Regional Operational Plan SF.2A.2016.08

Operational Plan: Kenai River Chinook Salmon Radio Telemetry

by

Tony Eskelin

May 2016

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.2A.2016.08

OPERATIONAL PLAN: KENAI RIVER CHINOOK SALMON RADIO TELEMETRY

by

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SIGNATURE/TITLE PAGE

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Project leader(s):	Tony Eskelin
Division, Region and Area	Sport Fish, Region II, Soldotna
Project Nomenclature:	F-10-30
Period Covered	May – December 2016
Field Dates:	May – August 2016
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project Leader	Tony Eskelin		4/28/2016
Biometrician	Matt Tyers		4/28/2016
Research Coordinator	Tim McKinley		5/26/16

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ABSTRACT

The primary goal of this study is to determine the number of radiotagged Chinook salmon that enter the Killey River and the number of radiotagged Chinook salmon that migrate upstream of the U.S. Fish and Wildlife Service (USFWS) Killey River weir in order to estimate Killey River Chinook salmon escapement. Chinook salmon captured during May and June at river mile (RM) 8 of the Kenai River will be tagged with radio transmitters. Fixed telemetry stations at the Killey River mouth and Killey River weir will count radiotagged Chinook salmon that migrate into the Killey River and those that pass the weir. Fixed stations will also be installed at the RM 13.7 Chinook salmon sonar site, Slikok Creek confluence, Funny River confluence, and the Kenai Lake outlet to monitor migration. Aerial surveys will be conducted to determine approximate tributary spawning locations. The combined total of Killey River and Funny River Chinook salmon escapement will provide a coarse minimum estimate of early-run Kenai River Chinook salmon abundance independent of sonar.

Key words: Chinook salmon, *Oncorhynchus tshawytscha*, Kenai River, early run, tributaries, Funny River, Killey River, radio transmitter.

INTRODUCTION

PURPOSE

The primary purpose of this research is to provide a coarse minimum estimate of tributary-bound early-run Kenai River Chinook salmon abundance that is independent of the existing sonar program. Run size of returning Kenai River Chinook salmon is an important metric used for inseason and postseason stock assessment. This project will allow the Alaska Department of Fish and Game (ADF&G) to indirectly monitor Kenai River early-run Chinook salmon abundance and provide the distribution of Kenai River tributary-bound Chinook salmon.

BACKGROUND

The Kenai River watershed encompasses approximately 2,200 square miles of the Kenai Peninsula including diverse landscapes such as glaciers, large lakes, high mountains, and vast lowlands. The Kenai River mainstem is approximately 82 miles long, including a 15-mile stretch through Skilak Lake (Figure 1). Populations of Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), sockeye salmon (*O. nerka*), pink salmon (*O. gorbuscha*), Dolly Varden (*Salvelinus malma*), and rainbow trout (*O. mykiss*) occur in the Kenai River and support valuable commercial and recreational fisheries.

For management purposes, Kenai River Chinook salmon are separated temporally into 2 runs: early-run fish are those that enter the river prior to July 1 and late-run fish are those that enter the river on or after July 1. Biologically, Kenai River Chinook salmon are separated into tributary- and mainstem-spawning populations. Most populations of tributary-spawning Chinook salmon arrive from late April to early July (Bendock and Alexandersdottir 1992; Burger et al 1983; Reimer 2013). Several Kenai River tributaries support spawning Chinook salmon (Figure 1) although the most abundant spawning populations utilize Funny River, Killey River, and Benjamin Creek, a tributary to the Killey River (Bendock and Alexandersdottir 1992; Burger et al 1983; Johnson and Daigneault 2013; Reimer 2013). Mainstem-spawning Chinook salmon arrive from mid-June to mid-August and utilize nearly the entire Kenai River mainstem upstream of river mile (RM) 12 (Bendock and Alexandersdottir 1992; Burger et al 1983; Hammarstrom et al. 1985; Reimer 2013).

