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

REVISION

2/2/2007

This report contains revised text on pages 16-17, addressing the subject of Ichthyophonus. The second paragraph has been revised in order to more clearly describe the research on the effects of Ichthyophonus and spawning success.

by

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and

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December 2006

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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by

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The Division of Sport Fish Special Publications series was established 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 other documents that do not fit in another publication series of the Division of Sport Fish. Since 2004, the Division of Commercial Fisheries has also used the same Special Publication series. Special Publications are intended for fishery and other technical professionals. Special Publications are available through the Alaska State Library 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 the September 2000 work session. An action plan was developed by the Alaska Department of Fish and Game (ADF&G, department) and acted upon by the BOF in January 2001. The stock of concern status for a yield concern was continued at the January 2004 BOF meeting. 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. The 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 (2002–2006). 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 (2002–2006) average. Although annual subsistence harvest continues to remain stable near 50,000 Chinook salmon, commercial harvests have decreased over 60% in recent years. Although the potential yield in 2003 may have been near the 10-year average (1989–1998), the average available harvest for the years 2002 through 2006 was substantially less than the average yield from 1989 through 1998. In continued response to the extremely poor run in 2000, conservative management strategies are still in effect. Based on the guidelines established in the *Policy for the Management* of Sustainable Salmon Fisheries (5 AAC 39.222), the department 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, effective 2000, amended 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, including escapement performance and ability of the stock to provide for historic harvestable surpluses.

In response to the guidelines established in the SSFP (5 AAC 39.222(f)(42)), the BOF classified the Yukon River Chinook salmon *Oncorhynchus tshawytscha* as a yield concern at the September 2000 work session. A stock of yield concern is defined as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs; a yield concern is less severe than a management concern" (5 AAC 39.222(f)(42)). The SSFP defines chronic inability as "the continuing or anticipated inability to meet expected yields over a 4 to 5 year period". This determination as a yield concern was originally based on low harvest levels for the previous 3-year period (1998–2000) and anticipated low harvest in 2001. An action plan was subsequently developed by the department (SSFP; 5 AAC 39.222) and acted upon by the BOF in January 2001. The classification as a yield concern was continued at the January 2004 BOF meeting (Lingnau and Bergstrom 2004). Based on definitions provided in SSFP (5 AAC 39.222(f)(5, 42)), only the most recent 5-year yield and escapements (2002–2006) and the historical levels of yield or harvestable surpluses were considered in our current analysis and subsequent recommendations concerning stock of concern status. For purposes of this report and the recommendation regarding the yield stock of concern classification, harvests during the 10-year

period, from 1989 through 1998, were considered the historical base of comparison for Yukon River Chinook salmon harvests.

Chinook salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage (Figure 1) the past 5 years (2002–2006). These include two biological escapement goals (BEGs) and five sustainable escapement goals (SEGs) established by the department for U.S. tributaries and a rebuilding escapement target for Canadian mainstem passage negotiated by members of the U.S./Canada Yukon River Panel (Panel). Inseason management actions have contributed to success in achieving escapement goals. However, total Chinook salmon harvests have decreased substantially, with the most recent 5-year (2002–2006) average harvest approximately 40% below the historic base 10-year (1989–1998) average of 156,092 fish. With annual subsistence harvests fairly stable near 50,000 Chinook salmon, this decline is largely represented by smaller commercial harvests, which have decreased over 60% for the same time periods. The extremely poor run in 2000 dictates continued conservative management strategies, and only the 2003 run provided an available surplus within the range of expected yield.

During the October 2006 BOF work session, the department recommended Yukon River Chinook salmon continue as a stock of yield concern. This recommendation 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 for 4 of the last 5 years.

STOCK ASSESSMENT BACKGROUND

Escapement

Chinook salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage the past 5 years 2002–2006 (Table 1). Tributary escapements have been monitored with counting tower projects in the Chena and Salcha rivers and with aerial surveys in the Andreafsky, Anvik, Gisasa, and Nulato rivers (Figure 1). BEGs in the Chena and Salcha Rivers have been met or exceeded since 2000, except in 2005 where no escapement estimate for Chena River was available due to high water affecting counts (Figure 2). The 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 because of missing years. SEGs in the East and West Fork Andreafsky River, Anvik and Gisasa rivers have been met in all years surveyed since 2002 and in the Nulato River in 2 of 3 years surveyed (Table 1). A full evaluation of escapement goal performance for these rivers is difficult due to incomplete aerial survey records.

To characterize spawning escapement, carcass surveys were conducted on the Chena and Salcha rivers on an annual basis. Raw sex and age composition survey data from both rivers were adjusted to account for biases associated with carcass surveys (Zhou 2002), based on data obtained from mark–recapture projects in the Chena River during 1989–1992, 1995, 1996, 1997, 2000 and 2002 and in the Salcha River during 1987–1992, and 1996. Evaluation of the bias associated with carcass surveys was based on recapture rates of fish that were captured and marked with electrofishing gear. A correction factor was developed for each river that adjusts the sex-age compositions in years when only a carcass survey is conducted (i.e. during years abundance is estimated from tower counts). During the periods 1989–1998 and 2002–2006, both average age and sex composition were very similar between rivers and among time periods. Age-6 and age-5 salmon dominated the escapement in both rivers during both time periods.

Average percent of age-6 salmon ranged from 40% to 51%, while average percent age-5 salmon ranged from 31% to 38%. Together, on average, these two age classes accounted for between 76% and 83% of the entire escapement. Percent of age-4 salmon ranged from 14%–17%, while percent age-7 salmon ranged from 3% to 6%. Percent female ranged from 30% in the Chena River during the 1989–1998 period to 39% in both rivers during the more recent period, 2002–2006. In the Chena and Salcha rivers, percent of female Chinook salmon in the escapement increased 9% and 5% percent, respectively, during the 2002–2006 period over the previous period. Although the average female component of the escapement did not dominate, female salmon escapement to both the Chena and Salcha rivers frequently achieve the lower end of the established escapement goal (Figure 2), which is based on total number of both female and male spawners.

Chena and Salcha Rivers Chinook Salmon Escapement
Average Age and Sex Composition

1989–1998

	Average Age Composition (%)				Average %
	4	5	6	7	Female
Chena River	17	36	40	6	30
Salcha River	14	35	44	6	34

2002–2006

	Average Age Composition (%)				Average %
	4	5	6	7	Female
Chena River	14	38	45	3	39
Salcha River	14	31	51	4	39

The rebuilding step escapement target of 28,000 in the Canadian mainstem Yukon River agreed to and adopted by the Panel has been exceeded each year since 2000 averaging 36,981 fish, based on the Canadian Department of Fisheries and Oceans (DFO) passage estimate, from 2001–2005 (Table 2; Figure 3). Escapements during this most recent period are approximately 42% higher than the average escapement of 27,858 Chinook salmon during the 1989–1998 period (Table 2). A preliminary border passage estimate of approximately 33,000 Chinook salmon and an associated escapement of approximately 28,000 Chinook salmon were presented by Canadian DFO staff to the U.S./Canada Yukon Panel members during their December 2006 meeting. However, Canadian DFO staff indicated that this estimate is biased low and is currently being analyzed further.

Harvest

Combined commercial and subsistence harvests show a substantial decrease in Chinook salmon yield from the 10-year period of 1989 to 1998 compared to the recent 5-year (2002–2006) average of 94,377 salmon (Table 3; Figure 4). This most recent 5-year average Alaskan Chinook salmon harvest is approximately 40% below the 10-year (1989–1998) average of 156,092 fish. Although the subsistence harvest continues to remain stable near 50,000 Chinook salmon annually, commercial harvests have decreased over 60% from an average of 100,695 annually (1989–1998) to the recent 5-year average (2002–2006) of 39,715 fish (Table 3) In response to the extremely poor run in 2000, conservative management strategies have been employed. After no commercial harvest in 2001, only 24,128 Chinook salmon were commercially harvested in

2002 (Table 3). In 2003, although the preseason outlook was for a small commercial harvest of between 0 and 20,000 fish, the Chinook salmon run was much stronger than anticipated and, the commercial harvest reached 40,438 salmon (Table 3). Record escapements into the Tanana River (Figure 2) and Canada (Figure 3) indicated that up to 40,000 additional Chinook salmon were available for commercial harvest but foregone because of conservative management strategies. Additionally, a smaller surplus of fish potentially available for commercial harvest in 2004 was foregone (Figures 2 and 3). However, the 2005 and 2006 commercial harvests were within the range of available surplus given the below average run size.

In summary, the trend of declining runs of Yukon River Chinook salmon began in 1998, with the 2000 run the worst on record. The average available harvest for the years 2002 through 2006 was substantially less than the average yield from 1989 through 1998. Potential yield in 2003 may have been near the previous 10-year average. However, increased run strength for Chinook salmon during the period 2001–2006 indicates production is improving.

Exploitation Rates

Knowledge of exploitation rates is an essential component for effective management of the Yukon River Chinook salmon fishery. Exploitation rate is defined as that portion 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 the Yukon River in Alaska because total escapement to these regions cannot be estimated. However, total run estimates for the upper river component, or the Canadian component, can be determined based on border passage estimates.

Border passage into Canada has been estimated since 1982 by the Canadian DFO using mark–recapture techniques, and more recently, by ADF&G using radiotelemetry (2002–2004) and sonar (2004–2006). The Canadian DFO border passage estimates have been derived from mark–recapture estimates using two fish wheels near the border at river mile (RM) 1,224. This border passage estimate has formed the basis for the U.S./Canada Yukon River Salmon Agreement (Agreement). The Canadian mark–recapture border passage estimates from 1982–2006 averaged 41,726 Chinook salmon, ranging from 16,174 in 2000 to 56,929 in 2003 (Table 2; Figure 3).

From 1982–2003 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 techniques. Apportionment of harvest to stock of origin indicates that the Canadian component comprises approximately 50% of the Alaska harvest, and probably, the run. This proportion has remained relatively constant over the years. Because of the gauntlet nature of Yukon River fisheries, we believe that the exploitation exerted on Canadian fish is most likely the highest of any Yukon River Chinook salmon stock.

Based on harvest apportionment estimates from the two techniques in conjunction with the border passage estimates, we estimated the total run size of the Canadian Chinook salmon stock from 1982–2006 (Figure 5). Based on the Canadian DFO mark–recapture estimate of border passage, total run size of the Canadian Chinook salmon run has ranged from approximately 38,300 in 2000 to 151,400 in 1995. Accordingly, we also calculated the exploitation rate that Alaskan fishers exert on the Canadian stock (Figure 5). Associated exploitation rates exerted by Alaskan fishers on this stock ranged from 31% in 2001 to 79% in 1987 (Figure 5). Average

exploitation rates during the period 2001–2005 decreased by 19% from the 1989–1998 average (Figure 5).

