YUKON RIVER SALMON 2019 SEASON SUMMARY AND 2020 SEASON OUTLOOK

Prepared by

THE UNITED STATES AND CANADA
YUKON RIVER JOINT TECHNICAL COMMITTEE

March 2020
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Alaska Department of Fish and Game
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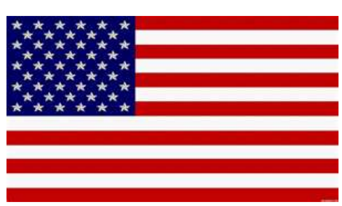

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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Division of Commercial Fisheries
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The Regional Information Report Series was established in 1987 and was redefined in 2007 to meet the Division of Commercial Fisheries regional need for publishing and archiving information such as area management plans, budgetary information, staff comments and opinions to Alaska Board of Fisheries proposals, interim or preliminary data and grant agency reports, special meeting or minor workshop results and other regional information not generally reported elsewhere. Reports in this series may contain raw data and preliminary results. Reports in this series receive varying degrees of regional, biometric and editorial review; information in this series may be subsequently finalized and published in a different department reporting series or in the formal literature. Please contact the author or the Division of Commercial Fisheries if in doubt of the level of review or preliminary nature of the data reported. Regional Information Reports are available through the Alaska State Library and on the Internet at: http://www.adfg.alaska.gov/sf/publications/.

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1.0 ABSTRACT

The Yukon River Joint Technical Committee (JTC) of the United States and Canada meets twice a year to analyze and discuss harvest and escapement goals, management trends, postseason reviews, preseason outlooks, and results of cooperative research projects for Canadian-origin Yukon River salmon. This report summarizes the status of Chinook *Oncorhynchus tshawytscha*, coho *O. kisutch*, and summer and fall chum salmon *O. keta* stocks in 2019, presents a 2020 season outlook, and provides data about salmon harvests in commercial, subsistence, aboriginal, personal use, domestic, and sport or recreational fisheries. Summaries of Yukon River research projects are also included. For 2019, the preliminary estimate of Chinook salmon (mainstem) spawning escapement into Canada was 42,052 fish, just below the lower end of the interim management escapement goal (IMEG) range of 42,500–55,000 fish. A preliminary estimate of the total Canadian-origin Chinook salmon run was 72,620 fish. The preliminary estimate of fall chum salmon spawning escapement in the Canadian mainstem Yukon River was approximately 99,738 fish, near the upper end of the IMEG range of 70,000–104,000 fish. The preliminary estimate of fall chum salmon spawning escapement in the Fishing Branch River (Porcupine River), obtained from a weir count, was 18,171 fish and below the IMEG range of 22,000–49,000 fish. Recommended interim management escapement goals for Canadian-origin mainstem Yukon River Chinook and fall chum salmon and Fishing Branch (Porcupine River) fall chum salmon in 2020 remain the same as for 2019.

Key words: Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, coho salmon *O. kisutch*, Yukon River, Yukon River Salmon Agreement, Joint Technical Committee, escapement, escapement goal, interim management escapement goal IMEG, management strategy, season outlook.

2.0 INTRODUCTION

The purpose of this annual *Yukon River Season Summary and Season Outlook* report is to present data for the Canadian-origin Yukon River salmon stocks subject to the *Yukon River Salmon Agreement*. In 2001, after many years of negotiation, the *Yukon River Salmon Agreement* was concluded, and in 2002 the agreement was signed by the governments of Canada and the United States. The Agreement continues to represent an international commitment to the restoration, conservation, and management of Canadian-origin Yukon River salmon. The Agreement also established the Yukon River Panel as the main instrument to implement the Treaty and the Joint Technical Committee (JTC) as the body responsible for acquiring the best science and management expertise possible to support the Yukon River Panel (YRP).

The JTC was established as an international advisory committee to evaluate management plans and escapement goals for the transboundary stocks of salmon within the Yukon River drainage. The JTC is comprised of representatives from both State, Territorial, and Federal agencies, and local and regional organizations in the U.S. and Canada. The JTC meets twice a year and is charged with various tasks related primarily to Yukon River salmon stock assessment and management, including reporting on preseason outlooks and postseason reviews, examining management regimes and recommending how they may be improved to achieve management and escapement goals, and evaluating the status of Canadian-origin salmon stocks and making recommendations for adjustments to rebuilding programs. This report fulfils several of the JTC's functions as well as serving as a repository for important data related to Canadian-origin Yukon River salmon stocks that is used by fisheries managers, Tribal and Yukon First Nation governments, fishers, and other stakeholders as the primary record for Yukon River salmon.

This report focuses on Chinook *Oncorhynchus tshawytscha*, fall chum *O. keta*, and coho salmon *O. kisutch* stocks that originate in Canadian waters and are covered by the *Yukon River Salmon Agreement*. Summer chum salmon occur entirely within the U.S. portion of the Yukon River drainage and have overlapping run timing with Chinook salmon and fall chum salmon. Where they overlap, the management of summer chum salmon is affected by the management of Chinook salmon and vice-versa. As such, this report contains information about summer chum salmon to provide context for fisheries assessment and management decisions that affect Canadian-origin Chinook and fall chum salmon. Few coho salmon are bound for the upper reaches of the Yukon River in Canada, therefore discussion of coho salmon is primarily limited to the Porcupine River population. This annual report covers salmon fishery and management topics addressed by the JTC following the 2019 season and preceding the 2020 season.

YUKON RIVER SALMON AGREEMENT MANAGEMENT PERFORMANCE SUMMARY

The following is a summary of information contained in the main body of the report, tables, figures, and appendices. This summary is provided at the request of the Yukon River Panel to summarize specific information about outcomes of the 2019 season, size of the 2020 salmon runs, and 2020 escapement goal recommendations related to the Yukon River Salmon Agreement (YRSA).

2019 Total Run Size, Harvest, and Escapement of Canadian-Origin Chinook Salmon

The preliminary estimate of the 2019 Canadian-origin Chinook salmon run in the mainstem Yukon River was 72,620 fish and was near the low end of the 2019 preseason outlook range of 69,000–99,000 fish. The Total Allowable Catch (TAC) was calculated postseason to be 17,620–30,120 fish. The harvest of Canadian-origin Chinook salmon in the U.S. was estimated to be 27,804 fish, which was above the U.S. harvest share of 13,039–24,096 fish. The estimated U.S./Canada border passage of Chinook salmon was 44,816 fish. The mainstem harvest of Chinook salmon in Canada was estimated to be 2,764 fish, which was below the Canada harvest share of 3,524–7,831 fish. The spawning escapement of mainstem Canadian-origin Yukon River Chinook salmon was estimated to be 42,052 fish, which was below the lower end of the Interim Management Escapement Goal (IMEG) range of 42,500–55,000 fish.

2019 Total Run Size, Harvest, and Escapement of Canadian-Origin Fall Chum Salmon

The preliminary estimate of the 2019 Canadian-origin fall chum salmon run in the mainstem Yukon River was approximately 177,839 fish and was below the preseason outlook range of 233,000–290,000 fish. The preliminary harvest estimate of mainstem Canadian-origin fall chum salmon in the U.S. was approximately 75,342 fish. The U.S. harvest is not known with certainty and was approximated as 25% of the total U.S. harvest of fall chum salmon that occurred downstream of the mainstem Yukon River sonar (258,331*0.25=64,583 fish) operated near the community of Eagle (hereafter Eagle sonar) plus the fall chum salmon harvested between the Eagle sonar and U.S./Canada border (10,759 fish). The estimation of U.S. harvest of fall chum salmon in 2019 was complicated by late run timing of summer chum salmon. This resulted in a high proportion of summer chum salmon after the regulatory transition date to fall season management. To account for this in the calculation of Canadian-origin fall chum salmon run size, an estimated 63,000 genetically-identified summer chum salmon were subtracted from the commercial harvest that occurred during the fall season and the remainder was added to other sources of harvest downriver from Eagle sonar before applying the 25%. The estimated U.S./Canada border passage of mainstem fall chum salmon was 102,497 fish. The harvest of mainstem fall chum salmon in

Canada was 2,759. The spawning escapement of mainstem Canadian-origin fall chum salmon was estimated to be 99,738 fish and within the IMEG range of 70,000–104,000 fish.

The total run size estimate for 2019 Fishing Branch fall chum salmon was 29,164 fish and is highly uncertain. Total harvest of Fishing Branch fall chum salmon in the U.S. was approximately 10,333 fish and assumed that 4% of the total U.S. harvest of fall chum salmon downriver from Eagle sonar were bound for the Fishing Branch River. The total harvest of Fishing Branch fall chum salmon in Canada was approximately 660 and assumed that 66% of the fall chum salmon harvested by the community of Old Crow were bound for the Fishing Branch River. Escapement past the Fishing Branch weir was 18,171 fall chum salmon and below the IMEG range of 22,000–49,000 fish.

2020 Outlooks

The preseason outlook range presented by the Joint Technical Committee for Canadian-origin salmon stocks:

- Chinook salmon: 59,000–90,000
- Mainstem fall chum salmon: 207,000–261,000
- Fishing Branch fall chum salmon: 33,000–42,000

2020 Escapement Goals

The JTC recommends no changes to the interim management escapement goals (IMEGs) for any Yukon River salmon stocks subject to the *Yukon River Salmon Agreement*. IMEG recommendations for the 2020 season are:

- Chinook salmon: 42,500–55,000
- Mainstem fall chum salmon: 70,000–104,000
- Fishing branch fall chum salmon: 22,000–49,000

3.0 ALASKA MANAGEMENT OVERVIEW

3.1 Chinook and Summer Chum Salmon

The Yukon River drainage in Alaska (Yukon Area) is divided into fishery districts and subdistricts for management purposes (Figure 1). Management of the Yukon Area summer season commercial salmon fisheries is in accordance with 5 ACC 39.222 *Policy for the Management of Sustainable Salmon Fisheries*, 5 ACC 05.360 *Yukon River Drainage King Salmon Management Plan*, and 5 ACC 05.362 *Yukon River Summer Chum Salmon Management Plan*. The summer chum salmon management plan establishes run size thresholds needed to allow subsistence, commercial, sport, and personal use fishing, prioritizing subsistence among uses, and prioritizing escapement over consumptive uses. Because summer chum and Chinook salmon migrate concurrently, regulations in the management plans allow for using selective gear types that target summer chum salmon during times of Chinook salmon conservation and allow immediate, live release of Chinook salmon back to the water. These regulations help ensure Chinook salmon escapement objectives will be met in years of low Chinook salmon run sizes and provide fishing opportunity on the more abundant summer chum salmon runs.

During the "summer season" (early May–July 15 in District 1), management and research staff are based in the Emmonak office and the focus is on assessing and managing the summer chum and Chinook salmon runs. After July 15, in Emmonak, Chinook salmon are nearly done entering the river and the summer chum salmon run transitions to the fall chum salmon run. On July 16, management transitions to the "fall season" and assessment and management become focused on fall chum and coho salmon runs.

Throughout most of the fishing season, the Yukon River Drainage Fisheries Association (YRDFA) facilitated weekly teleconferences to provide managers, fishermen, tribal/traditional council representatives, and other stakeholders the opportunity to share information, provide input, and discuss inseason management options. During these weekly teleconferences, the Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) staff provided inseason run assessment information from various assessment projects (Figure 2) and upcoming management strategies and subsistence fishermen reported on fishing effort and water conditions in their respective communities along the river.

Preseason Management Strategy Planning

The 2019 JTC preseason forecast for Canadian-origin Chinook salmon was for a run of approximately 69,000–99,000 fish, and the ADF&G preseason forecast for the Yukon River drainagewide run (U.S. and Canada stocks combined) was 168,000–241,000 fish. For Canadian-origin Chinook salmon, the IMEG range recommended by the Yukon River Panel was 42,500–55,000 fish.

The summer chum salmon outlook was projected to be approximately 1.9 million fish, which was a run size sufficient to meet escapement and subsistence needs and provide a harvestable surplus for commercial fisheries. However, the management of a summer chum salmon-directed commercial fishery would be affected by the need to conserve Chinook salmon and would depend on Chinook salmon run timing and abundance.

Initial fishery management would be conservative until inseason assessment indicated the Chinook salmon run size would be toward the upper end of the projected range and therefore was expected to be strong enough to meet U.S/Canada border passage objectives, tributary escapement goals in Alaska, and provide a harvestable surplus for Alaskan fisheries. Before the season began, YRDFA facilitated a meeting with U.S. management agencies, fishermen, tribal/traditional council representatives, and other stakeholders to develop a preseason management strategy. The purpose of this meeting was to cooperatively identify practical management strategies that would accomplish the following goals: achieve escapement objectives and harvest sharing of Canadian-origin salmon stocks subject to the *Yukon River Salmon Agreement*; ensure adequate numbers of Chinook salmon reach their spawning grounds in Alaska and Canada; provide some opportunity to harvest Chinook salmon; and provide ample opportunity to harvest abundant summer chum salmon and non-salmon species. Preseason planning also considered the following management recommendations from the Yukon River Panel for the 2019 season:

1. Recognizing uncertainty in assessment and management, the Canadian-origin Chinook salmon run should be managed to achieve the conservation objectives within the Yukon River Salmon Agreement, ensuring escapement falls within the established IMEG range and provides for the harvest shares in both countries.

2. To provide for Canadian-origin Chinook salmon conservation, consider use of 6-inch or smaller mesh gill nets upstream of Tanana River/Yukon River Mainstem confluence within the regulatory structures of each country.

3. Fishery opportunities should be provided conservatively until inseason assessment information confirms trends in abundance.

An annual informational flyer detailing the outlooks for Chinook, chum, and coho salmon and likely fishery management strategies was mailed preseason to approximately 2,750 Yukon River households.

Chinook and Summer Chum Salmon Inseason Management

In accordance with discussions at the fishermen's pre-season planning meeting, managers expected to provide some restricted subsistence harvest opportunity for Chinook salmon and liberal subsistence and commercial opportunity for summer chum salmon.

During the 2018 Board of Fisheries meeting, the regulation requiring full fishing closures during the first pulse of Chinook salmon in Districts 1 and 2 was removed when projected run sizes are adequate to meet escapements. Instead, the management strategy has been to reduce fishing schedules to half the regulatory time in order to protect part of each pulse to account for inseason uncertainty about the size and timing of the Chinook salmon run. This management action, even in years when abundance appears to be above average, is a good inseason tool to spread the harvest across the run and the various stocks.

Due to much support at the 2019 Board of Fisheries meeting for the traditional and religious importance of harvesting the first salmon, the management strategy continued to allow fishing on the early trickle of Chinook salmon that come in prior to the first pulse in all districts. This also provides early opportunity to target sheefish (inconnu) when only a small percentage of Chinook salmon are in the area. The 2019 trickle of Chinook salmon was much stronger than 2018, therefore early harvests of that species were reported on the first weekly YRDFA teleconferences to be good. Managers waited for increased Chinook salmon catches at the Lower Yukon Test Fishery (LYTF; Figure 3) indicating the presence of the first pulse before restricting the subsistence gillnet fishery to half the regulatory time with 7.5-inch or smaller mesh gillnets. In District 1, fishermen were placed on a reduced regulatory schedule of two 18-hour periods per week starting on June 10. Other districts went to their reduced schedules according to fish travel time.

The summer chum salmon run often comes into the river concurrent with Chinook salmon, though the peak is slightly later. In 2019, the summer chum salmon run was almost a week late, giving managers concerns about the strength of the run. With the first half of the summer chum salmon run assessed as below average, no commercial fishing periods occurred during the month of June because it was not clear how much harvestable surplus would be available. The low abundance of summer chum salmon during the first half of the summer season may have increased the efficiency of subsistence harvest of Chinook salmon despite management restrictions.

In most districts, the normal regulatory schedule consists of two fishing periods per week but varies by duration and days of the week (Table 1). This season, as Chinook salmon migrated into each district, districts were put on a reduced regulatory schedule in which each period was shortened to about half the usual fishing time. Based on fishermen feedback, these schedules were adjusted during the 2019 season to provide weekend fishing time whenever possible.

The management strategies used for 2019 were formulated from lessons learned during previous seasons and were similar to actions taken in 2018. Even as projected counts at the mainstem Yukon River sonar operated near the community of Pilot Station (hereafter Pilot Station sonar) indicated the run might be upwards of 200,000 fish, management actions stayed conservative for two reasons: 1) the mainstem water temperatures were warm enough to indicate salmon might experience heat stress and it was unknown if there would be increased mortality before fish made it to spawning grounds; 2) Chinook salmon harvests can be limited by the high abundance of summer chum salmon filling a fishermen's net. However, fishermen reported good harvests of Chinook salmon and better harvests than the previous year, possibly due to the lack of chum salmon present during the first half of the season and favorable fishing conditions. For these reasons, despite relatively high Chinook salmon counts at the sonar, managers felt that it was warranted to continue to manage conservatively. Therefore, in addition to the reduced fishing period length, the strategy of cancelling one fishing period per week in most districts to protect each pulse of fish and to spread the harvest across all pulses was implemented in all districts. To further protect Chinook salmon, fishing was also limited to 6-inch or smaller mesh gillnets at times. This allowed fishermen opportunity to harvest summer chum salmon for subsistence while restricting the harvests of Chinook salmon. However, due to early concern for the summer chum salmon run strength, the 6-inch mesh restriction was not used as much in 2019 as it was in 2018.

Near the midpoint of the 2019 run (around June 26) the projected end-of-season total at Pilot Station was 220,000 Chinook salmon, and 95,000 of those were estimated to be of Canadian-origin, based on genetic analysis. As run size estimates were refined inseason, the management team subtracted the IMEG (42,500–55,00) from the inseason estimate of Canadian-origin Chinook salmon and multiplied that result by the midpoint of the U.S. harvest share (77%) to estimate a harvest range of Canadian-origin fish available for Alaskan fishermen. Near the midpoint of the Chinook salmon run, this U.S. harvest share estimate was approximately 30,000–40,000 Canadian-origin fish. In the previous two years (2017–2018), with similar drainage-wide run sizes, Alaskans have harvested an average of 20,000 Canadian-origin salmon and delivered enough fish to the Canadian border to meet or exceed the IMEG and harvest share obligations. Therefore, it was assumed that if 2019 management actions were similar to 2018, then the U.S. harvest would fall within or below the inseason estimated harvest share and enough fish would remain to meet border passage objectives as outlined in the YRSA.

However, by July 24, the Eagle sonar project passage estimates for Chinook salmon were lower than expected based on inseason projections. Therefore, the reduced schedule (consisting of a single 84-hour period per week) was implemented on July 26 in Subdistrict 5-D with a 6-inch gillnet restriction and was followed by a cancelled period. The result was that subsistence fishing was closed for 10 days beginning on July 29 and reopened on August 9. After reopening, the 6-inch gillnet restriction was in place through August 12. More detail on management and conservation measures implemented[1] are also summarized in Appendix B19.

It is not certain why the inseason projections of Canadian-origin Chinook salmon based on Pilot Station sonar passage and application of genetics did not align well with the estimates of Chinook salmon at the Eagle sonar. In recent years (2014–2018), inseason projection methods have provided enough information to enable managers to restrict harvest sufficiently to achieve or exceed both the border escapement IMEG and provide for the Canadian harvest share. The U.S. harvest alone does not account for the difference between inseason projections and the abundance estimated at the border in 2019. It could be that there was an increased level of en route mortality of Chinook salmon headed for Canada. Though the number of fish that die during migration before making it to the border cannot be measured. Reports of large die-offs of chum salmon may be an indicator that Chinook salmon may also have had unusually high en route mortality this season.

[1] To look up a news release for the Yukon River fisheries in the U.S. go to the following website: http://www.adfg.alaska.gov/index.cfm?adfg=cfnews.search

3.2 Fall Chum And Coho Salmon

Management of the Yukon Area fall season commercial salmon fisheries is in accordance with the *Policy for the Management of Sustainable Salmon Fisheries* 5 ACC 39.222, the *Yukon River Drainage Fall Chum Salmon Management Plan* 5 ACC 1.249, the *Yukon River Coho Salmon Management Plan* 5 ACC 05.369, and the *Tanana River Salmon Management Plan* 5 AAC 05.367. The fall chum salmon plan incorporates *Yukon River Salmon Agreement* objectives for border passage and harvest shares of fall chum salmon and provides guidelines necessary for escapement and prioritized uses (Table 2). The intent of the plan is to align management objectives with the established escapement goals, provide flexibility in managing subsistence harvests when stocks are low, and bolster salmon escapement as run abundance increases. The sustainable escapement goal (SEG) range for the entire Yukon River drainage is 300,000–600,000 fall chum salmon (Fleischman and Borba 2009). The IMEG for Canadian-origin Mainstem Yukon River is 70,000–104,000 fall chum salmon, and the IMEG for Fishing Branch River is 22,000–49,000 fall chum salmon. There are provisions in the fall chum salmon management plan to allow incremental levels of subsistence salmon fishing balanced with requirements to attain escapement objectives during low runs. The threshold number of fall chum salmon needed to allow commercial fishing is 550,000 fish and commercial fishing is generally allowed only on the surplus projected above that level.

The coho salmon management plan allows for a coho salmon-directed commercial fishery if the incidental catch of fall chum salmon remains above a 500,000 fish threshold, a harvestable surplus of coho salmon is identified, and a commercial fishery will not have a significant impact on fall chum salmon escapement and allocation. The Tanana River plan specifies that commercial fishing in Subdistrict 5-A and District 6 are based on the assessment and timing of salmon stocks bound for the Tanana River drainage.

Fall Chum Salmon Management Overview

By regulation, the fall season began in District 1 on July 16 and all chum salmon assessed and harvested through the end of the season were considered fall chum salmon. The three primary assessment projects used for fishery management of the lower river include LYTF, Mountain Village drift gillnet test fishery (MVTF), and Pilot Station sonar. Both test fisheries provide information on salmon run timing and relative abundance. The LYTF is the earliest indicator of stocks entering the various mouths of the delta. The MVTF is located about two days (fish travel time) upriver from LYTF and provides a refined assessment due to its location in a confined channel of the mainstem Yukon River. The Pilot Station sonar project is located about three days upriver from LYTF and provides abundance estimates and a platform for collecting genetic-based stock composition information. Assessment projects and fall season management within each sequential district transitioned based on the migration timing of fall chum salmon. Harvest/effort information from both subsistence and commercial fisheries was assessed.

Escapement projects were operated to assess the run in the upper Yukon River tributaries and the upper mainstem of the Yukon River. The assessment projects included sonars in the mainstem Yukon River near the U.S./Canada border as well as in two tributaries (Teedriinjik-Chandalar and upper Porcupine rivers), and a weir/sonar combination on the Fishing Branch River (Porcupine River headwater). Data from these projects were analyzed collectively inseason and used to determine whether escapement goals would be achieved. Run timing for fall chum salmon was three days later than average across all the assessment projects.

Management strategies were implemented first based on an inseason projection developed from the relationship between the run sizes of the summer and fall chum salmon components. The amount of change between the preseason forecast and the inseason projection determined how precautionary management actions would be when the indicated run size is applied to the fall chum salmon management plan. In 2019, although the inseason projection was reduced substantially from the preseason forecast, it was anticipated that the fall chum salmon run size would provide for escapement needs. Therefore, all Yukon River mainstem districts and subdistricts were placed on their regulatory subsistence fishing schedules upon transitioning to fall season management. Because inseason run projections indicated fall chum salmon escapement goals would be achieved on the mainstem, subsistence fishing schedules were liberalized to seven days per week, 24-hours per day on the Yukon River mainstem. Also, upon transitioning to fall season management, subsistence fishermen could use gillnets up to 7.5-inch mesh size.

The fall season assessment projects detected four distinct pulses of chum salmon that entered the Yukon River. The first pulse contained the highest proportion on record of summer chum salmon (88%), which was due to the late timing of the summer chum salmon run. Initial commercial fishing in July was approached cautiously while waiting for the first substantial fall chum salmon pulse to arrive. Fall chum salmon abundance began building in early August when they dominated the three remaining pulses. Cumulative fall chum salmon passage past the Pilot Station sonar tracked above the historical median (1995, 1997–2008, 2010–2018) throughout the run largely due to the contribution of summer chum salmon in the first pulse. Inseason adjustments of run size were used to manage the run to account for the high proportion of summer chum salmon in the first pulse. The adjusted run size tracked along the 550,000 fall chum salmon threshold necessary to allow fall chum salmon directed commercial fishing through August 16. The two remaining pulses continued to increase the run size such that the upper end of the inseason projection was achieved. Management of the commercial fishery is based on a strategy of cropping each fall chum salmon pulse in order to spread out the harvest over the run while gaging the passage by Pilot Station sonar to provide for upriver fisheries and escapement obligations.

In 2019, like previous years, the fall chum salmon run into the upper Porcupine River continued to be poor. Both the Porcupine River sonar near Old Crow and the Fishing Branch River weir were projecting that the Fishing Branch River escapement objective would not be achieved. Consequently, subsistence salmon fishing in the Alaska portion of the mainstem Porcupine River was closed on August 23. The intent of this action was to overlap with the majority of fall chum salmon reaching that section of river. Subsistence salmon fishing on Porcupine River tributaries, such as the Sheenjek and Black rivers, remained open seven days a week, 24 hours per day. The closure was an attempt to protect fall chum salmon through the Alaska portion of the Porcupine River to the Canadian Border. Subsistence salmon fishing remained closed for the entire fall season in the Alaska portion of the Porcupine River.

Coho Salmon Management Overview

Coho salmon were managed as incidental harvest during the fall season commercial fishery since they overlap in timing with the more abundant fall chum salmon. In efforts to direct harvest at fall chum salmon some of the commercial periods were moved relative to the pulses in attempts to avoid the slower moving coho salmon. All lower river assessment projects, including the ratio of fall chum to coho salmon in the fisheries, indicated a below average coho salmon run. Coho salmon-directed commercial fisheries late in the season were considered but not prosecuted due to buyer constraints in the lower river and in the upper river there was confirmation of low coho salmon numbers reaching escapement assessment locations.

4.0 ALASKA HARVEST SUMMARIES

4.1 SUBSISTENCE SALMON FISHERY

Subsistence salmon fishing activities in the Yukon River drainage typically begin in late May and continue through mid-October (Jallen et al. 2017). Fishing opportunity in the Lower Yukon Area (Districts 1–3) in May and the Upper Yukon Area (Districts 4–6) in October is highly dependent upon river ice conditions. Throughout the drainage, most Chinook salmon harvested for subsistence use are dried, smoked, or frozen for later human consumption. Summer chum, fall chum, and coho salmon harvested in the lower Yukon River are primarily utilized for human consumption, often dried, smoked, or frozen for later use. In the Upper Yukon Area, summer chum, fall chum, and coho salmon are an important human food source, but a larger portion of the harvest is fed to dogs used for recreation and transportation (Andersen 1992).

Documentation of the subsistence salmon harvest is necessary to determine if sufficient salmon are returning to the Yukon Area and enough fishing opportunities are being provided to meet subsistence needs. In years with fishery restrictions, estimates of harvest can be used to assess the effect of the management actions taken to meet escapement goals to maintain future salmon production. The primary method of estimating subsistence harvest is voluntary participation in the annual subsistence salmon harvest survey program conducted by ADF&G, Division of Commercial Fisheries. The survey is conducted in 33 communities (including the 2 coastal communities of Hooper Bay and Scammon Bay) during the fall, after most households have completed fishing for salmon. Additional information about harvest timing is obtained from harvest calendars that are sent to households and filled out voluntarily. Fishing permits also provide information about harvest timing for areas of the river where permits are required (Subdistrict 6).

In 2019, subsistence harvest surveys identified approximately 2,714 households in the Yukon Area in 33 communities. Of these, an estimated 1,360 households fished for salmon. Permits are not required for subsistence fishing throughout most of the Yukon Area, except for the urban areas around Fairbanks and other areas accessible by road. Therefore, the largest share of subsistence harvest in the Yukon Area is estimated from the postseason survey results. A total of 319 salmon fishing permits were issued in 2019, approximately 94% of the subsistence salmon permits had been returned at the time of this publication, and 152 salmon permits reported fishing.

All 2019 subsistence harvest data are considered preliminary as of the publication date of this report. Final results will be included in an ADF&G Fishery Data Series publication after the analysis is completed and reviewed. Based on survey and permit data, the 2019 preliminary subsistence salmon harvest in the Alaska portion of the Yukon River drainage was estimated to be 48,379 Chinook; 63,303 summer chum; 63,862 fall chum; and 5,819 coho salmon (Appendices B2–B5). For comparison, recent 2014–2018 average subsistence salmon harvest estimates were 20,480 Chinook; 84,564 summer chum; 82,673 fall chum; and 11,367 coho salmon (Appendices B2–B5) from communities in the Alaska portion of the Yukon River drainage. For the first time since 2007, the estimated 2019 harvest of Chinook salmon fell within the levels defined by the

Alaska Board of Fisheries as Amounts Reasonably Necessary for Subsistence[2] (ANS). Fall chum, summer chum and coho salmon were below their respective ANS levels (Brown and Jallen 2012).

In order to assign stock composition to the Chinook salmon harvest, genetic samples have been collected from a subset of communities in select mainstem fishing districts (from 2006–2018) and the most appropriate historical proportion of Canadian-origin Chinook salmon in each set of samples was then applied to that district's harvest. The estimated Canadian-origin harvests from each district were then summed for a total U.S. Canadian-origin harvest estimate (e.g., DuBois 2018).

The Chinook salmon incidentally harvested and sold in the commercial chum salmon fishery (3,110) and the subsistence fishery harvest of 48,379 (Appendix B2; which includes Chinook salmon retained for subsistence purposes from the commercial fishery) are combined and then apportioned using the method above, for an estimated total U.S. harvest of Canadian-origin Chinook salmon of 27,804 fish (Appendix B18). Subsistence fish harvested in the Black River, Koyukuk drainage, Chandalar River, Birch Creek, and District 6 (Tanana River) are presumed to be U.S.-origin and therefore are not included in Canadian-origin harvest total. Similarly, sport fishery harvests typically occur in Alaskan tributaries and are not included. Small amounts of salmon harvests from some tributary community residences are harvested on the mainstem Yukon River; however, they were not included in the Canadian-origin analysis.

4.2 Commercial Fishery

Summer Season Harvest

The commercial summer chum salmon season began July 3, which was later than usual. Usually harvest begins with selective gear, to avoid retention of Chinook salmon, but the delay of the chum salmon commercial season resulted in the fleet commencing with gillnets of 6-inch mesh or smaller and retention of Chinook salmon was allowed for personal use. Catches of Chinook salmon were low, since the bulk of the run had already passed the lower river. This season there was only one processor purchasing chum salmon in Districts 1 and 2 and a single processor in District 6.

For the twelfth consecutive year, no commercial periods targeting Chinook salmon were allowed in the Yukon Management Area during the summer season. However, sale of incidentally-caught Chinook salmon was allowed, beginning July 9 (when over 97% of the run had passed District 2) because it was determined that with over 200,000 Chinook salmon counted at Pilot Station escapement goals were likely to be met, and most fishermen in the lower river had met their subsistence needs for Chinook salmon. Sale of commercially caught Chinook salmon in 2019 was small compared to much of the historical timeseries (Figure 4).

During the 2019 summer season, the total commercial harvest in the Alaska portion of the Yukon River drainage was 227,089 summer chum salmon (Appendices A2 and B3). The commercial harvest of summer chum salmon in the Lower Yukon Area (Districts 1–3) was 225,493 and in the Upper Yukon Area (Districts 4–6) was 1,596 fish. The summer chum salmon harvest was 56% below the recent 5-year (2014–2018) average harvest of 509,705 fish and was the lowest harvest since 2010 (Appendix B3).

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[2] Amounts reasonably necessary for subsistence are set by the Alaska Board of Fisheries for stocks which are determined to have customary and traditional use. See http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.reasonable for further definition.

Commercial fishermen were required to report all incidentally harvested Chinook salmon caught during the chum salmon commercial fishery. A total of 1,148 Chinook salmon were reported on fish tickets as caught but not sold from July 3 to July 8, and these fish were retained for personal use. During the summer chum salmon commercial season in Districts 1 and 2, a preliminary total of 2,582 Chinook salmon were incidentally harvested and sold. During the fall season an additional 528 Chinook salmon were sold. Total sale of incidentally harvested Chinook salmon was 3,110 fish (Figure 4 and Appendix A2). The average weight of Chinook salmon caught incidentally in the chum salmon commercial fishery was approximately 12 pounds.

Fall Season Harvest

During the 2019 fall season, there was a total of 40 commercial periods. The majority of fall season commercial harvest occurred in the lower river districts. Commercial fishing periods were established in Subdistricts 5-B, and 5-C and in District 6, but limited markets resulted in low fishing effort and relatively small harvests. There was one processor in the lower river and one processor and several catcher-sellers in the upper river. The total commercial harvest for the Yukon River in the Alaska portion of the drainage was 268,360 fall chum salmon and 58,591 coho salmon (Figures 5 and 6; Appendix A2). The fall chum salmon commercial harvest in 2019 was below the most recent 5-year (2014–2018) average of 330,014 fish (Appendix B4). The coho salmon commercial harvest in 2019 was also below the most recent 5-year (2014–2018) average of 137,275 fish (Appendix B5). The average weight of fall chum salmon caught commercially in Districts 1 and 2 was approximately 7.0 lbs. The average weight of coho salmon was approximately 6.0 lbs.

4.3 Sport Fishery

Sport fishing effort for wild salmon in the Yukon River drainage is directed primarily at Chinook salmon and, to a lesser degree, chum and coho salmon. However, over the past decade, Chinook salmon stocks have experienced periods of low productivity and subsistence fishing opportunity has been restricted. As a result, Chinook salmon sport fishing restrictions and closures have been implemented as warranted in the Yukon Management Area (which excludes the Tanana River) and/or Tanana River Management Area. All chum salmon harvested in the sport fishery are categorized as summer chum salmon because these fish are mostly caught incidental to Chinook salmon during mid-summer in clearwater tributaries. Some harvest of fall chum salmon entering clearwater tributaries occurs after Chinook salmon spawning concludes but is considered negligible relative to summer chum salmon harvests. Coho salmon are targeted primarily in the fall.

Alaska sport fishing effort and harvests are monitored annually through a statewide sport fishery postal survey.[3] Harvest estimates are not available until approximately one calendar year after the fishing season; therefore, 2019 estimates were not available for this report. Total sport harvest of salmon during 2018 in the Alaska portion of the Yukon River drainage (including the Tanana River) was estimated to be 200 Chinook, 200 summer chum, and 544 coho salmon (Appendices B2, B3, and B5). The 2014–2018 average sport salmon harvest within the Alaska portion of the

[3] Alaska Sport Fishing Survey database [Internet]. 1996–2018. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited December 30, 2019). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

Yukon River drainage was estimated to be 50 Chinook, 244 chum, and 791 coho salmon (Appendices B2, B3, and B5).

Most of the sport fishing effort for the Yukon River occurs in the Tanana River along the road system (Baker 2018). All of the Chinook salmon harvested since 2014 occurred in the Tanana River drainage. During 2014–2018, sport harvests for chum and coho salmon in the Tanana River represented, on average, 8%, and 44% of the total for these species respectively for the Yukon River. In the Tanana River, most Chinook and chum salmon are harvested from the Chena, Salcha, and Chatanika rivers, whereas most coho salmon are harvested from the Delta Clearwater and Nenana river systems. The majority of sport fishing effort for Chinook, chum, and coho salmon for the rest of the Yukon River drainage takes place in the Anvik and Andreafsky rivers.

Since 2005, all freshwater sport fishing guides and guide businesses operating in Alaska have been required to be licensed and until 2017 were also required to report harvest and catch (numbers of fish captured and released) in logbooks. From 2012–2016, guided sport harvests in the Yukon River drainage (excluding the Tanana River drainage) averaged 33 Chinook and 322 coho salmon. Data for 2017 is unavailable for this report. There was no reporting requirement for 2018 or 2019.

For 2019, all waters of the Alaska portion of the Yukon Management Area (which excludes the Tanana River) were closed to sport harvest of Chinook salmon effective May 11, 2019. However, due to a greater than anticipated number of Chinook salmon passing the Pilot Station sonar, a limited sport harvest of 1 annual Chinook salmon of 20 inches and greater in length was allowed effective July 11, 2019. Due to low Chinook salmon escapement numbers recorded by the counting towers on the Chena and Salcha rivers, the Chinook salmon sport fishery was restricted to catch and release in the Tanana River Management Area on July 17, 2019 and closed on July 26, 2019.

4.4 PERSONAL USE FISHERY

The Fairbanks Nonsubsistence Area, located in the middle portion of the Tanana River, contains the only personal use fishery within the Yukon River drainage. Subsistence or personal use permits have been required in this portion of the drainage since 1973. Personal use fishing regulations were in effect from 1988 until July 1990 and from 1992 until April 1994. In 1995, the Joint Board of Fisheries and Game established the Fairbanks Nonsubsistence Area which has subsequently been managed consistently under personal use regulations. Historical harvest data must account for these changes in status.

Subdistrict 6-C is completely within the Fairbanks Nonsubsistence Area and therefore falls under personal use fishing regulations. Personal use salmon or whitefish/sucker permits, and a valid resident sport fishing license are required to fish within the Fairbanks Nonsubsistence Area. The harvest limit for a personal use salmon household permit is 10 Chinook, 75 summer chum, and 75 fall chum and coho salmon combined. The personal use salmon fishery in Subdistrict 6-C has a subdistrict harvest limit of 750 Chinook; 5,000 summer chum; and 5,200 fall chum and coho salmon combined.

In 2019, the personal use salmon fishery followed the regulatory fishing schedule of two 42-hour periods per week starting at 6:00 pm Mondays and 6:00 pm Fridays. A total of 92 personal use salmon permits were issued. The 2019 preliminary harvest results, based on 98% of the personal use salmon permits returned in Subdistrict 6-C, included 244 Chinook, 294 summer chum, 408 fall chum, and 68 coho salmon. The 2014–2018 average personal use harvest was 78 Chinook, 316 summer chum, 356 fall chum, and 183 coho salmon (Appendices B2–B5) in the Alaska portion of the Yukon River drainage.

5.0 CANADIAN MANAGEMENT OVERVIEW

5.1 CHINOOK SALMON

The Yukon River drainage in Canada contains numerous tributaries, towns, and commercial fishing boundaries used for effective management (Figure 7). The 2019 total run of Canadian-origin mainstem Yukon River Chinook salmon was expected to be 69,000–99,000 fish, which is below the historical average estimated Canadian run size of 154,000 (years 1982–1997).

Prior to the season, meetings were held between Fisheries and Oceans Canada (DFO), Yukon Salmon Sub-Committee (YSSC), Yukon First Nation Governments, Renewable Resources Councils, and the public to discuss the 2019 forecast and possible management scenarios. The below average preseason forecast, coupled with the failure to achieve minimum escapement targets in 3 of the last 10 years, resulted in continued concern over the long-term health and sustainability of Canadian-origin Yukon River Chinook salmon stocks.

Each year, in advance of the salmon season, DFO develops an Integrated Fisheries Management Plan[4] (IFMP) for Yukon River Chinook, fall chum and coho salmon. The IFMP, which is in effect from July 1 of the current year to June 30 of the subsequent year, identifies the main objectives (i.e. *Yukon River Salmon Agreement* (YRSA)) and requirements for the management of Canadian salmon fisheries in the Yukon River, as well as the management measures that will be used to achieve these objectives.

Canadian management decisions were guided by the YRSA, YSSC recommendations, implementing a precautionary approach, the application of inseason assessment information to the *inseason fishery management decision matrix* (a component of the IFMP), and the following management recommendations from the Yukon River Panel for the 2019 season:

1. Recognizing uncertainty in assessment and management, the Canadian-origin Chinook salmon run should be managed to achieve the conservation objectives within the Yukon River Salmon Agreement, ensuring escapement falls within the established IMEG range and provides for the harvest shares in both countries.
2. To provide for Canadian-origin Chinook salmon conservation, consider use of 6-inch or smaller mesh gillnets upstream of Tanana River/Yukon River Mainstem confluence within the regulatory structures of each country.
3. Fishery opportunities should be provided conservatively until inseason assessment information confirms trends in abundance.

Based on the preseason forecast and recommendations from the YSSC, the 2019 season commenced with a full allocation available for the First Nation subsistence fishery while the allowable catch of Chinook salmon in commercial, domestic, and public angling fisheries was set to zero for the beginning of the season. An allocation to the commercial, domestic and public angling fisheries was subject to run abundance and would *only* be considered if a full allocation was available to the First Nation fishery, the upper end of the IMEG (55,000) was expected to be

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[4] The IFMP is available online at https://waves-vagues.dfo-mpo.gc.ca/Library/40801445.pdf

achieved, and that there were appropriate management controls in place to facilitate the orderly administration of the fisheries.

New for 2019, the salmon commercial and domestic conditions of licence required a maximum allowable gillnet mesh size of 6-inch and the mandatory release of incidentally caught Chinook salmon in the chum salmon commercial and domestic fisheries.

As opportunities for First Nation subsistence fisheries were available prior to having early-season and inseason assessment information (which provides greater certainty about the number of returning Chinook salmon and biological composition of the run) several recommendations for conservation measures were described in the IFMP. These include:

1. First Nations who initiate early-season fisheries are requested to initiate their harvest activities in a conservative manner;
2. Harvest of Chinook salmon should be directed at smaller (younger) fish – this can be achieved through the continued use of smaller-mesh gill nets (i.e., 6-inch or less) or selective release of larger (older) fish from fish wheels and/or hook and line fisheries.

As confidence in inseason abundance improved, fishery management actions would proceed according to the management decision matrix. The matrix provides detailed guidance for fisheries management and is linked to specific inseason run abundance levels. The matrix also serves to summarize the management reference points, general allocation plans, and anticipated management responses under different run size scenarios (Table 3).

Inseason Management Yukon River Mainstem Chinook Salmon

Early in the 2019 season, information from the LYTF near the community of Emmonak and the Pilot Station sonar in the Lower Yukon River Area suggested that the Canadian-origin Chinook salmon run was returning at the lower end of the outlook range of 69,000–99,000 fish. By late June the mid-point of the run had passed Pilot station and confirmed that the return would likely be within the outlook range. The first Chinook salmon were counted at Eagle sonar (located near the international border) during the first week of July, during which time the run was nearly complete at Pilot Station sonar and indicated a Canadian-origin run size estimate of 95,000 Chinook salmon. A run of this size was considered to provide for a management spawning escapement target of 48,750 Chinook salmon, and a Canadian fishery allocation of around 10,000 Chinook salmon, which would provide for a full First Nation subsistence fishery.

By the third week of July, late-season information from the Pilot Station sonar indicated the Canadian-origin return estimate was 98,000 fish, which was closer to the upper end of the outlook range. A run-size of 98,000 fish could potentially trigger an allocation to other fisheries in addition to the First Nation subsistence fishery. At this time data from Eagle sonar, located near the international border, indicated that the sonar estimate was about 10,000 fish fewer than anticipated and potentially running up to three days late. Due to the mismatch between Canadian-origin Chinook salmon run size information from the Pilot Station sonar and Eagle sonar, DFO maintained a precautionary approach and delayed making a decision to expand fishery opportunities.

By August 8, the run was around 85% complete at the border and the Eagle sonar inseason passage estimate of 43,293 Chinook salmon was significantly lower than expected. First Nation governments were notified that the Canadian, and subsequently First Nation fishery allocation was below expectations and it was recommended that they take further precautionary measures in accordance with the "Yellow Zone" of the management decision matrix. Taking into consideration Eagle sonar passage and the anticipated harvest numbers, it was evident that the midpoint of the spawning escapement management target would not be achieved, nor would Canada's harvest share materialize. Thus, in order to allow as many Chinook salmon as possible to pass to the spawning grounds, DFO enacted a complete salmon angling closure on the Yukon River and its tributaries and delayed the scheduled openings for the chum salmon angling, commercial, and domestic fisheries. The TAC available for commercial, domestic, and public angling fisheries remained at zero and the conservative approach described above was maintained in the First Nation fishery during the Canadian season. Throughout the run, DFO hosted weekly teleconferences with the First Nation lands and resources managers and the YSSC as a means to provide a forum to exchange management and assessment updates.

The public angling fishery daily catch and possession limits were reduced to zero, effective July 4, to coincide with the arrival of Chinook salmon in Canadian portions of the Yukon River. Chinook salmon commercial and domestic fisheries in Canada remained closed throughout the 2019 season. A summary of management and conservation measures implemented in Canada are presented in Appendix B19.

Inseason Management Porcupine River Chinook Salmon

In the absence of stock-specific information about Porcupine River Chinook salmon in Canada, the early season management of this stock is based on information and management of mainstem Yukon River Chinook salmon. Given the below average outlook for mainstem Chinook salmon in 2019, it was recommended that Porcupine River subsistence fishing activities proceed in a conservative manner. Consistent with the approach adopted for mainstem Chinook salmon, the fishery was opened early in the season with a recommendation to harvest in a conservative manner until such time that a more robust inseason estimate may be derived from information collected through the Porcupine River Chinook salmon sonar assessment program. It was further recommended that, when possible, female Chinook salmon caught in subsistence gillnets would be released if it were likely that the fish would survive, and that gillnets have a mesh size of 6-inches or less.

By late July, the inseason assessment of run strength at the Porcupine River sonar indicated that the return of Chinook salmon was stronger compared to mainstem returns. The Vuntut Gwitchin Government directs the First Nation fishery in accordance with the *Vuntut Gwitchin First Nation Final Agreement*[5] and the *Porcupine River Salmon Plan*[6].

5.2 Fall Chum Salmon

Mainstem Yukon River

The 2019 preseason forecast for the Canadian-origin fall chum salmon run to the mainstem Yukon River was expected to be an average run with a range of 233,000–290,000 fish. In early July the fall chum salmon forecast was revised to 125,000–188,000 (based on summer chum salmon run size). In early August, the summer chum run size was adjusted due to late run timing, and the fall chum salmon forecast was revised to 175,00–200,000 mainstem Canadian fall chum salmon. The

[5] https://www.vgfn.ca/vgfnfa/

[6] http://www.vgfn.ca/pdf/Porcupine%20Salmon%20Plan%2005%202019.pdf

interim management escapement goal (IMEG) range recommended by the Yukon River Panel remained at 70,000–104,000 Canadian-origin fall chum salmon.

Canadian management decisions were based on the application of inseason assessment information to the management decision matrix—a component of the IFMP. The decision matrix provides detailed guidance for the management of fisheries linked to specific inseason run abundance levels. The 2019 decision matrix summarized the management reference points, general allocation plans, and anticipated management responses under different run size scenarios (Table 4). The decision matrix is being reviewed to seek to realign it with the Yukon River Panel's current IMEG. This work was not yet concluded at time of publication of this report.

Inseason Management Mainstem Yukon Fall Chum Salmon

Inseason decisions about fishery openings and closures in Canada for fall chum salmon were made in a similar way to those for Chinook salmon. In 2019, early inseason information from the lower Yukon River suggested that border escapement would be strong enough to support a normal aboriginal harvest and to provide opportunities in the commercial fishery. Inseason projections of the Canadian component of the fall chum salmon run were first based on run estimates and genetic apportionment of Canadian-origin fall chum salmon from the Pilot Station sonar. As fall chum salmon approached and entered Canada in mid- to late August, estimates from the mainstem Yukon River sonar near Eagle provided robust projections.

Due to the lower than expected return and potential late run timing of Chinook salmon, openings in the chum salmon angling, commercial and domestic fisheries were delayed to allow for passage of any late running Chinook salmon to reach the spawning grounds.

New to 2019, the conditions of license in the commercial and domestic chum fisheries included the following:

- All incidentally caught Chinook salmon in both the chum commercial and domestic fisheries must be released, and;
- The maximum allowable mesh size is 6-inches in both the commercial and domestic chum salmon fisheries.

The intention of management actions in 2019 was to ensure that the IMEG range of 70,000–104,000 fall chum salmon was achieved. By late August, information from the Pilot Station sonar and LYTF data indicated that the total run would likely be below the preseason forecast range but estimates of border passage indicated that the return of chum salmon to Canada would be strong enough to support harvest in the First Nation, commercial/domestic and public angling fisheries. Given the relative strength of the return and anticipated low harvest, the commercial and domestic fisheries opened for 24 hours per day, seven days a week in all areas defined in regulation and remained open until October 31.

Fishing Branch (Porcupine) River

The 2019 preseason outlook estimate for Fishing Branch-origin (in the Porcupine River drainage) fall chum salmon was 37,000–46,000 fish. In early July, the Fishing Branch-origin outlook was revised to 20,000–30,000 fish (based on summer chum salmon run size). In mid-August, the Fishing Branch–origin chum salmon outlook was revised again to 30,000–34,000 fish, based on adjustment to the summer chum salmon run size. The current IMEG for the Fishing Branch River recommended by the Yukon River Panel is 22,000–49,000 fall chum salmon. Considering that the minimum spawning escapement of fall chum salmon to the Fishing Branch River had not been achieved in 5 of the last 10 years, a conservative approach was warranted. Following discussion with Vuntut Gwitchin First Nation, the North Yukon Renewable Resources Council, and the YSSC, it was recommended that a conservative chum salmon fishery occur in the Porcupine River until such a time that an inseason projection of greater than 22,000 to the Fishing Branch River could be determined. Important to note is that Vuntut Gwitchin Government directs the First Nation fishery according to the *Porcupine River Salmon Plan*.

Inseason Management Porcupine River Fall Chum Salmon

Canadian fishery management considered early season information from the LYTF and Pilot Station sonar. Estimates of fall chum salmon passage in combination with genetic mixed stock analysis (MSA) cannot be reliably used to project the return to Fishing Branch River. Because the Fishing Branch River component at the Pilot Station sonar is such a small part of the total run, the uncertainty associated with these estimates is very high; therefore, management decisions cannot be based on this information.

Inseason fishery management decisions are largely based on information from the Porcupine River sonar operated downstream of the community of Old Crow. The Porcupine River sonar passage projection is the primary indicator used to inform inseason management decisions, however harvest in Alaska before the fish reach Canada is also considered when making management decisions.

In 2019, Fishing Branch River enumeration of fall chum salmon was conducted using a combination of weir and sonar, and the trial of a video counter. Only a portion of the fall chum salmon that return to the Canadian Porcupine River are destined for the Fishing Branch River. Based on concurrent sonar and weir counts in 2019 (Appendix B15) approximately 66% of Porcupine River fall chum salmon were destined for the Fishing Branch River. As the season progressed, late run timing and low sonar counts at the Porcupine River sonar contributed to uncertainty as to whether the escapement goal would be achieved and the Vuntut Gwitchin First Nation maintained a conservative approach to harvest, in accordance with the *Porcupine River Salmon Plan.*

6.0 CANADIAN HARVEST SUMMARIES

6.1 First Nation Subsistence Fisheries

Harvest estimates of salmon in the First Nation fisheries on the Yukon and Porcupine rivers are determined from locally-conducted inseason and postseason interviews. For additional ease in reporting, DFO provides harvest calendars and harvest reporting forms to First Nation Government’s Lands and Resources staff for distribution among harvesters.

Mainstem Yukon River Chinook Salmon

Based on a preseason outlook for a below average run of 69,000–99,000 Canadian-origin Yukon Chinook salmon, YSSC recommended a conservative approach early in the 2019 fishing season. Inseason information from the LYTF and Pilot Station sonar indicated that the run was returning at the upper end of the preseason forecast, which would provide for a full allocation in the First Nation subsistence fishery. Inseason Eagle sonar passage was much lower than anticipated and by August 8, in consideration of the sonar passage and harvest upstream, it was unlikely that the midpoint of the IMEG would be met. Yukon First Nation governments followed conservative management plans throughout the 2019 season, resulting in a significantly reduced harvest compared to long-term historical averages. The First Nation harvest in the Canadian Yukon River mainstem drainage in 2019 was estimated to be 2,794 fish (Appendix B7). For comparison, the First Nation long-term (1961–2018) average is 4,970 fish; the most recent ten-year average (2009–2018) is 2,486; and, the most recent five-year average (2014–2018) is 2,031 (Appendix B7).

Mainstem Yukon River Fall Chum Salmon

The preseason outlook for Canadian-origin fall chum salmon in 2019 indicated an average run of 233,000–290,000 fish. The border passage estimate at this run projection would place Canadian management in the green zone and therefore no restrictions were expected in the First Nation fisheries. As inseason information became available, the First Nation fisheries proceeded without restrictions. The 2019 fall chum salmon harvest in the First Nation fisheries in the Canadian mainstem drainage is estimated to be 1,000 fish (Appendix B8). For comparison, the First Nation long-term (1961–2018) average harvest is 2,232 fall chum salmon; the most recent ten-year average (2009–2018) and five-year average (2014–2018) are both 909 fish (Appendix B8).