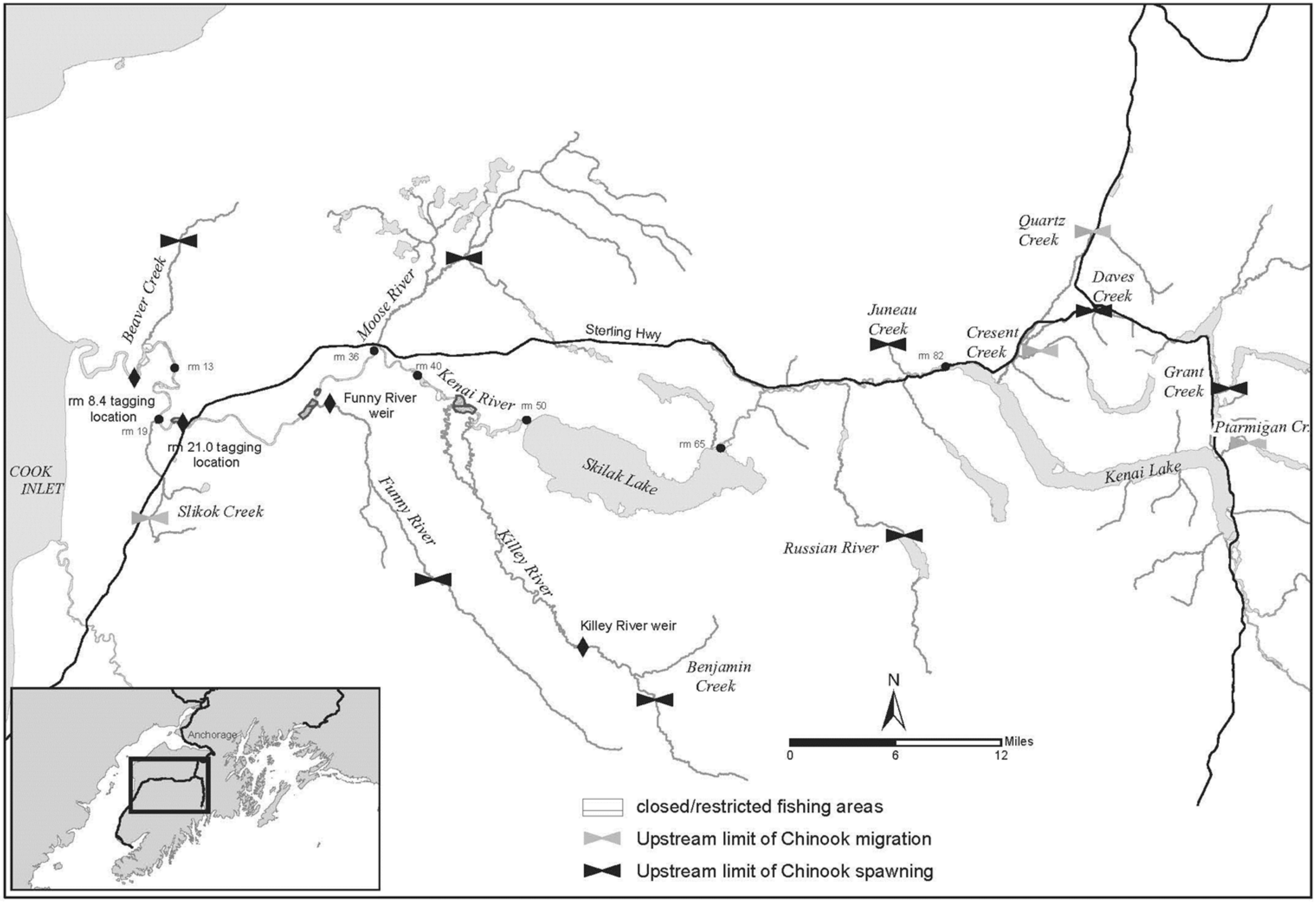

Figure 1.–The Kenai River Drainage.

