed fishing on EFH. The EFH EIS evaluates the long term effects of fishing on benthic habitat features, as well as the likely consequences of those habitat changes for each managed stock based on the best available scientific information.

In this analysis, the effects of fishing on EFH are analyzed for alternative salmon bycatch reduction measures, using the best available scientific information. Analysis included the review of the EFH Descriptions (EFH EIS Appendix D.3), the effects of fishing analysis (EFH EIS Appendix B.2), and associated Habitat Assessment Reports (EFH EIS Appendix F) to conclude whether or not an adverse effect on EFH will occur. A complete evaluation of effects would require detailed information on the distribution and abundance of habitat types, the life history of living habitat, habitat recovery rates, and natural disturbance regimes. Although more habitat data become available from various research projects each fishing year, much is still unknown about EFH in the EEZ off Alaska.

7.4.1 Description of the Action

The actions considered in this EFH assessment are the alternatives described in detail in Chapter 2. The important components of these alternatives for the EFH assessment are the gear used, the fishing effort, and the location of the fishery. This information for the pollock fishery is presented in the EFH EIS, and is incorporated here by reference. Appendix B of the EFH EIS contains an evaluation of the potential adverse effects of fishing activities on EFH, including the effects of pelagic trawl gear. Summaries and assessments of habitat information for all federally managed species in the BSAI are provided in Appendix F of the EFH EIS. The EFH EIS describes an overall fishery impact for each fishery based on the relative impacts of the gear used (which is related to physical and ecological effects), the type of habitat fished (which is related to recovery time), and the proportion of that bottom type utilized by the fishery. Under the alternative salmon bycatch reduction measures, pollock fishing effort may change and the location of the fisheries may change to avoid salmon bycatch or because specified areas may be closed to pollock fishing. However, the fishing seasons and the gear used in the fisheries are not likely to change under the alternatives. Changes to the prosecution of the pollock fishery are described in Chapter 4.

7.4.2 Impacts on EFH

Fishing operations change the abundance or availability of certain habitat features (e.g., prey availability or the presence of living or non-living habitat structure) used by managed fish species to spawn, breed, feed, and grow to maturity. These changes can reduce or alter the abundance, distribution, or productivity of that species, which in turn can affect the species’ ability to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem (50 CFR 600.10). The outcome of this chain of effects depends on characteristics of the fishing activities, the habitat, fish use of the habitat, and fish population dynamics. The duration and degree of fishing’s effects on habitat features depend on the intensity of fishing, the distribution of fishing with different gears across habitats, and the sensitivity and recovery rates of habitat features.

The Bering Sea pollock fishery harvests pollock with pelagic trawl gear in pelagic habitat. Pelagic habitat is identified as EFH for marine juvenile and maturing salmon. Amendments 7 and 8 defined salmon EFH in the FMP for the Salmon Fisheries in the EEZ off the Coast of Alaska. The EFH EIS, in Section 3.2.1.5 and Appendix F, provides habitat descriptions for the five salmon species managed under the FMP. Briefly, marine salmon stocks school in pelagic waters and utilize ocean conditions to grow and mature before returning to nearshore and freshwater adult spawning areas. Salmon are known to associate with ocean ledges and features, such as ridges and seamounts. Salmon utilize these features because the features attract and concentrate prey.

Appendix B to the EFH EIS describes how pelagic trawl gear impacts pelagic habitat (NMFS 2005). The EFH EIS concluded that pelagic effects from fisheries are minimal because no information was found indicating significant effects of fishing on features of pelagic waters serving a habitat function for managed species. The Bering Sea pollock fishery only interacts with salmon habitat in the ocean, and the concerns about these interactions center on effects on bycatch of prey and prey availability. Salmon prey (copepods, squid, herring, and other forage fish) are subject to only a few targeted fisheries outside of the EEZ, such as the State of Alaska herring fisheries and international squid fishery. However, the pollock fishery does catch salmon prey species, including squid, capelin, eulachon, and herring. Currently, the catch of these prey species is very small relative to overall population size of these species, thus fishing activities are considered to have minimal and temporary effects on prey availability for salmon. Chapter 7 provides more information on the impacts of the Bering Sea pollock fishery on these prey species.

Appendix B to the EFH EIS also describes how pelagic trawl gear impacts benthic species and habitat (NMFS 2005). The EFH EIS notes that "pelagic trawls may be fished in contact with the seafloor, and there are times and places where there may be strong incentives to do so, for example, the EBS shelf during the summer" (NMFS 2005). Trawl performance standards for the directed pollock fishery at 50 CFR 679.7(a)(14) reduce the likelihood of pelagic trawl gear use on the bottom. However, concern exists about the contact of pelagic trawl gear on the bottom and the current standards used to limit bottom contact (from June 2006 minutes of the SSC and AP, available at: http://www.fakr.noaa.gov/npfmc/minutes/minutes.htm). Flatfish and crab bycatch in the pollock fishery also shows that pelagic gear contacts the bottom. The description of impacts by pelagic trawl gear on habitat in this document is based on the best available science, but may be considered controversial with some believing the impact may be more than described.

The results of the EFH EIS analysis of the effects of fishing on benthic habitat features determined the long-term effect index (LEI) to represent the proportion of feature abundances (relative to an unfished state) that would be lost if recent fishing patterns were continued indefinitely. The LEI was 10.9% for the biological structure of sand/mud and slope habitats of the eastern Bering Sea where fishing effort is concentrated, and recovery rates are moderately low. The analysis also calculated the proportion of each LEI attributable to each fishery. The pollock pelagic trawl fishery was the largest single component (4.6%) of the total effects on living structure in the eastern Bering Sea sand/mud habitat. The combined effects of the bottom trawl fisheries made up all of the remaining 6.3%. Nearly all (7.2%) of the LEI for living structure on the eastern Bering Sea slope was due to the pollock pelagic fishery. Based on this analysis, the EFH EIS determined that the fishing effects are not limited in duration and therefore not temporary. However, the EFH EIS considered LEIs of less than 11% as small.

The EFH EIS also evaluated the effects on managed species to determine whether stock condition indicates that the fisheries affect EFH in a way that is more than minimal. To conduct this evaluation, the analysts first reviewed the LEI from the fishing effects model to assess overlap with the distribution of each stock. The analysts then focused on habitat impacts relative to the three life-history processes of spawning/breeding, feeding, and growth to maturity. Finally, the analysts assessed whether available information on the stock status and trends indicated any potential influence of habitat disturbance due to fishing. Based on the available information, the EFH EIS analysis found no indication that continued fishing at the current rate and intensity would affect the capacity of EFH to support life history processes of any species. In other words, the effects of fishing of EFH would not be more than minimal.

Due to the nature of this action, the Bering Sea pollock fishery as modified by the proposed action is not predicted to have additional impacts beyond those identified in the EFH EIS. Based on the analysis presented in the EFH EIS and summarized above, NMFS concludes that Alternative 1 would impact EFH for managed species, but that the available information does not identify effects of fishing that are more than minimal. In other words, effects may occur but they would not exceed the minimal and temporary limits established by 50 CFR 600.815(a)(2).

The Alternatives 2 caps would, to the extent that they prevent the pollock fleet from harvesting the pollock TAC and therefore reduce pollock fishing effort, reduce the pollock fisheries impacts on EFH from status quo. The RIR provides a discussion of the ability of the pollock fleet to harvest the TAC under Alternative 2.

The Alternative 3 trigger closures would close identified areas by month when triggered. The area closures would reduce the pollock fisheries impacts to EFH in the closed area, but it would increase the fishing effort and therefore the impacts in the adjoining areas. However, many areas identified as having vulnerable or sensitive habitat features, such as canyons, hard corals, and skate nursery areas would be contained in the closure area. Since the total amount of pollock harvested and the total effort would not change under Alternative 3, it is reasonable to conclude that the overall impacts on EFH would be similar to Alternative 1. As with Alternative 2, fishing effort may increase as vessels move to avoid salmon bycatch or as pollock catch rates decrease.

Alternative 4 proposes a large-scale fixed or triggered closure as a back-stop mechanism to encourage participation in the RHS program for bycatch reduction. Given that there is 100% participation by the fleet in the current RHS program it is reasonable to assume that under this alternative the incentive to remain in the program would be strong enough to continue to maintain 100% participation. Thus that the overall impacts on EFH would be similar to Alternative 1.

7.4.3 Mitigation

Currently, pelagic trawl gear is subject to a number of area closures to protect habitat and marine species: the Steller Sea lion closure areas, the Nearshore Bristol Bay closure, the Pribilof Islands Habitat Conservation Zone. If new information emerges to indicate that the Bering Sea pollock trawl fishery is having more than a minimal impact on EFH, the Council may consider additional habitat conservation measures.

7.4.4 Conclusions

All alternatives would have impacts on EFH similar to those found in the EFH EIS. NMFS concludes that all of the alternatives would affect EFH for managed species. However, best available information does not identify any effects of fishing as significantly adverse. In other words, effects may occur from fishing, however these effects do not exceed the minimal and temporary limits established by 50 CFR 600.815(a)(2). Alternatives 2 to the extent that the cap level would close the pollock fishery before the TAC is harvested, could have less of an impact on EFH. Alternative 3 may have less of an impact because it would close, if triggered areas that include important habitat. If information indicates that the Bering Sea pollock trawl fishery is having an increased impact on EFH as a result of salmon bycatch reduction measures, then the Council could consider habitat conservation measures for pelagic trawl gear.

The continuing fishing activity in the years 2008 to 2015 is potentially the most important source of additional annual adverse impacts on marine benthic habitat in the action area. The size of these impacts would depend on the size of the fisheries, the protection measures in place, and the recovery rates of the benthic habitat. However, a number of factors will tend to reduce the impacts of fishing activity on benthic habitat in the future. These include the trend towards ecosystems management. Ecosystem-sensitive management will increase understanding of habitat and the impacts of fisheries on them, protection of EFH and HAPC, and institutionalization of ecosystems considerations into fisheries governance. With diligent oversight, the effects of actions of other federal, state, and international agencies and private parties are likely to be less important when compared to the direct interaction of commercial fishing gear with the benthic habitat.

7.5 Ecosystem

Ecosystems consist of communities of organisms interacting with their physical environment. Within marine ecosystems, competition, predation, and environmental disturbance cause natural variation in recruitment, survivorship, and growth of fish stocks. Human activities, including commercial fishing, can also influence the structure and function of marine ecosystems. Fishing may change predator-prey relationships and community structure, introduce foreign species, affect trophic diversity, alter genetic diversity, alter habitat, and damage benthic habitats.

The EBS pollock fishery potentially impacts the EBS ecosystem by relieving predation pressure on shared prey species (i.e., species which are prey for both pollock and other species), reducing prey availability for predators of pollock, altering habitat, imposing bycatch mortality, or by ghost fishing caused by lost fishing gear. Ecosystem considerations for the EBS groundfish fisheries are summarized annually in the Ecosystem Considerations chapter of the EBS Stock Assessment and Fishery Evaluation report (Zador and Gaichas 2010). These considerations are summarized according to the ecosystem effects on the groundfish fisheries as well as the potential fishery effects on the ecosystem.

7.5.1 Effects of the Alternatives

An evaluation of the effects of the EBS pollock fisheries on the ecosystem is discussed annually in the Ecosystem Considerations section of the pollock chapter of the SAFE report (Ianelli et al 2010), and was evaluated in the Harvest Specifications EIS (NMFS 2007). This analysis concluded that the current EBS pollock fisheries do not produce population-level impacts to marine species or change ecosystem-level attributes beyond the range of natural variation. Consequently, Alternative 1 is not expected to have a significant impact on the ecosystem.

Alternatives 2 and 3 will either maintain or reduce the overall level of pollock harvest from the status quo. The level of fishing effort by pollock vessels is not expected to change, except in years where the fishery is closed early due to the attainment of the chum salmon c under Alternative 2 cap. At an ecosystem level, the effects of reducing fishing to this extent are not expected to be significant. While the location and timing of fishing activities may show some localized changes due to the fleet’s efforts to find areas with low chum salmon bycatch rates outside of area closures, overall the fleet is not likely to have a significant impact on the ecosystem under any of the alternatives.

8 Cumulative Effects

This section analyzes the cumulative effects of the actions considered in this environmental assessment. A cumulative effects analysis includes the effects of past, present, and reasonably foreseeable future action (RFFA). The past and present actions are described in several documents and are incorporated by reference. These include the PSEIS (NMFS 2004), the EFH EIS (NMFS 2005), and the harvest specifications EIS (NMFS 2007a). This analysis provides a brief review of the RFFA that may affect environmental quality and result in cumulative effects. Future effects include harvest of federally managed fish species and current habitat protection from federal fishery management measures, harvests from state managed fisheries and their associated protection measures, efforts to protect endangered species by other federal agencies, and other non-fishing activities and natural events.

The most recent analysis of RFFAs for the groundfish fisheries is in the Harvest Specifications EIS (NMFS 2007a). No additional RFFAs have been identified for this proposed action. The RFFAs are described in the Harvest Specifications EIS Section 3.3 (NMFS 2007a), are applicable for this analysis, and are incorporated by reference. A summary table of these RFFAs is provided below (Table 8-1). The table summarizes the RFFAs identified applicable to this analysis that are likely to have an impact on a resource component within the action area and timeframe. Actions are understood to be human actions (e.g., a proposed rule to designate northern right whale critical habitat in the Pacific Ocean), as distinguished from natural events (e.g., an ecological regime shift). CEQ regulations require a consideration of actions, whether taken by a government or by private persons, which are reasonably foreseeable. This is interpreted as indicating actions that are more than merely possible or speculative. Actions have been considered reasonably foreseeable if some concrete step has been taken toward implementation, such as a Council recommendation or the publication of a proposed rule. Actions simply “under consideration” have not generally been included because they may change substantially or may not be adopted, and so cannot be reasonably described, predicted, or foreseen. Identification of actions likely to impact a resource component within this action’s area and time frame will allow the public and Council to make a reasoned choice among alternatives.

The reasonably foreseeable future actions that may affect resource components and that also may be affected by the alternatives in this analysis are listed below and in Table XX. These include future actions that may affect the Bering Sea pollock fishery, the salmon caught as bycatch in that fishery, and the impacts of salmon bycatch on the resources components analyzed in this analysis. The actions in the list have been grouped in the following four categories:

- Ecosystem-sensitive management
- Traditional management tools
- Actions by other Federal, State, and international agencies
- Private actions

The “action area” for salmon bycatch management includes the Federal waters of the Bering Sea. Impacts of the action may occur outside the action area in salmon freshwater habitats and along salmon migration routes.

Table 8-1 summarizes the reasonably foreseeable “actions” identified in this analysis that are likely to have an impact on a resource component within the action area and timeframe.

