Regional Operational Plan SF.1J.2014.06

Coho Salmon Coded Wire Tagging and Escapement at Cowee Creek, 2014

by

Kercia Schroeder

Jeff Nichols

and

Sarah Power

June 2014

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

REGIONAL OPERATIONAL PLAN SF.1J.2014-06

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Alaska Department of Fish and Game, Division of Sport Fish, Douglas

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Division of Sport Fish

June 2014

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Kercia Schroeder, Jeff Nichols, and Sara Power
Alaska Department of Fish and Game, Division of Sport Fish,
PO Box 110024, Juneau, AK 99811-0024, USA

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Title	Name	Signature	Date
Project Leader	Kercia Schroeder	Kercia Sch	3/12/14
Biometrician	Sarah Power	SPower	3/12/14
Research Coordinator	John Der Hovanisian	John DH	3/17/14

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ABSTRACT

A coho salmon (*Oncorhynchus kisutch*) stock assessment project consisting of a 2-event mark-recapture experiment will be conducted at Cowee Creek, which is located north of Juneau on the road system. In spring 2014, coho salmon smolt emigrating from Cowee Creek will be captured using a combination of minnow, hoop, and spill traps; smolt ≥75 mm FL will be marked with coded wire tags and adipose fin clips. Marked fish harvested in marine sport and commercial fisheries will be sampled by ADF&G port and creel sampling programs in 2014 and 2015, which will provide a means for estimating marine harvest of smolt that emigrated from Cowee Creek in 2013 and 2014. In fall 2014, the escapement will be sampled to estimate the number of coho salmon smolt that emigrated from Cowee Creek in 2013, and to estimate the escapement of adult coho salmon returning in 2014. Adults will be captured using a combination of nets and sport fishing gear and will be inspected for adipose fin clips. All captured adults will be sampled for age, sex, and length data. This mark-recapture study and resulting information will allow managers to determine the extent of marine harvest related to this important roadside fishery, in addition to providing the basis for a more robust stock assessment.

Key words: Cowee Creek, Juneau roadside fishery, Southeast Alaska, coho salmon, stock assessment, mark-recapture, coded wire tag, marine survival, escapement, smolt production.

PURPOSE

The main purpose of this project is to estimate marine harvest and determine where, when, and by what gear type adult coho salmon (*Oncorhynchus kisutch*) from Cowee Creek are intercepted in marine fisheries. Cowee Creek, located on the Juneau road system, is believed to have one of the largest runs of coho salmon within this area, and is one of the most heavily fished streams in the Juneau roadside fishery. Currently, only limited information exists on the Cowee Creek coho population. Emigrating juvenile coho salmon will be tagged with coded wire tags (CWTs); tagged adults will be recovered in marine and inriver sampling programs to estimate harvest and assess harvest timing and distribution. This information will allow managers to determine the extent of harvest related to this important roadside fishery, in addition to providing the basis for a more robust stock assessment.

BACKGROUND

The core mission of the Alaska Department of Fish and Game, Division of Sport Fish (ADF&G-SF) is to protect and improve the state's recreational fisheries resources. A number of goals and supporting objectives have been identified to ensure the mission is achieved. To successfully manage these resources, it is important for managers to: 1) identify data needs or gaps that exist; 2) prioritize stock assessment and research projects based on existing needs or gaps; and 3) determine if any management concerns exist, based on data gathered through ADF&G-SF projects (ADF&G 2012b). Occasionally, concerns raised by the public or proposals submitted through the Board of Fisheries process may alert the attention of managers to issues not otherwise prioritized or considered. This may be especially true if potentially significant shifts in sport or commercial harvest patterns and effort occur.

Coho salmon are an important resource to numerous sport, commercial, and subsistence users in Southeast Alaska (SEAK) (Elliott and Kuntz 1988; Schmidt 1988; Halupka et al. 2000; Shaul et al. 2011; McCurdy 2012). The principle management objective, acted on jointly by the ADF&G-SF and ADF&G Division of Commercial Fisheries (ADF&G-CF), for coho salmon in SEAK fisheries is to achieve maximum sustained yield (MSY) from wild stocks. A secondary management objective, that may have varying significance for specific coho stocks, is to maintain long-term commercial gear-type allocations that were established by the Alaska Board of Fisheries in 1989. In the early 1980s, ADF&G implemented an improved stock assessment program to better understand and manage coho salmon stocks; new assessment projects were implemented for indicator stocks, which formed the basis for improved management of the species (Shaul et al. 2011). Despite the additional effort, stock-specific information is not available for over 90% of the coho salmon stocks in SEAK. Managing coho populations across SEAK is further clouded by the fact that the majority of commercial harvest occurs in temporally and geographically dispersed mixed stock fisheries where individual coho stocks intermingle (Shaul et al. 2011). The fact that coho have an extensive distribution in SEAK and return to fresh water during times of inclement weather and high stream flow further contribute to the complexity and cost of obtaining data once adults return to their natal streams. As a result, most data are derived from a small and limited subset of stocks throughout SEAK. Lack of sufficient information is the most pervasive risk factor threatening sustainable management of coho salmon stocks in the region (Halupka et al. 2000).

Coho salmon typically return to the marine waters of SEAK in July and August and enter fresh water in September and October. The direction of the return migration generally moves from northwest to southeast along the coast; however, relatively little is known about the migration routes used by specific coho salmon stocks (Schmidt 1988; Halupka et al. 2000). Commercial fisheries targeting other salmonid species often harvest a substantial incidental catch of coho salmon, which makes run timing an important biological trait that influences vulnerability. In general, stocks that pass through the most fisheries during their spawning migrations experience the highest exploitation rates. Stocks located in Lynn Canal, stocks in the Taku River region with normal run timing, and stocks in southern Southeast Alaska have the highest exploitation rates; stocks on the outer coast generally have the lowest exploitation rates (Halupka et al. 2000). Small stocks are particularly vulnerable to high exploitation rates, which may or may not be sustainable (Hilborn 1985; Elliott and Kuntz 1988; Halupka et al. 2000). Considering the above, those coho stocks associated with small or moderately-sized systems and located in inside waters of SEAK may be particularly vulnerable to unsustainable exploitation.

Recreational fisheries occur in both fresh and saltwater areas and have constituted an increasing component of the total coho salmon catch in recent years (Shaul et al. 2011). Based on ADF&G Statewide Harvest Survey (SWHS) results, one of the largest runs of coho salmon and one of the most heavily fished streams in the Juneau roadside fishery is Cowee Creek, located at the northern extent of the Juneau road system (ADF&G 2012a; Figure 1; Appendix A). There is very little additional information available on the Cowee Creek coho population; fish populations in this system have never been assessed in detail, either through juvenile fish studies or adult escapement surveys. The semi-glacial water condition in the Cowee Creek mainstem is one of the primary reasons for the lack of information on fish populations in the system (Bethers et al. 1995), at least with respect to visual counts of adult coho salmon obtained by foot or air.

In 2013, ADF&G-SF initiated a multi-year coded wire tagging stock assessment project on Cowee Creek; this 2014 operational plan describes work that will be conducted during the second year of the project. The primary focus of this project is to gain information about where and when adult coho salmon, originating in Cowee Creek, are harvested in marine fisheries. This will be realized by tagging juvenile coho salmon emigrating from Cowee Creek, followed by the recovery of returning adults intercepted in marine waters and in Cowee Creek. Tags recovered in marine sport and commercial fisheries will yield information on where (statistical area, district, etc.), when (statistical week), and how (type of fishery) coho smolt tagged in 2013 and 2014 were harvested. This information will be useful to managers who are responsible for protecting this important and productive Juneau roadside fishery. Funding for the work outlined in this operational plan is provided through the Dingell-Johnson (DJ) Fund with a 25% match provided by the Fish and Game Fund.

Description of Project Area

Cowee Creek is located approximately 64 km north of Juneau in the temperate coastal rainforest of SEAK (Figure 1). Cowee Creek is a popular sport fishing location due to its productive fisheries, road system access, and the presence of a trail that allows public access to fishing holes in the lower portion of the watershed (Figure 2). Cowee Creek has populations of coho, pink (*O. gorbuscha*), and chum salmon (*O. keta*), Dolly Varden (*Salvelinus malma*), and cutthroat trout (*O. clarkii*), and is reported to have small runs of spring and fall steelhead (*O. mykiss*) (Bethers et al. 1995). The Cowee Creek watershed has a drainage area of approximately 119 km^2 and empties into salt water at the south end of Berners Bay. The watershed is bordered by snow and glacier covered mountains and includes numerous tributary streams, of which Davies Creek, South Fork, and Canyon Creek are the largest (Figure 2). Both Cowee and Davies creeks have hanging glaciers that drain into their respective valleys (USFS 2009) that result in semi-glacial stream conditions from spring through fall (Bethers et al. 1995). Cowee Creek is believed to contain the largest amount of low gradient, floodplain stream habitat on the Juneau road system (CBJ 2012), and these habitats are often considered the most productive for salmon.

Nearly 88% of the land within the watershed boundary is owned and managed by the United States Forest Service (USFS), most of which is designated as the Héen Latinee Experimental Forest (USFS 2009). Other landowners within the watershed include: 1) the State of Alaska (including Point Bridget State Park); 2) Goldbelt, Incorporated; and 3) private owners. Land owned by the USFS is primarily in the upper portion of the watershed, while other entities own land in the lower portion of the watershed (Figure 3).

OBJECTIVES

1. Estimate the number of coho salmon smolt (≥75 mm FL) leaving Cowee Creek in 2014, such that the estimated number is within ±30% of the true value 80% of the time.
2. Estimate the age composition of coho salmon smolt (≥75 mm FL) captured in 2014 such that all age classes are estimated within ±10 percentage points of their true values 95% of the time.
    a. Estimate the proportion of small coho salmon smolt (75–85 mm FL) that are freshwater age 1 such that the estimate is within ±10 percentage points of the true value 95% of the time based on an a proportion ≥ 0.85.
    b. Estimate the proportion of large coho salmon smolt (>85 mm FL) that are freshwater age 1 such that the estimate is within ±10 percentage points of the true value 95% of the time based on a proportion of 0.50.
3. Estimate the marine harvest in sampled salmon fisheries in 2015 of adult coho salmon that originated from Cowee Creek via recovery of CWTs applied in 2014, such that the half-width of the calculated 95% confidence interval is 42% of the estimate.
4. Estimate the escapement of adult coho salmon in 2014 between August 1 and October 31, such that the estimate is within ±30% of the true value 80% of the time.

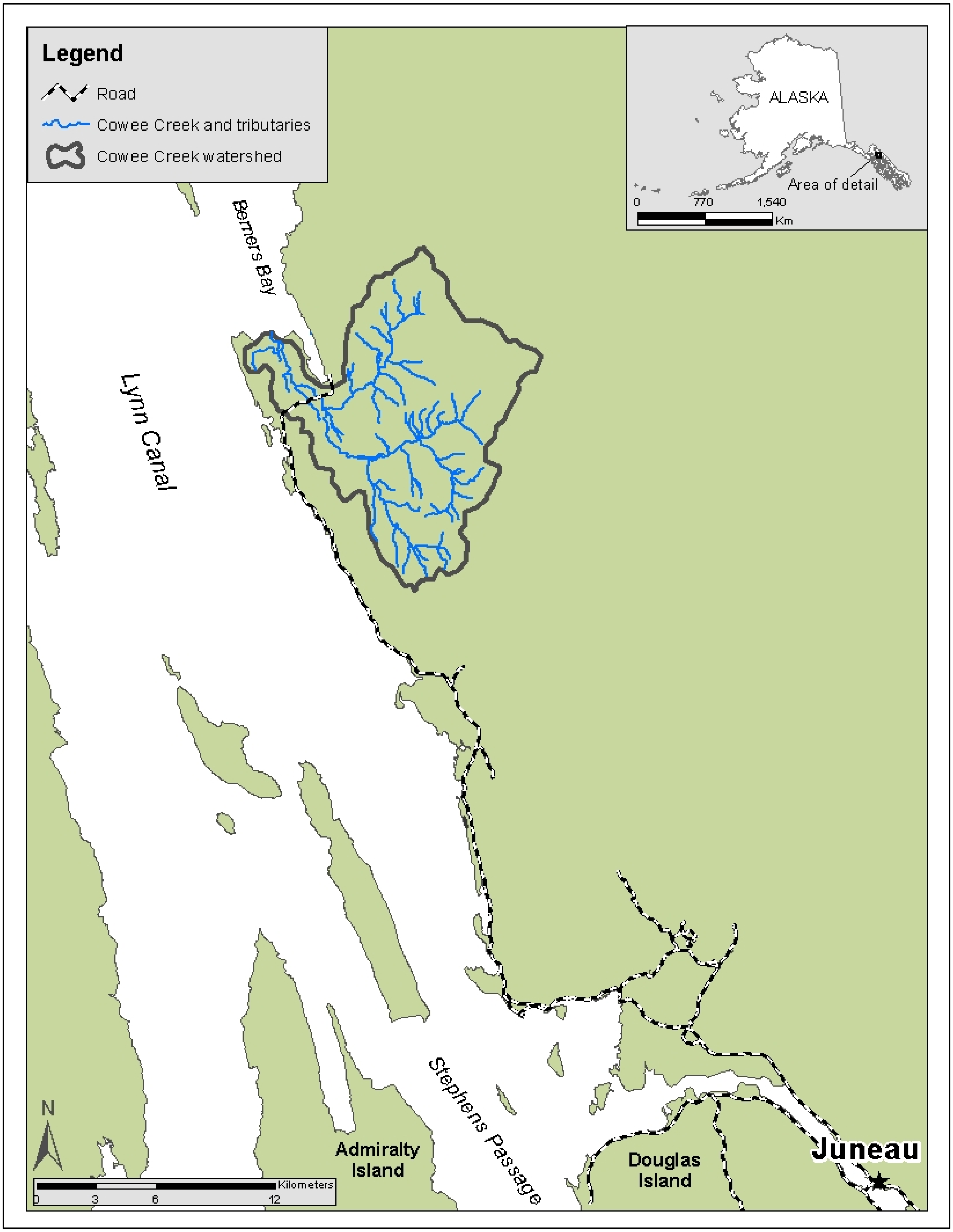

Figure 1.–Location of Cowee Creek watershed in Southeast Alaska.

