Special Publication No. 15-20

Yukon River King Salmon Stock Status, Action Plan and Summer Chum Salmon Fishery, 2015; a Report to the Alaska Board of Fisheries

by

Stephanie Schmidt

Sabrina Garcia

Holly Carroll

December 2015

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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)

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

SPECIAL PUBLICATION NO. 15-20

YUKON RIVER KING SALMON STOCK STATUS, ACTION PLAN AND SUMMER CHUM SALMON FISHERY, 2015; A REPORT TO THE ALASKA BOARD OF FISHERIES

by

Stephanie Schmidt
Sabrina Garcia
and
Holly Carroll

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

December 2015

The Special Publication series was established by the Division of Sport Fish in 1991 for the publication of techniques and procedures manuals, informational pamphlets, special subject reports to decision-making bodies, symposia and workshop proceedings, application software documentation, in-house lectures, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library, Alaska Resources Library and Information Services (ARLIS) and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and peer review.

Stephanie Schmidt, Sabrina Garcia, and Holly Carroll
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

This document should be cited as follows:
Schmidt, S., S. Garcia, and H. Carroll. 2015. Yukon River king salmon stock status, action plan and summer chum salmon fishery, 2015; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 15-20, Anchorage.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

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, 2010, and 2013 board meetings. King salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage the past 5 years (2010–2015). Conservative management actions taken inseason have contributed to success in achieving escapement goals. As a result of management actions, king salmon commercial and subsistence harvests have shown a substantial decrease from the historical 10-year period (1989–1998) to the recent 5-year period (2009–2014). Although king salmon run sizes showed a modest increase during the years 2003–2006 and 2009, lower returns have occurred since that time despite continued conservative management strategies. King salmon runs in 2014 and 2015 have shown moderate increases but are still below average in size. Although escapement goals were met in 2014 and 2015, it was through severe subsistence fishing restrictions and closures. Based on guidelines established in the SSFP (5 AAC 39.222), the classification of Yukon River king salmon as a stock of yield concern was continued at the 2015 work session. Yukon River summer chum salmon (*O. keta*) runs have had large surpluses available for harvest the past 5 years. However, the management of these two species is greatly affected because of the disparity in run sizes and the fact that the two species overlap in both space and time.

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 when conservation of king salmon is necessary.

In response to guidelines established in the SSFP, the board classified Yukon River king salmon as a yield concern at the 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" (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 compared to the previous 10-year (1989–1998) average harvest (Vania 2000). 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, January 2010, and January 2013 board meetings (Lingnau and Bergstrom 2004; Hayes et al. 2006; Howard et al. 2009; Schmidt and Newland 2012). Based on definitions provided in SSFP (5 AAC 39.222(f)(5) and (42)), only the most recent 5-year escapements and yield estimates (2011–2015 when 2015 data are available, 2010–2014 when 2015 data 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. Although 2015 escapement and commercial

harvest data are available, subsistence harvest data for this year are not yet available. Subsistence harvest estimates are expected to be far below the typical average harvest of approximately 50,000 king salmon, and are likely to be below 10,000 king salmon, reflecting the more conservative management actions taken during the 2015 season.

Based on definitions provided in SSFP (5 AAC 39.222(f)(42)), the department recommended continuing Yukon River king salmon as a stock of yield concern at the October 2015 board work session. Although the 2014 and 2015 runs of king salmon came in better than expected, 2011, 2012, and 2013 were years of low yields of king salmon on the Yukon River.

The board has made a positive customary and traditional (C&T) use finding for king, summer chum, fall chum, coho, and pink salmon in the Yukon Area. The board has found that 45,500-66,704 king, 83,500–142,192 summer chum, 89,500–167,900 fall chum, 20,500-51,980 coho, and 2,100–9,700 pink salmon are amounts reasonably necessary (ANS) for subsistence uses in the Yukon Area.

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 (2011–2015; Table 1). These include 2 biological escapement goals (BEGs) and 4 sustainable escapement goals (SEGs) established by the department for U.S. tributaries. Tributary escapements have been monitored with counting tower projects on the Chena and Salcha rivers; a weir project on the East Fork Andreafsky River; and aerial surveys on the Anvik, West Fork Andreafsky, and Nulato rivers (Figure 1). The East Fork Andreafsky River weir SEG was achieved in 4 of the last 5 years; and in 2013 escapement was just 100 fish short of meeting the goal. Chena and Salcha rivers are the largest king salmon producing tributaries within the Alaska portion of the Yukon River drainage. Since the BEG was established for the Chena in 2001, it has been met 9 of the 12 years that river was successfully monitored. The BEG in the Chena was not achieved in 2012 and 2013 but was met in both 2014 and 2015. Escapement on the Chena River could not be assessed in 2011 due to high water conditions. Since the BEG was established in 2001 for the Salcha River, it has been met in all years the river was monitored. Due to high water conditions in 2011, an aerial survey was used in lieu of tower counts on the Salcha River, and it was determined that the escapement goal was achieved. Escapement could not be assessed in 2014 due to high water conditions that hindered project operations for much of the season (Figure 2). Of the escapement observations for stocks indexed by aerial surveys, SEGs in West Fork Andreafsky River have been met in 4 of the last 5 years. Escapement on the West Fork Andreafsky River could not be assessed in 2012 due to poor survey conditions resulting in minimal counts. The Nulato River SEG was met in 4 of the last 5 years (no survey was conducted in 2014). The Anvik River SEG was met only in 2014 and 2015 (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; James W. Savereide, Alaska Department of Fish and Game, Division of Sport Fish, Fairbanks, personal communication). Sex data for 2015 are not presented here because they are currently unavailable. During the historical baseline period (1989–1998), average age and sex composition were similar between the Chena and Salcha rivers. In the recent 5-year period (2010-2014), there appears to be a slight divergence between the rivers, where age-5 king salmon dominate the age composition in the Chena River,

but age-5 and age-6 are equally present in the Salcha River (Table 2). There has been a decline in age-7 king salmon in both rivers from the historical baseline period to the recent 5-year period (Table 2). The percent female in the Chena River has gone down slightly from the historical average to the recent average (Table 2 and Figure 2).

Yukon River king salmon escapement at the Canadian border has been estimated using a sonar program at Eagle, Alaska, since 2005.[1] An interim management escapement goal (IMEG) of >45,000 king salmon was established by the Yukon River Panel in 2008 and continued in 2009. In 2010, the IMEG was revised at the spring Yukon River Panel meeting to a range of 42,500 to 55,000 king salmon. This IMEG range was continued through 2015. Since 2010, the sonar-based escapement goal was achieved in 2011, and exceeded in 2014 and 2015 (Table 3 and Figure 3).

Poor runs observed since 2007 do not appear to be related to poor escapements and are due to a period of low productivity from brood years 2002–2007 (Figure 4). Parent year escapements in 2001–2007 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 king salmon harvests since 1998 and decreased subsistence harvests since 2007. A king salmon directed commercial fishery has not occurred since 2007, and the summer chum salmon directed fishery has been managed to reduce incidental harvest of king salmon. Approximately 9,900 king salmon were incidentally harvested and sold in the 2010 chum salmon directed periods. The sale of incidentally caught king salmon was prohibited during the summer season in 2011 and prohibited during both summer and fall seasons beginning in 2012 and continuing through 2015.

During the most recent 5-year period for which subsistence harvest data are available (2010-2014), harvests in 2011–2014 were not within the ANS of 45,500–66,704 king salmon (Table 4) and the subsistence harvest in 2014 was by far the lowest on record, with only 3,286 king salmon harvested. Prior to 2008, annual subsistence harvest remained relatively stable near 50,000 king salmon. Subsistence salmon fishing restrictions have been progressively more conservative since 2010 in response to low run sizes. In 2011 and 2012, subsistence salmon fishing was closed during the first and second pulse of king salmon. Regulations passed by the board required first pulse protection effective with the 2013 summer season. Additionally, gillnets were restricted to 6-inch or smaller mesh size to provide further protection to king salmon. Given the weak king salmon run in 2013, subsistence salmon fishing was closed on all 3 pulses. During very limited subsistence openings between pulses, gillnets were restricted to 6-inch or smaller mesh size. Subsistence salmon fishing time was reduced by 68% to 96% along the river in 2013 in an effort to meet king salmon escapement goals. In 2014, subsistence salmon fishing was closed on the first pulse of king salmon as required by regulation. Once it was determined that at least 90% of the king salmon run was complete in a given district, subsistence fishing time restrictions were relaxed. Given the data uncertainty with run assessment and the need to ensure escapement objectives would be met, subsistence fishing time restrictions were not relaxed in the upper river until the king salmon run was more than 98% complete. However,

[1] Evidence suggests that Canada's Department of Fisheries and Oceans (DFO) fish wheel mark–recapture program (1982–2004) tended to underestimate passage of king salmon into Canada. Therefore, adoption of 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, although this should be cautiously considered. In this report, Eagle sonar-based data (2005–2015) are emphasized because they are deemed most accurate.

6-inch or smaller mesh size gillnet gear restrictions remained in place on the mainstem of the Yukon River. Management strategies in 2015 were similar to 2014, with pulse closures and gear restrictions in place to protect the majority of the king salmon run. Subsistence harvest data are not yet available for 2015; however, due to the conservative management actions taken during 2015, it is expected that the 2015 subsistence harvest will be <10,000 fish, which is well below the lower end of the ANS range.

In summary, conservative management actions to protect recent poor king salmon runs have resulted in a considerable reduction in the subsistence and commercial harvests of king salmon. 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 (2010–2014) average of approximately 2,000 fish (Table 4 and Figure 5). The average subsistence harvest of king salmon for the years 2010–2014 is 26,355 fish, approximately half the 1989-1998 average harvest and well below the ANS range (Table 4). Based upon postseason assessment and escapement information, there was a surplus of king salmon in 2014 and 2015 that could have been harvested in the subsistence fishery.

Exploitation Rates

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 and stock-specific harvest for the Canadian-origin stock can be determined based on border passage estimates and genetic mixed-stock analysis.

Border passage into Canada has been estimated from 1982–2008 by the Canada Department of Fisheries and Ocean (DFO) using mark–recapture techniques, and more recently by the Alaska Department of Fish and Game, using radiotelemetry (2002–2004) and sonar (2005–2015). 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 2006). The Eagle sonar project, operated by the department, has provided 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 93,700 in 1996, with a recent 5-year (2010–2014) average of 43,000 (Table 3 and Figure 3).

From 1982 through 2003, scale-pattern analysis was used to apportion king salmon harvests in Alaska 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 approximately 50% of Canadian-origin king salmon total run was taken in the Alaska harvest, and this proportion remained relatively constant through 2007 (Figure 6). With the poor returns of Canadian-origin fish in recent years and the conservative management

regime, the average exploitation rate for the most recent 5-year period of 2010–2014 has decreased to approximately 25% and fell as low as 2% in 2014 (Figure 6). These exploitation rates, however, only represent Alaska Yukon River exploitation and do not include exploitation by Canadian fishermen. The 1989–1998 average Canadian exploitation rates on the Canadian stock was 12% but has decreased considerably to 4% in the recent 2010–2014 period.

Brood Year Return Information

The brood-year data for Canadian-origin Yukon River king salmon is used as a representative of the overall run and is used to assess the productivity of the Canadian-origin stock. Total brood-year return divided by the parent-year escapement is a measure of stock productivity and is expressed as recruits or return per spawner (R/S; Figure 4). The most recent brood year with a full complement of represented return age classes is 2007. Based on spawner and recruit data, R/S for Canadian-origin king salmon stock has ranged from 0.93 for the 2006 brood year to 5.19 from the brood year in 1991, with an overall average of about 2.42 R/S from 1982 through 2007 (JTC 2015; Figure 4).

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 1979–2007 indicates that there was a dramatic decrease in age-7 salmon from an average of 28% during years 1979–1982, to an of 8% average during the 10-year period immediately following (1983-1992). From 1993–2008, the age-7 age-class has composed, on average, about 5% of the return. The brood-year age-class composition for age-4 salmon has remained relatively stable from 1993 to 2001 with slight increases from 2001–2008 (Figure 7). Starting in 1990, there has been a trend of age-5 and age-6 king salmon alternately dominating the brood-year age-class composition (Figure 7). Age-5 and age-6 king salmon were equally dominant in the return from the 2001 brood year. The proportion of age-7 salmon remains low but has shown a slight increase since 2005. 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).

STOCK OF CONCERN RECOMMENDATION

Many Yukon River king salmon escapements have been met since 2011. Given that the most recent 5-year average for Alaskan harvest of 28,715 king salmon remains at approximately 20% of the historic long-term average (Table 4) despite use of specific management measures, the Yukon River king salmon stock continues to meet the criteria of a stock of yield concern. Yield has been higher than expected the last 2 years and there are multiple indicators from the marine environment and age class composition that suggest yield is expected to increase over the next several years; however, it is recommended that the designation of Yukon River king salmon as a stock of yield concern be continued until increased yield from anticipated improved returns can be substantiated. Therefore, based on the definitions provided in the SSFP in 5 AAC 39.222(f)(42), the department recommended at the 2015 BOF work session the continuation of the yield concern classification for the Yukon River king salmon stock.

