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Yukon River Chinook Salmon Stock Status and Action Plan 2010; a Report to the Alaska Board of Fisheries

by

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and

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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)

Measures (fisheries)

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

Mathematics, statistics

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

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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.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone editorial and peer review.

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ABSTRACT

In response to the guidelines established in the *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222), the Alaska Board of Fisheries (BOF) classified the Yukon River Chinook 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 (ADF&G) and acted upon by the BOF in January 2001. The stock of concern status for a yield concern was continued at the January 2004 and 2007 BOF meetings. The SSFP directs ADF&G to assess salmon stocks in areas addressed during the BOF regulatory cycle to identify stocks of concern and in the case of Yukon River Chinook salmon, to reassess the stock of concern status. Assessment of the stock includes an evaluation of escapement performance, expected yields, and harvestable surpluses. Chinook salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage the past 5 years (2005–2009). Inseason management actions have contributed to success in achieving escapement goals. However, combined commercial and subsistence harvests show a substantial decrease in Chinook salmon yield from the 10-year period (1989–1998) to the recent 5-year (2004–2008) average. Although annual subsistence harvest remained stable near 50,000 Chinook salmon through 2007, commercial harvests have decreased over 66% in recent years (2005–2009) relative to historic (1989–1998) harvests. While Chinook salmon run size increased in 2005 and 2006, lower returns have occurred since that time, primarily for Canadian-origin stocks, despite continued conservative management strategies. Based on guidelines established in the SSFP (5 AAC 39.222), ADF&G recommends continued classification of Yukon River Chinook salmon as a stock of yield concern.

Key words: Yukon River, Chinook salmon, *Oncorhynchus tshawytscha*, stock of concern, commercial, fishing, ADF&G, 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 (ADF&G) to provide the Alaska Board of Fisheries (BOF) 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 BOF meetings. This report provides ADF&G's reassessment of Yukon River Chinook salmon *Oncorhynchus tshawytscha*, which has been classified as a yield concern.

In response to guidelines established in the SSFP (5 AAC 39.222(f)(42)), the BOF classified Yukon River Chinook salmon as a yield concern at its September 2000 work session. A stock of yield concern is defined as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs; a yield concern is less severe than a management concern" (5 AAC 39.222(f)(42)). The SSFP defines chronic inability as "the continuing or anticipated inability to meet expected yields over a 4 to 5 year period". This determination as a yield concern was originally based on low harvest levels for the previous 3-year period (1998–2000) and anticipated low harvest in 2001. An action plan was subsequently developed by ADF&G (SSFP; 5 AAC 39.222(d)(4)) and acted upon by the BOF in January 2001. The classification as a yield concern was continued at the January 2004 and January 2007 BOF meetings (Lingnau and Bergstrom 2004, Hayes et al. 2006). Based on definitions provided in SSFP (5 AAC 39.222(f) (5, 42)), only the most recent 5-year escapements and yield estimates (2005–2009), and historical levels of yield or harvestable surpluses (harvests during the 10-year period from 1989 through 1998 were used as the historical basis for comparison) were considered in the current analysis and subsequent recommendations concerning stock of concern status. While 2009 escapement and commercial harvest data are available, subsistence harvest data from 2009 are not yet available. Subsistence harvest estimates for 2009 are expected to be far below the typical average harvest of approximately 50,000 Chinook salmon, reflecting the unprecedented management restrictions in place during the 2009 season.

Based on definitions provided in SSFP (5 AAC 39.222(f)(42)), ADF&G recommended Yukon River Chinook salmon continue as a stock of yield concern at the October 2009 BOF work session. From 2005 to 2009, low yields of Chinook salmon have continued in Yukon River.

STOCK ASSESSMENT BACKGROUND

Escapement

Chinook salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage during the past 5 years 2005–2009 (Table 1). These include two biological escapement goals (BEGs) and five sustainable escapement goals (SEGs) established by ADF&G for U.S. tributaries. Tributary escapements have been monitored with counting tower projects in Chena and Salcha rivers and with aerial surveys in the Andreafsky, Anvik, Gisasa, and Nulato rivers (Figure 1). BEGs in Chena and Salcha rivers have been met or exceeded since 2005, although high water prevented accurate counts and escapement assessment in 2005 for Chena River and in 2008 for Salcha River (Figure 2). Chena and Salcha rivers are the major Chinook salmon producing tributaries within the Alaska portion of the Yukon River drainage. Assessment of aerial survey SEGs is more difficult due to incomplete or missing data over consecutives years. Of the escapement observations for those stocks indexed by aerial surveys, SEGs in East and West Fork Andreafsky River and Gisasa River have been met or exceeded in all years successfully surveyed since 2005. The Nulato River SEG was met in all years but 2005. The Anvik River SEG was not met in 2009 (Table 1).

Carcass surveys were conducted on Chena and Salcha rivers annually to collect age, sex, and length (ASL) data. Raw sex and age composition data from both rivers were adjusted to account for biases associated with carcass surveys (Zhou 2002; Matt Evenson, ADF&G Division of Sport Fish, Fairbanks; personal communication). Data for 2009 are not presented here as these are preliminary and have not yet been adjusted. During the historical baseline period (1989–1998) and the recent 5-year period (2004–2008), average age and sex composition were very similar between rivers and among time periods. Average contribution of age-6 salmon ranged from 38% to 49%, while age-5 salmon ranged from 37% to 42%. Average contribution of age-4 salmon ranged from 12% to 20%, while age-7 salmon ranged from 2% to 5%. Percent female ranged from 31% in the Chena River during the 1989–1998 period to 41% in the Salcha River during the more recent period, 2004–2008. For both rivers, the lower end of the established escapement goal was frequently achieved by female Chinook salmon alone (Figure 2).

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

	1989–1998						
	Average Age Composition (%)						Average
	3	4	5	6	7	8	Female (%)
Chena River	0.7	19.6	36.8	37.5	5.4	0.1	31.3
Salcha River	1.0	15.0	37.2	41.4	5.4	0.0	37.3
	2004–2008						
	Average Age Composition (%)						Average
	3	4	5	6	7	8	Female (%)
Chena River	2.7	11.6	41.8	41.0	2.8	0.0	32.6
Salcha River	0.2	12.5	37.0	49.0	1.5	0.0	41.1

For Yukon River escapement at the Canadian border, a rebuilding step escapement target of 28,000 Chinook salmon, estimated by mark–recapture with fish wheels operated by the Department of Fisheries and Oceans Canada (DFO), agreed to and adopted by the Yukon River Panel, had been exceeded in 2005. In 2006, escapement fell short of the goal of 28,000 Chinook salmon by approximately 10 fish. The escapement goal reverted to the one previously established in the U.S./Canada Yukon River Salmon Agreement as 33,000-43,000 fish for the 2007 season, also estimated with DFO fish wheels; this goal was not met in 2007. For 2008 and 2009, an interim management escapement goal (IMEG) of >45,000 Chinook salmon, estimated using a sonar program at Eagle, Alaska, was established.[1] This sonar-based escapement goal was not met in 2008, but was attained in 2009 (Table 2; Figure 3).

Poor runs observed in 2007–2009 do not appear to be related to poor escapements. Parent year escapements in 2001–2004 were mostly above average and nearly all escapement goals were met.

Harvest

Fishing restrictions necessary during poor runs have caused a dramatic decline in commercial harvests since 1998 and decreased subsistence harvests in 2008 and 2009. Chinook salmon commercial harvests show a substantial decrease in average yield from the 10-year historical period (1989–1998) of approximately 100,700 fish compared to the recent 5-year (2005–2009) average of approximately 23,000 (Table 3; Figure 4). The 2005 and 2006 commercial harvests were 32,000 and 46,000 Chinook salmon, respectively, although there was some foregone harvest based upon Eagle sonar estimates. The outlook for 2007 suggested a run that would provide surplus for commercial fishing and approximately 33,000 Chinook salmon were harvested. The 2007 run, however, did not materialize as projected and the Canadian border escapement goal was not met. The Chinook salmon run in 2008 was particularly poor, so no directed commercial fishery occurred. Less than 5,000 fish were incidentally harvested during chum salmon-directed periods. No Chinook salmon-directed commercial fishery occurred in 2009 and the sale of incidentally caught Chinook salmon was prohibited until July 16, to further reduce exploitation. Approximately 130 Chinook salmon were incidentally caught and sold in the summer chum salmon commercial fishery on July 16. Approximately 3,500 Chinook salmon were reported as caught, but not sold (utilized for subsistence needs), during this fishery.

During the most recent 5-year period for which subsistence harvest data are available, 2004–2008, harvests were within the amounts necessary for subsistence (ANS, 45,500–66,704) range 4 of 5 years (Table 3). Prior to 2008, annual subsistence harvest had remained relatively stable near 50,000 Chinook salmon. Reduced fishing periods were implemented for the subsistence fishery throughout the drainage in 2008. The resulting harvest of approximately 45,300 Chinook salmon was only slightly below the ANS range (Busher et al 2009). Despite these efforts, the 2008 escapement goal for Canada-bound Chinook salmon was not met. Even greater restrictions were implemented in 2009. Subsistence fishing time on the mainstem was approximately half the regularly scheduled fishing time and subsistence fishing was closed for 1 full week to protect the first pulse of Chinook salmon throughout the Alaskan portion of the mainstem.

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[1] Evidence suggests that DFO fish wheels tended to underestimate passage of Chinook salmon into Canada. Therefore, adoption of Eagle sonar as a more reliable method to estimate this number has dramatically improved estimates of escapement, exploitation rates, and brood year return information. Historical escapement goals were based on DFO fish wheels and are not directly comparable to present sonar-based escapement goals. Conversion factors have been developed to allow comparisons of escapement, exploitation rates, and brood year return information to historical data, though this should be cautiously considered. In this report, Eagle sonar-based data (2005-2009) are emphasized because they are deemed most accurate.

In summary, the average yield for the years 2005 through 2009 is substantially less than the 1989–1998 average yield. No directed commercial fishery occurred in 2008 and 2009. Subsistence fishing restrictions were also implemented in 2008 and 2009. Subsistence harvest data are not yet available for 2009; however, due to the conservative management regime employed, it is expected that the 2009 subsistence harvest was less than that observed in previous years and likely below ANS.

Exploitation Rates

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

Border passage into Canada has been estimated from 1982 to 2008 by DFO using mark–recapture techniques, and more recently, by ADF&G using radiotelemetry (2002–2004) and sonar (2005–2009). DFO border passage estimates were derived from mark–recapture estimates using two fish wheels near the border at river mile (rm) 1,224. This border passage estimate formed the basis for the escapement goal in the US/Canada Yukon River Salmon Agreement. Information from a number of sources suggested that the border passage estimates derived from the DFO Chinook salmon mark–recapture program were biased low. Eagle sonar, operated by ADF&G, has obtained border passage estimates since 2005 and has been the key project for escapement goal assessment since 2008. To make historical data comparable to contemporary sonar-based data, various stock-recruitment datasets were examined, including those developed from spawning escapement estimates derived from sonar, radio telemetry and aerial survey data (JTC 2008). Using these converted estimates, passage has ranged from approximately 30,700 in 2000 to about 93,600 in 1996 with a recent 5-year (2005–2009) average of 53,000 (Table 2 and Figure 3).

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

Based on harvest apportionment estimates from scale-pattern and GSI techniques, and border passage estimates, we estimate total run size of Canadian-origin Chinook salmon from 1982–2008 (Figure 5). Using these total run estimates, associated exploitation rates exerted by Alaskan fishermen on this stock ranged from 27% in 2001 to 66% in 1987 (Figure 5). Average exploitation rates during the period 2004–2008 decreased by 12% from the 1989–1998 average (Figure 5). These exploitation rates, however, only represent Alaskan exploitation and do not include exploitation exerted by Canadian harvesters.

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

Brood Year Return Information

Brood year tables have been constructed for three Chinook salmon stocks within the Yukon River drainage, Chena and Salcha rivers stocks in Alaska and the mainstem Yukon River stock in Canada. Total brood return divided by the parent-year escapement is a measure of productivity of the stock and is usually expressed as recruits or return per spawner (R/S). Based on these data, R/S for Canadian-origin Chinook salmon stock has ranged from 1.02 for the 1994 spawning event (or brood year) to about 5.19 for fish returning from the spawning event in 1991, with an overall average of about 2.86 R/S from 1982 through 2001 (2001 is the most recent year with a full complement of represented return age classes).

Brood year tables also provide information regarding age class composition of the return. Yukon River Chinook 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 Chinook salmon return from brood years 1979–2001 indicates that there was a dramatic decrease in age-7 salmon from the 28% average during years 1979–1982 to an 8% average during the 10-year period immediately following (1983–1992). Since that time, the age-class composition has remained relatively stable (Figure 6). Average age class composition comparisons between the 1982–1991 brood year period and the more recent 1997–2001 brood year period indicates that age-4 decreased by 4%, age-5 salmon increased by 6%, age-6 salmon increased by 6%, and age-7 salmon decreased by 8% (Figure 6).

Chena and Salcha river stocks have comparable datasets for Chinook salmon returns. These data, however, are only available through the 2000 brood year (Figures 7 and 8). Large fluctuations in relative proportions of age classes yield no clear patterns. Average age class composition comparisons between the 1982–1991 brood year period to the more recent 1997–2000 brood year period indicate that age-4 salmon increased by 4%, age-5 salmon increased by 7%, age-6 salmon decreased by 9%, and age-7 salmon decreased by 3% for Chena River (Figure 7). For Salcha River, differences between age class compositions of the 1983–1992 brood year period to the more recent 1997–2000 brood year period demonstrates an increase for age-4 by 4%, decrease of age-5 by 4%, increase of age-6 by 4%, and a decrease of age-7 by 4%. The only consistent trend among these three Yukon River stocks (Canadian-origin, Chena-origin, and Salcha-origin) is the decline in age-7 Chinook salmon.

Additionally, long-term data from other western Alaska river systems are available. Goodnews River age class composition is much different from Yukon River (Figure 9). Whereas age-4 Chinook salmon comprise a relatively small proportion, and overall returns are strongly dominated by age-5 and age-6 for Yukon River Canadian-origin stocks, age-4 Goodnews River Chinook salmon comprise a much more substantial percentage of the return. Using comparable time periods to the historical (1982–1991) and recent (1997–2001) time periods used for Yukon River Canadian-origin Chinook salmon, changes in relative proportions of age class returns for

Goodnews River are as follows: age-4 increased by 6%, age-5 increased by 8%, age-6 decreased by 12%, and age-7 decreased by 3% (Figure 9). As the commercial fishery on Goodnews River is restricted to 6-inch or smaller mesh size, it is unlikely that this commercial fishery is targeting the largest individuals.

Data from the Nushagak River Chinook salmon stock in Bristol Bay provide additional insight (Figure 10). The Nushagak River commercial fishery utilizes a variety of mesh size gillnets and therefore, the presence of any mesh size effect on observed patterns are indeterminable. This dataset includes years 1962–2000, and therefore, extends further back in time than the Yukon River datasets. These data illustrate an obvious long-term trend of decreasing age-6 and 7 fish, and increasing age-4 and -5 fish. Comparing the historical (1982–1991) and recent (1997–2001) time periods previously employed, changes in relative proportions of age class returns for Nushagak River are as follows: age-4 increased by 3%, age-5 increased by 10%, age-6 decreased by 12%, and age-7 decreased by 1% (Figure 10). This provides better context for interpreting Goodnews River data and how they relate to understanding Yukon River patterns. Based on a comparable time frame with Goodnews River, age-4 return composition for Nushagak River is relatively high, stable, and is a fairly substantial contributor to total returns. However, the longer time series of Nushagak River demonstrates that this is a relatively recent phenomenon. Historically, relative proportions of Nushagak River Chinook salmon age classes were similar to Canadian-origin age classes, but then, over time, adjusted to be more similar to Goodnews River age class compositions. Additionally, it should be noted that, except for one data point, neither Nushagak River nor Goodnews River age class compositions ever contained age-7 components in as high of proportions as was historically observed in Yukon River Canadian-origin Chinook salmon.

Average percent differences between historical (1982–1991) time periods and recent time periods for three Yukon River and two other western Alaska Chinook salmon stocks are listed in the table below. Recent time periods are from 1997–2001 for Canadian-origin and Goodnews River stocks; all other stocks include ranges of 1997–2000.

