Regional Operational Plan SF.1J.2015.14

Escapements of Chinook Salmon in Southeast Alaska and Transboundary Rivers in 2015

by

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and

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July 2015

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

Symbols and Abbreviations

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

Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm
Weights and measures (English)	
cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd
Time and temperature	
day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s
Physics and chemistry	
all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

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

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

REGIONAL OPERATIONAL PLAN SF.1J.2015.14

ESCAPEMENTS OF CHINOOK SALMON IN SOUTHEAST ALASKA AND TRANSBOUNDARY RIVERS IN 2015

by

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SIGNATURE/TITLE PAGE

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Approval

Title	Name	Signature	Date
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ABSTRACT

Estimates of Chinook salmon *Oncorhynchus tshawytscha* spawning escapement in 11 Southeast Alaska index systems will be summarized for 2015. Chinook salmon index systems include: Situk River, Alsek River, Chilkat River, Taku River, King Salmon River, Stikine River, Unuk River, Chickamin River, Blossom River, Keta River, and Andrew Creek. Spawning escapements will be estimated using aerial and foot surveys, mark-recapture studies, and weirs. The Alaska Department of Fish and Game and Fisheries and Oceans Canada use these data, along with age compositions data to make terminal and regional management decisions, and the Pacific Salmon Commission uses the data for coastwide management and stock assessment through the Chinook Technical Committee.

Key words: Chinook salmon, aerial surveys, foot surveys, mark-recapture, weir, inriver run, escapement, total run, age composition, Situk River, Alsek River, Chilkat River, Taku River, King Salmon River, Stikine River, Unuk River, Chickamin River, Blossom River, Keta River, Andrew Creek.

PURPOSE

The primary goals of this study are to: 1) collect peak aerial and foot survey counts for the Taku, Blossom, Keta, Unuk, Chickamin, and King Salmon rivers, and Andrew Creek; and 2) summarize and report the total spawning escapement estimates for the 11 Chinook salmon index systems in Southeast Alaska in 2015, which include the Situk, Alsek, Chilkat, Taku, King Salmon, Stikine Unuk, Chickamin, Blossom, and Keta rivers, and Andrew Creek. The Alaska Department of Fish and Game (ADF&G) and Fisheries and Oceans Canada (FOC) use this spawning escapement information to make terminal and regional management decisions, and the Pacific Salmon Commission (PSC) uses the data for coastwide management and stock assessment through the Chinook Technical Committee (CTC).

BACKGROUND

Populations of Chinook salmon *Oncorhynchus tshawytscha* are known to occur in 34 river systems throughout Southeast Alaska (SEAK), northwestern British Columbia, and the Yukon Territory, Canada. In the mid-1970s, it became apparent that some of the Chinook salmon stocks in the region were depressed relative to historical levels of production (Kissner 1974). As a result, a fisheries management program (ADF&G 1981) was implemented to rebuild depressed stocks of Chinook salmon in Southeast Alaska that included transboundary rivers (rivers that originate in Canada and flow into SEAK coastal waters) and non-transboundary systems existing only within U.S. lands. Initially, this management program included regulatory closures of commercial and recreational fisheries in terminal and near-terminal areas. This program was formalized and expanded in 1981 to a 15-year (roughly 3 life cycles) rebuilding program for the transboundary Taku, Stikine, Alsek, Unuk, Chickamin, and Chilkat rivers, and the non-transboundary Blossom, Keta, Situk, and King Salmon rivers (ADF&G 1981; Figure 1).

The objective of this program, which included regionwide, all-gear catch ceilings for Chinook salmon, was to rebuild spawning escapements to interim escapement goals by 1995 (ADF&G 1981). In 1985, the SEAK rebuilding program was incorporated into a broader coastwide rebuilding program for natural-wild stocks of Chinook salmon when the U.S./Canada Pacific Salmon Treaty (PST) was first implemented.

