Regional Operational Plan CF.1J.14-02

Operational Plan: Southeast Alaska Coho Stock Assessment

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and

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

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 CF.1J.14-02

OPERATIONAL PLAN: SOUTHEAST ALASKA COHO STOCK ASSESSMENT

by

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Approval

Title	Name	Signature	Date
Project Leader	Leon Shaul	Leon D. Shaul	03/04/2014
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PURPOSE

This project provides stock assessment information on long term Southeast Alaska coho salmon (*Oncorhynchus kisutch*) indicator stocks at Hugh Smith Lake and Berners River, and provides standardized, peak annual survey counts to aggregate Ketchikan Survey Index streams. Coho salmon smolts at Hugh Smith Lake and the Berners River are captured, sampled for age and length, adipose fin clipped, coded-wire-tagged, and released. Returning adults are enumerated and sampled for age, length, and sex, and the presence of coded wire tags. These data are used in combination with estimates of harvest of tagged fish by Alaska Department of Fish and Game catch sampling and Coded-wire Tag Laboratory programs to estimate a variety of parameters for the stocks. These programs, conducted continuously since the 1980s, provide detailed information on population dynamics useful for establishing objective escapement goals and for managing commercial fisheries that target coho salmon.

OBJECTIVES

1. Estimate the harvest rate in all marine fisheries for the Berners River and Hugh Smith Lake coho salmon stocks such that the estimated coefficient of variation is 5% or less.
2. Determine the total escapement to Hugh Smith Lake using a weir count. In the event of a failure to enumerate all fish that pass the weir, obtain a Chapman mark-recapture estimate of the escapement such that the estimated coefficient of variation is 7% or less.
3. Obtain a thorough survey count of the coho salmon escapement in the Berners River that is comparable with counts made in prior years.
4. Estimate the total coho salmon return (fisheries and escapements) to Berners River and Hugh Smith Lake such that the estimated coefficient of variation of each estimate is 7% or less.
5. Estimate the proportional distributions of the marine harvest of Berners River and Hugh Smith Lake coho salmon by gear type (troll, purse seine, drift gill net and sport).
6. Estimate the proportional distributions of the marine harvest of Berners River and Hugh Smith Lake coho salmon over nine groupings of fishing districts.
7. Estimate weekly proportions of the total harvest of Berners River and Hugh Smith Lake coho salmon in the troll fishery. Estimate the weekly proportions of the drift gill net harvest of Berners River coho salmon in District 115.
8. Estimate the smolt outmigration from the Berners River and Hugh Smith Lake such that the estimated total outmigration estimate has a coefficient of variation of 7% or less.
9. Estimate the age and sex compositions of the escapements to the Berners River and Hugh Smith Lake from a sample of approximately 600 returning adult spawners distributed throughout the run at each location so that the estimated proportion of each age class is within 5% of the true value with at least 95% probability.
10. Estimate the age composition of the smolt outmigration from the Berners River and Hugh Smith Lake from a sample of approximately 600 smolts distributed throughout the run at each location so that the estimated proportion of each age class is within 5% of the true value with at least 95% probability.

11. Obtain peak survey counts of coho spawning escapement that are comparable with prior years from 14 index streams near Ketchikan.

In addition to specific objectives above, information regarding inseason run-strength will be communicated to fishery managers and others on a regular basis, including estimates of marine survival and run strength and projected escapement.

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 2001–2010, of which an average 66% was harvested in troll fisheries (Shaul et al. 2011). The majority of the coho salmon harvested in Southeast Alaska originate in thousands of local streams, of which most are small producers about which little is known. Important contributions are also made by Canadian portions of three major transboundary rivers (Stikine, Taku and Alsek) 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.

The Alaska Department of Fish and Game (ADF&G) implemented marking programs in the 1970s to better understand and manage Southeast Alaska coho salmon stocks (Gray et al. 1978, Shaul et al. 1991). In the early 1980s, program emphasis shifted to long-term research on selected "indicator stocks" that represent a larger group of stocks (Shaul et al. 1986, Shaul 1994, Shaul and Crabtree 1998). Indicator stocks are marked as smolts or presmolts with coded-wire tags, which makes it possible to estimate smolt production and contribution to fisheries by systematically sampling fishery harvests and escapements. Four stocks have been studied continuously since the early 1980s: Berners River and Auke Lake north of Juneau, Ford Arm on the outer coast, and Hugh Smith Lake south of Ketchikan (Figure 1). 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 useful for establishing objective escapement goals and developing models to predict abundance (Clark et al. 1994; Shaul et al. 2009 and 2011), and provide for informed management of fisheries that target coho salmon.

This project covers ongoing stock assessment activities at the Berners River and Hugh Smith Lake. (Stock assessment at Ford Arm is described by Shaul and Crabtree 2013; The Auke Lake indicator stock is funded jointly by ADF&G Division of Sport Fish, and the National Marine Fisheries Service, Auke Bay Laboratory.) At both Hugh Smith Lake and the Berners River, coho salmon smolts are captured, sampled for age and length, adipose fin clipped, coded-wire-tagged and released. Returning adults are enumerated and sampled for age, length, and sex and the presence of coded wire tags. These data are used in combination with estimates of harvest of tagged fish by Alaska Department of Fish and Game catch sampling and Coded-wire Tag Laboratory programs to estimate a variety of parameters for the stocks. Information collected by this project will be used to evaluate and refine existing biological escapement goals.

This project also supports helicopter surveys that have been conducted annually on 14 index streams in the Boundary Area of District 101, near Ketchikan (Shaul et al. 2011). These surveys, conducted annually by long-term Ketchikan management staff since 1987, form the basis of the aggregate Ketchikan Survey Index escapement goal established in 2005 (Shaul and Tydinco 2006). High harvest rates on District 101 stocks by a wide range of mixed-stock fisheries (Shaul and Van Alen 2001, Shaul et al. 2009) indicates the need for a consistent, long-term index of the status of coho stocks in this district.

METHODS

SMOLT TAGGING

Outmigrating smolts are captured for tagging at Hugh Smith Lake and the Berners River. A smolt weir is installed at the outlet of Hugh Smith Lake, while smolts in the Berners River are captured at beaver dams using trough traps of a design described by Elliott and Kuntz (1988) and in the main slough using baited custom built traps similar to oversized Gee minnow traps.

Hugh Smith Lake

The Hugh Smith smolt weir will be installed on about 19 April. Olmsted (1998) described the structure and provided instructions for installation. The smolt weir is located at the lake outlet near saltwater and is composed of plastic screen panels supported by a cable across the stream. A small opening at the surface enters into a floating trap where smolts are captured. The trap is checked frequently during periods when the greatest migration occurs, primarily during the late evening and early morning hours. All coho smolts are removed, anesthetized, and coded-wire-tagged using the method described by Koerner (1977).

Smolt age and size composition will be estimated from a target sample of about 600 fish. The sample size was selected to achieve approximate 95% simultaneous confidence intervals (Appendix A; Thompson 1987, Angers 1989, Thompson et al. 1992), assuming there to be 3 age classes, an infinite population size, and allowing for up to 20% for scale samples that cannot be aged due to regeneration or other causes. Samples will be collected according to the following daily schedule:

Dates	Daily Sample
30 April–10 May	16
11–18 May	28
19 May–3 June	16

The length (snout-to-fork in mm) and weight (to the nearest 0.1 g) will be recorded for each fish sampled. Five to 10 scales are taken from 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 are removed with a surgical scalpel and distributed separately across one of four quadrants on a glass microscope. Samples from four fish are placed on each slide which is labeled with numbers and corresponding lengths on the frosted end. When a slide is full, another slide is fastened over it with clear tape to protect the scales. The fish will be sorted into three groups for tagging: 80–100 mm, 101–130 mm and >130 mm. Separate head fittings and tag implantation depth settings are used for each size group. Fish under 80 mm comprise a small proportion of the total catch. They are assumed not to be smolts and are released untagged. Tagged smolts will be held in a holding pen in quiet water until dark the following evening and released.

Tagging objectives call for tagging all healthy coho smolts that are captured. The presence of a substantial number of untagged adult fish in the escapement indicates that not all smolts are being captured in spite of the care that is taken to maintain the smolt weir. Some of these fish may be passing before or after the smolt weir is present or some of these fish may be strays from other systems.

Berners River

Smolts are captured using two styles of traps. Traps baited with salmon roe are used in the slough and river. These are custom built traps that are roughly similar to oversized Gee minnow traps (Magnus et al. 2006). Where beaver pond spillways are available, trough traps are used. The trough is a dewatering device that the spill is directed through. This leads outmigrant smolt through a flexible pipe into a rigid floating holding box. Other spills from the dams are blocked with sand bags or plastic mesh. The traps are tended twice daily, in the morning and evening. The catch is poured into a plastic pan and sorted, keeping only the >80 mm coho smolt intended for tagging. Coho smolts are transported in aerated plastic totes to floating nylon mesh holding pens located at the tagging site on lower Brown Slough. Fish from ponds are kept in separate pens from those trapped from the slough and they receive different tag codes.

