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Southeast Alaska Coho Stock Assessment, 2022–2024

by

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and

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March 2023

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

PURPOSE

This project provides stock assessment information for Southeast Alaska coho salmon (*Oncorhynchus kisutch*) indicator stocks at Berners River and Hugh Smith Lake. Coho salmon smolt at the Berners River and Hugh Smith Lake are captured, implanted with a coded wire tag (CWT), sampled for age and length, adipose fin clipped, and released unharmed. Concurrent to smolt tagging, a project to collect scales of a known age requires capturing and implanting a CWT into coho salmon fry, later to be recovered as smolt and adults. Returning adult coho salmon are examined for the presence of CWTs, enumerated, and sampled for age, length, and sex. These data are used in combination with estimates of harvest of tagged fish by Alaska Department of Fish and Game port sampling and Mark, Tag and Age Laboratory programs to estimate a variety of parameters for the stocks. These programs, conducted continuously since the 1980s, provide detailed information on long-term population dynamics useful for establishing escapement goals and for managing commercial fisheries that target coho salmon.

Keywords: Berners River, Hugh Smith Lake, *Oncorhynchus kisutch*, coho salmon, commercial harvest, harvest rate, known age, coded wire tag, escapement survey, mark–recapture study, marine survival, operational plan

BACKGROUND

The coho salmon (*Oncorhynchus kisutch*) is an important species to commercial, sport and subsistence fisheries in Southeast Alaska. The total common property commercial harvest averaged 2.3 million coho salmon over the decade 2011–2020, the majority of which were harvested in troll fisheries (Hagerman et al. 2021). Coho salmon in Southeast Alaska originate in over 2,350 local streams (Priest et al. 2021), mostly small producers about which little is known. Important stock contributions are also made by Canadian portions of major transboundary rivers (e.g., the Stikine and Taku Rivers) and streams along the British Columbia coast. Thus, management of fisheries for coho salmon in Southeast Alaska is complicated by the scattered distribution of the resource and highly mixed stock nature of most of the fisheries. Effective management requires an understanding of the migratory characteristics, status, productivity, harvest rates, and contribution to the fisheries of stocks or groups of stocks.

Beginning in the 1970s, the Alaska Department of Fish and Game (ADF&G) implemented marking programs to better understand and manage Southeast Alaska coho salmon stocks (Gray et al. 1978; Shaul et al. 1991). Program goals shifted in the early 1980s to emphasize long-term research on selected "indicator stocks" that represent a larger group of stocks (Shaul 1994; Shaul and Crabtree 1998). This long-term research allowed the estimation of smolt production and contribution to the fisheries by marking indicator stocks with coded wire tags (CWTs) and systematically sampling fishery harvests and escapements. Three indicator stocks, Berners River (north of Juneau), Auke Lake (also north of Juneau; operated by the National Marine Fisheries Service, Auke Bay Laboratory), and Hugh Smith Lake (south of Ketchikan; Figure 1), have been studied continuously since the early 1980s. By quantifying fishery harvest and escapement by jack (i.e., ocean-age-0) and adult (i.e., ocean-age-1) coho salmon, the estimated total run and productivity by system can be estimated. In addition to the indicator stocks, a systematic escapement survey program was developed to assess coho salmon spawning abundance in individual streams and aggregates of index streams in Southeast Alaska (Shaul et al. 2011). These programs provide detailed information on population dynamics necessary for establishing escapement goals and developing models to predict abundance (Clark et al. 1994; Shaul et al. 2009 and 2011) and provide for informed inseason management of fisheries that target coho salmon, particularly the troll fishery. Further, data gathered from this project form the basis for updates about indicator stocks required for Pacific Salmon Commission (PSC) annual updates or comprehensive reports (e.g., Priest et al. 2021).

This project operational plan covers the ongoing stock assessment activities at the Berners River and Hugh Smith Lake (i.e., CWT mark–recapture data) used to estimate a variety of parameters for the stocks. The Berners River biological escapement goal of 3,600–8,100 coho salmon was adopted in 2018 (Shaul et al. 2017; Heinl et al. 2021) and replaced an existing goal established in 1994 (Clark et al. 1994). The Berners River escapement is estimated by expanding peak foot and aerial survey counts (Shaul and Crabtree 2017). The Hugh Smith Lake biological escapement goal of 500–1,600 coho salmon was established in 2009 (Shaul et al. 2009; Heinl et al. 2021), and escapement is estimated with weir counts verified by a mark–recapture estimate. These escapement data, as well as inseason fishery tag recovery data, contribute to a long-term dataset that is used to evaluate existing biological escapement goals, monitor status, and estimate inseason harvest. Additionally, implanting fry with half-length CWTs has occurred annually since 1996 and 1997 at Berners River and Hugh Smith Lake, respectively, followed by the recapture of CWT marked (i.e., known age) smolt and adults. These known-age samples have been studied since 1999 and improve aging accuracy by establishing a known-age standard within each cohort.

OBJECTIVES

Smolt Migration

1. Estimate the coho salmon smolt outmigration from the Berners River and Hugh Smith Lake such that the estimates have a coefficient of variation of 7% or less.
2. Estimate the age composition of the coho salmon smolt outmigration from the Berners River and Hugh Smith Lake such that the estimated proportion of each age class is within 5% of the true value with at least 95% probability.

Adult Escapement

3. Obtain a complete survey count of the adult coho salmon escapement in the Berners River using standardized survey timing and coverage comparable to counts made in prior years and expand counts to an estimate of the total escapement.
4. Enumerate the adult (fish ≥ 400 mm mid eye to tail fork [METF] length) and jack (fish < 400 mm METF length) coho salmon escapement through the Hugh Smith Lake weir. In the event of a weir failure, obtain a Chapman mark–recapture estimate of the adult escapement such that the estimated coefficient of variation is 7% or less.
5. Estimate the adult coho salmon age and sex compositions of Berners River and Hugh Smith Lake escapements such that the estimated proportion of each age class is within 5% of the true value with at least 95% probability.

Harvest and Total Return

6. Estimate the proportional distributions of the marine harvest of Berners River and Hugh Smith Lake coho salmon by gear type (troll, purse seine, drift gillnet and sport) and area (fishing districts).
7. Estimate the total harvest rate for the Berners River and Hugh Smith Lake coho salmon stocks such that the estimated coefficient of variation is 5% or less.
8. Estimate the total coho salmon run (fisheries and escapements) to the Berners River and Hugh Smith Lake such that the estimated coefficient of variation of each estimate is 7% or less.
9. Estimate the annual smolt-to-adult survival (i.e., marine survival) of Berners River and Hugh Smith Lake coho salmon.

Improve Age Estimation

10. Collect scale samples from known-age Berners River and Hugh Smith Lake smolt and adult coho salmon to improve accuracy of aging from scale samples.

METHODS

SMOLT TAGGING

Outmigrating smolt will be captured for tagging at the Berners River and Hugh Smith Lake. Berners River smolt will be captured at beaver dams using spill traps, and from ponds and the mainstem river using baited minnow traps. All outmigrating Hugh Smith Lake smolt will be captured at the outlet of the lake using a smolt weir. All traps will be checked daily in the morning. During high smolt outmigration periods, traps will be checked again in the evening to prevent overcrowding.

After capture, all smolt large enough for CWT implants (≥80 mm snout to tail fork length) will be tagged using the method described by Koerner (1977). Smolt less than 80 mm snout to tail fork length will be released untagged. Before tagging, smolt will be lightly sedated using MS-222 or clove oil to facilitate safer handling, sorted by site specific tagging size bins, and externally marked by clipping the entire adipose fin. Sharp surgical scissors ensure that adipose fins are removed completely and cleanly to prevent regrowth and reduce chances of infection, respectively. After being clipped, smolt will be implanted with the CWT using a Mark IV coded wire tagging machine (Northwest Marine Technology, Inc., Anacortes, WA, USA) then checked for tag retention using a Quality Check Device (QCD). A subsample of randomly selected tagged smolt (approximately 100 total) will be retained overnight and tested for tag retention using the QCD. Upon completion of tagging for each location and size class, data will be recorded in a waterproof tagging journal. This journal will detail daily totals and tagging summaries. The total number of injections ("T. INJ") will be recorded from the Mark IV machine and total tags, number of re-tags, back tags, and inadvertent mortalities will all be recorded for each location and size class (Appendices E and F). Post-season, daily counts of tagged smolt, tag retention results, and tag codes will be entered into the ADF&G Mark, Tag and Age Laboratory database.

A random subset of smolt will be sampled for age, length (to the nearest mm), and weight (to the nearest 0.1 gram; Hugh Smith Lake samples only). An annual sampling goal will be selected to achieve approximate 95% confidence intervals (Appendix A; Thompson et al. 1992) assuming an infinite population size, two age classes, and allowing for 20% of scale samples to be unreadable due to regeneration or other causes. Further, daily sampling goals for each trapping location will be based on historical size and timing of smolt migration dates. From each sampled fish, eight to 12 scales will be taken from the preferred area located on the left side of the fish approximately two rows above the lateral line along a diagonal downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). The scales will be removed with a surgical scalpel and distributed separately across one of four quadrants on a standard 2.5 cm × 7.5 cm glass microscope slide and labeled with location, date, and corresponding fish lengths on the frosted end (Appendix B). When a slide is completed with four fish samples (8–12 scales per fish sample), another slide will be taped on top to protect the scales.