	Age-4	Age-5	Age-6	Age-7
Canadian-origin	–4%	+6%	+6%	–8%
Chena River	+4%	+7%	–9%	–3%
Salcha River	+4%		+4%	–4%
Goodnews River	+6%	+8%	–12%	–3%
Nushagak River	-3%	+10%	–12%	–1%

Obviously, the patterns illustrated among these datasets are complicated and numerous factors may be driving these patterns. Among the 5 stocks presented here, variable patterns were observed for all age classes except age-7, where all stocks showed declines. Because decreases in age-7 Chinook salmon are found in stocks outside of Yukon River, it fosters speculation that large-scale factors, such as environmental conditions, may have played some role.

CHINOOK SALMON SIZE TRENDS

Concerns over changing trends in the age, sex ratio, and size of Yukon River Chinook salmon populations have recently emerged. In response to these concerns, the U.S./Canada Joint Technical Committee (JTC) Salmon Size Subcommittee compiled relevant literature, existing analyses, and potential causes of these trends in their *Potential Causes of Size Trends in Yukon*

River Chinook Salmon Populations report (JTC 2006). Evidence that Yukon River Chinook salmon have undergone phenotypic alteration over time is limited, but suggestive. Analyses document a decrease in the weight of commercial harvests (Bigler et al. 1996), a reduction in the prevalence of the largest fish (Hyer and Schleusner 2005), decline in the proportion of age-7 fish in the commercial harvest (Hamazaki *In prep*), and the near disappearance of age-8 fish[2] (JTC 1998).

Whether the changes observed within Yukon River Chinook salmon have resulted from environmental or fishery-induced selective pressures, or a combination of both, is difficult to determine with certainty. The JTC report recognizes several factors that may contribute to these trends, including environmental changes in Bering Sea and Gulf of Alaska, fishery-induced selective pressures, and increased competition in the ocean from large numbers of hatchery fish. These apparent trends are problematical because datasets only represent a relatively recent time period compared to the duration in which fisheries have historically existed. The true baseline for these apparent patterns is unknown. Decreases in proportions of older age classes are not unique to Yukon River and are found elsewhere in the state (Figures 9 and 10). Unfortunately, data from these other drainages are equally limited in their historical scope.

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

Bromaghin et al. (2008) investigated the long-term effects of large mesh gillnet fisheries on Chinook salmon. They developed a model that integrated fish population dynamics and heritability of traits to simulate the effects of selective exploitation under a suite of productivity and fishing scenarios. Notwithstanding the important influence environmental factors have on the same phenotypic traits, the authors found that long term, selective exploitation of large Chinook salmon has the potential to reduce fish size and reproductive age, as well as population productivity, under all scenarios considered. They also found that the effectiveness of management strategies to reverse the decline in larger and older fish was enhanced by concurrent reduction of both exploitation rates and selectivity for large individuals, especially if implemented before large declines in mean size and age occur. While the authors conclude that a population-level response to size-selective exploitation seems likely, they note that accurate prediction of the magnitude of the response is not currently possible due to model limitations and the lack of sufficient data to parameterize some model components.

From 2007–2009, ADF&G and Yukon Delta Fisheries Development Association (YDFDA) initiated a mesh size study to investigate the performance of gillnets with smaller mesh than those currently used in the unrestricted mesh size fishery. This study specifically examined

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

species, age, gender and size (length, weight and girth) compositions of 7-inch, 7.5-inch, and 8-inch stretch-mesh drift gillnets from a test fishery conducted in District 1 near the City of Emmonak. Overall patterns indicate that larger mesh sizes catch a greater proportion of older fish, more Chinook salmon relative to chum salmon, a greater proportion of females, and more larger fish in respect to length, weight, and girth.

STOCK OF CONCERN RECOMMENDATION

Yukon River Chinook salmon escapement goals in Alaska have generally been met since 2004. Given that the most recent 5-year average harvest remains approximately 44% below the historic long-term average despite use of specific management measures, the Yukon River Chinook salmon stock continues to meet the criteria of a stock of yield concern. Therefore, based on the definitions provided in the *SSFP* in 5 AAC 39.222(f)(42), ADF&G recommends continuation of the yield concern classification for the Yukon River Chinook salmon stock.

OUTLOOK

The preliminary informal outlook for 2010 is for salmon abundance to be similar to levels observed in 2008 and 2009. Age data collected in 2009 are still being processed, but preliminary analyses indicate that the 6-year old component will be below average based upon the low proportion of age-5 fish returning in 2009. Meanwhile, it is expected that the age-5 component will be above average. The National Oceanic and Atmospheric Administration's (NOAA) Bering Arctic and Subarctic Integrated Surveys (BASIS) program has collected important data on oceanic salmon that is useful for understanding future returns. BASIS researchers observed high catches of 2-year-old juvenile Chinook salmon in 2007, which is promising for 2010 returns of age-5 fish. As with 2008 and 2009, Chinook salmon abundance is expected to be below the long-term average. This abundance may be adequate for subsistence harvests within the range identified for ANS, but it may be too low to support a directed commercial fishery.

ALASKA BOARD OF FISHERIES ACTION

In response to guidelines established in the SSFP, we anticipate the BOF to continue the yield concern classification for Yukon River Chinook salmon during its January 26–January 31, 2010 regulatory meeting.

ESCAPEMENT GOAL EVALUATION

ADF&G has undertaken a review of escapement goals for several Yukon River Chinook salmon stocks where sufficient long-term escapement, catch, and age composition data exist that enable development of BEGs or SEGs based on analysis of production consistent with the escapement goal policy (5 AAC 39.223) (Volk et al. 2009). The escapement goal team evaluated the type, quality, and amount of data for each stock to determine the appropriate type of escapement goal as defined in these policies. Seven escapement goals exist for Yukon River Chinook salmon including BEGs for Salcha and Chena rivers, and SEGs for East and West Fork Andreafsky, Anvik, Nulato, and Gisasa rivers. A separate report details the escapement goal review for AYK Region (Volk et al. 2009). In addition, there is a goal for Canadian-origin Chinook salmon, not listed here, which was established as part of the Yukon River Salmon Agreement. Escapement targets for Canadian-origin stocks are set annually by the Yukon River Panel through bilateral agreement.

The review team is recommending revision of the Chinook salmon SEG for East Fork Andreafsky River from an aerial survey-based goal to a weir-based goal. The recommended new SEG is 2,100–4,900 Chinook salmon and was derived using the percentile approach (Bue and Hasbrouck 2001). The team is also recommending elimination of the Gisasa River aerial survey goal for Chinook salmon because aerial surveys do not appear to track true abundance based on comparisons with recent weir counts. All other existing goals are recommended to continue without revision.

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

Stream (Project Type)	Current Goal	Recommended Range	Type of Goal
East Fork Andreafsky River (Aerial)[a]	960–1,900	2,100-4,900	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
Gisasa River (Aerial)	420–1,100	Eliminate	SEG
Chena River (Tower)	2,800–5,700	No Revision	BEG
Salcha River (Tower)	3,300–6,500	No Revision	BEG

[a] Change from aerial survey to weir.

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

YUKON RIVER CHINOOK SALMON MANAGEMENT PLAN REVIEW/DEVELOPMENT

Current Stock Status

In response to guidelines established in the *SSFP* (5 AAC 39.222), ADF&G recommended the continued stock of yield concern classification for Yukon River Chinook salmon during the October 2009 BOF work session. After reviewing stock status information and public input during its January 26–January 31, 2010 regulatory meeting, the BOF is anticipated to continue the stock of yield concern classification for Yukon River Chinook salmon. This expected determination is based on the inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs during the last 5 years.

Customary and Traditional Use Finding and Amount Necessary for Subsistence Uses

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

HABITAT FACTORS ADVERSELY AFFECTING THE STOCK

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

Mining

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

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

Logging

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

Flood Control and Other Dams

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

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

Habitat Projects Needed:

1. Continued monitoring of Illinois Creek Mine in the Innoko River drainage.
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.
4. Continued evaluation, and possibly implementation, of modifications to the Chena River Lakes Flood Control Project to reduce salmon mortality.
5. Continued monitoring of bank stabilization project near Rika's Roadhouse, a known fall chum salmon spawning area.
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. An estimated 50% of all water bodies in the Yukon watershed have not been evaluated for distribution of anadromous species. An estimated 70% of first and second order tributaries similarly have not been surveyed. Consequently, these streams are not afforded legal protection under the ADF&G's AS 16.05.871 permitting program.
8. A potential railroad extension from Fairbanks to Delta on the south side of Tanana River is slated to begin in the near future. This railway will cross several anadromous streams. Data

collection for an environmental impact statement began in 2005. Undocumented anadromous stream crossed by this project need to be identified and mitigated.

DO NEW OR EXPANDING FISHERIES ON THIS STOCK EXIST?

Federal regulations regarding customary trade that allow sales of subsistence fish caught in applicable waters may result in expansion of subsistence take on this stock. Additionally, Yukon River bound Chinook salmon are taken as bycatch in the Bering Sea groundfish fishery, and fishermen have expressed concern regarding impacts to Western Alaskan salmon stocks, particularly after an estimated 130,000 Chinook salmon were caught in 2007. Bycatch of Chinook salmon from the Bering Sea groundfish fishery greatly increased in 2003, reached record levels in 2005 through 2007, but then dropped to less than 19,000 fish in 2008. Preliminary data for 2009 suggest low bycatch numbers of Chinook salmon, similar to 2008. Actions by the North Pacific Fishery Management Council are currently underway to promote a Chinook salmon bycatch reduction program to help address bycatch concerns.

EXISTING MANAGEMENT PLAN

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

5 AAC 01.210. *Fishing Seasons and Periods.*

ACTION PLAN DEVELOPMENT

YUKON RIVER CHINOOK SALMON ACTION PLAN GOAL

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

REVIEW OF MANAGEMENT ACTION PLAN

Regulation Changes Adopted in January 2001

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

The BOF added wording to the plan under section (a) regarding management objectives and data used to manage Chinook salmon fisheries. Additionally, when the projected commercial harvest is 0–67,350 Chinook salmon, the BOF 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 BOF adopted a fishing schedule for the subsistence salmon fisheries. The schedule will be implemented chronologically, consistent with migratory timing as the run progresses upstream.

This schedule may be altered by emergency order if preseason or inseason indicators suggest this change is necessary.

YUKON AREA SUBSISTENCE FISHING SCHEDULE:

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

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

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

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

Old Minto Area: 5 days/week

The BOF provided ADF&G emergency order authority to restrict subsistence gillnets to no greater than 6 inches mesh size for conservation of Chinook salmon.

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

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

Regulation Changes Adopted in January 2004

The BOF 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 completion of the Rampart road construction project and increased mobility of fishermen.

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

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

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

Regulation Changes Adopted in January/February 2007

The BOF discontinued the stock of management concern designation for summer chum salmon as 2003–2006 runs were greatly improved and met or exceeded the historical average.

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

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

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

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

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

Management Review

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

Historically, Chinook salmon have been commercially harvested in both unrestricted and restricted mesh size fishery openings. Unrestricted openings are directed at Chinook salmon, though summer chum are also caught, and fishermen may use nets of any size mesh, though it is suspected that most fishermen use mesh sizes larger than 8 inches (Figure 11; Table 4). Restricted commercial openings target summer chum salmon by limiting mesh size to a maximum of 6 inches. In these restricted openings, on average, 30 summer chum salmon are caught for every 1 Chinook salmon, and these Chinook salmon are typically from younger age classes based on catch sampling (Figure12; Table 4). Approximately 500 (2006) to 40,000 (1988 and 1989) Chinook salmon were harvested annually in the summer chum salmon-directed fishery, with a 10-year average from 1986–1995 of approximately 17,000 fish. Restricted openings were numerous in the 1980s and early 1990s, but were discontinued in 1996 due to fallen summer chum salmon market demand. With a renewed summer chum salmon market, directed summer chum salmon fisheries have occurred in 2006 through 2009.

Management 2001–2007

Conservative management strategies based on the management action plan adopted by the BOF contributed to the successful achievement of escapement goals. Beginning in 2001, the subsistence salmon fishing schedule adopted by the BOF 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. Overall, it appeared that the subsistence fishing schedule assisted in spreading subsistence opportunity among users, particularly early in the run.

Historically, the first commercial opening occurred at the first quarter point of the run. In 2002 through 2005, preseason management strategies were developed to shift commercial fishing until the midpoint of the Chinook salmon run and later. This management strategy provided for passage of an early portion of the run through the lower river districts before commercial fishing started. In 2006–2007, based on preseason projections and inseason run assessments, commercial fishing was scheduled to commence near the first quarter point (historically June 15) of the Chinook 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.

Management 2008–2009

As anticipated, the 2008-2009 Chinook salmon runs were below average to poor. The preseason outlook was for no directed Chinook salmon commercial fishing and a reduction in subsistence fishing time. Directed commercial fishing for summer chum salmon was delayed to reduce incidental harvest of Chinook salmon. Because of the overlap in run timing between these species, this strategy resulted in lower summer chum salmon harvests than surplus allowed. A total of 151,786 and 170,272 summer chum salmon were sold in 2008 and 2009.

Before the 2009 season, YRDFA 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 the calls and meeting was to work cooperatively to identify options and practical management strategies for 2009 that would assist in getting adequate numbers of fish to the spawning grounds, particularly to Canada, should the 2009 Chinook salmon run be similar to the unexpected low runs of 2007 and 2008. Based on input from these meetings, a preseason management plan was developed for the subsistence fishery. The preseason plan included the following key components:

- Providing for escapement in both Alaska and Canada would be maintained as the highest management priority. Meeting the Canadian IMEG of >45,000 Chinook salmon based on the Eagle sonar program was a paramount concern after failing to meet the escapement goal in both 2007 and 2008. Subsistence fishing would remain as the highest priority use.

- Because of the below average to poor outlook for Chinook salmon in 2009, and to lessen the subsistence harvest impact on the anticipated weak Canadian component, a reduced subsistence fishing schedule would be implemented along the mainstem fishing Districts 1–5. Fishing schedules in each mainstem district would be reduced by half.
- The subsistence fishing schedule would begin approximately 7 days after ice out at Alakanuk in District 1, and implemented chronologically with the upriver migration. Delaying implementation of the schedule would allow for additional subsistence opportunity in late May and early June to harvest whitefish species, such as sheefish, and earlier returning Chinook salmon.
- Because of the large size of Subdistrict 5-D and the travel time that is associated with fish migrating through the area, that subdistrict would be divided into separate management portions: the area below 22 Mile Slough and the area above 22 Mile Slough. Subdividing Subdistrict 5-D into two smaller portions allowed for more management precision and flexibility. Coastal District, which primarily harvests summer chum and few Chinook salmon, would not be placed on a reduced fishing schedule. However, to reduce harvest of Canadian-origin Chinook salmon while still allowing for summer chum harvest, gillnet gear in Coastal District would be restricted to a maximum of 6-inch mesh size. The Koyukuk, Innoko, and Tanana River drainages, which do not harvest Canadian-bound Chinook salmon, would be managed independently and placed on normal subsistence fishing schedules.
- Additionally, to conserve the greatest number of Canada-bound Chinook salmon, there would be no fishing on the first pulse in mainstem districts. One to two subsistence fishing periods would be closed and similar actions would be implemented in upriver fishing districts and subdistricts based on migratory timing.
- Initial management would be based on this preseason management plan and projection. As the run developed, management decisions would incorporate inseason assessment information. The reduced subsistence fishing schedule was anticipated to be in place until estimated inseason run abundance was of sufficient strength to warrant relaxing, discontinuing, or decreasing the schedule.
- The federal manager planned to implement a Special Action(s) to limit the harvest of Chinook salmon in federal public waters to federally qualified rural subsistence users only.

To reduce incentive for targeting Chinook salmon in directed summer chum salmon commercial fisheries in 2009, buyers agreed to not purchase Chinook salmon during the first commercial opening in District 1 and District 2. Effective July 1, the BOF adopted an emergency regulation specifying that during the commercial summer chum salmon season in Districts 1–5, Chinook salmon taken may be retained but not sold. Therefore, fishermen could release live Chinook salmon or use them for subsistence purposes. Chinook salmon caught but not sold were to be reported on fish tickets. Buyers did process and ship a quantity of incidentally-caught Chinook salmon from the lower river to the Village of Eagle, which had been devastated by flooding during ice breakup. This emergency regulation was discontinued, effective July 16 since the majority of the Chinook salmon run had passed the lower river districts.

A total of 131 Chinook salmon were incidentally harvested and commercially sold during the seventh directed summer chum salmon period in District 2 on July 16. The total commercial harvest was 316 Chinook salmon for the Alaskan portion of the Yukon River drainage, which includes 185 fish harvested during the fall season. This range of commercial catch for Chinook salmon is 99% below the recent 10-year (1999–2008) average of 35,027 Chinook salmon. A total of 944 Chinook salmon were reported as caught but not sold on fish tickets in District 1, 2,596 in District 2, 200 in Subdistrict 4-A and 12 in District 6.