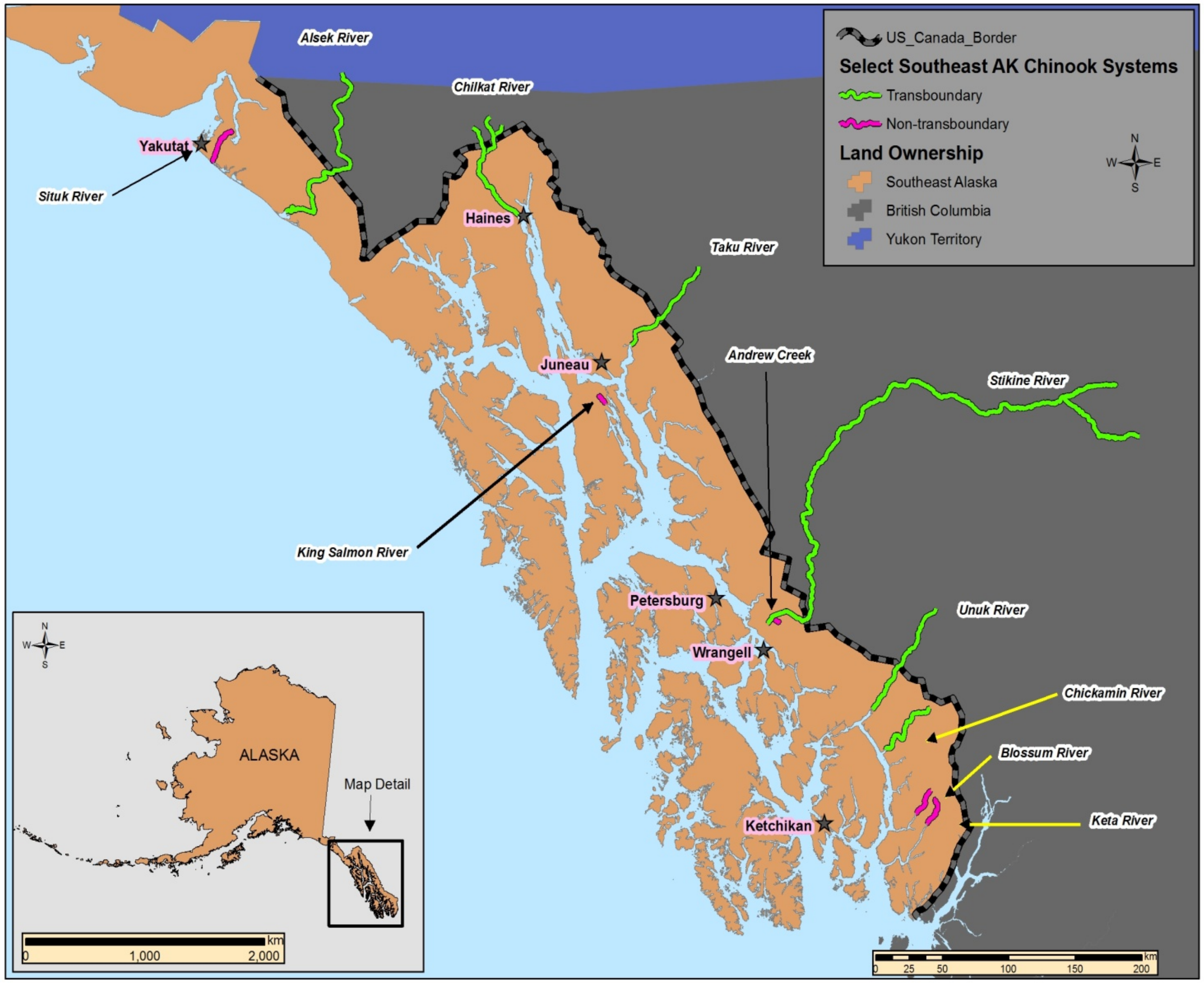

Figure 1.—Location of selected Chinook salmon systems annually surveyed to produce estimates of spawning escapement in Southeast Alaska, British Columbia, and the Yukon Territories.

One principal method of assessing Chinook salmon stock status is via the estimation of spawning escapement as judged against escapement goals. Since 1975, the SEAK Chinook Salmon Escapement Project has annually estimated escapements to selected index areas in a standardized program (Kissner 1982). Estimates of escapement are produced through various methods including weirs, mark-recapture, foot surveys, and aerial surveys. This operational plan identifies the methods used for foot and aerial surveys as well as analytical procedures for estimating Chinook salmon escapement from these types of surveys. Identification of methods and analyses used in weir and mark-recapture studies are referenced in brief, but presented in distinct Regional Operational Plans, that are specific to individual river systems where they are employed (e.g., Stikine River, Taku River, Chilkat River, Situk River, Unuk River). Regardless of the approach used to estimate Chinook salmon escapement in the 11 SEAK index systems, the final estimates of escapement will be presented in a single document that will promote standardization of results and efficiencies in reporting and publication.

A weir is used to estimate total Chinook salmon spawning escapement on the Situk River; mark-recapture, foot, and aerial surveys are not used in this system. Mark recapture experiments employing different gear types (fish wheels, drift- and set-gillnet, rod and reel) are used on Taku, Stikine, and the Chilkat rivers. Specific methods and analytical approaches used in these systems are presented in Williams et al. (2015a, 2015b), Jaecks et al. (2015a, 2015b) Elliott and Power (2015), and Elliott et al. (2014) respectively.

Counts made during aerial or foot surveys are timed to occur during periods of peak spawning of Chinook salmon on a system by system basis, recognizing past observations of migration and spawning chronology as well as environmental factors that dictate timing. Nearly all of the aerial surveys have been conducted by five different individuals, the first from 1975 through 1987, his successor from 1988 through 1989, and the third from 1990 to 2010. From 2006 to 2010, two surveyors were trained to conduct the aerial surveys, one out of Juneau and one out of Ketchikan. These 2 surveyors have conducted the aerial surveys from 2010 to present day. Consistency in survey timing and observers, with respect to peak spawning activity and personnel, reduces the effects of temporal and observer bias associated with index surveys conducted by air or foot.

Expansion factors to convert peak counts of all Chinook salmon observed during index surveys to escapement of large fish have been estimated through escapement studies for all index areas, except the Chilkat River (Pahlke 2007; McPherson et al. 2003). The development of expansion factors has significantly improved the accuracy of estimates of escapements for most systems where in past years peak counts were the only measure of spawning abundance. Expansion factors and escapement estimates are evaluated and revised periodically as new information is available. In general, the expansion factors are developed by the use of mark-recapture experiments (as conducted in the Taku, Stikine and Chilkat Rivers) or weirs (Situk River) which are used in these systems where inseason data are needed for the conduct of fisheries, or where they are called for in management plans. The CTC standard for expansion factors requires at least 3 years of paired estimates/counts and a CV <20%. The resulting escapement estimates are provided to the Joint CTC of the PSC. In accordance with the PST, these estimates are used to ascertain progress towards meeting escapement goals for the Chinook salmon stocks of SEAK and transboundary rivers shared by the U.S. and Canada (PSC 1993). Appropriate fishery regulations are promulgated by ADF&G and the PSC to maintain escapements and to harvest any surplus production.

Other systems that are not included in the index program have been periodically surveyed, including the Bradfield, Harding, Wilson, and Marten rivers, and Aaron Creek.

OBJECTIVES

Juneau Office:

1. Collect peak aerial survey counts for tributaries of the Taku River. Aerial counts will be made in the Nakina, Nahlin, Tatsamenie, Kowatua, Tseta, and Dudidontu rivers.
2. Collect peak aerial and foot survey counts for the King Salmon River and Andrew Creek.

Ketchikan Office:

1. Collect peak aerial survey counts for the Blossom and Keta rivers
2. Collect peak aerial and foot survey counts for tributaries of the Unuk (Eulachon River, Cripple, Kerr, Gene's Lake, Clear and Lake creeks) and Chickamin rivers (Butler, Leduc, Clear Falls, Humpy, King, Indian and Barrier creeks and South Fork Chickamin River).

SECONDARY OBJECTIVES:

1. Summarize and report the spawning escapement estimates for the 11 Chinook salmon index systems in Southeast Alaska: Situk River, Alsek River, Chilkat River, Taku River, King Salmon River, Stikine River, Unuk River, Chickamin River, Blossom River, Keta River, and Andrew Creek.
2. Train additional surveyors to perform aerial and foot survey counts for Chinook salmon in Southeast Alaska.