OUTLOOK

Marine surveys in the northeastern Bering Sea (NBS) were initiated in 2002 by the National Oceanic and Atmospheric Administration (NOAA) and have continued in recent years in partnership with the department. NBS surveys have provided important ecological and management insights for Yukon River king salmon (Murphy et al. 2013). These surveys occur primarily in September and capture juvenile salmon using surface trawls after they experience the critical transition from freshwater to marine environments. The most recent surveys have included sampling in both August and September in order to increase our understanding of factors affecting early marine survival. Important products of these surveys include indices of juvenile Yukon River king salmon abundance and run size forecasts, which can predict adult run size up to 3 years in advance. Reliable run size forecasting tools have become critical to decision making for Yukon River fishery managers, U.S./Canada Yukon River Panel members, and other stakeholders in light of low king salmon productivity and significant harvest restriction. The recent forecasts produced from juvenile abundance estimates are among the most promising tools to date. Current projections indicate increasing abundance should be expected over the next 3 years. The 2016 projection is for a run size similar to or better than 2015, which should meet escapement objectives and provide for subsistence harvest opportunity. Run sizes in 2017 and 2018 are expected to continue to improve.

ALASKA BOARD OF FISHERIES ACTION

In response to guidelines established in the SSFP, the board continued 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 Yukon River king salmon where sufficient long-term escapement, catch, and age composition data exist to allow development of BEGs or SEGs 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 goal or determine the necessity for new escapement goals 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, an interim management escapement goal of 42,500–55,000 Canadian-origin king salmon, not listed here, was established by the U.S./Canada Yukon River Panel in 2010. Escapement targets for Canadian-origin stocks are set annually by the Yukon River Panel through bilateral agreement. The review team recommended continuing all these existing goals in Alaska without revision (Conitz et al. 2015).

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, the department recommended the continued stock of yield concern classification for Yukon River king salmon during the October 2015 board work session. After reviewing stock status information and public input during its regulatory meeting held January 12-16, 2016, 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 Use

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 the Yukon Area using updated subsistence harvest data. The board made an ANS finding of 45,500–66,704 king salmon for Yukon Area, which has remained unchanged and was reconfirmed by the board in the 2013 cycle.

Habitat Factors Affecting the Stock

Yukon River salmon stocks have generally remained healthy because of undisturbed spawning, rearing, and migration habitat throughout the drainage; however, some habitat factors are present that may adversely affect salmon production. Although the effect of these factors cannot currently be quantified, the potential individual and cumulative effects of these habitat factors should be considered when assessing the future productivity of Yukon River salmon stocks. 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 road traffic along a few 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, by 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 stream reaches, sometimes affecting spawning and rearing habitats. A thorough discussion of mining activity and salmon presence in Yukon River Area can be found in Higgs (1995). Major placer, hard rock, and coal 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, Nenana River, Totatlanika 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, due both to the higher water-quality requirements and concurrent reclamation. Today, all mining operations must comply with several standards and obtain numerous environmental permits before initiating or continuing mining activity. Commercial placer mines are permitted through the interagency Alaska Permits for Mining Application (APMA) process. There are two large hard rock mines currently permitted and in operation: Fort Knox mine near Fairbanks Creek north of Fairbanks, and Pogo Mine near the Goodpaster River northeast of Delta Junction. Some mines are located in potential acid-generating deposits for which strict wastewater controls are necessary.

Usibelli Coal Mine has operations in the Lignite (aka Hoseanna) Creek area tributary to the Nenana River, and is developing new areas in the Jumbo Dome (Marguerite Creek) and Healy Creek areas nearby. Coal mining has been regulated since 1983 by the Alaska Surface Coal Mining Control and Reclamation Act with federal oversight.

Potential natural gas or oil development (currently in exploration) 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 but represents a much smaller acreage of vegetation disturbance than natural occurrences such as wind storms or wildland fires. Wood products are generally a commodity market, so the rate and volume is dependent on regional or global markets and fuel costs. Major revisions to the Alaska Forest Resources and Practices Act (FRPA) in 1990 focused on protecting fish habitat and water quality, and statutes and regulations for riparian standards in the Interior were revised in 2003. The FRPA is jointly administered in the field by Alaska Department of Natural Resources Division of Forestry, Alaska Department of Environmental Conservation, and the department.

Flood Control and Other Dams

The Chena River Lakes Flood Control Project was built by the U.S. Army Corps of Engineers in 1973–1979 to control flood waters in downtown Fairbanks in response to the devastating 1967 flood. Some fish resource users have raised concerns about the dam's effects on emigration of salmon fry or migration of adults. During high water events every few years, the dam's gates have been lowered to divert some of the Chena River's flow to manageable levels. This diverted water impounds in the vegetated floodway immediately upstream of the dam until the high water passes and the diverted flow is allowed to continue down the Chena River. Under exceptionally high discharges, the diverted water can pass over a control sill and be discharged into the Tanana River. In some of these flood events during spring months, birds were reported feeding on salmon fry above the dam and below the dam's fish passage chutes. Effects 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 Yukon River Drainage Fisheries Association (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, Alaska Department of Fish and Game, 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. Since removal of the dam, minnow trapping found salmon fry above the former dam site in the Chatanika River, Smith Creek, and Faith Creek, indicating this area is now used as salmon rearing habitat.

Habitat Projects Needed and Areas of Habitat Concern

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. It is estimated that at least 50% of all water bodies in the Yukon watershed have not been evaluated for distribution of anadromous species and a similar or higher percentage of first and second order tributaries similarly have not been surveyed. Without such surveys, and submittal of documentation based on field work, these streams are not afforded legal protection under Alaska Statute 16.05.841 (Fishway Act) or AS 16.05.871 (Anadromous Fish Act). 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 recently constructed a bridge across the Tanana River at Salcha as the first step in the railroad extension from Fairbanks to Delta Junction. Depending on final alignment, there may be unsurveyed future stream-crossing locations that 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. The number of applications to conduct small-scale placer mining in the Interior, including within the Yukon River drainage, is largely dependent on the price of gold and on the amount of media exposure, such as "reality" TV shows. After large increases for several years, the last 1 or 2 years have shown some moderating of permit 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 continually expressed concern regarding effects to Western Alaskan salmon stocks, particularly after an estimated 130,000 king salmon were caught in 2007. The North Pacific Fishery Management Council (Council) took action in 2009 to manage king salmon bycatch under Amendment 91 by creating a hard cap on king salmon bycatch and creating a bycatch avoidance program with incentive plans. Amendment 91 went into effect during the 2011 fishing season. A marked reduction in the bycatch occurred in 2008–2014. In April 2015, the Council voted to approve regulations that would lower the bycatch cap levels for king salmon in years of historically low western Alaskan king salmon runs as indexed by the combined preliminary run sizes from the Unalakleet, Upper Yukon, and Kuskokwim River stocks. However, the regulation for this abundance-based trigger is not yet in place. Current preliminary data for 2015 estimate 18,000 king salmon have been caught through November 2015. The most recent genetic information on bycatch of Western Alaska king salmon in the Bering Sea Aleutian Islands pollock fishery, 2005–2009, is 54% (Guthrie et al. 2012). It is important to note that the genetic grouping of Western Alaska king salmon includes stocks from Bristol Bay, Kuskokwim River, Yukon River, and the Norton Sound area.

It is unclear whether federal regulations regarding customary trade that allow the sale of subsistence fish caught in waters applicable to such regulations will result in expansion of subsistence take on this stock.

Existing Regulatory Management Plans

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

5 AAC 05.362. *Yukon River Summer Chum Salmon Management Plan.*

5 AAC 74.060. *Chena and Salcha River King Salmon Sport Harvest Management Plan.*

ACTION PLAN DEVELOPMENT

YUKON RIVER KING SALMON ACTION PLAN GOAL

The action plan is intended 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 2001

In January 2001, after reviewing 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 also adopted a fishing schedule for subsistence salmon fisheries. The schedule is implemented chronologically, consistent with migratory timing as the run progresses upstream. Managers may alter the subsistence schedule by emergency order if preseason or inseason indicators suggest this change is necessary. The subsistence schedule is as follows:

> 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

Additionally, the board provided the department with emergency order authority to restrict subsistence gillnets to no greater than 6-inch mesh size for conservation of king salmon.

Regulation Changes Adopted in 2003

Managers experienced difficulty maintaining the subsistence fishing schedule in Districts 1, 2, and 3 and Subdistrict 4-A. The difficulties were due in part to subsistence and commercial fishing times being addressed in separate regulations. In March 2003, the board addressed two Agenda Change Requests (ACRs) 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 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 2004

Several proposals were submitted to the board for the 2004 meeting. The following is a summary of the adopted proposals:

1. 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.
2. The board adopted a regulation requiring gillnets greater than 4-inch mesh size to be removed from the water and requiring fish wheels to stop rotating during subsistence closures.
3. 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.
4. 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 2007

There were several proposals submitted to the board, including requests to change commercial gillnet mesh sizes and depth, commercial harvest allocations, and district boundaries. None of these proposals were adopted. The subsistence marking requirement for Districts 1–3 was changed such that from June 1 to July 15 a person may not possess king salmon taken for subsistence uses unless both tips and 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. Additionally, 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.

The board passed a proposal that allowed catch-and-release of king salmon in the sport fishery on a portion of the Goodpaster River, downstream from the department regulatory markers located approximately 25 miles upstream from the confluence with the Tanana River. King salmon may not be removed from the water and must be released immediately without further harm. Additionally, 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 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 will 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 *Yukon River 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-hour 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 be released to the water alive immediately.

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 times 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 be released to the water alive immediately. This regulatory change implemented by the board was effective only for the 2012 fishing season.

Regulation Changes Adopted in 2013

During the 2013 board cycle, numerous regulation changes were adopted pertaining to king salmon in the Yukon River. The following list is a summary of the board's actions at that meeting:

1. Require first pulse protection in the king salmon management plan regardless of preseason run forecasts. After initiating the pulse closure, the department may discontinue subsistence fishing closures if inseason run assessment indicates that escapement objectives on specific components of the run and subsistence harvest needs are likely to be met.

2. Prohibit the sale of king salmon from the Yukon River drainage if king salmon escapement goals are not going to be met or subsistence salmon fishing is restricted in more than one district or portion of a district.

3. Allow for a directed chum salmon commercial fishery in Districts 1–3 in the lower Yukon Area during times of king salmon conservation with 5.5-inch or smaller mesh size gillnets not exceeding 30 meshes in depth.

4. Align Yukon Area subsistence regulations in Districts 1–3 with current management practices by adjusting closures around commercial fishing periods and allowing concurrent subsistence and commercial fishing by emergency order.

5. District 1 boundaries redefined to include coastal waters adjacent to the south mouth of the Yukon River from Chris Point to Black River, which opens Acharon Channel to salmon fishing.

6. Establish times when a commercial gillnet permit holder in the lower Yukon Area may use dip net and beach seine gear to commercially harvest summer chum salmon during times of king salmon conservation. All king salmon caught in dip net and beach seine gear must immediately be returned to the water alive, except that a dead king salmon may be taken but may not be retained; the dead king salmon must be recorded on a fish ticket and forfeited to the state. Beach seine mesh size is not to exceed 4-inches. Dip net gear specifications are in 5 AAC 39.105.(24).

7. Provide the department with emergency order authority to restrict gear to fish wheels only, require fish wheels to be closely attended, and require the live release of king salmon in District 6 during times necessary to conserve king salmon. Additionally, fish-friendly fish wheel construction specifications were adopted (5 AAC 05.362(j)) to reduce the potential for injury that king salmon may incur while being captured and released.

Regulation Changes Adopted in 2014

Three regulatory changes were adopted by the board out of cycle at the March 2014 meeting. One of the regulations adopted was a modification to provide a larger dip net frame for noncircular dip nets in which the width-height dimensions may not exceed 6 feet by 3 feet in the lower Yukon Area commercial summer chum salmon fishery. All other existing dip net specifications remained unaltered. Also, the board adopted a proposal that allows the use of a lead during commercial fish wheel operations. The final proposal adopted by the board was the removal of the exception that allows dead king salmon to be taken but not retained in the Yukon Area Districts 1–3 dip net and beach seine commercial summer chum salmon fisheries. Adoption of this proposal closed the loophole that may allow fishermen to illegally harvest king salmon while commercial fishing and clearly ensured that all king salmon are returned immediately to the water alive.

Regulation Changes Adopted in 2015

Two ACRs were accepted and the proposals carried unanimously by the board during the March 2015 board meeting. The first proposal modified language to allow drift gillnet subsistence fishing after June 10 in the upper portion of Subdistrict 4-A for the harvest of summer chum salmon by emergency order. This modification gives the department the flexibility to allow for the efficient harvest of chum salmon when the incidental harvest of king salmon is expected to be low.