In general, salmon harvests in the Yukon Area sport fishery are minor compared to commercial and subsistence fishery harvests. The Tanana River drainage is the exception because it supports a popular salmon sport fishery. Based upon the stock of concern status, the Yukon River drainage sport fishing bag limit was reduced preseason by emergency order to one Chinook or one chum salmon in 2001–2003. In 2008, due to the weak Chinook salmon run the sport fishing bag limit was reduced to one fish inseason (July 2). Effective June 1, 2009, in conjunction with the preseason commercial and subsistence restrictions, the Chinook salmon sport fishing bag limit was reduced to one fish in the Yukon River tributaries (excluding the Tanana River drainage) and retention of Chinook salmon was prohibited in the mainstem Yukon River to protect Canadian stocks. In addition, the retention of chum salmon was prohibited effective September 1, 2009 in the entire Yukon River drainage, to protect fall chum salmon stocks.

In summary, Chinook salmon fisheries management has been conservative since 2001. While a portion of the Chinook salmon surplus had gone unharvested in 2001, 2003 and 2004, run size declined in 2007–2009, and severe subsistence fishing restrictions were implemented in 2009.

ACTION PLAN ALTERNATIVE

ACTION 1.

Addressing Decline of Older and Larger Chinook Salmon

Objective: Reduce exploitation on the largest and oldest component of the Yukon River Chinook salmon run to achieve escapements that are more representative of the age and size class structure of the overall run (related to BOF proposals 89 and 90).

It is unlikely that a definitive causal relationship with either oceanic conditions or size selective fishing practices and Chinook salmon size will be ascertained in the near future, especially given the complex life histories of these fish and the environments they inhabit. There are few, if any, actions that can be taken to address oceanic or natural factors that may have contributed to the declining trend in Chinook salmon size; however, size selective fishing practices is a factor that can be addressed by taking management actions on the inriver fishery. Three options designed to reduce the exploitation rate on the largest and oldest component of the Yukon River Chinook salmon run are outlined below. These options would provide for spawning escapements that are more representative of the age and size class structure of the overall run. Additional benefits may include improved productivity and yield if the fishery is prosecuted in a manner to increase the number of larger and older individuals and females on the spawning grounds. Larger female fish tend to be more fecund (Quinn and Bloomberg 1992; Healey and Heard 1984). Older salmon produce larger eggs and can provide more yolk proteins for developing embryos, thereby yielding healthier offspring with a greater chance of survival (Healey 1986; Nicholas and Hankin 1988).

Option A.–Reduce Exploitation Through Fishing Time Reduction

Specific Action Recommended to Implement the Objective

Decrease the overall Chinook salmon harvest rate under existing management strategies and regulations through reductions in fishing time. When run abundance is poor to below average, the commercial fishery would be closed and the subsistence fishing schedule may have to be reduced. If there is a surplus of Chinook salmon beyond subsistence uses, Chinook salmon-directed commercial periods would be reduced in time and area and/or delayed. Although exploitation rates have generally decreased in the past decade through conservative management, this option would entail a further decrease in exploitation rates.

Benefits

A reduction in fishing time would decrease the exploitation rate of Chinook salmon from all age, sex, and size classes and should increase escapements of larger and older fish. All fishermen in the Yukon River mainstem would share the burden of conservation measures. Additionally, there would be no direct costs incurred by fishermen as they would be able to use existing gear.

Detriments

Overall harvest of Chinook salmon will be reduced by this option and harvest would still be selective towards larger and older fish, although at a reduced rate. In years of low abundance, there would be disruptions to subsistence fishing harvest patterns and could result in reduced harvest depending on stock composition of individual runs. Ultimately, this fishing strategy will often result in higher escapements at or above existing escapement goal thresholds, including the Canadian Yukon River mainstem. Thus, there will likely be foregone harvest of surplus fish. Subsistence and commercial fishing opportunities would be reduced and commercial fishery value would be affected. Additionally, fishermen need to support and adhere to actions implemented to achieve desired results. Any action that alters the nature of the gillnet fishery may reallocate harvest opportunity to other gear types or user groups.

Option B.–Limit Maximum Mesh Size of Commercial and/or Subsistence Gillnets

Specific Action Recommended to Implement the Objective

Adopt gillnet mesh size restrictions between 7.5 and 8 inches in Chinook salmon commercial and/or subsistence fisheries. Currently, older and larger individuals are disproportionately harvested in these unrestricted mesh size fisheries. A mesh size reduction could be adopted only for the commercial fishery, which is a lower use priority, or for both commercial and subsistence fisheries. This action should reduce exploitation rates on the largest and oldest components of the Chinook salmon run, while continuing to provide opportunity for subsistence uses, and limiting adverse effects on summer chum salmon stocks from a Chinook salmon-directed commercial fishery. Bromaghin et al. (2005) utilized net selectivity models to demonstrate that gillnets of this size harvest length distributions of Chinook salmon that are most proportional to typical size distribution of the run for this species, but are also large enough so as not to significantly target chum salmon (Figures 13a and 13b).

These net selectivity models allow for estimation of the length distribution of Chinook salmon escapements from hypothetical 7.5-inch and 8.5-inch mesh gillnet fisheries (Figure 14). Figure 14 shows estimated escapement at 50% exploitation from 8.5 inch mesh gear is weighted towards smaller individuals while estimated escapement after 50% exploitation from 7.5-inch mesh gear results in a broader distribution of size classes arriving at the spawning grounds.

Additional information comes from the Lower Yukon Mesh Size Study, which investigated catches from 7-, 7.5-, and 8-inch mesh gillnets (Howard and Evenson *In prep*). In general, this study demonstrated that larger mesh sizes tend to catch larger individuals (in length, weight, and girth), older individuals, and more females. Howard and Evenson found that 7-inch gear did not effectively target Chinook salmon more than chum salmon. Therefore, 7-inch mesh or smaller gear would neither direct harvest towards Chinook salmon nor minimize harvest of chum salmon in the event of a poor chum salmon run. This study also found a dramatic reduction in the proportion of large individuals (here defined as >900 mm in length) when mesh size is reduced to 8 inches or smaller. Together, the two studies highlighted here indicate that a mesh size between 7.5 and 8 inches would decrease exploitation of the largest and oldest individuals, limit incidental catch of chum salmon, and target the most abundant sizes present in the run.

Benefits

A reduction in maximum mesh size would decrease the exploitation rate of larger and older Chinook salmon caught in gillnets, and should increase the escapement of these demographic constituents. Under similar run abundance, implementation of this option would not require the time restrictions described in Option A and would not present the same potential for foregone harvest. Additionally, overall length distributions of the harvest would likely better reflect length distributions of the runs.

Evidence from Bromaghin (2005) suggests that gear with selectivity that matches the most abundant lengths of fish in the run garners a slightly higher CPUE. This suggests potential for fishermen to catch the same numbers of Chinook salmon with less effort if the gillnet mesh size used has a selectivity more similar to length distributions of the runs.

Detriments

Gear change to a smaller mesh size would come at a significant cost to subsistence and commercial fishermen, many of whom would need to buy new nets. The cost of replacing nets or hanging new webbing could range between $500 and $1,800 per net. Lower costs would be for replacing webbing and utilizing existing lead and float lines. Many fishermen would likely need to replace two or more shackles of gear. This burden could be somewhat mitigated if a phase-in period is established, as nets typically need replacing every 3–5 years. Alternatively, this option could be applied solely to the commercial fishery, thereby removing the burden from subsistence fishermen. Any action that alters the nature of the gillnet fishery may reallocate harvest opportunity to other gear types or user groups.

Additionally, larger fish are more desirable in both subsistence and commercial fisheries. If mesh size is reduced in the subsistence fishery, fishermen may fish longer to catch more large fish, thus increasing overall subsistence harvest. As larger fish are economically more valuable, short-term economic gain by commercial fishermen could be affected by having fewer large fish to sell. The Lower Yukon Mesh Size Study evaluated marketability of the Chinook salmon catch and the potential economic impacts of a reduced mesh size regulation (Howard and Evenson *In prep*). Currently, commercial fishermen are paid by the pound, regardless of the size of fish. If smaller mesh size nets catch smaller fish on average, then these fishermen would need to catch more fish to attain the same income. As an example, data from Howard and Evenson's study show the average weight of fish caught with 8.5-inch mesh gillnets is 20.2 pounds. If a fisherman caught 50 fish and received $4 a pound for these fish, they would net approximately $4,000. The average weight of fish caught in 8.0-inch and 7.5-inch nets are 19.2 and 18 pounds, respectively (Howard and Evenson *In prep*). If that fisherman caught 50 fish in those nets, they would likely net about $3,800 (5% reduction) and $3,600 (10% reduction), respectively. It is important to note, however, that data from the Pilot Station test fishery demonstrate that 7.5-inch mesh gear has a slightly higher CPUE than 8.5-inch mesh gillnets, so it may be possible for fishermen to compensate for catching smaller fish by catching more fish, without expending more effort (Bromaghin 2005).

Lower Yukon commercial fish buyers/processors receive varying prices for fish, graded by the headed and gutted (H&G) weight of each fish. Lower Yukon River Chinook salmon typically lose 25% of their body mass from H&G (Jack Schultheis, personal communication 2007). H&G Chinook salmon weighing >18 lbs command a premium price in the market, the second price tier is for fish weighing 15–18 lbs, the third tier is for fish weighing 11–15 lbs, the fourth tier is for 7–11 lbs fish, and fish < 7 lbs are very low value and currently garner approximately the same price as chum salmon (Jack Schultheis, personal communication 2009). The Lower Yukon Mesh Size Study demonstrates that the most economically valuable component of the catch (>18 lb Chinook salmon) comprises 24% of the catch in 8.5-inch mesh, 19% of the catch for 8-inch mesh, and 13% of the catch for 7.5-inch mesh. Therefore, a mesh size reduction to 7.5–8 inches would likely reduce the most valuable component by 5–11%, and the two most valuable components (>18 and 15–18 lbs) by 10–20%. It should be noted that this study was conducted under standardized protocols and commercial fishermen lack these constraints; therefore direct comparisons are problematic. Over the long term, however, if productivity and yield increase because more older and larger fish reach the spawning grounds, the economic loss from reduced catch of the largest individuals would likely be compensated by greater overall abundance of fish over time.

Fishermen have also raised concerns that smaller mesh nets would result in increased Chinook salmon dropouts. The degree to which dropouts occur is unknown and is extraordinarily difficult to quantify. A summary of available data compiled by the Chinook Technical Committee (CTC) of the Pacific Salmon Commission provide some estimates for Chinook salmon but also emphasizes the uncertainty of these estimates. The CTC advises that "rates are expected to vary from fishery to fishery due to variables such as mesh size, prevailing weather and sea conditions, and predator abundance" (CTC 1997). Dropout rates for gillnet fisheries in Southeast Alaska, Fraser River, Puget Sound (including some purse seine fisheries), Washington Coast, and Columbia River are estimated to be 2%, 8%, 8%, 2%, and 3% respectively. Should such dropouts occur, they would likely increase Chinook salmon mortality and decrease potential harvest of fish. It is unknown, however, whether a change in mesh size would alter existing dropout rates for Yukon River Chinook salmon.

Comparison of Options A and B

The effectiveness of Options A and B to reduce exploitation on the oldest and largest components of the run can be compared using a simple model. In this modeling exercise, two scenarios were used: 1) a run size of 150,000 fish, which represents a smaller run that would support a normal subsistence harvest but would support minimal or no directed commercial fishery, and 2) a run size of 200,000 fish, which represents a run that could support normal subsistence harvests and a small to moderate, directed commercial fishery. Both scenarios modeled the harvest response under 4 different exploitation rates (30%, 40%, 50%, and 60%)

using 7.5-inch, 8.0-inch, and unrestricted mesh sizes. These are hypothetical scenarios to illustrate the trade-offs between these options, and as such, it should be noted that high exploitation rates would be unlikely for small run sizes.

For the 150,000 fish run scenario, approximately half as many large (>900 mm) Chinook salmon would be harvested in a 7.5 to 8.0 inch mesh gillnet fishery under the same exploitation rate than would be harvested in the current unrestricted mesh fishery.

Harvest numbers and percentages of large (>900 mm) Chinook salmon from a 150,000 fish run using various mesh size nets and hypothetical exploitation rates are shown below:

	Exploitation Rate			
Mesh Size	30%	40%	50%	60%
7.5	2,610 (15%)	3,480 (19%)	4,350 (24%)	5,220 (29%)
8.0	3,150 (18%)	4,200 (23%)	5,250 (29%)	6,300 (35%)
Unrestricted	7,065 (39%)	9,420 (52%)	11,775 (65%)	14,130 (79%)

Using unrestricted mesh gillnets, exploitation would need to be reduced by more than half to achieve the same reduction in harvest of large Chinook salmon that smaller mesh sizes would provide. Although it is not represented in the above table, it should be noted that harvest of smaller (<900 mm) and younger Chinook salmon would also decrease from a reduction in exploitation rate, while their harvest would likely increase from a reduction in mesh size. However, either method would provide for more large fish to escape the fishery.

This pattern is maintained in the 200,000 fish run scenario. For larger run sizes, reducing mesh size in subsistence and commercial gillnet fisheries maximizes passage of larger Chinook salmon as evidenced in part (a) of the following table. When restrictions are only applied to the commercial fisheries in this larger run scenario, the benefits of a mesh size reduction are more pronounced when commercial harvests exceed subsistence harvests. It should be noted that during moderate to large run sizes, mesh size restrictions would likely be unnecessary at low exploitation rates. Nonetheless, these tables show that both options effectively reduce harvest on older and larger fish.

Harvest numbers and percentages of large (>900 mm) Chinook salmon from a 200,000 fish run using various mesh sizes and hypothetical exploitation rates if (a) commercial and subsistence fisheries were under the same mesh size regulation, and (b) the commercial fishery mesh size was restricted, but the subsistence fishery mesh size was unrestricted.

(a)	Exploitation Rate			
Mesh Size	30%	40%	50%	60%
7.5	3,480 (15%)	4,640 (19%)	5,800 (24%)	6,960 (29%)
8.0	4,200 (18%)	5,600 (23%)	7,000 (29%)	8,400 (35%)
Unrestricted[3]	9,420 (39%)	12,560 (52%)	15,700 (65%)	18,840 (79%)
(b)	Exploitation Rate			
Mesh Size	30%	40%	50%	60%
7.5	8,430 (35%)	9,590 (40%)	10,750 (45%)	11,910 (50%)
8.0	8,550 (36%)	9,950 (41%)	11,350 (47%)	12,750 (53%)
Unrestricted[3]	9,420 (39%)	12,560 (52%)	15,700 (65%)	18,840 (79%)

[3] Unrestricted represents the status quo and therefore no restrictions on mesh size are implemented. The savings from this mesh size, therefore, remains unchanged between treatments (a) and (b).

In summary, a reduction in total exploitation rate without restricting mesh size could be useful for decreasing the harvest of older and larger Chinook salmon. However, exploitation rate would need to be reduced dramatically to achieve results similar to mesh size reductions and would likely result in foregone harvests even during adequate run sizes. As harvestable surpluses would not be exploited, this strategy could also come at a cost to fishermen in the form of missed fishing opportunities and potentially, reduced subsistence harvests. This exercise also demonstrates that mesh size restrictions to the commercial fishery alone provides minimal benefit when the commercial fishery is small; however, the efficacy of this option increases as commercial harvests increase relative to the run. Additionally, it is anticipated that due to the costs of nets, some lower river commercial fishermen may use the same net for subsistence activities; this would likely further increase the number of large fish escaping the fisheries.

Option C.–Reduce Depth of Gillnets

Specific Action Recommended to Implement the Objective

Reduce depth of commercial and subsistence gillnets larger than 6-inch stretched mesh to no more than 35 meshes in depth.

This depth restriction would be the same as that in regulation for Kuskokwim River.

Under current regulations, gillnet depth is unrestricted in the subsistence fishery. Commercial gillnets greater than 6 inches may not be more than 45 meshes deep, and gillnets 6 inches or smaller may not be more than 50 meshes deep, for Districts 1–3. For the commercial fishery in Districts 4–6, gillnets greater than 6 inches may not be more than 60 meshes deep and gillnets 6 inch or smaller may not be more than 70 meshes deep.