METHODS

STUDY DESIGN

Estimating Escapement Using Peak Aerial and Foot Survey Counts

Large (≥660 mm MEF, assumed to be 3-, 4-, and 5-ocean age) Chinook salmon spawning in selected index areas will be counted shortly before, during or shortly after the peak of spawning. Peak spawning times are well defined from previous surveys of these same systems over the last 30 years (Table 1). Survey areas within each index stream were selected on the basis of their historical importance, size of the population, geographic distribution, historical database, and ease of data collection (i.e., water clarity, logistical access, canopy cover, and general survey conditions). Survey areas were originally described by landmarks and have since been defined by GPS coordinates (Kissner 1982; Pahlke 2010; Appendix A1). Counts made for the index streams will serve as an annual comparable index of the spawning escapement. Surveys will be conducted on foot, or from a Bell 206 or Hughes 500D helicopter during the peak of spawning. Each survey area will be surveyed at least twice per year and most systems are surveyed at least 3 times per year.

Table 1.–Survey areas, peak spawning dates and spawner distribution of major Chinook salmon index tributaries in Southeast Alaska, British Columbia, and Yukon Territories.

River	Tributary	Spawning peak date (historic)	Survey area	Spawner distribution	Remarks
TAKU RIVER	Nakina River	August-13	Grizzly Bar to canyon 3.2 km above confluence with Silver Salmon River.	Prime spawning habitat just above Grizzly Bay Kissner (1982)	Large numbers of spawning pinks and schooled sockeye will be observed in this area.
TAKU RIVER	Nahlin River	July-13	Telegraph Trail Crossing to forks about 48 km up-stream. Up each fork 1.6 km.	Most fish are found in index area III Kissner (1982)	Many sockeye in survey area
TAKU RIVER	Tatsamenie River	August-13	Tatsatua Junction to big Tatsaminie Lake.	Fish distributed throughout the index area Kissner (1982)	Sometimes semi-glacial. Survey should start by 10 a.m. Some sockeye in survey area.
TAKU RIVER	Kowatua River	August-13	Little Trapper Lake outlet to junction of small glacial stream that flows into Kowatua from south about 8 km below Little Trapper Lake.	Evenly distributed Kissner (1982).	Glacial survey, should start by 8 a.m. some sockeye in survey area.
TAKU RIVER	Tseta River	August-13	Upper barrier (falls) down-river to start of canyon.	Densest spawning in upper 3.2 km Kissner (1982).	Only Chinook observer in this tributary.
TAKU RIVER	Dudidontu River	August-13	End of canyon up-stream to 3.2 km past junction of matsatu Creek. Survey lower 1.6 km of Matsatu Creek.	Evenly distributed Kissner (1982).	Some sockeye sometimes present.
KING SALMON RIVER		July-13	All	Mostly in lower 4.8 km, but on years with large escapement, spawning occurs far upstream.	Many pinks and chums present.

-continued-

Table 1.–Page 2 of 3.

River	Tributary	Spawning peak date (historic)	Survey area	Spawner distribution	Remarks
STIKINE RIVER					
	Little Tahltan River	July-13	Confluence with mainstem Tahltan up-river for 16km to area where 762 m contour crosses the river.	Densest Spawning between Saloon Lake outlet and Tahltan junction. Kissner (1982)	Usually only Chinook in this System. Can be semi-glacial. Survey before noon.
ANDREW CREEK		August-13	Andrew Slough to barrier, include North Fork.	Evenly distributed	Pink, Chums and sockeye present
ALSEK RIVER					
	Klukshu River	August-13	Confluence with Tatshenshini up River to Klukshu Lake.	Evenly distributed.	Difficult to survey because of over-hanging trees. Many sockeye present
ALSEK RIVER	Takhanne River	August-13	Confluence with Tatshenshini up-river to falls.	Evenly distributed.	Survey in a.m. Windy in the p.m.
ALSEK RIVER	Blanchard River	August-13	Confluence with Tatshenshini up-river to bridge.	Many Chinook spawn up-river of bridge, but very difficult to observe. Survey to lake if clear.	Very glacial. Survey by 9 a.m.
UNUK RIVER					
	Cripple Creek	August-11	Confluence with Unuk up-river for 3.2 km.	Evenly distributed.	Semi-glacial. Survey in early a.m. by foot. Poor surveys by helicopter.
UNUK RIVER	Genes lake Creek	August-13	Confluence with Genes Lake up river for about 6.5 km.	Evenly distributed.	Many sockeye in area. Survey by foot. Poor surveys by helicopter.
	Eulachon River	August-13	1.6 km below forks up left fork 1 km to barrier, right fork to barrier about 4.8 km up-steam.	Evenly distributed.	Some Chinook will still be in holes below forks until late August.
UNUK RIVER	Clear Creek	August-12	Confluence with lake Creek up river for 1.6 km.	Evenly distributed.	Some Chinook just above narrow cut.
UNUK RIVER	Lake Creek	August-13	Confluence with Clear Creek up-steam to falls.	Spawning on shallow riffles and in falls	

-continued-

Table 1.–Page 3 of 3.

River	Tributary	Spawning peak date (historic)	Survey area	Spawner distribution	Remarks
UNUK RIVER (continued)					
	Kerr Creek	August-14	Falls to glacial water.	Falls pool area usually has 10–20 spawning Chinook.	
CHICKAMIN RIVER					
	South Fork	August-18	From junction of Chickamin Branch up-river to junction of Barrier Creek	Evenly distributed.	Many chums and pinks. Semi-glacial. Survey by 10 a.m.
CHICKAMIN RIVER	Barrier Creek	August-12	From junction of South Fork to Barrier 1.6 km upstream.	Evenly distributed.	Chums in survey area.
CHICKAMIN RIVER	Butler Creek	August-10	All.	Evenly distributed.	Chums in survey area.
CHICKAMIN RIVER	Leduc Creek	August-10	Mouth to barrier.	Evenly distributed.	Chums and pinks in survey area.
CHICKAMIN RIVER	Indian Creek	August-10	All.	Evenly distributed.	Chums and pinks in survey area.
CHICKAMIN RIVER	King Creek	1 Sept.	All.	Evenly distributed.	Chums and pinks in survey area.
CHICKAMIN RIVER	Clear Falls Creek	August-10	All.	Evenly distributed.	Chums and pinks in survey area. Note 2008 disturbance in upper water-shed above falls few Chinook seen spawning since.
BLOSSOM RIVER		August-13	All.	Fairly evenly distributed. A bit higher percent spawners in head waters.	Many pinks and chums.
KETA RIVER		August-13	All.	Fairly evenly distributed.	Many pinks and chums
MARTEN RIVER					
	Mainstem	August-13	All.	Fairly evenly distributed.	Many pinks and chums
MARTEN RIVER	Dicks Creek	August-13	All.	Very even distribution	Moderate pinks and chums
WILSON RIVER		August-13	All.	Very even distribution	Large numbers of pinks and chums

The accuracy of peak escapement counts in predicting total escapement will be evaluated by comparing them with mark-recapture estimates on the Taku and Stikine rivers and to weir counts on the Little Tahltan (tributary to the Stikine River).

