Bering Sea Chinook Salmon Report for Council: Stock status, AEQ analysis and PSC rate analysis

NPFMC/NMFS Staff discussion paper
October 2013

1 Introduction

In April the Council tasked staff to provide a report on Chinook salmon bycatch in the Bering Sea pollock fishery which includes the following:

1. A review of the status of Alaska Chinook salmon stocks, including subsistence, sport, and commercial fishery restrictions and whether escapement goals have been met.

2. A report of genetic stock identification (2011) along with stock-based adult-equivalency (AEQ), run reconstruction, and PSC harvest rate analyses for Chinook salmon stocks. The AEQ analysis should include an estimate of the impacts to each specific stock grouping of bycatch at the current cap levels (47,591 and 60,000) and actual bycatch levels in 2011 and 2012.

3. In order to evaluate fishing and bycatch performance under Amendment 91, the following items should be included from 2003 - 2013 (to date):
   - o Numbers and rates of bycatch taken by month, by sector
   - o Use of salmon excluders, by sector and season (or month if available)
   - o Variability between bycatch rates per vessel within each sector (2011 – 2012),
     - ▪ consistency year-to-year in vessels ranking relatively high and relatively low in performance rankings

This information is requested in order to best evaluate the efficacy of the current Chinook salmon bycatch management program in the context of the status of directed salmon fisheries and with updated analyses of bycatch impact rates by region of origin using recent genetic information. The Council requested that information be provided on the incentive mechanisms contained within the industry-run Incentive Program Agreements (IPAs). This information will be provided separately by each sector at the October Council meeting.

2 Status of Alaskan Chinook salmon stocks

The following sections contain information relating to Alaskan Chinook salmon stock status including whether stocks are classified as 'stocks of concern", whether escapement goals are established and met, and whether or not catch restrictions were in place in 2012. This information has been provided by staff at ADF&G per Council request in order to provide a context for the discussion of Chinook salmon PSC in the pollock fishery. A discussion of the State's Sustainable Salmon Fisheries Policy (SSFP), definitions for different escapement goals and objectives are provided in addition to updated information on individual stock status.

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 are 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). The current and historical stocks of concern are shown in Table 1.

Table 1. Historical and current Chinook salmon stocks of concern in Alaska.

Region	Area	Stock	Level of Concern	Year Initiated	Year Removed
Central	Cook Inlet	Anchor River	Management	2001	2004
	Cook Inlet	Alexander River	Management	2011	ongoing
	Cook Inlet	Theodore River	Management	2011	ongoing
	Cook Inlet	Lewis River	Management	2011	ongoing
	Cook Inlet	Chuitna River	Management	2011	ongoing
	Cook Inlet	Willow Creek	Yield	2011	ongoing
	Cook Inlet	Goose Creek	Yield	2011	ongoing
AYK	Kuskokwim	Kuskokwim River	Yield	2001	2007
	Yukon	Yukon River	Yield	2001	ongoing
	Norton Sound	Norton Sound SD 5/6	Yield	2004	Ongoing
Westward	Kodiak	Karluk River	Management	2011	Ongoing

The State of Alaska manages subsistence, sport/recreational (used interchangeably), commercial, and personal use harvest on lands and waters throughout Alaska. The Alaska Department of Fish and Game (ADF&G) is responsible for managing subsistence, commercial, sport, and personal use salmon fisheries. The first priority for management is to meet spawning escapement goals in order to sustain salmon resources for future generations. The highest priority use is for subsistence under both state and federal law. Salmon surplus above escapement needs and subsistence uses are made available for other uses. The Alaska Board of Fisheries (BOF) adopts regulations through a public process to conserve and allocate fisheries resources to various user groups. Subsistence fisheries management includes coordination with the Federal Subsistence Board and Office of Subsistence Management, which also manages subsistence uses by rural residents on federal lands and applicable waters under Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA). Yukon River salmon fisheries management includes obligations under an international treaty with Canada. Salmon fisheries management in southeast Alaska also includes international obligations under the Pacific Salmon Treaty.

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 in-river 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 in-river 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. A listing of escapement goals by river system and escapements 2004-2012 is included in Table 2. Additional information detailing whether or not management goals were met from 2004-2012 and whether catch restrictions were recently imposed (in 2011 and 2012 only) is shown in Table 3.

Chinook stock status in many rivers in western Alaska has been in a decline in recent years. In the AYK region, catch restrictions and closures have been enacted in all three major river systems (Kuskokwim, Yukon and Norton Sound). In the Kuskokwim Area, several tributaries had subsistence restrictions and closures in the last two years, no commercial fishing in Kuskokwim River, limited fishing in Kuskokwim Bay, and multiple tributaries closed to sport fishing in both years (Table 3). In the Yukon River there have been subsistence schedule restrictions for multiple years, no directed commercial fisheries and restrictions and bag limits in the sport fisheries (Table 3). Similarly in Norton Sound subsistence fishing has been restricted, there have been no commercial fisheries and sport fish restrictions (Table 3). Status and catch restrictions for other areas of the State are all contained within Table 3.

Table 2. Chinook salmon escapement goals and escapements in Alaska, 2004 to 2012.

		2012 Goal Range			Year	Escapement								
Region	System	Lower	Upper	Type	Implemented	2004	2005	2006	2007	2008	2009	2010	2011	2012
SEAK[a]	Blossom River	150	300	BEG	2012	333	445	339	135	257	123	363	147	205
	Keta River	175	400	BEG	2012	376	497	747	311	363	219	475	223	241
	Unuk River	1,800	3,800	BEG	2009	3,963	4,742	5,645	5,668	3,104	3,157[b]	3,835[b]	3,195[b]	956[c]
	Chickamin River	450	900	BEG	1997	798	924	1,330	893	1,111	611	1,156	852	444
	Andrew Creek	650	1,500	BEG	1998	2,991	1,979	2,124	1,736	981	628	1,205	936	587
	Stikine River	14,000	28,000	BEG	2000	48,900	39,833	24,405	14,560	18,352	12,810[b]	15,180[b]	14,469[b]	22,671[b]
	King Salmon River	120	240	BEG	1997	135	143	150	181	120	109	158	192	155
	Taku River	19,000	36,000	BEG	2009	75,032	38,725	42,296	14,854	27,383[b]	22,801[b]	29,302[b]	27,523[b]	19,429[b]
	Chilkat River	1,850	3,600	inriver[d]		3,422	3,366	3,039	1,445	2,905	4,429[b]	1,815[b]	2,688[b]	1,627[b]
		1,750	3,500	BEG	2003									
	Klukshu (Alsek) River	1,100	2,300	BEG	1998	2,451	1,034	568	676	466	1,466	2,159	1,667[b]	693[b]
	Situk River	450	1,050	BEG	2003	698	599	695	677	413	902	166[e]	240	322
Central	***Bristol Bay***													
	Nushagak River	40,000	80,000	SEG	2007	107,591	163,506	117,364	50,960	91,364	74,781	27,526	44,749	102,000
	Togiak River	9,300		lower-bound SEG	2007	NS	NS	NS	NS	NS	NS	NS	NS	NS
	Naknek River	5,000		lower-bound SEG	2007	12,878	NS	NS	5,498	6,559	3,305[f]	NS	NS	NS
	Alagnak River	2,700		lower-bound SEG	2007	6,755	5,084	4,278	3,455	1,825	1,957	NS	NS	NS
	Egegik River	450		lower-bound SEG	2007	579	335	196	458	162	350[g]	NS	NS	NS
	Upper Cook Inlet													
	Alexander Creek	2,100	6,000	SEG	2002	2,215	2,140	885	480	150	275	177	343	181
	Campbell Creek	380		lower-bound SEG	2011	964	1,097	1,052	588	439	554	290	260	NS
	Chuitna River	1,200	2,900	SEG	2002	2,938	1,307	1,911	1,180	586	1,040	735	719	502
	Chulitna River	1,800	5,100	SEG	2002	2,162	2,838	2,862	5,166	2,514	2,093	1,052	1,875	667
	Clear (Chunilna) Creek	950	3,400	SEG	2002	3,417	1,924	1,520	3,310	1,795	1,205	903	512	1,177
	Crooked Creek	650	1,700	SEG	2002	2,196	1,903	1,516	964	881	617	1,088	654	631
	Deshka River	13,000	28,000	SEG	2011	57,934	37,725	31,150	18,714	7,533	11,967	18,594	19,026	14,010
	Goose Creek	250	650	SEG	2002	417	468	306	105	117	65	76	80	57
	Kenai River - Early Run	5,300	9,000	OEG	2005	11,855	16,387	18,428	12,504	11,732	9,771	NA[h]	NA[h]	NA[h]
		4,000	9,000	SEG	2011									
	Kenai River - Late Run	17,800	35,700	SEG	2011	40,198	26,046	24,423	32,618	24,144	17,158	NA[i]	NA[i]	NA[i]
	Lake Creek	2,500	7,100	SEG	2002	7,598	6,345	5,300	4,081	2,004	1,394	1,617	2,563	2,366
	Lewis River	250	800	SEG	2002	1,000	441	341	0[j]	120	111	56	92	107
	Little Susitna River	900	1,800	SEG	2002	1,694	2,095	1,855	1,731	1,297	1,028	589	887	1,154
	Little Willow Creek	450	1,800	SEG	2002	2,227	1,784	816	1,103	NC	776	468	713	494
	Montana Creek	1,100	3,100	SEG	2002	2,117	2,600	1,850	1,936	1,357	1,460	755	494	416
	Peters Creek	1,000	2,600	SEG	2002	3,757	1,508	1,114	1,225	NC	1,283	NC	1,103	459
	Prairie Creek	3,100	9,200	SEG	2002	5,570	3,862	3,570	5,036	3,039	3,500	3,022	2,038	1,185
	Sheep Creek	600	1,200	SEG	2002	285	760	580	400	NC	500	NC	350	363
	Talachulitna River	2,200	5,000	SEG	2002	8,352	4,406	6,152	3,871	2,964	2,608	1,499	1,368	847
	Theodore River	500	1,700	SEG	2002	491	478	958	486	345	352	202	327	179
	Willow Creek	1,600	2,800	SEG	2002	2,840	2,411	2,193	1,373	1,255	1,133	1,173	1,061	756
	Lower Cook Inlet													
	Anchor River	3,800	10,000	SEG	2011	12,016	11,156	8,945	9,622	5,806	3,455	4,449	3,547	4,509[b]
	Deep Creek	350	800	SEG	2002	1,075	1,076	507	553	205	483	387	696	447
	Ninilchik River	550	1,300	SEG	2008	679	1,259	1,013	543	586	528	605	668	555[b]
	Prince William Sound													
	Copper River	24,000		lower-bound SEG	2003	30,628	21,528	58,454	34,565	32,487	27,787	16,771	27,994	29,600[k]