Benefits

This option would likely decrease efficiency of fishermen operating gillnet gear, decrease the exploitation rate of Chinook salmon, including larger and older Chinook salmon, and increase escapement of these demographic constituents. Although unsubstantiated, it is local traditional knowledge that larger Chinook salmon travel deeper in the water column. It is commonly reported that larger Chinook salmon are caught along the leadline. However, a radiotelemetry study showed that Chinook salmon were randomly distributed throughout the water column (John Eiler, NOAA, Juneau, personal communication) and there have been no studies documenting fish size caught by mesh depth. Reducing depth of gillnet gear is less expensive than changing gillnet mesh size.

Detriments

It is difficult to determine how effective reducing gillnet depth will be in reaching the objective of increasing the number of larger and older individuals and females to the spawning grounds. A decrease in depth of gillnets may require fishermen to expend more effort to harvest salmon needed for subsistence or commercial purposes. There will be a cost in time or money to reduce depth of existing gillnet gear. Any action that alters the nature of the gillnet fishery may reallocate harvest opportunity to other gear types or user groups.

Option D.–Other Gear Type Considerations

A reduction in harvest of larger, older Chinook salmon by decreased harvest rate in gillnet fisheries may result in reallocation of harvest to other gear types or fisheries. Other actions, such as the modification of fish wheel chutes and a size limit on Chinook salmon harvested in the sport fishery could potentially reduce harvest of larger, older Chinook salmon. Fish wheels with no more than four baskets on a single axel (5 AAC 39.105 (d) (9)) are allowed in all districts in the subsistence fishery and in Districts 4-6 for the commercial fishery.

Performance Measures

Subsistence and commercial harvests and escapements will continue to be determined through existing methodologies. GSI will be used to monitor stock contribution to commercial harvests and selected subsistence harvests. ASL data will continue to be monitored by ADF&G and other contributors at all test fisheries, various Alaskan-based escapement projects, and from subsistence and commercial harvests. ADF&G is working with DFO to expand ASL sampling projects at Canadian escapement sites as well. Unfortunately, no datasets pre-date extensive fishing efforts; hence, baseline ASL information is unknown, and a goal to return to baseline levels would be impractical. However, these monitoring projects will be necessary to evaluate exploitation rates on the largest and oldest components of the run, and evaluate the proportions of larger and older individuals on the spawning grounds. An analysis of ASL composition data obtained from commercial and subsistence harvests, test fisheries, and escapement projects would be used to determine the effectiveness of the selected option.

ACTION 2.

Align Gillnet Mesh Depth with Mesh Size

Objective: Establish mesh depths that are consistent with mesh size regulations and provide consistency throughout the Alaskan Yukon River for Chinook salmon-directed fisheries or gillnet mesh size >6-inch stretch mesh. If gillnet mesh size restrictions are adopted, mesh depth also needs to be addressed, as the depth of the overall net is generally related to the size of the meshes making the net (related to BOF proposal 89).

Specific Action Recommended to Implement the Objective

Require a specific mesh depth, by regulation, for both subsistence and commercial fisheries.

Option A.–Status Quo

Subsistence drift gillnets can be used in Districts 1–3 and Subdistrict 4-A. Commercial drift gillnets may be up to 50 fathoms in length and can be used in Districts 1–3. Set gillnets can be used drainagewide, may not exceed 150 fathoms in aggregate, and each gillnet may not exceed 50 fathoms in length. Gillnet mesh size is unrestricted unless restricted to 6 inch or smaller by emergency order to conserve Chinook salmon or 8 inch or greater to conserve chum salmon. Gillnet depth is unrestricted in the subsistence fishery. Commercial gillnets greater than 6 inches may not be more than 45 meshes deep, and gillnets 6 inches or smaller may not be more than 50 meshes deep, for Districts 1-3. For the commercial fishery in Districts 4-6, gillnets greater than 6 inches may not be more than 60 meshes deep and gillnets 6 inch or smaller may not be more than 70 meshes deep. Fish wheels with no more than four baskets on a single axel (5 AAC 39.105 (d) (9)) are allowed in all districts in the subsistence fishery and in Districts 4–6 for the commercial fishery.

Option B.–Adopt 45 Mesh Depth Restrictions Riverwide

Require depth restrictions for both subsistence and commercial fisheries following the 45 mesh depth restriction currently in regulation for the commercial fishery for gillnets >6-inch stretch mesh. Adopt gillnet depth restrictions riverwide for commercial and subsistence as currently in place for District 1-3 commercial fishing gear. If 7.75-inch mesh size restrictions are adopted, then 45 mesh deep nets would be approximately 29 feet in total depth (see table below).

Option C.–Modify Depth Restrictions to Adjust for Changes in Mesh Size

Adopt gillnet depth restrictions riverwide for commercial and subsistence as currently in place for District 1–3 commercial fishing gear. The following table provides comparative information for meshes of various sizes and their corresponding depth measurements. For instance, if mesh size was restricted to 7.75 inches, to maintain the approximate depth currently existing for commercial fisheries, regulations should require nets to be 50 meshes deep.

Depth comparisons for nets of various mesh sizes:

Mesh Size (inches)	Approximate Net Depth (45 meshes)	Approximate Net Depth (35 meshes)	Number of Meshes to Maintain Approximate Net Depth in Current Commercial Fishery (~32 ft)
6	23 ft	18 ft	64
7.5	28 ft	22 ft	51
7.75	29 ft	23 ft	50
8	30 ft	23 ft	48
8.5	32 ft	25 ft	45

Option A does not accommodate any potential changes in mesh size regulations, and mesh depth is currently inconsistent throughout the drainage. Proposal 89 suggests mesh depth reductions to 35 meshes based on 6-inch maximum mesh size. This would result in a net approximately 9 feet shallower than what is typically used in the current commercial fishery. The rationale for Proposal 89 is a depth regulation to limit the catch of larger and older individuals. While ADF&G opposes adoption of mesh depth requirements specific to 6-inch gear (see Action 1 for rationale of not adopting mesh sizes <7.5 inches), ADF&G is neutral to depth specifications. There is a paucity of sufficient data demonstrating that gillnet depth restrictions would effectively alter the size and age composition of the catch. Local traditional knowledge suggests that larger fish migrate in deeper water, so such actions may reduce harvest of larger, older Chinook salmon. Data from a recent radio tagging project on Yukon River Chinook salmon, however, do not support this claim (John Eiler, National Marine Fisheries Service Auke Bay Laboratory, Juneau; personal communication 2009). Even if net depth restrictions could alter the catch from a specific location, fishermen behavior could easily compensate for reduced net depth by fishing in shallower locations where a shallower depth net would not impede the catch of larger and more valuable Chinook salmon. Quantitative analyses of the effects of specific net depths on catches of Chinook salmon are wanting.

Performance Measures

Subsistence and commercial harvests and escapements will continue to be determined through existing methodologies. GSI will be used to monitor stock contribution to commercial harvests and selected subsistence harvests. ASL data will continue to be monitored by ADF&G and other contributors at all test fisheries, various Alaskan-based escapement projects, and from subsistence and commercial harvests. ADF&G is working with DFO to expand ASL sampling projects at Canadian escapement sites as well. Unfortunately, no datasets pre-date extensive fishing efforts; hence, baseline ASL information is unknown, and a goal to return to baseline levels would be impractical. However, these monitoring projects will be necessary to evaluate exploitation rates on the largest and oldest components of the run, and evaluate the proportions of larger and older individuals on the spawning grounds. An analysis of ASL composition data obtained from commercial and subsistence harvests, test fisheries, and escapement projects would be used to determine the effectiveness of the selected option.

2010 ALASKA BOARD OF FISHERIES REGULATORY PROPOSALS AFFECTING YUKON RIVER

CHINOOK SALMON

- Proposal 81 – Clarify subsistence fishing schedule in Subdistrict 4-B and 4-C.
- Proposal 82 – Modify Subsistence fishing schedule in Subdistrict 4-A.
- Proposal 83 – Require recording subsistence harvest on catch calendars.
- Proposals 84 and 85 – Extend Subdistricts 4-B and 4-C drift gillnet area for Chinook salmon.
- Proposal 86 – Allow set gillnets to be tied up during subsistence closures in Subdistrict 5-D.
- Proposal 87 – Review triggers, guideline harvest ranges and subsistence fishing schedules in Chinook Salmon Management Plan.
- Proposal 88 – Prohibit drift gillnet gear for subsistence and commercial fishing in Yukon River drainage.
- Proposal 89 – Restrict depth of subsistence and commercial gillnets to no more than 15' or 35 meshes deep in Yukon river drainage.
- Proposal 90 – Prohibit subsistence and commercial gillnets over 6 inch mesh in Yukon River drainage.
- Proposals 91–93 – Limit, prohibit sale or retention of king salmon harvested during chum salmon directed commercial fishing periods in Yukon River drainage.
- Proposal 94 – Require windowed schedule during lower river commercial fishery.
- Proposal 95 – Reallocate commercial king salmon harvest in Districts 1-6.
- Proposal 98 – Open commercial fishing between Black River and Chris Point for drift and set gillnets.
- Proposal 99 – Open Andreafsky River to commercial fishing.
- Proposal 100 – Close Tok River drainage to sport fishing.

Nearly all Yukon Area proposals before the BOF are directed at the Chinook salmon fishery. Proposal 81 would clarify the subsistence salmon fishing schedule in Subdistricts 4-B and 4-C during commercial fishing closures lasting longer than 5 days. Proposal 82 would modify the subsistence salmon fishing schedule in Subdistrict 4-A and allow subsistence fishing to be open for two 48-hour periods during the commercial fishing season. Proposal 83 would require all subsistence users have a catch calendar and record all harvested fish on the calendar in ink before concealing the fish from plain view, transporting fish from the fishing site, or off-loading fish from the vessel. Proposals 84 and 85 would extend Subdistricts 4-B and 4-C subsistence drift gillnet area for Chinook and fall chum salmon. Proposal 86 would allow set gillnets to be tied up during fishing closures and require gillnets be marked with a black anchor float in Subdistrict 5-D. Proposal 87 would evaluate potential triggers and management tools for managing subsistence, commercial, personal use and sport fisheries, review GHR, and review the subsistence fishing schedule. Proposal 88 would prohibit use of drift gillnets for subsistence and commercial fishing in the entire Yukon River drainage. Proposal 89 would decrease the depth of commercial and subsistence 6-inch mesh size gillnets to no more than 15 feet or 35 meshes deep. Proposal 90 would prohibit gillnets greater than 6-inch mesh in the commercial and subsistence fisheries. Proposals 91–93 would limit or prohibit sale or retention of Chinook salmon harvested during chum salmon-directed commercial fishing periods in the Yukon River drainage. Proposal 94 would only allow subsistence and commercial fishing during set windowed openings; this proposal would restrict fishermen from harvesting salmon outside of established fishing schedules regardless of inseason run assessment information. Proposal 95 would reduce Districts 1, 2, and 3 Chinook salmon harvest by more than two thirds and transfer that harvest to District 4, Subdistricts 5-B, 5-C, 5-D, and District 6, thereby shifting harvest from lower to upper river fishermen and altering fishery infrastructure. Proposal 98 would open commercial fishing between Black River and Chris Point and would increase the geographic size of District 1. Proposal 99 would open Andreafsky River in District 2 to commercial fishing.

RESEARCH PLAN

RESEARCH

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

ADF&G, several federal agencies, DFO Canada, Native organizations, and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River drainage, which are used by ADF&G's Division of Commercial Fisheries to manage Alaskan Yukon salmon fisheries. Preseason information involves run forecasts based upon historic performance of parent spawning abundance and is generally expressed as runs that will be below average, average, or above average. Inseason run assessment includes: (1) abundance indices from test fisheries, (2) sonar counts of passing fish, (3) various escapement assessment efforts in tributaries, (4) commercial and subsistence catch data, and (5) catch per effort data from monitored fisheries. ADF&G continues to monitor these abundance indices and has instituted additional projects such as the offshore test fishery near Scammon Bay in 2009.

U.S.-CANADA JOINT TECHNICAL COMMITTEE PLAN

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

INSEASON MIXED STOCK ANALYSIS

Beginning in 2008, inseason genetic stock identification of Chinook salmon has been used as an additional management tool and has been particularly useful in managing Canadian-origin stocks. In 2008, 900 fish representing three major pulses from the Lower Yukon Test Fishery (LYTF) were analyzed for stock composition of each pulse inseason; results were reported within 48 hours of receipt at the Genetics Conservation Laboratory. In 2009, it was difficult to detect pulses in the LYTF, and 1,221 fish from the LYTF and Pilot Station Test Fishery, representing four strata, were analyzed. The estimated proportion of Canadian-origin Chinook salmon in each stratum ranged from 70% in the first stratum to 43% in the fourth stratum. The low overall run strength in 2008 and 2009, combined with inseason genetic information on the Canadian-bound proportion of the run highlighted concerns regarding the run's capacity to meet escapement goals and subsistence harvests. Consequently, fishery managers implemented reductions in the subsistence fishery and delayed the summer chum salmon commercial fishery.

ABUNDANCE ESTIMATES

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

Inseason abundance indices, however, have remained problematic. To improve drainagewide abundance estimates, several steps have been taken. A large-scale radiotelemetry project to estimate abundance and distribution of Chinook salmon was conducted above Russian Mission and Marshall from 2001–2004 (Spencer et al. 2006). The goal of this multi-year cooperative study was to determine migratory characteristics, abundance, and spawning distribution. This project provided population estimates that closely tracked Pilot Station sonar estimates in 3 out of 4 years.

In 2007, the Pilot Station Sonar Capital Improvement Project (CIP) was initiated to provide an independent estimate of Chinook salmon abundance in Yukon River and to verify the performance of the Pilot Station sonar project, using a reverse mark–recapture technique. This project estimates total run abundance by first estimating number of Canadian-origin Chinook salmon passing Pilot Station sonar using genetic proportions applied to total passage estimates. The second step is estimating the number of Canadian-origin Chinook salmon in subsistence and commercial harvests above Pilot Station using genetic proportions applied to harvest estimates. Lastly, estimated number of Canadian-origin Chinook salmon passing Pilot Station sonar are compared with aggregate estimates of Canadian fish in harvests plus the Chinook salmon passage estimate at Eagle sonar. Data have been collected for this project in 2007, 2008, and 2009. Once final subsistence harvest data are collected and tabulated for 2009, analyses will be completed.

To improve sonar-based estimates at Pilot Station, several options are being considered. ADF&G has sought funding to support investigation of the following possibilities: use of a side-scan sonar further offshore to count fish farther away from the bank during periods of high silt; use of longer nets in the test fishing program to identify any potential species-specific net avoidance; testing alternative fishing locations downriver of the current left bank site; investigating alternative sites for the sonar; and review the species apportionment model. Although most of Pilot Station sonar's difficulties estimating salmon abundance are beyond anyone's control, these efforts would likely aid our ability to better manage these issues.

ICHTHYOPHONUS

Ichthyophonus is a small, unicellular parasite infecting various fish species, including Chinook salmon. While the parasite is not harmful to humans, the effects on the fish host can be devastating. In addition to typical stock assessment methods described in pervious sections, ADF&G began research on *Ichthyophonus* in Yukon River Chinook salmon in response to increasing concerns that this disease may be affecting spawning escapement and spawning success. In 1999, Dr. Richard Kocan began baseline monitoring of *Ichthyophonus* prevalence in Chinook salmon entering Yukon River at Emmonak (Kocan et al. 2004); ADF&G continued to monitor infection prevalence at Emmonak and demonstrated a relatively stable prevalence of 18%, 24%, and 16% for 2004, 2005, and 2006, respectively (Kahler et al. 2007; Bonnie Borba, ADF&G Division of Commercial Fisheries, Fairbanks; personal communication). Sampling also included two terminal spawning locations at Chena and Salcha rivers from 2004–2006. Prevalence monitoring was maintained in Emmonak from 2007–2009 with funding provided by the U.S./Canada Yukon River Panel. The community of Eagle was added to the sampling regime in 2008 to assess fish arriving at the border and to answer pressing questions on physiological effects of *Ichthyophonus* on stamina, fecundity, and egg quality. Preliminary results indicate that prevalence in Emmonak dropped from 17% (JTC 2008) in 2007 to 9% and 13% in 2008 and 2009, respectively (Lara Dehn, PhD, Assistant Professor of Marine Biology, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks; unpublished data). *Ichthyophonus* time series data from Emmonak indicate a cyclic pattern to disease outbreaks with maxima and minima observed in 2003 and 2008, respectively.