Porcupine River Chinook, Fall Chum, and Coho Salmon

An estimated harvest of 340 Chinook salmon occurred in the in 2019 First Nation subsistence fishery near Old Crow (Appendix B7). For comparison, the long-term (1961–2018) average harvest is 249 Chinook salmon; the most recent ten-year average (2009–2018) is 227 fish; and, the most recent five-year average (2014–2018) is 165 fish (Appendix B7).

An estimated harvest of 1,000 fall chum salmon occurred in the 2019 First Nation subsistence fishery near Old Crow (Appendix B8). For comparison, the long-term (1961–2018) average harvest is 4,228 fall chum salmon; the most recent ten-year average (2009–2018) is 1,996 fish; and, the most recent five-year average (2014–2018) is 1,946 fish (Appendix B8).

There was no reported harvest of coho salmon on the Porcupine River in 2019.

6.2 Commercial Fishery

Mainstem Yukon River Chinook Salmon

The commercial Chinook salmon fishery remained closed throughout the 2019 summer fishing season (Appendix B19).

Mainstem Yukon River Fall Chum Salmon

The return of fall chum salmon resulted in opportunities for the commercial fishery however, due to the depressed return of Chinook salmon, the chum salmon commercial fishery opening was delayed to September 12 through October 31. A total of 1,728 fall chum salmon were harvested during commercial fishery openings (Appendix B8). For comparison, the long-term (1961–2018) average is 9,485 fall chum salmon; the most recent ten-year average (2009–2018) is 2,582 fish; and, the most recent five-year average (2014–2018) is 2,291 fish (Appendix B8).

Since 1997, there has been a marked decrease in commercial catches of Upper Yukon River fall chum salmon as a result of a limited market. Between 1961 and 2019, the commercial fall chum salmon catch ranged from a low of 293 fish in 2009 (when the run was late and the fishery had been closed for most of season due to conservation concerns) to a high of 40,591 fish in 1987.

Mainstem Yukon River Coho Salmon

Commercial harvest of coho salmon in the mainstem Yukon River in Canada rarely occurs. This is thought to be due to a combination of low abundance and their late migration timing which limits availability of this species. There were no coho salmon harvested in the 2019 commercial fishery.

6.3 Domestic Subsistence Fishery

The domestic fishery was closed during the Chinook salmon season (Appendices B7 and B19) and open for the fall chum salmon season. The opening was concurrent with commercial fishery openings. In 2019, there was a harvest of 31 fall chum salmon in the domestic fishery (Appendix B8). For comparison, the long-term (1961–2018) average is 423 fall chum salmon; the most recent ten-year average (2009–2018) is 7 fish; and, the most recent five-year average (2014–2018) is 11 fish (Appendix B8).

6.4 Licensed Public Angling Fishery

In 1999, the Salmon Sub-Committee introduced a mandatory Yukon Salmon Conservation Catch Card to improve harvest estimates and to serve as a statistical base to ascertain the importance of salmon to the Yukon River public angling fishery. Anglers are required to report their catch and harvest by late fall. The information reported includes the number, species, fate (retained or released), sex, size, date, and location of all salmon caught. From preliminary catch card information received at the time of this publication, no Chinook salmon were caught or retained in the Yukon River or its tributaries in the 2019 public angling fishery, which is consistent with the angling closure that was in place for the duration of the 2019 Chinook salmon season.

Over the last 10 years, retention (harvest) of Chinook salmon in the public angling fishery was only permitted in 2009 and 2011 (Appendix B7). For the 2019 season, the daily catch and possession limits of fall chum salmon in the public angling fishery remained at 2 and 4 fish, respectively. There were no reports of fall chum salmon caught at the time of this publication.

7.0 TOTAL RUN, ESCAPEMENT, AND HARVEST SHARE ASSESSMENTS FOR 2019

7.1 Chinook Salmon

In 2019, the total Chinook salmon passage at the Pilot Station sonar was approximately 219,624 fish ± 20,477 (90% CI, Table 5, Appendix A1). This is considered an index of the drainagewide Chinook salmon run, rather than a total run size estimate, because some salmon are harvested or enter spawning areas below this sonar site. This passage was above the historical average[7] of 181,023 fish (Appendix A1). Chinook salmon entered the river in three pulses consisting of 62,164 fish; 33,073 fish; and 84,855 fish respectively. The first quarter point, midpoint, and third quarter point for the Pilot Station sonar passage were on June 20, June 26, and July 2, respectively. The 2019 Chinook salmon run was three days later than average based on the midpoint at the Pilot Station sonar.

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7 Average includes years 1995, 1997, 2000, 2002–2008, and 2010–2018. The sonar did not operate in 1996 and project difficulties occurred in 1998–1999, 2001, and 2009.

Total Chinook salmon passage estimated at Eagle sonar in 2019 was 45,560 fish (Appendix B11). After subtracting estimated U.S. subsistence harvest taken upriver from the Eagle sonar site (744 fish) and the estimated Canadian harvest of Chinook salmon (2,764 fish; Figure 8, Appendices B7, and B11), the estimated mainstem border passage was 44,816 fish (Appendices B11 and B18) and the estimated spawning escapement of Canadian-origin Yukon River Chinook salmon (mainstem) was 42,052 fish (Figure 9; Appendices B11 and B18). This escapement was below the lower end of the IMEG of 42,500–55,000 fish. Combining the spawning escapement estimate with the U.S. and Canadian harvests of Canadian-origin Chinook salmon indicates the total Canadian-origin run size was approximately 72,620 Chinook salmon (Appendix B18).

Postseason calculation of the total allowable catch, based on prescriptions outlined in the YRSA and a total run size estimate of 72,620 Chinook salmon, were for a U.S. harvest share of 13,039–24,096 fish and a Canadian harvest share of 3,524–7,831 fish (Appendix B18). The U.S. harvest of Canadian-origin Chinook salmon (27,804) exceeded the harvest share by 3,908 fish. The number of Chinook salmon that passed into Canada was 1,208 fewer fish than what was needed to meet the lower end of the IMEG range (42,500 fish) and provide for the minimum Canadian harvest share.

Age, sex, and length (ASL) composition was assessed at both mainstem sonar sites and in various escapement projects (Table 6; Appendices A4–A5). The ASL samples collected at the Pilot Station sonar are thought to be representative of all Chinook salmon stocks passing the site and include both U.S. and Canadian stocks. The ASL samples collected at the Eagle sonar are exclusively from Canadian-origin fish. Mesh sizes used to sample the runs differ at each location. The Chinook salmon age composition from the 734 samples that were aged from the test fishery at the Pilot Station sonar project (all mesh sizes combined) was less than 1% age-3, 12% age-4, 48% age-5, 39% age-6, and less than 2% age-7 fish. Females comprised 50% of the fish sampled. The age composition was near the 2009–2018 average for all age classes while percent female was above average. It is important to note that while the Pilot Station sonar test fishery uses a wide range of mesh sizes, and likely captures a representative sample across sizes and age classes, the sex is determined visually, and this method has reduced accuracy compared to internal inspection (Table 6; Appendix A4).

The Chinook salmon age composition from the 554 samples that were aged from the test fishery at the Eagle sonar project was 9% age-4, 48% age-5, 42% age-6, and 1% age-7 fish. The 2019 ages were similar to the 2014–2018 averages. Females made up 48% of the fish sampled (Table 6), which was above the 2014–2018 average of 41% (Appendix A5). Slight modifications have been made to the drift gillnet mesh sizes used at the Eagle sonar during the first three years of operation (2005–2007); however, mesh sizes measuring 5.25, 6.5, 7.5, and 8.5-inch have been used consistently since 2007. Small fish may be underrepresented in the samples, due to not fishing nets smaller than 5.25-inch.

Chinook salmon escapement in U.S. tributaries was assessed at three weirs, two counting towers, and with three aerial surveys (Table 7; Figure 10). In 2019, all but one U.S. tributary Chinook salmon escapement goals were met (Liller and Savereide 2018; Table 7; Appendix B10).

Passage of Chinook salmon to tributaries in Canada was assessed at the Whitehorse Rapids Fishway and on the Pelly, Big Salmon, and Porcupine rivers (Appendix B12). On the Big Salmon River, 3,874 Chinook salmon were counted, which was 34% below the 2009–2018 average count of 5,805 fish (Appendix B12). At the Whitehorse Rapids Fishway, 282 Chinook salmon were counted, which was 76% below the 2009–2018 average count of 1,174 fish (Appendix B12). Hatchery-produced fish accounted for 13% of the fish that returned to the Whitehorse fishway in 2019. On the Pelly River, a preliminary estimate of 6,927 Chinook salmon was counted using sonar, which was lower than the 2017–2018 average of 9,416 fish (Appendix B12). On the Porcupine River, 4,740 Chinook salmon were counted using sonar, which was the second highest count since the start of the project in 2014 (Appendix B12).

7.2 Summer Chum Salmon Alaska (U.S. Only)

In 2019, an estimated 1.4 million summer chum salmon ±85,902 (90% CI) passed the Pilot Station sonar (Table 5, Appendix A1), which was lower than the 1995–2018 (excluding 1996, 1998, 1999, 2001 and 2009) median of 1.9 million fish for the project. The first quarter point, midpoint, and third quarter point were June 29, July 3, and July 5, respectively, which was the latest run timing on record. Four pulses of summer chum salmon were detected at the sonar project; the largest group consisted of approximately 539,000 fish and passed between July 2–July 7. A summer chum salmon drainagewide biological escapement goal (BEG) with a range of 500,000–1,200,000 was adopted in 2016 (Liller and Savereide 2018; Table 8), and the 2019 escapement of approximately 1,477,000 fish exceeded this goal.

In 2019, multiple reports of en route mortality of summer chum salmon in response to elevated water temperatures prompted close inspection of tributary escapements relative to existing escapement goals and historical passage. The summer chum salmon escapement into the East Fork Andreafsky River of 49,881 exceeded the SEG of greater than 40,000 fish (Table 8; Appendix B13). Escapement into the Anvik River was 249,014 summer chum salmon, which was below the lower bound of the BEG of 350,000 fish. Passage estimates at the Gisasa and Henshaw Creek weirs in the Koyukuk River drainage were well below average (Appendix B13). Temperatures in the lower Yukon and Koyukuk rivers were warmer than previously recorded for an extended period in 2019. Thus, en route mortality related to heat stress may have contributed to the exceptionally low passage in the Koyukuk River. Sonars were used to supplement and corroborate tower counts for Chena and Salcha river salmon. Both assessment projects were hindered by high water and flooding events and with the late run timing of summer chum salmon in 2019, passage estimates for both rivers are incomplete (Table 8; Appendix B13).

7.3 Fall Chum Salmon

The initial method of determining total drainagewide (i.e., U.S.-origin and Canadian-origin) fall chum salmon run size inseason was based on the Pilot Station sonar passage estimate and the estimated inriver harvest of fall chum salmon downstream of the sonar site. The inseason run size model primarily uses the commercial fishery, which is the largest harvest component below the sonar site, to produce overall projections of abundance used to manage the fishery. The inseason total run size using this method was estimated to be greater than 1.0 million chum salmon. However, because of a large number of summer chum salmon present after the regulatory crossover date between summer and fall chum salmon management, genetic mixed stock analysis was used to adjust the inseason total run size estimate to better represent fall chum salmon.

Postseason, a Bayesian state-space model was used to estimate drainagewide escapement (Fleischman and Borba 2009). The total drainagewide run size is then derived by adding the estimated total harvest (U.S. and Canada) to the estimate of drainagewide escapement. The estimation of U.S. commercial harvest of fall chum salmon in 2019 was complicated by late run timing of summer chum salmon. There was a high proportion of summer chum salmon after the regulatory transition date to fall season management. To account for this in the calculation of drainagewide total run size, an estimated 63,000 genetically-identified summer chum salmon were subtracted from the commercial harvest that occurred during the fall season (268,360). The adjusted U.S. commercial harvest of fall chum salmon was 205,360. This method resulted in a total drainagewide run size estimate of 800,800 fall chum salmon, which was below the 2019 forecast of 933,000–1,160,000 fish. The total run size ended up near the upper end of the inseason projection of 700,000–800,000 fall chum salmon, which was based on the relationship between summer and fall chum salmon total run sizes after adjusting the summer chum salmon run size based on genetic MSA to account for late run timing.

The drainagewide escapement estimate produced by the Bayesian state-space model was 528,000 fall chum salmon, which was within the escapement goal range of 300,000–600,000 fall chum salmon (Liller and Savereide 2018; Table 9; Figure 11). The model utilized historical escapement data from the Toklat, Delta, Teedriinjik (Chandalar), Sheenjek, Fishing Branch, and Canadian mainstem Yukon rivers, as well as mark–recapture estimates of abundance from the upper Tanana, and Kantishna projects (Appendices B14–B16). The model explicitly balances information from each of these index projects, such that the model output and interpretation of drainagewide escapement performance tends to mirror what was observed at individual tributaries. For example, the fall chum salmon escapements to Chandalar River and Canadian mainstem Yukon River were within their respective goal ranges while the Delta River set a record, well above its escapement goal range (Liller and Savereide 2018; Table 9; Figure 12; Appendices B14, B16).

In 2019, the proportions by age class for fall chum salmon caught in the LYTF were used to represent the drainagewide run and included 1% age-3, 82% age-4, 17% age-5, and less than 1% age-6 fish. The age-4 component was above average while ages-3, 5, and 6 were slightly below average when compared to LYTF weighted odd-year averages for years 1977–2018. Fall chum salmon ASL composition estimates from data collected in the Delta River included 1% age-3, 86% age-4, and 13% age-5 (Appendix A10). Samples were also collected for the escapement into Canada based on test fishing near the Eagle sonar site, and included 1% age-3, 78% age-4, and 21% age-5 fall chum salmon (Appendix A10). The ages in the escapements were similar to those observed in the LYTF with high proportions of age-4 fall chum salmon.

Mainstem Yukon River Canadian-Origin Fall Chum Salmon

The U.S./Canada border passage estimate for fall chum salmon was 102,497. This was calculated by subtracting U.S. harvest between the sonar and the border (10,759 fish) from the Eagle sonar passage estimate (113,256 fish; Appendix B16). After subtracting the preliminary Canadian mainstem harvest of 2,759 fish (Figure 13; Appendix B8) the estimated spawning escapement of Yukon River mainstem Canadian-origin fall chum salmon was 99,738 fall chum salmon, which is within the IMEG of 70,000–104,000 fish (Figure 14; Table 10).

The preliminary reconstruction of the total 2019 Canadian-origin Yukon River mainstem fall chum salmon run was approximately 178,000 fish. Total run size was approximated using the expanded estimate of fall chum salmon which passed the Eagle sonar near the U.S./Canada border (113,256 fish) plus 25% of the U.S. harvest of fall chum salmon that occurred downstream of Eagle sonar (258,000 fish) and then rounded to the nearest 1,000. In 2019, an estimated 63,000 summer chum salmon taken in the lower river commercial fishery (based on MSA) was removed from the harvest prior to applying 25%. This run size estimate is well below the preseason outlook range of

233,000–290,000 Canadian-origin Yukon River mainstem fall chum salmon but similar to the various run size projections which were prepared inseason based on the summer chum salmon relationship.

Porcupine River (including the Fishing Branch River) Canadian-Origin Fall Chum Salmon

In 2019, the Porcupine River sonar, immediately downstream of the community of Old Crow, undertook its eighth year of operation counting fall chum salmon. An estimated 27,447 fall chum salmon passed by the sonar (Appendix B15). An estimated 1,000 fish were harvested in the Old Crow fishery (Appendix B8; details are presented in Section 8.3).

DFO operated the Fishing Branch River weir in 2019 and installed a sonar unit to monitor fish passage through a constrained opening in the weir. The 2019 spawning escapement estimate for fall chum salmon at the Fishing Branch River was 18,171 fish (Figure 14, Table 10 and Appendix B15). The Canadian harvest of Fishing Branch River fall chum salmon in 2019 is estimated at 660 fish. This assumes that 66% of the fall chum salmon in the Porcupine River drainage are destined for Fishing Branch (1,000 fish harvested in Old Crow X 0.66 = 660). The assumption of 66% was based on the 2019 ratio of fall chum salmon observed past the Porcupine Sonar and Fishing Branch weir. The total run size estimate for 2019 Fishing Branch fall chum salmon is 29,000 fish. This is calculated as the sum of the weir passage (18,171), the estimated Canadian harvest (660), and the estimated U.S. harvest of Fishing Branch fall chum salmon (4% of the total U.S. fall chum harvest downstream of Eagle sonar, 258,331 x 0.04 = 10,333) and then rounded to the nearest 1,000.

8.0 PROJECT SUMMARIES

8.1 ALASKA, U.S.

Salmon assessment programs operated throughout the U.S. portion of the Yukon River drainage are collaborative. This report summarizes salmon run, harvest, and escapement monitoring results from numerous projects. Data were provided by various entities including: Mountain Village Test Fishery (G. Sandone Consulting, LLC); East Fork Andreafsky River Weir (USFWS); Gisasa River weir (USFWS); Henshaw Creek weir (Tanana Chiefs Conference and USFWS); and chum salmon genetic stock identification (USFWS). Other project results were provided by ADF&G Division of Commercial Fisheries and Division of Sport Fisheries. Partner organizations that assisted with data collection include Spearfish Research, Yukon Delta Fisheries Development Association, Yukon River Drainage Fisheries Association, and DFO. A more in-depth overview of select stock assessment programs are described in the following sections of this report.

Lower Yukon Test Fishery

The LYTF program is designed to assess salmon run timing and relative abundance and consists of two Chinook salmon test fisheries. An 8.5-inch mesh set gillnet test fishery operated in the Middle and South mouths of the Yukon River and an 8.25-inch mesh drift gillnet operated at Big Eddy in the South Mouth, near Emmonak. The LYTF also has a summer chum salmon-directed drift gillnet test fishery using 5.5-inch mesh gear operated in the Middle and South mouths. These test fisheries provide catch per unit effort (CPUE), which gives an index of abundance and indicates the presence of large groups of fish, or "pulses", entering the mouths of the river.

The LYTF was fully operational at the South Mouth (Big Eddy) drift and set gillnet sites on May 25 and June 2, respectively, and at the Middle Mouth set gillnet site on June 6. The LYTF set gillnets concluded operations on July 9 in the South Mouth and July 13 in the Middle Mouth. The cumulative Chinook salmon CPUE for the set nets was 37.96, which was above the historical average CPUE of 24.51 (Figure 3). The first quarter point, midpoint, and third quarter point were June 18, June 23, and June 28, respectively. The 8.25-inch drift gillnet project for Chinook salmon operated in Big Eddy until July 15 and provided valuable supplemental run timing information for Chinook salmon entering the South Mouth of the Yukon River. The LYTF drift gillnets for summer chum salmon concluded operations on July 15. The cumulative summer chum salmon CPUE was 7,822.42, which was above the historical average CPUE of 6,707.64. The first quarter point, midpoint, and third quarter point were June 25, June 27, and July 1, respectively.

The LYTF project continues in the fall season after switching to 6-inch drift gillnets on July 16 and completed operations on September 10 (Yukon Delta Fisheries Development Association conducted drifts in late August through the end of the season). The cumulative CPUE for fall chum salmon of 1,680.29 which was near the historical median of 1,605.78 and the cumulative CPUE for coho salmon of 195.22 was well below the historical median of 440.44.

Chinook, chum, and coho salmon caught in the LYTF were either kept, sampled, and distributed to local community members or they were released alive. In 2019, 627 Chinook salmon were released alive from the LYTF while approximately 1,600 Chinook salmon were distributed to local community members (which were included in the U.S. subsistence harvest estimate), with emphasis given to elders and people who were unable to fish. For summer chum salmon, 298 fish were released alive, approximately 4,400 fish were distributed within the community, and 230 were sold by the department as a means of offsetting the costs of LYTF program and/or because it can be hard to distribute fish when the community has already met their chum salmon harvest needs. In the fall season, approximately 1,429 fall chum and 184 coho salmon were given away in the nearby communities and, in times of saturation, 275 fall chum and 40 coho salmon were sold. The fish donation program was coordinated with village tribal councils and with the assistance of Yukon Delta Fisheries Development Association.

Pilot Station Sonar

The goal of the Pilot Station sonar project is to estimate daily upstream passage of Chinook (Figure 15), summer and fall chum (Figure 16), and coho salmon (Figure 17). The project has been in operation since 1986. Both split-beam and Adaptive Resolution Imaging Sonar (ARIS)[8] are used to estimate total fish passage, and CPUE from the drift gillnet test fishing portion of the project is used to estimate species composition. The project's sonar equipment and apportionment methodologies have evolved over time (Pfisterer et al. 2017; Dreese and Lozori 2019).

Fish passage estimates at the Pilot Station sonar project are based on a sampling design in which sonar equipment is operated daily in three 3-hour periods and drift gillnets 25 fathoms long with mesh sizes ranging from 7.0 cm to 21.6 cm (2.75- to 8.5-inch), approximately 4.3 fathoms in depth, that are fished twice each day between sonar periods to apportion the sonar counts to species. During the 2019 season, both banks were fully operational on June 2 and continued operations through August 31. The ice went out on the mainstem Yukon River near Pilot Station on May 7 based on National Weather Service data.[9] Test fishing began on June 2, the first Chinook, chum and coho salmon were caught on June 2, June 4, and July 26, respectively.

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[8] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

[9] https://www.weather.gov/aprfc/breakupDB?site=488

An estimated 3,161,920 fish passed through the sonar sampling area between June 1 and August 31 (Table 5). Drift gillnetting resulted in a catch of 8,130 fish including 852 Chinook; 2,597 summer chum; 2,794 fall chum; and 453 coho salmon. A total of 1,434 fish of other species were also caught. Chinook salmon were sampled for ASL; while only sex (external) and length were collected from chum, pink *O. gorbuscha*, sockeye *O. nerka*, and coho salmon without aging structures; for all other non-salmon species, only length was collected. Genetic samples were taken from Chinook and chum salmon. Any captured fish that were not successfully released alive were distributed daily to residents in Pilot Station.

Overall in 2019, there were no significant operational problems and both sonars performed well throughout the season. Water levels observed near Pilot Station where above the 2009–2018 mean from June 1 through June 25, then fell below the mean through August 16, again rising above the mean on August 18 and remained above throughout the rest of the season.

In 2019, all project goals were met, and passage estimates were provided to fisheries managers daily during the season. Information generated at the Pilot Station sonar was also discussed weekly through multi-agency international teleconferences that included stakeholders from the lower Yukon River to the headwater communities in Canada. Preliminary daily salmon passage estimates were available online[10] and disseminated daily to the general public via a listserv.

Chinook Salmon Genetic Sampling, 2019

In 2019, ADF&G collected 2,107 tissue samples from adult Chinook salmon sampled in test fisheries that occurred in the Alaska portion of the Yukon River and included 636 fish from the LYTF, 843 fish from the Pilot Station sonar, and 628 fish from the Eagle sonar. In Alaska, a total of two baseline samples of Chinook salmon were collected from the Christian River.

Mixed Stock Analysis of Yukon River Chinook Salmon Sampled at the Pilot Station Sonar, 2005–2019

The ADF&G Gene Conservation Laboratory (GCL) estimates the stock composition using genotypes of samples collected from the Pilot Station sonar project's test fishery providing genetic Mixed Stock Analysis (MSA) of fish passage. This project provides fishery managers an important "first look" at the Canadian-origin Chinook salmon run strength and timing before those fish migrate through most Alaska fisheries. Without genetic MSA at the Pilot Station sonar, fishery managers would have no information about the Canadian-origin run until fish arrive at Eagle sonar, when most of the run has already passed through 1,900 kilometers of fisheries. Knowledge of relative abundance and migration timing from this project has led to improved inseason projections of total run size of Canadian-origin Chinook salmon and more refined management strategies to meet border passage goals.

Mixed stock analysis, conducted since 2005, was implemented to provide insight on stock-specific run dynamics and has proven to be a critical component of inseason management of salmon fisheries in Alaska. Project data has been used to estimate the total proportion of Canadian-origin Chinook salmon each year since 2005. Postseason estimates from this project indicate that the Canadian stock makes up 41% of the total run on average (2005–2018) and has ranged from 34%–52% (Table 11). Over this 15-year timeframe, the contribution of the Canadian-origin stock to the total run has been relatively stable; however, this project has highlighted a considerable amount of

[10] http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareayukon.salmon#fishcounts

within-year variability in the relative abundance of Canadian-origin Chinook salmon (Table 11). In nearly all years (2005–2018), the proportion of Canadian-origin stocks has been highest, often exceeding 50%, during the early portion of the run, but typically decreases to about 30% or less as the run progresses. This project, combined with the Pilot Station sonar passage estimates, has shown that while the proportion of Canadian-origin stocks are typically highest in the early portion of the run, the abundance (i.e., numbers of fish) of Canadian-origin fish is generally higher during the middle part of the run (Table 11). Analysis of the samples collected in 2019 conforms to the pattern of a higher proportion of Canadian-origin fish in the first stratum. However, unlike many past years, the abundance of Canadian-origin Chinook salmon was also higher in the first stratum than the second stratum in 2019.

Tissue samples were taken from most Chinook salmon caught in the test fishery at the Pilot Station sonar in 2019 and analyzed in three strata for genetic MSA. The three strata periods were June 2–June 23 (number analyzed (n) = 184), June 24–June 30 (n = 184), and July 1–August 23 (n = 171). Genetic MSA indicated the proportion of the total Chinook salmon run at the Pilot Station sonar that were Canadian-origin was 56% (approximately 46,000 fish) in stratum 1, 42%, (approximately 31,000 fish) in stratum 2, and 36%, (approximately 23,000 fish) in stratum 3. The total season Canadian percentage was 45% (weighted by passage) which is above the 2005–2018 average of 41% (Table 11).

Mixed Stock Analysis of Yukon River Chinook Salmon Harvested in Alaska, 2019

Three broad-scale stock (reporting) groups are used to apportion Chinook salmon harvest by Alaska fisheries within the Yukon River drainage. The Lower and Middle Yukon River stock groups spawn in Alaska and the Upper Yukon River stock group spawns in the Canadian mainstem. Scale pattern analysis, age composition estimates, and geographic distribution were used by ADF&G from 1981–2003 to estimate Chinook salmon stock composition in Yukon River harvests. From 2004 to present, genetic analysis has been the primary method for stock identification (e.g., DuBois 2018). Harvest percentages by stock group for 2014–2019 include the harvest from the Coastal District, whereas the Coastal District was not included in years prior to 2014.

An estimate of the 2019 total U.S. harvest of Chinook salmon by stock of origin required information about the genetic stock composition of the subsistence harvest, test fish giveaways, and incidental commercial harvest. There was no directed subsistence harvest sampling program in place for 2019. Therefore, genetic MSA results from prior year (2006–2018) subsistence harvest sampling programs were used to inform the 2019 subsistence harvest composition. Samples collected directly from the LYTF were used to determine the stock composition of the test fish giveaway. Stock composition estimates obtained from Pilot Station test fish were used to apportion incidental commercial harvest of Chinook salmon in 2019. Subsistence harvest and stock composition estimates for 2019 are still considered preliminary as of the publication date of this report.

Genetic MSA results indicate that the weighted U.S. harvest of Yukon River Chinook salmon was comprised of 14% Lower, 32% Middle, and 54% Upper (Canadian-origin) stock groups. U.S. harvest composition for 2019 was slightly below the 2014–2018 average for the Lower and Middle stock groups and above the 2014–2018 average for the Upper stock group (Appendix A6).

Yukon River Chum Salmon Mixed Stock Analysis, 2019

Chum salmon were sampled from the Pilot Station sonar from June 2 through August 31 and analyzed by the USFWS gene lab to provide stock composition estimates for most of the summer and fall chum salmon runs. Populations in the baseline are reported in aggregated stock groups (Table 12). Results from analysis of these samples were reported for each pulse or time stratum and distributed by email to fishery managers within 24–48 hours of receiving the samples. For summer chum salmon, the lower river stock group comprised 74% of the run and the middle river stock group comprised 26%. The Tanana component of the middle river stock group comprised 8% of the total summer chum salmon run and peaked in passage at the Pilot Station sonar during the sampling period of June 25–July 7. The run transition from summer to fall chum salmon occurred during the second period of the fall management season (July 27–August 9) when 64% of the mixture was comprised of fall chum salmon. For fall chum salmon, 70% of the run was of U.S.-origin and 30% of Canadian-origin. The composition of the U.S. contribution was 37% Tanana and 30% U.S. border (Teedriinjik-Chandalar, Sheenjek, and Black rivers). The composition of the Canadian contribution was 11% mainstem Yukon, 15% White and 6% Porcupine rivers. Preparations are underway to continue the project for the 2020 season.

Environmental Conditions Report

This U.S. environmental conditions report was added for the first time in 2019. This report differs from the Canadian environmental conditions report, which is much more detailed and was requested by the Panel. Instead, this addition was a first step to document environmental conditions relevant to adult salmon migrating through the U.S. portion of the Yukon River drainage. The need for this new section was highlighted in 2019 due to extreme warm weather and wide-spread elevated water temperatures throughout western Alaska, including the Yukon River. In addition, the 2019 season was noteworthy due to more than normal inseason and post season reports of en route salmon mortality—many of which were attributed to elevated water temperatures. Currently, environmental monitoring within the U.S. portion of the Yukon River is limited and existing assessment programs are inadequate to quantify the extent and variability of natural adult salmon pre-spawn mortality.

In the Alaska portion of the Yukon River in 2019, there were extreme warm water conditions and associated reports and direct observations of summer chum salmon mortalities. Many projects started late due to high water in the beginning of the season, but as the season progressed, water levels dropped to, or below, the lowest levels ever recorded for at least part of the season in most of the Alaskan portion of the drainage. In addition, water temperatures exceeded previous maximum daily temperatures at many projects in 2019 and were sustained for various periods of time during the salmon migrations. The LYTF near Emmonak measured high water temperatures ranging from 17°C–21°C (63°F–70°F) beginning the second week of June through mid-July which corresponded with the peak of Chinook and summer chum salmon migration (Figure 18). There were six consecutive days during the fall season (when most of the Chinook and summer chum salmon runs were through the lower river) when water temperatures at Pilot Station exceeded 21°C (70°F). Water temperatures above 21°C (70°F), for prolonged periods, can cause salmon mortality (McCullough et al. 2001), and these elevated temperatures were suspected to have caused reduced swim speeds for Chinook and summer chum salmon migrating through portions of the mainstem Yukon River. There were reports of dead chum salmon in the East Fork and West Fork of the Andreafsky River during the middle of July; however, the passage estimates at the East Fork Andreafsky weir and aerial surveys on both forks indicated escapement goals were achieved.

Similarly, 10 dead female summer chum salmon with full egg skeins were reported along the mainstem Yukon River above Russian Mission.

Hundreds of dead chum salmon were reported along the banks of the Koyukuk River by several local fishermen in late July. During a short boat survey between Hughes and Huslia, researchers counted over 800 chum salmon carcasses, which was considered an underestimate. All carcasses that were examined had not spawned. Most of the Koyukuk River summer chum salmon (headed for their spawning grounds at Henshaw and Gisasa rivers) likely migrated through the mainstem Yukon during early June's maximum temperatures and in the Koyukuk River during a period of extremely warm days with likely critically warm water temperatures. The very low escapement in the Gisasa River and Henshaw Creek may have been partially attributed to salmon dying en route to spawning grounds due to complications with heat stress. Despite these reports about summer chum salmon, there were very few reports of carcasses of other species seen dead. Post season, fishermen reported dozens of Chinook salmon had been found dead in pre-spawn condition in the lower river, at various locations near District 2, and above the confluence of the Tanana River.

8.2 Eagle Sonar

ADF&G and DFO collaborate to jointly assess the passage of Yukon River mainstem Chinook and chum salmon just downstream of the international border. Since 2006, Chinook and fall chum salmon passage has been estimated using split-beam and imaging sonar near the community of Eagle, Alaska at the Eagle sonar project (McDougall and Lozori 2018). Additionally, drift gillnets (5.25-, 6.5-, 7.5-, and 8.5-inch mesh), 25 fathoms in length, and approximately 4.3 fathoms in depth are fished daily to determine species composition, and collect ASL and genetic samples from Chinook and fall chum salmon passing the sonar site. Although there is some minor overlap, Chinook and fall chum salmon runs are largely discrete in time based on test fishery results, local knowledge of catches, and data collected in Canada.

Overall in 2019, there were no significant operational problems and both sonars performed well throughout the season. The 2019 Chinook salmon passage estimate at the project was 45,560 fish ± 451 (90% CI) for the dates July 1 through August 14 (Appendix B11). The fall chum salmon passage estimate was 101,678 fish ± 894 (90% CI) for the dates August 15 through October 6. Because of continued high passage at the termination of the project, the fall chum salmon estimate was subsequently adjusted to 113,256 fish (Appendix B16). This expansion was calculated using a second order polynomial calculated for each day through October 18.

8.3 Yukon, Canada

Yukon River (Mainstem) Adult Chinook Salmon Assessment

Big Salmon Sonar

An ARIS Explorer 1800 multi-beam sonar was used to enumerate the Chinook salmon escapement to the Big Salmon River in 2019. This was the fifteenth year of escapement monitoring at a site approximately 1.5 km upstream of the confluence of the Yukon River. Sonar operation began on July 14 and continued without interruption through August 21, producing a count of 3,865 fish. An expansion was used to interpolate the end of the run to August 23, using a polynomial equation based on daily counts of the previous 12 days. The expansion resulted in a total passage estimate of 3,874 Chinook salmon (Appendix B12). This is the eleventh highest escapement recorded and was below the ten-year average (2009–2018) estimate of 5,805 fish. The peak daily count of 230 fish occurred on August 5 and August 7, at which points 59% and 68% of the run passed the sonar site, respectively. Approximately 50% of the run had passed the sonar by August 4 (the average midpoint of the run from 2009–2018 is August 3[11]). The 2019 Big Salmon sonar project report will be publicly available through the YRP website [12] after submission to the Pacific Salmon Commission, R&E Fund Administrator.

Carcass samples were collected from August 22–25, over approximately 145 km of the Big Salmon River, yielding 105 Chinook salmon sampled for age, sex and length. Of this total, 67 fish (64%) were female and 38 fish (36%) were male. Mean lengths of mid eye to tail fork (METF) for female and male samples were 830 mm and 741 mm, respectively[13]. Of the 84 samples successfully aged, 1% (3% males, 0% females) were age-3, 31% (53% males and 17% females) were age-5, 67% (44% males and 81% females) were age-6, and 1% (2% females) were age-7.

Pelly River Sonar

On the Pelly River, an ARIS Explorer 1800 multi-beam (left bank), and an ARIS Explorer 1200 multi-beam (right bank) sonar systems were used to estimate the 2019 Chinook salmon passage. This was the fourth year of assessment undertaken by the Selkirk First Nation in collaboration with Environmental Dynamics Incorporated (EDI), at a site approximately 20 km upstream of the confluence of the Pelly and Yukon rivers. Sonar operation began on July 10 and concluded on August 26, counting 6,641 Chinook salmon. Preseason expansion to July 1 and postseason expansion to September 4 brought the total estimate to 6,927 fish (Appendix B12). The peak daily count of 402 fish on July 27 occurred when 43% of the run had passed. Approximately 50% of the run had passed by July 29. Project reports will be publicly available through the YRP website[14] after submission to the Pacific Salmon Commission, R&E Fund Administrator.

Whitehorse Rapids Fishway Chinook Salmon Enumeration

The Whitehorse Rapids Fishway is a fish ladder, owned and operated by Yukon Energy Corporation, that bypasses the Whitehorse dam. It has an observation window into a chamber with upstream and downstream gates. The viewing window allows visual enumeration of migrating adult Chinook salmon. In 2019, Fishway staff counted 282 adult Chinook salmon at the Whitehorse Rapids Fishway between July 30 and September 6 (Appendix B12). This escapement was well below the 2009–2018 average of 1,174 Chinook salmon, and the lowest count recorded since 1977. Of these salmon, 38 (13% of return) were of hatchery origin and 244 (87% of return) were considered to be wild origin. The hatchery component included 8 females and 30 males, comprising 22% female and 78% male fish. The wild component included 72 females and 172 males, comprising 30% female and 70% male fish. Female Chinook salmon made up 28% of the total return to the fishway.

The Whitehorse Rapids Fishway program is a joint initiative of the Yukon Fish and Game Association, Yukon Energy Corporation, with support from DFO. Students count all adult salmon migrating through the Fishway, record the sex and size category (small, medium, or large) of each salmon, identify hatchery-origin fish based on the absence of the adipose fin, and describe tags

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[11] Brian Mercer, Metla Environmental Inc., personal communication.

[12] https://www.yukonriverpanel.com/restoration-enhancement-fund/r-e-project-reports/

[13] Brian Mercer, Metla Environmental Inc., personal communication.

[14] https://www.yukonriverpanel.com/restoration-enhancement-fund/r-e-project-reports/

present on migrating salmon. Fishway staff also assist the Whitehorse Rapids Hatchery with broodstock collection at the Fishway.

Whitehorse Hatchery Operations

The Whitehorse Rapids Hatchery, owned and operated by Yukon Energy Corporation, has released Chinook salmon fry upstream of the dam since 1985. The current annual release target of 150,000 (2.0 gram) fry has been in place since 2002; releases since that time have ranged from 85,306 fry in 2008 to 176,648 fry in 2003. The recent 10-year average (2009–2018) is 139,950 fry clipped and released upstream of the dam.

In 2019, all Chinook salmon fry released from the Whitehorse Rapids Hatchery into the Yukon River were marked. Fish released to sites upstream of the dam were coded wire tagged and had their adipose fin removed (except for fish that were too small to tag which were therefore only adipose fin-clipped). The tagging procedure included the application of separate tag codes to distinguish groups released to 3 locations. This marking facilitates visual determination of the hatchery contribution to the return during observation of adult Chinook salmon migrating upstream through the viewing chamber at the Whitehorse Rapids Fishway; it also allows hatchery managers to identify origin of fish during broodstock collection. Fin clipping also enables researchers to distinguish hatchery fry from wild fry when investigating juvenile Chinook salmon habitat use. Marked fish are recovered in marine studies, in river stock assessment of juvenile and adult Yukon River Chinook salmon, and in harvests.

A total of 151,177 Chinook salmon fry[15] from the 2018 brood year were reared and marked (clipped and/or tagged) at the Whitehorse Rapids Hatchery and then released to 3 locations upstream of the Whitehorse Rapids hydroelectric dam between May 26 and June 12, 2019. Average weight of the tagged fry groups at the time of release was 2.63 grams and ranged from 2.62 grams (Michie Creek release group) to 2.90 grams (McClintock River release group).

Tag retention estimated 2–5 days after tagging, for the 2019 release (2018 brood year) was 98%. The total 2019 release above the dam included an estimated 147,030 adipose-clipped fish with coded wire tags and 4,147 fish that were clipped but not tagged, including the fish that were estimated to have lost their tags and 1,103 small (or unfit) fish.

Additionally, 2,682 fry from Whitehorse Rapids Hatchery, including fry from the classroom incubation program, were marked and released to Fox Creek, a tributary to Lake Laberge, on June 6, 2019.

Brood stock collection in 2019 began on August 14, after 25 Chinook salmon had migrated through the Whitehorse Rapids Fishway, and ended on August 28[16]. A total of 52 males, including 41 wild and 11 adipose-clipped (hatchery) Chinook salmon, were removed from the fishway for the brood stock program. Two Chinook salmon were released back to the fishway after milt collection. The hatchery removed 25.7% of the total 202 returning Chinook salmon males.

In total, 33 female Chinook salmon (41.25% of the total 80 female Chinook salmon return to the fishway), including 32 wild and 1 adipose-clipped (hatchery) salmon were removed for hatchery brood stock. Eggs were taken between August 24 and September 11, 2019 from 28 full (or nearly

[15] The fish released are referred to as fry; however, virtually all of them emigrate to the ocean shortly after release, and they may more accurately be referred to as pre-smolts.

[16] Lawrence Vano, Manager, Whitehorse Rapids Fish Hatchery, Feb 5, 2019, Whitehorse, personal communication.

full) ripe females, and 5 partially spent or poor condition females (including the sole hatchery female which died in holding prior to ripening). Fecundity estimates, excluding egg takes estimated to be partial, averaged approximately 5,000 eggs, and ranged from 3,054–7,611 eggs.

The total estimated egg take was 143,032 green eggs. Preliminary fertilization rate was estimated to be 90%. Removals including 330 egg samples to assess development, another 1,576 dead eggs prior to the eyed stage, and 7,486 at shocking (between October 13 and October 31) resulted in a green egg to eyed egg survival estimate of 93.4%. Thereafter 1,200 eggs were provided to the Stream to Sea classroom incubation program. After additional mortalities of 640 eyed eggs, 2,830 eggs and alevins during hatching, and 3,239 alevins after the hatching period, an estimated 125,731 Chinook salmon alevins were being held in incubators on January 31, 2020.

Porcupine River Investigations

Porcupine River Chinook Salmon Sonar

In 2019, the Vuntut Gwitchin First Nation Government and DFO collaborated to enumerate Chinook salmon on the Porcupine River near Old Crow using multi-beam ARIS Explorer 1200 (long range) sonars located on each bank. Both sonars alternated every 30 minutes between inshore ranges (1–20 m) and offshore ranges (20–40 m) 24 hours a day. Set gillnets were deployed throughout the run to assess species composition and collect ASL data from Chinook salmon. This was the sixth year of Chinook salmon sonar enumeration on the Porcupine River.

Chinook salmon sonar operations occurred from June 27 to August 17, producing a passage estimate of 4,740 Chinook salmon, including interpolated estimates for short periods of sonar downtime (Appendix B12). August 18 was selected as the crossover date to fall chum salmon, as it was the midpoint between the first chum salmon captures in the test fishery and the final Chinook salmon captures. Peak daily passage of 496 Chinook salmon occurred July 20, when 31% of the run had passed by the sonar site. Approximately 50% of the run had passed the sonars on July 25 (the average midpoint of the run from 2014–2018 is July 23). Most Chinook salmon enumerated (an estimated 76%) migrated along the right bank. The majority of Chinook salmon migrated within the first 10 m of the sonar transducer (59% of fish on right bank and 70% of fish on left bank). Passage rates were slightly higher during the first six hours of the day, with approximately one third of fish counted passing during this time.

The estimated passage of Chinook salmon was the second highest reported in six years of sonar operation and was above the average (2014–2018) estimate. Subtracting the local harvest estimate of 340 Chinook salmon results in an escapement estimate of 4,400 Chinook salmon to the Porcupine River (as harvest was not separated relative to sonar).

Porcupine River Chum Salmon Sonar

In 2019, the Vuntut Gwitchin First Nation Government and DFO collaborated to enumerate fall chum salmon on the Porcupine River near Old Crow using multi-beam ARIS sonars on each bank at the same location used for Chinook salmon enumeration. Drift and set gillnets were deployed throughout the run to assess species composition and collect ASL samples. This was the ninth year of Porcupine fall chum salmon sonar enumeration. Note that during the first two years of this project (2011 and 2012), the assessment did not cover the entire duration of the chum salmon run. Data from these years will be reviewed and adjusted before being presented in future versions of this report (Appendix B15).

The first chum salmon was caught in the drift gillnet test fishery on August 8, and a crossover date of August 18 was determined after the last Chinook salmon was captured on August 28. The final full day of operation for the right bank sonar was October 5, and the left bank was October 9. A linear relationship between bank passage during the 2019 season was used to estimate right bank passage for the dates October 6–9. A second order polynomial equation (Crane and Dunbar 2011) was applied from October 9 to expand the estimate through to a run end date of October 15, for a total season passage estimate of 27,447 fall chum salmon.

The run had three distinct peaks; September 13 (1,382 fish, 35% of the run passed), September 22 (988 fish, 65% of the run passed) and October 2, (757 fish, 86% of the run passed). Approximately 50% of the run had passed the weir by September 18; the average midpoint of the run (2013, 2015–2017) is September 15.

Most fall chum salmon enumerated (an estimated 91%) migrated along the left bank. As in previous years, the majority of fall chum salmon migrated within the first 10 m of the sonar transducer (69% on right bank and 84% on left bank). Passage rates were relatively consistent throughout the day with no discernable diurnal pattern.

The estimated passage of chum salmon was the fourth highest reported (2013, 2015–2017) and was below the average estimate. Subtracting the local harvest estimate of 1,000 fall chum salmon results in an escapement estimate of 26,447 fall chum salmon to the Porcupine River (as harvest was not separated relative to sonar).

Fishing Branch River Chum Salmon Weir

Fall chum salmon returns to the Fishing Branch River have been assessed annually since 1971. A weir has been used in most years, aerial surveys were used in some years, and in 2013–2014 estimates were based on proportion of radio tag recoveries combined with the sonar-based passage estimate on the Porcupine River mainstem (Appendix B15). Spawning escapement estimates for the Fishing Branch River have ranged from 5,100 to 353,300 fall chum salmon in 2000 and 1975, respectively (Appendix B15). In 2019, Fishing Branch River enumeration of fall chum salmon was conducted using a combination of weir and sonar, and the trial of a video counter. An ARIS 1800 (short range) sonar was installed immediately upstream of the weir site to observe fish passage through a constrained weir opening (trap box). Weir installation began September 1 and was completed September 6, with sonar enumeration beginning September 3, and operating until weir disassembly began October 27. Weir visual counts, sonar counts, and video counts were all used for cross verification.

No preseason expansion was applied. A postseason expansion estimate of 64 fish between weir removal and October 31 was also added to reflect the later run timing. The total weir-sonar passage estimate of 18,171 fall chum salmon (Appendix B15) is below the Fishing Branch River interim escapement goal range of 22,000–49,000 fish. This escapement is the sixth lowest count in the past 10 years of weir operation and ranked 27 out of 36 years of weir operation.

The run had two distinct peaks, with the initial peak daily count of 1,136 fish occurring on September 22 (54% of the run had passed), and a second peak of 707 fish occurring on October 3 (84% of run had passed). A third, weak peak was also observed October 11 (311 fish, 88% of run passed). Approximately 50% of the run had passed the weir by September 21; the average midpoint of the run from the past 10 years of weir operation (2007–2012 and 2015–2018) of observations is September 24.

Age, sex, and length (ASL) data were collected from 604 chum salmon between September 10 and October 26. Of the 585 samples which were successfully aged, 2.7% (1% males and 4% females) were age-3, 88.6% (86% males and 91% females) were age-4, 8.5% (13% males and 5% females) were age-5, and 0.2% (0% males and 0.3% females) were age-6 (Appendix A10). The mean METF length was 584 mm for sampled fall chum salmon (573 mm for females and 596 mm for males). Although sex composition was not available from the sonar data, the overall sex ratio of sampled fish was 55% female (unweighted by passage).

Aerial Surveys

An aerial survey of the Kluane River was conducted on October 21, 2019. Prior to the 2017 survey, the Kluane River has not been surveyed since 2006. The survey area involves many discrete spawning areas (sloughs and side channels) and ranges from low to high densities of fish. The Kluane River index count for 2019 was 928. Observer efficiency was moderate due to weather and variable water clarity. Historical data are presented in Appendix B15.

Genetic Stock Identification and Stock Composition of Canadian Yukon River Chinook and Fall Chum Salmon

Genetic samples of Chinook and fall chum salmon were collected from the drift gillnet test fishing program at the Eagle sonar project in 2018 and 2019. However, analysis of the samples has not been completed prior to the publication of this report, hence 2018 and 2019 regional stock contribution estimates are not available.

Environmental Conditions Report

This annual summary of environmental conditions intends to describe conditions influencing fish habitat in the Canadian sub-basin of the Yukon River, the area upstream of the Alaska/Yukon border that includes the Yukon River and the Porcupine River. The sub-basin encompasses a large expanse of salmon habitat including over 100 documented spawning streams and many more rearing streams. In lieu of annual surveys throughout these widespread spawning and rearing habitats, this brief summary serves to record significant environmental conditions that may influence Yukon River Chinook salmon spawning and rearing habitat.

Due to the spatial scale, specific salmon habitat information is not collected extensively from year to year; therefore, the following information is provided as a high-level synopsis of what was experienced in the Canadian sub-basin for a given year. Various weather records and stream discharge data from other agencies are applied as a means to 1) determine if environmental conditions are within normal ranges on record, 2) identify unusual trends and/or events, and 3) consider implications for salmon. Conditions reported are informed through observations based on relevant activities, projects, or studies carried out by the public, fishers, consultants, and DFO. Through scientific evidence, local knowledge, experience, and professional judgment, this information is applied to fish habitat to determine general conditions experienced for the year.

November 2018 to April 2019

The 2018–2019 winter involved a range of conditions throughout the territory. Monthly mean air temperatures were above average throughout the Porcupine and Canadian Yukon River sub-basin through this period, except during February when mean temperatures were below average in areas other than the Porcupine watershed. Precipitation in the Porcupine watershed ranged from wetter than normal early in this period to somewhat drier than normal at the end of the period. The mainstem Canadian Yukon River sub-basin was generally drier than normal through the period, with the exception of the southwest Yukon (White River watershed), which was wetter than average in February. Mean March air temperatures in the Canadian Yukon River sub-basin over this time were well above average, ranging from 2.7°C above normal in Teslin, 6.3°C above normal in Mayo, 5°C above normal in Faro, to 10°C above normal in Old Crow[17]. Overall winter precipitation was below normal throughout the winter for most of the territory, with the exception of high snowfall events in Southwest Yukon (White River watershed) in February. April snowpack values were slightly above normal in the Porcupine watershed, and well below normal elsewhere in the Canadian Yukon River sub-basin. April and May snowpack conditions were near to or less than 50% of average in areas around Mayo, Faro, Carmacks, Whitehorse and Teslin[18]. Spring streamflows rose to somewhat above average until April in response to warm spring conditions, and then dropped to below normal at the end of the period, except in the Porcupine River where water levels remained above normal through the spring[19]. Streamflow during the November to April period usually represents base flow/groundwater contributions, although warm periods, such as above average temperatures this spring, caused additional snowmelt contributions. These conditions represent the incubation and alevin development periods for Chinook and chum salmon.

May 2019 to July 2019

Air temperatures were above average during this period throughout the both the Porcupine and mainstem Yukon River sub-basins in Canada, exceeding normal mean temperatures in May by 4.3°C in Old Crow, 2.6°C in Teslin, 2.8°C in Dawson, 2.4°C in Beaver Creek and 3.3°C in Whitehorse[2]. Precipitation during this time period was above normal in southwest Yukon and near normal elsewhere. River levels during this period were near average in the Porcupine drainage, and below average elsewhere in the Canadian portion of the drainage, and many watersheds were at or near time series minimums. Water temperatures monitored in all tributaries during most of this period were well above recent averages. Very low water levels combined with above average air temperatures resulted in some extreme water temperatures: temperatures peaked at Stewart Crossing (Stewart River) and at Pelly Crossing (Pelly River) at 20°C on July 23, exceeding the recent averages for that date by over 4°C at both sites[20].

Conditions in this period align with age-1+ Chinook salmon outmigration, and age-0+ emergence and movement downstream, followed by age-0+ juvenile upstream migration into non-natal tributaries. Adult Chinook salmon upstream migration also occurs in this time period, with adult Chinook salmon entering the Yukon River in late May/early June and reaching the mainstem Canadian border at the beginning of July. Chinook salmon spawning activity peaks in July in the Klondike River and starts in July in many Canadian Yukon River tributaries. Water temperatures above 18°C pose a risk to migrating and spawning Chinook salmon.

August 2019 to October 2019

Temperatures dropped to below normal in early August throughout the Canadian portion of the drainage, and then rose to above average for the remainder of the period. Precipitation was below monthly normals throughout this period in central Yukon (Mayo and Faro) and was below normal

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[17] Station Results – 1981–2010 Climate Normals and Averages, https://climate.weather.gc.ca/climate_normals/station_select_1981_2010_e.html and Historical Data, https://climate.weather.gc.ca/historical_data/search_historic_data_e.html

[18] Yukon Snow Survey Bulletin and Water Supply Forecast, April 1, 2019, May 1, 2019 www.env.gov.yk.ca/snowbulletin

[19] Real-Time Hydrometric Data https://wateroffice.ec.gc.ca/search/real_time_e.html

[20] Al von Finster, Biologist, AvF R&D, Nov 18, 2019, Whitehorse, personal communication.

for the period in the Klondike River basin. Precipitation for the period was near normal in southern and eastern Yukon[21]. Water levels remained well below average in the Pelly and Stewart River through this period. Water temperatures dropped to below recent averages in response to the colder air temperatures in August, and then rose to near average after August.

