Regional Operational Plan No. ROP.CF.1J.2022.08

Inriver Abundance of Alsek River Chinook and Sockeye Salmon, 2022

by

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July 2022

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

REGIONAL OPERATIONAL PLAN NO. ROP.CF.1J.2022.08

INRIVER ABUNDANCE OF ALSEK RIVER CHINOOK AND SOCKEYE SALMON, 2022

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Approval

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PURPOSE

The abundance of Alsek River Chinook salmon *Oncorhynchus tshawytscha* (fish age-1.2 and older) and sockeye salmon *Oncorhynchus nerka* (fish ≥350 mm mid eye tail fork length [METF]) will be estimated, in 2022, using 2-event mark–recapture methods. The mark–recapture study will occur upstream of the commercial set gillnet fishery at river kilometer 19 (hereafter referred to as "Kilometer 19"). Immigrating Chinook and sockeye salmon caught at Kilometer 19 will be marked before being released. The second sampling event will consist of inspecting Chinook and sockeye salmon for marks upriver at Klukshu River and Village Creek enumeration projects, as well as on various Alsek River salmon spawning grounds, hereafter referred to as "headwaters". Age, sex, and length composition of Chinook and sockeye salmon will also be estimated. Tissues will be collected from all sockeye salmon captured at Kilometer 19 for a mixed stock genetic analysis and for a genetic mark–recapture expansion of the Klukshu and Nesketahin stocks. The Alaska Department of Fish and Game, Fisheries and Oceans Canada, and the Champagne and Aishihik First Nations use these data to make terminal and regional management decisions. The Pacific Salmon Commission uses the Chinook salmon data for coastwide management and stock assessment through the Chinook Technical Committee.

Key Words: Chinook salmon, *Oncorhynchus tshawytscha*, sockeye salmon, *Oncorhynchus nerka*, Alsek River, Klukshu River, Tatshenshini River, Nesketahin Lake, escapement, abundance, expansion factor, age and sex composition mark–recapture

OBJECTIVES

PRIMARY OBJECTIVES

1. Estimate the abundance of Chinook salmon (fish age-1.2 and older) in the Alsek River upstream of Kilometer 19 using 2-event mark–recapture methods, so that the estimate is within 25% of the true value 95% of the time. This satisfies the Pacific Salmon Commission Chinook Technical Committee requirement of a CV of 15% or less.
2. Estimate the abundance of sockeye salmon (fish ≥ 350 mm mid eye tail fork length [METF]) in the Alsek River upstream of Kilometer 19 using 2-event mark–recapture methods, so that the estimate is within 25% of the true value 95% of the time.
3. Estimate the age, sex, and length (ASL) compositions of Chinook salmon in the Alsek River, so that the estimates are within a distance of 0.05 of the true values 95% of the time.
4. Estimate the ASL compositions of sockeye salmon in the Alsek River, so that the estimates are within a distance of 0.05 of the true values 95% of the time.
5. Estimate the abundance of sockeye salmon (fish ≥ 350 mm METF) in the Alsek River upstream of Kilometer 19 using genetic mark–recapture methods, so that the estimate is within 25% of the true value 95% of the time.

SECONDARY OBJECTIVES

1. Estimate the proportion of Chinook and sockeye salmon that pass the Klukshu River and Village Creek enumeration projects.
2. Estimate the annual stock composition of Kilometer 19 sockeye salmon catch using genetic analysis such that estimates are within 5% of the true population size 90% of the time.
3. Estimate the ASL composition of the U.S. inriver commercial harvest of Chinook and sockeye salmon.
4. Record the CPUE for Chinook and sockeye salmon captured at Kilometer 19.

BACKGROUND

The Alsek River is a transboundary river system originating in Yukon Territory, Canada, and flows southerly into the Gulf of Alaska approximately 75 km southeast of Yakutat, Alaska (Figure 1). It is 1 of 3 transboundary rivers, along with the Taku and Stikine Rivers, that produce major runs of Chinook salmon (*Oncorhynchus tshawytscha*) and sockeye salmon (*Oncorhynchus nerka*) under joint management by the Alaska Department of Fish and Game (ADF&G) and Fisheries and Oceans Canada (DFO), as outlined in Chapter 1 of the 2019 Pacific Salmon Treaty.

Chinook and sockeye salmon originating from the Alsek River drainage are harvested in U.S. Dry Bay commercial and subsistence-personal use set gillnet fisheries in the lower portion of the Alsek River (Figure 1). In Canada, the salmon are harvested by Champagne and Aishihik First Nations (CAFN; subsistence) and recreational (sport) fisheries, which largely occur in the Tatshenshini River and its tributaries. Inriver runs of Chinook and sockeye salmon have averaged about 8,000 and 95,000 fish, respectively, since the mid-1980s, and annual harvests averaged about 500 and 15,000 fish, respectively (TTC 2022). Unknown quantities of Alsek River origin fish may also be taken in the U.S. marine commercial set gillnet and troll fisheries in the Yakutat area; however, timing of nearby fisheries and recovery of coded wire tags, implanted in Chinook salmon smolts from the Alsek River, indicate that significant harvest has been limited to terminal fisheries on the Alsek River stock (McPherson et al. 1998).

A comprehensive Alsek River Chinook and sockeye salmon stock assessment project is required to fulfill DFO and ADF&G Pacific Salmon Treaty obligations. The Pacific Salmon Treaty commits Canada and the U.S. to conservation and allocation obligations for salmon originating in the waters of the Canadian portion of the Alsek River. Chapter 1, Paragraph 1(a) under Annex IV of the Pacific Salmon Treaty specifically describes the need to "assemble and refine available information on migratory patterns, extent of exploitation and spawning escapement requirements of the stocks." To that end, this stock assessment program will be conducted to estimate Alsek River Chinook and sockeye salmon abundance upstream of the set gillnet site at river kilometer 19, hereafter referred to as "Kilometer 19", with the intent to refine and improve the information used for resource management. Canadian and U.S. fishery managers can use results from this project along with CPUE and stock composition data from the U.S. Dry Bay fishery to adjust fishing times, manage harvest, and generate inseason and postseason estimates of salmon run sizes and escapements.

Although harvest sharing of Alsek River salmon stocks between Canada and the U.S. has not yet been specified, the Pacific Salmon Treaty Annex IV Chapter 1, Paragraph (3)(c) calls for the development and implementation of cooperative abundance-based management programs for Alsek River Chinook and sockeye salmon. In February 2013, the bilateral Transboundary Technical Committee and bilateral Transboundary Panel agreed to revised biological escapement goals for Alsek River Chinook (Bernard and Jones 2010) and sockeye salmon (Eggers and Bernard 2011). Alsek River Chinook salmon have an escapement goal range of 3,500 to 5,300 fish with a management objective of 4,700 fish. This corresponds to a Klukshu River goal range of 800 to 1,200 fish with a management objective of 1,000 fish (Bernard and Jones 2010; TTC 2021). Alsek River sockeye salmon have an escapement goal range of 24,000 to 33,500 fish with a management objective of 29,700 fish, representing NMSY for this stock. This corresponds to a Klukshu River goal range of 7,500 to 11,000 fish with a management objective of 9,700 fish (Eggers and Bernard 2011; TTC 2021).

Since 1976, the principal escapement monitoring tool for Chinook and sockeye salmon stocks on the Alsek River has been the Klukshu River enumeration project, a project operated by DFO in cooperation with the CAFN. A weir (fence) with a trap was installed in Klukshu River in 1976, and a large and annually variable proportion of the drainagewide escapement of each species has been enumerated there every year since. The weir was modified to a video enumeration system in 2016. Escapements of sockeye salmon migrating to Nesketahin Lake have been estimated annually since 1986 in Village Creek, approximately 2 km upstream from its confluence with the Tatshenshini River. Enumeration was initially carried out using an electronic counter, but has been conducted using a video enumeration system since 2014.

In 1997, ADF&G, in cooperation with DFO, instituted a project to determine the feasibility of using mark–recapture methods to estimate abundance of Chinook salmon in the Alsek River drainage (Pahlke and Etherton 2002). The results of the feasibility project were encouraging, and in 1998 a revised, expanded Chinook salmon mark–recapture study was conducted to estimate abundance, along with a Chinook salmon radiotelemetry study to estimate spawning distribution (Pahlke et al. 1999). The radiotelemetry study on Chinook salmon was repeated in 2002 (Pahlke and Waugh 2003). The proportion of the total sockeye salmon escapement in the Alsek River system that is counted at the Klukshu River enumeration project had not been researched prior to 2000 except for a pilot study conducted in 1983 (McBride and Bernard 1984). From 2001 to 2003, mark–recapture and radiotelemetry studies were conducted on Alsek River sockeye salmon to determine abundance, stock-specific run timing, and spawning distribution (Smith et al. 2007, 2009).

Mark–recapture programs were conducted to estimate the total inriver abundance and the portion of escapement contributed by Klukshu River stocks from 1998 to 2004 for Chinook salmon and from 2000 to 2004 for sockeye salmon. Currently, drainagewide Alsek River Chinook salmon abundance is estimated by expanding the Klukshu River inriver run using an expansion factor of 4.0 (Bernard and Jones 2010). For sockeye salmon, Alsek River inriver run estimates are generated by DFO using a genetic mark–recapture of U.S. commercial harvest samples at Dry Bay with an expansion of the Klukshu River counts (Foos 2021); however, it is unknown if key mark–recapture assumptions are satisfied using this method. Specifically, it is unknown if fish are captured in proportion to the run in the U.S. Dry Bay commercial fishery that typically opens for 24 hrs per week and does not operate throughout the entire sockeye salmon run. It is also known that some (~20%) sockeye salmon spawning in the Klukshu River misclassify genetically as Nesketahin Lake salmon (Pestal et al. 2017).

The primary goals of this study are to use available data from both countries to estimate the annual abundance of Chinook and sockeye salmon above Kilometer 19 in the Alsek River in 2022, and to estimate the ASL composition of the run. Year 1 of this study (2022 field season) will focus on facilitating capture methods and estimating abundance using mark–recapture methods established in previous studies (Pahlke et al. 1999; Pahlke and Etherton 2001a, 2001b, 2002; Pahlke and Waugh 2003, 2004, 2006; Waugh et al. 2005; Smith et al. 2007, 2009). The Kilometer 19 stock assessment program will be standardized through time for Chinook and sockeye salmon assessment program; similar to the Chinook and sockeye salmon stock assessment programs (Bednarski et al. 2021 and Courtney et al. 2022) on the Stikine River. The intention is to establish a relationship between CPUE and run size for inseason management. In addition, the project will incorporate a genetic mark–recapture study on sockeye salmon (Hamazaki and DeCovich 2014) to estimate inriver abundance based on expansion of the Klukshu and Nesketahin stock component of the run, which will be compared to the genetic mark–recapture estimate generated from the Dry Bay commercial fishery. In 2023, we plan to expand the project to include radiotelemetry on Chinook and sockeye salmon. In general, ADF&G, DFO, and CAFN use data stock assessment program to make terminal and regional management decisions, and the Pacific Salmon Commission uses the Chinook salmon data for coastwide management and stock assessment of Chinook salmon through the Chinook Technical Committee.