During the years 2001–2004, a radiotelemetry, mark–recapture project was implemented to estimate the Chinook salmon passage past Russian Mission (RM 213). Starting in 2002, this project provided an independent estimate of the number of Chinook salmon passing into Canada. This estimate was based on the proportion of radio-tagged fish passing the Canadian border. Estimated total annual border passage of Chinook salmon into Canada during this period averaged about 69,100 fish and ranged from approximately 38,300 fish in 2002 to approximately 101,000 fish in 2003. During this period and using this method to determine border passage, the estimated exploitation rate exerted on the Canadian-origin Chinook salmon stock by Alaskan fishers averaged about 43%, ranging from 37% in 2003 to 47% in 2004 (Figure 6). Corresponding exploitation rates based on the Canadian DFO border passage estimate averaged 48% and ranged from 38% in 2002 to 56% in 2004 (Figure 6).

Because of the marked difference between the Canadian DFO mark–recapture and the ADF&G radiotelemetry border passage estimates, ADF&G initiated a sonar project at Eagle, Alaska in 2005 to more accurately estimate salmon passage into Canada on the mainstem Yukon River. The estimated number of Chinook salmon passing into Canada was approximately 81,500 and 75,000 fish in 2005 and 2006 respectively. Using the passage estimates derived from sonar operations, Alaskan fishers exerted an exploitation rate on Canadian-origin Chinook salmon of 35% in 2005 and 40% (preliminary estimate) in 2006 (Figure 6). Corresponding exploitation rates estimated based on the Canadian DFO border passage estimate were 51% and 60% (preliminary estimate), respectively (Figure 6).

Because the different population estimation methods result in markedly different estimates of Chinook salmon passing into Canada, associated Chinook salmon estimates of escapement on the spawning grounds in the mainstem Yukon River in Canada also differ markedly. Escapements derived from the border passage estimate using radiotelemetry, mark–recapture techniques ranged from 27% below the Canadian DFO escapement estimate in 2004 to nearly double the Canadian DFO escapement estimate in 2003. The Chinook salmon escapement estimate derived from the ADF&G sonar passage estimate was approximately 2.3 and 2.5 times the Canadian DFO escapement estimate for 2004 and 2005, respectively (Figure 7).

Using any of the above techniques, it is clear that recent exploitation rates are low in comparison to historic rates exerted during the 1970s, 1980s, and 1990s, reflecting the conservative fishery management regime in place. We believe that the Eagle sonar project provides the most accurate estimates of Chinook salmon passage into Canada and that exploitation rates derived from this method represent our most realistic measure for the future.

Brood Year Return Information

Brood year tables have been constructed for three Chinook salmon stocks within the Yukon River drainage, the Chena and Salcha rivers stocks in Alaska and the mainstem Yukon River stock in Canada. The total brood return divided by the parent-year escapement is a measure of the productivity of the stock and is usually expressed as recruits or return per spawner (R/S). Based on these data, the R/S for Canadian-origin Chinook salmon stock has ranged from 1.7 R/S for the 1994 spawning event (or brood year) to about 10.7 R/S for fish returning from the spawning event in 1986, with an overall average of about 5.1 R/S.

Brood year tables also provide information regarding the age-class composition of the return. Yukon River Chinook salmon return as age-2 through age-8 fish, but age-6 and age-5 salmon dominate the run. Unlike the age class composition of the run, which varies from year to year because of the variability in year class strength, the age class composition of the return represents a more accurate assessment of the age class composition of the stock over time. Of particular interest is the percentage of age-7 fish, which according to observations by fishers along the river, have been generally decreasing.

Age-class composition of the Canadian-origin Chinook salmon return from brood years 1979–1998 indicates that, aside from a dramatic decrease in age-7 salmon from the 27% average during years 1979–1982 to the 8% average during the 10-year period immediately following, 1983–1992, the age-class composition has remained relatively stable (Figure 8). Average age class composition comparisons between the 1983–1992 brood year period to the more recent 1993–1998 brood year period indicates that age-4 decreased an average of 5%, age-5 salmon decreased slightly by 2%, age-6 salmon increased an average of 6%, and age-7 salmon increased slightly by 2% (Figure 8).

Although more variable than the Canadian-origin Chinook salmon return, inspection of the age class composition of the Chinook salmon stock that originates in the Chena and Salcha rivers indicates the same general pattern with age-4 and age-5 salmon decreasing slightly from the 1983–1992 period to the 1993–1998 brood year period and age-6 and age-7 salmon increasing slightly (Figure 9 and 10). The dramatic and lasting decrease in the age-7 component in the Canadian-origin stock between 1982 and 1983 is not readily apparent in the Chena or the Salcha River stock. However, it is obvious in the much longer history of the Nushagak River Chinook salmon stock in Bristol Bay (Figure 11). Because this decrease in age-7 is found in a stock that is not within the Yukon River, it fosters speculation that other factors associated with environmental conditions may have played some role resulting in this obvious decline in the proportion age-7 salmon in the brood year return.

STOCK OF CONCERN RECOMMENDATION

Yukon River Chinook salmon escapement goals have generally been met since 2000. Although an additional harvestable surplus of Chinook salmon existed in 2003 and 2004, it was not taken because conservative management strategies were in effect. Given that the most recent 5-year average harvest from this stock remains approximately 40% 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 of 5 AAC 39.222(f)(42), ADF&G recommends continuation of the yield concern classification. However, the department also believes that the Yukon Chinook salmon stock may have been overexploited in the 1980s and 1990s. Therefore, it may not be appropriate to expect to return to average historic yields in the future. During the next 3 years, ADF&G will attempt to determine the level of sustainable yield for this stock, rather than simply comparing recent harvests to previous historical harvests.

OUTLOOK

The preliminary outlook for 2007 is for similar abundance as observed in 2006. The 6-year-old component is expected to be near average based on the high number of returning 5-year-old

Chinook salmon observed in 2006; the 5-year-old component is also expected to be near average. Information from previous Bering-Aleutian Salmon International Surveys (BASIS) and trawl bycatch information indicates above average abundance of all salmon species compared to historical years. Depending on the origin of these salmon, 2007 salmon runs may be average or somewhat better.

ALASKA BOARD OF FISHERIES ACTION

In response to guidelines established in the Policy for the Management of Sustainable Salmon Fisheries, we anticipate the Alaska Board of Fisheries to continue the yield concern classification for Yukon River Chinook salmon during the January 31–February 5, 2007 regulatory meeting.

ESCAPEMENT GOAL EVALUATION

ADF&G reviewed escapement goals for several Yukon River Chinook salmon stocks as mandated by the SSFP and the Escapement Goal Policy (5 AAC 39.223) (ADF&G 2004; Brannian et al. 2006). 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. Available data on escapement, harvest and age composition for each stock were compiled from research reports, management reports, and unpublished historical databases. Escapement goals developed in 2004 were reviewed for this BOF cycle with additional data using the Bue and Hasbrouck method (Bue and Hasbrouck *Unpublished*). These Chinook salmon escapement goals include the Salcha and Chena River BEGs, and the East and West Fork Andreafsky, Anvik, North and South Fork Nulato, and Gisasa River SEGs. A separate report details the escapement goal review for the AYK Region (Brannian et al. 2006). The escapement goal team did not recommend revisions to any Yukon River Chinook salmon escapement goals. However, in the future, ADF&G plans to formulate escapement goals that are based on older (greater than 2-ocean) Chinook salmon, rather than focusing on total numbers of fish getting to the spawning grounds. ADF&G would manage the fisheries to get the appropriate number of older age fish to the spawning grounds.

The Yukon River Salmon Agreement between the U.S. and Canada governments was initialed by the chief negotiators for the U.S. and Canada in March 2001 and subsequently signed in December 2002 by both governments. The escapement goal for Canada agreed to by the Parties is 33,000 to 44,000 Chinook salmon. However, per the Agreement, the Panel may recommend annual spawning escapement targets for implementation by the Parties through their management entities or revise targets for rebuilt stocks. In April of 1996, the Panel agreed to a 6-year rebuilding plan for Canadian mainstem Yukon River Chinook salmon stocks with an interim minimum spawning escapement target of 28,000 Chinook salmon. However, in response to very poor runs in 1998–2000, the Panel recommended in 2001 an interim escapement objective of 25,000 Chinook salmon if no commercial fishery occurred and 28,000 Chinook salmon if a commercial fishery occurred in Alaska. The Panel reviews the Canadian Yukon River mainstem escapement goal annually and in their spring 2006 meeting, the Panel agreed to continue the interim escapement target of 28,000 Chinook salmon through 2006. The escapement target for 2007 will be established at the U.S./Canada Panel meeting in April, 2007.

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

Stream	Current Goal	Recommended Range	Type of Goal
East Fork Andreafsky River Aerial	960–1,900	No Revision	SEG
West Fork Andreafsky River Aerial	640–1,600	No Revision	SEG
Anvik River Index Aerial	1,100–1,700	No Revision	SEG
Nulato River Aerial (Forks Combined)	940–1,900	No Revision	SEG
Gisasa River Aerial	420–1,100	No Revision	SEG
Chena River Tower	2,800–5,700	No Revision	BEG
Salcha River Tower	3,300–6,500	No Revision	BEG

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

YUKON RIVER CHINOOK SALMON MANAGEMENT PLAN REVIEW/DEVELOPMENT

Current Stock Status

In response to the guidelines established in the *Policy for the Management of Sustainable Salmon Fisheries* (5 AAC 39.222), the department recommended the continued stock of yield concern classification for Yukon River Chinook salmon during the October 2006 BOF work session. After reviewing stock status information and public input during the January 31–February 5, 2007 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 for 4 of the last 5 years.

Customary and Traditional Use Finding and Amount Necessary for Subsistence Uses

In 1988, the Alaska Board of Fisheries made a positive finding for customary and traditional use for all salmon in the Yukon Area. In 2001, the department recommended the BOF amend 5 AAC 01.236 to include a revised finding of the amount necessary for subsistence (ANS) for the Yukon Area using updated subsistence harvest data. After a thorough review of various options (SSFP; 5 AAC 39.222), the BOF made a finding of ANS for the Yukon Area by species.

ANS range for the Yukon River drainage by species

Chinook salmon	45,500–66,704
Summer chum salmon	83,500–142,192
Fall chum salmon	89,500–167,900
Coho salmon	20,500–51,980

During the most recent 5-year period that subsistence harvest data are available, 2001–2005, harvests were within the ANS range 4 of 5 years (Table 3). Chinook salmon harvests were below ANS in 2000 due to restrictive management actions on a poor run, and in 2002 for unknown reasons. We speculate that fishermen under-reported the number of jacks or diseased Chinook salmon as part of the total harvests in 2002. Preliminary data indicate ANS levels should have been reached in 2006. The department recommends no change to current ANS finding for Chinook salmon.