Berners River

The number of coho salmon smolt captured in the Berners River has varied considerably over the years, ranging from about 10,000 to over 50,000 smolt. There is no upper limit on the number of smolt to be tagged. However, in years of high abundance, a daily tagging cap of 3,000 smolt may be implemented to reasonably limit the number of hours worked when only two employees are onsite. There will be three general trapping locations: Shaul Pond, Brown Slough, and the lower Berners River (Figure 2), although other locations should be utilized as they become available.

Smolt will be captured using two styles of traps, depending on location. In Shaul Pond where beaver pond spillways are available, spill traps will be used. Spill traps utilize a dewatering device that leads outmigrant smolt through a flexible pipe into a rigid floating live box once other natural waterways and outflows from the dams are blocked with sandbags or plastic mesh (Magnus et al. 2006). In Brown Slough, custom-built minnow traps, similar to oversized Gee minnow traps (Magnus et al. 2006), will be used and baited with salmon roe (preferably eggs from chum salmon, *O. keta*). The bait will be prepared according to procedures detailed in Appendix H1 of Magnus et al. (2006), and traps will be re-baited daily before being redeployed.

In addition to the primary capture locations at Shaul Pond and Brown Slough, custom minnow traps will be fished in the lower mainstem Berners River approximately one km downstream of the entrance to Brown Slough (Figure 2), following the same procedures as minnow traps in Brown Slough. Traps in this secondary location are intended to provide a recapture sample for a preliminary smolt estimate (based on a simple Chapman estimator; Seber 1982) for use in inseason stock assessment. The value of this preliminary estimate has varied over the years and is considered a secondary objective. All fish captured in the recapture sampling traps will be examined for freshly clipped adipose fins, and the number of freshly clipped and unclipped fish in the catch will be recorded daily.

Captured coho salmon smolt from all locations will be transported in aerated plastic totes to floating nylon mesh holding pens at the tagging location on lower Brown Slough. Totes will be kept cool and aerated using a combination of portable water pumps and aeration stones. At the tagging location, smolt will be segregated by capture location as each group undergoes separate sampling schemes and will receive different CWT codes. The smolt will be sorted (Appendix D) into tagging groups of small (80–94 mm snout to tail fork length; head mold size 65), and medium (≥95 mm snout to tail fork length; head mold size 30) size classes. The 100 smolt retained for overnight retention checks will be kept in in an aerated bucket in the river; smolt from both locations (Shaul Pond and Brown Slough) will be combined for retention, roughly proportional to catches. For example, if approximately three times more fish were captured at Shaul Pond than Brown Slough, there would be 75 Shaul Pond smolt and 25 Brown Slough smolt retained for the retention check.

A seasonal target sample of 500 juveniles (i.e., smolt and pre-smolt) ≥ 75 mm, from each capture location (e.g., pond versus slough), will be sampled for length (snout to tail fork in mm) and age following the scale sampling described above. The minimum sample length (75 mm) is smaller than the minimum tagging length (80 mm) to account for ages of pre-smolt and ensure that all tagged fish are smolt. During 1997–2012, the age composition of smolt from Shaul Pond averaged 46.5% age 1, 53.4% age 2, and 0.1% age 3. As age 3 smolt are infrequently documented, sampling objectives were set based on just two age classes. Separate daily sampling schedules (Table 1) are

used for each capture location to account for differences in capture rates and to meet seasonal sampling goals.

Hugh Smith Lake

Since 1990, between 5,514 and 29,388 coho salmon smolt have been implanted with CWTs annually at Hugh Smith Lake smolt weir. Outmigration peaks after the first week of May, thus it is important to establish a good routine by then to efficiently tag up to 3,500 smolt a day. The smolt weir, located at the lake outlet near saltwater, utilizes an incline plane trap (Magnus et al. 2006) to capture all emigrating smolt. The weir will be installed on approximately 19 April and operated through the first week of June. Instructions for the smolt weir and inclined plane trap installation are further described by Olmsted (unpublished[1]). The weir is outfitted with a gate low in the water column ("Dolly door"), that can be opened to allow passage of large non-target species (e.g., rainbow trout *O. mykiss* and Dolly Varden *Salvelinus malma*) without handling.

Captured coho salmon smolt will be held in floating net pens housed within rigid floating boxes prior to tagging. The smolt will be sorted into tagging groups of small (80–100 mm snout to tail fork length; head mold size 65), medium (101–130 mm snout to tail fork length; head mold size 30), and large (>130 mm snout to tail fork length; head mold size 15) size classes. Smolt retained for overnight retention checks will be held in net pens housed within rigid floating boxes. To ensure long-term tag retention and to reduce latent mortality, examined fish will be released in calm waters during twilight hours the following evening.

A seasonal target sample of 600 smolt (any length) will be sampled for length (snout to tail fork length in mm), weight (to the nearest 0.1 g), and age following the scale sampling methods described above. No minimum sampling length is used; all smolt captured in the trap are assumed to be actively outmigrating. During 2000–2018, the age composition of Hugh Smith Lake coho salmon smolt averaged 78.2% age 1 and 21.8% age 2. Since Hugh Smith Lake coho salmon smolt are exclusively age 1 or age 2, seasonal sampling objectives were set using two age classes. The daily sampling schedule (Table 2) will meet seasonal sampling goals given historical run timing and abundance.

KNOWN-AGE STUDY

To assist with accurate age estimation, coho salmon fry are tagged so that recoveries of tagged smolt are of a known age. Once paired with the CWT sample, known-age scale samples will be used to calibrate smolt scale readings by providing reference scales. Coho salmon will be tagged as fry (age-0 fish) in the spring and subsequently recaptured as smolt at both the Berners River and Hugh Smith Lake. These smolt are incidentally captured during routine smolt collections for the CWT project. A sampling goal of 40 known-age smolt will be collected and euthanized each spring during the smolt tagging season. Additional known-age smolt will be injected with a dorsal CWT ("back tagged") for potential recovery as known-age adults in subsequent adult returns.

[1] Olmsted, N. 2014. Hugh Smith Lake smolt weir instructions. Alaska Department of Fish and Game, Division of Commercial Fisheries. Unpublished manuscript report, Douglas.

Known-Age Fry Marking

Each year, a goal of 3,000 newly emerged, age-0 fry will be captured, adipose clipped, and implanted with half-length CWTs at both the Berners River and Hugh Smith Lake. The timing of fry capture and tagging will be determined by fry emergence and availability but will be prioritized secondary to smolt tagging. At the Berners River, fry will be captured in small side sloughs just off the main channel where they congregate in beaver pond spillways in search of access to off-channel rearing habitat. At Hugh Smith Lake, fry will be captured near the mouths of inlet streams, i.e., Buschmann and Cobb Creeks. At all locations, fry will be caught by scooping these areas with a small-mesh (1/8" to 3/16") dip net.

After capture, all fry with absorbing or recently absorbed yolk sacs (fish generally ≤ 38 mm snout to tail fork length) will be tagged, generally following the methods described above in smolt tagging. Jeweler's glasses will be used when adipose-clipping fry to verify that adipose clips are completely removed. All fry will be tagged using a small head mold specially designed for use with fry. Berners River fry will be released into Shaul Pond and Hugh Smith Lake fry will be returned to calm water at the outlet of Buschmann Creek.

Known-Age Smolt Sampling

The known-age smolt, those tagged as emergent fry, will be recovered 1–2 years after tagging during normal smolt sampling when they will be visually recognized by their clipped but healed adipose fin. While sorting and tagging smolt, all adipose clipped smolt will be set aside (in an aerated tote or fish pen) for careful inspection. Before being sacrificed for the sample collection, adipose clipped smolt will be checked using the QCD tag detector to ensure that they contain a tag and will be carefully examined to determine that the adipose clip is from prior years. Care should be taken when examining the adipose clip to be certain that the clip wound is healed over (i.e., tagged previously as a fry and not earlier in the season), especially for catches from Hugh Smith Lake and Brown Slough, where recaptures are common. Known-age smolt samples will only be collected if the detector indicates the presence of a tag and the adipose clip is visibly healed (skin is contiguous without any opening). Additional scale samples will be collected and the entire smolt will be euthanized, retained, and preserved for tag recovery and age-related study.

Known-age smolt samples should be collected according to the following schedule:

- Collect a maximum of 40 specimens for the season.
- Collect a maximum of 4 specimens per day.

The known-age smolt specimens will not be randomly selected. If four or fewer known-age smolt are recovered, they will all be sampled. If more than four known-age smolt are recovered, select the two largest smolt, a medium sized smolt, and a small smolt. This will ensure a variety of ages present in the known-age samples.

