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Yukon River King Salmon Stock Status and Summer Chum Salmon Fishery, 2019: a Report to the Alaska Board of Fisheries

by

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and

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December 2018

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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ABSTRACT

In response to the guidelines established in the Policy for the Management of Sustainable Salmon Fisheries (SSFP; 5 AAC 39.222), the Alaska Board of Fisheries (board) classified the Yukon River king salmon Oncorhynchus tshawytscha stock as a stock of yield concern at its September 2000 work session. An action plan was developed by the Alaska Department of Fish and Game and acted upon by the board in January 2001. The status as a yield concern was continued at the January 2004, 2007, 2010, 2013 and 2016 board meetings. The stock of yield concern for king salmon was recommended to continue at the 2018 work session. King salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage the past 5 years (2014–2018). Conservative management actions taken inseason have contributed to achieving escapement goals. Run size has been improving since 2013, but runs are still below the 1989–1998 period when run sizes were much larger and provided unrestricted subsistence harvest and a consistent commercial harvest. King salmon runs in 2014–2016 and 2018 have shown moderate increases sufficient to provide some subsistence harvest, but not commercial harvest. The run size in 2017 was the largest since 2003 and could have provided a full subsistence harvest and a surplus available for commercial. Inseason assessment uncertainty makes it challenging to fully utilize available surpluses. Yukon River summer chum salmon (O. keta) runs have had large surpluses available for harvest the past 5 years.

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

INTRODUCTION

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

In response to guidelines established in the SSFP, the board classified Yukon River king salmon as a yield concern at the September 2000 work session and has continued that designation during each subsequent cycle. A *stock of yield concern* is defined as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs" (5 AAC 39.222(f)(42)). The SSFP defines chronic inability as "the continuing or anticipated inability to meet expected yields over a four to five year period." This determination as a yield concern was originally based on low harvest levels for the previous 3-year period (1998–2000) and anticipated low harvest in 2001 compared to the previous 10-year (1989–1998) average harvest (Vania 2000). An action plan was subsequently developed by the department (SSFP; 5 AAC 39.222(d)(4)) and acted upon by the board in January 2001. The board continued the classification as a yield concern in 2004, 2007, 2010, 2013 and 2016. The board has made a positive customary and traditional (C&T) use finding for king, summer chum, fall chum, coho, and pink salmon in the Yukon Area. The board has found that 45,500–66,704 king, 83,500–142,192 summer chum, 89,500–167,900 fall chum, 20,500–51,980 coho *O. kisutch*, and 2,100–9,700 pink salmon *O. gorbuscha* are amounts reasonably necessary (ANS) for subsistence uses in the Yukon Area. In response to not meeting king salmon escapement goals during the period from 2008–2013, the board has made extensive changes to the management plan and regulations to allow more management flexibility to reduce king harvest during low run abundance. As a result, king salmon escapement goals were generally met on systems where assessment was possible during the period 2014–2018 (Table 1). Reductions

in harvest because of restrictions on king salmon subsistence fisheries and the elimination of commercial fishing for king salmon has allowed for escapement goals to be met despite below-average king salmon run sizes.

The Yukon River Panel established an interim management escapement goal (IMEG) for the Canadian-origin stock of king salmon (42,500–55,000) for 2010–2018. During that period, escapements fell within the IMEG six times (Table 2). The upper bound of the IMEG has been exceeded annually since 2014.

STOCK OF CONCERN RECOMMENDATION

In past stock status reports, king salmon harvests have been compared to those during the period when run sizes were much larger and before productivity decreased. During this earlier time period, subsistence fishing was not restricted and there was a large commercial fishery (1989–1998; Table 3). Recent average king salmon subsistence harvest (2014–2017) was approximately 17,700 fish which is 66% below the historical average (1989–1998). Commercial harvests of king salmon have decreased nearly 100% from an average of approximately 101,000 annually (1989–1998) to the recent five-year period (2014–2018) where only a single sale of 168 kings occurred during the fall chum salmon-directed fishery.

Yukon River king salmon escapements have consistently been met since 2014. However, the average Alaskan harvest of 17,753 king salmon from 2014–2017 remains at approximately 11% of the historic long-term average of 156,191 king salmon (Table 3) despite use of conservative management measures. Although the yield has greatly improved the last 2 years, providing increased subsistence harvests, the run sizes are still too small to provide for any commercial harvest of king salmon. Forecasts generated from juvenile abundance in the Bering Sea indicate that run sizes may remain the same size seen in 2018 or possibly decrease over the next two years. Therefore, based on the definitions provided in the SSFP in 5 AAC 39.222(f)(42), the department recommended the continuation of the yield concern classification for the Yukon River king salmon stock at the October 2018 work session.

STOCK ASSESSMENT BACKGROUND

Management of the Yukon River salmon fishery is complex because of many factors, including: the difficulty in determining stock-specific abundance and timing, overlapping multi-species salmon runs; increasing efficiency of the fishing fleet; the gauntlet nature of the fisheries; allocation issues between lower and upper river Alaska fishermen; allocation and conservation issues between Alaska and Canada; and the immense size of the drainage (Figure 1). Fishermen within the Yukon River may harvest stocks that are still several weeks and over a thousand miles from their spawning grounds. Because the Yukon River fisheries are largely mixed stock fisheries, some tributary populations may be under- or overexploited in relation to their abundance. It is not possible to manage for individual stocks in most areas where commercial and subsistence fisheries occur.

Research and ongoing projects

The department, federal agencies, Department of Fisheries and Oceans (DFO) Canada, Native organizations, Yukon Delta Fisheries Development Association (YDFDA), and various organized groups of fishermen operate salmon stock assessment projects throughout the Yukon River

drainage, which are used by the department to manage Yukon River salmon fisheries in the Alaskan portion of the drainage.

Inseason run assessment includes: run timing and relative abundance indices from test fisheries, sonar counts of passing fish, various escapement assessment efforts in tributaries, commercial and subsistence catch data, catch per unit effort data from monitored fisheries, and inseason genetic mixed-stock analysis (MSA) from lower river test fisheries.

Main river sonar, tributary sonar, weirs, counting towers, and aerial surveys are used to monitor passage and escapement. Other information collected at assessment projects, may include, but is not limited to, age, sex and length (ASL) composition, samples for MSA, count data on resident species, and information from the recovery of tagged fish.

Pilot Station Sonar

Since 1995, sonar assessments at Pilot Station have provided inseason abundance estimates. Complex species apportionment, technological limitations, high water, and bank erosion have been known to affect the accuracy of the estimates, particularly for king salmon, which make up a relatively small proportion of the total number of fish counted at the project daily. The department has conducted the following investigations to improve upon and test assumptions of the Pilot Station sonar program: use of a side-scan sonar further offshore to count fish farther away from the bank during periods of high silt; use of longer nets in the test fishing program to identify any potential species-specific net avoidance; testing alternative fishing locations downriver of the current left bank site; investigating alternative sites for the sonar; and reviewing the species apportionment model.

Updated selectivity parameters for all species were developed after the 2015 season and are used for producing passage estimates inseason at the project (Pfisterer et al. 2017). The daily passage estimates, by species, from 1995 to present have been updated with these improved selectivity parameters. Estimates can be obtained from the ADF&G, Division of Commercial Fisheries, Arctic-Yukon-Kuskokwim database management system (AYKDBMS[1]; Table 4).

The estimated passage of salmon at Pilot Station sonar is used inseason along with historical run timing comparisons to project the end-of season run size. Managers then compare the run to the preseason projection and manage fishing accordingly. The drainagewide estimate is ultimately produced by taking the end-of-season Pilot Station sonar count, plus the harvest and escapement below the sonar (Table 5, Figure 2).

Inseason Mixed Stock Analysis

Beginning in 2005, genetic stock identification of king salmon has been used as an additional management tool and is particularly useful in projecting Canadian run size inseason. The Canadian stock has varied from 32%–52% but on average, comprises 41% of the run (Table 6). In most years, three pulses of king salmon sampled in the Pilot Station sonar test fishery were analyzed for stock composition inseason; results were reported within 48 hours of receipt at the department's Gene Conservation Laboratory in Anchorage. The pulse-specific genetic information assists with management decisions. For example, managers use the genetic proportions from each pulse applied to the weighted passage to assess Canadian-origin king salmon run strength. Having this

[1] AYKDBMS, http://www.adfg.alaska.gov/CommFishR3/WebSite/AYKDBMSWebsite/Default.aspx.

information early in the run allows managers to make informed decisions about the ability to meet escapement goals and support subsistence needs.

Genetic samples from chum salmon are collected from the Pilot Station sonar test fishery and analyzed by the United States Fish and Wildlife Service on a weekly basis (Pella and Masuda 2001). Estimates of stock composition provide the relative proportions between summer chum salmon and fall chum salmon stocks that overlap in July and assist with management and assessment of that species.

Subsistence Harvest Surveys

Most Yukon Area communities have no regulatory requirements to report their subsistence salmon harvest. For these communities, the department operates a voluntary survey program. Harvest information is collected through postseason household interviews, follow-up telephone interviews, postal questionnaires, and harvest calendars (Jallen et al. 2017). For surveyed communities, harvest estimates are created that account for all households in a community, including those not surveyed. In areas along the entire Tanana River drainage (District 6) and where the Yukon River is accessible by the Alaska Highway road system (portions of District 5), fishermen must document their harvest on a subsistence or personal use permit. Subsistence harvest information is critical for determining total run size post-season and as one index of whether adequate fishing opportunity was provided to meet subsistence needs when harvestable surpluses exist.

Escapement

King salmon escapement goals were generally met throughout the Alaska portion of the Yukon River drainage during the past 5 years (2014–2018; Table 1). Tributary escapements have been monitored with counting tower projects on the Chena and Salcha rivers; a weir project on the East Fork Andreafsky River; and aerial surveys on the Anvik, West Fork Andreafsky, and Nulato rivers (Figure 3). Chena and Salcha rivers are the largest king salmon-producing tributaries within the Alaska portion of the Yukon River drainage. The biological escapement goal (BEG) for the Chena River has been met or exceeded since 2014. The BEG for the Salcha River has been met 3 of the last 5 years. Escapement could not be assessed in 2014 due to high water conditions that hindered project operations for much of the season. Visual counts in both the Chena and Salcha rivers were incomplete in 2017 and 2018 because of high water conditions. In those years, the visual counts were expanded using sonar estimates for missed days and are preliminary. Of the escapement observations for stocks indexed by aerial surveys, the sustainable escapement goal (SEG) for the West Fork Andreafsky River has been met 3 of the last 5 years (no survey conducted in 2016). The Nulato River SEG was met 2 of the last 5 years (no survey was conducted in 2014 and 2016). The Anvik River SEG was met only in 2015 and 2018 (no survey was conducted in 2016, Table 1).

Eagle Sonar

Beginning in 2005, a sonar assessment project was established at Eagle, below the U.S./Canada border, to assess king salmon and fall chum salmon passage into the Canadian mainstem[2]. ASL

[2] Evidence suggests that Canada's Department of Fisheries and Oceans (DFO) fish wheel mark–recapture program (1982–2004) tended to underestimate passage of king salmon into Canada. Therefore, adoption of sonar as a more reliable method to estimate this number has dramatically improved estimates of escapement, exploitation rates, and brood-year return information. Historical escapement goals were based on DFO fish wheels and are not directly comparable to present sonar-based escapement goals. Conversion factors have been developed to allow comparisons of escapement, exploitation rates, and brood-year return information to historical data, although this should be cautiously considered. In this report, Eagle sonar-based data (2005–2018) are emphasized because they are deemed most accurate.

information from test fishing at Eagle sonar gives reasonable estimates of the age class composition of the escapement to Canada. The sonar site is ideal due to stable river bottom morphology and because king salmon and fall chum salmon runs are clearly separated by time at this location. The eagle sonar estimate does not account for the harvest that occurs in the community of Eagle, which is upstream from the sonar. To create a border passage estimate, the king salmon harvest in Eagle is subtracted from the king salmon passage estimate at the Eagle sonar (Table 2).The border passage estimate is a good measure of the number of fish escaping into Canada, and therefore is used to assess border objectives agreed to within the Yukon River Salmon Agreement.

Managers project the run size and potential harvest of the Canadian-origin king salmon within the Alaskan fishery throughout the season and manage the fishery in order to achieve the "border objective." This includes the spawning escapement goal (IMEG) of 42,500–55,000 king salmon and a harvest share for Canadian fishermen of 20–26% of the Total Allowable Catch (surplus above escapement needs) of Canadian-origin king salmon as outlined by the Agreement. Spawning escapement in Canada is estimated post season once Canadian harvest estimates are obtained. IMEG and Canadian harvest share objectives were exceeded in 2011, and 2014–2018 (Table 2 and Figure 4). Conservative management from 2014–2018, coupled with inseason management uncertainty regarding the number of king salmon available for harvest in Alaska resulted in exceeding the upper end of the border passage objective by an average of 4,500 fish (Table 2).

Particularly during the 2014–2018 period, many Canadian First Nations tribes and fishermen have foregone harvest of king salmon to rebuild the runs. As a result, the entire Canadian harvest share provided was not taken and the spawning escapement was proportionately higher. The upper threshold of the IMEG (55,000 king salmon) has been exceeded between 2014 and 2018 (Table 2).

Yield

Poor king salmon runs have caused a dramatic decline in commercial and sport king salmon harvests since 1998 and decreased subsistence harvests since 2007 (Figure 2, Table 3). A king salmon-directed commercial fishery has not occurred since 2007 and the summer chum salmon-directed fishery has been conservatively managed to reduce incidental harvest of king salmon. The sale of incidentally caught king salmon was prohibited during the summer season in 2011 and prohibited during both summer and fall seasons beginning in 2012 and continuing through 2016. The 2017 run size was large enough to support some commercial harvest of king salmon, so during the fall chum commercial fishery in 2017 a single sale of 168 incidentally-caught king salmon was allowed. Due to public concern after this sale the department discontinued further sales and sought direction from the board during the 2018 statewide meeting regarding future sales of king salmon. The board confirmed the intent for the department to determine when a harvestable surplus sufficient for commercial sale of king salmon is available after considerations of meeting goals and providing subsistence opportunity. The 2018 run size was not deemed large enough to provide any commercial surplus of king salmon. Yukon River king salmon sport fisheries (excluding the Tanana River drainage, which is managed independent of the Yukon River) have been restricted to a 1 fish bag limit or annual limit or closed since 2008, with the exception 2010 when no restrictive actions were taken (closed preseason in 2014, 2015, 2016, and 2018).

During the most recent period for which subsistence harvest data are available (2014–2017), harvests fell below the lower end of the ANS range of 45,500–66,704 king salmon (Table 3). The subsistence harvest in 2014 was the lowest on record, with only 3,286 king salmon harvested. Prior

to 2008, annual subsistence harvest remained relatively stable near 51,000 king salmon (Table 3). Subsistence salmon management has been progressively more conservative since 2010 in response to low run sizes. From 2013–2017, the board required "first pulse protection" which is a closure to salmon fishing during the first pulse of king salmon all the way up the river into Canada; often, the second and third pulse were also protected. Managers also restricted gillnets to 6-inch or smaller mesh size to reduce harvests of king salmon in most seasons. Management strategies in 2015 were similar to 2014, with pulse closures and gear restrictions in place to protect the majority of the king salmon run. To further protect king salmon during the early portions of the run in 2016–2018, selective gear types (dip nets, beach seines, manned fish wheels) were used in commercial and subsistence fisheries from Districts 1–5 to allow the harvest of summer chum salmon, while requiring all king salmon be released alive. Since 2015, the department has gained a better understanding of the effects of these various management restrictions on harvest levels and have further refined management based on feedback from fishermen at the pre-season stakeholder meetings. In 2017 and 2018, the department endeavored to better spread the harvest across the run, to allow more fishing opportunity early in the run, and to provide the opportunity to use king gear for short periods when run strength allowed for additional harvest.

Exploitation Rates

The exploitation rate is defined as that proportion of the run that is harvested; hence, stock-specific total run, escapement, and harvest estimates are needed to calculate exploitation rates. Exploitation rates cannot be estimated for king 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 accurately. However, total run estimates and stock-specific harvest for the Canadian-origin stock can be determined based on border passage estimates and genetic mixed-stock analysis.

From 1998–2007, when king salmon run sizes were higher, an average of 43% of Canadian-origin king salmon total run was taken in the Alaska harvest (Figure 5). With the poor returns of Canadian-origin fish in recent years and the conservative management regime, the average exploitation rate for the recent period of 2014–2017 has decreased to approximately 11% and was as low as 2% in 2014 (Figure 5).