The objective is to tag as many as can be captured by the end of the smolt migration. The number captured has varied considerably over the years, ranging from about 10,000 to over 50,000. There is no upper limit on the number tagged. However, in years of high abundance a daily tagging cap of 3,000 smolts may be implemented to reasonably limit the number of hours worked when only two employees are onsite. Four large minnow traps are fished in the mainstem Berners River within 1 km downstream of the entrance to Brown Slough 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 traps will be checked, re-baited, and reset each morning. All fish captured in the recapture sampling traps are examined for freshly clipped adipose fins, and the number of clipped and unclipped fish in the catch is recorded daily.

Smolts will be sampled for age and length daily using the methods described above for Hugh Smith Lake smolts. An average of approximately 75% of the catch has come from the pond with the remaining 25% caught in minnow traps. A separate sampling schedule has been established for pond smolts versus slough smolts to meet the precision objectives in Appendix A. Berners River smolts are primarily age 1 and 2, with age-3 smolts being rare. During 1997–2012, the age age composition of smolts from Shaul Pond has averaged 46.5% age 1, 53.4% age 2 and 0.1% age 3. Age and length sampling objectives were set based on two age classes, a projected 20% maximum rate of unageable samples, and a precision objective of 5% (again, sample sizes were selected to meet the 95% C.I. performance in Appendix A). The precision objective can be obtained with a sample of 500 fish. This number was set as a minimum seasonal sampling objective for the pond and slough catches, taking into account the fact that stratification by time period is expected to marginally increase the variance. Daily sampling objectives were established based on the historical size and timing of the smolt catch from both locations. If these objectives are followed, the seasonal sampling objective should be met or exceeded for pond and slough smolts:

Minnow Traps		Pond	
Catch	Sample	Number of Migrants	Sample
Fewer than 8	0	Fewer than 8	0
8 to 99	8	8 to 199	8
100 to 200	16	200 to 499	12
Over 200	24	500 to 1,000	24
		Over 1,000	36

ADULT TAG RECOVERY FROM FISHERIES

Marine fisheries in Southeast Alaska and northern British Columbia are sampled for coded wire tags. Commercial catch sampling for coded wire tagged coho salmon in Southeast Alaska is conducted by ADF&G sampling personnel stationed at fish processors and buying stations located throughout the region. The minimum sampling objective is 20% of the catch by district, gear type, and statistical week. The samplers examine coho salmon for missing adipose fins during off-loading and sorting operations. Skippers of fishing vessels and tenders are interviewed to determine fishing districts. The heads of all adipose fin clipped fish are sent to the ADF&G Coded Wire Tag Laboratory in Juneau for removal and reading of tags. Geographic areas used in expanding random tag recoveries vary by fishery: tag recoveries from the gillnet fishery are expanded by district, tag recoveries from the seine fishery are expanded by seine areas which consist of one or more districts, and recoveries from the troll fishery are expanded by four quadrants which are aggregations of several districts (Table 1, Figure 2). Time strata used for expanding net recoveries are statistical weeks (Sunday through Saturday) while troll fishery samples are expanded over the total catch for open periods (between closures). Exceptions are that troll recoveries are expanded by statistical week and quadrant for analysis of migratory timing for analysis of harvest distribution. Randomly recovered tags are expanded by the inverse of the proportion of the catch that is sampled within area, gear type, and weekly or period strata (Clark and Bernard 1987). An adjustment for lost samples is made by multiplying expansions by the inverse of one minus the proportion of heads and tags lost.

The ADF&G Division of Sport Fish conducts a creel census and survey of several marine recreational fisheries. Tags recovered from random samples are expanded over biweekly strata that contain additional stratifications including weekdays vs. weekends, mornings vs. afternoons and low use vs. heavy use docks (Suchanek and Bingham 1990).

Sampling of British Columbia coastal fisheries and reporting of coded wire tag recoveries is conducted by Fisheries and Oceans Canada.

ADULT ESCAPEMENT ENUMERATION AND SAMPLING

Berners River Surveys and Sampling

The Berners River escapement is 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 is conducted on the upper Berners River within the period 18–31 October. The trip is timed so that the vast majority of the run has entered the system from saltwater: fish are just beginning to enter headwaters spawning areas and small tributaries, most fish are holding in clear pools, and little if any spawning has occurred before the survey count. The 10-day trip is long enough to allow for periods of unfavorable survey conditions due to high water. Access is by helicopter to a campsite located beside one of the most important holding pools in the system, near the middle of the survey area.

Foot Surveys

A thorough escapement survey of the upper river will be conducted by foot immediately after arrival at the upper field camp (Figure 3). An additional survey is conducted later in the trip if there is evidence that more fish have moved into the upper river. The survey area is covered in two sequential days. The order of counting is typically from camp to the headwaters on the first day and downstream on the second day. However, the order may be reversed if conditions are good for surveying downstream pools the first day of the survey, with rain expected to begin the following day because counting efficiency in upstream reaches is less affected by conditions. The upper survey area includes the east branch all the way to its origin in a springs and the west branch to a distance of approximately 2 km above the fork. The lower section is surveyed downstream past the old mainstem channel to the pool where the new primary channel meets the mountainside just below the outlet of Berners Lake. The observer then crosses overland to the old channel and returns upstream. All side streams throughout the foot survey area are examined for fish.

The same observer (Leon Shaul) has conducted the Berners River surveys since 1982. The observer wears polarized sunglasses. In headwaters sections and tributaries, the observer walks upstream along the bank or in the stream channel, if necessary, to avoid dense vegetation. The observer looks ahead and counts fish individually as they dart downstream past the observer or under banks or logs. Rocks are thrown into suspected hiding areas to drive fish out to be counted. In some small tributaries with overhanging root systems, the observer probes under banks to drive hiding fish out to be counted. Pools with larger schools of over 100 fish are counted repeatedly from different angles and directions until the observer is satisfied with the count, which may be the average of several counts. The observer moves very quietly and slowly along the bank above the fish and attempts to count without disturbing them. Counting larger schools is often done by tens or alternately by tens and hundreds for the largest observed aggregations of 1,500–2,000 spawners. Coho salmon carcasses are extremely rare; however, any dead fish or fresh parts (jaws or pyloric caeca) that can be identified as individual fish are included in the count. Species identification is not a problem as the coho is the only salmon species (with rare exception) present in the area during late October, although schools of Dolly Varden char (*Salvelinus malma*) are present in some areas.

Helicopter Surveys

When the helicopter returns to remove the camp, the observer surveys the lower river from its confluence with the Lace River upstream to the mouth of lower Brown Slough. In past years, up to 760 fish (12% of the total survey count) have been counted from the air in four pools in this section. 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.

Helicopter surveys of lower river pools are conducted from an altitude of 30–50 m with the sun at the observer's back. The helicopter is 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.

Coded-wire Tag Sampling

Fish will be captured with a 13-m beach seine for sampling for coded wire tags and age, sex, and length. The coded-wire tag minimum sampling objective is 1,200 fish. Under recent tagging rates (1993–2012 average = 18.1%), this sample is expected to contain at least 150 (and more likely about 200) tagged fish. A three-person crew deploys the beach seine in holding pools. Fish that are captured in the beach seine will be marked with a partial dorsal clip using wire cutters (to prevent resampling) and examined for a missing adipose fin. If the fish has an adipose fin, it will be released. When an adipose clip is encountered, the fish will be examined with a coded-wire tag detecting wand to determine the presence of a tag and to distinguish if it may be a half-length tag. Half-length tags will be present in a small number of adults (< 1%) and are part of a separate age validation study. When a half-length tag is detected, or if no tag is detected, the fish will be killed and the head collected, labeled, and submitted to the ADF&G Coded Wire Tag Laboratory in Juneau for verification. If a full-length tag is detected, indicated by a strong signal from the wand, the fish will be released and tag presence recorded.

Age-Sex-Length Sampling

Age-sex-length samples will be collected from a sample of 600 fish caught in the beach seine. This sample will meet the statistical objectives for an infinite population with three major age classes (Appendix A) and allows for up to 15% of samples that could not be aged due to scale regeneration. Each fish sampled for age, sex, and length will be placed, unanesthetized, on a measuring trough and measured to the nearest millimeter (mid eye to fork length). The length and sex are recorded. Four scales will be taken from 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). Scales are mounted on gum cards and impressions later made in cellulose acetate (Clutter and Whitesel 1956).