Heavily anesthetize the smolt to be sampled until respiration no longer occurs. The scale sampling procedures will be slightly different than described above for the random smolt age collections: scales from two fish (rather than four) will be mounted on each glass slide (Appendix C). This will allow ample room to take a larger scale sample (20–25 scales) from these valuable specimens and minimize potential for contamination from one sample to another. An individually numbered Floy® tag will be attached to each smolt by inserting the tag through the boney back muscle mid-way between the dorsal fin and the spine. The Floy tag number will be recorded directly on the slide. All samples will be documented on the known-age sample data sheet (Appendix C),

including the date, location, known-age bottle number, slide number and position, Floy tag number, length, and sampler initials. The entire smolt will then be preserved in a container of ethyl alcohol. To prevent over packing, ensure adequate alcohol is available to preserve the smolt specimens; e.g., five or six specimens per 250 mL (approx. 1 cup) of alcohol. On season completion, all known-age smolt will be taken to the ADF&G Mark, Tag and Age Laboratory for CWT extraction and reading.

Back-Tagging Known-Age Smolt

The remaining known-age smolt (i.e., those not lethally sampled as described above) will be back-tagged with a full-length CWT (the same CWT codes used for snout tagging smolt) and released to provide the potential for recovery of known-age adult samples in the following year's escapement. Back-tagging will be done by holding the dorsal side of the smolt in a modified head mold that fits the back shape of a typical smolt. The mold must be carefully set for a shallow tag depth such that the needle does not come near the spine. The tag merely needs to be placed sufficiently beneath the skin behind the dorsal fin such that it is retained. To obtain a sufficient depth setting, the Mark IV CWT machine will be placed in "show" mode (needle in extended position) and the back mold moved until about 2 mm of needle tip is exposed through the mold. The back mold orientation (vertical vs. horizontal back mold position) varies by personal preference: most samplers find it easiest to hold the smolt vertically (i.e., with the saddle groove oriented horizontally). The number of back tags applied will be recorded in the daily tagging records.

SMOLT DATA MANAGEMENT

All smolt field data will be checked daily for quality assurance and reviewed prior to submission. These data checks, for example, will include checking that fewer fish were not caught than tagged, checking that totals match datasheets, and checking that daily tagging totals add correctly. Once entered into a spreadsheet, the original data will be reviewed against the entered data for accuracy.

Post-season, all datasheets and field journals will be scanned and stored on the Douglas ADF&G server. Datasheets, field journals, and completed smolt scale slides will then be archived at the Douglas office. Electronic data files will be checked by the project lead biologist and archived on the server. CWT release (daily smolt CWT releases) and recovery (known-age sample collection) data will be entered into the ADF&G Mark, Tag and Age Laboratory database. Currently, smolt data are not entered into the ADF&G Region I Commercial Fisheries Database (accessed via OceanAK) but this protocol is expected to be updated.

ADULT TAG RECOVERY FROM FISHERIES

Marine fisheries in Southeast Alaska and northern British Columbia will be sampled for CWTs (Shaul et al. 2019). Commercial catch sampling for coded wire tagged coho salmon in Southeast Alaska is conducted by ADF&G Port Sampling project personnel stationed at fish processors and buying stations located throughout the region (Reynolds-Manney et al. 2020). The minimum sampling objective is 20% of the harvest, stratified by district or area, gear type, and statistical week. The samplers examine coho salmon for missing adipose fins to identify potentially tagged fish during off-loading and sorting operations. Skippers of fishing vessels and tenders will be interviewed to determine fishing districts. The heads of all recovered adipose fin-clipped fish will be sent to the ADF&G Mark, Tag and Age Laboratory in Juneau for removal and reading of tags. Geographic areas used in expanding random tag recoveries vary by fishery. For example, tag

recoveries from the drift gillnet fishery will be expanded by district; tag recoveries from the purse seine fishery will be expanded by seine areas, which consist of one or more districts; and recoveries from the troll fishery will be expanded by four quadrants, which are aggregations of several districts (Hagerman et al. 2021). Time strata used for expanding net recoveries will be statistical weeks (Sunday through Saturday) and troll fishery samples will be expanded over the total catch for open periods (between closures). Troll recoveries will also be expanded by statistical week and quadrant for migratory timing analysis. Randomly recovered tags will be expanded by the inverse of the proportion of the catch that will be sampled within area, gear type, and weekly or period strata (Bernard and Clark 1996). An adjustment for lost samples will be made by multiplying expansions by the inverse of one minus the proportion of heads and tags lost.

In addition to Alaska commercial fisheries sampling, CWTs will be recovered in Alaska sport fisheries and in British Columbia fisheries. The ADF&G Division of Sport Fish conducts a creel census and survey of several marine recreational fisheries in Southeast Alaska. CWTs recovered from Alaska sport fishery random samples will be expanded over biweekly strata by port that contain additional stratifications including guided vs. unguided anglers, weekdays vs. weekends, time of day, and harvest location (Jaenicke et al. 2019). Sampling of British Columbia coastal fisheries (commercial and sport fisheries) and reporting of CWT recoveries is conducted by Fisheries and Oceans Canada.

ADULT ESCAPEMENT ENUMERATION AND SAMPLING

Escapements are estimated using helicopter and foot surveys at Berners River, and weir counts verified with mark–recapture analysis at Hugh Smith Lake. Age, sex, and length (ASL) sampling and CWT recovery sampling occurs at both locations. Presence or absence of adipose fins will be recorded for all fish. The presence of CWTs will be examined by moving a CWT detecting wand over the fish snout and behind the dorsal fin to determine the presence of a snout or back tag, respectively. Half-length snout tags will be present in a small number of adults (<1% of CWT tagged adults) and are part of the known-age study. The half-length tags can be distinguished from full CWTs based on a weak signal in the snout and/or the presence of a back tag. If a coho salmon is sacrificed for CWT sampling, the head will be collected, labeled, and submitted to the ADF&G Mark, Tag and Age Laboratory in Juneau for verification. For ASL sampling, mid eye to tail fork (METF) length will be measured to the nearest mm, sex will be recorded, and four scales will be taken from the preferred area, located on the left side of the fish approximately two rows above the lateral line along a diagonal downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). All scales will be mounted on gum cards in the field. Additional scales and information will be collected if a half-length CWT is suspected. Biological and environmental data associated with each scale card will be recorded in the field on bubble sheets, though other technologies will be utilized as they become available. All bubble sheets and scale cards will be mailed to Douglas to be processed, read, and archived. Scale impressions will be made in cellulose acetate (Clutter and Whitesel 1956) to be read and archived.

Berners River Surveys and Sampling

The Berners River escapement will be estimated from a combination of visual helicopter and foot survey counts conducted at the peak of the run. A 10-day escapement survey and sampling trip will be conducted on the upper Berners River during the period 18–31 October (typically 19–28 October). The trip is timed so that almost the entirety of the run has entered the system from saltwater yet before fish enter headwater spawning areas and small tributaries in large numbers.

Most fish will be holding in clear pools and little if any spawning will have occurred before the survey count. The 10-day duration allows for potential periods of unfavorable survey conditions (e.g., high water) to subside before sampling. To estimate total escapement, the total survey count (helicopter and foot surveys, combined) will be multiplied by an expansion factor of 1.2412 (Shaul et al. 2017).

Helicopter Surveys

During arrival to camp, observers will survey the lower Berners River by helicopter from the mouth of Berners River to where Brown Slough diverges from the mainstem (Figure 2) to account for any late arrivals to the Berners River. This section of river can contain substantial counts of late-arriving adult coho salmon, occasionally exceeding 10% of the total survey count (Shaul and Crabtree 2017). Extensive surveys in several years over the remainder of the system, including side tributaries, both major channels, and the small inlet stream to Berners Lake, have failed to document fish outside of the foot survey area. It is probable, however, that some additional spawning does occur in small side streams. During camp removal, observers will briefly survey the lower Berners River (below the foot survey limits) to see if additional schools have arrived since the aerial survey and, if present, add those totals to the previous count.

Helicopter surveys of lower river pools will be conducted from an altitude of 30–50 m and oriented so that the sun is at the observer's back. The helicopter will be first held stationary off to the side of the pool, so that prop wash on the water does not obscure visibility and so that the fish remain somewhat stationary and do not stir up bottom sediment. The helicopter may then be moved past the fish or in a circle around them if the observer needs to see their movement to confirm that all fish have been counted.

Foot Surveys

An escapement survey of the upper Berners River will be conducted by foot immediately after arrival at the upper field camp (Figure 2). An additional survey will be conducted later in the trip if there is evidence that more fish have moved into the upper river. The survey area will be covered in two sequential days. Typically, counts begin by surveying from camp to the headwaters on the first day, then downstream on the second day. However, because counting efficiency in upstream reaches is less affected by high water and turbidity, the order may be reversed if rain is expected to begin the following day. The upper survey area includes the east tributary to its source ("Spring Creek") and approximately 2 km of the Berners River mainstem above the fork. The lower survey area will be counted from camp to the pool where the primary channel has diverged from a former channel ("Divergence Pool").

