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Yukon River King Salmon Stock Status, Action Plan and Summer Chum Salmon Fishery, 2012; a Report to the Alaska Board of Fisheries

by

Stephanie N. Schmidt

and

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December 2012

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

In response to the guidelines established in the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222), the Alaska Board of Fisheries (board) classified the Yukon River king salmon *Oncorhynchus tshawytscha* stock as a stock of yield concern at its September 2000 work session. An action plan was developed by the Alaska Department of Fish and Game (department) and acted upon by the board in January 2001. The stock of concern status for a yield concern was continued at the January 2004, 2007, and 2010 board meetings. King salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage the past 5 years (2008–2012). Inseason management actions have contributed to success in achieving escapement goals. Subsequently, commercial and subsistence harvests show a substantial decrease in king salmon yield from the historical 10-year period (1989–1998) to the recent 5-year (2007–2011) average. There has been no directed commercial fishery for king salmon since 2007. While king salmon run sizes showed a modest increase during the years 2003–2006, lower returns have occurred since that time despite continued conservative management strategies. Based on guidelines established in the SSFP (5 AAC 39.222), the department recommends continued classification of Yukon River king salmon as a stock of yield concern. Yukon River summer chum salmon (*O. keta*) runs have had large surpluses available for harvest the past 5 years. However, summer chum and king salmon runs greatly overlap in run timing which greatly impacts fishery management of these 2 species.

Key words: Yukon River, King salmon, *Oncorhynchus tshawytscha*, summer chum salmon, *Oncorhynchus keta*, stock of concern, commercial, fishing, sustainable salmon fisheries policy, Alaska Board of Fisheries.

INTRODUCTION

The *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222, 2001) directs the Alaska Department of Fish and Game (department) to provide the Alaska Board of Fisheries (board) with reports on the status of salmon stocks and identify any salmon stocks that present a concern related to yield, management, or conservation during regular board meetings. This report provides the department's reassessment of Yukon River king salmon *Oncorhynchus tshawytscha*, which has been classified as a yield concern. A review of Yukon River summer chum salmon *O. keta* is also provided because the overlapping run timing with the king salmon run greatly affects management of both species.

In response to guidelines established in the SSFP (5 AAC 39.222(f)(42)), the board classified Yukon River king salmon as a yield concern at its September 2000 work session. A *stock of yield concern* is defined as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs; a yield concern is less severe than a management concern" (5 AAC 39.222(f)(42)). The SSFP defines chronic inability as "the continuing or anticipated inability to meet expected yields over a 4 to 5 year period". This determination as a yield concern was originally based on low harvest levels for the previous 3-year period (1998–2000) and anticipated low harvest in 2001. An action plan was subsequently developed by the department (SSFP; 5 AAC 39.222(d)(4)) and acted upon by the board in January 2001. The classification as a yield concern was continued at the January 2004, January 2007, and January 2010 board meetings (Lingnau and Bergstrom 2004; Hayes et al. 2006; Howard et al. 2009). Based on definitions provided in SSFP (5 AAC 39.222(f)(5, 42)), only the most recent 5-year escapements and yield estimates (2008–2012 when 2012 data are available, 2007–2011 when 2012 are still being analyzed), and historical levels of yield or harvestable surpluses (10-year period from 1989 through 1998) were considered in the current analysis and subsequent recommendations concerning stock of concern status. While 2012 escapement and commercial harvest data are available, subsistence harvest data for this year is not yet available. Subsistence harvest estimates are expected to be far below the typical average harvest of approximately 50,000 king salmon, reflecting the more conservative management actions taken during the 2012 season.

Based on definitions provided in SSFP (5 AAC 39.222(f)(42)), the department recommended Yukon River king salmon continue as a stock of yield concern at the October 2012 board work session. From 2008 to 2012, low yields of king salmon have continued on the Yukon River.

STOCK ASSESSMENT BACKGROUND

Escapement

King salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage during the past 5 years 2008–2012 (Table 1). These include two biological escapement goals (BEGs) and four sustainable escapement goals (SEGs) established by the department for U.S. tributaries. Tributary escapements have been monitored with counting tower projects in the Chena, Goodpaster, and Salcha rivers; a weir project on the East Fork Andreafsky River; and with aerial surveys in the Anvik, West Fork Andreafsky, and Nulato rivers (Figure 1). The East Fork Andreafsky River weir SEG was achieved the last 5 years. BEGs in Chena and Salcha rivers have generally been met or exceeded since 2008, with the exception of 2010 and 2012 for Chena River. High water prevented accurate counts and escapement assessment in 2011 for Chena River and Salcha River. However, an aerial survey in 2011 on Salcha River revealed that escapement was met (Figure 2). Chena and Salcha rivers are the largest king salmon producing tributaries within the Alaska portion of the Yukon River drainage. Assessment of aerial survey SEGs is more difficult due to incomplete or missing data over consecutive years. Of the escapement observations for those stocks indexed by aerial surveys, SEGs in West Fork Andreafsky River have been met or exceeded in all years successfully surveyed since 2008. The Nulato River SEG was met in 3 of the last 5 years. The Anvik River SEG was not met the last 4 years (Table 1).

Carcass surveys were conducted on Chena and Salcha rivers annually to collect age, sex, and length (ASL) data. Raw sex and age composition data from both rivers were adjusted to account for biases associated with carcass surveys (Zhou 2002; Matt Evenson, ADF&G Division of Sport Fish, Fairbanks; personal communication). Data for 2012 are not presented here as these are preliminary. During the historical baseline period (1989–1998), average age and sex composition were similar between rivers and among time periods. In the recent 5-year period (2007–2011), there appears to be slight divergence between the rivers, where age-5 king salmon dominate the age composition in Salcha River, while age-6 dominate in Chena River. Of particular note is the decline in age-7 king salmon in both rivers from the historical baseline period to the recent 5-year period. The percent female in both rivers has also gone down slightly from the historical average to the recent average. For both rivers, the lower end of the established escapement goal was frequently achieved by female king salmon alone (Figure 2).

Chena and Salcha rivers king salmon escapement and average age and female composition:

1989–1998							
	Average Age Composition (%)						Average
	3	4	5	6	7	8	Female (%)
Chena River	0.7	19.9	37.9	36.1	5.2	0.1	31.1
Salcha River	1.0	15.0	37.1	41.4	5.4	0.0	36.4
2007–2011							
	Average Age Composition (%)						Average
	3	4	5	6	7	8	Female (%)
Chena River	0.8	20.2	33.1	41.0	1.5	0.0	27.7
Salcha River	0.3	22.4	40.2	36.2	0.9	0.0	32.6

For Yukon River escapement at the Canadian border, an interim management escapement goal (IMEG) of >45,000 king salmon was established in 2008 and continued in 2009, and estimated using a sonar program at Eagle, Alaska.[1] In 2010, the IMEG was revised at the spring Yukon River Panel meeting to a range of 42,500 to 55,000. This IMEG range was also continued in both 2011 and 2012. Since 2008, the sonar-based escapement goal was only attained in 2009 and 2011 (Table 2; Figure 3).

Poor runs observed since 2007 do not appear to be related to poor escapements. Parent year escapements in 2001–2006 were mostly above average and nearly all escapement goals were met.

Yield

Fishing restrictions necessary during poor runs have caused a dramatic decline in commercial harvests since 1998 and decreased subsistence harvests since 2007. King salmon commercial harvests show a substantial decrease in average yield from the 10-year historical period (1989–1998) of approximately 100,000 fish compared to the recent 5-year (2008–2012) average of approximately 3,000 (Table 3; Figure 4). There has been no directed commercial king salmon fishery since 2007. Less than 5,000 king salmon were incidentally harvested and sold in 2008 during chum salmon-directed periods. In 2009, the sale of incidentally-caught king salmon was prohibited until July 16 to further reduce exploitation. Approximately 9,900 king salmon were incidentally harvested and sold in the 2010 chum salmon-directed periods. The sale of incidentally-caught king salmon during the summer season was prohibited in 2011 and in the summer and fall seasons in 2012.

During the most recent 5-year period for which subsistence harvest data are available, 2007–2011, harvests were within the amounts necessary for subsistence (ANS) of 45,500–66,704 only 1 of those years (Table 3). Prior to 2008, annual subsistence harvest had remained relatively stable near 50,000 king salmon. Reduced fishing periods were implemented for the subsistence fishery throughout the drainage in 2008, and the resulting harvest of approximately 45,200 king salmon was only slightly below the ANS range (Busher et al. 2009). Despite these efforts, the 2008 escapement goal for Canada-bound king salmon was not met. Even greater restrictions were implemented in 2009, 2011, and 2012. Subsistence fishing time on the mainstem was reduced in all 3 years and gear restrictions were implemented in 2012, in addition to subsistence fishing closures. Subsistence fishing was closed for approximately 10 days during the first and second pulse of king salmon throughout the Alaskan portion of the mainstem in 2009. In 2011, there were 2 closures to protect the first and second pulses of king salmon. The management strategies in 2012 were similar to 2011, but also included reduced fishing time through the end of the king salmon run in Alaska. Gear restrictions of 6-inch, or smaller, mesh size were also implemented during subsistence fishing openings in the lower half of the river to provide additional protection for king salmon during 2009, 2011, and 2012.

In summary, the average subsistence yield for the years 2007 through 2011 was substantially less than the 1989–1998 average yield and has averaged below the ANS range (Table 3). No directed commercial fishery has occurred since 2007 and the summer chum salmon-directed fishery has

[1] Evidence suggests that Canada's Department of Fisheries and Oceans (DFO) fish wheels tended to underestimate passage of king salmon into Canada. Therefore, adoption of Eagle sonar as a more reliable method to estimate this number has dramatically improved estimates of escapement, exploitation rates, and brood-year return information. Historical escapement goals were based on DFO fish wheels and are not directly comparable to present sonar-based escapement goals. Conversion factors have been developed to allow comparisons of escapement, exploitation rates, and brood-year return information to historical data, though this should be cautiously considered. In this report, Eagle sonar-based data (2005–2012) are emphasized because they are deemed most accurate.

been managed to reduce incidental harvest of king salmon. Subsistence fishing restrictions were also implemented in 2008, 2009, 2011, and 2012. Subsistence harvest data are not yet available for 2012; however, due to the conservative management regime employed, it is expected that the 2012 subsistence harvest will be less than observed in previous years and below the lower end of the ANS range.

Exploitation Rates

Knowledge of exploitation rates is an essential component of effective management of the Yukon River king salmon fishery. Exploitation rate is defined as that proportion of the run that is harvested; hence, total run estimates, escapement, and stock-specific harvests are needed to calculate exploitation rates. Exploitation rates cannot be estimated for king salmon stocks that spawn in the lower or middle regions of Yukon River in Alaska because total escapement to these regions cannot be estimated accurately. However, total run estimates for the Canadian-origin stock can be determined based on border passage estimates.

Border passage into Canada has been estimated from 1982 to 2008 by Department of Fisheries and Ocean (DFO) using mark–recapture techniques, and more recently, by the department using radiotelemetry (2002–2004) and sonar (2005–2012). DFO border passage estimates were derived from mark–recapture estimates using 2 fish wheels near the border at river mile (rm) 1,224. This border passage estimate formed the basis for the escapement goal in the U.S./Canada Yukon River Salmon Agreement. Independent estimates derived using radiotelemetry and sonar have suggested that border passage estimates derived from the DFO king salmon mark–recapture program were biased low (JTC 2006a). The Eagle sonar project, operated by the department, has obtained border passage estimates since 2005 and has been the key project for escapement goal assessment since 2008. To make historical data comparable to contemporary sonar-based data, various stock-recruitment datasets were examined, including those developed from spawning escapement estimates derived from sonar, radiotelemetry, and aerial survey data (JTC 2008). Using these converted estimates, border passage (total Canadian harvest plus escapement) has ranged from approximately 30,700 in 2000 to about 93,600 in 1996, with a recent 5-year (2008–2012) average of 45,000 (Table 2 and Figure 3).

From 1982 through 2003, scale-pattern analysis was used to apportion Alaskan king salmon harvests to region of origin, including the Canadian king salmon stock, which was later replaced in 2004 by genetic stock identification (GSI) techniques. Apportionment of harvest to stock of origin indicates that the Canadian component typically comprises approximately 50% of the Alaska harvest, and probably, the run. Until the poor returns of Canadian-origin fish in recent years, this proportion remained relatively constant. Because of the gauntlet nature of Yukon River fisheries and the longer migration distance necessary, we believe that exploitation exerted on Canadian-origin fish has most likely been the highest of any Yukon River king salmon stock.

Based on harvest apportionment estimates from scale-pattern and GSI techniques, and border passage estimates, we estimate total run size of Canadian-origin king salmon from 1982–2011 (Figure 5). Harvest data from 2012 are currently being analyzed. Using these estimates, associated exploitation rates exerted by Alaskan fishermen on this stock ranged from 21% in 2009 to 66% in 1987 (Figure 5). Average exploitation rates during the period 2007–2011 decreased by 16% from the 1989–1998 historical average (Figure 5). These exploitation rates, however, only represent Alaskan Yukon River exploitation and do not include exploitation exerted by Canadian fishermen.

Recent exploitation rates are lower in comparison to historic rates exerted during the 1970s, 1980s, and 1990s, reflecting the conservative fishery management regime in place. Current use of the Eagle sonar project has dramatically improved the accuracy of king salmon passage estimates into Canada and exploitation rates derived from this method represent the most realistic measures to date.

Brood Year Return Information

The brood-year table data for the mainstem Yukon River stock in Canada is used as a representative of the overall run. Total brood return divided by the parent-year escapement is a measure of productivity of the stock and is usually expressed as recruits or return per spawner (R/S). Based on these data, R/S for Canadian-origin king salmon stock has ranged from 1.02 for the 1994 spawning event (or brood year) to about 5.19 for fish returning from the spawning event in 1991, with an overall average of about 2.64 R/S from 1982 through 2004 (2004 is the most recent year with a full complement of represented return age classes).

Brood year tables also provide information regarding age-class composition of the return. Yukon River king salmon return as age-2 through age-8 fish, but age-5 and age-6 salmon dominate the run. Age-class composition of the run varies from year to year because of the variability in individual year class strengths. Age-class composition of the return, however, represents a more accurate assessment of age-class composition of the stock over time.

Age-class composition of the Canadian-origin king salmon return from brood years 1979–2004 indicates that there was a dramatic decrease in age-7 salmon from the 28% average during years 1979–1982, to an 8% average during the 10-year period immediately following (1983–1992). The brood-year age-class composition among age-4, age-5, and age-6 salmon remained relatively stable from 1993 to 2000, with age-6 salmon dominating (Figure 6). However, starting in 2001, there has been a trend where age-5 and age-6 salmon alternately dominate the brood-year age-class composition (Figure 6). The proportion of age-7 salmon remains low, but has increased from a previous 5-year average (1999–2003) of 2% to 8% in 2004 (Figure 6). Similar changes in age composition of age-4, age-5, and age-6 king salmon brood-year returns have been observed in Goodnews and Nushagak rivers (Howard et al. 2009). Age-8 king salmon have not returned to the Yukon River in consistent numbers since 1988 (JTC 2012).

King Salmon Size Trends

Concerns over changing trends in the age, sex ratio, and size of Yukon River king salmon populations have recently emerged. In response to these concerns, the U.S./Canada Joint Technical Committee (JTC) Salmon Size Subcommittee compiled relevant literature, existing analyses, and potential causes of these trends in its *Potential Causes of Size Trends in Yukon River King Salmon Populations* report (JTC 2006b). Evidence that Yukon River king salmon have undergone phenotypic alteration over time is limited, but suggestive. Analyses document a decrease in the weight of commercial harvests (Bigler et al. 1996), a reduction in the prevalence of the largest fish (Hyer and Schleusner 2005), decline in the proportion of age-7 fish in the commercial harvest (Hamachan Hamazaki, Division of Commercial Fisheries AYK

Biometrician, ADF&G, Anchorage; personal communication), and the near disappearance of age-8 fish[2] (JTC 1998).