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 and Piston 2013), and this project funds continued operation of the weir during 15 September–early November to enumerate coho salmon and verify weir counts with mark-recapture studies. The weir and its trap are constructed of vertical pickets of ¾” EMT conduit supported in three 8’ sections of aluminum channel drilled to accommodate 43 evenly spaced pickets per section, with a larger hole on each end for nominal 1” black iron pipe. To provide extra height in high water, the weir is extended from the top of the pickets to the catwalk handrail with 2”×2” 12 gauge galvanized hardware cloth. Coho salmon typically appear around the first of August, but no substantial migration occurs before mid-August. Frequently, 30–120 fish remain downstream from the weir in early November. These fish are carefully counted before the weir is removed and added to the weir count.

The weir has been operated into the first week of November since 1993, but the length of the project season has varied over the years. During 1982–1984, the weir was operated until the last week of November but it was removed a month earlier during 1986–1992 based on observations that few if any fish entered the system after late October. A substantial percentage (28%) of the run escaped uncounted in 1992, however, and ending the project in late October made it difficult to obtain adequate mark-recovery samples from the spawning grounds. Extending the season into early November has proved to be a cost-effective way to verify that the entire escapement was enumerated and that few if any fish escaped uncounted.

Mark-recapture studies are essential for validating the weir count and estimating escapement at Hugh Smith. Extreme fall floods threatened to destroy the structure in some years and pickets were pulled for a period or hours or days to relieve pressure on the weir (Shaul et al. 2009). This also permitted fish to escape upstream uncounted. Although the old wooden tripod weir was replaced in 1989 with a much stronger aluminum bipod structure, sufficient risk remains to justify annual implementation of a mark-recapture study to ensure that the opportunity to estimate the escapement is not lost in the event that the weir fails. Liberal sealing of the weir with sandbags appears to have largely eliminated uncounted escapement, with the exception of occasional holes or breaches during flood events.

In mark-recapture studies conducted in 1982 and 1983, fish were tagged at the weir with numbered Floy® tags [1]and recovered on the spawning grounds from mid-November to early February, and a stratified estimate (Schaefer 1951) was made (Shaul et al. 1985 and 1986). Recovery data from those years indicated virtually complete intermixing of marked fish between tagging and recovery and, therefore, that a single stratum estimate (Chapman 1951) should be unbiased (and relatively more precise).

Mark-recapture Sampling

All (100%) healthy adult coho salmon that pass through the weir will be captured in the trap, sampled for coded-wire tags, and marked with a fin clip. Three fin marks are used for periods that correspond to historical average thirds of the run: a partial dorsal fin clip August–15 September, a left ventral fin clip 16 September–6 October, and a right ventral fin clip 7 October–November. Previous investigations indicated that up to half of the escapement can pass unsampled in years when severe flooding disables the weir for 2–3 days (Shaul et al. 1985). Therefore, recovery samples needed to meet statistical objectives were determined based on historical escapements ranging from 424 to 2,144 adults and the assumption that 50% of the escapement is marked at the weir. Recovery sampling needs from the spawning grounds range from 120 to 156, but samples of over 200 fish are feasible to obtain if weather conditions are favorable.

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 some situations. In the case where a single event can be identified in which the weir was compromised in the early or middle portion of the run, a single stratum Chapman estimator can

[1] Product names within this document are included for completeness and do not constitute product endorsement.

be employed rather than a Schaefer estimator (which requires sampling the spawning grounds very late in the season to cover all run segments). The estimate is generated from the unmarked fish and only the mark applied during the period when the known breach occurred. The estimated variance for the Chapman estimate was provided by Seber (1982). Fish marked and counted in the other two periods are then added to the Chapman estimate for the period of the breach to achieve a total escapement estimate for the season.

Mark-recovery sampling will be conducted in October and early November. Fish will be captured with a beach seine and dip nets from the earlier-spawning Cobb Creek escapement and with spinning gear (spoons and spinners) off the mouth of Buschmann Creek. All sampled fish will be marked with a single left opercular punch (to prevent resampling) and released. All marks (adipose clip, left or right ventral clip, dorsal clip, opercular punch) will be recorded and the fish classified as adults (age .1) or jacks (age .0). 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. If later trips are needed, two recovery trips (2–3 days each) will be scheduled: one between 15 and 24 November and one during the first or second week of January. Additional trips will be made if necessary.

Age-Sex-Length Sampling

At the start of each season, males under 400 mm mid eye to fork length will be classified as jacks while larger fish are classified as adults. There is a chance of misclassifying a very small number of fish, because there is sometimes a small overlap between size distributions of the two ocean age classes. The length division between age classes will be evaluated and adjusted annually based on initial size distributions and age samples.

A total of 630 age-sex-length samples will be collected, with sampling distributed throughout the run according to the schedule in Table 2. Samples will be selected randomly between adults and jacks. This sample will meet the statistical objectives for a population of 4,000 adults with three major age classes (Appendix A) and allows for up to 25% of samples that could not be aged due to scale regeneration. Meeting this objective requires sampling at least 50% of the daily escapement throughout an average run. Each fish sampled for age-sex-length is removed from the weir trap, anesthetized in a clove oil solution (Woolsey et al. 2004), placed in a padded measuring trough, and measured to the nearest millimeter (mid eye to fork length). Four scales will be taken from 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). Scales are mounted on gum cards and impressions later made in cellulose acetate (Clutter and Whitesel 1956).

Coded-wire Tag Sampling

All coho salmon will be sampled for coded-wire tags. All fish counted past the weir will be captured in the trap and examined for the presence of an adipose fin. When an adipose clip is encountered, the fish will be examined with a coded-wire tag detecting wand to determine the presence of a tag and to distinguish if it may be a half-length tag. (A separate, ongoing ageing study has been conducted at Hugh Smith Lake since 1997, the same as at Berners River, so there will be a small number of the adults (< 1%) that have half-length tags.) When a half-length tag is detected, the fish will be killed and the head collected, labeled, and submitted to the ADF&G Coded Wire Tag Laboratory in Juneau for verification. If a full-length tag is detected, indicated by a strong signal from the wand, the fish will be released and tag presence recorded. If no tag is detected, the fish will be released and recorded as having no tag. An individual record is made of each fish that passes the weir including whether it is an adult (age .1) or jack (age .0), whether or not it has an adipose clip, and, if clipped, whether or not it registers a positive signal on the detector. Age-sex-length samples will be recorded on the same form.

Since escapement enumeration and coded-wire tag recovery objectives call for enumerating and sampling all fish that enter the lake, control of the precision of coded-wire tag estimates depends largely on the number of smolts that can be tagged and fishery sampling rates. Relative precision (P = 0.05) for 1990 estimates of total return, total harvest rate, troll fishery harvest rate, marine survival, and smolt migration were 10.5%, 3.1%, 11.6%, 15.3%, and 6.7%, respectively. Therefore, the statistical objectives for these estimates were achieved from a tag release of 7,187 smolts and a marine survival rate of 17% (1,219 tagged adults). This would equate to about 9,400 smolts in a year with average marine survival (13%). Smolt capture efficiencies have generally increased since 1987 with increased efforts at making the smolt weir more effective (Shaul et al. 2009). An average of 20,322 tagged smolts were released during 1997–2012. Based on a 20-year average survival rate of 13% and a historical range of 4–21% (Shaul 1994, Shaul and Crabtree 1998), this should result in a run of 2,600 tagged adults (range 800–4,200). In view of recent statistical results and the increased numbers tagged in most recent years, precision objectives will likely be met.

KETCHIKAN SURVEY INDEX COHO ESCAPEMENT SURVEYS

Helicopter surveys will be conducted annually on 14 index streams in the Boundary Area of District 101, near Ketchikan (Shaul and Tydinco 2006, Shaul et al. 2011). Three primary operational objectives in developing the escapement survey program were to: (a) select a sample of the best types of systems for conducting surveys that are representative of overall production; (b) employ consistent methods over time; and (c) conduct multiple surveys on the same streams at optimum times. The annual escapement survey index is the sum of peak counts for all 14 streams, including interpolated values for missing counts.

Selection of Streams

The most important criterion for selection of index streams was their suitability for conducting comparable surveys. Suitable streams should have good visibility from the air, water should be clear during the period when the most fish are present, and fish should be equally visible regardless of their distribution in the system (e.g., in holding pools and spawning riffles). This disqualifies lake systems and streams with potential holding areas in glacial or dark, organically-stained water. Lake systems are important in their contribution to production in this area but are impossible to accurately survey. Glacial systems that clear up very late in the fall after much spawning has already occurred are also not suitable. In addition to visibility, index streams were chosen for representativeness regarding geographical distribution, types of systems, and fishery exploitation patterns. Also, we favored streams for which historic coho escapement surveys already existed.