One observer (Leon Shaul; ADF&G Southeast Alaska Coho Salmon Project Leader 1982–2019, now retired) conducted the Berners River surveys from 1982 to 2021; and since 2019, has been paired with a new observer (Justin Priest, ADF&G Fisheries Biologist III, Southeast Alaska Coho Salmon Project Leader). Observers wear polarized sunglasses to reduce glare. In headwaters sections and tributaries, observers walk upstream along the bank or in the stream channel, if necessary, to avoid dense vegetation. Observers look ahead and count fish individually as they pass downstream or under banks or logs. Typically, observers move quietly and slowly along the bank above the fish and attempt to count without disturbing the fish. In small tributaries with overhanging root systems, observers will probe under banks to locate and count hiding fish. Pools that have larger schools (>100 fish) are counted repeatedly from different angles and directions until the observers are satisfied regarding the count, which may be the average of several counts.

Counting larger schools will typically be done by tens or alternately by hundreds for the largest observed aggregations of 1,500–2,000 spawners. Coho salmon carcasses are extremely rare; however, any dead fish or fresh body parts (e.g., jaws or pyloric caeca) that can be identified as individual fish are included in the count. Species identification is not a problem as coho salmon will be the only salmon species (with rare exception) present in the area during late October, although schools of Dolly Varden may be present in some areas.

ASL Sampling

After escapement surveys are completed, adult coho salmon will be captured using a 13-m beach seine. Captured adult coho salmon will be marked with a partial dorsal clip using wire cutters to prevent resampling, and sampled for ASL, until sampling goals are met. The ASL composition of the escapement will be estimated from a goal of 600 fish. This sample will meet the statistical objectives for an infinite population that has three major age classes (Appendix A) and allows for up to 15% of samples that could not be aged due to scale regeneration. Fish will not be anesthetized for sampling. Coho salmon jacks (ocean-age-0 fish, which are typically < 400 mm METF length) are extremely rare in the Berners River and not captured in most years (Shaul et al. 2017) but will be sampled if encountered. Each fish sampled for ASL will be placed on a measuring trough and the METF length will be measured to the nearest millimeter. The length and sex will be recorded. Four scales per fish will be sampled and processed as described above.

CWT Recovery Sampling

All captured coho salmon will be examined for the presence of adipose fins. Fish without an adipose fin (i.e., "adipose clipped") will further be examined for the presence of CWTs. The CWT presence/absence minimum sampling objective is 1,200 fish examined (i.e., after ASL sampling is completed, sampling is only to check for CWT presence). Under average tagging rates (17.1%; 1996–2015), the 1,200 fish sample will be expected to contain 150–200 tagged fish. If the fish has an adipose fin, it will be sampled for ASL until ASL goals have been met, be tallied as an adipose present fish, and released alive. If a fish is adipose clipped, it will be examined for the presence of a CWT with a CWT wand. If a full-length CWT is detected in an adipose clipped fish (indicated by a strong signal from the wand), the fish will be released alive with the clip and tag presence recorded. If a half-length CWT is detected in the snout or if the fish is adipose clipped but does not have a snout tag, it will be sacrificed, the head collected, labeled, and submitted to the ADF&G Mark, Tag and Age Laboratory. A separate scale card for these select samples (labeled "Select 1", "Select 2", etc.). will be used to collect scales from fish that are not part of the random ASL sample. In these select samples four additional scales (per fish) will be taken and placed in the margins of the scale card in line with other scales from the fish; length, sex, CWT head tag number, and the nature of the CWT signal (none, weak, and/or back tag) will be recorded. Fewer than 1% of tagged adults are expected to have a half-length tag.

Hugh Smith Lake Weir

The Hugh Smith Lake weir has been operated annually at the outlet of the lake since 1982. The weir is installed in early June to enumerate sockeye salmon (*O. nerka*; Brunette 2019), and this project funds continued operation of the weir from 15 August to early November to enumerate coho salmon and verify weir counts with mark–recapture studies. Coho salmon typically appear in small numbers around the first of August, but no substantial migration occurs before mid-August. The Hugh Smith Lake weir has been operated into the first week of November since 1993, but the length of the project season has varied over the years. Extending the season into early

November has proven to be a cost-effective way to verify that the entire escapement was enumerated and that few (if any) fish escaped uncounted.

Coho salmon enumerated and sampled at Hugh Smith Lake will be categorized as adults and jacks and recorded separately. Adults are typically ocean-age-1 fish and are defined as fish ≥400 mm METF length. Jacks are ocean-age-0 males and are defined as fish <400 mm METF length. Counts of jacks at the weir are typically incomplete in all years, because many jacks are small enough to slip between the weir pickets before they can be counted or sampled (Shaul et al. 2009).

Weir Counts and ASL Sampling

The Hugh Smith Lake weir is an aluminum bipod, channel-and-picket weir with an upstream trap for counting and sampling salmon. The weir is located at the outlet of the lake, approximately 50 m from the saltwater. To provide extra height during periods of high water, the weir will be extended from the top of the pickets to the catwalk handrail with 2" × 2" 12-gauge galvanized hardware cloth. Regular underwater inspections are conducted to verify the integrity of the weir. All coho salmon that pass through the weir to the trap will be captured with cloth nets, anesthetized in a clove oil solution (Woolsey et al. 2004) to reduce handling stress, examined for presence of adipose fin and CWTs, measured in a padded measuring trough, marked with a fin clip, and a random subset will be sampled for ASL (see ASL Sampling section below). If fish remain downstream from the weir in early November at the end of the season they will be carefully counted before weir removal and added to the weir count.

Mark–Recapture Estimate

Mark–recapture studies are essential for validating the weir count and estimating escapement at Hugh Smith Lake. Extreme fall floods may threaten structural integrity in some years and pickets have been pulled for several hours or days to relieve pressure on the weir and prevent catastrophic failure (Shaul et al. 2009). In years when this has occurred, removal of weir pickets permitted some fish to escape upstream uncounted. Although uncommon, annual implementation of a mark–recapture study ensures that escapement can be estimated should weir integrity be compromised. All coho salmon captured in the trap will be marked with a fin clip. Three fin marks will be used for periods that correspond to historical average thirds of the run: a partial dorsal fin clip 1 July–15 September, a left ventral fin clip 16 September–6 October, and a right ventral fin clip 7 October–10 November. Recapture sampling will be conducted from September to early November. Fish will be captured in Buschmann and Cobb Creeks using a beach seine and dip nets, and in the lake off the mouths of creeks using hook and line sampling. All recovered fish will be marked with a single left opercular punch to prevent resampling, then released. All marks (left or right ventral clip, dorsal clip, or unmarked) will be recorded, with the presence or absence of the adipose fin, as well as if the fish is a jack.

Mark–recapture results for the early and middle part of the run provide an early indication of the effectiveness of the weir operation in enumerating coho salmon. The 100% marking rate provides a major estimation advantage that can eliminate the need for mid-winter sampling trips in most situations. If samples indicate more than 10% of the run passed without being counted, the operational season will be extended with more intensive sampling effort and, potentially, additional sampling trips later in the season until enough samples are recovered. The estimate is generated from the unmarked fish and only the mark applied during the period when the known breach occurred. Fish marked and counted in the other two periods will be then added to the

Chapman mark–recapture estimate for the period of the breach to achieve a total escapement estimate for the season.

ASL Sampling

The ASL composition of the escapement will be estimated from a sample goal of 630 adults and 60 jacks collected throughout the run according to the sample schedule for each age class (Tables 3–4). The goal of 630 will meet the statistical objectives for a maximum (1982–2021) escapement of about 4,000 fish with three major age classes (Appendix A) and allows for up to 25% unreadable samples due to scale regeneration. Sometimes there will be a small overlap between size distributions of adult and jack age classes; therefore, there may be a chance of misclassifying a small number of fish. The length division between age classes will be evaluated and adjusted annually based on initial size distributions and age samples. Starting in 2023, as equipment is made available, biological and environmental data associated with each scale card will be recorded in parallel on bubble sheets and in electronic forms for direct uploading to the final database.

CWT Recovery Sampling

All coho salmon captured in the trap will be examined for the presence of an adipose fin and CWTs in the snout and back. There will be two detectors available: a blue wand and a yellow T-wand. The blue detector is preferable for distinguishing a full-length tag from a half-length tag signal. The yellow detector is very sensitive and does not discriminate well between the CWT tag sizes. Fish with an adipose present will be released upstream unless a CWT is detected; adipose present fish with CWTs will be sacrificed, the head collected, labeled, and submitted to the ADF&G Mark, Tag and Age Laboratory. If an adipose clipped fish has a full-length snout tag, it will be released upstream. If an adipose clipped fish has a suspected half-length snout tag, no snout tag, or presence of a back tag, the specimen is likely a known-age sample. All suspected known-age fish will be sacrificed, ASL sampled, the head collected, labeled, and submitted to the ADF&G Mark, Tag and Age Laboratory. A separate scale card for these select samples (labeled "Coho KA", starting at card number 001) will be used to collect scales from fish that are not part of the random ASL sample. In these select samples, ten scales per fish are collected and placed in the rows of the scale card; length, sex, CWT head tag number, and the nature of the CWT signal (none, weak, and/or back tag) will be recorded.