Whether the changes observed within Yukon River king salmon have resulted from environmental or fishery-induced selective pressures, or a combination of both, is difficult to determine with certainty. The JTC report recognizes several factors that may contribute to these trends, including environmental changes in Bering Sea and Gulf of Alaska, fishery-induced selective pressures, and increased competition in the ocean from large numbers of hatchery fish (JTC 2006b). These apparent trends are problematic because datasets only represent a relatively recent time period compared to the duration in which fisheries have historically existed. The true baseline for these apparent patterns is unknown. Decreases in proportions of older age classes are not unique to Yukon River and are found elsewhere in the state. Unfortunately, data from these other drainages are equally limited in their historical scope.

In addition to the work conducted by the JTC, the department conducted analyses of temporal changes in king salmon size from historical (1964–2007) District 1 commercial fishery data (Hamachan Hamazaki, Division of Commercial Fisheries AYK Biometrician, ADF&G, Anchorage; personal communication). This represents the longest time series for king salmon ASL data for the Yukon River. Analysis of this dataset revealed the following patterns: 1) a small increase in the proportion of female king salmon; 2) a small decline in the proportion of large (>900 mm) fish; 3) no apparent change in the proportion of age-6 king salmon over the time period, but a significant decline in the proportion of age-7 individuals; and 4) declines in length-at-age for age-6 and age-7 females and males. These relationships, however, are not strictly linear and other factors (e.g., changes in environmental conditions) may be involved.

From 2007–2009, the department and Yukon Delta Fisheries Development Association (YDFDA) initiated a mesh-size study to investigate the performance of gillnets with smaller mesh than those currently used in the unrestricted mesh-size fishery. This study specifically examined species, age, sex, and size (length, weight, and girth) compositions of 7-inch, 7.5-inch, and 8-inch stretch-mesh drift gillnets from a test fishery conducted in District 1 near the village of Emmonak. Overall patterns indicate that larger mesh sizes catch a greater proportion of older fish, more king salmon relative to chum salmon, a greater proportion of females, and larger fish in respect to length, weight, and girth (Howard and Evenson 2010). Based upon this study and Action Plan Alternatives in Howard et. al. (2009), the board adopted a new maximum mesh size of 7.5 inch for all subsistence, commercial, and personal use gillnets in the Yukon Area in January 2010, effective the 2011 fishing season.

STOCK OF CONCERN RECOMMENDATION

Yukon River king salmon escapement goals in Alaska have generally been met since 2004. Given that the most recent 5-year average harvest remains approximately 35% of the historic long-term average despite use of specific management measures, the Yukon River king salmon stock continues to meet the criteria of a stock of yield concern. Therefore, based on the definitions provided in the SSFP in 5 AAC 39.222(f)(42), the department recommends continuation of the yield concern classification for the Yukon River king salmon stock.

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[2] It should be noted that the Canadian-origin king salmon dataset only encompasses age-8 fish from brood year 1974 through the present. Moreover, only the earliest brood year had sizeable returns of age-8 fish, and those were a relatively small component of the overall return (never exceeded 4% of the Canadian-origin return).

OUTLOOK

The preliminary outlook for 2013 is for salmon abundance to be similar to levels observed in 2011 and 2012. Age data collected in 2012 are still being processed, but preliminary analyses indicate that the 6-year old component will be below average based upon the low abundance of age-5 fish returning in 2012. It is also expected that the age-5 component will be below average. The National Oceanic and Atmospheric Administration's (NOAA) Bering Arctic and Subarctic Integrated Surveys (BASIS) program has collected important data on oceanic salmon stocks during their juvenile life-history stage. Department researchers are working with NOAA scientists to better understand how these data may be used for understanding future returns. While forecasting tools based on this information are still being developed, BASIS researchers observed relatively low catches of 2-year-old juvenile king salmon in 2009 and 2010, which would suggest potentially poor returns of age-6 and age-5 fish in 2013. As with 2011 and 2012, king salmon abundance is expected to be below the long-term average. This abundance may be adequate for subsistence harvests within the lower end of the range identified for ANS (45,500–66,704 king salmon), but will undoubtedly be too low to support a directed commercial fishery.

ALASKA BOARD OF FISHERIES ACTION

In response to guidelines established in the SSFP, the board, during the January 15–20, 2013 regulatory meeting is anticipated to continue the classification of Yukon River king salmon as a stock of yield concern.

ESCAPEMENT GOAL EVALUATION

The department has undertaken a review of escapement goals for several Yukon River king salmon stocks where sufficient long-term escapement, catch, and age composition data exist to allow development of BEGs or SEGs based on analysis of production consistent with the escapement goal policy (5 AAC 39.223). The escapement goal team evaluated the type, quality, and amount of data for each stock to determine the appropriateness of the existing or any proposed new escapement goal as defined in these policies. Six escapement goals exist for Yukon River king salmon, which include SEGs for lower river stocks (East and West Forks of the Andreafsky River, Anvik River, and Nulato River), and BEGs for Salcha and Chena rivers, both tributaries of the Tanana River. In addition, a goal for Canadian-origin king salmon, not listed here, was established as part of the Yukon River Salmon Agreement. Escapement targets for Canadian-origin stocks are set annually by the Yukon River Panel through bilateral agreement. The review team recommended to continue all these existing goals in Alaska without revision (Conitz et al. 2012).

List of Current and Proposed BEG and SEGs for Yukon River King salmon:

Stream (Project Type)	Current Goal	Recommended Range	Type of Goal
East Fork Andreafsky River (weir)	2,100-4,900	No Revision	SEG
West Fork Andreafsky River (Aerial)	640–1,600	No Revision	SEG
Anvik River Index (Aerial)	1,100–1,700	No Revision	SEG
Nulato River (Aerial) (Forks Combined)	940–1,900	No Revision	SEG
Chena River (Tower)	2,800–5,700	No Revision	BEG
Salcha River (Tower)	3,300–6,500	No Revision	BEG

MANAGEMENT ACTION PLAN OPTIONS FOR ADDRESSING STOCK OF CONCERN AS OUTLINED IN THE SUSTAINABLE SALMON FISHERIES POLICY

YUKON RIVER KING SALMON MANAGEMENT PLAN REVIEW/DEVELOPMENT

Current Stock Status

In response to guidelines established in the SSFP (5 AAC 39.222), the department recommended the continued stock of yield concern classification for Yukon River king salmon during the October 2012 board work session. After reviewing stock status information and public input during its January 15–20, 2013 regulatory meeting, the board is anticipated to continue the stock of yield concern classification for Yukon River king salmon. This expected determination is based on the inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs during the last 5 years.

Customary and Traditional Use Finding and Amount Necessary for Subsistence Uses

In 1988, the board made a positive finding for customary and traditional use for all salmon in the Yukon Area. In 2001, the department recommended the board amend 5 AAC 01.236 to include a revised finding of ANS for Yukon Area using updated subsistence harvest data. The board made an ANS finding of 45,500–66,704 king salmon for Yukon Area.

HABITAT FACTORS ADVERSELY AFFECTING THE STOCK

Yukon River salmon stocks have generally remained healthy because of undisturbed spawning, rearing, and migration habitat, although some habitat issues adversely affect salmon production in Yukon River drainage. A detailed discussion of these issues is found in the Yukon River Comprehensive Salmon Plan for Alaska (Holder and Senecal-Albrecht 1998). This plan discusses mining, logging, and flood control (these topics are briefly discussed below) and potential pollution and habitat changes related to urban development, rural sanitation, increased traffic along tributaries, and agriculture.

Mining

The first anthropogenic habitat threats to salmon in the Yukon River drainage began in the early 1900s with mine exploration and development. Mining activity was, and continues to be, an important economic industry within the drainage. Most early mining activity occurred on localized, discrete, headwater streams using manual labor, minimizing impacts on spawning habitat. However, in the 1920s mining practices expanded to hydraulic mining and large scale dredges. Both of these practices disturbed extensive acreage, much of which remains un-reclaimed today. Hydraulic mining washed large quantities of overburden and fine sediment into downstream spawning and rearing habitats. A thorough discussion of mining activity and salmon presence in Yukon River Area can be found in Higgs (1995). Major mining activity occurred on many tributaries: Iditarod and Innoko River drainages in Lower Yukon; American Creek, Eureka Creek, Minook Creek, and upper Sulatna River in Middle Yukon; Birch Creek, Woodchopper Creek, Coal Creek, Nome Creek, Beaver Creek, and Fortymile River in Upper Yukon; Middle and South Forks of the Koyukuk River and Hogatza River in Koyukuk River

drainage; and Goldstream Creek, Chatanika River, Chena River, Livengood Creek, Salcha River, and Goodpaster River in Tanana River drainage.

Both small and large mining operations exist today. More rigid enforcement of environmental regulations since the mid-1980s has resulted in mining operations that are less detrimental to fisheries habitat than in the past. Today, all mining operations must obtain numerous environmental permits before initiating or continuing mining activity. Wastewater discharge must comply with Alaska's Water Quality Standards (http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf; accessed December 2012) and all mines permitted since October 14, 1991 must comply with Alaska's Mining Reclamation regulations (http://dnr.alaska.gov/mlw/mining/2009Reg_book.pdf; accessed December 2012). There are 3 large hard rock mines currently permitted; Fort Knox mine near Fairbanks (in operation), International Tower Hills Mines near Livengood (in production stage, current reserves appear to be large and development could impact Tolovana River) and Pogo Creek mine near Goodpaster River (now in production stage), near Delta Junction. Some of these mines are located in potential acid-generating deposits for which strict wastewater controls will be necessary. Potential natural gas development in the Minto Flats area of the Tanana River drainage may also impact habitat.

Logging

Logging may potentially impact fisheries habitat in the Tanana River drainage. Coincidental with transfer of large tracts of federal land into private, Alaska Native Corporation and state ownership, logging activity increased to meet both local and export timber demands. At a 2006 legislative session, in response to concerns relating to sufficient buffer zones to protect rivers and streams from loss of spawning and rearing habitat, the Alaska State Legislature established new regulations for riparian buffer zones throughout Tanana Valley.

Flood Control and Other Dams

Chena River Lakes Flood Control Project: the department, Yukon River Drainage Fisheries Association (YRDFA), and local sport and subsistence fishermen raised concerns about the dam's effects on springtime emigration of salmon fry. In spring flood years such as 1985, 1991, 1992, and 2007, the dam's gates were lowered to slow Chena River's flow to manageable levels. This closure caused the river to back up and spread throughout the willow and spruce brush in the Chena River valley floodway. In some of these flood event years, birds were seen feeding on salmon fry above the dam and below the dam's chutes where smolt were dumped via small waterfalls. Impacts of these events upon salmon returns are unknown.

The Chatanika River (Davidson Ditch) Dam was severely damaged by the 1967 flood; the top half was destroyed and washed downstream. The remainder of the dam was removed utilizing funding from YRDFA and Bureau of Land Management in 2001. Before removal, only two species of fish (Arctic grayling *Thymallus arcticus* and sculpin *Cottus* spp.) were documented above the dam (Alan Townsend, ADF&G Division of Habitat, Fairbanks; personal communication). Two species of salmon (king and chum), 3 species of whitefish *Coregonus* spp., sheefish *Stenodus leucichthys*, Arctic grayling, northern pike *Esox lucius*, burbot *Lota lota*, suckers *Catostomus* spp., and sculpin are documented in Chatanika River downstream of the dam. Although no adult spawners have been observed utilizing the area above the dam, minnow trapping 2002–2006 found salmon fry above the dam site, indicating this area is now used as rearing habitat.

Habitat Projects Needed:

1. Illinois Creek is in Post Closure Monitoring and currently is on a 5-year monitoring schedule. The last monitoring occurred in 2010 and the next is scheduled for 2015.
2. Continued restoration of Birch Creek and enhancements to allow fish passage in historical mining areas. Restoration of Birch Creek tributaries whose fish habitat still remains highly impaired because of mining, much of which predated the 1991 Mining Reclamation regulations.
3. Continued restoration of Nome Creek damaged from historic mining. There has been some recent culvert replacement on tributaries to Nome Creek.
4. Continued evaluation, and possibly implementation, of modifications to the Chena River Lakes Flood Control Project to reduce salmon mortality.
5. Monitoring phase of the bank stabilization project near Rika's Roadhouse, a known fall chum salmon spawning area, is essentially complete.
6. Survey and assessment of critical salmon spawning and rearing habitats in Tanana River drainage. Continued restoration of Tanana River tributaries from historic mining damage.
7. Advanced identification of previously undocumented anadromous fish streams in the Yukon River watershed. At least 50% of all water bodies in the Yukon watershed have not been evaluated for distribution of anadromous species. At least 70% of first and second order tributaries similarly have not been surveyed. Consequently, these streams are afforded legal protection under Alaska Statute 16.05.841 (Fishway Act) only, not AS 16.05.871 (Anadromous Fish Act) which requires the department to specify those waters important for the spawning, rearing, or migration of anadromous fish. A significant number of streams could be added/corrected in the Anadromous Waters Catalog. Regular review of the catalog should be conducted by biologists for the areas in which they are conducting work. Nominations should be submitted to document the presence of anadromous fish.
8. The Alaska Railroad is now constructing a bridge across the Tanana River at Salcha as the first step in the railroad extension from Fairbanks to Delta Junction. There are still unsurveyed future stream crossing locations that likely contain anadromous and resident fish habitat. Land ownership and accessibility continue to make this work challenging.
9. Several new road and mining projects are in the planning or scoping phases, or planning changes in operations within the Yukon River Drainage.

- Livengood Mine prospect – Livengood Creek in the upper Tolovana River drainage.
- Road to Ambler – Potential road route from Coldfoot area along the south slopes of the Brooks Range to the Ambler Mining District.
- Tofty Road – Road from Tofty (near Manley) to near the Yukon River upstream from the confluence of the Tanana and Yukon rivers.

10. There has been a considerable increase in the number of applications to conduct small scale placer mining in the Interior, including within the Yukon River drainage. Applications have approximately doubled in recent years from the typical 300 annual requests (not all applications result in mining).

DO NEW OR EXPANDING FISHERIES ON THIS STOCK EXIST?

Yukon River bound king salmon are taken as bycatch in the Bering Sea groundfish fishery, and fishermen have expressed concern regarding impacts to Western Alaskan salmon stocks, particularly after an estimated 130,000 king salmon were caught in 2007. Bycatch of king salmon from the Bering Sea groundfish fishery greatly increased in 2003, reaching record levels in 2005 through 2007. A marked reduction in the bycatch occurred in 2008-2011, as 19,000 fish were taken on average during these years. Preliminary data for 2012 suggest bycatch numbers of king salmon even lower than 2008–2011, with approximately 13,000 king salmon taken through November 3, 2012. Actions were taken by the North Pacific Fishery Management Council in 2010 to promote a king salmon bycatch reduction program to help address bycatch concerns. This program was initially implemented in 2011. The most recent genetic information on bycatch of Western Alaska king salmon in the BSAI pollock fishery, 2005–2009, is 54% (Guthrie et al. 2012).

It is unclear whether or not federal regulations regarding customary trade that allow the sale of subsistence fish caught in applicable waters result in expansion of subsistence take on this stock.

EXISTING MANAGEMENT PLAN

5 AAC 05.360. *Yukon River King Salmon Management Plan.*

5 AAC 01.210. *Fishing Seasons and Periods.*

ACTION PLAN DEVELOPMENT

YUKON RIVER KING SALMON ACTION PLAN GOAL

To reduce fishing mortality to meet spawning escapement goals, to provide opportunity for subsistence users to harvest levels within the ANS range, and to reestablish the historic range of harvest levels by other users.

REVIEW OF MANAGEMENT ACTION PLAN

Regulation Changes Adopted in January 2001

In January 2001, after review of management action plan options addressing this stock of concern, the board modified the *Yukon River King Salmon Management Plan,* 5 AAC 05.360.