Table 8-1. Reasonably foreseeable future actions

Ecosystem-sensitive management	• Ongoing Research to understand the interactions between ecosystem components • Increasing protection of ESA-listed and other non-target species • Increasing integration of ecosystems considerations into fisheries management
Traditional management tools	• Authorization of pollock fishery in future years • Increasing enforcement responsibilities • Technical and program changes that will improve enforcement and management • Development of a Salmon Excluder Device
Other Federal, State, and international agencies	• State management of salmon fisheries • Hatchery release of salmon • Future exploration and development of offshore mineral resources • Expansion and construction of boat harbors • Other State actions
Private actions	• Commercial pollock and salmon fishing • CDQ investments in western Alaska • Subsistence harvest of chum salmon • Sport harvest of chum salmon • Increasing levels of economic activity in Alaska's waters and coastal zone

8.1.1 Ecosystem-sensitive management[35]

8.1.2 Ongoing research to understand the interactions between ecosystem components

Researchers are learning more about the components of the ecosystem, the ways these interact, and the impacts of fishing activity on them. Research topics include cumulative impacts of climate change on the ecosystem, the energy flow within an ecosystem, and the impacts of fishing on the ecosystem components. Ongoing research will improve the interface between science and policy-making and facilitate the use of ecological information in making policy. Many institutions and organizations are conducting relevant research.

Recent fluctuations in the abundance, survival, and growth of salmon in the Bering Sea have added significant uncertainty and complexity to the management of Bering Sea salmon resources. Similar fluctuations in the physical and biological oceanographic conditions have also been observed; however, the limited information on Bering Sea salmon ecology was not sufficient to adequately identify mechanisms linking recent changes in ocean conditions to salmon resources. North Pacific Anadromous Fish Commission (NPAFC) scientists responded by developing BASIS (Bering-Aleutian Salmon International Survey), a comprehensive survey of the Bering

---

[35] The term "ecosystem-sensitive management" is used in this analysis in preference to the terms "ecosystem-based management" and "ecosystem approaches to management." The term was chosen to indicate a wide range of measures designed to improve our understanding of the interactions between groundfish fishing and the broader ecosystems, to reduce or mitigate the impacts of fishing on the ecosystems, and to modify fisheries governance to integrate ecosystems considerations into management. The term was used because it is not a term of art or commonly used term which might have very specific meanings. When the term "ecosystem-based management" is used, it is meant to reflect usage by other parties in public discussions.

Sea pelagic ecosystem. BASIS was designed to improve our understanding of salmon ecology in the Bering Sea and to clarify mechanisms linking recent changes in ocean conditions with salmon resources in the Bering Sea. The Alaska Fisheries Science Center's Ocean Carrying Capacity (OCC) Program is responsible for BASIS research in U.S. waters.

Researchers with the OCC Program have conducted shelf-wide surveys during fall 2002 through 2006 on the eastern Bering Sea shelf as part of the multiyear BASIS research program. The focus of BASIS research was on salmon; however, the broad spatial coverage of oceanographic and biological data collected during late summer and early fall provided insight into how the pelagic ecosystem on the eastern Bering Sea shelf responded to changes in spring productivity. Salmon and other forage fish (e.g., age-0 walleye pollock, Pacific cod, and Pacific herring) were captured with a surface net trawl, zooplankton were collected with oblique bongo tows, and oceanographic data were obtained from conductivity-temperature-depth (CTD) vertical profiles. More information on BASIS is provided in Chapter 5 and is available at the AFSC website at: http://www.afsc.noaa.gov/ABL/occ/ablocc_basis.htm.

In 2008, North Pacific Research Board (NPRB) and National Science Foundation (NSF) began a project for understanding ecosystem processes in the Bering Sea called the Bering Sea Integrated Ecosystem Research Program (BSIERP). Approximately 90 federal, state and university scientists will provide coverage of the entire Bering Sea ecosystem. Scientists conducted three years of field research on the eastern Bering Sea Shelf, from St. Lawrence Island to the Aleutians, and are currently conducting two more years for analysis and reporting. The study covers a range of issues, including atmospheric forcing, physical oceanography, and the economic and social impacts on humans and communities of a changing ecosystem. More information on this research project is available on the NPRB web site at: http://bsierp.nprb.org/index.htm.

Additionally, ecosystem protection is supported by an extensive program of research into ecosystem components and the integrated functioning of ecosystems, carried out at the AFSC. The AFSC’s Fishery Interaction Team (FIT), formed in 2000 to investigate the ecological impacts of commercial fishing, is focusing on the impacts of Pacific cod, pollock, and Atka mackerel fisheries on Steller sea lion populations (Conners and Logerwell 2005). The AFSC’s Fisheries and the Environment (FATE) program is investigating potential ecological indicators for use in stock assessment (Boldt 2005). The AFSC’s Auke Bay Lab and RACE Division map the benthic habitat on important fishing grounds, study the impact of fishing gear on different types of habitats, and model the relationship between benthic habitat features and fishing activity (Heifetz et al. 2003). Other AFSC ecosystem programs include the North Pacific Climate Regimes and Ecosystem Productivity Program, the Habitat and Ecological Processes program, and the Loss of Sea Ice program (J. Boldt, pers. comm., September 26, 2005). More information on these research programs is available at the AFSC website at: http://www.afsc.noaa.gov.

8.1.3 Increasing protection of ESA-listed and other non-target species

Pollock fishing may impact a wide range of other resources, such as seabirds, marine mammals, and non-target species, such as salmon and halibut. Recent Council and NMFS actions suggest that the Council and NMFS may consider measures for protection for ESA-listed and other non-target species.

Changes in the status of species listed under the ESA, the addition of new listed species, designation of critical habitat, and results of future Section 7 consultations may require modifications to pollock fishing practices to reduce the impacts of this fishery on listed species and critical habitat.

We are not aware of any changes to the ESA-listed salmon status or designated critical habitat that may affect the future pollock fishery. The impacts of the pollock fishery on ESA-listed salmon are currently limited to the Upper Willamette and Lower Columbia River stocks. The tracking of coded-wire tagged surrogate salmon for ESA-listed stocks may result in additional ESA-listed salmon stocks being identified as potentially impacted by the pollock fisheries. The possible take of any additional ESA-listed salmon stocks would trigger ESA consultation and may result in additional management measures for the pollock fishery depending on the result of the consultation.

Washington State’s Sea Grant program is currently working with catcher-processors in the Bering Sea pollock fishery to study the sources of seabird strikes in their operations and to look for ways fishermen can reduce the rate of strikes (Melvin et al. 2004). Other studies are investigating the potential for use of video monitoring of seabird interactions with trawl and longline gear (McElderry et al. 2004; Ames et al. 2005). This research is especially important because action area has very high seabird densities and potential aggregations of ESA-listed short tailed albatross (NMFS 2007b).

Information on listed marine mammals and potential for impacts from this action are contained in Chapter 7.

8.1.3.1 Increasing integration of ecosystems considerations into fisheries management

Ecosystem assessments evaluate the state of the environment, including monitoring climate–ocean indices and species that indicate ecosystem changes. Ecosystem-based fisheries management reflects the incorporation of ecosystem assessments into single species assessments when making management decisions, and explicitly accounts for ecosystem processes when formulating management actions. Ecosystem-based fisheries management may still encompass traditional management tools, such as TACs, but these tools will likely yield different quantitative results.

To integrate such factors into fisheries management, NMFS and the Council will need to develop policies that explicitly specify decision rules and actions to be taken in response to preliminary indications that a regime shift has occurred. These decision rules need to be included in long-range policies and plans. Management actions should consider the life history of the species of interest and can encompass varying response times, depending on the species’ lifespan and rate of production. Stock assessment advice needs to explicitly indicate the likely consequences of alternate harvest strategies to stock viability under various recruitment assumptions.

Management strategy evaluations (MSEs) can help in this process. MSEs use simulation models of a fishery to test the success of different management strategies under different sets of fishery conditions, such as shifts in ecosystem regimes. The AFSC is actively involved in conducting MSEs for several groundfish fisheries, including for several flatfish species in the BS, and for pollock in the GOA.

Both the Pew Commission report and the Oceans Commission report point to the need for changes in the organization of fisheries and oceans management to institutionalize ecosystem considerations in policy making (Pew 2003; U.S. Commission on Ocean Policy 2004). The Oceans Commission, for example, points to the need to develop new management boundaries corresponding to large marine ecosystems, and to align decision-making with these boundaries (U.S. Commission on Ocean Policy 2004).

Since the publication of the Oceans Commission report, the President has established a cabinet-level Committee on Ocean Policy by executive order. The Committee is to explore ways to structure government to implement ecosystem-based ocean management (Evans and Wilson 2005). Congress reauthorized the Magnuson-Stevens Act in December 2006 to addresses ecosystem-based management.

NMFS and the Council are continuing to develop their ecosystem management measures for the fisheries in the EEZ off Alaska. NMFS is currently developing national Fishery Ecosystem Plan guidelines. It is unclear at this time whether these will be issued as guidelines, or as formal provisions for inclusion in the Magnuson-Stevens Act.

The Council has created a committee to research ecosystem developments and to assist in formulating positions with respect to ecosystem-based management. The Council completed a fishery ecosystem plan for the Aleutian Islands ecosystem (NPFMC 2007). An interagency Alaska Marine Ecosystem Forum (AMEF) is improving inter-agency communication on marine ecosystem issues. The Council has signed a Memorandum of Understanding with 10 Federal agencies and 4 State agencies, to create the AMEF. The AMEF seeks to improve communication between the agencies on issues of shared responsibilities related to the marine ecosystems off Alaska’s coast. The initial focus of the AMEF will be on the Aleutian Islands marine ecosystem. The SSC holds annual ecosystem scientific meetings at the February Council meetings.

In addition to these efforts to explore how to develop its ecosystem management efforts, the Council and NMFS continue to initiate efforts to take account of ecosystem impacts of fishing activity. The Council has recommended habitat protection measures for the eastern Bering Sea (73 FR 12357, March 7, 2008). These measures include the Northern Bering Sea Research Area to address potential impacts of shifts in fishing activity to the north.

The Council’s Ecosystem Committee discusses ecosystem initiatives and advise the Council on the following issues: (1) defining ecosystem-based management; (2) identifying the structure and Council role in potential regional ecosystem councils; (3) assessing the implications of NOAA strategic planning; (4) drafting guidelines for ecosystem-based approaches to management; (5) drafting Magnuson-Stevens Act requirements relative to ecosystem-based management; and (6) coordinating with NOAA and other initiatives regarding ecosystem-based management. More details are available in the Council’s website at http://www.fakr.noaa.gov/npfmc/current_issues/ecosystem/Ecosystem.htm.

The Council established Federal fisheries management in the Arctic Management Area. The Council developed, and NMFS approved, an Arctic Fishery Management Plan that (1) closes the Arctic to commercial fishing until information improves so that fishing can be conducted sustainably and with due concern to other ecosystem components, (2) determines the fishery management authorities in the Arctic and provide the Council with a vehicle for addressing future management issues, and (3) implements an ecosystem based management policy that recognizes the unique issues in the Alaskan Arctic. No significant fisheries exist in the Arctic Management Area, either historically or currently. However, the warming of the Arctic and seasonal shrinkage of the sea ice may be associated with increased opportunities for fishing in this region. The action is necessary to prevent commercial fisheries from developing in the Arctic without the required management framework and scientific information on the fish stocks, their characteristics, and the implications of fishing for the stocks and related components of the ecosystem.

8.1.3.2 Fishery management responses to the effects of climate change

While climate warming trends are being studied and increasingly understood at a global scale (IPCC 2007), the ability for fishery managers to forecast biological responses to changing climate continues to be difficult. The Bering Sea is subject to periodic climatic and ecological "regime shifts." These shifts change the values of key parameters of ecosystem relationships, and can lead to changes in the relative success of different species.

The Council and NMFS have taken actions that indicate a willingness to adapt fishery management to be proactive in the face of changing climate conditions. The Council currently receives an annual update on the status and trends of indicators of climate change in the Bering Sea through the presentation of the Ecosystem Assessment and Ecosystem Considerations Report (Boldt 2007). Much of the impetus for Council and NMFS actions in the northern Bering Sea, where bottom trawling is prohibited in the Northern Bering Sea Research Area, and in the Alaskan Arctic, where the Council and NMFS have prohibited all fishing until further scientific study of the impacts of fishing can be conducted, derives from the understanding that changing climate conditions may impact the spatial distribution of fish, and consequently, of fisheries. In order to be proactive, the Council has chosen to close any potential loopholes to unregulated fishing in areas that have not previously been fished.

Consequently, it is likely that as other impacts of climate change become apparent, fishery management will also adapt in response. Because of the large uncertainties as to what these impacts might be, however, and our current inability to predict such change, it is not possible to estimate what form these adaptations may take.

8.1.4 Traditional management tools

8.1.4.1 Authorization of pollock fishery in future years

The annual harvest specifications process for the pollock (and the associated pollock fishery) creates an important class of reasonably foreseeable actions that will take place in every one of the years considered in the cumulative impacts horizon (out to, and including, 2015). Annual TAC specifications limit each year's harvest within sustainable bounds. The overall OY limits on harvests in the BSAI constrain overall harvest of all species. Each year, OFLs, ABCs, and TACs are specified for two years at a time, as described in the Alaska Groundfish Harvest Specifications EIS (NMFS 2007b).

The harvest specifications are adopted in accordance with the mandates of the Magnuson-Stevens Act, following guidelines prepared by NMFS, and in accordance with the process for determining overfishing criteria that is outlined in Section 3.2 of each of the groundfish FMPs. Specifications are developed using the most recent fishery survey data (often collected the summer before the fishery opens) and reviewed by the Council and its SSC, AP, and Plan Teams. The process provides many opportunities for public comment. The management process, of which the specifications are a part, is analyzed in an EIS (NMFS 2007b). Each year's specifications and the status of the environment are reviewed to determine the appropriate level of NEPA analysis.

Annual pollock harvests, conducted in accordance with the annual specifications, will impact pollock stocks. Annual harvest activity may change total mortality for the pollock stock, may affect stock characteristics through time by selective harvesting, may affect reproductive activity, may increase the annual harvestable surplus through compensatory mechanisms, may affect the prey for the target species, and may alter EFH.

The annual pollock harvests also impact the environmental components described in this analysis: salmon, non-target fish species, seabirds, marine mammals, and a more general set of ecological relationships. In general, the environmental components are renewable resources, subject to environmental fluctuations. Ongoing harvests of pollock may be consistent with the sustainability of other resource components if the fisheries are associated with mortality rates that are less than or equal to the rates at which the resources can grow or reproduce themselves.

The on-going pollock fishery employs hundreds of fishermen and fish processors, and contributes to the maintenance of human communities, principally in Alaska, Washington, and Oregon.

In 2010 the BSAI groundfish FMP was amended to ‘break out’ other species into individual categories for management purposes thus separate specification are now established for squid, sharks, octopus and skates (NPFMC 2010).. The number of TAC categories with low values for ABC/OFL is increasing which tends to increase the likelihood that NMFS will close directed fisheries to prevent overfishing. Managers closely watch species with fairly close amounts between the OFL and ABCs during the fishing year and the fleet will adjust behavior to prevent incurring management actions. While managing the species with separate ABCs and OFLs reduces the potential for overfishing the individual species, the effect of creating more species categories can increase the potential for incurring management measures to prevent overfishing.