DATA ANALYSIS

Estimation of Smolt Abundance

The abundance of coho salmon smolt by outmigration year ("smolt year") will be estimated using Chapman's modification of Petersen's estimator for closed populations (Chapman 1951; Seber 1982). A sample of smolt will be marked and a sample of returning adults will be inspected for marks. During the period between marking and recapture, the population is open to mortality but is assumed closed to recruitment. The abundance of smolt ($\widehat{N}_S$) will be estimated as follows:

$$\widehat{N}_S = \frac{(n_1+1)(n_2+1)}{(m_2+1)} - 1, \quad (1)$$

where

- n_1 is the number of smolt marked (adipose-clipped) and released in a year (without an adjustment for estimated tag loss at the time of release),
- n_2 is the number of escaped adults sampled for marks (adipose clips), and

- m_2 is the number of marks (adipose clipped fish) present in the sample of escaped adults (n_2).

The variance of the smolt abundance is calculated as:

$$var(\widehat{N_S}) = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)}. \quad (2)$$

Adjustment of the number of marks (m_2) is occasionally necessary if CWTs are recovered from outside the prevailing mark year; e.g., fish tagged two years prior to their return as adults, having remained in freshwater an additional year after tagging, or fish tagged as newly emerged fry with half-length (*HL*) tags for the aging validation study. To address these cases, the combined fishery recoveries of tagged adults will be used to apportion the number of tagged adults in the escapement samples as:

$$\widehat{m_2} = m_2\left(\frac{T_{(i-1)}}{T_{(i-1)}+T_{(i-2)}+T_{(HL)}}\right), \quad (3)$$

where

- $T_{(i-1)}$ is the number of fish recovered one year after tagging,
- $T_{(i-2)}$ is the number of fish recovered two years after tagging, and
- $T_{(HL)}$ is the number of fish that were half-length-tagged and recovered more than one year after tagging.

Escapement

Total escapements (N_E) are estimated using helicopter and foot surveys at Berners River, and weir counts verified with mark–recapture analysis at Hugh Smith Lake. Total escapement (N_E) is used in combination with the proportion of fish in the escapement that are tagged ($\hat{\theta}$) to estimate the total number of CWT tagged fish in the escapement ($\hat{E}$). To account for natural tag loss, $\hat{\theta}$ will incorporate checking multiple marks (adipose clips) for CWT presence. Tag loss will be estimated based on the proportion of fish in the escapement marked with an adipose clip that register no signal with the field detector and are found not to contain a tag upon further examination at the tag lab. We assume no natural incidence of adipose clips. Tag loss is typically low and is assumed to be equal among all tagged groups. However, an exception may be made if there is substantial tag loss that is likely attributed to a particular release group, in which case the number of adipose clipped spawners without tags can be apportioned based on each release group's reported tag loss rate at release and proportion of total tag recoveries from the fisheries.

The proportion of fish in the escapement that are marked with an adipose clip ($\hat{p}_2$) can be estimated as:

$$\hat{p}_2 = \frac{\widehat{m}_2}{n_2}, \quad (4)$$

with variance

$$var(\hat{p}_2) = \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}, \quad (5)$$

and the adult tag retention rate ($\hat{g}$) is

$$\hat{g} = \left(\frac{t}{m_s}\right), \quad (6)$$

with variance

$$var(\hat{g}) = \frac{\hat{g}(1-\hat{g})}{m_s}, \tag{7}$$

where

- m_s is the number of marked fish (m_2) in the escapement sampled for tags, and
- t is the number of tags detected.

The proportion of fish in the escapement that are tagged ($\hat{\theta}$) can then be estimated as

$$\hat{\theta} = \hat{p}_2 \hat{g}, \tag{8}$$

with variance

$$var(\hat{\theta}) = \hat{p}_2\, var(g) + \hat{g}\, var(\hat{p}_2) - var(\hat{g})\, var(\hat{p}_2). \tag{9}$$

Following the calculation of $\hat{\theta}$, the number of tagged fish in the escapement ($\hat{E}$) is estimated as:

$$\hat{E} = \widehat{N_E}\hat{\theta}\,, \tag{10}$$

where

- $\widehat{N_E}$ is the estimated total escapement, and
- $\hat{\theta}$ is the estimated proportion of fish in the escapement that have a tag present.

If there is a complete count of fish, then the variance of the estimate of N_E is 0. If $\widehat{N_E}$ is estimated by a Chapman estimate, then an estimated sample variance of $\widehat{N_E}$ is given in Ricker (1975). However, if $\widehat{N_E}$ is estimated with an aerial or foot count (sometimes with an expansion factor to account for unseen fish) there is no analytic means to get an estimated sampling variance for the estimate of $\widehat{N_E}$. An estimate of the variance of $\widehat{N_E}$ is needed to estimate the variance of E (Goodman 1960):

$$Var(\hat{E}) = \widehat{N_E}^2 Var(\hat{\theta}) + \hat{\theta}^2 Var(\widehat{N_E}) - Var(\widehat{N_E})Var(\hat{\theta}), \tag{11}$$

based on the assumption that estimation of the escapement and tagging proportion are two independent processes.

Fishery Harvest and Total Run

The estimated harvest of tagged fish (F_i) in each fishery (i) will be summed to determine the total harvest of tagged fish. Estimates of F_i are provided by the ADF&G Mark, Tag, and Age Laboratory for Alaska fisheries (DFGCWTOTOP 2022) and by the Regional Mark Processing Center for fisheries in northern British Columbia (RMIS 2022). Fishery contribution estimates for tagged fish will be divided by the proportion of tagged fish in escapement samples ($\hat{\theta}$) to estimate total stock contributions in the catch (C_i) as:

$$\hat{C_i} = \frac{\hat{F_i}}{\hat{\theta}}\,, \tag{12}$$

with variance

$$Var(C_i) = C_i^2 \left(\frac{Var(\hat{F_i})}{\hat{F_i}^2} + \frac{Var(\hat{\theta})}{\hat{\theta}^2}\right), \tag{13}$$

where

- $\hat{F}_i$ is the estimated number of tagged fish harvested (expanded sum of random fishery recoveries; Bernard and Clark 1996) in fishery *i*.

The total run ($\hat{X}$) will be estimated by summing the estimated harvest ($\hat{C}$) by gear type *i* and the escapement estimate ($\widehat{N_E}$):

$$\hat{X} = \widehat{N_E} + \sum \hat{C}_i, \tag{14}$$

with variance

$$var(\hat{X}) = var(\hat{N}_E) + \sum var(\hat{C}_i). \tag{15}$$

Harvest Rate

The harvest rate ($\widehat{H}_i$) for a stock in fishery *i* is estimated as follows:

$$\widehat{H}_i = \frac{\hat{C}_i}{\hat{X}}, \tag{16}$$

with variance

$$Var(\widehat{H}_i) = \widehat{H}_i^{\,2} \left(\frac{Var(\hat{C}_i)}{\hat{C}_i^2} + \frac{Var(\hat{X})}{\hat{X}^2} \right), \tag{17}$$

where

- $\hat{X}$ is the estimated total run.

The total harvest rate ($\widehat{H}$) by all fisheries is estimated as:

$$\widehat{H} = \sum \widehat{H}_i, \tag{18}$$

with variance

$$Var(\widehat{H}) = \sum Var(\widehat{H}_i). \tag{19}$$

Harvest Distribution

The harvest distribution (percent by area and gear type) will be estimated for tagged stocks. Expanded tag recoveries of a stock in each fishery (F_i) will be divided by the sum of expanded fishery recoveries in all fisheries. Tag recoveries from the Alaska troll fishery will be expanded by ADF&G quadrant (Hagerman et al. 2021) and fishing period. Tag recoveries from the net and trap fisheries will be expanded by district and statistical week. In addition, the distribution of the Southeast Alaska troll catch will be estimated using quadrant-period strata.

Migratory Timing

The migratory timing of the stocks in troll fishing districts will be estimated from the distribution of the harvest of tagged fish by week. Troll fishery tag recoveries will be expanded to total catch by quadrant and week. The weekly proportion of the total troll catch of each stock will be estimated. Expanded weekly recoveries will be divided by the sum of expanded recoveries from throughout the season to estimate weekly proportions of total catch. These estimates are based on the dates of landing of tagged fish at fishing ports. Since the average trip length for a troll vessel is 3–5 days, the average time of capture of landed fish is assumed to occur two days prior (G. Hagerman, Troll Management Biologist, ADF&G, Sitka, personal communication).

Marine Survival Rate

Survival rates will be estimated for tagged coho salmon smolt. Estimates will be for the period from the time of tagging until returning adults enter the fisheries. It is assumed that all marked adults returning to a system had been tagged there as smolt and that there is no incidence of naturally missing adipose fins (i.e., all adipose clipped fish that do not contain tags are assumed to have shed their tags). The survival rate (*S*), from the time of tagging (smolt) to the adult stage (ocean-age-1) will be estimated as follows:

$$\hat{S} = \frac{\hat{X}}{\widehat{N}_S}, \tag{20}$$

with variance

$$Var(\hat{S}) = \hat{S}^2 \left(\frac{Var(\hat{X})}{\hat{X}^2} + \frac{Var(\widehat{N}_S)}{\widehat{N}_S{}^2}\right), \tag{21}$$

where

- $\widehat{N}_S$ is the estimated smolt abundance in the year before the estimated total run ($\hat{X}$).