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 impact the salmon production in the Yukon River drainage. A detailed discussion of these issues is found in the Yukon River Comprehensive Salmon Plan for Alaska. 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 habitat threats to salmon caused by human presence 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. Fortunately, most historical 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 the Yukon River Area can be found in the report entitled "A History of Mining in the Yukon River Basin of Alaska" (Higgs 1995). Major mining activity occurred on many tributaries: the Iditarod, and Innoko River drainages in the Lower Yukon; American Creek, Eureka Creek, Minook Creek, and upper Sulatna River in the Middle Yukon; Birch Creek, Woodchopper Creek, Coal Creek, Nome Creek, Beaver Creek, and the Fortymile River in the Upper Yukon; Middle and South Forks of the Koyukuk River and Hogatza River in the Koyukuk River drainage; and Goldstream Creek, Chatanika River, Chena River, Livengood Creek, Salcha River, Goodpaster River, in the Tanana River drainage. Both small and large mining operations exist today. However, more rigid enforcement of environmental regulations since the mid-1980s has resulted in mining operations far 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 two large hard rock mines currently permitted; Fort Knox mine near Fairbanks (in operation) and the Pogo Creek mine near the 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 impact habitat in this area.

Logging

Logging has become a potential impact to fisheries habitat in the Tanana River drainage. Coincidental with the transfer of large tracts of federal land into private, 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 the Tanana Valley in 2006.

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, and 1992, the dam's gates were closed to slow the 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 in the backed up waters, below the dam's chutes where smolt were dumped via small waterfalls, and in pools of water above the dam when the flood waters receded. Impacts of these events upon salmon returns are unknown.

Chatanika River (Davidson Ditch) Dam: The 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 the Bureau of Land Management in 2001. Before the 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 the 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 the 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 the 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 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 the first and second order tributaries similarly have not been surveyed. Consequently, these streams are not afforded legal protection under the Department of Natural Resource AS 16.05.870 permitting program.
8. A potential railroad extension from Fairbanks to Delta on the south side of the 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 to allow sales of subsistence fish caught in applicable waters may result in the expansion of subsistence take on this stock. Otherwise, no new or expanding fisheries occur on this stock. However, Yukon River bound Chinook salmon are caught as bycatch in the Bering Sea groundfish fishery. Recent bycatch of Chinook salmon from the BSAI pollock trawl fishery greatly increased beginning in 2003 and has been at record levels in 2005 and 2006.

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

Reduce fishing mortality to meet spawning escapement goals, to provide opportunity for subsistence users to harvest levels within the ANS range, and to reestablish 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 the 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 king salmon fisheries. Additionally, when the projected commercial harvest is 0–67,350 king 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 the department emergency order authority to restrict subsistence gillnets to no greater than 6 inches mesh size for the conservation of Chinook salmon.

After commercial fishing was allowed in 2002, an issue arose whether the subsistence fishing schedule remains in effect or to implement previous subsistence fishing regulations if a surplus above escapement and subsistence needs was identified. Maintaining the subsistence fishing schedule in Districts 1, 2, and 3 and Subdistrict 4-A is 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 the 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 the 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 the conservation of chum salmon, 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 a fish wheel.

Management Review

Management of the Yukon 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 Yukon 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 the 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. A set gillnet test fishery near the mouth of the Yukon and a main river sonar project at Pilot

Station are the primary assessment tools to determine Chinook salmon run timing and relative run strength. Additionally, subsistence catch reports, discharge and weather are also used to estimate relative run strength and run timing.

Historically, Chinook salmon have been harvested commercially in both unrestricted and restricted fishery openings with respect to mesh size. Unrestricted openings are directed at Chinook salmon, though summer chum are also caught, and permit fishers may use nets of any size mesh, though it is suspected that most fishers use large mesh sizes (Figure 12). Restricted commercial openings target summer chum by limiting mesh size to a maximum of 6 inches; Chinook salmon are incidentally caught in an average ratio of over 30 summer chum to 1 Chinook salmon in chum gear, particularly smaller Chinook salmon from younger age classes (Figure 13). A range of nearly 500 (2006) to about 40,000 (1988 and 1989) Chinook salmon were harvested annually in this manner with a 10-year average from 1986–1995 of nearly 17,000 fish. Restricted openings were numerous in the 1980s and early 1990s, but were discontinued in 1996 due to fallen summer chum market demand. In 2006, a short fishery was directed at summer chum.

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 progressively upriver consistent with migratory timing. Typically, Chinook salmon were already present in relatively small numbers prior to establishing the schedule. Overall, it appeared that the subsistence fishing schedule assisted in spreading subsistence opportunity among users particularly early in the run. Based on an outlook for a very poor run in 2001, no commercial or sport fish fishing occurred. Inseason management actions were taken near the middle of the run to reduce subsistence fishing time less than the regulatory schedule. Subsequently, the run was judged to be large enough to provide for escapement and subsistence needs and to conserve summer chum salmon, subsistence gillnets were restricted to 8 inch or larger mesh size. Postseason, managers determined there was a surplus of approximately 20,000 Chinook salmon beyond escapement and subsistence needs in 2001.

In 2002–2005, preseason management strategies were developed to not allow commercial fishing until near the midpoint of the Chinook salmon run. Historically, the first commercial opening occurred at the first quarter point of the run. This management strategy provided for passage of a portion of the early run segment through the lower river districts before commercial fishing started. In 2006, based on the preseason projections and inseason run assessments, management strategy scheduled commercial fishing near the first quarter point (historically June 15) for Chinook salmon and continued spreading the harvest over the middle 50% of the run. Additional harvest after the third quarter point depended on information from assessment projects and available markets. As anticipated, the 2006 Chinook salmon run was similar in strength to the 2005 run. Escapement goals were achieved or exceeded throughout the drainage. The preseason outlook was for a conservative commercial harvest of 30–60,000 Chinook salmon. Based on inseason run assessment, the commercial harvest reached 45,829 fish. In 2002–2006, some limitations in processing capacity occurred in the Upper Yukon Area.

In general, sport fish salmon harvests in the Yukon Area are relatively minor compared to commercial and subsistence 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 through 2003.

In summary, Chinook salmon fisheries management has been cautious and conservative the last 6 years, and a portion of the surplus of Chinook salmon went unharvested in 2001, 2003 and 2004.

BOARD OF FISHERIES REGULATORY PROPOSALS AFFECTING YUKON RIVER

CHINOOK SALMON

- Marking of subsistence taken salmon: proposal 158
- Subsistence fishing schedule and fishing periods – proposals 159, 160, 161 and 162.
- Commercial and subsistence fishing gillnet mesh size – proposals 163 and 164
- Commercial and subsistence fishing gillnet depth – proposals 165 and 166.
- Place holder for YRDFA working group – proposal 167.
- Set initial commercial fishing dates – proposals 168 and 169.
- Reallocate harvest of BSAI trawl bycatch to District 1 – proposal 170.
- Move District 1 and 2 boundary to Mountain Village, separate District 1 and 2 allocations and reallocate harvest of BSAI trawl bycatch to District 1 – proposal 171.
- Move district 3 boundary downstream to include the village of Marshall – proposal 172.
- Sport fish management in Tanana River drainage – proposals 175, 176 and 177.

Nearly all Yukon Area proposals before the BOF are directed at the Chinook salmon fishery. Proposals 163 and 164 would prohibit gillnets greater than 6-inch mesh in the commercial and/or subsistence fishery, which would greatly increase the harvest of summer chum salmon. Although there is a substantial harvestable surplus above escapement requirements and subsistence uses for summer chum salmon, no commercial market exists. Without commercial markets that could absorb the summer chum salmon harvest, limiting gillnets to 6-inch mesh or less may result in a very limited commercial fishery for Chinook salmon or possibly wastage of summer chum salmon and an enforcement problem (Figure 13). Proposals 165 and 166 would decrease the depth of gillnets larger than 6 in mesh, which would reduce efficiency of this gear. The initial commercial fishing opening date would be set in regulation by proposals 168 and 169. Proposals 171 and 172 are intended to reallocate harvest of Chinook salmon by changing boundary lines which would also affect harvest and management of other Yukon River salmon fisheries. Proposals 175 and 176 would establish a catch-and-release fishery for Chinook salmon in the Goodpaster River. Proposal 177 would permit the use of archery equipment to take Chinook salmon in a portion of the Salcha River.

RESEARCH PLAN

U.S.-CANADA JOINT TECHNICAL COMMITTEE PLAN

The U.S./Canada Yukon River Joint Technical Committee 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. Projects can be prioritized, with personnel and equipment allocated accordingly. This plan guides the U.S./Canada Joint Technical Committee (JTC) on key research and conservation needs for the entire Yukon River basin and is used by each agency internally and to communicate 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.

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 that were conducted on a periodic basis. At best, they 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 data sets is relatively short and obtaining such information in the Yukon is expensive and difficult due to the remoteness of the area.

The ADFG, several Federal agencies, the Canadian Department of Fisheries and Oceans, native organizations, and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River drainage which is used by Division of Commercial Fisheries to manage the Alaskan Yukon salmon fisheries. Pre-season 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 fishing, (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. The department continues to monitor these abundance indices and has instituted additional projects such as the Eagle Sonar beginning in 2005.

ABUNDANCE ESTIMATES

Chinook salmon are commercially the most valuable salmon in the Yukon River, though determining their total abundance in the drainage has been very challenging. Sonar assessments in the lower river over the last two decades have provided abundance estimates; however, problems with species apportionment, technological limitations and bank erosion have adversely affected the quality of those estimates. New technology (DIDSON sonar) and more appropriate net selectivity models (Bromaghin 2005) have greatly improved Chinook population estimates at Pilot Station. A large-scale radio telemetry 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 the migratory characteristics, abundance, and spawning distribution. This project has provided population estimates that closely tracked Pilot Station sonar estimates in 3 out of 4 years. Recent efforts to assess Chinook salmon passage at Eagle, near the US/Canada border, beginning in 2005 look promising. 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. In the coming years (2007–2010) using State of Alaska Capital Improvement Project funds, we will use genetic stock identification techniques and the Chinook salmon passage estimate at Eagle to obtain an independent estimate of the number of Chinook salmon passing Pilot Station using a reverse mark–recapture technique. This will provide important insight on the reliability and meaning of

Pilot Station estimates and how they are most appropriately applied to management strategies. Additionally, increased ASL information from test fishing at the Eagle sonar will be utilized to estimate the age, sex and size characteristics of the estimated Chinook salmon run passing into Canada and will give us our first accurate estimate of the age-class composition of the escapement in Canada.