Note: Though not indicated on the map, the Kenai River upstream of Skilak Lake and all tributaries to the Kenai River are also closed to sport fishing for Chinook salmon.

ABUNDANCE ESTIMATION

The Alaska Board of Fisheries (BOF) has adopted escapement goal ranges for both runs and prescribed the management actions available to achieve those goals. The early-run optimum escapement goal range (OEG) is currently 5,300–9,000 Chinook salmon. The late-run sustainable escapement goal range (SEG) is currently 15,000–30,000 Chinook salmon. In the past 20 years, sport fishing was restricted in the 1997, 1998, 2000, 2002, and 2010–2015 early runs, and in the 1998 and 2011–2015 late runs to meet escapement goals. Implementation of these management plans attracts much public scrutiny.

The size of the inriver run is a key component for estimating spawning escapement and implementing management plans. Using hydroacoustic techniques, daily and seasonal estimates of Chinook salmon abundance at RM 8.6 have been generated from 1987 to 2014 and at RM 13.7 since 2013. Acoustic assessment of Chinook salmon in the Kenai River has been complicated by the presence of more abundant sockeye salmon, which migrate concurrently with Chinook salmon at RM 8.6. Due to this uncertainty, Chinook salmon abundance estimates from the RM 8.6 sonar (through 2014 only) have been compared to genetic capture–recapture estimates from 2007 to 2012, the Funny River weir escapements since 2006, Funny River and Killey River escapements since 2012, and a second sonar site operated near RM 13.7 during 2013 and 2014. The sonar at RM 8.6 was discontinued after the 2014 season and all sonar operations have moved to the RM 13.7 sonar location since. The sonar site at RM 13.7 allows for near complete riverwide (streambank to streambank) estimates of Chinook salmon passage and is outside of tidal influence.

Killey River Chinook salmon escapement cannot be measured directly and needs to be estimated because the Killey River weir is 28 river miles upstream from its confluence with the Kenai River and significant numbers of Chinook salmon spawn downstream of the Killey River weir but within the Killey River (Reimer 2013). Fish spawning in the Funny and Killey Rivers have represented 68–78% of all early-run fish radiotracked between 2010 and 2015 (Reimer 2013; Eskelin and Reimer *In prep*). Thus, Funny River and Killey River passage estimates provide a coarse minimum value for early-run abundance estimates generated by the sonar.

OBJECTIVES

PRIMARY OBJECTIVE

1) Estimate the Killey River Chinook salmon escapement such that the estimate is within 25% of the true value 80% of time[1].

SECONDARY OBJECTIVES

1) Count the number of radiotagged Chinook salmon that enter the Killey River.
2) Count the number of radiotagged Chinook salmon that migrate above the Killey River weir.
3) Determine the dates when radiotagged Chinook salmon enter the Funny River.
4) Determine the dates when radiotagged Chinook salmon enter the Killey River.

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[1] The USFWS will operate the Funny River and Killey River weirs. ADF&G will radiotag Chinook salmon and track them to spawning destinations. Killey River weir counts will be used in conjunction with radiotag data to estimate the Killey River Chinook salmon escapement.

5) Determine the dates when radiotagged Chinook salmon migrate upstream of the Slikok Creek regulatory boundary in the Kenai River.

6) Determine approximate spawning locations of radiotagged Chinook salmon within tributaries of the Kenai River via aerial surveys.