Region	System	2012 Goal Range Lower	2012 Goal Range Upper	Type	Year Implemented	Escapement 2004	2005	2006	2007	2008	2009	2010	2011	2012
AYK	***Kuskokwim Area***													
	North (Main) Fork Goodnews River	640	3,300	SEG	2005	7,462	NS	4,159	NS	2,155	NS	NS	853	NS
	Middle Fork Goodnews River	1,500	2,900	BEG	2007	4,388	4,633	4,559	3,852	2,161	1,630	2,244	1,861	513
	Kanektok River	3,500	8,000	SEG	2005	28,375	14,202	8,433	NS	3,659	NS	1,228	NS	NA
	Kogrukluk River	5,300	14,000	SEG	2005	19,651	22,000	19,414	13,029	9,730	9,702	5,690	6,891	NA
	Kwethluk River	6,000	11,000	SEG	2007	28,604	NA	17,618	12,927	5,275	5,744	1,669	4,076	NA
	Tuluksak River	1,000	2,100	SEG	2007	1,475	2,653	1,043	374	701	362	201	286	560
	George River	3,100	7,900	SEG	2007	5,207	3,845	4,357	4,883	2,698	3,663	1,500	1,571	2,267
	Kisaralik River	400	1,200	SEG	2005	5,157	2,206	4,734	692	1,074	NS	235	NS	610
	Aniak River	1,200	2,300	SEG	2005	5,362	NS	5,639	3,984	3,222	NS	NS	NS	NS
	Salmon River (Aniak R)	330	1,200	SEG	2005	2,177	4,097	NS	1,458	589	NS	NS	79	49
	Holitna River	970	2,100	SEG	2005	4,051	1,760	1,866	NS	NS	NS	587	NS	NS
	Cheeneetnuk River (Stony R)	340	1,300	SEG	2005	918	1,155	1,015	NS	290	323	NS	249	229
	Gagaryah River (Stony R)	300	830	SEG	2005	670	788	531	1,035	177	303	62	96	178
	Salmon River (Pitka Fork)	470	1,600	SEG	2005	1,138	1,801	862	943	1,305	632	135	767	670
	Yukon River													
	East Fork Andreafsky River	2,100	4,900	SEG	2010	8,045	2,239	6,463	4,504	4,242	3,004	2,413	5,213	2,517
	West Fork Andreafsky River	640	1,600	SEG	2005	1,317	1,492	824	976	NS	1,678	858	1,173	NS
	Anvik River	1,100	1,700	SEG	2005	3,679	2,421	1,876	1,529	992	832	974	642	722
	Nulato River (forks combined)	940	1,900	SEG	2005	1,321	553	1,292	2,583	922	2,260	711	1,401	1,374
	Gisasa River		eliminated		2010	731	958	843	593	487	515	264		
	Chena River	2,800	5,700	BEG	2001	9,645	NS	2,936	3,806	3,208	5,253	2,382	NS	2,200[l]
	Salcha River	3,300	6,500	BEG	2001	15,761	5,988	10,679	6,425	5,415	12,774	6,135	7,200[m]	7,165
	Canada Mainstem	42,500	55,000	agreement[n]	annual	48,469	67,985	62,630	34,904	33,883	65,278	31,818	46,017	32,456[b]
	Norton Sound													
	Fish River/Boston Creek	100		lower-bound SEG	2005	112	46	NS	NS	NS	NS	NS	NS	NS
	Kwiniuk River	300	550	SEG	2005	663	342	195	258	237	444	135	57	54
	North River (Unalakleet R)	1,200	2,600	SEG	2005	1,125	1,015	906	1,948	903	2,355	1,256	864	996
	Shaktoolik River	400	800	SEG	2005	91[o]	74[p]	150[o]	412	NS	NS	NS	106	NS
	Unalakleet/Old Woman River	550	1,100	SEG	2005	398[o]	510[p]	NS	821	NS	1,368	NS	105	NA
Westward	***AK Peninsula***													
	Nelson River	2,400	4,400	BEG	2004	6,959	4,993	2,516	2,492	5,012	2,048	2,767[q]	1,704[q]	992[q]
	Chignik													
	Chignik River	1,300	2,700	BEG	2002	7,633	6,037	3,175	1,675	1,620	1,590	3,515[r]	2,482[r]	1,449[r]
	Kodiak													
	Karluk River	3,000	6,000	BEG	2011	7,228	4,684	3,673	1,697	752	1,306	2,917	3,420	3,197[s]
	Ayakulik River	4,000	7,000	BEG	2011	24,425	8,175	2,937	6,232	3,071	2,615	5,197	4,252[t]	4,760[t]

Note: NA = data not available; NC = no count; NS = no survey.
[a] Goals are for large (≥660 mm MEF, or fish age 1.3 and older) Chinook salmon, except the Alsek River goal, which is germane to fish age 1.2 and older and can include fish <660 mm MEF.
[b] Preliminary data.
[c] 2012 Unuk River Chinook salmon escapement estimate based on expanded aerial survey index because mark-recapture experiment failed.
[d] Chilkat River Chinook salmon inriver goal accounts for inriver subsistence harvest, which averages <100 fish.
[e] Incomplete weir count due to inseason problems with weir (e.g., breach of weir).
[f] In 2009, aerial surveys were only flown on Big Creek (2,834 Chinook salmon) and King Salmon River (471 Chinook salmon). Mainstem Naknek River and Paul's Creek were not surveyed in 2009.
[g] Aerial surveys were conducted in the Egegik and King Salmon River systems on August 5, 2009 to provide escapement indices for Chinook and chum salmon. Resulting counts were 350 Chinook, and 277 chum salmon. Water conditions were poor; high and turbid conditions prevented observation on most of the surveyed systems. Chinook escapement indices were well below average in streams surveyed, but should be considered minimum counts due to the poor water conditions. Based on carcass distribution and observed presence, the survey was likely conducted after peak spawning.
[h] TS-based escapement estimate deemed unreliable or not available. Refer to McKinley and Fleischman (2013) for recent escapement estimates.
[i] TS-based escapement estimate deemed unreliable or not available. Refer to Fleischman and McKinley (2013) for recent escapement estimates.
[j] Lewis River diverged into swamp 1/2 mi. below bridge. No water in channel.
[k] The Copper River Chinook salmon spawning escapement estimate is preliminary. The estimate is generated from a mark-recapture project run by the Native Village of Eyak and LGL Consulting. The spawning escapement estimate is generated by subtracting the upper Copper River state and federal subsistence, state personal use, and sport fishery harvest estimates from the mark-recapture estimate of the inriver abundance. The estimates for the federal and state subsistence and the state personal use fishery harvests are generally not available for about 6 months after the fishery is closed. Additionally, the sport fishery harvest estimate is based on the mail-out survey and is generally available about 12 months after the fishery ends.
[l] 2012 Chena River Chinook salmon escapement estimate includes an expansion for missed counting days based on two DIDSON sonars used to assess Chinook salmon passage.
[m] 2011 Slacha River Chinook escapement is based on an aerial survey because high water prevented tower counting most of the season; therefore, aerial survey represents best estimate of escapement for the year.
[n] Canadian Yukon River Mainstem Chinook salmon IMEG (Interim Management Escapement Goal) of 42,500-55,000 was implemented for 2010, 2011, and 2012 seasons by the United States and Canada Yukon River Joint Technical Committee (JTC). Estimates from 2005-2012 represent escapement after subtraction of Canadian harvest.
[o] 2004 and 2006 Shaktoolik River surveys and combined Unalakleet and Old Woman rivers surveys (2004) are not considered complete as they were conducted well before peak spawn. Surveys during these years were rated as acceptable, but the observer noted difficulty enumerating Chinook salmon due to large numbers of pink salmon.
[p] 2005 Shaktoolik and Unalakleet River drainage surveys were conducted during peak spawning periods but Chinook salmon counts are thought to be underestimated due to large numbers of pink salmon.
[q] Nelson River Chinook salmon logbook data used to estimate sport harvest above weir 2010-2011. Angler effort not reported in SWHS. 2012 data only escapement counts.
[r] Chignik River Chinook salmon logbook data used to estimate sport harvest above weir 2010-2011. Angler effort not reported in SWHS. 2012 data only escapement counts.
[s] 2012 Karluk River Chinook salmon escapement is the weir count; no upriver harvest due to fishery closure.
[t] Ayakulik River Chinook salmon logbook data used to estimate sport harvest above weir 2011. Angler effort not reported in SWHS. 2012 data only escapement counts.

Table 3. Assessment of whether escapements met (Met), exceeded (Over), or did not meet (Under) the escapement goal in place at the time of enumeration for Chinook salmon stocks in Alaska.

Region	System	2004	2005	2006	2007	2008	2009	2010	2011	2012
SEAK	Blossom River	Met	Met	Met	Under	Met	Under	Met	Under	Met[a]
	Keta River	Met	Met	Over	Met	Met	Under	Met	Under	Met[a]
	Unuk River	Met	Met	Met	Met	Met	Met[b]	Over	Met	Under
	Chickamin River	Met	Over	Over	Met	Over	Met	Over	Met	Under
	Andrew Creek	Over	Over	Over	Over	Met	Under	Met	Met	Under
	Stikine River	Over	Over	Met	Met	Met	Under	Met	Met	Met
	King Salmon River	Met	Met	Met	Met	Met	Under	Met	Met	Met
	Taku River	Over	Met	Met	Under	Under	Met[a]	Met	Met	Met
	Chilkat River	Met	Met	Met	Under	Met	Over	Met	Met	Under
	Klukshu (Alsek) River	Over	Under	Under	Under	Under	Met	Met	Met	Under
	Situk River	Met	Met	Met	Met	Under	Met	Under	Under	Under
	Subsistence Fishery?								Yes	No, except Klukshu (Alsek) R. and Federal subsistence fishery on Stikine R., Chilkat R. normal closure extended by 2 weeks, Situk R. closed.
	Commercial Fishery?								Yes	No directed fisheries, except Taku R. - restricted then closed; Chilkat R. - normal closure extended by two weeks; Situk R. - closed. Regional purse seine - Chinook non-retention until August 6. Regional troll - Chinook non-retention July 1 - August 6 and September 9 - 30.
	Sport Fishery?								Yes	Situk River and Chilkat Inlet restricted
Central	***Bristol Bay***									
	Nushagak River	Over	Over	Over	Met[c]	Over	Met	Met	Met	Over
	Togiak River	NS	NS	NS	NS[d]	NS	NS	NS	NS	NS
	Naknek River	Over	NS	NS	Met[d]	Met	Under	NS	NS	NS
	Alagnak River				Met	Under	Under	NS	NS	NS
	Egegik River				Met	Under	Under	NS	NS	NS
	Subsistence Fishery?								Yes	Yes - no restrictions.
	Commercial Fishery?								Limited in Nushagak District	Limited in Nushagak District - This is confusing. Does this mean the fishery was restricted because of Chinook escp level? It was not. However no directed Chinook fishery occurred in 2012
	Sport Fishery?								Restricted on Nushagak	Yes - reduced annual limit from from June 28 - July 3; reduced bag limit from June 28 - July 7.
	Upper Cook Inlet									
	Alexander Creek	Met	Met	Under	Under	Under	Under	Under	Under	Under
	Campbell Creek	Over	eliminated			Met[c]	Met	Met	Under	NA
	Chuitna River	Over	Met	Met	Under	Under	Under	Under	Under	Under
	Chulitna River	Met	Met	Met	Over	Met	Met	Under	Met	Under
	Clear (Chunilna) Creek	Over	Met	Met	Met	Met	Met	Under	Under	Met
	Crooked Creek	Over	Over	Met	Met	Met	Under	Met	Met	Under
	Deshka River	Over	Over	Over	Met	Under	Under	Met	Met	Met
	Goose Creek	Met	Met	Met	Under	Under	Under	Under	Under	Under
	Kenai River - Early Run	Met	Over[a]	Over	Over	Over	Over	NA	NA	NA
	Kenai River - Late Run	Over	Met	Met	Met	Met	Under	NA	NA	NA
	Lake Creek	Over	Met	Met	Met	Under	Under	Under	Met	Under