The set of 14 index streams includes four at the mouth of the Unuk River, four tributaries of the Chickamin River, three streams in Boca de Quadra, one in Smeaton Bay, one in Portland Canal, and one in Carroll Inlet on Revillagigedo Island (Figure 4; Table 3). These streams are believed to be representative of the stream systems that contribute the majority of the coho production in District 101. Conditions for conducting fixed-wing aerial surveys of these streams were documented by Martin (1959) and Edgington and Larson (1977; Table 4). All of the surveyed streams have good to excellent features for conducting aerial surveys. Visibility and maneuvering conditions are less critical for surveys using a helicopter, because of the capability of flying lower at slower speeds and turning in restricted spaces.

Burroughs Bay-Unuk River. The Unuk River is thought to be one of the most important coho salmon producing systems in District 101 (Jones et al. 1999, Weller et al. 2006), if not the single largest producer. Four streams that enter Burroughs Bay at or near the mouth of the Unuk River have better survey conditions than the glacial Unuk River. These include Herman Creek, Grant Creek, the Eulachon River, and the Klahini River. The Eulachon River has been surveyed consistently since 1983 and has excellent conditions for surveys. It is an important coho salmon producer: peak counts since 1987 averaged 538 fish (range: 154–1,240). The other three systems, which are smaller producers, have been surveyed annually since 1988. (*Note*: Three tributaries of the Unuk River, Cripple Creek, Lake Creek, and Clear Creek, were surveyed 1988–1990; however, these streams were dropped due to funding limitations and poor survey conditions).

Chickamin River. The Chickamin River is probably the second most important coho salmon producing system in District 101 based on available rearing habitat. The four tributaries which are surveyed are Indian River, Barrier Creek, King Creek, and Choca Creek. All have good or excellent conditions for surveys. Indian River, the most important spawning tributary, has been surveyed since 1979, while surveys on the other tributaries were begun in 1988. Peak coho salmon survey counts since 1987 averaged 614 at Indian River (range: 245–1,250), 130 at Barrier Creek (range: 15–450), 489 at King Creek (range: 35–1,140) and 204 at Choca Creek (range: 100–450). (*Note*: Surveys were conducted for many years on Humpy Creek but were discontinued because visibility conditions were deemed to be too variable.)

Southeast Behm Canal. Four streams in Southeast Behm Canal and Boca de Quadra Inlet have been surveyed annually since the early 1980s. Three of these, the Keta River, Blossom River (tributary of the Wilson River), and Marten River, are important producers of salmon in this area and have excellent conditions for helicopter surveys. Peak coho salmon survey counts since 1987 averaged 1,184 at the Keta (range: 315–3,290), 1,389 at the Blossom (range: 350–7,100), and 1,270 at the Marten (range: 335–2,302). Humpback Creek drains a large lake that is blocked by a barrier falls. It is a somewhat smaller producer: peak survey counts since 1987 averaged 551 fish (range: 3–2,600). (*Note*: the Wilson River proper was surveyed in the 1980s but was dropped due to funding limitations and poor survey conditions.)

Portland Canal. The Tombstone River in Portland Canal is an important producer and has excellent attributes for surveys. It has been surveyed annually since 1987. Peak survey counts since 1987 averaged 1,083 fish (range: 225–2,446).

Revillagigedo Island. Carroll Creek, at the head of Carroll Inlet, Revillagigedo Island, is an important producer. It has been surveyed annually since 1981. Peak survey counts since 1987 averaged 334 fish (range: 70–1,100).

Survey Timing

Surveys are timed so that the maximum (peak) number of fish is available for counting. This usually occurs after most fish have entered the stream from saltwater but before most have begun spawning. The migration of most fall coho stocks into freshwater begins in late August and continues until mid- to late October, with peak entry in late September through the first week of October. In most short, coastal streams spawning begins in early October, peaks in late October, and continues through mid-November. Initial surveys will be conducted at the end of September when the majority of the run has entered the stream but before a substantial number are lost after spawning. A second survey will be made in mid-October to account for later migrants and variations in run timing.

Although entry timing into freshwater is relatively consistent from year to year, coho salmon are highly flexible in the timing of actual spawning, which is closely related to freshets. Large numbers of fish move from holding pools onto the spawning riffles and into small headwaters streams with each freshet. Once on the redds, stream life is usually very short due to intensive predation and subsequent freshets that bring up new fish while pushing most surviving spawned fish downstream and out of survey areas. In years of dry fall conditions, the optimum survey period may extend throughout most of October as spawning is delayed until long after most fish have entered the stream. Conversely, it is much more difficult to obtain comparable surveys in years when sequential freshets occur during early to mid-October, and surveys must be delayed until visibility conditions are adequate. In some years favorable conditions may not occur for periods of up to two weeks. This underscores the importance of conducting an early survey on each system so that at least one near-peak count is achieved, even if later conditions preclude further comparable surveys.

The index streams were divided into three groups of four to six streams based on geographical proximity and the timing of coho salmon migration and spawning (Table 5). The streams in each group are surveyed on the same day. Pre-peak surveys for the three groups are scheduled for 28 September–1 October while the peak surveys are scheduled for 15–20 October. If weather and water conditions are unfavorable, the surveys will be conducted as soon after these dates as possible.

Survey Techniques

Helicopter surveys are conducted from a Bell 206 B Jet Ranger or Hughs 500 helicopter. Surveys are conducted from an altitude of 6 to 50 m unless obstructions require flying higher. Airspeed varies from approximately 5 to 50 km per hour depending on terrain, visibility, and the presence or absence of fish. The door on the observer's side is removed and the helicopter is maneuvered so that the observer is able to look down into the stream continuously from the left side. The observer wears polarized glasses to reduce reflective glare and a billed hat to keep prop wash out of the observer's eyes. Surveys are conducted by observers experienced on each system. Observers new to conducting coho escapement surveys on a particular system always accompany an observer experienced on that system before surveying it by themselves. Survey data, including the number of fish counted and survey conditions (water level and visibility), are recorded and entered into the Southeast Alaska Integrated Fisheries Database.

Accounting for Missing Counts

Only peak survey counts that meet standards for timing, survey conditions, and completeness will be included in the annual index. Missing counts will be interpolated in order to maintain a comparable aggregate escapement index. Interpolations will be made for missing counts under the assumption that the expected value is determined for a given stream and year in a multiplicative way (i.e., counts across streams for a given year are multiples of counts for other years, and counts across years for a stream are multiples of counts for other streams). The estimated expected count for a given stream in a given year is then equal to the sum of all counts for the year times the sum of all counts for the stream divided by the sum of counts over all streams and years. If there is more than one missing value, an iterative procedure, as described by Brown (1974), will be used since the sums change as missing counts are filled in at each step.

ANALYSIS OF TAG RECOVERY DATA

We denote the proportion of fish in the escapement that was tagged as Θ. Let s denote the number of fish in the escapement sampled for adipose clips, let m_1 denote the number of fish in sample that have adipose clips, let m_2 denote the number of adipose clips in the escapement sampled for tags, and finally, let t denote number of adipose clipped fish in the escapement that are sampled for tags and are found to have tags. Then a reasonable estimate of Θ is given by

$$\hat{\Theta} = (\frac{m_1}{s})(\frac{t}{m_2}) . \qquad (1)$$

Let E denote the total number of tagged fish in the escapement, and this quantity is estimated by multiplying the total escapement (N) by the estimated proportion tagged:

$$\hat{E} = N\hat{\Theta} . \qquad (2)$$

Harvest by Gear Type and Escapement

The estimated harvest by gear type and escapement is computed for coho salmon returns to the three systems. Alaska troll fishery tag recoveries are expanded to total catch by quadrant and fishing period (time between fishery openings and closures). Recoveries from net fisheries are expanded by district and statistical week. Fishery contribution estimates for tagged fish are divided by the proportion tagged in escapement samples ($\hat{\Theta}$) to estimate total stock contributions C_i. Let $\hat{F}_i$ denote the estimated number of tagged fish harvested (expanded sum of random fishery recoveries) in fishery i, so that C_i can be estimated with

$$\hat{C}_i = \frac{\hat{F}_i}{\hat{\Theta}_t} . \qquad (3)$$

Let the total run size be denoted by X, and then this quantity can be estimated by adding the sum of the estimated catch of the stock in all fisheries and escapement. In other words, our estimate of total run size is given by

$$\hat{X} = N + \sum_i \hat{C}_i . \qquad (4)$$

If N is estimated, rather than based on a simple count, then N needs to be replaced by its estimate in the above equation.