Brood Year Return Information

The brood-year data for Canadian-origin king salmon is used to assess the productivity of the Canadian-origin stock and serves as a representative of the drainagewide run. Total brood-year return divided by the parent-year escapement is a measure of stock productivity and is expressed as recruits or returns per spawner (R/S). Higher R/S values suggest better productivity. The minimum level of replacement for a stock is set at an R/S of 1; i.e., for each fish that spawns, one fish returns to spawn (Figure 6). The most recent brood year with most of the age classes returned (ages 3 through 6) is 2011. The ratio of R/S for Canadian-origin king salmon stock has ranged from a low of 0.93 to high of 5.19, with an overall average of 2.35 R/S from 1982–2011 (Figure 6).

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

King salmon outlook

The pre-season outlook for total Yukon River king salmon is generated by applying the historical average proportions of Canadian-origin fish in the total run (41%) to the JTC-approved Canadian-origin run outlook which is based on a combination of sibling, spawner-recruit, and marine juvenile abundance forecast methods (JTC 2018). The 2019 pre-season outlook will not be available until December 2018.

Marine surveys in the northeastern Bering Sea (NBS) were initiated in 2002 by the National Oceanic and Atmospheric Administration (NOAA) and have continued in recent years in partnership with the department. NBS surveys have provided important ecological and management insights for Yukon River king salmon (Murphy et al. 2013). These surveys occur primarily in September and use surface trawls to capture juvenile salmon after they experience the critical transition from freshwater to marine environments. The most recent surveys have included sampling in both August and September in order to increase our understanding of factors affecting early marine survival. Important products of these surveys include indices of juvenile Yukon River king salmon abundance which can predict adult run size up to 3 years in advance. Current projections indicate decreasing abundance should be expected over the next 2 years (Figure 7).

Factors Affecting the Stock

Yukon River salmon stocks have generally remained healthy because of undisturbed spawning, rearing, and migration habitat throughout much of the U.S. portion of the drainage; however, some habitat factors are present that may adversely affect salmon production. Although the effect of these factors cannot currently be quantified, the potential individual and cumulative effects of these habitat factors should be considered when assessing the future productivity of Yukon River salmon stocks. A detailed discussion of these issues is found in the Yukon River Comprehensive Salmon Plan for Alaska (Holder and Senecal-Albrecht 1998). This plan discusses mining, logging, and potential pollution and habitat changes related to urban development, rural sanitation, increased road traffic along a few tributaries, and agriculture. This plan is currently being revised and updated, and reviewed through a public process with a proposed publication date in 2019.

While logging and mining may occur in the Yukon Territory of Canada where a large proportion of Yukon River king salmon spawn, these processes are monitored by the Canadian government and are not discussed in detail here.

It is estimated that at least 50% of all water bodies in the Yukon watershed have not been evaluated for distribution of anadromous species and a similar or higher percentage of first and second order tributaries similarly have not been surveyed. Without such surveys, and submittal of documentation based on field work, these streams are not afforded legal protection under Alaska Statute 16.05.841 (Fishway Act) or AS 16.05.871 (Anadromous Fish Act). A significant number of streams could be added/corrected in the Anadromous Waters Catalog. Regular review of the catalog is conducted by biologists for their assigned areas and nominations are submitted to document the presence of anadromous fish.

Flood Control and Other Dams

A large contributor to the Yukon River king salmon run is the Tanana River, with fish spawning mainly in the Chena and Salcha rivers; tributaries of the Tanana River. The Chena River Lakes Flood Control Project was built by the U.S. Army Corps of Engineers in 1973–1979 to control flood waters in downtown Fairbanks in response to the devastating 1967 flood. Some fish resource

users have raised concerns about the dam's effects on emigration of salmon fry or migration of adults. During high water events every few years, the dam's gates have been lowered to divert some of the Chena River's flow to manageable levels. This diverted water impounds in the vegetated floodway immediately upstream of the dam until the high water passes, which may flow into the Tanana River or drains back into the Chena River. The potential impacts such as stranding, avian predation, and imprinting are unknown.

The Whitehorse Dam on the mainstem Yukon River in Whitehorse, Canada is the only other dam on the Yukon River that may impede passage of spawning salmon, and the outmigration of juvenile salmon. This dam provides a fish ladder to allow passage of fish, and has a hatchery that releases approximately 150,000 king salmon fry each year upstream of the dam. These projects have been in place since the mid 1980's and data are summarized in the JTC report annually (JTC 2018).

Bering Sea Bycatch of Yukon River Stocks

Yukon River bound king salmon are taken as bycatch in the Bering Sea groundfish fishery and fishermen have continually expressed concern regarding effects to Western Alaskan salmon stocks, particularly after an estimated 130,000 king salmon were taken as bycatch in 2007. The North Pacific Fishery Management Council (council) acted in 2009 to manage king salmon bycatch under Amendment 91 by creating a hard cap on king salmon bycatch and creating a bycatch avoidance program with incentive plans. Amendment 91 went into effect during the 2011 fishing season. In April 2015, the council voted to approve regulations that would lower the bycatch cap levels for king salmon in years of historically low western Alaskan king salmon runs as indexed by the combined preliminary run sizes from the Unalakleet, Upper Yukon, and Kuskokwim River stocks. The 2018 run size index will be the first year to trigger these reduced bycatch cap levels, which will be included in the 2019 groundfish fishery harvest specifications during the council's October 2018 meeting.

A marked reduction in bycatch has occurred since 2008, and the recent 5-year average bycatch is less than 26,000 king salmon. Approximately 16,000 king salmon have been caught through September 2018, though these numbers are preliminary. Recent genetic information on bycatch of Western Alaska king salmon in the Bering Sea Aleutian Islands pollock fishery, 2008–2016, averages 58% (range 37–78%, Guthrie et al. 2018). It is important to note that the genetic grouping of Western Alaska king salmon includes stocks from Bristol Bay, Kuskokwim River, Yukon River, and the Norton Sound area.

Change in size and age at return

Alaskan king salmon returns appear to be declining in size over the past 30 years, largely due to a higher proportion of younger age classes returning, i.e. the loss of age-8 and age-7 returns. This could be a result of size-selective harvest but is more likely a result of changing ocean conditions which have dynamic effects on food sources, growth rates, competition among species, predator/prey interactions, and other factors affecting survival and age at maturity. This has appeared to be true for king salmon in the Yukon River, stocks which overwinter in the northern Bering Sea (Lewis et al 2015).

Age-class composition of the Canadian-origin king salmon return from brood years 1979–2010 indicates that there was a dramatic decrease in age-7 salmon from an average of 28% during years 1979–1982, to an average of 8% during the following 10-year period (1983–1992). From 1993–2010, the age-7 age-class has composed, on average, about 5% of the return. The brood-year age-

class composition for age-4 salmon has remained relatively stable from 1993 to 2001 with slight increases from 2001–2010 (Figure 8). Starting in 1990, there has been a trend of age-5 and age-6 king salmon alternately dominating the brood-year age-class composition (Figure 8).

In general, declining body size (at-age) has also occurred, and this, coupled with a reduction in older age classes influences quality of spawning escapement, the board acted in 2010 to reduce the maximum mesh size allowed on the Yukon River for king salmon subsistence fishing to 7.5-inch or smaller mesh. The reduction in mesh size was based on a study that established net selectivity models for king salmon (Bromaghin 2005). Applying these net selectivity models to data from the Pilot Station test fishery showed that 7.5-inch mesh net selectivity more closely resembled the length distribution of the population than larger or smaller mesh net selectivity). Consequently, using 7.5-inch nets to harvest king salmon was expected to result in a broader distribution of lengths for escapement. The department also addresses this concern for achieving quality escapements by monitoring the age composition at various assessment projects and the harvest when possible. The department does not have the ability to manage the mixed stock run to reduce harvests of a particular stock or age class, instead, the focus is on achieving escapement goals to the numbers of fish required for long-term sustainability. The board effectively capped commercial gillnets for chum salmon to 6-inch or smaller mesh, which is an ideal mesh size to target chum salmon. Any incidental catch of king salmon in this gear size is statistically less likely to be the larger, more fecund, females.

ACTION PLAN REVIEW

Five management plans drive the department's management of king and summer chum salmon on the Yukon River and they have been continually improved and refined (see summary of regulatory changes below) since the major stock downturns, they are: 5 AAC 05.360. *Yukon River King Salmon Management Plan*; 5 AAC 05.362. *Yukon River Summer Chum Salmon Management Plan*; 5 AAC 74.060. *Chena and Salcha River King Salmon Sport Harvest Management Plan*; 5 AAC 05.367. *Tanana River Salmon Management Plan*; 5 AAC 05.368. *Anvik River Chum Salmon Fishery Management Plan*. Original goals stated in the action plan include: reduce fishing mortality to meet spawning escapement goals; provide opportunity for subsistence users to harvest levels within the ANS range; and reestablish the historic range of harvest levels by other users. While meeting spawning escapement goals has been achieved in the last 5 years, the other two goals have not been achieved and this is directly related to stock productivity that the department cannot change inseason. It may be that while current king stock productivity does provide some level of yield each year, historical levels of harvest (which include large commercial harvests) may not be achieved in the foreseeable future. The current challenge for reliably harvesting any surplus is limited by management uncertainty inseason. Despite having the best possible assessment of abundance, inseason projections of run size become most accurate by about the midpoint of the run. This occurs after king salmon have moved thru half of the districts, therefore if we have underutilized the available surplus, it is hard to make up for that later in the run. The department continues to refine management actions such that the minimum amount of fishing restrictions are used inseason to maximize the harvest of surpluses, meet escapement goals and harvest share objectives. The current management plans are enough to achieve this.

REGULATORY CHANGES SINCE ACTION PLAN BEGAN

Regulation Changes Adopted in 2001

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

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

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

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

- Coastal District; Koyukuk River drainage; Subdistrict 5-D: 7 days/week;
- Districts 1–3: two 36-hour periods/week;
- District 4; Subdistricts 5-B and C: two 48-hour periods/week;
- Subdistrict 5-A; District 6: two 42-hour periods/week; and,
- Old Minto Area: 5 days/week.

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

Regulation Changes Adopted in 2003

Managers experienced difficulty maintaining the subsistence fishing schedule in Districts 1, 2, and 3 and Subdistrict 4-A. The difficulties were due in part to subsistence and commercial fishing times being addressed in separate regulations. In March 2003, the board addressed two Agenda Change Requests (ACRs) regarding the subsistence fishing schedule, specifically whether the schedule can be terminated inseason on the basis of run abundance and, if so, how that would be done based on current regulations. The board adopted a change to terminate the subsistence fishing schedule and revert to pre-2001 subsistence fishing regulations when sufficient abundance exists:

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

Regulation Changes Adopted in 2004

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

1. The board increased the permit harvest area for subsistence salmon fishing to include all of Subdistrict 5-C as a means to track resource use changes due to the anticipated completion of the Rampart road construction project and increased mobility of fishermen.
2. The board adopted a regulation requiring gillnets greater than 4-inch mesh size to be removed from the water and requiring fish wheels to stop rotating during subsistence closures.
3. The board increased the subsistence fishing schedule from two 42-hour periods per week to two 48-hour periods per week in Subdistrict 5-A.
4. In Subdistrict 4-A, during times when the commissioner determines that it is necessary for chum salmon conservation, the commissioner may, by emergency order, close the commercial fish wheel fishing season and immediately reopen the season during which set gillnet gear may be used instead of fish wheels.

Regulation Changes Adopted in 2007

There were several proposals submitted to the board, including requests to change commercial gillnet mesh sizes and depth, commercial harvest allocations, and district boundaries. None of these proposals were adopted. The subsistence marking requirement for Districts 1–3 was changed such that from June 1 to July 15 a person may not possess king salmon taken for subsistence uses unless both tips and lobes of the tail fin have been removed. Marking must be done before the person conceals the salmon from plain view or transfers the salmon from the fishing site. Additionally, a person may not sell or purchase salmon from which both lobes of the tail fin have been removed. Previously, the marking requirement was to remove the dorsal fin.

The board passed a proposal that allowed catch-and-release of king salmon in the sport fishery on a portion of the Goodpaster River, downstream from the department regulatory markers located approximately 25 miles upstream from the confluence with the Tanana River. King salmon may not be removed from the water and must be released immediately without further harm. Additionally, in the Goodpaster River drainage, from June 1 through August 31, only one unbaited single-hook artificial lure may be used.

Regulation Changes Adopted in 2010

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

1. Effective in 2011, the maximum mesh size for subsistence, commercial, and personal use gillnets in the Yukon River Area will be 7.5 inches. Previously mesh size was unrestricted.
2. During times of king salmon conservation, the department now has emergency order authority to prohibit the sale of king salmon during chum salmon directed commercial fishing periods.
3. The *Yukon River King Salmon Management Plan* was amended by adding a new subsection that the department may use emergency order authority to close all salmon fishing in a district or portion of a district if run assessment information indicates an insufficient abundance of king salmon.
4. The subsistence fishing schedule in Subdistrict 4-A was changed to two 48-hour periods per week, regardless of commercial fishing periods.

5. The subsistence fishing schedule in Subdistricts 4-B and 4-C was modified to open from 6:00 p.m. Sundays until 6:00 p.m. Fridays when commercial fishing closures last longer than 5 days.

6. The Innoko River subsistence fishing schedule was changed to open 7 days per week.

Regulation Changes Adopted in 2012

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

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

Regulation Changes Adopted in 2013

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

- Require first pulse protection in the king salmon management plan regardless of preseason run forecasts. After initiating the pulse closure, the department may discontinue subsistence fishing closures if inseason run assessment indicates that escapement objectives on specific components of the run and subsistence harvest needs are likely to be met.
- Prohibit the sale of king salmon from the Yukon River drainage if king salmon escapement goals are not going to be met or subsistence salmon fishing is restricted in more than one district or portion of a district.
- Allow for a directed chum salmon commercial fishery in Districts 1–3 in the lower Yukon Area during times of king salmon conservation with 5.5-inch or smaller mesh size gillnets not exceeding 30 meshes in depth.
- Align Yukon Area subsistence regulations in Districts 1–3 with current management practices by adjusting closures around commercial fishing periods and allowing concurrent subsistence and commercial fishing by emergency order.
- District 1 boundaries redefined to include coastal waters adjacent to the south mouth of the Yukon River from Chris Point to Black River, which opens Acharon Channel to salmon fishing.
- Establish times when a commercial gillnet permit holder in the lower Yukon Area may use dip net and beach seine gear to commercially harvest summer chum salmon during times of king salmon conservation. All king salmon caught in dip net and beach seine gear must immediately be returned to the water alive, except that a dead king salmon may be taken but may not be retained; the dead king salmon must be recorded

on a fish ticket and forfeited to the state. Beach seine mesh size is not to exceed 4-inches. Dip net gear specifications are in 5 AAC 39.105(24).

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

Regulation Changes Adopted in 2014

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

Regulation Changes Adopted in 2015

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

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

Regulation Changes Adopted in 2016

Several proposals were submitted to the board for the 2016 meeting. The following is a summary of the board's actions:

- Establish a new drainage-wide escapement goal for summer chum salmon (500,000–1,200,000) and lower management triggers in the *Yukon River Summer Chum Salmon Management Plan*. Subsistence fishing may occur at projected run sizes above 500,000 fish; up to 50,000 fish may be harvested commercially when the projected run size is more than 650,000 fish but less than 750,000 fish; and a drainagewide commercial fishery may be opened above a projected run size of 750,000 fish. Sport fishing and personal-use may be allowed for run sizes above 650,000.
- Eliminate holding of a salmon caught in fish wheels in liveboxes prior to live release. Fish wheel operators must closely attend their fish wheel while it is in operation and must release specified salmon to the water alive in times of conservation.