Region	System	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Lewis River	Over	Met	Met	Under	Under	Under	Under	Under	Under
	Little Susitna River	Met	Over	Over	Met	Met	Met	Under	Under	Met
	Little Willow Creek	Over	Met	Met	Met	NC	Met	Met	Met	Met
	Montana Creek	Met	Met	Met	Met	Met	Met	Under	Under	Under
	Peters Creek	Over	Met	Met	Met	NC	Met	NC	Met	Under
	Prairie Creek	Met	Met	Met	Met	Under	Met	Under	Under	Under
	Sheep Creek	Under	Met	Under	Under	NC	Under	NC	Under	Under
	Talachulitna River	Over	Met	Over	Met	Met	Met	Under	Under	Under
	Theodore River	Under	Under	Met	Under	Under	Under	Under	Under	Under
	Willow Creek	Over	Met	Met	Under	Under	Under	Under	Under	Under
	Subsistence Fishery?								Yes	Yes
	Commercial Fishery?								Restricted in Northern District	Restricted in Northern District. Set gillnetting restricted and then closed in Upper Subdistrict (Central District).
	Sport Fishery?								Various restrictions including complete closure	Various restrictions including closure of Kenai River. Anchorage area- Ship Cr closure, none to Campbell
	Lower Cook Inlet									
	Anchor River	Over	eliminated			Met[f]	Under	Under	Under[g]	Met
	Deep Creek	Over	Over	Met	Met	Under	Met	Met	Met	Met
	Ninilchik River	Met	Met	Met	Met	Met[h]	Under	Met	Met	Met
	Subsistence Fishery?								Yes	Yes
	Commercial Fishery?								Yes	Yes
	Sport Fishery?								Restricted; closed Anchor river	Restricted and then closed Anchor and Ninilchik rivers.
	Prince William Sound									
	Copper River	Met	Under	Met	Met	Met	Met	Under	Met	Met
	Subsistence Fishery?								Personal use fishery closed to retention of king salmon June 27.	Personal use fishery closed to retention of king salmon June 18.
	Commercial Fishery?								Yes with restrictions additional periods with inside closures	Yes with restrictions additional periods with inside closures
	Sport Fishery?								Yes	Reduced annual limit from 4 to 1 fish in the Upper Copper R drainage, no retention of king salmon in Gulkana River and single hooks, no bait effective June 30. No retention in the Klutina River and all waters downstream of the Klutina River and no bait effective July 28.
AYK	***Kuskokwim Area***									
	North (Main) Fork									
	Goodnews River	Met	NS[g]	Over	NS	Met	NS	NS	Met	NS
	Middle Fork									
	Goodnews River	Met	Over[g]	Over	Over[a]	Met	Met	Met	Met	Under
	Kanektok River	Met	Over[g]	Over	NS	Met	NS	Under	NS	NA
	Kogrukluk River	Met	Over[g]	Over	Met	Met	Met	Met	Met	NA
	Kwethluk River	Over	Over	NA	Over[f]	Under	Under	Under	Under	NA
	Tuluksak River				Under	Under	Under	Under	Under	Under
	George River				Met	Under	Met	Under	Under	Under
	Kisaralik River	Met	Over[g]	Over	Met	Met	NS	Under	NS	Met

Region	System	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Aniak River	Met	NS[g]	Over	Over	Over	NS	NS	NS	NS
	Salmon River (Aniak R)	Met	Over[g]	NS	Over	Met	NS	NS	Under	Under
	Holitna River	Met	Over[g]	Over	NS	Under	NS	Under	NS	NS
	Cheeneetnuk River (Stony R)		Met	Met	NS	Under	Under	NS	Under	Under
	Gagaryah River (Stony R)		Met	Met	Over	Under	Met	Under	Under	Under
	Salmon River (Pitka Fork)	Under	Over[g]	Met	Met	Met	Met	Under	Met	Met
	Subsistence Fishery?								Yes, 3 tributaries closed, restrictions in mainstem District 1	Yes, 5 tributaries closed, restrictions in mainstem Kuskokwim River through most of the season.
	Commercial Fishery?								None on Kuskokwim River, limited in Bay	None on Kuskokwim River, incidental retained as personal use in chum fishery. Limited in Kuskokwim Bay.
	Sport Fishery?								3 tributaries closed	6 tributaries closed June 1; bag limit reduced from 3 to 1in remaining tributaries and closed mainstem June 13; closed all waters of the Kuskokwim drainage June 22.
	Yukon River									
	E Fork Andreafsky River	Met	Over[g]	Under	Over	Under	Under	Met[f]	Over	Met
	W Fork Andreafsky River	Under	Met[g]	Met	Met	NS	Over	Met	Met	NS
	Anvik River	Met	Over[g]	Over	Met	Under	Under	Under	Under	Under
	Nulato River (all forks)	Met	Under[g]	Met	Over	Under	Over	Under	Met	Met
	Gisasa River	Met	Met[g]	Met	Met	Met	Met	eliminated		
	Chena River	Over	NS	Met	Met	Met	Met	Under	NS	Under
	Salcha River	Over	Met	Over	Met	Met	Over	Met	Over	Over
	Canada Mainstem	Met	Met	Met	Met[i]	Under[j]	Met	Under[j]	Met	Under
	Subsistence Fishery?								Yes, restricted fishing schedule	Yes, restricted fishing schedule
	Commercial Fishery?								No directed, small incidental take with chum but not sold	No directed, small incidental take with chum but not sold
	Sport Fishery?								Bag limit reduced to 1 all tributaries, no retention mainstem and Tanana R., no bait allowed Tanana R. tributaries	Bag limit reduced from 3 to 1 in tributaries and closed mainstem May 15. No retention in Tanana River drainage and no bait in tributaries July 21; Closed Chena River drainage and confluence with Tanana July 30.
	Norton Sound									
	Fish River/Boston Creek	Met	Under[d]	NS	NS	NS	NS	NS	NS	NS
	Kwiniuk River	Over	Met[j]	Under	Under	Under	Met	Under	Under	Under
	North River (Unalakleet R)	Under	Under[a]	Under	Met	Under	Met	Met	Under	Under
	Shaktoolik River	Under	Under[j]	Under	Met	NS	NS	NS	Under	NS
	Unalakleet/Old Woman River	Under	Under[j]	NS	Met	NS	Over	NS	Under	NS
	Subsistence Fishery?								Yes, with restrictions	Yes, with restrictions
	Commercial Fishery?								No directed, incidental take not sold	No directed, incidental take not sold
	Sport Fishery?								Started the season open then was closed and use of bait prohibited in Unalakleet and Shaktoolik rivers.	Started the season open then closed all waters of the Unalakleet and Shaktoolik drainages to sport fishing for king salmon and prohibited bait when sport fishing July 11.
Westward	***AK Peninsula***									
	Nelson River	Over[a]	Over	Met	Met	Over	Under	Met	Under	Under

Region	System	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Subsistence Fishery?								Yes	Yes
	Commercial Fishery?								Yes	Yes
	Sport Fishery?								Yes	Closed inseason
	Chignik									
	Chignik River	Over	Over	Over	Met	Met	Met	Over	Met	Met
	Subsistence Fishery?								Yes	Yes
	Commercial Fishery?								Yes	Yes
	Sport Fishery?								Yes	Restricted inseason to non-retention
	Kodiak									
	Karluk River	Met	Met	Met	Under	Under	Under	Under	Met[a]	Met
	Ayakulik River	Over	Met	Under	Met	Under	Under	Met	Met[a]	Met
	Subsistence Fishery?								Yes	Yes
	Commercial Fishery?								Restricted, nonretention in Karluk and Ayakulik areas	Restricted, nonretention in Karluk and Ayakulik areas
	Sport Fishery?								Restricted, nonretention in Karluk, reduced bag and annual limits in Ayakulik	Ayakulik: Restricted preseason - reduced bag limit; Karluk: Restricted preseason - nonretention

Note: NA = data not available; NC = no count; NS = no survey.
[a] Escapement goal reevaluated, goal changed.
[b] Prior to 2009, goal was based on index count of escapements.
[c] Escapement goal reevaluated, point goal changed to a range.
[d] Escapement goal reevaluated, point goal changed to a lower-bound goal.
[d] Previous escapement goal reinstated.
[f] Escapement assessment method changed; therefore, escapement numbers in Table 1 are not comparable to previous goal.
[g] Escapement goal reevaluated, lower-bound goal changed to a range.
[h] Escapement goal reevaluated, current goal based on escapement count over longer period during spawning season, escapement numbers in Table 2 are based on longer counting time.
[i] Escapement goal revised by The United States and Canada Yukon River Joint Technical Committee (JTC).
[j] Escapement goal reevaluated, goal type changed but goal value remained the same.

3 Adult equivalence analysis update

An adult equivalency (AEQ) model was developed for use in the Chinook Salmon PSC management measures final environmental impact statement (FEIS) (NPFMC/NMFS 2009). This was done to understand the impacts of bycatch on Chinook salmon populations, and required the development of a method to estimate how the different bycatch numbers would propagate to adult equivalent spawning salmon. This is distinguished from the annual bycatch numbers that are recorded by observers each year for management purposes.

The AEQ bycatch applies the extensive observer datasets on the length frequencies of Chinook salmon taken as bycatch and converts these to the ages of the bycaught salmon, appropriately accounting for the time of year that catch occurred. Coupled with information on the proportion of salmon that return to different river systems at various ages, the bycatch-at-age data is used to pro-rate, for any given year, how bycatch affects future potential spawning runs of salmon.

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. Because the salmon caught in the pollock fishery range in ages from 3-7 year olds, the impacts of bycatch in any one year may be lagged by several years. Thus a high bycatch year (such as in 2007) may have impacts lower than the number of PSC recorded as mortality in that year but will continue to impact returns to rivers for several years into the future. Similarly a low bycatch year may indicate low mortality in that year but the true impacts are influenced by the bycatch that has occurred in previous years. Therefore AEQ is a more accurate representation of the true impact to spawning salmon than the mortality in numbers of fish recorded in any one year.