Ichthyophonus research projects aim to track changes in baseline prevalence, test feasibility of non-lethal sampling techniques, and assess fecundity and egg quality of infected versus uninfected Chinook salmon. The 2004–2006 studies evaluated egg extrusion via internal examination of fish on the spawning grounds. On both Chena and Salcha rivers no significant difference was found in gamete extrusions between infected and uninfected Chinook salmon.

Therefore, preliminary results suggest Chinook salmon counted by escapement enumeration projects are depositing gametes regardless of infection. As a result, BEGs on Chena and Salcha rivers will not need to be reevaluated based on this criterion. However, these studies did not evaluate spawning success, as egg quality, embryo vitality, egg development, hatching success, and fry growth can be adversely affected by low energy reserves in spawning females. Energy reserves in Chinook salmon are considerable, but are almost completely depleted during the demanding spawning migration. Stress, such as disease caused by infection of *Ichthyophonus*, is energy demanding and diseased fish may re-route energy reserves from eggs to complete the spawning migration. Pre-spawning mortality is difficult to assess as Chinook salmon may travel over 900 miles in turbid glacial silt-laden rivers to reach spawning grounds. Analysis to determine egg quality is currently underway for samples collected in 2008 and 2009 at Eagle. In addition, studies to determine stress and tissue damage using chemical analysis of hormones and enzymes in blood plasma of Chinook salmon are currently being evaluated as a non-lethal tool to identify *Ichthyophonus*-positive fish.

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

CURRENT PROGRAMS

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

PILOT STATION SONAR

The lower river sonar assessment project located near Pilot Station (rm 107) has estimated passage of Chinook salmon in 1995 and 1997–2009. The Chinook salmon sonar estimate is further delineated by fish less than 655mm in length, which corresponds to age-4 and younger, and fish greater than or equal to 655mm in length; age-5 and older. Though problems with species apportionment, range limitations of the sonar, high water, and bank erosion affect the accuracy of these estimates, daily estimates combined with other indices (i.e., lower river test fishery CPUE) assist with inseason management strategies.

EAGLE SONAR

Due to concerns over the accuracy of Canadian border passage estimates derived from annual mark–recapture studies and the ability of the U.S. to meet treaty obligations for border passage based on these suspect estimates, ADF&G implemented a sonar program at Eagle, below the U.S./Canada border, to assess Chinook and fall chum salmon passage into the Canadian mainstem. Eagle sonar has operated from 2005–2009. Efforts to assess Chinook salmon passage at Eagle have been successful and, coupled with genetic stock identification, may provide a means to accurately estimate Chinook salmon in the Yukon River drainage.

WEIRS AND COUNTING TOWERS

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

FISH WHEELS

There are two fish wheel projects currently associated with assessment of Chinook salmon in Alaskan waters. One is located near the mouth of Tanana River (5-A) and another is located upstream near Nenana. Both of these fish wheels provide indices of Chinook salmon abundance through analysis of CPUE information.

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TABLES AND FIGURES

Table 1.–Yukon River Chinook salmon historical escapements from selected tributaries with escapement goals in Alaska.

		Ground Based Projects			Aerial Surveys [a]		
Year	Chena R.	Salcha R.	E. F. Andreafsky R.	W.F. Andreafsky	Anvik R.	Nulato R.	Gisasa R.
1980				1,500	1,330		951
1981							
1982			1,274	851			421
1983						1,006	572
1984				1,993			
1985			1,617	2,248	1,051	2,780	735
1986	9,065		1,954	3,158	1,118	2,974	1,346
1987	6,404	4,771	1,608	3,281	1,174	1,638	731
1988	3,346	4,562	1,020	1,448	1,805	1,775	797
1989	2,666	3,294	1,399	1,089			
1990	5,603	10,728	2,503	1,545	2,347		
1991	3,025	5,608	1,938	2,544		2,020	1,690
1992	5,230	7,862			1,536	579	910
1993	12,241	10,007	5,855	2,765	1,720	3,025	1,573
1994	11,877	18,399				1,795	2,775
1995	9,680	13,643	1,635	1,108	1,996	1,649	410
1996	7,153	7,570		624	839		
1997	13,390	18,514	1,140	1,510	3,979		
1998	4,745	5,027	1,027		709	1,053	
1999	6,485	9,198					
2000	4,694	4,595	1,018	427	1,721		
2001	9,696	13,328	1,065	570	1,420	1,884	1,298
2002	6,967	4,644	1,447	917	1,713	1,584	506
2003	8,739 [b]	11,758 [b]				1,321	731
2004	9,645	15,761	2,879	1,317	3,679	553	958
2005	[b]	5,988	1,715	1,492	2,421	1,292	843
2006	2,936	10,679		824	1,876	2,583	593
2007	3,806	6,425	1,758	976	1,529	922	
2008	3,212	2,731 [b]				2,260	515
2009	5,253	12,788		1,678	832		
5-Year Avg. (2005–2009)	3,802	8,970	1,737	1,243	1,665	1,522	727
BEGs:	2,800–5,700	3,300–6,500	SEG's: 960–1,700	640–1,600	1,100–1,700	940–1,900	420–1,100

[a] Only acceptable surveys are included.

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

Table 2.–Total Canadian harvest and escapement of Yukon River Chinook salmon, 1961–2009.

	Mainstem Yukon					Porcupine River		
	Non-Commercial					Old Crow	Total Canadian	
Year	Domestic	Aboriginal [a]	Sport [b]	Commercial	Total	Aboriginal	Harvest	Escapement
1961		9,300		3,446	12,746	500	13,246	
1962		9,300		4,037	13,337	600	13,937	
1963		7,750		2,283	10,033	44	10,077	
1964		4,124		3,208	7,332	76	7,408	
1965		3,021		2,265	5,286	94	5,380	
1966		2,445		1,942	4,387	65	4,452	
1967		2,920		2,187	5,107	43	5,150	
1968		2,800		2,212	5,012	30	5,042	
1969		957		1,640	2,597	27	2,624	
1970		2,044		2,611	4,655	8	4,663	
1971		3,260		3,178	6,438	9	6,447	
1972		3,960		1,769	5,729		5,729	
1973		2,319		2,199	4,518	4	4,522	
1974	406	3,342		1,808	5,556	75	5,631	
1975	400	2,500		3,000	5,900	100	6,000	
1976	500	1,000		3,500	5,000	25	5,025	
1977	531	2,247		4,720	7,498	29	7,527	
1978	421	2,485		2,975	5,881		5,881	
1979	1,200	3,000		6,175	10,375		10,375	
1980	3,500	7,546	300	9,500	20,846	2,000	22,846	
1981	237	8,879	300	8,593	18,009	100	18,109	
1982	435	7,433	300	8,640	16,808	400	17,208	43,538
1983	400	5,025	300	13,027	18,752	200	18,952	44,475
1984	260	5,850	300	9,885	16,295	500	16,795	50,005
1985	478	5,800	300	12,573	19,151	150	19,301	40,435

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Table 2.–Page 2 of 2.

	Mainstem Yukon					Porcupine River		
	Non-Commercial					Old Crow	Total Canadian	
Year	Domestic	Aboriginal [a]	Sport [b]	Commercial	Total	Aboriginal	Harvest	Escapement
1986	342	8,625	300	10,797	20,064	300	20,364	41,425
1987	330	6,069	300	10,864	17,563	51	17,614	41,307
1988	282	7,178	650	13,217	21,327	100	21,427	39,699
1989	400	6,930	300	9,789	17,419	525	17,944	60,299
1990	247	7,109	300	11,324	18,980	247	19,227	59,212
1991	227	9,011	300	10,906	20,444	163	20,607	42,728
1992	277	6,349	300	10,877	17,803	100	17,903	39,155
1993	243	5,576	300	10,350	16,469	142	16,611	36,244
1994	373	8,069	300	12,028	20,770	428	21,198	56,449
1995	300	7,942	700	11,146	20,088	796	20,884	50,673
1996	141	8,451	790	10,164	19,546	66	19,612	74,060
1997	288	8,888	1,230	5,311	15,717	811	16,528	53,821
1998	24	5,424		390	5,838	99	5,937	35,497
1999	213	8,804	177	3,160	12,354	114	12,468	37,184
2000		4,829			4,829	50	4,879	25,870
2001	89	8,183	146	1,351	9,769	370	10,139	52,564
2002	59	8,174	128	708	9,069	188	9,257	42,359
2003	115	6,384	275	2,672	9,446	173	9,619	80,594
2004	88	6,650	423	3,785	10,946	292	11,238	48,469
2005	65	6,376	173	4,066	10,680	394	11,074	68,551
2006	63	5,757	606	2,332	8,758	314	9,072	62,933
2007		4,792	2		4,794	300	5,094	34,903
2008		3,398		1	3,399	27	3,426	34,008
2009[c]	17	3,791	200	364	4,372	461	5,542	63,876
2005–2009 Avg.	48	4,823	245	1,691	6,401	299	6,842	52,854
1989–1998 Avg.	252	7,375	502	9,229	17,307	338	17,645	50,814

[a] Includes fish from DFO test fish operations.
[b] Canadian sport fish harvest unknown prior to 1980.
[c] Data are preliminary or unavailable.

Table 3.–Alaskan catch of Yukon River Chinook salmon, 1961–2009.

Year	Subsistence [a]	Commercial	Commercial Related [b]	Personal Use [c]	Test Fish Sales [d]	Sport Fish [e]	Total
1961	21,488	119,664					141,152
1962	11,110	94,734					105,844
1963	24,862	117,048					141,910
1964	16,231	93,587					109,818
1965	16,608	118,098					134,706
1966	11,572	93,315					104,887
1967	16,448	129,656					146,104
1968	12,106	106,526					118,632
1969	14,000	91,027					105,027
1970	13,874	79,145					93,019
1971	25,684	110,507					136,191
1972	20,258	92,840					113,098
1973	24,317	75,353					99,670
1974	19,964	98,089					118,053
1975	13,045	63,838					76,883
1976	17,806	87,776					105,582
1977	17,581	96,757				156	114,494
1978	30,785	99,168				523	130,476
1979	31,005	127,673				554	159,232
1980	42,724	153,985				956	197,665
1981	29,690	158,018				769	188,477
1982	28,158	123,644				1,006	152,808
1983	49,478	147,910				1,048	198,436
1984	42,428	119,904				351	162,683
1985	39,771	146,188				1,368	187,327
1986	45,238	99,970				796	146,004
1987	55,039	134,760 [f]		1,706		502	192,007
1988	45,495	100,364		2,125	1,081	944	150,009
1989	48,462	104,198		2,616	1,293	1,053	157,622
1990	48,587	95,247	413	2,594	2,048	544	149,433
1991	46,773	104,878	1,538		689	773	154,651
1992	47,077	120,245	927		962	431	169,642
1993	63,915	93,550	560	426	1,572	1,695	161,718
1994	53,902	113,137	703		1,631	2,281	171,654

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Table 3.–Page 2 of 2.

Year	Subsistence [a]	Commercial	Commercial Related [b]	Personal Use [c]	Test Fish Sales [d]	Sport Fish [e]	Total
1995	50,620	122,728	1,324	399	2,152	2,525	179,748
1996	45,671	89,671	521	215	1,698	3,151	140,927
1997	57,117	112,841	769	313	2,811	1,913	175,764
1998	54,124	43,618	81	357	926	654	99,760
1999	53,305	69,275	288	331	1,205	1,023	125,427
2000	36,404	8,518		75	597	276	45,870
2001 [g]	55,819			122		679	56,620
2002	43,742	24,128		126	528	486	69,010
2003	56,959	40,438		204	680	2,719	101,000
2004	55,713	56,151		201	792	1,513	114,370
2005	53,409	32,029		138	296	483	86,355
2006	48,593	45,829		89	817	739	96,067
2007 [h]	55,156	33,634		136	849	960	90,735
2008 [h]	45,312	4,641		121	0	409	50,483
2009 [h]	— [i]	131 [f]		130	0	— [i]	—
Average							
2005–2009	—	23,253		123	392	—	—
2004–2008	51,637	34,457		137	551	821	87,602
1989–1998	51,625	100,011	760	989	1,578	1,502	156,092

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

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

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

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

[e] Sport fish harvest for the Alaskan portion of the Yukon River drainage. Most of this harvest is believed to have been taken within the Tanana River drainage (see Schultz et al. 1993; 1992 Yukon Area Annual Management Report).

[f] No commercial fishery was conducted.

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

[h] Subsistence and personal use data are preliminary.

[i] Data not yet available and estimates cannot be ascertained due to unprecedented fishing restrictions.

Table 4.–Commercial catches of Chinook and summer chum salmon by mesh size, Districts 1 and 2, Lower Yukon Area, 1961–2009.

	Unrestricted Mesh Size [a]				6 inch Maximum Mesh Size [b]	
	Chinook			Summer Chum	Chinook	Summer Chum
Year	District 1	District 2	Total	Districts 1 and 2	Districts 1 and 2	Districts 1 and 2
1961	84,466	29,026	113,492	-	-	-
1962	67,099	22,224	89,323	-	-	-
1963	85,004	24,221	109,225	-	-	-
1964	67,555	20,246	87,801	-	-	-
1965	89,268	23,763	113,031	-	-	-
1966	70,788	16,927	87,715	-	-	-
1967	104,350	20,239	124,589	10,919	-	
1968	79,465	21,392	100,857	14,402	-	-
1969	70,588	14,756	85,344	41,418	97	15,437
1970	56,469	17,141	73,610	104,705	57	16,623
1971	84,397	19,226	103,623	42,189	1,176	57,851
1972	68,059	17,317	85,376	78,698	1,991	37,881
1973 [c]	52,790	12,479	65,269	89,841	5,168	196,540
1974	69,457	17,464	86,921	349,758	1,631	227,507
1975	41,550	9,064	50,614	148,919	4,162	345,472
1976	56,392	15,296	71,688	267,075	7,631	128,431
1977	65,745	15,328	81,073	157,909	4,720	205,634
1978	53,198	28,872	82,070	275,512	7,737	354,603
1979	61,790	33,347	95,137	136,973	22,136	434,188
1980	78,157	42,755	120,912	95,876	19,474	605,679
1981	88,038	37,660	125,698	163,979	18,648	758,767
1982	70,743	35,656	106,399	225,106	6,887	217,563
1983	76,280	30,798	107,078	121,927	31,002	590,329
1984	65,101	29,355	94,456	242,076	16,394	287,531
1985 [d]	76,106	38,194	114,300	170,345	22,445	265,240
1986	42,922	36,603	79,525	231,372	15,307	438,182
1987	62,147	40,127	102,274	128,017	21,827	269,757
1988	32,792	20,009	52,801	225,049	39,469	848,321
1989 [e]	32,180	21,494	53,674	126,360	38,548	765,233
1990 [e]	42,092	24,000	66,092	99,588	18,147	281,418

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Table 4.–Page 2 of 2.

	Unrestricted Mesh Size [a]				6 inch Maximum Mesh Size [d]	
	Chinook			Summer Chum	Chinook	Summer Chum
Year	District 1	District 2	Total	Districts 1 and 2	Districts 1 and 2	Districts 1 and 2
1991 [e]	52,074	36,290	88,364	108,986	4,145	205,610
1992 [e]	54,569	28,679	83,248	81,458	27,678	242,878
1993	47,084	37,293	84,377	47,488	2,202	45,503
1994 [f]	61,633	41,692	103,325	39,832	608	15,369
1995	74,827	39,607	114,434	113,860	3,098	112,223
1996	56,642	30,209	86,851	123,233	0	0
1997	63,062	39,052	102,114	49,953	3,611	28,204
1998	24,202	16,806	41,008	20,314	1,211	7,804
1999	37,145	27,119	64,264	27,883	0	0
2000	4,735	3,783	8,518	6,624	0	0
2001 [g]	0	0	0	0	0	0
2002	11,087	11,434	22,521	10,354	0	0
2003	22,709	14,220	36,929	6,162	0	0
2004	28,403	24,145	52,548	20,652	0	0
2005	16,619	13,413	30,032	32,278	0	0
2006	23,728	19,356	43,084	35,574	478	11,785
2007	13,558	9,238	22,796	11,311	9,121	164,911
2008 [h]	0	0	0	0	4,348	125,598
2009 [h]	0	0	0	0	131	157,906
10 Year Average 1986–1995	50,232	32,579	82,811	120,201	17,103	322,449
10 Year Average 1996–2005	26,460	18,018	44,479	29,745	482	3,601

Note: ADF&G test fishery sales included, 1961–1990. ADF&G test fishery sales not included, 1991–2009. Does not include Chinook caught during the fall season fishery.

[a] Primarily 8 to 8 ½ inch mesh size used during early June to early July.

[b] Catch through July 15–20; relatively few Chinook and summer chum salmon taken after these dates.