8.1.5 Increasing enforcement responsibilities

The U.S. Coast Guard (USCG) conducts fisheries enforcement activities in the EEZ off Alaska in cooperation with NOAA Office for Law Enforcement (OLE). New programs to protect resource components from pollock fishery impacts will create additional responsibilities for enforcement agencies. Despite this likely increase in enforcement responsibilities, it is not clear that resources for enforcement will increase proportionately.

The USCG is expected to bear a heavy responsibility for homeland security and is not expected to receive proportionate increases in its budget to accommodate increased fisheries enforcement. Increased responsibilities for homeland security and for detection of increasing drug-smuggling activities in waters off Alaska have limited the resources available for the USCG to conduct enforcement activities at the same level as in the recent past. Any deterrent created by Coast Guard presence in enforcing fisheries regulations and restrictions would likely be reduced, as would the opportunities for detection of fisheries violations at-sea.

Likewise, the NOAA OLE has not recently received increased resources consistent with its increasing enforcement obligations (J. Passer, pers. comm., March 2008). However, new enforcement assistance has become available in recent years through direct Congressional line item appropriations for Joint Enforcement Agreements (JEAs) with all coastal states. The State of Alaska has received approximately $10 million of this funding since 2001, and has used JEA money to purchase capital assets such as patrol vessels and patrol vehicles. The State has also hired new personnel to increase levels of at-sea and dockside enforcement and used JEA money to pay for support and operational expenses pertaining to this increased effort (J. Passer, pers. comm., March 2008).

Uncertainties about Congressional authorization of increased enforcement funding preclude any prediction of trends in the availability of resources to meet increased enforcement responsibilities. Thus, while an increase in responsibilities is reasonably foreseeable, a proportionate increase in funding is not.

8.1.6 Technical and program changes that will improve enforcement and management

Managers are increasingly using technology for fisheries management and enforcement. Managers are likely to increase use of vessel monitoring systems (VMS) in coming years. Vessels fishing for pollock in the Bering Sea are required to operate VMS units (50 CFR 679.7(a)(18)). Managers and enforcement personnel are making extensive use of the information from existing VMS units, and are likely to make more use of it in the future, as they continue to learn how to use it more effectively.

Monitoring the catch of pollock and salmon bycatch in the pollock fisheries relies heavily on data collected by NMFS-certified observers. Increased observer coverage requirements as a result of Amendment 91 are contained in Chapter 2. Observers currently are provided through a system known as “pay-as-you-go” under which vessels operators required to carry a NMFS certified observer contract directly for observer services with observer providers (businesses who hire and provide observers).

The Council took action in October 2010 to restructure the North Pacific Groundfish Observer Program to provide a new system for procuring and deploying observers in those fisheries that require at least 100% observer coverage. The Council recommended restructuring the program such that NMFS would contract directly with observer companies to deploy observers according to a scientifically valid sampling and deployment plan, and industry would pay a fee equal to 1.25% of the ex-vessel value of the landings included under the program. (The Magnuson Stevens Act authorizes collection of an ex-vessel fee of up to 2%.) As all sectors benefit from the resulting data, the Council chose to apply the same fee percentage to all restructured sectors, in order to develop a fee program that is fair and equitable across all sectors in the restructured program.

The new program is intended to address problems identified under the status quo. Under the status quo, NMFS cannot determine when and where to deploy observers in the sectors with less than 100% coverage requirements, coverage levels are fixed in regulation, and data gaps exist for sectors without any coverage. The restructured program is intended to provide NMFS with the flexibility to deploy observers in response to fishery management needs and to reduce the bias inherent in the existing program by employing a random vessel selection process, to the benefit of the resulting data. While this action denotes a significant change in the observer program for many vessels and fisheries, it does not affect monitoring in the BS pollock fishery, as the Council action explicitly placed industry sectors that are determined to need at least 100% coverage in the ‘full coverage’ category. This category of vessels will continue to meet observer coverage requirements by contracting directly with observer companies under the status quo service delivery model. Vessels and processors in the full coverage category include: all catcher processors and motherships; catcher vessels while fishing under a management system that uses prohibited species caps in conjunction with a catch share program (e.g., catcher vessels while participating in AFA pollock and GOA rockfish catch share program); and shoreside and floating processors when taking deliveries of AFA and CDQ pollock. Thus, the primary improvements in monitoring within the BS pollock fishery are due to the increased observer coverage requirements implemented under Amendment 91 (refer to Chapter 2).

Support of the observer program and investigations involving observers and observer data quality are the highest priority of the NOAA OLE. Since 1998, the NOAA OLE has provided dedicated staff to investigate observer reported violations and to maintain the partnership between NOAA

OLE and the NPGOP. NOAA OLE currently dedicates two Special Agents to liaison with and to provide law enforcement support for the observer program. The dedicated agents provide inseason enforcement, observer deployment and debriefing support, subject matter expertise, and observer training to the NPGOP staff and the observers. NOAA OLE provides support to observers and industry through public outreach, partnership building, education, program development, and the enforcement of laws and regulations intended to protect observers and to provide them safe and productive work environments. NOAA OLE strives to promote voluntary compliance and law enforcement through communication with the observers themselves, NMFS observer program staff, fishery stakeholders, and other law enforcement agencies.

In 2008, when compared to 2006 and 2007, NOAA OLE saw an increase of at least 62% in the total number of North Pacific groundfish observer statements alleging violations. This increase coincides with the increased concerns regarding prohibited species numbers and with the implementation of the Amendment 80 fisheries. Stronger prohibited species restrictions will continue to increase the need for the high quality observer data, while simultaneously providing greater incentive for industry to hide fish or to manipulate or bias observer data.

During 2008, NOAA OLE provided compliance monitoring training to more than 450 new and prior observers in more than 40 training sessions. NOAA OLE provides observer training on prohibited species mishandling, sample station requirements, limited access fishery requirements, reasonable assistance, accommodations, access to catch and records, recordkeeping and reporting, conflict resolution, interference, sample biasing, and hostile work environments. Under Amendment 91, NOAA OLE anticipates the need for additional law enforcement support and NOAA OLE provided training on the above subject categories and on issues related specifically to salmon number verification.

NMFS is investigating the use of shipboard video monitoring to ensure compliance with full retention requirements in other regions. In the Alaska Region, NMFS has implemented video monitoring to monitor catch sorting actions of crew members inside fish holding bins and investigating the use of video to monitor regulatory discards. An EFP for continued development of the capability to do video monitoring of rockfish catch in the GOA is currently under consideration by NMFS and Council (73 FR 14226, March 14, 2008). NMFS is hopeful that these investigations could lead to regulations that allow use of video monitoring to supplement observer coverage in some fisheries. Electronic monitoring technology is evolving rapidly, and it is probable that video and other technologies will be introduced to supplement current observer coverage and enhance data collection in some fisheries. Video monitoring as not been sufficiently tested to ensure compliance with a no discard requirement at this time, but NMFS would support and encourage research to explore the feasibility of video for this use.

In addition to the technical aspects of video monitoring, several other issues related to video must be resolved. These include the amount of staff time and resources that would be required to review video footage, curation and storage questions, and the costs to NMFS and the fishing industry. Until these issues are resolved, NMFS will continue to implement existing proven monitoring and catch estimation protocols. Electronic monitoring is discussed in more detail in section 10.5.7.4.

8.1.6.1 Development of the salmon excluder device

Gear modifications are one way to reduce salmon bycatch in the pollock fisheries. NMFS has issued exempted fishing permits for the purpose of testing a salmon excluder device in the pollock trawl fishery of the Bering Sea from 2004 to 2006 and for fall 2008 through spring 2011.

The successful development of a salmon excluder device for pollock trawl gear may result in reductions of salmon bycatch, potentially reducing costs associated with the harvest of pollock and reducing the potential impact on the salmon stocks. The excluder has been successful in reducing Chinook salmon bycatch and modifications are being tested to improve its effectiveness for reducing chum salmon bycatch.

8.1.7 Actions by Other Federal, State, and International Agencies

8.1.7.1 State salmon fishery management

ADF&G is responsible for managing commercial, subsistence, sport, and personal use salmon fisheries. The first priority for management is to meet spawning escapement goals to sustain salmon resources for future generations. Highest priority use is for subsistence under both State and Federal law. Surplus fish beyond escapement needs and subsistence use are made available for other uses. Stock assessment overviews by region for Chum stocks and a description of state management by area are contained in Chapter 5. The Alaska Board of Fisheries (BOF) adopts regulations through a public process to conserve fisheries resources and to allocate fisheries resources to the various users. Yukon River salmon fisheries management includes obligations under an international treaty with Canada. Subsistence fisheries management includes coordination with U.S. Federal government agencies where federal rules apply under ANILCA. Subsistence salmon fisheries are an important culturally and greatly contribute to local economies. Commercial fisheries are also an important contributor to many local communities as well as supporting the subsistence lifestyle.

The Area M fishery in the Alaska Peninsula is managed by the State of Alaska. Area M is further divided into two management areas, the North Alaska management area and the South Alaska management area. Stock status of this region and direct impacts of the action on the Area M stocks are contained in Chapter 5 of this analysis. Combined harvests in the fishery in 2009 totaled more than 1.7 million fish. It seems reasonably foreseeable that this fishery will continue in the future.

Per Council request for additional information regarding the stock of origin if chum salmon caught in the combined Area M chum salmon fisheries, the following information was excerpted from a report presented by ADF&G to the BOF in February 2010 entitled “Summary of Studies Addressing Stock Composition in the South Unimak and Shumagin Islands Fishery” (ADF&G, 2010). The origin of chum salmon stocks harvested in the South Unimak and Shumagin Islands June fishery has been a source of concern among fishermen throughout Western Alaska for several decades. Many studies have been conducted to ascertain origins of harvested stocks and their relative proportions in fisheries during the past 88 years with the most recent study currently undergoing analysis (Western Alaska Salmon Stock Identification Project; WASSIP). The two most current completed analyses of stock composition in the June fishery are known as the “1987 Tagging Study” (Eggers et al. 1988; Eggers et al. 1991; ADF&G BOF Report 1992) and “Genetic analysis of chum salmon harvested in the South Unimak and Shumagin Islands June Fisheries, 1993-1996” (Seeb et al. 1997). Another genetic study called “Genetic analysis of chum salmon harvested in the South Peninsula Post June Fishery, 1996-1997” (Crane and Seeb 2000) was conducted along the South Peninsula during July and August of 1996 and 1997.

Regarding the first study, there were many caveats noted in the BOF report with respect to tagging methodology and analysis but in general, the most recent analysis of data from the 1987 tagging study (ADF&G BOF Report 1992) attempted to model the possible range of stock compositions in the fishery. All modeled cases showed an overwhelming representation (83%-

90%) of Western Alaska summer chum complex (Kotzebue, Norton Sound, Yukon, Kuskokwim, Bristol Bay) and Asian stocks, with stocks from North Peninsula, South Peninsula, and Central Alaska present in much smaller proportions. Early tag releases tended to be from Norton Sound, Yukon and Kuskokwim stocks while later releases were mainly from Bristol Bay, North or South Alaska Peninsula, and Central Alaska stocks. This study provided insight into the broad composition of stocks in the June fishery, which was valuable in determining appropriate baseline representation for subsequent genetic analyses.

Regarding the second study, chum salmon were sampled for genetic (allozyme) analysis during the June fisheries in 1993 through 1996 at South Unimak and 1994 through 1996 in the Shumagin Islands. The purpose was to estimate stock proportions in samples (Seeb et al. 1997). Results of this study were broadly similar to those of the 1987 tagging study, in that NW Alaska summer and Asian chum stocks represented the majority of stock groups present. Northwest Alaska summer chum was the largest component of the South Unimak and Shumagin Islands June fishery in every year sampled and was a larger component of the South Unimak fishery than the Shumagin Islands fishery in two of the three years.

Finally with respect to studies of stock composition from this fishery, during July and early August of 1996 and 1997, chum salmon were sampled for genetic stock identification on the South Alaska Peninsula (Crane and Seeb 2000). Fish were sampled from the department test fishery as well as from commercial harvests. The commercial fishery was divided into two geographical areas (the Shumagin Islands area consisting of the Shumagin Island Section of the Southeastern District and the Mainland Area consisting of the Southeastern District Mainland and the Unimak, Southwestern, and South Central districts) and into three time periods. Stock group proportions were estimated using allozymes and chum salmon were assigned to the same ten reporting groups as identified in the June genetics study. Over the time period analyzed in this study, little change in stock composition was observed. The majority of stocks came from the Alaska Peninsula/Kodiak group. In contrast to the pattern of stock contributions in the June fishery, proportions of NW Alaska summer and Fall Yukon in the post-June fishery were very low.

The Western Alaska Salmon Stock Identification Project (WASSIP) was initiated in 2006 and has comprehensively sampled commercial and subsistence fisheries for chum and sockeye salmon throughout Western Alaska, from Chignik to Kotzebue over a four year period. Mixed stock analyses to estimate relative stock contributions to catches will be accomplished using the single nucleotide polymorphism (SNP) baseline for chum salmon. The chum salmon baseline has been greatly expanded in recent years, and consists of greater than 30,000 individuals from 167 populations throughout the Pacific Rim. Analyses will be conducted using 96 SNP markers, many of which are being developed to differentiate among chum salmon populations spawning within western Alaska and Alaska Peninsula drainages. With addition of more baseline populations, development of additional genetic markers and incorporation of methods designed to more precisely estimate small stock proportions in samples, WASSIP will be the most comprehensive stock identification project to date, including more than 75,000 individuals from harvest samples. It is anticipated that when the analysis is released in 2012 it will provide significantly more detailed and accurate information than all preceding stock identification projects.

While specific aspects of overall State of Alaska salmon fishery management continue to be modified, it is reasonably foreseeable that the current State management of the salmon fisheries will continue into the future.

8.1.7.2 Hatchery releases of salmon

Hatcheries produce salmon fry and release these small salmon into the ocean to grow and mature before returning as adults to the hatchery or local rivers and streams for harvest or breading. Hatchery production increases the numbers of salmon in the ocean beyond what is produced by the natural system. A number of hatcheries produce salmon in Korea, Japan, Russia, the US, and Canada. The North Pacific Anadromous Fish Commission summarizes information on hatchery releases, by country and by area, where available. Chapter 5, Chum salmon, and Chapter 6, Chinook salmon, provide more information on current and past hatchery releases. It is reasonably foreseeable the hatchery production will continue at a similar level into the future.

8.1.7.3 Future exploration and development of offshore mineral resources

The Minerals Management Service (MMS) expects that reasonably foreseeable future activities include numerous discoveries that oil companies may begin to develop in the next 15-20 years in federal waters off Alaska. Potential environmental risks from the development of offshore drilling include the impacts of increased vessel offshore oil spills, drilling discharges, offshore construction activities, and seismic surveys. In an EIS prepared for sales in the OCS Leasing Program, the MMS has assessed the cumulative impacts of such activities on fisheries and finds only small incremental increases in impacts for oil and gas development, which are unlikely to significantly impact fisheries and essential fish habitat (MMS 2003).