CHINOOK SALMON SIZE TRENDS

Concerns over changing trends in the age, sex ratio, and size Yukon River Chinook salmon populations have recently emerged. In response to these concerns, the U.S./Canada Joint Technical Committee Salmon Size Subcommittee compiled relevant literature and existing analyses pertaining to these trends and potential causes of these trends in their *Potential Causes of Size Trends in Yukon River Chinook Salmon Populations* report (JTC 2006). This informational summary was divided into six sections: history of the Alaskan Yukon River Chinook salmon harvest and fishery sampling, history of the Canadian Yukon River Chinook salmon harvest, summary of prior age, sex and size investigations, summary of Yukon River gillnet selectivity, heritability of traits and potential effects of selective fisheries, and oceanic influences on salmon size. There is some 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), and the apparent near disappearance of age-8 fish (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 report recognizes several factors that may contribute to these trends, including environmental changes in the Bering Sea and Gulf of Alaska, fishery induced selective pressures and increased competition in the ocean from large numbers of hatchery fish. ADF&G is committed to continued monitoring of size and age trends in Yukon River Chinook salmon populations and will use this summary report as a means to develop hypotheses for further study.

ICHTHYOPHONUS

In addition to the typical stock assessment methods described in pervious sections, the department began research on the prevalence of *Ichthyophonus* within Yukon River Chinook salmon in response to increasing concerns that this disease was affecting spawning escapement and spawning success. In 2002, ADF&G directed research to determine management and conservation implications of *Ichthyophonus* in Yukon River Chinook salmon. In 1999, Dr. Richard Kocan began a baseline of the disease's overall infection rate entering the Yukon River at Emmonak (Kocan et al. 2003); ADF&G continued to monitor infection rates at Emmonak which resulted in infection rates of 22%, 24%, and 16% for the years 2004 through 2006 respectively. Sampling was also continued at two terminal spawning locations including the Chena and Salcha rivers.

The research was designed to track changes in the baseline rate, test feasibility of non-lethal sampling techniques, and assess spawning success. Spawning success was evaluated based on a classification of spawn-out rates including spawned out, partially spawned out and did not spawn. Female escapement ground samples from 2005 resulted in 44% infected and 43% uninfected classified as spawned out, 10% infected and 6% uninfected were classified as partially spawned out and 1% infected and 2% uninfected were classified as did not spawn.

These results are similar to observations in 2004 Chena River samples. Preliminary results based on spawn-out rates of both infected and uninfected individuals suggest Chinook salmon counted past escapement enumeration projects are spawning successfully. As a result, biological escapement goals on the Chena and Salcha rivers will not need to be reevaluated based on an affect from this disease. The comparisons of infected and uninfected Chinook salmon based on samples collected in 2004 and 2005 did not appear significantly different and the 2006 data is currently being analyzed.

CURRENT PROGRAMS

Main river sonar, tributary sonar, weir, and counting tower projects and aerial surveys are used to monitor escapement. Other information collected at ground based projects may include, but is not limited to, salmon 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 from various projects.

LOWER RIVER SONAR

The lower river sonar assessment project located near Pilot Station (RM 107) has estimated passage of Chinook salmon in the years 1995 and 1997–2005. The Chinook salmon sonar estimate is further delineated by Chinook less than 655mm in length, which corresponds to age-4 and younger, and Chinook greater than or equal to 655mm in length; age-5 and older. Though problems with species apportionment, range limitations of the sonar, 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.

Border 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 passage into the Canadian mainstem Yukon River. These efforts to assess Chinook salmon passage at Eagle look promising 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 the Gisasa, Tozitna, Henshaw, Chena, and Salcha Rivers. These projects provide daily estimates of spawning escapement for Chinook salmon.

Fish Wheels

There are two fish wheel projects currently associated with the assessment of Chinook salmon in Alaskan waters. One is located near the mouth of the 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 catch per unit effort information.

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TABLES AND FIGURES

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

	Ground Based Projects			Aerial Surveys [a]				
Year	Chena R.	Salcha R.		East Fork Andreafsky	West Fork Andreafsky	Anvik R.	Nulato R.	Gisasa R.
1980					1,500	1,330		951
1981								
1982				1,274	851			421
1983							1,006	572
1984				1,573	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	875	2,020	1,690
1992	5,230	7,862		1,030	2,002	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	1,249	709	1,053	889
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 [b]		1,447	977	1,713	1,584	506
2003	8,739 [b]	15,500 [b, c]			1,578			
2004	9,645 [b]	15,761 [b]		2,879	1,317	3,681	1,321	731
2005	N/A [b]	5,988		1,492	1,715	2,421	553	950
2006	2,936 [b]	10,679			824	1,886	1,295	843
10 Yr. Avg. (1997-2006)	7,483	9,761		1,438	1,130	2,191	1,282	870
BEGs	2,800-5,700	3,300-6,500	SEGs	960-1,700	640-1,600	1,100-1,700	940-1,900	420-1,100

[a] Only acceptable surveys are included.

[b] Escapement estimates are conservative because of missed counts due to no or poor visibility.

[c] Expanded counts based on average run timing.

Table 2.–Total Canadian harvest and escapement of Yukon River Chinook salmon, 1961–2006.

	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	19,790
1983	400	5,025	300	13,027	18,752	200	18,952	28,990
1984	260	5,850	300	9,885	16,295	500	16,795	27,616
1985	478	5,800	300	12,573	19,151	150	19,301	10,729
1986	342	8,625	300	10,797	20,064	300	20,364	16,415
1987	330	6,069	300	10,864	17,563	51	17,614	13,259
1988	282	7,178	650	13,217	21,327	100	21,427	23,117
1989	400	6,930	300	9,789	17,419	525	17,944	25,201
1990	247	7,109	300	11,324	18,980	247	19,227	37,699
1991	227	9,011	300	10,906	20,444	163	20,607	20,743
1992	277	6,349	300	10,877	17,803	100	17,903	25,382
1993	243	5,576	300	10,350	16,469	142	16,611	28,559
1994	373	8,069	300	12,028	20,770	428	21,198	25,890
1995	300	7,942	700	11,146	20,088	796	20,884	32,261
1996	141	8,451	790	10,164	19,546	66	19,612	28,409
1997	288	8,888	1,230	5,311	15,717	811	16,528	37,683
1998	24	5,424		390	5,838	99	5,937	16,749
1999	213	8,804	177	3,160	12,354	114	12,468	11,362
2000		4,829			4,829	50	4,879	11,343
2001	89	8,183	146	1,351	9,769	370	10,139	42,438
2002	59	8,174	128	708	9,069	188	9,257	40,145
2003	115	6,384	275	2,672	9,446	173	9,619	47,486
2004	88	6,650	423	3,785	10,946	292	11,238	37,165
2005	65	6,376	173	4,066	10,680	394	11,074	31,565
2006[c]	63	5,757	500	2,291	8,611	314	8,925	24,389
2001–2005 Avg.	80	7,153	274	2,516	9,982	283	10,265	39,760
1989–1998 Avg.	252	7,375	502	9,229	17,307	338	17,645	27,858

[a] Includes fish from DFO test fish operations. Escapement objectives set by the US-Canadian Panel. For 2003, the objective was 28,000 if commercial fishing occurred and 25,000 if no commercial fishing.

[b] Canadian sport fish harvest unknown prior to 1980.

[c] Data are preliminary or unavailable.

Table 3.–Alaska Yukon River Chinook salmon harvests, 1961–2006.

Year	Commercial	Commercial Related	Total Commercial	Subsistence [a]	Personal Use	ADF&G Test Fish Catch	Sport Fish [b]	Total
1961	119,664	0	119,664	21,488				141,152
1962	94,734	0	94,734	11,110				105,844
1963	117,048	0	117,048	24,862				141,910
1964	93,587	0	93,587	16,231				109,818
1965	118,098	0	118,098	16,608				134,706
1966	93,315	0	93,315	11,572				104,887
1967	129,656	0	129,656	16,448				146,104
1968	106,526	0	106,526	12,106				118,632
1969	91,027	0	91,027	14,000				105,027
1970	79,145	0	79,145	13,874				93,019
1971	110,507	0	110,507	25,684				136,191
1972	92,840	0	92,840	20,258				113,098
1973	75,353	0	75,353	24,317				99,670
1974	98,089	0	98,089	19,964				118,053
1975	63,838	0	63,838	13,045				76,883
1976	87,776	0	87,776	17,806				105,582
1977	96,757	0	96,757	17,581			156	114,494
1978	99,168	0	99,168	30,785			523	130,476
1979	127,673	0	127,673	31,005			554	159,232
1980	153,985	0	153,985	42,724			956	197,665
1981	158,018	0	158,018	29,690			769	188,477
1982	123,644	0	123,644	28,158			1,006	152,808
1983	147,910	0	147,910	49,478			1,048	198,436
1984	119,904	0	119,904	42,428			351	162,683
1985	146,188	0	146,188	39,771			1,368	187,327
1986	99,970	0	99,970	45,238			796	146,004
1987	134,760	0	134,760 [c]	55,039	1,706		502	192,007
1988	100,364	0	100,364	45,495	2,125	1,081	944	150,009
1989	104,198	0	104,198	48,462	2,616	1,293	1,053	157,622
1990	95,247	413	95,660	48,587	2,594	2,048	544	149,433
1991	104,878	1,538	106,416	46,773		689	773	154,651
1992	120,245	927	121,172	47,077		962	431	169,642
1993	93,550	560	94,110	63,915	426	1,572	1,695	161,718
1994	113,137	703	113,840	53,902		1,631	2,281	171,654
1995	122,728	1,324	124,052	50,620	399	2,152	2,525	179,748
1996	89,671	521	90,192	45,671	215	1,698	3,151	140,927
1997	112,841	769	113,610	57,117	313	2,811	1,913	175,764
1998	43,618	81	43,699	54,124	357	926	654	99,760
1999	69,275	288	69,563	53,305	331	1,205	1,023	125,427
2000	8,518		8,518	36,404	75	597	276	45,870
2001				55,819	122		679	56,620
2002	24,128		24,128	43,742	126	528	486	69,010
2003	40,438		40,438	56,959	204	680	2,719	101,000
2004	56,151		56,151	55,713	201	792	1,513	114,370
2005	32,029		32,029	53,409	138	310	485	86,371
2006[e]	45,829		45,829	53,128 [d]	158 [d]	841	1,176 [d]	101,133
1989–1998 Average	100,011	684	100,695	51,625	989	1,578	1,502	156,092
Average 2001–2005				53,128	158		1,176	
2002–2006	39,715		39,715			630		94,377

[a] Includes salmon harvested for subsistence and an estimate of the number of salmon harvested for the commercial production of salmon roe and the carcasses used for subsistence. These data are only available since 1990.

