Regional Operational Plan SF.2A.2017.15

Operational Plan: Russian River Early Run Sockeye Salmon Tagging Study

by

Tony Eskelin

May 2017

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.2017.15

OPERATIONAL PLAN: RUSSIAN RIVER EARLY RUN SOCKEYE SALMON TAGGING STUDY

by
Tony Eskelin

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

May 2017

Tony Eskelin,,
Alaska Department of Fish and Game, Division of Sport Fish,
43961 Kalifornsky Beach Road, Suite B, Soldotna, AK 99669-8267, USA

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SIGNATURE/TITLE PAGE

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Project Leader	Tony Eskelin		5/11/17
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ABSTRACT

The primary goal of this study is to estimate the time it takes for Russian River early-run sockeye salmon to migrate from the Kenai River rivermile (RM) 13.7 sonar site to the Russian River area sport fishery at Kenai River RM 73.0 and to the Russian River weir near Lower Russian Lake. A representative sample of 50 sockeye salmon will be captured with inriver gillnets at RM 8 and implanted with radio transmitters during 25 May to 30 June 2017, then tracked throughout their migration using fixed telemetry stations, and boat and aerial tracking. A sample of at least 200 captured sockeye salmon will also be deployed with spaghetti tags and recaptured at the Russian River weir to further assess the migration timing of Russian River early-run sockeye salmon. The sonar at RM 13.7 can enumerate fish passage by size, thereby providing a minimum estimate of run size of sockeye salmon at RM 13.7. Detailed knowledge of Russian River early-run sockeye salmon run timing from the sonar site to the sport fishery and weir will help with future inseason management of this stock.

Key words: sockeye salmon, *Oncorhynchus nerka*, Kenai River, Russian River, early run, radio transmitter

INTRODUCTION

PURPOSE

This study will provide an estimate of the mean time it takes for Russian River–bound early-run sockeye salmon to migrate from the Kenai River Chinook salmon sonar site at RM 13.7 to the inriver sport fishery at Kenai River RM 73.0 and to the Russian River weir near lower Russian Lake. The mean migration times to these locations will be used for more effective inseason management of this stock to meet the biological escapement goal of 22,000–42,000 Russian River early-run sockeye salmon. By knowing the time it takes sockeye salmon to migrate from the RM 13.7 sonar site to the Russian River area sport fishery, fishery managers will be better prepared and informed regarding any potential inseason management actions that may be necessary to manage the Russian River sockeye salmon early run sport fishery to meet the biological escapement goal.

BACKGROUND

The Russian River is a clearwater tributary of the Kenai River on the Kenai Peninsula approximately 100 miles south of Anchorage (Figure 1) and supports one of the largest freshwater sport fisheries for sockeye salmon (*Oncorhynchus nerka*) in Alaska (Jennings et al. 2015). The Russian River has 2 genetically distinct runs (Barclay and Habicht 2012) and exhibit a bimodal entry pattern with the modes referred to the early and late runs (Begich et al. 2017).

Russian River early-run sockeye salmon primarily enter the Kenai River in May and June and migrate 120 river kilometers (RKM) upstream to the Russian River, spawning in the upper reaches of the drainage. Harvest of this stock occurs primarily in the Russian River area sport fishery between river mile (RM) 73.0 and 73.6 and in the lower Russian River, although fish are also harvested in the Kenai River downstream of RM 73.0 and in the lower Russian River for subsistence use (Figure 2).