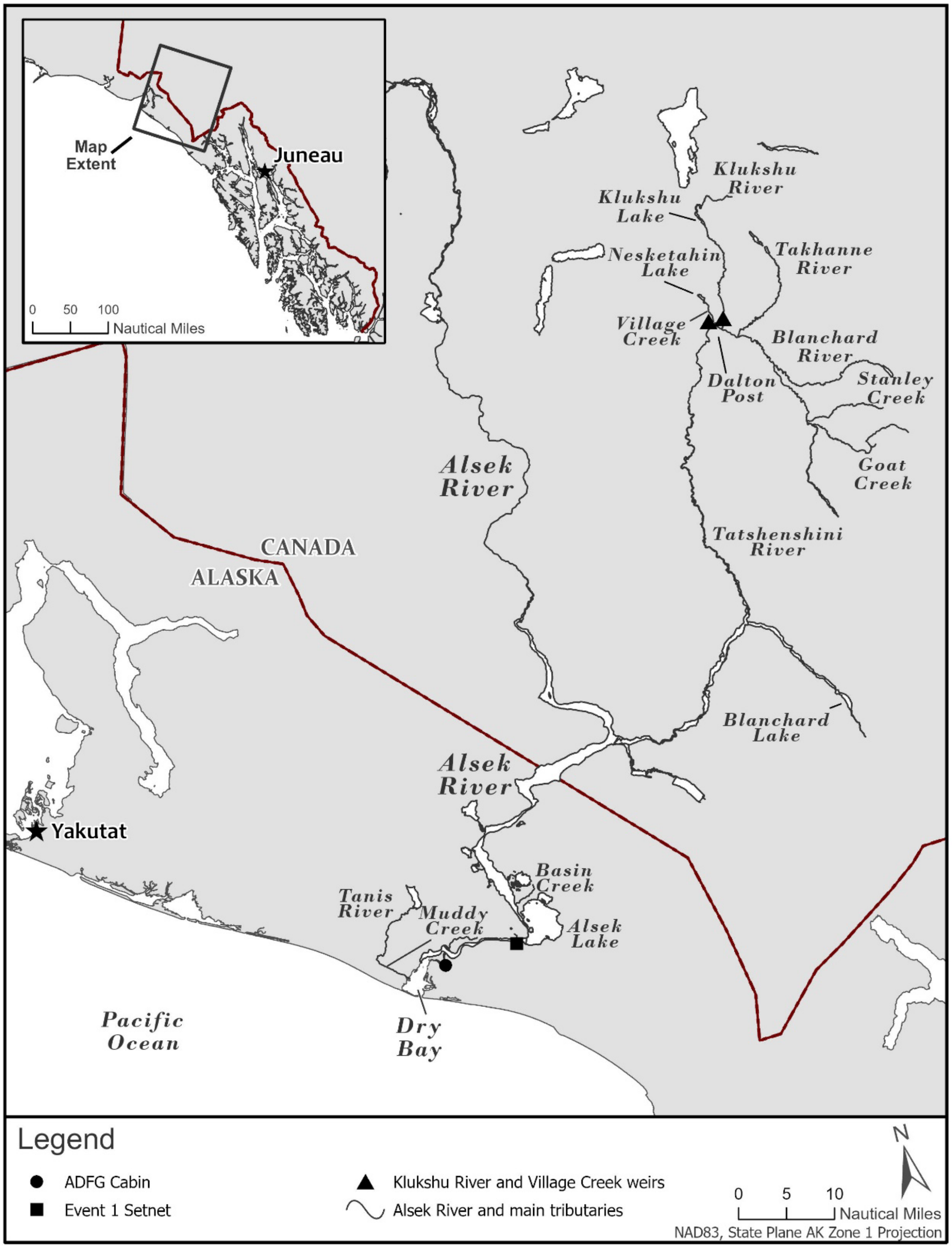

Figure 1.–Alsek River drainage in Southeast Alaska and Canada.

STUDY SITE

The Alsek River drainage covers about 28,000 km^2 (Bigelow et al. 1995), but much of it, including the mainstem of the Alsek River, is inaccessible to anadromous salmonids due to velocity barriers. The largest tributaries are the Dezadeash and Tatshenshini Rivers. Significant spawning areas for Chinook salmon are found mostly in tributaries of the Tatshenshini River, including the Klukshu, Blanchard, and Takhanne Rivers and in headwater creeks in the upper Tatshenshini River (Figure 1; Pahlke and Waugh 2006). Significant spawning areas for sockeye salmon are the Klukshu, lower Tatshenshini, Blanchard, upper Tatshenshini, and lower Alsek Rivers and Klukshu, Blanchard, and Nesketahin Lakes (Figure 1; Smith et al. 2009). The Klukshu and upper Tatshenshini Rivers are accessible by road near Klukshu Village and Dalton Post, Yukon Territory.

METHODS

STUDY DESIGN

Spawning Abundance of Chinook Salmon (Objective 1)

A mark–recapture study will be conducted to estimate the abundance of Alsek River Chinook salmon upstream of Kilometer 19. Chinook salmon are defined as fish ≥ age-.2. Immigrating Chinook salmon caught at Kilometer 19 will be tagged and marked before being released as the first of 2 sampling events. Event 2 will consist of inspecting Chinook salmon for marks upriver at or near spawning grounds. Mark recovery efforts will include 1) all live fish that pass through the Klukshu River and Village Creek enumeration projects, 2) sampling live or postspawn fish in 3 or more other tributaries, and 3) sampling available fish from the Canadian recreational (sport) and First Nation subsistence fisheries in the Klukshu and Dalton Post area.

Alsek River Chinook salmon generally emigrate from freshwater as yearling smolt, spend 1 to 5 years at sea, and return to the lower river during May and June. Abundance of age-1.2 to -1.5 Chinook salmon will be estimated because the current escapement goal is germane to fish ≥ age-.2 (Bernard and Jones 2010), and fish ≥ age-.2 are thought to be fully enumerated at the enumeration project locations.

Spawning Abundance of Sockeye Salmon (Objective 2)

A concurrent mark–recapture study will be conducted to estimate the abundance of Alsek River sockeye salmon ≥350 mm in METF length upstream of Kilometer 19. Immigrating sockeye salmon caught at Kilometer 19 will be tagged and marked before being released as the first of 2 sampling events. Event 2 will consist of inspecting sockeye salmon for marks upriver at or near spawning grounds. Mark recovery effort will include 1) all live fish that pass through the Klukshu River and Village Creek enumeration projects, 2) sampling live or postspawn fish in 3 or more other tributaries, and 3) sampling available fish from the Canadian recreational (sport) and First Nation subsistence fisheries in the Klukshu and Dalton Post area.

Capture and Marking at Kilometer 19

Personnel will capture Chinook and sockeye salmon at Kilometer 19, located at approximately river km 19 in the Alsek River, between the upper boundary of the U.S. commercial fishery and the outlet of Alsek Lake (Figure 1). Two set gillnets will be fished, each ~36.5 M (120 ft) long, 1 with 18.4 cm (7 ¼ in Chinook salmon gear) mesh and 1 with 13.3 cm (5¼ in sockeye salmon gear), fitted with heavy leadline (90.7 kg per 183 m weight). Each net will be tended by a skiff with a minimum of 2 persons on board. Chinook salmon gear is hung relatively loose at approximately a 2.2:1 ratio, sockeye salmon gear is hung at a 3:1 ratio. Each set gillnet will be fished for 6 wet hours daily beginning in mid-May, excluding sampling time and time required to clean debris from the set and clear snags. The Chinook salmon set gillnet will be fished through the first week of July, and the sockeye salmon set gillnet will be fished until mid-August. Crews will fish 7 days per week and keep fishing effort as constant as possible each day. Crews will carefully record fishing and processing time on a Gillnet ASL Form (Appendix A) to ensure that set gillnets are fished for 6 wet hours daily.

Immediately upon realization that a salmon has been captured (typically a tug of the net and bobbing corks), the fish will be carefully removed from the net, cutting the net if needed, and placed into a submerged sling in a box partially filled with fresh river water. Chinook and sockeye salmon captured in good condition will be sampled for length (METF for sockeye salmon and both METF and post orbit to hypural plate [POH] for Chinook salmon), sex, and scales, marked with 3 separate marks, the condition and maturity will be assessed and noted, and the fish will be carefully released. The combination of marks will help identify marked fish on the spawning grounds 1–3 months later. The primary mark will be an individually numerically coded, solid-core, spaghetti tag. Chinook salmon will receive a blue-colored tag, while sockeye salmon will receive an orange-colored tag. The secondary mark will be a hole punched in the upper one-third of the left operculum with a paper punch. Hole punches must be clearly severed to prevent them from healing shut. A tertiary mark will be a left axillary appendage clip (LAA). The left axillary appendage is located at the base of the left pelvic fin. The severed axillary appendage will be collected as a tissue sample for genetic analysis. Use of secondary marks provides redundancy for cases where the primary tag is lost or unobserved. Fish with deep wounds, damaged gills or fish in a lethargic condition will be sampled for length, sex, scales and tissues and released without being marked. Age, sex, and length data forms (bubble sheets) for Chinook and sockeye salmon will be scanned and archived in the ADF&G Region 1 Commercial Fisheries Database.

The solid-core spaghetti tags consist of a piece of hollow clear tubing shrunk onto a 38 cm (15 in) piece of 36 kg (80 lb) monofilament fishing line, over which 6.3 cm (2 ½ in) of standard blue Floy tubing with lettering will be placed and the works laminated with clear plastic tubing. For Chinook salmon the lettering is "PH 867-393-6722" on the first line and "Salmon Tag AKXXXX" on the second line (AK = Alsek king" with number "XXXX" unique to each tag, blue in color, numbered between AK0001 and AK2000 for the 2022 field season). For sockeye salmon, the lettering is "PH 867-393-6722" on the first line and "Salmon Tag ASXXXX" on the second line (AS = Alsek sockeye" with number "XXXX" unique to each tag, orange in color, numbered between AS0001 and AS2000 for the 2022 field season). The monofilament tags will be threaded through one-half of a double metal connector sleeve (1.6 mm ID) sewn through the back of the salmon at the posterior end of the dorsal fin with a cannula (hollow base end) needle, threaded through the second half of the connector sleeve, pulled tight, and the connector crimped with a pair of crimpers. The excess monofilament will be cut off, leaving the tag exposed, with no exposed knot or loop.

Recovery at Event 2

Primary event 2 sampling will be conducted at video enumeration projects operated on the lower reaches of Klukshu River and Village Creek. The Klukshu River is a major spawning location for Chinook and sockeye salmon, while the headwater Klukshu Lake is a major spawning location for sockeye salmon. The Nesketahin Lake sockeye salmon population will be enumerated at Village Creek. Both video enumeration projects will be in place prior to the arrival of any salmon and will remain operating well past the end of the Chinook and sockeye salmon runs (to enumerate coho salmon). A salmon-tight fence (weir) will be constructed across the entire stream channel and migrating fish will be directed through one or two counting chambers (depending on annual setup), which consist of a free and open tunnel for fish to swim through unimpeded. The top and one side of the tunnel are constructed of Plexiglas, and a camera, mirror, and light system provide a clear view of the top and left side of the fish. The back wall and bottom of the tunnel have a grid pattern, that once each specific camera setup is calibrated, allows estimation of fish length based on the fish's position in the tunnel. Each fish passing through the system triggers the motion sensing video camera to record an 11 second video of the fish's passage. These recordings are stored on the local computer that operates the system. Each day the systems will be cleaned and checked for proper operation, and daily data will be downloaded to an external hard drive. Video recordings will be reviewed, and all salmon captured in videos will be identified to species, sex, and visually inspected for primary marks; mark presence will be detected, but we will not be able to recover individual spaghetti tag numbers or secondary marks. Length (tip of nose to tail fork [FL] nearest 5mm) will be estimated for all Chinook salmon passing into the Klukshu River system; FL will be converted METF or POH as needed, based on established length regressions from physical sampling in the Klukshu River.