[b] 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 AMR).

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

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

[e] Data are preliminary.

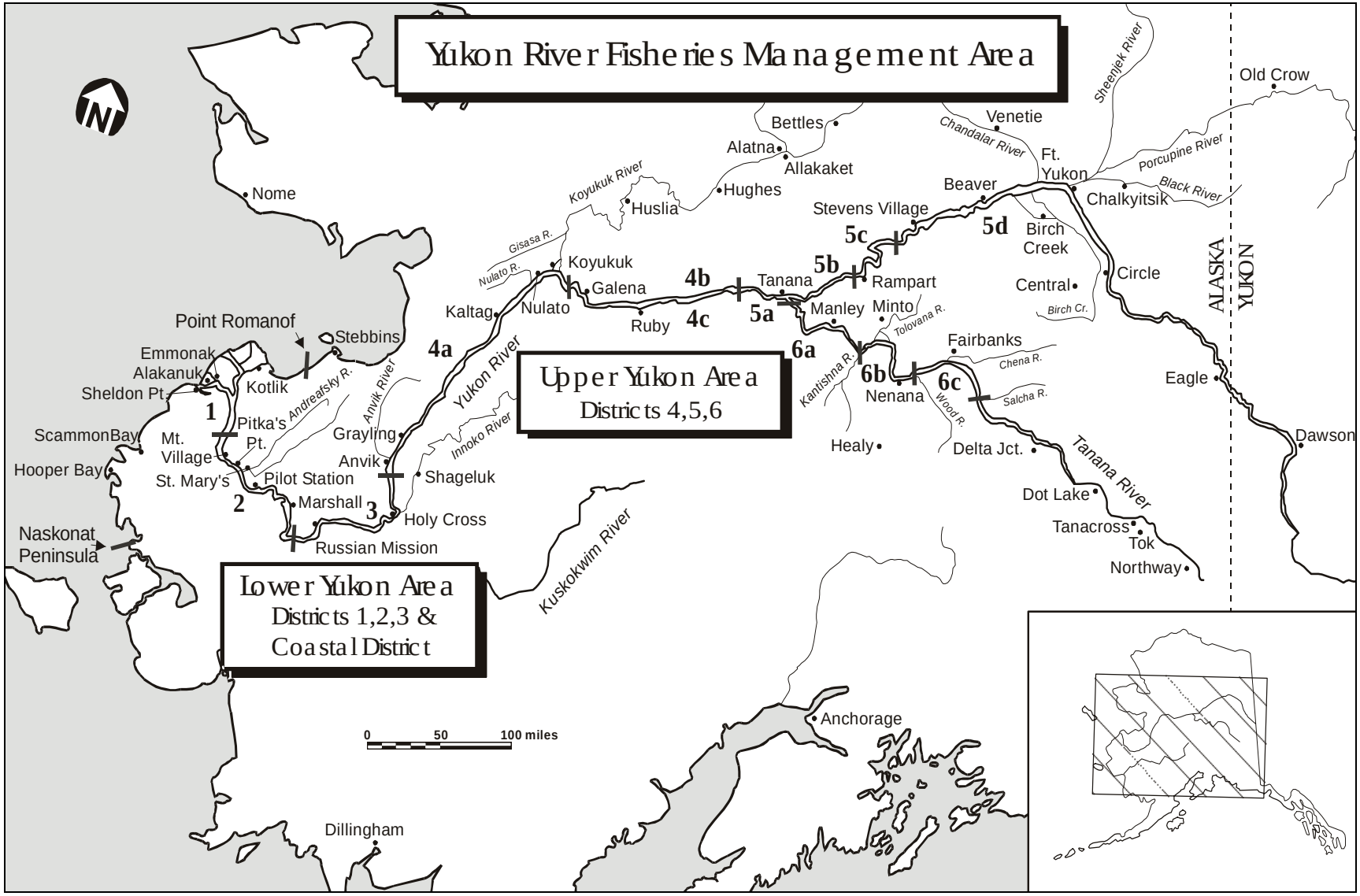
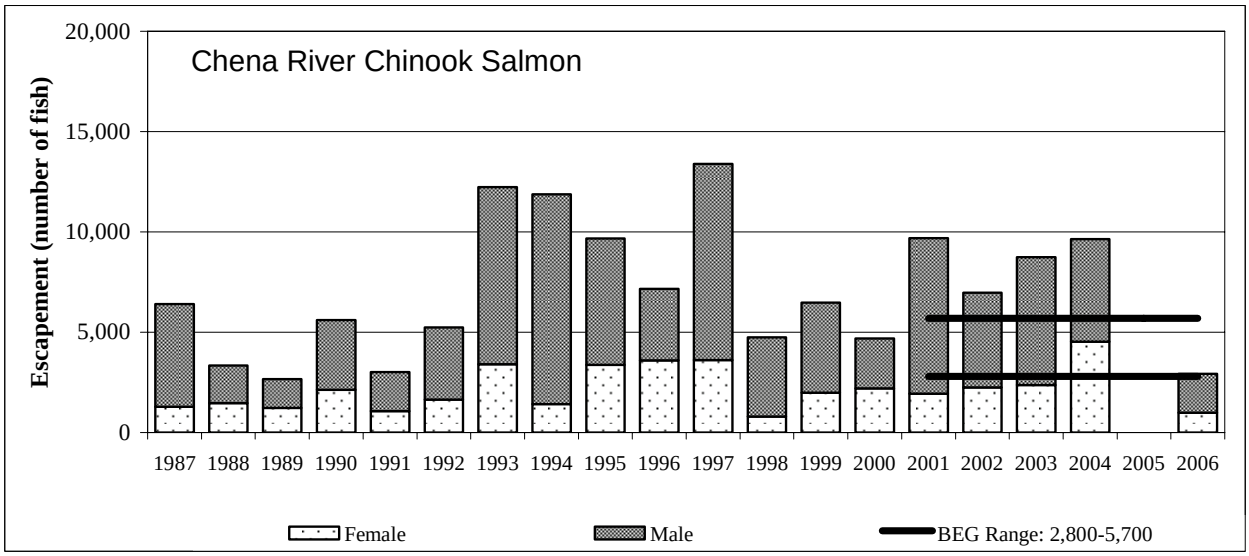


Figure 1.–Alaska portion of the Yukon River drainage showing communities and fishing districts.



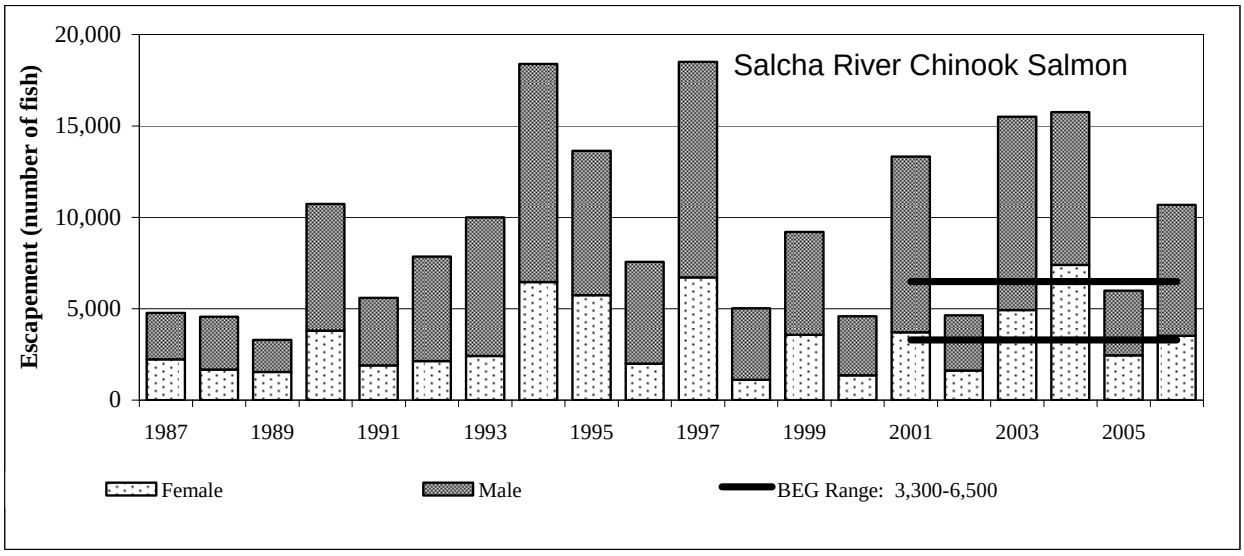


Figure 2.–Chinook salmon escapement by year and sex observed in the Chena (above) and Salcha (below) rivers, Alaska, 1987–2006.