METHODS

CHINOOK SALMON CAPTURE

Chinook salmon will be captured by an existing inriver gillnetting study conducted in the lower Kenai River near river mile (RM) 8.6 (Pershbacher *In prep a*). The primary crew will sample daily beginning 16 May from 7:00 AM to 1:00 PM using 60 ft long, 2-panel drift gillnets. Each net has one 30 ft section of 5.0 inch stretched mesh web and one 30 ft section of 7.5 inch stretched mesh web. Nets will be deployed systematically with respect to bank, distance offshore, and mesh size closest to shore to ensure that fish of all sizes throughout the sampling area have a reasonable possibility of capture. The secondary crew will sample at least 4 days per week during the early run from 1:00 PM to 7:00 PM as part of a 4.0 inch and 6.0 inch mesh size pilot study in an attempt to capture a more representative sample of returning Chinook salmon. For the pilot study, nets will consist of 1 mesh size only (4.0 inch or 6.0 inch stretched measure), and mesh size will alternate each day the pilot study is conducted. . See Perschbacher (*In prep b*) for a more detailed description of the inriver gillnetting study that will be responsible for Chinook salmon capture and deployment of radio transmitters.

RADIO TRANSMITTER DEPLOYMENTS

Radio transmitters will be deployed in Chinook salmon between 16 May and 30 June 2016 to represent tributary spawning populations. Negligible numbers of tributary-bound Chinook salmon were captured after 30 June in 6 years of radiotag deployments and no tagged fish have migrated to the Funny River or Killey River after 30 June during any year (Reimer 2013; Eskelin and Reimer *In prep*). The minimum Chinook salmon tagging size will be 480 mm mid eye to tail fork (METF). Tagged fish less than 480 mm METF survived to migrate at a much lower rate than larger fish during the 2 years (2010 and 2014) when fish of all sizes were tagged. Two sizes of radio tags will be deployed. Given that tag weight should not exceed 2% of the fish weight (Winter 1996), fish as small as 800 g (1.75 lb) could be tagged, which is smaller than any Chinook salmon 480 mm METF or greater. Chinook salmon less than 600 mm METF but at least 480 mm METF will be tagged with Advanced Telemetry Systems[2] (ATS, Isanti, MN) model F1835B[3] radio transmitters. Chinook salmon 600 mm METF and above will be tagged with either ATS model F1845B[4] or F1835B radio transmitters, depending on availability of each tag. All F1845B radio transmitters will be used to tag Chinook salmon 600 mm METF and above prior to using any F1835B for Chinook salmon of that size range. There will be 30 1835B and 90 1845b radio transmitters available for deployment. The 1835B to 1845B tag ratio will approximate the ratio corresponding to the respective size of Chinook salmon (480–599 mm, or 600 mm and above) that were captured in 2015.

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[2] Product names used in this publication are included for completeness but do not constitute product endorsement.
[3] ATS 1835B radio tags are 17 mm diameter, 48 mm long, and weigh 16 grams.
[4] ATS 1845B radio tags are 19 mm diameter, 56 mm long, and weigh 26 grams.

Based on captured rates in 2015 and with supplemental tagging in the mesh size pilot study, we anticipate capturing 240 Chinook salmon during the early run. To ensure that tags are deployed throughout the entire early run, every other Chinook salmon will be sampled for biological data but not tagged. If catch rates are significantly lower than 2015, we may change the subsampling rate to ensure all tags are deployed. Only captured Chinook salmon deemed healthy will be fitted with a transmitter.

Radiotagged Chinook salmon will be located passively by stationary radio receiving stations. Pulse-coded radio transmitters broadcasting on 8 frequencies (151.300–151.580 MHz, 17 pulse codes per frequency) will be used for this project. During stationary radiotracking, the scan time for each frequency will be 2 s with a 15 s timeout. Thus, each frequency will be scanned for 2 s; if a transmission is detected, then the receiver pauses for 15 seconds on each antenna to decode the pulse code and signal strength. Total scan time will range from 16 s (8 frequencies × 2 s/frequency) when no signals are detected to 360 s (8 frequencies × 15 s/frequency × 3 antennas) when each frequency has at least 1 signal detected. Similar scan times have provided satisfactory detection and resolution for both manual and stationary tracking in past years. Fixed telemetry stations will be placed at the RM 13.7 Chinook salmon sonar site, Slikok Creek confluence, Funny River confluence, Killey River confluence, Killey River weir, Skilak Lake outlet, and Kenai Lake outlet. Stations will be equipped with 2 or 3 directional antennas; 1 antenna pointed upstream, 1 antenna pointed downstream, and 1 antenna pointed up from the tributary confluence (when applicable). The direction of fish movement can be discerned by comparing signal strengths between antennas within the chronological data.