Harvest Rate

The harvest rate (H) for a stock in fishery i is estimated as follows:

$$\hat{H}_i = \frac{\hat{F}_i}{\sum \hat{F}_i + \hat{E}} . \qquad (5)$$

The total harvest rate by all fisheries is estimated as follows:

$$\sum \hat{H}_i = \frac{\sum \hat{F}_i}{\sum \hat{F}_i + \hat{E}} \qquad (6)$$

Harvest Distribution

The harvest distribution (percent by area and gear type) is estimated for tagged stocks. Expanded tag recoveries of a stock in each fishery (F_i) are divided by the sum of expanded fishery recoveries in all fisheries. Tag recoveries from the Alaska troll fishery are expanded by PMFC area (Table 1) and fishing period while recoveries from the net and trap fisheries are expanded by district and statistical week. In addition, the distribution of the Southeast Alaska troll catch of the three stocks is estimated using quadrant-period strata.

Migratory Timing

The migratory timing of the three stocks in troll fishing districts is estimated from the distribution of the harvest of tagged fish by week. Troll fishery tag recoveries are expanded to total catch by quadrant and week. The weekly proportion of the total troll catch of each stock is estimated. Expanded weekly recoveries are 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 4–6 days, the average time of capture of landed fish probably occurs 2–3 days previously.

Survival Rate

Survival rates are estimated for tagged coho salmon smolts that outmigrate from Hugh Smith Lake and the Berners River. Estimates are 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 smolts and that there is no incidence of naturally missing adipose fins. Therefore, all adipose clipped fish that do not contain tags are assumed to have shed their tags. T_1 juveniles are tagged two years before returning as adults. A sample of adipose clipped fish (m_2) is drawn from the escapement and sampled for coded wire tags, of which t fish are found to be tagged. The survival rate, denoted S, from the time of tagging (smolt) to the adult stage (age .1) is estimated as follows:

$$\hat{S} = \frac{(\sum \hat{F}_i + \hat{E})(\frac{m_2}{t})}{T_1}. \qquad (7)$$

Typically, 90% or more of recoveries from juvenile tag groups have been recovered in a single return year while virtually all tagged smolts have returned in a single year. Tag retention is assumed to be the same in fish from a single return year because it is impossible to determine when adipose clipped fish without tags were marked. Potential bias occurs in the estimates to the extent that different tag retention rates occur in releases from different years.

Estimation of Smolt Abundance

The abundance of coho salmon smolts is estimated using Chapman's modification of Petersen's estimator for closed populations (Seber 1982, p. 60). A sample of smolts was marked and a sample of adults returning the two years later is inspected for marks. During the period between marking and recovery the population is open to mortality but is assumed closed to recruitment. The abundance of smolts (N_S) is estimated as follows:

$$\hat{N}_S = \frac{(M+1)(C+1)}{(R+1)} - 1 \quad (8)$$

where M is the number of smolts marked and released in a year (without an adjustment for estimated tag loss at the time of release) and R is the number of adipose clip marks in a sample of C returning adult spawners inspected for marks.

In this equation, R is the random variable, and C and M are assumed to be constants. In mark-recapture sampling, R follows a hyper geometric distribution by definition, which can be approximated with the Poisson distribution (Thompson et al. 1992). By simplifying the Chapman mark-recapture equation, we have

$$\frac{1}{\hat{N}_S} \approx \frac{R}{CM}. \quad (9)$$

In the Poisson approximation for R, the mean and variance are the same, so that the variance (var), standard error (SE), and coefficient of variation (CV) of $\frac{1}{\hat{N}}$ are calculated as follows:

$$\text{var}(\frac{1}{\hat{N}_S}) \approx \frac{R}{(CM)^2}, \quad (10)$$

$$\text{SE}(\frac{1}{\hat{N}_S}) = \frac{\sqrt{R}}{CM}, \text{ and} \quad (11)$$

$$\text{CV}(\frac{1}{\hat{N}_S}) = \frac{1}{\sqrt{R}} \cdot 100. \quad (12)$$

If the numbers of mark-recoveries are moderate or large, the Chapman estimate should meet the criteria outlined above. The distribution for R can then be approximated with the normal distribution. Under these circumstances, we will assume $\frac{1}{\hat{N}_S}$ is approximately normally distributed, and we will generate 95% confidence intervals for $\frac{1}{N_S}$ as

$$\frac{1}{\hat{N}_S} \pm 1.96 \cdot \text{SE}(\frac{1}{\hat{N}_S}). \quad (13)$$

Finally, 95% confidence intervals for N_S were generated by inverting the confidence intervals for $\frac{1}{N_S}$.

The adult return sometimes includes fish tagged two years prior to their return as adults, having remained in freshwater an additional year after tagging, and fish tagged as newly emerged fry with half-length (*HL*) tags for an aging validation study. In those cases, the combined sample of fishery recoveries of returning tagged adults is used to apportion the number of tagged adults passing the weir to estimate R attributable the primary smolt year. When recoveries from tagging two years prior occurred, a substitute estimate of R was generated by multiplying the number of adipose clips in the escapement sample by the proportion of tags recovered in the inriver sample that were tagged one year prior to adulthood ($T_{(i-1)}$) compared with the sum of all adult tag recoveries from the system:

$$\hat{R} = R\left(\frac{T_{(i-1)}}{T_{(i-1)} + T_{(i-2)} + T_{(HL)}}\right) \tag{14}$$

Tag loss is estimated based on the proportion of fish in the escapement that register no signal with the field detector and are found not to contain a tag upon further examination at the tag lab under an inherent assumption of 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.

Variances

The variances for the estimated parameters are based on methods and equations given in Clark and Bernard (1987), Goodman (1960), and Cochran (1977, p. 154). Most of the variances are approximations, based on product or ratio estimators. For example,

$$Var(\hat{\Theta}_t) = \frac{m_1(m_2-1)(s-1)\hat{\Theta}^2}{m_2(m_1-1)s} + \frac{m_1\hat{\Theta}}{m_2 s} - \hat{\Theta}^2 \text{, and} \tag{15}$$

$$Var(t) = \frac{m_2(m_2-1)s(s-1)\Theta^2}{m_1(m_1-1)s} + \frac{m_2 s\Theta}{m_2} - \Theta. \tag{16}$$

If there is a complete count of fish, then the variance of the estimate of N is 0 and N is a constant. If N is estimated by a Chapman estimate, then an estimated sample variance of N is given in Ricker (1975, p. 78). However, if N is estimated with an aerial or foot count (possibly expanded to account for unseen fish) there is no analytic means to get an estimated sampling variance for the estimate of N. A rough guess at will be imputed using best professional judgment. The bounds about the escapement estimate are those that the project leader is comfortable with saying that he/she is 95% sure that the true escapement is within these bounds. This interval is then divided by 3.92 (i.e., 2 × 1.96), and squared to get a guess at the variance of the estimate of N. For example, if the escapement estimate is 7,000 coho salmon, and the project leader is sure (at least 95% sure) that the true escapement between 6,000 and 8,000 fish, then the estimated variance for the population size will assumed to be approximately $(2{,}000/3.92)^2$ or 260,000. Either way, an estimate of the variance of N is needed to estimate the variance of E:

$$Var(\hat{E}) = \hat{N}^2 Var(\hat{\Theta}) + \hat{\Theta}^2 Var(\hat{N}) - Var(\hat{N})Var(\hat{\Theta}), \tag{17}$$

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

If we assume that the estimate of Θ is very close to the true value of Θ (i.e., the variance is small, and there is no bias), the variance of C_i can be approximated by,

$$Var(C_i) = \frac{\hat{F}_i^2}{\hat{\Theta}^2}\left(\frac{Var(\hat{F}_i)}{\hat{F}_i^2} + \frac{Var(\hat{\Theta})}{\hat{\Theta}^2}\right). \tag{18}$$

The variance of the F_i can be estimated following formulas in Clark and Bernard (1987). The variance of the total run size is estimated as the sum of the component variances. The estimated variance of harvest rates is approximated by

$$Var(\hat{H}_i) \approx [\frac{\hat{F}_i}{\sum \hat{F}_i + \hat{E}}]^2[\frac{Var(\hat{F}_i)}{\hat{F}_i} + \frac{\sum Var(\hat{F}_i) + \hat{E}}{(\sum \hat{F}_i + \hat{E}_i)^2} - \frac{2Var(\hat{F}_i)}{\hat{F}_i(\sum \hat{F}_i + \hat{E})}], \tag{19}$$

and the variance of the sum of H_i over all catch strata is estimated with

$$Var(\sum \hat{H}_i) = [\frac{(E\sum \hat{F}_i)^2}{(\sum \hat{F}_i + \hat{E})^4}][\frac{Var(\hat{E})}{\hat{E}^2} + \frac{\sum Var(\hat{F}_i)}{\sum \hat{F}_i^2}]. \tag{20}$$

Because the estimates of R_1 and H_1 are equivalent, the estimated variance of R_1 is the same as the variance of H_1. The estimated variances of R_{i} will be calculated analogous to the variances of the estimate of H_i.