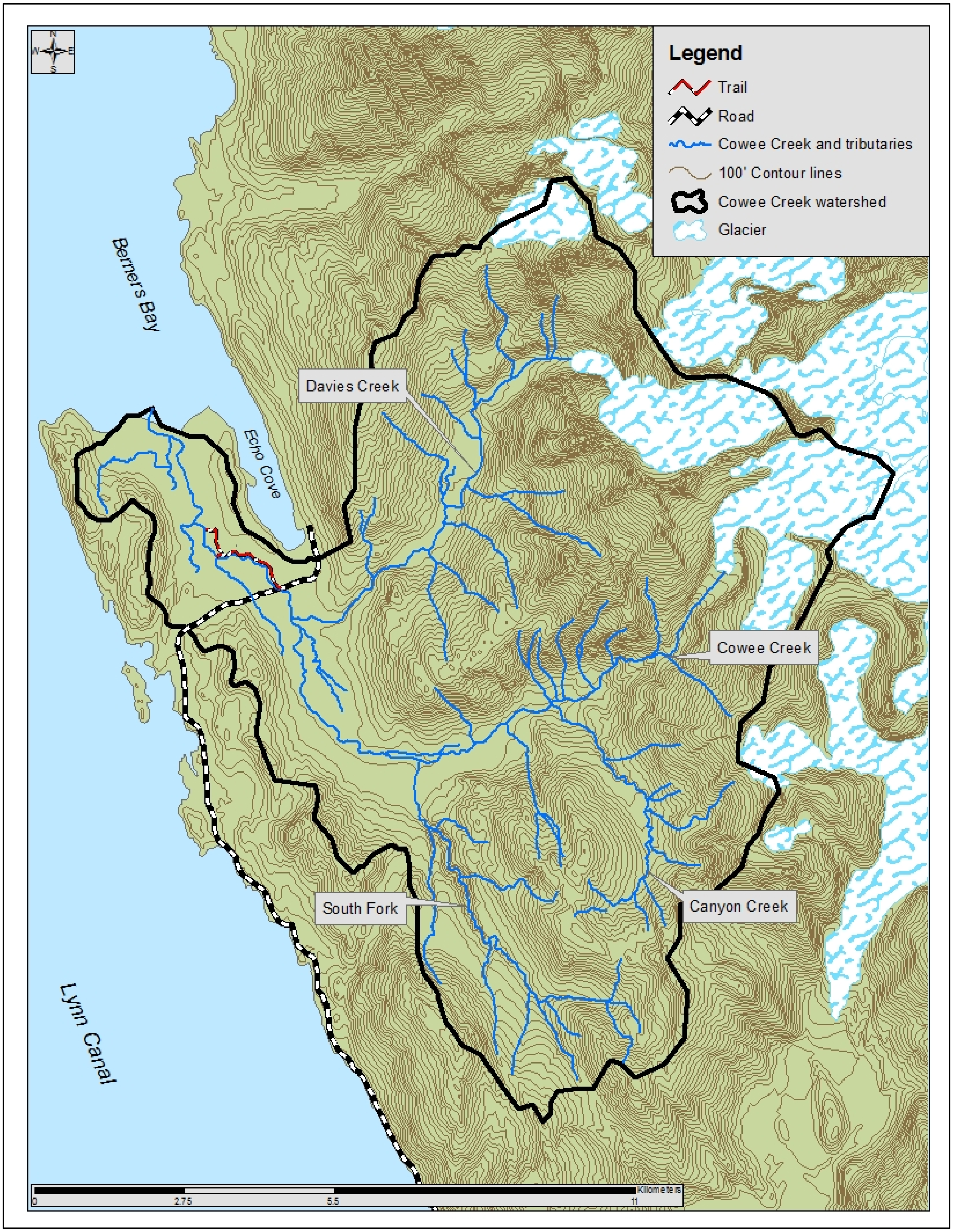

Figure 2.–Map identifying Cowee Creek and significant tributaries in Cowee Creek watershed, Southeast Alaska.

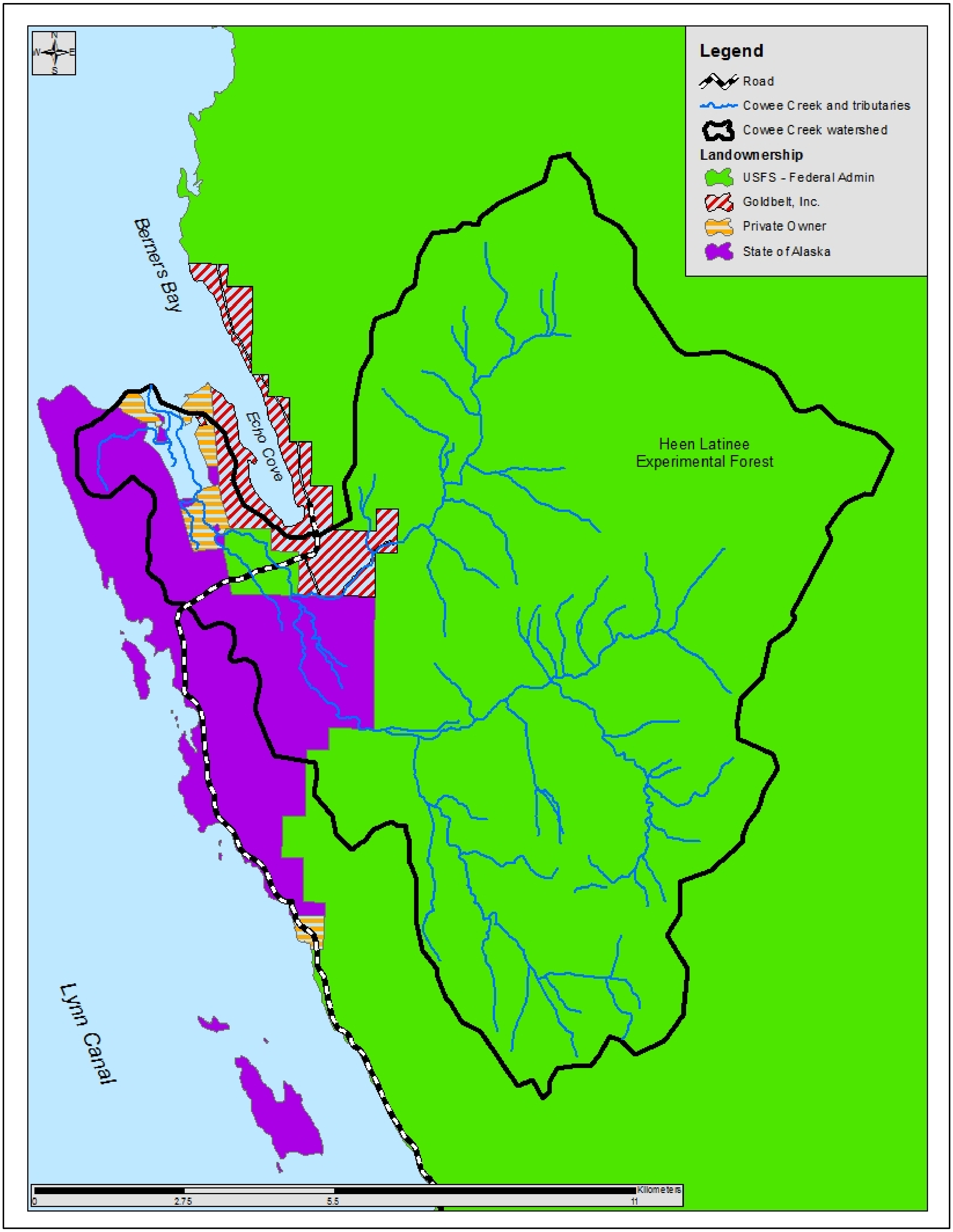

Figure 3.–Map identifying landownership in Cowee Creek watershed, Southeast Alaska.

SECONDARY OBJECTIVES

This project will address the following secondary objectives:

1. Estimate the mean length of coho salmon smolt (≥75 mm FL) in 2014.
2. Estimate the mean weight of coho salmon smolt (≥75 mm FL) in 2014.
3. Test the hypothesis that smaller coho salmon smolt (75–85 mm FL) survive at the same rate as larger smolt (>85 mm).
4. Determine the freshwater age of all adult coho salmon with readable scales sampled in Cowee Creek in 2014.
5. Determine the length and gender of all adult coho salmon sampled in Cowee Creek in 2014.
6. Record numbers of coho smolt and adults captured, by location, with the use of handheld Global Positioning System (GPS) units for each trap or gear type used.
7. Measure stream water conditions at the Cowee Creek bridge; water temperature will be recorded to the nearest 0.5°C and stream water level will be measured to the nearest 10th of a foot, during each day of operations.

This experiment will be based on the following assumptions: a total smolt abundance of 75,000; a marine survival of 10%; and an estimated 3,400 harvested in marine fisheries (Appendix B1), leaving 4,100 adults that enter the stream.

METHODS

STUDY DESIGN AND SAMPLE SIZES

Smolt Sampling

Smolt Abundance

A 2-event closed population mark-recapture experiment will be used to estimate the abundance of coho salmon smolt that emigrate from Cowee Creek in 2014. Smolt will be tagged in spring 2014 with CWTs and marked with adipose fin clips as part of Event I of the 2-event experiment. As part of Event II, returning adult coho salmon will be inspected for a missing adipose fin in 2015.

A minimum of a 2-person crew will be dedicated to capturing, tagging, and releasing juvenile coho salmon with CWTs, which will occur daily between approximately April 14 and June 13, 2014. Additional crew members will be used as available.

Juvenile coho salmon will be captured primarily in the lower portion of Cowee Creek watershed (Figure 4). A 2–3 person crew will set approximately 25–30 baited minnow traps and hoop traps daily on the mainstem and tributaries located in close proximity to the road system. Smolt trapping will not occur in tidally influenced reaches to avoid the additional stress that could occur in transitional habitats. Trapping effort may be adjusted based on additional staff availability, weather and water conditions, or smolt timing, distribution, and abundance patterns. In addition to the use of minnow and hoop traps, a spill trap will be installed near the outlet of a beaver pond complex where approximately 75% of all coho smolt tagged in 2013 were captured (Figure 4). Methods that will be used for operation and maintenance of minnow and spill traps will closely follow those described in Magnus et al. (2006).

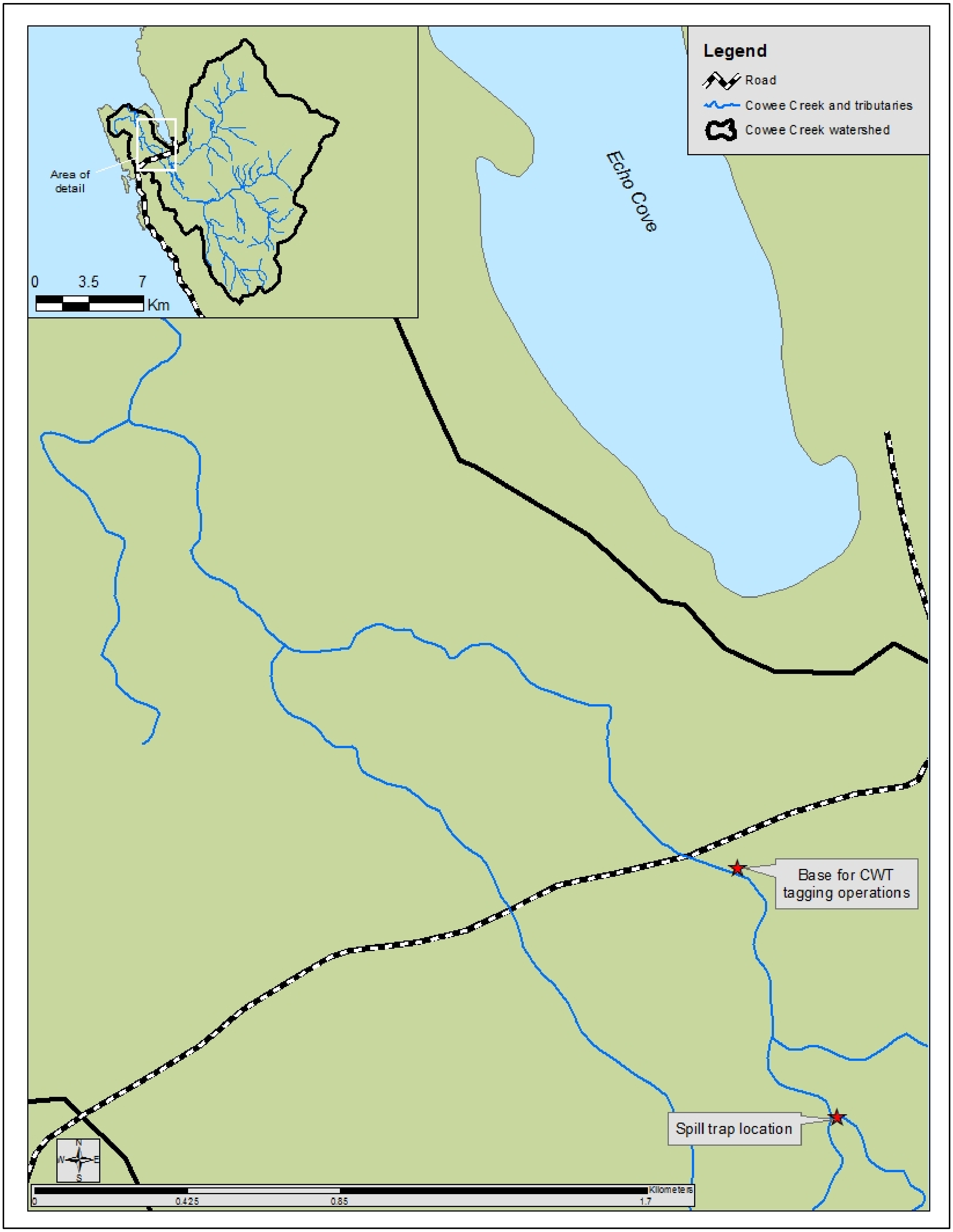

Figure 4.–Map displaying the lower portion of Cowee Creek watershed where juvenile coho salmon capture, sampling, and tagging will occur in 2014, Southeast Alaska.