8.1.8 Private actions

8.1.8.1 Commercial pollock and salmon fishing

Fishermen will continue to fish for pollock, as authorized by NMFS, and salmon, as authorized by the State. Fishing constitutes the most important class of reasonably foreseeable future private actions and will take place indefinitely into the future. Chapter 4 and the RIR, provide more information on the Bering Sea pollock fishery.

Commercial salmon fisheries exist throughout Alaska, in marine waters, bays, and rivers. Chapter 5 Chum Salmon, Chapter 6 Chinook Salmon, and the RIR provide more information on the commercial salmon fisheries.

8.1.8.2 CDQ Investments in western Alaska

The CDQ Program was designed to improve the social and economic conditions in western Alaska communities by facilitating their economic participation in the BSAI fisheries. The large-scale commercial fisheries of the BSAI developed in the eastern BS without significant participation from rural western Alaska communities. These fisheries are capital-intensive and require large investments in vessels, infrastructure, processing capacity, and specialized gear. The CDQ Program was developed to redistribute some of the BSAI fisheries' economic benefits to adjacent communities by allocating a portion of commercially important BSAI species to such communities as fixed shares, or quota, of groundfish, halibut, and crab. The percentage of each annual BSAI catch limit allocated to the CDQ Program varies by both species and management area. These allocations, in turn, provide an opportunity for residents of these communities to both participate in and benefit from the BSAI fisheries.

Sixty-five communities participate in the CDQ Program. These communities are organized under six non-profit corporations (CDQ groups) to manage and administer the CDQ allocations, investments, and economic development projects. Annual CDQ allocations provide a revenue stream for CDQ groups through various channels, including the direct catch and sale of some species, leasing quota to various harvesting partners, and income from a variety of investments. In 2009, the six CDQ groups generated nearly $180 million in revenue with operating expenses of $161 million, resulting in an increase in net assets of nearly $18 million. Operating expenses include all program costs, investments, and general and administrative expenses.[36]

One of the most tangible direct benefits of the CDQ Program has been employment opportunities for western Alaska village residents. Jobs generated by the CDQ Program included work aboard a wide range of fishing vessels, internships with the business partners or government agencies, employment at processing plants, and administrative positions. Many of the jobs generated by the CDQ Program are associated with shoreside fisheries development projects in CDQ communities. This includes a wide range of projects, including those directly related to commercial fishing. Examples of such projects include building or improving seafood processing facilities, purchasing ice machines, purchasing and building fishing vessel, gear improvements, and construction of docks or other fish handling infrastructure.

CDQ groups also have invested in peripheral projects that directly or indirectly support commercial fishing for halibut, salmon, and other nearshore species. This includes seafood branding and marketing, quality control training, safety and survival training, construction and staffing of maintenance and repair facilities that are used by both fishermen and other community residents, and assistance with bulk fuel procurement and distribution. Several CDQ groups are actively involved in salmon assessment or enhancement projects, either independently or in collaboration with ADF&G. Salmon fishing is a key component of western Alaska fishing activities, both commercially and for subsistence. The CDQ Program provides a means to support and sustain both such activities.

8.1.8.3 Subsistence harvest of salmon

Communities in western and Interior Alaska depend on salmon from the Bering Sea for subsistence and the associated cultural and spiritual needs. Chum and Chinook salmon consumption can be an important part of regional diets, and salmon products are distributed as gifts or through barter and small cash exchanges to persons who do not directly participate in the subsistence fishery. Subsistence harvests will continue indefinitely into the future. The RIR provides more information on subsistence harvests.

8.1.8.4 Sport fishing for salmon

Regional residents may harvest chum and Chinook salmon for sport, using a State sport fishing license, and then use these salmon for essentially subsistence purposes. Regional sport fisheries, including salmon fisheries may also attract anglers from other places. Anglers who come to the action area from elsewhere to sport fish generate economic opportunities for local residents. Sport fishing for salmon will continue indefinitely into the future.

---

[36] 2009 CDQ Sector report, WACDA, p. 16. http://www.wacda.org/media/pdf/SMR_2009.pdf

8.1.9 Summary of cumulative impacts

Note that significance criteria will be developed and incorporated into the impact analysis for the public review draft in order to evaluate the significance of the impacts of the alternative management measures on cumulative impacts.

Reasonably foreseeable future actions that may affect target and prohibited species are shown in Table 8-1. Ecosystem management, rationalization, and traditional management tools are likely to improve the protection and management of target and prohibited species, including pollock and chum salmon and are not likely to result in significant effects when combined with the direct and indirect effects of Alternatives 2, 3 and 4. Ongoing research efforts are likely to improve our understanding of the interactions between the harvest of pollock and salmon. NMFS is conducting or participating in several research projects to improve understanding of the ecosystems, fisheries interactions, and gear modifications to reduce salmon bycatch.

The State of Alaska manages the commercial salmon fisheries off Alaska. The State’s first priority for management is to meet spawning escapement goals to sustain salmon resources for future generations. Subsistence use is the highest priority use under both State and Federal law. Surplus fish beyond escapement needs and subsistence use are made available for other uses, such as commercial and sport harvests. The State carefully monitors the status of salmon stocks returning to Alaska streams and controls fishing pressure on these stocks.

Other government actions and private actions may increase pressure on the sustainability of target and prohibited fish stocks either through extraction or changes in the habitat or may decrease the market through aquaculture competition, but it is not clear that these would result in significant cumulative effects. Any increase in extraction of target species would likely be offset by federal management. These are further discussed in Sections 4.1.3 and 7.3 of the Harvest Specifications EIS (NMFS 2007).

Reasonably foreseeable future actions for non-specified and forage species include ecosystem-sensitive management, traditional management tools, and private actions. Impacts of ecosystem-sensitive management and traditional management tools are likely to be beneficial as more attention is brought to the taking of non-specified species in the fisheries and accounting for such takes.

Reasonably foreseeable future actions for marine mammals and seabirds include ecosystem-sensitive management; rationalization; traditional management tools; actions by other federal, state, and international agencies; and private actions, as described in Sections 8.4 and 9.3 of the Harvest Specifications EIS (NMFS 2007a). Ecosystem-sensitive management, rationalization, and traditional management tools are likely to increase protection to marine mammals and seabirds by considering these species more in management decisions, and by improving the management of the pollock fishery through the restructured observer program, catch accounting, seabird avoidance measures, and vessel monitoring systems (VMS). Research into marine mammal and seabird interactions with the pollock fisheries are likely to lead to an improved understanding leading to trawling methods that reduce adverse impacts of the fisheries. Changes in the status of species listed under the ESA, the addition of new listed species or critical habitat, and results of future Section 7 consultations may require modifications to groundfish fishing practices to reduce the impacts of these fisheries on listed species and critical habitat. Any change in protection measures for marine mammals likely would have insignificant effects because any changes would be unlikely to result in the PBR being exceeded and would not be likely to result in jeopardy of continued existence or adverse modification or destruction of designated critical habitat. Additionally, since future TACs will be set with existing or enhanced protection measures, it is reasonable to assume that the effects of the fishery on the harvest of prey species and disturbance will likely decrease in future years.

Any action by other entities that may impact marine mammals and seabirds will likely be offset by additional protective measures for the federal fisheries to ensure ESA-listed mammals and seabirds are not likely to experience jeopardy or adverse modification of critical habitat. Direct mortality by subsistence harvest is likely to continue, but these harvests are tracked and considered in the assessment of marine mammals and seabirds. The cumulative effect of these impacts in combination with measures proposed under Alternatives 2, 3 and 4 is not likely to be significant.

Reasonably foreseeable future actions for habitat and the ecosystem include ecosystem-sensitive management; rationalization; traditional management tools; actions by other federal, state, and international agencies; and private actions, as detailed in Sections 10.3 and 11.3 of the Harvest Specifications EIS (NMFS 2007). Ecosystem-sensitive management, rationalization, and traditional management tools are likely to increase protection to ecosystems and habitat by considering ecosystems and habitat more in management decisions and by improving the management of the fisheries through the observer program, catch accounting, seabird and marine mammal protection, gear restrictions, and VMS. Continued fishing under the harvest specifications is likely the most important cumulative effect on EFH but the EFH EIS (NMFS 2005) has determined that this effect is minimal. The Council is also considering improving the management of non-specified species incidental takes in the fisheries to provide more protection to this component of the ecosystem. Any shift of fishing activities from federal waters into state waters would likely result in a reduction in potential impacts to EFH because state regulations prohibit the use of trawl gear in much of state waters. Nearshore impacts of coastal development and the management of the Alaska Water Quality Standards may have an impact on EFH, depending on the nature of the action and the level of protection the standards may afford. Development in the coastal zone is likely to continue, but Alaska overall is lightly developed compared to coastal areas elsewhere and therefore overall impact to EFH are not likely to be great. The EBS pollock fishery has been independently certified to the Marine Stewardship Council environmental standard for sustainable fishing. Overall, the cumulative effects on habitat and ecosystems are under Alternatives 2, 3 and 4 are not likely to be significant.

Considering the direct and indirect impacts of the proposed action when added to the impacts of past and present actions previously analyzed in other documents that are incorporated by reference and the impacts of the reasonably foreseeable future actions listed above, the cumulative impacts of the proposed action are determined to be not significant.

9 Preparers and Persons Consulted

Lead preparers:

North Pacific Fishery Management Council:
Diana L. Stram
Nicole S. Kimball

NOAA Alaska Fisheries Science Center:
James N. Ianelli

NOAA Regional Office:
Scott A. Miller

Additional contributions:

Jeannie Heltzel, NPFMC

NOAA Alaska Fisheries Science Center:
Alan Haynie
Jeff Guyon
Ellen Martinson

ADF&G (Ch 5 stock status sections):
John Linderman
Tim Baker
Eric Volk
Scott Kelley
Steven Honnold
Dan Bergstrom
Dan Gray
Tracy Lingnau
Karla Bush
Ruth Christianson

Individuals consulted:
Bill Templin
Hamachan Hamazaki
Karl Haflinger
John Gruver
Mary Furuness
Michele Masuda

Note this list will be revised for the public review draft to include those personnel we inadvertently omitted to list for this version.

10 References

[Note any missing references will be included in the public review draft]

Alaska Department of Fish and Game, 2010. Summary of Studies Addressing Stock Composition in the South Unimak and Shumagin Islands Fishery. ADF&G report RC-60 BOF.

Alaska Department of Fish and Game, 1992, 1987 South Peninsula Tagging Study (review and revisions). Report to the Alaska Board of Fisheries. March 3, 1992. 35 pp.

Anderson, T.J. 2010. Chignik Management Area commercial salmon fishery harvest strategy, 2010. Alaska Department of Fish and Game, Fishery Management Report No. 10-18, Anchorage.

Balsiger, J. W. 2011. Memorandum to the Record regarding Amendment of Incidental Take Statement in the 2010 Biological Opinion Issued for the Alaska Groundfish Fisheries of the Bering Sea, Aleutian Islands, and Gulf of Alaska Addressing the Incidental Take of Six Marine Mammal Stocks listed under the Endangered Species Act. February 10, 2011. NMFS Alaska Region, P. O. Box 21668, Juneau, AK 99802. Available at http://www.fakr.noaa.gov/protectedresources/stellers/esa/biop/final/its_auth_022011.pdf

Beacham, T.D., J.R. Candy, K.D. Le, and M. Wetklo. 2009b. Population structure of chum salmon (Oncorhynchus keta) across the Pacific Rim, determined from microsatellite analysis. Fish. Bull. 107: 244-260.

Beacham, T.D., J.R. Candy, S. Sato, S. Urawa, K.D. Le, and M. Wetklo. 2009a. Stock origins of chum salmon (*Oncorhynchus keta*) in the Gulf of Alaska during winter as estimated with microsatellites. N. Pac. Anadr. Fish Comm. Bull. 5: 15-23.

Branch, T.A.and R. Hilborn. 2010. A general model for reconstructing salmon runs. Canadian Journal of Fisheries & Aquatic Sciences. 67:5. 886-904.

Bue, B. G., D. B. Molyneaux, and K. L. Schaberg. 2008. Kuskokwim River chum salmon run reconstruction. Alaska Department of Fish and Game, Fishery Data Series No. 08-64, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds08-64.pdf

Bue, F. 2000a. Norton Sound Subdistrict 1 (Nome) chum salmon stock status and development of management/action plan options. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-36, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2000.36.pdf

Bue, F. 2000b. Norton Sound Subdistricts 2 and 3 (Golovin and Moses Point) chum salmon stock status and development of management/action plan options. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A00-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2000.35.pdf

Burkey, Jr., C. E., M. Coffing, D. B. Molyneaux, and P. Salomone. 2000. Kuskokwim River chum salmon stock status and development of management/action plan options, report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A00-41, Anchorage.

Clark, J. H. 2001. Biological escapement goal for chum salmon in Subdistrict one of Norton Sound. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A01-09, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/RIR.3A.2001.09.pdf

Clark, J. H., G. F. Woods, and S. Fleischman. 2003. Revised biological escapement goal for the sockeye salmon stock returning to the East Alsek-Doame river system of Yakutat, Alaska. Alaska Department of Fish and Game, Special Publication Series No. 03-04, Anchorage.

Collie, J. S., R.M. Peterman and B.M. Zuehlke 2009. A Risk Assessment Framework for Alaska Chum Salmon. Arctic Yukon Kuskokwim Sustainable Salmon Initiative report number XXXX.

Crane, P. A. and Seeb, L. W. 2000. Genetic analysis of chum salmon harvested in the South Peninsula, post June fishery, 1996-1997. Alaska Department of Fish and Game, Anchorage, Alaska. Regional Information Report No. 5J00-05.

Davis, Lucas W., "The Effect of Driving Restrictions on Air Quality in Mexico City," *Journal of Political Economy*, 2008, *116(1)*, 38–81.

Davidson, W., R. Bachman, W. Bergmann, D. Gordon, S. Heinl, K. Jensen, K. Monagle, S. Walker. 2008. Annual management report of the 2008 Southeast Alaska commercial purse seine and drift gillnet fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 08-70, Anchorage.

Demaster, D. 2009. Memorandum to Doug Mecum regarding Aerial Survey of Steller Sea Lions in Alaska, June-July 2009 and Update on the Status of the Western Stock in Alaska. December 2, 2009, Alaska Fisheries Science Center, National Marine Mammal Laboratory (NMML), 7600 Sand Point Way NE, Seattle WA 98115. http://www.afsc.noaa.gov/nmml/PDF/SSL-Survey-09-memo-11-30-09.pdf.

Dinnocenzo, J., G. Spalinger, and I.O. Caldentey. 2010. Kodiak Management Area commercial salmon fishery annual management report, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-22, Anchorage.

Dorn, M.W. 1992. Detecting environmental covariates of Pacific whiting *Merluccius productus* growth using a growth-increment regression model. Fish. Bull. 90:260-275.

Eggers, D. M., M. D. Plotnick, and A. M. Carroll. 2010. Run forecasts and harvest projections for 2010 Alaska salmon fisheries and review of the 2009 season. Alaska Department of Fish and Game, Special Publication No. 10-02, Anchorage.