PREVIOUS OPERATIONAL PLANS

This operational plan replaces the previous operational plan (Shaul and Crabtree 2017). Since that operational plan was released, two changes in protocols have been implemented: 1) to re-instate ASL sampling of jack coho salmon which were not sampled since 2016, and 2) to cease collecting otoliths from up to 50 adult Hugh Smith Lake coho salmon. Clarification was added to document that during mark–recapture sampling at Hugh Smith Lake, the recovered marks should be collected separately for jack and adult coho salmon. Lastly, the previous operational plan included details for the Ketchikan Area Coho Salmon Index surveys; that information has since been moved into a separate operational plan.

RESPONSIBILITIES, SCHEDULE, AND DELIVERABLES

Date	Personnel	Activity
7/01–9/30	Justin Priest	Technical reporting; summarize Spring CWT releases and report to ADF&G Mark, Tag and Age Laboratory.
7/01–7/31	Justin Priest Teresa Fish	Final logistical planning and supply purchasing for escapement operations.
8/01–11/10	Maureen Chambrone Lewis Rogers other Technicians	Enumerate adult coho salmon at Hugh Smith Lake; sample for CWT and ASL.
10/18– 10/30	Justin Priest other technicians	Foot and helicopter escapement survey of the Berners River; sample for CWT and ASL.
8/15–12/15	Danny Green	Age scale samples; enter and summarize data; repair, maintain and store field gear.
1/01–6/30	Justin Priest	Analyze tag recovery data; write operational plans and reports.
1/15–4/15	Justin Priest Teresa Fish	Hire seasonal employees, prepare equipment, plan logistics, and purchase supplies for field projects.
4/18–6/03	Chessaly Towne Ethan Christensen other technicians	Capture, enumerate, coded-wire-tag, and sample coho smolt at Hugh Smith Lake.
5/04–6/12	Justin Priest Caleb Owen other Technicians	Capture, enumerate, coded-wire-tag, and sample coho smolt at the Berners River.
6/13–30	Justin Priest Danny Green other Technicians	Maintain, repair, and store gear from Berners River smolt project.
6/30	Justin Priest	Final annual report on Hugh Smith project due to PSC.

Project results will be periodically reported in ADF&G Fishery Data or Fishery Manuscript series reports. Results from these studies will be incorporated into a regional coho salmon stock status report in the form of a Special Publication which will be produced approximately every three years. Results will also be presented in workshop and symposium documents, and orally at meetings of scientists, interested public groups (such as fishing organizations), and management entities, including the Alaska Board of Fisheries, Pacific Salmon Commission, and Federal Subsistence Regional Advisory Council.

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TABLES AND FIGURES

Table 1.–Daily scale sampling goals by location for Berners River coho salmon smolt.

Brown Slough		Shaul Pond	
Daily catch	Sample goal	Daily catch	Sample goal
< 8	0	< 8	0
8–99	8	8–199	8
100–200	16	200–499	12
≥201	24	500–1,000	24
		≥1,000	36

Table 2.–Daily scale sampling goals for Hugh Smith Lake coho salmon smolt.

Date range	Daily sample goal (count)
30 April–10 May	16
11–18 May	28
19 May–3 June	16

Table 3.–Weekly and cumulative adult coho salmon age-sex-length (ASL) sampling targets at Hugh Smith Lake. Time periods in future years will vary slightly as the sample goals are based on statistical weeks which run Sunday–Saturday.

		Adult ASL sample	
Statistical week	2022 time period	Weekly target	Cumulative target
SW 33	7–13 August	10	10
SW 34	14–20 August	10	20
SW 35	21–27 August	40	60
SW 36	28 August–3 September	70	130
SW 37	4–10 September	90	220
SW 38	11–17 September	90	310
SW 39	18–24 September	90	400
SW 40	25 September–1 October	90	490
SW 41	2–8 October	50	540
SW 42	9–15 October	50	590
SW 43	16–22 October	30	620
SW 44+	23 October–10 November	10	630

Table 4.–Jack coho salmon age-sex-length (ASL) sampling targets and sampling periods at Hugh Smith Lake. These strata are not based on statistical weeks and are lined up to match dates for adult fin clip marking.

Time period	ASL sample	
	Weekly target	Cumulative target
1 August–15 September	20	20
16 September–6 October	20	40
7 October–15 November	20	60

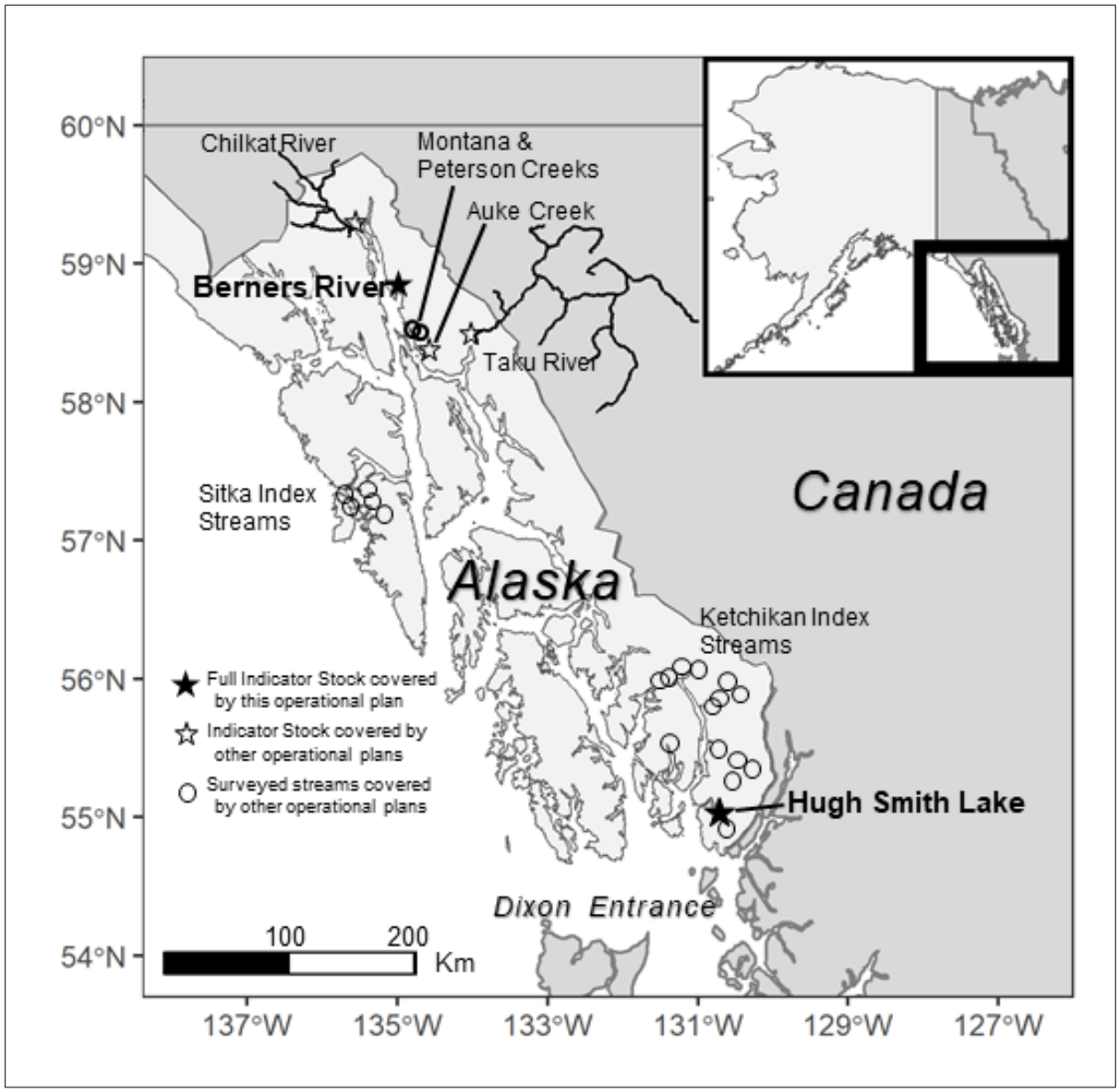


Figure 1.–Map of Southeast Alaska showing the locations of Berners River and Hugh Smith Lake indicator stock projects in relation to other monitored systems. Stars mark full indicator streams and circles mark surveyed streams; filled stars denote the projects covered under this operational plan.