The second proposal allows fish wheel fishermen in the Yukon Area to retain king salmon while fishing for and targeting summer chum salmon when some small king salmon harvest is justified based upon inseason run assessment. Adoption of this proposal provides the department the flexibility to allow for a small incidental king salmon harvest when justified based on inseason run assessment. Both of these changes in regulations went into effect for the 2015 summer season.

Management Review

Management of the Yukon River salmon fishery is complex because of many factors, including the following: 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 and upper river Alaska fishermen, allocation and

conservation issues between Alaska and Canada, and the immense size of the drainage. Salmon fisheries within the Yukon River may harvest stocks that are several weeks and over a thousand miles from their spawning grounds. Because the Yukon River fisheries are largely mixed stock fisheries, some tributary populations may be under- or overexploited in relation to their 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, and weather are also used as indicators of relative run strength and 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. From 2002–2005, preseason management strategies were developed to shift commercial fishing to the midpoint of the king salmon run or later. This management strategy allowed the early portion of the run to pass 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.

A king salmon directed commercial fishery did not occur in 2008 and management actions were taken to protect the second and third pulses throughout the Yukon River mainstem. Less than 5,000 king salmon were incidentally harvested and sold in 2008 during chum salmon directed periods. 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 because of poor run abundance.

The 2008 season marked the start of 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 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 their 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, fishing was closed on the first pulse in mainstem districts in 2009. Additionally, subsistence fishing periods were closed in districts and subdistricts based on the migratory timing of king salmon. Summer chum salmon directed commercial fishing was delayed to decrease the incidental harvest of king salmon. Additionally, to reduce the incentive for targeting king salmon in summer chum salmon directed commercial fisheries, buyers agreed to not purchase king salmon during the first commercial opening in Districts 1 and 2. In July 2009, the board adopted an emergency regulation specifying that king salmon taken may be retained but not sold during the commercial summer chum salmon season in Districts 1–5 by emergency order. Therefore, fishermen could release live king salmon or use them for subsistence purposes.

Also effective in 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 the retention of king salmon was prohibited in the mainstem Yukon River to protect Canadian stocks. The combination of all conservation measures was effective in providing protection to king salmon and the escapement goal into Canada was achieved in 2009.

Management 2010–2012

Preseason stakeholder meetings occurred annually since 2009 and provided an instrumental platform for guiding the management of the king salmon fishery. Based on the larger king salmon preseason run size projection in 2010, strategies were developed for implementing less severe subsistence conservation measures than those implemented in 2009. Possible conservation measures included promoting voluntary reductions, encouraging a shift in harvest to other species, spreading harvest out over the entire run, reducing 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. The department recognized that fishing conditions were difficult in 2010 because periods of high water and debris coincided with king salmon pulses, probably 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 king salmon had passed. Unfortunately, even after conservative management measures, 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. Subsistence closures were similarly implemented in upriver fishing districts and subdistricts based on migratory timing.
- The Coastal District, Subdistrict 4-A, and Subdistrict 5-D 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 subsistence fishing period, subsistence fishing time was further reduced.

- Gear restrictions of 6-inch or smaller mesh size were implemented for short fishing periods 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 fish 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 management options that have been used to address this issue:

- In an effort to reduce incidental harvest of king salmon, the summer chum salmon commercial fishery in Districts 1 and 2 was delayed until the third quarter point of the king salmon run.
- The sale of incidentally caught king salmon was prohibited to reduce the monetary incentive to target king salmon during chum salmon directed commercial periods.
- 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 time king salmon were susceptible to harvest.
- Based on inseason assessment and run timing information, commercial fishing has on occasion been limited to areas or times in which the incidental harvest of king salmon was anticipated to be low. For example, District 1 commercial fishing opportunity in 2012 was confined to waters of the South Mouth of the Yukon River when test fishery indices signaled a high abundance of summer chum salmon and limited presence of king salmon at that location and time.
- 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.

Management 2013–2015

The 2013 preseason run outlook projected a poor to below-average king salmon run. Due to the decreased productivity of king salmon observed in recent years, achieving escapement goals was expected to be challenging and severe conservation measures would be necessary. Unfortunately, a preseason stakeholder meeting was not funded in 2013. A preseason plan was developed based on input from other relevant stakeholder meetings, such as Advisory Council and federal Regional Advisory Committee meetings. The plan included the following key components:

- Gillnets would be restricted to 6-inch or smaller mesh size in each district.
- Subsistence salmon fishing on the first pulse of king salmon would be closed. Based on the poor preseason forecast, subsistence closures would be extended to protect the second pulse if necessary.
- The Tanana River would be managed to meet the Chena and Salcha rivers escapement goals. The personal use fishery would be restricted to 6-inch or smaller mesh size gillnets.
- The sport fishery would be closed on the mainstem Yukon River.
- New commercial gear options (dip nets, beach seines, 5.5-inch gillnets, and fish-friendly fish wheels) would be utilized in the summer chum salmon directed commercial and subsistence fishery to reduce the incidental harvest of king salmon.

The 2013 king salmon run was weak and was unlikely to meet all escapement objectives even under conservative management actions. All 3 pulses of king salmon were protected by subsistence fishing closures as they migrated through Yukon Area Districts 1–5. Very limited subsistence fishing opportunity was provided between pulses to allow the harvest of summer chum salmon and other non-salmon species with gillnets restricted to 6-inch or smaller mesh size. Additionally, the use of gillnets was delayed until the midpoint of the king salmon run had migrated through a district. Conservation measures were also enacted in the commercial fishery to reduce the harvest of king salmon, such as utilizing new gear types that allowed for the live release of king salmon (e.g., dip nets, beach seines, and fish wheels). Sport fishing for king salmon was closed preseason in the Yukon River Drainage, excluding the Tanana River Drainage. Sport fishing restrictions were later placed on the Tanana River drainage inseason. In District 1, commercial gillnet fishing was restricted to the South Mouth of the Yukon River initially where summer chum salmon abundance was high and king salmon encounter rates were anticipated to be low. Concurrent subsistence and commercial fishing opportunity was provided to minimize the time that king salmon were exposed to fishing pressure. Even with all these conservation measures, several Alaska escapement goals and the border passage IMEG were not met in 2013.

The 2014 king salmon run was expected to be weaker than 2013, which was the worst run on record. Therefore, managers entered the summer season extremely conservatively and did not expect a harvestable surplus for subsistence fishing. Managers expected escapement goals were unlikely to be met even under severe fishing restrictions. Management actions similar to those implemented in 2013 were expected to be in place for the entire summer season (e.g., subsistence salmon fishing closures on all pulses of the king salmon run). Subsistence salmon fishing closed prior to the arrival of king salmon and remained closed on the first pulse of king salmon as required in regulation and continued through the second and third pulses. During these subsistence salmon closures, fishermen could use 4-inch or smaller mesh gillnets not exceeding 60 feet in length to target non-salmon species. Once summer chum salmon became abundant, subsistence and commercial fishing opened with dip nets and beach seines and required the live release of king salmon. In upper river districts, live-release fish wheels were utilized for subsistence salmon fishing. Once inseason assessment projects indicated that the run was larger than expected and the king salmon run was at least 90% complete in a district, subsistence fishing restrictions and closures were incrementally relaxed and subsistence fishing opportunity was provided with 6-inch or smaller mesh size gillnets to maximize summer chum salmon

harvest. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River Drainage. The 2014 season was one of the most conservatively managed king salmon seasons on record. Because of the efforts of fishermen on the river, all assessed escapement goals, including the border IMEG, were achieved in 2014.

The preseason forecast range for the 2015 king salmon season was 118,000–140,000 king salmon; the upper end of this range was similar to the run size that returned in 2014. However, given the trend in low run sizes in recent history, initial management would be based on the lower end of the preseason forecast. Managers expected that achieving escapement goals would be challenging and conservation measures would be necessary. Gillnets were restricted to 6-inch or smaller mesh size before king salmon entered a district. Once king salmon were present in a district, subsistence salmon fishing was closed. These subsistence salmon fishing closures were implemented chronologically with the upstream migration of king salmon. However, some opportunity was provided in Subdistrict 5-D with gillnets restricted to 6-inch or smaller mesh size prior to the arrival of the first pulse of king salmon. During subsistence salmon fishing closures, 4-inch or smaller mesh gillnets not exceeding 60 feet in length could be used to target non-salmon species. Once summer chum salmon became abundant, subsistence and commercial fishing opened with selective gear types such as dip nets, beach seines, and live-release fish wheels, which required the live-release of king salmon. Short subsistence gillnet openings with gear restricted to 6-inch or smaller mesh size were provided between pulses of king salmon when summer chum abundance was expected to be high. Once inseason run assessment at the sonar project near Eagle indicated that the border escapement objective would be met, subsistence fishing restrictions were relaxed. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River Drainage. Based on the passage of king salmon at the border sonar project, the 2015 king salmon came in better than expected but still below average. All king salmon escapement goals were met or exceeded in 2015.

ACTION PLAN ALTERNATIVES

No new action plans necessary; continue under current plans.

2016 ALASKA BOARD OF FISHERIES REGULATORY PROPOSALS AFFECTING YUKON RIVER KING SALMON AND SUMMER CHUM SALMON

- Proposal 107 – Close the Yukon River summer chum salmon fishery to protect king salmon.
- Proposal 108 – Reduce management triggers in the Yukon River Summer Chum Salmon Management Plan based on the run size of summer chum salmon.
- Proposal 109 – Modify management triggers in the Yukon River Summer Chum Salmon Management Plan based on a newly developed drainagewide escapement goal.
- Proposal 111 – Eliminate the use of guideline harvest ranges in the Yukon River King Salmon Management Plan.
- Proposal 112 – Allow all gear used in Yukon Area commercial fisheries to be allowed in Yukon Area subsistence fisheries.

- Proposal 113 – Prohibit the use of drift gillnets in Yukon Area subsistence and commercial fisheries.
- Proposal 114 – Require subsistence salmon fishing permits in Yukon Area District 5 and set permit limits for king salmon during times of king salmon conservation.
- Proposal 115 – Allow for the retention of king salmon less than 25 inches in length in Yukon Area fish wheel subsistence fisheries.
- Proposal 116 – During times of salmon conservation in the Yukon Area, require fish wheels with live boxes to be manned and require immediate release of the specified salmon.
- Proposals 117 – Prohibit the use of beach seines in the Yukon Area subsistence and commercial salmon fisheries (including those in the Anvik River).
- Proposal 118 – Establish specifications for a beach seine used for subsistence fishing in the Yukon Area.
- Proposal 119 – Require live release of king salmon from subsistence beach seines during times of king salmon conservation in the Yukon Area.
- Proposal 121 – Expand the area of allowable subsistence drift gillnet fishing for chum salmon in Subdistrict 4-A of the Yukon Area.
- Proposal 122 – Modify Yukon Area commercial set gillnet length specification to an aggregate length standard.
- Proposal 123 – Further define commercial beach seine specifications for summer chum salmon in the Yukon Area.
- Proposal 124 – Allow for 6-inch or smaller mesh gillnets in the commercial salmon fishery in Yukon River District 6 by emergency order.
- Proposal 125 – Establish gillnet gear provisions to allow a directed pink salmon commercial fishery in Districts 1–3 of the Yukon Area.
- Proposal 126 – Add purse seine gear as an allowable commercial salmon fishing gear to target summer chum salmon in Districts 1–3 of the Yukon River during times of king salmon conservation.
- Proposal 127 – Expand the commercial fishing area of Yukon Area District 1 from Apoon Pass to Point Romanof.
- Proposal 128 – Extend the commercial fishing area 3 miles offshore and north to Point Romanof in Yukon Area District 1.

A number of these proposals relate to conserving king salmon. Proposals 107, 113, 116, 117, 119, 124, and 126 are attempting to close fishing for king salmon with some gear types or otherwise address the incidental harvest of king salmon in the subsistence salmon fishery or summer chum salmon directed commercial fishery. Proposal 126 would allow use of purse seines to harvest summer chum salmon for commercial purposes, which would be a new gear type.

Proposal 125 would establish gillnet mesh size to target pink salmon in the lower river fishery, and Proposals 127 and 128 would increase the coastal waters open to commercial fishing in

District 1. These proposals may assist in increasing harvest of summer chum salmon and pink salmon but may also increase incidental harvest of king salmon.

Proposals 108 and 109 seek to modify the summer chum salmon management plan triggers. The department recently developed and is recommending a drainagewide escapement goal for summer chum salmon of 500,000–1,200,000. These proposals would modify the summer chum salmon management plan triggers in relation to the recommended drainagewide escapement goal.

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). 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 1997–2015, (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 the 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, and the escapement to West Fork Andreafsky is assumed to be equal to the numbers observed in East Fork Andreafsky (Clark 2001). However, because Pilot Station sonar counts are so much greater than total catch and monitored escapement, the total run estimate is primarily based upon sonar passage estimates. The total run of Yukon River summer chum averaged about 1.7 million fish during the 20-year period (1995 and 1997–2014) and has shown an 8-fold level of variation among years, from a low of about 500,000 fish in 2001 to over 3.8 million fish in 2006 (Figure 8).