The board added wording to the plan under section (a) regarding management objectives and data used to manage king salmon fisheries. Additionally, when the projected commercial harvest is 0–67,350 king salmon, the board provided the percentage of harvest allocated by district or subdistrict determined from the low end of the established guideline harvest ranges:

Districts 1 and 2:	89.1%
District 3:	2.7%
District 4:	3.3%
Subdistricts 5-B and 5-C:	3.6%
Subdistricts 5-D:	0.4%
District 6:	0.9%

The board adopted a fishing schedule for the subsistence salmon fisheries. The schedule is implemented chronologically, consistent with migratory timing as the run progresses upstream. This schedule may be altered by emergency order if preseason or inseason indicators suggest this change is necessary.

YUKON AREA SUBSISTENCE FISHING SCHEDULE:

Coastal District; Koyukuk River drainage; Subdistrict 5-D: 7 days/week

Districts 1–3: two 36-hour periods/week

District 4; Subdistricts 5-B and C: two 48-hour periods/week

Subdistrict 5-A; District 6: two 42-hour periods/week

Old Minto Area: 5 days/week

The board provided the department emergency order authority to restrict subsistence gillnets to no greater than 6 inches mesh size for conservation of king salmon.

Maintaining this subsistence fishing schedule in Districts 1, 2, and 3 and Subdistrict 4-A proved problematic and inflexible for managers when subsistence and commercial fishing time is separated under other regulations. In March 2003, the board addressed two agenda change requests regarding the subsistence fishing schedule, specifically whether the schedule can be terminated inseason on the basis of run abundance and, if so, how that would be done based on current regulations. The board adopted a change to terminate the subsistence fishing schedule and revert to the pre-2001 subsistence fishing regulations when sufficient abundance exists:

> 5 AAC 05.360. (e) If inseason run strength indicates a sufficient abundance of king salmon to allow a commercial fishery, subsistence fishing shall revert to the fishing periods specified in 5 AAC 01.210. (c)-(h).

Regulation Changes Adopted in January 2004

The board increased the permit harvest area for subsistence salmon fishing to include all of Subdistrict 5-C as a means to track resource use changes due to the anticipated completion of the Rampart road construction project and increased mobility of fishermen.

The board adopted a regulation requiring gillnets greater than 4-inch mesh size to be removed from the water and fish wheels must stop rotating during subsistence closures.

The board increased the subsistence fishing schedule from two 42-hour periods per week to two 48-hour periods per week in Subdistrict 5-A.

In Subdistrict 4-A, during times when the commissioner determines that it is necessary for chum salmon conservation, the commissioner may, by emergency order, close the commercial fish wheel fishing season and immediately reopen the season during which set gillnet gear may be used instead of fish wheels.

Regulation Changes Adopted in January/February 2007

There were several proposals submitted to the board, including requests to change commercial gillnet mesh sizes and gillnet depth, commercial harvest allocations, and district boundaries. None of these proposals were adopted. The subsistence marking requirement for Districts 1–3 was changed as follows:

> 5 AAC 01.240. Marking and use of subsistence-taken salmon. (c) In **Districts 1–3**, from **June 1 to July 15** a person may not possess king salmon taken for subsistence uses unless **both tips (lobes) of the tail fin** have been removed. Marking must be done before the person conceals the salmon from plain view or transfers the salmon from the fishing site. A person may not sell or purchase salmon from which **both lobes of the tail fin** have been removed.

Previously, the marking requirement was to remove the dorsal fin.

In addition, the board passed a proposal that allowed catch and release of king salmon in Goodpaster River as follows:

> 5 AAC 70.015. Seasons, bag, possession, and size limits, and methods and means in the Tanana River Management Area. (c)(12) the Goodpaster River drainage is closed to sport fishing for salmon; **except that downstream from ADF&G regulatory markers located approximately 25 miles upstream from the confluence with the Tanana River, catch-and-release fishing for king salmon is allowed; king salmon may not be removed from the water and must be released immediately without further harm;**
>
> **(d)(20) in the Goodpaster River drainage, from June 1 through August 31, only one unbaited single-hook, artificial lure may be used.**

Regulation Changes Adopted in January 2010

The board adopted several changes to the regulations pertaining to Yukon Area fisheries management in January 2010. The following is a summary of the board's actions at that meeting:

1. Effective in 2011, the maximum mesh size for subsistence, commercial, and personal use gillnets in the Yukon River Area would be 7.5 inches. Previously mesh size was unrestricted.
2. During times of king salmon conservation, the department now has emergency order authority to prohibit the sale of king salmon during chum salmon directed commercial fishing periods.
3. The *King Salmon Management Plan* was amended by adding a new subsection that the department may use emergency order authority to close all salmon fishing in a district or portion of a district if run assessment information indicates an insufficient abundance of king salmon.
4. The subsistence fishing schedule in Subdistrict 4-A was changed to two 48-hours periods per week, regardless of commercial fishing periods.
5. The subsistence fishing schedule in Subdistricts 4-B and 4-C was modified to open from 6:00 p.m. Sundays until 6:00 p.m. Fridays when commercial fishing closures last longer than 5 days.
6. The Innoko River subsistence fishing schedule was changed to open 7 days per week.

Regulation Changes Adopted in 2012

Regulations adopted by the board out of cycle in March 2012 allowed the department to open summer chum salmon directed commercial fishing periods in Subdistrict 4-A during time of king salmon conservation with fish wheels only. In addition, fish wheels must be attended at all times during operation, and all king salmon caught in the fish wheels must immediately be released to the water alive.

In addition, an emergency regulation was adopted by the board on July 17, 2012 to allow the department to open summer chum salmon directed commercial fishing periods in District 6 during time of king salmon conservation with fish wheels only. Fish wheels must be attended at all times during operation, and all king salmon caught in the fish wheels must immediately be released to the water alive. This regulatory change implemented by the board was effective only for the 2012 fishing season.

Management Review

Management of the Yukon River salmon fishery is complex because of the difficulty in determining stock specific abundance and timing, overlapping multi-species salmon runs, increasing efficiency of the fishing fleet, the gauntlet nature of the fisheries, allocation issues between lower river and upper river Alaskan fishermen, allocation and conservation issues between Alaska and Canada, and the immense size of the drainage. Salmon fisheries within Yukon River may harvest stocks that are up to several weeks and over a thousand miles from their spawning grounds. Since the Yukon River fisheries are largely mixed stock fisheries, some tributary populations may be under or over exploited in relation to abundance. It is not possible to manage for individual stocks in most areas where commercial and subsistence fisheries occur. However, recent refinements in genetic stock identification methods allow managers to obtain regional stock proportions of king salmon inseason. A set gillnet test fishery near the mouth of the Yukon River and a mainstem sonar project at Pilot Station are the primary assessment tools to determine king salmon run timing and relative run strength. Subsistence catch reports, age composition of harvest, river discharge, and weather are also used as indicators of relative run strength and run timing.

Management 2001–2009

Beginning in 2001, the subsistence salmon fishing schedule adopted by the board was implemented with chronological progression upriver as the run advanced upstream. The objectives of the schedule are to 1) reduce harvest early in the run when there is a higher level of uncertainty, 2) spread the harvest throughout the run to reduce harvest impacts on any particular component of the run, and 3) provide subsistence fishing opportunity among all users during years of low salmon runs.

Historically, the first commercial opening occurred at the first quarter point of the run. In 2002 through 2005, preseason management strategies were developed to shift commercial fishing until the midpoint of the king salmon run and later. This management strategy provided for passage of an early portion of the run through the lower river districts before commercial fishing started. In 2006–2007, based on preseason projections and inseason run assessments, commercial fishing was scheduled to commence near the first quarter point (historically June 15) of the king salmon run and harvest was spread over the middle 50% of the run. Additional harvest after the third quarter point depended on information from assessment projects and available markets.

No king salmon directed commercial fishery occurred in 2008 and management actions were taken to protect the second and third pulses throughout the Yukon River mainstem. Although sport fishery harvests in the Yukon River drainage are generally small compared to commercial or subsistence harvests, the sport fishing bag limit for king salmon was reduced to 1 fish inseason (July 2) in 2008 because of poor run abundance.

The 2008 season marked the beginning of a trend of more actively managing the subsistence fishery in order to conserve king salmon. If the pattern of poor king salmon runs was to continue the department recognized there was a need to develop a preseason plan to direct management of the subsistence fishery. In preparation for the 2009 season, YRDFA, through funding from the Yukon River Panel, facilitated a series of regional teleconferences and an in-person meeting to provide managers, fishermen, tribal council representatives, and other stakeholders the opportunity to share information, provide input, and discuss management options. The purpose of these meetings was to work cooperatively to identify options and practical management strategies that would assist in getting adequate numbers of fish to the spawning grounds, particularly to Canada. Based on input from these meetings, a preseason management plan was developed to specifically guide management of the subsistence fishery. The key component of this plan was the formulation of the pulse protection strategy.

To conserve the greatest number of Canada-bound king salmon, there was no fishing on the first pulse in mainstem districts in 2009. One to two subsistence fishing periods were closed and similar actions were implemented in upriver fishing districts and subdistricts based on migratory timing. Summer chum salmon directed commercial fishing was delayed to decrease incidental harvest of king salmon. Additionally, to reduce incentive for targeting king salmon in directed summer chum salmon commercial fisheries in 2009, buyers agreed to not purchase king salmon during the first commercial opening in districts 1 and 2. In July of 2009, the board adopted an emergency regulation specifying that during the commercial summer chum salmon season in districts 1–5, king salmon taken may be retained but not sold. Therefore, fishermen could release live king salmon or use them for subsistence purposes.

Effective June 1, 2009, in conjunction with the preseason commercial and subsistence restrictions, the king salmon sport fishing bag limit was reduced to 1 fish in the Yukon River tributaries (excluding the Tanana River drainage) and retention of king salmon was prohibited in the mainstem Yukon River to protect Canadian stocks. These conservation measures appeared to be effective in providing protection to king salmon and the escapement goal into Canada was achieved in 2009.

Management 2010–2012

Preseason meetings have occurred annually since 2009, providing an instrumental platform for guiding the management of the king salmon fishery. Based on an improved king salmon preseason run size projection in 2010, strategies were developed in preparation for implementing subsistence conservation measures, much less severe than those used in 2009. Conservation measures, if required, were to include promoting voluntary reductions, such as encouraging a shift in harvest to other species, spreading harvest out over the duration of the run, reductions in extended sharing, and keeping fish harvested within the village or local area. The department did not impose additional hardship on fishermen by reducing the regulatory schedule further; rather the department recognized that fishing conditions were already difficult in 2010 as periods of high water and debris coincided with king salmon pulses, likely contributing to decreased

harvests. The summer chum salmon commercial fishery was managed conservatively by opening the commercial fishing season near the third quarter point of the king salmon run, after the majority of Canadian-origin fish had passed. Unfortunately, the escapement goal into Canada was not achieved. In hindsight, additional conservation measures were needed to meet this goal.

Management of the subsistence fishery became increasingly more conservative in 2011 and 2012 and similar management approaches were taken in these years to conserve king salmon. Some of the key strategies employed include the following:

- Based on poor king salmon preseason run size projections, fishing time on the first pulse of king salmon was closed. Beginning in District 1, at least one fishing period was closed (approximately 5-day closure) and this action was similarly implemented in upriver fishing districts and subdistricts based on migratory timing.
- Due to the travel time that is associated with fish migrating through the larger subdistricts such as Coastal District, Subdistrict 4-A, and Subdistrict 5-D these areas were divided into smaller management portions. This strategy provided more management precision and flexibility when implementing a reduced subsistence fishing schedule.
- When inseason assessment indicated king salmon run strength continued to be poor after closing the first period, subsistence fishing time was reduced further.
- Gear restrictions of 6-inch or smaller mesh size were implemented at times to allow subsistence fishermen the opportunity to harvest summer chum salmon while still conserving king salmon.
- No directed king salmon commercial openings occurred.
- Based on the preseason projection, retention of king salmon was not permitted in the mainstem Yukon River sport fishery. In the Yukon River tributaries (excluding the Tanana River drainage) the king salmon bag and possession limit was reduced from 3 to 1 fish.

The conservation measures taken in the subsistence fishery to reduce the harvest of king salmon has adversely affected the ability to harvest the available surplus of summer chum salmon in recent years. The department has been developing management options that allow for summer chum salmon directed commercial opportunities while attempting to minimize the incidental harvest of king salmon. The following are a few of the current management options that have been used to address this issue:

1. In an effort to reduce incidental harvest of king salmon, the summer chum salmon commercial fishery in districts 1 and 2 was delayed until near the 75% point of the king salmon run.
2. The sale of incidentally caught king salmon was prohibited to reduce the monetary incentive to target king salmon during chum directed commercial periods.
3. Summer chum salmon directed commercial fishing periods in districts 1 and 2 have been intermittently instituted concurrent with subsistence fishing periods, primarily

during June. The intent of these concurrent openings was to streamline commercial and subsistence fishing into a single harvest event, therefore reducing the amount of time that king salmon were susceptible to harvest.

4. Based on inseason assessment and run timing information, commercial fishing has in some instances been limited to areas or times in which the incidental harvest rate of king salmon was anticipated to be low. For example, District 1 commercial fishing opportunity has been confined to waters of the South Mouth of the Yukon River when test fishery indices signal a high abundance of summer chum salmon and limited presence of king salmon at that location and time.
5. Through the use of new regulations available in the 2012 season the department opened summer chum salmon directed commercial fishing periods in Subdistrict 4-A and District 6 with fish wheels only. Fish wheels had to be attended at all times during operations, and all king salmon caught in the fish wheels had to be immediately released to the water alive.

ACTION PLAN ALTERNATIVES

No new action plans necessary; continue under current plans.

2012 ALASKA BOARD OF FISHERIES REGULATORY PROPOSALS AFFECTING YUKON RIVER

KING AND SUMMER CHUM SALMON

- Proposal 130 – Review amounts reasonably necessary (ANS) for subsistence salmon in Yukon-Northern Area.
- Proposal 131 – Require pulse protection in the king salmon management plan.
- Proposal 132 – Prohibit sale of king salmon from the Yukon River drainage unless there is a directed king salmon commercial fishery.
- Proposal 133 – Allow for a directed chum salmon commercial fishery in districts 1, 2, and 3 in the Yukon Area during times of king salmon conservation efforts using 5.5-inch or smaller mesh size.
- Proposal 134 – Require 6-inch or smaller mesh size gillnets, with a maximum depth of 30 meshes, during June to July in District 1 if king salmon are a stock of concern and revert back if king salmon are no longer a stock of concern.
- Proposal 135 – Allow for a commercial summer chum salmon fishery with 6-inch or smaller mesh size in District 1 in the Yukon River, beginning July 1, and allow for additional fisheries upriver chronologically during times of conservation of king salmon.
- Proposal 136 – Cap bycatch of king salmon in the summer chum salmon directed commercial fishery in districts 1 and 2 at 2,000 fish.