Physical sampling of live and postspawn fish and available carcasses will also be conducted at other spawning locations, including known sites along the lower Alsek, Tatshenshini, Blanchard, and Takhanne Rivers and various other headwater tributaries (Figure 1). Because prior studies showed there are differences in migratory timing and/or size composition across stocks returning to the Alsek River and its tributaries, sampling will be spatially and temporally distributed to determine if marking rates are relatively constant across stocks within the Alsek River drainage.

Personnel from DFO and CAFN will sample fish at or near the spawning grounds on the Klukshu River. DFO will sample Chinook and sockeye salmon harvested in the Klukshu/Dalton Post recreational (sport) fishery from 15 August on if there are fishery openings. CAFN may sample fish from the Canadian Aboriginal fishery above and below the Klukshu River enumeration project from July through August. Chinook and sockeye salmon sampled in event 2 will be closely examined for tags and/or secondary marks, sampled for sex, length, and scales. Sampled fish will then be marked to ensure they are not double sampled. A hole will be punched on the lower (ventral) left operculum if the fish is live sampled. Sampled Chinook and sockeye salmon carcasses will be slashed along the left side to prevent double sampling.

Sample Size

To ensure precision around the mark–recapture estimates, the number of fish marked at Kilometer 19 will be calculated using two parameters: 1) the inriver run size, and 2) the number of fish sampled for marks in event 2 (see Robson and Regier (1964) for details). For 2022, these values were calculated using the recent 10-year average inriver abundance and enumeration counts from Klukshu River and Village Creek (2012–2021; TTC 2022). Additionally, we will inspect at least 500 Chinook salmon and 500 sockeye salmon on the spawning grounds, as this was the minimum number inspected in all previous studies (Pahlke and Waugh 2006; Smith et al. 2007).

Dropout Adjustment

Based on estimates from previous Alsek River Chinook and sockeye salmon telemetry studies, approximately 10% of both Chinook and sockeye salmon that were radiotagged at Kilometer 19 did not cross the border into Canada (i.e., they dropped out of the study) (Pahlke and Waugh 2005;

Smith et al. 2009). Mark–recapture estimates will be biased high if similar dropout rates occur in 2022 and the marked fish that dropout are not censored from the study. We will account for this 10% dropout rate by reducing the number of marked fish at Kilometer 19 by 10% for both Chinook and sockeye salmon during analyses. For example, if 400 Chinook salmon are marked at Kilometer 19, this number will be reduced by 40 to 360 marked fish (400*0.9) when used in the analyses.

Chinook Salmon

The recent 10-year average Alsek River inriver abundance and combined Klukshu River and Village Creek enumeration counts were 4,720 and 1,073 Chinook salmon, respectively (TTC 2022). We expect 100% (1,073) of Klukshu River fish to be inspected for marks when passing through the video enumeration systems, along with an additional 500 fish from various other spawning grounds, for a total of about 1,500 fish inspected in event 2. Following Robson and Regier (1964), our marking target is 145 Chinook salmon at Kilometer 19. Accounting for the 10% dropout rate, an additional 15 (145*0.1) fish will need to be marked, for a total marking target of 160 fish (145+15). This sample size will result in a 95% relative precision of 25% for an estimate of passage upstream at Kilometer 19 (primary objective 1) and satisfy the Pacific Salmon Commission's requirement that Chinook salmon escapement estimates have a CV of 15% or less (CTC 2013).

We intend to mark and inspect as many fish as possible, so the sample sizes will likely differ from what is described here. In 2022, we will start fishing at the Kilometer 19 site on approximately 20 May. We will fish established fishing sites using proven techniques, while also modifying the net depth and location in response to seasonal changes in the river channel and water depth. In previous Alsek River mark–recapture studies, when set gillnets were fished approximately 7 hours/day, the number of Chinook salmon marked at Kilometer 19 ranged from 245 fish in 1998 to 732 fish in 2004 (Pahlke and Waugh 2006). Therefore fishing 6 hours/day in 2022 should result in at least 213 fish marked.

Sockeye Salmon

The recent 10-year average Alsek River inriver abundance and combined Klukshu River and Village Creek enumeration counts were 84,778 and 11,927 sockeye salmon, respectively (TTC 2022). We expect 100% of the Klukshu River and Nesketahin Lake fish to be inspected for marks when passing through the video enumeration systems, along with an additional 500 fish from various other spawning grounds, for a total of about 12,400 fish inspected in event 2. Following Robson and Regier (1964), our marking target is 406 sockeye salmon at Kilometer 19. Accounting for the 10% dropout rate, an additional 41 (406*0.1) fish will need to be marked, for a total marking target of 447 fish (406+41). This sample size will result in a 95% relative precision of 25% for an estimate of passage upstream of Kilometer 19 (primary objective 2). This sample size also exceeds requirements for estimating abundance at Kilometer 19 using genetic mark–recapture methods, as 400 samples are needed to estimate the genetic stock composition of Klukshu/Nesketahin reporting group within 25% of the true value, 95% of the time (primary objective 5).

We intend to mark and inspect as many fish as possible, so the sample sizes will likely be higher than what is described here. In 2022, we will start fishing at the Kilometer 19 site on approximately 20 May. We will fish established fishing sites using proven techniques, while also modifying the net depth and location in response to seasonal changes in the river channel and in water depth. In previous Alsek River mark–recapture studies, when set gillnets were fished approximately 7 hours/day, the number of sockeye salmon marked at Kilometer 19 ranged from 1,080 fish in 2000 to 2,978 fish in 2002 (Smith et al. 2007). Therefore fishing 6 hours/day in 2022 should result in at least 603 fish tagged.

Age, Sex, Length Composition of Chinook Salmon (Objective 3)

Age composition samples from Kilometer 19 and each event 2 location will be tabulated separately. Data from separate event 2 sampling locations may be pooled when compositions by age class are not meaningfully different.

Scales from a systematically drawn sample of 636 Chinook salmon will be collected to meet the precision criteria outlined in the objectives. Based on procedures in Thompson (1987), 509 samples are needed to estimate the age composition and meet the objective criteria for precision; however, we assume that 80% of scale samples will be readable, hence we increased the sample size to 636 fish (509/0.80). More than 636 scales re expected to be collected from the various sampling locations, when all sites are pooled. Ages will be determined from patterns of circuli according to objective criteria developed by the Division of Commercial Fisheries scale aging group (Olsen 1992). This sample size will also meet length and sex composition requirements.

Age, Sex, Length Composition of Sockeye Salmon (Objective 4)

Age composition samples from Kilometer 19 and each event 2 location will be tabulated separately. Data from separate event 2 sampling locations may be pooled when compositions by age class are not meaningfully different.

Scales from a systematically drawn sample of 636 sockeye salmon will be collected to meet the precision criteria outlined in the objectives. Based on procedures in Thompson (1987), 509 samples are needed to estimate the age composition and meet the objective criteria for precision; however, we assume that 80% of scale samples will be readable, hence we increased the sample size to 636 fish (509/0.80). More than 636 scales are expected to be collected from the various sampling locations, when all sites are pooled. Ages will be determined from patterns of circuli according to objective criteria developed by the Division of Commercial Fisheries scale aging group (Olsen 1992). This sample size will also meet length and sex composition requirements.

Estimate the Inriver Abundance of Alsek River Sockeye Salmon Using Genetic Mark–Recapture (Objective 5)

Tissue samples will be collected from all sockeye salmon captured at Kilometer 19 for genetic analysis and to estimate the inriver abundance of sockeye salmon using genetic mark–recapture expansion. These samples will be analyzed at the ADF&G Gene Conservation Laboratory. Genetic stock composition results will be compiled by statistical week and season for 3 reporting groups: 1) a Klukshu/Nesketahin reporting group that includes the Klukshu River, Klukshu Lake, and Nesketahin Lake populations, which are all populations originating from above the Klukshu River and Village Creek assessment sites, 2) all sockeye salmon populations in the Alsek River located above the U.S./Canada border, and 3) all other sockeye salmon populations in the baseline. Although there are numerous discrete spawning populations that are genetically differentiable within each reporting group, these reporting groups have been chosen for this project for 2 reasons: 1) we will enumerate all populations in group 1 and can expand genetic proportions against a known run size, and 2) we can differentiate these reporting groups with high accuracy. The total Kilometer 19 marking target of 447 fish exceeds requirements for estimating abundance at Kilometer 19 using genetic mark–recapture methods, as 400 samples are needed to estimate the genetic stock composition of Klukshu/Nesketahin reporting group within 25% of the true value, 95% of the time. Tissue samples will be collected from all Chinook salmon captured at Kilometer 19; once baseline collections are robust future analysis may include stock composition and/or genetic mark–recapture.

INJURED OR DEAD MARINE MAMMALS

Consistent with the terms and conditions of the Biological Opinion for Southeast Alaska, if during the course of the study injured or entangled marine mammals are observed, the following protocols will be implemented:

- Document with photos/video (if possible, remain at least 100 yards from the animal) and record the date, time, and location (latitude/longitude, description of bay, point, island, etc.).
- If possible, record the species of marine mammal, age class, sex (for sea lions), type of gear, a description of the gear (e.g., line, gillnet, etc.) and how the animal is entangled, its relative degree of impairment, and direction of travel.
- As soon as possible, report to the ALASKA MARINE MAMMAL STRANDING NETWORK (24-hr hotline 877-925-7773; 877-9-AKR-PRD) and include information gathered above. Ideally for dead animals, if communications allow, contact the hotline while near the carcass to determine if additional information/samples can be collected.
- Specifically for an observed live and entangled whale, immediately call the U.S. COAST GUARD (VHF Channel 16).

DATA COLLECTION

CAPTURE AND MARKING

Effort and catch at Kilometer 19 gillnetting operations will be recorded on forms drafted by ADF&G. Set gillnets at Kilometer 19 will be fished 6 wet hours daily, excluding sampling time and time required to clean debris from the set and clear snags. Weekly scheduling and effort will be determined by onsite staff in consultation with the project leader. Fishing time, catch, etc., will be recorded on Setnet Recording Forms (Appendices A and B). River height to nearest 1/10 foot, temperature to nearest 1 ºC (both at 0900 each day), any shutdown time, and other comments will be recorded on the forms.

Data collected from each Chinook and sockeye salmon captured will be recorded on Op Scan Forms (Bubble sheets) and include the date and time caught, fish number, sex, METF and POH (POH for Chinook salmon only) lengths in mm, spaghetti tag number, and any pertinent comments (state of maturation [bright, dark red, etc.], condition, wounds, etc.). Fish number will begin with the first Chinook salmon marked and continue sequentially throughout the remainder of the season. This means each salmon caught and tagged will have a unique fish number; do not number fish that are not tagged (i.e., badly injured or sacrificed). Fish number is arbitrarily assigned to keep track of total numbers tagged and released and is not to be confused with the spaghetti tag number. There will be a row of data on the ASL form for each fish sampled to ensure that scales match up with biological data. This is especially important for fish that are sampled but not tagged; they will not receive a fish number but will have a line of data and scales. If a tagged fish is recaptured, note the tag number and the condition of the fish, but do not collect ASL data.