- Established beach seine specifications for subsistence salmon fishing in the Yukon Area. beach seines used for subsistence salmon fishing may not exceed 150 fathoms in length, 100 meshes in depth, and 4-inches stretched measure. Beach seines may not be constructed of single-strand or multiple-strand monofilament web.
- Require the live release of king salmon from subsistence beach seines during times of king salmon conservation for both subsistence and commercial beach seines.
- Expand the area of allowable subsistence drift gillnet fishing for chum salmon in Subdistrict 4-A by emergency order only from June 10 to August 2.
- Modify the Yukon Area commercial set gillnet to an aggregate combined total length of 150 fathoms.
- Allow the department to restrict gillnets in the District 6 commercial fishery to 6 inches or less stretched measure during periods established by emergency order.
- Establish gillnet specifications for a pink salmon directed commercial fishery in District 1 of the Yukon River from June 15 to July 31 using gillnets that do not exceed 4.75-inches stretched measure. A pink salmon commercial fishery may only occur if a harvestable surplus of pink salmon is sufficient for subsistence use and if chum salmon escapement goals are expected to be achieved.
- Expand the commercial fishing area in Yukon Area District 1 from its terminus at the Black River to its terminus at Point Romanof and includes marine waters that extend 3 miles outward from any grassland bank.
- Modify the dates gillnet gear may be used for subsistence fishing in the South and Middle Forks of the Koyukuk River from August 30 through June 1.
- Under new regulations, that portion of the Chatanika River from its confluence with Goldstream Creek to a point three miles upriver is closed to the subsistence taking of northern pike through the ice. No changes to the bag and possession limits were adopted, nor were any size restrictions adopted.
- In Racetrack Slough off of the Koyukuk River and in the sloughs of the Huslia River drainage, from when each river is free of ice through June 15, the offshore end of a set gillnet may not be closer than 20 feet from the opposite bank, unless closed by emergency order.
- Allow the retention of incidentally-caught northern pike in the Yukon Area Subdistrict 6-C personal use area.

Regulation Changes Adopted in 2018

Several proposals were submitted as out of cycle ACR to the board for the 2018 statewide meeting. The following is a summary of the board's actions:

- Allowed salmon to be taken by drift gillnets in Subdistricts 4-B and 4-C during subsistence fishing periods. Drift gillnets may not be longer than 150 feet (25 fathoms).
- Removed the mandatory closure on the first pulse of king salmon in Districts 1 and 2 and direct ADF&G to manage the king salmon run conservatively, and only require

first pulse closure in Districts 1 and 2 if the preseason forecast indicates a poor run of king salmon.

- Specified that if king salmon escapement goals are projected to be met, subsistence fishing is not restricted, and subsistence fishing opportunity for king salmon has been provided within the season, ADF&G may open a commercial salmon fishery (e.g. for summer chum, fall chum, coho, or pink salmon) during which incidentally-caught king salmon may be sold.
- Clarified District 1 boundaries and specified that during the fall commercial fishing season set nets only may be used in the coastal waters of District 1.
- Removed the October 1 closure date for commercial fishing in District 6 and allows the season to be closed by emergency order.
- Adopted as an emergency regulation: in Subdistrict 4-A of the Yukon River allow the harvest of chum salmon by drift gillnets after August 2 downstream from Stink Creek. (This took effect during a July emergency petition meeting of the board and went into effect prior to the fall 2018 fishing season).

MANAGEMENT REVIEW

Management 2001–2009

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

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

A king salmon directed commercial fishery did not occur in 2008 and management actions were taken to protect the second and third pulses throughout the Yukon River mainstem. Less than 5,000 king salmon were incidentally harvested and sold in 2008 during chum salmon directed periods. Although sport fishery harvests in the Yukon River drainage are generally small compared to commercial or subsistence harvests, the sport fishing bag limit for king salmon was reduced to 1 fish inseason because of poor run abundance.

The 2008 season marked the start of actively managing the subsistence fishery in order to conserve king salmon. If the pattern of poor king salmon runs was to continue, the department recognized a need to develop a preseason plan to direct management of the subsistence fishery. In preparation for the 2009 season, YRDFA, through funding from the Yukon River Panel, facilitated a series of regional teleconferences and an in-person meeting to provide managers, fishermen, tribal council

representatives, and other stakeholders the opportunity to share information, provide input, and discuss management options. The purpose of these meetings was to work cooperatively to identify options and practical management strategies that would assist in getting adequate numbers of fish to their spawning grounds, particularly to Canada. Based on input from these meetings, a preseason management plan was developed to specifically guide management of the subsistence fishery. The key component of this plan was the formulation of the pulse protection strategy.

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

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

Management 2010–2012

Based on the larger king salmon preseason run size projection in 2010, managers developed strategies for implementing less severe subsistence conservation measures than those implemented in 2009. Possible conservation measures included promoting voluntary reductions, encouraging a shift in harvest to other species, spreading harvest out over the entire run, reducing extended sharing, and keeping harvested fish within the village or local area. Periods of high water and debris coincided with king salmon pulses, likely contributing to decreased harvests. The summer chum salmon commercial fishery was managed conservatively by opening the commercial fishing season near the third quarter point of the king salmon run, after the majority of Canadian-origin king salmon had passed. Unfortunately, even after conservative management measures, the escapement goal into Canada was not achieved. In hindsight, additional conservation measures were needed to meet this goal.

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

- Based on poor king salmon preseason run size projections, fishing time on the first pulse of king salmon was closed. Subsistence closures were similarly implemented in upriver fishing districts and subdistricts based on migratory timing.
- The Coastal District, Subdistrict 4-A, and Subdistrict 5-D areas were divided into smaller management portions. This strategy provided more management precision and flexibility when implementing a reduced subsistence fishing schedule.

- When inseason assessment indicated king salmon run strength continued to be poor after closing the first subsistence fishing period, subsistence fishing time was further reduced.
- Gear restrictions of 6-inch or smaller mesh size were implemented for short fishing periods to allow subsistence fishermen the opportunity to harvest summer chum salmon while still conserving king salmon.
- There were no directed king salmon commercial openings.
- Based on the preseason projection, retention of king salmon was not permitted in the mainstem Yukon River sport fishery. In the Yukon River tributaries (excluding the Tanana River drainage), the king salmon bag and possession limit was reduced from 3 fish to 1 fish.

The conservation measures taken in the subsistence fishery to reduce the harvest of king salmon adversely affected the ability to harvest the available surplus of summer chum salmon during this period. As a result, managers used the following options to address this issue:

- In an effort to reduce incidental harvest of king salmon, the summer chum salmon commercial fishery in Districts 1 and 2 was delayed until the third quarter point of the king salmon run.
- The sale of incidentally caught king salmon was prohibited to reduce the monetary incentive to target king salmon during chum salmon directed commercial periods.
- Summer chum-directed commercial fishing periods in Districts 1 and 2 have been intermittently instituted concurrent with subsistence fishing periods, primarily during June. The intent of these concurrent openings was to streamline commercial and subsistence fishing into a single harvest event, therefore reducing the time king salmon were susceptible to harvest.
- Based on inseason assessment and run timing information, commercial fishing has on occasion been limited to areas or times in which the incidental harvest of king salmon was anticipated to be low. For example, District 1 commercial fishing opportunity in 2012 was confined to waters of the South Mouth of the Yukon River when test fishery indices signaled a high abundance of summer chum salmon and limited presence of king salmon at that location and time.
- Through the use of new regulations available in the 2012 season, the department opened summer chum-directed commercial fishing periods in Subdistrict 4-A and District 6 with fish wheels only. Fish wheels had to be attended at all times during operations, and all king salmon caught in the fish wheels had to be immediately released to the water alive.

Management 2013–2015

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

The 2013 king salmon run was weak and unlikely to meet all escapement objectives even under conservative management actions. All 3 pulses of king salmon were protected by subsistence fishing closures as they migrated through Yukon Area Districts 1–5. Very limited subsistence fishing opportunity was provided between pulses to allow the harvest of summer chum salmon and other nonsalmon species with gillnets restricted to 6-inch or smaller mesh size. The use of gillnets was delayed until 50% of the king salmon run had migrated through the district. Conservation measures were also enacted in the commercial and sport fisheries to reduce the harvest of king salmon. For example, sport fishing for king salmon was closed preseason in the Yukon River drainage, excluding the Tanana River drainage. Sport fishing restrictions were later placed on the Tanana River drainage inseason. Fishers could use non-lethal gear types that allowed for the live release of king salmon (e.g., dip nets, beach seines, and fish wheels). In District 1, commercial gillnet fishing was restricted to the South Mouth of the Yukon River initially where summer chum salmon abundance was high and king salmon encounter rates were anticipated to be low. Concurrent subsistence and commercial fishing opportunity was provided to minimize the time that king salmon were exposed to fishing pressure. Despite these conservation measures, several Alaska escapement goals and the border passage IMEG were not met in 2013.

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

The preseason forecast range for the 2015 king salmon season was 118,000–140,000 king salmon; the upper end of this range was similar to the run size that returned in 2014. However, given the trend in low run sizes in recent history, initial management was based on the lower end of the preseason forecast. Managers expected that achieving escapement goals would be challenging and conservation measures would be necessary. Gillnets were restricted to 6-inch or smaller mesh size before king salmon entered a district. Once king salmon were present in a district, subsistence salmon fishing was closed. These subsistence salmon fishing closures were implemented chronologically with the upstream migration of king salmon. However, some opportunity was provided in Subdistrict 5-D with gillnets restricted to 6-inch or smaller mesh size prior to the arrival of the first pulse of king salmon. During subsistence salmon fishing closures, 4-inch or smaller

mesh gillnets not exceeding 60 feet in length could be used to target nonsalmon species. Once summer chum salmon became abundant, subsistence and commercial fishing opened with selective gear types such as dip nets, beach seines, and live-release fish wheels, which required the live-release of king salmon. Short subsistence gillnet openings with gear restricted to 6-inch or smaller mesh size were provided between pulses of king salmon when summer chum abundance was expected to be high. Once inseason run assessment at the sonar project near Eagle indicated that the border escapement objective would be met, subsistence fishing restrictions were relaxed. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River drainage. Based on the passage of king salmon at the border sonar project, the 2015 king salmon came in better than expected but still below average. All king salmon escapement goals were met or exceeded in 2015.

Management 2016–2018

Suggested actions from stakeholders at the preseason meetings have included: 1) separate subsistence and commercial fishing openings, 2) offer fishing opportunity with selective gear for subsistence harvest of summer chum salmon instead of closures early in the season, and 3) less confusing management actions (i.e. fewer surgical openings, more notice about openings and fishing on a schedule).

2016

The 2016 drainage-wide king salmon outlook was for a run size of 130,000 to 175,000 fish. Conservative actions were broadly implemented early in the king salmon run. In Districts 1, 2, and 3, subsistence salmon fishing was limited to dip nets and beach seines through the first and second pulses of the king salmon run. Openings with gillnets did not occur until during the third pulse and were on a reduced regulatory schedule. Throughout the summer season, the South Coastal area was restricted to 6-inch mesh and the North Coastal area was closed.

Similar to management actions taken in the lower river, subsistence salmon fishing with gillnets and fish wheels closed from Subdistrict 4-A through 5-C, and then re-opened with selective gear during the first 3 pulses of king salmon. Late in the run, subsistence fishing with 6-inch or smaller mesh gillnets was allowed on a reduced regulatory schedule, and a short 7.5-inch or smaller mesh gillnet subsistence period was provided in each subdistrict. Subsistence fishing in Subdistricts 5-A, 5-B, and 5-C was liberalized to five days per week once the lower end of the border escapement goal was achieved.

Subdistrict 5-D was open to subsistence fishing for king salmon prior to the arrival of the first pulse with 6-inch or smaller mesh gillnets and fish wheels; this subsistence opportunity was only provided in this area since they receive the most restrictive management actions to protect Canadian-origin king salmon. Fishing was closed during the first pulse, and the opportunity to fish with selective gear types was not provided because summer chum salmon do not migrate into Subdistrict 5-D. Once it became clear that the upper end of the border escapement goal and Canadian harvest sharing goals would be met, subsistence fishing opened for a 4.5-day period and was then relaxed to 24 hours a day, 7 days per week. The post season run size estimates indicated that the run came in at the upper end of the preseason projection range. Subsistence harvest estimates show that the opportunities provided in 2016 allowed subsistence fishermen to meet their summer chum salmon needs (as determined by ANS) and increase their king salmon harvest relative to 2014 and 2015. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River drainage.

2017

Along with the regulatory schedule, ADF&G implemented gear restrictions and additional closures during the summer season. In 2017, managers waited for increased king salmon catches at the Lower Yukon Test Fish (LYTF) assessment project before restricting the subsistence gillnet fishery to 6-inch or smaller mesh, to provide opportunity to target sheefish and other species following ice-out.

In the Lower Yukon, subsistence salmon fishing with gillnets closed and fishing was restricted to selective gear during the early fish and first pulse of king salmon. The North Coastal area was managed as part of District 1. The South Coastal area was restricted to 6-inch or smaller mesh gillnets for a portion of the summer season and remained open. Once run strength indicated harvest of king salmon could be supported, short periods of gillnet fishing ('surgical openings') with 7.5-inch gillnets or smaller mesh gillnets were opened.

In the Upper Yukon, subsistence fishing was restricted to the regulatory schedule with 6-inch or smaller mesh gillnets through Subdistrict 5-C during the early portion of the run. During the first pulse of king salmon, fishing was limited to selective gear types. The 2017 king salmon run was conservatively managed in the early part of the season when there was higher uncertainty with the run assessment. Managers relaxed or removed restrictions once run projections coincided with the upper end of the preseason forecast. Due to the strength of the run that could provide unrestricted subsistence opportunity, conservative management actions were not taken in Yukon River tributaries or Subdistrict 5-D. Although the subsistence harvest of 36,992 king salmon did not meet ANS levels in 2017, it was the largest harvest since 2011, and above the recent ten-year average of 29,514 fish. Border objectives (which include the escapement goal and harvest share for Canada) were achieved. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River drainage, based on indications that the run was better than anticipated the sport fishery opened to a bag and annual limit of 1 king salmon on June 26.

2018

In 2018, fishing was restricted to half of the regulatory schedule during most of the king salmon run. Subsistence periods were cancelled during the first and second pulses of the run in most districts. Subsistence fishing was allowed with salmon gear all season and was not restricted to the use of selective gear, but commercial summer chum fisheries were restricted to selective gear in Districts 1, 2 and 4. The 2018 run size of approximately 190,000 king salmon, was near the lower end of the pre-season run outlook of 173,000–251,000 fish. Subsistence fisheries were not relaxed to the full regulatory schedule with 7.5-inch gillnets until the majority of the run had migrated through each district and managers were more confident that escapement objectives would be met. Sport fishing for king salmon was closed preseason in the Yukon River drainage, inclusive of the Tanana River drainage.

2019 ALASKA BOARD OF FISHERIES REGULATORY PROPOSALS

At its 2019 meeting for Arctic-Yukon-Kuskokwim fisheries issues, the board will consider a total of 42 proposals. Seven proposals relate to the subsistence fishery for northern pike in the Chatanika River. Sixteen proposals address sport fisheries in the Tanana River drainage, 15 of which address nonsalmon species or stocked species. The remaining proposal—proposal 81—would increase the bag and possession limit of salmon, other than king salmon, in the Tanana River Area.

Eleven proposals address the Yukon River salmon subsistence fishery:

- Proposal 86 – Allow subsistence fishing for nonsalmon fish with hook and line gear in District 4 of the Yukon Area, as follows: allow hook and line gear to be used to catch subsistence nonsalmonid fish in the Kaltag, Nulato, and Old Village (or Rodo) River year-round.
- Proposal 87 – Allow subsistence fishing for salmon with drift gillnets in the entire Yukon River.
- Proposal 88 – Require fish wheels to be closely attended during times of conservation for any species.
- Proposal 89 – Allow retention of king salmon for subsistence purposes, by emergency order, during times of king salmon conservation in the Yukon Area.
- Proposal 90 – Reduce the amount of time prior to opening of the commercial fishing season in Districts 1–3 and Subdistrict 4-A of the Yukon Area when subsistence fishing for salmon is prohibited.
- Proposal 91 – Reduce the amount of time prior to opening of each commercial fishing period in Districts 1–3 of the Yukon Area when subsistence fishing for salmon is prohibited
- Proposal 92 – Restrict gillnet mesh size to a maximum of 6 inches in Districts 4, 5, and 6 subsistence and commercial salmon fisheries.
- Proposal 93 – Repeal the requirement to remove the tips of the tail fin of subsistence-taken salmon in Districts 1–3 of the Yukon Area
- Proposal 94 – Allow the taking of the first king salmon entering the Yukon River for religious and ceremonial use.
- Proposal 95 – In the Yukon River between the marker at Waldron Creek and Hess Creek, require a minimum distance of 300 feet between units of set gillnet gear and limit the amount of net gear that may be deployed in an eddy to 350 feet.
- Proposal 96 – Allow subsistence fishing for fall chum salmon in District 5 without time restrictions if commercial fishing for fall chum salmon is open in other Yukon River districts.
- Eight proposals address the Yukon River salmon commercial fishery
- Proposal 97 – Divide District 2 of the Yukon Area into two subdistricts.
- Proposal 98 – Decrease gillnet depth in Districts 4–6 of the Yukon Area.
- Proposal 99 – Allow use of beach seine gear to harvest salmon during open commercial fishing periods in Districts 1–3 of the Yukon Area.
- Proposal 100 – Adopt maximum size and depth restrictions for fish wheel baskets.
- Proposal 101 – Open and close the commercial fishery for fall chum and coho salmon in the Yukon Area by emergency order.
- Proposal 102 – Include the Pastolik and Pastoliak Rivers in District 1 of the Yukon Area.
- Proposal 103 – Repeal closed waters within 500 yards of the mouth of the Pastolik River and the Pastoliak River.