The Council requested an updated AEQ analysis (from the 2009 version) including expanding the analysis to stock of origin using the most recent genetic information from the Chinook salmon bycatch in the pollock fishery (2011). The previous analysis (presented at final action on Amendment 91 in 2009; NPFMC/NMFS 2009) provided an estimate of the AEQ by stock of origin from 2003-2007 using genetic data from sampling in 2005-2007 (Templin et al., 2007) and was designed to complement information provided to the Council and the public as to the likely impacts of different bycatch management cap levels at that time.

Since the Council's action in 2009 some additional work has been done to augment and update the AEQ analysis prior to the Council's most recent request. Notably the analysts were requested to provide a white paper in conjunction with the Arctic Yukon Kuskokwim Sustainable Salmon Initiative (AYKSSI) science panel review and subsequent outreach meeting in May and December of 2012, respectively. This was to provide additional information to assist with their hypotheses on Chinook salmon decline[1] by summarizing information on Chinook salmon AEQ in the pollock fishery. Information that was provided to the AYKSSI science panel as well as additional analyses summarized below are being compiled into a manuscript for submission to a peer-reviewed publication as soon as possible (Ianelli and Stram, In prep).

3.1 Methods

Methods are the same as detailed in the 2009 analysis (NPFMC/NMFS, 2009) with modifications to account for the lagged-effect of genetic stock ID information compared to the year that the Chinook salmon were expected to return (as was presented in the chum salmon EA of 2012 (Ianelli and Stram, In

[1] Hypothesis #5: Ocean Bycatch/Ecosystem Overfishing – Fishery caused mortality or changes in Bering Sea ecosystem structure and function have contributed to the decline of AYK-region Chinook salmon stocks. Per request that paper addressed only the ocean bycatch portion of the hypothesis.

prep). Data are partitioned into three strata: the entire fishing area for the A-season (which is usually constrained by ice), and the two other strata are defined as the NW and SE regions of the eastern Bering Sea for the B season.

3.2 Observer data and age compositions

NMFS scientific observers collect extensive data on target species and prohibited species such as Chinook salmon taken incidentally in the pollock fishery. The number of Chinook salmon lengths measured in this fishery since 1991 by sector and season/area are shown in Table 4 (Figure 1). The observer program, in conjunction with landings data provide estimates of total Chinook salmon catch which is broken down by strata (Table 5). The result of the age composition (with proportion by age that occurs in the A season) shows considerable variability between years but age 4 is typically the predominant Chinook salmon age group in the bycatch (Table 6). Table 7 and Table 8 show the season-specific estimate of uncertainty at age in the bycatch with a marked increase in uncertainty due to the reduced sampling for lengths (and ages) since 2008.

Table 4. The number of Chinook salmon measured for lengths in the pollock fishery by season (A and B), area (NW=east of 170°W; SE=west of 170°W), and sector (S=shorebased catcher vessels, M=mothership operations, CP=catcher-processors). *Source: NMFS Alaska Fisheries Science Center observer data.*

Season	A	A	A	B	B	B	B	B	B	
Area	All	All	All	NW	NW	NW	SE	SE	SE	
Sector	S	M	CP	S	M	CP	S	M	CP	Total
1991	2,227	302	2,569		25	87	221	10	47	5,488
1992	2,305	733	889	2	4	14	1,314	21	673	5,955
1993	1,929	349	370	1	11	172	298	255	677	4,062
1994	4,756	408	986	3	93	276	781	203	275	7,781
1995	1,209	264	851		8	31	457	247	305	3,372
1996	9,447	976	2,798		17	161	5,658	1,721	493	21,271
1997	3,498	423	910	12	303	839	12,126	370	129	18,610
1998	3,124	451	1,329		38	191	8,277	2,446	1,277	17,133
1999	1,934	120	1,073		1	627	1,467	97	503	5,822
2000	608	17	1,388	4	40	179	564	3	120	2,923
2001	4,360	268	3,583		25	1,816	1,597	291	1,667	13,607
2002	5,587	850	3,011		23	114	5,353	520	494	15,952
2003	9,328	1,000	5,379	258	290	1,290	4,420	348	467	22,780
2004	7,247	594	3,514	1,352	557	1,153	8,884	137	606	24,044
2005	9,237	694	3,998	4,081	244	1,610	10,336	45	79	30,324
2006	17,875	1,574	5,716	685	66	480	12,757	3	82	39,238
2007	16,008	1,802	9,012	881	590	1,986	21,725	2	801	52,807
2008	21	272	1,306	1	94	164	28	0	22	1,908
2009	221	124	653	0	33	106	43	2	0	1,182
2010	13	52	916	3	6	27	8	2	0	1,027
2011	464	46	228	15	5	131	1,386	232	66	2,573
2012	480	36	287	9	1	3	338	2	1	1,157

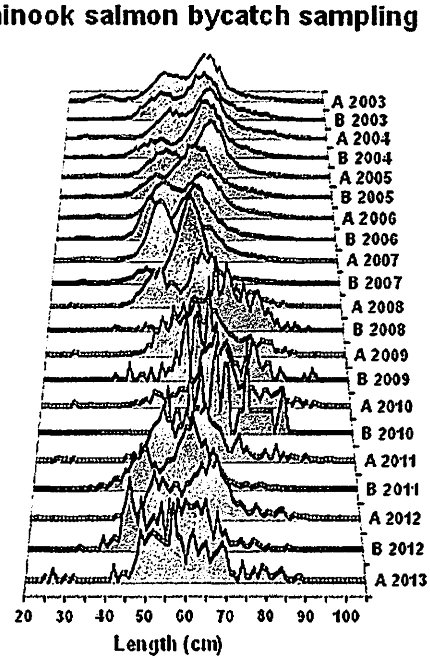

Figure 1. NMFS Observer program Chinook salmon length frequency by season and year, 2003-2012.

Table 5. Chinook salmon PSC taken bycatch in the pollock fishery by season (A and B), area (NW=east of 170°W; SE=west of 170°W), and sector (S=shorebased catcher vessels, M=mothership operations, CP=catcher-processors). Note that CDQ prior to 2003 were included in the other sectors. *Source: NMFS Alaska Regional Office, Aug 23 2013.*

Season Area Sector	A All S	A All M	A All CP	A All CDQ	B NW S	B NW M	B NW CP	B NW CDQ	B SE S	B SE M	B SE CP	B SE CDQ	Total
1991	10,192	9,001	17,645		0	48	318		1,667	103	79		39,054
1992	6,725	4,057	12,631		0	26	187		1,604	1,739	6,702		33,672
1993	3,017	3,529	8,869		29	157	7,158		2,585	6,500	4,775		36,619
1994	8,346	1,790	17,149		0	121	771		1,206	452	2055		31,890
1995	2,040	971	5971		0	35	77		781	632	2896		13,403
1996	15,228	5,481	15,276		0	113	908		9,944	6,208	2,315		55,472
1997	4,954	1,561	3,832		43	2,143	4,172		22,508	3,559	1,549		44,320
1998	4,334	4,284	6,500		0	309	511		27,218	6,052	2,037		51,244
1999	3,103	554	2694		13	12	1,284		2,649	362	1306		11,978
2000	878	19	2525		4	230	286		714	23	282		4,961
2001	8,555	1,664	8,264		0	162	5,346		3,779	1,157	4,517		33,444
2002	10,336	1,976	9,481		0	38	211		9,560	1,717	1,175		34,495
2003	15,367	2,567	12,982	1,693	712	858	2,461	504	6,286	971	817	368	45,586
2004	11,576	1,830	8,559	1,140	2,310	1,375	1,824	1,217	19,921	494	845	609	51,699
2005	13,797	1,864	10,328	1,299	8,870	546	3,792	555	25,956	144	105	62	67,319
2006	35,638	4,864	16,204	1,585	961	148	1,251	130	21,687	11	165	26	82,671
2007	36,463	4,816	25,841	3,113	1,637	1,825	4,558	2,023	39,701	20	1,748	506	122,252
2008	10,692	1,127	4,091	605	251	175	339	31	3,994	0	38	5	21,347
2009	6,241	547	2,738	358	115	70	310	89	2,092	16	0	0	12,576
2010	3,735	493	3,066	335	73	20	50	0	1,859	64	1	0	9,695
2011	4,441	459	1,806	430	142	69	1,244	76	13,809	2,357	408	258	25,499
2012	4,624	312	2,484	344	75	7	52	2	3,358	42	40	3	11,343
2013	3,640	557	3,563	472	13	7	34	6	697	18	32	2	9,041

Table 6. Calendar year age-specific Chinook salmon bycatch estimates based on the mean of 100 bootstrap samples of available length and age data. Age-length keys for 1997-1999 were based on Myers et al. (2003) data split by year while for all other years, a combined-year age-length key was used. Values in parenthesis indicate the proportion that occurred in the "A" season.

Year	Age 3		Age 4		Age 5		Age 6		Age 7		Total	
1991	5,624	(96%)	15,901	(93%)	13,486	(95%)	3,445	(95%)	347	(90%)	38,802	(94%)
1992	5,136	(20%)	9,528	(49%)	14,538	(93%)	3,972	(96%)	421	(97%)	33,596	(70%)
1993	2,815	(44%)	16,565	(22%)	12,992	(57%)	3,673	(76%)	401	(72%)	36,446	(42%)
1994	849	(51%)	5,300	(66%)	20,533	(91%)	4,744	(89%)	392	(83%)	31,817	(86%)
1995	498	(53%)	3,895	(26%)	4,827	(80%)	3,796	(93%)	367	(89%)	13,382	(67%)
1996	5,091	(17%)	18,590	(39%)	26,202	(88%)	5,062	(88%)	421	(83%)	55,366	(65%)
1997	5,855	(8%)	23,972	(8%)	7,233	(50%)	5,710	(68%)	397	(68%)	43,167	(24%)
1998	19,168	(8%)	16,169	(14%)	11,751	(74%)	2,514	(83%)	615	(83%)	50,216	(30%)
1999	870	(59%)	5,343	(31%)	4,424	(71%)	1,098	(82%)	21	(85%)	11,757	(53%)
2000	662	(55%)	1,923	(61%)	1,800	(78%)	518	(87%)	34	(78%)	4,939	(69%)
2001	6,512	(44%)	12,365	(28%)	11,948	(82%)	1,994	(90%)	190	(90%)	33,009	(55%)
2002	3,843	(41%)	13,893	(36%)	10,655	(87%)	5,469	(97%)	489	(98%)	34,349	(63%)
2003	5,575	(51%)	16,297	(56%)	19,423	(86%)	3,661	(91%)	286	(90%)	45,242	(71%)
2004	6,582	(16%)	22,662	(24%)	17,654	(71%)	4,247	(85%)	390	(87%)	51,536	(45%)
2005	10,406	(13%)	30,520	(23%)	21,661	(71%)	4,295	(77%)	301	(74%)	67,184	(40%)
2006	11,801	(30%)	31,296	(56%)	32,210	(94%)	6,589	(96%)	487	(95%)	82,382	(70%)
2007	16,129	(36%)	66,131	(45%)	33,693	(86%)	5,651	(91%)	361	(89%)	121,966	(57%)
2008	1,144	(46%)	7,025	(58%)	10,775	(91%)	2,177	(93%)	108	(92%)	21,229	(78%)
2009	589	(50%)	4,789	(63%)	5,900	(92%)	1,074	(97%)	87	(97%)	12,439	(79%)
2010	461	(29%)	2,698	(45%)	4,816	(96%)	1,591	(99%)	71	(98%)	9,637	(79%)
2011	6,253	(5%)	13,203	(16%)	4,944	(75%)	951	(91%)	66	(96%)	25,418	(28%)
2012	1,722	(10%)	3,959	(55%)	4,650	(96%)	874	(99%)	84	(99%)	11,288	(69%)

Table 7. Estimates of coefficients of variation of Chinook salmon bycatch estimates for the **A-season** and calendar age based on the mean of 100 bootstrap samples of available length and age data. Note shaded cells are based on the new length-frequency sampling protocol.