Eggers, D.M. and A.M. Carroll. 2011. Run forecasts and harvest projections for 2011 Alaska salmon and review of the 2010 season. Alaska Department of Fish and Game, Special Publication No. 11-03, Anchorage.

Eggers, D.M. and A.M. Carroll. 2011. Run forecasts and harvest projections for 2011 Alaska salmon and review of the 2010 season. Alaska Department of Fish and Game, Special Publication No. 11-03, Anchorage.

Eggers, D.M., and S.C. Heinl. 2008. Chum salmon stock status and escapement goals in Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 08-19, Anchorage.

Eggers, D. M., K. Rowell and B. Barrett. 1988. The stock composition of the catches of sockeye and chum salmon in the 1987 South Peninsula and June fishery based on tagging, Volume 1 - Text. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J88-03, Juneau.

Eggers, D. M., K. Rowell and B. Barrett. 1988. The stock composition of the catches of sockeye and chum salmon in the 1987 South Peninsula and June fishery based on tagging, Volume 2 - Appendices. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J88-03, Juneau.

Eggers, D. M., K. Rowell, and B. Barrett. 1991. Stock composition of sockeye and chum salmon catches in southern Alaska Peninsula fisheries in June. Fishery Research Bulletin No. 91-01, Alaska Department of Fish and Game, Division of Commercial Fisheries, Juneau, Alaska.

Estensen, J. L., D. B. Molyneaux, and D. J. Bergstrom. 2009. Kuskokwim River salmon stock status and Kuskokwim area fisheries, 2009; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 09-21, Anchorage.

Fall. J. A., D. Caylor, M. Turek, C. Brown, J. Magdanz, T. Krauthoefer, J. Heltzel, and D. Koster. 2007. Alaska subsistence salmon fisheries 2005 annual report. Alaska Department of Fish and Game, Division of Subsistence Technical Paper No. 318, Juneau.

Gilk, S.E., W.D. Templin, D. B. Molyneaux, T. Hamazaki, and J.A. Pawluk. 2005. Characteristics of fall chum salmon Oncorhynchus keta in the Kuskokwim River drainage. Alaska Department of Fish and Game, Fishery Data Series No. 05-56, Anchorage.

Gray, A., T. McCraney, C. Marvin, C. M. Kondzela, H. T. Nguyen, and J. R. Guyon. 2010. Genetic Stock Composition Analysis of Chum Salmon Bycatch Samples from the 2008 Bering Sea Groundfish Fisheries. Auke Bay Laboratories, Alaska Fisheries Science Center, NOAA Fisheries, 17109 Pt. Lena Loop Road Juneau, AK 99801. **DRAFT** Submitted November 29, 2010

Guyon, J.R., C. Kondzela, T. McCraney, C. Marvin and E. Martinson. 2010. Genetic Stock Composition Analysis of Chum Salmon Bycatch Samples from the 2005 Bering Sea Groundfish Fishery. Auke Bay Laboratories, Alaska Fisheries Science Center, NOAA Fisheries, 17109 Pt. Lena Loop Road Juneau, AK 99801. **DRAFT** Submitted February 2, 2010

Hammarstrom, L.F. and E.G. Ford. 2010. 2009 Lower Cook Inlet Annual Finfish Management Report. Alaska Department of Fish and Game, Fishery Management Report No. 10-17, Anchorage.

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.

Hartill, T. G., and R. L. Murphy. 2010. North Alaska Peninsula commercial salmon annual management report, 2009. Alaska Department of Fish and Game, Fishery Management Report 10-19, Anchorage.

Hilborn, R.M. Peterman, P. Rand, D. Schindler, J. Stanford, R.V. Walker, and C.J. Walters. 2009. The salmon MALBEC Project: A North Pacifc-scale study to support salmon conservation planning. N. Pac. Anadr. Fish Comm. Bull 5: 333–354.

Honnold, S. G., M. J. Witteveen, I. Vining, H. Finkle, M. B. Foster, and J. J. Hasbrouck. 2007. Review of salmon escapement goals in the Alaska Peninsula Aleutian Islands Management Areas, 2006. Alaska Department of Fish and Game, Fishery Manuscript No. 07-02, Anchorage.

Jackson, J., and J. Dinnocenzo. 2010. Kodiak management area harvest strategy for the 2010 commercial salmon fishery. Alaska Department of Fish and Game, Fishery Management Report No. 10-16, Anchorage.

Jackson, J.V., and T.J. Anderson. 2010. Chignik Management Area salmon and herring annual management report, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-59, Anchorage.

Johnson, J. and M. Daigneault. 2008 Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Western Region, Effective June 2, 2008. Alaska Department of Fish and Game, Special Publication No. 08-08, Anchorage. http://www.sf.adfg.state.ak.us/Static/AWC/PDFs/WST_2008_CATALOG.pdf.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2011. Yukon River salmon 2010 season summary and 2011 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report NO. 3A11-01, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2011. Yukon River salmon 2010 season summary and 2011 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report NO. 3A11-01, Anchorage.

Kimura, D.K. 1989. Variability in estimating catch-in-numbers-at-age and its impact on cohort analysis. *In* R.J. Beamish and G.A. McFarlane (eds.), Effects on ocean variability on recruitment and an evaluation of parameters used in stock assessment models. Can. Spec. Publ. Fish. Aq. Sci. 108:57-66.

Lee, David S. and Thomas Lemieux. 2009. “Regression Discontinuity Designs in Economics,” NBER Working Paper No. 14723, October.

Lewis, B., J. Botz, R. Brenner, G. Hollowell, and S. Moffitt. 2008. 2007 Prince William Sound area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 08-53, Anchorage.

Linderman, J. C. Jr., and D. J. Bergstrom. 2006. Kuskokwim River Chinook and chum salmon stock status and Kuskokwim area fisheries; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-35, Anchorage.

Lynch, B., and P. Skannes. 2008. Annual management report for the 2008 Southeast Alaska/Yakutat salmon troll fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 08-69, Anchorage.

Mantua, N.J., N.G. Taylor, G.T. Ruggerone, K.W. Myers, D. Preikshot, X. Augerot, N.D. Davis, B. Dorner, R.

Marvin, C. Wildes, S, Kondzela C, Nguyen H, and J.R. Guyon. 2010. Genetic Stock Composition Analysis of Chum Salmon Bycatch Samples from the 2006 Bering Sea Groundfish Fisheries. Auke Bay Laboratories, Alaska Fisheries Science Center, NOAA Fisheries, 17109 Pt. Lena Loop Road Juneau, AK 99801. **DRAFT** submitted September 21, 2010

McCraney, W.T., C.M. Kondzela, J. Murphy, and J.R. Guyon. 2010. Genetic stock identification of chum salmon from the 2006 and 2007 Bering-Aleutian Salmon International Survey. NPAFC Doc. 1288. 11 p. Auke Bay Laboratories, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 17109 Pt. Lena Loop Road, Juneau, AK 99801, USA. (Available at http://www.npafc.org).

Memorandum. 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region4/finfish/salmon/kodiak/09kodseasum.pdf.

Memorandum. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region4/fishfish/salmon/chignik/09chigsum.pdf.

Menard J., and D. J. Bergstrom. 2003a. Norton Sound Nome Subdistrict 1 chum salmon stock status and action plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-35, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2003.35.pdf

Menard J., and D. J. Bergstrom. 2003b. Norton Sound, Golovin, and Moses Point Subdistricts chum salmon stock status and action plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A03-36, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.3A.2003.36.pdf

Menard J., and D. J. Bergstrom. 2006a. Norton Sound Nome Subdistrict chum salmon stock status and action plan. Alaska Department of Fish and Game, Special Publication 06-33, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/sp06-33.pdf

Menard J., and D. J. Bergstrom. 2006b. Norton Sound, Golovin, and Moses Point Subdistricts chum salmon stock status and action plan. Alaska Department of Fish and Game, Special Publication No. 06-37, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp06-32.pdf

Menard J., and D. J. Bergstrom. 2009a. Norton Sound Nome Subdistrict chum salmon stock status and action plan. Alaska Department of Fish and Game, Special Publication 09-20, Anchorage. http://www.sf.adfg.state.ak.us/FedAidpdfs/sp09-20.pdf

Menard J., and D. J. Bergstrom. 2009b. Norton Sound, Golovin, and Moses Point Subdistricts chum salmon stock status and action plan. Alaska Department of Fish and Game, Special Publication No. 09-37, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp09-19.pdf

Molyneaux, D. B., A. R. Brodersen, and C. A. Shelden. 2009. Salmon age, sex, and length catalog for the Kuskokwim Area, 2008. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No.09-06, Anchorage.

Morstad, S., M. Jones, T. Sands, P. Salomone, T. Baker, G. Buck, and F. West. 2010. 2009 Bristol Bay area annual management report. Alaska Department of Fish and Game, Fishery Management Report No. 10-25, Anchorage.

Munro, A.R., and E.C. Volk. 2010. Summary of Pacific salmon escapement goals in Alaska with a review of escapements from 2001 to 2009. Alaska Department of Fish and Game, Special Publication No. 10-12, Anchorage.

News Release. 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/lci/lcisum09.pdf.

News Release. 2009. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/uci/ucipos09.pdf.

News Release. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/lci/lciout10.pdf.

News Release. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/uci/uciout10.pdf.

News Release. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/pws/pwspos09.pdf.

News Release. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/pws/pwsfor10.pdf.

News Release. 2010. Alaska Department of Fish and Game, Division of Commercial Fisheries. www.cf.adfg.state.ak.us/region2/finfish/salmon/pws/pwsout10.pdf.

NMFS 2010a. ESA Section 7 Biological Opinion on the Alaska Groundfish Fisheries. November 2010. NMFS Alaska Region, P.O. Box 21668, Juneau, AK 99802-1668.

NMFS 2010b. Draft ESA Section 7 Biological Opinion on the Alaska Groundfish Fisheries. July 2010. NMFS Alaska Region, P.O. Box 21668, Juneau, AK 99802-1668.

Olsen, J. B., T. D. Beacham, K. D. Le, M. Wetklo, L. D. Luiten, E. J. Kretschmer, J. K. Wenburg, C. F. Lean, K. M. Dunmall, and P. A. Crane. 2006. Genetic variation in Norton Sound chum salmon populations. Arctic Yukon Kuskokwim Sustainable Salmon Initiative report number XX.

Poetter, A. D., M. D. Keyse, and A. C. Bernard. 2010. South Alaska Peninsula salmon annual management report, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-XX, Anchorage.

Poetter, A.D. and M. Keyse. 2010. Aleutian Islands and Atka-Amila Islands management areas salmon annual management report, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-20, Anchorage.

Ruggerone, G.T., R.M. Peterman, B.Dorner, and K.W. Myers. 2010. Magnitude and Trends in Abundance of Hatchery and Wild Pink Salmon, Chum Salmon, and Sockeye Salmon in the North Pacific Ocean. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 2010; 2: 306-328

Salomone, P., S. Morstad, T. Sands, M. Jones, T. Baker, G. Buck, F. West, and T. Kreig. 2011. 2010 Bristol Bay area management report. Alaska Department of Fish and Game, Fishery Management Report No. 11-23, Anchorage. http://www.adfg.alaska.gov/FedAidPDFs/FMR11-23.pdf

Seeb, L. W., P. A. Crane, and E. M. Debevec. 1997. Supplementary appendices: genetic analysis of chum salmon harvested in the South Unimak and Shumagin Islands June Fisheries, 1993-1996. Alaska Department of Fish and Game, Anchorage, AK. Regional Information Report No. 5J97-18.

Shields, P. 2010. Upper Cook Inlet commercial fisheries annual management report, 2009. Alaska Department of Fish and Game, Fishery Management Report No. 10-27, Anchorage.

Shotwell, S.K. and M.D. Adkison. 2004. Estimating indices of abundance and escapement of pacific salmon for data-limited situations. Transactions of the American Fisheries Society 133:538-558.

Stram, D.L., and J.N. Ianelli. 2009. Eastern Bering Sea pollock trawl fisheries: variation in salmon bycatch over time and space. Amer. Fish. Soc. Sym. 70: 827-850.

Thistlethwaite, Donald L. and Donald T. Campbell, "Regression-Discontinuity Analysis: An Alternative to the Ex-Post Facto Experiment," *Journal of Educational Psychology*, December 1960, *51*, 309–317.

Tingley, A., and W. Davidson. 2010. Overview of the 2009 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No.10-15, Anchorage.

Tingley, A., and W. Davidson. 2008. Overview of the 2008 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 08-57, Anchorage.

Volk, E., M. J. Evenson, and R. A. Clark. 2009. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim region salmon stocks, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 09-07, Anchorage.

White, B. 2010. Alaska salmon enhancement program 2009 annual report. Alaska Department of Fish and Game, Fishery Management Report No. 10-05, Anchorage.

Wilmot, R.L., C.M. Kondzela, C.M. Guthrie, and M.M. Masuda. 1998. Genetic stock identification of chum salmon harvested incidentally in the 1994 and 1995 Bering Sea trawl fishery. N. Pac. Anadr. Fish Comm. Bull. 1: 285-299.

Witteveen, M. J., H. Finkle, M. Loewen, M. B. Foster, and J. W. Erickson. 2009. Review of salmon escapement goals in the Alaska Peninsula Aleutian Islands Management Areas; A report to the Alaska Board of Fisheries, 2010. Alaska Department of Fish and Game, Fishery Manuscript No. 09-09, Anchorage.

Woods, Gordon F. 2008. Annual Management Report of the 2008 Yakutat Area commercial salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 08-66, Anchorage.

Appendix 1: Council motions June 2010 and December 2009 to refine Chum bycatch management alternatives

Council motion June 2010

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

C-1(b) Bering Sea Chum Salmon Bycatch

Alternative 1 – Status Quo

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

Alternative 2 – Hard Cap

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

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

Component 2: Sector Allocation

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

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

For Analysis:

CDQ	Inshore CV	Mothership	Offshore CPS
3.4%	81.5%	4.0%	11.1%
6.7%	63.3%	6.5%	23.6%[37]
10.7%	44.77%	8.77%	35.76%

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

---

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

Component 3: Sector Transfer

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

  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
    - 1) 50%
    - 2) 70%
    - 3) 90%
- c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing

Component 4: Cooperative Provision

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

  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
    - 1) 50%
    - 2) 70%
    - 3) 90%
- b) Allow NMFS to rollover unused bycatch allocation to inshore cooperatives that are still fishing.