- Proposal 104 – Repeal closed waters in the lower three miles of the Pastolik and Pastoliak rivers.

A number of these proposals relate to increasing harvest opportunity and allowing fishermen more flexibility in meeting their needs for king salmon. Proposals 87, 89, 90, 91, 93, and 94 address retention of king salmon from selective gear types, reducing the number of hours subsistence fishing is closed around commercial periods, and allowing harvest on the early part of the run. Several proposals (88, 92, 95, 98, 99, and 100) would make changes to gear types and operation, which may protect king salmon or other salmon species. Proposals 102, 103, and 104 would open closed waters of the Pastolik and Pastoliak Rivers for commercial and subsistence fishing.

SUMMER CHUM SALMON STOCK STATUS

Most summer chum salmon spawn in the Yukon River drainage downstream of and within the Tanana River drainage (Figure 1). Stock composition of Yukon River summer chum runs has varied over the last decade. The contribution of the Anvik River, the largest producer of summer chum salmon, to the overall Yukon River stock production above Pilot Station sonar has decreased from approximately 46% during the years 1995–2002 to an average of 22% after 2002. This reduction corresponds with increased production in other chum salmon spawning streams. In 2014 and 2015, the department implemented a comprehensive radiotagging project for summer chum salmon to gain a better understanding of spawning distribution and abundance. Roughly 22% of the tagged summer chum salmon entered the Koyukuk River in 2014; however, that number increased to 27% in 2015. During both years, roughly 21% of tagged summer chum salmon entered the Anvik River and roughly 10% entered the Bonasila River (Larson et al. 2017).

An approximate estimate of total run of summer chum salmon in Yukon River can be obtained by summing (1) the sonar based estimates of summer chum salmon passage at Pilot Station, 1998–2018; (2) total harvest of summer chum salmon in District 1 and that portion of District 2 below the Pilot Station sonar site; and (3) summer chum salmon escapement estimates in East and West forks of the Andreafsky River (Figure 9). The estimate is approximate because some commercial and subsistence harvest in District 2 may not be accurately reported by location in relation to the Pilot Station sonar site, and the escapement to the West Fork Andreafsky River is assumed to be equal to the numbers observed in the East Fork Andreafsky River (Clark 2001).

Since it was established in 2016, the drainagewide BEG of 500,000–1,200,000 has been exceeded annually. Had the same BEG been in place historically, it would have been exceeded each year since 2002 (Figure 9). The BEG for the Anvik River, created in 2001 and updated in 2005, has been met or exceeded since 2010, except for 2016 and 2018 (Figure 10). Since it was established in 2010, the SEG for the East Fork Andreafsky River was met or exceeded in all years except 2014 and 2018 (Figure 11)

The Yukon River summer chum salmon run is typically managed as a single stock. The regulatory management plan, 5 AAC 05.362 *Yukon River Summer Chum Salmon Management Plan,* was modified in 2016 to provide recommended management actions based on various run sizes and to account for the new drainagewide escapement goal (Table 7).

SUMMER CHUM HARVEST

Combined commercial and subsistence harvests of summer chum salmon have fluctuated from decade to decade. The average harvest was highest in the 1980s with approximately 1,200,000

summer chum salmon harvested and lowest in the 2000s with an average harvest of 158,000 summer chum salmon. The recent (2014–2017) average of summer chum salmon harvested in commercial, subsistence, personal use and sport fisheries combined is 580,919 (Table 8; Figure 12). Subsistence harvests for summer chum salmon have been relatively stable in the Yukon Area, averaging about 90,400 fish harvested annually since 1998 (Table 8), and indicates a continued reliance on this species as an important subsistence resource. Subsistence fishermen mainly target summer chum salmon in the Lower Yukon River. Although summer chum salmon are found as far upstream as the lower portion of Districts 5 and 6, fishermen typically do not target them for human consumption due to their poor quality in those upstream areas. Since 2012, managers have opened fishing periods during the summer season with selective gear types (beach seines, dip nets and fish-friendly fish wheels) that require the live release of king salmon. These gear types are less effective than gillnets, but allow managers to open commercial and subsistence fisheries targeting chum salmon in times of king salmon conservation.

Commercial harvest of summer chum salmon averaged about 394,000 during the 1990s and 71,000 during the 2000s. The recent 5-year average (2014–2018) of 509,705 summer chum salmon is a marked increase from the previous 5-year average (2009–2013) of 296,697 fish. Since 2007 there has been renewed market interest for summer chum salmon in Districts 1 and 2, and since 2008, in Subdistrict 4-A.

Average summer chum and king salmon run timing overlap considerably with the middle 50% of the king salmon run overlapping with the middle 50% of the summer chum salmon run for 9 days (Figure 13). Due to this overlap and king salmon harvest restrictions, the department is challenged to develop management strategies that address the need to conserve king salmon during poor runs while providing harvest opportunities on the available surplus of summer chum salmon.

With the use of selective gear types to commercially harvest summer chum salmon, commercial fishing in 2014–2018 was initiated earlier than other years (Table 9). The commercial harvest of summer chum salmon in Districts 1 and 2 averaged 428,554 fish in 2014–2018, which was more than double the average for the years 2008–2012, when selective gear types were not used, and commercial fishing with gillnets was delayed. Although dip nets are not as efficient as gillnets for harvesting summer chum salmon, the success of the 2014–2018 commercial fisheries is largely due to the use of selective gear which accounted for 34%–64% of the total summer chum salmon commercial harvest (Table 9). Summer chum salmon commercial harvests during this same period were the largest since 1996 (Figure 12).

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TABLES AND FIGURES

Table 1.–Yukon River king salmon estimates from sonar projects and selected tributaries, 1998–2018.

	Sonar		Tower or weir			Aerial survey [a]		
Year	Pilot	Eagle [b]	Chena	Salcha	East Fork Andreafsky	West Fork Andreafsky	Anvik [c]	Nulato
1998	108,038		4,745	5,027	4,034			1,053
1999	184,218		6,485	9,198	3,444			
2000	54,560		4,694	4,595	1,609	427		
2001	121,089		9,696	13,328		565	1,420	1,884
2002	151,713		6,967	9,000 [d, e]	4,123	917	1,713	1,584
2003	318,088		11,100 [d, e]	15,500 [d, e]	4,336			
2004	200,761		9,645	15,761	8,045	1,317	3,625	1,321
2005	259,015	81,529	– [d]	6,000	2,239	1,492	2,410	553
2006	228,763	73,691	2,936	10,679	6,463	824		1,292
2007	170,246	41,697	3,806	6,425	4,504	976		2,583
2008	175,046	38,097	3,210	2,731 [d]	4,242			922
2009	177,796	69,957	5,253	12,774	3,004	1,678	832	2,260
2010	145,088	35,074	2,382	6,135	2,413	858	965	711
2011	148,797	51,271	– [d]	– [d, f]	5,213	1,173	642	1,401
2012	127,555	34,747	2,219	7,165	2,517		722	1,374
2013	136,805	30,725	1,860	5,465	1,998	1,090	941	1,118
2014	163,895	63,462	7,191	– [d]	5,949	1,695	1,051	
2015	146,859	84,015	6,294	6,288 [g]	5,474	1,356	2,487	1,564
2016	176,898	72,329	6,665	2,675	2,676			
2017	263,014	73,313	4,949 [d]	4,195 [d]	2,970	942	1,080	943
2018 [h]	161,900	57,959	4,227 [d]	4,053 [d]	3,972	455	1,109	870
5-Year average (2014-2018)	182,513	70,216	5,865	4,303	4,208	1,112	1,432	1,126
Goal range and type		42,500-55,000 (IMEG)	2,800-5,700 (BEG)	3,300-6,500 (BEG)	2,100-4,900 (SEG)	640-1,600 (SEG)	1,100-1,700 (SEG)	940-1,900 (SEG)

Note: Blank cells indicate no data. Chena BEG was established in 2001.

[a] Only surveys that were complete and had a higher rating than fair are included.

[b] Estimated number of king salmon at Eagle sonar. Does not account for harvest above the sonar project.

[c] Standardized for ecapment goal review to include mainstem between sonar and McDonald creek. Also includes Beaver, Swift and Otter creeks.

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

[e] Estimate includes an expansion for missed counting days based on average run timing.

[f] Aerial survey indicated escapement of at least 3,500 king salmon.

[g] Final estimate uses a binomial mixed-effects model to create passage estimates for the period of missed counts prior to start of tower operations on July 12.

[h] Preliminary estimate subject to change.

Table 2.–Estimated run size, escapement and harvest shares for Canadian-origin Yukon River king salmon, 2005–2018.

	Yukon River Panel goal or IMEG [a]				Total allowable catch (TAC)		U.S. share (%) of TAC			Canada share (%) of TAC				Border objective		Objectives exceeded?	
Year	from	to	Border passage [b]	Total king salmon run size [c]	from	to	74%	80%	U.S. harvest [d]	20%	26%	Canada harvest	Spawning escapement [e]	Lower end border objective [f]	Upper end border objective [g]	Lower end border objective [h]	Upper end border objective [i]
2005	28,000	28,000	78,962	123,612	95,612	95,612	43,703	47,246	44,650	11,812	15,355	10,977	67,985	39,812	43,355	39,150	35,607
2006	28,000	28,000	71,388	119,485		91,485	42,044	45,453	48,097	11,363	14,772	8,758	62,630	39,363	42,772	32,025	28,616
2007	33,000	43,000	39,698	87,899	44,899	54,899	20,335	29,984	48,201	5,496	9,745	4,794	34,904	38,496	52,745	1,202	-13,047
2008	45,000	45,000	37,282	62,637		17,637	13,051	14,110	25,328	3,527	4,586	3,399	33,883	48,527	49,586	-11,245	-12,304
2009	45,000	45,000	69,575	87,682		42,682	31,585	34,146	17,646	8,536	11,097	4,297	65,278	53,536	56,097	16,039	13,478
2010	42,500	55,000	34,470	59,741	4,741	17,241	3,505	13,789	25,271	947	4,481	2,456	32,014	43,447	59,481	-8,977	-25,011
2011	42,500	55,000	50,901	71,726	16,726	29,226	12,590	23,610	20,823	3,344	7,597	4,594	46,107	45,844	62,597	5,057	-11,696
2012	42,500	55,000	34,656	48,494	0	5,994	4,544	4,912	13,841	1,199	1,558	2,000	32,656	43,699	56,558	-9,043	-21,902
2013	42,500	55,000	30,573	37,177	0	0	0	0	6,604	0	0	1,904	28,669	42,500	55,000	-11,927	-24,427
2014	42,500	55,000	63,431	64,886	9,886	22,386	7,315	17,909	1,455	1,961	5,799	100	63,331	44,461	60,799	18,970	2,632
2015	42,500	55,000	83,674	87,323	32,323	44,823	23,919	35,858	3,649	6,467	11,657	1,000	82,674	48,967	66,657	34,707	17,017
2016	42,500	55,000	71,567	82,702	27,702	40,202	20,499	32,161	11,476	5,609	10,541	2,769	68,798	48,109	65,541	23,458	6,026
2017	42,500	55,000	71,815	92,622	37,622	50,122	27,840	40,097	20,807	7,524	13,032	3,500	68,315	50,024	68,032	21,791	3,783
2018 [j]	42,500	55,000	57,500	78,000	23,000	35,500	17,020	28,400	19,500	4,600	9,230	1,000	57,500	47,100	64,230	10,400	-6,730
2014 to 2018 Average			69,597	81,106	26,106	38,606	19,319	30,885	11,377	5,232	10,052	1,674	68,124	47,732	65,052	21,865	4,546

Note: Total Allowable Catch (TAC) range is calculated by subtracting each end of the goal range from the total run. Meeting the IMEG and providing Canada's share of the TAC is part of the U.S. obligation to meet the harvest share objectives. Border objective is the number of fish that would acheive the goal and the harvest share.

[a] Yukon River Panel goals were not always a range. The current interim management escapement goal (IMEG) began in 2010. The IMEG is not a biologically-based escapement goal.

[b] Border passage estimates are the king salmon estimate from the sonar at Eagle, minus any Alaskan harvest from the community of Eagle upstream of the sonar.

[c] Total Canadian-origin run size is border passage plus Alaskan harvest of Canadian-origin king salmon. Beginning in 2014, this includes harvest from the Coastal District.

[d] U.S. harvest estimated by applying the Canadian-origin genetic stock proportions collected from harvest sampling to number of fish harvested in Alaska.

[e] Spawning escapement is the border passage estimate minus the harvest in Canada.

[f] Border passage required to meet lower end of IMEG and provide 20% Canadian Harvest share (Lower end objective).

[g] Border passage required to meet upper end of IMEG and provide 26% Canadian Harvest share (Upper end objective).

[h] Number of fish additional to Lower end of Agreement (a negative number is the number of fish below required value).

[i] Number of fish additional to Upper end of Agreement (a negative number is the number of fish below required value).

[j] Harvest data not available. Assumes 500 fish harvested above Eagle sonar, and 19,500 fish harvested below. Assumes 1,000 fish harvested in Canada.

Table 3.–Alaskan harvest of Yukon River king salmon, 1989–2018.

Year	Commercial	Commercial related [a]	Total commercial	Subsistence [b]	Personal Use [c]	Test fish sales [d]	Sport fish [e]	Total
1989	104,198		104,198	48,462	2,616	1,293	1,063	157,632
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	3,873	141,649
1997	112,841	769	113,610	57,117	313	2,811	2,174	176,025
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	8,515	0	8,515	36,404	75	597	276	45,867
2001	0 [f]	0	0 [f]	55,819	122	0	679	56,620
2002	24,128	230	24,358	43,742	126	528	486	69,240
2003	40,438	0	40,438	56,959	204	680	2,719	101,000
2004	56,151	0	56,151	55,713	201	792	1,513	114,370
2005	32,029	0	32,029	53,409	138	310	483	86,369
2006	45,829	0	45,829	48,593	89	817	739	96,067
2007	33,634	0	33,634	55,174	136	849	960	90,753
2008	4,641 [f,g]	0	4,641 [f,g]	45,186	126	0	409	50,362
2009	316 [f,g]	0	316 [f,g]	33,805	127	0	863	35,111
2010	9,897 [f,g]	0	9,897 [f,g]	44,559	162	0	474	55,092
2011	82 [f,g]	0	82 [f,g]	40,980	89	0	474	41,625
2012	0 [f]	0	0 [f]	30,415	71	0	345	30,831
2013	0 [f]	0	0 [f]	12,533	42	0	166	12,741
2014	0 [f]	0	0 [f]	3,286	1	0	0	3,287
2015	0 [f]	0	0 [f]	7,577	5	0	13	7,595
2016	0 [f]	0	0 [f]	21,658	57	0	20	21,735
2017	168 [f,g]	0	168 [f,g]	38,100	125	0	- [h]	38,393
2018	0 [f]	0	0 [f]	- [h]	- [h]	0	- [h]	-
Recent average (2014-2017)	42	0	42	17,655	47	0	11	17,753
Historical average (1989-1998)	100,011	760	100,695	51,625	989	1,578	1,601	156,191

Note: Blank cells indicate no data.

[a] Refers to production of roe, including carcasses from subsistence-caught fish. Data not available prior to 1990.

[b] Includes harvest from the Coastal District and test fishery harvest that were utilized for subsistence. Subsistence includes fish commercially caught but not sold and test fishery catch given to subsistence users.

[c] Prior to 1987, and in 1990, 1991, and 1994, Personal Use was considered part of subsistence.

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

[e] Sport fish harvest for the Alaskan portion of the Yukon River drainage. Most of this harvest is taken within the Tanana River drainage (see Wuttig and Baker 2017; Behr 2015).

[f] No directed king salmon commercial fishery was conducted.