As mentioned above, expansion factors exist for all index streams, each requiring at least three mark-recapture (or weir)-survey count data pairs and with sufficiently low error (CV<20% for expansion factor). (See Appendix B1 for details on calculation of expansion factors and variance estimation).

Comparison of Survey Methods

Several index areas are routinely surveyed by more than one method: Andrew Creek is surveyed from airplanes (ADF&G, Division of Commercial Fisheries), helicopters and by foot, while King Salmon River is surveyed from helicopter and foot survey. We will attempt to conduct these various surveys on the same day to enable comparison of the different methods. In general, foot surveys are believed to be the most precise, followed by helicopter aerial counts, with fixed-wing aerial surveys being the least precise. The project leaders will make the final decision on which count will be considered the peak survey count based on several factors including the system, survey conditions, and surveyor experience.

DATA COLLECTION

Only large (≥660 mm MEF) Chinook salmon will be counted during aerial or foot surveys. Depending on observed water conditions, weather, and run timing, survey conditions will be rated as poor, normal, or excellent and recorded for each survey. For each survey area (see Appendix A1) the observer will evaluate and record the following attributes: stream level, water visibility, weather conditions (clear or overcast, wind, precipitation), and light conditions. Additional surveys will be conducted if the survey conditions are not rated normal or excellent. Raw data from all surveys will be included in the Fishery Data Series report.

When the survey is from a helicopter, the craft will fly approximately 6 to 15 m above the river (when it is safe to do so) at approximately 6 to 16 km per hour. The observer's door will be removed and the helicopter will hover sideways with observations made out of the open space. The best views are gained by leaning outside the helicopter as it travels upriver at a slight angle so the left side of the helicopter is at 10 to 30 degrees pointed upriver. This angle will differ throughout the flight and is controlled by the helicopter pilot with the objective of giving the observers the best view of the river, yet maintaining a safe flight path. Whenever possible, the sun will be kept behind the helicopter and the observer will wear polarized sunglasses to eliminate reflection. The observer will wear an inflatable life jacket, broad billed hat, and radio headset while surveying. While in the helicopter, a shoulder harness and lap belt will be used, and survival gear and a firearm will always be carried in the helicopter. Reserve fuel for the helicopter will be placed at strategic locations in the Taku River watershed (Windy, Long, and Trapper Lakes), Stikine Watershed (Tahltan Lake), along the Unuk and Chickamin rivers, and near Wilson Arm.

Foot surveys will be conducted on Andrew Creek, King Salmon River, and most of the index tributaries of the Unuk River. Foot surveys are used where aerial surveys are ineffective, and also in areas that are surveyed aerially to calibrate the foot surveys.

Training and calibrating additional Juneau- and Ketchikan-based surveyors started in 2012 and will continue in 2015. The objective of the training flights is to allow the trainee to become familiar with the start and stop points of each index area and the unique geography and topography of each system. Training flights also allow the observer to become familiar with distinguishing large Chinook salmon from the helicopter and how to count when presented with various densities or mixed species congregations; the trainer will point out these instances. Ideally the trainee would count in a fashion similar to the trainer.

The trainer will be in the front seat of the helicopter and the trainee will be in the back seat. The doors will be removed to optimize the field of view. During training, the trainer will point out different species and be in communication with the trainee as much as possible. At least two training flights will be made for each index area in each system. After the training flights are completed, calibration flights will be flown the same way except there will be no communication between the trainer and the trainee. Flying with both the trainer and the trainee will be the most cost effective means to do calibration flights. It will also eliminate most of the temporal and spatial variables ensuring that both the trainer and the trainee are counting the same area given the same speed, time, and environmental conditions. Calibration flights should be conducted whenever possible and across the spatial and temporal spectrum of the project. A minimum of 2 calibrations flights should be made in each system.

DATA REDUCTION

The surveyor will record start/stop times, visibility and survey conditions, and counts of live and dead large Chinook salmon for each index area. In addition, for each day's survey the surveyor will record the pilot's name, aircraft, and other comments concerning numbers of Chinook salmon < 660 mm MEF, other salmonid species, predators, and run timing. Data will be recorded in waterproof field notebooks (Appendix A3) and transferred to escapement survey forms (Appendix A2) at the regional office at least once each week. The ADF&G Division of Commercial Fisheries (DCF), Integrated Fisheries Database (IFDB) is the repository for all information on salmon escapement. Files will be checked for data entry errors such as incorrect dates or counts, and then the data will be entered into the IFDB. The database entry system prevents many data entry errors such as nonsensical stream codes or survey conditions.

A final, edited copy of the data, along with a data map, will be sent to ADF&G Research and Technical Services (RTS) in Anchorage electronically for archiving. The data map will include a description of all electronic files contained in the data archive, all data fields and details of where hard copies of any associated data are to be archived, if not in RTS. For this project, all escapement data is archived permanently in the IFDB. Prior to final archiving data files will be stored on the H drive under H:\REPORTS\Escapement\ESC2015.

DATA ANALYSIS

Counts from foot and helicopter surveys will be tabulated for analysis by ADF&G and either estimates of total escapement or peak counts will be provided to the U.S./Canada CTC. Estimates of escapement will either be provided from mark-recapture experiments and weirs or will be based on expansions of peak counts; the expansion factors used in these cases will be based on previous paired survey count and mark recapture (or weir) estimates. The method of calculating the expansion factor $\hat{\pi}$ and associated variance for each system is shown in Appendix B1 along with an example for the Keta River (Appendix B2).

Calibration for new observers with respect to current or past observers will be on a system by system basis. An estimate of the calibration constant r for a given system will be the average ratio of the trainer count to the new observer count on a particular section of a system or entire system.