It is recognized that trapping near the estuary in the Cowee Creek watershed may lead to the capture of juvenile coho salmon originating from nearby streams that may have entered Cowee Creek for rearing. To reduce this concern, the majority of effort will be focused upstream from the estuary. However, if smolt capture is inadequate higher in the system, trapping and tagging operations will be expanded accordingly. If coho smolt from other systems are tagged in Cowee Creek and return as adults to their nearby natal streams to spawn, one of the assumptions will be violated and the calculations may be suspect. However, without considerable effort to look for marked and tagged fish in nearby watersheds, this possibility cannot be eliminated or addressed through the methods and means currently identified.

All healthy coho smolt ≥75 mm FL captured each day will be transported by foot to a central location on the mainstem, near the bridge, for sampling and tagging (Figure 4). Fish will be transported in buckets using aerators to help maintain adequate oxygen levels, and water will be added as needed to maintain a near constant temperature similar to stream temperatures. Juvenile coho salmon that are ≥75 mm FL will be tranquilized with a buffered MS 222 solution, will have their adipose fin removed, and will be injected with a CWT. Each CWT will be formed and inserted in the smolt by using a Mark IV tagging machine that cuts a 1.1 mm section of wire from a spool stamped with a unique numeric code. Four 2,500-tag spools of wire will be used for 2 size classes of coho salmon smolt: those 75–85 mm FL (small), and those >85 mm FL (large) (Table 1).

Table 1.–Coded wire tag codes that will be used for tagging small and large juvenile coho salmon on Cowee Creek, 2014.

Smolt size class	Spool Size	Tag code
Small (75-85 mm)	2.5K	04-35-84
Large (> 85 mm)	2.5K	04-35-85
Large (> 85 mm)	2.5K	04-35-86
TBD[a]	2.5K	TBD

[a] Additional tag codes will be available for use to tag more smolt of the above size classes if need be.

Prior to release, all tagged fish will recover for 24 hours in a holding pen and will be checked for tag retention and post-tagging mortality to ensure a ≥98% retention rate. The subsample of tagged fish to check for tag retention will consist of 100 fish if the total number of tagged fish is ≥100; otherwise, every tagged fish will be examined for tag retention. Following these actions, all fish will be released in pocket waters of the mainstem near the sampling and tagging location.

Event II of the mark-recapture experiment will occur in 2015, when adult coho salmon returning to Cowee Creek will be sampled and inspected for missing adipose fins. The marked fraction (fish missing adipose fins) of coho salmon captured will be used to estimate smolt abundance in 2014 and marine harvest in 2015.

Model Assumptions for Estimation of Smolt Abundance

This 2-event closed population mark-recapture experiment is designed so that a Petersen-type estimator may be used to estimate smolt abundance. For the estimate of abundance to be unbiased, certain assumptions must be met (Seber 1982). These assumptions, expressed in the circumstances of this study, along with their respective design considerations and test procedures, are:

Assumption I: There is no recruitment to the population between years.

Considering the life histories of coho salmon, there should be no recruitment between sampling events. Because almost all surviving smolt return to their natal stream as adults to spawn, there will be no meaningful recruitment added to the population while they are at sea (i.e., low incidence of straying).

Assumption II: There is no trap-induced behavior, including mortality.

There is no explicit test for this assumption because the behavior of unhandled fish cannot be observed. Trap-induced behavior is unlikely because different sampling gears will be used to capture smolt and adults. Results from other studies (Elliott and Sterritt 1990; Vincent-Lang 1993) indicate that clipping adipose fins and implanting CWTs does not affect the mortality of tagged salmon smolts.

Assumption III: Tagged fish will not lose their marks between sampling events and all marks are recognizable.

The use of properly applied adipose fin clips will ensure that marks are not lost and that all marked fish are recognizable during second event sampling. Adipose fins will not regenerate like other fins if excised at the base. Naturally missing adipose fins on wild stocks of coho salmon are very rare (Magnus et al. 2006).

Assumption IV: One of the following 3 sets of conditions on mortality and sampling will be met:

- S1. All fish have an equal probability of being captured and marked during the first event; or
- S2. All fish have the same probability of surviving between events whether marked or unmarked and across all tagging groups and complete mixing of marked and unmarked fish occurs prior to the second event; or,
- S3. All fish have the same probability of surviving between events whether marked or unmarked and across all tagging groups and all fish have an equal probability of being captured and inspected for marks during the second event.

Assumption V: All fish marked as juveniles are smolt emigrating to sea during the same year they were marked and will not return to another stream.

One might have support that this assumption has been violated if a tag code comes back a year later than expected, or if a tag code is recovered escaping to a different system. If there are fish that do not smolt in a given tagging year, or return to a different system, then it may appear that there is a higher marked-to-unmarked ratio. If the smaller juveniles are less likely to smolt, it will appear that smaller fish survived at a lower rate.

As water conditions allow, minnow traps and the spill trap will be operated continuously, 7 days a week during the 2014 smolt emigration. In 2015, adult coho salmon immigrations will be sampled throughout the Cowee Creek watershed, 7 days a week, as water conditions allow.

It is noted that migration during both events may vary from day to day due to short-term changes in water conditions and fish behavior. Non-constant sampling and daily variations may reduce equal probabilities of capture throughout migrations, although the vast majority of fish will be eligible for capture. However, S2 of assumption IV is expected to be met. Recall that this assumption does not rely on equal probability of capture. Due to the extended time period between the marking and recovery events and the difference in behavior of salmon between these events, it is likely that complete mixing of marked and unmarked fish will effectively occur prior to the adult recovery events.

A contingency table analysis (Agresti 2007) will be conducted to test the null hypothesis that the probability of an adult missing an adipose fin is independent of when the fish was inspected for marks during the second event. Failure to reject the null hypothesis will indicate that S1 and/or S2 of assumption IV are satisfied.

Coho salmon smolt likely represent at least 2 age groups and cover a range of sizes. In the Taku River, there has been size-selective sampling during the first event and size-differential mortality rates detected for coho salmon emigrating from the Taku River (Jones III et al. 2006), resulting in failure of all 3 sets of conditions.

Equal survival between the coho smolt tagging groups (2 sizes) will be evaluated using contingency table analysis (Agresti 2007) to test for lack of independence between tagging group and probability of recovery during adult sampling (Secondary Objective 3). If no lack of independence between tagging group and adult tag recovery is detected, at least S2 is satisfied and Chapman 's (1951) modification to the Petersen estimator will be used to estimate abundance after pooling the tag codes. If lack of independence is detected between adult tag recovery rate and tagging group, then equal probability of capture during the tagging event will need to be evaluated. The weighted variant of Chapman's modification to the Petersen estimator (equation 3 below) must be calculated in order to estimate the ratio of the catchability coefficient for larger to smaller smolt A (equation 5 below) and the sampling variance of the ratio. If the estimate of A is not significantly different from 1.0, Chapman's (1951) formula will be used to estimate abundance as noted above. Otherwise, the modified estimator (equation 3) will be used to provide an unbiased estimate (see Data Analysis; Appendix C1). Past use of this estimator on the Taku River has increased the coefficient of variation of the estimate modestly (about 2.5 percentage points) (Williams et al. 2013b).

Assuming 75,000 smolt emigrate from Cowee Creek in 2014, a tagging rate of 0.03 will result in 2,250 smolt released with coded wire tags. Using the methods of Robson and Regier (1964), a minimum of 572 adult (ocean age 1) coho salmon will need to be inspected in the Cowee Creek escapement in 2015 to satisfy the precision criterion in Objective 1.

Smolt Age Composition

Based on an expected catch of about 2,250 coho salmon smolt, scale samples will be taken from every 10th coho salmon smolt to achieve a systematic sample of 225. Assuming scales from 20% of the fish sampled are unreadable, a minimum sample of 61 small smolt (75–85 mm) and 120 large smolt (>85 mm) will be necessary to meet the precision criteria in Objectives 2a and 2b, respectively (Cochran 1977). The precision criteria for Objectives 2a and 2b are necessary to minimize the contribution of the variances of $\hat{\phi}_1$ and $\hat{\phi}_2$ to the variance of A (see equation 5).

During the 2013 smolt sampling effort in Cowee Creek, approximately 32% of the smolt tagged were small and 68% were large. If similar proportions are realized in 2014, approximately 72 small smolt and 153 large smolt will be sampled. The overall sample of 225 will be more than sufficient to meet the precision criterion for Objective 2.

Smolt Mean Length

No precision criteria were given for Secondary Objectives 1 and 2 relating to mean length and weight of coho smolt, as these data are considered ancillary. The sample size for estimating ages should be large enough to get a reasonably precise estimate on mean length and weight. Weights and lengths will be recorded for every 10th coho salmon smolt sampled (i.e., every smolt that scales are taken from).

Adult Sampling

Adult Marine Harvest

After losses due to natural and harvest mortality in the marine environment, virtually all coho salmon smolt tagged in 2014 are expected to return to the Cowee Creek watershed to spawn in 2015. Some returning adults will be harvested in marine sport and commercial fisheries in 2015, which are sampled by ADF&G port and creel sampling programs. Heads will be collected from fish carrying CWTs, as identified by a missing adipose fin. The CWTs will be decoded by the ADF&G-CF Mark, Tag, and Age Laboratory (Tag Lab). Recovery of Cowee Creek CWTs intercepted in marine fisheries will provide important information to managers about where and when Cowee Creek coho salmon are being harvested, which is currently not known. Additionally, with the inriver adult work, a marked-to-unmarked ratio will be estimated, which will allow for expanding the number of tags recovered in fisheries to the number of Cowee Creek coho harvested in those fisheries. If an escapement estimate is pursued in 2015, then an exploitation rate estimate can be developed.

To meet the precision criterion in Primary Objective 3 (95% relative precision (RP) = ±42%), 3% of the coho salmon smolt (or approximately 2,250) need to be tagged in 2014 according to procedures in Bernard et al. (1998). This is based on inspecting about 30% of the anticipated harvest in the various commercial fisheries and 10–20% in sport fisheries (Glen Oliver, Fishery Scientist, ADF&G-CF, Douglas, personal communication; Mike Jaenicke, Fishery Biologist, ADF&G-SF, Douglas, personal communication).

The marine fisheries evaluation used in this simulation (Appendix B1), where Cowee Creek coho salmon are expected to be recovered, was modified from a list of fisheries where Taku River coho salmon are commonly recovered. The reason for using the Taku River stock as a surrogate for expected marine harvest, instead of Berners River, was due to the similar run timing between the Taku and Cowee stocks, compared to the later run timing exhibited by Berners River coho salmon.

Assuming 75,000 coho salmon smolt outmigrate in 2014 and 2,250 of them are tagged, 15 random fishery recoveries of CWTs are anticipated in 2015. Methodology in Bernard et al. (1998) was used to estimate the chance of missing harvest in fisheries. In the commercial troll fishery, the anticipated probability of recovering at least 1 CWT in all troll strata is 0.52 and the anticipated troll fishery harvest is 46% of the total harvest. In the sport fishery the probability of recovering at least 1 CWT in all strata is 0.13 and the anticipated sport fishery harvest is 18% of the total harvest. The seine and gillnet fisheries have 0.25 and 0.19 probabilities, respectively, of recovering at least 1 CWT in all strata and it is anticipated these fisheries will harvest 15% (seine) and 22% (gillnet) of the total harvest.

In 2015, adult coho salmon returning to Cowee Creek will be sampled and inspected for missing adipose fins between the end of July and the end of October. The marked fraction (fish missing adipose fins) of coho salmon captured will be used to estimate smolt abundance in 2014 and the harvest in the marine environment during 2015. See the "Smolt Abundance" section earlier in this methods section.

Adult Escapement

A mark-recapture experiment will be conducted between the end of July and the end of October in 2014, when adult coho salmon returning to Cowee Creek will be sampled and inspected for missing adipose fins. Escapement of adult coho salmon in Cowee Creek in 2014 will be estimated using a Petersen-type mark-recapture model (Seber 1982). During the mark-recapture experiment, adult coho salmon returning to Cowee Creek will be sampled and inspected for missing adipose fins to estimate the marked-unmarked ratio from the 2013 smolt marking experiment, which will be necessary to estimate smolt abundance in 2013 (Schroeder et al. 2013). It should be noted that adult sampling did not occur in the fall of 2013, so there were no observations of coho jacks that might have returned. Because larger smolts tend to produce jacks (McCurdy 2012), survival may be biased low, especially for large (>85 mm) smolts, for the initial year of this project. This limitation is accepted with the idea that the resulting bias should be low.