The estimated variance of the estimate of S is

$$Var(\hat{S}) = \hat{S}^2[\frac{Var(t)}{t^2} + \frac{\sum Var(\hat{F}_i) + Var(\hat{E})}{(\sum \hat{F}_i + \hat{E})^2}]. \tag{21}$$

This variance is not quite correct (there is a covariance term in there, which is probably relatively small), but will be used until the equations can be rearranged to remove the covariance.

SCHEDULE AND DELIVERABLES

Date	Personnel	Activity
7/1–9/30	Leon Shaul	Technical reporting; summarize spring coded-wire tag releases and report to ADF&G Tag Lab.
7/01–7/31	Leon Shaul Kent Crabtree	Final logistical planning and supply purchasing for escapement operations.
8/01–11/5	Nick Olmsted Molly Kemp other Technicians	Enumerate adult coho salmon at Hugh Smith Lake; sample for coded-wire tags and age-sex-length.
9/28–10/25	Justin Breese Bo Meredith	Survey coho salmon escapements by helicopter in 14 Ketchikan area index streams.
10/18–10/30	Leon Shaul Kent Crabtree other Technicians	Foot and helicopter escapement survey of the Berners River; sample for coded-wire tags and age-sex-length.
8/15–12/15	Kent Crabtree Molly Kemp	Age scale samples; enter and summarize data; repair, maintain and store field gear.
1/1–6/30	Leon Shaul Kent Crabtree	Analyze tag recovery data; write operational plans and reports.
1/15–4/15	Kent Crabtree Leon Shaul	Hire seasonal employees, prepare equipment, plan logistics, and purchase supplies for field projects.
4/18–6/3	Nick Olmsted Molly Kemp	Capture, enumerate, coded-wire-tag, and sample coho smolts at Hugh Smith Lake.
5/4–6/12	Kent Crabtree other Technicians	Capture, enumerate, coded-wire-tag, and sample coho smolts at the Berners River.
6/13–30	Kent Crabtree other Technicians	Maintain, repair, and store gear from smolt projects.

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 is produced at 3-year intervals. 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.

RESPONSIBILITIES

Duties are assigned in the schedule provided above. Positions that are presently unfilled are referenced by position title only.

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TABLES AND FIGURES

Table 1.–Statistical areas of Southeast Alaska by seine areas and quadrants.

Seine Area	Statistical Area (Districts)
SACO	109, 110
SACI	105, 106, 107
SASO	103, 104
SASI	101, 102
SA11	111
SA12	112
SA13	113
SA14	114
Quadrant	**Statistical Areas (Districts)**
NW	113, 114, 116, 154
	156, 157, 181, 183
	186, 189, 191
NE	109, 110, 111, 112
	115
SW	103, 104, 150, 152
SE	101, 102, 105, 106
	107, 108

Table 2.–Weekly and cumulative age-sex-length sampling objective for adult and jack coho salmon, combined, at Hugh Smith Lake.

Period	Weekly Target	Cumulative Target
10–16 August	10	10
17–23 August	10	20
24–30 August	40	60
31 August–6 September	70	130
7–13 September	90	220
14–20 September	90	310
21–27 September	90	400
28 September–4 October	90	490
5–11 October	50	540
12–18 October	50	590
19–25 October	30	620
26 October–8 November	10	630

Table 3.–Peak coho salmon survey counts and aggregate biological escapement goal for 14 index streams in the Ketchikan area, 1987–2010. Combined survey count is the sum of counts and interpolated values (interpolated values are shown in shaded bold italic print).

Year	Herman Creek	Grant Creek	Eulachon River	Klahini River	Indian River	Barrier Creek	King Creek	Choca Creek	Carroll River	Blossum River	Keta River	Marten River	Humpback Creek	Tombstone River	Combined Survey Index
1987	92	***88***	154	***62***	***387***	***98***	***304***	***145***	180	700	800	740	650	532	4,933
1988	72	150	205	20	300	50	175	150	193	790	850	600	52	1,400	5,007
1989	75	101	290	15	925	450	510	200	70	1,000	650	1,175	350	950	6,761
1990	150	30	235	150	***282***	***72***	35	***105***	***139***	800	550	575	135	275	3,533
1991	245	50	285	50	550	100	300	220	375	725	800	575	671	775	5,721
1992	115	270	860	90	675	100	250	150	360	650	627	1,285	550	1,035	7,017
1993	90	175	460	50	475	325	110	300	310	850	725	1,525	600	1,275	7,270
1994	265	220	755	200	560	175	325	225	475	775	1,100	2,205	560	850	8,690
1995	250	94	435	165	600	220	415	180	400	800	1,155	1,385	82	2,446	8,627
1996	94	92	383	40	570	230	457	220	240	829	1,506	1,924	440	1,806	8,831
1997	75	***85***	420	60	***371***	***94***	***292***	175	140	1,143	571	759	32	847	5,063
1998	94	130	460	120	304	50	411	190	***255***	1,004	1,169	1,961	256	666	7,070
1999	75	127	657	150	356	25	627	225	425	598	1,895	1,518	520	840	8,038
2000	135	94	600	110	380	72	620	180	275	1,354	1,619	1,421	102	1,672	8,634
2001	80	110	929	151	1,140	***212***	891	450	173	1,561	***1,612***	1,956	506	***1,704***	11,475
2002	88	138	1,105	20	940	70	700	220	270	1,359	1,368	2,302	2,004	1,639	12,223
2003	242	***197***	875	39	690	57	1,140	380	***427***	1,940	1,934	1,980	214	1,745	11,859
2004	150	230	801	170	935	250	640	180	455	1,005	1,200	1,835	1,230	823	9,904
2005	510	300	1,240	360	890	190	810	270	500	3,680	3,290	1,130	500	1,170	14,840
2006	165	***124***	190	176	280	30	405	130	***272***	2,300	645	335	260	1,600	6,912
2007	134	75	***298***	35	245	15	290	210	***171***	990	970	351	3	***701***	4,488
2008	115	55	570	25	1,250	23	420	100	***613***	7,100	***2,524***	925	2,600	360	16,680
2009	***160***	330	330	340	750	110	1,050	100	1,100	***1,041***	315	1,675	700	225	8,226
2010	85	102	370	***68***	880	90	570	190	***202***	350	550	350	200	***650***	4,656
Avg.	148	140	538	111	614	130	489	204	334	1,389	1,184	1,270	551	1,083	8,186
Biological Escapement Goal:															
Lower Range															4,250
Point															5,100
Upper Range															8,500

Table 4.–Aerial survey conditions in Ketchikan area streams surveyed for coho salmon escapements as documented by 1) Edgington and Larson (1977) and 2) Martin (1959).

Stream	Source	Comments
Herman Creek	1	Clear water and light colored bottom makes salmon enumeration easy. However, the valley is narrow and trees along stream are tall—careful flight planning is required.
Grant Creek	1	The valley is broad, the bottom is light colored gravel, and water is usually clear making aerial surveying very effective.
Klahini River	1	Wide valley and stream, plus light colored bottom makes aerial survey efficient method of salmon enumeration.
Eulachon River	1	Good visibility and an easily followed stream course enables excellent aerial survey conditions.
Tombstone River	1	Excellent conditions available. Wide open stream with light colored substrate. Clear water, no turbidity.
Humpback Creek	1	This stream is easily observed from the air.
Keta River	1	Excellent conditions. Wide valley, light colored substrate.
Blossom River	1	Easily surveyed by light plane from Keta River pass upstream. Occasional strong downdrafts on SE side of valley—caution advised.
Marten River	1	Excellent conditions. Water clear, wide valley, light colored substrate. Survey during periods of low rainfall.
Carroll Creek	2	Excellent aerial visibility. Terminal point and barrier falls easily seen from the air.
Indian River	1	Several deep holes at lower portion of stream and dark rusty colored bottom may mask some fish, but generally good.
Barrier Creek	1	Considerable portions of stream are swift with many rocks and small pools. Fish on riffles in the lower portion are seen easily.
Humpy Creek	1	Good for aerial survey work in lower section. Light colored bottom and open canopy.
King Creek	1	Light colored bottom and clear water make for good visibility. Very little tree cover on lower section.
Choca Creek	1	Light colored bottom and clear water provide good visibility. Lower section of stream has little overhead cover.

Table 5.–Coho salmon escapement survey schedule for the Ketchikan area.