- Proposal 137 – Develop an optimum escapement or inriver goal for the Yukon River summer chum salmon stock that originates above Pilot Station.
- Proposal 139 – Align Yukon subsistence regulations in districts 1–3 with current management practices, adjusting closures around commercial fishing periods, and allowing concurrent subsistence and commercial fishing by emergency order (EO).
- Proposals 140 – Require windows-only fishing schedule in the Yukon River.
- Proposal 141 – Allow for concurrent subsistence and commercial fishing periods in districts 1–3 of the Yukon River Area.
- Proposal 142 – Open Yukon River District 5-D from July 4–18 for subsistence fishing.
- Proposal 144 – Restrict gillnets to 35 meshes in depth in the Yukon River drainage.
- Proposal 145 – Restrict depth of subsistence and commercial nets in districts 1-5 to 35 meshes.
- Proposal 146 – Allow only 6-inch stretched mesh gillnet gear in the Yukon River drainage.
- Proposal 147 – Allow drift gillnets as legal gear in the subsistence fishery in District 4-A of the Yukon River, upriver to the community of Ruby.
- Proposal 148 – Extend subdistricts 4-B and 4-C drift gillnet area downstream from the mouth of the Yuki River for king salmon.
- Proposals 149 and 150 – Create a harvest reporting system for subsistence-taken salmon in the Yukon River.
- Proposal 151 – Require primary use of subsistence-caught salmon within the Yukon Area be for direct personal or family consumption as food.
- Proposal 152 – Open Acharon Channel in the Yukon River drainage to salmon fishing.
- Proposal 154 – Close the Black River and its tributaries to sport fishing for king salmon.
- Proposal 240 – Provide the department Emergency Order (EO) authority to allow dip net and beach seine gear only to be operated to selectively harvest summer chum salmon during commercial fishing periods in Districts 1–3.
- Proposal 241 – Provide the department Emergency Order (EO) authority to allow fish wheel gear only to be operated to selectively harvest summer chum salmon during commercial fishing periods in District 6.

Most of these proposals relate to conserving king salmon. Proposals 132-136, 240, and 241 are attempting to address incidental harvest of king salmon in the summer chum salmon directed commercial fishery. Average summer chum and king salmon run timing overlap considerably (Figure 7) with the middle 50% of the king salmon run overlapping with the middle 50% of the summer chum salmon run for approximately 7 days; a directed summer chum commercial fishery has the potential to catch incidental king salmon. Because of overlapping run timing it is difficult to allow for commercial harvest on surplus summer chum salmon during years of conservation for king salmon such that incidental catch of king salmon is reduced.

In recent years, the department has been faced with the challenge of trying to develop management strategies that address the need to conserve king salmon during below average to poor runs while providing harvest opportunities on the available surplus of average to above average summer chum runs. Summer chum directed commercial opportunities are weighed against the potential for incidental harvest king salmon. In each year from 2008-2012, to protect king salmon the department has delayed the opening of the summer chum directed commercial fishery until after the midpoint or later of the king salmon run. This strategy has been successful in providing protection to the earlier portion of king salmon run. However, this strategy effectively shortens the summer chum commercial season, resulting in lost harvest opportunity.

SUMMER CHUM SALMON STOCK STATUS

Escapement

Most summer chum salmon spawn in the Yukon River drainage downstream of and within the Tanana River drainage (Figure 1). The Yukon River summer chum salmon run is typically managed as a single stock for which there is currently a drainagewide threshold of 600,000 fish, measured at Pilot Station sonar, as identified in the regulatory management plan, 5 AAC 05.362. *Yukon River Summer Chum Salmon Management Plan* (Table 4). 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 1997–2012, (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 Andreafsky (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 1.7 million fish during the 14-year period (1995 and 1997–2012), 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 8).

Currently, there is not an established drainage-wide escapement goal for summer chum salmon because of a lack of long-term accurate spawner and recruitment data. However, the management plan identifies summer chum salmon runs with a projected run size of 900,000–1,000,000, commercial harvests may occur up to 50,000 fish to maintain commercial markets during lower run sizes; additional surplus harvest can occur when projected run sizes are above 1,000,000 fish (Table 4). Thus, under the plan, drainagewide escapement would be 900,000 fish minus the subsistence harvest, which equates to a minimum of approximately 750,000 fish. Escapement goal analysis of fall chum salmon indicates that there is a wide range of escapement that will provide similar yield and this could likely be the case for summer chum salmon. Of note is that the record abundance in 2006 was from some of the lowest parent year escapements on record (2001 and 2002).

Presently, there are 2 established BEGs for summer chum salmon in the Yukon River drainage. The BEG range for Anvik River is 350,000–700,000 chum salmon and the SEG range for East Fork Andreafsky River is >40,000 chum salmon. The BEG for Anvik River has been met or

exceeded in 4 of the last 5 years, with 2009 being the exception (Table 5; Figure 9). Since 2008, the SEG in East Fork Andreafsky River was met or exceeded in the most recent 3 years (Table 5; Figure 10).

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 25% 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 225,000 in the Gisasa River were observed in 2005 and 2006, respectively, but then decreased again to an average of 56,000 during 2007–2012. 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; Henshaw Creek escapement estimates have averaged over 250,000 in 2011–2012 compared to an average of 98,000 in the previous 4 years (2006–2010). The disparate strength of individual stocks within and among years seems to signal a shift in summer chum production. The department has submitted a comprehensive radiotagging project for summer chum salmon to gain a better understanding of spawning distribution and abundance.

Harvest

Combined commercial and subsistence harvests show a substantial decrease from the 1980s and 1990s compared to the recent 5-year (2007–2011) average of approximately 277,600 (Table 6; Figure 11). The recent decline in utilization is largely due to reductions in commercial harvest. Commercial harvest of summer chum salmon averaged about 376,000 during the 1990s and 205,500 from 2007 through 2011; though this recent 5-year average is a marked increase from the previous 5 years (approximately 36,800 fish) (Table 6). Since 2007 there has been renewed market interest for summer chum salmon in Districts 1 and 2, and since 2008, in Subdistrict 4-A. Directed summer chum salmon commercial opportunity has been provided in 2007 through 2012. Unfortunately, despite harvestable surpluses available in these years, redevelopment of this fishery has been largely hindered by management strategies taken in response to poor king salmon runs which co-migrate with summer chum salmon. Summer chum salmon-directed commercial fisheries have been managed to reduce incidental king salmon harvest (Table 7), which has negatively affected the summer chum salmon fishery. In the last 2 years, because of the uncertainty about king salmon run strength, summer chum salmon-directed commercial periods were scheduled to occur when and where king salmon abundance was expected to be low, reducing potential for incidental harvest. Based on inseason assessment and run timing information, commercial fishing has in some instances been limited to areas or times in which the incidental harvest rate of king salmon was anticipated to be low. In 2011 and 2012, several District 1 commercial fishing periods have been confined to waters of the South Mouth of the Yukon River (Figure 12) when test fishery indices signal a high abundance of summer chum salmon and limited presence of king salmon at that location and time.

Additionally, there is a regulatory management plan to allow directed commercial harvest of summer chum salmon in Anvik River if inseason run assessment projections indicate that 500,000 or greater summer chum salmon will be available for escapement in that specific system. Summer chum salmon were harvested in this terminal area only during the years 1994–1997 (Hayes et al. 2008).

RESEARCH PLAN

RESEARCH

Long-term stock assessment information is needed to assess how various king salmon stocks that spawn in the Yukon River drainage can support sustained fisheries. Little stock assessment information is available for Yukon salmon prior to statehood and most stock assessment information collected during the 1960s and 1970s consisted of aerial surveys, which occurred on a periodic basis. At best, these data provide very crude estimates of spawning abundance. Long-term and accurate estimates of abundance and composition of spawning stocks is needed, along with harvest estimates in the various fisheries of the Yukon River drainage. Much progress toward these objectives has been made since the late 1980s and, in particular, over the last decade. However, the time series for many datasets is relatively short and obtaining this data in the Yukon River is expensive and difficult due to the remoteness of the area.

The department, several federal agencies, DFO Canada, Native organizations, and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River drainage, which are used by the department's Division of Commercial Fisheries to manage Alaskan Yukon salmon fisheries. Preseason information involves run forecasts based upon historic performance of parent spawning abundance and is generally expressed as runs that will be below average, average, or above average. Inseason run assessment includes: (1) abundance indices from test fisheries, (2) sonar counts of passing fish, (3) various escapement assessment efforts in tributaries, (4) commercial and subsistence catch data, (5) catch per unit effort data from monitored fisheries, and (6) inseason genetic mixed stock analysis (MSA) from lower river test fisheries.

U.S.-CANADA JOINT TECHNICAL COMMITTEE PLAN

The JTC completed a research plan in 2005 that was initiated in 2002 (JTC 2005). The goals, issues, and needs contained in this plan provide a framework for research in the entire Yukon River basin. The intent of the plan is to help management meet and protect escapements while maximizing harvests. This plan provides focus and direction for research time and monies. This plan guides the JTC on key research and conservation needs for the entire Yukon River basin, is used by each agency internally, and aids in communications with the public.

INSEASON MIXED STOCK ANALYSIS

Beginning in 2008, inseason genetic stock identification of king salmon and summer chum salmon has been used as an additional management tool and has been particularly useful in managing Canadian-origin king salmon stocks. In 2011, 807 fish representing the first two major pulses from the LYTF and Pilot Station sonar were analyzed for stock composition of each pulse inseason; results were reported within 48 hours of receipt at the Genetics Conservation Laboratory. In 2012, the first pulse of king salmon at LYTF and Pilot Station sonar were analyzed, along with the second and third pulses at Pilot Station sonar. A total of 665 samples were analyzed from LYTF and Pilot Station sonar. The estimated proportion of Canadian-origin king salmon in each stratum was relatively constant, ranging from 45% in the first and third stratums to 47% in the second stratum. The low overall run strength in 2011 and 2012, combined with inseason genetic information on the Canadian-bound proportion of the run highlighted concerns regarding the run's capacity to meet escapement goals and subsistence

harvests. Consequently, fishery managers implemented reductions in the subsistence fishery and delayed the summer chum salmon commercial fishery.

Knowledge of the origin of chum salmon as they enter the river assists in managing fisheries to achieve adequate escapement and may allow for increased fishing opportunities by identifying harvestable surpluses, particularly with respect to the independent Tanana River terminal fisheries. In addition, a breakdown between summer chum and fall chum salmon stocks is provided for overlap in run timing during July. Estimates of stock compositions for major Yukon River summer chum salmon stock groups have been provided inseason to facilitate management. From the beginning of the spawning run, genetic samples were collected from the Pilot Station test fishery and analyzed on a weekly basis using Bayesian mixture modeling as implemented in the computer program BAYES (Pella and Masuda 2001).

ABUNDANCE ESTIMATES

Determining the total abundance of king salmon and summer chum salmon for an expansive drainage such as the Yukon River is very challenging. Since 1995, sonar assessments at Pilot Station have provided inseason abundance estimates; however, problems with species apportionment, technological limitations, high water, and bank erosion have adversely affected the quality of those estimates. The Pilot Station assessment project currently uses some of the most advanced sonar technology available, as well as region and species-specific net selectivity models (Bromaghin 2005). Beginning in 2005, another sonar assessment project was established at Eagle, near the Canada border. This site is ideal for sonar estimates due to favorable river bottom morphology, and because king and chum salmon runs are clearly separated in time at this location. Additionally, increased ASL information from test fishing at Eagle sonar will give more accurate estimates of the age class composition of the escapement in Canada.

In 2007, a Capital Improvement Project (CIP) was initiated to provide an independent estimate of king salmon abundance in the Yukon River and to verify the performance of the Pilot Station sonar project, using a reverse mark–recapture technique. This project estimates total run abundance by first estimating number of Canadian-origin king salmon passing Pilot Station sonar using genetic proportions applied to total passage estimates. The second step is estimating the number of Canadian-origin king salmon in subsistence and commercial harvests above Pilot Station using genetic proportions applied to harvest estimates. Lastly, estimated number of Canadian-origin king salmon passing Pilot Station sonar are compared with aggregate estimates of Canadian fish in harvests plus the king salmon passage estimate at Eagle sonar. Data were collected for this project in 2007, 2008, and 2009 and analyses are currently being conducted (Hamachan Hamazaki, Division of Commercial Fisheries AYK Biometrician, ADF&G, Anchorage; personal communication).

To improve sonar-based estimates at Pilot Station, several actions have been taken. The department has conducted the following investigations in hopes to improve upon and test assumptions of the Pilot Station sonar program: use of a side-scan sonar further offshore to count fish farther away from the bank during periods of high silt; use of longer nets in the test fishing program to identify any potential species-specific net avoidance; testing alternative fishing locations downriver of the current left bank site; investigating alternative sites for the sonar; and review the species apportionment model.

The state legislature approved funding in 2012 for a Tanana River sonar project that would operate for king, summer chum, fall chum, and coho salmon and improve abundance estimates

for one of the most productive tributaries in the Yukon River drainage. In September and October 2012, detailed bathymetry data was collected along the Tanana River along a section of river extending approximately 20 miles above and below the village of Manley. Two sites with acceptable profiles were identified and the department is currently checking on land status and will begin the process of staffing the project for the upcoming 2013 field season. The 2013 season will be the first feasibility year and the department will proceed with plans to construct a field camp, deploy sonar, and test methods of test fishing at a location about 6 miles downriver from the village of Manley.

ICHTHYOPHONUS

Ichthyophonus is a small, unicellular parasite infecting various fish species, including king salmon. While the parasite is not harmful to humans, the effects on the fish host can be devastating. In addition to typical stock assessment methods described in previous sections, the department began research on *Ichthyophonus* in Yukon River king salmon in response to increasing concerns that this disease may be affecting spawning escapement and spawning success. In 1999, Dr. Richard Kocan began baseline monitoring of *Ichthyophonus* prevalence in king salmon entering Yukon River at Emmonak (Kocan et al. 2004); ADF&G continued to monitor infection prevalence at Emmonak and the community of Eagle was added to the sampling regime in 2008 to assess fish arriving at the border and to answer pressing questions on physiological effects of *Ichthyophonus* on stamina, fecundity, and egg quality. Preliminary results indicate that prevalence in Emmonak dropped from 17% (JTC 2008) in 2007 to 9% in 2008 (JTC 2009), 8% in 2009 (JTC 2010), and 9% in 2010 (JTC 2011). *Ichthyophonus* prevalence at Eagle was 12% in 2008 (JTC 2009), 13% in 2009 (JTC 2010), and 7% in 2010 (JTC 2011).

Continued monitoring and research on the effects of *Ichthyophonus* on salmon undergoing long spawning migrations is essential in providing fishery managers with additional tools to maintain viable fisheries and adequate spawning escapements.

CURRENT PROGRAMS

Main river sonar, tributary sonar, weirs, counting towers, and aerial surveys are used to monitor escapement. Other information collected at ground-based projects, such as test fisheries, may include, but is not limited to, sex and length composition, scales for age determination, samples for genetic stock identification, data on resident species, and information from the recovery of tagged fish.

PILOT STATION SONAR

The lower river sonar assessment project located near Pilot Station (rm 107) has estimated passage of king salmon in 1995 and 1997–2012. The king salmon sonar estimate is further delineated by fish less than 655 mm in length, which corresponds to age-4 and younger, and fish greater than or equal to 655 mm in length; age-5 and older. Though problems with species apportionment, range limitations of the sonar, high water, and bank erosion affect the accuracy of these estimates, daily estimates combined with other indices (i.e., LYTF CPUE) assist with inseason management strategies.

EAGLE SONAR

Due to concerns over the accuracy of Canadian border passage estimates derived from annual mark–recapture studies and the ability of the U.S. to meet treaty obligations for border passage based on these suspect estimates, the department implemented a sonar program at Eagle, below the U.S./Canada border, to assess king and fall chum salmon passage into the Canadian mainstem. Eagle sonar has operated from 2005–2012. Efforts to assess king salmon passage at Eagle have been successful and, coupled with genetic stock identification, may provide a means to accurately estimate Canadian-origin king salmon in the Yukon River drainage.

TRIBUTARY SONAR

Anvik River is a major producer of summer chum salmon on Yukon River, accounting for as much as 50% of the overall summer chum salmon run during the period from 1995–2002. Summer chum salmon have been monitored in Anvik River since 1978.

WEIRS AND COUNTING TOWERS

Weirs or counting towers are operated by various agencies on Andreafsky, Gisasa, Henshaw, Chena, Salcha, and Goodpaster rivers. These projects provide daily estimates of spawning escapement for king salmon and summer chum salmon.

FISH WHEELS

There is currently only one fish wheel project that is associated with assessment of king salmon and summer chum salmon in Alaskan waters. This project is located upstream of Tanana near Rapids (Subdistrict 5-B). The project provides indices of king, summer chum, and fall chum salmon abundance through catch per unit effort (CPUE) information.