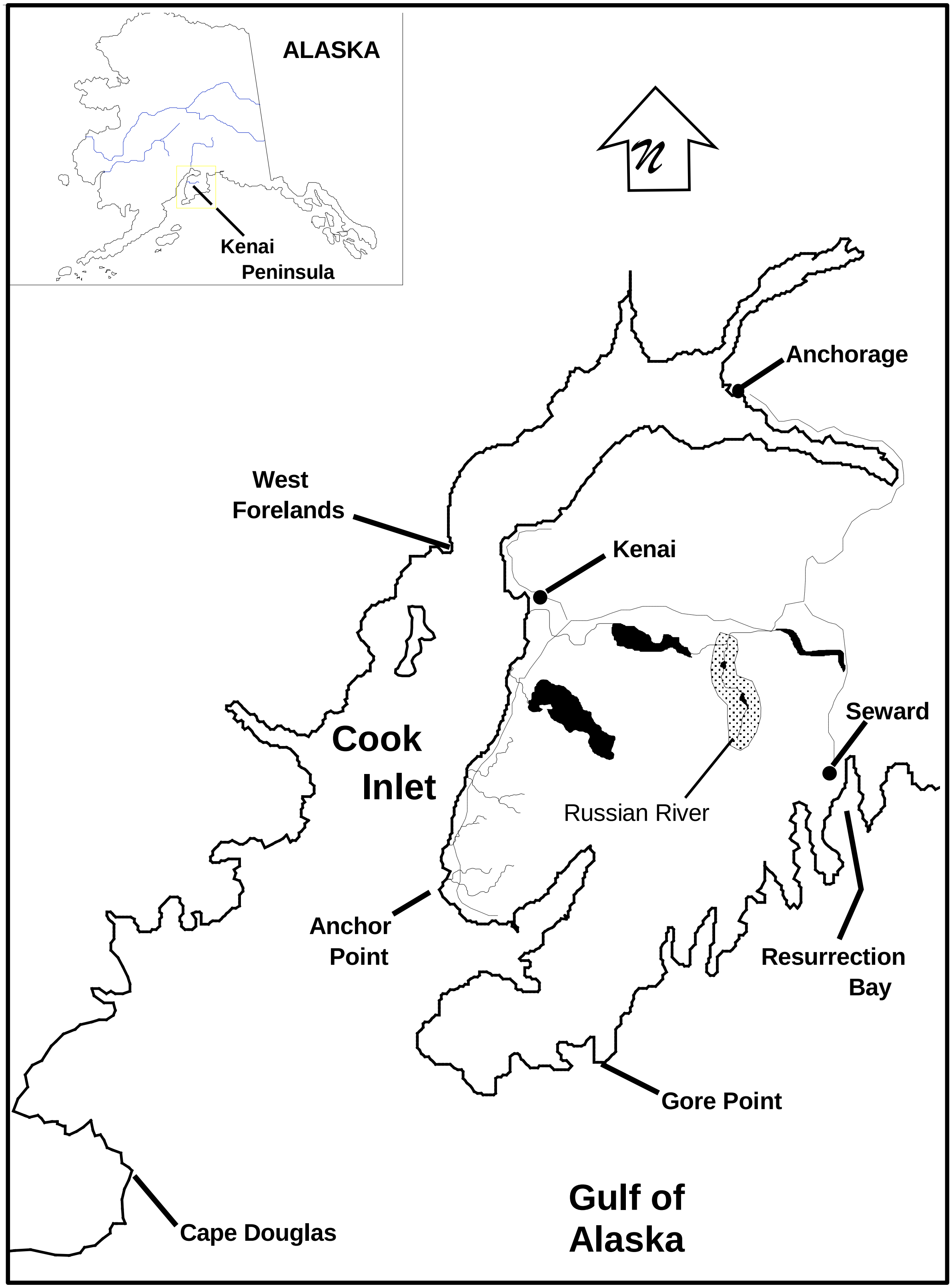

Figure 1.–Location of the Russian River.