Area	Stream	ADF&G Stream Number	Target Dates	
			First Survey	Second Survey
Burroughs Bay-Unuk River	Herman Creek	101-75-005	28 September	15 October
	Grant Creek	101-75-010		
	Klahini River	101-75-050		
	Eulachon River	101-75-015		
Southeast Behm Canal & Portland Canal	Tombstone River	101-15-019	30 September	18 October
	Humpback Creek	101-30-083		
	Keta River	101-30-030		
	Blossom River	101-55-040		
	Marten River (including Dick's Creek)	101-30-060		
Revillagigedo Island & Chickamin River	Carroll Creek	101-45-078	1 October	20 October
	Indian Creek	101-71-04I		
	Barrier Creek	101-71-04A		
	King Creek	101-71-04K		
	Choca Creek	101-71-04E		

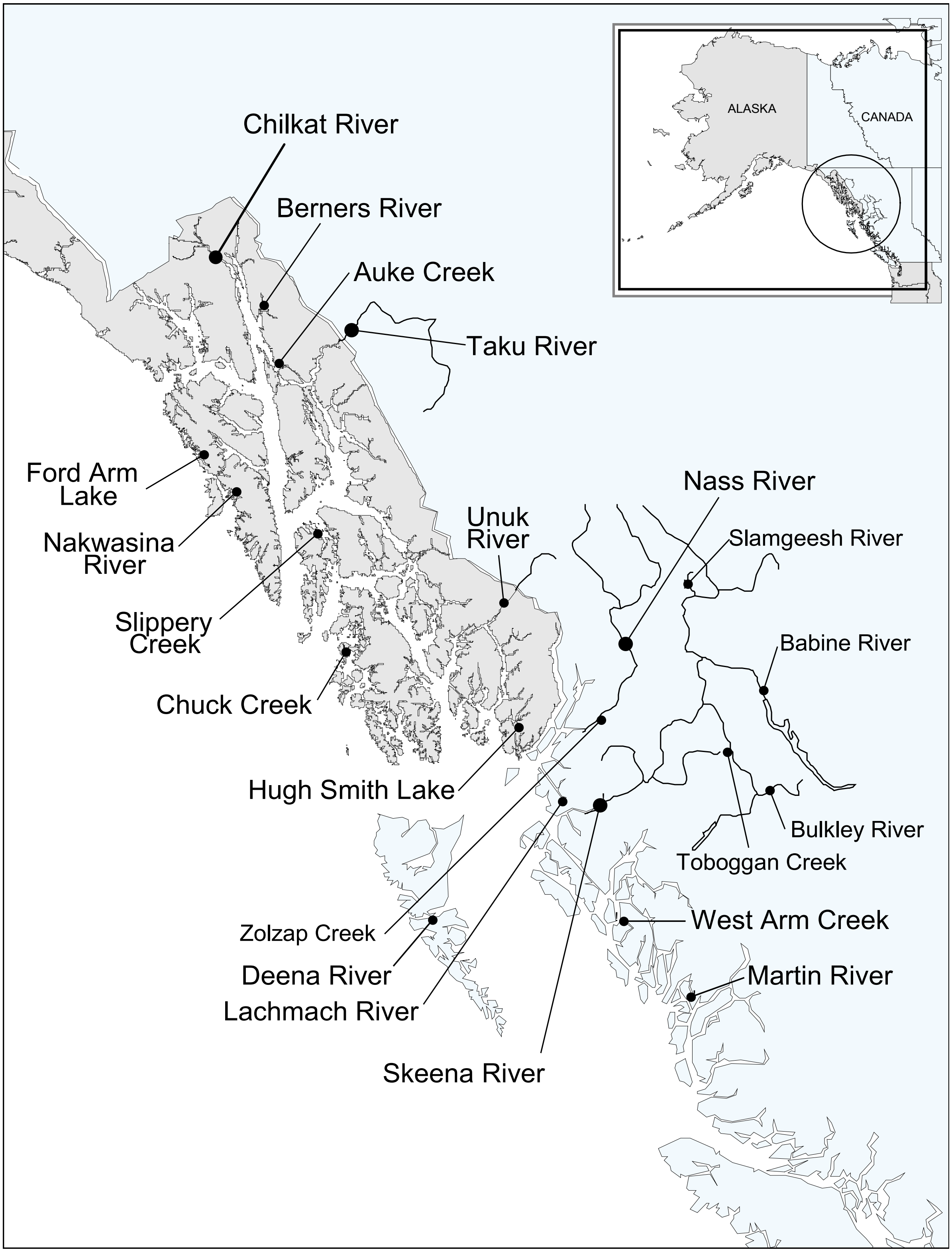

Figure 1.–Map of Southeast Alaska and northern British Columbia, showing the locations of long-term coho salmon stock assessment projects.

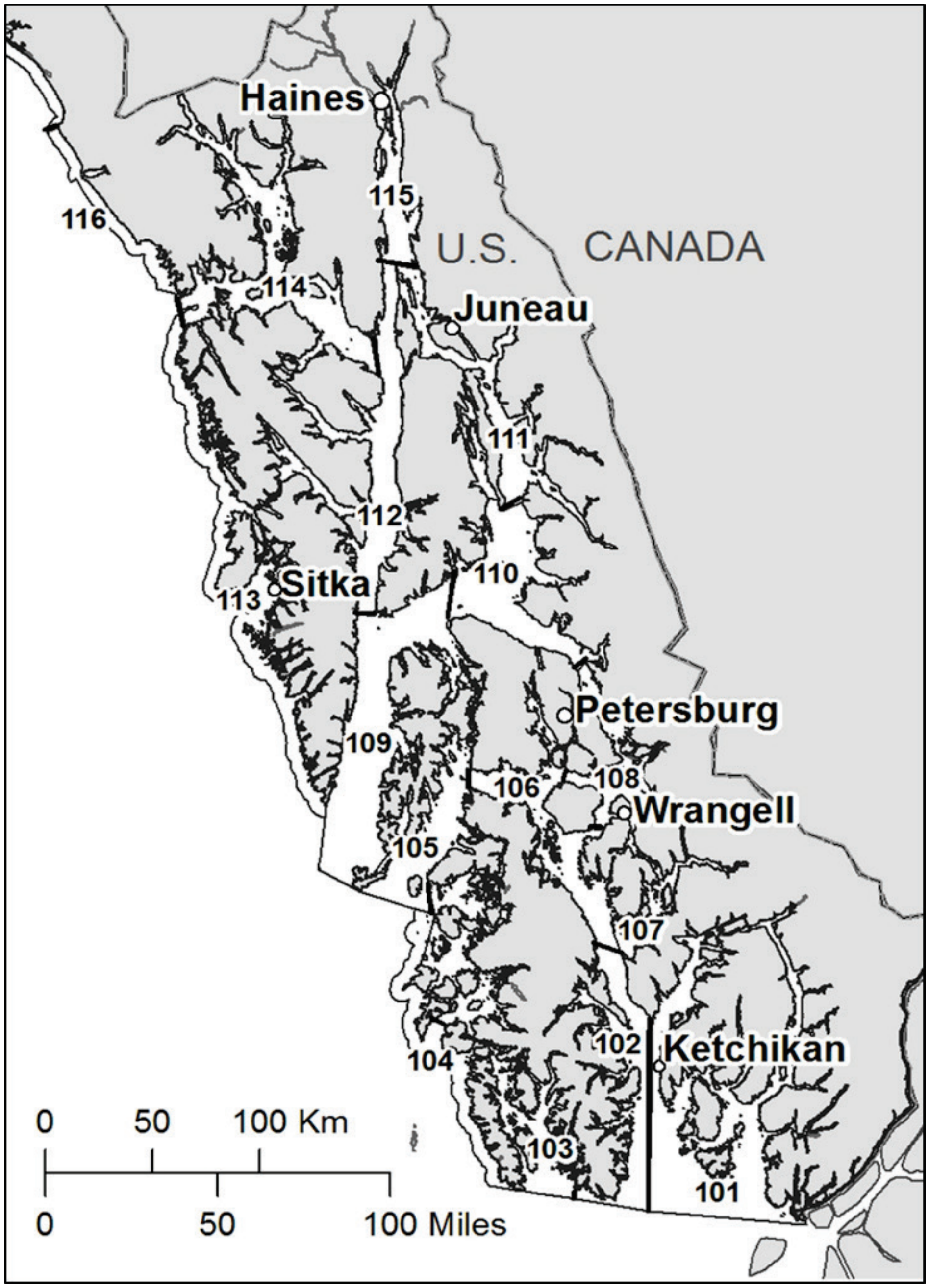

Figure 2.–Fishery management districts in Southeast Alaska.