Samplers will collect ASL data from each Chinook and sockeye salmon captured (all sizes) in the set gillnets (Appendix C). Five scales will be collected per Chinook salmon and 3 scales will be collected per sockeye salmon. Scales will be taken from the left side of the fish from the preferred area. For sockeye salmon, this is 2 rows up from the lateral line and 1 in (2.5 cm) apart. For Chinook salmon, 3 scales will be taken from the same area as sockeye salmon, and 2 additional scales will be taken 4–5 rows up and 1/2 in (1.3 cm) apart horizontally from the lower 3. Scales will be affixed anterior side up on gum cards, and cards should be labeled completely. Begin a new gum card after every 10 fish and record the gum card # along the right margin of the ASL form. It is very important that gum cards and ASL forms be labeled completely so that the scales and data can be matched up in the aging lab. It is also very important to keep the gum cards dry and free of dirt. Excessive moisture will dissolve the card's glue, which can lead to scales falling off the card or washing out of alignment. Glue and dirt can also cover scales and cause unreadable imprints. If scales are not collected from a fish, the column on the scale card should be crossed off in pencil. The corresponding row on the ASL form should be filled out with an "X" in the Age column and "no scales" in the comments section.

If a Chinook salmon with an adipose fin clip is captured, it will be sacrificed, sampled for ASL, a cinch strap tag (from the ADF&G Mark, Tag and Age Laboratory) will be applied to the lower jaw, and the cinch strap tag number will be recorded on the GILLNET ASL FORM.

Chinook salmon scale samples will be analyzed in Ketchikan. Sockeye salmon scale samples will be analyzed at the Region I Scale Aging Laboratory in Douglas, Alaska. Scale impressions will be made in cellulose acetate and prepared for analysis as described by Clutter and Whitesel (1956). Scales will be examined under moderate (70×) magnification to determine age. Age classes will be designated by the European aging system where freshwater and saltwater years are separated by a period (e.g., age 1.3 denotes a fish with 1 freshwater and 3 ocean years and represents a 5-year-old fish; Koo 1962).

In addition, samplers will collect the left axillary processes from all fish for DNA analysis. Directions for sampling are provided by the ADF&G Gene Conservation Lab (Appendix C) and duplicate tissue samples will be provided to DFO by cutting the axillary in half.

RECOVERY

All fish physically sampled on the spawning grounds will be inspected for the 3 primary marks applied at Kilometer 19 and for marks indicating the fish had been previously inspected at the recovery site. Note that the first time a live salmon is inspected, it will be given a hole punch on the lower (ventral) left operculum (LOP) after it has been sampled. It is extremely important that during the spawning grounds sampling, we obtain an accurate count of the total number of fish inspected by size and age category and, of those, accurately detect any fish that were marked at Kilometer 19.

Each fish sampled will be inspected for the lower left opercle punch (LOP), indicating the fish has already been inspected on the spawning grounds and should not be sampled again. Fish without a LOP will be examined for: 1) an upper opercle punch (UOP), 2) a spaghetti tag or scar where a spaghetti tag may have once been affixed, or 3) a missing left axillary appendage. Any of the 3 marks indicate a fish was marked at Kilometer 19 and is a valid recovery. For all valid recoveries, crews will complete ASL sampling and apply the LOP mark. If the fish is dead, the left side will be slashed to prevent double sampling. Note that if the spaghetti tag falls off, it is vital that the secondary marks (tag scar, UOP or LAA) be found. These marks may heal partially or fully, but because they are standardized and there are 3 of them, it should be possible to detect them with careful inspection.

All physical recovery sampling information will be recorded on the Spawning Grounds ASL Form (Appendix D). Record species, date, fish number, sex, length (METF, FL, and POH), and spaghetti tag number (if present) on a new row for each unsampled fish. Leave blank columns for age and AEC (ager error code). Most importantly, a "Y" will be recorded if the upper opercle punch is present and detectable under the column labeled UOP (even for fish with a spaghetti tag) and a "Y" will be recorded under LAA for fish without a left axillary appendage. If there are fish with no spaghetti tag but with a tag scar, we will record "scar" under Spaghetti Tag # and note if 1 or both secondary marks are present. All fish captured on spawning grounds will be sampled for species, scales, sex, and length (METF, FL, and POH). Scale samples will be mounted on DFO gum card scale booklets, and the book number and sample address will be recorded. If fish condition prohibits length measurement, judgment will be used as to whether the fish meets size thresholds, sex will be determined if possible, and scale samples will be collected, if possible, even if from outside the preferred area. The lower opercle punch should be visible in carcasses so if the head can be examined and size and sex determined, it will be a valid sample.

Each fish will be examined for adipose fin clips to determine the rate of straying of coded wire tagged fish. Any Chinook salmon missing its adipose fin will be sacrificed, the head saved, a cinch strap tag or label (appropriate to country of recovery) affixed around the left jaw, and the cinch tag or label number recorded on the Spawning Grounds ASL Form. Any head samples must be frozen or salted for preservation. As able, heads with cinch straps/labels and associated forms will be sent to Phil Richards, ADF&G, Douglas or Aaron Foos, DFO, Whitehorse (as appropriate) in a clearly labeled container.

Klukshu River and Village Creek Enumeration

All salmon passing the video enumeration systems on Klukshu River and Village Creek will be recorded into permanent video clips by motion sensing video camera systems. Video clips will be backed up and reviewed daily to identify and count fish to species, determine sex, and estimate FL (nearest 5 mm) of Chinook salmon. All data will be recorded onto DFO video counter data sheets by hour and day, verified by a second reviewer, transcribed into Excel spreadsheets, and shared daily with the Whitehorse DFO office.

Canadian Recreational (Sport) Fishery and First Nations (Subsistence) Fishery

Chinook and sockeye salmon harvested in the Canadian recreational (sport) fishery and First Nations fishery may be sampled for ASL and to recover information on fish marked at Kilometer 19. Sampling will follow the protocols described above.

U.S. Commercial Fishery

Some tagged fish may back downriver and get harvested in the U.S. commercial fishery. The harvest in this fishery will be sampled for sex, length, age, and tag recovery through a separate project.

DATA ANALYSIS

ABUNDANCE

Assuming mark–recapture data do not need to be stratified by time or area, we will use Chapman's modification of the Petersen method (Seber 1982) to estimate abundance of Chinook and sockeye salmon as

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1, \quad (1)$$

with variance

$$\text{var}\left(\hat{N}\right) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} - 1, \quad (2)$$

where: $\hat{N}$ = estimated abundance of salmon at Kilometer 19;
M = number of salmon marked and released at Kilometer 19, adjusted for 10% dropout rate;
C = number of salmon sampled for marks in event 2; and
R = number of sampled salmon with marks in event 2.

The conditions for accurate use of this methodology are:

1. all salmon have an equal probability of being marked at Kilometer 19; **or**
2. all salmon have an equal probability of being inspected for marks during event 2; **or**
3. marked salmon are mixed completely with unmarked fish in the population between events; **and**
4. there is no recruitment to the population between events; **and**
5. there is no tag-induced mortality; **and**
6. fish do not lose their marks and all marks are recognizable.

The second condition will not be met for salmon in different stocks within the Alsek River. Sampling on the spawning grounds will be restricted to the Klukshu, Takhanne, and Blanchard Rivers, and perhaps other large spawning concentrations, so not every spawner in the Alsek River watershed above Kilometer 19 will have the same chance of being sampled in event 2. Because of our inability to meet this condition, our chance for an unbiased estimate of spawning abundance of salmon depends on meeting the first condition, that every fish has an equal chance of being sampled at Kilometer 19. Set gillnets will be fished with consistent effort throughout the immigration period past the set gillnet marking site. This relatively constant sampling effort will tend to equalize the probabilities of capture for all salmon passing the marking site regardless of when they pass (condition 1). The assumption of proportional marking will be tested by comparing marked-to-unmarked ratios between or among tributaries sampled during event 2 using a chi-square test (Seber 1982:439). Mark–recapture studies and consistency tests conducted at the Alsek River in the past have shown that condition 1 was met using the fishing effort we propose here (Pahlke et al. 1999; Pahlke and Etherton 2001a; Pahlke and Etherton 2001b; Pahlke and Etherton

2000; Pahlke and Waugh 2004; Pahlke and Waugh 2003; Waugh et al. 2005; Pahlke and Waugh 2006; Smith et al 2007; Smith et al 2009). Each fish marked at Kilometer 19 will receive a numbered tag and secondary and tertiary marks, meaning marks will be recognizable during the second event sampling and any tag loss will be accounted for in the analysis (condition 6).

Meeting the second and third conditions for salmon of different sizes and sexes will be tested with a battery of hypothesis tests to determine size-selective sampling in the tributaries during event 2 and at the Kilometer 19 set gillnet marking site (Appendix E). If size-selective sampling is indicated, data will be stratified into 2 size groups, and abundance will be estimated separately for each. The same procedures will be used to determine if sampling was sex-selective.

Marked fish may have a greater mortality rate than unmarked fish (condition 5) because some handled salmon delay their migration and sometimes move back downstream (Bernard et al. 1999). Based on estimates from previous Alsek River Chinook and sockeye salmon ratiotelemetry studies, approximately 10% of both Chinook and sockeye salmon that were radiotagged did not cross the border (i.e., they dropped out of the study) (Pahlke and Waugh 2005; Smith et al. 2009). Mark–recapture estimates will be biased high if similar dropout rates occur in 2022 and marked fish that do not cross the border are not censored from the experiment. We will account for this assumed 10% dropout rate mathematically by reducing the number of marked fish in the first event by 10% for both Chinook and sockeye salmon during analyses.

Klukshu Count to Total Escapement Expansion Factor

An expansion factor to relate the fish count C_i at the Klukshu video enumeration project to the inriver run upstream of Kilometer 19 will be estimated by

$$\hat{\pi} = \frac{\hat{N}_i}{C_i}, \tag{3}$$

with estimated variance

$$\text{var}(\hat{\pi}) = \frac{\text{var}(\hat{N}_i)}{C_i^2}, \tag{4}$$

where $\hat{N}_i$ is the mark–recapture estimate in the Alsek River drainage and C_i is the count of salmon at Klukshu River in the same year.

The mean or long-term expansion factor (π) and its variance will be estimated by

$$\hat{\pi} \ = \ \frac{1}{k}\sum_{i=1}^{k} \hat{\pi}_i, \text{ and} \tag{5}$$

$$\text{var}(\hat{\pi}) \ = \ \frac{1}{k^2}\sum_{i=1}^{k} v(\hat{\pi}_i), \tag{6}$$

where *k* is the number of years with mark–recapture estimates for the Alsek River.

The estimator for expanding Klukshu River counts into estimates of abundance in year *t* without a mark–recapture estimate is

$$\widehat{N}_t = \pi\, C_t\,, \tag{7}$$

and the variance will be calculated as

$$\mathrm{var}(\widehat{N}_t) \;=\; C_t^2\; v(\pi). \tag{8}$$

Length, Age, and Sex Composition

Estimates of mean length at age and its variance will be calculated with standard normal procedures. If there is no evidence of significant size-selective sampling at Kilometer 19 or event 2, estimates of relative ASL composition will be estimated as proportions from multinomial and binomial distributions:

$$\hat{p}_i = \frac{n_i}{n}, \tag{9}$$

with variance estimated as:

$$\mathrm{var}(\hat{p}_i) = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}, \tag{10}$$

where n_i is the number of salmon in the sample of age or sex *i*, *n* is the total sample size, and $\hat{p}_i$ is the estimated proportion of the population that is age or sex *i*. If sampling proves to be size- or sex-selective, a stratified estimate of age or sex composition will be calculated using the procedures outlined in Appendix F.