The equation for the estimated calibration constant *r* will be as follows:

$$\hat{r} = \frac{\sum_{i=1}^{g} \frac{n_i}{t_i}}{g} \qquad (1)$$

where n_i is the i[th] count from the new observer , t_i is the corresponding count from the trainer, and g is the number of times a calibration is done on that particular system with the specific new observer-trainer pair. The variance of *r* will be calculated:

(2)

$$var(\hat{r}) = \frac{\frac{\sum_{i=1}^{g} \left(\frac{n_i}{t_i} - r\right)^2}{g-1}}{\mathrm{g}}$$

The calibration factor will be used to adjust the number of fish reported for a new observer only if $\hat{r}$ is significantly <0.75 or >1.25. The adjustment, if necessary, will be made as follows:

$$\hat{C} = c\,\hat{r} \qquad (2)$$

where *c* is the count the new observer obtained, with variance

$$var(\widehat{C}) = c^2 var(\widehat{r}) \qquad (4)$$

BUDGET

This investigation is financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-31, Job No. S-1-6.

SCHEDULE AND DELIVERABLES

Field activities will be initiated in each year around 22 July and will conclude around 15 September. Data editing and analysis will be initiated before the end of the field season. Escapement survey data will be entered into microcomputer files on a biweekly basis, and at the end of the season all data will be entered into IFDB, maintained by DCF Region I staff.

REPORTS

A report in the Fishery Data Series containing the estimates of escapements will be completed by October 31, 2016. This report will fulfill the reporting obligation as an annual report of progress for Federal Aid Project F-10-31, Job No. S-1-6. In addition, information from the project will be summarized in reports to the Alaska Board of Fisheries, the Joint CTC, and the Transboundary River Technical Committee (TTC) of the PSC.

RESPONSIBILITIES

Philip Richards, Fisheries Biologist III (project leader)

Duties: This position is responsible for supervision of all project activities including administrative, field, personnel and other activities. He will fly the index surveys on the Taku River drainage, King Salmon River, and Andrew Creek, analyze the data, prepare the end-of-season memo, and write the final report. He will also train an additional Juneau-based surveyor.

Todd Johnson, Fisheries Biologist II (project leader)

Duties: Will assist in all aspects of this project. He will fly all surveys based out of Ketchikan area (Unuk, Chickamin, Blossom, and Keta rivers), conduct several foot surveys, and assist with data analysis and preparation of the final report. He will also train an additional Ketchikan-based surveyor.

Ed Jones, Salmon Research Coordinator

Duties: Responsible for overseeing all aspects of the project, including review of budgets, operational plan and reports.

Jeff Nichols, Regional Research Coordinator

Duties: Responsible for reviewing operational plans and reports.

David Evans, Biometrician III

Duties: Project biometrician and provides input to and approves sampling design. Reviews and preforms biometrics for the operational plan, data analysis, and final report.

Troy Jaecks, Fishery Biologist II

Duties: Will train to conduct aerial surveys (Juneau-based surveyor).

Stephen Todd Fisheries Biologist I

Duties: Will train lower level technicians to conduct foot surveys of systems in the Juneau Area survey locations.

Micah Sanguinetti Fish and Wildlife Technician IV

Duties: Will train to conduct aerial surveys (Ketchikan-based surveyor), assist with operational plan, as well as train lower level technicians to conduct foot surveys of systems in the Ketchikan Area survey locations.

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APPENDIX A

Appendix A 1.–Latitude and longitude of Chinook salmon survey index areas (IA) and other survey landmarks.

Index River[a]	Way point	Description	Latitude	Longitude	Altitude
KS	1	top of King Salmon River Index Area	N58 04.662	W134 24.073	268 ft
TAK	2	Windy Lake fuel cache, near Nakina	N59 05.262	W132 55.529	2930 ft
TAK	3	Grizzly Bar, bottom of IA1 Nakina	N59 03.494	W133 01.789	1163 ft
TAK	4	Top of IA1, Nakina River, Taku	N59 04.581	W133 01.264	993 ft
TAK	5	Top of IA2, Nakina River	N59 05.866	W133 00.646	1012 ft
TAK	6	Top of IA3, Nakina River	N59 07.560	W132 55.143	1144 ft
TAK	7	Top of IA4, Nakina Canyon, telegraph trail	N59 11.048	W132 50.210	1338 ft
TAK	8	Top of Tseta Creek, Taku River	N59 02.011	W132 13.255	2676 ft
TAK	9	Long Lake fuel cache, near Nahlin River	N58 44.557	W131 30.607	3559 ft
TAK	10	Top of IA3, Nahlin River	N58 39.557	W131 10.259	3485 ft
TAK	11	Top of IA1, Nahlin River	N58 48.541	W131 28.027	3064 ft
TAK	12	Bottom of IA1, Nahlin River	N58 53.126	W131 45.054	2308 ft
TAK	13	Bottom of Dudidontu Index Area	N58 38.816	W131 48.707	3298 ft
TAK	14	Fork with Matsatu Creek, Dudidontu	N58 35.358	W131 47.002	3167 ft
TAK	15	Top of Dudidontu IA, maybe need to be revised	N58 31.005	W131 50.585	3157 ft
STK	18	Top end of Little Tahltan River IA, Stikine	N58 11.896	W131 28.876	2505 ft
STK	19	Saloon Lake fuel cache, near Tahltan	N58 07.473	W131 22.752	2315 ft
STK	20	Little Tahltan River weir	N58 07.328	W131 19.239	1942 ft
ALK	21	Bottom Takhanne River IA, Alsek	N60 05.687	W136 59.386	2340 ft
ALK	22	Top Takhanne River IA, Alsek	N60 06.493	W136 56.838	2290 ft
UNK	23	Bottom of [Eulachon River IA, Unuk	N56 06.597	W131 07.293	321 ft
UNK	24	Top of Eulachon River IA, 2nd avalanche chute	N56 09.216	W131 07.884	181 ft
CHK	25	Chickamin River camp	N55 49.493	W130 52.826	53 ft
CHK	26	Bottom King Creek IA, Chickamin River	N55 50.507	W130 51.162	311 ft
CHK	27, 28	Top of King Creek IA, Chickamin	N55 49.149	W130 48.006	178 ft
BLM	29–31	Blossom river fish locations			
TAK	32	Bottom of Kowatua River IA, Taku	N58 30.324	W132 32.512	2675 ft
TAK	33	Bottom of Tatsamenie IA, Taku	N58 28.647	W132 23.273	3076 ft
BLM	34–36	Blossom river fish locations			

-continued-

Appendix A1.–Page 2 of 3.