A minimum of a 2-person crew will be dedicated to capturing and sampling adult coho salmon; additional crew members will be used as available. Adult salmon will be captured weekly in Cowee Creek using a beach seine (15-m long x 2.5-m deep, with 3.75-cm stretch mesh), tangle net (12.5-m long x 2.5-m deep, with 7.5-cm stretch mesh), and hook-and-line (i.e., sport fishing) gear. Care will be taken not to injure any fish during capture and sampling; extra care will be taken in handling fish captured in the lower river due to sensitivity to handling stress observed in transition zones in other systems.

Each adult coho salmon captured will be sampled using methods similar to other ADF&G-SF salmon mark-recapture stock assessment projects in SEAK (Chapell and Elliott 2013; Jaecks et al. 2013; Johnson 2013; Williams et al. 2013a). Captured coho will be inspected for adipose fin clips (indicating they were CWT-tagged as a juvenile), presence of a T-bar anchor tag (indicating they were sampled during the first event), and operculum punches (indicating they have already been previously sampled). After inspection, all adult coho salmon that have not been previously captured will be sampled for age, sex, and length (ASL). Adult coho salmon that appear to be in good health will be marked with a uniquely numbered T-bar anchor tag and a secondary mark will be used to identify sampled fish, which will prevent double sampling in the event of primary tag loss. During Event 1, the secondary mark used will be one of various combinations of operculum punches identified in Table 2. Fish that are sampled during Event 2 will receive a single punch on the lower left operculum (LLOP); carcasses encountered during surveys will also be sampled for ASL data and will be marked by multiple slashes on the left side of the carcass to prevent double sampling.

Table 2.–Locations of operculum punches that will be used in 2014 as a secondary mark to identify adult Cowee Creek coho that have been sampled, which will prevent double sampling in the event of primary tag loss.

Date	Abbreviation	Secondary mark (operculum punch)
August 4–10	LU	left, upper
August 11–17	LM	left, middle
August 18–24	LUU	left, upper, upper
August 25–31	LMM	left, middle, middle
September 1–7	LUM	left, upper, middle
September 8–14	RU	right, upper
September 15–21	RM	right, middle
September 22–28	RUU	right, upper, upper
September 29 – October 5	RMM	right, middle, middle
October 6–12	RUM	right, upper, middle
October 13–19	LUUM	left, upper, upper, middle
October 20–26	LMMU	left, middle, middle, upper
October 27–November 2	RUUM	right, upper, upper, middle

The marked fraction (fish missing adipose fins) of coho salmon captured will be used to estimate smolt abundance in 2013 and marine harvest in 2014. All fish observed with a missing adipose fin will be sacrificed and its head taken. Each head will be assigned an individual head tag number and will be sent to the Tag Lab for further dissection and tag decoding.

Event 1 (i.e., marking event) of the adult escapement mark-recapture experiment will occur in the lower portion of Cowee Creek, between the upper extent of saltwater influence and the confluence with Davies Creek (Figure 5). Sampling in lower Cowee Creek for Event 1 will begin August 4 and will continue through the first extreme high tide cycle in early October. Most sampling will occur in pools where adult coho salmon hold. Sampling locations in the lower portion of the watershed will be accessed by foot.

Event 2 (i.e., recapture event) of the adult escapement mark-recapture experiment will occur in accessible reaches of Davies Creek, and in the Cowee Creek mainstem upstream of the confluence between the two streams (Figure 6). Starting the first week of September, Event 2 sampling will occur 1–2 days per week. After the first extreme high tide cycle in October, and continuing through the end of October, all remaining sampling will be for Event 2. Most sampling will occur in pools where adult salmon hold. Sampling locations for the second event will be accessed by foot, as well as by helicopter as funding allows.

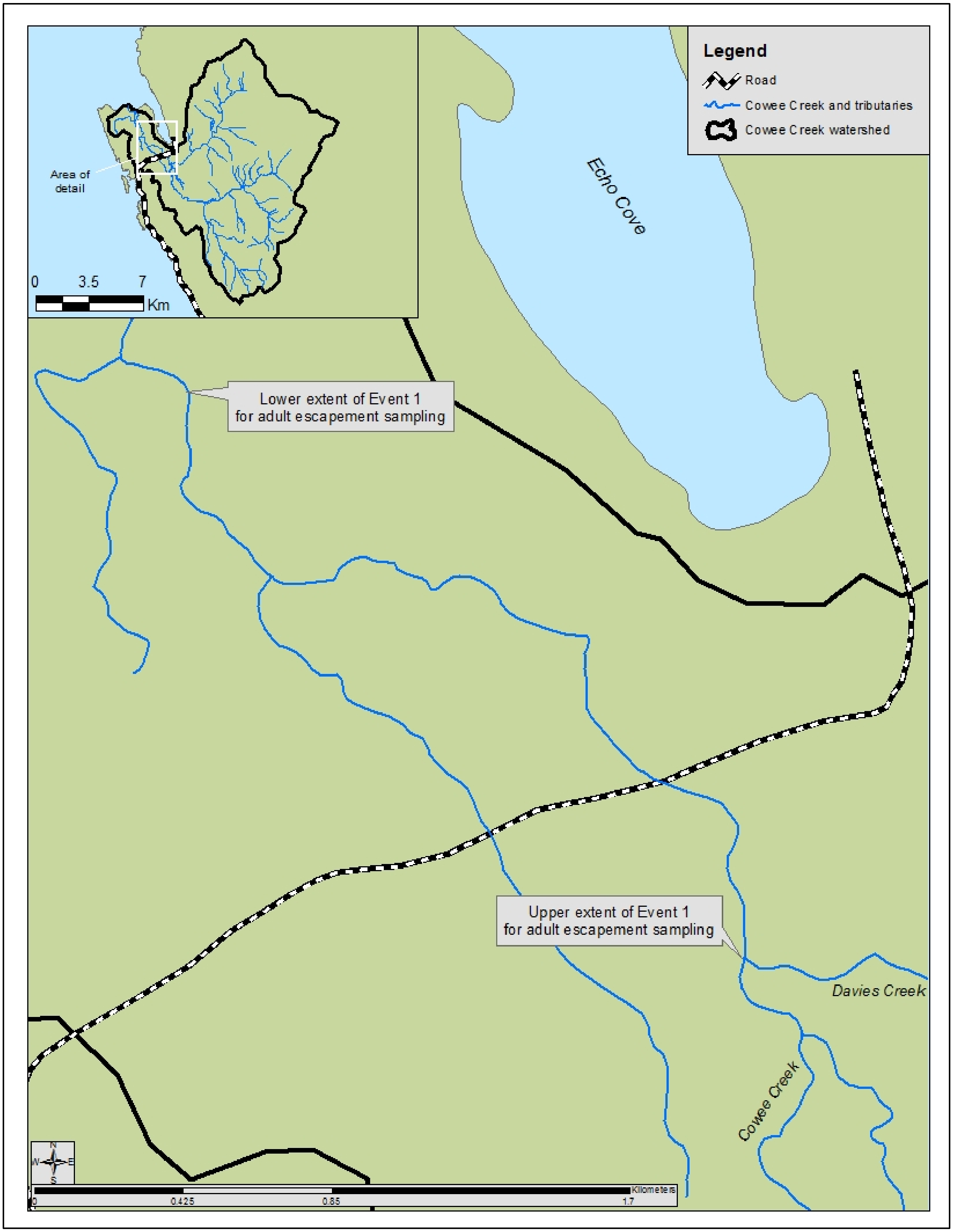

Figure 5.–Lower portion of Cowee Creek watershed where Event 1 of adult coho salmon escapement mark-recapture sampling will occur in 2014, Southeast Alaska.

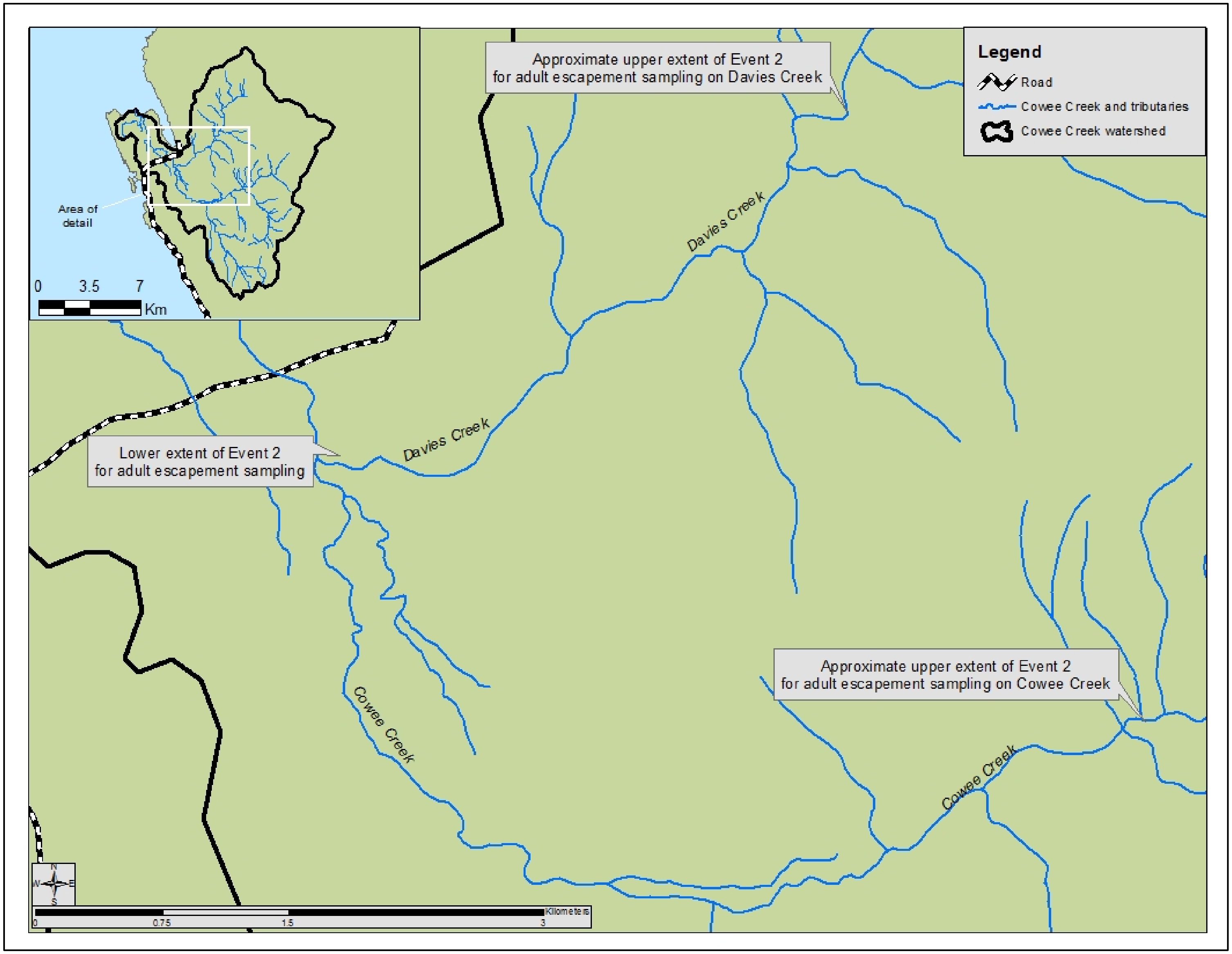

Figure 6.–Upper portion of Cowee Creek watershed where Event 2 of adult coho salmon escapement mark-recapture sampling will occur in 2014, Southeast Alaska.

Model Assumptions for Estimation of Coho Salmon Escapement

This 2-event closed population mark-recapture experiment is designed so that a Petersen-type estimator may be used to estimate abundance. For the estimate of abundance to be unbiased, certain assumptions must be met (Seber 1982). These assumptions, expressed in the circumstances of this study, along with their respective design considerations and test procedures, are:

Assumption I: The population is closed to births, deaths, immigration, and emigration.

Considering the life histories of coho salmon, there should be no recruitment between sampling events. First event sampling (marking) will begin prior to any significant passage of fish past the tagging sites and will continue through the run until passage has dropped to near zero.

Assumption II: Marking and handling will not affect the catchability of coho salmon in the second event.

There is no explicit test for this assumption because the behavior of unhandled fish cannot be observed. However, an attempt will be made to meet this assumption by minimizing holding and handling time of all captured fish. Any obviously stressed or injured fish will not be tagged.

Assumption III: Tagged fish will not lose their marks between sampling events and all marks are recognizable and detected.

Adult coho that appear to be in good health will be marked with a uniquely numbered T-bar anchor tag and a secondary mark will be used to identify sampled fish, which will prevent double sampling in the event of primary tag loss. The secondary mark used will be one of various combinations of operculum punches identified in Table 2.

Assumption IV: One of the following 3 conditions will be met:

A1. All coho salmon will have the same probability of being caught in the first event; or
A2. All coho salmon will have the same probability of being captured in the second event; or,
A3. Marked fish will mix completely with unmarked fish between samples.

Equal probability of capture will be evaluated by time, area, size, and sex. The procedures to analyze sex and length data for statistical bias due to gear selectivity are described in Appendix E1. If different probabilities are indicated, abundance estimates will be stratified within size groups. In this experiment, it is unknown whether marked and unmarked fish will mix completely.