Alternative 3 – Trigger Closure

Component 1: Trigger Cap Formulation

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

Application of Trigger Caps
- a) Apply trigger to all chum bycatch
- b) Apply trigger to all chum bycatch between specific dates
- ~~c) Apply trigger to all chum bycatch in a specific area.~~

Trigger limit application:

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

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

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

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

<u>Component 2</u>: Sector allocation

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

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

For Analysis:

CDQ	Inshore CV	Mothership	Offshore CPS
3.4%	81.5%	4.0%	11.1%
6.7%	63.3%	6.5%	23.6%[38]
10.7%	44.77%	8.77%	35.76%

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

~~Component 3: Sector Transfer~~

~~a) No transfers or rollovers~~
~~b) Allow NMFS-approved transfers between sectors~~
    ~~Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:~~
        ~~1) 50%~~
        ~~2) 70%~~
        ~~3) 90%~~
~~c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing~~

---

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

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

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

Component **3**~~Component 4~~ : Cooperative Provisions

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

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

   4) 50%
   5) 70%
   6) 90%

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

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

~~a. Large area closure~~

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

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

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

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

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

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

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

   ~~a. for the remainder of year~~
   ~~b. for specific date range~~

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

1. A large area trigger closure (encompassing 80% of historical bycatch).

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

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

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

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

1. Analyze discrete area approach normalized across years (i.e. proportion of salmon caught in an area in a year rather than numbers of salmon);
2. Discuss how Component **6**~~7 and suboption~~ would be applied;
3. In depth description of the rolling hot spot regulations (Amendment 84), focusing on parameters that could be adjusted if the Council found a need to refine the program to meet objectives under Component 7. **Specifically analyze:**
    - **a. the base rate within the RHS program;**
    - **b. the options for revising the tier system within the RHS program;**
    - **c. the Council's options for revising the fine structure within the RHS program. Analysis should include a discussion of the meaningfulness of fines, including histograms of number and magnitude of fines over time as well as a comparison of penalties under the RHS program to agency penalties and enforcement actions for violating area closures.**
4. Discussion from NMFS of catch accounting for specific caps for discrete areas, and area aggregations described in Component 5 and for areas within those footprints that may have other shapes that could be defined by geographic coordinates [Component 6(c)] Discussion from NMFS on the ability to trigger a regulatory closure based on relative bycatch within a season (with respect to catch accounting system and enforcement limitations) considering changes in bycatch monitoring under Amendment 91.
5. Contrast a regulatory closure system (Components 5 and 6) to the ICA closure system (Component 7) including data limitations, enforcement, potential level of accountability (i.e., fleet-wide, sector, cooperative, or vessel level).
6. Examine differences between high bycatch years (i.e. 2005) and other years to see what contributes to high rates (i.e. timing/location, including fleet behavior and environmental conditions).
7. Examine past area closures and potential impacts of those closures on historical distribution of bycatch and on bycatch rates (qualitative); include 2008 and 2009 data and contrast bycatch distribution under VRHS versus the Chum Salmon Savings Area.

Council motion December 2009
C-4(b) Bering Sea Salmon Bycatch
Council motion: strike-outs and underlines to indicate additions and deletions from original alternative set

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

Alternative 2 – Hard Cap
Component 1: Hard Cap Formulation (with CDQ allocation of 10.7%)

a) ~~58,000~~ 50,000
b) ~~206,000~~ 75,000
c) ~~353,000~~ 125,000
d) ~~488,000~~ 200,000
e) 300,000
f) 353,000

Component 2: Sector Allocation

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

- a) No sector allocation
- b) Allocations to Inshore, Catcher Processor, Mothership, and CDQ
  - 1) Pro-rata to pollock AFA pollock sector allocation
  - 2) Historical average
    - i. ~~2004-2006~~ 2007-2009
    - ii. ~~2002-2006~~ 2005-2009
    - iii. ~~1997-2006~~ 2000-2009
    - iv. 1997–2009
  - 3) Allocation based on 75% pro-rata and 25% historical
  - 4) Allocation based on 50% pro-rata and 50% historical
  - 5) Allocation based on 25% pro-rata and 75% historical
- c) Allocate 10.7% to CDQ, remainder divided among other sectors

Component 3: Sector Transfer

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

  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
  - 1) 50%
  - 2) 70%
  - 3) 90%
- c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing

Component 4: Cooperative Provision

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

  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
  - 1) 50%
  - 2) 70%
  - 3) 90%
- b) Allow NMFS to rollover unused bycatch allocation to inshore cooperatives that are still fishing.

Alternative 3 – Trigger Closure

Component 1: Trigger Cap Formulation

Cap level

- a) ~~45,000~~ 25,000
- b) ~~58,000~~ 50,000
- c) ~~206,000~~ 75,000
- d) ~~353,000~~ 125,000
- e) ~~488,000~~ 200,000

Application of Trigger Caps

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

Component 2: Sector allocation

Use blend of CDQ/CDQ partner bycatch numbers for historical average calculations.
a) No sector allocation
b) Allocations to Inshore, Catcher Processor, Mothership, and CDQ
  1) Pro-rata to pollock AFA pollock sector allocation
  2) Historical average
    i. ~~2004-2006~~ 2007-2009
    ii. ~~2002-2006~~ 2005-2009
    iii. ~~1997-2006~~ 2000-2009
    iv. 1997-2009
  3) Allocation based on 75% pro-rata and 25% historical
  4) Allocation based on 50% pro-rata and 50% historical
  5) Allocation based on 25% pro-rata and 75% historical
c) Allocate 10.7% to CDQ, remainder divided among other sectors

Component 3: Sector Transfer
a) No transfers or rollovers
b) Allow NMFS-approved transfers between sectors
  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
    1) 50%
    2) 70%
    3) 90%
c) Allow NMFS to roll-over unused bycatch allocation to sectors that are still fishing
  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
    1) 50%
    2) 70%
    3) 90%

Components 4: Cooperative Provisions
a) Allow allocation at the co-op level for the inshore sector, and apply transfer rules (Component 3) at the co-op level for the inshore sector.
  Suboption: Limit transfers to the following percentage of salmon that is available to the transferring entity at the time of transfer:
    1) 50%
    2) 70%
    3) 90%
b) Allow NMFS to roll-over unused bycatch allocation to cooperatives that are still fishing

Component 5: Area Option
a) Area identified in October, 2008 discussion paper (B-season chum bycatch rate-based closure described on pages 14-15 of December 2009 discussion paper)
~~b) Existing Chum Salmon Savings Area (differs from status quo with application of other components)~~
b) New areas [to be identified by staff] which are small, discrete closure areas, each with its own separate cap whereby bycatch in that area only accrues towards the cap

Component 6: Timing Option – Dates of Area Closure
~~a) Existing closure dates (August 1 – August 31 and September 1 through October 14 if trigger is reached.)~~

b) New closure dates [to be developed from staff analysis of seasonal proportions of pollock and chum salmon by period across additional ranges of years]

Component 7: Rolling Hot Spot (RHS) Exemption – Similar to status quo, participants in a vessel-level (platform level for Mothership fleet) RHS would be exempt from regulatory triggered closure(s).

a) Sub-option: RHS regulations would contain an ICA provision that the regulatory trigger closure (as adopted in Component 5) apply to participants that do not maintain a certain level of rate-based chum salmon bycatch performance.

Appendix 2: Non-Chinook ICA agreement for 2011

AMENDED AND RESTATED
BERING SEA POLLOCK FISHERY ROLLING HOT SPOT CLOSURE NON-CHINOOK SALMON BYCATCH MANAGEMENT AGREEMENT

This AMENDED AND RESTATED BERING SEA POLLOCK FISHERY ROLLING HOT SPOT CLOSURE NON-CHINOOK SALMON BYCATCH MANAGEMENT AGREEMENT is entered into by and among POLLOCK CONSERVATION COOPERATIVE (“PCC”), the HIGH SEAS CATCHERS COOPERATIVE (“High Seas”), MOTHERSHIP FLEET COOPERATIVE (“MFC”), the “Inshore Coops”, i.e., AKUTAN CATCHER VESSEL ASSOCIATION, NORTHERN VICTOR FLEET COOPERATIVE, PETER PAN FLEET COOPERATIVE, UNALASKA FLEET COOPERATIVE, UNISEA FLEET COOPERATIVE and WESTWARD FLEET COOPERATIVE, and the “CDQ Groups”, i.e., ALEUTIAN PRIBILOF ISLAND COMMUNITY DEVELOPMENT ASSOCIATION, BRISTOL BAY ECONOMIC DEVELOPMENT CORPORATION, CENTRAL BERING SEA FISHERMEN’S ASSOCIATION, COASTAL VILLAGES REGION FUND, NORTON SOUND ECONOMIC DEVELOPMENT CORPORATION and YUKON DELTA FISHERIES DEVELOPMENT ASSOCIATION, and SEA STATE, INC. (“Sea State”) and UNITED CATCHER BOATS ASSOCIATION (“UCB”) as of ___________, 2010. PCC, High Seas, MFC, and the Inshore Coops are hereafter collectively referred to as the “Coops”.

This Agreement is entered into with respect to the following facts:

RECITALS

Western Alaskans have expressed conservation and allocation concerns regarding the incidental catch of non-Chinook salmon in the Bering Sea pollock fishery. While such bycatch is regulated by the North Pacific Fishery Management Council (the “Council”) and the National Marine Fisheries Service (“NMFS”), the Coops desire to address this issue by inter-cooperative agreement, out of respect for the concerns of Western Alaskans, to avoid unnecessary incidental catch of non-Chinook salmon and to obviate the need for regulatory salmon savings areas.

Now, therefore, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties agree as follows:

AGREEMENT

1. Purpose of Agreement. This Amended and Restated Non-Chinook Salmon Bycatch Management Agreement amends and supersedes that certain Salmon Bycatch Management Agreement entered into among the parties set forth above as of December 1, 2007. The purpose of this Agreement is to implement a private, contractual inter-cooperative program to reduce non-Chinook salmon bycatch in the Bering Sea directed pollock fishery, inclusive of both the Community Development Quota (“CDQ”) and non-CDQ allocations (the “Fishery”). Each party to this Agreement agrees exercise all commercially reasonable efforts to achieve that purpose.

2. Monitoring and Management. The Coops shall retain Sea State to facilitate vessel bycatch avoidance behavior, information sharing, data gathering, analysis, and fleet monitoring necessary to implement the bycatch management program contemplated under this Agreement. The Coops shall retain United Catcher Boats (UCB) as the ICA representative. UCB will provide day-to-day management of inter- cooperative matters related to the performance of this Agreement.

3. Bycatch Management. The parties agree that because the bycatch of non-Chinook salmon is typically very low during the Fishery “A” season, the bycatch management of non-Chinook salmon by this Agreement will occur during the Fishery “B” season. Therefore, non-Chinook salmon bycatch in the Fishery “B” season shall be managed on an inter-cooperative basis as follows. Sea State shall use a bycatch rate (the “Base Rate”) as a trigger for identifying areas to be closed to pollock fishing by certain Coops (“Chum Salmon Savings Areas”), and as a basis for determining each Coop’s tier status, which in turn shall govern whether, and if so, when, each Coop’s members may harvest pollock inside of a Savings Area. During “B” seasons, Sea State shall monitor non-Chinook salmon bycatch, and may announce Chum Salmon Savings Areas for non-Chinook salmon, and Sea State shall assign each Coop a bycatch tier status. In addition, Sea State shall have the authority to declare up to two Chum Salmon Savings Areas in the Bering Sea region east of 168 degrees West longitude (the “East Region”) and up to two Chum Salmon Savings Areas in the Bering Sea/Aleutian Islands region west of 168 degrees West longitude (the “West Region”). The non-Chinook salmon Base Rate shall be adjusted during each “B” season in response to non-Chinook bycatch rates, to take into account fluctuations in non-Chinook salmon encounters.

a. Initial non-Chinook Base Rate. The initial “B” season non-Chinook salmon Base Rate shall be 0.19 non-Chinook salmon per metric ton of pollock.

b. Non-Chinook Base Rate In-Season Adjustment. Commencing on July 1 of each year that this Agreement is in effect, and on each Thursday through the duration of each “B” season thereafter, Sea State shall recalculate the “B” season non-Chinook salmon Base Rate. The recalculated Base Rate shall be the three week rolling average of the Fishery “B” season non-Chinook bycatch rate for the then-current year. The recalculated Base Rate shall be the governing non-

Chinook salmon Base Rate for purposes of each "Thursday Announcement" of a "Friday Closure" (as defined below) following recalculation.

c. Implementation of Salmon Savings Measures. Sea State shall use Fishery "B" season bycatch data from fishing activity after June 10 of each year to provide Coops with preliminary information regarding the location and concentration of non-Chinook salmon, and to determine initial Chum Salmon Savings Area closures and Coop Tier assignments (as defined below). Sea State shall implement Chum Salmon Savings Area closures as appropriate upon non-Chinook bycatch rates exceeding the Base Rate, and thereafter through the balance of each Fishery "B" season.

d. Cooperative Tier Assignments. Rate calculations for purposes of tier assignments shall be based on each Coop's pollock catch in the Fishery for the prior two weeks (the denominator) and the aggregate amount of associated bycatch of non-Chinook salmon taken by its members (the numerator). For purposes of this Section, a Coop's non-Chinook salmon bycatch amount shall be based on observer data.

- Coops with non-Chinook salmon bycatch rates of less than 75% of the applicable Base Rate shall be assigned to "Tier 1.
- Coops with non-Chinook salmon bycatch rates equal to or greater than 75% of the applicable Base Rate but equal to or less than 125% of the Base Rate shall be assigned to "Tier 2".
- Coops with non-Chinook salmon bycatch rates greater than 125% of the applicable Base Rate shall be assigned to "Tier 3".

e. Bycatch Hot Zone Identification. When the Fishery "B" season is open to any of the inshore, catcher/processor or mothership components, on an ongoing basis Sea State shall calculate the non-Chinook bycatch rates for each Alaska Department of Fish and Game ("ADF&G") statistical area for which Sea State receives a non-Chinook salmon bycatch report, and when feasible, for each lateral half of each such statistical area. Bycatch rates shall be recalculated and updated every four (4) or seven (7) days during the season, immediately proceeding the closure announcements described in Section 4.g., below, as Sea State determines appropriate given the quality of data available for the area. The non-Chinook bycatch rates shall be calculated on the basis of reports Sea State determines to be adequately accurate, including reliable tow-by-tow estimates from the fishing grounds. In every case, rates calculated on the basis of the actual number of salmon observed per tow shall be given priority over rates based on sampling and extrapolation.

f. Chum Salmon Savings Areas. On each Thursday and on each Monday following June 10, for the duration of the Fishery "B" season, Sea State shall, subject to the criteria set forth below, provide notice to the Coops identifying one or more areas designated as "Chum Salmon Savings Areas", within which pollock fishing shall be restricted on the basis of each Coop's Tier status.

(i) Savings Area Designation Criteria. To qualify as a Chum Salmon Savings Area, (a) an amount of pollock that Sea State in its sole discretion determines to be substantial must have been taken in the Savings Area during the period on which its designation as a Savings Area is based, or the area must have been designated a Savings Area for the prior notification period and there must be evidence satisfactory to Sea State in its sole discretion that suggests that non-Chinook salmon bycatch rates in the area are not likely to have changed, and (b) the salmon bycatch rate in the area for the period on which its definition as a Chum Salmon Savings Area is based must exceed the Base Rate. For purposes of (a), above, Sea State shall consider a pollock harvest of two percent (2%) of the total amount of pollock harvested in the Fishery during the period on which a Chum Salmon Savings Area designation is based to be indicative of, but not dispositive of, whether a substantial amount of pollock has been harvested in an area.