The Yukon River summer chum salmon run is typically managed as a single stock. There is currently a drainagewide minimum escapement of 600,000 fish, as identified in the regulatory management plan, 5 AAC 05.362 *Yukon River Summer Chum Salmon Management Plan* (Table 5). Under the plan subsistence fishing is allowed when run size is above 600,000 fish. Because limited commercial fishing may occur when the run size is greater than 900,000 fish, escapement increases with larger run size. The department recently completed a spawner-recruit analysis for the Yukon River summer chum salmon and has developed a drainagewide escapement goal of 500,000 to 1,200,000. Based upon the recommended escapement goal, the management plan may be modified to allow subsistence fishing above 500,000 fish, and management triggers for commercial fishing and other fisheries may also be modified based upon the drainagewide escapement goal. Of note is that the large returns in 2005 and 2006 were a product of some of the lowest parent-year escapements on record in 2000 and 2001 (Figure 8).

Presently, there are 2 established tributary escapement goals for summer chum salmon in the Yukon River drainage. The BEG range for Anvik River is 350,000–700,000 summer chum salmon and the SEG range for East Fork Andreafsky River is >40,000 summer chum salmon. The BEG for Anvik River has been met or exceeded in 10 of the last 11 years, with 2009 being the exception (Figure 9). Since it was established in 2010, the SEG for the East Fork Andreafsky River was met or exceeded in all years except 2014 (Figure 10).

Stock composition of Yukon River summer chum runs has been in flux over the last decade. Contribution of the Anvik River, the largest producer of summer chum salmon, to the overall Yukon River stock production above Pilot Station sonar has decreased from approximately 46% during the years 1995–2002 to an average of 27% after 2002. This reduction corresponds with a shift to potential increased production in other chum salmon spawning streams. In 2014 and 2015, the department implemented a comprehensive radiotagging project for summer chum salmon to gain a better understanding of spawning distribution and abundance. Roughly 17% of the tagged summer chum salmon entered the Koyukuk River in 2014; however, that number increased to 26% in 2015. During both years, roughly 20% of tagged summer chum salmon entered the Anvik River and 8–9% entered the Bonasila River (Sean Larson, Fishery Biologist, Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage; personal communication).

HARVEST

Combined commercial and subsistence harvests of summer chum salmon have fluctuated from decade to decade. The average harvest was highest in the 1980s with approximately 1,200,000 summer chum salmon harvested and lowest in the 2000s with an average harvest of 143,000 summer chum salmon. The recent 5-year (2010–2014) average of summer chum salmon harvested in commercial and subsistence fisheries combined is approximately 452,000 (Figure 11). Commercial harvest of summer chum salmon averaged about 394,000 during the 1990s and 71,000 during the 2000s. The recent 5-year average (2010–2014) of 369,000 summer chum salmon is a marked increase from the 2005–2009 average of approximately 131,000 fish. Since 2007 there has been renewed market interest for summer chum salmon in Districts 1 and 2, and since 2008 in Subdistrict 4-A. Despite harvestable surpluses of summer chum salmon available, redevelopment of this fishery has been largely hindered by management strategies taken in response to poor king salmon runs that co-migrate with summer chum salmon.

Average summer chum salmon and king salmon run timing overlap considerably (Figure 12) with the middle 50% of the king salmon run overlapping with the middle 50% of the summer chum salmon run for 9 days. Due to this overlap, management of a directed summer chum salmon commercial fishery has to contend with the incidental catch of king salmon. 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 poor runs while providing harvest opportunities on the available surplus of summer chum salmon. From 2008–2012, the department delayed the opening of the summer chum salmon directed commercial gillnet fishery with 6-inch or smaller mesh size until after the midpoint of the king salmon run and periods were scheduled to occur when and where king salmon abundance was expected to be low, reducing potential for incidental harvest while using gillnets (Table 6). Although successful in providing protection to the earlier portion of king salmon run, this strategy effectively shortens the summer chum salmon fishing season, thus resulting in lost harvest opportunity. With new regulations allowing for the use of dip nets, beach seines, and live-release fish wheels to commercially harvest summer chum salmon, commercial fishing in 2013, 2014, and 2015 was initiated earlier than other years (Table 6). With increased fishing opportunity, the commercial harvest of summer chum salmon in Districts 1 and 2 averaged 387,000 fish in 2013–2015, which was more than double the average for the years 2008–2011. Although dip nets are not as efficient as gillnets for harvesting summer chum salmon, the success of the 2013–2015 commercial fisheries is largely due to use of dip net gear with harvest from dip nets accounting for 50% to 61% of the total summer chum salmon commercial harvest (Table 6). The number of king salmon caught

and released by beach seine, dip net, and fish wheel gear is reported on fish tickets. It is of note that the 2014 commercial summer chum salmon season was the largest on record since 1996 (Figure 11).

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 AND ONGOING PROJECTS

The department, federal agencies, DFO Canada, Native organizations, Yukon Delta Fisheries Development Association (YDFDA), and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River drainage, which are used by the department to manage Alaskan Yukon River salmon fisheries. Inseason run assessment includes (1) run timing and relative 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.

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, count data on resident species, and information from the recovery of tagged fish.

ABUNDANCE ESTIMATES

Pilot Station Sonar

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, complex species apportionment, technological limitations, high water, and bank erosion have been known to affect the accuracy of the estimates, particularly for king salmon. 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). The department has conducted the following investigations 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 reviewing the species apportionment model.

The lower river sonar assessment project located near Pilot Station (rm 107) has estimated passage of king salmon in 1995 and 1997–2015. 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). Although 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 (e.g., Lower Yukon test fishery CPUE) assist with inseason management strategies.

Eagle Sonar

Beginning in 2005, a sonar assessment project was established at Eagle, below the U.S./Canada border, to assess king salmon and fall chum salmon passage into the Canadian mainstem. The sonar site is ideal due to favorable river bottom morphology and because king salmon and fall chum salmon runs are clearly separated by time at this location. Additionally, ASL information from test fishing at Eagle sonar gives reasonable estimates of the age class composition of the escapement in Canada. Efforts to assess king salmon passage at Eagle have been successful and, coupled with genetic stock identification, provide a means to accurately estimate Canadian-origin king salmon in the Yukon River drainage.

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 most years, 3 pulses of king salmon sampled in the Pilot Station sonar test fishery were analyzed for stock composition inseason; results were reported within 48 hours of receipt at the Department Genetics Conservation Laboratory in Anchorage. The estimated proportion of Canadian-origin king salmon was 54% in 2013; 40% in 2014; and 49% in 2015 (these estimates are preliminary). The pulse-specific genetic information received inseason assists with management decisions. For example, using the genetic proportions from each pulse gives the department the ability to assess Canadian-origin king salmon run strength. Having this information early in the run allows managers to make informed decisions about the ability to meet escapement goals and support subsistence needs.

Knowledge of the origin of chum salmon as they enter the river assists in managing fisheries to achieve adequate escapement and deciding if commercial fisheries can be prosecuted. Estimates of stock compositions for major Yukon River summer chum salmon stock groups are provided inseason to facilitate management; they also provide the relative proportions between summer chum salmon and fall chum salmon stocks that overlap in July. From the start of the spawning run, genetic samples were collected from the Pilot Station test fishery and analyzed by United States Fish and Wildlife Service on a weekly basis using Bayesian mixture modeling as implemented in the computer program BAYES (Pella and Masuda 2001).

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, postal questionnaires, and harvest calendars (Busher et al. 2009). 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 being provided to meet subsistence needs. Additionally, subsistence harvest information is critical for run reconstruction analysis and forecasting.

REFERENCES CITED

Brase, A. L. J., and B. Baker. 2015. Fishery management report for recreational fisheries in the Tanana River management area, 2013. Alaska Department of Fish and Game, Fishery Management Report No. 15-31, 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. 2015. Fishery management report for sport fisheries in the Yukon Management Area, 2013. Alaska Department of Fish and Game, Fishery Management Report No. 15-30, 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. 2015. Escapement goal recommendations for select Arctic-Yukon-Kuskokwim Region salmon stocks, 2016. Alaska Department of Fish and Game, Fishery Manuscript No. 15-08, Anchorage.

Guthrie III, C. M., H. T. Nguyen, and J. R. Guyon. 2012. Genetic stock composition analysis of Chinook salmon bycatch samples from the 2010 Bering Sea trawl fisheries. 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, Division of Commercial Fisheries, CFSP.26, Juneau.

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.

JTC (Joint Technical Committee of the Yukon River US/Canada Panel). 2006. 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). 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). 2015. Yukon River salmon 2014 season summary and 2015 season outlook. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A15-01, Anchorage.

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.

Murphy, J., K. Howard, L. Eisner, A. Andrews, W. Templin, C. Guthrie, K. Cox, and E. Farley. 2013. Linking abundance, distribution, and size of juvenile Yukon River Chinook salmon to survival in the Northern Bering Sea. North Pacific Anadromous Fish Commission Technical Report No. 9:25–30.

REFERENCES CITED (Continued)

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

Schmidt, S. N., and E. Newland. 2012. Yukon River king salmon stock status, action plan, and summer chum salmon fishery, 2012; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publications No. 12-30, Anchorage.

Vania, T. 2000. Yukon River Chinook salmon stock status and development of management/action plan options; a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report, No. 3A00-38, 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, 1980–2015.

	Ground-based projects			Aerial surveys			
Year	Chena R. (tower and carcass)	Salcha R. (tower and carcass)	E. F. Andreafksy R. (weir)	E. F. Andreafsky R.	W. F. Andreafsky	Anvik R.	Nulato R.
1980				958	1,500	1,330	1,323 [a]
1981				2,146 [a]	231 [a]	804 [a]	791 [a]
1982				1,274	851		
1983						653 [a]	1,006
1984				1,573	1,993	641 [a]	
1985				1,617	2,248	1,051	2,780
1986	9,065 [b]		1,530 [c]	1,954	3,158	1,118	2,974
1987	6,404 [b]	4,771 [b]	2,011 [c]	1,608	3,281	1,174	1,638
1988	3,346 [b]	4,322 [b]	1,341 [c]	1,020	1,448	1,805	1,775
1989	2,730 [b]	3,294 [b]		1,399	1,089	442 [a]	
1990	5,603 [b]	10,728 [b]		2,503	1,545	2,347	998 [a]
1991	3,172 [b]	5,608 [b]		1,938	2,544	875 [a]	2,020
1992	5,580 [b]	7,862 [b]		1,030 [a]	2,052 [a]	1,536	579
1993	12,241	10,007		5,855	2,765	1,720	3,025
1994	11,877	18,399	7,801	300 [a]	213 [a]	913 [a]	1,795
1995	11,394 [b]	13,643	5,841	1,635	1,108	1,996	1,649
1996	7,153 [b]	7,570 [b]	2,955		624	839	100 [a]
1997	13,390	18,514	3,186	1,140	1,510	3,979	
1998	4,745	5,027	4,034	1,027	1,249 [a]	709 [a]	1,053
1999	6,485	9,198	3,444		870 [a]	950 [a]	
2000	4,694 [b]	4,595	1,609	1,018		1,721	
2001	9,696	13,328	1,148	1,059	565	1,420	1,884
2002	6,967 [b]	9,000 [d]	4,123 [e]	1,447	917	1,713	1,584
2003	11,100	15,500 [d]	4,336	1,116 [a]	1,578	973 [a]	
2004	9,645	15,761	8,045	2,879	1,317	3,679	1,321

-continued-

Table 1.–Page 2 of 2.

	Ground-based projects			Aerial surveys			
Year	Chena R. (tower and carcass)	Salcha R. (tower and carcass)	E. F. Andreafksy R. (weir)	E. F. Andreafsky R.	W. F. Andreafsky	Anvik R.	Nulato R.
2005		5,988	2,239	1,715	1,492	2,421	553
2006	2,936	10,679	6,463	591 [a]	824	1,886	1,292
2007	3,806	6,425	4,504	1,758	976	1,529	2,583
2008	3,208	5,415 [d]	4,242	278 [a]	262 [a]	992 [a]	922
2009	5,253	12,774	3,004	84 [a]	1,678	832	2,260
2010	2,382	6,135	2,413	537 [a]	858	974	711
2011		7,200 [d]	5,213	620	1,173	642	1,401
2012	2,220 [f]	7,165	2,517		227 [a]	722	1,374
2013	1,859 [e]	5,465	1,998	1,441	1,094	940	1,118
2014	7,192 [g]		5,949		1,695	1,584	
2015	4,067 [e]	4,558	5,474	2,167 [a]	1,356 [a]	2,616	1,564
2010–2014 Avg.[h]	3,931	6,491	3,618	1,031	1,205	972	1,151
Escapement Goals	2,800–5,700	3,300–6,500	2,100–4,900	960–1,700	640–1,600	1,100–1,700	940–1,900

Note: Blank cells indicate no data available.

[a] Incomplete, poor timing, and/or poor survey conditions resulting in minimal or inaccurate counts.