SUBSISTENCE HARVEST SURVEYS

Most Yukon Area communities have no regulatory requirements to report their subsistence salmon harvest. For these communities, the department operates a voluntary survey program. Harvest information is collected through postseason household interviews, follow-up telephone interviews and postal questionnaires, and harvest calendars. In areas along the entire Tanana River drainage (District 6) and where the Yukon River is accessible by the Alaska Highway road system (portions of District 5), fishermen must document their harvest on a subsistence or personal use permit. Subsistence harvest information is necessary to determine if sufficient salmon are returning to the Yukon Area for escapement and subsistence requirements, and if adequate fishing opportunity is provided to meet subsistence needs. Subsistence harvest information is critical for run reconstruction analysis and forecasting.

REFERENCES CITED

Bigler, B. S., D. W. Welch, and J. H. Helle. 1996. A review of size trends among North Pacific salmon (*Oncorhynchus spp*.). Canadian Journal of Fisheries and Aquatic Sciences 53: 455-456.

Brase, A. L. J. 2009. Fishery management report for recreational fisheries in the Lower Tanana River management area, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-46, Anchorage.

Bromaghin, J. F. 2005. A versatile net selectivity model, with application to Pacific salmon and freshwater species of the Yukon River, Alaska. Fisheries Research 74: 157-168.

Burr, J. 2009. Fishery Management Report for sport fisheries in the Yukon Management Area, 2008. Alaska Department of Fish and Game, Fishery Management Report No. 09-51, Anchorage.

Busher, W. H., T. Hamazaki, and D. M. Jallen. 2009. Subsistence and personal use salmon harvests in the Alaska portion of the Yukon River drainage, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-73, Anchorage.

Clark, J. H. 2001. Biological escapement goal for the Andreafsky River chum salmon. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A01-07, Anchorage.

Conitz, J. M., K.G. Howard, and M. J. Evenson. 2012. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2013. Alaska Department of Fish and Game, Fishery Manuscript No. 12-07, Anchorage.

Guthrie, C. M. III, H. T. Nguyen, and J. R. Guyon. 2012. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2010 Bering Sea trawl fisheries, 22 p. NTIS No. PB2012-104700.

Hayes, S. J., D. F. Evenson, and G. J. Sandone. 2006. Yukon River King salmon stock status and action plan; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 06-38, Anchorage.

Hayes, S. J., F. J. Bue, B. M. Borba, K. R. Boeck, H. C. Carroll, L. Boeck, E. J. Newland, K. J. Clark, and W. H. Busher. 2008. Annual management report Yukon and Northern areas 2002-2004. Alaska Department of Fish and Game, Fishery Management Report No. 08-36, Anchorage.

Higgs, A. S. 1995. A history of mining in the Yukon River basin of Alaska. Northern Land Use Research, Inc., Fairbanks.

Holder, R. R. and D. Senecal-Albrecht. 1998. Yukon River comprehensive salmon plan for Alaska. Alaska Department of Fish and Game. 162 pp.

Howard, K. G., S. J. Hayes, and D. F. Evenson. 2009. Yukon River Chinook salmon stock status and action plan 2010; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 09-26, Anchorage.

Howard, K. G., and D. F. Evenson. 2010. Yukon River Chinook salmon comparative mesh size study. Alaska Department of Fish and Game, Fishery Data Series No. 10-92, Anchorage.

Hyer, K. E. and C. J. Schleusner. 2005. Chinook salmon age, sex, and length analysis from selected escapement projects on the Yukon River. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Information Services Division. Alaska Fisheries Technical Report Number 87. Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 1998. Yukon River Joint Technical Committee report to the March 1998 negotiation session. Anchorage, Alaska.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2005. US and Canada Yukon River Salmon Joint Technical Committee strategic plan. The United States/Canada Yukon River Joint Technical Committee, March 2005, Anchorage.

REFERENCES CITED (Continued)

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2006a. Yukon River salmon 2005 season summary and 2006 season outlook. Alaska Department of Fish and Game. Division of Commercial Fisheries, Regional Information Report No. 3A06-03, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2006b. Potential causes of size trends in Yukon River King salmon populations. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A06-07, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2008. Yukon River salmon 2007 season summary and 2008 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A08-01, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2009. Yukon River salmon 2008 season summary and 2009 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A09-01, Anchorage.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2010. Yukon River salmon 2009 season summary and 2010 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A10-01, 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.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2012. Yukon River salmon 2011 season summary and 2012 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A12-01, Anchorage.

Kocan, R. M., P. K. Hershberger, and J. Winton. 2004. Effects of Ichthyophonus on survival and reproductive success of Yukon River King salmon, Federal Subsistence Fishery Monitoring Program, Final Project Report No. FIS 01-200. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fishery Information Services Division, Anchorage, Alaska.

Lingnau, T. L. and D. J. Bergstrom. 2004. Yukon River King salmon stock status and action plan. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A03-34, Anchorage.

Pella, J., and M. Masuda. 2001. Bayesian methods for analysis of stock mixtures from genetic characters. Fishery Bulletin 99:151-167.

Schultz, K. C., R. R. Holder, L. H. Barton, D. J. Bergstrom, C. Blaney, G. J. Sandone, D. J. Schneiderhan. 1993. Annual management report for subsistence, personal use, and commercial fisheries of the Yukon Area, 1992. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A93-10, Anchorage.

Zhou, S. 2002. Size-dependent recovery of King salmon in carcass surveys. Transactions of the American Fisheries Society, 131:1194-1202.

TABLES AND FIGURES

Table 1.–Yukon River King salmon historical escapements from selected tributaries with escapement goals in Alaska, 1980–2012.

	Ground Based Projects			Aerial Surveys			
Year	Chena River (tower & carcass)	Salcha River (tower & carcass)	East Fork Andreafsky R. (weir)	East Fork Andreafsky River	West Fork Andreafsky River	Anvik River	Nulato River
1980				[a]	1,500	1,330	[a]
1981				[a]	[a]	[a]	791
1982				1,274	851		
1983						[a]	1,006
1984				[a]	1,993	[a]	
1985				1,617	2,248	1,051	2,780
1986	9,065			1,954	3,158	1,118	2,974
1987	6,404	4,771		1,608	3,281	1,174	1,638
1988	3,346	4,562		1,020	1,448	1,805	1,775
1989	2,666	3,294		1,399	1,089	[a]	
1990	5,603	10,728		2,503	1,545	2,347	[a]
1991	3,025	5,608		1,938	2,544	[a]	2,020
1992	5,230	7,862		[a]	[a]	1,536	579
1993	12,241	10,007		5,855	2,765	1,720	3,025
1994	11,877	18,399	7,801	[a]	[a]		1,795
1995	9,680	13,643	5,841	1,635	1,108	1,996	1,649
1996	7,153	7,570	2,955		624	839	100
1997	13,390	18,514	3,186	1,140	1,510	3,979	
1998	4,745	5,027	4,034	1,027		709	1,053
1999	6,485	9,198	3,444	[a]	[a]	[a]	[a]
2000	4,694	4,595	1,609	1,018	427	1,721	[a]
2001	9,696	13,328	[e]	1,059	565	1,420	1,884
2002	6,967	4,644	4,123	1,447	917	1,713	1,584
2003	11,000[b]	15,500[b]	4,336	[a]	[a]	[a]	[a]
2004	9,645	15,761	8,045	2,879	1,317	3,679	1,321
2005	564[c]	5,988	2,239	1,715	1,492	2,421	553
2006	2,936	10,679	6,463	[a]	824	1,876	1,292
2007	3,564	6,425	4,504	1,758	976	1,529	2,583
2008	3,212	2,731[c]	4,242	[a]	[a]	[a]	922
2009	5,253	12,788	3,004		1,678	832	2,260
2010	2,382	6,135[d]	2,413	537	858	974	711
2011	[e]	7,200[e, g]	5,213	620	1,173	642	1,401
2012	1,615[c, f]	7,165[d]	2,515	[a]	[a]	707	1,374
5-Year Avg. (2008-2012)	3,116	7,204	3,477	579	1,236	789	1,334
BEGs	2,800-5,700	3,300-6,500	SEGs	960-1,700	640-1,600	1,100-1,700	940-1,900

Note: Blank cells indicate no data available.

[a] Only acceptable surveys are included.

[b] Tower counts expanded for non-counting days.

[c] Incomplete count, project was not operated or was inoperable for a large portion of the season due to water conditions.

[d] Only tower counts.

[e] No estimate due to high water conditions that prevented counting for much of the season.

[f] Preliminary estimate.

[g] SEG goal discontinued in 2010.

[h] Based on aerial survey estimate.

Table 2.–Total Canadian harvest and escapement of Yukon River King salmon, 1980–2012.

	Mainstem Yukon					Porcupine R.	Total	
	Non-Commercial					Old Crow	Canadian	
Year	Domestic	Aboriginal	Sport	Commercial	Total	Aboriginal	Harvest	Escapement
1980	3,500	7,546	300	9,500	20,846	2,000	22,846	
1981	237	8,879	300	8,593	18,009	100	18,109	
1982	435	7,433	300	8,640	16,808	400	17,208	43,538
1983	400	5,025	300	13,027	18,752	200	18,952	44,475
1984	260	5,850	300	9,885	16,295	500	16,795	50,005
1985	478	5,800	300	12,573	19,151	150	19,301	40,435
1986	342	8,625	300	10,797	20,064	300	20,364	41,425
1987	330	6,069	300	10,864	17,563	51	17,614	41,307
1988	282	7,178	650	13,217	21,327	100	21,427	39,699
1989	400	6,930	300	9,789	17,419	525	17,944	60,299
1990	247	7,109	300	11,324	18,980	247	19,227	59,212
1991	227	9,011	300	10,906	20,444	163	20,607	42,728
1992	277	6,349	300	10,877	17,803	100	17,903	39,155
1993	243	5,576	300	10,350	16,469	142	16,611	36,244
1994	373	8,069	300	12,028	20,770	428	21,198	56,449
1995	300	7,942	700	11,146	20,088	796	20,884	50,673
1996	141	8,451	790	10,164	19,546	66	19,612	74,060
1997	288	8,888	1,230	5,311	15,717	811	16,528	53,821
1998	24	5,424	-	390	5,838	99	5,937	35,497
1999	213	8,804	177	3,160	12,354	114	12,468	37,184
2000	-	4,829[a]	-	-	4,829	50	4,879	25,870
2001	89	8,188[a]	146	1,351	9,774	370	10,144	52,564
2002	59	8,174[a]	128	708	9,069	188	9,257	42,359
2003	115	6,384[a]	275	2,672	9,446	173	9,619	80,594
2004	88	6,650[a]	423	3,785	10,946	292	11,238	48,469
2005	99	6,376	436	4,066	10,977	394	11,371	67,985
2006	63	5,757	606	2,332	8,758	314	9,072	62,630
2007	-	4,792[a]	2	-	4,794	300	5,094	34,904
2008	-	3,398[a]	-	1	3,399	27	3,426	33,883
2009	17	3,791	125	364	4,297	461	4,758	65,278
2010	-	2,455	1	-	2,456	191	2,647	31,818
2011	-	4,550	40	4	4,594	290	4,884	46,338
2012[b]	-	1,615	-	-	1,615	160	1,775	30,568
2008–2012 Avg.	17	3,162	55	123	3,272	226	3,498	41,577
1989–1998 Avg.	252	7,375	502	9,229	17,307	338	17,645	50,814

Note: dashes indicate fishery closure. Blank cells indicate no data available.

[a] Includes fish from DFO test fish operations.

[b] Data are preliminary or unavailable.

Table 3.–Alaskan harvest of Yukon River king salmon, 1980–2012.

Year	Subsistence [a]	Commercial	Commercial Related [b]	Personal Use [c]	Test Fish Sales [d]	Sport Fish[e]	Total
1980	42,724	153,985				956	197,665
1981	29,690	158,018				769	188,477
1982	28,158	123,644				1,006	152,808
1983	49,478	147,910				1,048	198,436
1984	42,428	119,904				351	162,683
1985	39,771	146,188				1,368	187,327
1986	45,238	99,970				796	146,004
1987	55,039	134,760[f]		1,706		502	192,007
1988	45,495	100,364		2,125	1,081	944	150,009
1989	48,462	104,198		2,616	1,293	1,053	157,622
1990	48,587	95,247	413	2,594	2,048	544	149,433
1991	46,773	104,878	1,538	0	689	773	154,651
1992	47,077	120,245	927	0	962	431	169,642
1993	63,915	93,550	560	426	1,572	1,695	161,718
1994	53,902	113,137	703	0	1,631	2,281	171,654
1995	50,620	122,728	1,324	399	2,152	2,525	179,748
1996	45,671	89,671	521	215	1,698	3,151	140,927
1997	57,117	112,841	769	313	2,811	1,913	175,764
1998	54,124	43,618	81	357	926	654	99,760
1999	53,305	69,275	288	331	1,205	1,023	125,427
2000	36,404	8,518	0	75	597	276	45,870
2001	55,819	0[g]	0	122	0	679	56,620
2002	43,742	24,128	0	126	528	486	69,010
2003	56,959	40,438	0	204	680	2,719	101,000
2004	55,713	56,151	0	201	792	1,513	114,370
2005	53,409	32,029	0	138	296	483	86,355
2006	48,593	45,829	0	89	817	739	96,067
2007	55,174	33,634	0	136	849	960	90,753
2008	45,186	4,641	0	126	0	409	50,362
2009	33,805	316[g]	0	127	0	863	35,111
2010	44,559	9,897	0	162	0	474	55,092
2011	40,980[h]	82[g]	0	89[h]	0	474	41,625
2012[b]	[i]	0[g]	0	[i]	0	[i]	
Average							
2008-2012	[i]	2,987		126	0	555	45,548
2007-2011	43,941	9,714	0	128	170	636	54,389
1989-1998	51,625	100,011	760	692	1,578	1,502	156,092

Note: Blank cells indicate no data available.

[a] Includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay, and from test fish harvest and commercial retained fish (not sold) that were utilized for subsistence.

[b] Includes an estimate of the number of salmon harvested for the commercial production of salmon roe; including carcasses from subsistence caught fish. These data are only available since 1990.

[c] Prior to 1987, and 1990, 1991, and 1994 personal use was considered part of subsistence.

[d] Includes only test fish catch that were sold commercially.

[e] Sport fish harvest for the Alaskan portion of the Yukon River drainage. Most of this harvest is believed to have been taken within the Tanana River drainage (Schultz et al. 1993).

[f] Includes 653 and 2,136 Chinook salmon illegally sold in Districts 5 (Yukon River) and 6 (Tanana River), respectively.

[g] No commercial fishery was conducted.

[h] Data are preliminary.

[i] Data not yet available.

Table 4.–Yukon River summer chum salmon management plan overview, 2012.

	Recommended Management Actions			
Projected Run Size [a]	Commercial	Personal Use	Sport	Subsistence
600,000 or Less	Closure	Closure	Closure	Closure [b]
600,001 to 700,000	Closure	Closure	Closure	Possible Restrictions [b]
700,001 to 1,000,000	Restrictions [b]	Restrictions [b]	Restrictions [b]	Normal Fishing Schedules
900,001 to 1,000,000	0-50,000	Open	Open	Normal Fishing Schedules
Greater than 1,000,000 [d]	Open [c]	Open	Open	Normal Fishing Schedules

[a] The department will use the best available data including preseason projections, mainstem river sonar passage estimates, plus the estimated harvest below the sonar site and the Andreafsky River escapement.

[b] The fishery may be opened or less restrictive in areas that indicator(s) suggest the escapement goals(s) in that area will be achieved.

[c] 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) and 5 AAC 05.365 if buying capacity allows.

[d] Inriver run goal: This is a specific management objective for salmon stocks that are subject to harvest upstream of the point where escapement is estimated.