[g] King salmon sold commercially were incidentally caught in chum-directed commercial fishery.

[h] Data are not yet available.

Table 4.–Pilot Station sonar project estimates with standard error, 1998–2018.

Year [a]	Chinook	SE	Summer chum	SE	Fall chum	SE	Coho [b]	SE	Pink	SE
1998	108,038	51,703	824,901	39,270	375,222	12,387	146,365	9,403	103,416	6,806
1999	184,218	57,953	969,459	47,296	451,505	15,253	76,174	5,356	3,947	1,741
2000	54,560	6,601	448,665	14,395	273,206	12,539	206,365	10,208	61,389	6,958
2001 [c]	121,089	9,106	442,546	14,703	408,961	19,343	160,272	11,811	2,846	1,343
2002	151,713	24,298	1,097,769	31,062	367,886	17,508	137,077	7,689	123,698	11,745
2003	318,088	17,359	1,183,009	36,869	923,540	36,052	280,552	20,301	11,370	2,251
2004	200,761	12,145	1,344,213	30,363	633,368	22,206	207,844	11,933	399,339	20,531
2005 [d]	259,014	25,807	2,570,697	47,944	1,893,688	67,359	194,372	17,823	61,091	6,866
2006	228,763	16,836	3,780,760	94,500	964,238	27,749	163,889	11,044	183,006	14,376
2007	170,246	15,523	1,875,491	45,224	740,195	28,175	192,406	11,708	126,282	13,655
2008	175,046	12,989	1,849,553	41,667	636,525	18,251	145,378	8,441	580,127	52,427
2009 [c]	177,796	15,885	1,477,186	42,490	274,227	23,436	240,779	17,758	34,529	7,658
2010	145,088	89,628	1,415,027	93,896	458,103	24,800	177,724	7,592	917,731	48,439
2011	148,797	12,264	2,051,501	47,104	873,877	25,933	149,533	12,626	9,754	1,813
2012	127,555	11,339	2,136,476	48,046	778,158	37,802	130,734	9,602	420,344	36,366
2013	136,805	20,001	2,849,683	69,667	865,295	43,937	110,515	14,162	6,126	3,948
2014	163,895	11,389	2,020,309	60,127	706,630	37,630	283,421	17,089	679,126	36,469
2015	146,859	18,820	1,591,505	59,825	669,483	24,776	121,193	8,884	39,690	7,560
2016	176,898	11,226	1,921,748	48,946	994,760	39,170	168,297	11,187	1,364,849	52,975
2017	263,014	17,696	3,093,735	84,048	1,829,931	54,179	166,320	20,382	166,529	18,991
2018 [e]	161,831	14,917	1,612,688	65,257	928,664	33,460	136,347	7,231	689,607	29,159
Averages										
1998-2018	172,384		1,740,806		764,165		171,217		284,990	
2014-2018	182,499		2,047,997		1,025,894		175,116		587,960	

Note: To calculate a 90% Confidence interval, multiply the Standard Error (SE) by 1.645.

[a] Estimates for all years were generated with the most current apportionment model.

[b] Estimate may not include entire run. From 2008 to present, operations were extended to September 7, instead of the usual end date of August 31.

[c] High water levels were experienced all season in 2001. In 2009 high water levels occurred during the summer season followed by extreme low water during the fall season, therefore passage estimates are considered speculative.

[d] Estimates include extrapolations from June 10 to June 18 to account for the time before the DIDSON was deployed.

[e] Preliminary estimates.

Table 5.–Reconstructed drainage-wide Yukon River king salmon run size, 1997–2018.

Year	Canadian-origin king salmon Total run	Harvest below Pilot Station sonar [a]	Total Andreafsky River [b]	Pilot Station sonar estimate	Drainage-wide total run [c]
1997	161,700	115,336	6,372	199,763	321,471
1998	88,282	52,323	8,068	108,038	168,429
1999	110,446	69,838	6,888	184,218	260,944
2000	52,842	21,257	3,218	54,560	79,035
2001	85,663	18,915	2,296	121,089	142,300
2002	81,487	32,188	8,246	151,713	192,147
2003	149,979	48,591	8,672	318,088	375,351
2004	117,247	62,511	16,090	200,761	279,362
2005	123,612	40,842	4,478	259,014	304,334
2006	119,485	51,619	12,926	228,763	293,308
2007	87,899	45,505	9,008	170,246	224,759
2008	62,637	17,471	8,484	175,046	201,001
2009	87,682	10,255	6,008	177,796	194,059
2010	59,741	22,435	4,826	145,088	172,349
2011	71,726	12,467	10,426	148,797	171,690
2012	48,494	11,889	5,034	127,555	144,478
2013	37,177	3,952	3,996	136,805	144,753
2014	64,886	2,407	11,898	163,895	178,200
2015	87,323	3,942	10,948	146,859	161,749
2016	82,702	6,301	5,352	176,898	188,551
2017	93,099	9,212	5,940	263,014	278,166
2018 [d]	78,000	5,000	7,944	161,831	174,775
Average 2014-2018	82,002 [e]	5,466 [e]	8,416	182,499	196,288

[a] Harvest below Pilot station sonar includes commercial and subsistence harvest in statistical area codes 334-11 through 334-19 and 334-21 through 334-23. Also includes test fish sales for 1988–2007. Test fish harvest after 2007 is combined with subsistence harvest.

[b] East Fork Andreafsky River weir escapement count multiplied by two.

[c] Drainagewide total run for 1997–2017 is the sum of harvest below Pilot station sonar, the total Andreafsky river passage, and the Pilot station sonar count.

[d] Canadian-origin king salmon total run size and harvest data are rough estimates for 2018.

[e] Average from 2014–2017. Harvest numbers for 2018 are only rough estimates.

Table 6.–Pilot Station sonar king salmon passage and Canadian-origin proportion by strata, 2005–2017.

Year	Strata [a]	Pilot Station passage	Proportion of run	Canadian proportion [b]	Estimated number of Canadian fish
2005	Stratum 1	91,136	0.35	0.60	54,335
	Stratum 2	119,627	0.46	0.45	53,533
	Stratum 3	48,451	0.19	0.29	14,002
	Total	259,214	1.00	0.47	121,871
2006	Stratum 1	63,374	0.28	0.44	28,106
	Stratum 2	165,389	0.72	0.39	64,312
	Total	228,763	1.00	0.40	92,417
2007	Stratum 1	50,083	0.29	0.53	26,629
	Stratum 2	62,907	0.37	0.37	23,502
	Stratum 3	57,256	0.34	0.21	11,772
	Total	170,246	1.00	0.37	61,903
2008	Stratum 1	41,294	0.24	0.47	19,532
	Stratum 2	42,554	0.24	0.33	13,958
	Stratum 3	90,559	0.52	0.31	27,711
	Total	174,407	1.00	0.35	61,201
2009	Stratum 1	7,000	0.04	0.68	4,750
	Stratum 2	27,229	0.15	0.53	14,347
	Stratum 3	83,866	0.47	0.41	34,509
	Stratum 4	59,701	0.34	0.17	10,265
	Total	177,796	1.00	0.36	63,871
2010	Stratum 1	31,478	0.22	0.49	15,377
	Stratum 2	49,902	0.34	0.50	25,179
	Stratum 3	63,486	0.44	0.28	17,828
	Total	144,866	1.00	0.40	58,385
2011	Stratum 1	31,273	0.21	0.58	18,148
	Stratum 2	67,686	0.45	0.36	24,611
	Stratum 3	49,838	0.33	0.16	8,034
	Total	148,797	1.00	0.34	50,792
2012	Stratum 1	31,998	0.25	0.45	14,463
	Stratum 2	63,648	0.50	0.47	30,042
	Stratum 3	31,909	0.25	0.34	10,753
	Total	127,555	1.00	0.43	55,258
2013	Stratum 1	78,133	0.57	0.72	56,568
	Stratum 2	58,672	0.43	0.26	15,137
	Total	136,805	1.00	0.52	71,706
2014	Stratum 1	45,236	0.28	0.49	22,347
	Stratum 2	82,146	0.50	0.42	34,255
	Stratum 3	36,513	0.22	0.18	6,718
	Total	163,895	1.00	0.39	63,320

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Table 6.–Page 2 of 2.

Year	Strata	Pilot Station passage	Proportion of run	Canadian proportion [a]	Number of Canadian fish
2015	Stratum 1	30,600	0.21	0.50	15,178
	Stratum 2	51,172	0.35	0.37	18,780
	Stratum 3	65,087	0.44	0.33	21,218
	Total	146,859	1.00	0.38	55,176
2016	Stratum 1	37,511	0.21	0.52	19,136
	Stratum 2	86,622	0.49	0.34	29,114
	Stratum 3	52,765	0.30	0.54	28,282
	Total	176,898	1.00	0.43	76,532
2017	Stratum 1	30,088	0.11	0.43	12,857
	Stratum 2	79,913	0.30	0.49	38,929
	Stratum 3	69,392	0.26	0.43	30,121
	Stratum 4	83,621	0.32	0.41	34,008
	Total	263,014	1.00	0.44	115,915
2005 - 2017 Average					
	Stratum 1	43,785	0.25	0.53	23,648
	Stratum 2	73,651	0.41	0.41	29,669
	Stratum 3	59,011	0.34	0.32	19,177
	Total	178,393	1.00	0.41	72,950

[a] Stratum 1 generally represents early fish and first pulse of the king salmon run. Statum 2 generally represents the second pulse and stratum 3 generally represents the third pulse and any late season fish in the king salmon run.

[b] Weighted proportion of the total estimated king salmon run that is of Canadian origin.

Table 7.–Yukon River summer chum salmon management plan overview.

Projected run size [a]	Recommended management actions				Targeted drainagewide escapement
	Subsistence	Commercial	Personal Use	Sport	
500,000 or less	Restrictions [b]	Closure	Closure	Closure	>500,000
500,001 to 650,000	Possible restrictions [c]	Closure [d]	Closure [d]	Closure [d]	
650,001 to 750,000	Normal fishing schedule	0 - 50,000 [e]	Restrictions [d]	Restrictions [d]	
Greater than 750,000	Normal fishing schedule	400,000 - 1,200,000 [f]	Open	Open	500,000 - 1,200,000

[a] ADF&G will use best available data including preseason projections, test fishing indices, age and sex composition, subsistence and commercial harvest reports, and passage estimates from escapement monitoring projects to assess the run.

[b] A directed subsistence summer chum salmon fishery may be opened by emergency order in a district, subdistrict, or portion of a district or subdistrict if indicators show the individual escapement goal for that area will be met.

[c] The department may restrict the subsistence summer chum salmon fishery, except that, if indicators show that individual escapement goals within a district, subdistrict, or portion of a district or subdistrict will be met, the commissioner may open, by emergency order, a less restrictive directed subsistence summer chum fishery in that district, subdistrict, or portion of a district or subdistrict.

[d] If indicators show that individual escapement goals and subsistence needs within a district, subdistrict, or portion of a district or subdistrict will be met, the commissioner may open, by emergency order, a summer chum salmon fishery for commercial, sport, or personal use fishing in that district, subdistrict, or portion of a district or subdistrict.

[e] ADF&G may open a drainagewide commercial fishery to harvest up to 50,000 fish above the run size of 650,000 chum salmon distributed by district or subdistrict in proportion to the guideline harvest levels established in (g) of this section if buying capacity allows.

[f] When the projected run size of summer chum salmon is more than 750,000 fish, ADF&G may open, by emergency order, a drainagewide commercial fishery managed to achieve escapements within the established drainagewide escapement goal range of 500,000–1,200,000 summer chum salmon. The targeted harvest of the surplus will be distributed by district or subdistrict in proportion to the guideline harvest levels established in 5 AAC 05.362 (g).

Table 8.–Yukon River summer chum salmon commercial and subsistence utilization in numbers of fish, 1998–2018.

Year	Subsistence [a]	Commercial	Commercial related [b]	Personal Use [c]	Test fish sales	Sport fish [d]	Yukon Area total
1998	87,366	28,611	187	84	3,019	421	119,688
1999	83,784	29,389	24	382	836	555	114,970
2000	78,072	6,624	0	30	648	161	85,535
2001	72,155		0	146	0	82	72,383
2002	87,056	13,558	19	175	218	384	101,410
2003	82,272	10,685	0	148	119	1,638	94,862
2004	77,934	26,410	0	231	217	203	104,995
2005	93,259	41,264	0	152	134	435	135,244
2006	115,078	92,116	0	262	456	583	208,495
2007	92,926	198,201	0	184	10	245	291,566
2008	86,514	151,186	0	138	80	371	238,289
2009	80,539	170,272	0	308	0	174	251,293
2010	88,373	232,888	0	319	0	1,183	322,763
2011	96,020	275,161	0	439	0	294	371,914
2012	126,992	319,575	0	321	2,412	271	449,571
2013	115,114	485,587	0	138	2,304	1,423	604,566
2014	86,900	530,644	0	235	0	374	618,153
2015	83,567	358,856	0	220	2,494	194	445,331
2016	87,351	525,809	0	176	380	264	613,980
2017	87,437	556,516	0	438	1,819		[e] 646,210
2018 [e]		576,700	0		1,028		
Recent Average 2014-2018 [f]	86,314	509,705	0	267	1,144	277	580,919

[a] Subsistence harvest includes the Coastal District communities of Hooper Bay and Scammon Bay.

[b] In Districts 4, 5, and 6, (excluding the Anvik River), commercial related refers to the estimated number of females and incidental males harvested to produce roe sold. Beginning in 2006, the numbers of females harvested are included in the total commercial harvest.

[c] The Fairbanks nonsubsistence area is the only personal use area in the Yukon River drainage.

[d] Estimated sport fish harvest for all chum salmon (assumes majority of chum caught during summer season) in Alaskan portion of the drainage. A majority of the sport fish harvest occurs in the Tanana River drainage (District 6).

[e] Data are preliminary or unavailable at this time.

[f] Averages do not include data that is unavailable from recent year or years with no information.

Table 9.–Salmon commercial harvests in summer chum-directed commercial fishing periods in Districts 1 and 2, Yukon River, 2008–2018.

					Districts 1 and 2 combined				
					Incidental king salmon [a]				
Year	Date of first commercial		Gear	Proportion of king salmon passage [b]	Number of periods	Sales	Caught but not sold	Caught and released	Summer chum salmon sales	Proportion of commercial harvest
2008	2-Jul		6.0" gillnet	0.87	11	4,348	0	0	125,598	1.00
2009 [c]	29-Jun		6.0" gillnet	0.81	13	131	3,540	0	157,906	1.00
2010	28-Jun		6.0" gillnet	0.72	15	9,897	1,810	0	183,215	1.00
2011 [c]	24-Jun		6.0" gillnet	0.62	20	82	4,090	0	266,510	1.00
2012 [c]	29-Jun		6.0" gillnet	0.42	16	0	2,421	0	207,849	1.00
2013 [c]	18-Jun		Selective gear	0.06	32	0	[d]	927	189,208	0.50
	2-Jul	[e,f]	5.5", 30 mesh gillnet	0.84	6	0	88	0	74,452	0.20
	8-Jul		6.0" gillnet	0.93	10	0	351	0	115,483	0.30
				Season total		0	439	927	379,143	
2014 [c]	9-Jun		Selective gear	0.14	44	0	[d]	5,440	272,849	0.64
	3-Jul		6.0" gillnet	0.99	12	0	440	0	154,498	0.36
				Season total		0	440	5,440	427,347	
2015 [c]	11-Jun		Selective gear	0.18	39	0	[d]	9,507	227,214	0.64
	2-Jul	[e]	5.5", 30 mesh gillnet	0.89	3	0	874	0	34,153	0.10
	6-Jul		6.0" gillnet	0.97	12	0	2,415	6	92,719	0.26
				Season total		0	3,289	9,513	354,086	

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Table 9.–Page 2 of 2.