To further evaluate the 3 conditions of this assumption, contingency table analyses recommended by Seber (1982) and described in Appendix E2 will be used to detect significant temporal or geographic violations of assumptions of equal probability of capture. Based on previous experience, it is anticipated temporal violations of these assumptions will be detected, and a Petersen-type model would yield a biased estimate. Therefore, abundance will most likely be estimated according to models developed by Darroch (1961) for a 2-event mark-recapture experiment on a closed population when temporal or spatial distributions of fish affect their probabilities of capture.

If the escapement of coho salmon into Cowee Creek in 2014 is approximately 6,600 fish (Schroeder et al, 2013), at least 326 fish need to be marked during Event 1 and 326 fish need to be inspected for marks during event 2 to achieve the precision criterion for Objective 4 (Robson and Regier 1964) assuming a Chapman (1951) model can be used to estimate abundance. If a Darroch model is required and we assume a Darroch (1961) model will provide an estimate with an SE that is about 50% larger than a Chapman model, at least 480 fish will need to be handled during each event.

If the escapement of coho salmon into Cowee Creek in 2014 is approximately 4,100 fish, at least 254 fish need to be marked during Event 1 and 254 fish need to be inspected for marks during event 2 to achieve the precision criterion for Objective 4 (Robson and Regier 1964) assuming a Chapman (1951) model can be used to estimate abundance. If a Darroch model is required, at least 371 fish will need to be handled during each event.

Temporal and Spatial Data Collection

Handheld GPS units will be used to capture smolt and adult observation data by identifying latitude/longitude for specific areas sampled and the numbers of fish collected over time.

Monitoring Stream Water Conditions

A crest staff gage currently exists on the mainstem of Cowee Creek, located on river left approximately 20 m downstream from the bridge. This gage will be checked each morning and the water level recorded to the nearest 0.1 foot. Two thermometers will remain at the staff gage location throughout the field season and will be checked at the same time the water level is obtained. One thermometer will be for water temperatures and the other will be for air temperatures; temperatures will be recorded to the nearest 0.5°C.

DATA COLLECTION

Smolt Sampling

Tag codes used will be recorded on the Coded Wire Verification Form (Appendix D1), as well as the Tagging and Release Information Form (Appendix D2); both forms are located on the Tag Lab's website. For each roll of tags used, a short section of the spool of coded wire will be taped to the Coded Wire Verification Form (Appendix D1) on the first day of tagging to identify which code is used for each of the two size classes. All tag and recapture data will be recorded daily on the form entitled Salmon Smolt CWT Daily Log (Appendix D3). The data on the Daily Log will be used to record daily environmental data, catch, tagging, release, and recapture data. A new daily log will be filled out for each day of operation. Magnus et al. (2006) describes in detail the methods that will be used for tagging coho smolt.

Daily procedures will be as follows:

1. Record air and water temperature to nearest 0.5°C and stream water level to the nearest 0.1 foot. Climatological data should be collected at the same time each day and recorded on the Daily Log.
2. Remove fish from traps, sort coho smolt from other species and only transport coho smolt ≥75 mm FL to the tagging station. Record coho trap catches on the Salmon Smolt Capture and GPS Location Form (Appendix D4).
3. Inspect each live coho smolt ≥75 mm and count the number with adipose clips. Test all recaptures for tag retention, measure for length to the nearest mm, and release. Record

number caught with and without CWTs on the Daily Log form and record length of all recaptures on the Salmon Smolt Length, Weight, and Scale Samples Form (Appendix D5).

4. Inject all live fish with a CWT and pass each through the tag detector. If rejected by the detector, retag and tally all retags on a hand counter. Write the beginning and ending machine numbers on the daily log and record retags, mistags (i.e., goofs, misses, etc.), and practice tags. Show your calculations for the number of tags used.
5. Select every 10th coho smolt for sampling as described below.
6. Count the number of mortalities and record on the Salmon Smolt CWT Daily Log (Appendix D3).
7. At 0900–1000 hrs the following day, check all fish for any overnight mortality and randomly select 100 representative fish (or all fish if <100 were tagged) for each size class to check for tag retention. Record results on the Salmon Smolt CWT Daily Log (Appendix D3). If tag retention is 98% or greater, count and record mortalities, record results, then transport fish to the release site and release all fish. Retag all fish that test negative. If tag retention is less than 98%, reprocess the entire batch as described above and retag any that test negative.

Every 10th coho salmon smolt tagged will be measured from snout to fork of tail (FL) to the nearest 1 mm, weighed to the nearest 0.1 g, and sampled for scales. Twelve to 15 scales will be removed from the preferred area on the left side of the coho salmon smolt (Scarnecchia 1979). Scales will be sandwiched between two 1- x 3-in microscope slides and numbered consecutively for each sampled fish. Slides will be taped together and the unique number and length of each fish will be written on the frosted portion of the bottom slide according to scale position on the slide. Fish-slide number, length, location, date, and sampler's initials will be included on the Salmon Smolt Length, Weight, and Scale Samples Form (Appendix D5). Ages will be estimated postseason.

Instructions to improve the ability to read scales, as determined by staff experience, are:

1. Clean the scales, spread them out so they do not touch,
2. Do not tape over any scales, and
3. Make sure slides and slide covers are accurately labeled.

Adult Escapement Sampling

Data collected for each adult coho salmon captured during Event 1 of escapement surveys will be recorded on the Cowee Creek Adult Coho ASL Form (Appendix D6). Information to be recorded includes: location (lower Cowee will be circled for Event 1); sampling crew; and comments about weather and water conditions. For each fish captured, the following data will be recorded: date; GPS waypoint and associated error; cumulative fish number (each newly captured fish will be sequentially numbered to keep track of the total number of coho salmon inspected and is not to be confused with anchor tag number because not all coho salmon will necessarily be tagged); gear type used for capture (T = tangle net, B = beach seine, Sp = sport, Sn = snag); sex (M = male, F = female; determined by examining external secondary maturation characteristics); scale card number, scale sample number on the card (1–10), length (to the nearest 5 mm MEF measurement), anchor tag number, cinch tag number (for fish that are missing their adipose fin and are sacrificed to have their head sent to the Tag Lab for CWT retrieval), operculum punch applied (Table 2), condition of the fish (1 = bright; 2 = slight coloration; 3 = obvious coloration, prespawn; 4 = postspawn; 5 = carcass), and any other comments the samplers might have about the fish (e.g., tag number and operculum punches for recaptured fish, presence of an adipose clip, presence of sea lice, etc.).

Each newly captured coho salmon should have a row of data associated with it on the ASL form, even if it does not receive an anchor tag. Fish that are recaptured will also have a row on the ASL form; however, only the date, anchor tag number, operculum punch observed, condition, and comments will be recorded.

To determine the age of each coho sampled, scale samples will be collected using methods adapted from standard ADF&G procedures (ADF&G 1994) and those described in Welander (1940). Five scales will be taken from the left side of the fish from the preferred area (2 scale rows above the lateral line, along a diagonal line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin). Three scales will be taken 2 rows up from the lateral line and 1 inch apart (the center scale is considered to be the preferred scale), and 2 scales will be taken 4 rows up from the lateral line, 0.5 inch to the right and 0.5 inch to the left of the preferred scale. Scales will be cleaned off, moistened slightly, then affixed to a completely labeled gum card (species; card number; locality = Cowee Creek or Davies Creek; stat. code = 115-20-062 for Cowee Creek or 115-20-063 for Davies Creek; date; gear; collectors = last names; remarks = weather, missing scales, etc.).

It will be very important to completely label gum cards and forms so that the scales and data can be matched up in the aging lab. Each scale will be mounted on the card in uniform direction, which will be with the anterior side up and the outward (i.e., sculptured or textured) side of the scale facing out. All five scales taken from an individual coho will be mounted in one column on the card (i.e., scales from fish #1 will be placed on the card over box 1, 11, 21, 31, and below 31). Scale samples from 10 fish will be mounted on each gum card and the scale card and scale numbers will be recorded on the Cowee Creek Adult Coho ASL Form (Appendix D6). If for some reason scales are not collected from a fish, that column on the scale card will be crossed off in pencil and "no scales for fish #_" noted in the comments box. For example, recaptured fish will be released without taking scales. It will be very important to keep the gum cards dry and free of dirt; excessive moisture will dissolve the glue on the card, which can lead to scales falling off the card or washing out of alignment. Running glue and dirt can also obscure ridges on the scales, resulting in unreadable imprints. Scales should be remounted on a new card, at the end of the day, if they have been sampled in extremely wet conditions, if the scales are dirty, or if the scales are not mounted in uniform direction.

The sex of each fish sampled will be determined by visually inspecting external secondary maturation characteristics. As they mature, males develop hooked upper and lower jaws and a slight hump (Mecklenburg et al. 2002). Females have prominent bellies compared to males (Johnson 2013) and as they become more sexually mature, it is also common for them to develop a protruded vent.

All coho salmon captured with an adipose fin clip will be sacrificed, sampled for ASL data, then the head will be tagged around the jaw with a numbered cinch strap obtained from the Tag Lab. The cinch strap number will be recorded on the Cowee Creek Adult Coho ASL Form (Appendix D6). Heads with cinch straps will be preserved in field camp and will be delivered to the Tag Lab within 2 business days of the head being collected. Each head will be clearly labeled with the capture site, date, species, sex, and length (in mm MEF). Each day a head is collected, samplers will complete a Southeast Region Rack and Escapement Sampling Form (Appendix D7), which will be submitted to the Tag Lab along with the head.

Data collected for each adult coho salmon captured during Event 2 of escapement surveys will be recorded on the Cowee Creek Adult Coho ASL Form (Appendix D6). Information to be recorded includes: location (upper Cowee or Davies Creek will be circled for Event 2); sampling crew; and comments about weather and water conditions. For each fish captured, the following data will be recorded: date; GPS waypoint and associated error; cumulative fish number (each newly captured fish will be sequentially numbered to keep track of the total number of coho salmon inspected); gear type used for capture (T = tangle net, B = beach seine, Sp = sport, Sn = snag); sex (M = male, F = female; determined by examining external secondary maturation characteristics); scale card number, scale sample number on the card (1–10), length (to the nearest 5 mm MEF measurement), anchor tag number (for recaptured fish), cinch tag number (for fish that are missing their adipose fin and are sacrificed to have their head sent to the Tag Lab for CWT retrieval), operculum punch applied (LLOP) or observed (for recaptured fish), condition of the fish (1 = bright; 2 = slight coloration; 3 = obvious coloration, prespawn; 4 = postspawn; 5 = carcass), and any other comments the samplers might have about the fish (e.g., note fish as 'unmarked' for new captures, tag number and operculum punches for recaptured fish, presence of an adipose clip, presence of sea lice, etc.).

Each newly captured coho salmon should have a row of data associated with it on the ASL form and will be identified as 'unmarked' in the comments section. Fish that are recaptured will also have a row on the ASL form; however, only the date, anchor tag number, operculum punch observed, condition, and comments will be recorded.

Temporal and Spatial Data Collection

A GPS waypoint will be collected at smolt and adult capture locations. For smolt sampling, each waypoint taken and the associated GPS accuracy level (i.e., error in meters) will be recorded on the Salmon Smolt Capture and GPS Locations form (Appendix D4). For adult sampling, each waypoint taken and the associated GPS accuracy level will be recorded on the Cowee Creek Adult Coho ASL Form (Appendix D6).

Monitoring Stream Water Conditions

Each morning, the following information will be recorded on the Cowee Creek Daily Environmental Conditions Form (Appendix D8): the water level observed on the Cowee Creek crest staff gage (to the nearest 0.1 foot); water temperature (to the nearest 0.5°C); air temperature (to the nearest 0.5°C); and general weather or water comments (e.g., sunny, windy, raining, clear water, glacial water, etc.). The gage and thermometers will be located on river left, approximately 20 m downstream from the bridge.

DATA REDUCTION

The leader of the field crew will ensure that data forms are kept up to date at all times and will check all data for errors. Data will be sent to the office at regular intervals and inspected for accuracy and compliance with sampling procedures. Data will be transferred from forms to

EXCEL®[1] files. When input is complete, data lists will be obtained and checked against the original field data. Electronic data files will be used to check tagging totals on data forms, to identify lengths less than prescribed guidelines, sampling rates for age, weight, and length, and for data to be included on forms submitted to the Tag Lab.

Forms that will be submitted to the Tag Lab include the Coded Wire Verification Form (Appendix D1), the CWT Release Report Form (Appendix D2), and the Southeast Region Rack and Escapement Sampling Form (Appendix D7). The Tag Lab is the clearinghouse for all information on CWTs. All CWT data (sampled fish, decoded tags, location, data type, samplers, etc.) are archived and accessible on a permanent ADF&G statewide database and once per year are provided to the permanent coastwide database administered by the Pacific States Marine Fisheries Commission.

Accumulated data for this project, including both juvenile and adult sampling, will be stored in Juneau at the following location: S:\DJ_ReportingPlanning\CoweeCreek_FreshwaterAssessment_2012\Data. A final, edited copy of the data, along with a data map, will be sent to Research and Technical Services (RTS) in Anchorage electronically for archiving.

DATA ANALYSIS

Smolt Abundance

The mark-recapture experiment based on coho salmon smolts and returning adults will use Chapman's modification of the Petersen Method (Seber 1982) to estimate abundance of smolts and its variance:

$$\hat{S} = \frac{(M+1)(C+1)}{(R+1)} - 1 \qquad (1)$$

$$V[\hat{S}] = \frac{\hat{S}(M-R)(C-R)}{(R+1)(R+2)} \qquad (2)$$

where $\hat{S}$ is estimated abundance of smolts in 2014, M is the number of marked smolt (all tag codes) released alive into the population in 2014, C is the total number of adults inspected for marks in 2015, and R is the number of adults with missing adipose fins in samples taken in 2015.