A season	Age 3	Age 4	Age 5	Age 6	Age 7
1991	14%	6%	6%	10%	31%
1992	20%	9%	4%	9%	27%
1993	22%	9%	5%	10%	37%
1994	27%	12%	3%	10%	30%
1995	25%	12%	5%	6%	22%
1996	19%	6%	2%	9%	21%
1997	35%	12%	6%	7%	28%
1998	16%	9%	3%	10%	23%
1999	19%	10%	5%	11%	91%
2000	25%	9%	6%	9%	27%
2001	10%	6%	3%	7%	22%
2002	15%	6%	3%	4%	16%
2003	14%	6%	3%	8%	21%
2004	15%	6%	2%	5%	20%
2005	18%	6%	3%	7%	23%
2006	17%	5%	3%	7%	22%
2007	22%	5%	4%	8%	25%
2008	75%	33%	13%	39%	105%
2009	40%	12%	5%	16%	45%
2010	106%	46%	13%	28%	49%
2011	29%	10%	6%	12%	42%
2012	41%	10%	5%	15%	42%

Table 8. Estimates of coefficients of variation of Chinook salmon bycatch estimates for the **B-season** and calendar age based on the mean of 100 bootstrap samples of available length and age data. Note shaded cells are based on the new length-frequency sampling protocol.

B season	Age 3	Age 4	Age 5	Age 6	Age 7
1991	23%	8%	12%	27%	67%
1992	9%	9%	25%	69%	87%
1993	19%	4%	9%	20%	65%
1994	17%	6%	6%	14%	27%
1995	21%	5%	12%	23%	48%
1996	6%	3%	7%	11%	29%
1997	12%	3%	10%	12%	39%
1998	5%	6%	9%	23%	36%
1999	16%	3%	8%	22%	149%
2000	9%	5%	8%	25%	49%
2001	7%	3%	8%	20%	52%
2002	6%	2%	8%	17%	43%
2003	8%	3%	5%	15%	32%
2004	6%	2%	5%	12%	30%
2005	5%	2%	5%	10%	23%
2006	4%	3%	8%	15%	33%
2007	6%	2%	7%	13%	28%
2008	58%	14%	39%	102%	145%
2009	61%	10%	36%	82%	163%
2010	77%	18%	54%	96%	190%
2011	7%	4%	13%	42%	234%
2012	12%	9%	32%	145%	250%

3.3 Chinook salmon in-river data

The State of Alaska provided some estimates of Chinook salmon for western Alaska systems (Table 9; Figure 2). For preliminary examinations on impact rates (AEQ / run estimates) these estimates were used for the period 1994-2012 (during the time that AEQ estimates can be computed and aggregated to similar stock groupings). The ADFG scientists also provided estimates of the age composition for these systems which were used in the AEQ model to estimate the age-specific proportion of Chinook salmon taken at sea that would return to spawn (Table 10).

Table 9. Estimated run size in numbers of Chinook salmon by system for 1976-2012 as provided by ADFG. The "CWAK" column represents the sum of five columns to the left of it. Analyses on impacts were done as aggregated for CWAK and for the Upper Yukon from 1994-2012.

Year	Nushagak	KuskoBay	Kuskokwim River	Norton Sound	Lower and Mid Yukon	"CWAK"	Upper Yukon
1976	348,677		233,967				
1977	324,983		295,559				
1978	531,783		264,325				
1979	544,859		253,970				
1980	454,644		300,573				
1981	741,073		389,791				
1982	741,092		187,354				148,000
1983	650,754		166,333				158,200
1984	321,238		188,238				123,000
1985	401,845		176,292		224,324		145,700
1986	164,656		129,168		186,298		155,900
1987	231,453		193,465		177,287		156,700
1988	141,908		207,818		146,991		141,000
1989	187,644		241,857		102,297		146,100
1990	156,663		264,802		196,126		161,600
1991	246,718		218,705		156,538		140,600
1992	232,103		284,846		183,889		157,800
1993	283,385		269,305		267,718		141,100
1994	334,604		365,246		253,226	953,077	185,600
1995	271,126		360,513		224,219	855,858	194,800
1996	193,029		302,603	23,080	86,934	605,646	198,500
1997	247,097		303,189	59,196	324,333	933,816	186,900
1998	370,883		213,873	35,916	139,171	759,843	93,090
1999	148,963		189,939	18,972	193,172	551,046	114,600
2000	137,979		136,618	13,087	112,255	399,939	52,660
2001	213,128		223,707	13,586	166,822	617,243	97,910
2002	228,919	29,954	246,296	15,685	159,138	679,992	95,250
2003	224,724	36,908	248,789	16,244	170,637	697,303	160,800
2004	351,930	76,429	388,136	14,581	249,800	1,080,875	135,700
2005	307,245	60,875	366,601	12,528	158,044	905,294	123,900
2006	218,031	45,646	307,662	13,628	178,348	763,315	119,200
2007	125,077	55,511	273,060	15,311	144,449	613,408	87,420
2008	128,445	33,104	237,074	11,505	109,548	519,675	63,640
2009	117,530	32,095	204,747	19,707	111,612	485,692	86,540
2010	93,676	32,312	118,507	8,360	96,232	349,086	59,789
2011	144,795	31,463	133,059	6,718	126,428	442,464	71,751
2012	196,545	12,043	99,143	6,645	73,555	387,930	50,094

Table 10. Average age composition estimated by system for 2003-2012 as provided by ADFG. The "combined" row represents the weighted average over the systems.

In-river age	3	4	5	6	7	8
Norton sound	1%	10%	37%	49%	3%	0%
Yukon	0%	12%	40%	44%	3%	0%
Kuskokwim River	0%	25%	39%	34%	2%	0%
Kuskokwim Bay	1%	35%	35%	28%	1%	0%
Nushagak	1%	27%	43%	29%	1%	0%
Combined	0%	27%	38%	32%	2%	0%
Natural mortality	0.3	0.2	0.1	0.1	0	0
Oceanic maturity rate (from combined average brood age composition)	0.0422	0.2684	0.4892	0.9196	1.000	1

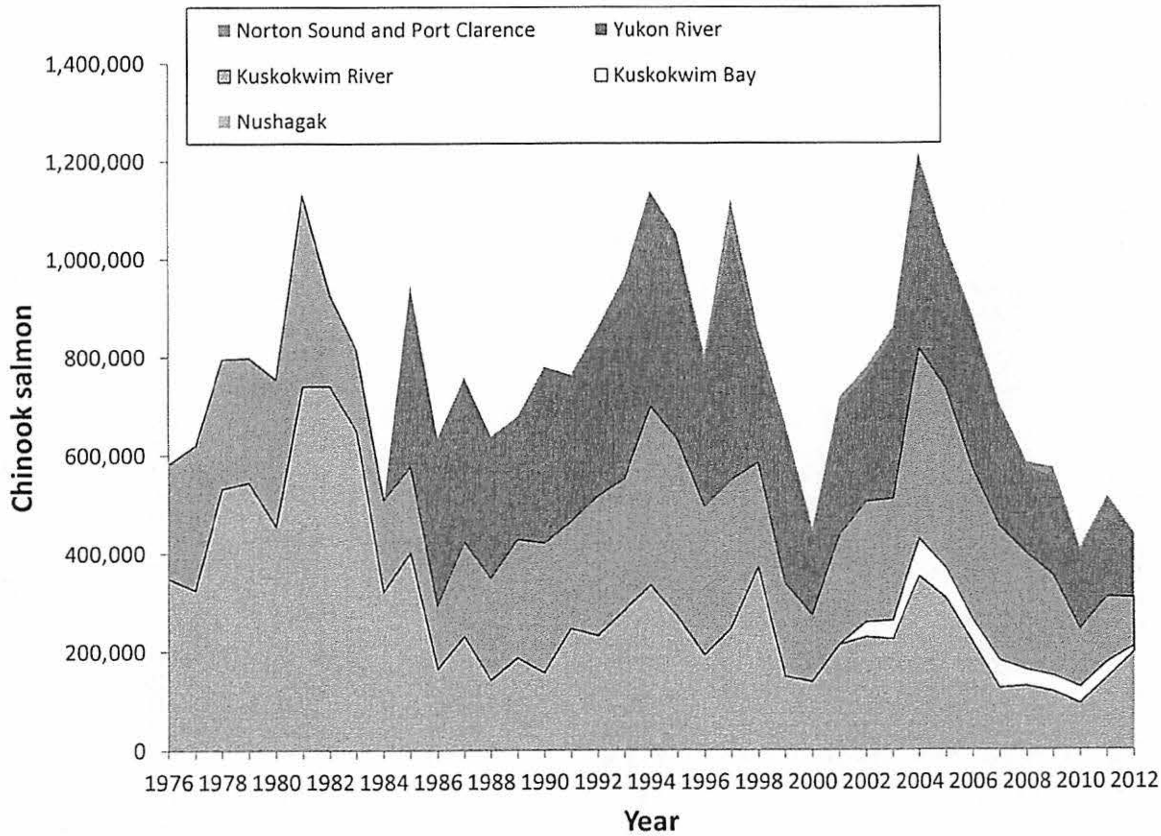

Figure 2. Estimates of western Alaska region total return by sub-area. Years included for this analysis include 1994-2012.

3.4 Genetics

Updated AEQ analysis based on the ongoing studies at the NMFS Auke Bay Lab were applied here. Whereas refinements continue and stock discrimination methods have improved (i.e., as in Guthrie et al. (2013), for the purposes of comparing past work with the improved samples and methods, the new data were processed according to the same strata used in NPFMC/NMFS (2009) for comparisons and these are shown in Table 11. The earlier study was required to weight the available stock ID information according to where and when the bycatch occurred since sampling was out of proportion to the bycatch. This resulted in a higher variance in the estimates as applied to the AEQ analysis but recent sampling protocols have been precisely proportional (Table 12).

Table 11. Stock composition based on genetic samples stratified by year, season, and region (SE=east of 170°W, NW=west of 170°W). Source: Templin et al. 2011; Guthrie et al. 2013; and Guyon et al. 2012 (as modified by first author to match these strata and stock groupings).