Summary

Migration, spawning, and rearing conditions in the Canadian sub-basin of the Yukon River were varied throughout the drainage in 2018–2019. Moderate winter conditions were likely favorable for incubation of the 2018 brood year eggs. Warm temperatures throughout the summer may also have provided good growing conditions for the rearing juvenile salmon, although low water levels may have reduced the available rearing habitat in some rivers. Summer warm temperatures and low water levels likely had a negative impact on migrating adult Chinook salmon and the beginning of the fall chum salmon migration in the Canadian portion of the Yukon River. Warm water temperatures during spawning at some locations, particularly in the Stewart River watershed, may also have negatively impacted salmon spawning success and egg viability. Low water levels likely also restricted spawning areas and increased adult salmon vulnerability to predation at some spawning locations. The drop in water temperatures brought by cooler August weather likely resulted in good conditions for spawning and egg incubation for salmon that spawned after the first week of August. With increased climate variability, increased habitat monitoring and assessment in the Yukon River Canadian Sub-basin is encouraged to inform management, research, restoration strategies, and habitat considerations for Yukon River Pacific salmon populations.

9.0 MARINE FISHERIES INFORMATION

Yukon River salmon migrate into the Bering Sea during the spring and summer after spending 0, 1, or 2 winters rearing in fresh water. Information about stock of origin from tagging, scale patterns, parasites, and genetic analysis indicate that Yukon River salmon are present throughout the Bering Sea, in regions of the North Pacific Ocean, south of the Aleutian Chain, and the Gulf of Alaska during their ocean migration (Healey 1991; Salo 1991). Yukon River salmon have the potential to be captured by fisheries that harvest mixed stocks of salmon, other species of fish (bycatch), and by illegal fishing activities throughout their oceanic distribution. Coded-wire tag recoveries in these fisheries and in research surveys provide a key descriptor of the oceanic distribution of Yukon River Chinook salmon. However, genetic stock identification has become the primary tool for identifying Yukon River Chinook salmon in marine habitats (Larson et al. 2013; Guthrie et al. 2016). The U.S. groundfish trawl fisheries in the Gulf of Alaska (GOA) and Bering Sea-Aleutian Islands (BSAI) management areas are managed to limit the incidental harvest (bycatch) of salmon.

Appendix C was prepared by NOAA in coordination with ADF&G at the request of the YRP. It provides background information on BSAI fisheries, bycatch regulations, and information to understand bycatch impacts on Canadian-origin salmon. Recent year and historical bycatch information is provided and will be updated annually as new information is available.

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[21] Environment Canada Forecast Verification https://weather.gc.ca/saisons/ver_e.html

10.0 RUN OUTLOOKS 2020

10.1 Yukon River Chinook Salmon

Over the years, the JTC has used a range of methods to produce an annual preseason outlook of Canadian-origin Chinook salmon run abundance. Run outlooks are used by fishery managers and stakeholders as a tool for guiding the development of preseason harvest strategies. In general, the Canadian-origin Chinook salmon outlook provided by the JTC has been similar to the observed run size estimated postseason (Figure 19).

Canadian-origin Brood Table

The brood table for Canadian-origin Yukon River Chinook salmon (Appendix A3) is the basis of the current spawner-recruitment model (Figure 20) which is used to forecast returns in future years. Age-specific returns have been estimated from harvest and escapement data by age class in the return years. Because assessment methods have changed over time, the brood table is constructed from a variety of data sources. For the years 1982–2001, initial estimates were derived from the DFO Chinook salmon mark–recapture program, but information from several sources, reviewed in 2008, indicated that these data were probably biased low. Subsequently, the 1982–2001 Canadian spawning escapement estimates were reconstructed using a linear regression of the estimated total spawning escapements for 2002–2007 against a 3-area aerial survey index of combined counts from Big Salmon, Little Salmon, and Nisutlin rivers. Spawning escapement estimates for years 2002–2004 were based on radiotelemetry studies. Since 2005, spawning escapement estimates have been estimated by subtracting both Canadian and U.S. harvests that occurred upriver from the sonar project site from the passage estimates at Eagle sonar.

In 2018, ADF&G published standardized age and sex estimates of Chinook salmon sampled at the U.S. Canada border, which accounted for the different selectivity of fish wheels compared to the gillnet test fishery operated at Eagle sonar since 2005 (Hamazaki 2018). A length-selectivity method was used to standardize the historical age-sex dataset collected from fishwheels (1982–2004) with the age-sex dataset collected from the gillnet test fish data (2005–2019). At the March 2019 JTC meeting in Fairbanks, the JTC chose to adopt the standardized 1982–2006 age data as recommended by Hamazaki 2018. In addition, the JTC agreed to use the standardized age estimates to update the Canadian-origin Chinook salmon brood table prior to producing the 2020 outlook. The JTC chose not to adopt the standardized sex dataset presented by Hamazaki 2018 because the age-specific estimates of sex composition were not needed for conventional forecasting analyses conducted by the JTC and because the estimates of age-4 female proportion appeared biased high when compared to confirmed sex samples collected from throughout the Yukon River drainage (Appendix D).

Canadian-origin Yukon River Chinook Salmon

The 2019 preseason forecast for Canadian-origin Chinook salmon is based on an average of two forecast ranges devised using two independent methods. The first method was based on an average of the spawner-recruitment and sibling models, after correcting for historical model performance. The second method was based on juvenile abundance estimates from Northern Bering Sea trawl surveys.

Spawner-recruit and Sibling Model Average

Spawner-recruitment and sibling models predict the 2020 run size of Canadian-origin Chinook salmon will be approximately 92,800 and 102,500 fish, respectively (Table 13). The average of those two models indicates a return of about 98,000 Chinook salmon. However, these models do not account for uncertainty associated with lower productivity and periods of poor model performance. Over the last 10 years, observed run sizes were approximately 29% lower than preseason outlooks developed with the spawner-recruitment model, 30% lower than preseason outlooks developed with the sibling model, and 31% lower than preseason outlooks developed by averaging the two models.

The 2020 uncorrected spawner-recruit and sibling average forecast of 98,000 Canadian-origin Chinook salmon was adjusted to account for poor model performance observed from 2007–2013 and improved model performance observed from 2014–2018. An annual correction factor was calculated for each year since 2007 as the ratio of observed to predicted run size. The 2007–2013 average correction was 0.60. The 2014–2019 average correction was 0.80. The forecast range was developed by multiplying the uncorrected forecast of 98,000 by 0.60 and 0.80 respectively. This forecast method has been used by the JTC since 2016. The corrected average of the spawner-recruit and sibling model produced a 2020 run forecast range of 58,000–78,000 Canadian-origin Chinook salmon.

Juvenile-based Forecast

Fisheries and oceanographic research surveys in the northern Bering Sea shelf were initiated in 2002 as part of the Bering-Aleutian Salmon International Survey (BASIS; NPAFC 2001). The BASIS project was developed by member nations of the North Pacific Anadromous Fish Commission (NPAFC; United States, Russia, Japan, Canada, and Korea) to improve our understanding of marine ecology of salmon in the Bering Sea. These surveys use pelagic rope trawls to sample fish at or near the surface. The surveys are designed to support broad-scale marine ecosystem research. Although the investigators, vessels, funding support, and research objectives of these trawl surveys have varied with time, attempts have been made to sample a core station grid to improve the consistency of data collected during these research surveys. Stations are typically sampled during September along a systematic latitude and longitude grid with stations separated by approximately 30 nautical miles.

Pelagic trawl surveys in the northern Bering Sea capture Yukon River salmon stocks during their first summer at sea (juvenile life-history stage). Canadian-origin juvenile Chinook salmon are the primary stock group encountered during the northern Bering Sea trawl surveys (Murphy et al. 2009). Since 2003, juvenile Chinook salmon catch from the trawl surveys, coupled with genetic MSA, has been used to provide stock-specific juvenile abundance estimates (Figure 21; Murphy et al. 2017). Juvenile Chinook salmon experience relatively stable marine survival following their first summer in the northern Bering Sea, suggesting that cohort strength is determined prior to the pelagic trawl surveys. As a result of this stable marine survival, the relationship between juvenile Chinook salmon abundance in the northern Bering Sea correlates to adult returns to the Yukon River (Figure 22). This relationship is pivotal to the juvenile-based forecast model used to predict adult returns up to 3 years in advance.

Juvenile abundance-based forecasts of Canadian-origin Chinook salmon have been provided to the JTC and Yukon River Panel since 2013 (Table 13). Since 2014, the juvenile-based forecast has been used as auxiliary information about future year run sizes. Beginning in 2018, the JTC decided to explicitly incorporate the juvenile-based forecast as part of the formal outlook. In 2017, the genetic baseline used to estimate juvenile abundance of Canadian-origin Chinook salmon was updated and additional improvements were made to the methods used to forecast adult returns to the Yukon River (Howard et.al. 2019). The 2019 and 2020 juvenile forecasts were calculated using the new methodology. Earlier forecasts from 2013–2018 will remain unchanged in this report as they reflect the information available at that time.

Juvenile Chinook salmon in the Bering Sea in 2016 and 2017 will be the primary contributors to the 2020 adult run (returning as age-6 and age-5, respectively). While the 2016 juvenile abundance was above average, the 2017 juvenile abundance was below average and marked the beginning of a downward trend in juvenile abundance in the northern Bering Sea (Figure 21). Juvenile abundance models indicate that the run size of Canadian-origin Chinook salmon in 2020 should be between 59,000–102,000 fish. Early indications suggest that Canadian-origin adult returns to Yukon River will decrease in 2021 and 2022 (Figure 23).

2020 Canadian-origin Chinook Salmon Forecast

The final forecast for 2020 Canadian-origin Chinook salmon run was developed by averaging the forecast ranges based on the adjusted spawner-recruit/sibling method and the juvenile-based method. The lower end of the final forecast range was the average of the lower ends of the two independent forecast methods; similarly, the upper end of the final forecast range was the average of the upper ends of the two methods. A simple model average was chosen to give equal weight to both methods. The 2020 forecast range is for a run size of 59,000–90,000 Canadian-origin Chinook salmon. The 2020 outlook suggests a run size of similar or slightly smaller than the run size observed in 2019 (Table 13), similar to the 2010–2019 average of 70,000 Chinook salmon (Appendix B18), but below the 1982–1997 average of 153,000 Chinook salmon.

The Chinook salmon runs on the Yukon River are typically dominated by age-5 and age-6 fish. The brood years producing these age classes in 2020 are 2014 (age-6) and 2015 (age-5). The Canadian-origin Yukon River Chinook salmon spawning escapement in 2014 of 63,331 fish was above the 1982–2012 average escapement of 47,000 fish and the 2015 escapement of 82,674 fish was the largest ever observed (Appendix A3; Figure 9). The age-4 (7,085) and age-5 (35,572) estimated returns in 2019 were slightly above the long-term average (1982–2018) of 5,753 and 32,402 fish, respectively (Appendix A3). The large spawning escapements in 2014 and 2015 and the above average returns of age-4 and age-5 in 2019 suggests an above average age-5 and age-6 return in 2020.

10.2 Yukon River Summer Chum Salmon

The strength of the summer chum salmon run in 2020 will be dependent on production from the 2016 (age-4 fish) and 2015 (age-5 fish) escapements, because these age classes generally dominate the run. The drainagewide spawning escapement in 2015 and 2016 was approximately 1.6 million and 1.9 million summer chum salmon, respectively. The escapement goal on the Anvik River (350,000–700,000 fish) was achieved in 2015 but not 2016, and the escapement goal on the East Fork Andreafsky River (>40,000 fish) was met in 2015 and 2016. It is expected that the 2020 run will be similar or slightly smaller than the 2019 run of approximately 1.8 million fish.

The 2020 run is anticipated to provide for escapements, a normal subsistence harvest, and a surplus for commercial harvest. Summer chum salmon runs have provided for a harvestable surplus in each of the last 16 years (2004–2019). If inseason indicators of run strength suggest sufficient abundance exists to allow for a commercial fishery, the commercially harvestable surplus in Alaska could range from 700,000–1,200,000 summer chum salmon. Similar to the last 5 years, commercial harvests of summer chum salmon in 2020 are expected to be affected by measures taken to protect Chinook salmon from incidental harvest in chum salmon-directed fisheries.

10.3 YUKON RIVER FALL CHUM SALMON

Drainagewide Fall Chum Salmon

Preseason outlooks are determined using estimates of escapement and resulting production. Yukon River drainagewide estimated escapement of fall chum salmon for the period 1974 through 2013 have ranged from approximately 224,000 (2000) to 2,200,000 (1975) fish, based on Bayesian analysis of escapement assessments to approximate overall abundance (Fleischman and Borba 2009). Escapements between 1974 and 2013 resulted in subsequent returns that ranged in size from approximately 318,000 (1996 production) to 2,900,000 (2001 production) fish. Corresponding return per spawner rates ranged from 0.3–9.0, averaging 1.8 for all years combined (1974–2013; Appendix A8).

A considerable amount of uncertainty has been associated with these run forecasts, particularly in the last two decades, because of unexpected run failures (1998–2002) followed by strong runs from 2003 through 2008. Weakness in these salmon runs prior to 2003 was generally attributed to reduced productivity in the marine environment and not to low levels of parental escapement. Similarly, improvements in productivity (2007–2010, 2012–2014) have been attributed to the marine environment.

Beginning in 1999, Yukon River fall chum salmon preseason outlooks have been presented as a range, in order to better represent uncertainty in the expected run size. In all years, the expected run size (point estimate) was forecast using estimates of brood year escapement, estimates of returns per spawner (production), and maturity schedules developed for even and odd years based on historical averages. In 1998, the forecast method overestimated run size due to an unexpected poor return. To account for this, the point estimate was used as the upper bound of the forecast range in subsequent years (1999–2005). The lower end of the forecast range was generated by adjusting the point estimate based on the average forecast performance (i.e., ratio of observed to predicted). Forecast performance from 1998–2003 were used to inform the 1999–2004 outlooks. As run sizes increased over the early to mid-2000s, the forecast performance improved, and in 2005 the lower bound of the forecast range was based on the 2001–2004 average forecast performance. Beginning in 2006, adjustments to the point estimate were no longer applied. Instead, the outlook range was based on a statistical confidence interval around the point estimate. Since 2006, the annual forecasts have been informed by different odd- and even-year maturity schedules based on the historical averages available at the time and assumptions of stock productivity. For example, in 2006 and 2007 average age composition from years 1974–1983 were used to represent high productivity years, whereas in 2008–2012 data from 1984–2012 was used to represent low productivity years. Since 2013, the average odd- and even-year maturity schedules have been calculated from the complete historical dataset.

The 2020 Yukon River fall chum salmon forecast was based on similar methods used since 2006. The majority of fall chum salmon return at age-4 and age-5, and a smaller proportion return as age-3 and age-6 (Appendix A8). As such, the 2020 run will be composed of brood years 2014–2017 (Table 14). Estimates of returns per spawner (R/S) were used to estimate production for 2014 and 2015, and a Ricker spawner-recruit model was used to predict returns from 2016 and 2017.

The average even and odd year maturity schedule was calculated from the complete historical dataset since 1974. That maturity schedule was applied to the estimated production (i.e., returns) for each contributing brood year and summed to estimate the total number of fall chum salmon that were expected to return in 2020. The result was an outlook point estimate of 936,000 fall chum salmon returning in 2020. The outlook range was based on the 80% confidence bounds for the point estimate. Confidence bounds were calculated using deviation of point estimates and observed returns from 1987 through 2019. Therefore, the 2020 forecasted run size is expressed as a range from 827,000–1,045,000 fall chum salmon (Table 14). This forecasted drainagewide fall chum salmon run size is below average (1998–2019; Table 15).

The dominant parent year escapements contributing to this outlook are 2015 and 2016. The escapement in 2015 was within the drainagewide escapement goal range of 300,000–600,000 fall chum salmon while escapement in 2015 exceeded the upper end of the goal range. The major contributor to the 2020 fall chum salmon run is anticipated to be age-4 fish returning from the 2016 parent year (Table 14).

For fall chum salmon, the sibling relationship is best between the age-5 and age-6 component ($R^2 = 0.55$). Typically, the sibling relationship between the age-3 and age-4 fish ($R^2 = 0.39$) is better than the age-4 and age-5 fish ($R^2 = 0.26$). Brood year returns of age-3 fish range from zero to 198,000 chum salmon. Returns of age-4 fish from even-numbered brood years during the time period 1974–2013 averaged 493,000 fall chum salmon with a range from a low of 175,000 for brood year 1996 to a high of 1,167,000 for brood year 2012. Returns of age-5 fish from the same time period for odd-numbered brood years averaged 275,000 fall chum salmon with a range from a low of 67,000 fish for brood year 1975 to a high of 715,000 fish for brood year 2001. Considering the sibling relationship described, the contribution of age-5 fish should be below the odd-numbered year average while the age-4 component should be above the even-numbered year average.

The forecast models rarely predict extreme changes in production. The fluctuations observed in fall chum salmon run sizes (postseason run size estimates) in comparison with the expected run sizes (preseason outlooks) are reflected in the outlook performance; i.e., proportions of the expected run size, observed for the 1998–2019 period (Table 15).

During the 2020 fall fishing season, estimated strength of the projected run of fall chum salmon will be adjusted using the relationship to summer chum salmon run abundance and assessed based on various inseason monitoring project data. With a forecasted run size range of 827,000–1,045,000 fall chum salmon (midpoint 936,000 fish; Table 14), it is anticipated that escapement goals will be met while supporting normal subsistence fishing activities. The forecast suggests a commercial surplus between 277,000 and 495,000 fall chum salmon may be available. However, commercially harvestable surpluses will be determined inseason and applied to the guidelines outlined in the management plan with further considerations of fishing effort and buying capacity. The first inseason projection will refine the forecast based on the relationship between the summer and fall chum salmon runs at the beginning of the fall season.

Canadian-origin Upper Yukon River Fall Chum Salmon

To develop an outlook for the 2020 Canadian-origin Yukon River fall chum salmon, the drainagewide outlook range of 827,000–1,045,000 fall chum salmon was multiplied by 25% (the estimated contribution of mainstem Yukon River Canadian-origin fall chum salmon), producing an outlook range of 207,000–261,000 fish with a midpoint of 234,000 fish (rounded to the nearest

1,000; Table 16). Recent genetic stock identification analyses have indicated that the assumption of 25% is reasonable.

Canadian-origin Porcupine River Fall Chum Salmon

In the Canadian section of the Porcupine River, a majority of the production of fall chum salmon originates from the Fishing Branch River, though it varies between years. Canadian-origin Porcupine River stocks have been estimated to comprise approximately 5% of the drainagewide run. Fishing Branch River fall chum salmon are estimated to comprise up to 80% of the Canadian-origin Porcupine River stocks, and approximately 4% of the drainagewide run, though estimates have ranged from 1.3%–7%. Applying the 4% average estimate to the drainagewide outlook range of 827,000–1,045,000 fish yields a Fishing Branch River outlook of 33,000–42,000 fish, with a midpoint of 37,000 fish (rounded to the nearest 1,000 fish; Table 17). This outlook is considered uncertain due to the high variation in contributions of Fishing Branch River fall chum salmon to drainagewide stocks.

Though the models used to develop forecasts have varied from year-to-year, the postseason run size estimates of Fishing Branch River fall chum salmon have been consistently below preseason outlooks since 1998, except for 2003–2005, 2016, and 2017.

10.4 Yukon River Coho Salmon

Although there is little comprehensive escapement information for Yukon River drainagewide coho salmon, it is known that coho salmon primarily return as age-2.1 fish (4-year-old, age in European notation) and overlap in run timing with fall chum salmon. The major contributor to the 2020 coho salmon run will be age-4 fish returning from the 2016 parent year. Based on the run reconstruction index (1995–2019, excluding 1996 and 2009), the 2016 escapement was estimated to be 186,000 coho salmon, which was above the median (165,000). In 2016, a relatively large amount of coho salmon was harvested incidentally in the directed fall chum salmon commercial fisheries (exploitation estimate at 53%). Subsistence harvest in 2016 was well below the 2011–2015 average of 17,000 coho salmon. The recent 5 years of returns (2014–2018) have been high abundance years which may indicate good productivity which typically cycles for several years in succession. However, the run size observed in 2019 was much lower, possibly indicating the end of the high cycle.

Escapements are primarily monitored in the Tanana River drainage. The Delta Clearwater River (DCR) is a major producer of coho salmon in the upper Tanana River drainage and has comparative escapement monitoring data since 1972 (Appendix B17). The DCR parent year escapement of 6,767 fish in 2016 was slightly above the lower end of the SEG range of 5,200–17,000 coho salmon. Six other locations in the Tanana River drainage were surveyed for coho salmon specifically; half were above average when compared to the 2014–2018 average escapements. Very informal coho salmon outlooks are made preseason based on average survival of the primary parent year escapement estimate, which in 2020 would indicate that the return would be near average.

11.0 STATUS OF ESCAPEMENT GOALS

11.1 Spawning Escapement Target Options In 2020

Canadian-origin mainstem Yukon River Chinook and fall chum salmon are managed under the umbrella of the *Yukon River Salmon Agreement* (YRSA). The Yukon River Panel meets annually and recommends escapement goals to the Canadian and U.S. management agencies.

Canadian-origin Mainstem Yukon River Chinook Salmon

In 2010, the Yukon River Panel adopted an IMEG range of 42,500–55,000 Chinook salmon. In the absence of a biological escapement goal, i.e., a goal based on a production or population model, the IMEG has been retained each year since then. The JTC is currently undertaking a comprehensive multi-year review of the current IMEG and anticipates presenting the YRP with recommendations during the Spring 2022 YRP meeting. In the interim, the JTC recommends that the current IMEG of 42,500–55,000 be used for the 2020 and 2021 seasons.

Canadian-origin Mainstem Yukon River Fall Chum Salmon

In 2010, the Yukon River Panel adopted an IMEG range of 70,000–104,000 Canadian-origin mainstem Yukon River fall chum salmon. This range was developed as 0.8–1.2 times the estimated spawners at maximum sustained yield (86,600 fish), which was derived prior to the returns from the exceptional 2005 spawning escapement of over 437,000 fall chum salmon. Run size at the border has been assessed through the joint U.S./Canada sonar program near Eagle since 2006. The YRP extended this IMEG for the two-year period of 2018 and 2019. The JTC recommendation is to extend this goal for a three-year period, 2020–2022.

Fishing Branch River Fall Chum Salmon

An IMEG range of 22,000–49,000 fall chum salmon for the Fishing Branch River has been extended for three-year periods since 2008 (Appendix B15). The most recent three-year period ended in 2019. The JTC recommendation is to extend this goal for another three-year period, 2020–2022.

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TABLES AND FIGURES

Table 1.–Yukon Area regulatory subsistence salmon fishing schedule.

Border passage	Regulatory subsistence fishing periods	Pilot Station sonar
Coastal District	7 days per week	M/T/W/TH/F/SA/SU - 24 hours/day
District 1	Two 36-hour periods per week	Mon 8 pm to Wed 8 am / Thu 8 pm to Sat 8 am
District 2	Two 36-hour periods per week	Wed 8 pm to Fri 8 am / Sun 8 pm to Tue 8 am
District 3	Two 36-hour periods per week	Wed 8 pm to Fri 8 am / Sun 8 pm to Tue 8 am
District 4	Two 48-hour periods per week	Sun 6 pm to Tue 6 pm / Wed 6 pm to Fri 6 pm
Koyukuk and Innoko Rivers	7 days per week	M/T/W/TH/F/SA/SU - 24 hours/day
Subdistricts 5-A, -B, -C	Two 48-hour periods per week	Tue 6 pm to Thu 6 pm / Fri 6 pm to Sun 6 pm
Subdistrict 5-D	7 days per week	M/T/W/TH/F/SA/SU - 24 hours/day
Subdistrict 6	Two 42-hour periods per week	Mon 6 pm to Wed Noon / Fri 6 pm to Sun Noon
Old Minto Area	5 days per week	Friday 6 pm to Wednesday 6 pm

Note: In the Upper Yukon, fishing times are longer by regulation to help account for longer travel times and lower numbers of fish available as fish leave the mainstem Yukon River to spawn in U.S. tributaries. This schedule was altered during the 2019 season based on Chinook salmon run strength.

Table 2.–Yukon River drainage fall chum salmon management plan overview.

Run size estimate [b] (point estimate)	Recommended management action [a] Fall chum salmon directed fisheries				Targeted drainagewide escapement
	Commercial	Personal use	Sport	Subsistence	
300,000 or Less	Closure	Closure	Closure	Closure [c]	300,000
300,001 to 550,000	Closure	Closure [c]	Closure [c]	Possible restrictions [c, d]	to
Greater than 550,001	Open [e]	Open	Open	No restrictions	600,000

[a] Considerations for the Canadian mainstem interim management escapement goal may require more restrictive management actions.

[b] Alaska Department of Fish and Game will use the best available data, including preseason projections, mainstem river sonar passage estimates, test fisheries indices, subsistence and commercial fishing reports, and passage estimates from escapement monitoring projects.

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

[d] Subsistence fishing will be managed to achieve a minimum drainagewide escapement goal of 300,000 fall chum salmon.

[e] Drainagewide commercial fisheries may be open and the harvestable surplus above 550,000 fall chum salmon will be distributed by district or subdistrict (in proportion to the guidelines harvest levels established in 5 AAC 05.365 and 5 AAC 05.367).

Table 3.–Inseason fishery management decision matrix for Yukon River mainstem Chinook salmon in Canada, 2019.

Canadian allowable harvest zones [a]	Spawning escapement [b] *(based on inseason run size projections)*	Fishery			
		First Nation	Public angling	Commercial	Domestic
0	<42,500	**Closed** Removal of allocation for conservation purposes.	**Closed** No retention permitted. Additional closures possible.	**Closed**	**Closed**
0 to ~ 10,000	42,500 to 55,000 *Management Target: 48,750* [c]	**Varies** **42,500 to 48,750** Harvest of less than 10% of historical catch. **48,750 to 55,000** Harvest of between 10% and 90% of historical catch and varies with abundance	**Closed** No retention permitted	**Closed**	**Closed**
>10,000	>55,000 2019 Canadian Management Target [e]	**Open** Unrestricted	**Potentially open** [d] No retention permitted	**Potentially open** [d] Allocation varies with run size	**Potentially open** [d] Allocation varies with run size

[a] Determination of the Allowable Harvest Zone is based on International Yukon River Salmon Agreement Canadian Allowable Harvest Allocation.

[b] Spawning escapement does not include (i.e. is in addition to) the Canadian Allowable Harvest Allocation.

[c] The International Management Target of 48,750 is the number of adult Chinook salmon passed to spawning grounds (the midpoint of the Yukon River Panel’s Interim Management Escapement Goal of 42,500 to 55,000.

[d] Allocation to Canadian public angling, domestic, and commercial fisheries is subject to run abundance and is only considered if: there is a full allocation available to the First Nation fishery; the upper end of the spawning escapement goal is projected to be achieved; appropriate fishery management controls are available / in-place to facilitate an orderly administration of fisheries; and, there is a high degree of confidence that fishery harvest can be managed within allocation potentially available.

[e] The 2019 Canadian Management (spawning escapement) Target of 55,000, in addition to a Canadian Allowable Harvest Allocation of over 10,000 fish, serves as the fishery management threshold to inform potential public angling, domestic and commercial fishery harvest opportunities.

Table 4.–Inseason fishery management decision matrix for mainstem Yukon River fall chum salmon in Canada, 2019.

International border passage *(based on Eagle Sonar estimate)*	Fishery			
	First Nation	Recreation	Commercial	Domestic
< 40,000 (Red Zone)	**Closed** Removal of allocation for conservation purposes	**Closed** No retention permitted	**Closed**	**Closed**
40,000 to 73,000 (Yellow Zone)	**Varies** [a] Catch target to vary with abundance within zone	**Closed** No retention permitted	**Closed**	**Closed**
> 73,000 (Green Zone)	**Open** Unrestricted	**Open** [a] Retention permitted. No catch anticipated	**Open** [a] Allocation varies with run size	**Open** [a] Allocation varies with run size

[a] Allocations (harvest opportunities) are subject to run abundance and international harvest sharing provisions (*Yukon River Salmon Agreement*).

Table 5.–Cumulative fish passage estimates by species with 90% confidence intervals (CI), at the Pilot Station sonar in 2019.

Species	Total passage	90% CI	
		Lower	Upper
Large Chinook [a]	172,242	153,278	191,206
Small Chinook [b]	47,382	39,657	55,107
All Chinook	219,624	199,147	240,101
Summer chum	1,402,925	1,317,023	1,488,827
Fall chum	842,041	804,890	879,192
Coho	86,401	76,871	95,931
Pink	42,353	33,460	51,246
Cisco	270,434	233,838	307,030
Humpback whitefish *C. pidschian*	196,905	166,449	227,361
Broad whitefish *C. nasus*	25,694	20,438	30,950
Sheefish *Stenodus leucicthys*	22,673	16,725	28,621
Other [c]	52,870	47,211	58,529
Total [d]	3,161,920		

[a] Large Chinook salmon >655 mm.

[b] Small Chinook salmon ≤655 mm.

[c] Includes sockeye salmon, cisco *Coregonus*, whitefish *Coregonus* or *Prosopium*, sheefish, burbot *Lota lota*, long nose sucker *Catastomus catostomus*, Dolly Varden *Salvelinus malma*, and northern pike *Esox lucius*.

[d] All Chinook subtotal not included in total passage sum.

Table 6.–Yukon River Chinook salmon age and female percentage estimated from samples collected at the Pilot Station and Eagle sonar projects, 2019.

Age/sex	Chinook salmon age or sex composition (percentage of test fishery samples)			
	Pilot Station sonar		Eagle sonar	
	Historical average (2009–2018)	2019	Historical average (2009–2018)	2019
Age-4	11.5	11.6	6.9	8.5
Age-5	49.3	47.8	40.6	48.4
Age-6	36.8	38.7	49.4	41.9
Female	40.5	50.4	43.3	47.8

Note: Sampling at the Pilot Station sonar uses a range of 6 mesh sizes (2.75–8.5 inch) whereas sampling at Eagle sonar uses a range of 4 mesh sizes (5.25–8.5 inch). This difference in mesh sizes can possibly affect the difference in observed age classes. In addition, sex is determined only through visual inspection of external body characteristics at both projects. Sexual dimorphism is more pronounced by the time fish reach Eagle making sex identification more accurate at that site. These factors need to be considered when comparing between projects.

Table 7.–Summary of 2019 Chinook salmon escapement estimates in Alaska tributaries compared to existing escapement goals.

Location	Assessment method	Escapement goal (type)	2019 Escapement
E. Fork Andreafsky	Weir	2,100–4,900 (SEG)	5,111
W. Fork Andreafsky	Aerial survey	640–1,600 (SEG)	904
Anvik (drainagewide)	Aerial survey	1,100–1,700 (SEG)	1,432
Nulato (forks combined)	Aerial survey	940–1,900 (SEG)	1,141
Gisasa	Weir	none	1,328
Henshaw	Weir	none	438
Chena	Tower/Sonar	2,800–5,700 (BEG)	2,018 [a]
Salcha	Tower/Sonar	3,300–6,500 (BEG)	4,678 [a]

Note: Biological escapement goal (BEG) and sustainable escapement goal (SEG).

[a] Visual and sonar counts were combined for missed days to derive a preliminary estimate.

Table 8.–Summary of 2019 summer chum salmon escapement estimates in Alaska compared to existing escapement goals.

Location	Assessment method	Escapement goal (type)	2019 Summer chum salmon escapement
Drainagewide	Sonar	500,000-1,200,000 (BEG)	1,477,154 [a]
E. Fork Andreafsky	Weir	>40,000 (SEG)	49,881
Anvik	Sonar	350,000–700,000 (BEG)	249,014
Gisasa	Weir	none	19,099
Henshaw	Weir	none	34,342
Chena	Tower/sonar	none	2,704 [b]
Salcha	Tower/sonar	none	2,117 [b]

Note: Biological escapement goal (BEG) and sustainable escapement goal (SEG).

[a] Drainagewide escapement based on the Pilot Station sonar and Andreafsky weir minus harvest estimates above the sonar site.

[b] Visual and sonar counts were combined for missed days to derive a preliminary estimate. Estimates are considered incomplete due to late run timing.

Table 9.–Summary of 2019 fall chum salmon escapement estimates compared to existing escapement goals in Alaska.

Location	Assessment method	Escapement goal (type)	2019 Fall chum salmon escapement [a]
Drainagewide	Bayesian	300,000–600,000 (SEG)	528,000
Chandalar River [b]	Sonar	85,000–234,000 (SEG)	116,000
Delta River	Ground surveys	7,000–20,000 (SEG)	52,000

Note: Sustainable escapement goal (SEG).

[a] Numbers are rounded.

[b] The Chandalar River and North Fork collectively were renamed the Teedriinjik River and the Middle Fork was renamed Ch'idriinjik in September of 2015.

Table 10.–Summary of 2019 preliminary fall chum salmon spawning escapements in Canada in comparison with existing international interim management escapement goals (IMEG).

Location	Assessment method	Escapement goal (type)	2019 Fall chum salmon escapement
Fishing Branch River	Weir/sonar count	22,000–49,000 (IMEG)	18,171
Yukon River Mainstem	Sonar and harvest	70,000–104,000 (IMEG)	99,738
Porcupine River (Canadian portion)	Sonar and harvest	none	26,447

Table 11.–Pilot Station sonar Chinook salmon passage and Canadian-origin proportion by strata, 2005–2019.

Year	Strata	Dates	Pilot Station passage	Proportion of run	Canadian proportion [a]	Estimated number of Canadian fish
2005	Stratum 1	06/04–06/17	91,136	0.35	0.60	54,335
	Stratum 2	06/18–07/03	119,627	0.46	0.45	53,533
	Stratum 3	07/04–08/20	48,451	0.19	0.29	14,002
	Total		259,214	1.00	0.47	121,871
2006	Stratum 1	06/07–06/24	63,374	0.28	0.44	28,106
	Stratum 2	06/25–07/26	165,389	0.72	0.39	64,312
	Total		228,763	1.00	0.40	92,417
2007	Stratum 1	06/06–06/19	50,083	0.29	0.53	26,629
	Stratum 2	06/20–06/30	62,907	0.37	0.37	23,502
	Stratum 3	07/01–08/16	57,256	0.34	0.21	11,772
	Total		170,246	1.00	0.37	61,903
2008	Stratum 1	06/07–06/23	41,294	0.24	0.47	19,532
	Stratum 2	06/24–06/29	42,554	0.24	0.33	13,958
	Stratum 3	06/30–08/02	90,559	0.52	0.31	27,711
	Total		174,407	1.00	0.35	61,201
2009	Stratum 1	06/09–06/16	7,000	0.04	0.68	4,750
	Stratum 2	06/17–06/22	27,229	0.15	0.53	14,347
	Stratum 3	06/23–06/29	83,866	0.47	0.41	34,509
	Stratum 4	06/30–07/19	59,701	0.34	0.17	10,265
	Total		177,796	1.00	0.36	63,871
2010	Stratum 1	06/12–06/21	28,885	0.21	0.49	14,110
	Stratum 2	06/22–06/27	45,306	0.33	0.50	22,860
	Stratum 3	06/28–09/05	63,708	0.46	0.28	17,891
	Total		137,899	1.00	0.40	54,861
2011	Stratum 1	06/01–06/18	31,273	0.21	0.58	18,148
	Stratum 2	06/19–06/27	67,686	0.45	0.36	24,611
	Stratum 3	06/28–08/07	49,838	0.33	0.16	8,034
	Total		148,797	1.00	0.34	50,792
2012	Stratum 1	06/10–06/24	31,998	0.25	0.45	14,463
	Stratum 2	06/25–07/02	63,648	0.50	0.47	30,042
	Stratum 3	07/03–07/30	31,909	0.25	0.34	10,753
	Total		127,555	1.00	0.43	55,258
2013	Stratum 1	06/14–06/27	78,133	0.57	0.72	56,568
	Stratum 2	06/28–08/02	58,672	0.43	0.26	15,137
	Total		136,805	1.00	0.52	71,706
2014	Stratum 1	06/01–06/14	45,236	0.28	0.49	22,347
	Stratum 2	06/15–06/24	82,146	0.50	0.42	34,255
	Stratum 3	06/25–08/04	36,513	0.22	0.18	6,718
	Total		163,895	1.00	0.39	63,320
2015	Stratum 1	05/30–06/17	30,600	0.21	0.50	15,178
	Stratum 2	06/18–06/26	51,172	0.35	0.37	18,780
	Stratum 3	06/27–08/17	65,087	0.44	0.33	21,218
	Total		146,859	1.00	0.38	55,176

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Table 11.–Page 2 of 2.

Year	Strata	Dates	Pilot Station passage	Proportion of run	Canadian proportion [a]	Estimated number of Canadian fish
2016	Stratum 1	05/30–06/14	37,511	0.21	0.52	19,136
	Stratum 2	06/15–06/25	86,622	0.49	0.34	29,114
	Stratum 3	06/26–08/24	52,765	0.30	0.54	28,282
	Total		176,898	1.00	0.43	76,532
2017	Stratum 1	05/31–06/13	30,088	0.11	0.43	12,857
	Stratum 2	06/14–06/20	79,913	0.30	0.49	38,929
	Stratum 3	06/21–06/25	69,392	0.26	0.43	30,121
	Stratum 4	06/26–08/11	83,621	0.32	0.41	34,008
	Total		263,014	1.00	0.44	115,915
2018	Stratum 1	06/02–06/13	16,275	0.10	0.53	8,621
	Stratum 2	06/14–06/24	56,344	0.35	0.47	26,357
	Stratum 3	06/25–07/03	57,070	0.35	0.41	23,227
	Stratum 4	07/04–08/05	32,209	0.20	0.29	9,402
	Total		161,831	1.00	0.42	67,609
2019	Stratum 1	06/02–06/23	82,035	0.37	0.56	45,637
	Stratum 2	06/24–06/30	73,551	0.33	0.42	30,563
	Stratum 3	07/01–08/24	64,038	0.29	0.36	22,910
	Total		219,624	1.00	0.45	99,110
Average 2005–2018	Stratum 1		41,635	0.24	0.53	22,484
	Stratum 2		72,087	0.40	0.41	29,267
	Stratum 3		58,868	0.34	0.32	19,520
	Total		176,713	1.00	0.41	72,317
Minimum-18				0.04	0.16	
Maximum-18				0.72	0.72	

Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Total Canadian proportion is weighted with "Proportion of run".

Table 12.–Microsatellite baseline is comprised of 37 stocks used to estimate stock composition from chum salmon sampled in the test drift gillnet program at the Pilot Station sonar in 2019.

Stock aggregate name	Populations in baseline
Lower	Andreafsky, Anvik, California, Chulinak, Clear, Dakli, Kaltag, Nulato, Gisasa, Melozitna, Rodo, Tolstoi
Upper Koyukuk+Main	Henshaw, Jim, Middle Fork Koyukuk, South Fork Koyukuk (early and late run), Tozitna
Tanana Summer	Chena, Salcha
Tanana Fall	Bluff Cabin, Delta, Nenana, Kantishna, Tanana Mainstem, Toklat
Border U.S.	Big Salt, Black, Chandalar, Sheenjek
Porcupine	Fishing Branch
Mainstem	Big Creek, Minto, Pelly, Tatchun
White	Donjek, Kluane
Teslin	Teslin
Aggregate name	**Aggregate within aggregate**
Summer	Lower, Middle
Middle	Upper Koyukuk+Main, Tanana Summer
Fall	Tanana Fall, Border U.S., Border Canada, Upper Canada
Fall U.S.	Tanana Fall, Border U.S.
U.S.	Lower, Middle, Tanana Fall, Border U.S.
Border Canada	Porcupine, Mainstem
Upper Canada	White, Teslin
Canada	Border Canada, Upper Canada

Table 13.–Preseason Canadian-origin Yukon River Chinook salmon outlooks for 2013–2020 and the observed run sizes for 2013–2019.

	Expected run size (preseason)									Postseason estimate
				Adjusted outlook range [a]		Juvenile-based model range		Average of adjusted outlook and juvenile-based model ranges [b]		
Year	Spawner-recruit	Sibling	Model average	Low end	High end	Low end	High end	Low end	High end	Estimated run size [c]
2013	109,984	79,160	95,000	**49,000**	**72,000**	43,000	61,000			37,000
2014	100,159	53,287	77,000	**32,000**	**61,000**	45,000	65,000			65,000
2015	96,083	103,701	100,000	**59,000**	**70,000**	55,000	79,000			87,000
2016	96,983	108,003	102,000	**65,000**[d]	**88,000**[d]	61,000	88,000			83,000
2017	93,724	135,105	114,000	**73,000**[d]	**97,000**[d]	93,000	134,000			93,000
2018	89,356	120,834	105,000	63,000[d]	88,000[d]	78,000	117,000	**71,000**	**103,000**	76,000
2019	91,947	108,365	100,000	60,000[d]	82,000[d]	77,000	115,000	**69,000**	**99,000**	73,000
2020	92,812	102,505	98,000	58,000[d]	78,000[d]	59,000	102,000	**59,000**	**90,000**	

Note: Bold numbers represent the outlook range used in each year.

[a] From 2013–2015, the Spawner-recruitment model and Sibling model based outlooks have been adjusted by applying average (2007–2015) model performance (percent difference from expected) to the projection and rounding to the nearest 1,000 to create an “adjusted outlook range”.

[b] Average of the lower ends of the adjusted outlook and the juvenile ranges determines lower end. Average of the upper ends of the adjusted outlook and the juvenile ranges determines upper end.

[c] Estimated run size is the border passage estimate plus the U.S. and Canada harvest of Canadian-origin Chinook salmon. U.S. harvest estimates are determined using Canadian stock genetic proportion estimates applied to U.S. harvest.

[d] Starting in 2016, the adjusted outlook uses the average of the 2 model forecasts and applies a correction factor (2007–2013 average performance) for the lower end and the correction factor seen in 2014 through current year for the upper end.

Table 14.–Forecasted 2020 total run size of fall chum salmon based on parent year escapement for each brood year and predicted return per spawner (R/S) rates, Yukon River, 2014–2017.

Brood year	Escapement	Estimated production (R/S)	Estimated production	Age	Contribution based on age	Current return
2014	741,300	1.29	956,277	6	1.2%	11,066
2015	541,000	1.71	925,110	5	24.1%	225,433
2016	832,200	1.22	1,017,359	4	72.0%	673,576
2017	1,706,000	0.51	877,482	3	2.8%	25,960
Total expected run (unadjusted)						936,035
Total 2020 run size expressed as a range based on the forecasted vs. observed returns from 1987 to 2019 (80% CI):						827,000 to 1,045,000

Table 15.–Preseason Yukon River drainagewide fall chum salmon outlooks 1998–2020 and estimated run sizes for 1998–2019.

Year	Expected run size (preseason)	Estimated run size (postseason) [a]	Performance of preseason outlook (preseason/postseason)
1998	880,000	352,000	0.40
1999	1,197,000	419,300	0.35
2000	1,137,000	252,900	0.22
2001	962,000	374,400	0.39
2002	646,000	427,700	0.66
2003	647,000	791,900	1.22
2004	672,000	652,900	0.97
2005	776,000	2,181,000	2.81
2006	1,211,000	1,212,000	1.00
2007	1,106,000	1,160,000	1.05
2008	1,057,000	856,900	0.81
2009	791,000	598,200	0.76
2010	690,000	587,000	0.85
2011	740,000	1,238,000	1.67
2012	1,114,000	1,086,000	0.97
2013	1,029,000	1,212,000	1.18
2014	932,000	954,600	1.02
2015	1,060,000	823,500	0.78
2016	666,000	1,389,000	2.09
2017	1,560,000	2,288,000	1.47
2018	1,700,000	1,113,000	0.65
2019	1,045,000	800,799	0.77
2020	936,000		

Note: The expected run sizes are point estimates (rounded). Ranges were used since 1999 but until 2006 were not always distributed around the point estimate. Starting in 2006, expected run sizes are the midpoint of the outlook range.

[a] Postseason estimates are updated annually based on the Bayesian space-state modeling of the drainagewide escapement estimates and may include refined harvest estimates.

Table 16.–Preseason Canadian-origin mainstem Yukon River fall chum salmon outlooks for 1998–2020 and observed run sizes for 1998–2019.

Year	Expected run size (preseason)	Estimated run size (postseason)	Performance of preseason outlook (preseason/postseason)
1998	198,000	70,000	2.83
1999	336,000	116,000	2.90
2000	334,000	66,000	5.06
2001	245,000	49,000	5.00
2002	144,000	113,000	1.27
2003	145,000	182,000	0.80
2004	147,000	193,000	0.76
2005	126,000	558,000	0.23
2006	126,000	330,000	0.38
2007	147,000	347,000	0.42
2008	229,000	269,000	0.85
2009	195,000	128,000	1.52
2010	172,000	143,000	1.20
2011	184,000	326,000	0.56
2012	273,000	238,000	1.15
2013	257,000	303,000	0.85
2014	230,000	223,000	1.03
2015	265,000	205,000	1.29
2016	166,000	298,000	0.56
2017	388,000	563,000	0.69
2018	425,000	279,000	1.52
2019	262,000	178,000	1.47
2020	234,000		

Note: The 2009 through 2020 preseason expected run sizes are the midpoint of the outlook range. Estimated run sizes are calculated by adding estimated U.S. harvest of Canadian-origin fall chum salmon to the mainstem Yukon River sonar passage estimate. In recent years, the proportion of Canadian mainstem fall chum salmon in the total U.S. harvest is assumed to be equal to the proportion of Canadian-origin fall chum salmon in the drainagewide escapement (i.e. 25%).

Table 17.–Preseason Fishing Branch River fall chum salmon outlooks for 1998–2020 and observed run sizes for 1998–2019.

Year	Expected run size (preseason)	Estimated run size (postseason) [a]	Performance of preseason outlook (preseason/postseason)
1998	112,000	25,000	4.48
1999	124,000	24,000	5.17
2000	150,000	13,000	11.54
2001	101,000	33,000	3.06
2002	41,000	19,000	2.16
2003	29,000	46,000	0.63
2004	22,000	32,000	0.69
2005	48,000	186,000	0.26
2006	54,000	48,000	1.13
2007	80,000	50,000	1.60
2008	78,000	30,000	2.60
2009	49,000	40,000	1.23
2010	43,000	20,000	2.15
2011	37,000	28,000	1.32
2012	55,000	50,000	1.10
2013	52,000	39,000 (52,000) [b]	–
2014	46,000	13,000 (24,000) [b]	–
2015	17,000	13,000	1.31
2016	27,000	54,000	0.50
2017	62,000	73,000	0.85
2018	68,000	29,000	2.34
2019	42,000	29,000	1.45
2020	37,000		

Note: Run sizes are rounded to nearest 1,000. The 2009 through 2019 preseason forecasted run sizes are the midpoint of an outlook range. The Fishing Branch River weir monitors the dominant spawning stock within the Porcupine River drainage.

[a] The total run size is estimated by adding the estimated Canadian (Porcupine) harvest and U.S. harvest of Fishing Branch River fall chum salmon to the Fishing Branch River weir escapement estimate, unless otherwise noted. In recent years, the proportion of Fishing Branch River fall chum salmon in the total U.S. harvest is assumed to be equal to the proportion of Fishing Branch River fall chum salmon in the drainagewide escapement (i.e. 4%). Beginning in 2016, it is also assumed that Fishing Branch River fall chum salmon comprise 80% of Canadian chum salmon harvest in the Porcupine River. Previously 100% of Canadian fall chum salmon harvest in the Porcupine River was included in the Fishing Branch River estimated run size.

[b] Run size was based on Old Crow sonar counts and proportion of tag recoveries. Numbers in parentheses are the corresponding Canadian-origin Porcupine River sonar-based estimates. Outlook performances are not included due to uncertainty in the assessment methods compared with previous years.

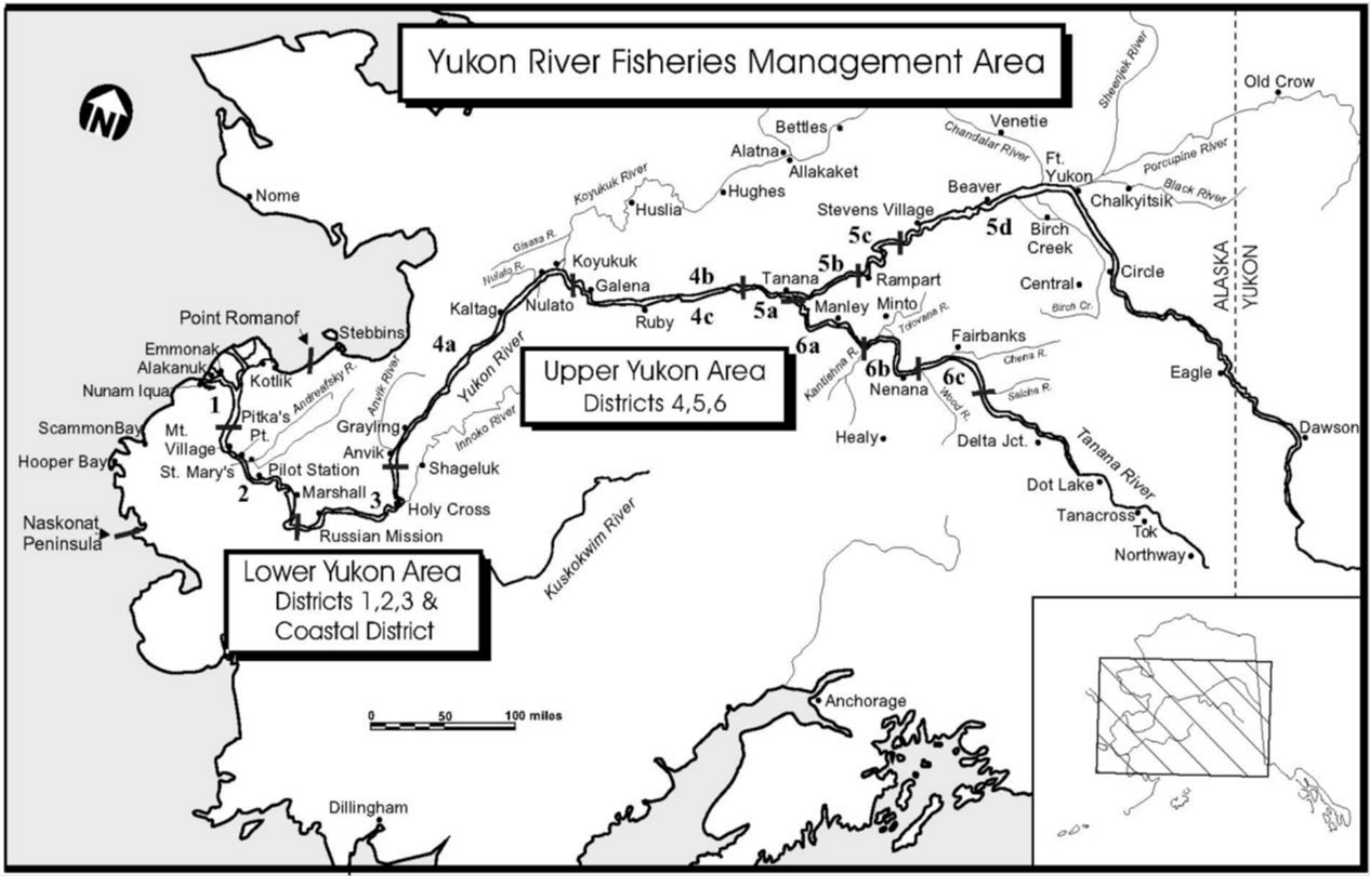

Figure 1.–Map of the Alaska (U.S.) portion of the Yukon River drainage showing communities and fishing districts.