Table 5.–Yukon River summer chum salmon historical escapements 1980–2012.

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]	1,189,602					
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	157,589	100,912	
1997	1,415,641	51,139 [d]	609,118	48,018	157,975	31,800	76,454	
1998	826,385	67,591 [d]	471,865	8,113	49,140	18,228	212 [b]	
1999	973,708	32,229 [d]	437,631	5,300	30,076	9,920	11,283 [b]	[b]
2000	456,271	22,918 [d]	196,349	6,727	24,308	14,410	19,376	27,271
2001	441,450	[b,d]	224,058	[b]	[b]	17,936 [b]	3,674	35,031
2002	1,088,463	45,019 [d]	462,101	13,583	72,232	32,943	13,150	25,249
2003	1,168,518	22,603 [d]	251,358	3,056 [b]	17,814 [b]	24,379	5,230	22,556
2004	1,357,826	62,730 [d]	365,691	5,247	[f]	37,851	15,661	85,966
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]	225,225	29,166 [h]	[b]
2007	1,726,885	69,642 [d]	459,038	[f]	[f]	46,257	[f]	31,442
2008	1,665,667	57,259 [d]	374,929	[f]	[f]	36,938	[f]	97,281
2009	1,285,437	8,770 [d]	193,099	[f]	[f]	25,904	3,981 [i]	156,201
2010	1,327,581	72,839 [d]	396,173	[f]	[f]	47,669	840 [i]	105,398
2011	1,778,870	100,473 [d]	642,528	[f]	[f]	95,796	3,665 [i]	248,247
2012	2,130,871 [j]	56,680 [d,j]	483,506 [i]	[f]	[f]	83,423 [j]	[f]	292,082
2008-2012 avg.	1,637,685	59,204	418,047	n/a	n/a	57,946	n/a	179,842
Escapement Goal		>40,000	350,000-700,000	n/a	n/a	n/a	n/a	n/a

Note: Blank cells indicate no data avaliable.

[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] Aerial counts used.

[j] Data are preliminary.

Table 6.–Yukon River total summer chum salmon utilization, 1980–2012.

Year	Subsistence [a]	Commercial [b]	Commercial Related [c]	Personal Use [d]	Test Fish Sales [e]	Sport Fish [f]	Yukon River Total
1980	167,705	928,609	139,106			483	1,235,903
1981	117,629	1,006,938	272,763			612	1,397,942
1982	117,413	461,403	255,610			780	835,206
1983	149,180	744,879	250,590			998	1,145,647
1984	166,630	588,597	277,443			585	1,033,255
1985	157,744	516,997	417,016			1,267	1,093,024
1986	182,337	721,469	467,381			895	1,372,082
1987	170,678	442,238	180,303	4,262		846	798,327
1988	196,599	1,148,650	468,032	2,225	3,587	1,037	1,820,130
1989	167,155	955,806 [g]	496,934	1,891	10,605	2,132	1,634,523
1990	115,609	302,625 [h]	214,552	1,827	8,263	472	643,348
1991	118,540	349,113 [i]	308,989		3,934	1,037	781,613
1992	125,497	332,313 [j]	211,264		1,967	1,308	672,349
1993	104,776	96,522	43,594	674	1,869	564	247,999
1994	109,904	80,284	178,457		3,212	350	372,207
1995	118,723	259,774	558,640	780	6,073	1,174	945,164
1996	102,503	147,127	535,106	905	7,309	1,946	794,896
1997	97,109	95,242	133,010	391	2,590	662	329,004
1998	86,004	28,611	187	84	3,019	421	118,326
1999	70,323	29,389	24	382	836	555	101,509
2000	64,895	6,624	0	30	648	161	72,358
2001	58,239	- [k]	0	146	0	82	58,467
2002	72,260	13,558	19	175	218	384	86,614
2003	68,304	10,685	0	148	119	1,638	80,894
2004	69,672	26,410	0	231	217	203	96,733
2005	78,902	41,264	0	152	134	435	120,887
2006	90,907	92,116	0	262	456	583	184,324
2007	76,805	198,201	0	184	10	245	275,445
2008	68,394	151,186	0	138	80	371	220,169
2009	67,742	170,272	0	308	0	174	238,496
2010	65,948	232,888	0	319	0	1,183	300,338
2011	77,715 [l]	275,161	0	439	0	511 [m]	353,826
2012		319,575		3,070			
Avg. 2007-2011	71,321	205,542	0	278	18	497	277,655
Avg. 2002-2011	73,665	121,174	2	236	123	573	195,773

-continued-

Note: The amount necessary for subsistence (ANS) is 83,500–142,192. Blank cells indicate no data available. Most data for 2012 are not yet available.

[a] Includes test fish harvest and commercial retained fish (not sold) that were utilized for subsistence. Does not include harvest from the Coastal District communities of Scammon Bay and Hooper Bay.

[b] Includes ADF&G test fish sales prior to 1988.

[c] Includes an estimate of the number of salmon harvested for the commercial production of salmon roe and the carcasses used for subsistence.

[d] Prior to 1987, and 1990, 1991, and 1994 personal use was considered part of subsistence.

[e] ADF&G test fish that were sold commercially.

[f] The majority of the sport fish harvest is believed to be taken in the Tanana River drainage (Brase 2009; Burr 2009). Division of Sport Fish does not differentiate between the two races of chum salmon. Sport fish harvest is assumed to be primarily summer chum salmon caught incidental to directed king salmon fishing.

[g] Includes illegal sales of 150 summer chum salmon in District 1.

[h] Does not include 1,233 female summer chum salmon sold in Subdistrict 6-C with roe extracted and roe sold separately. These fish are included in estimated harvest to produce roe sold.

[i] Includes the illegal sales of 1,023 summer chum salmon.

[j] Includes the illegal sales of 31 summer chum salmon in District 1, and 91 summer chum salmon in District 2.

[k] Summer season commercial fishery was not conducted.

[l] Data are preliminary.

[m] Data are unavailable at this time. Estimated based on the previous 5-year average.

Table 7.–Districts 1 and 2 salmon commercial harvests in summer chum-directed commercial fishing periods, Yukon River, 2008–2012.

				Districts 1 and 2 Combined		
				Incidental King Salmon [a]		Summer Chum
Year	Date First Commercial	Percent King Salmon Passage [b]	Number of Periods	Sales	Caught, but not Sold	Salmon Sales
2008	2-Jul	87	11	4,348	0	125,598
2009 [c]	29-Jun	81	13	131	3,540	157,906
2010	28-Jun	78	15	9,897	0	183,215
2011 [c]	24-Jun	62	20	0	4,090	266,510
2012 [c]	29-Jun	42	16	0	2,421	207,849

[a] Does not include king salmon caught during the fall season fishery.

[b] The proportion of king salmon run passed at the time of first commercial harvest based on lower river test fisheries.

[c] Sale of incidentally-caught king salmon prohibited during portions or all of summer season.

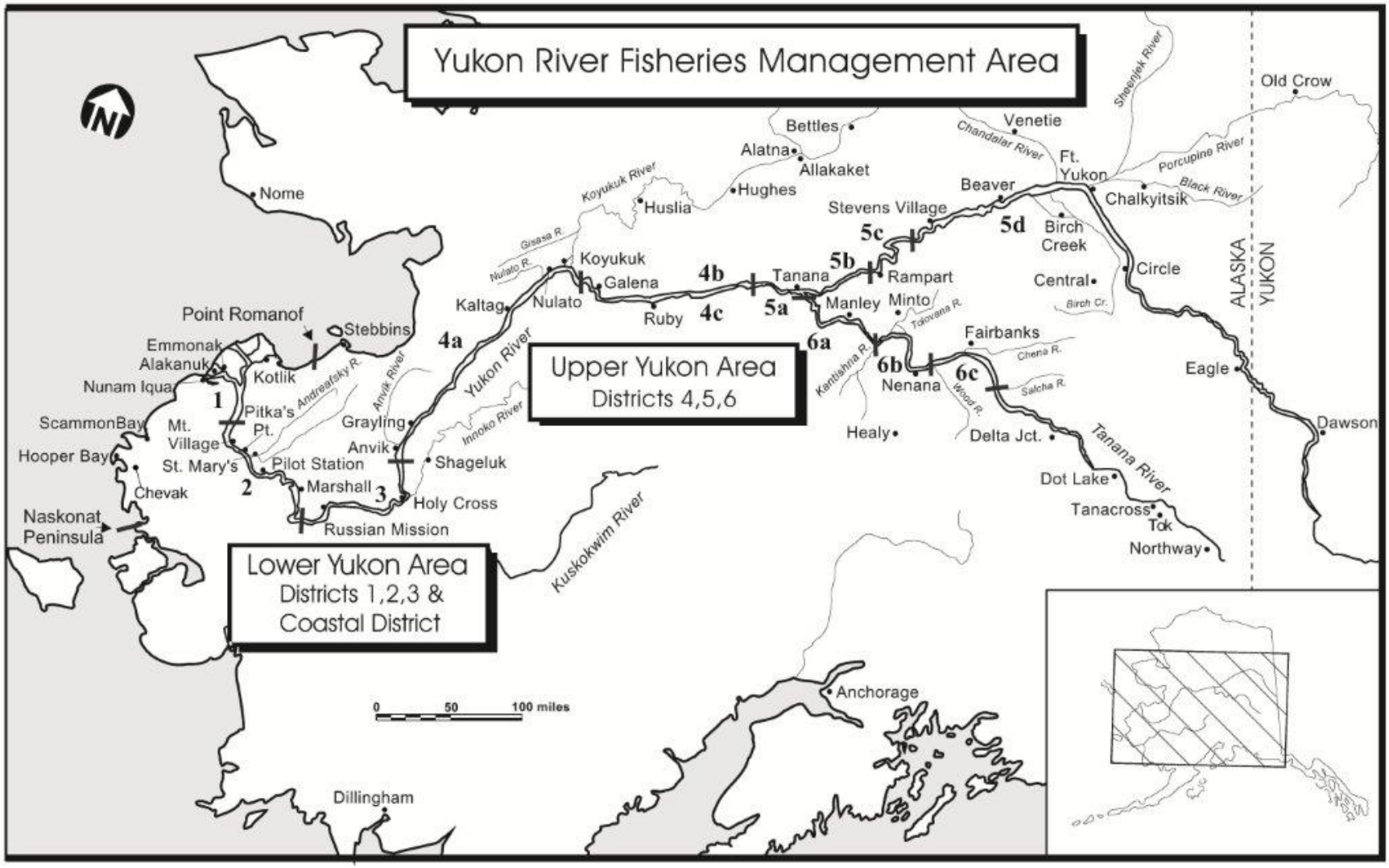
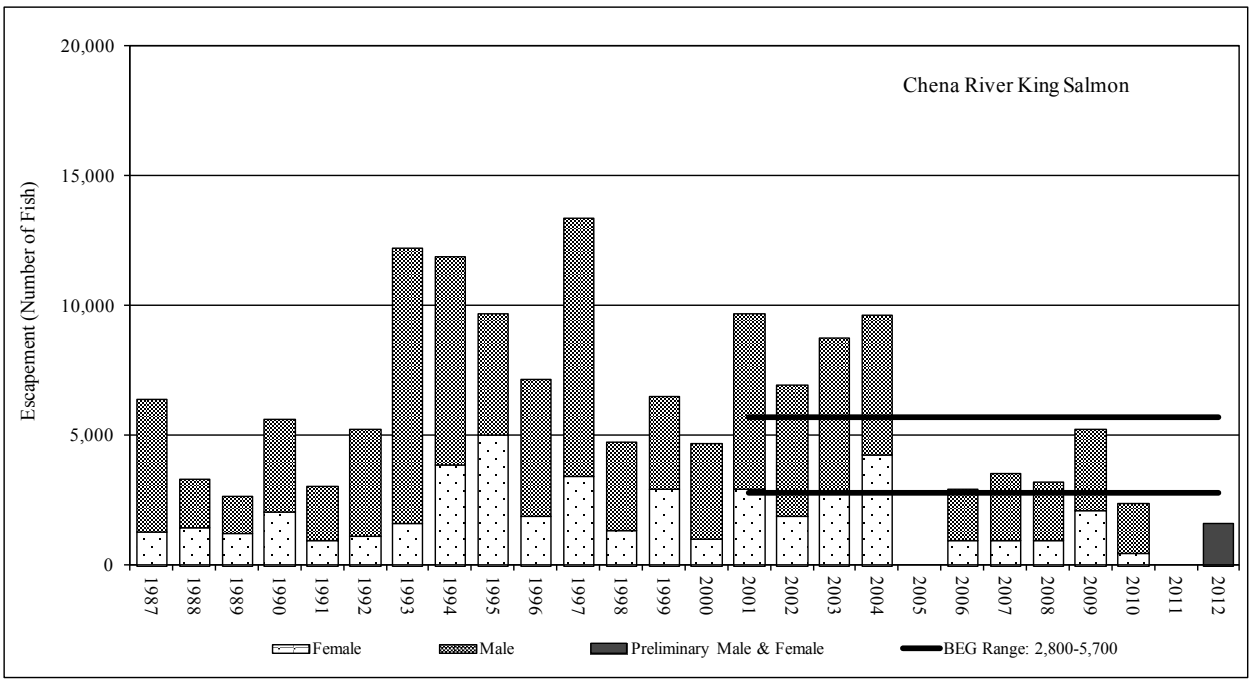


Figure 1.–Alaska portion of the Yukon River drainage showing communities and fishing districts.