FUNNY RIVER WEIR

The Funny River weir has been operated by the United States Fish and Wildlife Service (USFWS) since 2006. Upstream migrating fish swim freely through a fish passage chute in the resistance board weir where they are recorded by a motion activated digital video recording device. The video footage from the site is reviewed by a technician to determine upstream passage. The weir will be operational from approximately May until mid-August to monitor the entire migration.

The weir is located approximately 0.75 miles upstream from the Funny River confluence with the Kenai River. A limited amount of spawning does occur downstream of the weir[5]. Since 2012, weir counts have averaged 1,235 Chinook salmon (Boersma and Gates 2013, 2014, 2016; Gates and Boersma 2014b).

KILLEY RIVER WEIR

The Killey River weir has been operated by the USFWS since 2012. Similar to the Funny River weir, upstream migrating fish swim freely through a fish passage chute in the resistance board weir where they are recorded by a motion-activated digital video recording device. The video footage from the site is reviewed by a technician to determine upstream passage. The weir will be operational from approximately June until mid-August to monitor the entire migration.

[5] Between 2010 and 2015, 66 radiotagged Chinook salmon spawned within the Funny River drainage. Sixty-three fish spawned upstream of the weir, 1 fish spawned immediately downstream of the weir, and 2 fish that spawned near the weir were not confirmed as upstream or downstream of the weir.

The weir is located approximately 28 miles upstream from the confluence with the Kenai River, and there is significant spawning downstream of the weir. Radio tags will be used to determine the proportion of Killey River Chinook salmon that migrated upstream of the weir in order to estimate Killey River Chinook salmon escapement. Table 1 provides summary information for Killey river weir passage, radio tags, and escapement estimates. Since 2012, the average proportion of Killey River radio tags that passed the weir is 0.50 (Table 1).

Table 1.–Killey River weir passage, number of tags, and estimate of Killey River Chinook salmon escapement, 2012–2015.

Year	Killey River weir passage	Number of Killey River tags	Number of tags above Killey River weir	Proportion of tags above Killey River weir	SE	Killey River escapement	SE
2012	1,602	53	21	0.40	0.07	4,043	686
2013	1,881	38	19	0.50	0.08	3,762	610
2014	1,713	51	24	0.47	0.07	3,640	541
2015	2,653	28	18	0.64	0.09	3,650	412
Average	1,732	43.5	20.5	0.50	0.04	3,774	286

Source: Weir passage data provided by USFWS (Gates and Boersma 2013, 2014a,c, 2016).

SAMPLE SIZES

The goal will be to tag 120 Chinook salmon with radio transmitters in the lower Kenai River during the entire early run. Since 2012, 55% (on average) of Chinook salmon that were tagged at RM 8 that were greater than or equal to 480 mm were classified as migrants, and of these, as few as 54% were observed to enter the Killey River in any year. Assuming this low proportion as a worst-case scenario and that the same proportion of tagged Chinook salmon enter the Killey River in 2016, then we expect 36 tagged Chinook salmon to enter the Killey River, which will still allow an abundance estimate to be within the stated objective criteria (Robson and Regier 1964).

DATA COLLECTION

Telemetry data will be collected primarily at automated, fixed, data-recording stations. A typical fixed station will consist of a guy-wire stabilized mast with 2 or 3 directional antennas, an antennae switch, radio receiver, a data collection computer, a 12-volt deep-cycle battery, and a weather-resistant box to house the battery and the receiving and data collection equipment. Antennas will be Yagi-style model P154-4 (Cushcraft, Inc. New Hampshire) tuned to receive the 150–154 MHz frequency band. The antennae switch will be ATS Model 100. Stations will be equipped with an ATS R4500 series receiver or DCC. This system will be used to detect unique radio tags and record the radio frequency, pulse code, date, time, antenna on which the signal was detected, and a measure of signal strength.