[b] Mark–recapture population estimates.

[c] Based on tower count.

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

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

[f] Estimate includes an expansion for missed counting days based on using two DIDSON sonars to assess king salmon passage.

[g] Due to high water, DIDSON sonar was used and preliminary species apportionment was estimated using average run timing.

[h] Years with incomplete counts are excluded from the average.

Table 2.–Historical king salmon average escapement age and average female composition on the Chena and Salcha rivers.

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	37.2	41.4	5.4	0.0	36.4
2010–2014							
	Average age composition (%)						Average
	3	4	5	6	7	8	female (%)
Chena River	0.8	17.5	52.2	28.6	0.9	0.0	27.0
Salcha River	0.8	15.7	41.9	40.1	1.5	0.0	37.2

Table 3.–Total Canadian harvest and escapement of Yukon River king salmon, 1980–2015.

	Mainstem Yukon					Porcupine River	Total	Total Canadian mainstem	
	Non-commercial								
Year	Domestic	Aboriginal	Sport	Commercial	Total	Old Crow Aboriginal	Canadian harvest	Border passage	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	60,346	43,538
1983	400	5,025	300	13,027	18,752	200	18,952	63,227	44,475
1984	260	5,850	300	9,885	16,295	500	16,795	66,300	50,005
1985	478	5,800	300	12,573	19,151	150	19,301	59,586	40,435
1986	342	8,625	300	10,797	20,064	300	20,364	61,489	41,425
1987	330	6,069	300	10,864	17,563	51	17,614	58,870	41,307
1988	282	7,178	650	13,217	21,327	100	21,427	61,026	39,699
1989	400	6,930	300	9,789	17,419	525	17,944	77,718	60,299
1990	247	7,109	300	11,324	18,980	247	19,227	78,192	59,212
1991	227	9,011	300	10,906	20,444	163	20,607	63,172	42,728
1992	277	6,349	300	10,877	17,803	100	17,903	56,958	39,155
1993	243	5,576	300	10,350	16,469	142	16,611	52,713	36,244
1994	373	8,069	300	12,028	20,770	428	21,198	77,219	56,449
1995	300	7,942	700	11,146	20,088	796	20,884	70,761	50,673
1996	141	8,451	790	10,164	19,546	66	19,612	93,606	74,060
1997	288	8,888	1,230	5,311	15,717	811	16,528	69,538	53,821
1998	24	5,424 [a]	–	390	5,838	99	5,937	41,335	35,497
1999	213	8,804	177	3,160	12,354	114	12,468	49,538	37,184
2000	–	4,829 [a]	–	–	4,829	50	4,879	30,699	25,870
2001	89	8,188 [a]	146	1,351	9,774	370	10,144	62,338	52,564
2002	59	8,174 [a]	128	708	9,069	188	9,257	51,428	42,359
2003	115	6,384 [a]	275	2,672	9,446	173	9,619	90,040	80,594
2004	88	6,650 [a]	423	3,785	10,946	292	11,238	59,415	48,469
2005	99	6,376	436	4,066	10,977	394	11,371	78,962	67,985
2006	63	5,757	606	2,332	8,758	314	9,072	71,388	62,630
2007	–	4,792 [a]	2	–	4,794	300	5,094	39,698	34,904
2008	–	3,398 [a]	–	1	3,399	314	3,713	37,282	33,883
2009	17	3,791	125	364	4,297	461	4,758	69,575	65,278
2010	–	2,455	1 [b]	–	2,456	250	2,706	34,465	32,009
2011	–	4,550	40	4 [c]	4,594	290	4,884	50,901	46,307
2012	–	2,000	–	–	2,000	200	2,200	34,656	32,656
2013	18	1,902	–	2 [c]	1,922	242	2,164	30,591	28,669
2014	19	100	–	–	119	3	122	63,450	63,331
2015 [d]	–	1,000	–	–	1,000	204	1,204	83,615	82,615
2010–2014 Avg.	19	2,201	21	3	2,218	197	2,415	42,813	40,594
1989–1998 Avg.	252	7,375	502	9,229	17,307	338	17,645	68,121	50,814

Note: Blank cells indicate no data available. En dash (–) indicates fishery closure.

[a] Includes fish from DFO test fish operations.

[b] Fishery was closed; 1 fish was mistakenly caught and retained.

[c] Closed during king salmon season, harvested in fall chum fishery.

[d] Data are preliminary.

Table 4.–Alaskan harvest of Yukon River king salmon, 1980–2014.

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	1,063	157,632
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	3,230	141,006
1997	57,117	112,841	769	313	2,811	2,174	176,025
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	277	45,871
2001	55,819	0	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	458	86,330
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**	82 [g]	0	89	0	474	41,625
2012	**30,415**	0 [g]	0	71	0	345	30,831
2013	**12,533**	0 [g]	0	42	0	166	12,741
2014	**3,286**	0 [g]	0	1	0	0	3,287
2015	[h]	0 [g]	0	0	0	0	
2010–2014 Avg.	26,355	1,996	0	73	0	292	28,715
2005–2014 Avg.	36,794	12,643	0	98	196	489	50,220
1989–1998 Avg.	51,625	100,011	760	692	1,578	1,537	156,127

Note: Blank cells indicate data are not available. Bold cells indicate years when Amount Necessary for Subsistence (ANS) was not achieved. The ANS range for king salmon on the Yukon River is 45,500 to 66,704.

[a] Includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay, from test fish giveaways, 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. These data are only available since 1990.

[c] Prior to 1987, and in 1991, 1992, and 1994, personal use was considered part of subsistence.

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

[e] Sport fish harvest for the Alaskan portion of the Yukon River drainage. Most of this harvest is taken within the Tanana River drainage (see Brase and Baker 2015; Burr 2015).

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

[g] Sale of king salmon was prohibited, except during fall season in 2009 and 2011.

[h] Data are not yet available.

Table 5.–Current Yukon River summer chum salmon management plan overview.

	Recommended management actions				Targeted drainagewide
Projected run size [a]	Subsistence	Commercial	Personal use	Sport	escapement
600,000 or less	Closure [b]	Closure	Closure	Closure	>600,000
600,001 to 700,000	Possible restrictions [b]	Closure	Closure	Closure	
700,001 to 1,000,000	Normal fishing schedule	Restrictions [b]	Restrictions [b]	Restrictions [b]	
900,001 to 1,000,000	Normal fishing schedule	0-50,000	Open	Open	
Greater than 1,000,000	Normal fishing schedule	Open [c]	Open	Open	>1,000,000[d]

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

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

[c] The department may open a drainagewide 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 6.–Salmon commercial harvests in summer chum-directed commercial fishing periods in Districts 1 and 2, Yukon River, 2008–2015.

				Districts 1 and 2 combined					
					Incidental king salmon [a]				
Year	Date of first commercial	Gear	Proportion of king salmon passage [b]	Number of periods	Sales	Caught but not sold	Caught and released	Summer chum salmon sales	Proportion of commercial harvest
2008	2-Jul	6.0" gillnet	0.87	11	4,348	0	0	125,598	1.00
2009 [c]	29-Jun	6.0" gillnet	0.81	13	131	3,540	0	157,906	1.00
2010	28-Jun	6.0" gillnet	0.72	15	9,897	1,810	0	183,215	1.00
2011 [c]	24-Jun	6.0" gillnet	0.62	20	82	4,090	0	266,510	1.00
2012 [c]	29-Jun	6.0" gillnet	0.42	16	0	2,421	0	207,849	1.00
2013 [c]	18-Jun	dip net	0.06	32	0	[d]	908	188,488	0.50
	18-Jun	beach seine	0.06	32	0	[d]	19	720	0.002
	2-Jul	[e,f] 5.5", 30 mesh gillnet	0.84	6	0	88	0	74,452	0.20
	8-Jul	6.0" gillnet	0.93	10	0	351	0	115,483	0.30
			SEASON TOTAL		*0*	*439*	*927*	*379,143*	
2014 [c]	9-Jun	dip net	0.14	44	0	[d]	5,268	259,771	0.61
	9-Jun	beach seine	0.14	44	0	[d]	172	13,078	0.03
	3-Jul	6.0" gillnet	0.99	12	0	440	0	154,498	0.36
			SEASON TOTAL		*0*	*440*	*5,440*	*427,347*	
2015 [c]	11-Jun	dip net	0.18	39	0	[d]	8,657	217,654	0.61
	11-Jun	beach seine	0.18	39	0	[d]	850	9,560	0.03
	2-Jul	[e] 5.5", 30 mesh gillnet	0.89	3	0	874	0	34,153	0.10
	6-Jul	6.0" gillnet	0.97	12	0	2,415	6	92,719	0.26
			SEASON TOTAL		*0*	*3,289*	*9,513*	*354,086*	

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

[b] The proportion of king salmon run passed at time of first commercial is based on the Lower Yukon fishery CPUE information.

[c] The sale of incidentally caught king salmon was prohibited during portions or all of the summer season.

[d] Regulations do not allow for retention of king salmon from this gear type.

[e] Implemented in District 1 only.

[f] First 5 commercial periods restricted to South Mouth only.

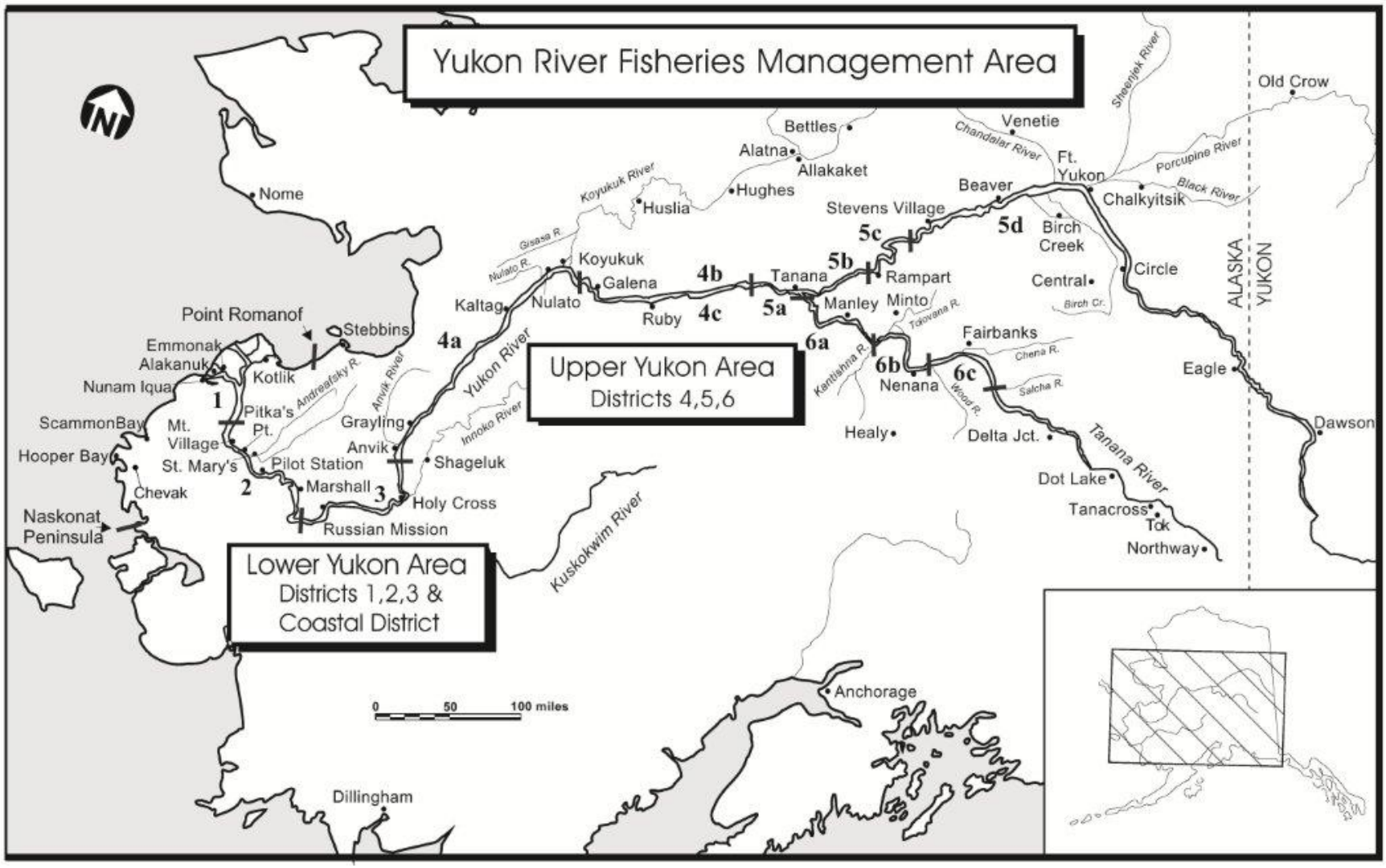
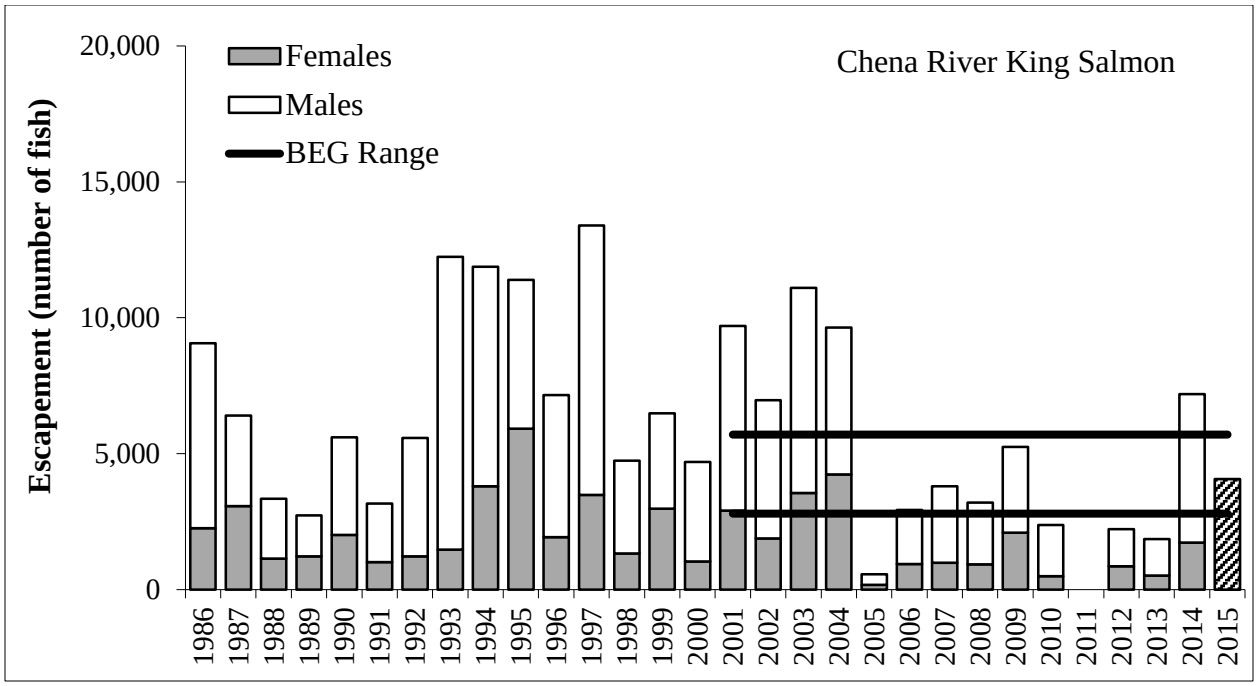