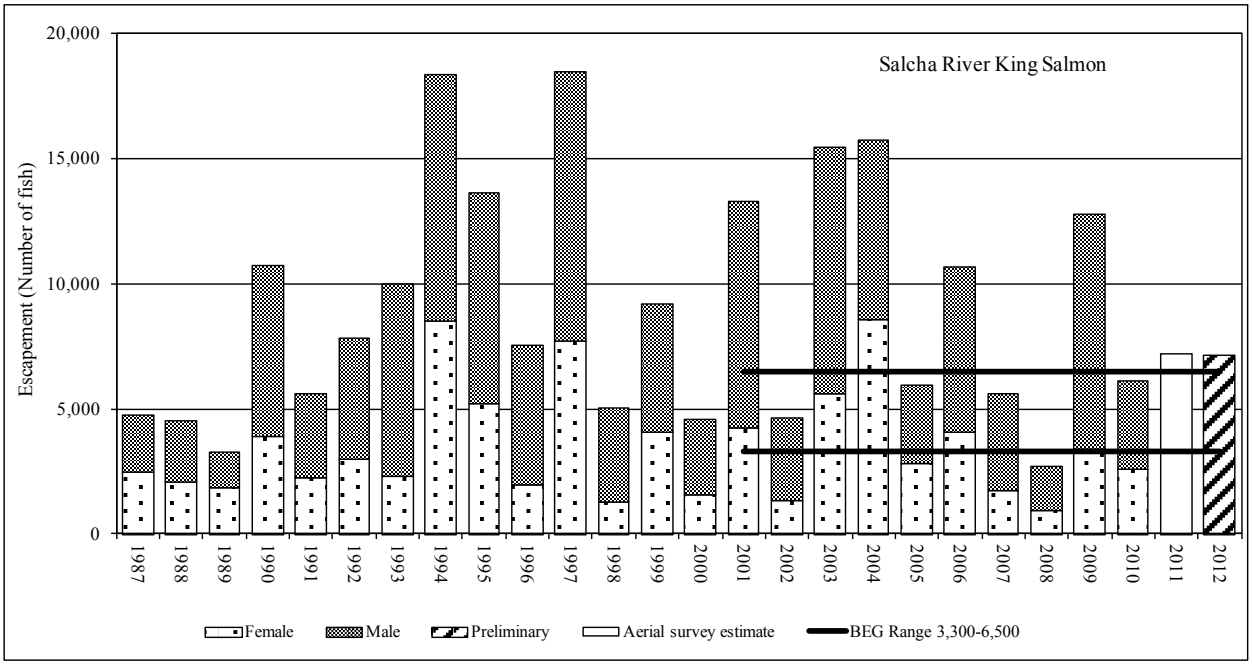
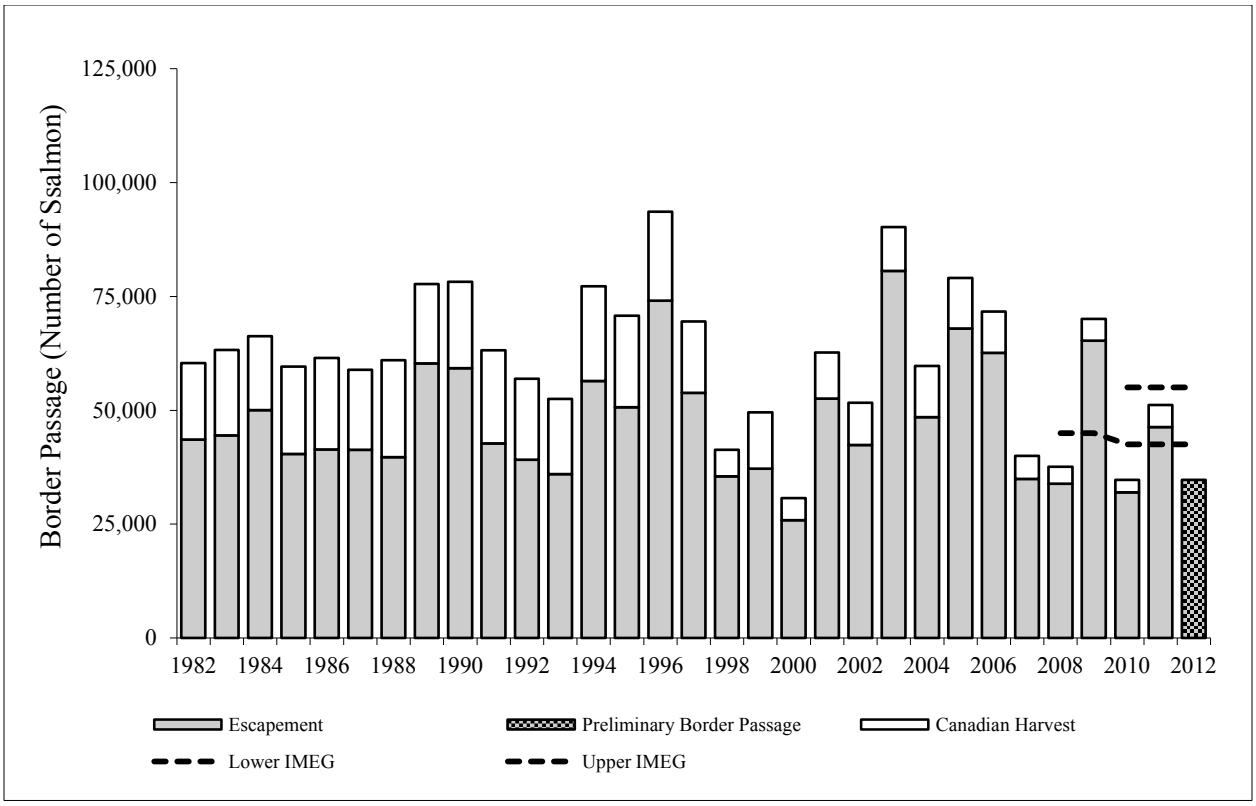
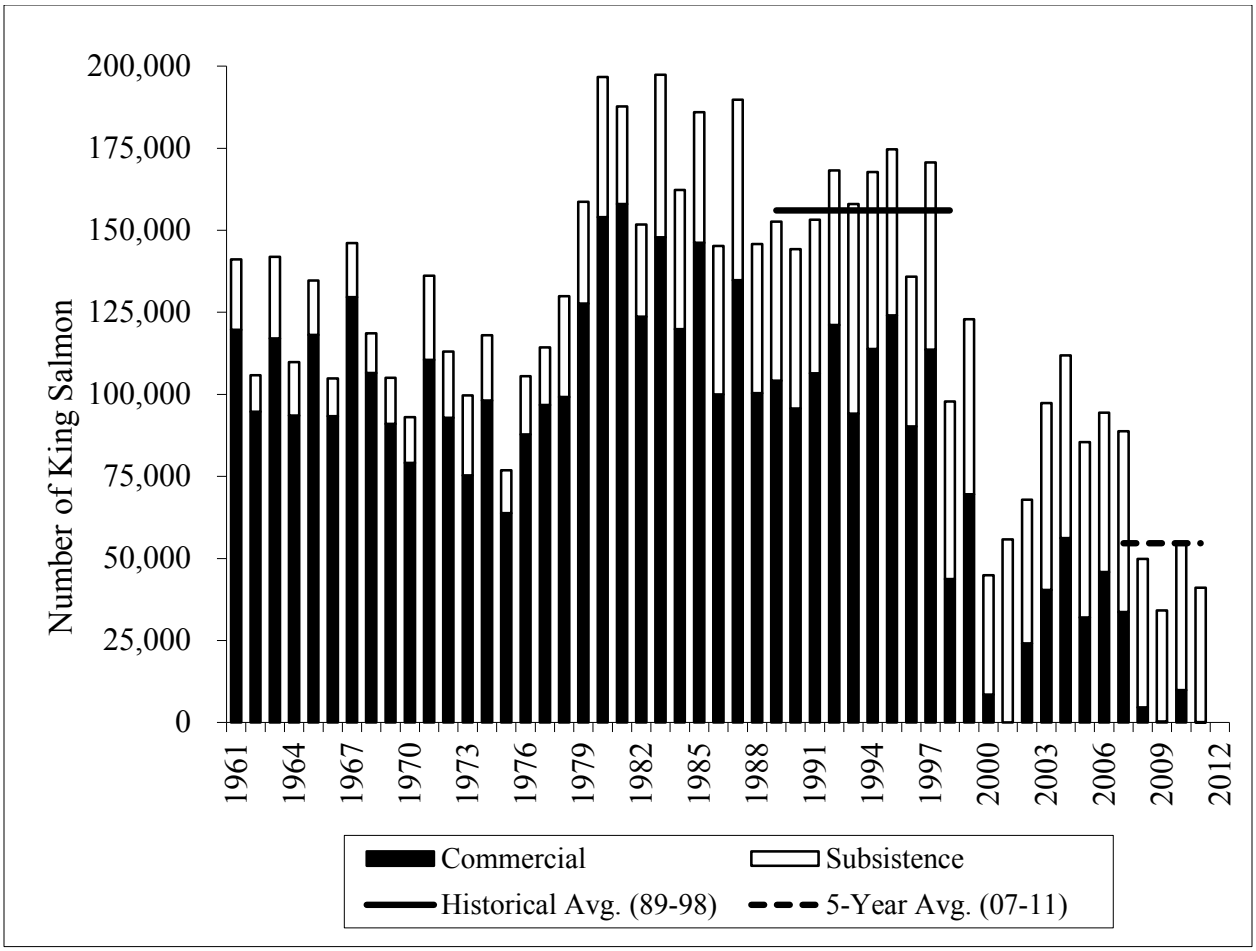


Figure 2.–King salmon escapement by year and sex observed in Chena (above) and Salcha (below) rivers, Alaska, 1987–2012.



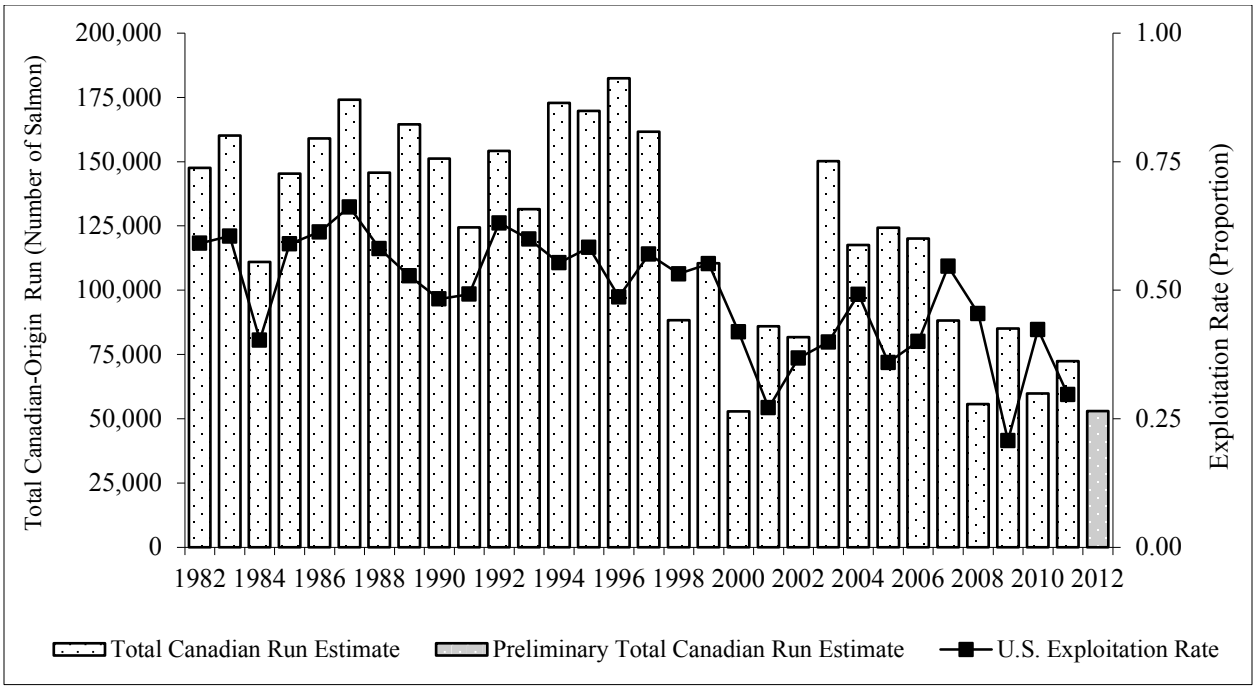
Note: Estimates are based on a 3-area escapement index (1982–2001), Eagle Sonar (2005–2012), and radiotelemetry (2002–2004) data. Canadian harvest data are not yet available for 2012.

Figure 3.–Eagle sonar-based border passage estimates of Yukon River king salmon passing into Canada broken down by Canadian harvest and escapement, mainstem Yukon River, Canada, 1982–2012.



Note: Subsistence harvest data for 2012 are not illustrated as they are not yet available and there was no commercial fishing for king salmon.

Figure 4.–Yukon River king salmon subsistence and commercial harvests compared to the historical baseline 1989–1998 average (156,092) and the recent 2007–2011 average (54,665).



Note: Estimates prior to 2002 are based on a 3-area escapement index, Eagle Sonar (2005–2012), and radio telemetry (2002–2004) data.

Figure 5.–Annual Yukon River Canadian-origin king salmon run estimates and associated U.S. exploitation rates, 1982–2012.

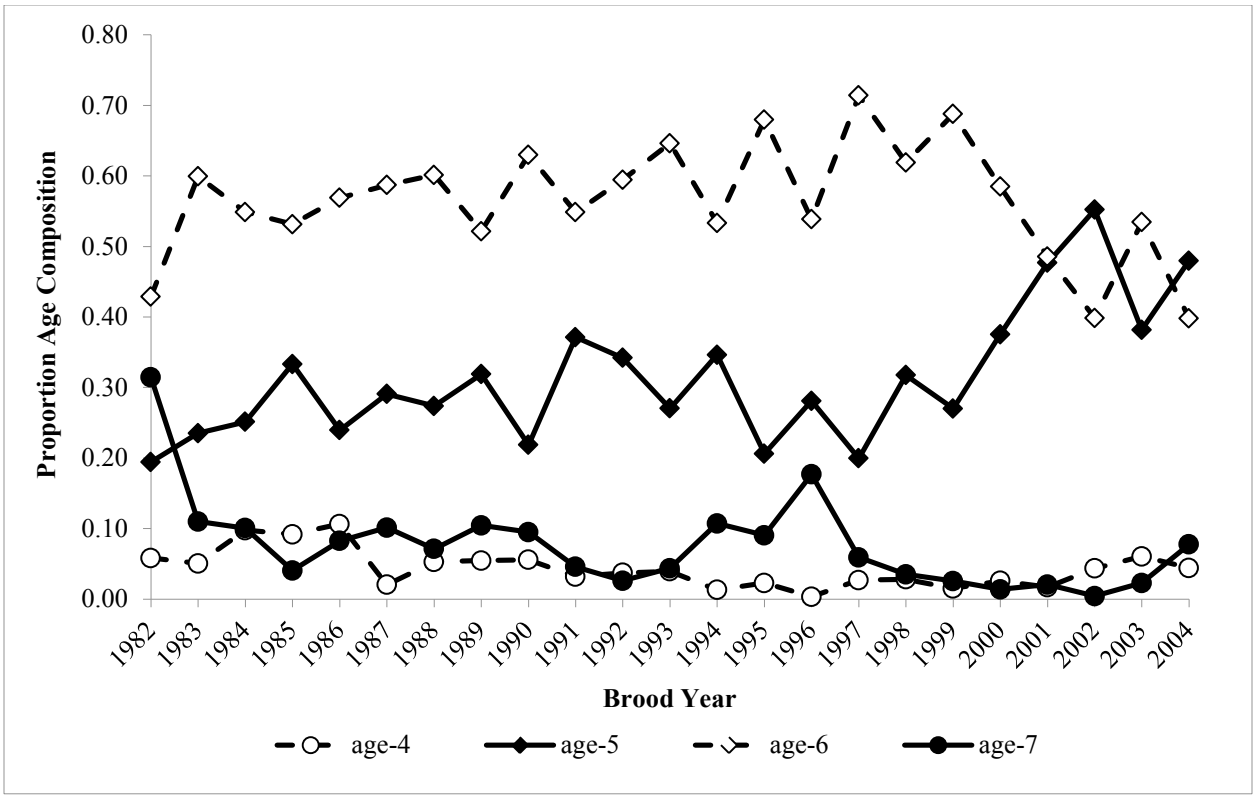


Figure 6.–Brood year return age class composition of Yukon River Canadian-origin king salmon 1979–2004.