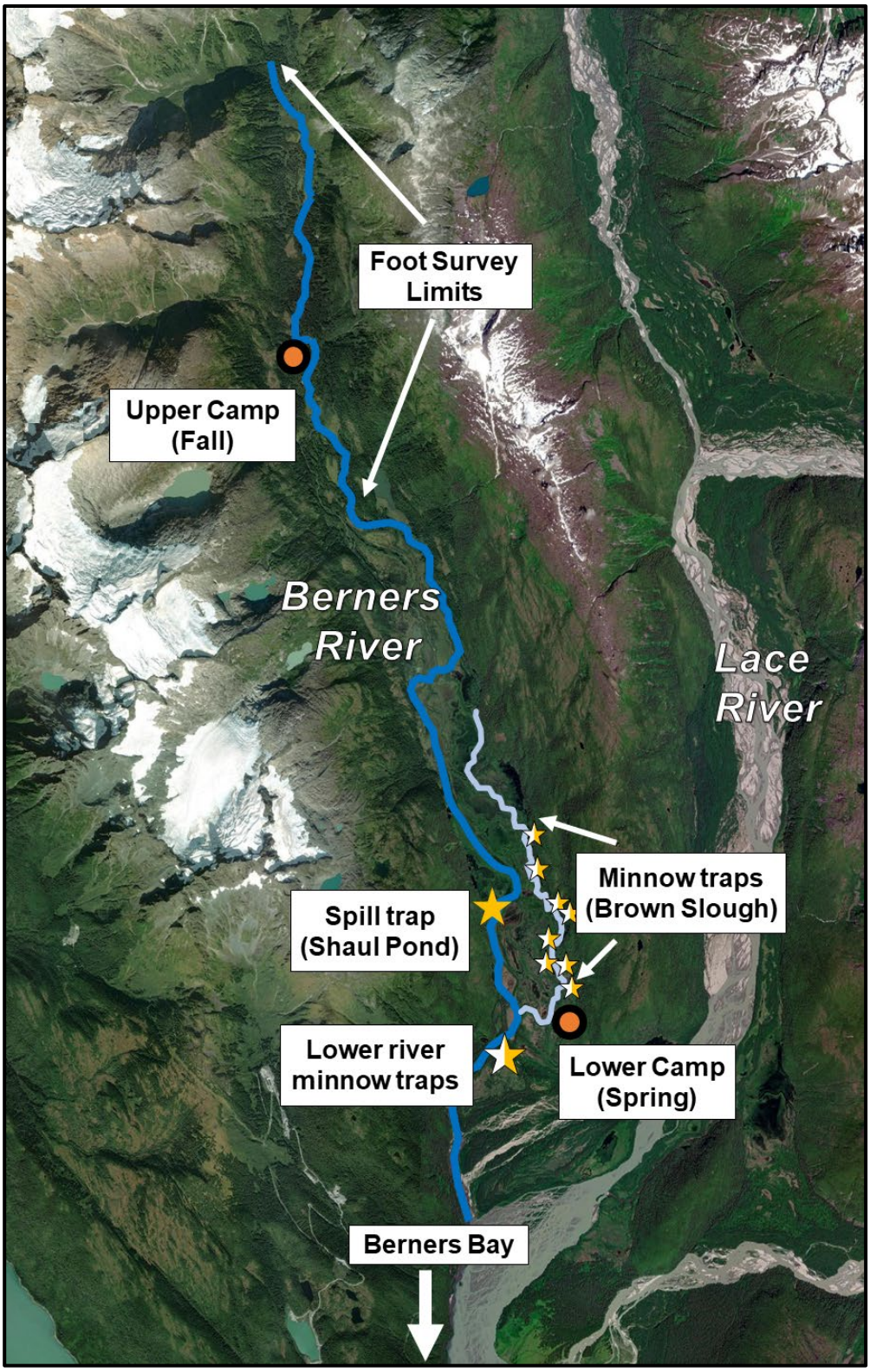


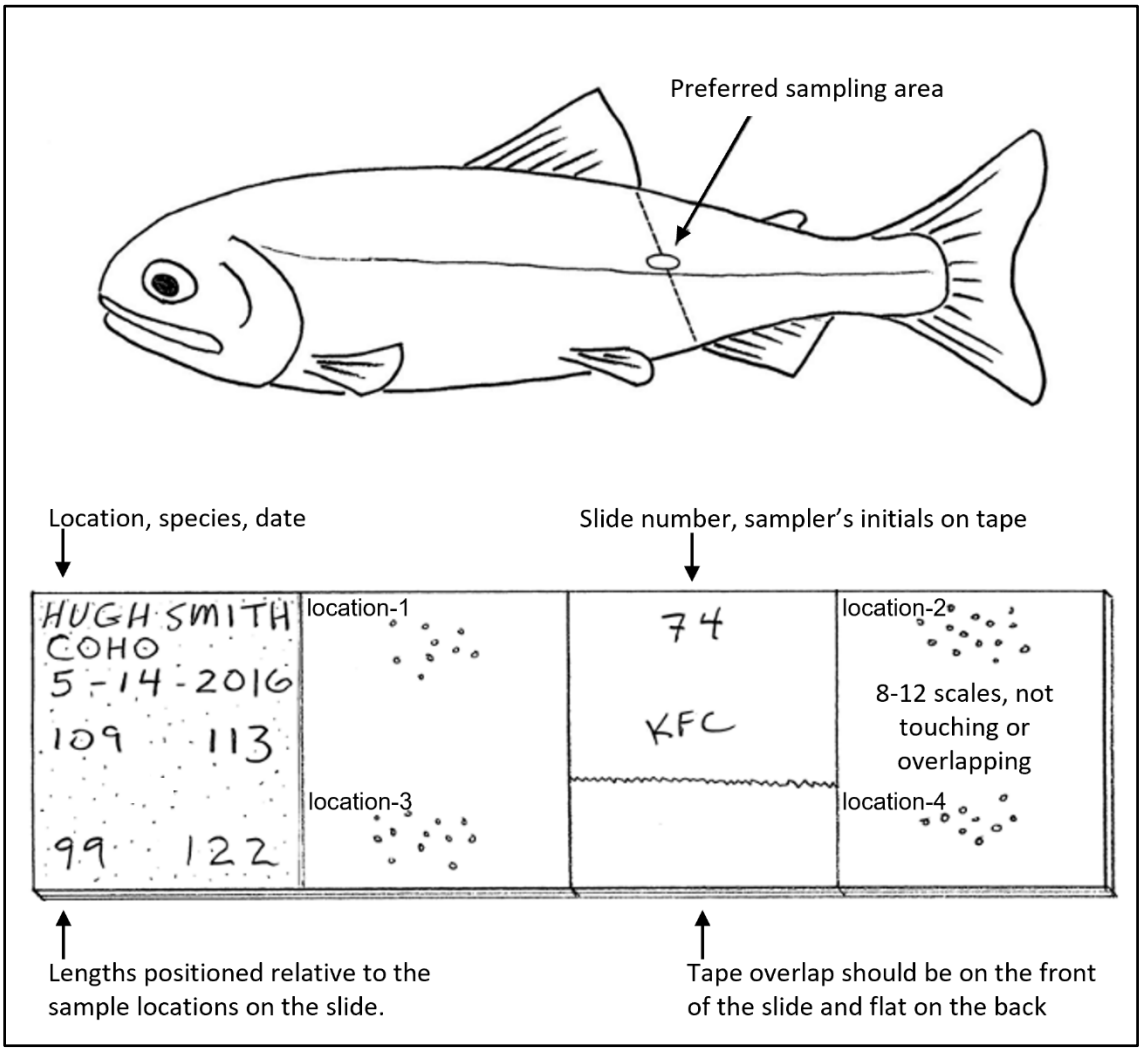
Figure 2.–Map of the Berners River drainage showing the mainstem Berners River (dark blue), Brown Slough (light blue), camp locations, smolt trapping locations, and range of the fall foot escapement survey.

APPENDICES

Appendix A.–Scale sample sizes (number of individual fish samples) required to achieve the approximate 90% or 95% confidence intervals.

Population size	Number of age classes					
	90% Confidence			95% Confidence		
	2	3	4+	2	3	4+
500	176	218	224	218	251	253
1,000	214	278	288	278	335	338
1,500	230	306	318	306	377	381
2,000	239	323	336	323	402	407
2,500	245	334	347	334	419	424
3,000	249	341	356	341	431	436
3,500	252	347	362	347	440	445
4,000	254	351	366	351	447	452
4,500	256	355	370	355	453	458
5,000	257	357	373	357	457	463
6,000	259	362	378	362	464	470
7,000	261	365	381	365	469	475
8,000	262	367	384	367	473	479
9,000	263	369	386	369	476	483
10,000	264	370	388	370	479	485
15,000	266	375	393	375	487	493
20,000	267	377	395	377	491	497
25,000	268	379	397	379	493	500
30,000	269	380	398	380	495	501
35,000	269	380	398	380	496	503
40,000	269	381	399	381	497	504
45,000	269	381	399	381	497	504
50,000	270	382	400	382	498	505
60,000	270	382	400	382	499	506
70,000	270	383	401	383	499	506
80,000	270	383	401	383	500	507
90,000	270	383	401	383	500	507
100,000	270	383	401	383	500	507
Infinite	271	385	403	385	503	510

Appendix B.–Example of coho salmon smolt scale collection procedures and placement on glass sampling slides. Individuals for this sampling will be randomly selected.