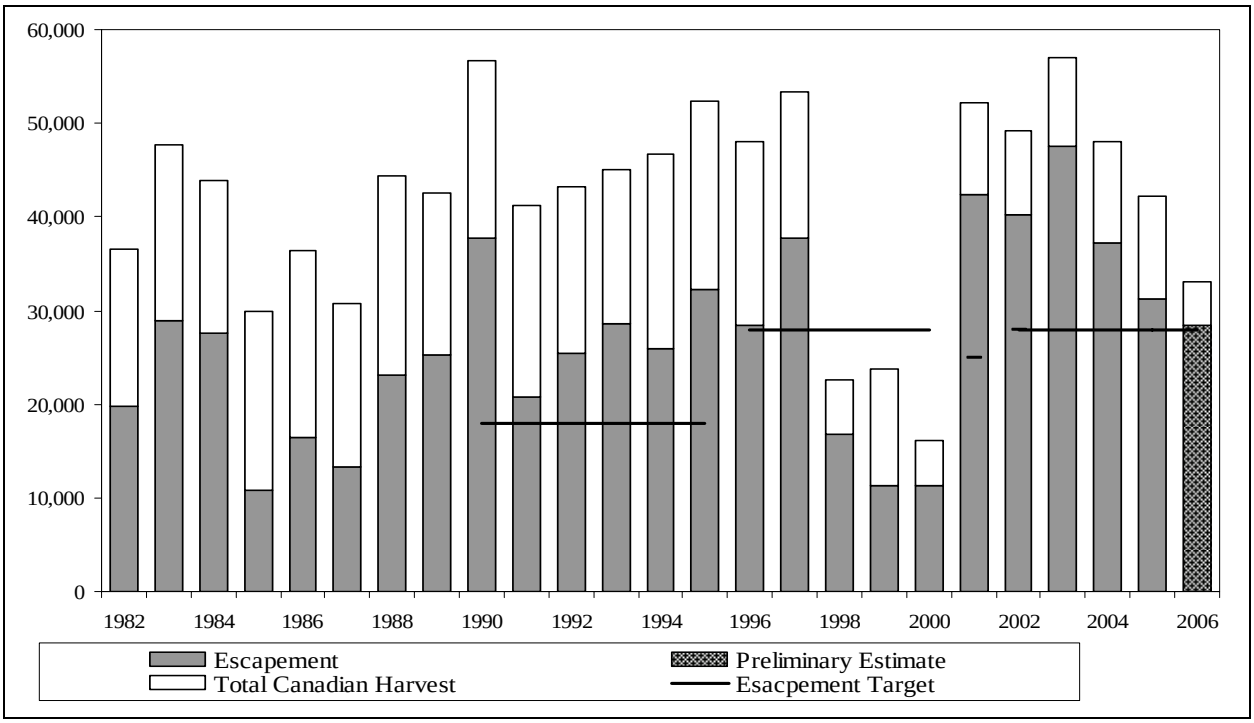
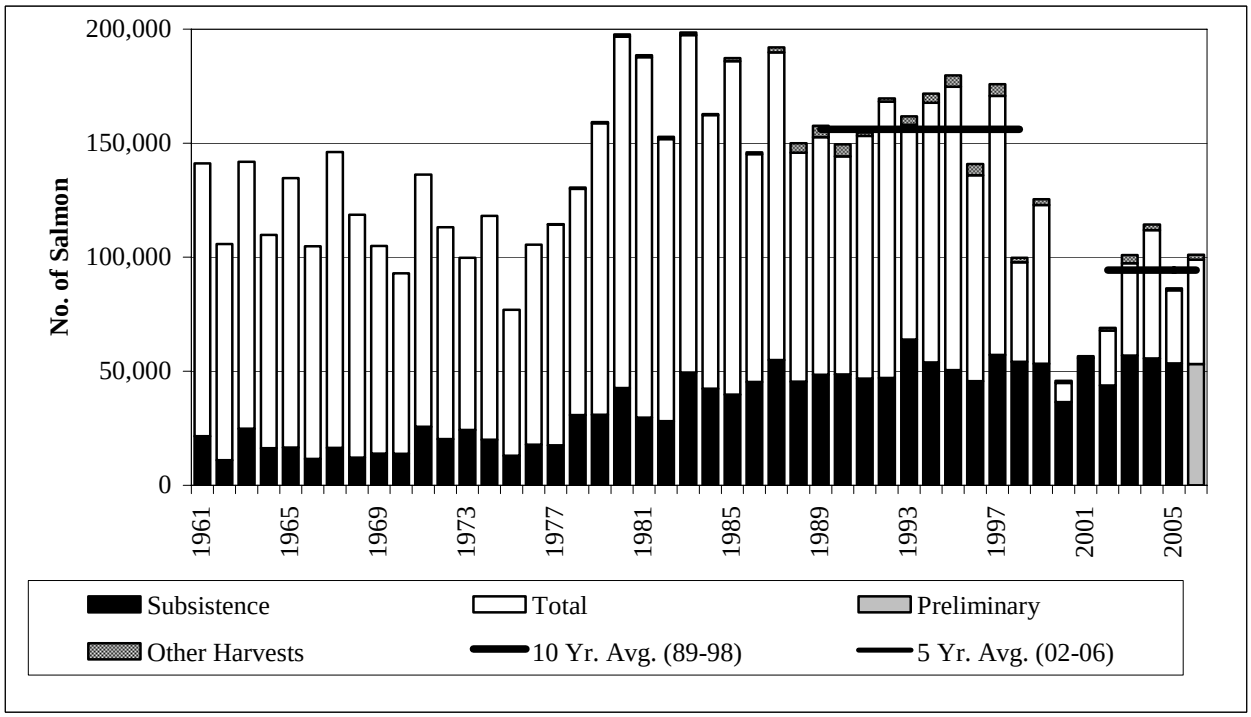
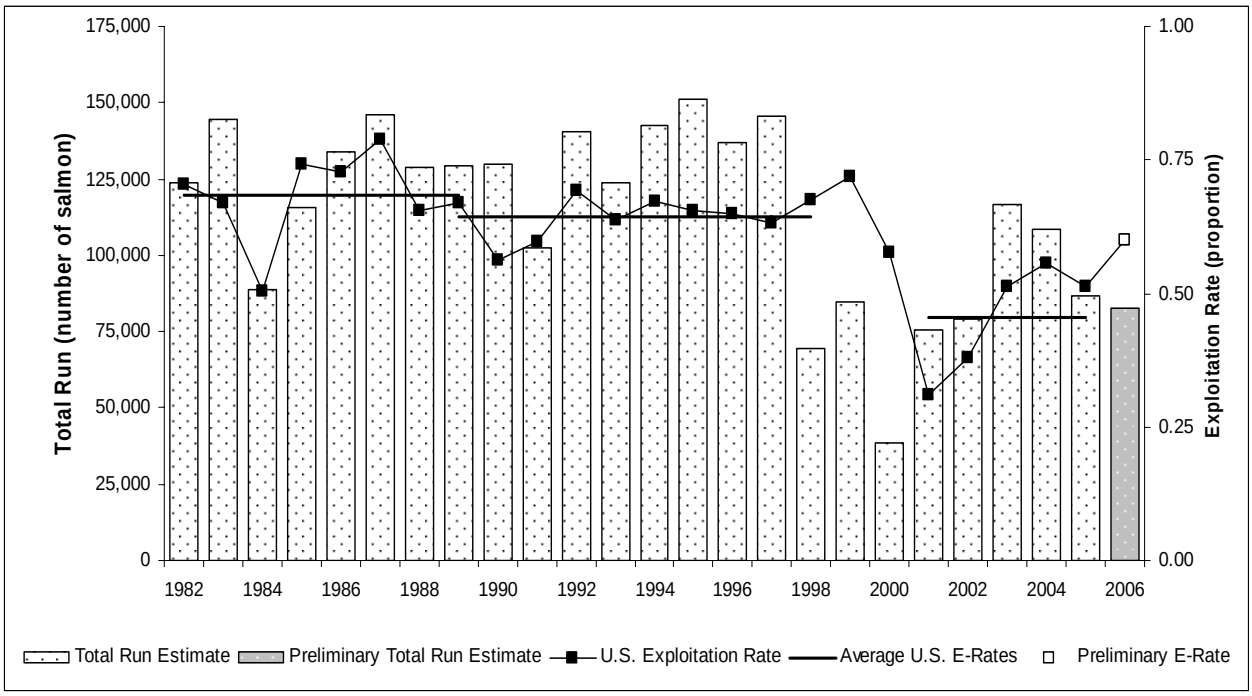


Figure 3.–Canadian DFO estimates of Yukon River Chinook salmon passing into Canada by Canadian harvest and escapement, mainstem Yukon River, Canada, 1982–2006.



Note: Other harvests include personal use, ADF&G test fish, and Sport Fish harvests. Subsistence, personal use and sport fish harvest data are unavailable for 2006. The previous 5-year average harvest was substituted.

Figure 4.–Alaskan harvest of Yukon River Chinook salmon, 1961–2006.



Note: All estimates are based on the Canadian DFO mark–recapture border passage estimate of Chinook salmon passing into Canada.

Figure 5.–Annual total run estimates and associated U.S. exploitation rates on Canadian-origin Yukon River Chinook salmon, 1982–2006.

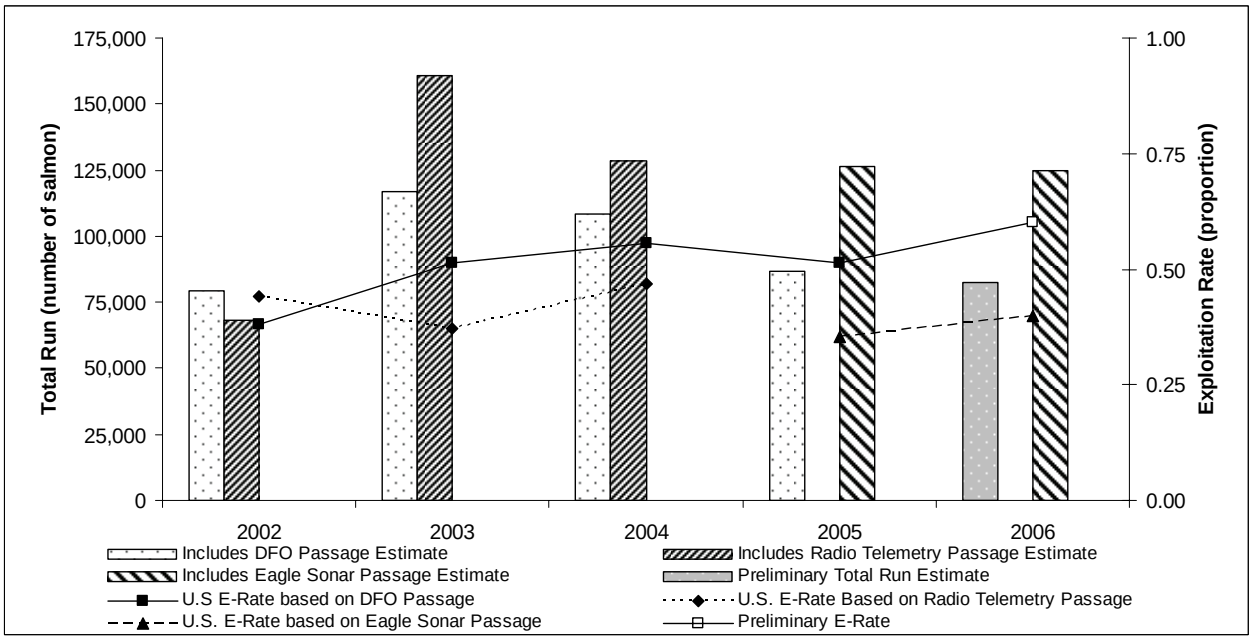


Figure 6.–Annual total run estimates and associated U.S. exploitation rates on Canadian-origin Yukon River Chinook salmon based on Canadian DFO mark–recapture estimates, 2002–2006, Alaskan radio telemetry mark–recapture estimates, 2002–2004 and Alaskan border sonar estimates, 2005 and 2006.