(ii) Savings Area Boundaries and Limitations. Subject to the limits set forth in this Section, Savings Areas shall be defined by a series of latitude/longitude coordinates as Sea State determines appropriate to address salmon bycatch. Notwithstanding the foregoing, the following limits shall apply to designations of "B" season Savings Areas: (i) Chum Salmon Savings Area closures in the East Region may not exceed three thousand (3,000) square miles in total area during any single closure period; (ii) Chum Salmon Savings Areas in the West Region may not exceed one thousand (1,000) square miles in total area during any single closure period; (iii) there may be up to two (2) Savings Areas per Region per closure period.

g. Savings Area Closure Announcements. Fishery "B" season Savings Area closures announced on Thursdays (the "Thursday Announcement" of the "Friday Closures") shall be effective from 6:00 pm the following Friday through 6:00 pm the following Tuesday, and Savings Area closures announced on Mondays (the "Monday Announcement" of "Tuesday Closures") shall be effective from 6:00 pm the following Tuesday through 6:00 pm the following Friday. Upon a Chum Salmon Savings Area closure taking effect, fishing by Coop vessels participating in the Fishery shall be restricted pursuant to Subsection 4.i., below. Each Thursday Announcement shall include the following information: (i) season update on pollock harvest and non-Chinook salmon bycatch by pollock fishery sector and in total; (ii) each Coop's updated rolling two week non-Chinook salmon bycatch rate, associated Tier status, and Savings Area closure dates, times and days; (iii) the coordinates describing each Chum Salmon Savings Area, and a map of the Area; (iv) non-Chinook salmon bycatch rates for each Alaska Department of Fish and Game statistical area in which there was directed pollock fishing during the previous week; and (v) updated vessel performance lists, as defined in 4.j., below. Each Monday Announcement shall include the information described in clauses (i), (iii), (iv), and a reminder to each Coop of its chum bycatch Tier status.

h. Savings Area Implementation. During the Fishery "B" seasons, Savings Area closures shall apply to Coop member vessels as follows. Chum Salmon Savings Areas announced as Friday Closures and as updated by Tuesday Closures shall be closed to fishing by Tier 3 Coop vessels for seven days. Chum Salmon Savings Areas announced as Friday Closures shall be closed to fishing by Tier 2 Coop vessels through 6:00 pm the following Tuesday. Tier 1 Coop vessels may fish in Chum Salmon Savings Areas closed to the Tier 2 and Tier 3 Coop vessels.

i. Vessel Performance Lists. On a weekly basis, Sea State shall provide salmon bycatch performance lists to the Coops calculated on the basis of non-Chinook bycatch.

i. A list of the 20 vessels with the highest non-Chinook bycatch rates for the previous 2 weeks in excess of the Base Rate.

ii. A list of the 20 vessels with the highest non-Chinook bycatch rates for the previous week in excess of the Base Rate.

j. Throughout the Fishery "B" season, Sea State shall provide salmon "hot spot" advisory notices concerning areas of high non-Chinook salmon bycatch that do not fall within Savings Area closures.

4. Data Gathering and Reporting. The Coops acknowledge that the effectiveness of the bycatch management program being implemented under this Agreement depends on rapidly gathering, analyzing and disseminating accurate data concerning non-Chinook salmon bycatch in the Fishery. The Coops therefore agree as follows.

a. Each Coop shall require its members to take all actions necessary to release their vessels' NMFS observer reports and official landing records to Sea State as soon as commercially practicable after such documents are completed. Each Coop shall request its members' vessels to exercise commercially reasonable efforts to report to Sea State within 24 hours the location of, estimated pollock tonnage of and estimated number of non-Chinook salmon in each trawl tow. PCC may satisfy its obligation under this section 6.a. by arranging to have its members' vessels' observer reports concerning non-Chinook salmon bycatch transmitted to Sea State. MFC and High Seas may satisfy their obligations under this Section by arranging to have the pollock amounts and non-Chinook salmon counts for their members' vessels reported to Sea State by the observers on the processing vessels to which their members' vessels deliver. The Inshore Coops shall arrange for their vessels to report the crew's best estimate of the amount of pollock and the number of non-Chinook salmon in the tow when reporting its location. Each Inshore Coop shall develop its own methods and means to accurately calculate (when feasible) or estimate the amount of pollock and the number of salmon contained in each tow by its members' vessels, and to rapidly and accurately report that information to Sea State.

b. Sea State shall from time to time announce a non-Chinook bycatch rate that shall trigger an incident reporting requirement. Each Coop shall require its members' vessels to notify their coop manager (if applicable), the intercooperative manager and, if feasible, Sea State as soon as possible of any tow with a non-Chinook salmon bycatch rate that the crew estimates to be equal to or greater than the incident reporting rate threshold.

5. Savings Area Closure Enforcement. Upon a Coop receiving a Savings Area closure notice which has the effect of closing one or more Savings Areas to fishing by its members' vessels under this Agreement, the Coop shall timely notify its members. Each Coop agrees to take enforcement action with respect to any violation of a Savings Area closure notice, and to collect the assessments set forth below in cases where a vessel is found to have violated a closure.

a. Sea State shall monitor the fishing activities of all Coops' members' vessels, and shall promptly report all apparent Savings Area violations to all Coops. For purposes of this Agreement, "fishing" shall mean all activity of a vessel between the time of initial gear deployment and final gear retrieval. For purposes of this Section 5.a., "gear deployment" and "gear retrieval" shall have the meanings given them in 50 C.F.R. 679.2 or its successor, as the same may be amended from time to time. Initial gear deployment shall mean setting trawl gear with an empty codend, and final gear retrieval shall mean retrieving trawl gear to either pull a codend aboard the vessel or to deliver the codend to another vessel.

b. Upon receiving notice of an apparent violation from Sea State, the Board of Directors of the Coop to which the vessel belongs shall have one hundred and eighty (180) days to take action in connection with the apparent violation, and to provide a report of the action taken and a copy of the record supporting that action to all other Coops. When the Board of Directors to which the vessel belongs provides its report, or if the Coop Board of Directors fails to provide its report within such 180 day period, then Sea State and/or UCB shall provide each other Coop, the CDQ Groups, the Association of Village Council Presidents ("AVCP"), Bering Sea Fishermen's Association ("BSFA"), Tanana Chiefs' Conference ("TCC") and Yukon River Drainage Fishermen's Association ("YRDFA") with the Coop's report (if provided) and the record developed by Sea State in connection with the apparent violation, and each of such parties shall have standing to pursue Savings Area closure enforcement actions equivalent to such Coop's own rights with respect to its members.

c. The Coops hereby adopt a uniform assessment for a skipper's first annual violation of a Savings Area closure of Ten Thousand Dollars ($10,000.00), a uniform assessment for a skipper's second annual violation of a Savings Area closure of Fifteen Thousand Dollars ($15,000.00), and a uniform assessment of Twenty Thousand Dollars ($20,000.00) for a skipper's third and subsequent violations in a year. The Coops acknowledge that the damages resulting from violating a Savings Area closure are difficult to estimate, and that the foregoing assessment amounts are therefore intended to be a substitute in all cases for direct, indirect and consequential damages. Therefore, the Coops agree that the assessment amounts established under this Subsection 5.c are liquidated damages, the payment of which (together with reasonable costs of collection) shall satisfy a Coop's and its members' obligations related to a Savings Area closure violation. The Coops hereby waive any and all claims to direct, indirect or consequential damages related to such violation.

d. The Coops agree that any funds collected in connection with a violation of this agreement, in excess of those necessary to reimburse the prevailing party for its costs and attorneys fees, shall be used to support research concerning salmon taken incidentally in the Fishery. The Coops agree to consult with the CDQ Groups, AVCP, BSFA, TCC and YRDFA regarding the most appropriate use of such funds.

e. For purposes of this Section 5, State and Federal landing reports, observer data, VMS tracking data, vessel log books and plotter data and Coop catch data produced by the Sea State in conformance with NMFS catch accounting and bycatch estimation procedures shall be presumed accurate and sufficient for determining whether a vessel violated a Savings Area closure, absent a clear and compelling demonstration of manifest error. The Coops agree to take all actions and execute all documents necessary to give effect to this provision.

f. The Coops agree to require their members to obtain and maintain an operational VMS unit approved by Sea State on their vessels, provided that such units are available on a commercially reasonable basis. The Coops agree to cause their members to release their VMS tracking data to Sea State. Sea State agrees not to disclose any such information, other than as specifically authorized under this Agreement, as necessary to fulfill the intents and purposes of this Agreement, or with prior consent from the affected vessel owner. The Coops agree that the damages resulting from vessels operating in non-compliance with this subsection are difficult to estimate, and the Coops therefore hereby adopt a uniform assessment of One Thousand Dollars ($1,000.00) per day for each consecutive day over thirty (30) consecutive days that a Coop member's vessel is employed in the Fishery without an operational VMS unit approved by Sea State, provided such unit is available on a commercially reasonable basis.

6. Release and Waiver of All Claims Against SeaState and United Catcher Boats; Indemnification and Hold Harmless. The parties acknowledge that the effectiveness of this Agreement depends to a significant extent on Sea State's and UCB's discretion and judgment in designating and defining Savings Areas, determining each Coop's Tier status, monitoring compliance with Savings Area closures, and initiating and supporting enforcement actions under circumstances where a Coop member appears to have violated this Agreement. The parties further acknowledge that if Sea State or UCB were potentially liable for simple negligence in connection with such actions, it would be necessary for Sea State and UCB to charge a substantially larger fee for the services they provide in connection with this Agreement, to offset that potential liability. It is therefore in the parties' interest to reduce Sea State's and UCB's potential liability under this Agreement. Therefore, the Coops and the CDQ Groups hereby waive and release any and all claims against Sea State and UCB arising out of or relating to Sea State's or UCB's services in connection with this Agreement, other than those arising out of gross negligence or willful misconduct by Sea State or UCB. Further, the Coops jointly and severally agree to indemnify, defend and hold Sea State and UCB harmless against any third party claims asserted against Sea State or UCB arising out of or relating to Sea State's or UCB's services in connection with this Agreement, other than those arising out of gross negligence or willful misconduct by Sea State or UCB.

7. ICA Representative contact information:

United Catcher Boats
4005 20th Ave. West, Suite 116
Seattle, WA 98199
Phone: 206-282-2599
Fax: 206-282-2414
E-mail: penguin@ucba.org

8. Coop Membership Agreement Amendments. To give effect to this Agreement, the Coops agree to cause each of their Membership Agreements to include the following provisions.

a. Each member shall acknowledge that its vessel's operations are governed by this Agreement, and shall agree to comply with its terms.

b. Each member shall authorize its Coop's Board of Directors to take all actions and execute all documents necessary to give effect to this Agreement.

c. Each member shall authorize its Coop Board of Directors to enforce this Agreement, and if the Board fails to do so within one hundred eighty (180) days of receiving notice from Sea State that a cooperative member may have failed to comply with the Agreement, each member shall authorize each other Coop, each of the CDQ groups, AVCP, BSFA, TCC and YRDFA to individually or collectively enforce this Agreement.

d. Each member shall agree to maintain an operational VMS unit approved by Sea State on its vessel at all times that its vessel is participating in the Fishery, provided such VMS unit is available on a commercially reasonable basis, and shall agree to cause its vessel's VMS tracking data to be released to Sea State on a basis that permits Sea State to determine whether the member's vessel has operated in compliance with this Agreement. Each Coop member shall release to Sea State its State and Federal landing reports, observer data, VMS tracking data, and vessel log books and plotter data for purposes of determining its compliance with this Agreement, and agrees that in the event Sea State concludes that its vessel may have violated a hot spot closure, Sea State may release such data as Sea State in its sole discretion determines appropriate to facilitate enforcement of this Agreement.

e. Each member shall agree that the information contained in the records identified in d., above, shall be presumed accurate absent a clear and compelling demonstration of manifest error, and shall be presumed sufficient to determine its compliance with this Agreement.

f. Each member shall agree that the damages resulting from violating a Savings Area closure are difficult to estimate, and that the assessment amounts provided under this Agreement are therefore intended to be a substitute in all cases for direct, indirect and consequential damages. Each member shall agree that its Coop Board of Directors may modify Savings Area violation assessment amounts from time to time, as necessary to maintain an effective deterrent to Savings Area violations. Each member shall agree that each trawl tow during which the member's vessel fishes in a Savings Area in violation of this Agreement shall constitute a separate violation for purposes of assessment calculation. Each member shall agree that damages for violating this Agreement shall apply on a strict liability basis, regardless of a member's lack of knowledge of the violation or intent to violate the agreement. Each member shall agree that actual damages for violating this Agreement would be difficult to calculate, and shall therefore agree to pay the assessment amounts established under this Agreement, as amended from time to time, as liquidated damages. Each member agrees to modify its skipper contracts to make its skipper(s) fully responsible for the assessments levied in connection with a breach of the agreement. Further, each member agrees that in the event a skipper fails to assume such assignment of liability, or in the event such assumption of liability is deemed invalid, the member shall be liable for the full amount of such assessment, and all related costs and attorneys' fees.

g. Each member shall agree that in connection with any action taken to enforce this Agreement, the prevailing party shall be entitled to the costs and fees it incurs in connection with such action, including attorneys' fees.

h. Each member shall agree that in addition to legal remedies, the Board of Directors of each cooperative, each of the CDQ groups, BSFA and YRDFA shall be entitled to injunctive relief in connection with the second and subsequent violations of this Agreement.

i. Each member shall agree to waive and release any and all claims against Sea State and UCB arising out of or relating to Sea State's or UCB's services in connection with this Agreement, other than those arising out of gross negligence or willful misconduct by Sea State or UCB.

j. Each member shall acknowledge that, notwithstanding the definition of "fishing" used in this Agreement (which is the consistent with the definition used by NMFS for logbook entries and observer reporting purposes), it is the Coops' policy that no member's vessel will be present in a Savings Area that is closed to fishing by such Coops' members' vessels unless and until such vessel's trawl doors have been fully retrieved or stored. Further, each member shall agree that, absent extenuating circumstances, such member exercise its best efforts to comply with this policy.

9. <u>Term</u>. This Agreement shall take effect as of November 30, 2010. The initial term of this Agreement shall extend through November 1, 2013. The term of this Agreement shall be automatically extended for an additional year as of September 15 each year it remains in effect, i.e., as of September 15, 2011, the new expiration date of this Agreement shall be November 1, 2014, and so on. A party to this Agreement may terminate its status as a party by providing written notice to all other parties to this Agreement to that effect, provided that the effective date of such party's termination shall be the expiration date of this Agreement in effect at the time the termination notice is delivered. For example, if a Coop provides termination notice on August 15, 2011, its termination shall not be effective until November 1, 2013. If a Coop provides termination notice on October 1, 2011, its termination shall not be effective until November 1, 2014. Notwithstanding any party's termination of its participation in this Agreement or the expiration of its term, the enforcement provisions of Section 7, above, shall survive with full force and effect.