Index River	Way point	Description	Latitude	Longitude	Altitude
CHK	37	Top of King Creek king distribution, Chickamin	N55 48.523	W130 46.940	147 ft
CHK	38	Mouth of King Creek	N55 50.441	W130 50.848	832 ft
CHK	39	Bottom Humpy Creek IA, Chickamin	N55 50.812	W130 52.309	417 ft
CHK	40	Top Humpy Creek IA, Chickamin	N55 52.076	W130 53.638	105 ft
BLM	41	Apparent barrier on Blossom River	N55 30.285	W130 28.708	254 ft
BLM	42	top end of good habitat above Barrier, Blossom R.	N55 32.398	W130 25.251	587 ft
KET	43	Bottom of Keta River	N55 19.880	W130 29.099	1104 ft
KET	44	First big rapids on Keta, not barrier	N55 21.357	W130 26.923	231 ft
KET	45	Chute on Keta, not barrier	N55 25.087	W130 20.881	257 ft
NA	46	Second rapids, not barrier	N55 26.004	W130 20.919	257 ft
KET	47	Top of Index area Keta River	N55 27.430	W130 20.946	257 ft
NA	49	Wheeler Creek, barrier	N57 59.437	W134 41.555	ND
AC	50	Andrew Creek, top IA	N56 36.008	W132 09.408	ND
AC	51	Andrew Creek, mouth	N56 38.398	W132 12.002	ND
NA	52	Arron Creek chinook spawning area	N56 27.760	W131 57.469	ND
CHK	53	Indian Creek, Chickamin, mouth	N55 57.355	W130 41.532	ND
CHK	54	Indian Creek, Chickamin, top	N55 59.534	W130 40.017	ND
CHK	55	Lucky Jake Creek, Chickamin	N55 59.207	W130 38.001	ND
CHK	56	Ranger Paige Creek, Chickamin	N55 59.701	W130 36.985	ND
CHK	57	Butler Creek mouth	N56 02.357	W130 43.354	ND
CHK	58	Butler Creek, top	N56 02.870	W130 43.359	ND
CHK	59	Clear Falls, Chickamin	N55 58.812	W130 45.560	ND
CHK	60	Top of King Creek foot survey	N55 49.262	W130 48.449	ND
KET	61	Keta King spots, August 2004	N55 20.562	W130 28.239	ND
KET	62	Keta King spots, August 2004	N55 22.515	W130 24.182	ND
KET	63	Keta King spots, August 2004	N55 24.990	W130 21.301	ND
KET	64	Keta King spots, August 2004	N55 26.282	W130 20.809	ND

-continued-

Appendix A1.–Page 3 of 3.

Index River	Way point	Description	Latitude	Longitude	Altitude
UNK	NA	Kerr Creek Mouth	N56 10.599	W130 55.852	ND
UNK	NA	Genes lake start	N56 12.573	W130 52.021	ND
UNK	NA	Genes Lake Creek end point	N56 14.979	W130 49.097	ND
UNK	NA	Cripple Creek Start Point	N56 15.637	W130 48.732	ND
UNK	NA	Cripple Creek End Point	N56 14.865	W130 45.587	ND
UNK	NA	Clear Creek mouth	N56 08.104	W130 58.347	ND
UNK	NA	Clear Falls Barrier	N56 07.550	W 130 57.478	ND
UNK	NA	Lake Creek start	N56 08.104	W130 58.347	ND
UNK	NA	Lake Creek Barrier	N56 09.355	W130 53.877	ND
UNK	NA	Kerr Creek start	N56 10.640	W130 55.960	ND
UNK	NA	Kerr Creek Barrier	N56 11.000	W130 55.846	ND

Appendix A 2.–ADF&G salmon escapement survey form.