Year	Date of first commercial	Gear	Proportion of king salmon passage [b]	Districts 1 and 2 combined: Number of periods	Incidental king salmon [a]: Sales	Incidental king salmon [a]: Caught but not sold	Incidental king salmon [a]: Caught and released	Summer chum salmon sales	Proportion of commercial harvest
2016 [c]	7-Jun	Selective gear		22	0	0	8,213	181,146	0.35
	25-Jun [e]	5.5", 30 mesh gillnet		9		2,417	44	126,033	0.24
	27-Jun	6.0" gillnet		18		2,912	4	214,610	0.41
			Season total		0	5,329	8,261	521,789	
2017 [c]	10-Jun	Selective gear		0	0	0	4,618	135,043	0.34
	23-Jun [e]	5.5", 30 mesh gillnet		4	0	2,848	0	107,519	0.27
	2-Jul	6.0" gillnet		0	0	2,741	5	150,603	0.38
			Season total		0	5,589	4,623	393,165	
2018 [c]	9-Jun	Selective gear		39	0	0	11,928	243,811	0.55
	4-Jul	6.0" gillnet		19	0	2,982	60	202,570	0.45
			Season total		0	2,982	11,988	446,381	
Average 2014 to 2018		Selective gear			0	0	7,941	212,013	0.50
		5.5", 30 mesh gillnet [g]			0	2,046	15	89,235	0.20
		6.0" gillnet			0	2,298	15	163,000	0.37
			Average total		0	3,526	7,965	428,554	

Note: Selective gear includes dip nets and beach seines. Few fishermen use beach seines, and harvest from beach seines represented less than 5% of the selective gear harvest.

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

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

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

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

[e] Implemented in District 1 only.

[f] First five commercial periods restricted to only the South Mouth portion of District 1.

[g] Average does not include 2018 and 2014 when there were no openings restricted to this mesh size.

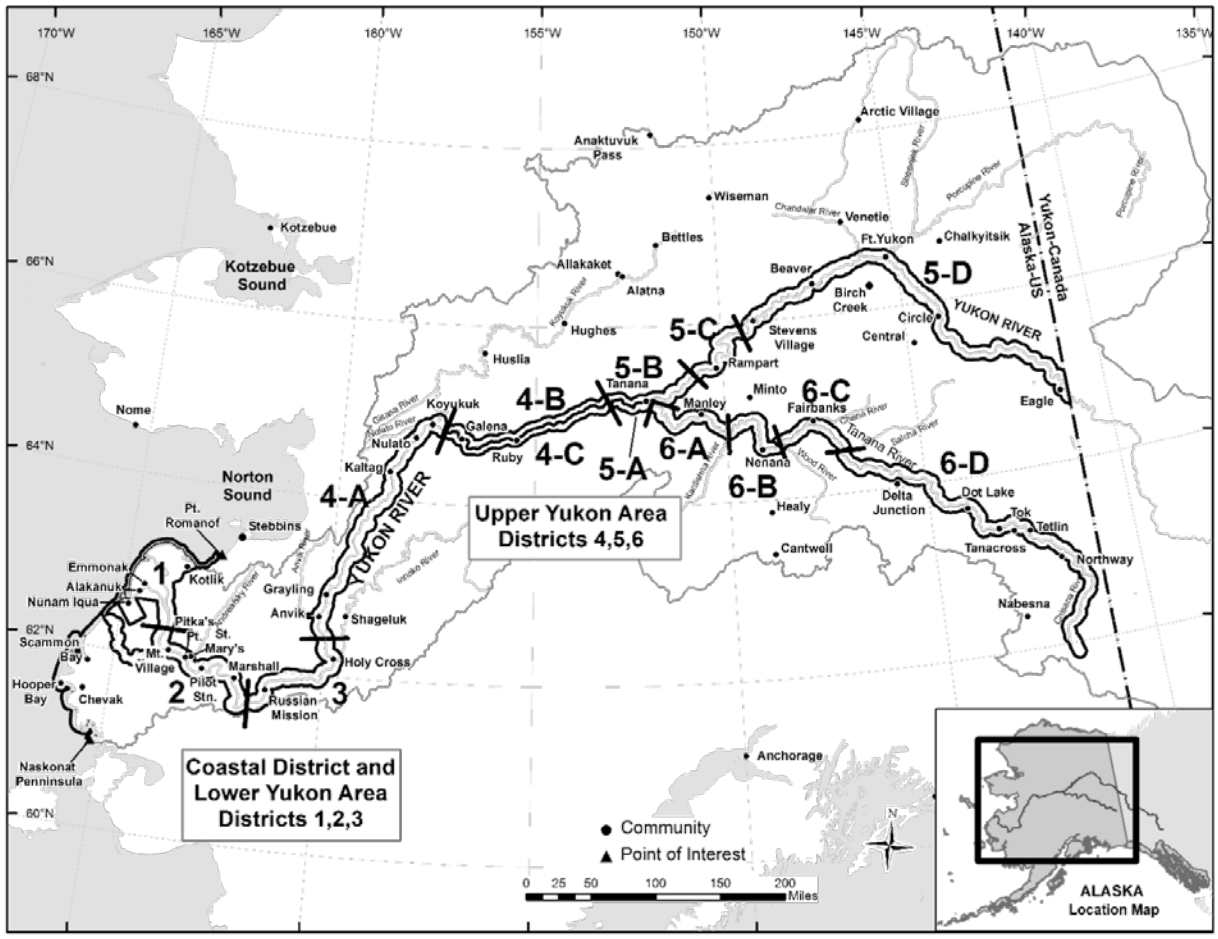

Figure 1.–Map of the Alaska portion of the Yukon River drainage showing communities and fishing districts.

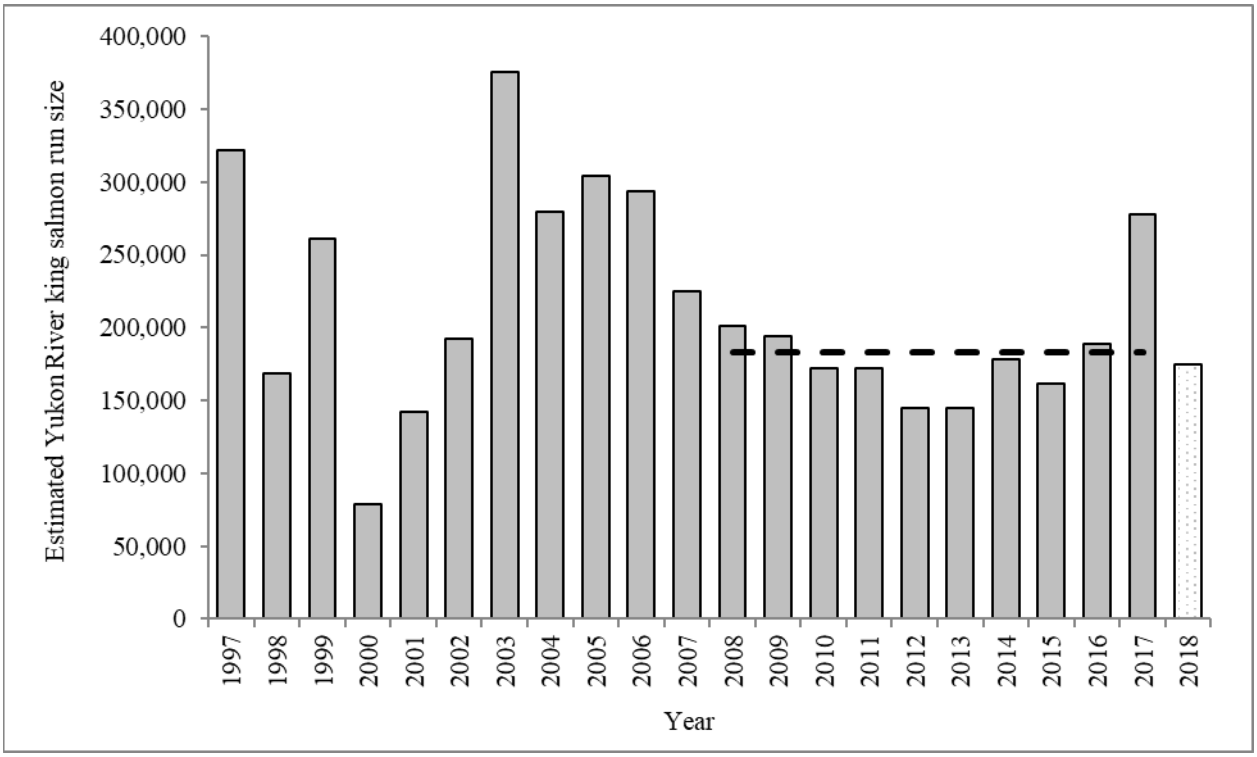

Figure 2.–Drainagewide king salmon run size 1997–2018.

Note: Drainagewide total run is the sum of harvest below Pilot station sonar, the total Andreafsky river passage, and the Pilot station sonar count. The dashed line is 2008–2017 average run size.

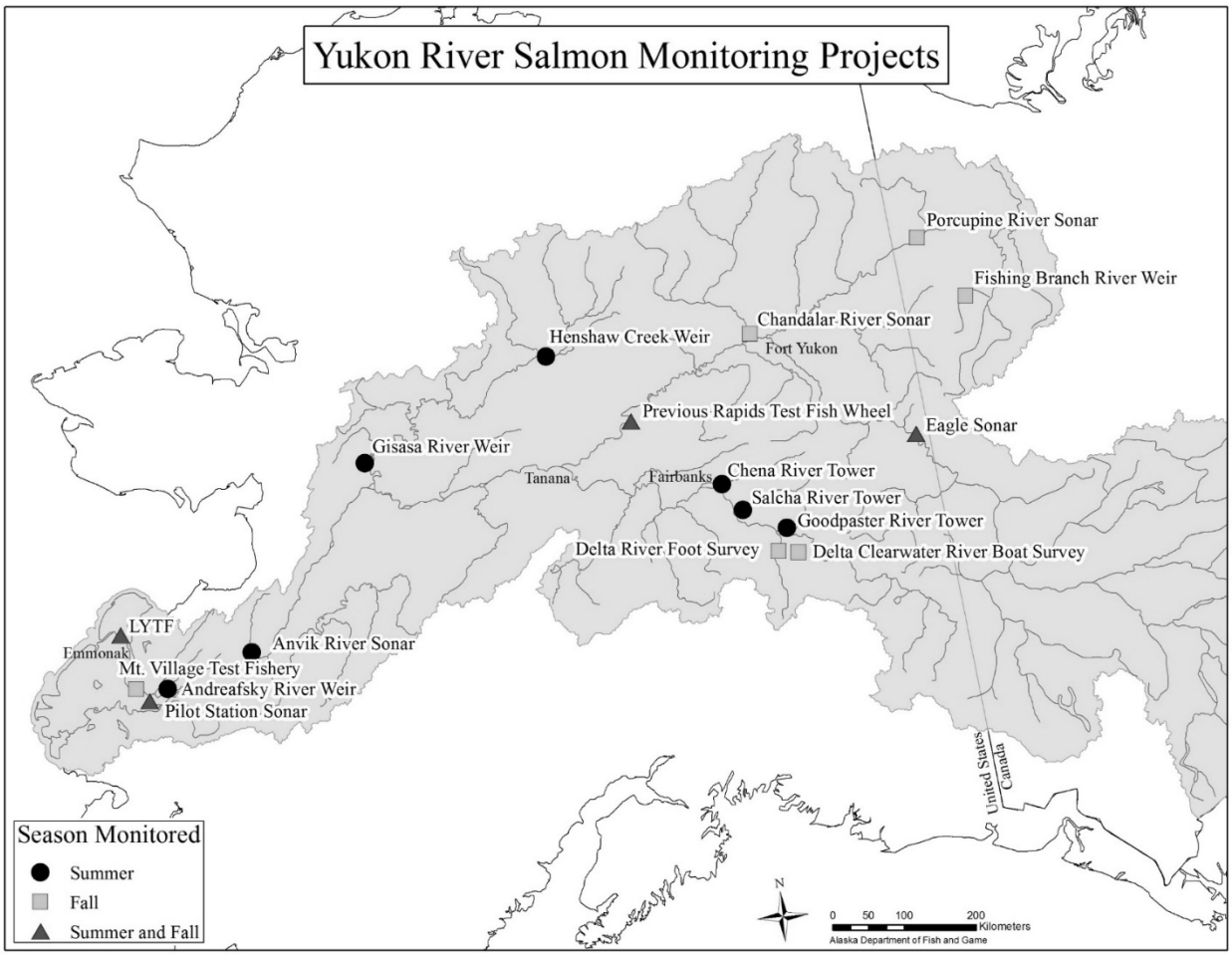

Figure 3.–Map of Yukon Area salmon monitoring projects.

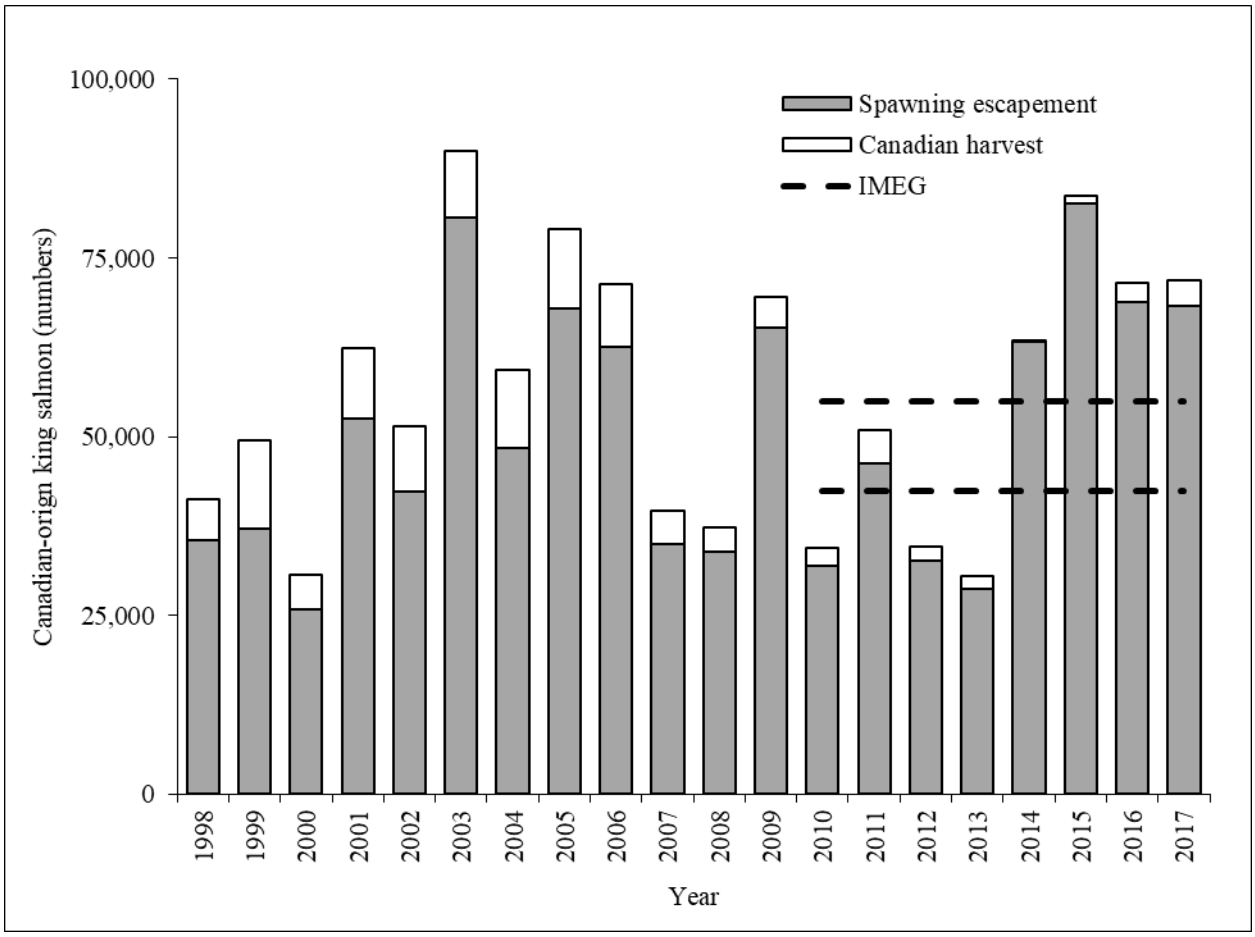

Figure 4.–Spawning escapement and harvest estimates for Canadian-origin Yukon River king salmon, 1998–2017.