Alsek River Sockeye Salmon Genetic Composition

Laboratory Analysis for Stock Composition

To determine stock composition of the sockeye salmon set gillnet samples from Kilometer 19, genomic DNA will be extracted from axillary tissue samples using a NucleoSpin® 96 Tissue Kit by Macherey-Nagel (Düren, Germany). DNA will be screened for 96 SNPs using Fluidigm® 96.96 Dynamic Arrays (http://www.fluidigm.com). The Dynamic Arrays will be read on a Fluidigm® EP1™ System after amplification and scored using Fluidigm® SNP Genotyping Analysis software. If necessary, SNPs may be rescreened on a QuantStudio™ 12K Flex Real-Time PCR System (Life Technologies) as a backup method for assaying genotypes. Approximately 8% of individuals analyzed for this project will be re-extracted and genotyped as a quality control measure to identify laboratory errors and to measure rates of inconsistencies during repeated analyses. The quality control analyses will be performed by staff not involved in the original genotyping, and the methods are described in detail in Dann et al. (2012). Genotypes will be imported and archived in the Gene Conservation Laboratory Oracle database, LOKI.

Statistical Analysis for Stock Composition

Genotypes in the LOKI database will be imported into the statistical program R for analysis[1]. Prior to statistical analysis, 3 statistical quality control analyses will be performed to ensure high-quality data: 1) individuals missing >20% of their genotype data (markers) will be identified and removed from analyses, as this is indicative of low-quality DNA (80% rule; Dann et al. 2012); 2) duplicate

[1] R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

individuals will be identified and removed; and 3) non-sockeye salmon will be identified and removed.

The stock composition will be estimated for the following reporting groups: 1) a Klukshu/Nesketahin reporting group which includes the Klukshu River, Klukshu Lake, and Nesketahin Lake populations, which are all populations originating from above the Klukshu River and Village Creek assessment sites, 2) all other sockeye salmon populations in the Alsek River located above the U.S./Canada border, and 3) all other sockeye salmon populations in the baseline. The current genetic baseline consists of 241 populations (Rogers Olive et al 2018, with minor additions to the Yakutat region; Appendix G), which are representative of the major producing stocks in the study area. The baseline has been evaluated to ensure that the previously mentioned groups meet reporting criteria as described in Barclay et al (2019). Stock composition for each stratum will be estimated using a method that incorporates ages from matched scales and hatchery thermal marks on matched otoliths to help inform the genetic estimates. Since there are no expected hatchery contributions to the Alsek, no otoliths will be sampled for analysis. Similarly, age-specific stock composition for all major contributing age classes (>5%) will be estimated seasonally. This method ("mark- and age-enhanced GSI"; MAGMA) is conducted in a Bayesian framework and provides two sets of estimates: 1) a vector of stock compositions, summing to one, with a proportion for each of the wild and hatchery stocks weighted by harvest per stratum; and 2) a matrix of age composition, with a row for each of the wild and hatchery stocks (summing to one), and a column for each age class. Each fish is stochastically assigned to a most likely population based on its genotype and age, and stock proportions are estimated based on summaries of the individual assignments. In this process, all available information (i.e., age and genotype) is used to assign individuals to stock of origin.

A Markov Chain Monte Carlo (MCMC) algorithm is utilized for estimation in the MAGMA method. To initialize the algorithm, all fish with unknown origin or age are stochastically assigned to a population or age group, then proportions for populations and age groups are estimated in the following steps:

1) All age data are summarized by assigned and observed populations for both wild and hatchery individuals;
2) Population and age composition are estimated from previous summaries (accounting for sampling error);
3) Each wild fish with genotypes is stochastically assigned to a wild population of origin based on the product of its genotypic frequency, age frequency, and population proportion;
4) Each wild fish without genotypes is stochastically assigned to a population of origin based on the product of its age frequency and population proportion; and
5) Steps 1–4 are repeated while updating the estimates of the stock proportions and age compositions with each iteration.

The MCMC algorithm will be run for 40,000 repetitions, and the first 20,000 repetitions discarded to eliminate the effect of the initial state. Five independent MCMC sampling processes (i.e., chains) will be run and checked for convergence among chains graphically, using the Gelman-Rubin convergence diagnostic (Gelman and Rubin 1992; Brooks and Gelman 1998), and using effective number of simulation draws (Gelman et al. 2014). The point estimates and credible intervals for stock-specific age compositions are summary statistics of the joint posterior output.

Inriver Abundance Estimate

We will use a genetic mark–recapture technique (Hamazaki and DeCovich 2014) to estimate inriver Alsek River sockeye salmon (fish ≥ 350 mm METF) run abundance. This method is similar to the historical method for estimating run abundance (Gazey 2010; TTC 2022). In genetic mark–recapture, an unbiased estimate of abundance (N) at the Kilometer 19 site is

$$\widehat{N} = \frac{\hat{E}_m + \hat{C}_m}{\hat{p}_m}, \tag{11}$$

where $\hat{E}_m$ and $\hat{C}_m$ are the estimates of escapement and harvest of the Klukshu and Nesketahin sockeye salmon run above Kilometer 19, $\hat{p}_m$ is the GSI estimate of the portion of Klukshu and Nesketahin stock in the sockeye salmon caught at Kilometer 19. We will derive the variance of the above estimate using a parametric bootstrap simulation (Efron and Tibshirani 1993). In this simulation, we will incorporate variances associated with both run size or harvest estimates and genetic proportion.

To successfully apply a genetic mark–recapture, there are four assumptions that must be met: (1) the marked stock (i.e., Klukshu and Nesketahin stock) is genetically identifiable through GSI methods, (2) accurate estimate of escapement of the genetically marked stock, (3) accurate estimate of the proportion of the genetically marked stock at Kilometer 19 (i.e., that the Kilometer 19 sampling is representative of the entire run), and (4) accurate estimates of harvest (or other removal) of the genetically marked stock between Kilometer 19 and escapement enumeration (weir, sonar, etc.) (Hamazaki and DeCovich 2014). In order to achieve a genetic mark–recapture estimate with high precision and accuracy, the marked stock needs to be a large enough proportion of the total, typically greater than 20%.

There is no evidence that the first assumption (i.e., marked stock is genetically identifiable through GSI methods) will be violated, as the current genetic baseline consists of 241 populations, which are representative of the major producing stocks potentially present in the study area. The baseline consists of minor changes to Rogers Olive et al. (2018), with additional years pooled with existing Tatsatua Lake and Nahlin River populations and additional collections in the Yakutat area. The baseline was evaluated to ensure that the reporting groups meet reporting criteria as outlined in Barclay et al. (2019). Stock composition will be estimated for the following reporting groups: 1) Klukshu and Nesketahin (Klukshu River, Klukshu Lake and Nesketahin Lake populations), 2) Alsek (all other sockeye salmon populations in the Alsek River located above the U.S./Canada border), and 3) Other (all other sockeye salmon populations in the baseline).

The second assumption (i.e., accurate estimate of escapement of the genetically marked stock) will be met; the Klukshu River sockeye salmon escapement has been enumerated annually at the weir since 1976. The enumeration facility is in place well before the sockeye salmon run begins (for enumeration of early returning Chinook salmon), and operation extends beyond the end of the sockeye salmon run (about 14 days after the last sockeye). The Klukshu River sockeye salmon stock comprises a substantial but variable portion of the total Alsek River sockeye salmon run. Radiotelemetry studies conducted from 2001 to 2003 found the Klukshu stock represented an average 27% of the Alsek River escapement, and concurrent mark–recapture studies conducted from 2000 to 2004 found it represented an average 24% (range 15–32%) of the escapement (Smith et al. 2007). Analyses using GSI for the years 2005, 2006, and 2011–2021 found the Klukshu stock comprised an average 17% (range 4–36%) of the escapement (Gazey 2010; TTC 2022). In most cases these values exceeded recommendations for utility in genetic expansion, as values >20% are desirable.

The third assumption (i.e., accurate estimate of the proportion of the genetically marked stock at Kilometer 19) will be met if the catch of the set gillnets is representative of the total run and effort is consistent throughout the immigration period. A relatively constant sampling effort will tend to equalize the probabilities of capture for all salmon passing the marking site regardless of when they pass.

The fourth assumption (i.e., complete accounting for removals of the marked stock between Kilometer 19 and escapement enumeration) will be met. Canadian harvest of these stocks may occur below the enumeration sites and will be estimated by DFO and CAFN. Existing catch sampling and GSI programs in Canada will account for removal of these stocks or historical information will be used to estimate the Klukshu and Nesketahin stock proportion.

SCHEDULE AND DELIVERABLES

Field activities for marking salmon at Kilometer 19 will begin in mid-May and extend through early August. Field activities for recovery of marked salmon will begin in mid-June at the Klukshu River and Village Creek enumeration projects. Recovery effort on other headwaters spawning grounds will begin in late July and finish approximately mid-September. Mark inspection will occur throughout the duration of the U.S. Alsek River commercial and Canadian recreational (sport) and First Nation (subsistence) fisheries. Data from Kilometer 19 will be emailed to the Pacific Salmon Commission Transboundary Technical Committee (TTC) daily. Data from Canadian recovery locations will be emailed weekly to the TTC, and additional details sent weekly to the ADF&G project leader in Juneau. Preliminary data will be shared by 1 October 2022, edited, then distributed for any final editing by 1 December 2022. ASL and genetic samples will be processed postseason and analysis will be completed and shared by 31 December 2022. ADF&G will draft a written report by 1 March 2023 and distribute to DFO for editing and further writing. Changes to the report will be submitted by DFO to ADF&G by 15 April 2023 and the final report will be submitted to ADF&G publications for peer review by 1 May 2023. A final copy of the report will be distributed to the TTC and the Pacific Salmon Commission Chinook Technical Committee.

RESPONSIBILITIES

I. Agency Responsibilities

A. ADF&G. Will plan project in cooperation with DFO and CAFN. Will write operational plan with DFO. Will conduct and provide personnel and equipment for all aspects of marking, sampling, room and board at Dry Bay, and other operating supplies. Will summarize all marking data from Kilometer 19 and email to the TTC daily. Will perform analysis of data and first draft of report. Will provide final data and draft of report for review to DFO.

B. DFO (with CAFN support). Will assist in planning of project. Will conduct the Klukshu River and Village Creek enumeration projects. Will conduct and cover logistics associated with sampling Canadian inriver fisheries and spawning grounds sampling for ASL and mark recoveries. Will provide project data to as per above schedule. Will participate in data review and analysis, provide input into report, write sections regarding mark recovery, and serve as coauthor.

II. U.S. Personnel Responsibilities

Philip Richards, FBIII, Project Leader. In concert with Nathan Frost and Aaron Foos, sets up all aspects of project, including planning, budget, sample design, permits, equipment, personnel, and training. Assists in supervising Dry Bay operations and assists with supervision of recovery. Coalesces, edits, analyzes, and reports data; assists with fieldwork; arranges logistics with field crew. Takes lead role in analysis and first draft of report.

Nathan Frost, FBII. Oversees and assists with all aspects of the project including planning, budget, sample design, permits, equipment, and supervising field operations. Responsible for aging Chinook salmon scales. Coalesces, edits, analyzes, and reports data; assists with fieldwork.

Chase Jalbert, Fishery Geneticist I. Will oversee and assist with genetics portion of the project. Writes code for genetic analyses, provides stock compositions for genetic mark–recapture, and calculates inriver run abundance estimate.

Xinxian Zhang, Biometrician III. Provides input to and approves sampling design. Reviews operational plan and provides biometric details. Writes code for and completes data analysis and reviews final report.

Steve Heinl, Regional Research Coordinator. Reviews project planning, operational plans, and technical reports.