Several conditions must be met for this estimator to be unbiased for the experiment as noted earlier in this plan.

Equal survival between tagging groups will be evaluated using contingency table analysis (Agresti 2007) to test for lack of independence between tagging group and probability of recovery during adult sampling. If the null hypothesis of independence is not rejected, at least S2 (from assumptions listed earlier in this plan) is assumed to be satisfied and equations (1) and (2) will be used to estimate abundance after pooling the tag codes. If lack of independence is detected between the adult tag recovery rate, a weighted variant of Chapman’s modification to the Petersen estimator will be used to estimate abundance of Cowee Creek smolt:

[1] This and subsequent product names are included for a complete description of the process and do not constitute product endorsement.

$$\hat{S}'' = \frac{(\hat{A}M_1 + M_2 + 1)(\hat{C}' + 1)}{\hat{A}(R_1 + \hat{\pi}_1 R_3) + (R_2 + \hat{\pi}_2 R_3) + 1} - 1 \quad (3)$$

where A is the ratio of the catchability coefficients for larger (>85 mm FL) to smaller (≤85 mm FL) Cowee Creek smolt during the marking event and π_i is the fraction of adults that were smaller or larger Cowee Creek smolts during the marking event.

The estimate of A is used to adjust for differences in catchability during the marking event such that A>1 when larger smolt are more catchable, and A<1 when larger smolt are less catchable. Because some recaptured fish are not sacrificed to find tags or some marked adults do not contain tags, π_I's are used to assign recaptured fish of unknown pedigree to the appropriate smolt size group. The estimate of π is calculated:

$$\hat{\pi}_i = \frac{T_i}{T_1 + T_2} \quad (4)$$

where T_i is the number of all tags representing a smolt size group (i = 1, 2) recovered or recaptured from adult salmon regardless of how or where recovered or recaptured.

Evidence for smolts not having equal probability of being marked regardless of size can be found through calculations based on estimates of relative freshwater age composition of smolts and adults. If $\hat{p}$ is the estimated fraction of all <u>adults</u> that are of age 1., if $\hat{\phi}_1$ is the estimated fraction of <u>smolts</u> in the smaller-size group that were age 1., and if $\hat{\phi}_2$ is the estimated fraction of <u>smolts</u> in the larger size group that were age 1., an estimate of the ratio of catchability coefficients for larger to smaller smolt is (see Appendix C1 for derivation):

$$\hat{A} = \frac{T_2(\hat{\phi}_2 - \hat{p})}{T_1(\hat{p} - \hat{\phi}_1)} \quad (5)$$

Simulation results (see below) will be used to evaluate if this estimated rate is statistically different than 1.

Variance and 95% credible interval for $\hat{S}'$ or $\hat{S}''$ and $\hat{A}$ will be estimated using empirical Bayesian methods (Carlin and Louis 2000). Using Markov Chain Monte-Carlo techniques, posterior distributions for the estimated parameters will be generated by collecting 100,000 simulated values of the parameter components and parameters that are calculated using equations described from simulated data. Simulated values are modeled from observed data using the appropriate binomial or multinomial distributions.

Smolt Age Composition

Proportions by age will be estimated by:

$$\hat{p}_j = \frac{n_j}{n} \quad (6)$$

$$\text{var}[\hat{p}_j] = \frac{\hat{p}_j(1 - \hat{p}_j)}{n - 1} \quad (7)$$

where p_j is the proportion in the population in group j, n is sample size, and n_j *is* the subset of n that belong to group j. The systematic selection of samples implies proportional sampling and reduces bias from any inseason changes in age composition.

Estimates of Smolt Mean Length and Weight

Standard sample summary statistics will be used to estimate mean length- and weight-at-age and associated variances (Thompson 2002).

Adult Marine Harvest

The contribution r_{ij} of a release group j to a fishery stratum i is estimated:

$$\hat{r}_{ij} = \hat{N}_i \left[\frac{m_{ij}}{\lambda_i n_i} \right] \hat{\theta}_j^{-1} \tag{8}$$

where

- N_i = total harvest in fishery stratum i,
- n_i = number of fish inspected in fishery stratum i (the sample),
- λ_i = $(a_i' t_i')/(a_i t_i)$ is the decoding rate for CWTs from recovered salmon,
- a_i = number of fish which were missing an adipose fin,
- a_i' = number of heads that arrived at the lab,
- t_i = number of heads with CWTs detected,
- t_i' = number of CWTs that were dissected from heads and decoded,
- m_{ij} = number of CWTs with code(s) of interest, and
- θ_j = fraction of the cohort tagged with code(s) of interest.

Note: j represents the different tagging codes. If no statistical difference in survivability or capture is found between the tagging codes, then j = 1 and the equations may be simplified. See Bernard and Clark (1996) for further details.

Because N_i is estimated with error in sport fisheries, unbiased estimates of the variance of $\hat{r}_{ij}$ will be obtained using the appropriate large-sample equations in Table 2 of Bernard and Clark (1996), including the covariance between estimated harvests of cohorts within strata.

The total harvest for a cohort was calculated as the sum of strata estimates:

$$\hat{H} = \sum_i \sum_j \hat{r}_{ij} \tag{9}$$

$$Var\left[\hat{H}\right] = \sum_i \sum_j v\left[\hat{r}_{ij}\right] \tag{10}$$

Commercial catch data for the analysis will be summarized by ADF&G statistical week and district (for gillnet and seine fisheries) or by period and quadrant for troll fisheries (e.g., see Clark et al. 1985). Sport harvest estimates from ADF&G Statewide Harvest Survey reports (e.g., Jennings et al. 2011) will be apportioned using information from sampled marine sport fisheries to obtain estimates of total harvest by biweek and fishery. Sport fish CWT recovery data will be obtained from Tag Lab reports and summarized by biweek and fishery (e.g., biweek 16 during the Sitka Marine Creel Survey) to estimate contribution. In most cases, CWTs of interest may be recovered in only a few of the sport fish sampling strata that defined the fishery biweek. Assuming that the harvests of fish with CWTs of interest are independent of sampling strata within fishery biweeks, harvests and sampling information will be totaled over the fishery biweek to estimate contributions.

Adult Escapement

A two-sample mark-recapture model will be used to estimate the escapement of adult coho salmon into Cowee Creek in 2014. The appropriate abundance estimator will depend on the results of the aforementioned tests (Appendices E1 and E2). If stratification is not needed, Chapman's (1951) version of Petersen’s abundance estimator for closed populations (Seber 1982) will be used:

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 \qquad (11)$$

where $\hat{N}$ = estimated number of coho salmon, M = the number of coho salmon marked during Event 1 sampling, C = the number of coho salmon inspected for marks during Event 2 sampling, and R = number of marked coho salmon recaptured during Event 2 sampling.

If temporal-geographic stratification is not required but stratification by size or sex is (Appendix E1), the data will be fully stratified and estimates for each stratum will be generated using equations (1–3). These stratum estimates summed to estimate total abundance and variance.

An estimate of the variance for $\hat{N}$ will be obtained through bootstrapping (Efron and Tibshirani 1993), using the methods in Buckland and Garthwaite (1991). The four components of the mark-recapture experiment:

- $M - R$: fish that are marked during Event 1 but not recaptured;
- $C - R$: unmarked fish examined durng Event 2;
- R: marked fish recaptured during the Event 2; and
- $\hat{N} - M - C + R$: estimated number of fish not seen during either event;

will be modeled as a multinomial process using the proportions calculated from experimental data. A bootstrap realization (b) will be a randomized draw from this multinomial distribution. Subsequently, for each bootstrap sample $\hat{N}_b^*$ will be calculated using equation (1).

A minimum of 1,000,000 bootstrap samples (B) will be so drawn. The approximate variance will be calculated as:

$$\text{var}(\hat{N}) = \frac{\sum_{b=1}^{B} (\hat{N}_b^* - \hat{\bar{N}}^*)^2}{B-1} \qquad (12)$$

where $\hat{\bar{N}}^*$ is the average of the $\hat{N}_b^*$. Confidence intervals will be obtained using the percentiles of the distribution of the *B* bootstrap samples.

If geographic or temporal stratification is required, estimation of abundance will follow procedures described by Darroch (1961). Initial modeling will be conducted using the computer program SPAS (Arnason et al. 1996). If stratification by size is required, size stratification will be conducted first and methods to correct for geographic or temporal capture heterogeneity will be applied independently to each size stratum. The contingency tables described in Appendix E2 will be further analyzed to identify a) Event 1 strata (individual or contiguous groupings of temporal-geographic categories) where probability of recapture during the second event is homogeneous within strata and different between strata; and b) Event 2 strata where marked: unmarked ratios are homogeneous within strata and different between strata. Temporal categories generally will consist of groupings of sample data collected by week. Stratification will also be guided by environmental conditions encountered during data collection (stream stage height and rainfall). If the initial stratification does not result in an admissible maximum-likelihood (ML) estimate of abundance, further stratification may be necessary before an admissible estimate can be calculated. Nonadmissible estimates include failure of convergence of the ML algorithm in SPAS or convergence to estimators with estimated negative capture probabilities or estimated negative abundance. Goals in this case are always that observations within the pooled stratum should be as homogeneous as possible with respect to capture, migration, and recapture (Arnason et al. 1996).

A goodness of fit (GOF) test (provided in SPAS) that compares the observed and predicted statistics will indicate the adequacy of a stratified model. Once a stratification is identified that results in an admissible estimate of abundance, GOF will be evaluated. Further stratification, according to the guidelines described above, may be necessary to produce a model and abundance estimate with a satisfactory GOF. In general, the model selected will be that which provides an admissible estimate of abundance where no stratification guidelines are violated, no significant evidence of lack of fit is detected, and the smallest number of strata parameters are estimated for the model. This model will usually yield the smallest ML estimate of variance for the abundance estimate.

If the Darroch (1961) procedure is used to estimate abundance and the number of first event (s) and second event (t) strata in the preferred model is not equal, further modeling will be conducted to identify an alternative preferred model with s equal to t. The reason for the alternative model is that an analytical solution may be calculated for the ML estimate of abundance using equations provided in Seber (1982) – no ML search algorithm is required. An analytical solution greatly simplifies the bootstrap modeling that will be used to estimated variance (described below). For $s < t$, typically the largest (most recaptures) marking strata in the preferred model can be divided into 2 or more smaller strata to increase s. For $s < t$, the Event 2 strata will be divided to provide a larger t. Several alternative models, constructed in the manner, may be explored using the SPAs software. For all but the most ill-behaved data sets, this process will commonly produce one or more alternative models where $s = t$ and the ML estimates of abundance and SE are nearly identical to, and not statistically discernable from, those estimates from the preferred model. The chosen alternative model will be that for which the parameter estimates most closely match the preferred model.

Using the preferred alternative model ($s = t$), bootstrap methodology (Efron and Tibshirani 1993) will be used to estimate variance and confidence intervals. The procedures described above for the Chapman estimator will generally be followed, except a more complex multinomial distribution for fish in the population will be required. There will be (s)(t) capture histories for recaptured coho salmon, s capture histories for salmon marked but never recaptured, t histories for coho salmon captured upstream in the Event 2 sampling without marks, and one history for all salmon never caught.

Similar to what was described above for the Chapman estimator, a minimum of 1,000,000 bootstrap samples (B) will be drawn. For each bootstrap iteration, a randomized realization of the components of the partially stratified Darroch model will be drawn. An estimate of $\hat{N}$ will then be calculated for each of the B bootstrap samples using the methods describe in section 11.1 of Seber (1982). Equation (12) will be used to estimate the variance of the abundance estimate.

SCHEDULE AND DELIVERABLES

Dates for 2014 field and office activities associated with this project are included in Table 3.

Table 3.–Schedule for all office and field related activities for this project, 2014.

Date	Activity
March 3–April 11, 2014	Preparations for juvenile field sampling
April 14–June 13, 2014	Smolt trapping and tagging
June 16–20, 2014	Field clean-up
June 23–27, 2014	Data entry
June 30–August 1, 2014	Preparations for adult field sampling
August 4–October 31, 2014	Adult inriver recapture
September, 2014	Federal aid performance report due
November 3–7, 2014	Field clean-up
November 10–14, 2014	Data entry

A federal aid performance report will be prepared in September 2014 detailing all activities performed and any results produced during the reporting period. A Fisheries Data Series report will be prepared by July 1, 2015 that will summarize the initial 2013 CWT operations, information obtained from CWT recovery, the 2014 marine harvest of Cowee Creek originated coho stock, as well as the 2014 adult escapement for Cowee Creek coho salmon.

RESPONSIBILITIES

Kercia Schroeder, Fishery Biologist II (Douglas).

> Project leader. Oversees all aspects of the project, including study design, planning, budgeting, equipment acquisition, training, logistical matters, data collection, data entry, QA/QC, etc. Writes all required documents related to the project.

Jeff Nichols, Habitat Biologist III (Douglas).

Oversees and reviews the following aspects of the project including study design; planning, budgeting, equipment acquisition, training, and supervision of project personnel. Assists with field work and data collection.

Vacant, Fish and Wildlife Technician III (Douglas).

Assists with all aspects of field work and data collection, as well as installation and removal of field equipment. This position will be the field crew leader and will be responsible for making sure all data is accurate, organized, and is provided to the project leader in a timely manner.

Vacant, Fish and Wildlife Technician II (Douglas).

Assists with all aspects of field work and data collection, as well as installation and removal of field equipment.

Vacant, Fish and Wildlife Technician II (Douglas).

Assists with all aspects of field work and data collection, as well as installation and removal of field equipment.