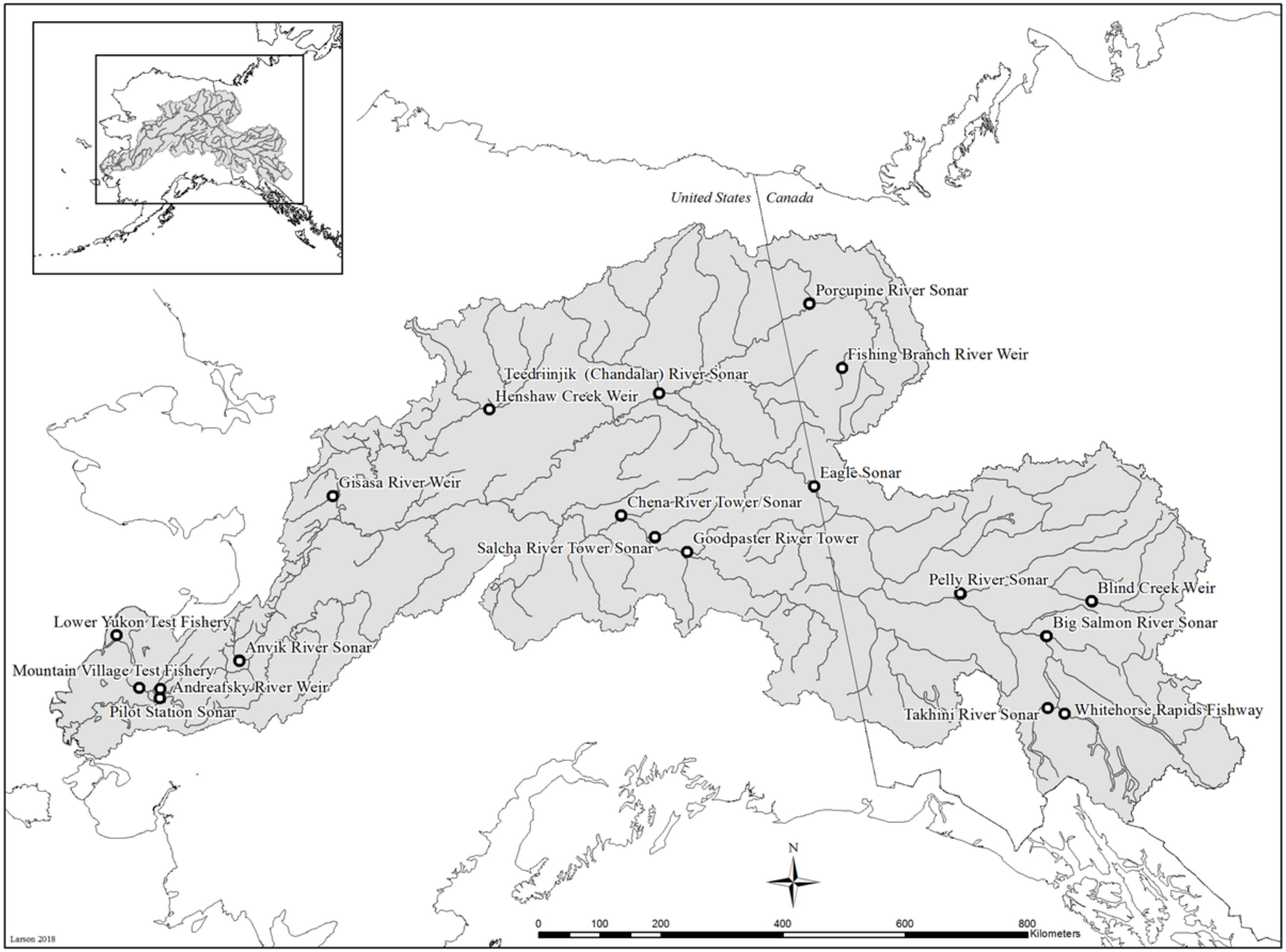

Figure 2.–Primary assessment projects operated in the U.S. and Canada used to assess Chinook and fall chum salmon run strength or escapement.

Note: Some projects may or may not have operated this season.

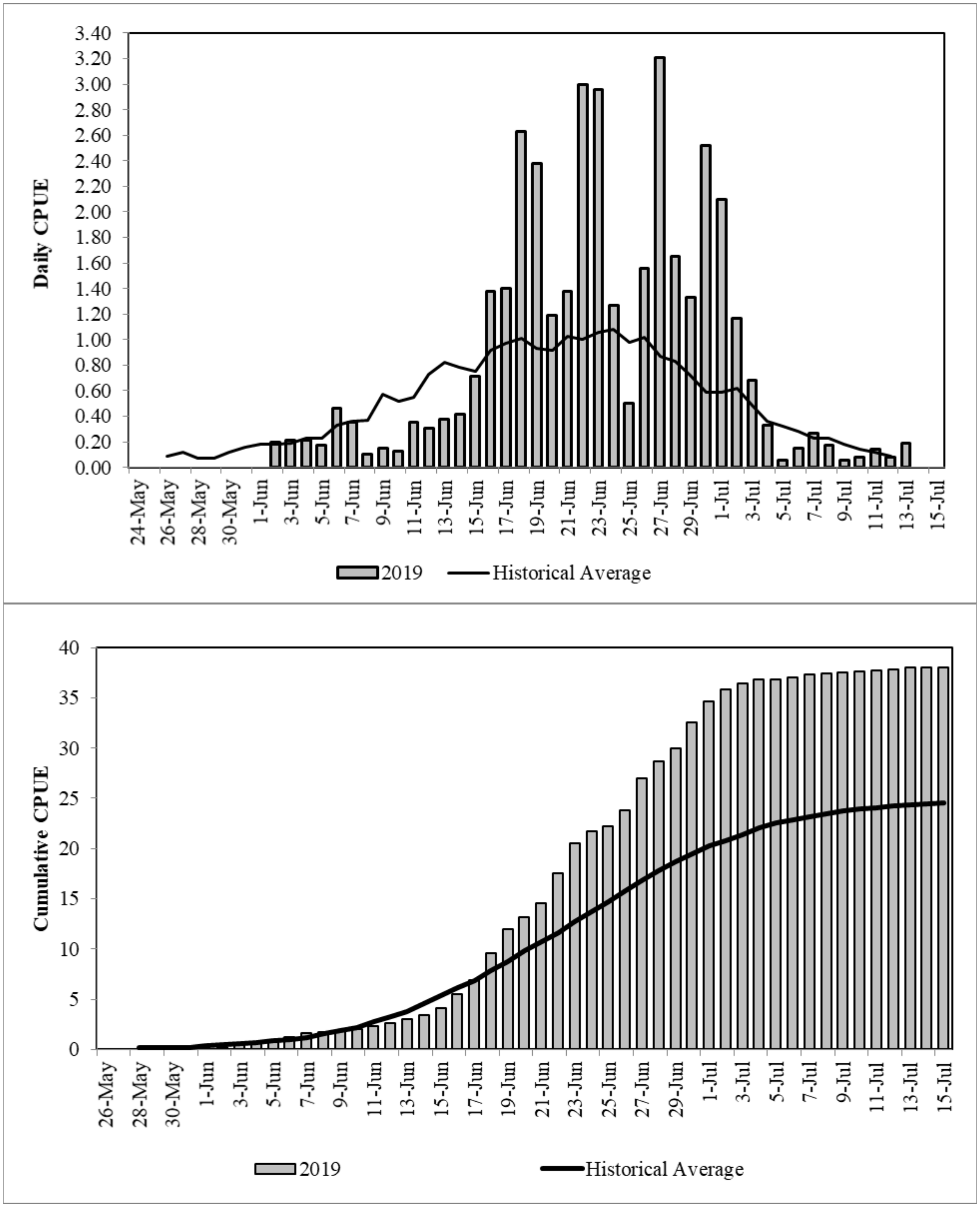

Figure 3.–Daily (top) and cumulative (bottom) catch per unit effort (CPUE) for Chinook salmon in 8.5-inch Lower Yukon set gillnet test fishery in 2018, compared to historic average CPUEs.

Note: Historical average includes 1989–2018, excluding 2001, 2009 and 2012–2013.

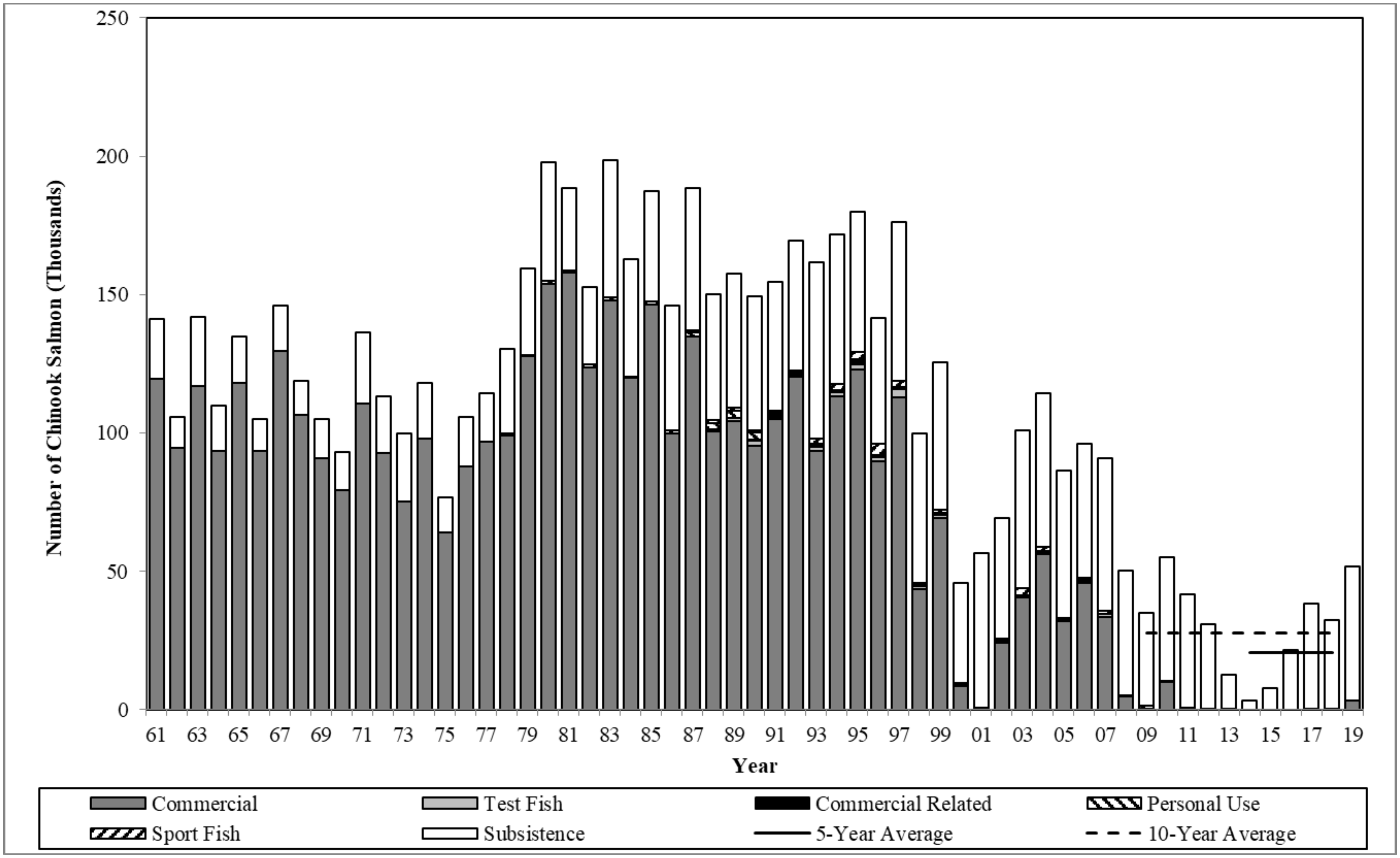

Figure 4.–U.S. (Alaska) harvest of Chinook salmon, Yukon River, 1961-2019.

Note: The 2016–2019 harvest estimates are preliminary. Commercial harvests through 2007 were Chinook salmon-directed commercial fishing. Commercial harvests 2008 to present include Chinook salmon incidentally harvested and sold from the chum salmon fisheries. 'Commercial related' refers to the estimated harvest of female Chinook salmon to produce roe sold between 1990 and 2002.

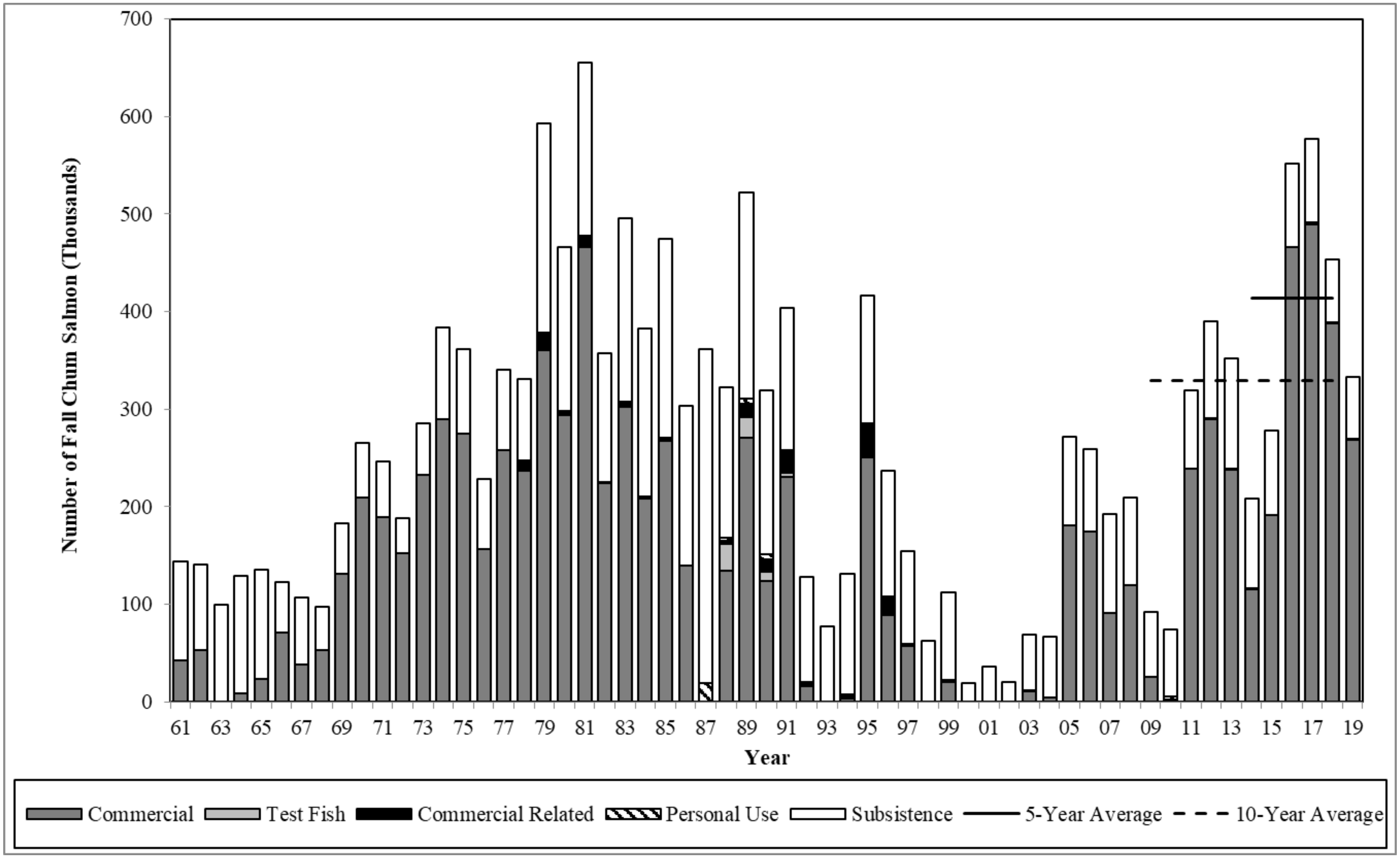

Figure 5.–U.S. (Alaska) harvest of fall chum salmon, Yukon River, 1961–2019.

Note: Subsistence harvest estimates of fall chum salmon are minimal prior to 1979 because of timing of harvest surveys. The commercial fishery was closed in 1963, 1987, 1993, 1998, and 2000–2002. 'Commercial related' refers to the estimated harvest of female salmon to produce roe sold. The 2016–2019 harvest estimates are preliminary.

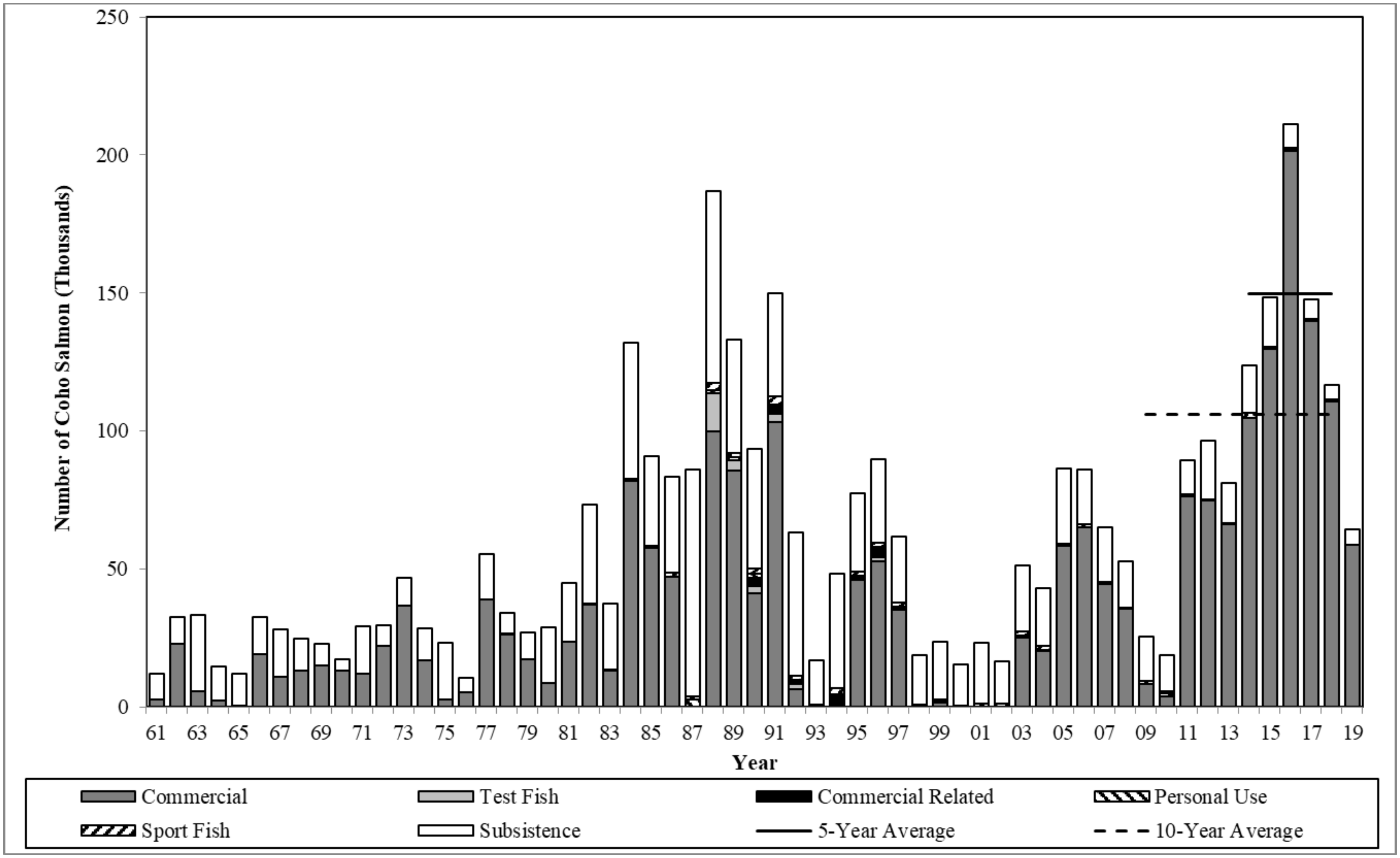

Figure 6.–U.S. (Alaska) harvest of coho salmon, Yukon River, 1961–2019.

Note: Subsistence harvest estimates of coho salmon are minimal prior to 1979 because of timing of harvest surveys. The commercial fishery was closed 1987, 1993, 1998 and 2000–2002. 'Commercial related' refers to the estimated harvest of female salmon to produce roe sold. The 2016–2019 harvest estimates are preliminary.

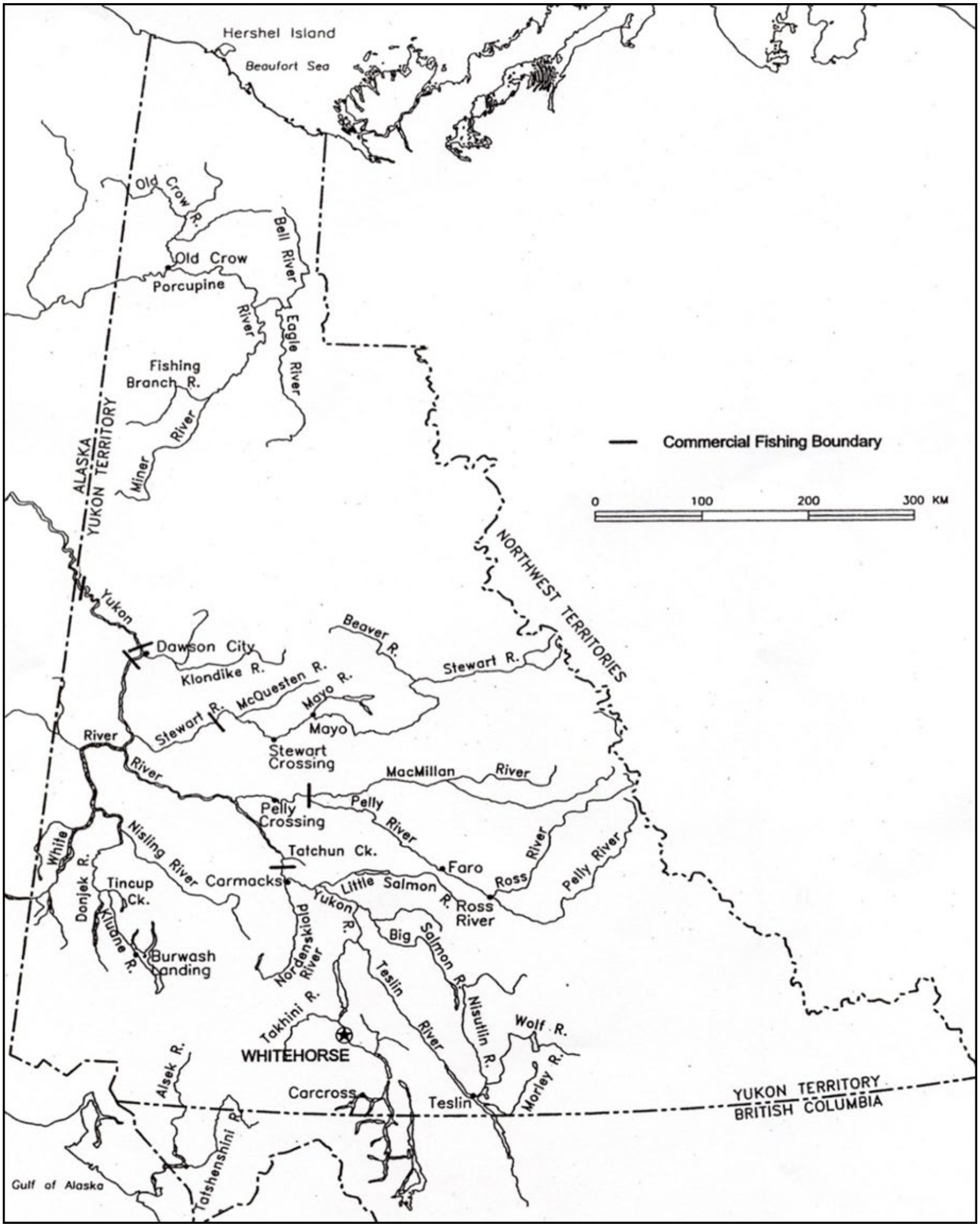

Figure 7.–Commercial fishing boundaries, tributaries, and major towns within the Yukon Territory, Canada.

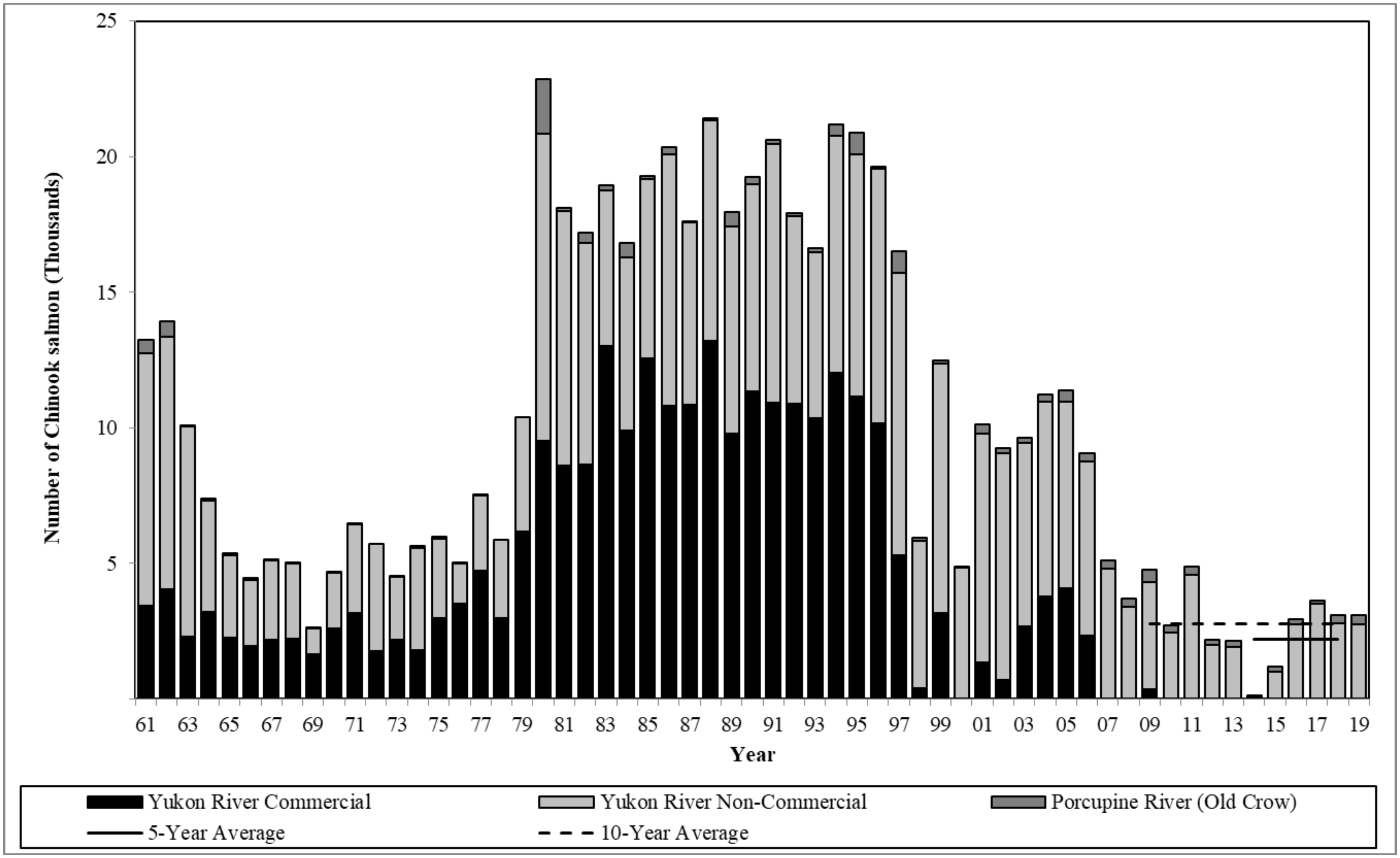

Figure 8.–Canadian harvest of Chinook salmon, Yukon River, 1961–2019.

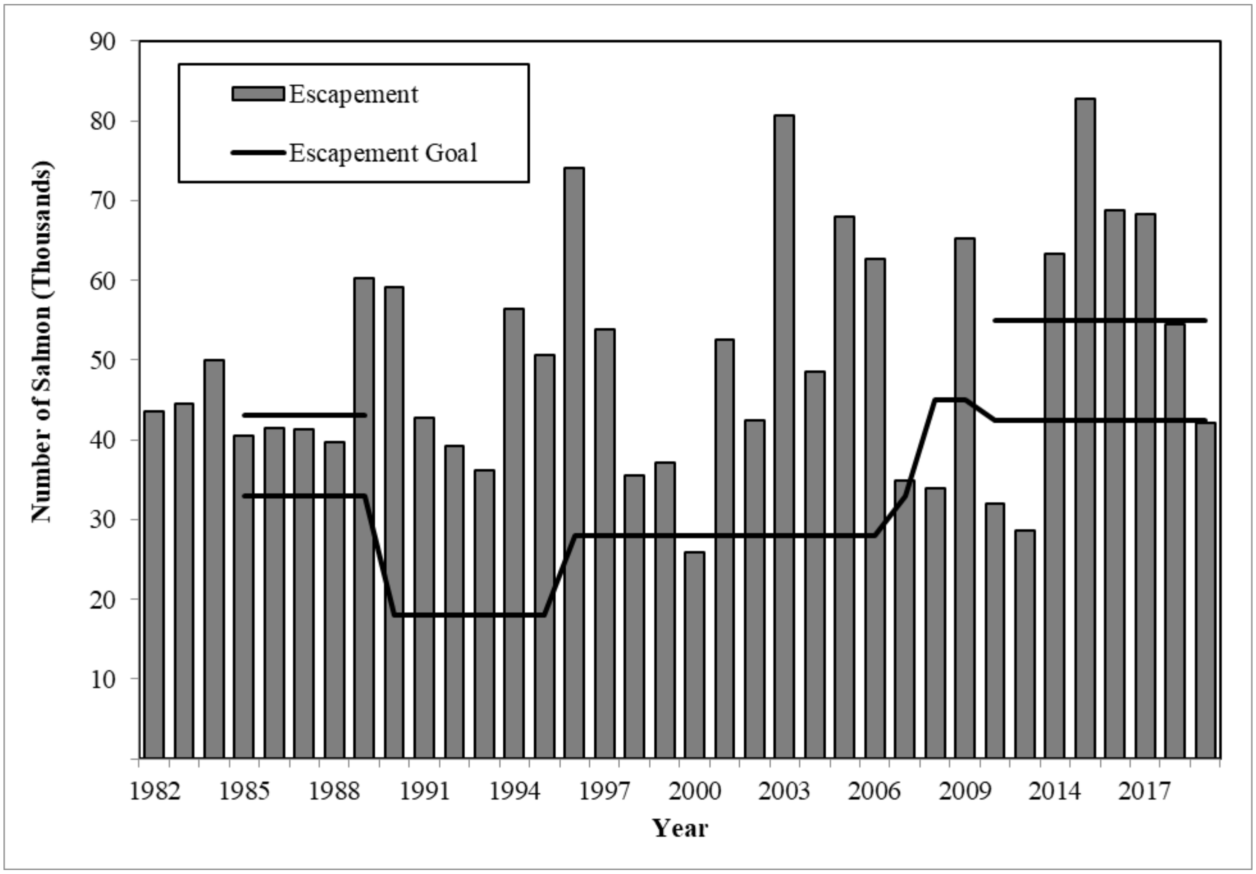

Figure 9.–Spawning escapement estimates for Canadian-origin Yukon River mainstem Chinook salmon, 1982–2019.

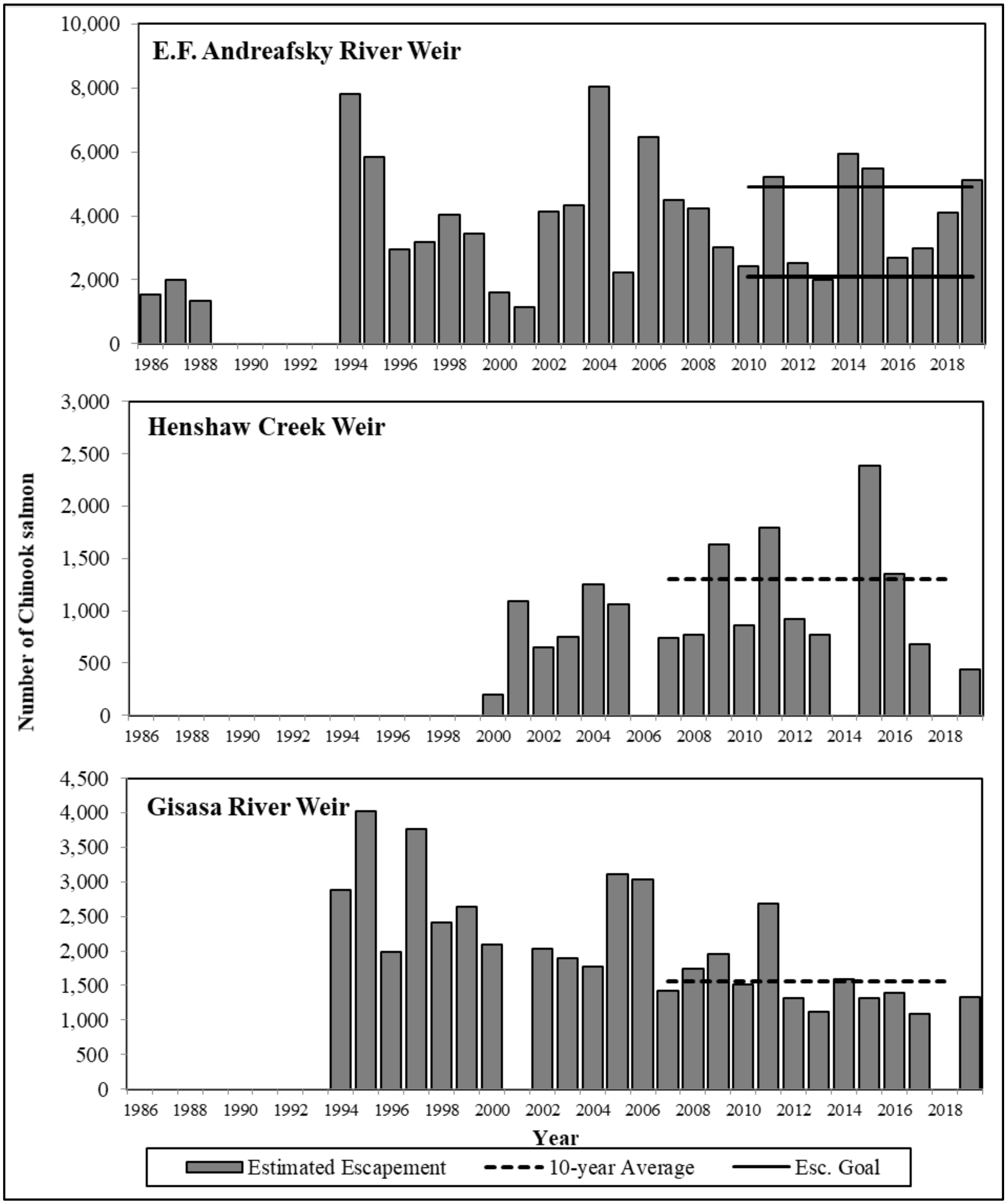

Figure 10.–Chinook salmon ground-based escapement estimates for selected tributaries in the U.S. (Alaska) portion of the Yukon River drainage, 1986–2019.

Note: Esc. Goal = escapement goal range relative to years when the goal was in effect. There are no escapement goals at the Henshaw Creek and Gisasa River weirs. Incomplete counts caused by late installation and/or early removal of project or high-water events are excluded from the graphs. Vertical scale is variable.

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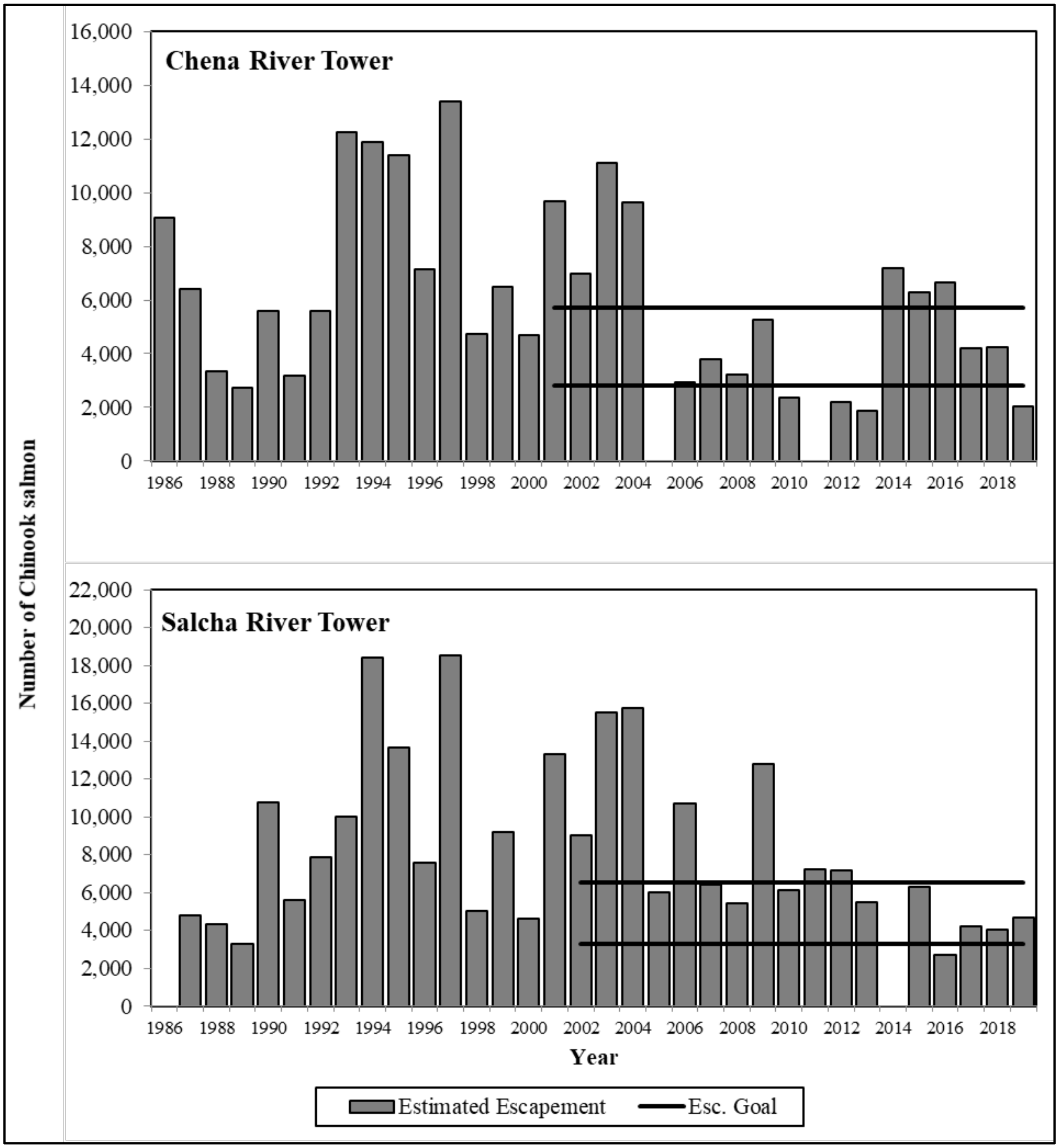

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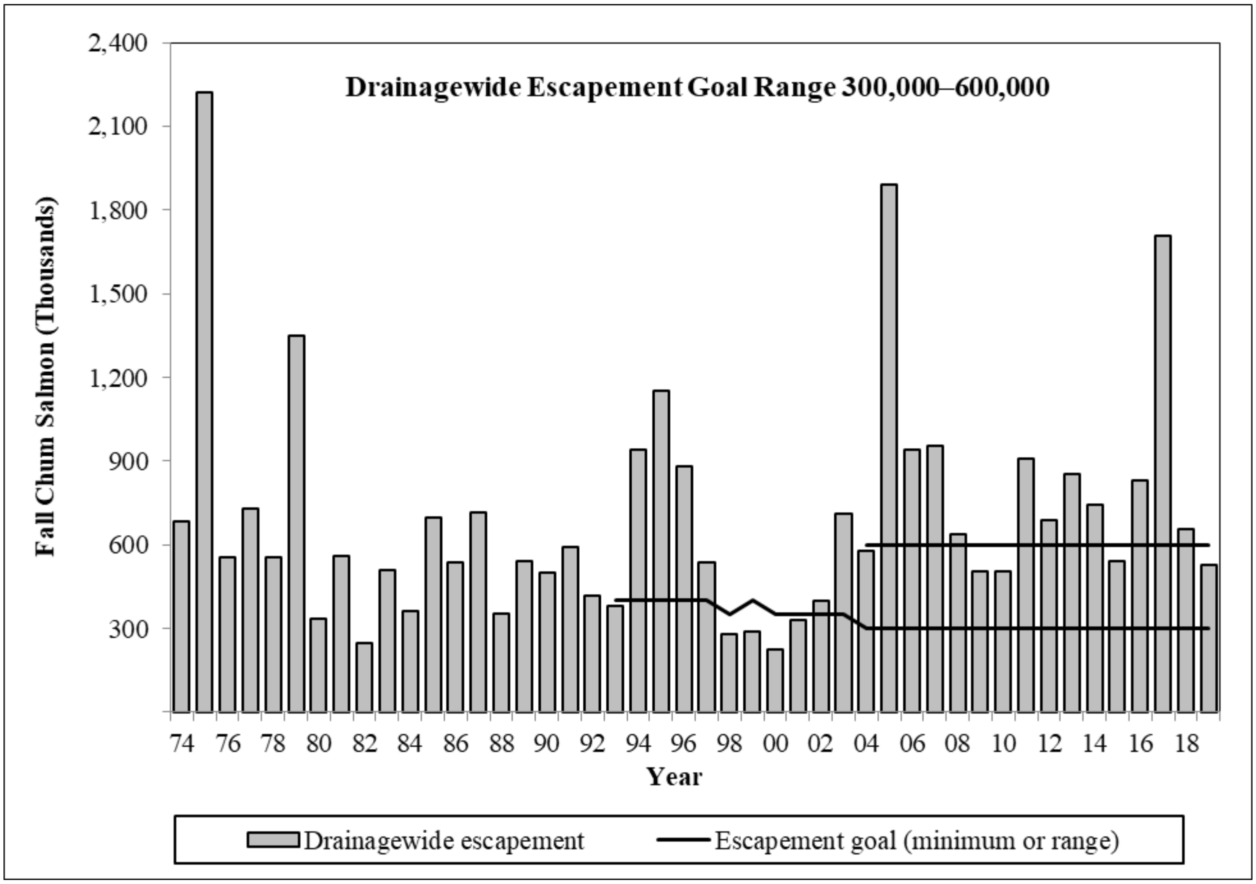


Figure 11.–Estimated drainagewide escapement of fall chum salmon, Yukon River, 1974–2019.

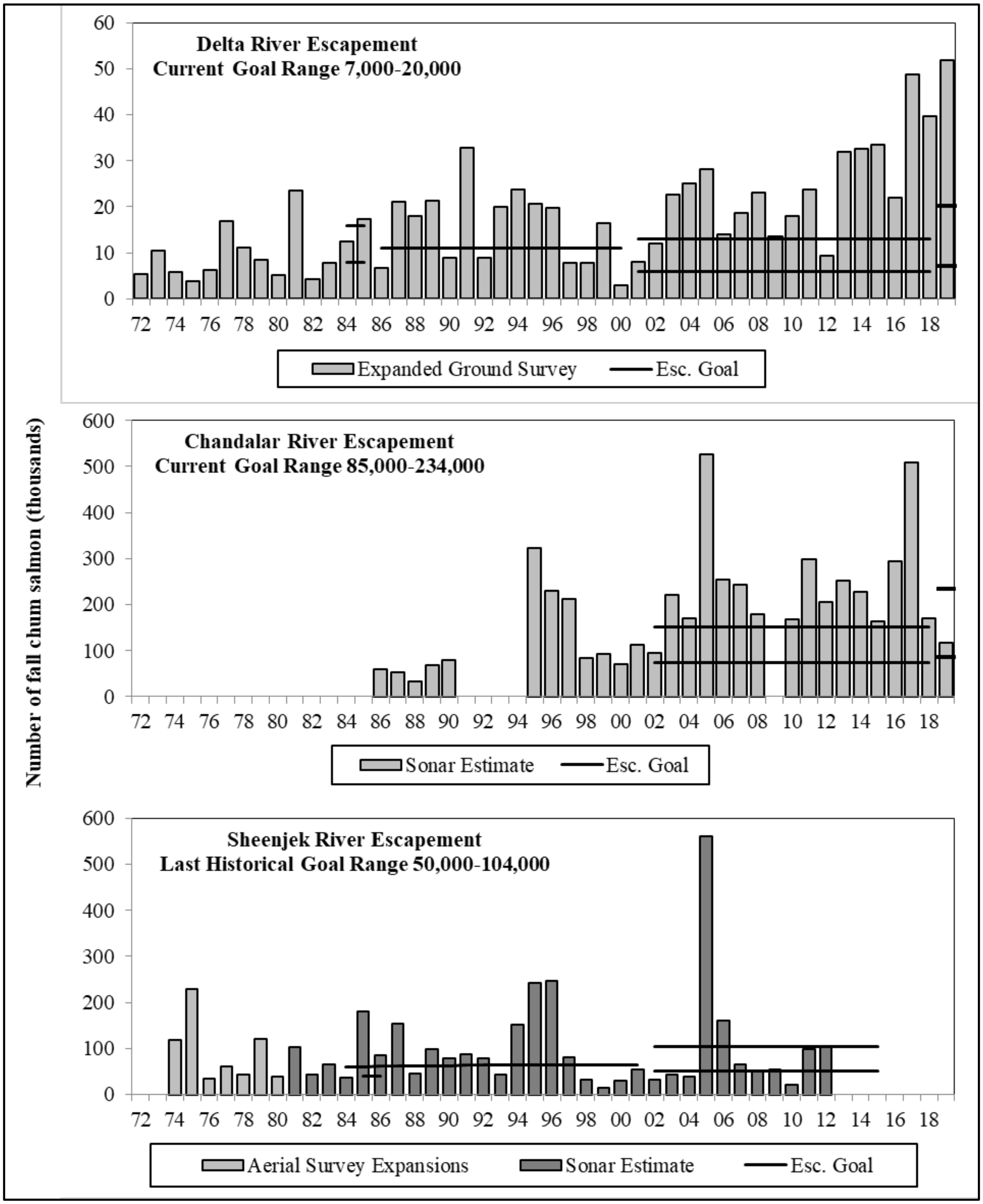


Figure 12.–Fall chum salmon escapement estimates for selected spawning areas in the U.S. (Alaska) portion of the Yukon River drainage, 1972–2019.

Note: Horizontal lines represent escapement goals or ranges. The vertical scale is variable. Esc. = escapement relative to years applied as either goal minimums or ranges. Sheenjek escapement project was not funded after 2012 and the goal was discontinued in 2016.

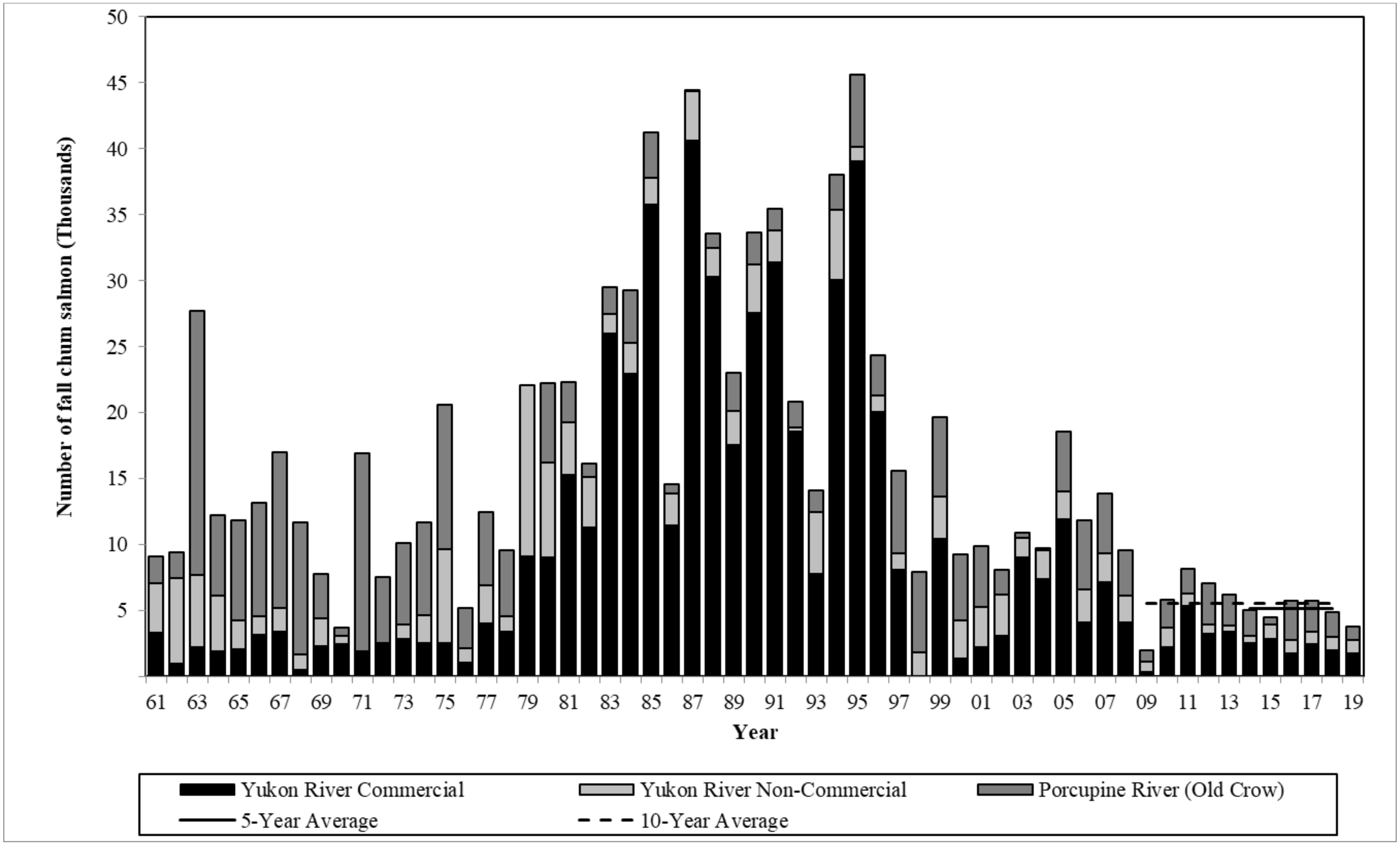


Figure 13.–Canadian harvest of fall chum salmon, Yukon River, 1961–2019.

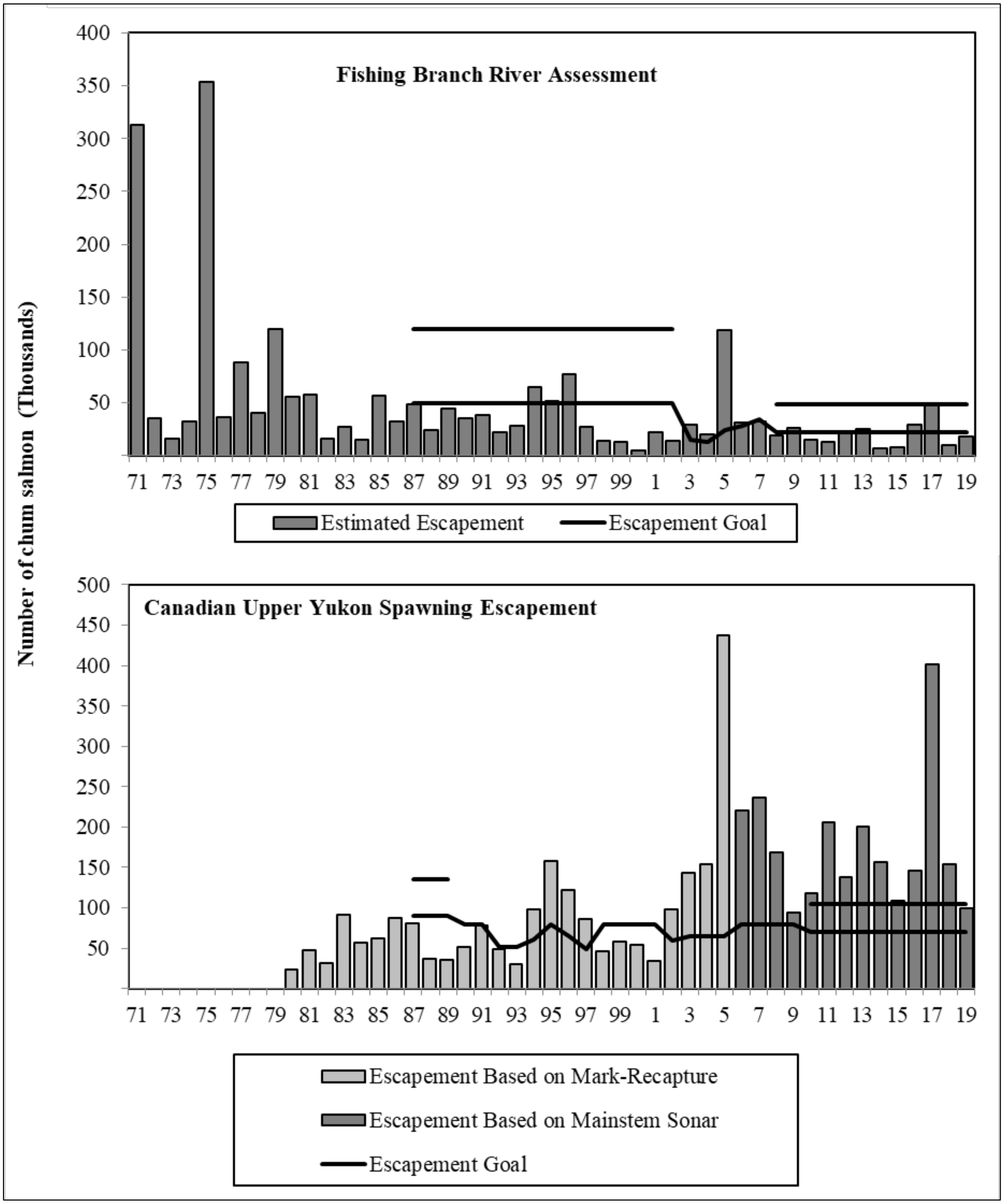


Figure 14.–Spawning escapement estimates for Canadian-origin fall chum salmon at the Fishing Branch River and the mainstem Yukon River, 1971–2019.