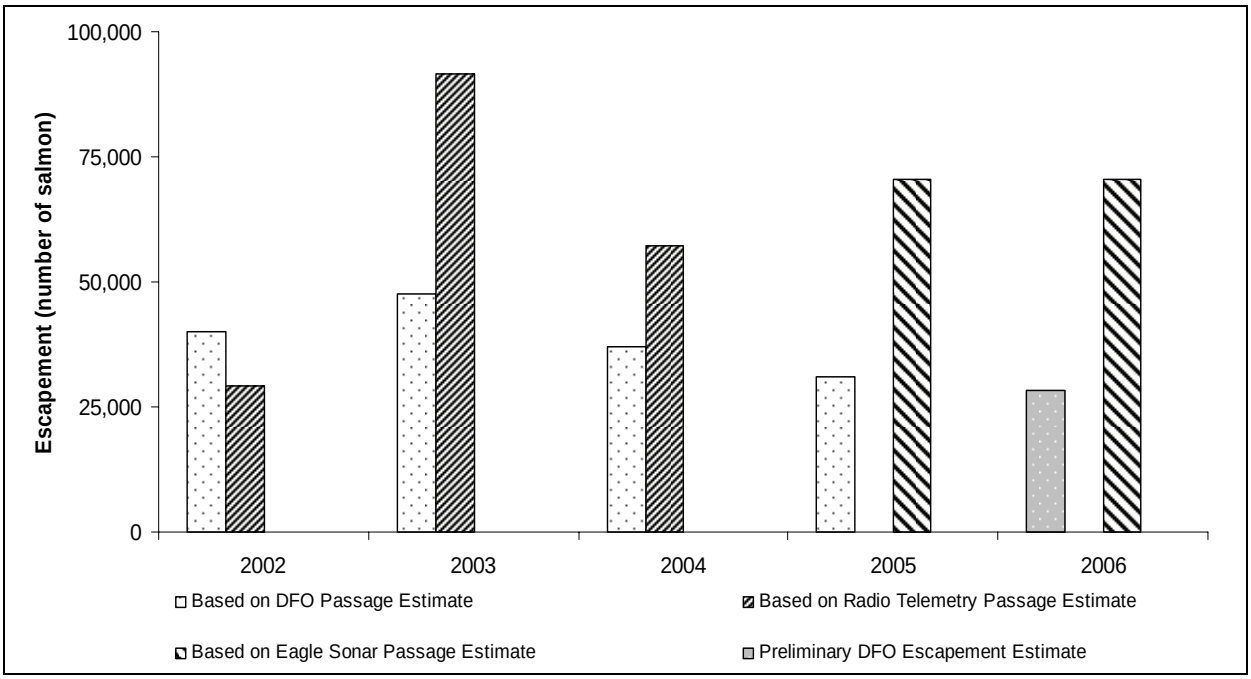


Figure 7.–Annual Chinook salmon escapement estimates for the mainstem Yukon River in Canada based on the estimated number of Chinook salmon passing into Canada generated by the Canadian DFO mark–recapture estimate, ADF&G radiotelemetry mark–recapture estimate and the ADF&G sonar passage estimate, 2002–2006.

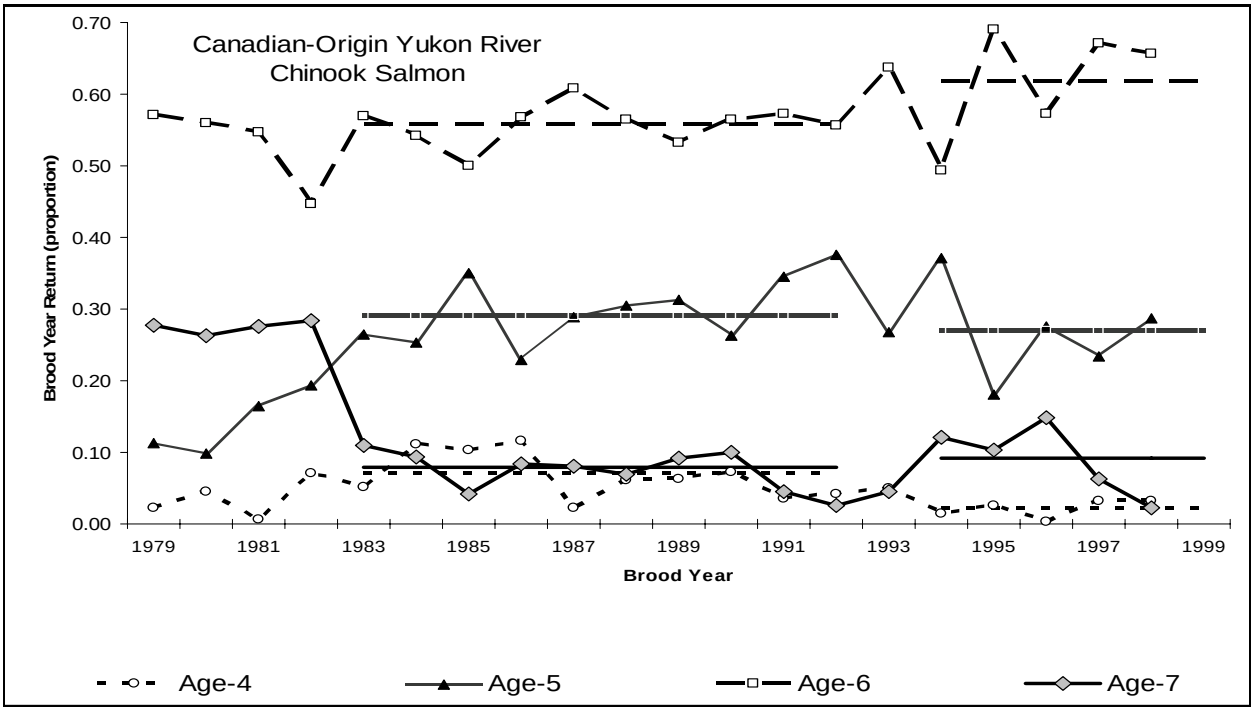


Figure 8.–Brood year return age-class composition of Yukon River Canadian-origin Chinook salmon, 1979–1998.

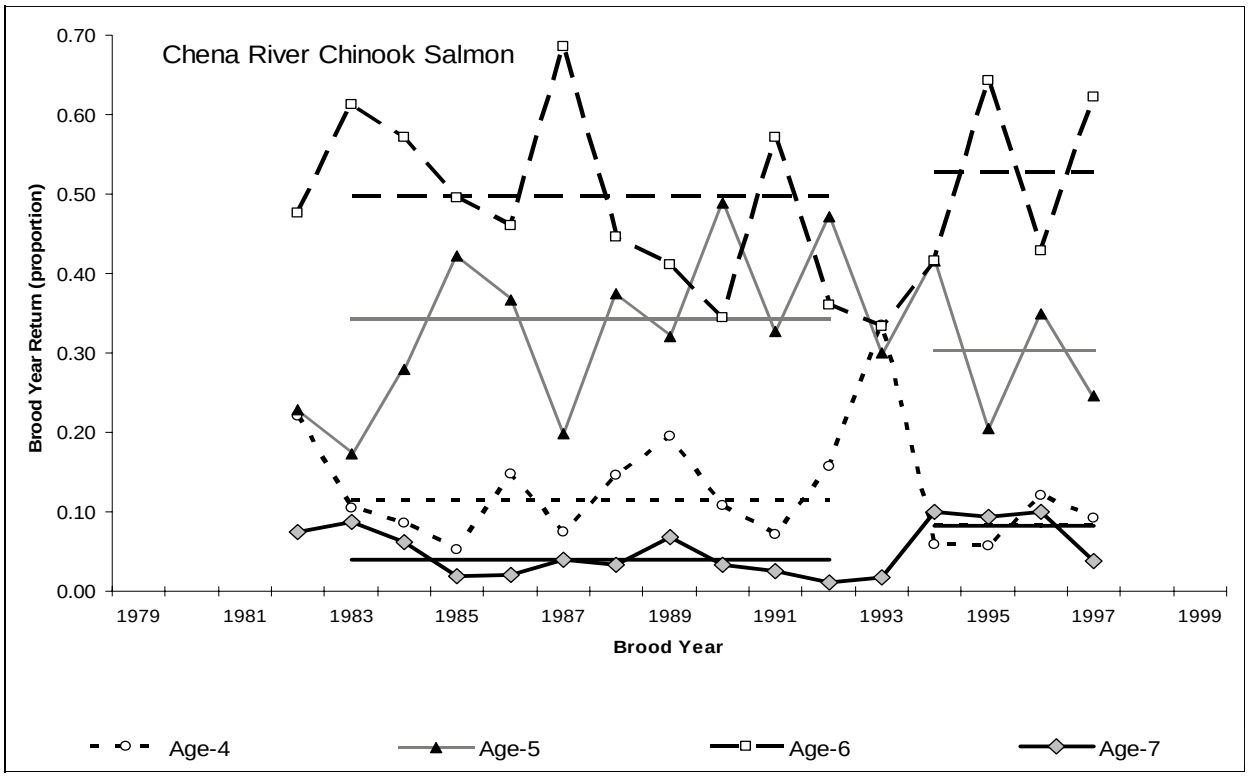


Figure 9.–Brood year return age-class composition, of Chena River-origin Chinook salmon, 1982–1997.