10. <u>Breach and Termination of Exemption</u>. Each Coop acknowledges that, as of the opening of the 2011 "B" season Fishery, NMFS is expected to issue an annual exemption to the regulatory salmon savings closures (the "Exemptions") to each Coop that is a party to and complies with this Agreement. Further, each Coop acknowledges that a Coop's material breach of this Agreement that is not timely cured shall result in forfeiture of such Coop's right to retain its Exemption. The following shall constitute material breaches of this Agreement:

(i) a Coop failing to take enforcement action within one hundred eighty (180) days of being notified by Sea State of an apparent violation of a Savings Area closure by one or more of its members, as provided in Section 5.b, above;

(ii) a Coop failing to collect and/or disburse an assessment in compliance with this Agreement within one hundred eighty (180) days of a determination that its member(s) violated a Savings Area closure, as provided in Sections 5.c and 5.d, above;

(iii) a Coop failing to collect and/or disburse an assessment in compliance with this Agreement within one hundred eighty (180) days of a determination that a member of the Coop failed to maintain an available, operational VMS unit approved by Sea State on its vessel as provided in Section 5.f of this Agreement and/or failed to cause such vessel(s) to release their VMS tracking data to Sea State as provided in Section 5.f of this Agreement.

In the event of a material breach of this Agreement by a Coop that is not cured within thirty (30) days of such Coop's authorized representative receiving written notice of such breach from one or more other Coop(s), a CDQ Group, AVCP, BSFA, TCC or YRDFA, any one of such parties may demand that the breaching Coop tender its Exemption to NMFS, and such Coop shall do so within ten (10) days. If a Coop fails to timely tender its Exemption, any of such parties may seek injunctive relief requiring such Coop to tender its Exemption.

11. Annual Compliance Audit. The Coops shall annually retain an entity that is not a party to this Agreement (the "Compliance Auditor") to review and prepare a report concerning Sea State's performance of its monitoring and notification obligations under this Agreement and actions taken by the Coops in response to all notifications from Sea State to the Coops regarding potential violations of this Agreement. All parties to this Agreement will be provided an opportunity to participate in selecting the non-party Compliance Auditor. Sea State and the Coops shall cooperate fully with the Compliance Auditor, and shall provide any information the Compliance Auditor requires to complete its review and report. If the Compliance Auditor identifies a failure to comply with this Agreement as part of its review, the Compliance Auditor shall notify all parties to this Agreement of the failure to comply, shall distribute to all parties to this Agreement the information used to identify the failure to comply, and shall provide notice of any such failures in the Compliance Auditor's final report.

12. Miscellaneous.

a. No amendment to this Agreement shall be effective against a party hereto unless in writing and duly executed by such party. The parties agree to amend this Agreement as reasonably necessary to conform with changes in law or circumstances.

b. This Agreement shall be governed by and construed in accordance with applicable federal law and the laws of the State of Washington.

c. This Agreement may be executed in counterparts which, when taken together, shall have the same effect as a fully executed original. Delivery of a signed copy of this Agreement by telefacsimile shall have the same effect as delivering a signed original.

d. The parties agree to execute any documents necessary or convenient to give effect to the intents and purposes of this Agreement.

e. All notices required to be given under this Agreement shall be deemed given five (5) days following deposit in certified first class U.S. mail, postage prepaid, with the correct address, or upon the first business day following confirmed telefacsimile or e-mail transmission to the recipient. Each party to this Agreement agrees to provide the name, postal address, telefacsimile number and e-mail address of its duly authorized representative(s) for purposes of receiving notices under this Agreement within three (3) days of executing this Agreement.

f. In the event that any provision of this Agreement is held to be invalid or unenforceable, such provision shall be deemed to be severed from this Agreement, and such holding shall not affect in any respect whatsoever the validity of the remainder of this Agreement.

g. Each Coop agrees to use its best efforts to resolve any disputes arising under this Agreement through direct negotiations. Breaches of this Agreement for which a party seeks a remedy other than injunctive relief that are not resolved through direct negotiation shall be submitted to arbitration in Seattle, Washington upon the request of any party to this Agreement. The party's written request will include the name of the arbitrator selected by the party requesting arbitration. The other party will have ten (10) days to provide written notice of the name of the arbitrator it has selected, if any. If the other party timely selects a second arbitrator, the two arbitrators will select a third arbitrator within ten (10) days. If the other party does not timely select the second arbitrator, there shall be only the one arbitrator. The single arbitrator or the three (3) arbitrators so selected will schedule the arbitration hearing as soon as possible thereafter. Every arbitrator, however chosen, must have no material ties to any Coop or Coop member. The decision of the arbitrator (or in the case of a three (3) arbitrator panel, the decision of the majority) will be final and binding. The arbitration will be conducted under the rules of (but not by) the American Arbitration Association. The parties will be entitled to limited discovery as determined by the arbitrator(s) in its or their sole discretion. The arbitrator(s) will also determine the "prevailing party" and that party will be entitled to its reasonable costs, fees and expenses, including attorneys' and arbitrator fees, incurred in the action by said party. In no event will arbitration be available pursuant to this paragraph after the date when commencement of such legal or equitable proceedings based on such claim, dispute, or other matter in question would be barred by the applicable statute of limitations.

Entered into as of the date first set forth above.

Pollock Conservation Cooperative

By ______________________________

Its ______________________________

High Seas Catchers Cooperative

By ______________________________

Its ______________________________

Mothership Fleet Cooperative

By ______________________________

Its ______________________________

Akutan Catcher Vessel Association

By ______________________________

Its ______________________________

Northern Victor Fleet Cooperative

By ______________________________

Its ______________________________

Peter Pan Fleet Cooperative

By ______________________________

Its ______________________________

Unalaska Fleet Cooperative

By ______________________________

Its ______________________________

Unisea Fleet Cooperative

By ______________________________

Its ______________________________

Westward Fleet Cooperative

By ______________________________

Its ______________________________

Aleutian Pribilof Island Community Development

By ______________________________

Its ______________________________

Bristol Bay Economic Development Corporation

By ______________________________

Its ______________________________

Central Bering Sea Fishermen’s Association

By ______________________________

Its ______________________________

Coastal Villages Region Fund

By ______________________________

Its ______________________________

Norton Sound Economic Development Corporation

By ______________________________

Its ______________________________

Yukon Delta Fisheries Development Association

By ______________________________

Its ______________________________

Sea State Inc.

By ______________________________

Its ______________________________

United Catcher Boats Association

By ______________________________

Its ______________________________

Appendix: RHS B-Season Closure Periods 2003-2009

The following table, Table 10-2, provides detailed information on chum and Chinook bycatch during periods that RHS closures were implemented for 2003-2009. The table provides detailed information on the pollock fishing and bycatch for 1) the 5-day period before each closure – *inside the closure*, 2) the 5-day period before each closure – *outside the closure*, and 3) the 5-day period *after* each closure – in all locations.

We present this information for informational purposes. In the analyses above, the changes ranging from 1-3 days before and after each closure are examined most thoroughly.

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

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

Several caveats should be noted when examining the table:

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

Table 10-2. Comparison of pollock and bycatch activity in and out of RHS Closures Before implementation and After Closures in All Locations

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

	Information for 5 days before RHS closure -- Outside the Closure							Information for 5 days after RHS closure -- Outside the Closure						
Start date	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate	Hauls	Chum	Chinook	Pollock	Duration (hours)	Chum rate	Chinook rate
07/11/03	312	1309	42	35809	819	0.037	0.001	395	2193	30	43220	1279	0.051	0.001
07/11/03	292	1050	40	31467	778	0.033	0.001	395	2193	30	43220	1279	0.051	0.001
07/18/03	231	1735	10	29496	807	0.059	0.000	375	2668	33	34410	1421	0.078	0.001
07/18/03	199	1422	7	24085	622	0.059	0.000	375	2668	33	34410	1421	0.078	0.001
07/25/03	243	1566	10	25123	1159	0.062	0.000	522	2494	95	54600	1369	0.046	0.002
08/08/03	221	4187	83	22609	728	0.185	0.004	433	9702	95	44038	1853	0.220	0.002
08/15/03	186	3534	66	19068	738	0.185	0.003	396	6920	176	41064	1416	0.169	0.004
08/15/03	265	13034	57	29990	1336	0.435	0.002	396	6920	176	41064	1416	0.169	0.004
08/22/03	329	6986	149	31128	1356	0.224	0.005	516	8521	280	46155	1832	0.185	0.006
08/22/03	367	8384	150	37139	1526	0.226	0.004	516	8521	280	46155	1832	0.185	0.006
08/29/03	327	2685	197	30395	1180	0.088	0.006	441	6951	836	44559	1274	0.156	0.019
09/09/03	304	4871	282	32159	1278	0.151	0.009	367	9916	719	36421	1835	0.272	0.020
09/12/03	291	6808	446	31486	1413	0.216	0.014	364	10175	557	34311	1955	0.297	0.016
09/12/03	295	7365	489	32551	1430	0.226	0.015	364	10175	557	34311	1955	0.297	0.016
09/26/03	227	16476	433	20871	1208	0.789	0.021	262	3914	876	20458	1793	0.191	0.043
10/03/03	278	8704	1197	17105	1897	0.509	0.070	220	10073	2431	14769	1329	0.682	0.165
10/10/03	159	5788	1893	10164	950	0.569	0.186	132	7113	1661	11060	875	0.643	0.150
10/17/03	76	1891	603	8054	415	0.235	0.075	42	273	184	3280	225	0.083	0.056
07/02/04	262	3011	61	29996	969	0.100	0.002	424	2355	119	39596	1677	0.059	0.003
07/02/04	252	3134	59	28139	911	0.111	0.002	424	2355	119	39596	1677	0.059	0.003
07/09/04	432	2549	168	42864	1637	0.059	0.004	454	3220	153	43224	1482	0.075	0.004
07/16/04	411	2244	96	41141	1396	0.055	0.002	443	6133	87	42550	1708	0.144	0.002
07/23/04	327	4227	77	36322	1329	0.116	0.002	424	4154	88	46738	1567	0.089	0.002
07/23/04	321	4207	75	36038	1285	0.117	0.002	424	4154	88	46738	1567	0.089	0.002
07/30/04	268	2892	53	31591	1201	0.092	0.002	378	16554	127	36849	1442	0.449	0.003
08/06/04	170	38307	240	23112	929	1.657	0.010	495	18075	207	48471	1923	0.373	0.004
08/06/04	143	33839	224	18767	801	1.803	0.012	495	18075	207	48471	1923	0.373	0.004
08/10/04	229	14237	188	26961	1067	0.528	0.007	501	13935	278	48525	2192	0.287	0.006
08/13/04	335	8574	212	35374	1525	0.242	0.006	434	9343	291	38801	1969	0.241	0.007

08/17/04	302	4311	143	27939	1341	0.154	0.005	374	27992	629	32423	1911	0.863	0.019
08/17/04	351	10796	243	33289	1751	0.324	0.007	374	27992	629	32423	1911	0.863	0.019
08/24/04	286	11891	828	24093	1437	0.494	0.034	485	13996	758	40813	2535	0.343	0.019
08/27/04	313	18964	991	27234	1895	0.696	0.036	453	10419	951	46210	1959	0.225	0.021
08/31/04	331	9895	673	31479	1780	0.314	0.021	466	14354	1463	50451	1678	0.285	0.029
08/31/04	337	10078	686	32108	1838	0.314	0.021	466	14354	1463	50451	1678	0.285	0.029
09/03/04	366	12128	1150	42824	1357	0.283	0.027	440	54622	1300	40024	2152	1.365	0.032
09/10/04	344	42675	949	30857	1843	1.383	0.031	487	54211	2732	35393	2610	1.532	0.077

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

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

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

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

			Information for 5 days before RHS closure -- Inside the Closure									
Start date	Days closed	Closure type	Hauls	Chum	Chinook	Pollock	Proportion Chum	Proportion Chinook	Proportion Pollock	Chum rate	Chinook rate	Duration (hours)
07/06/07	7	Chum	26	401	13	1785	0.18	0.18	0.07	0.225	0.007	113
07/10/07	3	Chinook										
07/17/07	3	Chum	9	73	3	621	0.12	0.06	0.03	0.118	0.004	44
07/20/07	11	Chum										
07/24/07	7	Chum	22	97	0	1908	0.07	0.00	0.10	0.051	0.000	70
07/31/07	7	Chum	28	363	0	1648	0.16	0.00	0.09	0.220	0.000	92
08/03/07	4	Chum	10	352	13	648	0.11	0.14	0.04	0.543	0.019	94
08/07/07	3	Chum	9	240	5	418	0.11	0.12	0.06	0.575	0.013	59
08/10/07	7	Chum	36	455	4	1402	0.23	0.07	0.16	0.324	0.003	276
08/21/07	3	Chum	30	1024	28	3161	0.11	0.07	0.11	0.324	0.009	237
08/17/07	7	Chum	66	1385	216	6850	0.42	0.47	0.20	0.202	0.032	215
08/21/07	3	Chum	7	2884	33	367	0.31	0.09	0.01	7.860	0.089	36
08/21/07	7	Chum	20	1727	45	1314	0.18	0.12	0.05	1.314	0.034	85
08/21/07	7	Chum	11	4349	54	641	0.46	0.14	0.02	6.782	0.084	52
08/17/07	4	Chum	52	571	0	4468	0.17	0.00	0.13	0.128	0.000	416
08/28/07	3	Chinook	13	662	49	844	0.09	0.08	0.04	0.784	0.058	115
08/31/07	4	Chinook	9	209	22	400	0.04	0.03	0.02	0.522	0.055	72
08/31/07	4	Chum	10	379	23	970	0.07	0.03	0.06	0.391	0.023	57
09/04/07	3	Chinook	48	1100	334	3797	0.18	0.29	0.22	0.290	0.088	201
09/04/07	7	Chum	5	76	17	95	0.01	0.01	0.01	0.799	0.176	33
09/11/07	7	Chum	14	57	37	504	0.01	0.02	0.03	0.114	0.074	114
09/11/07	3	Chinook	16	1241	701	1628	0.19	0.45	0.10	0.762	0.430	137
09/14/07	4	Chinook	7	26	76	581	0.00	0.02	0.04	0.045	0.131	28
09/21/07	7	Chinook	51	789	817	2808	0.59	0.66	0.53	0.281	0.291	512
09/25/07	10	Chinook	16	163	229	559	0.14	0.21	0.05	0.291	0.409	177
09/25/07	10	Chinook	28	117	57	753	0.10	0.05	0.07	0.155	0.076	149
10/05/07	4	Chinook	8	13	68	384	0.02	0.01	0.02	0.034	0.176	55
10/09/07	3	Chinook	3	21	163	177	0.03	0.05	0.02	0.116	0.917	20
10/09/07	3	Chinook										
10/12/07	7	Chinook	51	131	3121	3446	0.20	0.44	0.26	0.038	0.906	581
10/12/07	7	Chinook	11	75	170	810	0.11	0.02	0.06	0.093	0.210	108
10/19/07	14	Chinook	23	38	1260	1545	0.04	0.23	0.07	0.024	0.816	198
10/23/07	3	Chinook	58	82	542	2501	0.14	0.10	0.13	0.033	0.217	285

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

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

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