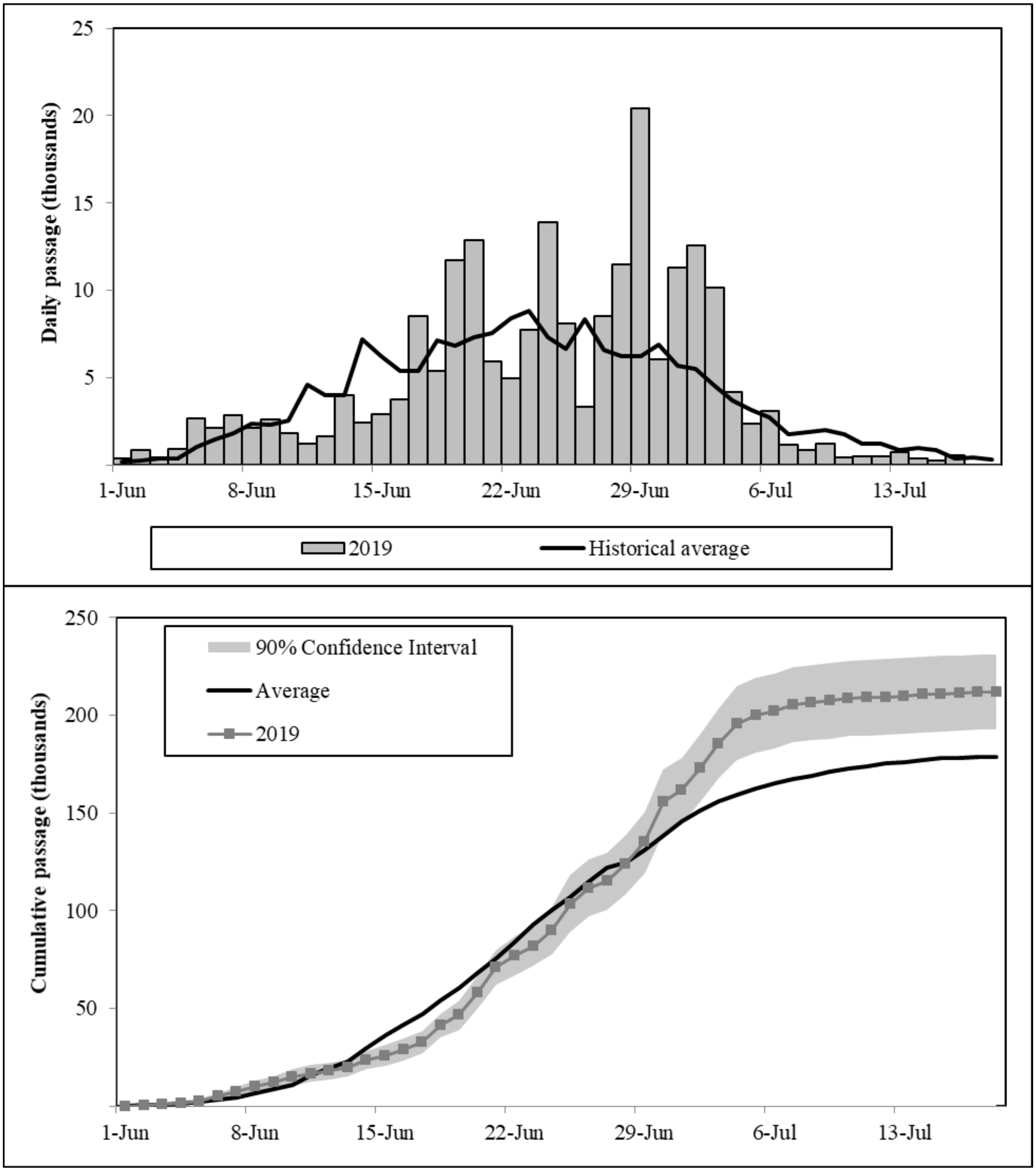
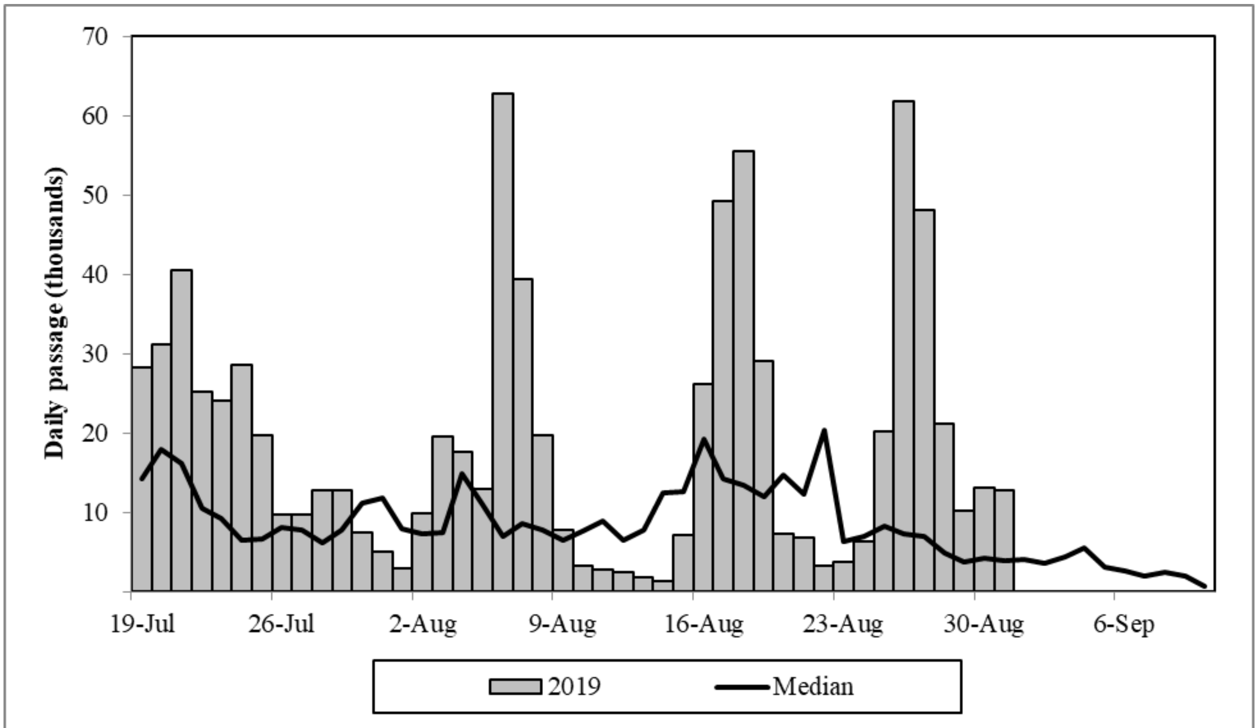


Figure 15.–Daily passage estimates of Chinook salmon at the Pilot Station sonar in 2019 (top) and cumulative passage estimate, including 90% confidence intervals (bottom), 2019 compared to historical average.

Note: Historical average includes 1995, 1997, 2000, 2002–2008, 2010–2018.



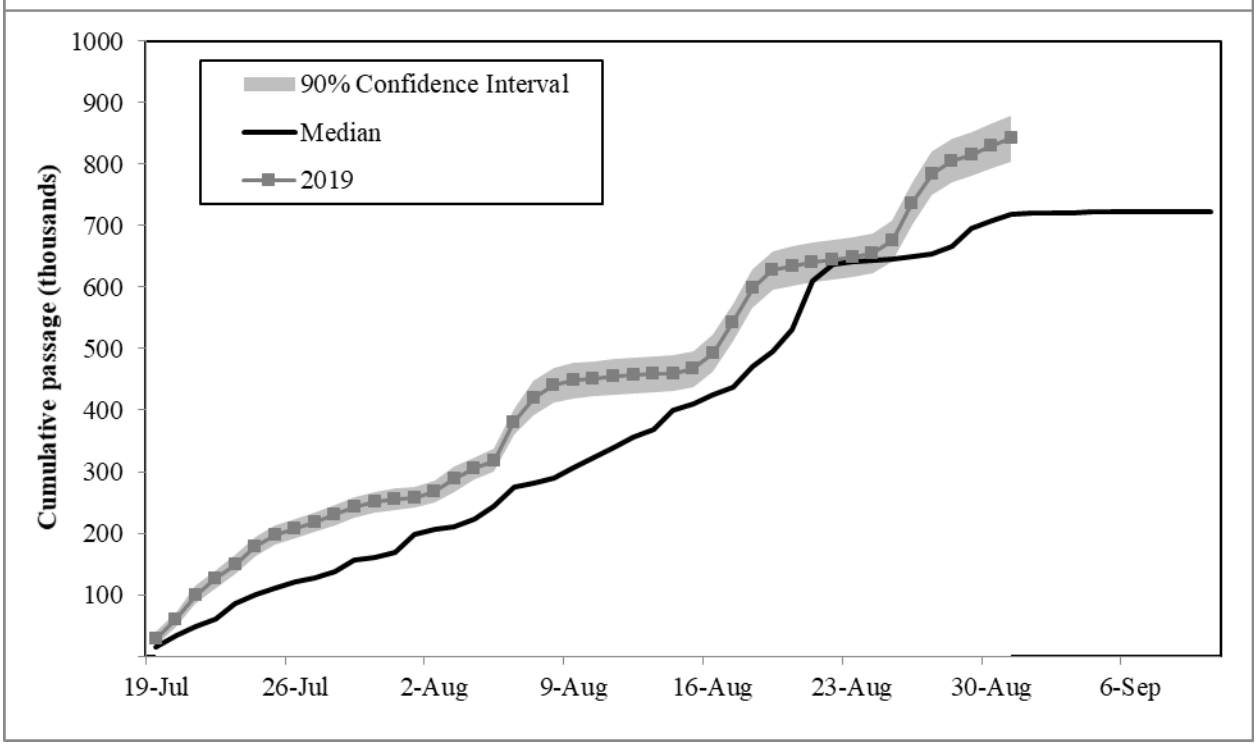


Figure 16.–Daily passage estimates of fall chum salmon at the Pilot Station sonar in 2019 (top), cumulative passage estimates, including 90% confidence intervals (bottom), compared to median passages.

Note: Historical median includes 1995–2018, excluding 1996 and 2009.

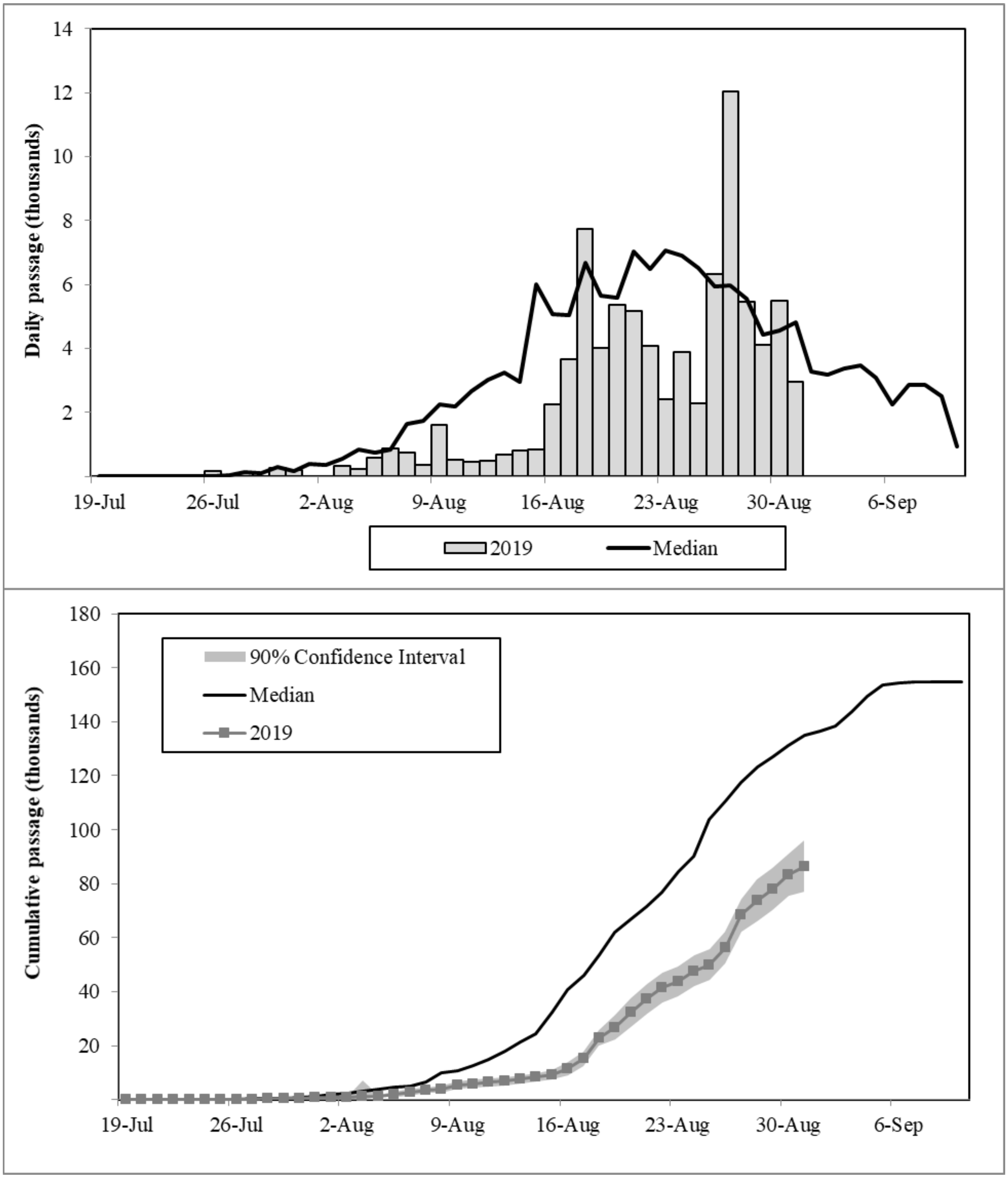


Figure 17.–Daily passage estimates of coho salmon at the Pilot Station sonar in 2019 (top), cumulative passage estimates, including 90% confidence intervals (bottom), compared to median passages.

Note: Historical median includes 1995–2018, excluding 1996 and 2009.

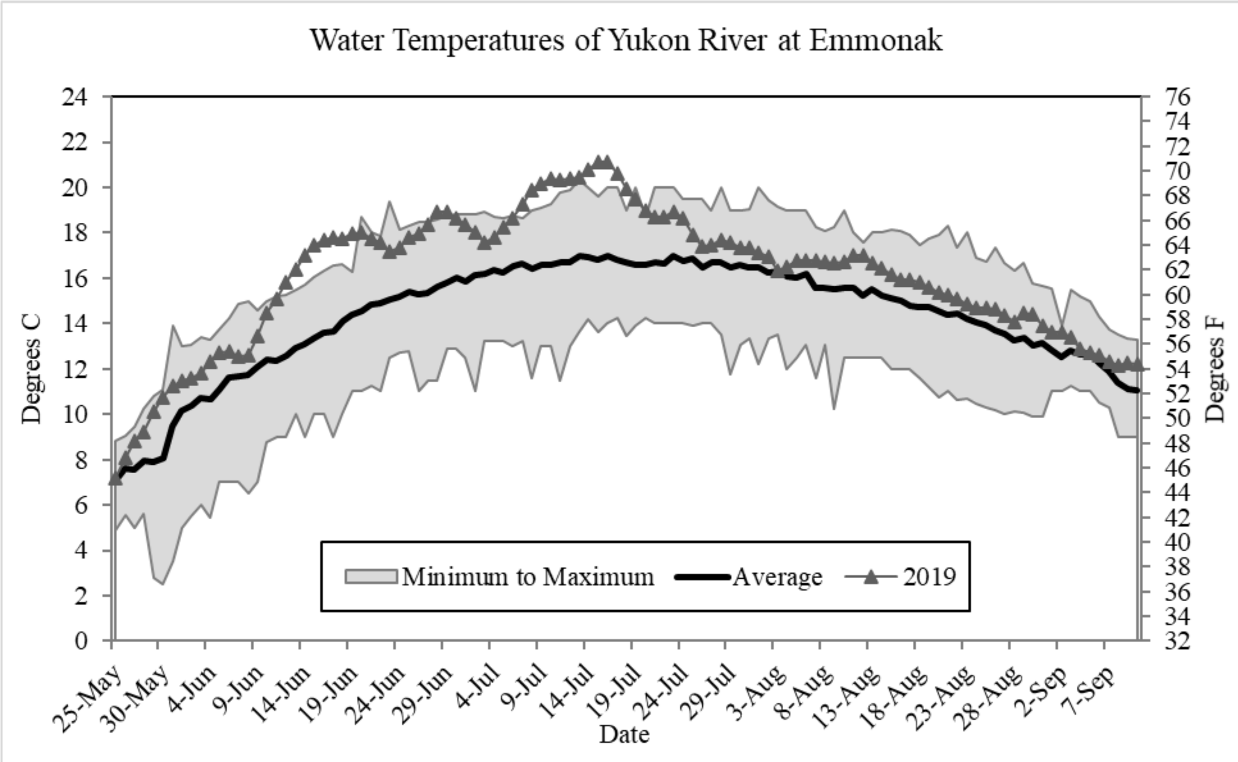


Figure 18.–Lower Yukon daily water temperatures, comparing 2019 to historical minimum, maximum, and average temperatures.

Note: Temperatures were collected in the Yukon River near Emmonak using handheld thermometers (1984–present) and data loggers (2004–present). The years the data types overlap are averaged together.

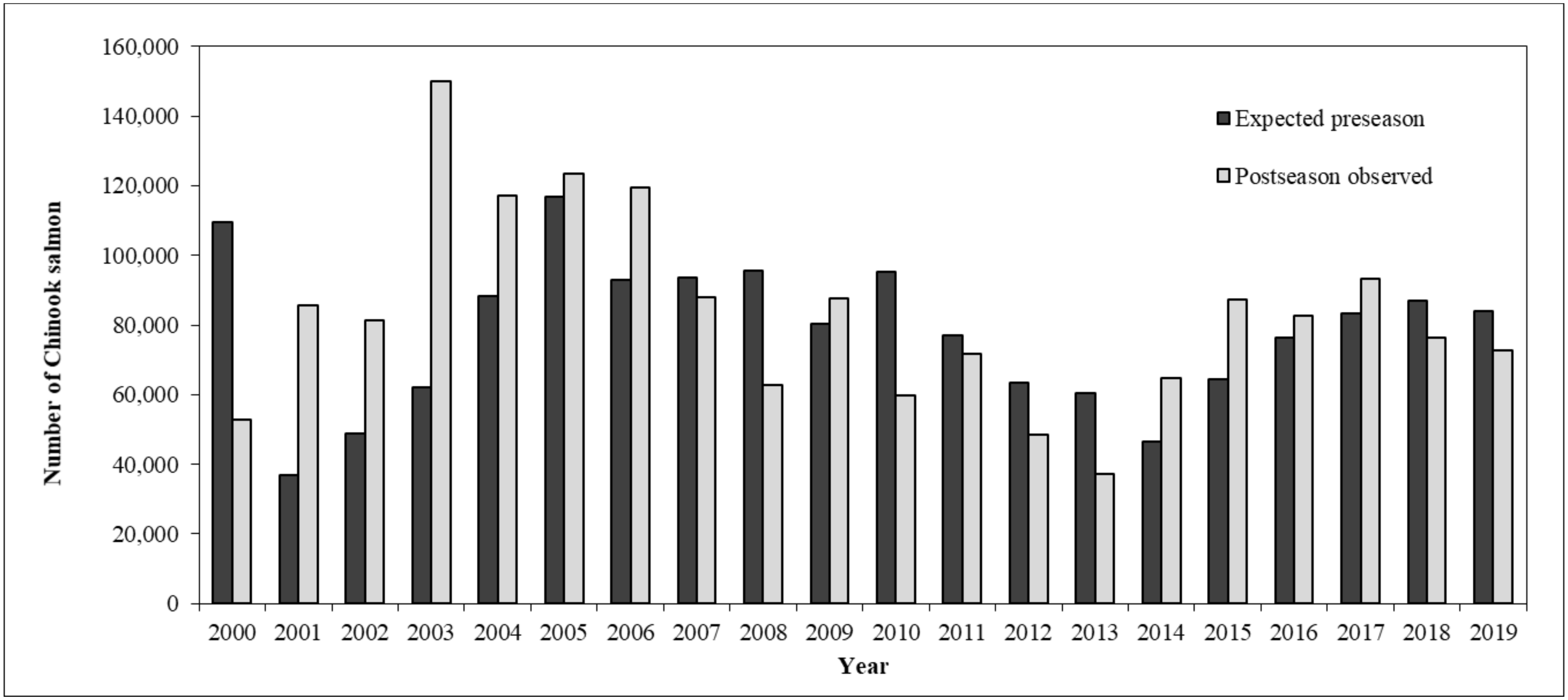


Figure 19.–Expected versus observed number of Canadian-origin Chinook salmon returning to spawn, 2000–2019.

Note: Forecast methods have changed over time and the "expected" value is the published JTC forecast range midpoint. The "observed" is estimated total Canadian-origin run size. This is calculated as the spawning escapement plus estimated U.S. and Canada harvest.

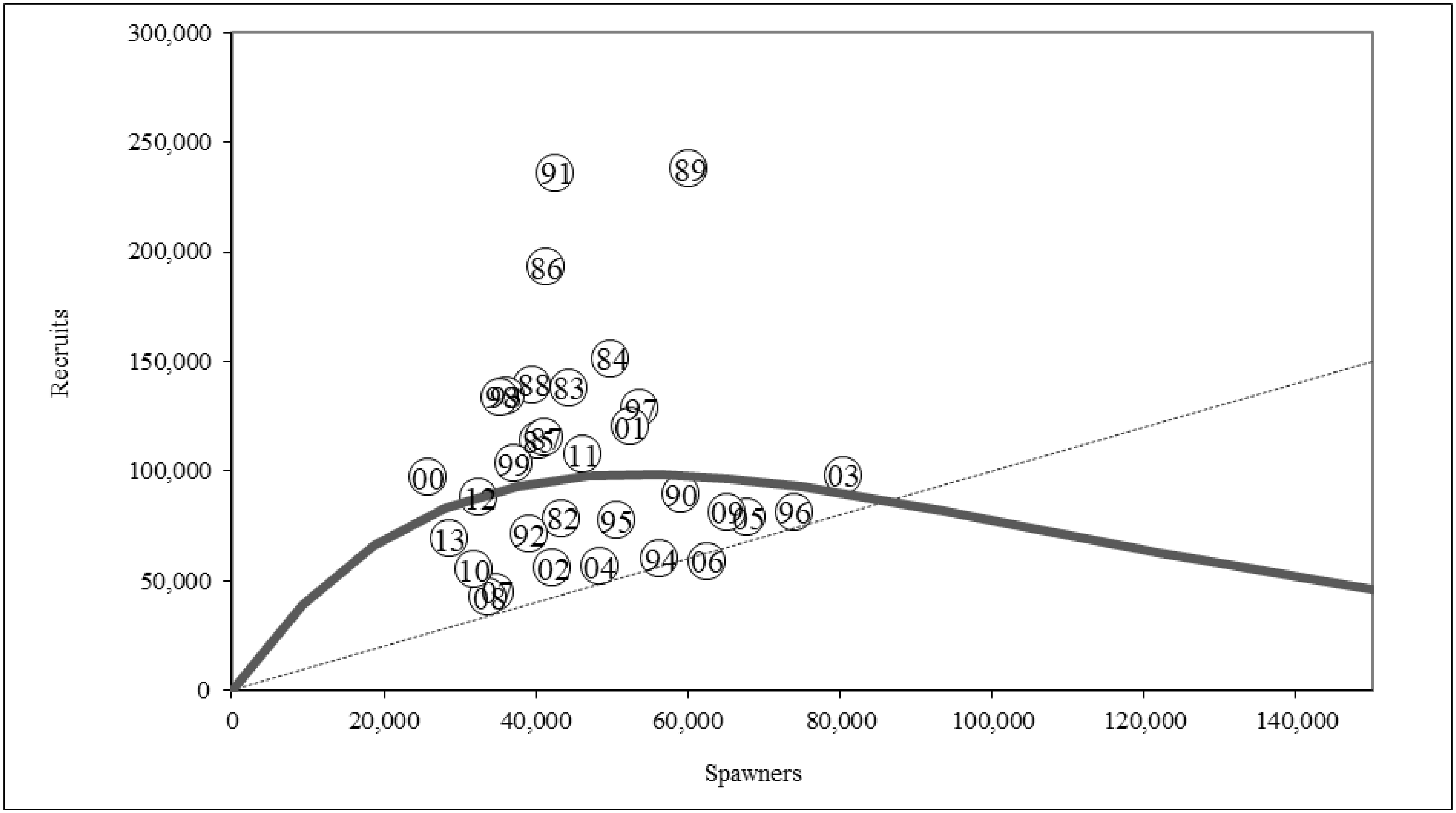


Figure 20.–Yukon River Canadian-origin Chinook salmon recruits versus spawners, Ricker curve (solid line), and 1:1 replacement line (dotted). Brood years 1982–2013 are included.

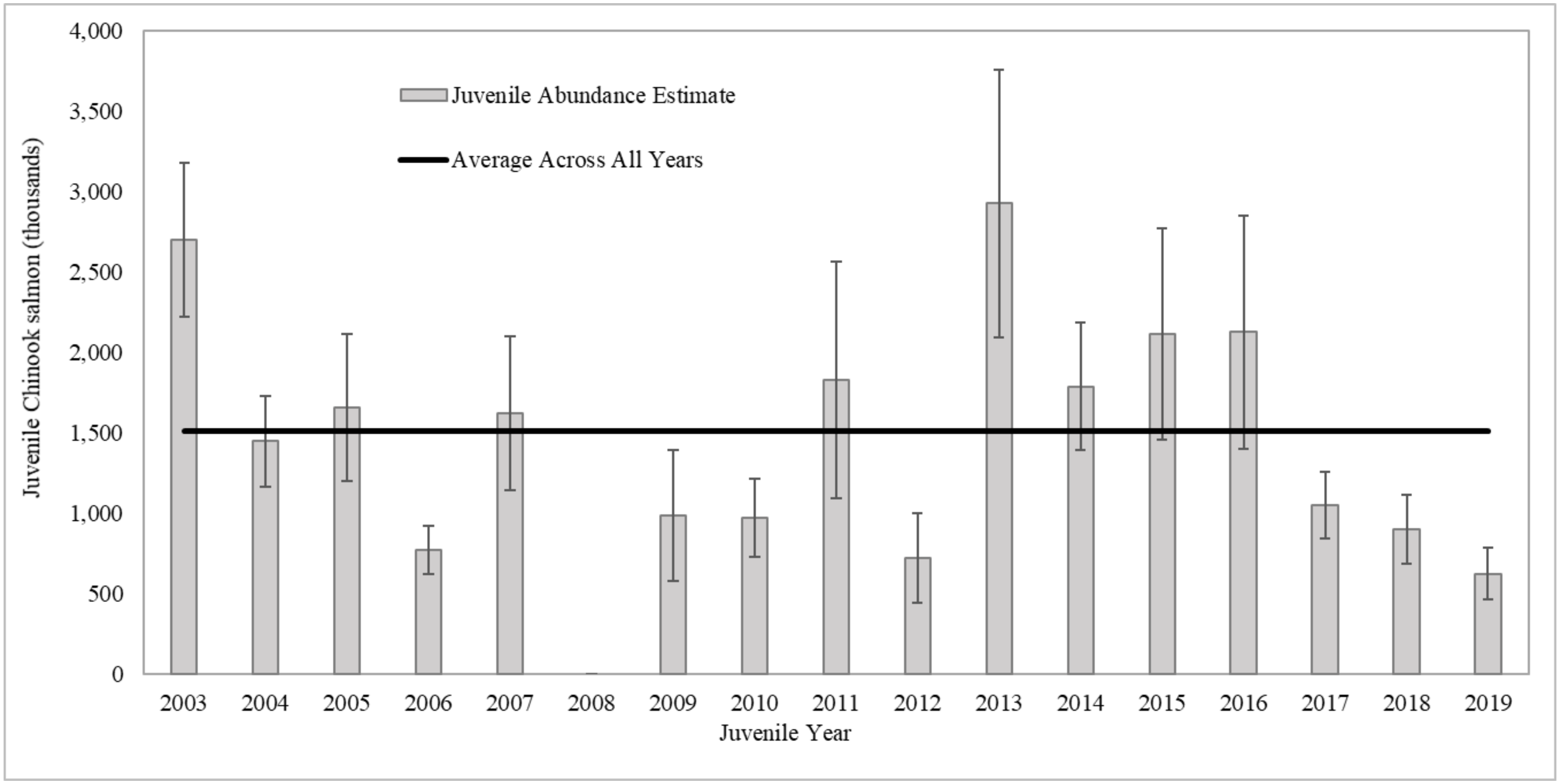


Figure 21.–Juvenile abundance estimates of Canadian-origin Chinook salmon from the Yukon River based on pelagic trawl research surveys in the northern Bering Sea (2003–2019).

Note: Error bars ranges are one deviation above and below the abundance estimates. The 2019 estimate is preliminary and subject to change.

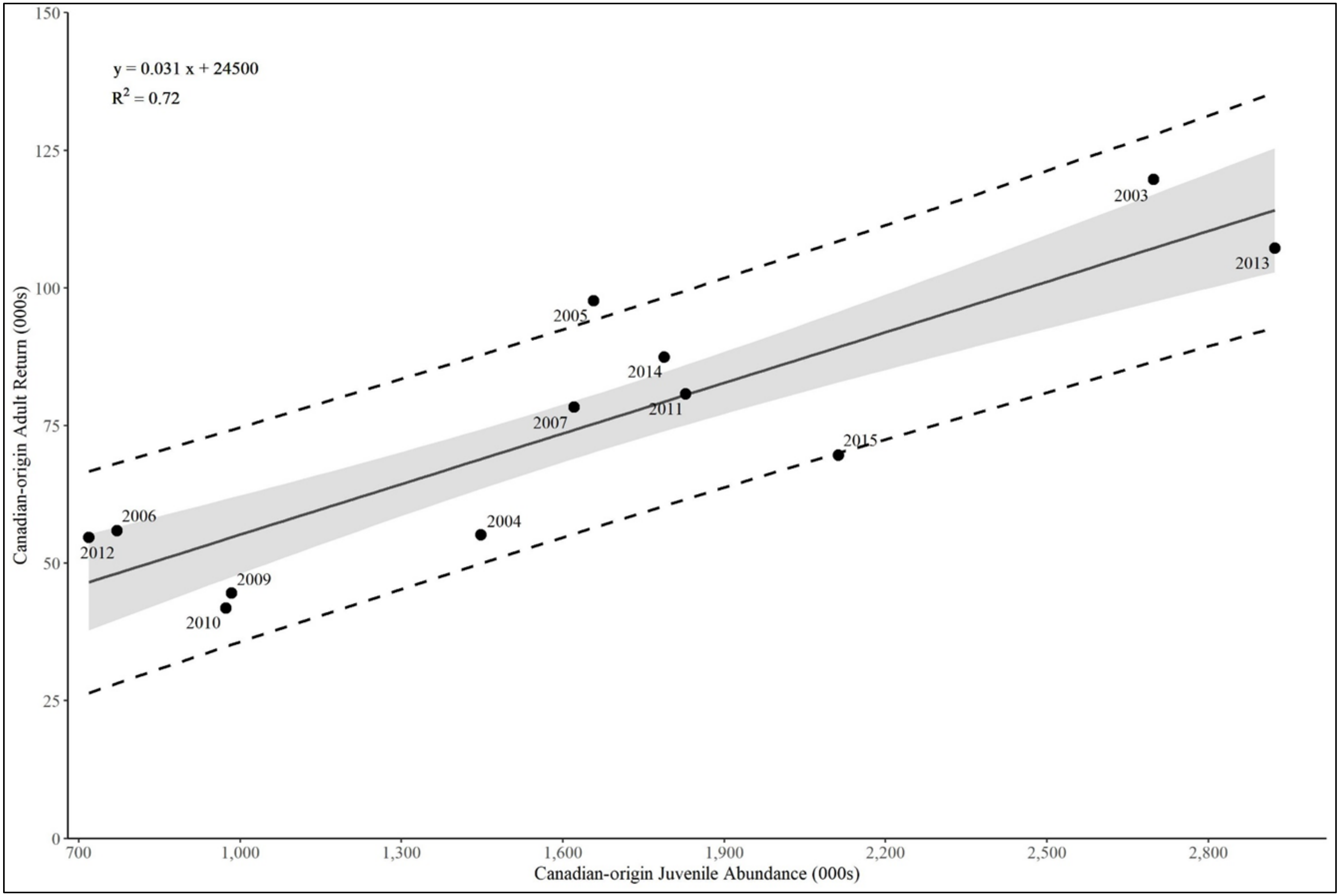


Figure 22.–The relationship between juvenile and adult return abundance for Canadian-origin Chinook salmon from the Yukon River. Data labels indicate juvenile year, gray shaded area indicates the 80% confidence interval, and black dashed lines indicate the 80% prediction interval.

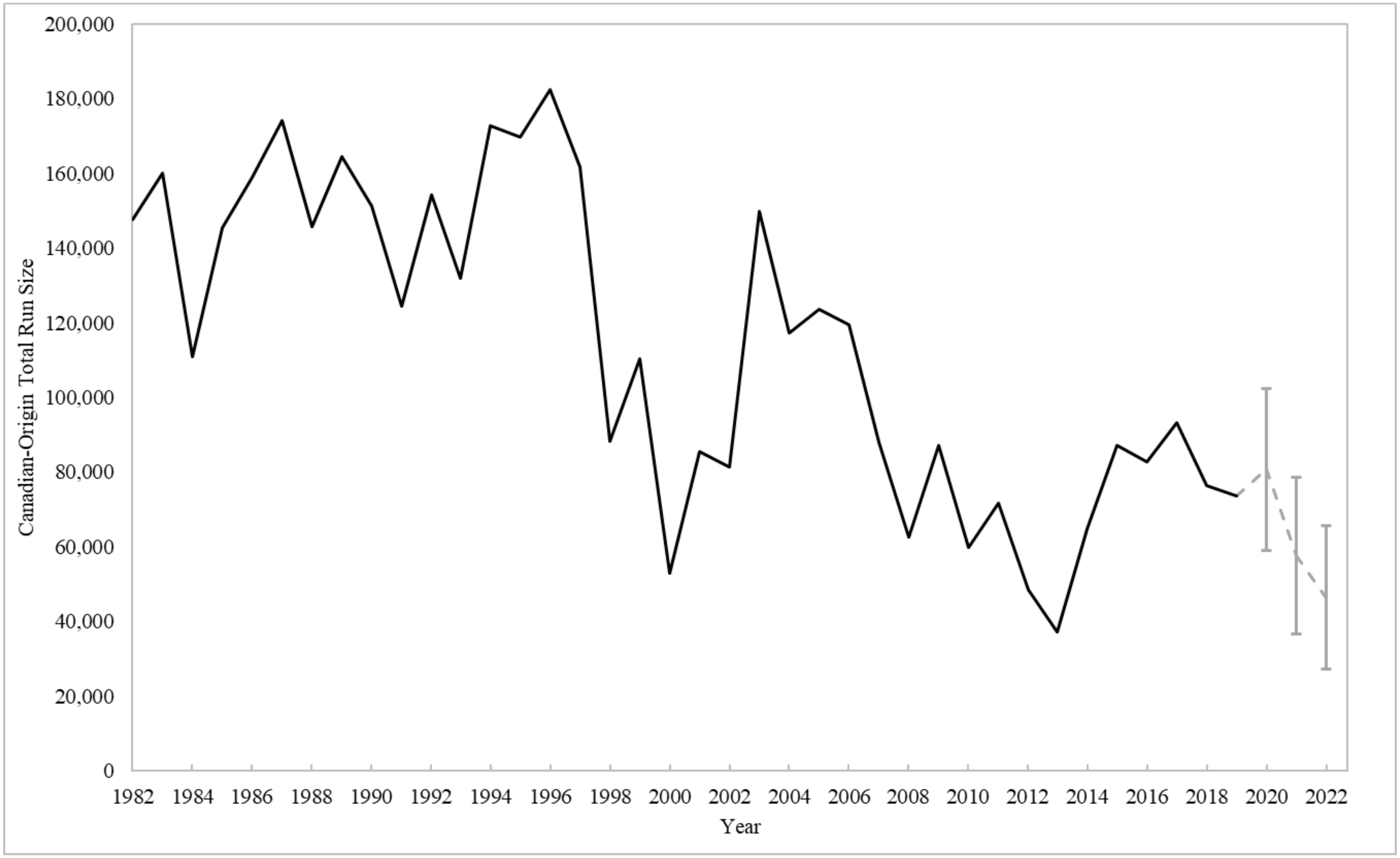


Figure 23.–Historic run size estimates of Canadian-origin Chinook salmon in the Yukon River (solid line 1982–2019) and preliminary projected run sizes based on juvenile abundance (dashed line 2020–2022).

Note: Error bar ranges reflect the 80% prediction interval around the abundance estimates.

APPENDIX A: TABLES

Appendix A1.–Passage estimates from the Pilot Station sonar, Alaska, Yukon River drainage, 1995 and 1997–2019.

	Chinook			Chum						
Year [a]	Large [b]	Small	Total	Summer	Fall [c]	Total	Coho [c]	Pink	Other [d]	Total
1995	164,867	45,874	210,741	3,632,179	1,148,916	4,781,095	119,893	53,277	708,747	5,873,753
1997 [e]	114,519	85,244	199,763	1,359,117	579,767	1,938,884	118,065	3,872	376,841	2,637,425
1998	88,129	19,909	108,038	824,901	375,222	1,200,123	146,365	103,416	210,677	1,768,619
1999	159,805	24,413	184,218	969,459	451,505	1,420,964	76,174	3,947	337,701	2,023,004
2000	48,321	6,239	54,560	448,665	273,206	721,871	206,365	61,389	262,627	1,306,812
2001 [f]	104,060	17,029	121,089	442,546	408,961	851,507	160,272	2,846	265,749	1,401,463
2002	111,290	40,423	151,713	1,097,769	367,886	1,465,655	137,077	123,698	405,534	2,283,677
2003	287,729	30,359	318,088	1,183,009	923,540	2,106,549	280,552	11,370	379,651	3,096,210
2004	138,317	62,444	200,761	1,344,213	633,368	1,977,581	207,844	399,339	391,939	3,177,464
2005 [g]	227,154	31,861	259,015	2,570,696	1,893,688	4,464,384	194,372	61,091	364,250	5,343,112
2006	192,296	36,467	228,763	3,780,760	964,238	4,744,998	163,889	183,006	531,047	5,851,703
2007	119,622	50,624	170,246	1,875,491	740,195	2,615,686	192,406	126,282	761,657	3,866,277
2008	138,220	36,826	175,046	1,849,553	636,525	2,486,078	145,378	580,127	306,225	3,692,854
2009 [h]	128,154	49,642	177,796	1,477,186	274,227	1,751,413	240,779	34,529	589,916	2,794,433
2010	118,335	26,753	145,088	1,415,027	458,103	1,873,130	177,724	917,731	567,454	3,681,127
2011	117,213	31,584	148,797	2,051,501	873,877	2,925,378	149,533	9,754	453,537	3,686,999
2012	106,529	21,026	127,555	2,136,476	778,158	2,914,634	130,734	420,344	464,058	4,057,325
2013	120,536	16,269	136,805	2,849,683	865,295	3,714,978	110,515	6,126	732,009	4,700,433
2014	120,060	43,835	163,895	2,020,309	706,630	2,726,939	283,421	679,126	584,831	4,438,212
2015	105,063	41,796	146,859	1,591,505	669,483	2,260,988	121,193	39,690	853,989	3,422,719
2016	135,013	41,885	176,898	1,921,748	994,760	2,916,508	168,297	1,364,849	355,365	4,981,917
2017	217,821	45,193	263,014	3,093,735	1,829,931	4,923,666	166,320	166,529	796,199	6,315,728
2018	122,394	39,437	161,831	1,612,688	928,664	2,541,352	136,347	689,607	547,959	4,077,096
2019	172,242	47,382	219,624	1,402,925	842,041	2,244,966	86,401	42,353	568,576	3,161,920

Note: Historical passage estimates at the Pilot Station sonar were adjusted in 2016 after the adoption of a new species apportionment model.

[a] Estimates for all years were generated with the most current apportionment model and may differ from earlier estimates.

[b] Chinook salmon >655 mm measured mid eye to tail fork length.

[c] This estimate may not include the entire run. Most years operated through August 31, except 1995 (September 3), 1998 (September 9), 2000 (September 14), 2008–2014 and 2017–2018 (September 7).

[d] Includes sockeye salmon, cisco, whitefish, sheefish, burbot, suckers, Dolly Varden, and northern pike.

[e] The Yukon River sonar project did not operate at full capacity in 1996 and there are no passage estimates for this year.

[f] High water levels were experienced at Pilot Station in 2001 throughout the season, and therefore passage estimates are considered conservative.

[g] Estimates include extrapolations for the dates June 10–June 18, 2005 to account for the time before the DIDSON was deployed.

[h] High water levels were experienced at Pilot Station in 2009 during the summer season and extreme low water occurred during the fall season, and therefore passage estimates are considered conservative.

Appendix A2.–Alaska commercial salmon sales (number of fish) by district and subdistrict, 2019.

District/Subdistrict	Number of fishermen [a]	Chinook	Summer chum	Fall chum	Coho	Pink
1	294	2,100	183,658	145,692	40,621	10,647
2	143	1,010	41,835	106,141	15,622	315
3 [b]	–	–	–	–	–	–
Total Lower Yukon	417	3,110	225,493	251,833	56,243	10,962
Anvik River	–	–	–	–	–	–
4-A	–	–	–	–	–	–
4-BC	–	–	–	–	–	–
Subtotal District 4 [b]	–	–	–	–	–	–
5-ABC	3	–	–	900	0	0
5-D	–	–	–	–	–	–
Subtotal District 5	3	0	0	900	0	0
6-ABC	4	0	1,596	15,627	2,348	0
Total Upper Yukon	7	0	1,596	16,527	2,348	0
Total Alaska	424	3,110	227,089	268,360	58,591	10,962

Note: En dash indicates no commercial fishing activity occurred. Does not include ADF&G test fishery sales.

[a] Number of unique permits fished by district, subdistrict, or area. Totals by area may not add up due to transfers between districts or subdistricts.

[b] Fishery did not operate in District 3 or 4 in 2019.

Appendix A3.–Yukon River Canadian-origin Chinook salmon total run by brood year and escapement by year.

Brood	Age								
year	3	4	5	6	7	8	Return	Spawners	R/S
1974						4,388			
1975					34,696	278			
1976				82,801	20,859	47			
1977			18,964	107,561	20,000	547	147,071		
1978		5,204	28,339	63,387	32,684	793	130,406		
1979	1,534	3,168	21,293	99,647	44,935	1,202	171,780		
1980	15	6,308	10,976	78,443	30,605	4,332	130,679		
1981	0	1,505	29,105	124,142	65,576	1,076	221,404		
1982	0	5,246	13,141	32,404	27,166	171	78,128	43,538	1.79
1983	560	4,970	32,100	86,220	13,707	108	137,665	44,475	3.10
1984	69	11,041	37,824	81,832	20,060	192	151,018	50,005	3.02
1985	223	11,873	36,643	59,757	4,771	64	113,331	40,435	2.80
1986	356	18,829	42,293	114,716	16,137	138	192,470	41,425	4.65
1987	7	2,142	27,309	69,477	15,988	18	114,941	41,307	2.78
1988	21	6,760	35,595	83,506	12,893	68	138,844	39,699	3.50
1989	471	10,480	68,225	126,578	31,814	0	237,568	60,299	3.94
1990	125	4,665	22,520	56,724	4,836	9	88,880	59,212	1.50
1991	363	7,470	89,841	126,660	11,207	0	235,540	42,728	5.51
1992	309	4,035	24,212	39,924	2,295	0	70,775	39,155	1.81
1993	21	5,860	34,834	84,973	7,450	477	133,615	36,244	3.69
1994	132	2,189	20,831	27,856	8,334	0	59,341	56,449	1.05
1995	119	2,330	15,468	48,952	10,113	10	76,991	50,673	1.52
1996	19	2,069	23,375	43,760	11,789	2	81,013	74,060	1.09
1997	0	4,526	22,321	94,778	6,426	14	128,065	53,821	2.38
1998	0	5,237	41,060	80,818	6,271	0	133,386	35,497	3.76
1999	56	2,330	25,048	73,931	1,411	0	102,775	37,184	2.76
2000	12	4,954	40,562	49,713	1,202	0	96,443	25,870	3.73
2001	0	2,813	63,400	51,278	2,223	0	119,713	52,564	2.28
2002	21	4,962	29,302	20,646	227	9	55,166	42,359	1.30
2003	0	6,118	37,202	52,067	2,261	1	97,649	80,594	1.21
2004	0	2,531	26,680	21,938	4,763	1	55,913	48,469	1.15
2005	9	8,232	29,477	38,855	1,755	0	78,327	67,985	1.15
2006	15	6,009	25,248	25,697	1,567	0	58,536	62,630	0.93
2007	47	2,858	17,737	22,193	1,694	0	44,529	34,904	1.28
2008	1	3,131	11,091	25,750	1,853	1	41,828	33,883	1.23
2009	173	2,325	32,868	44,942	454	0	80,762	65,278	1.24
2010	1	4,379	29,627	19,751	876	0	54,634	32,014	1.71
2011	194	10,645	52,818	42,322	1,209	1	107,188	46,307	2.31
2012	255	9,650	44,760	31,923	858		87,447	32,656	2.68
2013	92	5,116	33,631	29,713			68,551	28,669	2.39
2014	115	9,566	35,089					63,331	
2015	28	6,954						82,674	
2016	5							68,798	
2017								68,315	
2018								54,474	
2019								42,052	
Average 1982–2012							104,919	47,475	2.35
							Contrast	3.12	

Note: Spawner data are derived from a 3-area aerial survey index of combined counts from Big Salmon, Little Salmon, and Nisutlin rivers (1982–2001), radiotelemetry (2002–2004), and the mainstem Yukon River sonar at Eagle (2005–2019). Shaded values are preliminary estimates by brood year. Average includes the years with complete brood information through age-7. Ages used were from samples collected at the mainstem sonar test fishery (2007–present) and converted fish wheel data based on a length selectivity method for years 1982–2006 (Hamazaki 2018).

Appendix A4.–Chinook salmon age and sex percentages from selected Yukon River monitoring projects operated in Alaska, 2019.

Location	Sample size		Age 3	4	5	6	7	Total	Mean length
East Fork Andreafsky River [a, b]	59	Male	1.7	47.5	16.9	0.0	0.0	66.1	538
		Female	0.0	0.0	18.6	15.3	0.0	33.9	737
		Total	1.7	47.5	35.5	15.3	0.0	100.0	605
Gisasa River [a, b]	192	Male	1.0	43.8	29.7	1.6	0.1	76.2	573
		Female	0.0	0.0	12.0	12.0	0.0	24.0	759
		Total	1.0	43.8	41.7	13.6	0.1	100.2	618
Henshaw Creek [a]	98	Male	0.0	18.4	20.4	0.0	0.0	38.8	640
		Female	0.0	27.6	19.4	14.3	0.0	61.3	652
		Total	0.0	46.0	39.8	14.3	0.0	100.1	647
Pilot Station test fishery [c]	734	Male	0.4	11.2	27.1	10.8	0.1	49.6	689
		Female	0.0	0.4	20.7	27.9	1.4	50.4	788
		Total	0.4	11.6	47.8	38.7	1.5	100.0	739
Eagle test fishery [c]	554	Male	0.0	8.5	31.9	11.4	0.0	51.8	737
		Female	0.0	0.0	16.4	30.5	0.9	47.8	810
		Total	0.0	8.5	48.3	41.9	0.9	99.6	772
Salcha River [d]	118	Male	0.0	14.4	31.4	10.2	0.0	56.0	678
		Female	0.0	0.0	15.3	28.8	0.0	44.1	794
		Total	0.0	14.4	46.7	39.0	0.0	100.1	730

Note: Length is measured mid eye to the fork of tail to the nearest millimeter.

[a] Samples were collected from a weir trap.

[b] Sampling curtailed during some days due to high water temperatures.

[c] Samples were from test fishing with drift gillnets.

[d] Samples were handpicked from carcasses.

Appendix A5.–Yukon River Chinook salmon age, female percentage, and mean length from the Eagle sonar project, 2005–2019.

		Percent by age class						
		Age-3	Age-4	Age-5	Age-6	Age-7		
Year	Sample size	(1.1)	(1.2, 2.1)	(1.3, 2.2)	(1.4, 2.3)	(1.5, 2.4)	Percent female	Mean length
2005	171	0.0	8.2	50.3	38.0	3.5	33.9	779
2006	256	0.0	16.8	60.2	22.7	0.4	37.9	737
2007	389	0.0	5.7	40.1	53.7	0.5	43.4	787
2008	375	0.0	2.7	56.3	36.5	4.5	36.8	780
2009	647	0.0	7.7	33.2	59.0	0.0	39.6	791
2010	336	0.0	7.4	46.4	42.0	4.2	40.5	770
2011	419	0.0	2.1	29.6	60.4	7.9	51.3	809
2012	246	0.4	6.1	29.7	59.3	4.5	49.6	780
2013	265	0.0	4.2	27.5	63.4	4.9	51.7	807
2014	606	0.2	6.6	50.5	40.1	2.6	35.1	763
2015	926	0.3	10.8	34.3	52.4	2.2	42.1	776
2016	666	0.0	9.2	65.0	25.2	0.6	32.4	759
2017	719	0.1	4.2	46.5	48.1	1.1	50.9	797
2018	700	0.0	10.3	43.0	45.0	1.7	43.4	769
2019	554	0.0	8.5	48.4	41.9	1.3	47.8	772
Average (2005–2018)	485	0.1	7.4	44.1	45.9	2.7	42.4	778
5-yr Average (2014–2018)	723	0.1	8.2	47.9	42.2	1.6	40.8	773

Note: Length is measured mid eye to the fork of tail to the nearest millimeter. Age nomenclature (years in freshwater "." years at sea).

Appendix A6.–Yukon River Chinook salmon harvest percentage by stock group for U.S. harvest, U.S. and Canada harvest combined, and the percentage of the upper stock group harvest by each country, 1981–2019.