Joseph Simonowicz, FBI. Supervises at Kilometer 19 field marking program. Responsible for all aspects of field operations, including safe operation of riverboats, and other equipment, marking, data collection, and general field camp duties. Will assume lead role in equipment and camp maintenance.

James Bryant, FTIII. Crew lead, responsible for assisting in all aspects of field operations, including safe operation of riverboats and other equipment, marking, data collection, general field camp duties, and equipment and camp maintenance.

Corbin Lind, FTII. Assists with all aspects of field operations, including safe operation of riverboats and other equipment, marking, data collection, general field camp duties, and equipment and camp maintenance.

II. Canadian Personnel Responsibilities

Aaron Foos, Senior Aquatic Science Biologist. In concert with Philip Richards and Nathan Frost, will oversee and assist with all Canadian aspects of the project including planning, budget, sample design, permits, equipment, and supervising field operations. Coalesces, edits, analyzes, and reports data; assists with fieldwork. Will review data, provide input to report, write sections regarding mark recovery and serve as co-author.

Bill Waugh, Manager, Transboundary Rivers Operations. This position is responsible for general oversight of this project and the transboundary river stock assessment programs in the Area. Reviews project planning, operational plans, and technical reports

Sean Stark, Senior Aquatic Science Technician. In concert with Philip Richards, Nathan Frost, Joseph Simonowicz, and Aaron Foos will coordinate and assist in all Canadian aspects of the program. Responsible for technical coordination of DFO field operations in the Alsek River drainage. Will coordinate and participate as needed in field components and programs. Will review data and provide input into report.

Melina Hougen. Director, Heritage, Lands, and Resources, CAFN. Will coordinate and oversee all CAFN involvement in the program. May participate in field components as required.

Various DFO and CAFN Technicians. Will conduct all aspects of Canadian field operations, including safe operation of equipment, sampling, tag recovery data collection, and general field camp duties. Will assist in equipment and camp maintenance.

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APPENDICES

Appendix A.–Gillnet effort recording form.

Location ___________________________ Date _______________ Page _______________

Water Temp________at ________Hr _ Water Depth____ at __ _____Hr _

Water Comments ____________________ Weather Comments________________________

Gear Description ____________________ Crew ___________________________________

Set #	Start Time	Stop Time	Minutes Fished	Cumulative Minutes	salmon	Comments: other species, snags. Note, ad clips and salmon caught but not tagged
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
Daily Totals						

Appendix B.–Catch-effort form.

RECORD AND PHONE IN DATA FROM SHADED CELLS

Date	Crew 1, minutes	Crew 2, minutes	Total minutes	Total hours	Catch	Tagged	Cum Catch	Cum Tagged	CPUE

Appendix C.–Adult finfish tissue sampling for DNA analysis.

Adult Finfish Tissue Sampling for DNA Analysis

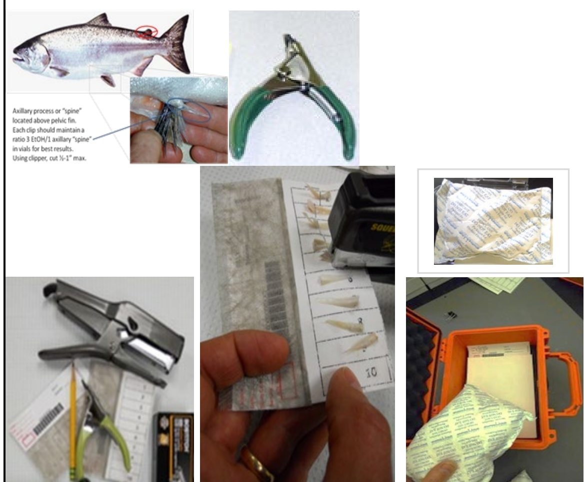
ADF&G Gene Conservation Lab, Anchorage

I. General Information

We use fin tissues as a source of DNA to genotype fish. Genotyped fish are used to determine the genetic characteristics of fish stocks or to determine stock compositions of fishery mixtures. The most important thing to remember in collecting samples is that **only quality tissue samples give quality results**. If sampling from carcasses: tissues need to be as "fresh" and as cold as possible.

Preservative used: Silica desiccant bead packet dries and preserves tissues for later DNA extraction. Quality DNA preservation requires **dry storage (**with desiccant packs) in Pelican case or watertight file box.

II. Sampling Method



III. Sampling Instructions

- **Prior to Sampling:**
  - Set up workspace and fill out required collection information (location, date, species, and latitude/longitude).
  - Place Whatman genetic card (10WGC) on mini clipboard flat for easy access. One Whatman card per scale card. Same card can be used throughout same day.
- **Sampling:**
  - Wipe excess water and/or slime off the axillary process "spine" prior to sampling to avoid getting excess water or fish slime.
  - Clip off the axillary "spine" using dog clippers or scissors to get roughly a ½ **- 1" inch maximum** piece and/or about the size of a small fingernail.
  - Place one clipped axillary onto appropriate grid space. Follow sampling order printed on card - **do not deviate**. If large tissue sample, center tissue diagonally on grid space.
  - **Only one axillary clip per fish into each numbered grid space**.
  - Staple every axillary clip to 10WGC card (see photo).
  - Sampling complete for each day and/or the card is full, place in case.
  - Fold the black cloth**, do not** staple landscape cloth to paper edge.
  - Periodically, wipe or rinse clippers with water to eliminate cross contamination of samples.
  - Place the 10WGC card inside Pelican case and layer with blotter cards and desiccant packs. Leave card in Pelican case overnight.
  - Close and secure the lid of Pelican case so drying begins.
  - Data: Record **each fin clip number to paired data** information (example: location, sample date, and card barcode). Electronic version.
  - **Prior to next day of sampling**, remove all cards from daily Pelican case and place them into file box for long term dry storage.
- **Loading Pelican Case:**
  - 1st card: Remove blotter papers and desiccant packs (remove from vacuum plastic) from 2nd Pelican case. Place first card in the case with tissues facing up. Next, place blotter paper directly over card and place one or 2 desiccant packs on top. Close and secure lid so long term drying begins.
  - With this collection, all cards can be stacked for long term dry storage in 2nd Pelican case. Add them so **tissue samples always face the blotter paper** and place the desiccant pack(s) on top of both.
  - Close and secure Pelican case after inserting daily cards.
  - For **every morning** begin by removing all dried card(s) from previous day & put them into 2nd Pelican case long term dry storage.
  - All cards must **remain in file box with desiccant pack at all times** to dry flat.
- **Post-sampling storage:**
  - Store dried 10WGC tissue cards in 2nd Pelican or file box at room temperature or cooler. Two desiccant packs fit inside Pelican 1150 case, helps flatten the cards as they dry out over time. **DO NOT REMOVE FOAM!**
- **Shipping at end of the season:**
  - Keep all **dried** cards layered inside Pelican or file box with secured lid, pack all dry cards in photo sleeves and inside priority mailing box with returning sampling supplies. Tape box shut and tape return address on box and/or hand carry on aircraft for delivery.

IV. Supplies included in sampling kit:

1. Clippers - for cutting a portion of selected fin.
2. Whatman genetics card (10WGC) – holds 10 fish/card.
3. Stapler – extra protection, secure sample to numbered grid.
4. Staples – only use staples provided, specific for stapler.
5. Silica packs – desiccant removes moisture from samples
6. Pelican case – long term dry storage before return shipment (1150).
7. File box – long term dry storage prior to return shipment.
8. Blotter cards – insert between 10WGC and desiccant pack.
9. Laminated "return address" labels.
10. Sampling instructions.
11. Pencil

V.

Return to ADF&G Anchorage lab:
ADF&G – Genetics — Lab staff: 907-267-2247
333 Raspberry Road — Judy Berger: 907-267-2175
Anchorage, Alaska 99518 — Freight code: _________

-continued-

Appendix C.–Page 2 of 2.

Location: Alsek River at River Mile 19

Species: Chinook sockeye (circle one) **Gear Type:** Set Gillnet

Date: ____/____/______

Sampler: ______________

Scale Card

Barcode

GCL USE ONLY

SILLY: **SILLY**

Barcode

Appendix D.–Event 2: inspection, recapture, and age-sex-length form.

Location ______________________ Page ______________________
Stream Code____________________ Year ______________________
Species ________________________ Gear Type ________________

Cum Fish #	Date	Sex	Card #	Scale #	METF	POH	AEC	Spag Tag #	Ad Clip	Cinch Tag #	Cond	Comments: LAA and/or ULOP present, **ULOP shape**?
				1								
				2								
				3								
				4								
				5								
				6								
				7								
				8								
				9								
				10								
				1								
				2								
				3								
				4								
				5								
				6								
				7								
				8								
				9								
				10								
				1								
				2								
				3								
				4								
				5								
				6								
				7								
				8								
				9								
				10								
				1								
				2								
				3								
				4								
				5								
				6								
				7								
				8								
				9								
				10								

Condition (Cond.): PS = pre-spawn, LPS = live postspawn, D = dead

Size- and sex-selective sampling may cause bias in two-event mark–recapture estimates of abundance and size and sex composition. Kolmogorov-Smirnov (KS) two sample tests are used to detect size-selective sampling and contingency table analyses (Chi-square tests of independence) are used to detect evidence of sex-selective sampling.

Results of the KS and Chi-square tests will dictate whether the data need to be stratified to obtain an unbiased estimate of abundance. The nature of the detected selectivity will also determine whether the first, second, or both event samples are used for estimating size and sex compositions.

DEFINITIONS

M = Lengths or sex of fish marked in the first event.
C = Lengths or sex of fish inspected for marks in the second event.
R = Lengths or sex of fish marked in the first event and recaptured in the second event.

SIZE-SELECTIVE SAMPLING: KS TESTS

Three KS tests are used to test for size-selective sampling.

KS Test 1	C vs R	Used to detect size selectivity during the 1st sampling event. H_o: Length distributions of populations associated with C and R are equal.
KS Test 2	M vs R	Used to detect size selectivity during the 2nd sampling event. H_o: Length distributions of populations associated with M and R are equal.
KS Test 3	M vs C	Used to corroborate the results of the first two tests. H_o: Length distributions of populations associated with M and C are equal.

SEX-SELECTIVE SAMPLING: CHI-SQUARE TESTS

Three contingency table analyses (χ^2-tests on 2×2 tables) are used to test for sex-selective sampling.

χ^2 Test 1	C vs R	Used to detect sex selectivity during the 1st sampling event. H_o: Sex is independent of the C - R classification.
χ^2 Test 2	M vs R	Used to detect sex selectivity during the 2nd sampling event. H_o: Sex is independent of the M - R classification.
χ^2 Test 3	M vs C	Used to corroborate the results of the first two tests. H_o: Sex is independent of the M - C classification

-continued-

The following table presents possible results of selectivity testing, their interpretation, and prescribed action:

	KS or χ^2 Test			
Case	M vs. R (2nd event test)	C vs. R (1st event test)	M vs. C (1st vs 2nd event)	Interpretation and Action
I	Fail to reject H_o	Fail to reject H_o	Fail to reject H_o	**Interpretation**: No selectivity during either sampling event. **Action**: Abundance: Use a Petersen-type model without stratification. Composition: Use all data from both sampling events.
II	Reject H_o	Fail to reject H_o	Reject H_o	**Interpretation:** No selectivity during the 1st event but there is selectivity during the 2nd event. **Action**: Abundance: Use a Petersen-type model without stratification. Composition: Use data from the 1st sampling event without stratification. 2nd event data only used if stratification of the abundance estimate is performed, with weighting according to Equations 1–3 below.
III	Fail to reject H_o	Reject H_o	Reject H_o	**Interpretation:** No selectivity during the 2nd event but there is selectivity during the 1st event. **Action**: Abundance: Use a Petersen-type model without stratification. Composition: Use data from the 2nd sampling event without stratification. 1st event data may be incorporated into composition estimation only after stratification of the abundance estimate and appropriate weighting according to Equations 1–3 below.
IV	Reject H_o	Reject H_o	Either result	**Interpretation:** Selectivity during both 1st and 2nd events. **Action**: Abundance: Use a stratified Petersen-type model, with estimates calculated separately for each stratum. Sum stratum estimates for overall abundance. Composition: Combine stratum estimates according to Equations 1–3 below.
V	Fail to reject H_o	Fail to reject H_o	Reject H_o	**Interpretation:** The results of the 3 tests are inconsistent. **Action:** Need to determine which of Cases I–IV best fits the data. Inconsistency can arise from high power of the M vs. C test or low power of the tests involving R. Examine sample sizes (generally M or C from <100 fish and R from <30 are considered small), magnitude of the test statistics (D_{max}), and the *P*-values of the three tests to determine which of which of Cases I–IV best fits the data.