Figure 1.–Alaska portion of the Yukon River drainage showing communities and fishing districts.



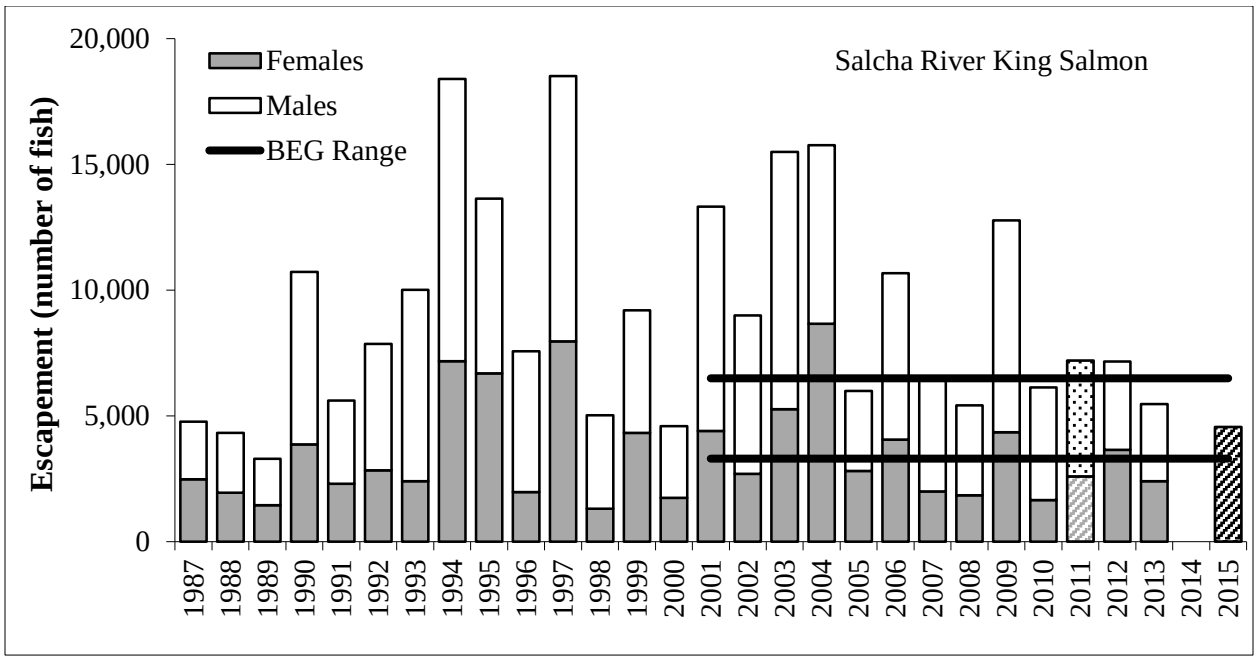


Figure 2.–King salmon escapement by year and sex observed in Chena (top) and Salcha (bottom) rivers, Alaska, 1986–2015.

Note: Sex data are not yet available for 2015. Escapement estimates for 2015 are preliminary. The 2015 estimate for Salcha River is considered a minimum estimate due to missed days caused by poor water conditions. The BEG range for Chena River is 2,800 to 5,700 and for the Salcha River is 3,300 to 6,500. Chena and Salcha River towers did not operate in 2011 and 2014, respectively, due to high water conditions. An aerial survey was conducted in 2011 on the Salcha River to provide escapement estimates.

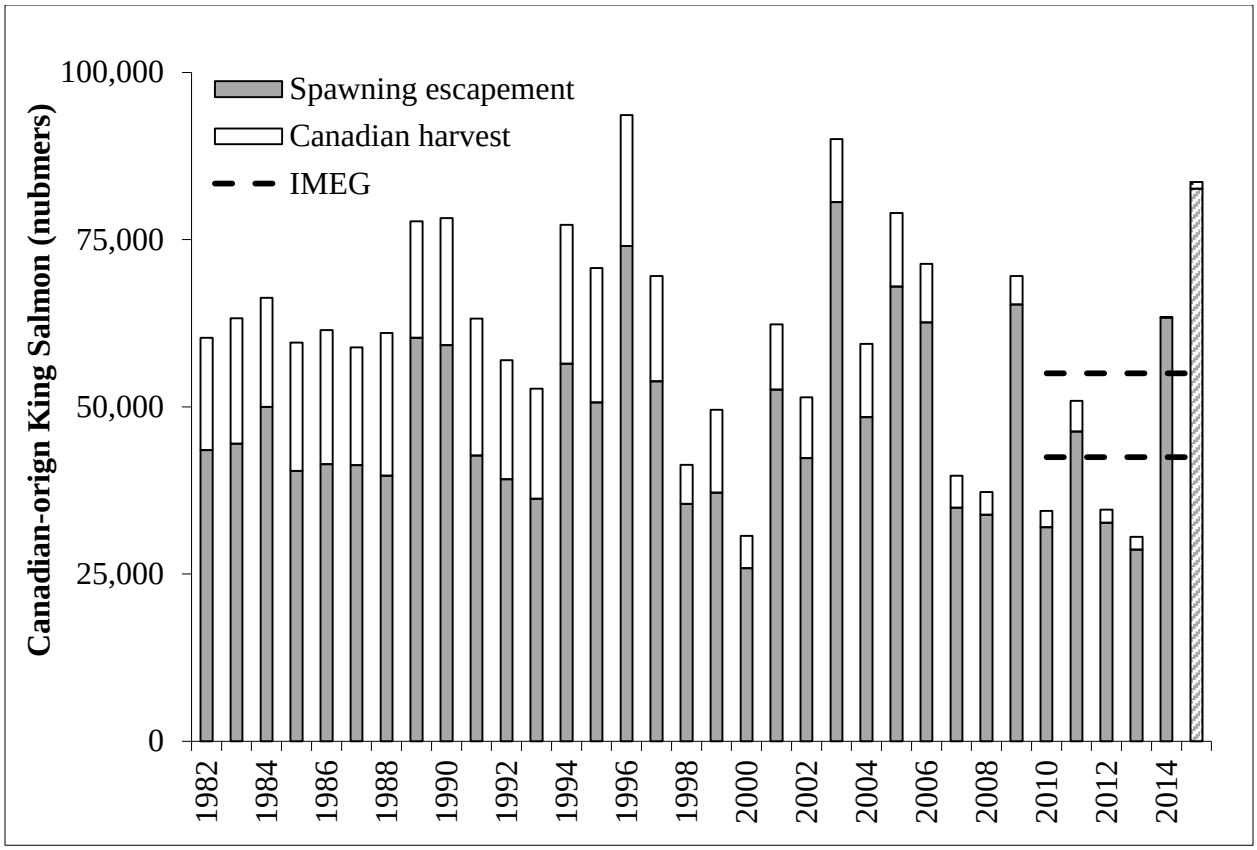


Figure 3.–Eagle sonar-based border passage estimates of Yukon River king salmon passing into Canada broken down by Canadian harvest and escapement, mainstem Yukon River, Canada, 1982–2015.

Note: Estimates are based on a 3-area escapement index (1982–2001), Eagle Sonar (2005–2015), and radiotelemetry (2002–2004) data. Canadian escapement and harvest data are considered preliminary for 2015.

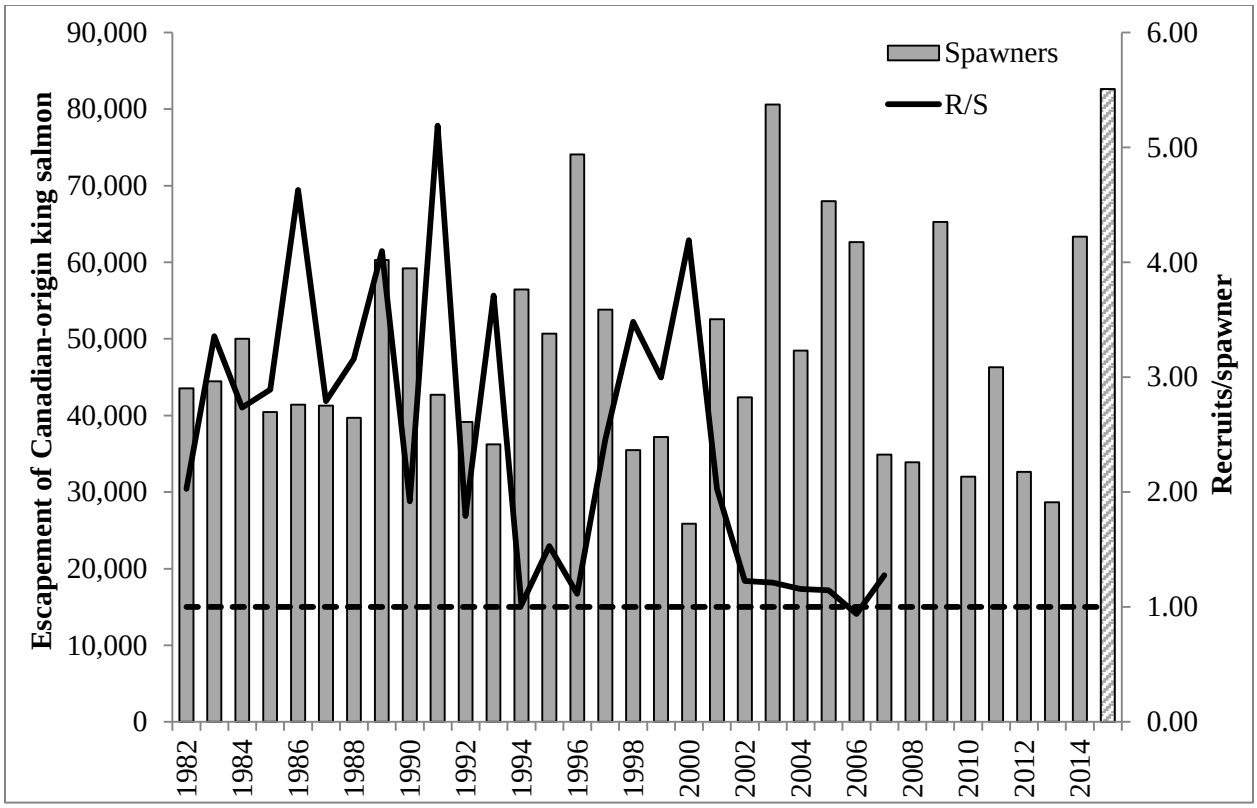


Figure 4.–Total escapement estimates for Canadian-origin king salmon (1982–2014) and the resulting productivity (R/S) from each complete brood year (1982–2007).