	Stock groups (U.S. harvest)			Stock groups (U.S. and Canada harvest)			Upper stock group	
Year	Lower	Middle	Upper	Lower	Middle	Upper	U.S.	Canada
1981	5.9	59.8	34.3	5.4	54.5	40.1	78.1	21.9
1982	15.4	27.5	57.1	13.9	24.7	61.4	83.5	16.5
1983	14.2	37.0	48.9	12.9	33.7	53.3	83.7	16.3
1984	28.0	44.3	27.7	25.3	40.2	34.5	72.7	27.3
1985	30.4	24.6	45.1	27.6	22.3	50.1	81.6	18.4
1986	22.3	10.9	66.8	19.5	9.6	70.9	82.7	17.3
1987	17.4	21.4	61.2	15.9	19.6	64.5	86.7	13.3
1988	24.9	18.1	57.0	21.8	15.8	62.5	79.8	20.2
1989	27.2	17.7	55.1	24.4	15.9	59.7	82.9	17.1
1990	22.8	28.4	48.8	20.2	25.2	54.7	79.2	20.8
1991	31.8	28.7	39.6	28.0	25.3	46.7	74.8	25.2
1992	18.0	24.1	57.8	16.3	21.8	61.9	84.5	15.5
1993	23.7	28.0	48.3	21.5	25.4	53.1	82.6	17.4
1994	20.4	24.1	55.5	18.2	21.4	60.4	81.8	18.2
1995	20.0	25.0	55.0	17.9	22.4	59.7	82.4	17.6
1996	24.0	11.8	64.2	21.0	10.4	68.6	81.9	18.1
1997	28.9	18.3	52.8	26.4	16.8	56.9	84.8	15.2
1998	34.7	18.5	46.8	32.7	17.4	49.8	88.8	11.2
1999	44.1	6.9	49.0	40.1	6.3	53.6	83.0	17.0
2000	37.5	13.6	48.9	33.9	12.3	53.8	81.9	18.1
2001	37.5	19.0	43.5	31.6	16.0	52.4	69.8	30.3
2002	22.1	33.3	44.6	19.4	29.2	51.4	76.3	23.5
2003	7.5	31.7	60.8	6.8	28.9	64.3	86.2	13.8
2004	16.9	31.6	51.5	15.3	28.8	55.9	83.7	16.3
2005	23.4	24.2	52.4	20.7	21.4	57.9	80.1	19.9
2006	19.2	30.2	50.5	17.6	27.6	54.9	84.1	15.9
2007	13.7	32.3	54.0	13.0	30.6	56.4	90.5	9.5
2008	18.2	30.0	51.8	17.0	28.0	55.0	88.1	11.9
2009	12.7	35.8	51.6	11.1	31.4	57.5	78.8	21.2
2010	18.7	34.3	47.0	17.8	32.7	49.5	90.5	9.5
2011	15.6	33.3	51.1	13.9	29.8	56.3	81.0	19.0
2012	14.4	37.5	48.2	13.3	34.8	51.9	86.3	13.7
2013	16.0	25.0	59.0	13.4	21.0	65.6	75.5	24.5
2014	29.8	26.0	44.3	25.4	27.8	46.8	93.4	6.6
2015	15.6	36.3	48.1	13.5	31.3	55.2	75.2	24.8
2016	15.1	33.5	51.5	13.3	29.5	57.2	80.4	19.6
2017	9.3	35.0	55.6	8.5	32.1	59.3	85.9	14.1
2018	8.6	31.8	59.6	7.9	29.2	62.9	87.2	12.8
2019 [a]	14.0	32.3	53.7	13.3	30.6	56.1	91.0	9.0
Average								
2009–2018	15.6	32.8	51.6	13.8	30.0	56.2	83.4	16.6
2014–2018	15.7	32.5	51.8	13.7	30.0	56.3	84.4	15.6
Minimum-18	5.9	6.9	27.7	5.4	6.3	34.5	69.8	6.6
Maximum-18	44.1	59.8	66.8	40.1	54.5	70.9	93.4	30.3

Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Data are preliminary.

Appendix A7.–Stock group percentage by major stock and by country, from chum salmon beginning July 19 at the Pilot Station sonar, 1999–2019.

	Season stock groups		U.S. stock groups		Fall stock country groups	
Year [a]	Summer	Fall	Tanana fall	Border U.S. [b]	Fall U.S.	Canada
1999	16.2	83.8	–	–	–	–
2000	12.0	88.0	–	–	–	–
2001	13.3	86.7	–	–	–	–
2002	19.2	80.8	–	–	–	–
2003	–	–	–	–	–	–
2004	13.6	86.4	31.5	27.4	58.8	27.6
2005	11.2	88.8	20.6	42.7	63.3	25.5
2006	18.2	81.8	16.8	36.1	52.9	28.9
2007	21.2	78.8	22.9	25.7	48.6	30.2
2008	16.2	83.8	21.8	31.2	53.1	30.8
2009	24.4	75.6	19.4	30.0	49.4	26.2
2010	24.9	75.1	24.2	19.6	43.8	31.3
2011	13.7	86.3	13.3	38.4	51.7	34.5
2012	20.0	80.0	25.9	31.8	57.8	22.2
2013	11.2	88.8	33.1	23.7	56.7	32.1
2014	9.7	90.3	28.7	32.2	60.9	29.4
2015	22.7	77.3	22.0	28.8	50.8	26.4
2016	20.1	79.9	23.5	28.9	52.5	27.4
2017	11.9	88.1	32.5	33.2	65.6	22.4
2018	17.3	82.7	35.1	22.9	58.0	24.7
2019	34.8	65.2	24.3	19.8	44.2	21.0
Average						
2004–2018	17.1	82.9	24.8	30.2	54.9	28.0
2014–2018	16.4	83.6	28.4	29.2	57.5	26.1
Minimum-18	9.7	75.1	13.3	19.6	43.8	22.2
Maximum-18	24.9	90.3	35.1	42.7	65.6	34.5

Note: July 19 is the date when U.S. management switches from a focus on summer chum to fall chum salmon in this section of the river. Minimum and maximum indicate year with the lowest and highest values through 2018. En dash indicates no analysis is available.

[a] Stock identification methods from 1999 through 2002 were based on allozyme analysis, SD are not available. No samples were collected in 2003. Beginning in 2004, analysis was based on microsatellite baseline.

[b] Border U.S. stocks include Big Salt, Teedriinjik (Chandalar), Sheenjek and Black rivers.

Appendix A8.–Drainagewide Yukon River fall chum salmon estimated brood year production and return per spawner estimates 1974–2019.

Brood	Number of salmon by age [a]						Return/
year	3	4	5	6	Return	Spawners [b]	spawner
1974	112,017	654,046	96,746	0	862,809	685,200	1.26
1975	197,691	1,725,889	67,333	124	1,991,038	2,220,000	0.90
1976	143,742	644,242	137,940	4,844	930,769	557,600	1.67
1977	112,580	1,082,274	197,191	4,960	1,397,005	727,500	1.92
1978	22,369	372,893	107,263	0	502,526	557,400	0.90
1979	46,146	911,222	311,016	4,006	1,272,390	1,351,000	0.94
1980	9,920	410,665	214,978	3,840	639,404	335,850	1.90
1981	51,991	983,244	342,099	9,440	1,386,774	560,450	2.47
1982	11,653	491,944	177,118	707	681,421	247,900	2.75
1983	15,445	929,755	232,674	2,389	1,180,264	508,350	2.32
1984	7,530	424,848	179,961	10,041	622,380	361,350	1.72
1985	48,556	903,716	319,518	3,200	1,274,990	698,400	1.83
1986	0	506,719	369,252	5,230	881,201	535,300	1.65
1987	14,636	618,758	349,367	8,237	990,998	717,700	1.38
1988	41,085	210,552	162,571	12,867 [c]	427,076	353,100	1.21
1989	3,297	301,849	407,640 [c]	22,234	735,021	540,900	1.36
1990	757	684,392 [c]	458,542	32,739	1,176,430	498,650	2.36
1991	4,326 [c]	1,122,992	396,858	12,943	1,537,119	593,200	2.59
1992	7,411	702,799	209,637	4,117	923,966	419,600	2.20
1993	8,327	480,101	107,935	3,228	599,591	382,400	1.57
1994	4,597	237,372	149,220	1,694 [c]	392,884	940,000	0.42
1995	2,499	266,408	72,822 [c]	374	342,103	1,150,000	0.30
1996	419	175,075 [c]	133,896	8,340	317,731	879,800	0.36
1997	3,262 [c]	239,419	118,982	3,405	365,068	537,200	0.68
1998	636	271,110	59,233	7,117	338,095	281,100	1.20
1999	29,254	720,610	185,422	13,083	948,369	288,100	3.29
2000	8,631	315,741	110,111	0	434,483	224,300	1.94
2001	144,616	2,057,224	715,025	34,796	2,951,662	329,300	8.96
2002	0	470,386	245,080	14,310	729,776	400,200	1.82
2003	25,675	879,991	475,999	17,226	1,398,890	712,800	1.96
2004	0	364,090	156,229	2,113	522,431	576,600	0.91
2005	2,485	398,467	96,135	5,446	502,533	1,890,000	0.27
2006	26,198	403,615	350,662	30,454	810,928	940,600	0.86

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Brood	Number of salmon by age [a]						Return/
year	3	4	5	6	Return	Spawners [b]	spawner
2007	85,043	871,394	191,011	6,655	1,154,103	954,200	1.21
2008	10,274	852,092	411,043	7,767	1,281,176	638,900	2.01
2009	12,132	792,120	421,604	23,069	1,248,925	504,800	2.47
2010	1,941	500,715	246,069	9,196	757,921	506,900	1.50
2011	24,431	485,257	182,553	2,302	694,543	910,400	0.76
2012	69,060	1,167,359	327,927	5,793	1,570,140	689,100	2.28
2013	29,193	1,900,586	315,870	3,229	2,248,877	853,800	2.63
2014	57,007	760,893	126,490	11,056	955,446	741,300	1.29 [d]
2015	29,753	663,043	232,924		925,720	541,000	1.71 [d]
2016	8,037					832,200	
2017						1,706,000	
2018						654,300	
2019						527,950	
Average 1974–2013					975,595	676,499	1.77
Minimum-2013					317,731	224,300	0.27
Maximum-2013					2,951,662	2,220,000	8.96

Note: Spawner data are derived from Bayesian spawner-recruit model. Average includes the years with complete brood information through age-6. Minimums and maximum indicate the lowest and highest values for each year presented through 2013.

[a] Age composition is based on samples from the lower Yukon test fishery gillnets, weighted by test fish catch per unit effort. Prior to 1983 commercial sampling was used to supplement test fishery age samples.

[b] Contrast in escapement data is 9.90.

[c] Based upon expanded test fish age composition estimates for years in which the test fishery terminated early both in 1994 and 2000.

[d] Return per spawner includes preliminary estimates from incomplete brood year (shaded value).

Appendix A9.–Escapement, rebuilding and interim goals for Canadian-origin Chinook and fall chum salmon stocks, 1985–2020.

	Canadian origin stock targets					
	Chinook salmon		Fall chum salmon			
					Fishing Branch	
Year	Mainstem escapement goal [a]	Stabilization/ rebuilding/ interim goals	Mainstem escapement goal [b]	Stabilization/ rebuilding/ interim goals	Escapement goal [b]	Interim goal
1985	33,000-43,000					
1986	33,000-43,000					
1987	33,000-43,000		90,000-135,000		50,000-120,000	
1988	33,000-43,000		90,000-135,000		50,000-120,000	
1989	33,000-43,000		90,000-135,000		50,000-120,000	
1990		18,000	80,000		50,000-120,000	
1991		18,000	80,000		50,000-120,000	
1992		18,000		51,000	50,000-120,000	
1993		18,000		51,000	50,000-120,000	
1994		18,000		61,000	50,000-120,000	
1995		18,000	80,000		50,000-120,000	
1996		28,000		65,000	50,000-120,000	
1997		28,000		49,000	50,000-120,000	
1998		28,000	80,000		50,000-120,000	
1999		28,000	80,000		50,000-120,000	
2000		28,000	80,000		50,000-120,000	
2001		28,000	80,000		50,000-120,000	
2002		28,000		60,000	50,000-120,000	
2003 [c]		28,000 [d]		65,000		15,000
2004		28,000		65,000		13,000
2005		28,000		65,000		24,000
2006		28,000	80,000			28,000
2007	33,000-43,000		80,000			34,000
2008		45,000 [e]	80,000			22,000-49,000 [f]
2009		45,000	80,000			22,000-49,000
2010		42,500-55,000 [g]		70,000-104,000 [h]		22,000-49,000
2011		42,500-55,000		70,000-104,000		22,000-49,000
2012		42,500-55,000		70,000-104,000		22,000-49,000
2013		42,500-55,000		70,000-104,000		22,000-49,000
2014		42,500-55,000		70,000-104,000		22,000-49,000
2015		42,500-55,000		70,000-104,000		22,000-49,000
2016		42,500-55,000		70,000-104,000		22,000-49,000
2017		42,500-55,000		70,000-104,000		22,000-49,000
2018		42,500-55,000		70,000-104,000		22,000-49,000
2019		42,500-55,000		70,000-104,000		22,000-49,000
2020[i]		42,500-55,001		70,000-104,001		22,000-49,001

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Note: As per the Yukon River Salmon Agreement (YRSA), the Yukon River Panel (Panel) may recommend that both parties manage the current year salmon run to achieve annual stabilization/rebuilding/interim spawning escapement goals that differ from the escapement goals outlined in Appendix 1 and 2 of the YRSA. The goals shown in this table document what both parties managed to achieve in each year, based on recommendations by the Panel. All single numbers are considered minimums.

[a] Defined in Appendix 2 of the Yukon River Salmon Agreement. Not shown in years when different goals were recommended by the Panel.

[b] Defined in Appendix 1 of the Yukon River Salmon Agreement. Not shown in years when different goals were recommended by the Panel.

[c] Treaty was signed by governments in December 2002.

[d] In 2003, the Chinook salmon goal was set at 25,000 fish. However, if the U.S. conducted a commercial fishery the goal would be increased to 28,000 fish.

[e] Interim Management Escapement Goal (IMEG) assessed using sonar near Eagle (previous years were measured by mark–recapture abundance estimates).

[f] Interim Management Escapement Goal (IMEG) established for 2008–2010, based on percentile method, and recommended to continue by default if no new analysis in subsequent years.

[g] IMEG of 42,500 to 55,000 fish recommended in 2010, based on levels selected from several unpublished analyses.

[h] IMEG established in 2010 based on brood table of Canadian-origin mainstem stocks (1982–2003) and recommended to continue by default if no new analysis in subsequent years.

[i] 2020 Interim goals were recommended by the JTC for consideration by the Yukon River Panel.

Appendix A10.–Fall chum salmon age and sex percentages with average lengths from selected Yukon River escapement projects, 2019.

Location	Sample size		Age 3	Age 4	Age 5	Age 6	Age 7	Total	Mean length
Emmonak, Alaska [a]	1,187	Males	0.5	39.3	7.2	0.3	0.0	47.3	577
		Females	0.4	42.5	9.5	0.3	0.0	52.7	574
		Total	0.9	81.8	16.7	0.6	0.0	100.0	575
Delta River, Alaska [b]	160	Males	0.6	51.9	6.3	0.0	0.0	58.8	597
		Females	0.6	34.4	6.3	0.0	0.0	41.3	571
		Total	1.2	86.3	12.6	0.0	0.0	100.1	587
Yukon mainstem	311	Males	0.0	44.7	14.1	0.0	0.0	58.8	608
at Eagle, Alaska [a]		Females	1.3	33.1	6.8	0.0	0.0	41.2	583
		Total	1.3	77.8	20.9	0.0	0.0	100.0	598
Fishing Branch	585	Males	0.5	38.6	6.0	0.0	0.0	45.1	596
River, Canada [c]		Females	2.2	49.9	2.6	0.2	0.0	54.9	573
		Total	2.7	88.5	8.5	0.2	0.0	100.0	584

Note: Length is measured mid eye to the fork of tail to the nearest millimeter.

[a] Samples were from test fishing with drift gillnets, structure is scales.

[b] Samples were handpicked carcasses from east and middle channels, structure is vertebra.

[c] Samples were collected live at the weir, structure is scales.

APPENDIX B: TABLES

Appendix B1.–Alaska and Canadian total utilization of Yukon River Chinook, chum, and coho salmon, 1961–2019.

	Alaska/U.S. [a, b]			Yukon Territory/Canada [c]			Total		
Year	Chinook	Other salmon	Total	Chinook	Other salmon [d]	Total	Chinook	Other salmon	Total
1961	141,152	461,597	602,749	13,246	9,076	22,322	154,398	470,673	625,071
1962	105,844	434,663	540,507	13,937	9,436	23,373	119,781	444,099	563,880
1963	141,910	429,396	571,306	10,077	27,696	37,773	151,987	457,092	609,079
1964	109,818	504,420	614,238	7,408	12,221	19,629	117,226	516,641	633,867
1965	134,706	484,587	619,293	5,380	11,789	17,169	140,086	496,376	636,462
1966	104,887	309,502	414,389	4,452	13,324	17,776	109,339	322,826	432,165
1967	146,104	352,397	498,501	5,150	16,961	22,111	151,254	369,358	520,612
1968	118,632	270,818	389,450	5,042	11,633	16,675	123,674	282,451	406,125
1969	105,027	424,399	529,426	2,624	7,776	10,400	107,651	432,175	539,826
1970	93,019	585,760	678,779	4,663	3,711	8,374	97,682	589,471	687,153
1971	136,191	547,448	683,639	6,447	17,471	23,918	142,638	564,919	707,557
1972	113,098	461,617	574,715	5,729	7,532	13,261	118,827	469,149	587,976
1973	99,670	779,158	878,828	4,522	10,182	14,704	104,192	789,340	893,532
1974	118,053	1,229,678	1,347,731	5,631	11,646	17,277	123,684	1,241,324	1,365,008
1975	76,705	1,307,037	1,383,742	6,000	20,600	26,600	82,705	1,327,637	1,410,342
1976	105,582	1,026,908	1,132,490	5,025	5,200	10,225	110,607	1,032,108	1,142,715
1977	114,494	1,090,758	1,205,252	7,527	12,479	20,006	122,021	1,103,237	1,225,258
1978	130,476	1,615,312	1,745,788	5,881	9,566	15,447	136,357	1,624,878	1,761,235
1979	159,232	1,596,133	1,755,365	10,375	22,084	32,459	169,607	1,618,217	1,787,824
1980	197,665	1,730,960	1,928,625	22,846	23,718	46,564	220,511	1,754,678	1,975,189
1981	188,477	2,097,871	2,286,348	18,109	22,781	40,890	206,586	2,120,652	2,327,238
1982	152,808	1,265,457	1,418,265	17,208	16,091	33,299	170,016	1,281,548	1,451,564

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	Alaska/U.S. [a, b]			Yukon Territory/Canada [c]			Total		
Year	Chinook	Other salmon	Total	Chinook	Other salmon [d]	Total	Chinook	Other salmon	Total
1983	198,436	1,678,597	1,877,033	18,952	29,490	48,442	217,388	1,708,087	1,925,475
1984	162,683	1,548,101	1,710,784	16,795	29,767	46,562	179,478	1,577,868	1,757,346
1985	187,327	1,657,984	1,845,311	19,301	41,515	60,816	206,628	1,699,499	1,906,127
1986	146,004	1,758,825	1,904,829	20,364	14,843	35,207	166,368	1,773,668	1,940,036
1987	188,386	1,276,066	1,464,452	17,614	44,786	62,400	206,000	1,320,852	1,526,852
1988	150,009	2,360,718	2,510,727	21,427	33,915	55,342	171,436	2,394,633	2,566,069
1989	157,632	2,292,211	2,449,843	17,944	23,490	41,434	175,576	2,315,701	2,491,277
1990	149,433	1,055,515	1,204,948	19,227	34,304	53,531	168,660	1,089,819	1,258,479
1991	154,651	1,335,111	1,489,762	20,607	35,653	56,260	175,258	1,370,764	1,546,022
1992	169,642	880,535	1,050,177	17,903	21,312	39,215	187,545	901,847	1,089,392
1993	161,718	362,551	524,269	16,611	14,150	30,761	178,329	376,701	555,030
1994	171,654	567,074	738,728	21,198	38,342	59,540	192,852	605,416	798,268
1995	179,748	1,455,736	1,635,484	20,884	46,109	66,993	200,632	1,501,845	1,702,477
1996	141,649	1,143,992	1,285,641	19,612	24,395	44,007	161,261	1,168,387	1,329,648
1997	176,025	560,777	736,802	16,528	15,900	32,428	192,553	576,677	769,230
1998	99,760	201,480	301,240	5,937	8,168	14,105	105,697	209,648	315,345
1999	125,427	250,198	375,625	12,468	19,736	32,204	137,895	269,934	407,829
2000	45,867	120,424	166,291	4,879	9,283	14,162	50,746	129,707	180,453
2001	56,620	131,500	188,120	10,144	9,872	20,016	66,764	141,372	208,136
2002	69,240	137,688	206,928	9,258	8,567	17,825	78,498	146,255	224,753
2003	101,000	214,323	315,323	9,619	11,435	21,054	110,619	225,758	336,377
2004	114,370	214,744	329,114	11,238	9,930	21,168	125,608	224,674	350,282
2005	86,369	493,542	579,911	11,371	18,583	29,954	97,740	512,125	609,865

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	Alaska/U.S. [a, b]			Yukon Territory/Canada [c]			Total		
Year	Chinook	Other salmon	Total	Chinook	Other salmon [d]	Total	Chinook	Other salmon	Total
2006	96,067	553,299	649,366	9,072	11,908	20,980	105,139	565,207	670,346
2007	90,753	548,568	639,321	5,094	14,332	19,426	95,847	562,900	658,747
2008	50,362	500,029	550,391	3,713	9,566	13,279	54,075	509,595	563,670
2009	35,111	368,717	403,828	4,758	2,011	6,769	39,869	370,728	410,597
2010	55,092	415,968	471,060	2,706	5,891	8,597	57,798	421,859	479,657
2011	41,625	780,784	822,409	4,884	8,226	13,110	46,509	789,010	835,519
2012	30,831	935,740	966,571	2,200	7,033	9,233	33,031	942,773	975,804
2013	12,741	1,037,537	1,050,278	2,146	6,170	8,316	14,887	1,043,707	1,058,594
2014	3,287	950,408	953,695	103	5,166	5,269	3,390	955,574	958,964
2015	7,595	872,084	879,679	1,204	4,453	5,657	8,799	876,537	885,336
2016 [e]	21,704	1,376,984	1,398,688	2,946	5,750	8,696	24,650	1,382,734	1,407,384
2017 [e]	38,411	1,369,593	1,408,004	3,631	5,787	9,418	42,042	1,375,380	1,417,422
2018 [e]	32,213	1,225,703	1,257,916	3,098	4,856	7,954	35,311	1,230,559	1,265,870
2019 [e]	51,733	688,339	740,072	3,104	3,759	6,863	54,837	692,098	746,935
Average									
1961–2018	112,121	890,327	1,002,448	10,219	16,167	26,386	122,340	906,494	1,028,834
2009–2018	27,861	933,352	961,213	2,768	5,534	8,302	30,629	938,886	969,515
2014–2018	20,642	1,158,954	1,179,596	2,196	5,202	7,399	22,838	1,164,157	1,186,995
Minimum-18	3,287	120,424	166,291	103	2,011	5,269	3,390	129,707	180,453
Maximum-18	198,436	2,360,718	2,510,727	22,846	46,109	66,993	220,511	2,394,633	2,566,069

Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Catch in number of salmon. Includes estimated number of salmon harvested for the commercial production of salmon roe.

[b] Commercial, subsistence, personal use, test fish retained for subsistence, and sport catches combined. Beginning 2017, includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

[c] Catch in number of salmon. Commercial, Aboriginal, domestic, and sport catches combined.

[d] Includes coho salmon harvests in First Nations, public angling, and commercial fisheries, most of which was harvested in the Old Crow Aboriginal fishery (99.8%).

[e] Data are preliminary; particularly not yet published Alaska subsistence harvest data from 2016–2019.

Appendix B2.–Alaska harvest of Yukon River Chinook salmon, 1961–2019.

Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales	Sport fish	Yukon Area total
1961	21,488	119,664					141,152
1962	11,110	94,734					105,844
1963	24,862	117,048					141,910
1964	16,231	93,587					109,818
1965	16,608	118,098					134,706
1966	11,572	93,315					104,887
1967	16,448	129,656					146,104
1968	12,106	106,526					118,632
1969	14,000	91,027					105,027
1970	13,874	79,145					93,019
1971	25,684	110,507					136,191
1972	20,258	92,840					113,098
1973	24,317	75,353					99,670
1974	19,964	98,089					118,053
1975	12,867	63,838					76,705
1976	17,806	87,776					105,582
1977	17,581	96,757				156	114,494
1978	30,785	99,168				523	130,476
1979	31,005	127,673				554	159,232
1980	42,724	153,985				956	197,665
1981	29,690	158,018				769	188,477
1982	28,158	123,644				1,006	152,808
1983	49,478	147,910				1,048	198,436
1984	42,428	119,904				351	162,683
1985	39,771	146,188				1,368	187,327
1986	45,238	99,970				796	146,004
1987	51,418	134,760 [e]		1,706		502	188,386

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales	Sport fish	Yukon Area total
1988	45,495	100,364		2,125	1,081	944	150,009
1989	48,462	104,198		2,616	1,293	1,063	157,632
1990	48,587	95,247 [e]	413	2,594	2,048	544	149,433
1991	46,773	104,878 [e]	1,538		689	773	154,651
1992	47,077	120,245 [e]	927		962	431	169,642
1993	63,915	93,550	560	426	1,572	1,695	161,718
1994	53,902	113,137	703		1,631	2,281	171,654
1995	50,620	122,728	1,324	399	2,152	2,525	179,748
1996	45,671	89,671	521	215	1,698	3,873	141,649
1997	57,117	112,841	769	313	2,811	2,174	176,025
1998	54,124	43,618	81	357	926	654	99,760
1999	53,305	69,275	288	331	1,205	1,023	125,427
2000	36,404	8,515	-	75	597	276	45,867
2001	55,819	-	-	122	-	679	56,620
2002	43,742	24,128	230	126	528	486	69,240
2003	56,959	40,438	-	204	680	2,719	101,000
2004	55,713	56,151	-	201	792	1,513	114,370
2005	53,409	32,029	-	138	310	483	86,369
2006	48,593	45,829	-	89	817	739	96,067
2007	55,174	33,634	-	136	849	960	90,753
2008	45,186	4,641	-	126	-	409	50,362
2009	33,805	316	-	127	-	863	35,111
2010	44,559	9,897	-	162	-	474	55,092
2011	40,980	82 [f]	-	89	-	474	41,625
2012	30,415	-	-	71	-	345	30,831
2013	12,533	-	-	42	-	166	12,741
2014	3,286	-	-	1	-	0	3,287

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales	Sport fish	Yukon Area total
2015	7,577	-	-	5	-	13	7,595
2016	21,627 [g]	-	-	57 [g]	-	20	21,704
2017	38,100 [g]	168 [f]	-	125 [g]	-	18	38,411
2018	31,812 [g]	-	-	201 [g]	-	200	32,213
2019	48,379 [g]	3,110 [h]	-	244	-	- [i]	51,733
Averages							
1961–2018	34,797	86,368	669	454	1,192	877	112,121
2009–2018	26,469	2,616	-	88	-	257	27,861
2014–2018	20,480	168	-	78	-	50	20,642
Minimum-18	3,286	82	81	1	310	0	3,287
Maximum-18	63,915	158,018	1,538	2,616	2,811	3,873	198,436

Note: Minimum and maximum indicate lowest and highest values through 2018.

[a] Includes test fish harvest and commercial retained fish (not sold) that were utilized for subsistence. Beginning 2017, includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

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

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

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

[e] Includes Chinook salmon sold illegally.

[f] No Chinook salmon were sold in the summer season. A total of 82 and 168 Chinook salmon were sold in District 1 and 2 in the fall season in 2011 and 2017 respectively.

[g] Data are not yet published and are considered preliminary.

[h] Incidental harvest to chum salmon directed fishery in the summer season and allowed sales in the fall season.

[i] Data are unavailable at this time.

Appendix B3.–Alaska harvest of Yukon River summer chum salmon, 1970–2019.

Year	Subsistence[a]	Commercial[b]	Commercial related[c]	Personal use[d]	Test fish sales	Sport fish	Yukon Area total
1970	166,504	137,006					303,510
1971	171,487	100,090					271,577
1972	108,006	135,668					243,674
1973	161,012	285,509					446,521
1974	227,811	589,892					817,703
1975	211,888	710,295					922,183
1976	186,872	600,894					787,766
1977	159,502	534,875				316	694,693
1978	171,383	1,052,226	25,761			451	1,249,821
1979	155,970	779,316	40,217			328	975,831
1980	167,705	928,609	139,106			483	1,235,903
1981	117,629	1,006,938	272,763			612	1,397,942
1982	117,413	461,403	255,610			780	835,206
1983	149,180	744,879	250,590			998	1,145,647
1984	166,630	588,597	277,443			585	1,033,255
1985	157,744	516,997	417,016			1,267	1,093,024
1986	182,337	721,469	467,381			895	1,372,082
1987	200,346	442,238	180,303	4,262		846	827,995
1988	227,829	1,148,650	468,032	2,225	3,587	1,037	1,851,360
1989	169,496	955,806[e]	496,934	1,891	10,605	2,132	1,636,864
1990	115,609	302,625	214,552	1,827	8,263	472	643,348
1991	118,540	349,113[e]	308,989		3,934	1,037	781,613
1992	142,192	332,313[e]	211,264		1,967	1,308	689,044
1993	125,574	96,522	43,594	674	1,869	564	268,797
1994	124,807	80,284	178,457		3,212	350	387,110
1995	136,083	259,774	558,640	780	6,073	1,174	962,524
1996	124,738	147,127	535,106	905	7,309	1,946	817,131

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales	Sport fish	Yukon Area total
1997	112,820	95,242	133,010	391	2,590	662	344,715
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	[f]	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 [g]	194	445,331
2016	87,992 [h]	525,809	0	176 [h]	380	264	614,621
2017	87,437 [h]	556,516	0	438 [h]	1,819	186	646,396
2018	76,926 [h]	576,700	0	509 [h]	1,028	200	655,363
2019	63,303 [h]	227,089	0	294 [h]	230	- [i]	290,916

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales	Sport fish	Yukon Area total
Averages							
1970–2018	127,824	390,300	133,537	620	2,116	664	624,168
2009–2018	92,986	403,201	0	310	1,044	456	497,997
2014–2018	84,564	509,705	0	316	1,144	244	595,973
Minimum-18	72,155	6,624	0	30	0	82	72,383
Maximum-18	227,829	1,148,650	558,640	4,262	10,605	2,132	1,851,360

Note: Minimum and maximum indicate lowest and highest values through 2018.

[a] Includes test fish giveaways and commercial retained fish (not sold) that were utilized for subsistence. Beginning 2017, includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

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

[c] Includes an estimate of the number of salmon harvested for the commercial production of salmon roe; including carcasses from subsistence caught fish.

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

[e] Includes illegal sales of summer chum salmon.

[f] Summer season commercial fishery was not conducted.

[g] Test fish sales includes both the Lower Yukon Test Fishery sales and Purse Seine Test Fishery sales.

[h] Data are not yet published and are considered preliminary.

[i] Data are unavailable at this time.

Appendix B4.–Alaska harvest of Yukon River fall chum salmon, 1961–2019.

Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales [e]	Yukon Area total
1961	101,772 [f, g]	42,461	0			144,233
1962	87,285 [f, g]	53,116	0			140,401
1963	99,031 [f, g]					99,031
1964	120,360 [f, g]	8,347	0			128,707
1965	112,283 [f, g]	23,317	0			135,600
1966	51,503 [f, g]	71,045	0			122,548
1967	68,744 [f, g]	38,274	0			107,018
1968	44,627 [f, g]	52,925	0			97,552
1969	52,063 [f, g]	131,310	0			183,373
1970	55,501 [f, g]	209,595	0			265,096
1971	57,162 [f, g]	189,594	0			246,756
1972	36,002 [f, g]	152,176	0			188,178
1973	53,670 [f, g]	232,090	0			285,760
1974	93,776 [f, g]	289,776	0			383,552
1975	86,591 [f, g]	275,009	0			361,600
1976	72,327 [f, g]	156,390	0			228,717
1977	82,771 [g]	257,986	0			340,757
1978	84,239 [g]	236,383	10,628			331,250
1979	214,881	359,946	18,466			593,293
1980	167,637	293,430	5,020			466,087
1981	177,240	466,451	11,285			654,976
1982	132,092	224,187	805			357,084
1983	187,864	302,598	5,064			495,526
1984	172,495	208,232	2,328			383,055
1985	203,947	267,744	2,525			474,216
1986	163,466	139,442	577			303,485
1987	342,819 [h]	[i]		19,066		361,885

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales [e]	Yukon Area total
1988	153,848	133,763	3,227	3,881	27,663	322,382
1989	211,303	270,195	14,749	5,082	20,973	522,302
1990	167,900	124,174	12,168	5,176	9,224	318,642
1991	145,524	230,852	23,366	0	3,936	403,678
1992	107,808	15,721 [j]	3,301	0	1,407	128,237
1993	76,882	[i]		163	0	77,045
1994	123,565	3,631	4,368	0	0	131,564
1995	130,860	250,766	32,324	863	1,121	415,934
1996	129,258	88,342	17,288	356	1,717	236,961
1997	95,141	56,713	1,474	284	867	154,479
1998	62,901	[i]		2	0	62,903
1999	89,940	20,371	0	262	1,171	111,744
2000	19,395	[i]		1	0	19,396
2001	35,703	[i]		10	0	35,713
2002	19,674	[i]		3	0	19,677
2003	56,930	10,996	0	394	0	68,320
2004	62,526	4,110	0	230	0	66,866
2005	91,534	180,249	0	133	87	272,003
2006	84,002	174,542	0	333	0	258,877
2007	101,221	90,677	0	173	0	192,071
2008	89,357	119,265	0	181	0	208,803
2009	66,119	25,876	0	78	0	92,073
2010	68,645	2,550	0	3,209	0	74,404
2011	80,202	238,979	0	347	0	319,528
2012	99,309	289,692	0	410	166	389,577
2013	113,384	238,051	0	383	121	351,939
2014	92,529	115,599	0	278	30	208,436

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales [e]	Yukon Area total
2015	86,600	191,470	0	80	50	278,200
2016	84,650 [k]	465,511	0	283 [k]	668	551,112
2017	85,093 [k]	489,702	0	626 [k]	1,246	576,667
2018	64,494 [k]	387,788	0	514 [k]	907	453,703
2019	63,862 [k]	268,360 [l]	0	408 [k]	275	332,905
Averages						
1961–2018	103,766	174,537	3,313	1,338	2,302	262,120
2009–2018	84,103	244,522	0	621	319	329,564
2014–2018	82,673	330,014	0	356	580	413,624
Minimum-18	19,395	2,550	0	0	0	19,396
Maximum-18	342,819	489,702	32,324	19,066	27,663	654,976

Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Includes test fish harvest and commercial retained fish (not sold) that were utilized for subsistence. Beginning 2017, includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

[b] Includes fish sold in the round and estimated numbers of female salmon commercially harvested for production of salmon roe (Bergstrom et al. 1992). Includes ADF&G test fish prior to 1988. Beginning in 1999, commercial harvest may include some commercial related harvest.

[c] Includes an estimate of number of salmon harvested for the commercial production of salmon roe and the carcasses used for subsistence. In prior JTC reports, subsistence plus commercial related harvests are noted as subsistence "use".

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

[e] Test fish sales is the number of salmon sold by ADF&G test fisheries.

[f] Catches estimated because harvests of species other than Chinook salmon were not differentiated.

[g] Minimum estimates from 1961–1978 because subsistence surveys were conducted prior to the end of the fishing season.

[h] Includes an estimated 95,768 and 119,168 fall chum salmon illegally sold in Districts 5 (Yukon River) and 6 (Tanana River), respectively.

[i] Commercial fishery was not conducted.

j Commercial fishery operated only in District 6, the Tanana River.

[k] Data are not yet published and are considered preliminary.

Appendix B5.–Alaska harvest of Yukon River coho salmon, 1961–2019.

Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales [e]	Sport fish [f]	Yukon Area total
1961	9,192 [g, h]	2,855	0				12,047
1962	9,480 [g, h]	22,926	0				32,406
1963	27,699 [g, h]	5,572	0				33,271
1964	12,187 [g, h]	2,446	0				14,633
1965	11,789 [g, h]	350	0				12,139
1966	13,192 [g, h]	19,254	0				32,446
1967	17,164 [g, h]	11,047	0				28,211
1968	11,613 [g, h]	13,303	0				24,916
1969	7,776 [g, h]	15,093	0				22,869
1970	3,966 [g, h]	13,188	0				17,154
1971	16,912 [g, h]	12,203	0				29,115
1972	7,532 [g, h]	22,233	0				29,765
1973	10,236 [g, h]	36,641	0				46,877
1974	11,646 [g, h]	16,777	0				28,423
1975	20,708 [g, h]	2,546	0				23,254
1976	5,241 [g, h]	5,184	0				10,425
1977	16,333 [h]	38,863	0			112	55,308
1978	7,787 [h]	26,152	0			302	34,241
1979	9,794	17,165	0			50	27,009
1980	20,158	8,745	0			67	28,970
1981	21,228	23,680	0			45	44,953
1982	35,894	37,176	0			97	73,167
1983	23,905	13,320	0			199	37,424
1984	49,020	81,940	0			831	131,791
1985	32,264	57,672	0			808	90,744
1986	34,468	47,255	0			1,535	83,258
1987	82,371 [i]	[j]		2,523		1,292	86,186

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Year	Subsistence[a]	Commercial[b]	Commercial related[c]	Personal use[d]	Test fish sales[e]	Sport fish[f]	Yukon Area total
1988	69,679	99,907	0	1,250	13,720	2,420	186,976
1989	40,924	85,493	0	872	3,945	1,811	133,045
1990	43,460	41,032	3,255	1,181	2,650	1,947	93,525
1991	37,388	103,180	3,506	0	2,971	2,775	149,820
1992	51,980	6,556 [k]	1,423	0	1,629	1,666	63,254
1993	15,812	[j]		0	0	897	16,709
1994	41,775	120	4,331	0	0	2,174	48,400
1995	28,377	45,939	1,074	417	193	1,278	77,278
1996	30,404	52,643	3,339	198	1,728	1,588	89,900
1997	23,945	35,320	0	350	498	1,470	61,583
1998	18,121	1	0	9	0	758	18,889
1999	20,891	1,601	0	147	236	609	23,484
2000	14,939	[j]		0	0	554	15,493
2001	22,122	[j]		34	0	1,248	23,404
2002	15,489	[j]		20	0	1,092	16,601
2003	23,872	25,243	0	549	0	1,477	51,141
2004	20,795	20,232	0	233	0	1,623	42,883
2005	27,250	58,311	0	107	0	627	86,295
2006	19,706	64,942	0	279	0	1,000	85,927
2007	19,624	44,575	0	135	0	597	64,931
2008	16,855	35,691	0	50	0	341	52,937
2009	16,006	8,311	0	70	0	964	25,351
2010	13,045	3,750	0	1,062	0	944	18,801
2011	12,344	76,303	0	232	0	463	89,342
2012	21,533	74,789	0	100	39	131	96,592
2013	14,457	66,199	0	109	1	266	81,032
2014	17,098	104,692	0	174	0	1,855	123,819

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Year	Subsistence [a]	Commercial [b]	Commercial related [c]	Personal use [d]	Test fish sales [e]	Sport fish [f]	Yukon Area total
2015	18,107	129,700	0	145	8	593	148,553
2016	8,822 [l]	201,482	0	266 [l]	11	670	211,251
2017	7,281 [l]	139,915	0	200 [l]	63	291	147,750
2018	5,527 [l]	110,587	0	131 [l]	48	544	116,837
2019	5,819 [l]	58,591	0	68	40	- [m]	64,518
Averages							
1961–2018	21,848	41,323	319	339	895	953	61,255
2009–2018	13,422	91,573	0	249	17	672	105,933
2014–2018	11,367	137,275	0	183	26	791	149,642
Minimum-18	3,966	1	0	0	0	45	10,425
Maximum-18	82,371	201,482	4,331	2,523	13,720	2,775	211,251

Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Includes test fish harvest and commercial retained fish (not sold) that were utilized for subsistence. Beginning 2017, includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

[b] Includes fish sold in the round and estimated numbers of female salmon commercially harvested for production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area Annual Management Report). Includes ADF&G test fish prior to 1988. Beginning in 1999, commercial harvest may include some commercial related harvest.

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

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

[e] Test fish sales is the number of salmon sold by ADF&G test fisheries.

[f] The majority of the sport-fish harvest is taken in the Tanana River drainage.

[g] Catches estimated because harvests of species other than Chinook salmon were not differentiated.

[h] Minimum estimates from 1961–1978 because subsistence surveys were conducted prior to the end of the fishing season.

[i] Includes an estimated 5,015 and 31,276 coho salmon illegally sold in Districts 5 (Yukon River) and 6 (Tanana River), respectively.

[j] Commercial fishery was not conducted.

[k] Commercial fishery operated only in District 6, the Tanana River.

[l] Data are not yet published and are considered preliminary.

[m] Data are unavailable at this time.

Appendix B6.–Alaska and Canadian total utilization of Yukon River Chinook and fall chum salmon, 1961–2019.

	Chinook salmon			Fall chum salmon		
Year	Canada [a]	Alaska [b, c]	Total	Canada [a]	Alaska [b, c]	Total
1961	13,246	141,152	154,398	9,076	144,233	153,309
1962	13,937	105,844	119,781	9,436	140,401	149,837
1963	10,077	141,910	151,987	27,696	99,031 [d]	126,727
1964	7,408	109,818	117,226	12,187	128,707	140,894
1965	5,380	134,706	140,086	11,789	135,600	147,389
1966	4,452	104,887	109,339	13,192	122,548	135,740
1967	5,150	146,104	151,254	16,961	107,018	123,979
1968	5,042	118,632	123,674	11,633	97,552	109,185
1969	2,624	105,027	107,651	7,776	183,373	191,149
1970	4,663	93,019	97,682	3,711	265,096	268,807
1971	6,447	136,191	142,638	16,911	246,756	263,667
1972	5,729	113,098	118,827	7,532	188,178	195,710
1973	4,522	99,670	104,192	10,135	285,760	295,895
1974	5,631	118,053	123,684	11,646	383,552	395,198
1975	6,000	76,705	82,705	20,600	361,600	382,200
1976	5,025	105,582	110,607	5,200	228,717	233,917
1977	7,527	114,494	122,021	12,479	340,757	353,236
1978	5,881	130,476	136,357	9,566	331,250	340,816
1979	10,375	159,232	169,607	22,084	593,293	615,377
1980	22,846	197,665	220,511	22,218	466,087	488,305
1981	18,109	188,477	206,586	22,281	654,976	677,257
1982	17,208	152,808	170,016	16,091	357,084	373,175
1983	18,952	198,436	217,388	29,490	495,526	525,016
1984	16,795	162,683	179,478	29,267	383,055	412,322
1985	19,301	187,327	206,628	41,265	474,216	515,481
1986	20,364	146,004	166,368	14,543	303,485	318,028
1987	17,614	188,386	206,000	44,480	361,885 [d]	406,365
1988	21,427	150,009	171,436	33,565	322,382	355,947
1989	17,944	157,632	175,576	23,020	522,302	545,322
1990	19,227	149,433	168,660	33,622	318,642	352,264
1991	20,607	154,651	175,258	35,418	403,678	439,096
1992	17,903	169,642	187,545	20,815	128,237 [e]	149,052
1993	16,611	161,718	178,329	14,090	77,045 [d]	91,135
1994	21,198	171,654	192,852	38,008	131,564	169,572
1995	20,884	179,748	200,632	45,600	415,934	461,534
1996	19,612	141,649	161,261	24,354	236,961	261,315
1997	16,528	176,025	192,553	15,600	154,479	170,079
1998	5,937	99,760	105,697	7,954	62,903	70,857
1999	12,468	125,427	137,895	19,636	111,744	131,380

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	Chinook salmon					Fall chum salmon				
Year	Canada	a	Alaska	b, c	Total	Canada	a	Alaska	b, c	Total
2000	4,879		45,867		50,746	9,246		19,396	d	28,642
2001	10,144		56,620	f	66,764	9,872		35,713	d	45,585
2002	9,258		69,240		78,498	8,092		19,677	d	27,769
2003	9,619		101,000		110,619	10,905		68,320		79,225
2004	11,238		114,370		125,608	9,750		66,866		76,616
2005	11,371		86,369		97,740	18,572		272,003		290,575
2006	9,072		96,067		105,139	11,796		258,877		270,673
2007	5,094		90,753		95,847	13,830		192,071		205,901
2008	3,713		50,362		54,075	9,566		208,803		218,369
2009	4,758		35,111		39,869	2,011		92,073		94,084
2010	2,706		55,092		57,798	5,787		74,404		80,191
2011	4,884		41,625	f	46,509	8,163		319,528		327,691
2012	2,200		30,831	f	33,031	7,023		389,577		396,600
2013	2,146		12,741	f	14,887	6,170		351,939		358,109
2014	103		3,287	f	3,390	5,033		208,436		213,469
2015	1,204		7,595	f	8,799	4,453		278,200		282,653
2016 [g]	2,946		21,704	f	24,650	5,750		551,112		556,862
2017 [g]	3,631		38,411	f	42,042	5,716		576,667		582,383
2018 [g]	3,098		32,213	f	35,311	4,831		453,703		458,534
2019 [g]	3,104		51,733		54,837	3,759		332,905		336,664
Averages										
1961–2018	10,219		112,121		122,340	15,991		262,120		278,111
2009–2018	2,768		27,861		30,629	5,494		329,564		335,058
2014–2018	2,196		20,642		22,838	5,157		413,624		418,780
Minimum-18	103		3,287		3,390	2,011		19,396		27,769
Maximum-18	22,846		198,436		220,511	45,600		654,976		677,257

Note: Minimum and maximum indicate year with the lowest and highest values through 2018. Canadian managers do not refer to chum as fall chum salmon since they only have 1 chum salmon run.

[a] Catches in number of salmon. Includes commercial, Aboriginal, domestic, and sport catches combined.

[b] Catch in number of salmon. Includes estimated number of salmon harvested for the commercial production of salmon roe (see Bergstrom et al. 1992: 1990 Yukon Area Annual Management Report).

[c] Commercial, subsistence, personal-use, test fish, and sport catches combined. Beginning 2017 includes harvest from the Coastal District communities of Scammon Bay and Hooper Bay even though not all stocks are bound for the Yukon River. Coastal District harvest information is included in the following years: 1978, 1987–1989 and 1992 to present.

[d] Commercial fishery did not operate within the Alaskan portion of the drainage.

[e] Commercial fishery operated only in District 6, the Tanana River.

[f] No commercial fishery was conducted during the summer season.

[g] Data are preliminary.

Appendix B7.–Canadian harvest of Yukon River Chinook salmon, 1961–2019.

	Mainstem Yukon River harvest							Porcupine River	
Year	Commercial	Domestic	Aboriginal fishery	Recreational [a]	Test fishery	Combined non-commercial	Total	Aboriginal fishery harvest	Total Canadian harvest
1961	3,446		9,300			9,300	12,746	500	13,246
1962	4,037		9,300			9,300	13,337	600	13,937
1963	2,283		7,750			7,750	10,033	44	10,077
1964	3,208		4,124			4,124	7,332	76	7,408
1965	2,265		3,021			3,021	5,286	94	5,380
1966	1,942		2,445			2,445	4,387	65	4,452
1967	2,187		2,920			2,920	5,107	43	5,150
1968	2,212		2,800			2,800	5,012	30	5,042
1969	1,640		957			957	2,597	27	2,624
1970	2,611		2,044			2,044	4,655	8	4,663
1971	3,178		3,260			3,260	6,438	9	6,447
1972	1,769		3,960			3,960	5,729		5,729
1973	2,199		2,319			2,319	4,518	4	4,522
1974	1,808	406	3,342			3,748	5,556	75	5,631
1975	3,000	400	2,500			2,900	5,900	100	6,000
1976	3,500	500	1,000			1,500	5,000	25	5,025
1977	4,720	531	2,247			2,778	7,498	29	7,527
1978	2,975	421	2,485			2,906	5,881		5,881
1979	6,175	1,200	3,000			4,200	10,375		10,375
1980	9,500	3,500	7,546	300		11,346	20,846	2,000	22,846
1981	8,593	237	8,879	300		9,416	18,009	100	18,109
1982	8,640	435	7,433	300		8,168	16,808	400	17,208
1983	13,027	400	5,025	300		5,725	18,752	200	18,952
1984	9,885	260	5,850	300		6,410	16,295	500	16,795
1985	12,573	478	5,800	300		6,578	19,151	150	19,301
1986	10,797	342	8,625	300		9,267	20,064	300	20,364
1987	10,864	330	6,069	300		6,699	17,563	51	17,614
1988	13,217	282	7,178	650		8,110	21,327	100	21,427
1989	9,789	400	6,930	300		7,630	17,419	525	17,944
1990	11,324	247	7,109	300		7,656	18,980	247	19,227
1991	10,906	227	9,011	300		9,538	20,444	163	20,607
1992	10,877	277	6,349	300		6,926	17,803	100	17,903

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	Mainstem Yukon River harvest							Porcupine River	
Year	Commercial	Domestic	Aboriginal fishery	Recreational [a]	Test fishery	Combined non-commercial	Total	Aboriginal fishery harvest	Total Canadian harvest
1993	10,350	243	5,576	300		6,119	16,469	142	16,611
1994	12,028	373	8,069	300		8,742	20,770	428	21,198
1995	11,146	300	7,942	700		8,942	20,088	796	20,884
1996	10,164	141	8,451	790		9,382	19,546	66	19,612
1997	5,311	288	8,888	1,230		10,406	15,717	811	16,528
1998	390	24	4,687	-	737	5,448	5,838	99	5,937
1999	3,160	213	8,804	177		9,194	12,354	114	12,468
2000	-	-	4,068	-	761	4,829	4,829	50	4,879
2001	1,351	89	7,421	146	767	8,423	9,774	370	10,144
2002	708	59	7,139	128	1,036	8,362	9,070	188	9,258
2003	2,672	115	6,121	275	263	6,774	9,446	173	9,619
2004	3,785	88	6,483	423	167	7,161	10,946	292	11,238
2005	4,066	99	6,376	436		6,911	10,977	394	11,371
2006	2,332	63	5,757	606		6,426	8,758	314	9,072
2007	-	-	4,175	2 [b]	617	4,794	4,794	300	5,094
2008	1 [c]	-	2,885	-	513	3,398	3,399	314	3,713
2009	364	17	3,791	125	-	3,933	4,297	461	4,758
2010	-	-	2,455 [d]	1 [e]	-	2,456	2,456	250	2,706
2011	4 [c]	-	4,550 [d]	40	-	4,590	4,594	290	4,884
2012	-	-	2,000 [d]	-	-	2,000	2,000	200	2,200
2013	2 [c]	-	1,902 [d]	-	-	1,902	1,904	242	2,146
2014	-	-	100	-	-	100	100	3	103
2015	-	-	1,000	-	-	1,000	1,000	204	1,204
2016	1 [c]	-	2,768	-	-	2,768	2,769	177	2,946
2017	-	-	3,500	-	-	3,500	3,500	131	3,631
2018	1 [c]	-	2,789	-	-	2,789	2,790	308	3,098
2019	-	-	2,764	-	-	2,764	2,764	340	3,104
Averages									
1961–2018	5,717 [f]	393	4,970	342 [f]	608	5,449	9,983	249	10,219
2009–2018	364 [f]	17	2,486	55	-	2,504	2,541	227	2,768
2014–2018	-	-	2,031	-	-	2,031	2,032	165	2,196
Minimum-18	1	17	100	1	167	100	100	3	103
Maximum-18	13,217	3,500	9,300	1,230	1,036	11,346	21,327	2,000	22,846

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Note: Minimum and maximum indicate year with the lowest and highest values through 2018. Dash indicates fishery did not occur.

[a] Recreational harvest unknown before 1980.

[b] Recreational fishery involved non-retention of Chinook salmon for most of the season thus effectively closed.

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

[d] Adjusted to account for underreporting.

[e] Fishery was closed, 1 fish mistakenly caught and retained.

[f] Excluding years when no directed fishery occurred.

Appendix B8.–Canadian harvest of Yukon River fall chum salmon, 1961–2019.