[c] Six inch maximum mesh size regulation beginning late June to early July became effective in 1973.

[d] Six inch maximum mesh size regulation by emergency order during commercial fishing season became effective in 1985.

[e] Only includes information from fish ticket database; does not include salmon purchased illegally.

[f] Eight inch or greater mesh size restriction was in effect until June 27 and fishers were requested to take chum salmon home for subsistence use until June 22 in order to reduce the harvest of chums.

[g] No commercial fishery in 2001.

[h] Due to conservation concern for Chinook salmon no unrestricted commercial periods were authorized.

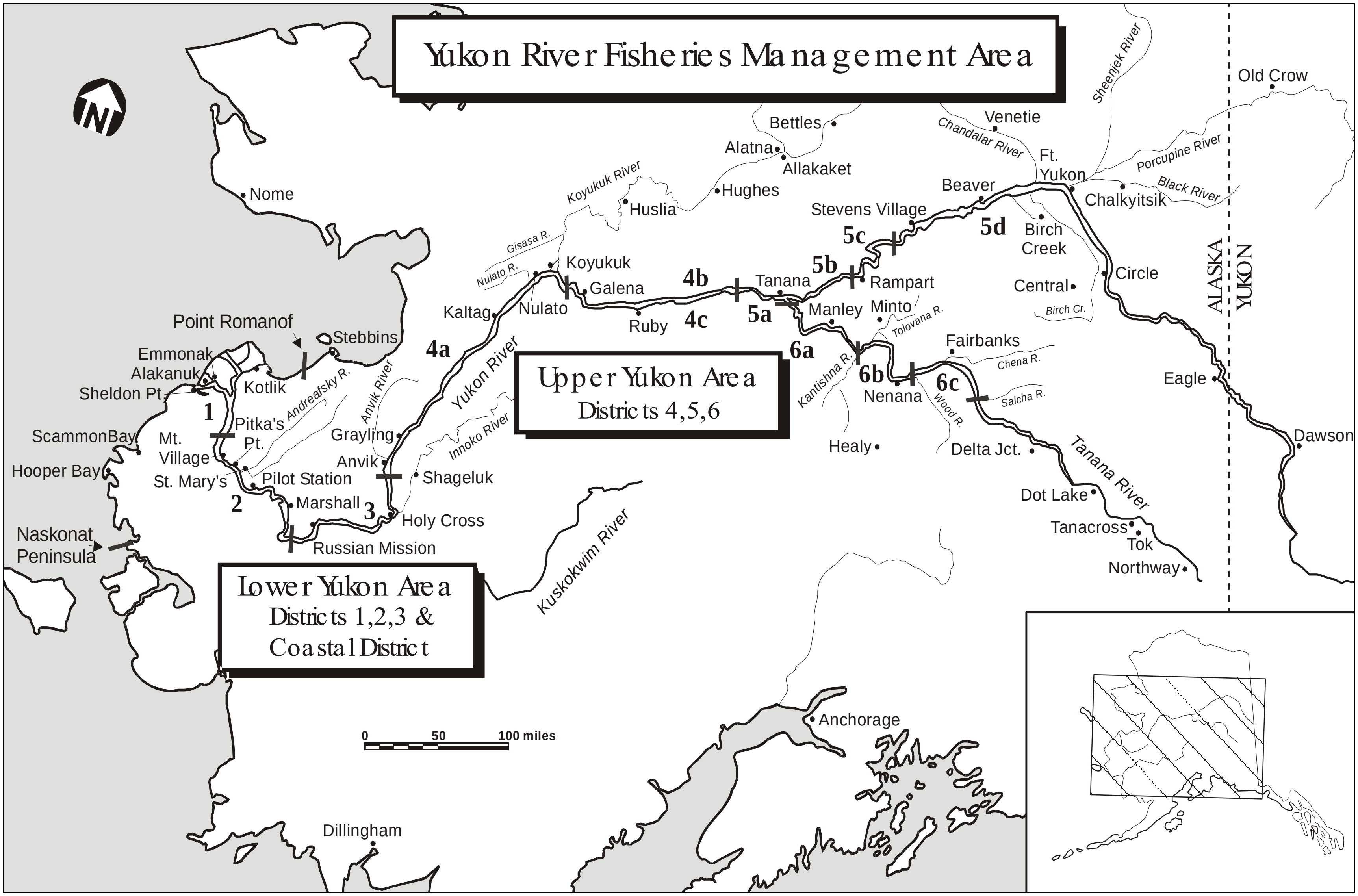
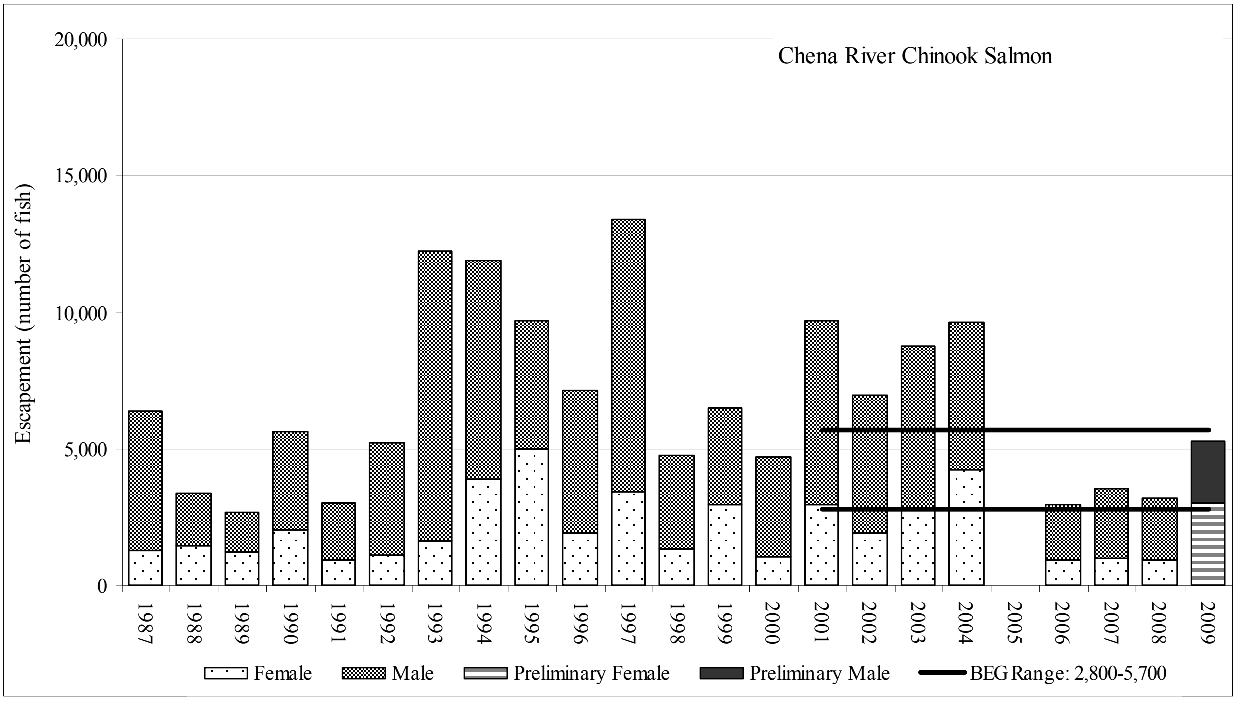


Figure 1.–Alaska portion of the Yukon River drainage showing communities and fishing districts.



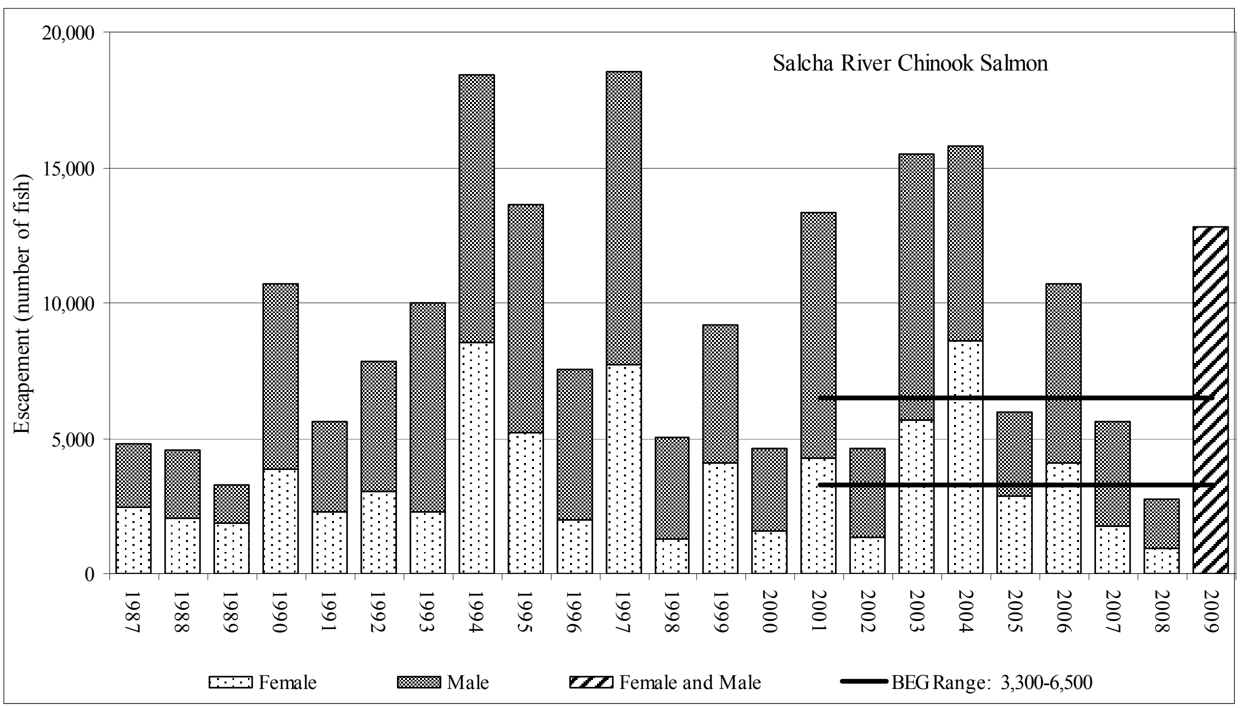
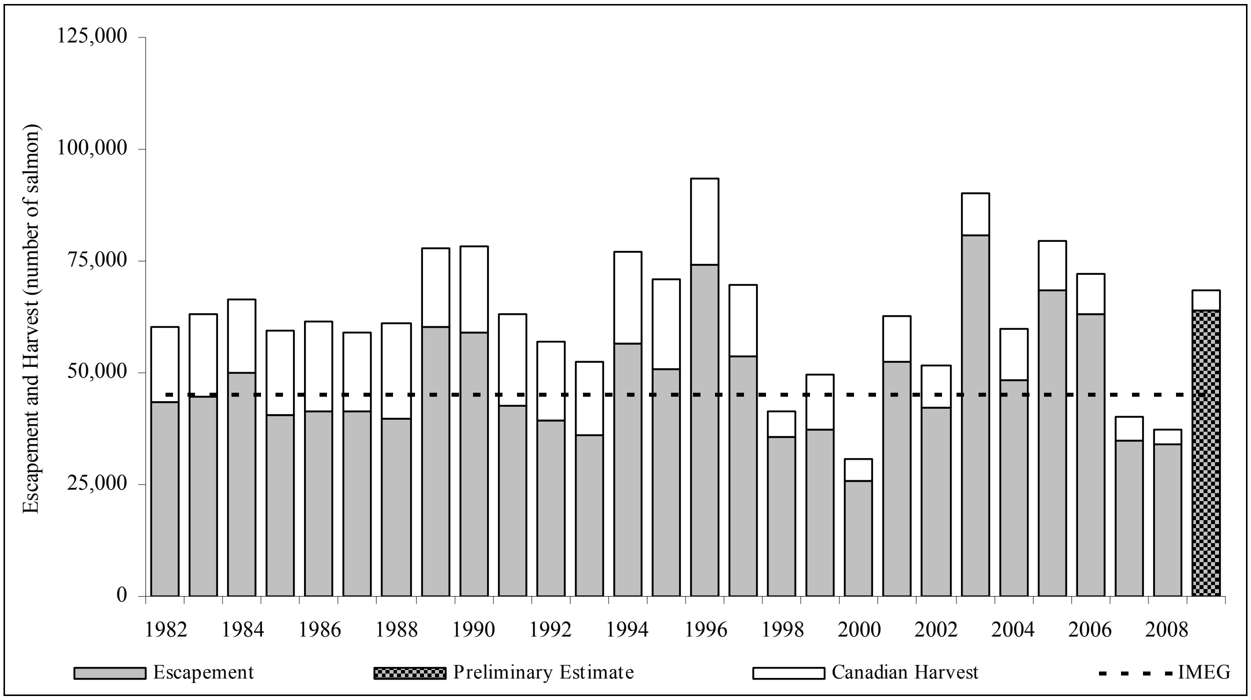
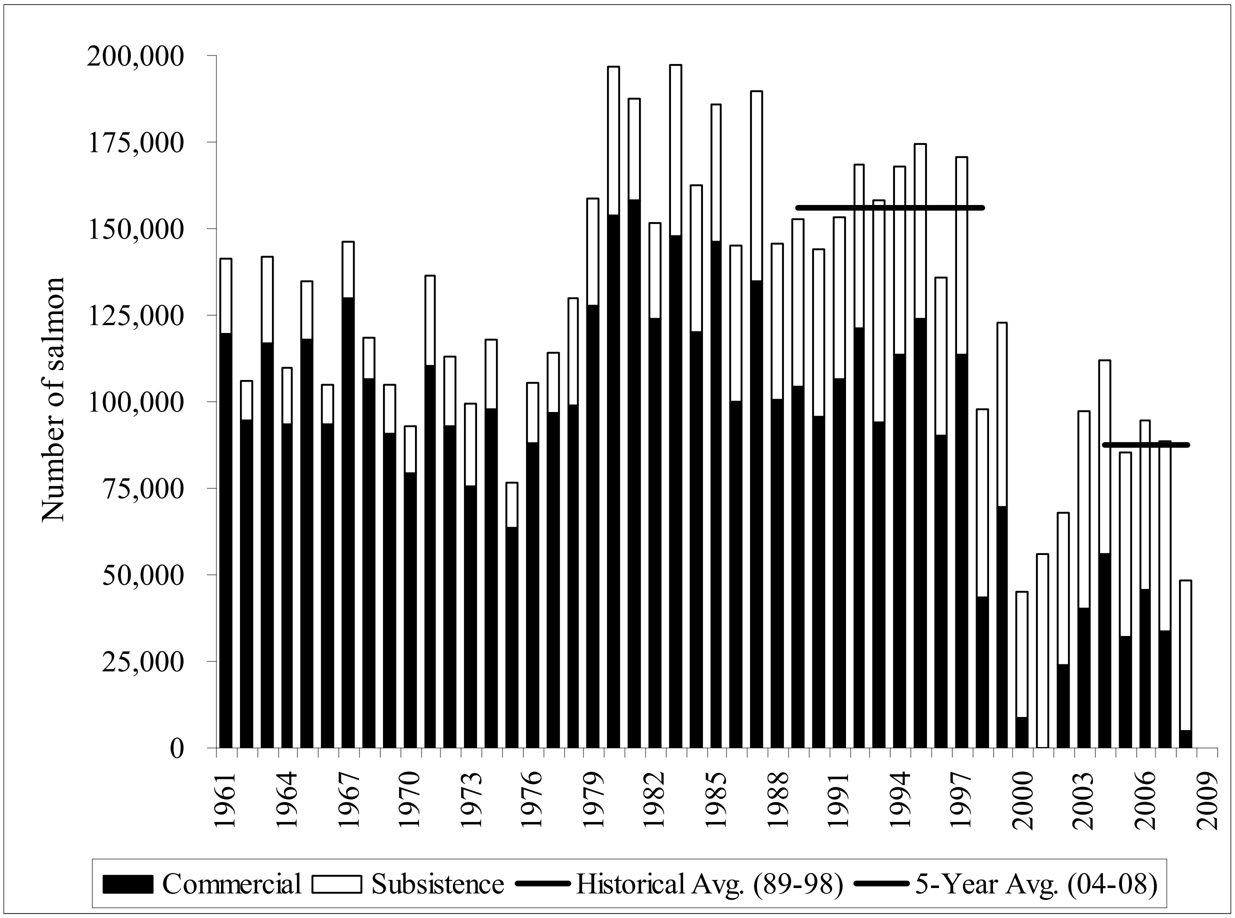


Figure 2.–Chinook salmon escapement by year and sex observed in Chena (above) and Salcha (below) rivers, Alaska, 1987–2008.