Note: The dashed line indicates the replacement line of 1. Escapement data for 2015 are considered preliminary.

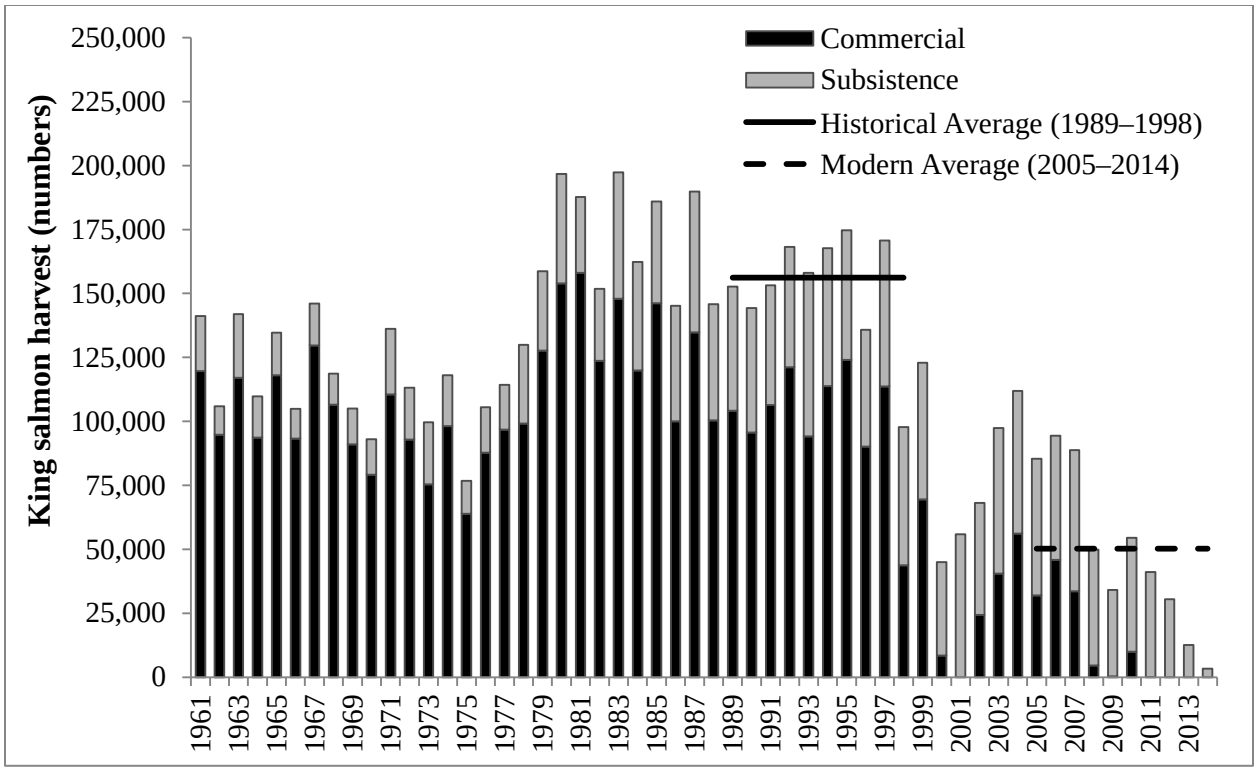


Figure 5.–Yukon River king salmon subsistence and commercial harvests compared to the historical baseline 1989–1998 average (156,191) and the recent 2005–2014 average (50,224).

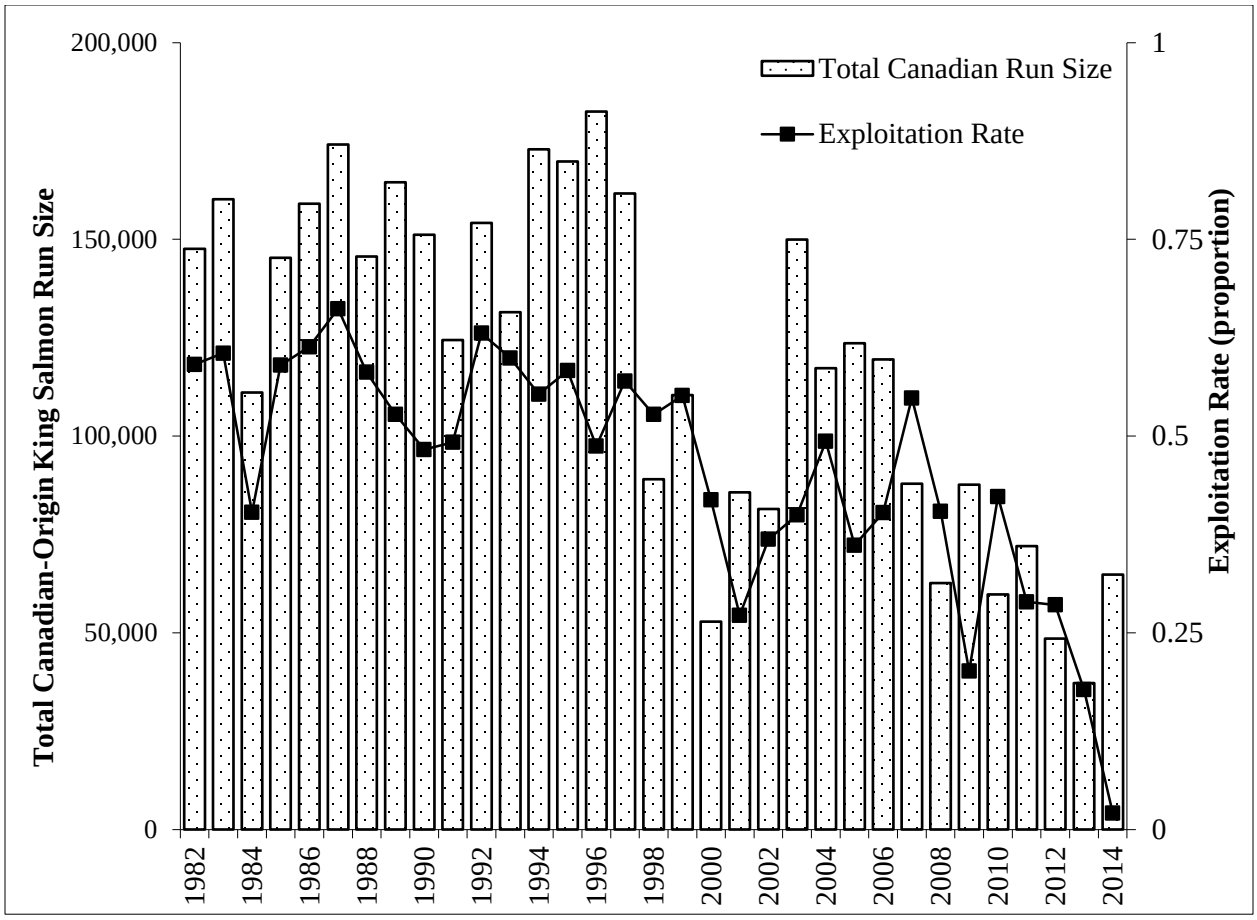


Figure 6.–Annual Yukon River Canadian-origin king salmon run estimates and associated U.S. exploitation rates, 1982–2014.

Note: Estimates prior to 2002 are based on a 3-area escapement index, Eagle Sonar (2005–2014), and radio telemetry (2002–2004) data. A total run size estimate is not yet available for 2015.

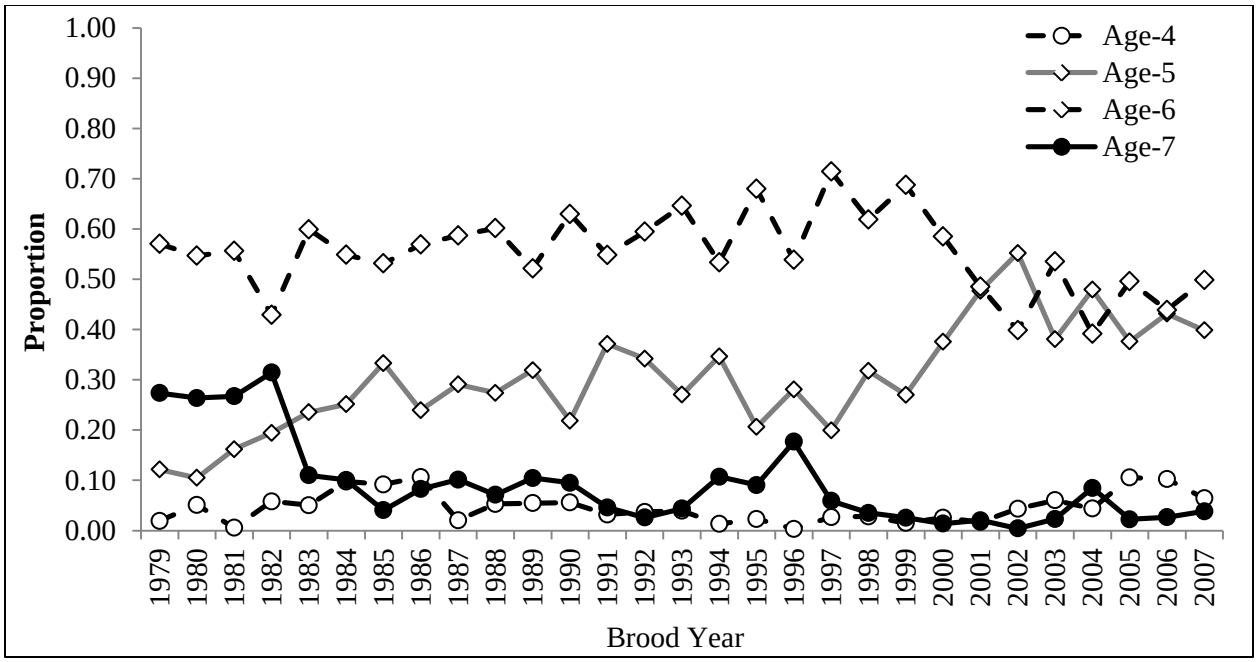


Figure 7.–Brood year return age class composition of Yukon River Canadian-origin king salmon 1979–2007.

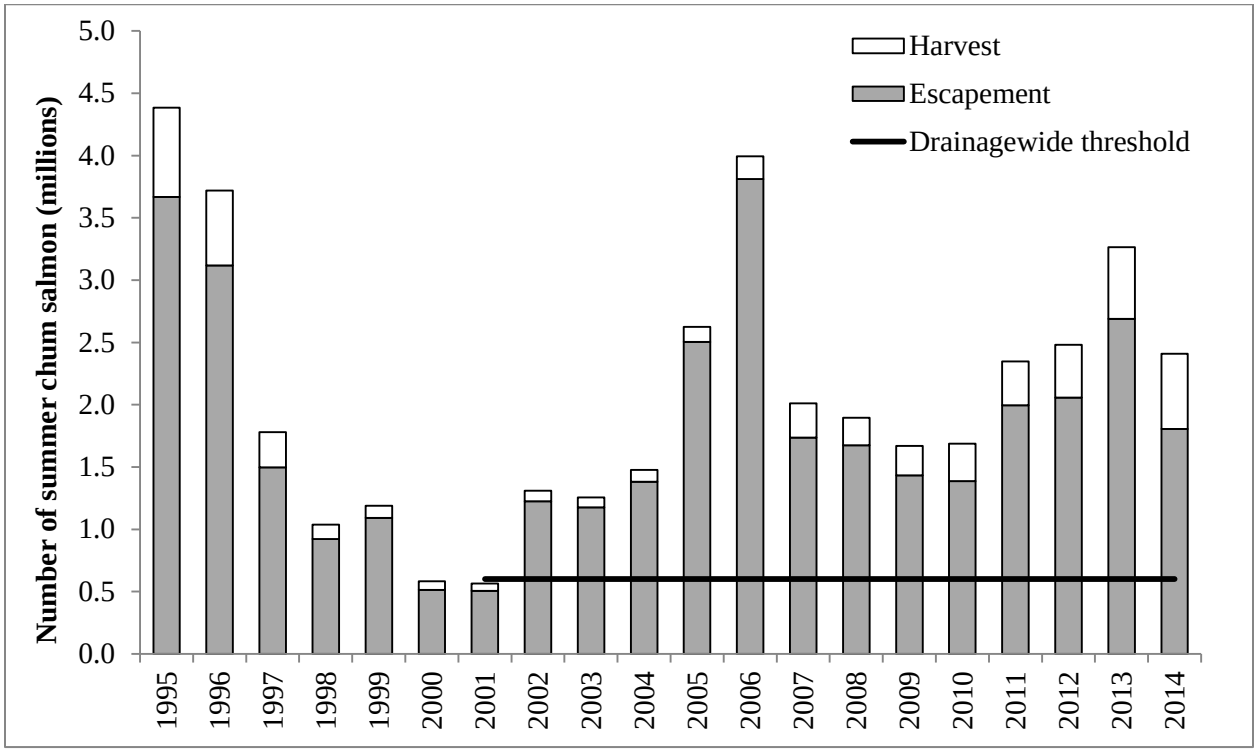


Figure 8.–Approximate total run size of Yukon River summer chum salmon, by harvest and escapement, compared to the drainagewide threshold of 600,000 fish, 1995–2014.