	Mainstem Yukon River harvest						Porcupine River	
Year	Commercial	Domestic	Aboriginal fishery	Test fishery	Combined non-commercial [a]	Total [a]	Aboriginal fishery harvest	Total Canadian harvest
1961	3,276		3,800		3,800	7,076	2,000	9,076
1962	936		6,500		6,500	7,436	2,000	9,436
1963	2,196		5,500		5,500	7,696	20,000	27,696
1964	1,929		4,200		4,200	6,129	6,058	12,187
1965	2,071		2,183		2,183	4,254	7,535	11,789
1966	3,157		1,430		1,430	4,587	8,605	13,192
1967	3,343		1,850		1,850	5,193	11,768	16,961
1968	453		1,180		1,180	1,633	10,000	11,633
1969	2,279		2,120		2,120	4,399	3,377	7,776
1970	2,479		612		612	3,091	620	3,711
1971	1,761		150		150	1,911	15,000	16,911
1972	2,532				0	2,532	5,000	7,532
1973	2,806		1,129		1,129	3,935	6,200	10,135
1974	2,544	466	1,636		2,102	4,646	7,000	11,646
1975	2,500	4,600	2,500		7,100	9,600	11,000	20,600
1976	1,000	1,000	100		1,100	2,100	3,100	5,200
1977	3,990	1,499	1,430		2,929	6,919	5,560	12,479
1978	3,356	728	482		1,210	4,566	5,000	9,566
1979	9,084	2,000	11,000		13,000	22,084		22,084
1980	9,000	4,000	3,218		7,218	16,218	6,000	22,218
1981	15,260	1,611	2,410		4,021	19,281	3,000	22,281
1982	11,312	683	3,096		3,779	15,091	1,000	16,091
1983	25,990	300	1,200		1,500	27,490	2,000	29,490
1984	22,932	535	1,800		2,335	25,267	4,000	29,267
1985	35,746	279	1,740		2,019	37,765	3,500	41,265
1986	11,464	222	2,200		2,422	13,886	657	14,543
1987	40,591	132	3,622		3,754	44,345	135	44,480

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	Mainstem Yukon River harvest						Porcupine River	
Year	Commercial	Domestic	Aboriginal fishery	Test fishery	Combined non-commercial [a]	Total [a]	Aboriginal fishery harvest	Total Canadian harvest
1988	30,263	349	1,882		2,231	32,494	1,071	33,565
1989	17,549	100	2,462	300	2,562	20,111	2,909	23,020
1990	27,537	0	3,675		3,675	31,212	2,410	33,622
1991	31,404	0	2,438		2,438	33,842	1,576	35,418
1992	18,576	0	304		304	18,880	1,935	20,815
1993	7,762	0	4,660		4,660	12,422	1,668	14,090
1994	30,035	0	5,319		5,319	35,354	2,654	38,008
1995	39,012	0	1,099		1,099	40,111	5,489	45,600
1996	20,069	0	1,260		1,260	21,329	3,025	24,354
1997	8,068	0	1,238		1,238	9,306	6,294	15,600
1998[b]	-		1,795		1,795	1,795	6,159	7,954
1999	10,402	0	3,234		3,234	13,636	6,000	19,636
2000	1,319	0	2,927		2,927	4,246	5,000	9,246
2001	2,198	3	3,077	1 [b]	3,080	5,278	4,594	9,872
2002	3,065	0	3,167	2,756 [b]	3,167	6,232	1,860	8,092
2003	9,030	0	1,493	990 [b]	1,493	10,523	382	10,905
2004	7,365	0	2,180	995 [b]	2,180	9,545	205	9,750
2005	11,931	13	2,035		2,048	13,979	4,593	18,572
2006	4,096	0	2,521		2,521	6,617	5,179	11,796
2007	7,109	0	2,221	3,765 [b]	2,221	9,330	4,500	13,830
2008	4,062	0	2,068		2,068	6,130	3,436	9,566
2009	293	0	820		820	1,113	898	2,011
2010	2,186	0	1,523 [c]		1,523	3,709	2,078	5,787
2011	5,312	0	1,000 [c]		1,000	6,312	1,851	8,163
2012	3,205	0	700 [c]		700	3,905	3,118	7,023
2013	3,369	18	500 [c]		518	3,887	2,283	6,170

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Year	Mainstem Yukon River harvest: Commercial	Domestic	Aboriginal fishery	Test fishery	Combined non-commercial [a]	Total [a]	Porcupine River: Aboriginal fishery harvest	Total Canadian harvest
2014	2,485	19	546		565	3,050	1,983	5,033
2015	2,862	35	1,000 [c]		1,035	3,897	556	4,453
2016	1,745	0	1,000 [c]		1,000	2,745	3,005	5,750
2017	2,404	0	1,000 [c]		1,000	3,404	2,312	5,716
2018	1,957	0	1,000 [c]		1,000	2,957	1,874	4,831
2019	1,728	31	1,000 [c]		1,031	2,759	1,000	3,759
Averages								
1961–2018	9,485	423	2,232	1,468	2,514	11,836	4,228	15,991
2009–2018	2,582	7	909	-	916	3,498	1,996	5,494
2014–2018	2,291	11	909	-	920	3,211	1,946	5,157
Minimum-18	293	0	100	1	0	1,113	135	2,011
Maximum-18	40,591	4,600	11,000	3,765	13,000	44,345	20,000	45,600

Note: Minimum and maximum indicate year with the lowest and highest values through 2018. Dash indicates fishery did not occur.

[a] Test fishery was not included in totals as it was live release.

[b] The chum salmon test fishery practiced live release therefore not included in the annual harvest totals.

[c] Adjusted to account for underreporting.

Appendix B9.–Chinook salmon aerial survey indices for selected spawning areas in the U.S. (Alaska) portion of the Yukon River drainage, 1961–2019.

	Andreafsky River		Anvik River		Nulato River			Gisasa River
Year	East Fork	West Fork	Drainagewide total	Index area [a]	North Fork [b]	South Fork	Both forks	
1961	1,003	-	1,226		376 [c]	167	543	266 [c]
1962	675 [c]	762 [c]	-	-	-	-	-	-
1963	-	-	-	-	-	-	-	-
1964	867	705	-	-	-	-	-	-
1965	-	344 [c]	650 [c]	-	-	-	-	-
1966	361	303	638	-	-	-	-	-
1967	-	276 [c]	336 [c]	-	-	-	-	-
1968	383	383	310 [c]	-	-	-	-	-
1969	274 [c]	231 [c]	296 [c]	-	-	-	-	-
1970	665	574 [c]	368	-	-	-	-	-
1971	1,904	1,682	-	-	-	-	-	-
1972	798	582 [c]	418	-	-	-	-	-
1973	825	788	222	-	-	-	-	-
1974	-	285 [c]	-	-	55 [c]	23 [c]	78 [c]	161
1975	993	301 [c]	730	-	123	81	204	385
1976	818	643	1,053	-	471	177	648	332
1977	2,008	1,499	1,371	-	286	201	487	255
1978	2,487	1,062	1,324	-	498	422	920	45 [c]
1979	1,180	1,134	1,484	-	1,093	414	1,507	484
1980	958	1,500	1,330	1,192	954 [c]	369 [c]	1,323 [c]	951
1981	2,146 [c]	231 [c]	807 [c]	577 [c]	-	791 [c]	791 [c]	
1982	1,274	851	-		-	-	-	421
1983	-	-	653 [c]	376 [c]	526	480	1,006	572
1984	1,573	1,993	641 [c]	574 [c]	-	-	-	-
1985	1,617	2,248	1,051	720	1,600	1,180	2,780	735
1986	1,954	3,158	1,118	918	1,452	1,522	2,974	1,346
1987	1,608	3,281	1,174	879	1,145	493	1,638	731
1988	1,020	1,448	1,805	1,449	1,061	714	1,775	797
1989	1,399	1,089	442 [c]	212 [c]	-	-	-	-
1990	2,503	1,545	2,347	1,595	568 [c]	430 [c]	998 [c]	884 [c]
1991	1,938	2,544	875 [c]	625 [c]	767	1,253	2,020	1,690
1992	1,030 [c]	2,052 [c]	1,536	931	348	231	579	910
1993	5,855	2,765	1,720	1,526	1,844	1,181	3,025	1,385
1994	300 [c]	213 [c]	913 [c]	913 [c]	-	-	-	2,775
1995	1,635	1,108	1,996	1,147	968	681	1,649	410
1996		624	839	709	-	100	100 [c]	-
1997	1,140	1,510	3,979	2,690	-	-	-	144 [c]
1998	1,027	1,249 [c]	709 [c]	648 [c]	507	546	1,053	889 [c]

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	Andreafsky River		Anvik River		Nulato River			Gisasa River
Year	East Fork	West Fork	Drainagewide total	Index area [a]	North Fork [b]	South Fork	Both forks	
1999	-	870 [c]	950 [c]	950 [c]	-	-	-	-
2000	1,018	427	1,721	1,394	-	-	-	-
2001	1,059	565	1,420	1,177	1,116	768	1,884 [d]	1,298 [c]
2002	1,447	917	1,713	1,329	687	897	1,584	506
2003	1,116 [c]	1,578	973 [c]	973 [c]	-	-	-	-
2004	2,879	1,317	3,679	3,304	856	465	1,321	731
2005	1,715	1,492	2,421	1,922	323	230	553	958
2006	591 [c]	824	1,886	1,776 [e]	620	672	1,292	843
2007	1,758	976	1,650	1,497	1,684	899	2,583	593
2008	278 [c]	262 [c]	992 [c]	827 [c]	415	507	922	487
2009	84 [c]	1,678	832	590	1,418	842	2,260	515
2010	537 [c]	858	974	721	356	355	711	264
2011	620	1,173	642	501	788	613	1,401	906
2012	-	227 [c]	722	451	682	692	1,374	[c]
2013	1,441	1,090	940	656	586	532	1,118	201 [c]
2014	-	1,695	1,584	800	[c]	[c]	[c]	[c]
2015	2,167	1,356	2,616	1,726	999	565	1,564	558
2016	-	-	-	-	-	-	-	-
2017	-	942	1,101	894	500	443	943	
2018	746	455	1,109 [c]	800	438	432	870	452
2019	1,547	904	1,432	1,043	656	485	1,141	-
SEG [f]	[g]	640–1,600	1,100–1,700				940–1,900	[h]
Averages								
1961–2018	1,312	1,105	1,221	1,080	768	566	1,291	711
2009–2018	933	1,053	1,169	793	721	559	1,280	483
2014–2018	1,457	1,112	1,603	1,055	646	480	1,126	505
Minimum-18	84	213	222	212	55	23	78	45
Maximum-18	5,855	3,281	3,979	3,304	1,844	1,522	3,025	2,775

Note: Aerial survey counts are peak counts only. Survey rating was fair or good unless otherwise noted. Minimum and maximum indicate year with the lowest and highest values through 2018. Dash indicates no survey.

[a] Anvik River Index Area includes mainstem counts between Beaver Creek and McDonald Creek.

[b] Nulato River mainstem aerial survey counts below the forks are included with the North Fork.

[c] Incomplete, poor timing, and/or poor survey conditions resulting in minimal, inaccurate, or no counts.

[d] In 2001, the Nulato River escapement goal was established for both forks combined.

[e] The count represents the index area and an additional 8 river miles downstream of Yellow River confluence.

[f] Sustainable Escapement Goal.

[g] Aerial escapement goal for Andreafsky River was discontinued in 2010. Note: weir-based goal replaced East Fork Andreafsky River aerial survey goal.

[h] Gisasa River aerial escapement goal was discontinued in 2010.

Appendix B10.–Chinook salmon escapement counts and percentage females counted for selected spawning areas in the U.S. (Alaska) portion of the Yukon River drainage, 1986–2019.

	East Fork Andreafsky River weir		Nulato River tower	Henshaw Creek weir		Gisasa River weir		Chena River tower		Salcha River tower	
Year	No. fish	% Fem.	No. fish	No. fish	% Fem.	No. fish	% Fem.	No. fish	% Fem. [a]	No. fish	% Fem. [a]
1986	1,530	29 [b]	-	-	-	-	-	9,065 [c]	25	-	35
1987	2,011	53 [b]	-	-	-	-	-	6,404 [c]	58	4,771 [c]	63
1988	1,341	42 [b]	-	-	-	-	-	3,346 [c]	61	4,322 [c]	40
1989	-	5	-	-	-	-	-	2,730 [c]	65	3,294 [c]	62
1990	-	38	-	-	-	-	-	5,603 [c]	47	10,728 [c]	47
1991	-	28	-	-	-	-	-	3,172 [c]	32	5,608 [c]	47
1992	-	26	-	-	-	-	-	5,580 [c]	38	7,862 [c]	34
1993	-	29	-	-	-	-	-	12,241	17	10,008	28
1994	7,801	35	1,795	-	-	2,888	-	11,877	45	18,404	45
1995	5,841	42	1,412	-	-	4,023	46	11,394 [c]	66	13,643	56
1996	2,955	42	756	-	-	1,991	20	7,153 [c]	44	7,570 [c]	51
1997	3,186	37	4,766	-	-	3,764	26	13,390	40	18,514	50
1998	4,034	29	1,536	-	-	2,414	16	4,745	41	5,027	30
1999	3,444	29	1,932	-	-	2,644	26	6,485	66	9,198	55
2000	1,609	32	908	193	30	2,089	34	4,694 [c]	26	4,595	44
2001	1,148	64	-	1,091	36	3,052	49	9,696	43	13,328	38
2002	4,123	21 [d]	2,696	649	31	2,025	21	6,967 [c]	32	9,000 [e]	35
2003	4,336	48	1,716 [f]	748	39	1,901	38	11,100	45	15,500 [e]	42
2004	8,045	35	-	1,248	23	1,774	34	9,645	63	15,761	63
2005	2,239	50	-	1,059	42	3,111	36	- [d]	42	5,988	54
2006	6,463	44	-	-	- [d]	3,031	29	2,936	46	10,679	43
2007	4,504	45	-	740	43	1,427	41	3,806	40	6,425	36
2008	4,242	39	-	766	27	1,738	15	3,208	44	5,415 [e]	39

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Year	East Fork Andreafsky River weir		Nulato River tower	Henshaw Creek weir		Gisasa River weir		Chena River tower		Salcha River tower	
	No. fish	% Fem.	No. fish	No. fish	% Fem.	No. fish	% Fem.	No. fish	% Fem. [a]	No. fish	% Fem. [a]
2009	3,004	47	-	1,637	54	1,955	28	5,253	55	12,774	39
2010	2,413	49	-	857	49	1,516	30	2,382	31	6,135	33
2011	5,213	20	-	1,796	34	2,692	19	- [d]	32	7,200 [e]	42
2012	2,517	27	-	922	43	1,323	39	2,220 [g]	56	7,165	60
2013	1,998	39	-	772	47	1,126	34	1,859 [d]	40	5,465	50
2014	5,949	48	-	-	- [d]	1,589	19	7,192 [h]	33	- [d]	32
2015	5,474	40	-	2,391	41	1,319	30	6,294	55	6,288 [i]	43
2016	2,676	49	-	1,354	48	1,395	27	6,665 [i]	23	2,675 [i]	39
2017	2,970	26	-	677	42	1,083	28	4,201 [i]	45	4,195 [i]	41
2018 [j]	4,114	25	-	-	- [d]	-	-	4,227	55	4,053	56
2019 [j]	5,111	34	-	438	61	1,328	24	2,018	63	4,678	44
SEG [k]	2,100–4,900										
BEG [l]								2,800–5,700		3,300–6,500	
Averages											
1986–2018	3,756	37	1,946	1,056	39	2,161	30	6,307	44	8,438	45
2009–2018	3,633	37	-	1,301	45	1,555	28	4,477	42	6,217	43
2014–2018	4,237	38	-	1,474	44	1,347	26	5,716	42	4,303	42
Minimum-18	1,148	5	756	193	23	1,083	15	1,859	17	2,675	28
Maximum-18	8,045	64	4,766	2,391	54	4,023	49	13,390	66	18,514	63

Note: Minimum and maximum indicate year with the lowest and highest values through 2018. No. = number; Fem. = female. Dashes indicate a value cannot be calculated.

[a] Adjustment factor was applied.

[b] Tower counts.

[c] Mark–recapture population estimate.

[d] Project operations were hindered by high water most of the season.

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

[f] Weir count.

[g] Estimated includes an expansion for missed counting days based on using 2 DIDSON sonars to assess Chinook salmon passage.

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

[i] Final estimate uses a binomial mixed-effects model to create passage estimates for periods of missed counts.

[j] Preliminary.

[k] Sustainable Escapement Goal (SEG).

[l] Biological Escapement Goal (BEG).

Appendix B11.–Estimated spawning escapement of Canadian-origin Yukon River mainstem Chinook salmon, 1982–2019.

Year	Historic mark–recapture border passage estimate [a]	Eagle sonar estimate	U.S. harvest above Eagle sonar [b]	Canadian mainstem border passage estimate	Canadian mainstem harvest	Spawning escapement estimate [c]
1982	36,598			60,346 [d]	16,808	43,538
1983	47,741			63,227 [d]	18,752	44,475
1984	43,911			66,300 [d]	16,295	50,005
1985	29,881			59,586 [d]	19,151	40,435
1986	36,479			61,489 [d]	20,064	41,425
1987	30,823			58,870 [d]	17,563	41,307
1988	44,445			61,026 [d]	21,327	39,699
1989	42,620			77,718 [d]	17,419	60,299
1990	56,679			78,192 [d]	18,980	59,212
1991	41,187			63,172 [d]	20,444	42,728
1992	43,185			56,958 [d]	17,803	39,155
1993	45,027			52,713 [d]	16,469	36,244
1994	46,680			77,219 [d]	20,770	56,449
1995	52,353			70,761 [d]	20,088	50,673
1996	47,955			93,606 [d]	19,546	74,060
1997	53,400			69,538 [d]	15,717	53,821
1998	22,588			41,335 [d]	5,838	35,497
1999	23,716			49,538 [d]	12,354	37,184
2000	16,173			30,699 [d]	4,829	25,870
2001	52,207			62,338 [d]	9,774	52,564
2002	49,214			51,428 [e]	9,070	42,358
2003	56,929			90,040 [e]	9,446	80,594
2004	48,111			59,415 [e]	10,946	48,469
2005	42,245	81,528	2,566	78,962 [f]	10,977	67,985
2006	36,748	73,691	2,303	71,388 [f]	8,758	62,630
2007	22,120	41,697	1,999	39,698 [f]	4,794	34,904
2008	14,666	38,097	815	37,282 [f]	3,399	33,883

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Year	Historic mark–recapture border passage estimate [a]	Eagle sonar estimate	U.S. harvest above Eagle sonar [b]	Canadian mainstem border passage estimate	Canadian mainstem harvest	Spawning escapement estimate [c]
2009	-	69,957	382	69,575 [f]	4,297	65,278
2010	-	35,074	604	34,470 [f]	2,456	32,014
2011	-	51,271	370	50,901 [f]	4,594	46,307
2012	-	34,747	91	34,656 [f]	2,000	32,656
2013	-	30,725	152	30,573 [f]	1,904	28,669
2014	-	63,482	51	63,431 [f]	100	63,331
2015	-	84,015	341	83,674 [f]	1,000	82,674
2016	-	72,329	762	71,567 [f]	2,769	68,798
2017	-	73,313	1,498	71,815 [f]	3,500	68,315
2018	-	57,893	629	57,264 [f]	2,790	54,474
2019	-	45,560	744	44,816 [f]	2,764	42,052
Averages						
1971–2018	40,136	57,701	897	60,832	11,157	49,675
2009–2018	-	57,281	488	56,793	2,541	54,252
2014–2018	-	70,206	656	69,550	2,032	67,518
Minimum-18	14,666	30,725	51	30,573	100	25,870
Maximum-18	56,929	84,015	2,566	93,606	21,327	82,674

Note: Minimums and maximum indicate the lowest and highest values for each year presented through 2018.

[a] From 1982–2008, a mark–recapture program was used to determine border passage; fish were sampled and tagged near the border using fish wheels and sampled for marks/tags in upstream fisheries. The Eagle sonar project replaced the mark–recapture program in 2005.

[b] U.S. harvests between the sonar site and border prior to 2008 are unknown because subsistence harvest in the Eagle area extended above and below the sonar site but were most likely in the hundreds for Chinook salmon. Starting in 2008, subsistence harvests between the sonar site and the U.S./Canada border were recorded specifically for the purpose of estimating border passage.

[c] Canadian spawning escapement estimated as border passage minus Canadian harvest.

[d] Chinook salmon passage for Yukon mainstem at U.S./Canada border from 1982–2001 was reconstructed using a linear relationship with 3-area index (aerial surveys of Little Salmon, Big Salmon, and Nisutlin rivers in 2002–2007) plus Canadian harvests.

[e] Border passage estimated in 2002–2004 using escapement estimate from a radio tagging proportion study, plus Canadian harvest.

[f] Since 2005, border passage was estimated as fish counted by the Eagle sonar minus the U.S. harvest upriver from the sonar project.

Appendix B12.–Chinook salmon escapement counts for selected spawning areas in the Canadian (Yukon Territory) portion of the Yukon River drainage, 1961–2019.

Year	Tatchun Creek [a]	Blind Creek weir	Chandindu River weir	Big Salmon sonar	Klondike River sonar	Teslin River sonar	Pelly River sonar	Porcupine River sonar	Takhini River sonar	Whitehorse Fishway Count	Whitehorse Fishway Percent hatchery contribution
1961										1,068	0
1962										1,500	0
1963										483	0
1964										595	0
1965										903	0
1966	7 [b]									563	0
1967										533	0
1968										414	0
1969										334	0
1970	100									625	0
1971	130									856	0
1972	80									391	0
1973	99									224	0
1974	192									273	0
1975	175									313	0
1976	52									121	0
1977	150									277	0
1978	200									725	0
1979	150									1,184	0
1980	222									1,383	0
1981	133									1,555	0
1982	73									473	0
1983	264									905	0
1984	153									1,042	0
1985	190									508	0
1986	155									557	0
1987	159									327	0
1988	152									405	16
1989	100									549	19
1990	643									1,407	24
1991										1,266 [c]	51 [c]
1992	106									758 [c]	84 [c]

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Year	Tatchun Creek [a]	Blind Creek weir	Chandindu River weir	Big Salmon sonar	Klondike River sonar	Teslin River sonar	Pelly River sonar	Porcupine River sonar	Takhini River sonar	Whitehorse Fishway Count	Whitehorse Fishway Percent hatchery contribution
1993	183									668 [c]	73 [c]
1994	477									1,577 [c]	54 [c]
1995	397									2,103	57
1996	423									2,958	35
1997	1,198	957								2,084	24
1998	405	373	132							777	95
1999	252	892	239							1,118	74
2000	276 [d]		4 [e]							677	69
2001			129 [f]							988	36
2002			[g]							605	39
2003		1,115	185 [h]							1,443	70
2004		792								1,989	76
2005		525		5,618						2,632	57
2006		677		7,308						1,720	47
2007		304		4,506						427	56
2008		276		1,329						399	54
2009		716		9,261	5,147					828	47
2010		270		3,817	803					672	49
2011		360		5,156	1,181					1,534	48
2012		157		2,584		3,396				1,030	59
2013		312		3,242		9,916				1,139	67
2014		602		6,321		17,507		2,951 [i]		1,601	78
2015		964		10,078		20,410		4,623		1,465	60
2016		664		6,761			5,807 [i]	6,457		1,556	42
2017		[j]		5,672			9,081	1,191	1,872 [i]	1,226	39
2018		612		5,159			9,751	3,414	1,554	691	37
2019 [k]				3,874			6,927	4,740		282	13
Averages											
1971–2018	235	587	138	5,487	2,377	12,807	8,213	3,727	-	973	28
2009–2018	-	517	-	5,805	2,377	12,807	8,213	3,727	-	1,174	53
2014–2018	-	711	-	6,798	-	-	-	-	1,713	1,308	51
Minimum-18	7	157	4	1,329	803	3,396	5,807	1,191	1,554	121	0
Maximum-18	1,198	1,115	239	10,078	5,147	20,410	9,751	6,457	1,872	2,958	95

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Note: Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] All foot surveys prior to 1997, except 1978 (boat survey) and 1986 (aerial survey). Weir counts from 1997–2000.

[b] Incomplete and/or poor survey conditions resulting in minimal or inaccurate counts.

[c] Counts and estimated percentages may be slightly exaggerated. In some or all of these years, a number of adipose-clipped fish ascended the Fishway and were counted more than once. These fish would have been released into the Fishway as fry between 1989 and 1994, inclusive.

[d] Flood conditions caused early termination of this program.

[e] High water delayed project installation, therefore counts are incomplete.

[f] Weir was breached from July 31–August 7 due to high water.

[g] Resistance board weir (RBW) tested for 3 weeks.

[h] Combination RBW and conduit weir tested and operational from July 10–30.

[i] Sonar feasibility year.

[j] High water conditions prevented weir operation.

[k] Data are preliminary.

Appendix B13.–Summer chum salmon escapement counts for selected spawning areas in the U.S. (Alaska) portion of the Yukon River drainage, 1973–2019.

	Andreafsky River			Anvik River		Rodo River	Kaltag River	Nulato River		
	East Fork		West Fork					South Fork	North Fork [a]	Mainstem
Year	Aerial [b]	Sonar, tower, or weir counts [c]	Aerial [b]	Tower and aerial [d]	Sonar	Aerial [b]	Tower	Aerial [b]	Aerial [b]	Tower
1973	10,149 [e]		51,835	249,015	-					
1974	3,215 [e]		33,578	411,133	-	16,137		29,016	29,334	
1975	223,485		235,954	900,967	-	25,335		51,215	87,280	
1976	105,347		118,420	511,475	-	38,258		9,230 [e]	30,771	
1977	112,722		63,120	358,771	-	16,118		11,385	58,275	
1978	127,050		57,321	307,270	-	17,845		12,821	41,659	
1979	66,471		43,391	-	277,712	-		1,506	35,598	
1980	36,823 [e]		114,759	-	482,181	-		3,702 [e]	11,244 [e]	
1981	81,555	152,665	-	-	1,479,582	-		14,348	-	
1982	7,501 [e]	181,352	7,267 [e]	-	444,581	-		-	-	
1983	-	113,328	-	-	362,912	-		1,263 [e]	19,749	
1984	95,200 [e]	72,598	238,565	-	891,028	-		-	-	
1985	66,146	-	52,750	-	1,080,243	24,576		10,494	19,344	
1986	83,931	152,730	99,373	-	1,085,750	-		16,848	47,417	
1987	6,687 [e]	45,221 [f]	35,535	-	455,876	-		4,094	7,163	
1988	43,056	68,937 [f]	45,432	-	1,125,449	13,872		15,132	26,951	
1989	21,460 [e]	-	-	-	636,906	-		-	-	
1990	11,519 [e]	-	20,426 [e]	-	403,627	1,941 [e]		3,196 [e, g]	1,419 [e]	
1991	31,886	-	46,657	-	847,772	3,977		13,150	12,491	
1992	11,308 [e]	-	37,808 [e]	-	775,626	4,465		5,322	12,358	
1993	10,935 [e]	-	9,111 [e]	-	517,409	7,867		5,486	7,698	
1994	-	200,981 [g]	-	-	1,124,689	-	47,295	-	-	148,762 [g]
1995	-	172,148	-	-	1,339,418	12,849	77,193	10,875	29,949	236,890
1996	-	108,450	-	-	933,240	4,380	51,269	8,490 [e]	-	129,694

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	Andreafsky River			Anvik River		Rodo River	Kaltag River	Nulato River		
	East Fork		West Fork					South Fork	North Fork [a]	Mainstem
Year	Aerial [b]	Sonar, tower, or weir counts [c]	Aerial [b]	Tower and aerial [d]	Sonar	Aerial [b]	Tower	Aerial [b]	Aerial [b]	Tower
1997	-	51,139	-	-	605,751	2,775 [e]	48,018	-	-	157,975
1998	-	67,720	-	-	487,300	-	8,113	-	-	49,140
1999	-	32,587	-	-	437,355	-	5,339	-	-	30,076
2000	2,094 [e]	24,785	18,989 [e]	-	196,350	-	6,727	-	-	24,308
2001	-	2,134 [g]	-	-	224,059	-	-	-	-	-
2002	-	44,194	-	-	459,058	-	13,583	-	-	72,232
2003	-	22,461	-	-	256,920	-	3,056	-	-	19,590 [g]
2004	-	64,883	-	-	365,354	-	5,247	-	-	-
2005	-	20,127	-	-	525,392	-	22,093	-	-	-
2006	3,100 [e]	102,260	617	-	605,487	-	-	7,772	11,658	-
2007	-	69,642	-	-	459,038	-	-	21,825	15,277	-
2008	9,300	57,259	25,850	-	374,933	-	-	12,070	10,715	-
2009	736	8,770	3,877	-	193,098	621	-	2,120	567	-
2010	1,982	72,893	24,380	-	396,174	-	-	1,891	1,038	-
2011	12,889	100,473	10,020	-	642,529	6,011	-	9,454	8,493	-
2012	-	56,680	-	-	484,091	15,606	-	20,600	14,948	-
2013	10,965	61,234	9,685	38,915	577,876	-	-	13,695	13,230	-
2014	-	37,793	9,650	54,061	399,796	-	-	-	-	-
2015	6,004 [e]	48,809	2,837 [e]	36,871	374,968	3,685	-	4,102	9,525	-
2016	-	50,362	-	-	337,821	-	-	-	-	-
2017	-	55,532	11,655	38,191	415,139	-	-	4,890	7,882	-
2018	16,206	36,330	13,837	30,309	305,098	-	-	3,930	1,164	-
2019 [i]	26,048	49,881	17,198	15,499	249,014	-	-	2,612	4,898	-
GOAL [h]		>40,000			350,000–700,000					
Average										
1973–2018	42,059	73,640	49,748	266,998	584,690	12,018	26,176	10,997	20,471	96,519
2009–2018	8,130	52,888	10,743	39,669	412,659	6,481	-	7,585	7,106	-
2014–2018	11,105	45,765	9,495	39,858	366,564	3,685	-	4,307	6,190	-
Minimum–18	736	2,134	617	30,309	193,098	621	3,056	1,263	567	19,590
Maximum–18	223,485	200,981	238,565	900,967	1,479,582	38,258	77,193	51,215	87,280	236,890

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	Henshaw Creek	Gisasa River		Hogatza River		Tozitna River	Chena River		Salcha River	
				Clear & Caribou Cr.	Clear Creek					
Year	Weir	Aerial [b]	Weir	Aerial [b]	Tower	Weir and aerial [b]	Aerial [b]	Tower	Aerial [b]	Tower
1973							79 [e]		290	
1974		22,022				1,823	4,349		3,510	
1975		56,904		22,355		3,512	1,670		7,573	
1976		21,342		20,744		725 [e]	685		6,484	
1977		2,204 [e]		10,734		761 [e]	610		677 [e]	
1978		9,280 [e]		5,102		2,262	1,609		5,405	
1979		10,962		14,221		-	1,025 [e]		3,060	
1980		10,388		19,786		580	338		4,140	
1981		-		-		-	3,500		8,500	
1982		334 [e]		4,984 [e]		874	1,509		3,756	
1983		2,356 [e]		28,141		1,604	1,097		716 [e]	
1984		-		184 [e]		-	1,861		9,810	
1985		13,232		22,566		1,030	1,005		3,178	
1986		12,114		-		1,778	1,509		8,028	
1987		2,123		5,669 [e]		-	333		3,657	
1988		9,284		6,890		2,983	432		2,889 [e]	
1989		-		-		-	714 [e]		1,574 [e]	
1990		450 [e]		2,177 [e]		36	245 [e]		450 [e]	
1991		7,003		9,947		93	115 [e]		154 [e]	
1992		9,300		2,986		794	848 [e]		3,222	
1993		1,581		-		970	168	5,483	212	5,809
1994		6,827	51,116 [g]	8,247 [i]		-	1,137	9,984	4,916	39,450
1995		6,458	136,886	-	116,735	4,985	185 [e]	3,519 [g]	934 [e]	30,784
1996		-	158,752	27,090 [i]	100,912	2,310	2,061	12,810 [g]	9,722	74,827
1997		686 [e]	31,800	1,821 [e]	76,454	428 [e]	594 [e]	9,439 [g]	3,968 [e]	35,741
1998		-	21,142	120 [e]	212 [g]	7 [e]	24 [e]	5,901	370 [e]	17,289
1999		-	10,155	-	11,283	-	520	9,165	150	23,221
2000	24,457	-	11,410	-	19,376	480	105	3,515	228	20,516
2001	34,777	-	17,946	-	3,674	12,527	2	4,773	-	14,900

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Year	Henshaw Creek	Gisasa River		Hogatza River		Tozitna River	Chena River		Salcha River	
				Clear & Caribou Cr.	Clear Creek					
	Weir	Aerial [b]	Weir	Aerial [b]	Tower	Weir and aerial [b]	Aerial [b]	Tower	Aerial [b]	Tower
2002	25,249	-	33,481	-	13,150	18,789	-	1,021 [g]	78	27,012 [j]
2003	21,400	-	25,999	-	6,159	8,487	-	573 [g]	-	-
2004	86,474	-	37,851	-	15,661	25,003	-	15,163 [g]	-	47,861
2005	237,481	-	172,259	-	26,420	39,700	219	16,873 [g]	4,320	194,933
2006	-	1,000	261,306	-	29,166 [j]	22,629	469	35,109 [g]	152	113,960
2007	44,425	-	46,257	-	6,029 [j]	8,470	-	4,999	4 [e]	13,069
2008	96,731	20,470	36,938	-	-	9,133	37	1,300 [g]	0 [e]	2,213 [g]
2009	156,933	1,060	25,904	3,981	-	8,434	-	16,516	-	31,035
2010	105,398	1,096	47,669	840	-	-	-	7,561	-	22,185
2011	248,247	13,228	95,796	3,665	-	11,351	4,600	-	1,154	66,564 [k]
2012	292,082	-	83,423	23,022	-	11,045	1,180	6,882	-	46,252
2013	285,008	9,300 [e]	80,055	-	-	-	135 [e]	21,372	-	60,981
2014	-	-	32,523	-	-	-	1,317	13,303 [e]	1993 [e]	- [e]
2015	238,529	5,601	42,747	6,080	-	-	-	8,620	0 [e]	12,812
2016	286,780	-	66,670	-	-	-	-	6,493 [g]	-	2,897 [g]
2017	360,687	-	73,584	-	-	-	-	21,156 [g]	-	29,093 [g]
2018 [l]	- [g]	8,058	-	3,307	-	-	-	13,084 [g]	-	22,782 [g]
2019 [l]	34,342	-	19,099	-	-	-	-	2,704	-	2,117
GOAL										
Average										
1973–2018	159,041	9,452	66,736	10,186	32,710	6,568	1,008	10,185	2,924	39,841
2009–2018	246,708	6,391	60,930	6,816	-	10,277	-	12,776	1049	32,733
2014–2018	295,332	6,830	53,881	4,694	-	-	-	12,531	996.5	16,896
Minimum–18	21,400	334	10,155	120	212	7	2	573	0	2,213
Maximum–18	360,687	56,904	261,306	28,141	116,735	39,700	4,600	35,109	9,810	194,933

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Note: Unless otherwise noted, blank cells indicate years prior to the project being operational. Dashes indicate years in which no information was collected. Minimum and maximum indicate the lowest and highest values through 2018.

[a] Includes mainstem counts below the confluence of the North and South forks, unless otherwise noted.

[b] Aerial survey counts are peak counts only, survey rating is fair or good unless otherwise noted.

[c] East Fork Andreafsky passage estimated with sonar 1981–1984, tower counts 1986–1988; weir counts from 1994–present. The project did not operate in 1985 and 1989–1993.

[d] From 1972–1979, counting tower operated; escapement estimate listed is the tower counts plus expanded aerial survey counts below the tower.

[e] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.

[f] Mainstem counts below the confluence of the North and South forks of the Nulato River included in the South Fork counts.

[g] Incomplete count due to late installation and/or early removal of project or high water events.

[h] Biological escapement goal (Andreafsky) or sustainable escapement goal (Anvik).

[i] Bureau of Land management helicopter survey.

[j] Project operated as a video monitoring system.

[k] Estimate includes an expansion for missed counting days based on average run timing. Minimum documented abundance from successful counting days was 30,411 (SE not reported).

[l] Data are preliminary.

Appendix B14.–Fall chum salmon abundance estimates or escapement estimates for selected spawning areas in the U.S. (Alaska) portions of the Yukon River drainage, 1971–2019.

	Yukon	Tanana River drainage					Upper Yukon River drainage	
Year	Yukon River mainstem sonar estimate [a]	Toklat River [b]	Kantishna River abundance estimate [c]	Delta River [d]	Bluff Cabin Slough [e]	Upper Tanana River abundance estimate [f]	Treedrinijik-Chandalar River [g]	Sheenjek River [h]
1971								
1972				5,384 [i]				
1973				10,469 [i]				
1974		41,798		5,915 [i]				117,921 [j]
1975		92,265		3,734				227,935 [j]
1976		52,891		6,312				34,649 [j]
1977		34,887		16,876				59,878 [j]
1978		37,001		11,136 [i]				42,661 [j]
1979		158,336		8,355 [i]				120,129 [j]
1980		26,346 [k]		5,137 [i]	3,190 [l]			38,093 [j]
1981		15,623		23,508 [i]	6,120 [l]			102,137 [m]
1982		3,624		4,235 [i]	1,156			43,042 [m]
1983		21,869		7,705 [i]	12,715			64,989 [m]
1984		16,758		12,411 [i]	4,017			36,173 [m]
1985		22,750		17,276	2,655 [l]			179,727 [m, n]
1986		17,976		6,703	3,458		59,313	84,207 [n, o]
1987		22,117		21,180 [i]	9,395		52,416	153,267 [n, o]
1988		13,436		18,024 [i]	4,481 [l]		33,619	45,206 [o]
1989		30,421		21,342	5,386 [l]		69,161	99,116 [o]
1990		34,739		8,992	1,632		78,631	77,750 [o]
1991		13,347		32,905	7,198			86,496 [p]
1992		14,070		8,893	3,615 [l]			78,808
1993		27,838		19,857 [i]	5,550 [l]			42,922
1994		76,057		23,777	2,277 [l]			150,565
1995	1,156,278	54,513 [k]		20,587 [i]	19,460	268,173	323,586	241,855
1996	[q]	18,264		19,758	7,074 [d]	134,563	230,450	246,889

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Year	Yukon River mainstem sonar estimate [a]	Tanana River drainage: Toklat River [b]	Kantishna River abundance estimate [c]	Delta River [d]	Bluff Cabin Slough [e]	Upper Tanana River abundance estimate [f]	Upper Yukon River drainage: Treedrinijik-Chandalar River [g]	Sheenjek River [h]
1997	579,767	14,511		7,705	5,707 [d]	71,661	211,914	80,423 [r]
1998	375,222	15,605		7,804	3,549 [d]	62,014	83,899	33,058
1999	451,505	4,551	27,199	16,534	7,559 [d]	97,843	92,685	14,229
2000	273,206	8,911	21,450	3,001	1,595	34,844	71,048	30,084 [s]
2001	408,961	6,007 [t]	22,992	8,103	1,808 [l]	96,556 [u]	112,664	53,932
2002	367,886	28,519	56,665	11,992	3,116	109,961	94,472	31,642
2003	923,540	21,492	87,359	22,582	10,600 [l]	193,418	221,343	44,047 [v]
2004	633,368	35,480	76,163	25,073	10,270 [l]	123,879	169,848	37,878
2005	1,894,078	17,779 [j]	107,719	28,132	11,964 [l]	337,755	526,838	561,863 [n]
2006	964,238		71,135	14,055		202,669	254,778	160,178 [n]
2007	740,195		81,843	18,610		320,811	243,805	65,435 [n]
2008	636,525			23,055	1,198 [l]		178,278	50,353 [n]
2009	[q]			13,492	2,900 [l]		[p]	54,126 [n]
2010	458,103			17,993	1,610 [l]		167,532	22,053
2011	873,877			23,639	2,655 [l]		298,223	97,976 [n]
2012	778,158			9,377 [e]			205,791	104,701 [n]
2013	865,295	9,161 [l]		31,955	5,554 [l]		252,710	
2014	706,630			32,480 [e]	4,095 [l]		226,489	
2015	669,483	8,422 [l]		33,401 [e]	6,020 [l]		164,486	
2016	994,760	16,885 [l]		21,913 [e]	4,936 [l]		295,023	
2017	1,829,931			48,783 [e]			509,115	
2018	928,664	19,141 [l]		39,641 [e]	5,554 [l]		170,356	
2019 [w]	842,041			51,748 [e]	4,664 [l]		116,323	
Escapement Goal Ranges [x]	300,000–600,000 [y]			7,000–20,000 [z]			85,000–234,000 [z]	

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	Yukon River mainstem sonar estimate [a]	Tanana River drainage					Upper Yukon River drainage	
Year		Toklat River [b]	Kantishna River abundance estimate [c]	Delta River [d]	Bluff Cabin Slough [e]	Upper Tanana River abundance estimate [f]	Treedrinijik-Chandalar River [g]	Sheenjek River [h]
Averages								
1971–2018	795,894	29,261	61,392	17,017	5,431	158,011	192,803	97,856
2009–2018	900,545	13,402	-	27,267	4,166	-	254,414	69,714
2014–2018	1,025,894	14,816	-	35,244	5,151	-	273,094	-
Minimum-18	273,206	3,624	21,450	3,001	1,156	34,844	33,619	14,229
Maximum-18	1,894,078	158,336	107,719	48,783	19,460	337,755	526,838	561,863

Note: Minimum and maximum indicate the lowest and highest values through 2018.

[a] New model estimates generated in 2015 and applied to dataset back to 1995 and used since.

[b] Expanded total abundance estimates for upper Toklat River index area using stream life curve (SLC) developed with 1987–1993 data. Index area includes Geiger Creek, Sushana River, and mainstem floodplain sloughs from approximately 0.25 mile upstream of roadhouse.

[c] Fall chum salmon abundance estimate for the Kantishna and Toklat River drainages is based on a mark–recapture program. Number of tagging and recovery wheels changed over the years.

[d] Population estimate generated from replicate foot surveys and stream life data (area under the curve method), unless otherwise indicated.

[e] Peak foot survey, unless otherwise indicated.

[f] Fall chum salmon abundance estimate for the upper Tanana River drainage is based on a mark–recapture program. Upper Tanana River consists of that portion upstream of the confluence with the Kantishna River. Number of tagging and recovery wheels changed over the years.

[g] Single-beam sonar estimate for 1986–1990 (not used in run reconstruction), split-beam sonar estimate 1995–2006, DIDSON in use since 2007, project was aborted in 2009. Sonar counts on the Chandalar River are extrapolated after conclusion of the project through October 9 from 1995–present, with 2018 expanded to October 14 due to late run timing.

[h] Single-beam sonar estimate beginning in 1981, split-beam sonar estimate 2003–2004, and DIDSON 2005–2012. Sonar counts on the Sheenjek River are extrapolated after conclusion of the project through October 9 from 2005–2012.

[i] Estimates are a total spawner abundance, using migratory time density curves and stream life data.

[j] Total escapement estimate using sonar to aerial survey expansion factor of 2.22.

[k] Minimal estimate because of late timing of ground surveys with respect to peak of spawning.

[l] Aerial survey count, unless otherwise indicated.

[m] Project started late, estimated escapements expanded for portion missed using average run timing curves based on Teedriinjik (Chandalar; 1986–1990) and Sheenjek (1991–1993) rivers.

[n] Sonar counts include both banks in 1985–1987, 2005–2009, and 2011–2012.

[o] Expanded estimates for period approximating second week of August through fourth week of September, using annual Chandalar River run timing data (1986–1990).

[p] Total abundance estimates are for the period approximating second week of August through fourth week of September (1991–present). Comparative escapement estimates before 1986 are considered more conservative; approximating the period end of August through September.

[q] Project operated all or partial season, estimate was not useable.

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[r] Data interpolated due to high water from August 29–September 3, 1997 during buildup to peak passage on the Sheenjek River.
[s] Sheenjek sonar project ended early (September 12) because of low water therefore estimate was expanded based on average run timing (62%).
[t] Minimal estimate because Sushana River was breached by the main channel and uncountable.
[u] Low numbers of tags deployed and recovered resulted in an estimate with an extremely large confidence interval (95% CI +/- 41,072).
[v] Sheenjek sonar project ended on peak daily passages due to late run timing, estimate was expanded based on run timing (87%) at Rampart.
[w] Data are preliminary.
[x] Escapement Goals (EG) expressed as ranges.
[y] Drainagewide escapement goal is related to mainstem passage estimate based on the sonar near Pilot Station minus upriver harvests.
[z] Escapement goal revised to a sustainable escapement goal range in 2019 based on percentile method.

Appendix B15.–Fall chum salmon escapement estimates for selected spawning areas in Canadian (Yukon Territory) portions of the Yukon River drainage, 1971–2019.

	Porcupine Drainage		Mainstem			
Year	Fishing Branch River [a]	Porcupine River Sonar	Yukon River Index [b,c]	Koidern River [b]	Kluane River [b, d]	Teslin River [b, e]
1971	312,800 [f]					
1972	35,230 [g]				198 [h,l]	
1973	15,991		383		2,500	
1974	31,841				400	
1975	353,282		7,671		362 [h]	
1976	36,584 [f]				20	
1977	88,400 [f]				3,555	
1978	40,800 [f]				0 [h]	
1979	119,898 [f]				4,640 [h]	
1980	55,268 [f]				3,150	
1981	57,386 [i]				25,806	
1982	15,901 [f]		1,020 [j]		5,378	
1983	27,200 [f]		7,560		8,578 [h]	
1984	15,150 [f]		2,800 [k]	1,300	7,200	200
1985	56,223		10,760	1,195	7,538	356
1986	31,811		825	14	16,686	213
1987	49,038		6,115	50	12,000	
1988	23,645		1,550	0	6,950	140
1989	44,042		5,320	40	3,050	210 [l]
1990	35,000 [m]		3,651	1	4,683	739
1991	37,870		2,426	53	11,675	468
1992	22,539		4,438	4	3,339	450
1993	28,707		2,620	0	4,610	555
1994	65,247		1,429 [j]	20 [j]	10,734	209 [l]
1995	51,971 [n]		4,701	0	16,456	633
1996	77,302		4,977		14,431	315
1997	27,031		2,189		3,350	207
1998	13,687		7,292		7,337	235
1999	12,958				5,136	19 [i]
2000	5,057		933 [l]		1,442	204
2001	21,737		2,453		4,884	5
2002	13,636		973		7,147	64
2003	29,713		7,982		39,347	390
2004	20,417		3,440		18,982	167
2005	119,058		16,425		34,600	585
2006	30,954		6,553		18,208	620
2007	32,150					
2008	19,086 [n]					
2009	25,828 [o]					
2010	15,413 [o]					
2011	13,085 [n, o]					

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	Porcupine Drainage		Mainstem			
	Fishing	Porcupine	Yukon			
	Branch	River	River	Koidern	Kluane	Teslin
Year	River [a]	Sonar	Index [b, c]	River [b]	River [b, d]	River [b, e]
2012	22,399 [o]					
2013	25,376 [p]	35,615				
2014	7,304 [p]	17,756				
2015	8,351	21,397				
2016	29,397	54,395				
2017	48,524	67,818			16,265 [q]	
2018	10,151	[r]			1,734	
2019 [s]	18,171	27,447			928	
Goal [t]	50,000–120,000					
IMEG [u]	22,000–49,000					
Averages						
1971–2018	47,509	39,396	4,480	223	8,983	317
2009–2018	20,583	39,396	-	-	9,000	-
2014–2018	20,745	40,342	-	-	9,000	-
Minimum-18	5,057	17,756	383	0	0	5
Maximum-18	353,282	67,818	16,425	1,300	39,347	739

Note: Minimum and maximum indicate the lowest and highest values through 2018.

[a] Weir count, unless otherwise indicated. Weir counts from 1972–1975, 1985–1989, 1991–1992, 1996–2012 were expanded to represent the remainder of the run after the project was terminated for the season through October 25.

[b] Aerial survey, unless otherwise indicated.

[c] Index area includes Tatchun Creek to Fort Selkirk.

[d] Index area includes Duke River to end of spawning sloughs below Swede Johnston Creek.

[e] Index area includes Boswell Creek area (5 km below to 5 km above confluence).

[f] Total escapement estimated using weir to aerial survey expansion factor of 2.72, unless otherwise indicated.

[g] Weir installed September 22. Estimate consists of weir count of 17,190 after September 22, and tagging passage estimate of 17,935 before weir installation.

[h] Foot survey, unless otherwise indicated.

[i] Initial aerial survey count doubled before applying the weir/aerial expansion factor of 2.72 because only half of the spawning area was surveyed.

[j] Boat survey.

[k] Total index not surveyed. Survey included the mainstem Yukon River between Yukon Crossing to 30 km below Fort Selkirk.

[l] Incomplete and/or poor survey conditions resulting in minimal or inaccurate counts.

[m] Weir not operated. Although only 7,541 chum salmon were counted on a single survey flown October 26, a population estimate of approximately 27,000 fish was made through date of survey, based upon historic average aerial-to-weir expansion of 28%. Actual population of spawners was reported by DFO as between 30,000–40,000 fish considering aerial survey timing.

[n] Incomplete count caused by late installation and/or early removal of project or high water events.

[o] Run timing was late and counts were expanded to represent the remainder of the run after the project was terminated for the season.

[p] Fishing Branch River weir did not operate, and escapement was estimated from a sonar operated on the upper Porcupine River minus Old Crow harvest and the proportion of radio tags to Fishing Branch River.

[q] Aerial survey as part of Yukon River Restoration and Enhancement Fund project number CRE-145-17.

[r] High water in August and early ice up prevented a complete passage estimate for Porcupine River fall chum salmon.

[s] Data are preliminary.

[t] Interim Management Escapement Goal (IMEG) established for 2008–2012, based on percentile method, and recommended to continue by default if no new analysis in subsequent years.

[u] Interim Management Escapement Goal (IMEG) established for 2010–2018 based on brood table of Canadian origin mainstem stocks (1982 to 2003) and recommended to continue by default if no new analysis in subsequent years.

Appendix B16.–Estimated spawning escapement of Canadian-origin Yukon River fall chum salmon, 1980–2019.

Date	Eagle sonar estimate	Eagle sonar expanded estimate [a]	U.S. harvest above Eagle sonar [b]	U.S./Canada mainstem border passage estimate [b]	Canadian mainstem harvest	Spawning escapement estimate [c]
1980				39,130	16,218	22,912
1981				66,347	19,281	47,066 [d]
1982				47,049	15,091	31,958
1983				118,365	27,490	90,875
1984				81,900	25,267	56,633 [d]
1985				99,775	37,765	62,010
1986				101,826	13,886	87,940
1987				125,121	44,345	80,776
1988				69,280	32,494	36,786
1989				55,861	20,111	35,750
1990				82,947	31,212	51,735
1991				112,303	33,842	78,461
1992				67,962	18,880	49,082
1993				42,165	12,422	29,743
1994				133,712	35,354	98,358
1995				198,203	40,111	158,092
1996				143,758	21,329	122,429
1997				94,725	9,306	85,419
1998				48,047	1,795	46,252
1999				72,188 [e]	13,636	58,552
2000				57,978 [e]	4,246	53,732
2001				38,769 [e]	5,278	33,491
2002				104,853 [e]	6,232	98,621
2003				153,656 [e]	10,523	143,133
2004				163,625 [e]	9,545	154,080
2005				451,477	13,979	437,498
2006	236,386	245,290	17,775	227,515 [f, g]	6,617	220,898
2007	235,871	265,008	18,691	246,317 [f, g]	9,330	236,987
2008	171,347	185,409	11,381	174,028 [f, g]	6,130	167,898

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Date	Eagle sonar estimate	Eagle sonar expanded estimate [a]	U.S. harvest above Eagle sonar	U.S./Canada mainstem border passage estimate [b]	Canadian mainstem harvest	Mainstem spawning escapement est. [c]
2009	95,462	101,734	6,995	94,739 [f]	1,113	93,626
2010	125,547	132,930	11,432	121,498 [f]	3,709	117,789
2011	212,162	224,355	12,477	211,878 [f]	6,312	205,566
2012	147,710	153,248	11,681	141,567 [f]	3,905	137,662
2013	200,754	216,791	12,642	204,149 [f]	3,887	200,262
2014	167,715	172,887	13,041	159,846 [f]	3,050	156,796
2015	112,136	125,095	12,540	112,555 [f]	3,897	108,658
2016	144,035	161,027	13,015	148,012 [f]	2,745	145,267
2017	407,166	419,099	14,110	404,989 [f]	3,404	401,585
2018 [h]	136,732	168,798	11,715	157,083 [f]	2,957	154,126
2019 [h]	101,678	113,256	10,759	102,497 [f]	2,759	99,738
Averages						
1980–2018	184,079	197,821	12,884	132,697	14,787	117,910
2009–2018	174,942	187,596	11,965	175,632	3,498	172,134
2014–2018	193,557	209,381	12,884	196,497	3,211	193,286
Minimum-18	95,462	101,734	6,995	38,769	1,113	22,912
Maximum-18	407,166	419,099	18,691	451,477	44,345	437,498

Note: Table includes information on U.S/Canada border passage estimates, Eagle area subsistence harvest between the sonar and the border (where applicable), and Canadian mainstem harvest. Estimates for subsistence caught salmon between the sonar site and border (Eagle area) prior to 2008 include an unknown portion caught below the sonar site. This number is most likely in the thousands for chum salmon. Starting in 2008, the estimates for subsistence-caught salmon only include salmon harvested between the sonar site and the U.S./Canada border. Minimum and maximum indicate the lowest and highest values through 2018.

[a] Sonar estimates include an expansion for fish that may have passed after operations ceased through October 18. In 2018, expanded to October 23 due to late run timing.

[b] Border passage estimate is based on a mark–recapture estimate unless otherwise indicated.

[c] Estimated mainstem border passage minus Canadian mainstem harvest (excludes Fishing Branch River). Current interim management escapement goal is 70,000 to 104,000 fall chum salmon.

[d] Escapement estimate based on mark–recapture program unavailable. Estimate based on assumed average exploitation rate.

[e] From 1999–2004, border passage estimates were revised using a Stratified Population Analysis System (Arnason et. al 1995).

[f] From 2006–present, border passage estimate is based on sonar minus harvest from U.S. residents upstream of deployment.

[g] Mark–recapture border passage estimates include 217,810; 235,956; and 132,048 fish from 2006–2008 respectively, during transition to sonar.

[h] Data are preliminary.