Telemetry stations will be set up in early May prior to tag deployment. After site installation, the detection range for each site will be tested and mapped with a reference tag. The testing procedure calls for 2 staff members communicating via walkie-talkie; 1 at the radio receiving station and 1 in a boat near the site. The boat is held stationary while a radio transmitter is lowered to the river bottom using a weighted string. The location-specific signal strength for each antenna is then recorded on a map of the site. This procedure is repeated until the detection area for the site has been accurately mapped and the ability to detect tags on each antenna is satisfactory. Of primary interest is a long reach with bank-to-bank detection on both antennas and ensuring that the pattern of signal strengths on each antenna allows correct determination of the tag location relative to the site. Data will be downloaded from each site periodically using a laptop computer and software supplied by the manufacturer. During download sessions each fixed site will undergo routine maintenance. Two records of download and maintenance history will be kept. A site log will be kept at each fixed station and used to record the download and maintenance history at that station over the course of the season (Appendix A1). In addition, a fixed station download form will be used to document all download and maintenance activities (Appendix A2).

An ATS R4520 receiver with dual H-style antennas will be used for airplane surveys. The airplane will be flown slowly adjacent to the stream or river of interest while the receiver, gain set to max, scans all active frequencies. If a transmission is heard, the scan will be briefly held on the active frequency while the receiver decodes the transmission. In most cases, the plane continues its flight path without regard for the presence or absence of radio tags and tags are located 2–4 times at disjoint locations along the flight path. In areas with multiple co-located fish, the airplane will fly tight circles above the co-located radio tags to allow sufficient time to decode all tags present. Each successfully decoded transmission triggers the receiver to record the following information: date, time, frequency, pulse code, GPS coordinates, mortality switch position, and signal strength. The record with the largest signal strength will be considered the approximate location.

DATA REDUCTION

Raw telemetry data will be downloaded from ATS equipment in a proprietary format and saved with a file name that references the date and time when the download occurred. SAS software will be used to convert the individual downloads into a seasonal file in comma-separated file format. A data map for the fixed station telemetry file is shown in Appendix B1. The date, time, and direction of fish movement past each fixed station will be discerned by comparing signal strengths between the antennas at each station within the chronological data. The data map for the manual tracking file is shown in Appendix B2.

DATA ANALYSIS

The proportion of mainstem-spawning Chinook salmon that migrate upstream of the Killey River weir will be estimated as follows:

$$\hat{p} = \frac{R}{M} \tag{1}$$

where

R = the number of radiotagged Chinook salmon that passed upstream of the Killey River weir, and

M = the number of radiotagged Chinook salmon that entered into the Killey River.

The variance of the proportion (Equation 1) will be estimated according to Cochran (1977):

$$\text{var}[\hat{p}] = \frac{\hat{p}(1-\hat{p})}{M-1}. \tag{2}$$

If the subsampling rate is constant throughout the tagging effort, Killey River Chinook salmon abundance will be estimated using a Chapman estimator (Seber 1982):

$$\hat{N} = \frac{(M+1)(C+1)}{R+1} - 1 \tag{3}$$

where C is the number of Chinook salmon counted at the Killey River weir.

The variance of Killey River abundance will be estimated as follows (Seber 1982):

$$\text{var}(\hat{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}. \tag{4}$$

If subsampling rates are not constant throughout the tagging effort, an approximately unbiased estimator of Killey River Chinook salmon abundance will be calculated using a weighted time-stratified estimator. Weights (w_i) will be calculated for each time stratum inversely proportional to the tagging rate for that stratum:

$$w_i = \frac{k_i}{t_i} \tag{5}$$

where k_i is the number of Chinook salmon caught by the midriver crew during time stratum *i*, and t_i is the number of fish tagged by the midriver crew during stratum *i*.