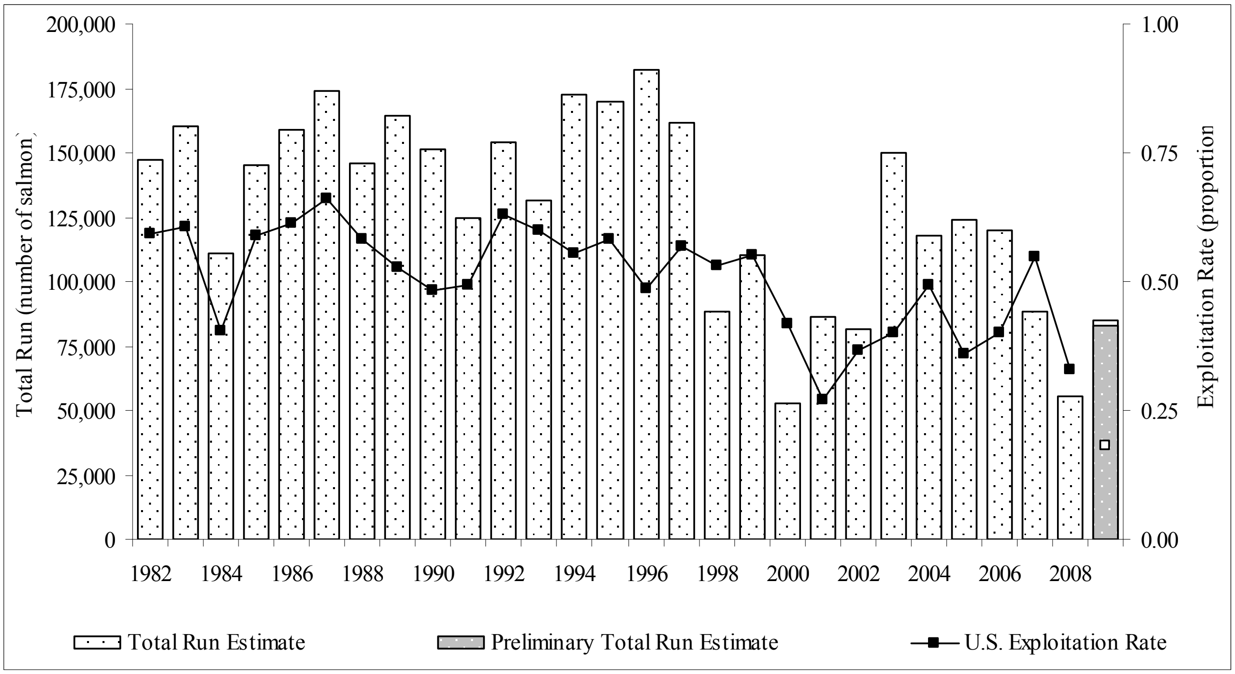
Note: Estimates prior to 2005 are based on a 3-area escapement index, Eagle Sonar (2005–2007), and radio telemetry (2002–2004) data.

Figure 3.–Eagle sonar-based estimates of Yukon River Chinook salmon passing into Canada by Canadian harvest and escapement, mainstem Yukon River, Canada, 1982–2009.



Note: Subsistence harvest data for 2009 are not illustrated as they are not yet available.

Figure 4.–Yukon River Chinook salmon subsistence and commercial harvests compared to the historical baseline 1989–1998 average (156,092) and the recent 2004–2008 average (87,777).



Note: Estimates prior to 2005 are based on a 3-area escapement index, Eagle Sonar (2005–2007), and radio telemetry (2002–2004) data.

Figure 5.–Annual total run estimates and associated U.S. exploitation rates on Canadian-origin Yukon River Chinook salmon, 1982–2009.

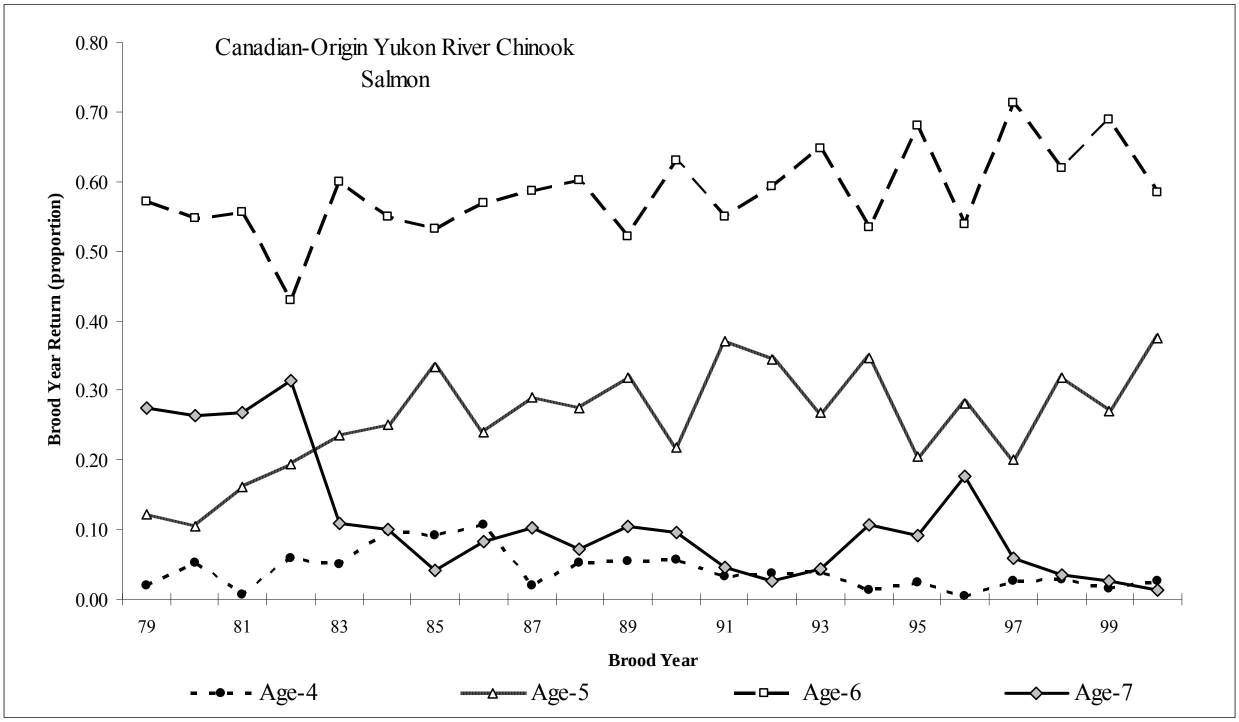


Figure 6.–Brood year return age class composition of Yukon River Canadian-origin Chinook salmon 1979–2000.

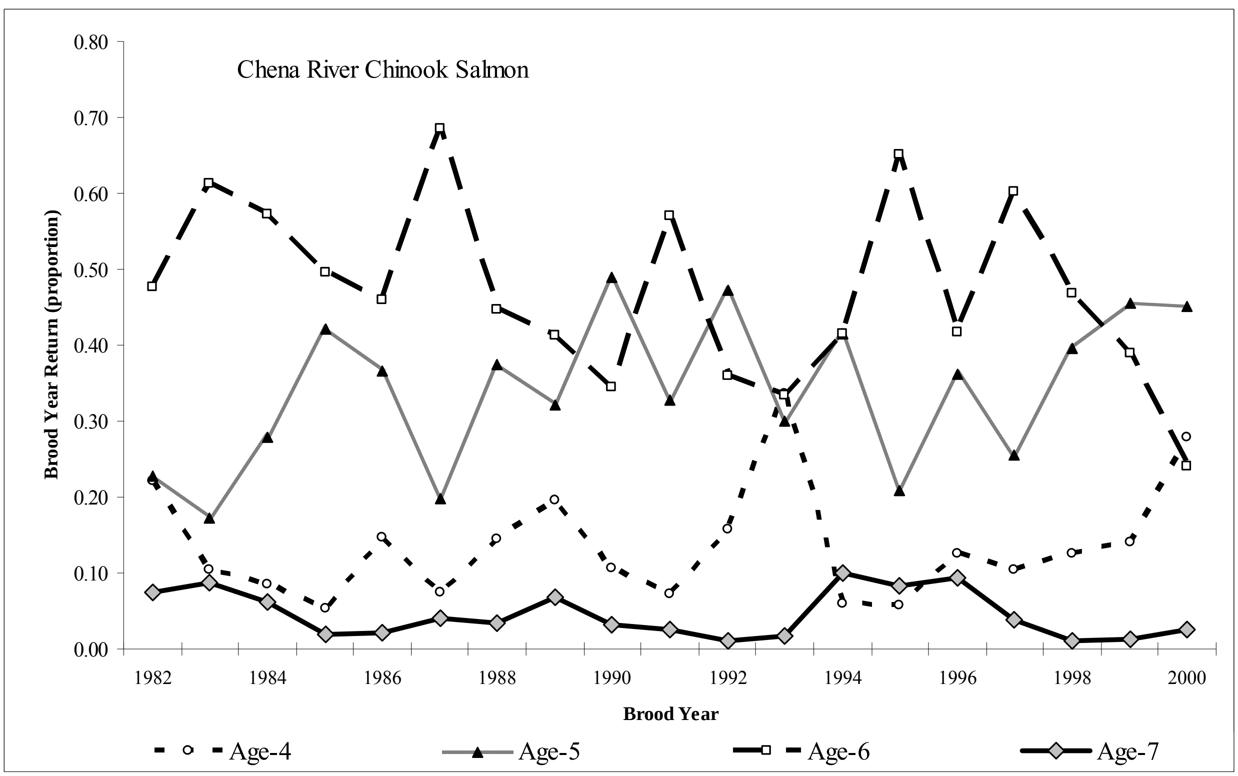


Figure 7.–Brood year return age class composition of Chena River-origin Chinook salmon, 1982–2000.

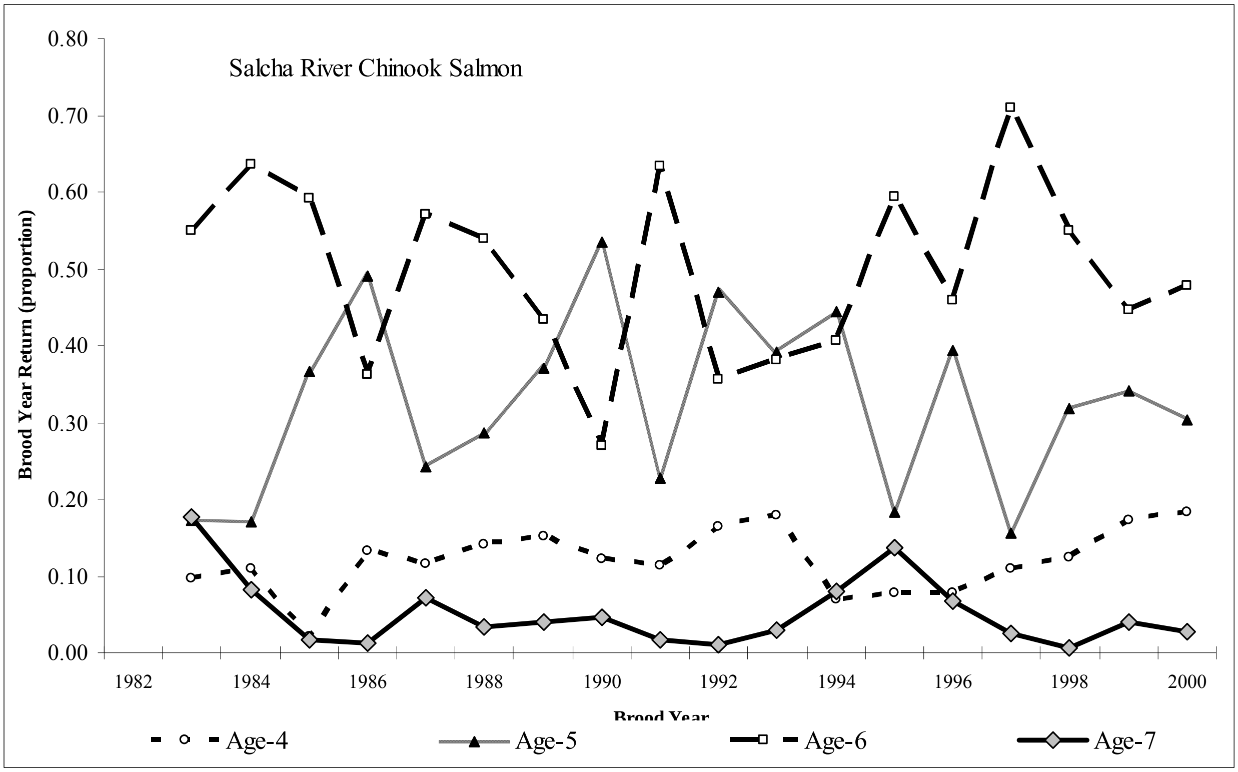


Figure 8.–Brood year return age class composition of Salcha River-origin Chinook salmon, 1983–2000.

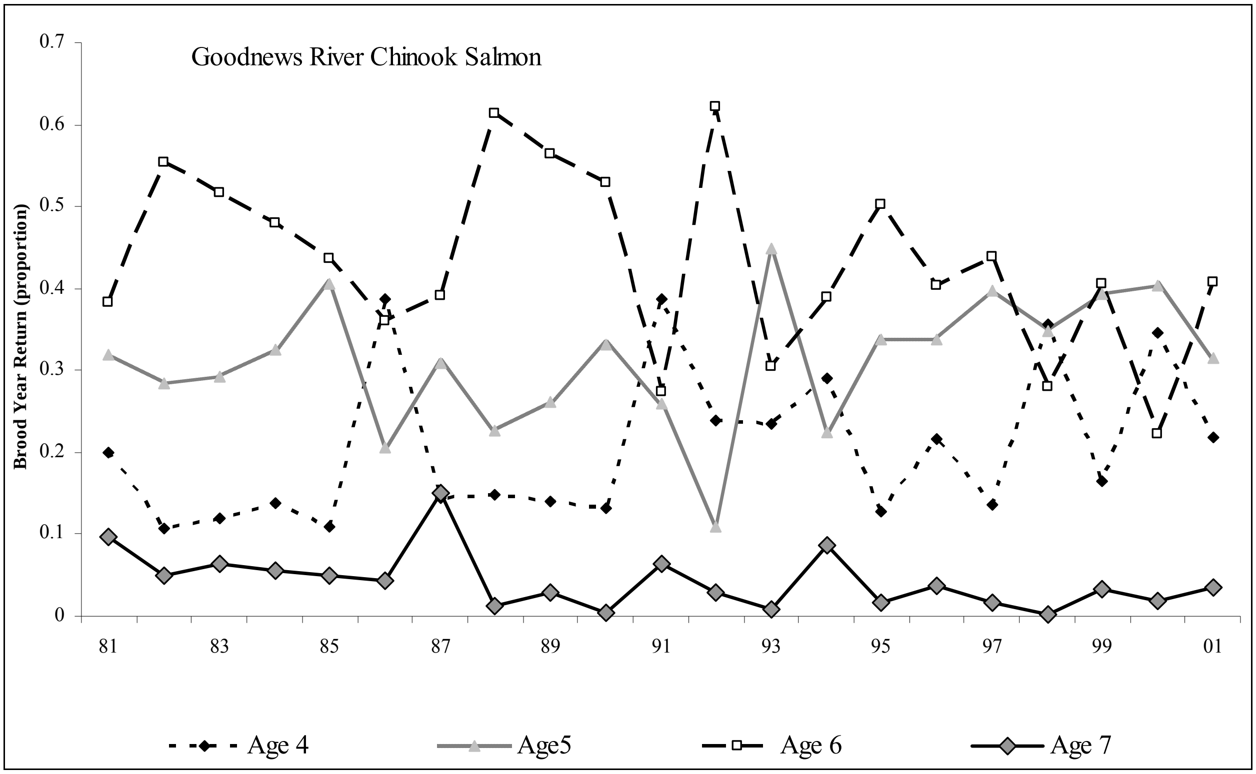


Figure 9.–Brood year return age class composition of Goodnews River-origin Chinook salmon, 1981–2001.