-continued-

COMPOSITION ESTIMATION FOR STRATIFIED ESTIMATES

An estimate of the proportion of the population in the k^{th} size or sex category for stratified data with I strata is calculated as follows:

$$\hat{p}_k = \sum_{i=1}^{I} \frac{\hat{N}_i}{\hat{N}} \hat{p}_{ik} , \tag{1}$$

with variance estimated as

$$var[\hat{p}_k] \approx \frac{1}{\hat{N}^2} \sum_{i=1}^{I} \left(\hat{N}_i^2 \, var[\hat{p}_{ik}] + \left(\hat{p}_{ik} - \hat{p}_k \right)^2 var[\hat{N}_i] \right), \tag{2}$$

where

$\hat{p}_{ik}$ = estimated proportion of fish belonging to category k in stratum i;

$\hat{N}_i$ = estimated abundance in stratum i; and

$\hat{N}$ = estimated total abundance:

$$= \sum_{i=1}^{I} \hat{N}_i \ . \tag{3}$$

Appendix F.–Tests of consistency for the Petersen estimator (from Seber 1982, page 438). Excerpted from Elliott and Power (2016). Revised August 2016.

Three contingency table analyses are used to determine if the Petersen estimate can be used (Seber 1982). If any of the null hypotheses are not rejected, then a Petersen estimator may be used. If all three of the null hypotheses are rejected, a temporally or spatially-stratified estimator (Darroch 1961) should be used to estimate abundance.

Seber (1982) describes 4 conditions that lead to an unbiased Petersen estimate, some of which can be tested directly:

1. Marked fish mix completely with unmarked fish between events,
2. Equal probability of capture in event 1 and equal movement patterns of marked and unmarked fish,
3. Equal probability of capture in event 2, and
4. The expected number of marked fish in recapture strata is proportional to the number of unmarked fish.

In the following tables, the terminology of Seber (1982) is followed, where *a* represents fish marked in the first event, *n* represents fish captured in second event, and *m* represents marked fish recaptured in the second event; $m_{\bullet j}$ and $m_{i\bullet}$ represent summation over the i^{th} and j^{th} indices, respectively.

I. Mixing Test

Tests the hypothesis (condition 1) that movement probabilities (θ_{ij}), describing the probability that a fish moves from marking stratum *i* to recapture stratum *j*, are independent of marking stratum: H_0: $\theta_{ij} = \theta_j$ for all *i* and *j*.

Area/Time marking strata *(i)*	Area/Time recapture strata *(j)*				Not recaptured
	1	2	…	t	$a_i - m_{i\bullet}$
1	m_{11}	m_{12}	...	m_{1t}	$a_1 - m_{1\bullet}$
2	m_{21}	m_{22}	...	m_{2t}	$a_2 - m_{2\bullet}$
...	...	...	...	...	…
s	m_{s1}	m_{s2}	...	m_{st}	$a_s - m_{s\bullet}$

II. Equal Proportions Test[a] (SPAS[b] terminology)

Tests the hypothesis (condition 4) that the marked to unmarked ratio among recapture strata is constant: H_0: $\Sigma_i a_i\theta_{ij} / U_j = k$, where k = a constant, U_j = unmarked fish in stratum *j* at the time of 2nd event sampling, and a_i = number of marked fish released in stratum *i*. Failure to reject H_0 means the Petersen estimator should be used only if the degree of closure among tagging strata is constant, i.e., $\Sigma_j\theta_{ij} = \lambda$ (Schwarz and Taylor 1998, p 289). A special case of closure is when all recapture strata are sampled, such as in a fishwheel to fishwheel experiment, where $\Sigma_j\theta_{ij} = 1.0$; otherwise biological and experimental design information should be used to assess the degree of closure.

	Area/Time recapture strata *(j)*			
	1	2	…	t
Recaptured ($m_{\cdot j}$)	$m_{\bullet 1}$	$m_{\bullet 2}$	…	$m_{\bullet t}$
Unmarked ($n_j - m_{\cdot j}$)	$n_1 - m_{\bullet 1}$	$n_2 - m_{\bullet 2}$	…	$n_t - m_{\bullet t}$

-continued-

III. Complete Mixing Test[a] (SPAS[b] terminology)

Tests the hypothesis that the probability of re-sighting a released animal is independent of its stratum of origin: H_0: $\Sigma_j \theta_{ij} p_j = d$, where p_j is the probability of capturing a fish in recapture stratum j during the second event, and d is a constant.

	Area/Time marking strata *(i)*			
	1	2	…	s
Recaptured (m_i)	$m_{1\bullet}$	$m_{2\bullet}$	…	$m_{s\bullet}$
Not recaptured (a_i - $m_{i\bullet}$)	$a_1 - m_{1\bullet}$	$a_2 - m_{2\bullet}$	…	$a_s - m_{s\bullet}$

[a] There is no 1:1 correspondence between Tests II and III and conditions 2–3 above. It is pointed out that equal probability of capture in event 1 will lead to (expected) non-significant Test II results, as will mixing, and that equal probability of capture in event 2 along with equal closure ($\Sigma j \theta ij = \lambda$) will also lead to (expected) non-significant Test III results.

[b] Stratified Population Analysis System (Arnason et al. 1996).

Appendix G.–Reporting group, location, ADF&G collection code, and the number (*n*) of sockeye salmon used in the genetic baseline for mixed stock analysis of Alsek River set net catches.

Reporting group	Location	ADF&G collection code	*n*
Alsek	Alsek - Blanchard River	SBLAN07	89
Alsek	Alsek - Blanchard River	SBLAN09	62
Alsek	Alsek - Border Slough	SBORD07.SBORD08	71
Alsek	Alsek - Border Slough	SBORD09.SBORD11	70
Alsek	Alsek - Datlasaka Creek	SDATLAS12	95
Alsek	Alsek - Goat Creek	SGOATC07.SGOATC12	56
Alsek	Alsek - Kudwat (Little Tatshenshini Lake)	SLTATS01.SLTATS03	65
Alsek	Alsek - Kudwat (Tatshenshini) - Bridge/Silver	SBRIDGE11.SBRIDGE12	105
Alsek	Alsek - Kudwat (Tatshenshini) - Kwatini	SKWAT11	65
Alsek	Alsek - Kudwat (Tatshenshini) - Stinky Creek	SSTINKY11	40
Alsek	Alsek - Kudwat (Upper Tatshenshini)	SUTATS03	95
Alsek	Alsek - Kudwat Creek (Tatshenshini)	SKUDW09.SKUDW10.SKUDW11	100
Alsek	Alsek - Tweedsmuir	STWEED07	48
Alsek	Alsek - Tweedsmuir	STWEED09	46
Alsek	Alsek - Vern Ritchie	SVERNR09.SVERNR10	114
Klukshu/Neskatahin	Alsek - Neskataheen Lake	SNESK07	195
Klukshu/Neskatahin	Alsek - Klukshu River	SKLUK07	94
Klukshu/Neskatahin	Alsek - Klukshu River Weir late	SKLUK06	95
Other	East Alsek River	SEAST03B	94
Other	Stikine - Chutine Lake	SCHUTL09.SCHUT11	224
Other	Taku - King Salmon Lake	SKSLK10.SKSLK11	214
Other	Taku - Kuthai Lake	SKUTH06	171
Other	Taku - Tatsatua Lake (Tatsatua)	SLTAT11.SLTAT12	153
Other	Taku - Little Trapper	SLTRA90.SLTRA06	237
Other	Stikine - Andy Smith Slough	SFOWL07.SFOWL08.SFOWL09.SANDY07.SANDY09	54
Other	Stikine - Bronson Slough	SBRON08.SBRON09	78
Other	Stikine - Christina Lake	SCHRI11.SCHRI12	70
Other	Stikine - Chutine River	SCHUT08	94
Other	Stikine - Craig River	SCRAIG06.SCRAIG07.SCRAIG08	38
Other	Stikine - Devil's Elbow	SDEVIL07.SDEVIL08	148
Other	Stikine - Devil's Elbow	SDEVIL09	53
Other	Stikine - Iskut River	SISKU85.SISKU86.SISKU02.SISKU06.SISKU08.SISKU09	153
Other	Stikine - Iskut River (Craigson Slough)	SISKU07	42
Other	Stikine - Porcupine River	SPORCU07.SPORCU11	74
Other	Stikine - Scud River	SSCUD07.SSCUD08.SSCUD09	191
Other	Stikine - Shakes Slough Creek	SSHAKS06.SSHAKES07.SSHAKS09	67

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Reporting group	Location	ADF&G collection code	*n*
Other	Taku - Fish Creek	SFISHCR09.SFISHCR10	159
Other	Taku - Hackett River	SHACK08	52
Other	Taku - Sustahine Slough	SSUSTA08.SSHUST09	185
Other	Taku - Tulsequah River	STULS07.STULS08.STULS09	156
Other	Taku - Tuskwa Creek	STUCH08.SCHUNK09.STUSK08.SBEARSL09.STUSKS08.STUSKS09	356
Other	Taku - Yehring Creek	SYEHR07.SYEHR09	171
Other	Taku - Yellow Bluff	SYELLB08.SYELLB10.SYELLB11	81
Other	Taku Mainstem - Taku River	STAKU07	95
Other	Taku Mainstem - Takwahoni/Sinwa	STAKWA09	67
Other	Taku - Nahlin River	SNAHL03.SNAHL04.SNAHL05.SNAHL06.SNAHL07.SNAHL12	341
Other	Taku - Tatsamenie Lake	STATS05.STATS06	288
Other	Ahrnklin River	SAHRN07	90
Other	Akwe River	SAKWE09.SAKWE16	186
Other	Antler-Gilkey River	SANTGILK13	53
Other	Bainbridge Lake	SBAIN10	95
Other	Banana Lake - Klutina	SBANA08	80
Other	Bar Creek - Essowah Lake	SBAR04	95
Other	Bartlett River - Creel survey	SBART13	69
Other	Bear Hole - tributary Klutina	SBEARH08	94
Other	Bering Lake	SBERI91	95
Other	Berners River	SBERN03.SBERN13	165
Other	Big Lake - Ratz Harbor Creek	SBIGLK10.SBIGLA14	161
Other	Bloomfield Lake	SBLOOM05	93
Other	Central - Kitlope Lake	SKITL06	95
Other	Central Coast - Amback Creek	SAMBA04	91
Other	Chilkat Lake	SCKAT13	189
Other	Chilkat Lake early run	SCKAT07E.SCKAT07L	190
Other	Chilkat Mainstem - Bear Flats	SBEARFL07	95
Other	Chilkat Mainstem - Mosquito Lake	SMOSQ07	95
Other	Chilkat River - Mule Meadows	SMULE03.SMULE07	190
Other	Chilkoot Lake - beaches	SCHILB07	251
Other	Chilkoot Lake - Bear Creek	SCHILBC07	233
Other	Chilkoot River	SCHIK03	159
Other	Clear Creek at 40 Mile	SCLEAR07	86
Other	Coghill Lake	SCOGH91.SCOG92HL.SCOG92ES.SCOGH10	378
Other	Columbia River - Okanagan River	SOKAN02	95
Other	Crescent Lake	SCRES03	194
Other	Dangerous River	SDANG09	95
Other	Eek Creek	SEEK04.SEEK07	50