Then the proportion of Killey River Chinook salmon spawning above the weir can be estimated as follows:

$$\hat{p} = \frac{\sum_{i=1}^{T} w_i r_i}{\sum_{i=1}^{T} w_i m_i} \tag{6}$$

where r_i is the number of fish tagged during time stratum *i* that spawn above the weir, m_i is the number of fish tagged during time stratum *i* that enter the Killey River, and *T* is the number of time strata.

Assuming independence of the tagging events in different time strata and treating m_i as a constant, the variance of $\hat{p}$ can be estimated as follows:

$$\text{var}(\hat{p}) = \frac{\sum_{i=1}^{T} w_i^2 \text{ var}(r_i)}{(\sum_{i=1}^{T} w_i m_i)^2} \tag{7}$$

where $\text{var}(r_i) = m_i \hat{p}_i (1-\hat{p}_i)$ and $\hat{p}_i = \frac{r_i}{m_i}$.

A delta-method unbiased estimator for abundance can be calculated as follows:

$$\hat{N} = C\left(\frac{1}{\hat{p}} - \frac{var(\hat{p})}{\hat{p}^3}\right) \tag{8}$$

with variance estimated as

$$var(\hat{N}) = C^2 var\left(\frac{1}{\hat{p}}\right) \tag{9}$$

with $var\left(\frac{1}{\hat{p}}\right)$ approximated according to the delta method as

$$var\left(\frac{1}{\hat{p}}\right) = \frac{var(\hat{p})}{\hat{p}^4}. \tag{10}$$

Conditions for an unbiased Chapman Estimator

The following conditions must be met for the Chapman estimate to be unbiased. Based on satisfying most or all of these conditions, it is assumed that bias in Killey River Chinook salmon escapement estimate will be low in this study.

1) *The population must be closed to births, deaths, immigration, and emigration.*

   Tagged fish that enter the Killey River bound for locations upstream of the Killey River weir may die before migrating above the weir; however, we think this will be a rare occurrence and will assume that it will happen to the same proportion of tagged and untagged Chinook salmon.

2) *Marking and handling will not affect the migratory behavior of Chinook salmon.*

   It is well documented that Chinook salmon behavior is affected by capture and handling; migration is often delayed in fish that have been handled or survival of tagged fish is lower than untagged fish (Bernard et al. 1999). To mitigate this problem, every possible effort will be made to minimize the effect of handling. First, obviously stressed or injured fish will not be tagged. Holding and handling time of all captured fish will be minimized and tags will be applied as quickly and efficiently as possible. Also, tagged fish that enter the Killey River will have already migrated 35 miles upstream from the tagging location, thereby short term tagging effects will be mitigated. For example, Chinook salmon radiotagged near RM 8.5 demonstrate similar run timing as unmarked fish at the Funny River and Killey River weirs (Reimer 2013).

3) *Killey River Chinook salmon will have equal probabilities of capture in either the first or the second sample; or, marked fish will mix completely with unmarked fish between samples.*

   In the marking event, sampling will likely be conducted over the entire span of the run. We will attempt to capture and distribute tags representatively through time and area by approximately equal weekly netting effort and capturing fish from both banks and midchannel. If differential subsampling occurs between time strata in the marking event, capture probabilities in the first event cannot be considered equal. If needed, a weighted stratified estimator may be used instead. The Killey River weir personnel will attempt to enumerate all fish passage, and radio tags will be identified via fixed telemetry sites at the Killey River confluence, at the Killey River weir, and from aerial surveys. To examine the assumption that fish that spawn in the Killey River upstream of the weir will be captured with equal probability to those that spawn below the weir, we will examine the age, sex, and length (ASL) composition of tagged fish above and below the weir, and of all Chinook salmon that migrate upstream of the weir. In addition, radio tag fates will be analyzed by size class to examine possible differences in handling effect by size.