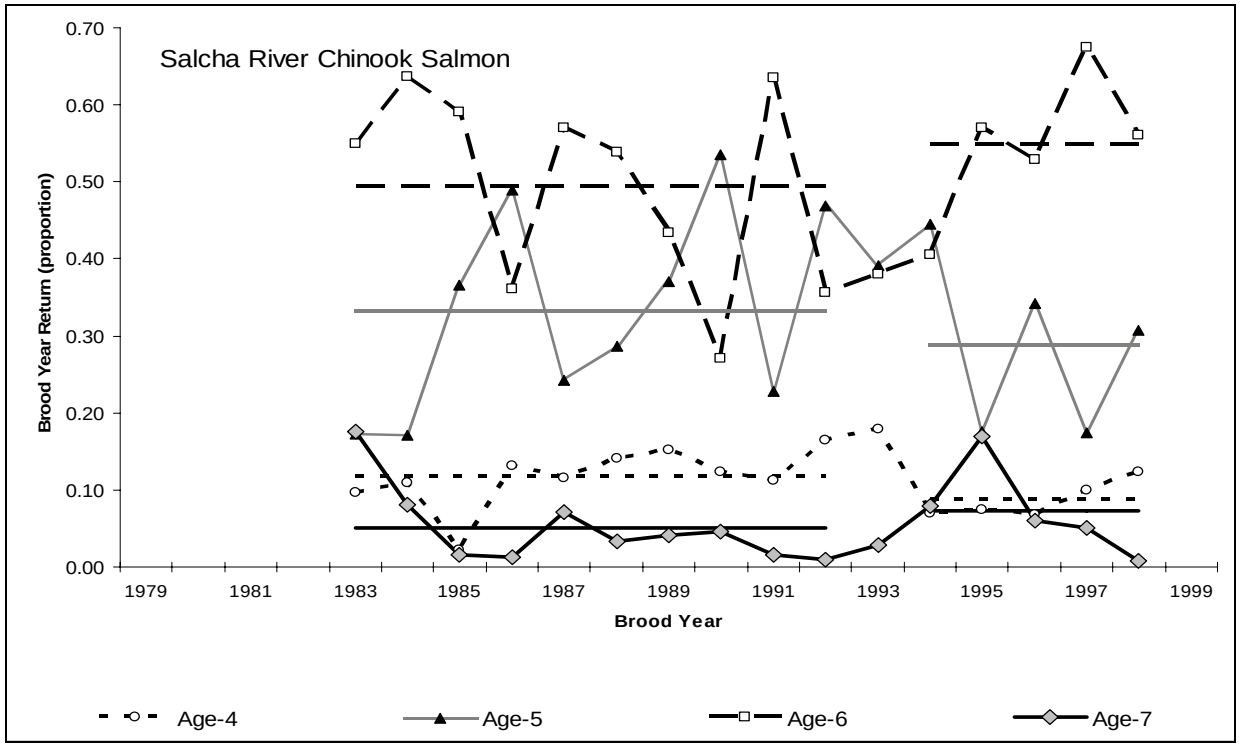
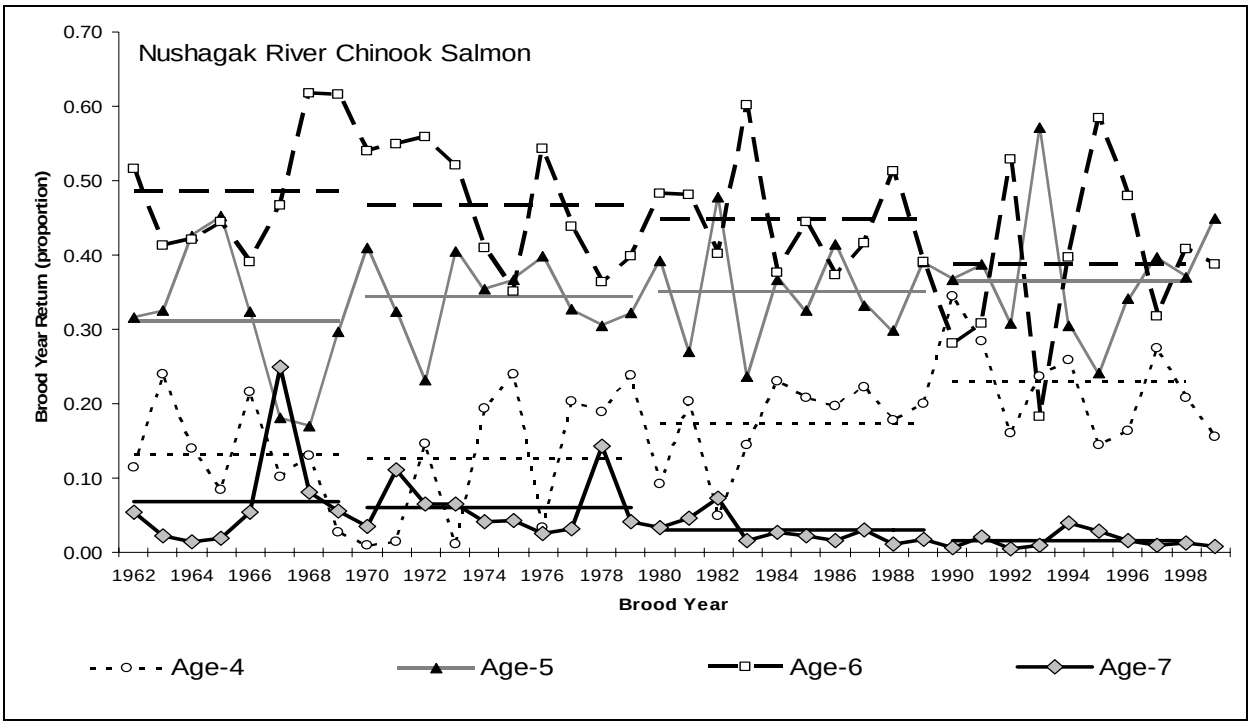


Figure 10.–Brood year return age-class composition, of Salcha River-origin Chinook salmon, 1983–1998.



Source: Data are from Baker et al. (2006).

Figure 11.–Brood year return age-class composition, of Nushagak River origin (Bristol Bay) Chinook salmon, 1983–1998.

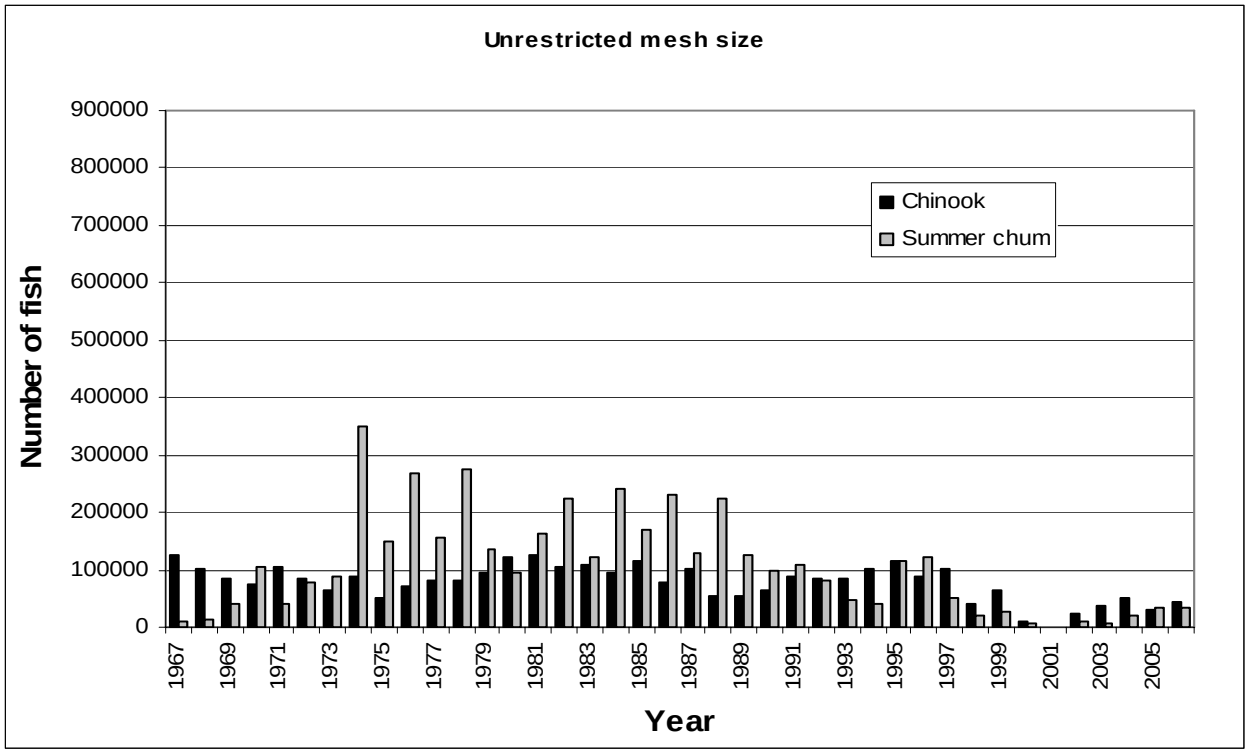


Figure 12.–Number of Chinook and summer chum salmon harvested during lower river commercial fishery openings of unrestricted mesh size, 1967–2006.

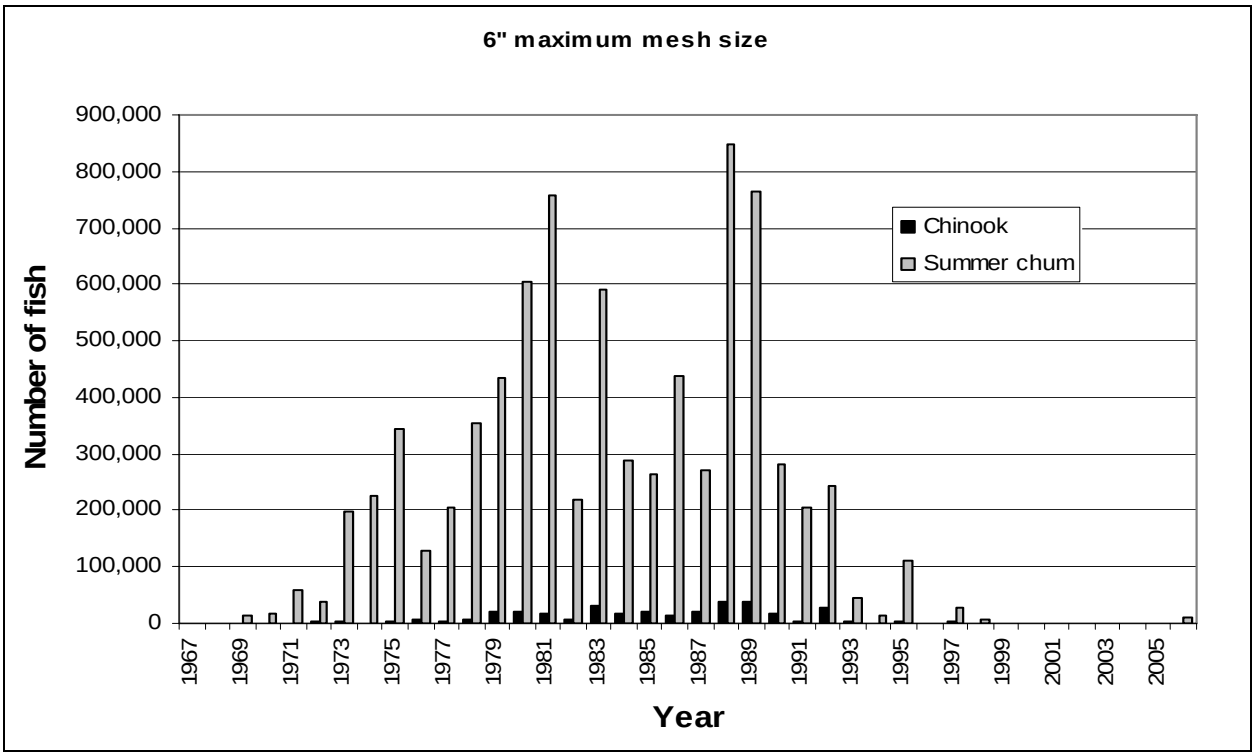


Figure 13.–Number of Chinook and summer chum salmon harvested during lower river commercial fishery openings restricted to 6-inch maximum mesh size, 1967–2006.