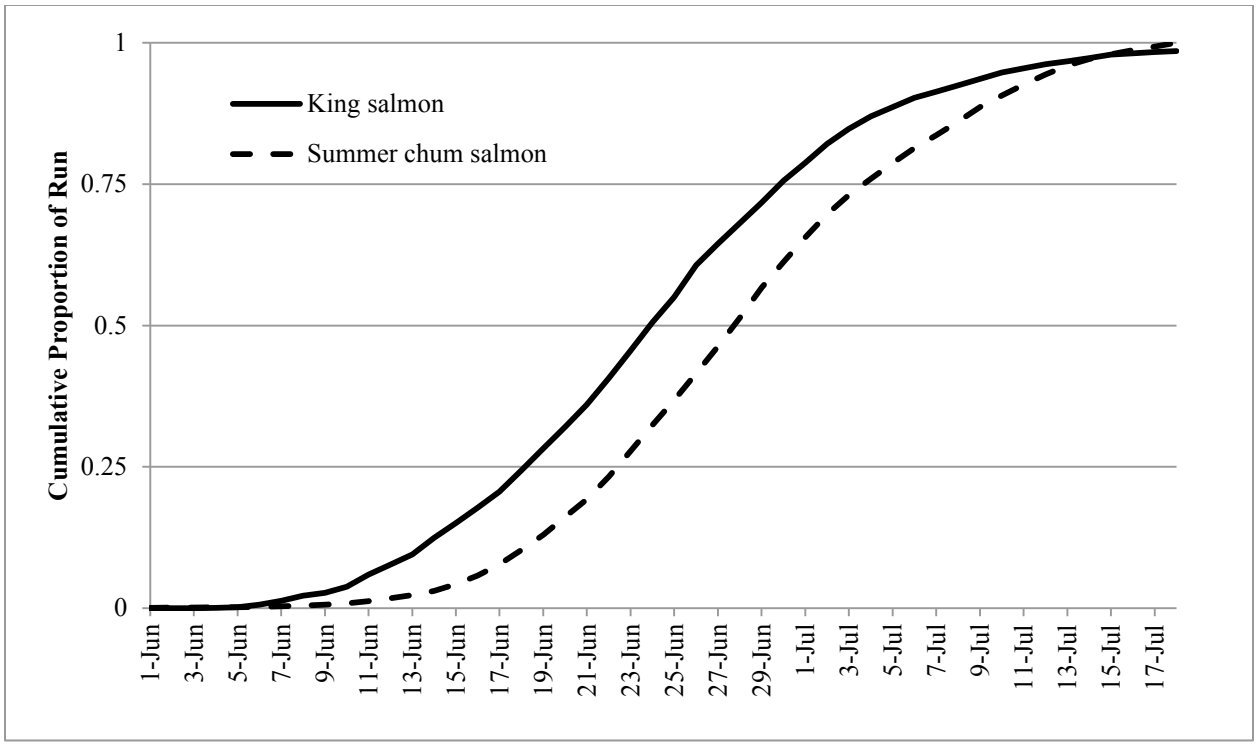
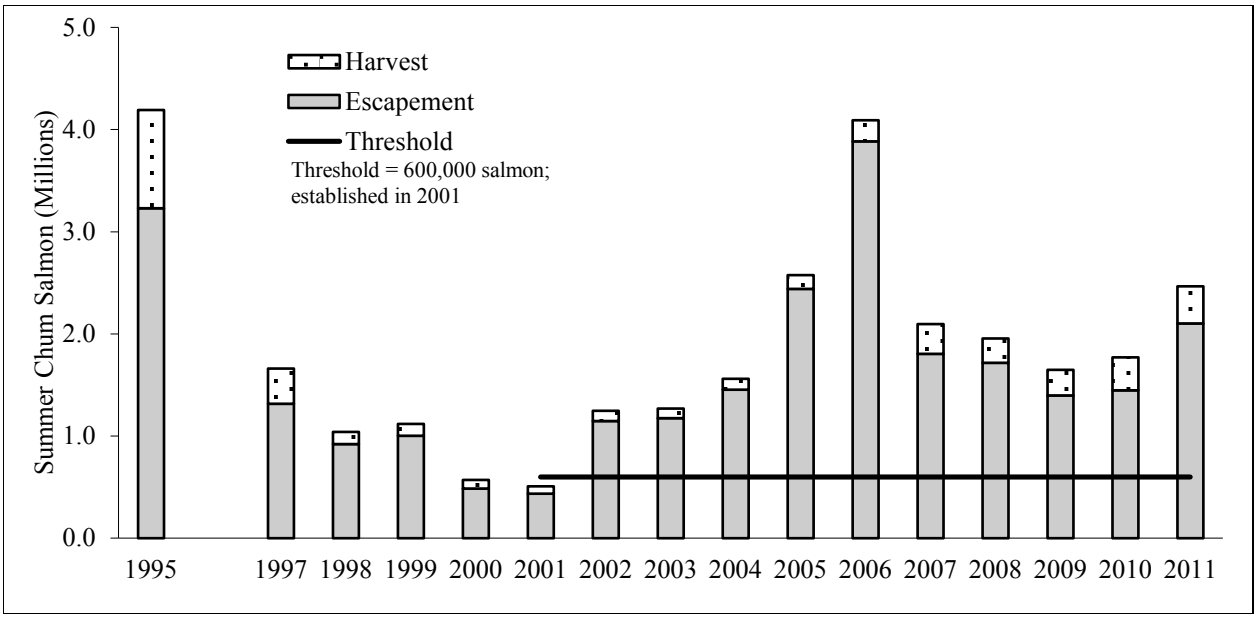


Figure 7.–Average cumulative proportion of the run past Pilot Station sonar for king salmon (1995, 1997, 2000, 2002–2008, 2009–2012) and summer chum salmon (1995, 1997–2000, 2002–2012).



Note: Data for 2012 were not yet available.

Figure 8.–Approximate total run size of Yukon River summer chum salmon, by harvest, and escapement, with escapement compared to the drainagewide threshold, 1995 and 1997–2011.

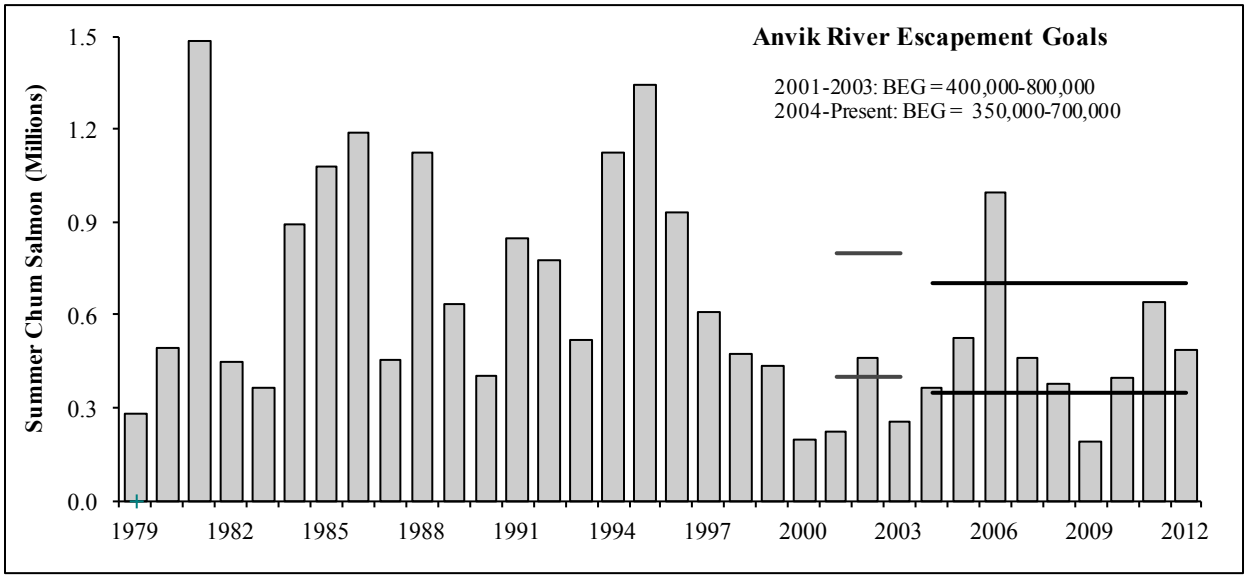


Figure 9.–Summer chum salmon escapement estimates and escapement goals for Anvik River, 1979–2012.

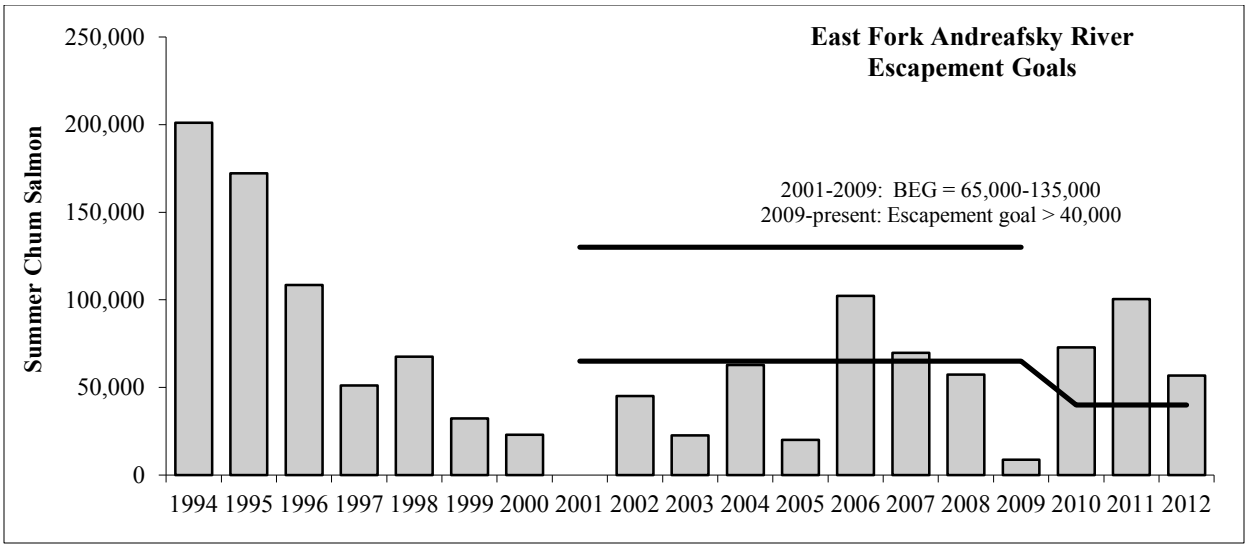
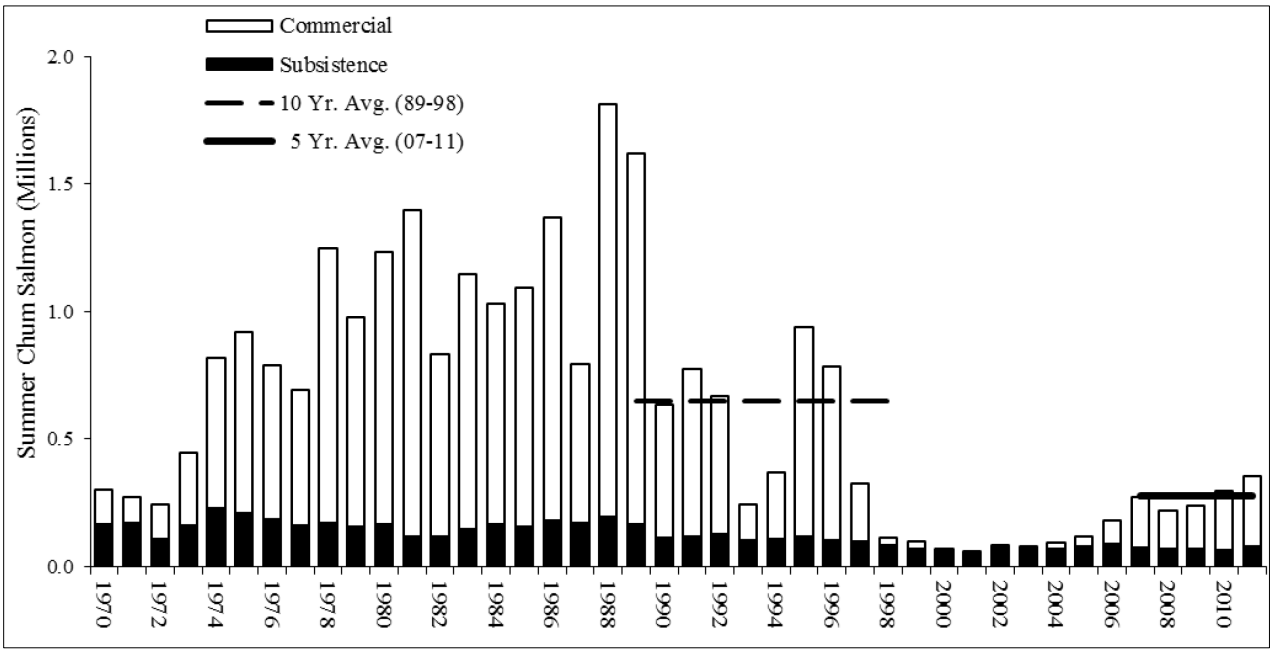


Figure 10.–Summer chum salmon escapement estimates and escapement goals for East Fork Andreafsky weir 1994–2012.



Note: Data for 2012 are not yet available.

Figure 11.–Yukon River summer chum salmon subsistence and commercial harvests from 1970 to 2011, compared to the 1989–1998 average (approximately 665,100 fish) and the 2007–2011 average (277,600 fish).

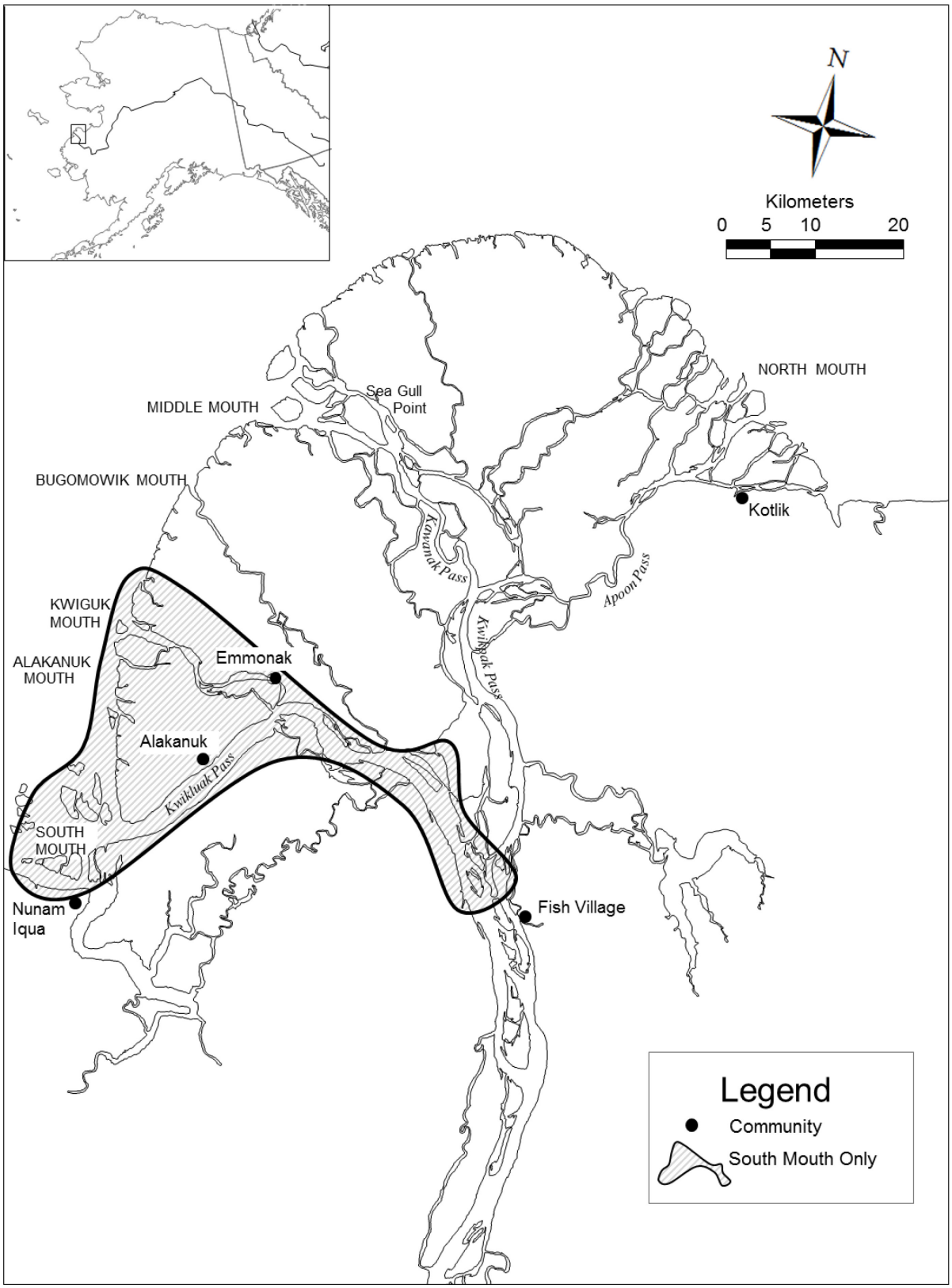


Figure 12.–South Mouth area opened by emergency order in 2011 and 2012, District 1, lower Yukon River.