Year / Season / Area		Sample size	BC-WA-OR	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Other	Russia	SEAK	Upper Yukon
2005	B SE	282	45.3%	34.2%	5.3%	0.2%	8.8%	0.6%	3.3%	0.0%	2.4%
2005	B NW	489	6.5%	70.9%	2.2%	4.7%	6.7%	2.0%	3.5%	2.8%	0.7%
2006	A All	801	22.9%	38.2%	0.2%	1.1%	31.2%	1.1%	1.1%	2.3%	1.9%
2006	B SE	304	38.4%	37.2%	7.5%	0.2%	7.0%	0.6%	4.3%	0.1%	4.7%
2006	B NW	286	6.4%	67.3%	3.0%	8.0%	2.1%	3.3%	0.5%	8.0%	1.4%
2007	A All	360	9.4%	75.2%	0.1%	0.5%	12.0%	0.2%	0.1%	0.1%	2.4%
2007	B SE	464	6.1%	77.9%	3.6%	3.3%	3.5%	0.3%	0.9%	1.2%	3.1%
2007	B NW	402	1.4%	71.7%	2.6%	5.9%	5.3%	0.4%	3.3%	0.0%	9.3%
2008	A All	788	0.9%	59.5%	0.0%	0.4%	33.4%	0.0%	0.8%	0.4%	4.4%
2008	B SE	280	11.1%	71.0%	3.6%	2.0%	5.7%	1.6%	1.8%	1.8%	1.5%
2008	B NW	245	2.0%	71.1%	2.8%	5.3%	3.9%	0.2%	2.2%	0.6%	11.8%
2009	A All	202	0.5%	47.3%	2.9%	4.9%	22.2%	0.3%	1.1%	0.0%	21.0%
2009	B SE	78	28.9%	54.6%	3.1%	3.0%	3.9%	0.0%	0.1%	2.1%	4.4%
2009	B NW	88	0.1%	70.8%	0.9%	11.2%	5.2%	0.3%	1.6%	0.9%	8.9%
2010	A All	702	3.4%	41.4%	0.6%	12.1%	16.2%	0.0%	2.2%	0.3%	23.9%
2010	B SE	107	46.2%	34.8%	4.8%	1.0%	4.0%	2.7%	1.0%	5.6%	0.0%
2010	B NW	17	11.6%	45.6%	4.8%	16.2%	0.0%	0.0%	11.9%	0.7%	9.2%
2011	A All	695	11.2%	54.0%	0.6%	1.8%	21.8%	0.0%	0.2%	3.1%	7.4%
2011	B SE	1,627	15.1%	72.7%	4.1%	0.9%	3.3%	1.1%	0.7%	1.5%	0.5%
2011	B NW	151	2.9%	75.5%	2.8%	3.6%	2.4%	1.7%	4.9%	1.6%	4.6%

Table 12. NMFS regional office estimates of Chinook salmon bycatch in the pollock fishery compared to genetics sampling levels by season and region, 2005-2012 (SE=east of 170°W, NW=west of 170°W) in absolute terms (top 8 data rows) and percentages (bottom 8 data rows).

	Genetic samples			PSC		
	A season	B SE	B NW	A season	B SE	B NW
2005	NA	282	489	27,209	26,425	13,793
2006	801	304	286	58,035	21,922	2,484
2007	360	464	402	70,054	42,353	10,089
2008	788	280	245	16,510	4,017	793
2009	202	78	88	9,866	2,100	469
2010	702	107	17	7,623	1,923	143
2011	695	1,627	151	7,131	16,832	1,531
2012	NA	NA	NA	7,761	3,570	136
	Genetic samples			PSC		
	A season	B SE	B NW	A season	B SE	B NW
2005		37%	63%	40%	39%	20%
2006	58%	22%	21%	70%	27%	3%
2007	29%	38%	33%	57%	35%	8%
2008	60%	21%	19%	77%	19%	4%
2009	55%	21%	24%	79%	17%	4%
2010	85%	13%	2%	79%	20%	1%
2011	28%	66%	6%	28%	66%	6%
2012				68%	31%	1%

3.5 Results

Application of the AEQ model provides estimates of the number of Chinook salmon that would have returned to the different systems had the bycatch not occurred. In recent years the aggregate numbers of Chinook salmon impacted from bycatch has dropped markedly and has been at record low levels since 2010 (for the period 1994-2012; Table 13 and Figure 3). This figure also shows that the updated results (in aggregate) are identical to the previous analysis presented in the NPFMC/NMFS (2009). Broken down by the genetic stock IDs, the largest component of the bycatch impact is from the coastal western Alaska regions with some interesting patterns by season (Table 13). For example, larger proportions of the Upper Yukon Chinook salmon are taken in the fishery during the winter months than in the summer fishery.

Applying the updated genetics data shows some subtle differences from the 2009 study for the CWAK region (Figure 4). For the Upper Yukon the updated information increased the historical estimates of AEQ Chinook salmon but their uncertainty remains high (Figure 5). The reason for this increase is principally due to the new genetics information from 2008-2011 which was unavailable for the earlier analysis. Since the stock proportions attributed to the Upper Yukon from the genetics data are much higher (Table 11), the mean proportion has increased which affects the estimates from earlier years. As noted above, the improved sampling for genetics has reduced the variance of the estimates in recent years (e.g., Figure 5 for 2010 and 2011 the relative uncertainty is lower). In summary, the new improved sampling design for genetics information resulted in an increase in the estimate and presumably is a better depiction of the impact of the pollock fishery on the Upper Yukon River Chinook salmon for the period 1994-2004.

The next step for these estimates was to apply them to evaluate the potential impact relative to estimated run strengths. This was done by using the AEQ estimates in Table 13 divided the analogous run size estimates as supplied by ADFG (Table 9). For the CWAK region the impact rate peaks at about 7.5% in 2007 whereas for the Upper Yukon stock the peak occurred in 2010 year at about 3.7% (Figure 6; Table 14). For 2011 and 2012 the average impact for the Upper Yukon was estimated at 1.5% and for the CWAK region it was 1.8%. Comparable run size estimates were unavailable for the 2009 analysis (NPFMC/NMFS) hence these are the first time impact rates have been formally estimated.

As requested by the Council, a "what-if" analysis was done where the PSC was raised (proportional to the observed PSC timing and locales) to the cap levels of 47,591 and 60,000 Chinook salmon for 2011 and 2012. For simplicity, season and sector-specific limits were ignored and the full annual PSC limit was attained by inflating the observed PSC. This resulted in a change in impact on the CWAK group which went from the 2011 estimate of 1.6% to about 3.0% for 60,000 fish cap (Table 15). A similar pattern occurred by doing the same operation on the 2012 data (Figure 7). Applying the cap of 47,591 is intermediate to the estimated observed impact and the higher cap. Note that there is a lagged effect of applying caps to 2011 (they weren't applied to prior years) so that the impact of the 2011 (and 2012) cap (and resulting higher PSC levels compared to the actual PSC in those years) will be spread over future years.

However, for the Upper Yukon, the difference between the estimated impact for 2011 and 2012 and the hypothetical impact had the bycatch equaled either of the caps was smaller. For 2011 the estimated impact was 1.6% and had the 47,591 fish cap been taken the impact would have increased to 1.9% (2.1% for the 60,000 fish cap; Figure 8). The peak impact rates for Upper Yukon are below that observed for the CWAK stocks. As with the CWAK results the impact of applying these caps would spread into future years given the higher implied impact of reaching those cap levels. Results for 2012 (lower panel of Figure 8) show higher uncertainty than 2011 (as shown by a broader distribution of the curve) due to the fact that uncertainty is estimated based on between-year mean values and not actual data for 2012 (as these data are unavailable). Once 2012 genetic data are used to estimate stock proportions for that year the uncertainty would be more similar to the 2011 estimates (upper panel of Figure 8) as represented by a more narrow distribution of the curve. Genetics data from 2012 will be available in 2014.

The results suggest that—assuming that environmental factors that affect the degree of overlap of Chinook salmon and the pollock fishery are the same—the fishery has reduced the impact of Chinook salmon bycatch on western Alaska stocks. The extent that this arises from lower overall TACs for pollock (which were at 813 kt in 2010 and subsequently 1.2 million t in 2011 and 2012) and/or environmental conditions is unclear. This what-if analysis also shows that current cap levels are well below the higher impact rates estimated in 2007 for CWAK. For the Upper Yukon, the estimated impact rate in 2011 and 2012 is less than half of the highest estimate (which occurred in 2010).

Again, it is important to note that expecting that the full limit would have been attained given the proportional bycatch as observed is highly unrealistic (i.e., some sectors would have reached their limit while others could remain below). Nonetheless, this illustrates some degree of the effectiveness of the management measures put in place in 2011.

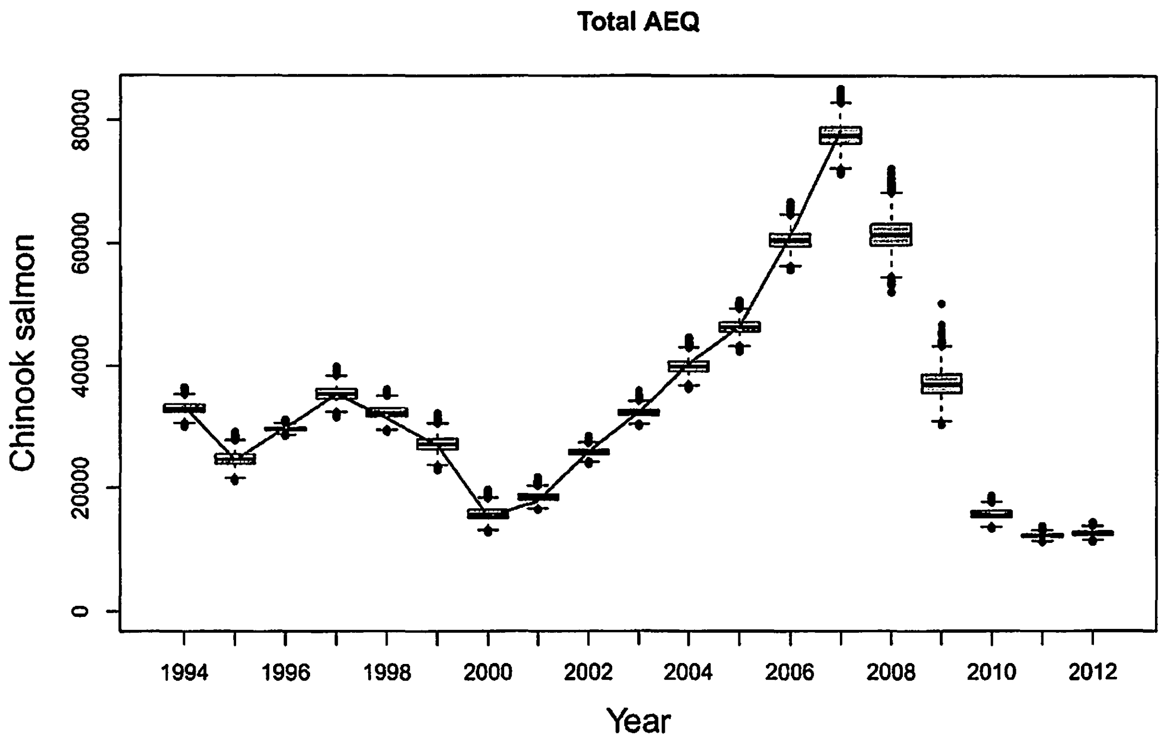

Figure 3. Total estimated AEQ mortality of Chinook salmon from the EBS pollock fishery, 1994-2012. Units are numbers of salmon and height of boxes represent the uncertainty due to uncertain oceanic survival and other factors that vary within the model. The line represents the estimate from the FEIS result (1994-2007) for comparison.