ALASKA DEPARTMENT OF FISH AND GAME
SALMON ESCAPEMENT SURVEYS

Depart Time: ____

Document No. ____

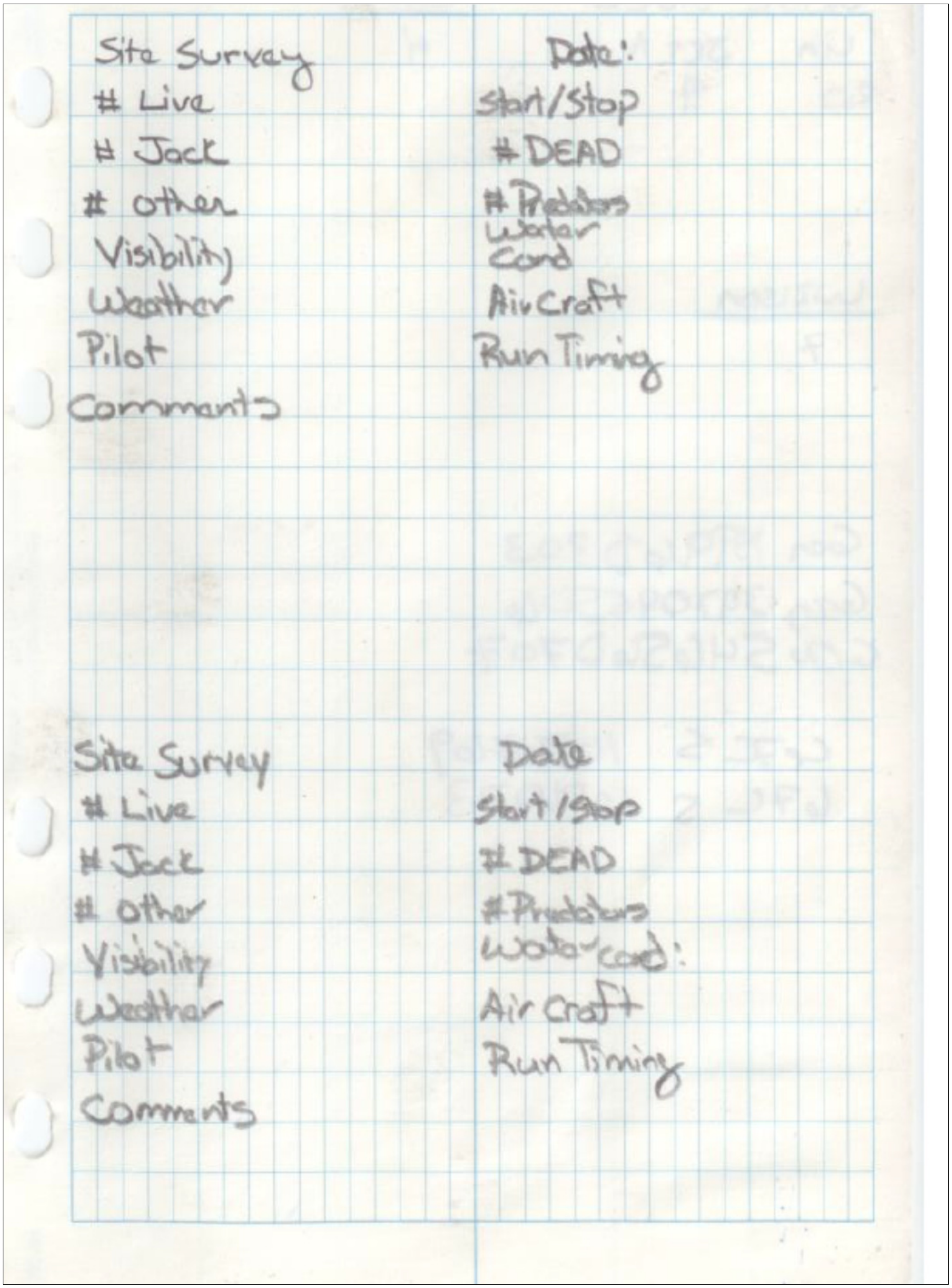
Return Time: ____

Year ____ Area ____

	Field 1			2	3	4	5	6	7	8	9	10	11	12	13
No.	Stream Number			Stream Name	Mo/Day	Length	Type	Mouth	Intertidal	Steam Live	Stream Dead	Species	Observer	Usage Code	Coded Remarks
01															
02															
03															
04															
05															
06															
07															
08															
09															
10															
11															
12															
13															
14															
15															

Distance: (tenths	Length:	Type:	Coded Remarks:	Usage Codes:
I=Intertidal	L=complete	A=Aerial	11=Fish present but not counted in Mouth	00=Not coded yet
M=Mouth	P=partial	F=Foot	12=Fish present but not counted in Tidal	01=Not useful for indexing or estimating escapement of this species.
B=Bay	U=unknown	B=Boat	13=Fish present but not counted in Live	02= Potentially useful for indexing or estimating escapement of this species.
L=Length		H=Helicopter	14=Fish present but not counted in Dead	03= Potentially useful as the "peak" survey count for this species.

Appendix A 3.–Example of aerial sampling form.



Site Survey
Live
Jack
other
Visibility
Weather
Pilot
Comments

Date:
Start/Stop
#DEAD
Predators
Water Cond
AirCraft
Run Timing

Site Survey
Live
Jack
other
Visibility
Weather
Pilot
Comments

Date
Start/Stop
#DEAD
#Predators
water cond:
Air Craft
Run Timing

APPENDIX B

Appendix B1.–Predicting escapement from index counts using an expansion factor[a].

The expansion factor provides a means of predicting escapement in years where only an index count of the escapement is available, i.e. no weir counts or mark-recapture experiments were conducted. The expansion factor is the average over several years of the ratio of the escapement estimate (or weir count) to the index count.

Systems where escapement is known

On systems where escapement can be completely enumerated with weirs or other complete counting methods, the expansion factor is an estimate of the expected value of the "population" of annual expansion factors (π's) for that system:

$$\bar{\pi} = \frac{\sum_{y=1}^{k} \pi_y}{k} \qquad (1)$$

where $\pi_y = N_y / C_y$ is the observed expansion factor in year *y*, N_y is the known escapement in year *y*, C_y is the index count in year *y*, and *k* is the number of years for which these data are available to calculate an annual expansion factor.

The estimated variance for expansion of index counts needs to reflect two sources of uncertainty for any predicted value of π, (π_p). First is an estimate of the process error (*var*(π): the variation across years in the π's, reflecting, for example, weather or observer-induced effects on how many fish are counted in a survey for a given escapement)), and second is the sampling variance of $\bar{\pi}$ (*var*($\bar{\pi}$)), which will decline as we collect more data pairs. (These two sources of variability are analagous to the variability in the ε_i and in the $\hat{Y}_i$, respectively, in the usual linear regression set-up).

The variance for prediction will be estimated (Neter et al. 1990):

$$var(\pi_p) = var(\pi) + var(\bar{\pi}) \qquad (2)$$

where

$$var(\pi) = \frac{\sum_{y=1}^{k} (\pi_y - \bar{\pi})^2}{k-1} \qquad (3)$$

and

$$var(\bar{\pi}) = \frac{\sum_{y=1}^{k} (\pi_y - \bar{\pi})^2}{k(k-1)} \qquad (4)$$

such that

a Var is used to denote population variance
var is used to denote estimated variance

$$var(\pi_p) = \frac{\sum_{y=1}^{k}(\pi_y - \overline{\pi})^2}{k-1} + \frac{\sum_{y=1}^{k}(\pi_y - \overline{\pi})^2}{k(k-1)} \quad (5)$$

Systems where escapement is estimated

On systems where escapement is estimated, the expansion factor is an estimate of the expected value of the "population" of annual expansion factors (π's) for that system:

$$\overline{\pi} = \frac{\sum_{y=1}^{k}\hat{\pi}_y}{k} \quad (6)$$

where $\hat{\pi}_y = \hat{N}_y / C_y$ is the estimate of the expansion factor in year *y*, $\hat{N}_y$ is the estimated escapement in year *y*, and other terms are as described above.

The variance for prediction will again be estimated:

$$var(\pi_p) = var(\pi) + var(\overline{\pi}) \quad (7)$$

Component: $var(\pi)$

var (π) should again reflect only process error. Variation in $\hat{\pi}$ across years, however, represents process error **plus** measurement error within years (e.g. the mark-recapture induced error in escapement estimation) and is described by the relationship (Cochran 1977; equation 10.2):

$$Var(\hat{\pi}) = Var[E(\hat{\pi})] + E[Var(\hat{\pi})] \quad (8)$$

This relationship can be rearranged to isolate process error ($Var[E(\hat{\pi})]$), that is:

$$Var[E(\hat{\pi})] = Var[\hat{\pi}] - E[Var(\hat{\pi})] \quad (9)$$

var (π) representing an estimate of only process error therefore is:

$$var(\pi) = var(\hat{\pi}) - \frac{\sum_{y=1}^{k} var(\hat{\pi}_y)}{k} \quad (10)$$

where

$$var(\hat{\pi}) = \frac{\sum_{y=1}^{k}(\hat{\pi}_y - \overline{\pi})^2}{k-1} \quad (11)$$

and

$var(\hat{\pi}_y) = var(\hat{N}_y) / C_y^2$, with $var(\hat{N}_y)$ = Obtained during the experiment when N_y is estimated.