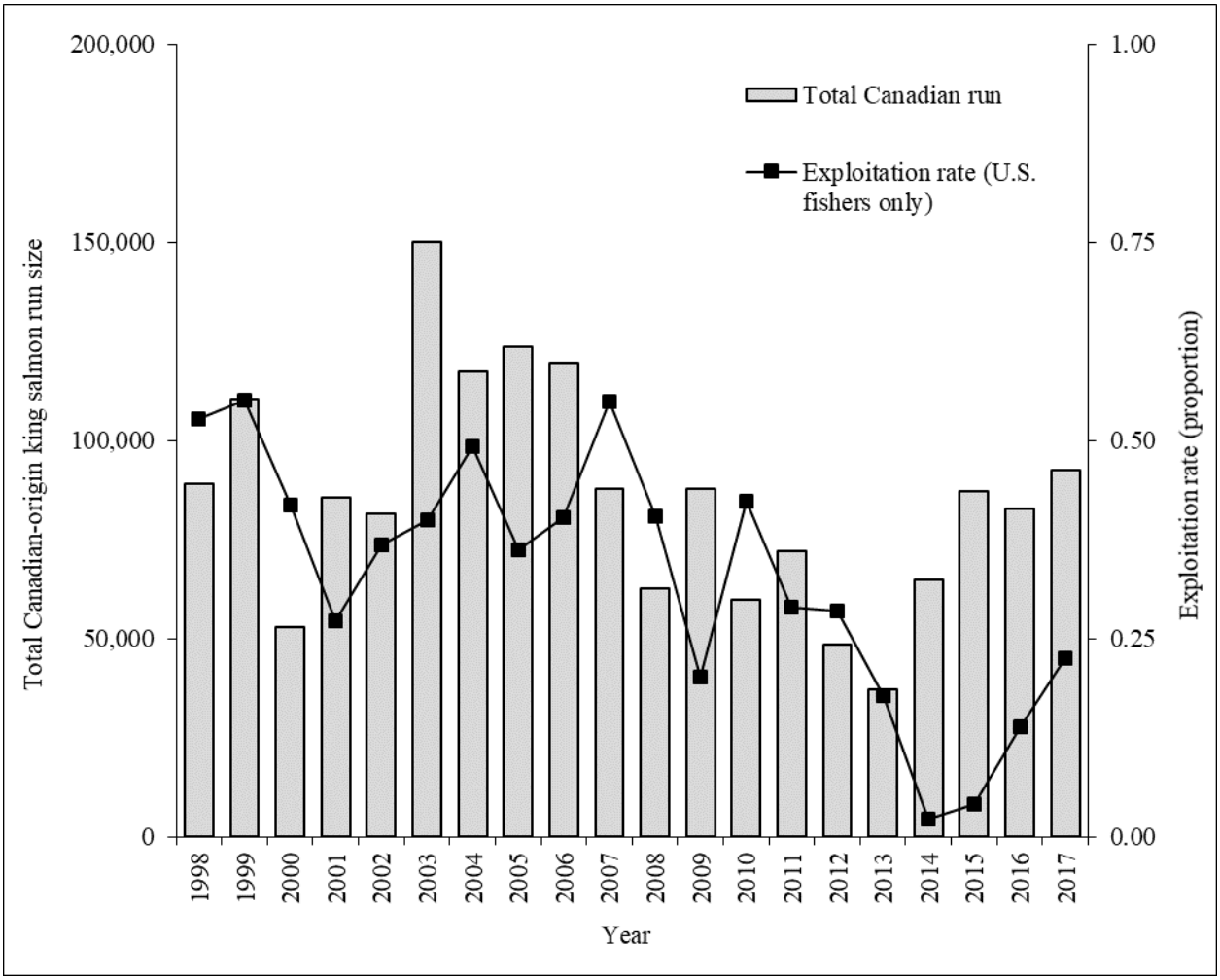

Figure 5.–Total Canadian-origin Yukon River king salmon run size and exploitation rate in U.S. fisheries, 1998–2017.

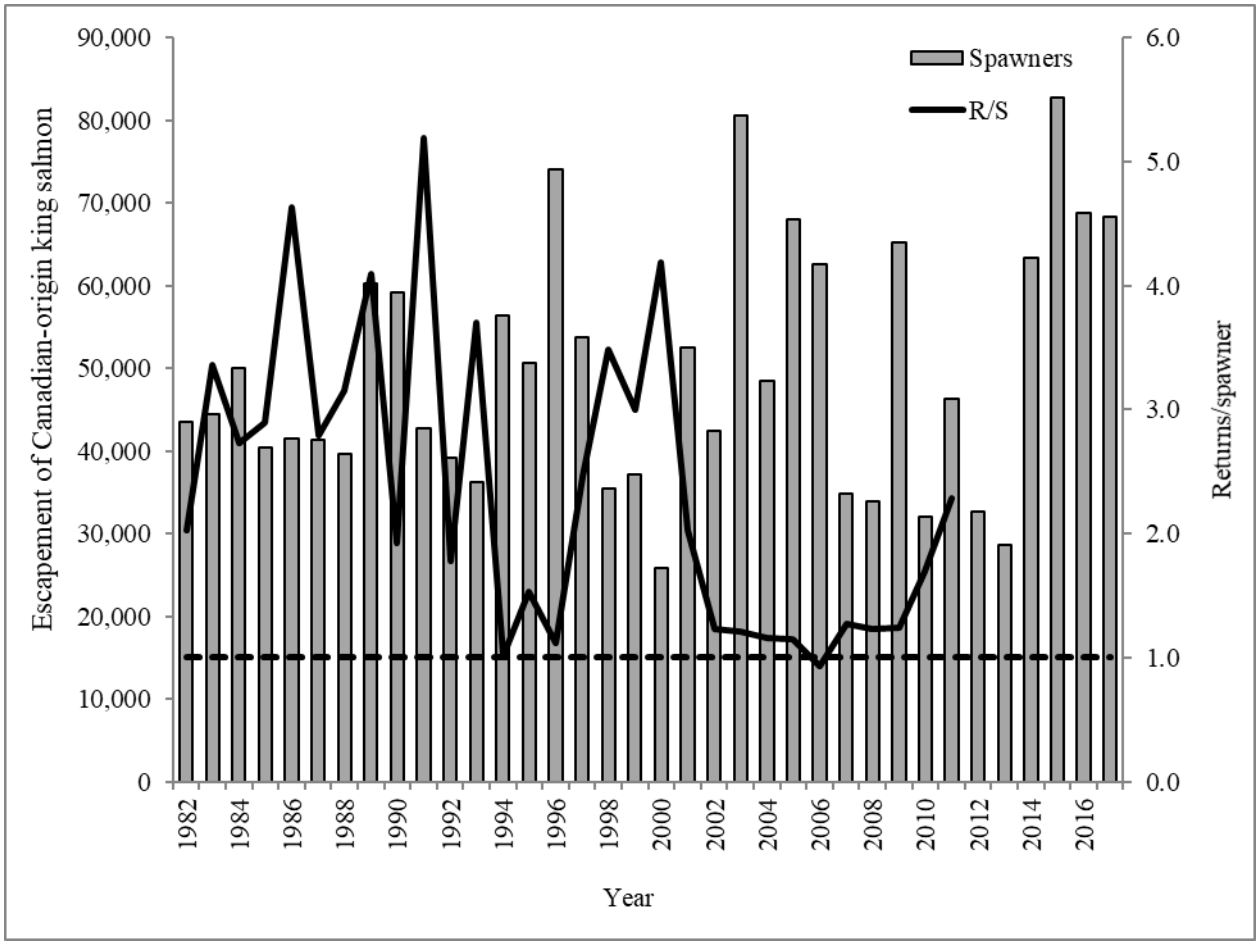

Figure 6.–Canadian-origin king salmon returns per spawner (R/S).

Note: Total escapement for Canadian-origin king salmon and returns per spawner (R/S) from each brood year with the age-3 through age-6 retuns. Age-7 returns do not change the R/S value considerably becasue of the relatively small proportion of the run they comprise. The dashed line indicates a necessary replacement level of recruits per spawner of 1.

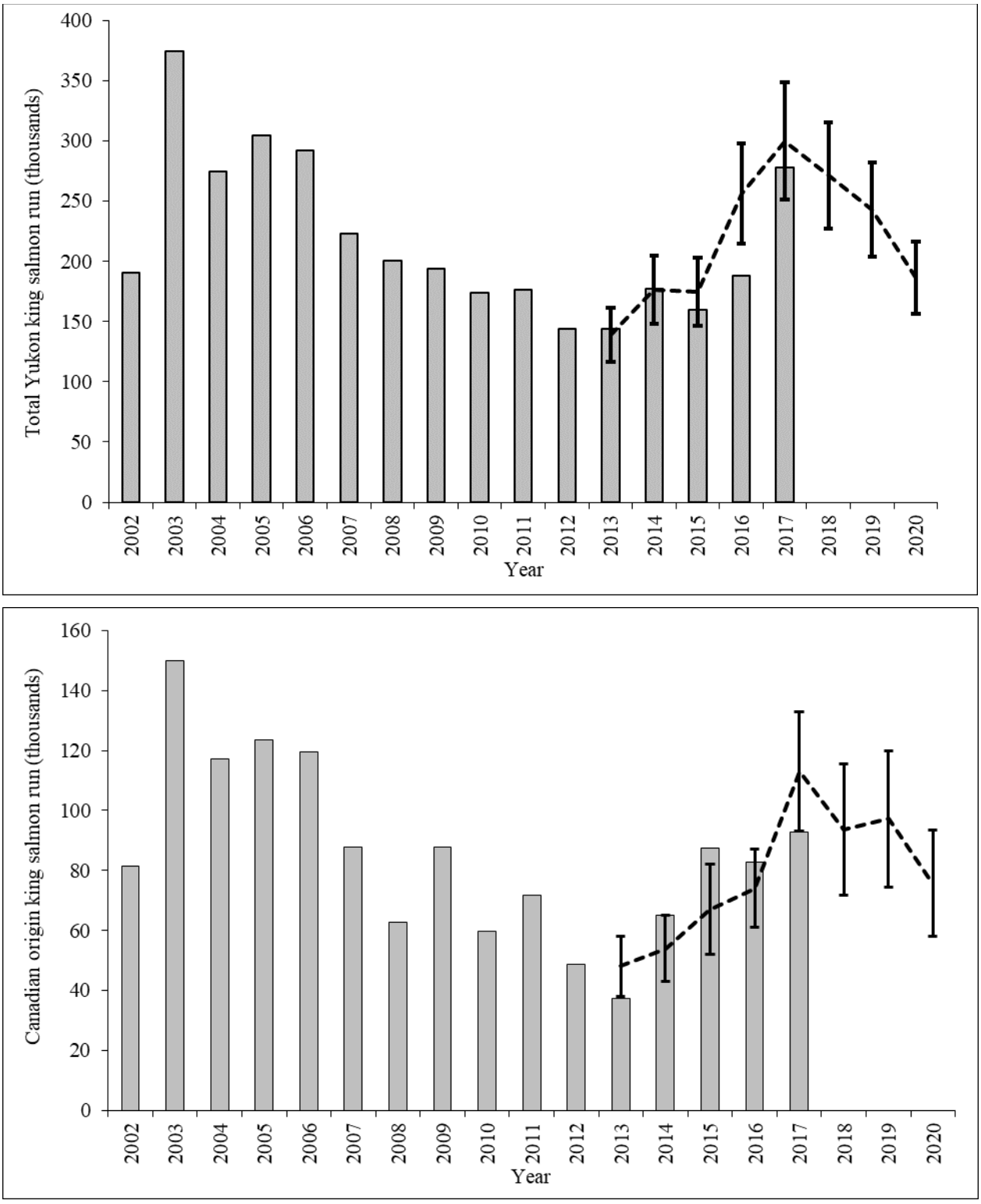

Figure 7.–King salmon total run size and projections.

Note: Adult run size of Total Yukon (top) and Canadian-origin (bottom) Yukon River king salmon (grey bars) and projected run size based on juvenile abundance forecast (black dashed line and error bars indicating forecast range). Note different scales on the y axes of each panel.

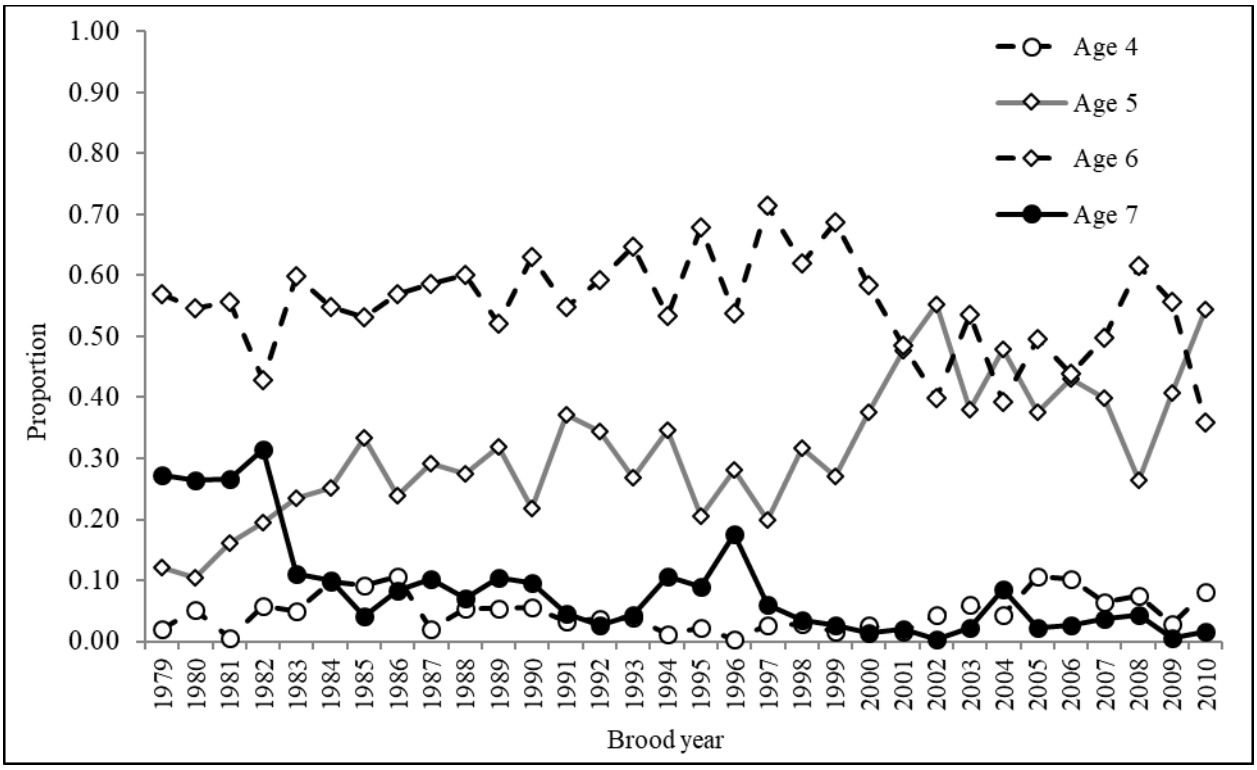

Figure 8.–King salmon proportion-at-age from brood years 1979–2010.

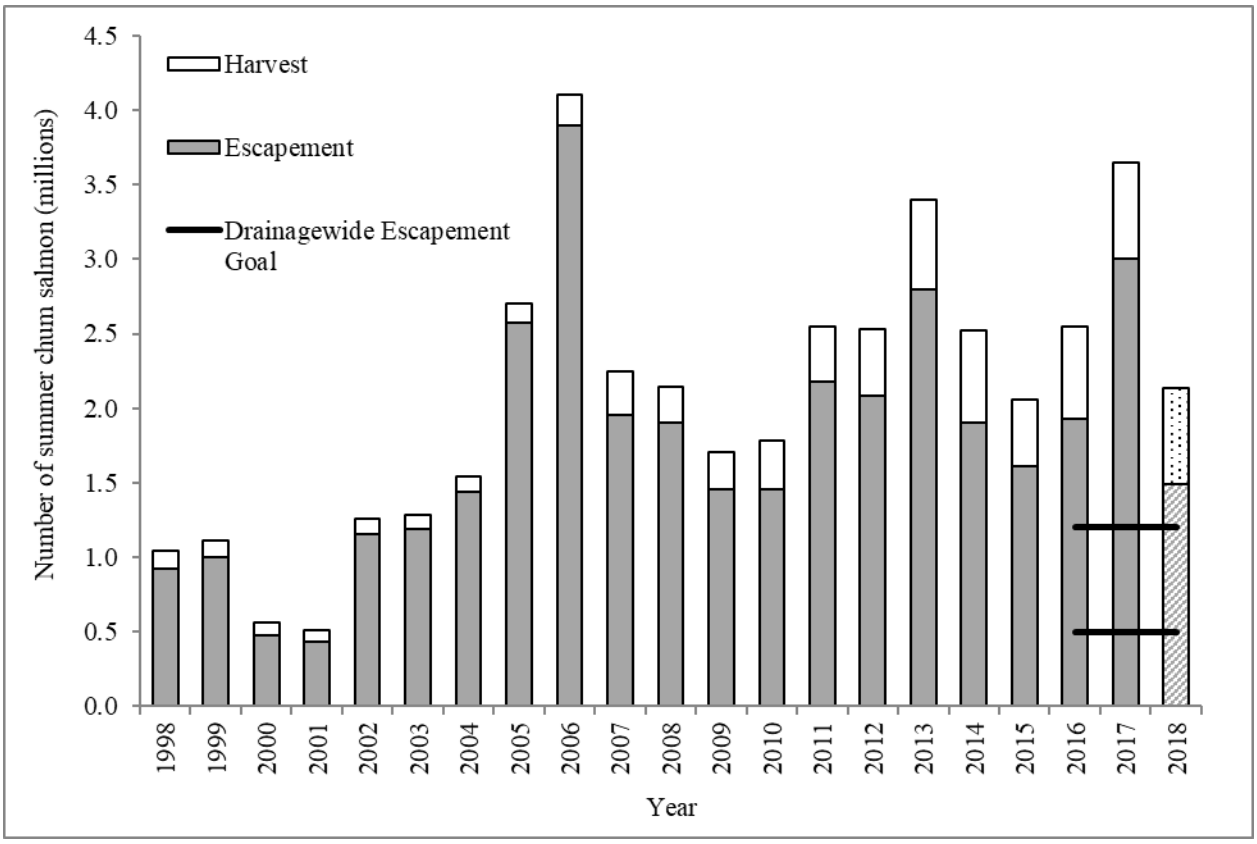

Figure 9.–Yukon River summer chum salmon total run size.