Note: The 2015 data are not yet available.

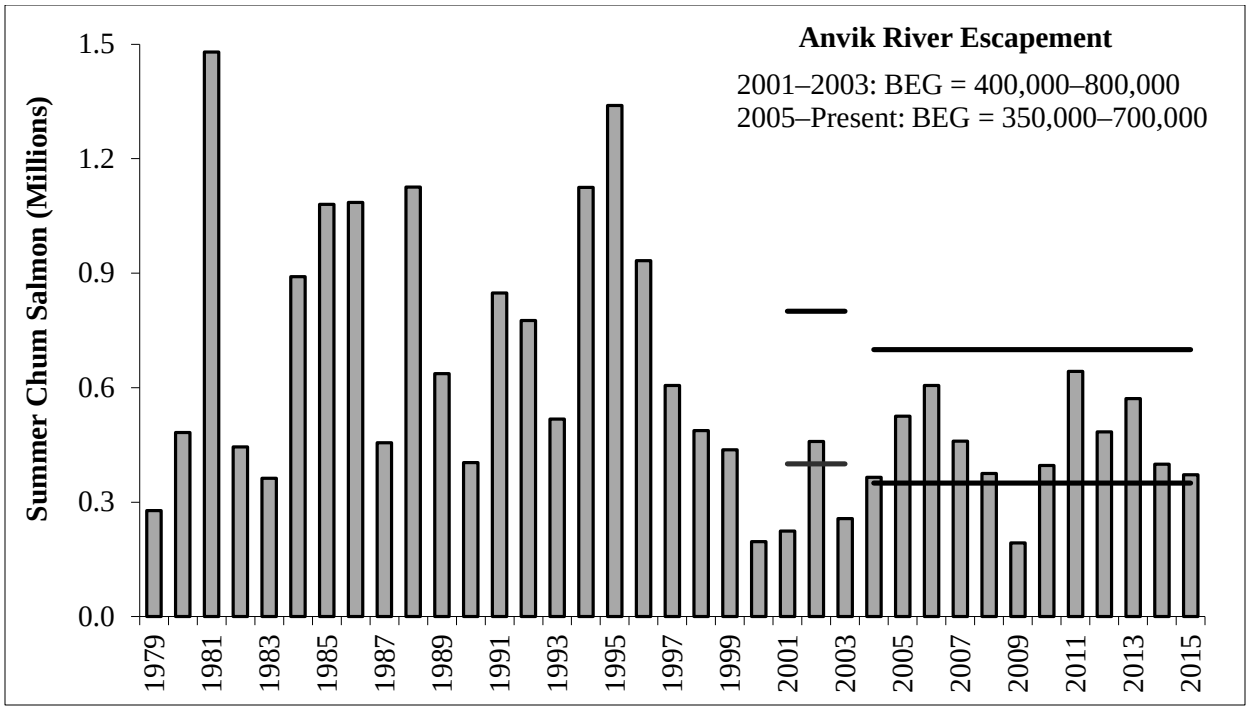


Figure 9.–Summer chum salmon escapement estimates and escapement goals for Anvik River, 1979–2015.

Note: 2015 escapement estimate is preliminary.

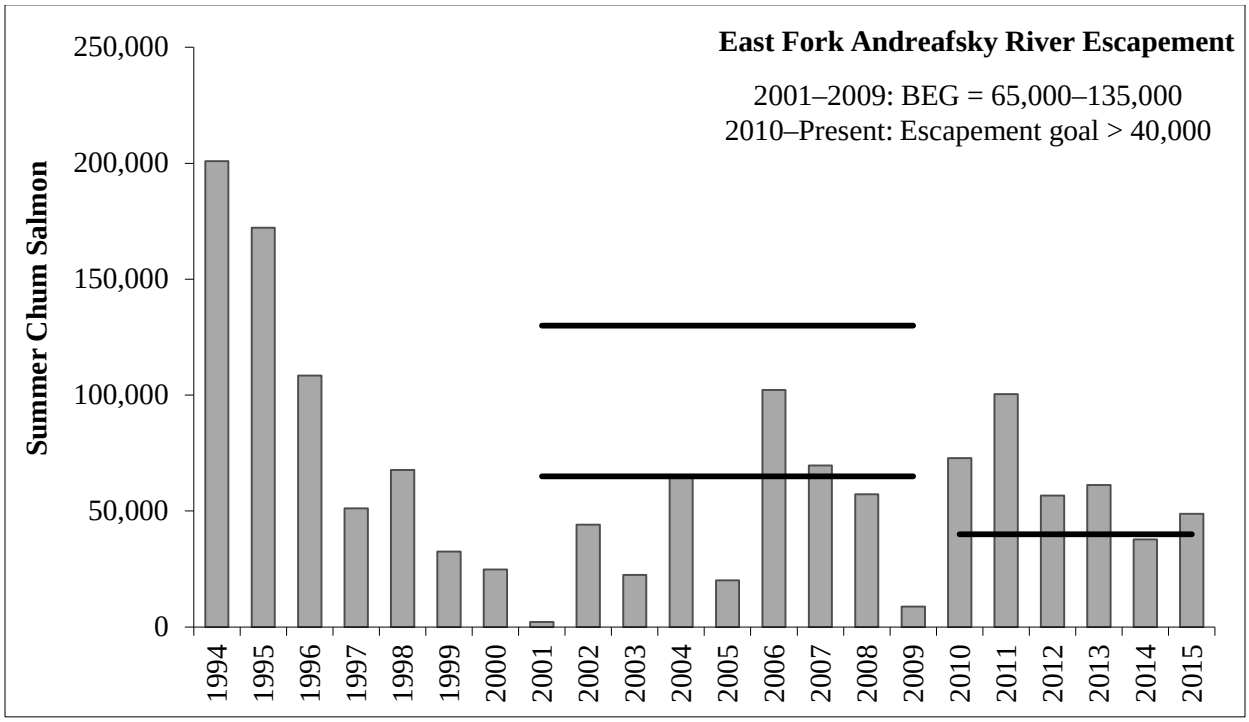


Figure 10.–Summer chum salmon escapement estimates and escapement goals for East Fork Andreafsky River weir 1994–2015.

Note: 2015 escapement estimate is preliminary.

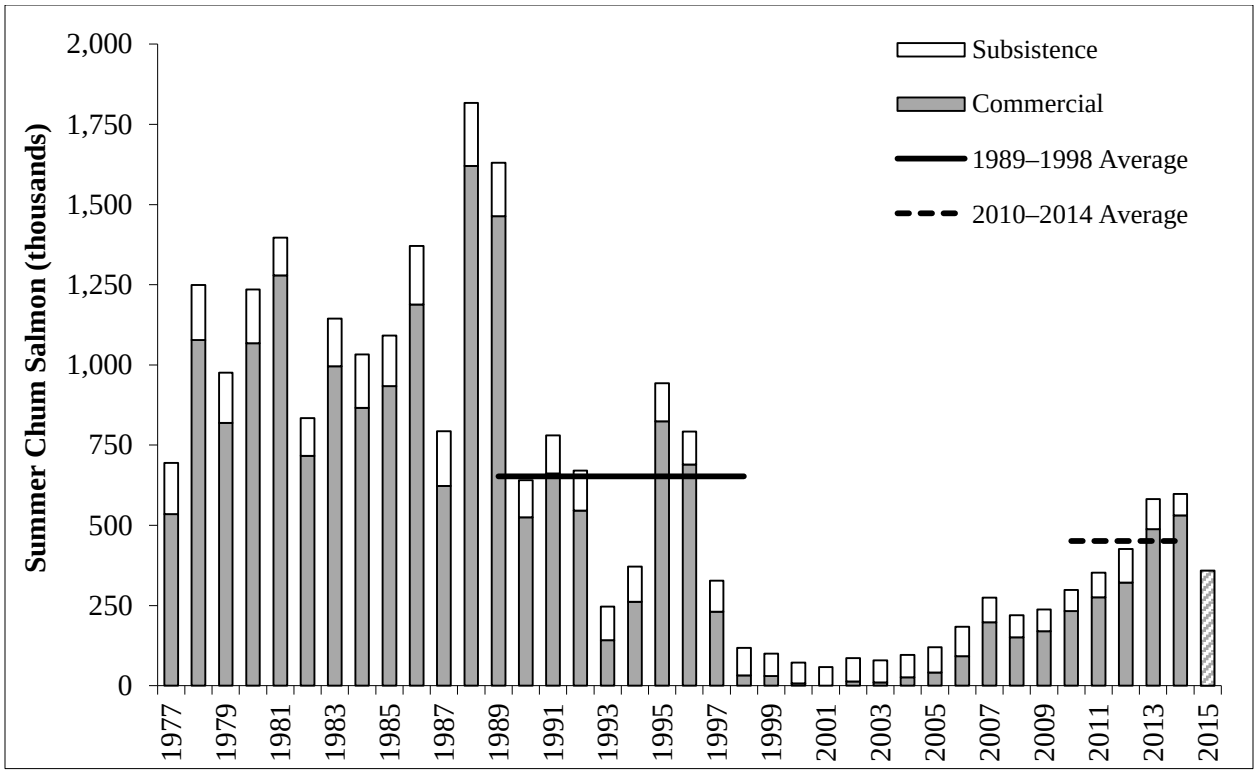


Figure 11.–Yukon River summer chum salmon subsistence and commercial harvests from 1977 to 2014, compared to the combined subsistence and commercial harvest 1989–1998 average (652,000 fish) and the combined 2010–2014 average (452,000 fish).

Note: Subsistence data for 2015 are not yet available.

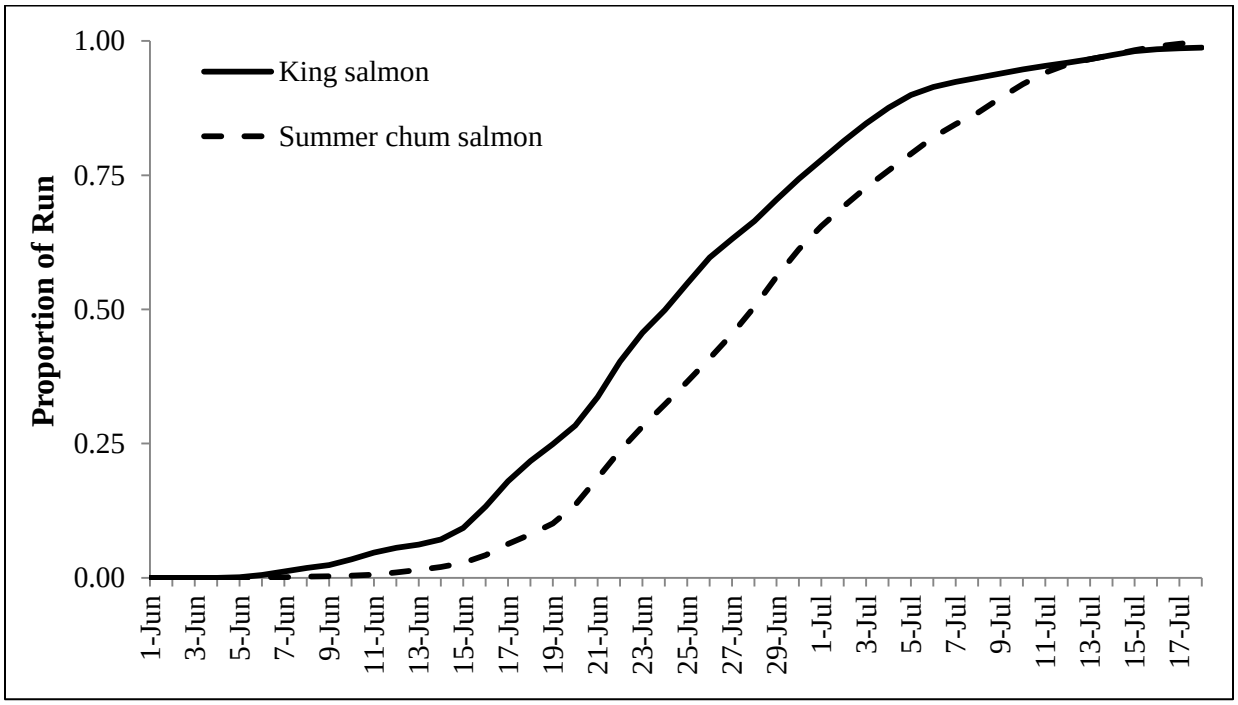


Figure 12.–Average cumulative proportion of the run past the sonar near Pilot Station for king salmon (1995, 1997, 2000, 2002–2008, 2009–2015) and summer chum salmon (1995, 1997–2000, 2002–2015).