Component: $var(\bar{\pi})$

As we did above:

$$var(\bar{\pi}) = \frac{\sum_{y=1}^{k}(\hat{\pi}_y - \bar{\pi})^2}{k(k-1)} \tag{12}$$

For large k ($k > 30$), equations 11 and 12 provide reasonable parameter estimates, however for small k the estimates are imprecise and may result in negative estimates of variance when the results are applied as in equation 7.

Because k is typically < 10, we will obtain $var(\hat{\pi})$ and $var(\bar{\pi})$ using parametric bootstrap techniques (Efron and Tibshirani 1993). The sampling distributions for each of the $\hat{\pi}_y$ are modeled using normal distributions with means $\hat{\pi}_y$ and variances $v\hat{a}r(\hat{\pi}_y)$. At each bootstrap iteration, a bootstrap value $\hat{\pi}_{y(b)}$ is drawn from each of these normal distributions and the bootstrap value $\hat{\pi}_{(b)}$ is randomly chosen from the k values of $\hat{\pi}_{y(b)}$. Then, a bootstrap sample of size k is drawn from the k values of $\hat{\pi}_{y(b)}$ by sampling with replacement, and the mean of this bootstrap is the bootstrap value $\bar{\pi}_{(b)}$. This procedure is repeated B = 1,000,000 times. We can then estimate $var(\hat{\pi})$ using:

$$var_B(\hat{\pi}) = \frac{\sum_{b=1}^{B}(\hat{\pi}_{(b)} - \overline{\hat{\pi}_{(b)}})^2}{B-1} \tag{13}$$

where

$$\overline{\hat{\pi}_{(b)}} = \frac{\sum_{b=1}^{B}\hat{\pi}_{(b)}}{B} \tag{14}$$

and we can calculate $var_B(\bar{\pi})$ using equations 13 and 14 with appropriate substitutions.

The variance for prediction is then estimated:

$$var(\pi_p) = var_B(\hat{\pi}) - \frac{\sum_{y=1}^{k}\mathrm{var}(\hat{\pi}_y)}{k} + var_B(\bar{\pi}) \tag{15}$$

As the true sampling distributions for the $\hat{\pi}_y$ are typically skewed right, using a normal distribution to approximate these distributions in the bootstrap process will result in estimates of $var(\hat{\pi})$ and $var(\bar{\pi})$ that are biased slightly high, but simulation studies using values similar to those realized for this applications indicated that the bias in equation 15 is < 1%.

Predicting Escapement

In years when an index count (C_p) is available but escapement (N_p) is not known, it can be predicted:

$$\hat{N}_p = \overline{\pi}\, C_p \tag{16}$$

$$var(\hat{N}_p) = C_p^2 var(\pi_p)\ . \tag{17}$$

Appendix B2.–Peak aerial survey counts, estimated total spawning abundance $\hat{N}_L$ with associated SE's and approximate 95% CIs for large Chinook salmon spawning in the Keta River 1975–2013.

Year	Survey counts	Expansion factor	$\hat{N}_L$	SE ($\hat{N}_L$)	Lower 95% CI	Upper 95% CI	$v(\hat{N}_L)$	CV
1975	203	3.01	611	114	388	834	12,921	18.6%
1976	84	3.01	253	47	161	345	2,212	18.6%
1977	230	3.01	692	129	440	945	16,587	18.6%
1978	392	3.01	1,180	220	750	1,610	48,181	18.6%
1979	426	3.01	1,283	239	815	1,750	56,901	18.6%
1980	192	3.01	578	108	367	789	11,559	18.6%
1981	329	3.01	990	184	629	1,352	33,939	18.6%
1982	754	3.01	2,270	422	1,442	3,097	178,256	18.6%
1983	822	3.01	2,475	460	1,573	3,377	211,858	18.6%
1984	610	3.01	1,836	342	1,167	2,506	116,670	18.6%
1985	624	3.01	1,879	349	1,194	2,563	122,087	18.6%
1986	690	3.01	2,077	386	1,320	2,835	149,279	18.6%
1987	768	3.01	2,312	430	1,469	3,155	184,937	18.6%
1988	575	3.01	1,731	322	1,100	2,362	103,666	18.6%
1989	1,155	3.01	3,477	647	2,210	4,745	418,278	18.6%
1990	606	3.01	1,824	339	1,159	2,489	115,145	18.6%
1991	272	3.01	819	152	520	1,117	23,197	18.6%
1992	217	3.01	653	122	415	891	14,765	18.6%
1993	362	3.01	1,090	203	693	1,487	41,088	18.6%
1994	306	3.01	921	171	585	1,257	29,359	18.6%
1995	175	3.01	527	98	335	719	9,602	18.6%
1996	297	3.01	894	166	568	1,220	27,658	18.6%
1997	246	3.01	741	138	471	1,011	18,975	18.6%
1998	180	**2.48**	**446**	**50**	**348**	**544**	**2,500**	**11.2%**
1999	276	**3.51**	**968**	**116**	**741**	**1,195**	**13,456**	**12.0%**
2000	300	**3.05**	**914**	**122**	**675**	**1,153**	**14,884**	**13.3%**
2001	343	3.01	1,033	192	656	1,409	36,888	18.6%
2002	411	3.01	1,237	230	786	1,688	52,965	18.6%
2003	322	3.01	969	180	616	1,323	32,510	18.6%
2004	376	3.01	1,132	211	719	1,545	44,328	18.6%
2005	497	3.01	1,496	278	951	2,042	77,449	18.6%
2006	747	3.01	2,248	418	1,429	3,068	174,962	18.6%
2007	311	3.01	936	174	595	1,277	30,326	18.6%
2008	363	3.01	1,093	203	694	1,491	41,316	18.6%
2009	172	3.01	518	96	329	707	9,278	18.6%
2010	475	3.01	1,430	266	908	1,951	70,742	18.6%
2011	223	3.01	671	125	426	916	15,592	18.6%
2012	241	3.01	725	135	461	990	18,211	18.6%
2013	493	3.01	1,484	276	943	2,025	76,206	18.6%
Averages	412		1,241					
Minimum	84		253					
Maximum	1,155		3,477					
$\bar{\pi}$		3.01						
SE $\bar{\pi}$		0.56						
var $\bar{\pi}$		0.31354						

Note: Statistics in bold come directly from mark–recapture experiments in 1998–2000; all other statistics are expanded from counts based on the relationship between counts and estimates during years with mark–recapture experiments.