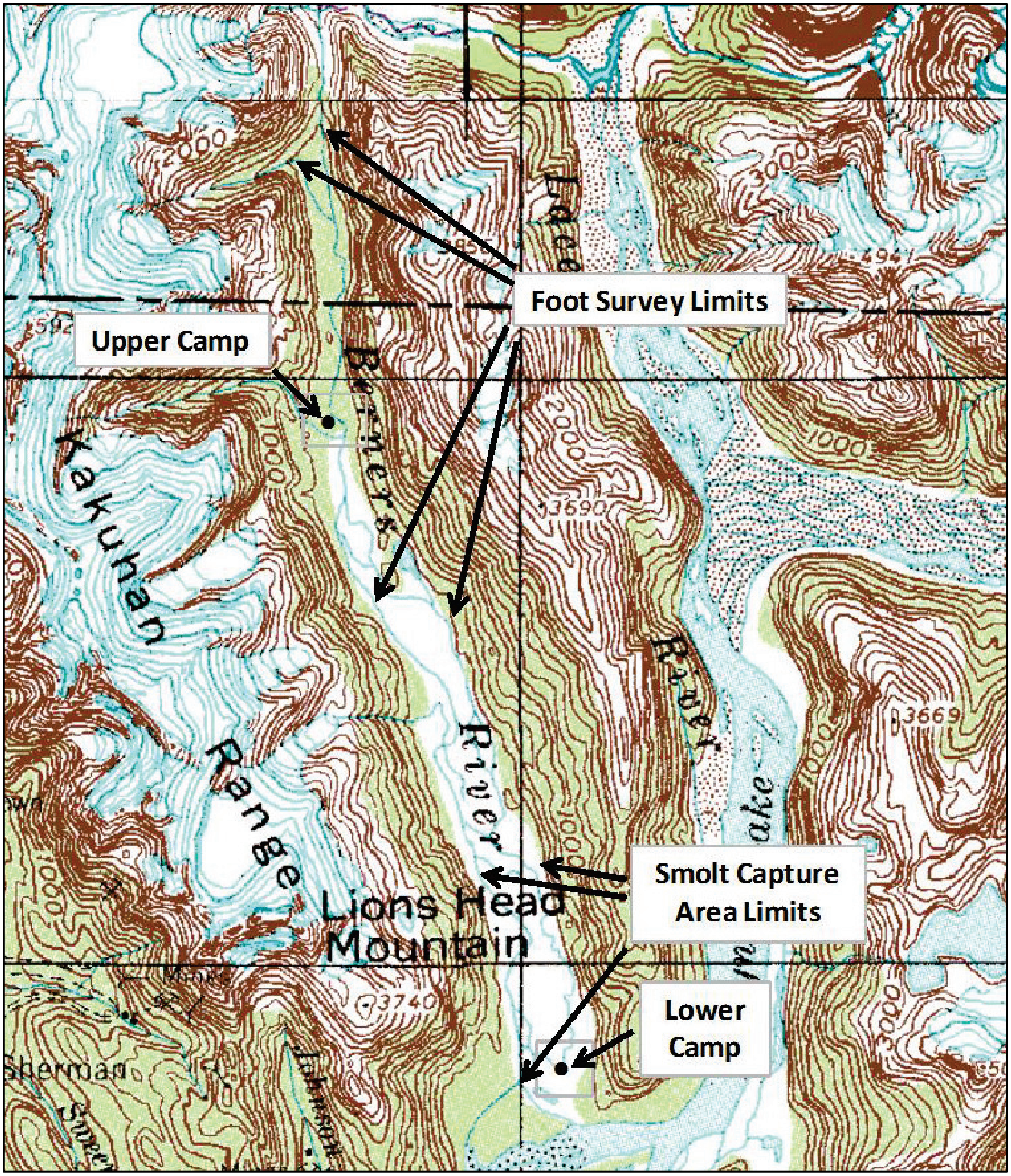

Figure 3.–Berners River drainage showing camp locations, and downstream and upstream limits of the fall foot escapement survey and spring smolt trapping with trough and minnow traps.

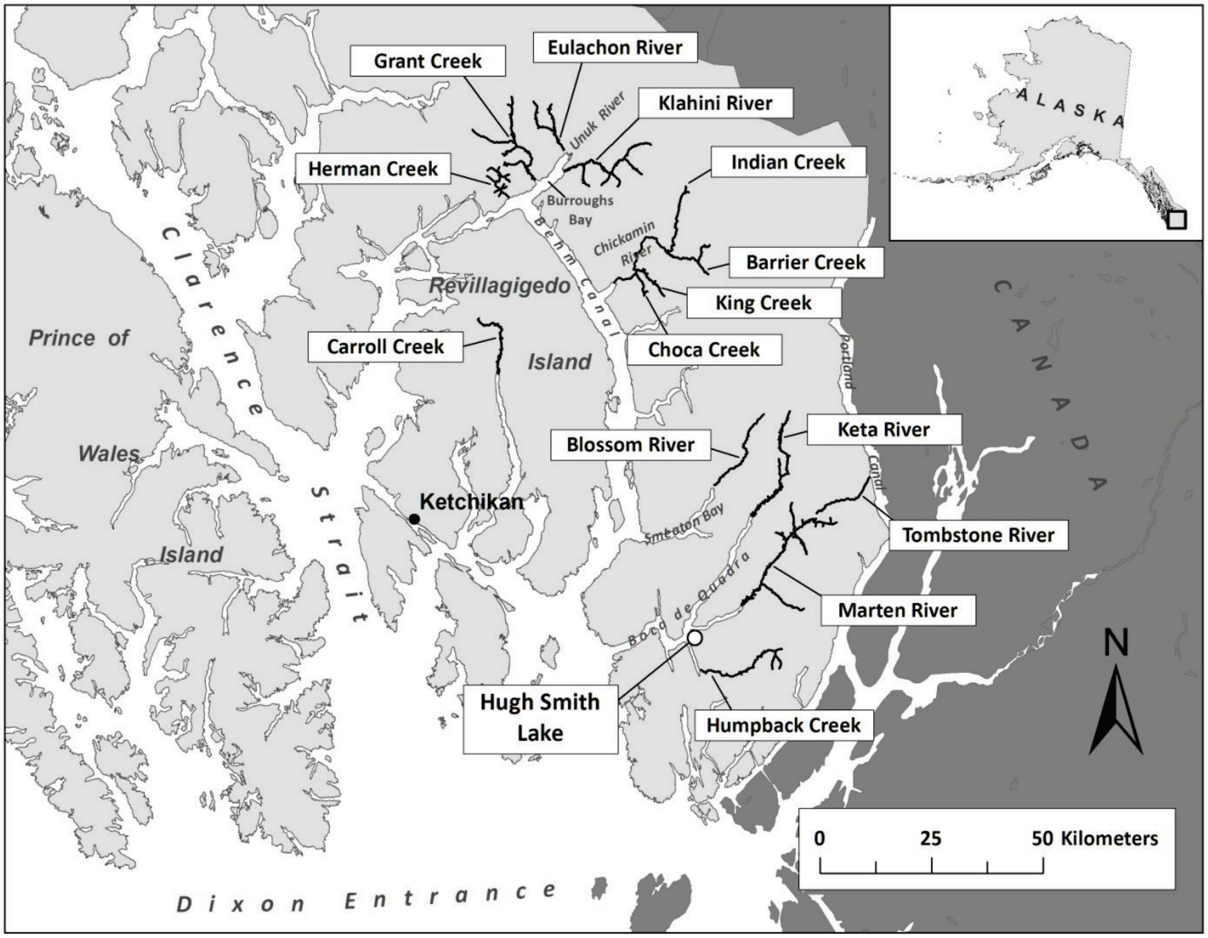

Figure 4.–Map of the Ketchikan area, showing Hugh Smith Lake and District 101 coho salmon index streams.

Appendix A.–Sample size required for approximate 90% or 95% simultaneous confidence intervals.

	Number of age classes					
	90% Confidence			95% Confidence		
Population Size	2	3	4+	2	3	4+
500	176	218	224	218	251	253
1000	214	278	288	278	335	338
1500	230	306	318	306	377	381
2000	239	323	336	323	402	407
2500	245	334	347	334	419	424
3000	249	341	356	341	431	436
3500	252	347	362	347	440	445
4000	254	351	366	351	447	452
4500	256	355	370	355	453	458
5000	257	357	373	357	457	463
6000	259	362	378	362	464	470
7000	261	365	381	365	469	475
8000	262	367	384	367	473	479
9000	263	369	386	369	476	483
10000	264	370	388	370	479	485
15000	266	375	393	375	487	493
20000	267	377	395	377	491	497
25000	268	379	397	379	493	500
30000	269	380	398	380	495	501
35000	269	380	398	380	496	503
40000	269	381	399	381	497	504
45000	269	381	399	381	497	504
50000	270	382	400	382	498	505
60000	270	382	400	382	499	506
70000	270	383	401	383	499	506
80000	270	383	401	383	500	507
90000	270	383	401	383	500	507
100000	270	383	401	383	500	507
Infinite	271	385	403	385	503	510