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Reporting group	Location	ADF&G collection code	*n*
Other	Eshamy Creek	SESHAR08.SESHA91	185
Other	Eyak Lake - Hatchery Creek	SEYAK10	95
Other	Eyak Lake - Middle Arm	SEYAM07	95
Other	Eyak Lake - South beaches	SEYASB07	87
Other	Falls Lake - East Baranof Island	SFALL03.SFALL10	190
Other	Fillmore Lake - Hoffman Creek	SFILLM05	52
Other	Fish Creek - off East Fork Gulkana River	SFISHC08	95
Other	Ford Arm Creek	SFORD13	199
Other	Ford Arm Lake weir	SFORD04	207
Other	Fraser - Adams River - Shuswap late	SLADA02.SADAM07	187
Other	Fraser - Birkenhead	SBIRK07	90
Other	Fraser - Chilko Lake	SCHILK01	87
Other	Fraser - Chilliwack Lake	SCHILW04	89
Other	Fraser - Cultus Lake	SCULT02	91
Other	Fraser - Fraser Lake	SFRAS96	85
Other	Fraser - Gates Creek	SGATES09	90
Other	Fraser - Harrison River	SHARR07	95
Other	Fraser - Lower Horsefly River	SLHOR01.SUHOR01.SHORSE07	274
Other	Fraser - Middle Shuswap River	SMSHU02	91
Other	Fraser - Nahatlatch - Nahatlatch River	SNAHAT02	92
Other	Fraser - North Thompson	SNTHOM05	95
Other	Fraser - Raft River	SRAFT01	84
Other	Fraser - Scotch River	SSCOT00	91
Other	Fraser - Stellako River	SSTEL07	94
Other	Fraser - Tachie River	STACH01	94
Other	Fraser - Trembleur - Kynock	SKYNO97	94
Other	Fraser - Weaver Creek	SWEAV01	88
Other	Great Central Lake	SGCENLK02	95
Other	Gulkana River - East Fork	SGULK08EF	75
Other	Hasselborg Lake	SHASSEL12.SHASSELR13	209
Other	Hatchery Creek - Sweetwater	SHATC03.SHATC07	142
Other	Heckman Lake	SHECK04.SHECK07	189
Other	Helm Lake	SHELM05	94
Other	Hetta Creek - early run	SHETT10E	95
Other	Hetta Creek - late run	SHETT03.SHETT08.SHETT09L	281
Other	Hetta Creek - middle run	SHETT09M	95
Other	Hoktaheen - marine waters	SHOKTAM14	47
Other	Hoktaheen - upper lake main inlet	SHOKTAI04	47
Other	Hoktaheen - upper lake outlet	SHOKTAO04	49

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Reporting group	Location	ADF&G collection code	*n*
Other	Hugh Smith - Cobb Creek	SCOBB07	99
Other	Hugh Smith Lake	SHSMI92.SHUGH13	155
Other	Hugh Smith Lake - Bushmann Creek	SHUGH04	150
Other	Inlet Creek - Klawock	SINCK03.SINCK08.SHALF08	212
Other	Issaquah Creek - Puget Sound Drainage	SISSA96	82
Other	Italio River	SITAL17	41
Other	Kah Sheets Lake	SKAHS03	96
Other	Kanalku Creek	SKANA07.SKANA10.SKANAL13	319
Other	Kegan Lake	SKEGA04	95
Other	Kitimat River	SKITIM10	93
Other	Kitwanga River	SKITW12	92
Other	Klag Bay Stream outlet	SKLAG09	200
Other	Klakas Lake	SKLAK04	95
Other	Klawock-Three Mile Creek	STHRE04.STHRE10	181
Other	Klutina Lake - inlet	SKLUTI08.SKLUTI09	95
Other	Klutina River - mainstem	SKLUT08	95
Other	Kook Lake	SKOOK12E.SKOOK13	148
Other	Kook Lake - late	SKOOK07.SKOOK10L.SKOOK12L	194
Other	Kunk Lake - Etolin Island system	SKUNK03	96
Other	Kushtaka Lake	SKUSH07.SKUSH08	189
Other	Kutlaku Lake	SKUTL03	95
Other	Kutlaku Lake	SKUTL12	78
Other	Kutlaku Lake	SKUTL13	50
Other	Lace River	SLACE13	63
Other	Lake Creek	SAUKE13baseline.SLAKECR14	318
Other	Lake Eva	SLEVA12	115
Other	Lake Pleasant - Soleduck River	SLAKE97	76
Other	Lake Wenatchee	SWENA98	95
Other	Long Lake weir	SLONGLK05	95
Other	Lost/Tahwah Rivers	SLOST03B.SLOST03C	139
Other	Luck Lake - P.O.W. Island	SLUCK04	94
Other	Mahlo River	SMAHL08	94
Other	Mahoney Creek	SMAHO03.SMAHO07	153
Other	Main Bay	SMAIN91	96
Other	Martin Lake	SMART07.SMART08	187
Other	Martin River Slough	SMARTR08	95
Other	McDonald Lake - Hatchery Creek	SMCDO01.SMCDO03.SMCDO07.SMCDO13	368
Other	McGilvery Creek	SKART92.SMCGI03.SMCGI04.SMCGI16	472
Other	McKinley Lake	SMCKI07	95

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Reporting group	Location	ADF&G collection code	*n*
Other	McKinley Lake	SMCKI08	95
Other	McKinley Lake	SMCKI91	95
Other	McKinley Lake - Salmon Creek	SMCKSC07	93
Other	Mendeltna Creek	SMEND08.SMEND09	188
Other	Mentasta Lake	SMENT08	95
Other	Mill Creek Weir Early - Virginia Lake	SMILLC07E	94
Other	Mill Creek Weir Late - Virginia Lake	SMILLC07L	95
Other	Miners Lake	SMINE91.SMINE09	191
Other	Mitchell River	SMITCH01	94
Other	Nass - Bonney Creek	SBONN01.SBONN12	164
Other	Nass - Bowser Lake	SBOWS01	94
Other	Nass - Damdochax Creek	SDAMD01	93
Other	Nass - Gingit Creek	SGING97	94
Other	Nass - Hanna Creek	SHANNA06	93
Other	Nass - Kwinageese	SKWIN01.SKWIN12U	76
Other	Nass - Meziadin Beach	SMERI01.SMEZIB06	186
Other	Nass - Tintina Creek	STINT06	94
Other	Necker Bay	SNECKER91.SNECKER93	95
Other	Neva Lake weir	SNEVA08	94
Other	Neva Lake weir	SNEVA09.SNEVA13	255
Other	North Berg Bay inlet	SNBERG91	53
Other	North Berg Bay inlet	SNBERG92	100
Other	Old Situk	SOSITU07	163
Other	Pavlof River	SPAVLOF12.SPAVLOFR13	174
Other	Paxson Lake - outlet	SPAXSO09	75
Other	Petersburg Lake	SPETL04	95
Other	QCI - Naden River	SNADE95	95
Other	QCI - Yakoun Lake	SYAKO93	70
Other	Red Bay Lake	SREDBL04	95
Other	Redfish Lake Beaches	SREDB93	94
Other	Redoubt Lake - outlet	SREDOUBT13	200
Other	Salmon Bay Lake	SSALM04.SSALM07	170
Other	Salmon Creek - Bremner	SSALMC08	93
Other	Salmon Lake weir	SSALML07.SSALML08	185
Other	Sarkar - Five Finger Creek	SSARK00.SSARF05	91
Other	Seclusion Lake - in lake	SSECLK14.SSECLKIN14	117
Other	Shipley Lake	SSHIP03	94
Other	Sitkoh Lake	SSITK03.SSITK11.SSITK12	351
Other	Situk Lake	SSITU07	159

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Reporting group	Location	ADF&G collection code	*n*
Other	Situk Lake	SSITU13	190
Other	Skeena - Alastair Lake	SALAS87.SALAS06	118
Other	Skeena - Four Mile Creek	SFMILE06	85
Other	Skeena - Fulton River	SFULT06	95
Other	Skeena - Grizzly Creek	SGRIZ87	76
Other	Skeena - Kispiox River	SKISP02	53
Other	Skeena - Kitsumkalum Lake	SKALUM06	56
Other	Skeena - Kitsumkalum Lake	SKALUM12	94
Other	Skeena - Lakelse Lake (Williams)	SLAKEL06	93
Other	Skeena - Lower Tahlo River	SLTAH94	78
Other	Skeena - McDonell Lake (Zymoetz River)	SMCDON02.SMCDON06	131
Other	Skeena - Morrison	SMORR07	92
Other	Skeena - Motase Lake	SMOTA87	47
Other	Skeena - Nangeese River	SNANG06	40
Other	Skeena - Nanika River	SNANI88.SNANI07	113
Other	Skeena - Pierre Creek	SPIER06	95
Other	Skeena - Pinkut Creek	SPINK94.SPINK06	187
Other	Skeena - Salix Bear	SSALIX87.SSALIX88	94
Other	Skeena - Slamgeesh River	SSLAM06	95
Other	Skeena - Stephens Creek	SSTECR01	95
Other	Skeena - Sustut River	SSUST01	79
Other	Skeena - Swan Lake	SSWANLK06	93
Other	Skeena - Tahlo Creek	STAHLO07	95
Other	Skeena - Upper Babine River	SUBAB06	95
Other	Snettisham Hatchery	SSNET06.SSPEE07	190
Other	Snettisham Hatchery - Speel Lake	SSPEE13	146
Other	Sockeye Creek	SSOCK17.SSOCK18	136
Other	Speel Lake	SSPEE03	95
Other	St. Anne Creek	SSANN05.SSTACR08	186
Other	Steamboat Lake - Bremner	SSTEAM08	95
Other	Steep Creek	SSTEE03	91
Other	Stikine - Little Tahltan	SLTAH90	95
Other	Stikine - Tahltan Lake	STAHL06	196
Other	Swede Lake	SSWEDE08	95
Other	Tanada Creek weir	STANA05	94
Other	Tanada Lake - lower outlet	STANAO09	95
Other	Tanada Lake - shore	STANAS09	93
Other	Tankeeah River	STANK03	47
Other	Tankeeah River	STANK05	47

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Reporting group	Location	ADF&G collection code	*n*
Other	Tawah Creek	STAWA17	94
Other	Thoms Lake	STHOM04.STHOM14	93
Other	Tokun Lake	STOKUN08.STOKUN09	189
Other	Tonsina Lake	STONSL09	94
Other	Unuk River - Gene's Lake	SGENE07	95
Other	Unuk River - Gene's Lake	SGENE08	69
Other	Vancouver Island - Quatse River	SQUAT03	95
Other	Vivid Lake	SVIVID93	48
Other	Windfall Lake	SWIND03.SWIND07	142