Note: Approximate total run size of Yukon River summer chum salmon, by harvest and escapement, compared to the drainagewide escapment goal of 500,000 to 1,200,000 fish, 1997–2017. Estimates from 2018 are preliminary; subsistence harvest data from 2018 is not available and is calculated from recent average harvests and 2018 commercial harvests, and escapement estimates are prelminary.

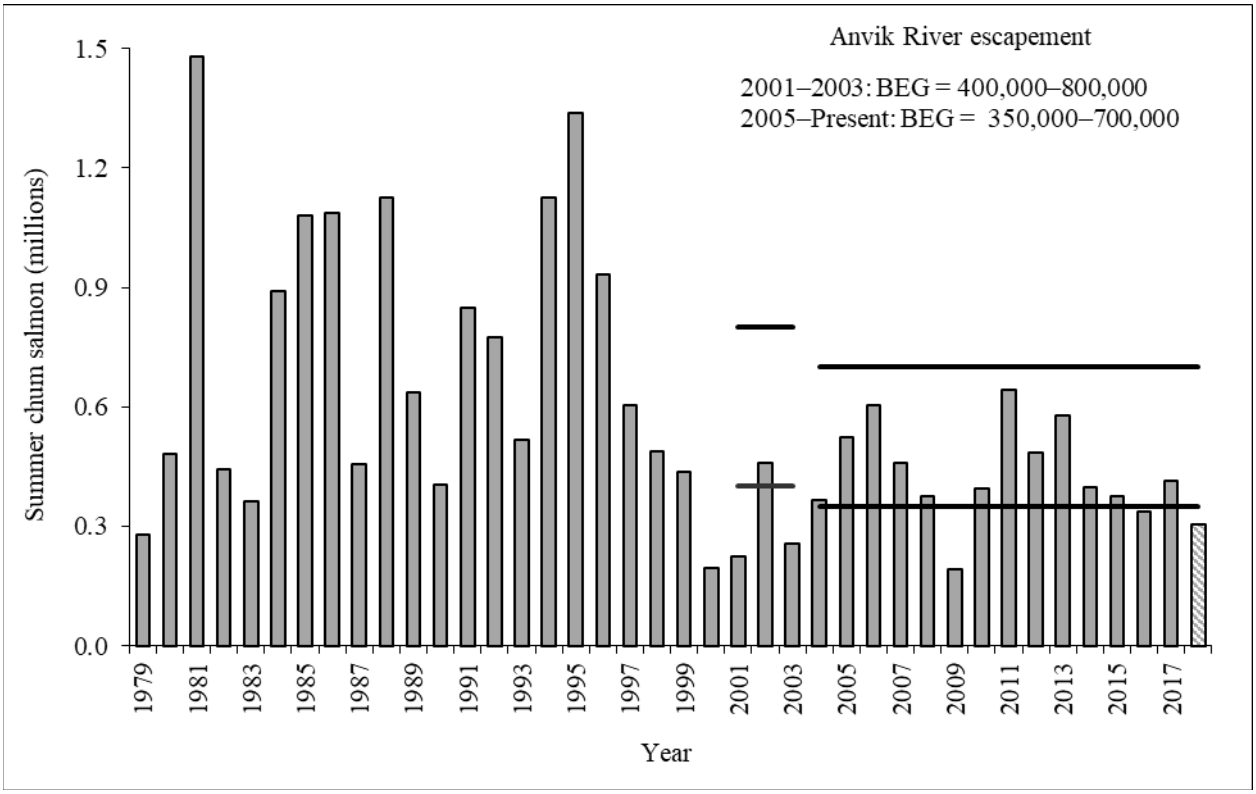

Figure 10.–Anvik River summer chum salmon passage estimates and escapement goals.

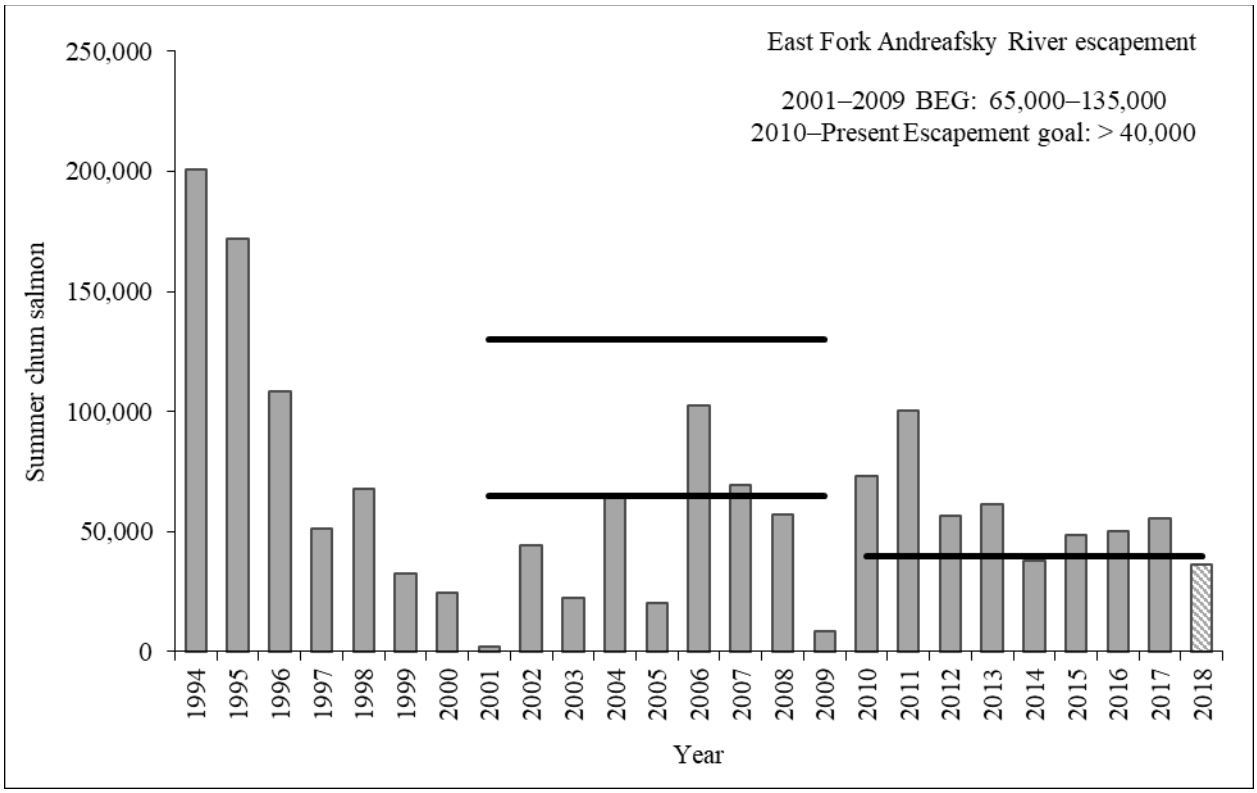

Figure 11.–East Fork Andreafsky River summer chum salmon passage estimates and escapement goals.

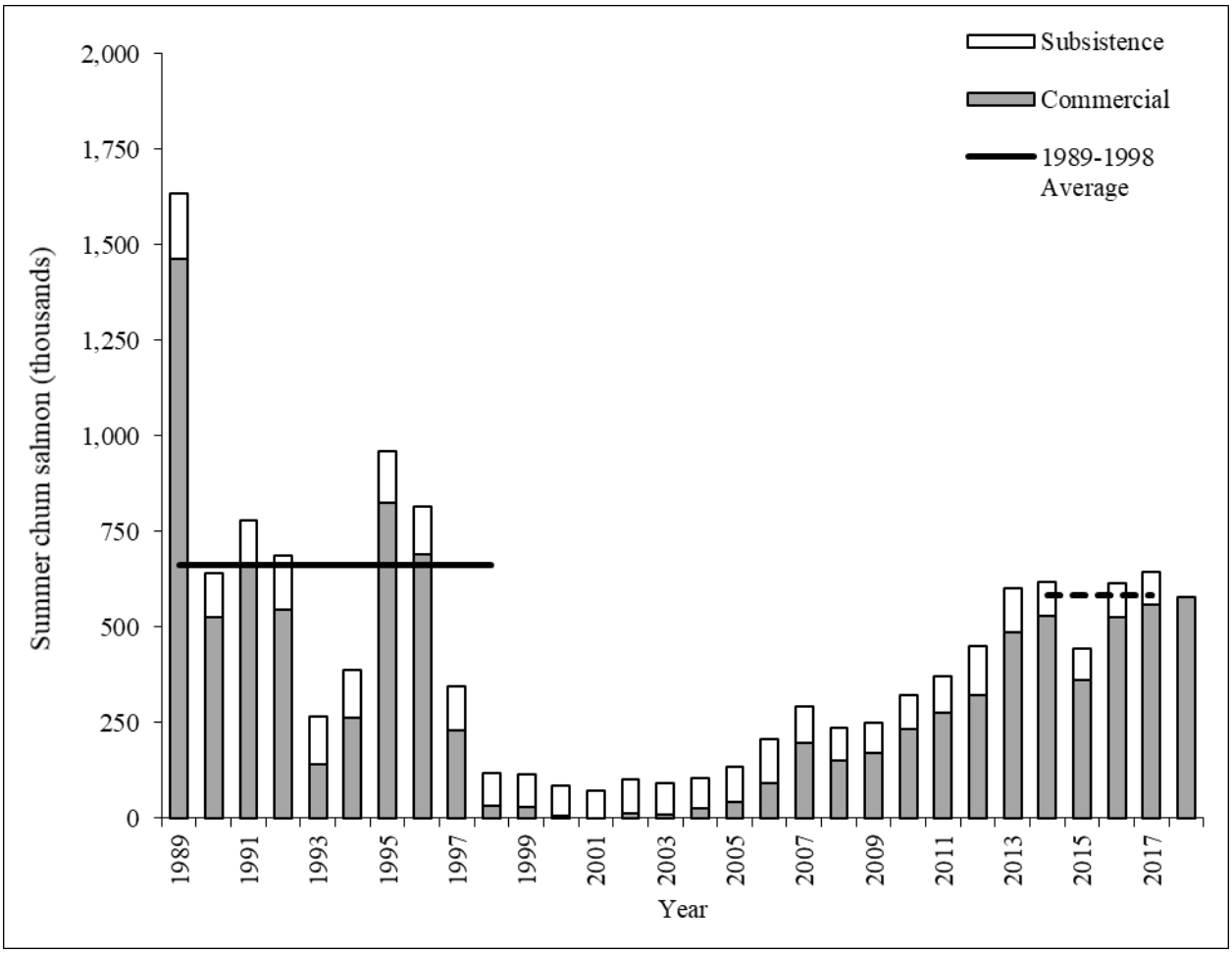

Figure 12.–Yukon River summer chum salmon commercial and subsistence harvests, 1989–2018.

Note: Subsistence estimates for 2018 are not available at this time. Does not include sport fish or Personal Use harvests. The average combined sport fish and Personal Use harvest is less than 1,000 fish.

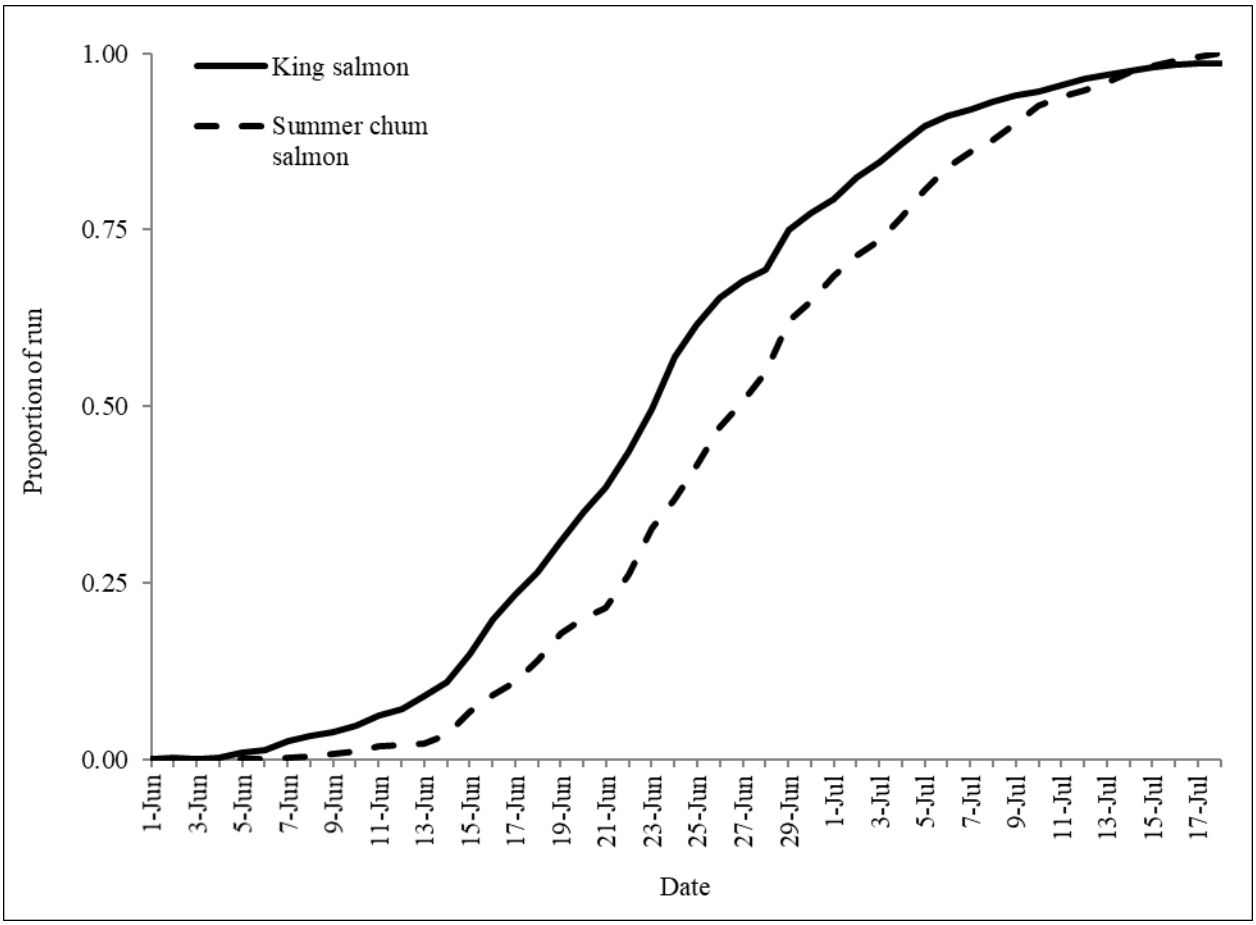

Figure 13.–Cumulative proportion of king and summer chum salmon runs past the sonar project near Pilot Station in 2018.