4) *Tagged fish will not lose their tags between events.*

   Tags may be lost from fish between the tagging event and the resampling event; however, radio transmitters are uniquely identifiable, which will allow for any discounting of fish that lost tags. Fish that regurgitate tags almost always do so within the first couple days of implant; however, if a tagged fish bound for upstream of the Killey River weir migrates into the Killey River, but loses the tag prior to migrating upstream of the weir, it would positively bias the Killey River escapement estimate. This occurrence is not likely to happen.

SCHEDULES, DELIVERABLES, AND RESPONSIBILITIES

Tony Eskelin, Fishery Biologist II, Project leader.

May–September 2016

Radio telemetry: Responsible for field installation and removal of telemetry equipment, maintenance, downloading telemetry data, and conducting aerial surveys.

Fall–Winter 2016

Post season data reduction to determine Killey River Chinook salmon escapement and spawning distribution of radio tagged Chinook salmon.

Winter 2016–2017

Author the 2016 Kenai River Chinook salmon radio telemetry FDS report.

Matt Tyers, Biometrician II, Biometrician

April–May 2016, Fall 2016

Assists project leader in operational planning, data analysis and reporting.

Timothy McKinley, Fishery Biologist IV, Project Leader Supervisor

Supervises project leader.

Oversees planning, analysis, and reporting.

BUDGET SUMMARY

FY16

Line item	Category	FY16($K)
100	Personnel Services	0.0
200	Travel	0.0
300	Contractual	26.3
400	Commodities	0.5
500	Equipment	0.0
Total		26.8

REFERENCES CITED

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APPENDIX A: SAMPLING FORMS

Appendix A1.–Fixed station site log.

Kenai River Chinook Salmon Fixed Station Site Log

Site Code: ___________ Site Name: _________________________________

Date	Time	Rec. /DCC	Batt. Volts	# of blocks	Comments

DCC capacity is 32,024 blocks, R4500 capactiy is 98,304 blocks (stationary)

Appendix A2.–Kenai River Chinook salmon fixed station download form.

Name: ________________________

Name	Date	Rec/ DCC	Batt. voltage	Blocks	filename	Comments
Chinook Sonar						
Slikok Creek						
Funny River						
Killey River						
Skilak Lake outlet						
Kenai Lake outlet						

APPENDIX B: DATA MAPS

Appendix B1.–Fixed station telemetry data map.

Data map for files kkstation16.dta

Data Field Name	Start Column	End Column	Comma Column	Codes/ Comments
Date code	1	8	9	format YYYYMMDD
Hour	10	11	12	24-hour clock
Minute	13	14	15	
Antenna number	16	16	17	1–3
Frequency	18	23	24	KHz, six digit number, 151xxx
Pulse code	25	27	28	
Mortality signal	29	29	30	Y or blank
(Blank)	31	34	35	
Signal strength	36	38	39	measure of signal strength
Station name	40	42	43	Character code
Latitude	40	50	51	DDD MM.MMMM
Longitude	52	62	63	DDD MM.MMMM
Rivermile	64	67	68	

Appendix B2.–Manual tracking telemetry data map.

Data map for files kkboat16.dta

Data Field Name	Start Column	End Column	Comma Column	Codes/ Comments
Date code	1	8	9	format YYYYMMDD
Survey method	10	14	15	Boat, Plane or Foot
Survey start rivermile	16	19	20	Downstream extent of survey
Survey end rivermile	21	24	25	Upstream extent of survey
Time located	26	29	30	hhmm, 24-hour clock
Frequency	28	33	34	KHz, 6 digit number; 151xxx
Pulse code	25	27	28	
Latitude	29	39	40	DDD MM.MMMM
Longitude	41	51	52	DDD MM.MMMM
Signal strength	53	55	56	
Rivermile	57	60	61	
Drainage	64	78	79	
Mortality	80	80		Y or blank