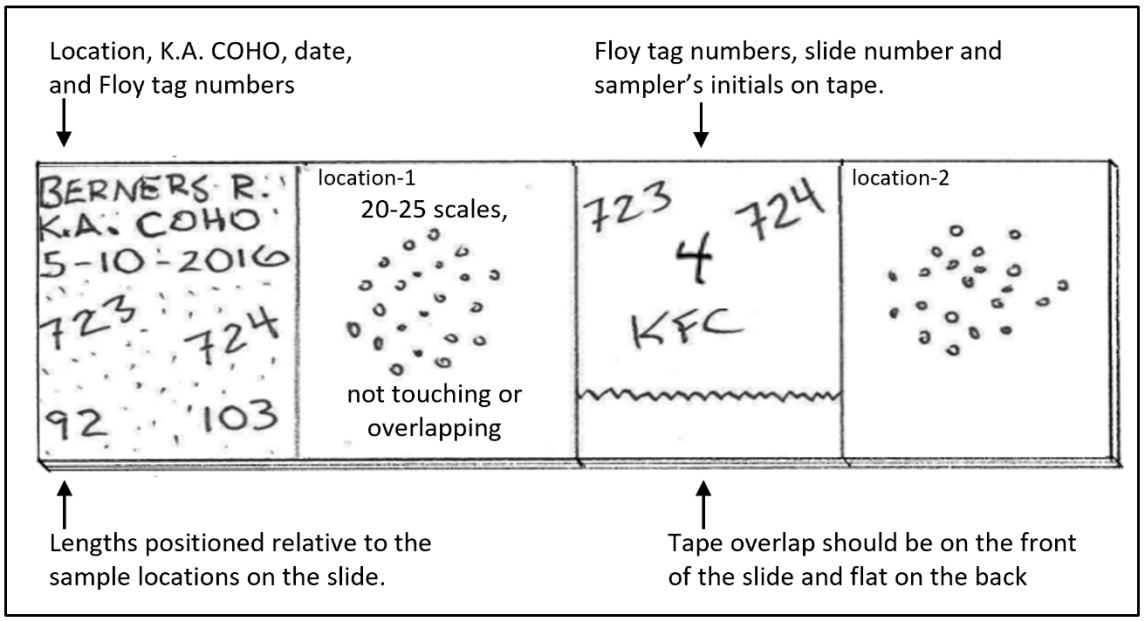


Appendix C.–Example of known-age sampling data recording procedures and scale placement on glass sampling slides. Individuals for this sampling will not be randomly selected but chosen to reflect a representative range of smolt lengths.

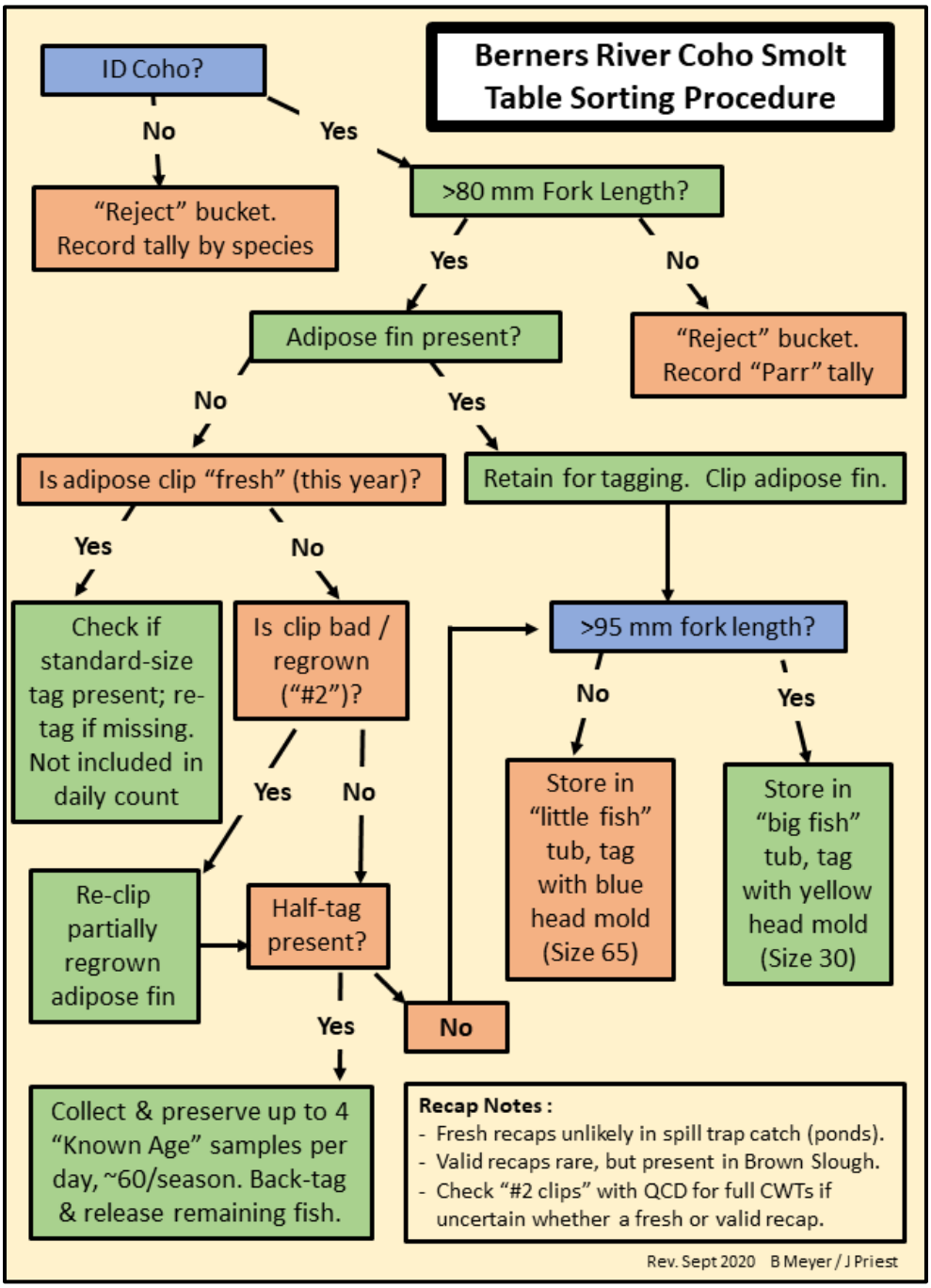
Example of known-age sample data recorded in yellow "Rite-In-Rain" book:

Date	Location	KA Bottle #	Slide # - location	Floy Tag #	Length (mm)	Sampler initials	Notes
5/9/2021	S. Pond	1	1 - 1	0722	112	CET	
5/9/2021	Brown Sl.	1	2 - 1	0723	92	CET	
5/10/2021	Brown Sl.	1	2 - 2	0724	103	CET	
5/11/2021	Brown Sl.	1	3 - 1	0725	87	CET	

Example diagram of a scale sample slide for known-age samples:



Appendix D.–"Table sorting" flowchart of procedures and decisions to make during processing coho salmon smolt on the Berners River.



Appendix E.–Berners River smolt tagging datasheet.

ADF&G Berners River Coho Tagging Datasheet, 2021

Date:

Tagger:

Daily Notes:

Shaul Pond Smolt – CWT Tag #: _____

80–95 mm		≥96 mm	
# Smalls Tagged: _____		# Bigs Tagged: _____	
End:	INJ:	End:	INJ:
Start:	Rejects:	Start:	Rejects:

Total Live Tagged:
(both sizes combined)

Tagging Notes:

Pond Known Age Recaptures (both sizes)
Sampled: # Backtagged:

Recap Notes (Bad clips? Untagged recaps?)

Brown Slough Smolt – CWT Tag #: _____

80–95 mm		≥96 mm	
# Smalls Tagged: _____		# Bigs Tagged: _____	
End:	INJ:	End:	INJ:
Start:	Rejects:	Start:	Rejects:

Total Live Tagged:
(both sizes combined)

Tagging Notes:

Slough Known Age Recaptures (both sizes)
Sampled: # Backtagged:

Recap Notes (Bad clips? Untagged recaps?)

Fry Tagging – Half-Length CWT Tag #: _____

Total Tagged: _____

End: INJ:

Start: Rejects:

Tagging Notes:

Tag Retention *(of previous day's fish)*

Shaul Pond Smolt		Brown Slough Smolt		Fry Tagged	
# Checked:		# Checked:		# Checked:	
# Valid Tags:		# Valid Tags:		# Valid Tags:	
# Morts:		# Morts:		# Morts:	
# Retagged:		# Retagged:		# Retagged:	

Note: Verify for all tags that Total = End - Start - Rejects AND Total = INJ - Rejects

Appendix F.–Example of Hugh Smith Lake smolt tagging datasheet to be recorded in yellow "Rite-In-Rain" book.

Date: 5/8/2021	**T. INJ start:**	**T. INJ end:**	**Session INJ**
Tagger: KFC	1,784,294	1,784,966	672

Smolt size (mm)	TAG (INJ) #	REJ #	TOT #	NOTES
80-99	54	0	54	
100-129	589	1	588	14 w/ worms
> 130	19	0	19	2 KA smolt
Back	10	5	5	
Total	672	6	666	
Sac'd			665	1 sac for placement
Retags	1		664	Re-tagged from 5/7