Appendix B17.–Coho salmon passage estimates or escapement estimates for selected spawning areas in the U.S. (Alaska) portion of the Yukon River drainage, 1972–2019.

	Yukon River mainstem	Nenana River drainage				Upper Tanana River drainage		
Year	sonar estimate [a]	Lost Slough	Nenana mainstem [b]	Wood Creek	Seventeen Mile Slough	Delta Clearwater River [c]	Clearwater Lake and outlet	Richardson Clearwater River
1972						632 (b)	417 (f)	454 (f) [d]
1973						3,322 (u)	551 (u)	375 (u)
1974		1,388 (f)			27 (f)	3,954 (h) [d]	560 (f)	652 (h)
1975		827 (f)			956 (f)	5,100 (b)	1,575 (b)	
1976		118 (f)			281 (f)	1,920 (b)	1,500 (b)	80 (f) [d]
1977		524 (f) [d]		310 (g)	1,167 (f)	4,793 (b)	730 (b)	327 (f)
1978		350 (f)		300 (g)	466 (f)	4,798 (b)	570 (b)	
1979		227 (f)			1,987 (f)	8,970 (b)	1,015 (b)	372 (f)
1980		499 (f) [d]		1,603 (g)	592 (f)	3,946 (b)	1,545 (b)	611 (f)
1981		274 (f)		849 (w) [e]	1,005 (f)	8,563 (u) [f]	459 (f)	550 (f)
1982				1,436 (w) [e]	(f)	8,365 (g) [f]		
1983		766 (f)		1,042 (w)	103 (f)	8,019 (b) [f]	253 (f)	88 (f)
1984		2,677 (f)		8,826 (w)	(f)	11,061 (b)	1,368 (f)	428 (f)
1985		1,584 (f)		4,470 (w)	2,081 (f)	5,358 (b)	750 (f)	
1986		794 (f)		1,664 (w)	218 (b)	10,857 (b)	3,577 (f)	146 (f) [d]
1987		2,511 (f)		2,387 (w)	3,802 (f)	22,300 (b)	4,225 (b)	
1988		348 (f)		2,046 (w)		21,600 (b)	825 (b)	
1989				412 (w)	824 (f) [d]	11,000 (b)	1,600 (b)	483 (f)
1990		688 (f)	1,308 (f)		(h) [d]	8,325 (b)	2,375 (b)	
1991		564 (f)	447 (f)		52 (f)	23,900 (b)	3,150 (b)	
1992		372 (f)			490 (f)	3,963 (b)	229 (b)	500 (f)
1993		350 (f)	419 (f)	666 (w) [g]	581 (h)	10,875 (b)	3,525 (b)	
1994		944 (h)	1,648 (h)	1,317 (w) [h]	2,909 (h)	62,675 (b)	3,425 (b)	5,800 (f)
1995	119,893	4,169 (f)	2,218 (h)	500 (w)	1,512 (h)	20,100 (b)	3,625 (b)	

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Year	Yukon River mainstem sonar estimate[a]	Nenana River drainage: Lost Slough	Nenana River drainage: Nenana mainstem[b]	Nenana River drainage: Wood Creek	Nenana River drainage: Seventeen Mile Slough	Upper Tanana River drainage: Delta Clearwater River[c]	Upper Tanana River drainage: Clearwater Lake and outlet	Upper Tanana River drainage: Richardson Clearwater River
1996	[i]	2,040 (h)	2,171 (h)	201 (u)[d]	3,668 (g/b)	14,075 (b)	1,125 (h)[d]	
1997	118,065	1,524 (h)	1,446 (h)	[j]	1,996 (h)	11,525 (b)	2,775 (b)	
1998	146,365	1,360 (h)[d]	2,771 (h)[d]	[j]	1,413 (g/b)	11,100 (b)	2,775 (b)	
1999	76,174	1,002 (h)[d]	745 (h)[d]	370 (h)	662 (h)[d]	10,975 (b)		
2000	206,365	55 (h)[d]	68 (h)[d]	[j]	879 (h)[d]	9,225 (b)	1,025 (b)	2,175 (h)
2001	160,272	242 (h)	859 (h)	699 (h)	3,753 (h)	46,985 (b)	4,425 (b)	1,531 (f)
2002	137,077	0 (h)	328 (h)	935 (h)	1,910 (h)	38,625 (b)	5,900 (b)	874 (f)
2003	280,552	85 (h)	658 (h)	3,055 (h)	4,535 (h)	102,800 (b)	8,800 (b)	6,232 (h)
2004	207,844	220 (h)	450 (h)	840 (h)	3,370 (h)	37,550 (b)	2,925 (b)	8,626 (h)
2005	194,622	430 (h)	325 (h)	1,030 (h)	3,890 (h)	34,293 (b)	2,100 (b)	2,024 (h)
2006	163,889	194 (h)	160 (h)	634 (h)	1,916 (h)	16,748 (b)	4,375 (b)	271 (h)
2007	192,406	63 (h)	520 (h)	605 (h)	1,733 (h)	14,650 (b)	2,075 (b)	553 (h)
2008	145,378	1,342 (h)	1,539 (h)	578 (h)	1,652 (h)	7,500 (b)	1,275 (b)	265 (h)
2009	[i]	410 (h)		470 (h)	680 (h)	16,850 (b)	5,450 (b)	155 (h)
2010	177,724	1,110 (h)	280 (h)	340 (h)	720 (h)	5,867 (b)	813 (b)	1,002 (h)
2011	149,533	369 (h)		0 (h)[j]	912 (h)	6,180 (b)	2,092 (b)	575 (h)
2012	130,734		106 (h)	0 (h)[j]	405 (h)	5,230 (b)	396 (h)	515 (h)
2013	110,515	721 (h)		55 (h)	425 (h)	6,222 (b)	2,221 (h)	647 (h)
2014	283,421	333 (h)	378 (h)	649 (h)	886 (h)	4,285 (b)	434 (h)	1,941 (h)
2015	121,193	242 (h)	1,789 (h)	1,419 (h)	3,890 (h)	19,533 (b)	1,621 (h)	3,742 (h)
2016	168,297	334 (h)	1,680 (h)	1,327 (h)	2,746 (h)	6,767 (b)	1,421 (h)	1,350 (h)
2017	166,320	1,278 (h)	862 (h)	2,025 (h)	1,942 (h)	9,617 (b)		
2018	136,347	1,822 (h)	241 (h)	361 (h)	347 (h)	2,884 (b)	2,465 (h)	976 (h)
2019	86,401 [k]		749 (h)	184 (h)	424 (h)	2,043 (b)	258 (h)	300 (h)

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		Nenana River drainage				Upper Tanana River drainage		
Year	Yukon River mainstem sonar estimate [a]	Lost Slough	Nenana mainstem [b]	Wood Creek	Seventeen Mile Slough	Delta Clearwater River [c]	Clearwater Lake and outlet	Richardson Clearwater River
SEG [l]						5,200–17,000		
Averages								
1972–2018	163,318	837	937	1,241	1,546	15,189	2,144	1,385
2009–2018	160,454	735	762	665	1,295	8,344	1,879	1,211
2014–2018	173,149	802	990	1,156	1,962	8,617	1,485	2,002
Minimum-18	76,174	0	68	0	27	632	229	80
Maximum-18	283,421	4,169	2,771	8,826	4,535	102,800	8,800	8,626

Note: Only peak counts presented. Survey rating is fair to good, unless otherwise noted. Denotations of survey methods include: (b)=boat, (f)=fixed wing, (g)=ground/foot, (h)=helicopter, (u)=undocumented, and (w)=weir. Minimum and maximum indicate year with the lowest and highest values through 2018.

[a] Passage estimates for coho salmon are incomplete. The sonar project is terminated prior to the end of the coho salmon run. New model estimates generated in 2015 and applied to dataset back to 1995 and used since.

[b] Index area includes mainstem Nenana River between confluences of Lost Slough and Teklanika River.

[c] Index area is lower 17.5 miles of system.

[d] Poor survey resulted in minimal count.

[e] Weir was operated at the mouth of Clear Creek (Shores Landing).

[f] Expanded estimate based on partial survey counts and historic distribution of spawners from 1977–1980.

[g] Weir project terminated on October 4, 1993. Weir normally operated until mid- to late October.

[h] Weir project terminated September 27, 1994. Weir normally operated until mid- to late October.

[i] Project operated all or partial season, estimate was not useable.

[j] No survey of Wood Creek due to obstructions in creek or surveyed with zero fish observed.

[k] Data are preliminary.

[l] Sustainable escapement goal (SEG) established January 2004 (replaces BEG of greater than 9,000 fish established March 1993), based on boat survey counts of coho salmon in the lower 17.5 river miles during the period October 21–27.

Appendix B18.–Estimated run size, escapement and harvest shares for Mainstem Canadian-origin Yukon River Chinook salmon, 2001–2019.

	Yukon River Panel goal or IMEG [a]		Border	Total	Total allowable catch (TAC)		U.S. share (%) of TAC		U.S.	Canada share (%) of TAC		Canada	Spawning
Year	From	To	passage [b]	run size [c]	From	To	0.74	0.8	harvest [d]	0.2	0.26	harvest	escapement [e]
2001	18,000	28,000	62,338	85,663	57,663	67,663	42,671	54,131	23,325	11,533	17,592	9,774	52,564
2002	28,000		51,428	81,487	53,487		39,580	42,790	30,058	10,697	13,907	9,070	42,359
2003	25,000	28,000	90,040	149,979	121,979	124,979	90,264	99,983	59,939	24,396	32,495	9,446	80,594
2004	28,000		59,415	117,247	89,247		66,043	71,398	57,832	17,849	23,204	10,946	48,469
2005	28,000		78,962	123,612	95,612		70,753	76,490	44,650	19,122	24,859	10,977	67,985
2006	28,000		71,388	119,485	91,485		67,699	73,188	48,097	18,297	23,786	8,758	62,630
2007	33,000	43,000	39,698	87,899	44,899	54,899	33,225	43,919	48,201	8,980	14,274	4,794	34,904
2008	45,000		37,282	62,610	17,610		13,031	14,088	25,328	3,522	4,579	3,399	33,883
2009	45,000		69,575	87,221	42,221		31,244	33,777	17,646	8,444	10,977	4,297	65,278
2010	42,500	55,000	34,470	59,741	4,741	17,241	3,508	13,793	25,271	948	4,483	2,456	32,014
2011	42,500	55,000	50,901	71,726	16,726	29,226	12,377	23,381	20,825	3,345	7,599	4,594	46,307
2012	42,500	55,000	34,656	48,494	0	5,994	4,435	4,795	13,840	1,199	1,558	2,000	32,656
2013	42,500	55,000	30,573	37,177	0	0	0	0	6,604	0	0	1,904	28,669
2014	42,500	55,000	63,431	64,886	9,886	22,386	7,315	17,909	1,455	1,977	5,820	100	63,331
2015	42,500	55,000	83,674	87,323	32,323	44,823	23,919	35,858	3,649	6,465	11,654	1,000	82,674
2016	42,500	55,000	71,567	82,765	27,765	40,265	20,546	32,212	11,739	5,553	10,469	2,769	68,798
2017	42,500	55,000	71,815	93,188	38,188	50,688	28,259	40,550	22,043	7,638	13,179	3,500	68,315
2018	42,500	55,000	57,264	76,356	21,356	33,856	15,803	27,085	19,266	4,271	8,803	2,790	54,474
2019	42,500	55,000	44,816	72,620	17,620	30,120	13,039	24,096	27,804	3,524	7,831	2,764	42,052
Average 2014–2018			69,550	80,904	25,904	38,404	19,169	30,723	11,630	5,181	9,985	2,032	67,518

Note: 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.

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

[b] From 2005–2019, border passage estimates are the Chinook salmon estimate of abundance 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 Chinook salmon. Beginning in 2014, this includes harvest from the Coastal District.

[d] U.S. Harvest estimates are 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.

Appendix B19.–Summary of management and conservation measures implemented in the U.S (Alaska) and Canada, 2001–2019.

Year	U.S. management actions (commercial)	U.S. management actions (subsistence)	Canadian management actions (commercial, domestic, recreational)	Canadian management actions (subsistence)
2001	No commercial fishing for Chinook or summer chum salmon.	Subsistence fishing schedule implemented (and continued in following years).	Test fishery implemented in early season; commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2002	Chinook commercial fishing shifted to midpoint of run and later.		Test fishery implemented in early season; commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2003	Chinook commercial fishing shifted to midpoint of run and later.		Test fishery implemented in early season; commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2004	Chinook commercial fishing shifted to midpoint of run and later.		Test fishery implemented in early season; commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2005	Chinook commercial fishing shifted to midpoint of run and later.		Commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2006	Chinook commercial fishing delayed until start of second pulse.		Commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Unrestricted
2007	Short fishing period on historic first quarter point date. Majority of harvest spread over middle 50% of the run.		Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Unrestricted
2008	Chinook commercial fishing closed.	Protection on 2nd and 3rd pulses.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Voluntary reduction in harvest.
2009	Chinook commercial fishing closed and no sale of incidental catch; summer chum fishing delayed.	1st and 2nd pulse closure.	Commercial/domestic openings determined by weekly estimates of abundance, recreational open.	Voluntary reduction in harvest in early season.

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Year	U.S. management actions (commercial)	U.S. management actions (subsistence)	Canadian management actions (commercial, domestic, recreational)	Canadian management actions (subsistence)
2010	Chinook commercial fishing closed; summer chum fishing delayed.		Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery.	Voluntary reduction in harvest.
2011	Chinook commercial fishing closed and no sale of incidental catch; summer chum fishing delayed; summer chum fishing restricted to certain areas of low Chinook abundance.	1st and 2nd pulse closure; additional fishing time reductions in upper districts; 7.5" mesh size restriction all season.	Chinook commercial/domestic fishing closed; recreational fishing varied to non-retention in the recreational fishery, angling closure at Tatchun River, recreational restrictions lifted late in the season.	Voluntary reduction in harvest in early season.
2012	Chinook commercial fishing closed and no sale of incidental catch; summer chum fishing delayed and restricted to areas of low Chinook abundance; chum fish wheels attended at all times and Chinook released alive.	1st and 2nd pulse closure; additional fishing time reductions in upper districts; 6" mesh size restriction after closures.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Voluntary reduction in harvest.
2013	Chinook commercial fishing closed and no sale of incidental catch. Summer chum fishing with beach seines and dip nets, all Chinook released alive. Gillnet summer chum fishing restricted to 5.5" and 30 meshes; delayed and restricted to areas of low Chinook abundance; chum fish wheels attended at all times and Chinook released alive.	1st, 2nd and 3rd pulse closures - limited opportunity in between pulses; additional fishing time reductions in upper districts; 6" mesh size restriction all season.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River and Teslin River.	Voluntary reduction in harvest.

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Year	U.S. management actions (commercial)	U.S. management actions (subsistence)	Canadian management actions (commercial, domestic, recreational)	Canadian management actions (subsistence)
2014	Chinook commercial fishing closed; liberal opportunity for summer chum fishing with beach seines and dip nets - all Chinook released immediately and alive; 6" or smaller gillnet summer chum fishing delayed until majority of Chinook run complete; no sale of incidental Chinook; chum fish wheels had to be attended at all times and all Chinook released immediately to the water; concurrent subsistence and commercial openings.	Entire mainstem river closed to Chinook-directed fishing; no gillnets allowed greater than 4" mesh size to harvest non-salmon species; opportunity to harvest summer chum salmon in Districts 1-4 using elective gear that allows immediate and live release of Chinook allowed (dip nets, beach seines, and fish wheels); short openings with 6" or smaller gillnets allowed in each districts after >90% of Chinook salmon run had passed through; >99% in District 5.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River and Teslin River	Regulatory removal of TAC until 3rd quartile, voluntary reduction or closure maintained by majority of First Nations.
2015	Chinook commercial fishing closed; liberal opportunity for summer chum fishing with beach seines and dipnets - all Chinook released immediately and alive; 6" or smaller gillnet summer chum fishing delayed until majority of Chinook run complete; no sale of incidental Chinook; fish wheels had to be attended at all times and all Chinook released immediately to the water; concurrent subsistence and commercial openings.	Entire river closed to Chinook-directed fishing; no gillnets allowed greater than 4" mesh size to harvest non-salmon species; opportunity to harvest summer chum salmon in Districts 1–4 using selective gear that allows immediate and live release of Chinook (dipnets, beach seines, and fish wheels); short openings with 6" or smaller gillnets allowed in each district between pulses of Chinook salmon when summer chum abundance was high. Subsistence fishing was allowed in Subdistrict 5-D on the early trickle of Chinook salmon. Subsistence schedules liberalized in Districts 4 and 5 once Chinook salmon border escapement was surpassed.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Regulatory removal of TAC until 2nd quartile, voluntary reduction or closure maintained by majority of First Nations.

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Year	U.S. management actions (commercial)	U.S. management actions (subsistence)	Canadian management actions (commercial, domestic, recreational)	Canadian management actions (subsistence)
2016	Chinook commercial fishing closed; liberal opportunity for summer chum fishing with selective gear - all Chinook released immediately and alive; 6" or smaller gillnet summer chum fishing delayed until majority of Chinook run complete; no sale of incidental Chinook. No concurrent subsistence and commercial openings.	Early season only: Districts 1–5 using selective gear requiring live release of Chinook (dipnets, beach seines, and fish wheels); Subdistrict 5-D had open fishing on the early trickle with 6" gillnets. Reduced regulatory schedule fishing with gillnets restricted to 6" in most districts. Followed by surgical openings with 7.5" gillnets late in the run. Subsistence schedules liberalized in Districts 4 and 5 once Chinook salmon border escapement was surpassed.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Aboriginal Fishery open with recommendation for reduced harvest (30%), voluntary reduction or closure maintained by majority of First Nations.
2017	Chinook commercial fishing closed; liberal opportunity for summer chum fishing with selective gear - all Chinook released immediately and alive; 6" or smaller gillnet summer chum fishing delayed until majority of Chinook salmon run had entered the river. No sale of incidental Chinook salmon in summer season; one commercial period occurred in District 1 where Chinook salmon caught during fall chum directed commercial fishing were allowed to be sold. No concurrent commercial and subsistence openings in Districts 1 and 2.	Early season only: Districts 1–5 placed on regulatory schedule fishing with gillnets restricted to 6" prior to the first pulse. Fishing restricted to selective gear requiring live release of Chinook (dipnets, beach seines, and fish wheels), then reopened to regulatory schedule with 7.5-inch of smaller mesh. Coastal District, Koyukuk and Innoko Rivers, and Subdistrict 5-D remained open with 7.5-inch or smaller mesh all season.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Aboriginal Fishery open with recommendation for reduced harvest, voluntary reduction or closure maintained by majority of First Nations.

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Year	U.S. management actions (commercial)	U.S. management actions (subsistence)	Canadian management actions (commercial, domestic, recreational)	Canadian management actions (subsistence)
2018	Chinook commercial fishing closed; liberal opportunity for summer chum fishing with selective gear - all Chinook released immediately and alive; 6" or smaller gillnet summer chum fishing delayed until majority of Chinook salmon run had entered the river. No sale of incidental Chinook salmon. No concurrent commercial and subsistence openings in Districts 1 and 2.	Early season: Districts 1–5 placed on half regulatory schedule fishing with gillnets restricted to 6”. Two subsistence periods (one per week) were cancelled in Districts 1–4A. Later in the season, limited opportunity (one reduced time opening per week) was provided with 7.5” mesh in Districts 1-4. District 5 remained restricted to 6” mesh through the third pulse of the Chinook salmon run. Coastal District, Koyukuk and Innoko Rivers remained open with 7.5-inch or smaller mesh all season.	Chinook commercial/domestic fishing closed; varied to non-retention in the recreational fishery, angling closure at Tatchun River.	Aboriginal Fishery open with recommendation for reduced harvest; voluntary reduction or closure maintained by majority of First Nations.
2019	Summer chum commercial fishing delayed due to late run timing; 6" or smaller gillnet summer chum commercial fishing occurred after the majority of Chinook run complete. Sale of incidental Chinook salmon allowed in the summer season after over 200,000 Chinook salmon had been counted at Pilot Station sonar. Sale of incidental Chinook salmon allowed during fall chum-directed commercial fishing. No concurrent commercial and subsistence openings.	Most of season: Districts 1-5 placed on **half** regulatory schedule fishing. 6"or smaller mesh restrictions added for at least 2 periods in Districts 1-6. One subsistence period was cancelled in Districts 1-4. Fishing was closed for 10 days in Subdistrict 5-D. Coastal District, Koyukuk and Innoko Rivers remained open with 7.5" or smaller mesh all season.	Commercial and Domestic fishery Conditions of License limited harvesters to gillnets with a 6" or smaller mesh size; Chinook commercial/domestic fisheries were closed. In advance of the Chinook return, retention varied to zero in the angling (recreational) fishery. A complete angling closure was enacted on the Yukon River and its tributaries as a Chinook conservation measure. Similarly, chum commercial/domestic fishery opening delayed to mid-September due to Chinook late run timing and low returns. Salmon angling fishery reopened in late September.	Season commenced on July 1 with an opening and full allocation available for First Nation Chinook Fishery. Voluntary reduction or closure maintained by majority of First Nations. First Nation Governments were notified in early August advised to implement additional precautionary measures due to lower than expected passage at Eagle sonar and unlikeliness of achieving the midpoint of the IMEG.

APPENDIX C: BERING SEA-ALEUTIAN ISLANDS BYCATCH SUMMARY AND IMPACT ON YUKON RIVER CANADIAN-ORIGIN SALMON

Yukon River Salmon Bycatch Summary

January 2020

The Yukon River Salmon Agreement identifies the need to identify, quantify, and undertake efforts to reduce marine catches and bycatch of Yukon River salmon. This section provides an overview of information on U.S. groundfish fisheries in the Bering Sea-Aleutian Islands (BSAI) management region, bycatch regulations, and bycatch impacts on Yukon River Canadian-origin salmon.

Bycatch impacts on Canadian-origin salmon

Yukon River Canadian-origin salmon are caught as bycatch in BSAI groundfish fisheries along with other salmon stocks from Alaska, the west coast of Canada and the United States, eastern Asia, and Russia. Largely due to the mixed-stock nature of salmon bycatch, the total number of salmon captured as bycatch is much larger than the bycatch of Canadian-origin salmon. For example, the total annual bycatch of Chinook salmon in BSAI pollock fishery is estimated to be approximately 5,000 to 125,000 fish from 1991 to 2019 (Table 1), while the bycatch of Yukon River Canadian-origin Chinook salmon over this same time period is estimated to be approximately 350 to 2,300 fish (Table 2, rounded values). The average bycatch impact rate of the BSAI pollock fishery is estimated to be less than 1% of the Yukon River Canadian-origin Chinook salmon run (Ianelli and Stram, 2018). The average bycatch impact to western Alaska chum salmon (not Canadian-origin chum salmon) is estimated to be 0.4% with annual rates less than 1.3% (Murphy et al. 2017). Ongoing regulatory and management measures implemented by the North Pacific Fisheries Management Council (NPFMC) are a key factor limiting the bycatch impact rates on Canadian-origin salmon in BSAI groundfish fisheries.

Current BSAI bycatch information

- Total bycatch of Chinook salmon in BSAI groundfish fisheries during 2019 was 31,403, which is similar to their recent 5-year average (Table 1). Chinook salmon bycatch in the BSAI pollock fishery during 2019 was 24,948, approximately 79% of the total bycatch.
- Total bycatch of non-Chinook salmon (primarily chum salmon) in BSAI groundfish during 2019 was 358,797, approximately 12% higher than the recent 5-year average (Table 1). Bycatch of non-Chinook salmon in the BSAI pollock fishery during 2019 was 347,880, approximately 97% of the total bycatch.
- Bycatch impacts to Canadian-origin Chinook salmon by BSAI Pollock fishery is estimated by run year. The 2017 run is the most recent year for which bycatch impact estimates are available for Canadian-origin Chinook salmon.
    - The total Yukon River Canadian-origin Chinook salmon run in 2017 was 93,188. An additional 772 Yukon River Canadian-origin Chinook salmon would have contributed to the 2017 run if they had not been captured as bycatch in the BSAI pollock fishery (Table 2). This represents a 0.83% impact rate on Yukon River Canadian-origin Chinook salmon in 2017.

Background Information

Bycatch management

- U.S. groundfish trawl fisheries in the BSAI management area are managed to limit the bycatch of salmon under the Magnuson-Stevens Fisheries Conservation and Management Act by the NPFMC and are regulated by National Marine Fisheries Service (NMFS).
- The pollock fishery is the primary focus of bycatch management as it accounts for an average of 88% of the total Chinook salmon bycatch and 99% of the non-Chinook salmon bycatch in the BSAI management area.
- The pollock fishery is managed according to the Fishery Management Plan (FMP) for Groundfish of the BSAI Management Area.
  https://www.npfmc.org/wp-content/PDFdocuments/fmp/BSAI/BSAIfmp.pdf

Bycatch regulations

- The BSAI groundfish FMP contains regulatory measures to reduce salmon bycatch.
- The BSAI pollock fishery is one of the most heavily regulated and monitored fisheries in the world and includes 100% observer coverage.
- Notable bycatch reduction measures include amendment 91 and amendment 110.
- Amendment 91 (https://alaskafisheries.noaa.gov/rules-notices/search) was implemented in 2011 and, among other things, established bycatch caps.
- Amendment 110 (https://alaskafisheries.noaa.gov/rules-notices/search) was implemented in 2016 and, among other things, established abundance-based bycatch caps to further protect western Alaska and Canadian-origin Chinook salmon stocks harvested for subsistence purposes. Bycatch caps are set relative to the in-river run size of combined Unalakleet, Upper Yukon (Canadian-origin), and Kuskokwim River Chinook salmon stock groups (termed the three-system index).

Bycatch impact methods

- The number of salmon captured as bycatch in a given year is not equivalent to the number of adult salmon that would have returned to the Canadian portion of the Yukon River drainage in that year for two reasons.
  - Salmon stocks throughout the North Pacific are captured as bycatch in the BSAI groundfish fisheries. Information on stock origin is required to evaluate the impact of bycatch to a given stock or stock group.
  - Salmon are predominately captured as bycatch during their immature life-history stage. Immature salmon will spend one or more years in the ocean before returning to freshwater. Bycatch numbers of immature salmon require an adjustment for natural mortality before they can be compared to the number of adults returning to freshwater. Estimates that are adjusted for natural mortality are referred to as Adult Equivalent (AEQ) bycatch.
- Bycatch impacts on Yukon River Canadian-origin salmon are based on stock-specific Adult Equivalent (AEQ) estimates of bycatch, not total bycatch. These estimates rely on the following data inputs: total salmon bycatch, bycatch stock mixtures, bycatch age composition, average salmon maturity schedules, and assumptions on annual rates of natural mortality of salmon in marine habitats.

Additional resources

- Bycatch numbers are reported by the National Marine Fisheries Service, available at: https://alaskafisheries.noaa.gov/fisheries-catch-landings?tid=286
- Bycatch updates are reported by the North Pacific Fisheries Management Council, available at: https://www.npfmc.org/bsai-salmon-bycatch/

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Table 1.–Numbers of Chinook and non-Chinook (chum) salmon captured as bycatch in the Bering Sea-Aleutian Islands (BSAI) groundfish fisheries by season (A-season: winter, B-season: summer/fall), 1991-2019.

	BSAI Chinook salmon bycatch						BSAI Non-Chinook salmon bycatch					
	A-season		B-season		Annual		A-season		B-season		Annual	
Year	Pollock fisheries	All fisheries	Pollock fisheries	All fisheries	Pollock fisheries	All fisheries	Pollock fisheries	All fisheries	Pollock fisheries	All fisheries	Pollock fisheries	All fisheries
1991 [a]	38,791	46,392	2,114	2,488	40,905	48,880	2,850	3,015	26,101	27,245	28,951	30,260
1992 [a]	25,691	31,418	10,259	10,536	35,950	41,954	1,951	2,120	38,324	39,329	40,275	41,449
1993 [a]	17,264	24,688	21,252	21,325	38,516	46,013	1,594	1,848	240,597	241,422	242,191	243,270
1994	28,451	38,921	4,686	4,899	33,137	43,820	3,991	5,599	88,681	88,949	92,672	94,548
1995	10,579	18,939	4,405	4,497	14,984	23,436	1,708	3,033	17,556	18,842	19,264	21,875
1996	36,068	43,316	19,554	19,888	55,622	63,204	222	665	77,014	77,395	77,236	78,060
1997	10,935	16,401	33,973	34,128	44,908	50,529	2,083	2,710	63,904	64,285	65,987	66,995
1998	16,132	19,869	40,308	40,679	56,440	60,548	4,090	4,520	60,866	61,177	64,956	65,697
1999	6,352	8,793	5,627	5,805	11,979	14,598	362	393	44,909	46,739	45,271	47,132
2000	3,422	6,567	1,539	1,655	4,961	8,222	213	350	58,358	58,976	58,571	59,326
2001	18,484	24,871	14,961	15,676	33,445	40,547	2,386	2,903	54,621	57,827	57,007	60,730
2002	21,794	26,276	12,701	13,407	34,495	39,683	1,377	1,697	79,274	80,784	80,651	82,481
2003	33,478	40,058	12,183	13,603	45,661	53,661	3,831	3,831	184,513	184,559	188,344	188,390
2004	24,925	30,766	26,837	29,272	51,762	60,038	426	426	451,907	452,131	452,333	452,560
2005	27,960	33,622	40,224	41,462	68,184	75,084	594	594	710,196	710,926	710,790	711,520
2006	58,547	62,547	24,205	24,568	82,752	87,115	1,323	1,323	305,674	305,852	306,997	307,175
2007	72,943	78,156	51,780	51,844	124,723	130,000	8,481	8,481	84,387	85,152	92,868	93,641
2008	16,495	18,828	4,811	5,009	21,306	23,837	247	247	14,732	14,732	14,980	14,980
2009	9,882	11,289	2,697	2,825	12,579	14,114	48	48	45,397	45,397	45,445	45,445
2010	7,649	9,480	2,071	2,921	9,720	12,401	40	40	13,238	13,237	13,278	13,278
2011	7,137	7,602	18,362	19,007	25,499	26,609	297	297	191,138	194,405	191,435	194,819
2012	7,765	8,981	3,579	3,949	11,344	12,930	11	11	22,172	23,766	22,183	24,073
2013	8,237	9,186	4,797	6,821	13,034	16,007	215	215	125,101	126,554	125,316	127,001
2014	11,539	13,837	3,492	4,261	15,031	18,098	577	577	218,865	222,634	219,442	224,263
2015	12,304	17,502	6,025	7,752	18,329	25,254	4,800	4,800	232,996	237,196	237,796	243,402
2016	16,828	25,721	5,098	6,840	21,926	32,561	3,903	3,903	339,098	342,503	343,001	347,341
2017	21,828	27,008	8,248	9,272	30,076	36,280	1,906	1,906	465,772	469,134	467,678	471,448
2018	8,631	11,251	5,095	6,130	13,724	17,379	1,199	1,199	293,864	306,926	295,062	309,797
2019	15,781	20,080	9,203	11,323	24,948	31,403	2,239	2,239	345,641	354,288	347,880	358,797

Note: https://www.fisheries.noaa.gov/sites/default/files/akro/chinook_salmon_mortality2019.html; https://www.fisheries.noaa.gov/sites/default/files/akro/chum_salmon_mortality2019.html

[a] Community Development Quota (CDQ) bycatch not included.

Table 2. –Estimated adult equivalent (AEQ) bycatch of Canadian-origin Chinook from the Yukon River in the Bering Sea-Aleutian Islands (BSAI) pollock fisheries by run year, run size of the Canadian-origin Chinook salmon, and bycatch exploitation rates, 1994–2017 (Ianelli and Stram, 2018).

Run year	Canadian-Origin AEQ bycatch	Canadian-Origin run	Canadian-Origin Impact rate
1994	1,035	172,885	0.60%
1995	817	169,789	0.48%
1996	998	182,504	0.55%
1997	995	161,700	0.62%
1998	760	88,282	0.86%
1999	588	110,446	0.53%
2000	347	52,842	0.66%
2001	508	85,663	0.59%
2002	835	81,487	1.02%
2003	1,044	149,979	0.70%
2004	1,214	117,247	1.04%
2005	1,267	123,612	1.02%
2006	1,843	119,485	1.54%
2007	2,361	87,899	2.69%
2008	1,918	62,610	3.06%
2009	1,127	87,899	1.28%
2010	518	59,741	0.87%
2011	359	71,726	0.50%
2012	351	48,494	0.72%
2013	364	37,177	0.98%
2014	401	64,886	0.62%
2015	455	87,323	0.52%
2016	532	82,765	0.64%
2017	772	93,188	0.83%
Average (1994-2017)	892	99,985	0.96%
Average (2008-2017)	680	69,581	1.00%
Average (2013-2017)	505	73,068	0.72%
Minimum	347	37,177	0.48%
Maximum	2361	182,504	3.06%

APPENDIX D: AN EVALUATION OF AGE-SPECIFIC FEMALE PROPORTION ESTIMATES OF YUKON RIVER CHINOOK SALMON AT THE ALASKA BORDER

An Evaluation of Age-specific Female Proportion Estimates of Yukon River Chinook Salmon at the Alaska Yukon Border

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Introduction

At the spring 2019 Joint Technical Committee (JTC) meeting the committee reviewed the new reanalysis of what has been considered to be biased sample data collected in the Alaska Yukon border area between 1982 and 2006 (Hamazaki 2018). The committee subsequently approved the new age structure data for incorporation in the JTC report and related production and forecasting purposes. The committee, however, did not support changes in the associated age-specific sex composition data for two primary reasons: first, age-specific sex composition data is unnecessary for conventional stock recruit analyses, which is the primary reason for our efforts to correct perceived sampling biases of these older age structure data; and second, for the age 4 component of the run in particular, the female proportion data appeared to be implausibly high when compared to relatively large collections of known-sex samples from the drainage and with the more recent sampling data from the Eagle sonar test fishing project, suggesting a different type of bias being conferred to those older samples. In the following pages I will justify the decision by presenting and comparing the age-specific sex composition data presented in Hamazaki (2018) with known-sex data from test fishing operations in the lower Yukon River from 2000–2019, two carcass sampling programs that have been operating most years since the early 1970s (Salcha River) and 1980s (Chena River), and the recent sampling data from the Eagle sonar test fishing project (2007–2019).

Methods

Known-sex data were downloaded from the State of Alaska website <http://www.adfg.alaska.gov/CommFishR3/Website/AYKDBMSWebsite/DataSelection.aspx> that was established to make these types of data available. Test fishing data from the lower Yukon River were from drift and set net projects in the Middle Mouth, Big Eddy, Dall Point, Emmonak, Kotlik, and Mountain Village; a total of more than 32,000 samples in which sex was determined by internal examination of gonads. While gillnets are known to be size selective (Bromaghin 2005), within age classes the two sexes are morphologically reasonably similar, particularly early in the spawning migration, and are considered to be representative of the annual run. Sex classification from the post-spawning carcass samples collected from the Chena (n > 14,000) and Salcha (n > 14,000) rivers were at least in part by external examination but are assumed to be correctly classified because of the distinctive morphology exhibited by males and females during their spawning period. Carcass samples are known to be biased towards larger fish and females overall (Zhou 2002), but within age classes the sexes were thought to be representative of the annual runs. Some annual collections of the carcass samples were rejected for these analyses because sample sizes were too small to provide adequate estimates of proportions of females within the four age classes. Sample sizes of annual collections that were used included a minimum of 174 and 149 fish in the Chena and Salcha River collections, respectively, and averaged 420 and 382 samples. Similar to the lower Yukon test fishing projects, female proportions within age classes of the Eagle sonar test fishing data are thought to be reliable because of the sex-specific morphological changes that occur during the course of a spawning migration even though most years they were classified as males or females by external observation. Our analyses dealt with the proportion female within age classes of annual collections.

Known-sex data from the lower Yukon River test fishing projects, the two carcass sampling projects, and the Eagle test fishing project were compared with data presented by Hamazaki (2018) in Table 6 on page 12. Null hypotheses that mean female proportions within the four major age classes, brood-year ages 4–7, were similar among collections versus the alternative hypothesis that at least one group was significantly different, were compared with analysis of variance procedures (ANOVA). While there is some annual variability in age at maturity for male and female Chinook Salmon, the consistent pattern has been that males dominate age classes 4 and 5 and females dominate age classes 6 and 7 (Healey 1991). The three collections of known-sex data were expected to conform to this pattern and were used to establish representative mean values and a range of variability we might expect from other collections in the Yukon River drainage including those from the Alaska Yukon border area. A large deviation from known-sex values in this analysis would lead us to conclude that there was either incorrect sex assignment in the original data set or a bias correction model that was imperfect.

Results

Mean female proportions were similar within all four age classes for the two carcass sample data sets so they were pooled for further analyses (Table 1). The mean proportion female within four brood-year age classes, ages 4–7, were all similar among the three sampling programs, the lower Yukon River test fishing program, the pooled carcass samples from the Chena and Salcha rivers, and the Eagle test fishing program associated with the sonar project during the years 2007–2019 (Table 2; Figure 1). Mean female proportions in the new analysis of the older sample data collected from the Alaska Yukon border area between 1982 and 2006 (Hamazaki 2018), however, were significantly different than the other three groups for age classes 4 and 6, significantly different than the more recent Eagle test fishing program for age 7, and similar to the other three groups for age 5. The new analysis suggests a mean proportion female age 4 as 0.10, compared to means of 0.02 or less for the other three sample groups. Known-sex collections of age 4 Chinook Salmon in the Yukon River drainage are always strongly dominated by males. The carcass data extending back in time to the early 70s and early 80s for the Salcha and Chena River collections, respectively, demonstrate that the age of maturity of male and female Chinook Salmon was similar throughout the time period being considered.

Table 1. Comparisons of mean female proportion within four age classes, brood-year ages 4–7, for carcass samples collected on the Chena and Salcha rivers. Sample sizes (n) indicate the number of years of data in which carcass samples numbering 149 fish or greater were collected. Mean female proportion within age classes were similar for all four age classes.

Variable	Project	*n*	Mean	SE Mean	StDev	Statistics	
PropF Age-4	Chena	33	0.0229	0.0074	0.0424	$F_{1,67} = 0.16$	$P = 0.693$
	Salcha	36	0.01849	0.0084	0.0505		
PropF Age-5	Chena	33	0.2557	0.0186	0.1070	$F_{1,67} = 1.38$	$P = 0.244$
	Salcha	36	0.2256	0.0176	0.1055		
PropF Age-6	Chena	33	0.7177	0.0177	0.1019	$F_{1,67} = 0.58$	$P = 0.449$
	Salcha	36	0.7010	0.0132	0.0789		
PropF Age-7	Chena	30	0.7415	0.0447	0.2446	$F_{1,62} = 0.18$	$P = 0.670$
	Salcha	34	0.7652	0.0338	0.1971		

Conclusion

The mean female proportions within brood-year age classes presented in the reanalysis of the older sample data from the border region were significantly divergent from mean values from these sample groups of more reliable sex composition data. Some have criticized this approach of using known-sex collections to identify flaws in sex assignments by contending that each population might have its own sex-specific maturity schedule. While this may be a valid criticism, all of the known-sex collections examined to date in the Yukon River, whether main stem or tributary locations, have always been similar to those presented here for the lower Yukon test fishery, Chena and Salcha River carcass samples, and the more recent Eagle test fishery samples, and much lower for the age 4 female proportion than the mean of 0.10 introduced by Hamazaki (2018). If there are Chinook Salmon populations in the Yukon River that exhibit consistently greater female maturation at age 4 than what we have observed here, it would be good to present those data and document that life history variant. However, because the age-specific female proportions presented in Hamazaki (2018) are so divergent from values in known-sex collections, and age-specific female proportions are not required for production analyses, the JTC is justified in deciding not to change historical sex composition data.

Table 2. Comparisons of female proportion within four age classes, brood-year ages 4–7, for carcass samples collected over the last few decades on the Chena and Salcha rivers combined, Eagle sonar test fishing samples 2007–2019, known-sex samples from the lower Yukon test fishery 2000–2019, and the new analysis of the biased sample data collected in the border area of the Yukon River between Alaska and Yukon 1982–2006. Sample sizes (n) indicate the number of years of sample data being considered. Mean values were compared among groups with a one-way ANOVA followed by a Tukey multiple comparisons procedure if initial comparisons were significant. Groups with different grouping letters were found to be significantly different.

Variable	Project	*n*	Mean	Grouping	SE Mean	StDev
PropFAge4	Carcass	69	0.0205	B	0.0056	0.0465
	EagleSonar	13	0.0166	B	0.0105	0.0379
	LYTestFish	20	0.0095	B	0.0031	0.0138
	NewAnal	24	0.1013	**A**	0.0301	0.1475
PropFAge5	Carcass	69	0.2400		0.0128	0.1065
	EagleSonar	13	0.2172		0.0184	0.0662
	LYTestFish	20	0.2666		0.0149	0.0664
	NewAnal	24	0.2286		0.0183	0.0897
PropFAge6	Carcass	69	0.7090	A	0.0109	0.0903
	EagleSonar	13	0.6667	A	0.0115	0.0413
	LYTestFish	20	0.6604	A	0.0116	0.0519
	NewAnal	24	0.5846	**B**	0.0158	0.0775
PropFAge7	Carcass	64	0.7541	AB	0.0274	0.2192
	EagleSonar	12	0.8373	**A**	0.0340	0.1178
	LYTestFish	20	0.7170	AB	0.0225	0.1004
	NewAnal	24	0.6486	**B**	0.0355	0.1739

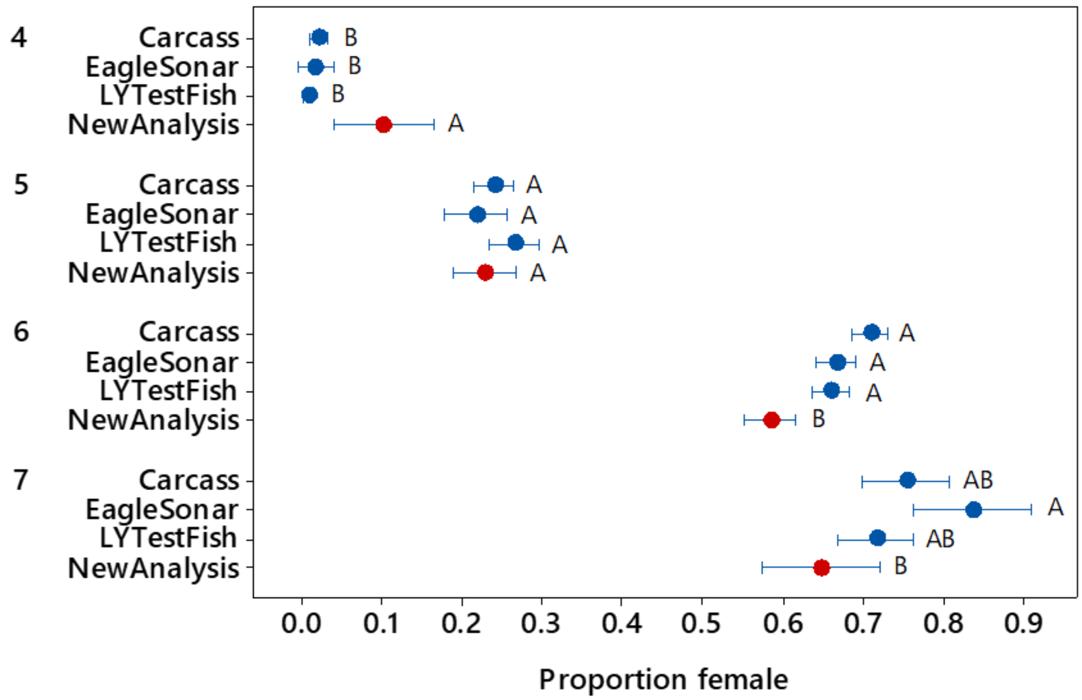

Figure 1. Interval plots of mean female proportion within four age classes, brood-year ages 4–7, for carcass sample data from the Chena and Salcha rivers, the test fishing associated with the Eagle sonar project, lower Yukon River test fishing operations, and the new analysis of older, biased sample data from the border area between Alaska and Yukon on the Yukon River. Results of ANOVA comparisons of mean female proportion within age classes are indicated with the statistical grouping letters; groups that do not share a grouping letter are significantly different.

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APPENDIX E: PORCUPINE SUBCOMMITTEE REPORT

Introduction: In the spring of 2015, the Joint Technical Committee (JTC) assigned six members to a new Porcupine River Fall Chum Salmon Sub-Committee. Overall, this subcommittee was tasked with considering new analytical, monitoring, and management approaches to address the low abundance of fall chum salmon in the upper Porcupine River in recent years. Fall chum salmon escapements into the Fishing Branch River, a tributary of the Porcupine River, have frequently fallen short of meeting the interim management escapement goal (IMEG) of 22,000 to 49,000 fish agreed upon by U.S. and Canadian representatives of the Yukon River Panel despite strong escapements elsewhere in the drainage. This document summarizes the results of the subcommittee's efforts and provides some recommendations from the JTC to the Panel regarding current and future actions related to Canadian-origin Porcupine River chum salmon.

Meeting Summaries: The subcommittee met a total of three times between 2015 and 2017. The first meeting was to discuss the goals and objectives for the group. The objectives agreed upon were designed to improve assessment and monitoring efforts related to the population, evaluate the reasons for the low returns of fall chum salmon to the Fishing Branch River and the chronic inability for the population to achieve at least the lower end of the IMEG range. The objectives chosen were:

- Investigate Canadian Porcupine River chum salmon productivity.
- Examine the accuracy of estimating Fishing Branch River escapement using sonar counts from the Porcupine River sonar project in conjunction with radio telemetry proportion methods.
- Compare the pros and cons of the current Fishing Branch River weir IMEG versus a mainstem Porcupine River sonar IMEG.

During the subsequent meetings, the objectives were addressed, and the subcommittee's findings are summarized below.

Objective 1: **Develop spawner/recruit relationship for Canadian Porcupine River Chum Salmon.** The subcommittee discussed the possibility that the chronic inability of Canadian origin Porcupine River chum salmon could be the result of declining productivity. The subcommittee wanted to inventory the available age structure data, escapement, and stock specific harvest information available to determine if productivity could be estimated.

Information necessary for determining productivity of a stock requires data to estimate the total return of the stock. For the Fishing Branch River, most of the escapement estimates are provided by weir counts thus are very robust. The weir project typically operates annually for 46 days but has been operated for as long as 60 days providing a broad representation of timing of the stock in this system which can be used to interpolate individual years when necessary. The data used for the current goal is based on weir counts from 1985–2007 and the project has been operational to present, except for 2013 and 2014.

Age data is necessary to apportion the total run to the year in which its parents spawned (brood year). Age, sex and length data has been collected most all the years the weir has been in operation (since 1985). The ages are based on scales which may have some resorption issues as they are taken on the spawning grounds after traveling approximately 1,600 river miles a migration period of 50 days. Collection of some paired age data from either otoliths or vertebra has been discussed but not implemented to verify scale ages (would have to use carcasses). Preliminary work had been started on organizing the existing electronic age data however more work would be necessary to get it in a useable format. Assumptions would still have to be made for the years the weir was not in operation for both estimates of escapement and the age composition if gaps in any brood table were to be minimized.

Harvest plus escapement are the basis for determining total annual production of a spawning unit or stock. Currently, apportionment of Canadian-origin harvest through Alaska fisheries and even within Canada is not obtainable for the Fishing Branch River stock. With the operation of a sonar project downstream of the community of Old Crow in Yukon Territory on the upper Porcupine River, stocks other than the Fishing Branch River are contributing to the Canadian origin run in undetermined amounts.

From the harvest, escapement, and age datasets in hand, a rigorous spawner/recruit analysis is not possible. Without primary data to develop an estimate of total run with acceptable measurement error, the likelihood of determining productivity for this stock that would pass scientific rigor is low.

Objective 2: Examine the accuracy of estimating Fishing Branch River escapement using sonar counts from the Porcupine River in conjunction with radio telemetry methods to estimate the proportion of the passage migrating into the Fishing Branch River. Beginning in 2011, a sonar project began operation to estimate main-stem Porcupine River chum salmon passage near the community of Old Crow, upstream from the Alaska Yukon border. Operation of the Fishing Branch River weir was suspended following the 2012 season, leaving only the main stem sonar passage estimate with no way to estimate if the Fishing Branch River weir IMEG was achieved. In 2013 and 2014, a radio telemetry program was added to the sonar project to estimate the proportion of the sonar passage estimate that migrated into the Fishing Branch River. There were concerns within the JTC that, given the low numbers of radio tags deployed during the season and the way they were deployed, the project lacked the necessary precision to determine whether the Fishing Branch River escapement goal was achieved or not.

In response to these concerns, both the sonar counting project with the radio telemetry proportion component as well as the Fishing Branch River weir were operated in 2015. A post-season analysis of the combined projects was conducted by members of the subcommittee, and the findings are summarized here. The Porcupine River chum salmon situation can be considered a binomial case, with the objective of estimating Fishing Branch River escapement by multiplying the radio tag proportion estimate by the sonar count data. In 2015, 95 transmitters were deployed, 85 went upstream and got through the fishery, and 55 went past the weir into Fishing Branch River. The proportion estimate was therefore 0.65. Confidence intervals were established using formulae presented by Bromaghin (1993), which resulted in an interval of ±0.1 for a 95% CI ranging from 0.55 to 0.75. The sonar passage estimate was 21,303 chum salmon. When the sonar passage estimate was multiplied by the transmitters proportion with CI, an escapement estimate of 13,847 ±2,130. (95% CI = 11,717 to 15,977) was achieved. Because the weir count was only 7,598 chum salmon into the Fishing Branch River, well below the lower 95% CI, the subcommittee determined there was a possibility that the sonar was counting other species as chum salmon, the radio tags were not being applied in a representative manner through the run, the weir missed a large portion of the run, or some combination of these options. These results were conveyed to the JTC during the 2016 fall meeting. The operation of the Fishing Branch River weir was resumed in 2016 season and the use radio telemetry methods to estimate the proportion of the passage migrating into the Fishing Branch River was discontinued.

Objective 3: Examine the pros and cons of a Fishing Branch River weir IMEG versus and border or mainstem Porcupine River sonar near Old Crow. A mainstem sonar has been operated in the Canadian portion of the Porcupine River near the community of Old Crow since 2011. In the fall of 2016, the JTC asked the subcommittee to consider the pros and cons of the current IMEG based on the Fishing Branch River weir data versus an IMEG based on sonar passage data. The following are the results from the subcommittees' discussion:

Pros for the Fishing Branch River weir IMEG:

- The Fishing Branch River weir data set contains long-term chum salmon escapement estimates since 1971.
- The Fishing Branch River is the primary spawning area for Canadian origin Porcupine River drainage chum salmon.
- Weirs provide a higher certainty in escapement estimates compared to sonars.
- Is located upstream of harvest whereas Porcupine sonar goal requires harvest monitoring in combination with passage estimates.
- Easier to attain quality ASL data from a weir.

Cons for the Fishing Branch River weir:

- Because of its location in relation to the main harvest area on the Porcupine River, the weir provides minimal inseason information for management. Escapement information provides a post season IMEG assessment.
- Escapement estimates do not include all the Canadian origin Porcupine River drainage chum salmon.
- Operation of the weir is more expensive because of its remoteness, hence the logistics and costs required for getting to the site.

Pros for the mainstem sonar near Old Crow:

- Because of its location in relation to the main harvest area on the Porcupine River, passage information would be timelier for US management.
- Because of its proximity to Old Crow, the project would be less costly to operate.
- Because of its proximity to Old Crow, local hire, stewardship, and capacity building with Vuntut Gwitchin First Nation could be more easily achieved than at Fishing Branch River.
- Escapement estimates would include all Canadian origin Porcupine River drainage chum salmon.

Cons for the mainstem sonar near Old Crow:

- Harvest monitoring at Old Crow would be needed to estimate escapement.
- There is more uncertainty associated with sonar escapement estimates versus weir counts because of species apportionment.
- The Porcupine River is a flashy system and can experience large water fluctuations within short periods of time. The use of sonar during extreme high or low water is not possible. This, in addition to risks of early fall ice up, poses an increased risk of attaining incomplete passage estimates and preventing the ability to assess an escapement goal on a consistent basis.

Recommendations: During the last meeting of the subcommittee, it was agreed that the subcommittee would go on hiatus until additional information or developments became available to consider new analytical, monitoring, and management approaches. The subcommittee did make recommends that subcommittee members should continue to examine ways to estimate Porcupine River-specific harvests in the U.S. commercial and subsistence fisheries, to allow estimation of Canadian origin Porcupine River chum salmon productivity and to enable stock-specific forecasting in the future.

Cited References:

Bromaghin, J. F. 1993. Sample Size Determination for Interval Estimation of Multinominal Probabilities. *The American Statistician*, 47(3):203–206.