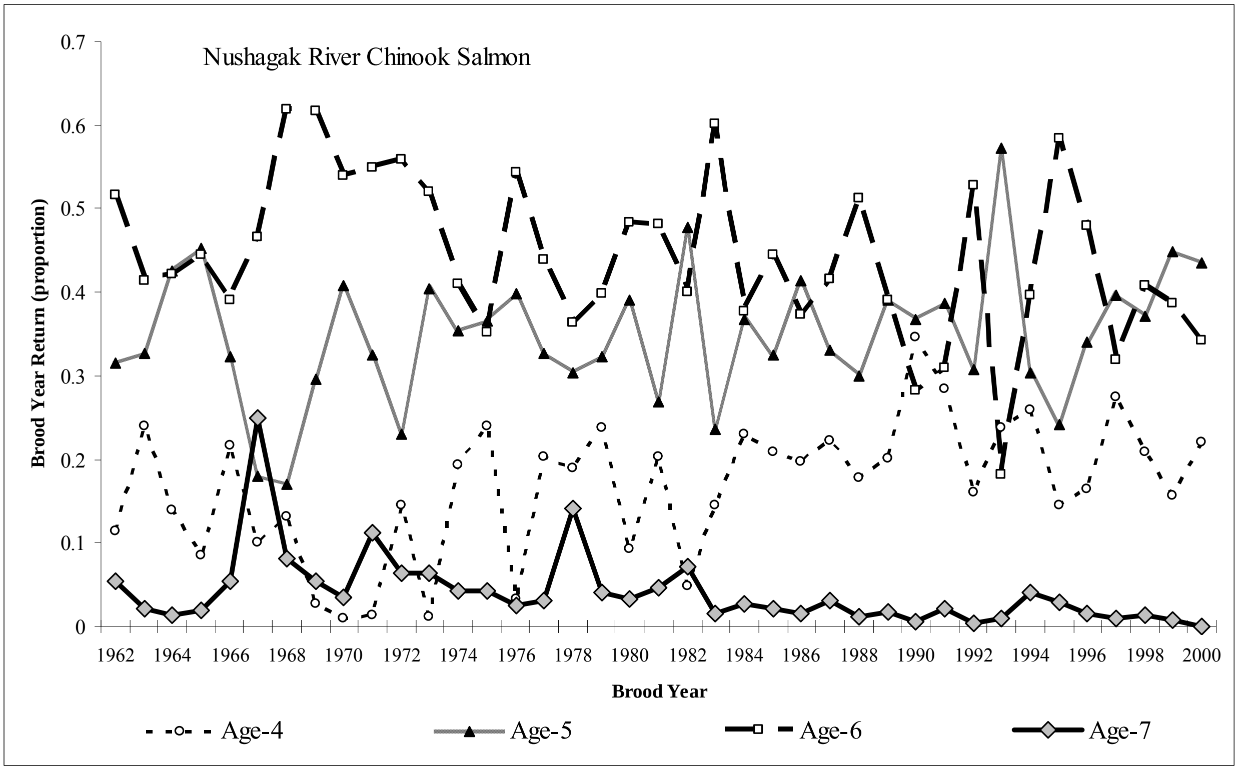


Figure 10.–Brood year return age class composition of Nushagak River-origin Chinook Salmon, 1962–2000.

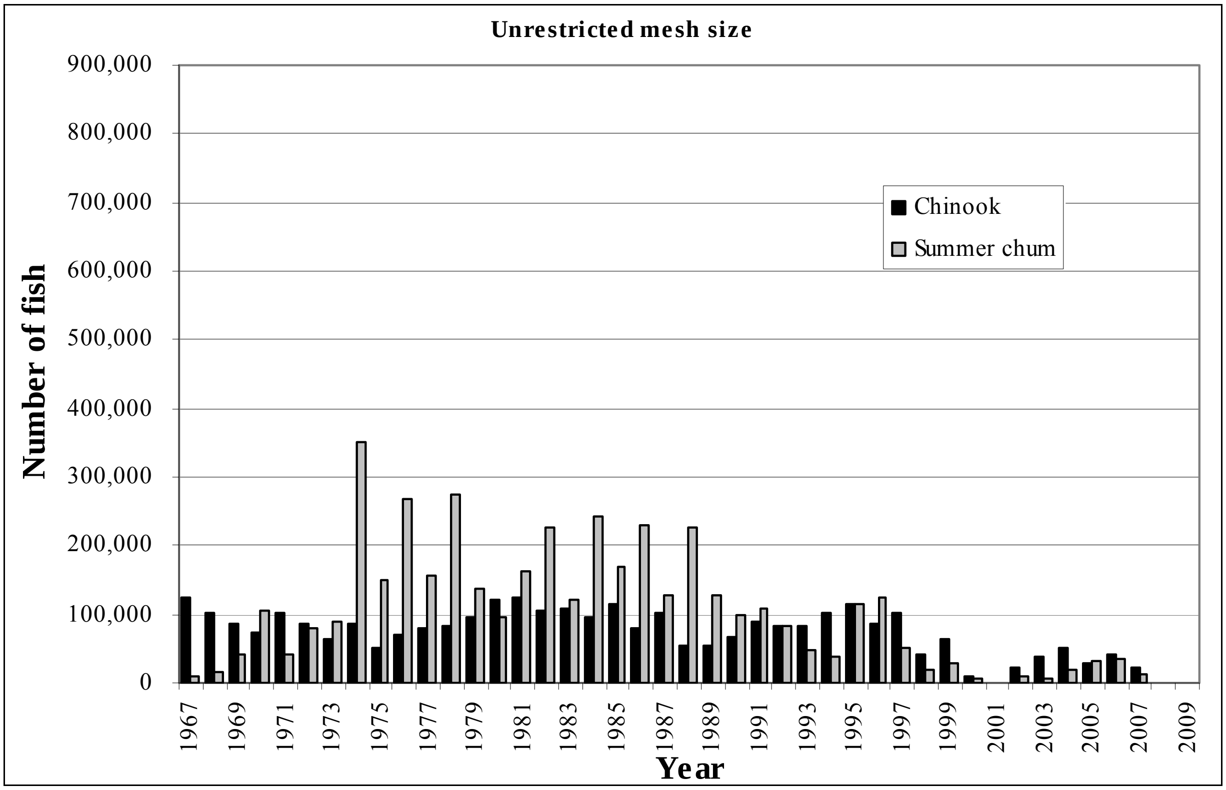


Figure 11.–Number of Chinook and summer chum salmon harvested during lower river commercial fishery openings of unrestricted mesh size, 1967–2009.

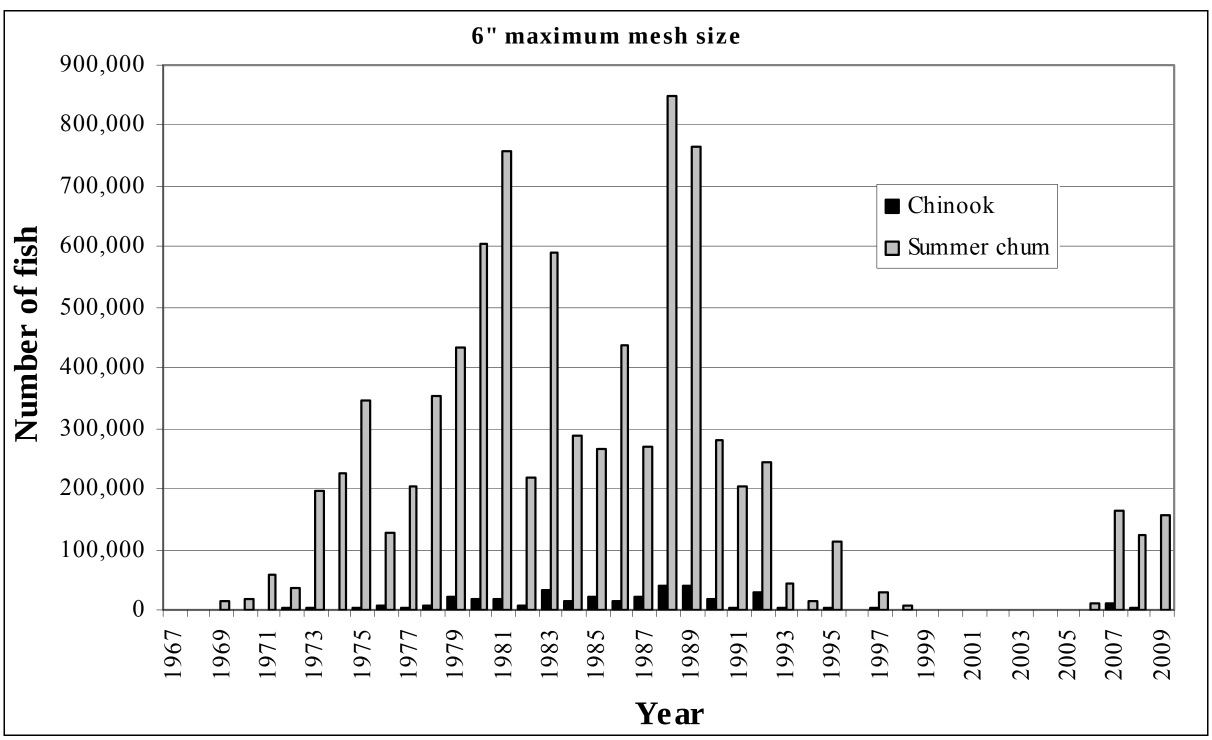
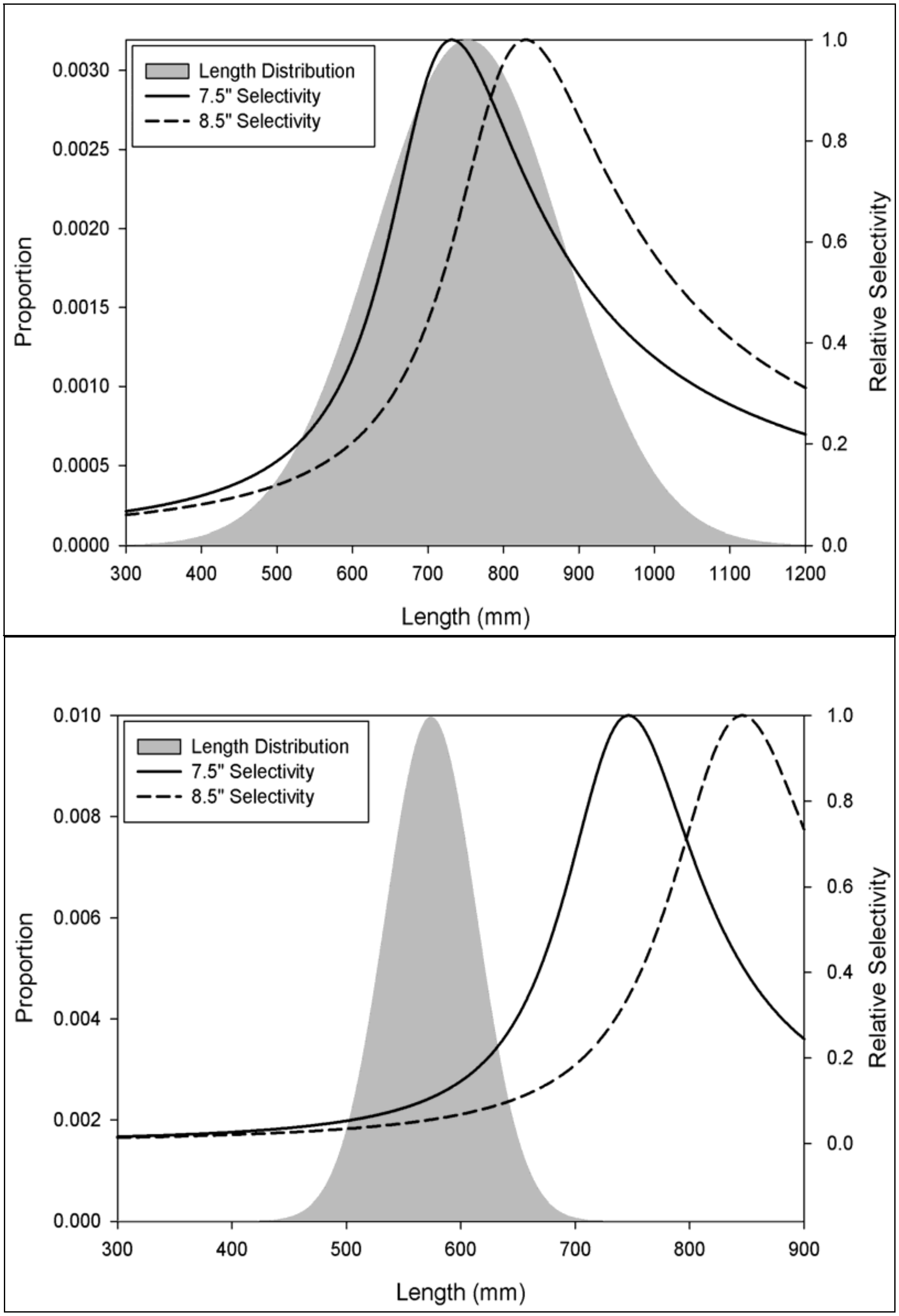
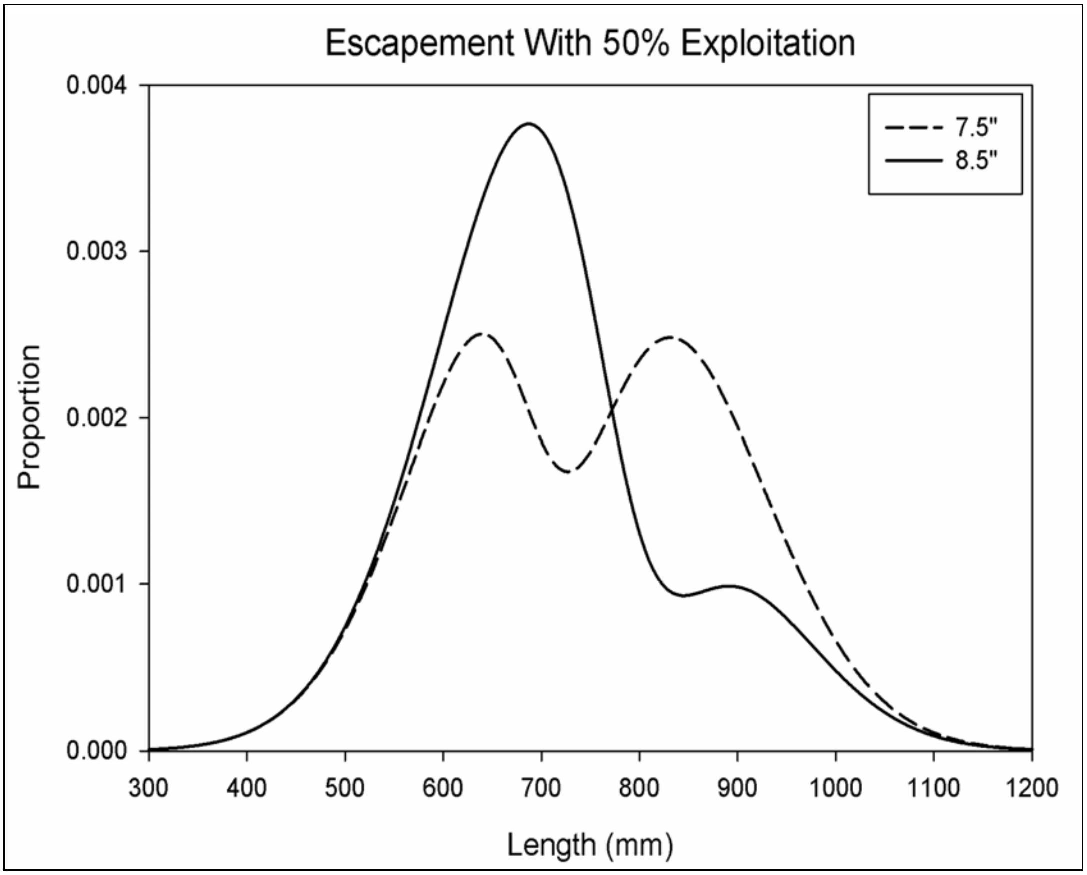


Figure 12.–Number of Chinook and summer chum salmon harvested during lower river commercial fishery openings restricted to 6-inch maximum mesh size, 1967–2009.



Source: J. Bromaghin, USFWS; personal communication.

Figure 13.–Comparison of estimated size distributions of Yukon River Chinook (top graph) and chum salmon (bottom graph) runs and mesh selectivity for 7.5 and 8.5 inch mesh gillnets.



Source: J. Bromaghin, USFWS; personal communication.

Figure 14.–Comparison of estimated length frequencies for escapements of an example Chinook salmon run for fisheries using 7.5 and 8.5 inch mesh gillnets.