Vacant, Regional Research Coordinator (Douglas).

Will review all operational plans and reporting documents.

Sarah Power, Biometrician II (Douglas).

Responsible for biometric input including study design, writing of operational plan, and review of all reporting documents.

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APPENDIX A. STATEWIDE HARVEST SURVEY RESULTS FOR JUNEAU ROADSIDE FISHERIES

Appendix A1.–Statewide Harvest Survey results for number of coho salmon harvested in Juneau roadside fisheries from 1996 to 2012.

	Number of coho salmon harvested (by survey year)																	
Juneau roadside stream name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Cowee Creek	361	271	735	393	575	312	644	989	456	588	498	230	468	1,270	505	458	228	528.3
Montana Creek	353	218	274	230	324	301	658	361	90	264	349	264	245	438	285	571	443	333.4
Peterson Creek and Salt Chuck	0	131	6	11	63	19	178	158	0	0	98	101	38	250	60	ND	ND	74.2
Fish Creek (Douglas Island)	30	0	30	0	111	73	111	35	0	197	0	110	24	0	376	35	45	69.2
Other Juneau road system	85	10	58	262	0	68	114	101	13	24	9	0	0	118	15	30	271	69.3

Appendix A2.–Statewide Harvest Survey results for number of anglers fishing Juneau roadside fisheries from 1996 to 2012.

	Number of anglers that fished (by survey year)																	
Juneau roadside stream name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Cowee Creek	665	836	1,146	589	938	875	852	1,195	880	1,044	1,143	1,221	917	1,221	845	743	812	936.6
Montana Creek	805	810	806	686	669	973	707	892	564	820	780	785	819	814	781	785	634	772.5
Peterson Creek and Salt Chuck	393	441	482	336	367	387	462	440	333	459	288	520	805	550	427	ND	ND	445.7
Fish Creek (Douglas Island)	924	795	580	808	981	1,192	787	972	1,032	1,196	695	1,018	1,099	908	594	743	707	884.2
Other Juneau road system	845	405	550	433	493	719	742	760	699	623	824	708	407	683	629	954	1,293	709.6

Appendix A3.–Statewide Harvest Survey results for number of days fished in Juneau roadside fisheries from 1996 to 2012.

	Number of days fished (by survey year)																	
Juneau roadside stream name	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average
Cowee Creek	1,639	1,555	2,135	1,522	2,594	3,087	1,845	2,989	2,250	2,489	2,507	1,703	2,222	4,252	2,803	1,861	1,702	2,303.2
Montana Creek	2,241	2,448	2,221	2,069	2,763	3,993	3,015	2,229	1,570	1,782	1,654	2,072	2,796	4,887	2,890	2,474	1,628	2,513.6
Peterson Creek and Salt Chuck	1,076	1,090	1,334	906	1,249	1,613	1,469	1,275	803	1,134	800	946	1,475	1,030	1,431	ND	ND	1,175.4
Fish Creek (Douglas Island)	1,432	1,690	918	1,627	2,068	2,359	2,234	1,533	3,022	3,926	1,819	1,981	2,215	2,119	1,945	1,695	2,182	2,045.0
Other Juneau road system	1,718	704	1,379	842	1,375	1,840	2,503	1,703	1,194	1,893	1,647	2,212	1,289	1,791	1,369	1,822	2,635	1,642.1

APPENDIX B. RESULTS FROM A SIMULATION PERFORMED TO ESTIMATE MARINE HARVEST FOR ADULT COHO RETURNING TO COWEE CREEK IN 2014

Appendix B1.–Statistics used to link the number of coho salmon smolt tagged in 2013 with the ultimate relative precision of the estimated marine harvest from adults returning to Cowee Creek in 2014.

ϕ = 0.30 (average all fisheries); θ = 0.03 (x 75,000 smolt corresponds to 2,250 smolt tagged)

Stratum	N_i or $\hat{N}_i$	$V[\hat{N}_i]$	n_i	m_i	λ_i	$\hat{r}_{ij}$	ϕ_i	$G(\hat{p}_i)$	$G(\hat{N}_i)$	$SE[\hat{r}_{ij}]$	Prob(m_{ij} >0)
Troll NW	464,526		136,722	5	0.9680	585	29%	0.198		260	0.993
Troll NW	342,310		107,596	3	0.9775	325	31%	0.330		187	0.950
Troll NE	116,205		32,082	2	0.9850	245	28%	0.496		173	0.865
Troll NW	2,473		274	1	0.7143	421	11%	0.998		421	0.632
Seine 112	66,452		11,548	1	1.0000	192	17%	0.995		191	0.632
Seine 114	17,511		3,675	1	1.0000	159	21%	0.994		158	0.632
Seine 109	9,874		2,341	1	1.0000	141	24%	0.993		140	0.632
Sport	3,389	418,542	3,389	3	0.9863	101	100%	0.323	0.0364	60	0.950
Sport	908	112,138	499	2	1.0000	121	55%	0.492	0.1360	91	0.865
Sport	5,720	706,420	2,328	1	0.8750	94	41%	0.989	0.0216	93	0.632
Sport	702		685	1	1.0000	34	98%	0.971		34	0.632
Sport	996	123,006	194	1	0.8333	205	19%	0.995	0.1240	205	0.632
Sport	316		302	1	0.6667	52	96%	0.981		52	0.632
Drift GN	17,759		6,692	2	0.9765	181	38%	0.494		127	0.865
Drift GN	2,740		577	2	1.0000	317	21%	0.497		223	0.865
Drift GN	9,101		3,811	1	1.0000	80	42%	0.987		79	0.632
Drift GN	723		584	1	0.9167	45	81%	0.978		45	0.632
Drift GN	2,228		637	1	1.0000	117	29%	0.991		116	0.632
	1,063,933	1,360,106	313,936	15		3,415	30%			738	

APPENDIX C. ESTIMATION OF THE RATIO OF CATCHABILITIES

The fraction p of adults with 1-freshwater age can be expressed as:

$$p = \frac{N_1\phi_1 S_1 + N_2\phi_2 S_2}{N_1 S_1 + N_2 S_2} = \frac{N_1\phi_1 S_1 + N_2\phi_2 B S_1}{N_1 S_1 + N_2 B S_1} = \frac{N_1\phi_1 + N_2\phi_2 B}{N_1 + N_2 B}$$

where N_i is smolt number by smolt size group i , S_i their survival rate, ϕ_i the fraction of the smolt group comprised of smolt age 1-freshwater, and B is the ratio of survival rates S_2/S_1. This relationship simplifies to:

$$\frac{N_1}{N_2} = \frac{B(\phi_2 - p)}{(p - \phi_1)}$$

If α_i is the capture rate of smolts, then $M_i = \alpha_i N_i$ is the number of smolts marked for groups i, and:

$$\frac{N_1}{N_2} = \frac{M_1}{M_2}\frac{\alpha_2}{\alpha_1} = \frac{B(\phi_2 - p)}{(p - \phi_1)}$$

If A is the ratio of catchability for the 2 groups of smolts, then $A = \alpha_2/\alpha_1$ since fishing effort by definition is equal for both groups. Substitution creates:

$$A = \frac{M_2 B(\phi_2 - p)}{M_1(p - \phi_1)}$$

A naïve estimate of A is therefore:

$$\hat{A} = \frac{M_2 \hat{B}(\hat{\phi}_2 - \hat{p})}{M_1(\hat{p} - \hat{\phi}_1)}$$

Noting that the estimate for the ratio of survival rates is:

$$\hat{B} = \frac{T_2}{M_2}\frac{M_1}{T_1} \text{ since } B = \frac{S_2}{S_1} \propto \frac{\frac{T_2}{M_2}}{\frac{T_1}{M_1}}$$ where T_i is the number tags recovered from group i

A simpler estimate for A is:

$$\hat{A} = \frac{T_2(\hat{\phi}_2 - \hat{p})}{T_1(\hat{p} - \hat{\phi}_1)}$$

APPENDIX D. DATA FORMS USED FOR JUVENILE AND ADULT SAMPLING

Appendix D1.–The ADF&G Coded Wire Verification Form that will be used to supply the Mark, Tag, and Age Laboratory with a sample of coded wire used to tag coho salmon at Cowee Creek.

Coded Wire Verification Form

Alaska Department of Fish and Game
Mark, Tag & Age Laboratory
10107 Bentwood Place
Juneau, AK 99811 - 5526
907-465-3483

Page ________ of ________

Facility or Project ____________________

Tag Code	Release Site	Species	# of K Purchased	Wire Samples, one per spool unless sequential wire then one from the beginning and another from the end of tagging.			

Appendix D2.–The ADF&G Tagging and Release Information Form that will be completed and submitted to the Mark, Tag, and Age Laboratory at the end of the field season.

Alaska Department of Fish and Game
Tagging and Release Information Form

TAG CODE (1/form): AG D1 D2 D3 D4 Beginning Seq.: ______ Ending Seq.: ______ Page ___ of ___

FOR TAG LAB USE ONLY
Code Verified As ______
By ______ Date ______

TAPE WIRE SAMPLE HERE (1/SPOOL)

SEQUENTIAL WIRE SAMPLES
First Tag Last Tag

GENERAL INFORMATION

Project Leader ______ Species (common name) ______
Agency ______ Brood Year ______
Division/Section (ADF&G only) ______ Stock ______
Facility ______ (leave Facility blank if Rearing Type = Wild) Ancestral Stock ______ (leave Ancestral Stock blank if Rearing Type = Wild)
Run ______ Funding Source ______
Statistical Replicates (not embedded) ______
Experimental Narrative (brief): ______ (leave Experimental Narrative blank if Rearing Type = Wild)

Rearing Type:
H - Hatchery
M - Mixed
W - Wild

ReleaseType:
E - Experimental
B - Both (E + P)
I - Index (not PSC)
K - PSC key
P - Production
O - Other

Experimental Class: (leave Experimental Class blank if Rearing Type = Wild)
A - Adult Return Timing
B - Brood Selection
C - Colonization
D - Diet Trial
E - Rearing Strategy
F - Genetic Study
M - Mass Marking
R - Remote Stocking
S - Size at Release
T - Time of Release
Y - Rearing Density
Z - Zero Check
Other:

Mark Type:
AD+CWT AD+CWT+VI AD+LV+CWT+TM AD+RV+CWT+TM
AD+CWT+TM AD+LV+CWT AD+RV+CWT Other:

TAGGING INFORMATION

Tagging Supervisor ______ Size of Tagged Fish ______ Grams # Naturally Missing Ad Fins ______

1 Date Mo/Day/Yr	2 Machine Number	3 Number Injected	4 Overnight Mortality	5 Good Fin Clip Sample Ratio	6 %Good Fin Clips (to 0.1%)	7 Adjusted Tagged (3-4)	8 Tag Retention Sample Ratio	9* % Tag Retention (to 0.1%)	10 Total Valid Tagged (7x9)
/ /				/			/		
/ /				/			/		
/ /				/			/		
/ /				/			/		
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Page Total (individual)					6A Weighted Average (Σ7/(Σ3−Σ4))		8A # Sampled	9A Weighted Average (Σ10/Σ7)	
Grand Total (all pages)								-	

Note: Fin clip information is currently not used in tagging calculations.

RELEASE INFORMATION

Release Supervisor ______
Release Site ______
Habitat Stream # ______
Time of Release ______ Military Time

Release Stage:
E - emergent fry
F - fed fry
G - fingerling
P - presmolt
S - smolt
A - adult

Unmarked Fish Counting Method:
B - book
C - actual count
F - feed conversion
P - Petersen estimate
V - volumetric
W - weight estimate

Expected Survival:
N - normal
D - fish destroyed
W - serious problem

Hatchery Release Strategy:
F - forced
M - mixed
V - volitional

11 Date of Final Good Fin Clip Test	12 Final Fin Clip Sample Ratio	13 % Good Fin Clips (to 0.1%)
DO NOT APPLY		
/ /	/	

14 Date of Final Tag Retention Test	15 Tag Retention Sample Ratio	16 ** % Tag Retention (to 0.1%)
DO NOT ENTER OVERNIGHT TEST DATA		
/ /	/	

17 Size at Release: Weight (grams/fish)	17 Size at Release: Fork Length (in mm)

18 Release Dates: Began Mo/Day/Yr	18 Release Dates: Ended Mo/Day/Yr
/ /	/ /

19 Total Injected (From 3 above)	20 Overnight Morts (From 4 above)	21 Morts After Tagging	22 Surviving Tagged Fish (19-20-21)	23 Best Estimator of Good Fin Clips	24 Surviving Fish With Good Clips (22x23)
				100%	

25 Best Estimator of Tag Retention (Either 9A or 16)	26 # of Marked Fish Having Tags (24x25)	27 # of Marked Fish that Shed Tags (24−26)	28 # of Fish Released NOT Marked but Represented by this Code	29 # of Failed Marks (22-24)	30 Total Unmarked Fish Released (28+29)	31 Total Number Fish Released (26+27+30)
				⊖		

Comments:

* Determined from a sample size of at least 200 tagged fish/machine/day ** Determined from a sample size of at least 500 tagged fish/code upon release

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Appendix D3.–Data form to record daily environmental conditions and coded wire tagging results.