Table 13. Results of the Chinook salmon AEQ analysis combined with the available genetic data for the years 1994-2012 in numbers (top panel) and also shown is the proportion for each stock group that occurred during the A season (bottom panel).

	BC-WA-OR	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Other	Russia	SEAK	Upper Yukon	Total
1994	3,936	18,926	539	739	5,845	108	355	288	2,310	33,045
1995	3,043	14,039	403	516	4,447	77	252	213	1,732	24,722
1996	3,532	16,779	443	607	5,585	83	286	248	2,151	29,715
1997	5,141	20,359	776	734	5,390	151	414	338	2,150	35,452
1998	5,617	18,688	915	620	3,985	174	416	340	1,623	32,380
1999	5,038	15,777	847	513	2,973	162	369	298	1,235	27,210
2000	3,059	9,134	511	277	1,684	96	211	175	690	15,836
2001	2,347	10,951	386	483	2,714	85	247	180	1,149	18,542
2002	3,009	14,851	411	591	4,606	84	279	225	1,825	25,883
2003	3,756	18,638	520	752	5,716	107	355	283	2,277	32,405
2004	5,025	23,082	736	915	6,605	150	460	364	2,652	39,989
2005	7,527	25,591	1,000	1,044	7,081	232	748	423	2,707	46,353
2006	13,616	27,952	1,142	990	12,176	503	1,055	904	2,190	60,527
2007	12,957	45,744	1,356	1,201	11,694	439	1,018	796	2,393	77,598
2008	6,864	40,236	1,075	965	8,791	232	663	464	2,114	61,403
2009	2,211	25,433	737	873	5,108	99	336	224	2,166	37,188
2010	1,312	7,978	336	916	2,546	67	227	144	2,220	15,746
2011	1,442	6,974	277	497	1,588	64	132	209	1,137	12,321
2012	1,615	7,763	283	262	1,711	73	114	204	688	12,714

	BC-WA-OR	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Other	Russia	SEAK	Upper Yukon	Total
1994	40%	66%	17%	68%	91%	16%	47%	52%	87%	68%
1995	40%	68%	17%	75%	91%	17%	50%	54%	89%	69%
1996	44%	72%	20%	81%	93%	21%	57%	59%	92%	73%
1997	27%	53%	10%	60%	85%	10%	35%	38%	81%	54%
1998	16%	38%	6%	46%	75%	6%	23%	25%	70%	39%
1999	12%	30%	4%	38%	69%	4%	17%	19%	63%	32%
2000	11%	29%	4%	39%	67%	4%	17%	18%	62%	30%
2001	29%	49%	10%	45%	84%	9%	29%	36%	76%	52%
2002	42%	66%	17%	68%	91%	17%	47%	53%	87%	68%
2003	41%	65%	17%	66%	91%	16%	46%	52%	87%	67%
2004	35%	59%	13%	61%	89%	13%	40%	45%	84%	61%
2005	23%	53%	10%	52%	81%	8%	24%	38%	80%	52%
2006	49%	59%	8%	56%	88%	56%	34%	72%	72%	62%
2007	54%	62%	7%	38%	86%	53%	29%	64%	57%	63%
2008	54%	61%	6%	28%	87%	40%	29%	48%	53%	61%
2009	50%	54%	20%	36%	87%	19%	36%	25%	70%	58%
2010	17%	63%	40%	85%	90%	11%	68%	20%	93%	68%
2011	33%	49%	21%	84%	88%	5%	55%	52%	94%	57%
2012	34%	46%	11%	71%	87%	5%	39%	48%	91%	52%

Table 14. Results of the Chinook salmon AEQ analysis combined with the available genetic data for the years 1994-2012 impact as the ratio of AEQ to estimated ADFG run size. Note that middle Yukon is added to the coastal west Alaska group.

Year	CWAK	Upper Yukon	Year	CWAK	Upper Yukon
1994	2.0%	1.2%	2004	2.1%	1.9%
1995	1.6%	0.8%	2005	2.8%	2.1%
1996	2.8%	1.0%	2006	3.7%	1.8%
1997	2.2%	1.1%	2007	7.5%	2.7%
1998	2.5%	1.7%	2008	7.7%	3.3%
1999	2.9%	1.0%	2009	5.2%	2.5%
2000	2.3%	1.2%	2010	2.3%	3.7%
2001	1.8%	1.1%	2011	1.6%	1.6%
2002	2.2%	1.8%	2012	2.0%	1.4%
2003	2.7%	1.3%			

Table 15. Results of the Chinook salmon AEQ analysis combined with the available genetic data for the years 1994-2012 impact as the ratio of AEQ to estimated ADFG run size. Note that middle Yukon is added to the coastal west Alaska group.

	Coastal West Alaska		
	Estimated	If 47,591 cap	If 60,000 cap
2011	1.6%	2.5%	3.0%
2012	2.0%	3.0%	6.3%
	Upper Yukon		
	Estimated	If 47,591 cap	If 60,000 cap
2011	1.6%	1.9%	2.1%
2012	1.4%	3.9%	4.8%

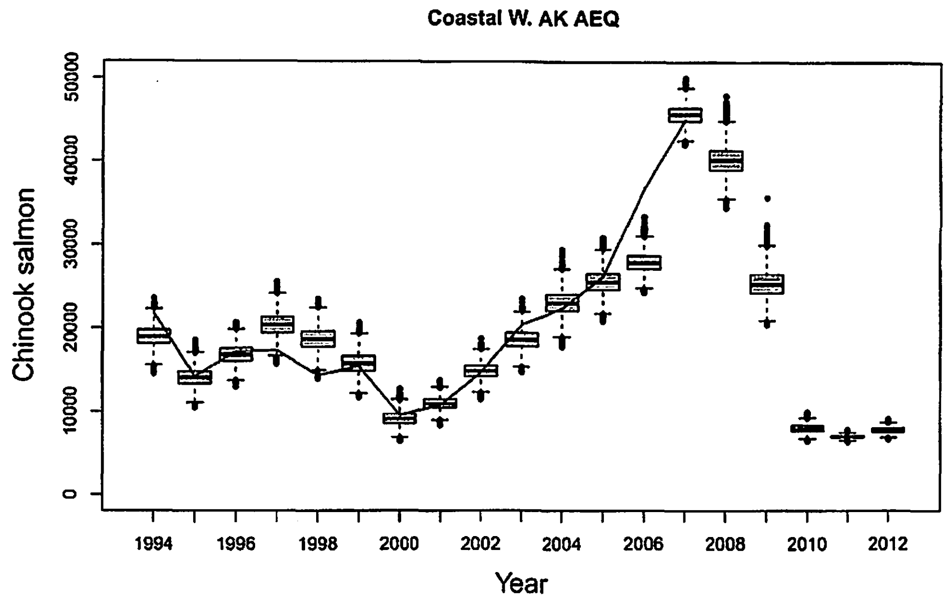

Figure 4. Estimated AEQ mortality of Chinook salmon from the EBS pollock fishery attributed to the **coastal western Alaska** stocks, 1994-2012. Units are numbers of salmon and height of boxes represent the uncertainty due to uncertain oceanic survival and other factors that vary within the model. The line represents the estimate from the FEIS result (1994-2007) for comparison.

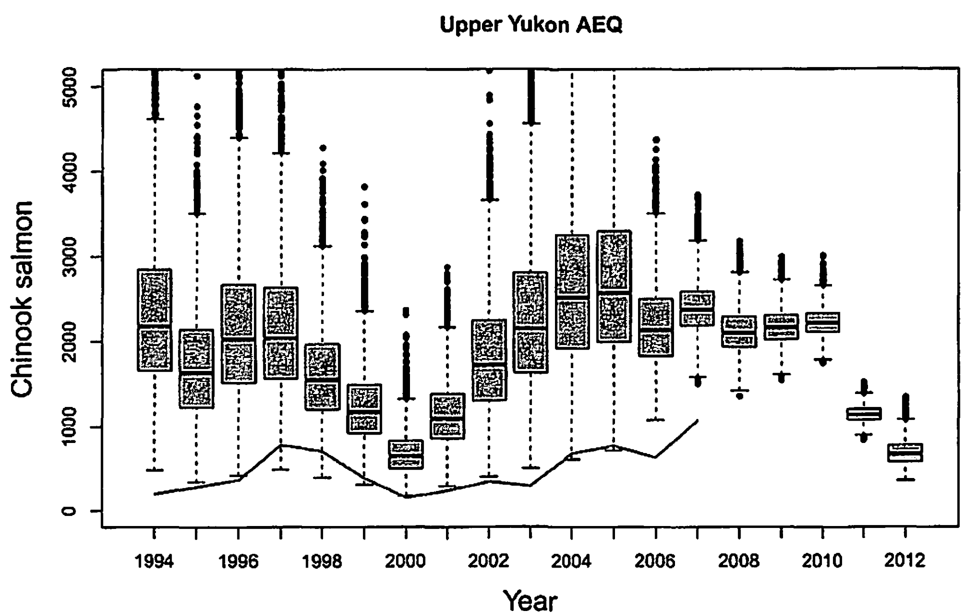

Figure 5. Estimated AEQ mortality of Chinook salmon from the EBS pollock fishery attributed to the **Upper Yukon** stock, 1994-2012. Units are numbers of salmon and height of boxes represent the uncertainty due to uncertain oceanic survival and other factors that vary within the model. The line represents the estimate from the FEIS result (1994-2007) for comparison.

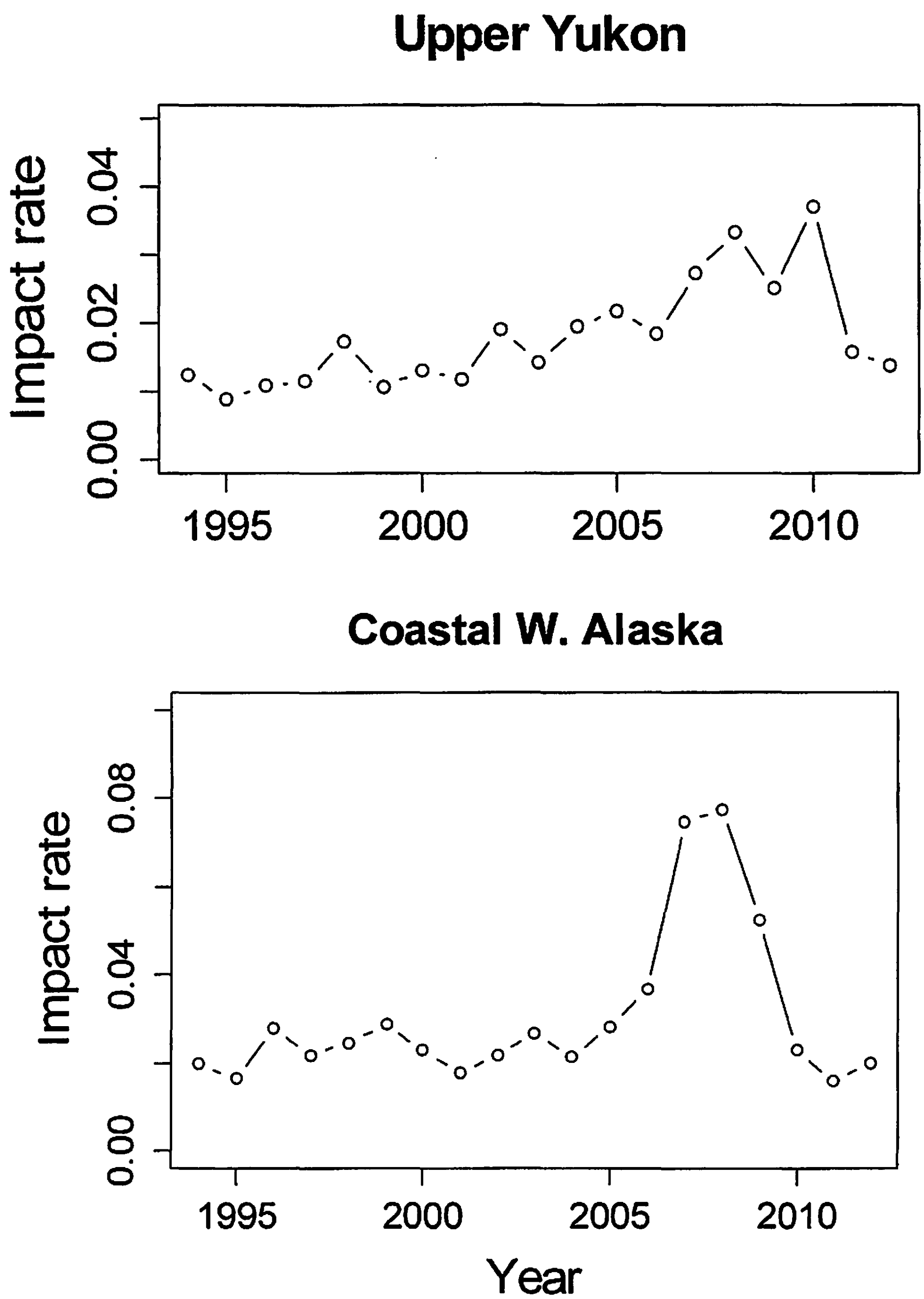

Figure 6. Estimated impact of the EBS pollock fishery on the Upper Yukon stock (top) and coastal west Alaska (which includes the "middle Yukon"; bottom), 1994-2012. Vertical axis is the ratio of AEQ over the point estimates of run sizes.

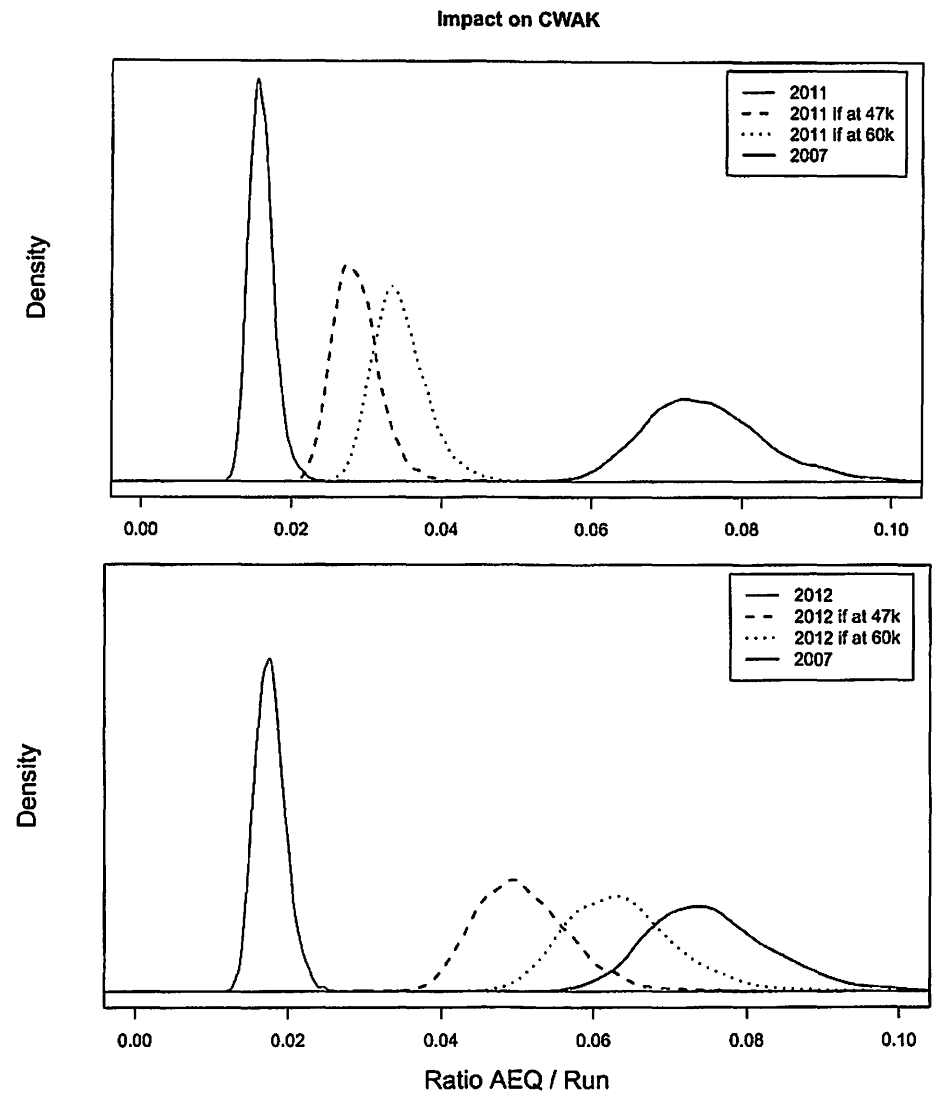

Figure 7. Estimated impact (thin solid line) of the EBS pollock fishery on the coastal west Alaska (which includes the "middle Yukon") for 2011 (top) and 2012 (bottom). The height of the shapes is intended to represent the relative probability (density) of impact rates shown on the horizontal scale. Also plotted are densities of impacts estimated for 2007 (red line) and for 2011 and 2012 had the current constraints been attained.

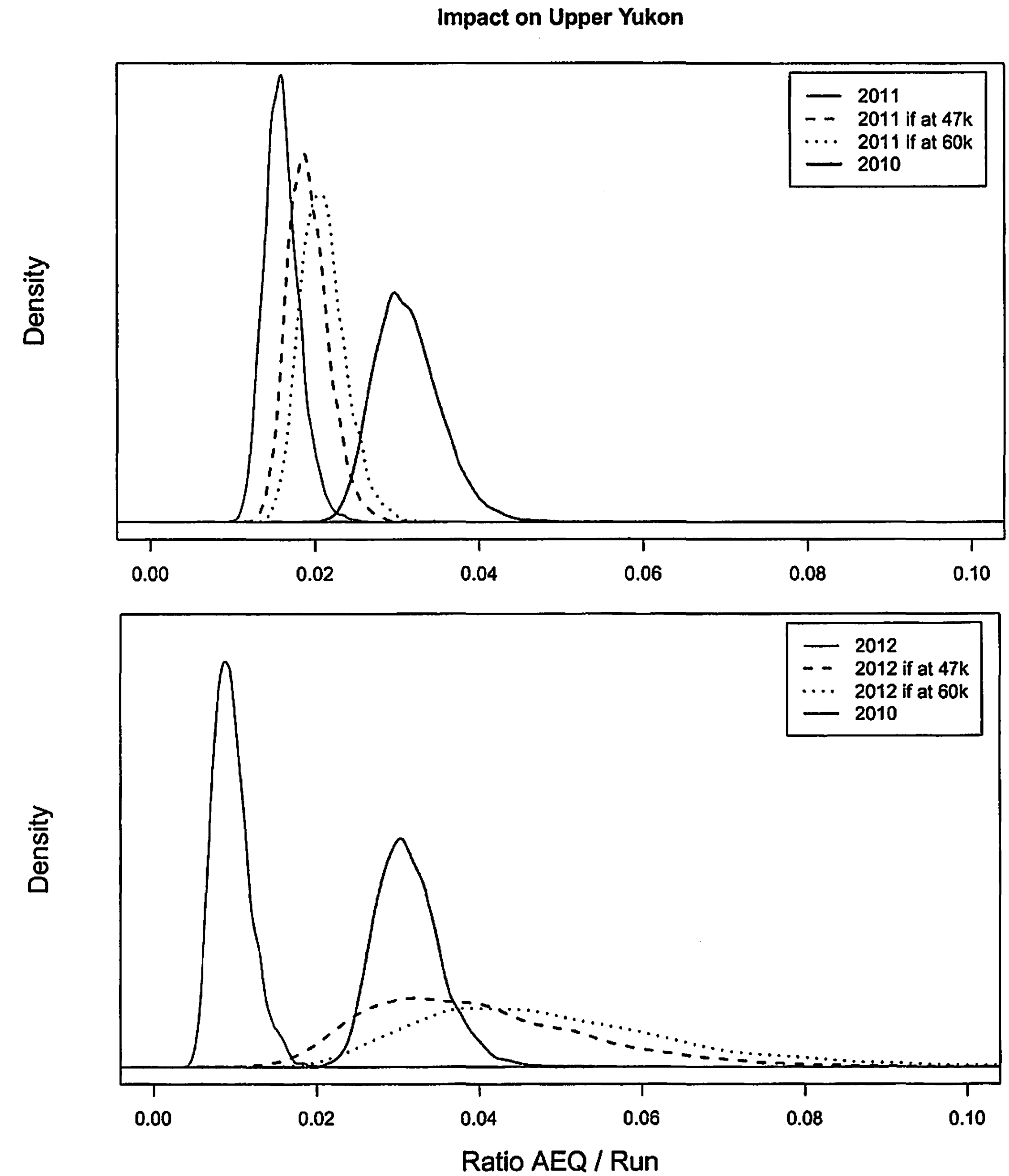

Figure 8. Estimated impact (thin solid line) of the EBS pollock fishery on the Upper Yukon for 2011 (top) and 2012 (bottom). The height of the shapes is intended to represent the relative probability (density) of impact rates shown on the horizontal scale. Also plotted are densities of impacts estimated for 2007 (red line) and for 2011 and 2012 had the current constraints been attained.