SALMON SMOLT CWT DAILY LOG
SPORT FISH DIVISION

Tagging Site: Cowee Creek (above bridge) **Species:** coho salmon **Date**_______________

Air Temp: **Min.** __________ ° C **Max.** __________ ° C

Water Temp ________ ° C **Staff Gage Level** ________ft

Comments____

---

1. TAG RETENTION (The # released today alive that were tagged yesterday) __________________

TODAY'S TAGGING

2. TRAP MORTS: Fish found dead in trap or box______ / # of marked (ad clipped) dead fish______

3. RECAPTURES:

a. Total with CWTs ________ (Release immediately)

b. Number without CWTs ________ (Release next day after retention)

4. NEW CWTS APPLIED:

a. Ending Number ________ (Machine No.)

b. Beginning Number ________ (Machine No.)

c. Retags ________ (Hand counter)

d. Subtotal (a-b-c) ________ (Total CWTs Applied)

5. POST TAGGING MORTS: ________ (Morts)

6. NUMBER FISH HELD FOR TAG RETENTION ________ (Hold till next day)

7. TOTAL DAILY RELEASE (1+4d-5-6) ________

Notes:

---

1. TAG RETENTION TESTS (those fish held from the previous day):

a. From 24hr Hold : # of fish w/CWTs________ # of fish w/o CWTs________

b. Morts: _________

c. Retention Release: _________ (Carry over to next day

Appendix D4.–Data form used to record GPS and juvenile capture data.

SALMON SMOLT CAPTURE and GPS LOCATIONS

Year: 2014 **GPS Unit #:**_________ **Location:** Cowee Creek **Observers:**____

Comments:____

Date	Wpt # & Error (m)	# of traps checked	# of traps removed	Total # of traps	# of coho	# of DV	# of CT	Comments

*** a waypoint should only be associated with traps that are <5 m away from the place where the waypoint was captured; if you take a waypoint and place several traps that are <5 m away from that location, then place 1 additional trap and realize it's ~7 m away, then take a new waypoint for the 1 additional trap.

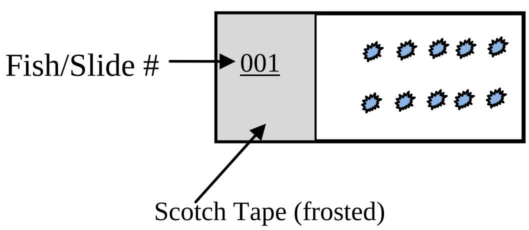
Appendix D5.–A representative portion of the data form for recording salmon smolt length, weight, and scale samples.

SALMON SMOLT LENGTH, WEIGHT, AND SCALE SAMPLES

Location: Cowee Creek **Year:** 2014 **Samplers:**______________________________

Page ____ **of** ____

Scale Slide



Scale Envelope

Location:_Cowee__ Date:____________

Species:_Coho________ Sample #_________

Length:_______ Scale determined Age:_______

Date	Fish/Slide #	Length (mm)	Weight (g)	Age	Comments

Appendix D6.–Data form used to record age, sex, and length data collected during adult coho escapement surveys.

Cowee Creek Adult Coho ASL Data Form

Pg _____ of _____

Location (circle one): lower Cowee upper Cowee Davies Creek

Date pg. started: __________

Crew: ____

Date pg. ended: ___________

Weather comments: ____

Water conditions: ____

								Office Use Only								
Sample Date	Wpt/ Error	Cum Fish #	Gear* (T/B/Sp/Sn)	Sex (M/F)	Scale Card #	Scale # (1-10)	Length (MEF) (mm)	Age (FW)	Age (SW)	AEC	Anchor Tag #	Cinch # (ad clip)	Operc Punch	Cond** (1-5)	Comments (unmarked?, recap?, anchor tag #, operc punch, sea lice, etc.)

*Gear: **T** = tangle net **B** = beach seine **Sp** = sport **Sn** = snag

**Condition:
1 = bright
2 = slight coloration
3 = obvious coloration, pre-spawn
4 = post-spawn
5 = carcass

Operculum Punches				
8/4-8/10	LU		9/22-9/28	RLL
8/11-8/17	LL		9/29-10/5	LUL
8/18-8/24	RU		10/6-10/12	RUL

8/25-8/31	RL		10/13-10/19	LUUU
9/1-9/7	LUU		10/20-10/26	LLLL
9/8-9/14	LLL		10/27-11/2	RUUU
9/15-9/21	RUU			

Appendix D7.–The ADF&G Southeast Region Rack Return and Escapement Survey Form used to record data associated with fish heads sent to the Mark, Tag, and Age Laboratory for coded wire tag recovery.

Alaska Department of Fish and Game

Coded Wire Tag Sampling Form

Rack Return and Escapement Survey

Southeast Region

Page info for this Sample Number only! See Instructions

PAGE ____ OF PAGES ____

SAMPLE NUMBER: 1 _ _ _ _ _ _ _

SOURCE: (circle one) rack return escapement survey

SURVEY SITE: ______________________

SAMPLE TYPE: random select

SAMPLER: ______________________

DATE SAMPLED: _ _ - _ _ - 1 _

SAMPLING INFORMATION

This Box to be completed for RANDOM Samples Only

SPECIES (CODE)	TOTAL # FISH CHECKED FOR AD-CLIPS	# AD-CLIPS SEEN	WERE ALL CHECKED?
(410)CHIN			y n
(411)JACK CHINOOK-ONLY			y n
(420)SOCK			y n
(430)COHO			y n
(440)PINK	Not in S.E.		y n
(450)CHUM			y n
(540)STHD			y n

AREA INFORMATION (DISTRICT - SUBDISTRICT)

101-	106-	111-	116-	157-	191-
102-	107-	112-	150-	181-	192-
103-	108-	113-	152-	182-	OTHER DISTRICTS
104-	109-	114-	154-	183-	______
105-	110-	115-	156-	189-	______

NAME of PLACE SURVEYED: (HATCHERY OR STREAM) ______________________

WATER TYPE: saltwater freshwater

ANADROMOUS STREAM# (FRESHWATER-ONLY) ___-___-___-___-___-___

HEAD RECOVERY INFORMATION

✓	HEAD NUMBER	SPECIES CODE	LENGTH (mid-eye to fork in mm)	CLIP	SEX

COMMENTS

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Appendix D8.–Data form used to record daily environmental conditions.

Cowee Creek Environmental Conditions Data Form

Date/time	Air temp (°C)	Water temp (°C)	Staff Gage (dec. ft.)	Water Clarity (clear vs. turbid)	Weather* (C, O, R, S, W)	Comments (water level rising/falling, rain on snow event, high water, low water, etc.)

*Weather:
C = clear
O = overcast
R = raining
S = snowing
W = windy

APPENDIX E: STATISTICAL TESTS FOR ANALYZING DATA FOR SEX AND SIZE BIAS AND TEMPORAL/GEOGRAPHIC VARIATION IN CAPTURE PROBABILITIES

Appendix E9.–Detection of size and/or sex selective sampling during a two-sample mark recapture experiment and its effects on estimation of population size and population composition.

Size selective sampling: The Kolmogorov-Smirnov two sample test (Conover 1980) is used to detect significant evidence that size selective sampling occurred during the first and/or second sampling events. The second sampling event is evaluated by comparing the length frequency distribution of all fish marked during the first event (M) with that of marked fish recaptured during the second event (R) by using the null test hypothesis of no difference. The first sampling event is evaluated by comparing the length frequency distribution of all fish inspected for marks during the second event (C) with that of R. A third test that compares M and C is then conducted and used to evaluate the results of the first two tests when sample sizes are small. Guidelines for small sample sizes are <30 for R and <100 for M or C.

Sex selective sampling: Contingency table analysis (Chi^2-test) is generally used to detect significant evidence that sex selective sampling occurred during the first and/or second sampling events. The counts of observed males to females are compared between M&R, C&R, and M&C using the null hypothesis that the probability that a sampled fish is male or female is independent of sample. If the proportions by gender are estimated for a sample (usually C), rather an observed for all fish in the sample, contingency table analysis is not appropriate and the proportions of females (or males) are then compared between samples using a two sample test (e.g. Student's t-test).

M vs. R	**C vs. R**	**M vs. C**
Case I:		
Fail to reject H_o	Fail to reject H_o	Fail to reject H_o

There is no size/sex selectivity detected during either sampling event.

Case II:

Reject H_o	Fail to reject H_o	Reject H_o

There is no size/sex selectivity detected during the first event but there is during the second event sampling.

Case III:

Fail to reject H_o	Reject H_o	Reject H_o

There is no size/sex selectivity detected during the second event but there is during the first event sampling.

Case IV:

Reject H_o	Reject H_o	Either result possible

There is size/sex selectivity detected during both the first and second sampling events.

Evaluation Required:

Fail to reject H_o	Fail to reject H_o	Reject H_o

Sample sizes and powers of tests must be considered:

A. If sample sizes for M vs. R and C vs. R tests are not small and sample sizes for M vs. C test are very large, the M vs. C test is likely detecting small differences which have little potential to result in bias during estimation. *Case I* is appropriate.

B. If a) sample sizes for M vs. R are small, b) the M vs. R p-value is not large (~0.20 or less), and c) the C vs. R sample sizes are not small and/or the C vs. R p-value is fairly large (~0.30 or more), the rejection of the null in the M vs. C test was likely the result of size/sex selectivity during the second event which the M vs. R test was not powerful enough to detect. *Case I* may be considered but *Case II* is the recommended, conservative interpretation.

C. If a) sample sizes for C vs. R are small, b) the C vs. R p-value is not large (~0.20 or less), and c) the M vs. R sample sizes are not small and/or the M vs. R p-value is fairly large (~0.30 or more), the rejection of the null in the M vs. C test was likely the result of size/sex selectivity during the first event which the C vs. R test was not powerful enough to detect. *Case I* may be considered but *Case III* is the recommended, conservative interpretation.

D. If a) sample sizes for C vs. R and M vs. R are both small, and b) both the C vs. R and M vs. R p-values are not large (~0.20 or less), the rejection of the null in the M vs. C test may be the result of size/sex selectivity during both events which the C vs. R and M vs. R tests were not powerful enough to detect. *Cases I, II, or III* may be considered but *Case IV* is the recommended, conservative interpretation.

Case I. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated after pooling length, sex, and age data from both sampling events.

Case II. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the first sampling event without stratification. If composition is estimated from second event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the M vs. R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case III. Abundance is calculated using a Petersen-type model from the entire data set without stratification. Composition parameters may be estimated using length, sex, and age data from the second sampling event without stratification. If composition is estimated from first event data or after pooling both sampling events, data must first be stratified to eliminate variability in capture probability (detected by the C vs. R test) within strata. Composition parameters are estimated within strata, and abundance for each stratum needs to be estimated using a Petersen-type type formula. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance according to the formulae below.

Case IV. Data must be stratified to eliminate variability in capture probability within strata for at least one or both sampling events. Abundance is calculated using a Petersen-type model for each stratum, and estimates are summed across strata to estimate overall abundance. Composition parameters may be estimated within the strata as determined above, but only using data from sampling events where stratification has eliminated variability in capture probabilities within strata. If data from both sampling events are to be used, further stratification may be necessary to meet the condition of capture homogeneity within strata for both events. Overall composition parameters are estimated by combining stratum estimates weighted by estimated stratum abundance.

If stratification by sex or length is necessary prior to estimating composition parameters, then an overall composition parameters (p_k) is estimated by combining within stratum composition estimates using:

$$\hat{p}_k = \sum_{i=1}^{j} \frac{\hat{N}_i}{\hat{N}_\Sigma} \hat{p}_{ik} \text{ ; and,} \tag{1}$$

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

where: j = the number of sex/size strata;

$\hat{p}_{ik}$ = the estimated proportion of fish that were age or size k among fish in stratum i;

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

$\hat{N}_\Sigma$ = sum of the $\hat{N}_i$ across strata.

TESTS OF CONSISTENCY FOR PETERSEN ESTIMATOR

Of the following conditions, at least one must be fulfilled to meet assumptions of a Petersen estimator:

1. Marked fish mix completely with unmarked fish between events;
2. Every fish has an equal probability of being captured and marked during event 1; or,
3. Every fish has an equal probability of being captured and examined during event 2.

To evaluate these three assumptions, the chi-square statistic will be used to examine the following contingency tables as recommended by Seber (1982). At least one null hypothesis needs to be accepted for assumptions of the Petersen model (Bailey 1951, 1952; Chapman 1951) to be valid. If all three tests are rejected, a temporally or geographically stratified estimator (Darroch 1961) should be used to estimate abundance.

I.-Test For Complete Mixing[a]

Area/Time Where Marked	Area/Time Where Recaptured				Not Recaptured
	1	**2**	**…**	**t**	$(n_1\text{-}m_2)$
1					
2					
…					
s					

II.-Test For Equal Probability of capture during the first event[b]

	Area/Time Where Examined			
	1	**2**	**…**	**t**
Marked (m_2)				
Unmarked $(n_2\text{-}m_2)$				

III.-Test for equal probability of capture during the second event[c]

	Area/Time Where Marked			
	1	**2**	**…**	**s**
Recaptured (m_2)				
Not Recaptured $(n_1\text{-}m_2)$				

[a] This tests the hypothesis that movement probabilities (θ) from time or area *i* (*i* = 1, 2, ...s) to section *j* (*j* = 1, 2, ...t) are the same among sections: H_0: $\theta_{ij} = \theta_j$.

[b] This tests the hypothesis of homogeneity on the columns of the 2-by-t contingency table with respect to the marked-to-unmarked ratio among time or area designations: H_0: $\Sigma_i a_i \theta_{ij} = kU_j$, where k = total marks released/total unmarked in the population, U_j = total unmarked fish in stratum *j* at the time of sampling, and a_i = number of marked fish released in stratum *i*.

[c] This tests the hypothesis of homogeneity on the columns of this 2-by-s contingency table with respect to recapture probabilities among time or area designations: H_0: $\Sigma_j \theta_{ij} p_j = d$, where p_j is the probability of capturing a fish in section *j* during the second event, and d is a constant.