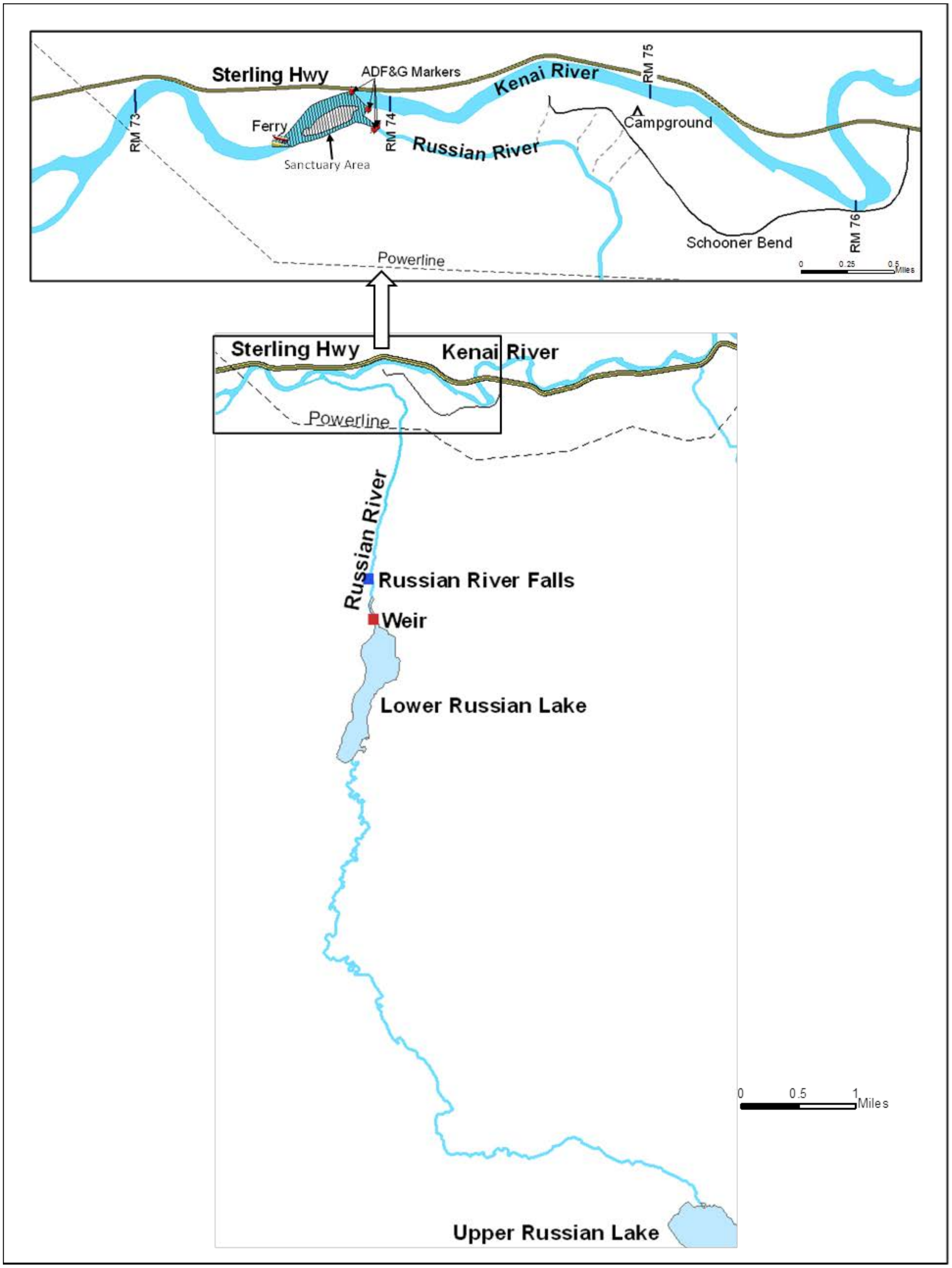

Figure 2.–Map of the Russian River sockeye salmon recreational fishing areas and fishing access locations.

A weir located at the outlet of Lower Russian Lake is used to enumerate the spawning escapement as well as provide a means to trap fish and collect age, sex, and length information (Pawluk 2015). Sockeye salmon passing the weir prior to 15 July are classified as early-run fish and those passing the weir on or after 15 July are classified as late-run fish. Although Russian River sockeye salmon have been studied for several decades, their population dynamics are not well understood. Considerably more is known about the population dynamics of the Russian River early run compared to the Russian River late run because the annual total early run is estimated by adding estimated sport fishery harvest (the only known source of significant early-run harvest) to enumerated escapement past the Russian River weir whereas the late run is harvested by a number of fisheries (commercial set gillnet, commercial drift gillnet, personal use, sport, and subsistence), making harvest estimation and therefore total run estimates more difficult for the late run. A brood table has been developed for the early run, and stock–recruit analyses have been conducted periodically (Hasbrouck and Edmundson 2007). A biological escapement goal (BEG) of 22,000–42,000 sockeye salmon past the weir is in place for the early run whereas a sustainable escapement goal (SEG) of 30,000–110,000 sockeye salmon is established for the late run (Erickson et al. 2017). See Table 1 for detailed fishery harvests, escapements, and run sizes for Russian River early-run sockeye salmon.

Table 1.–Angler effort (hours), harvest, escapement and total run for Russian River early run sockeye salmon.

Year	Effort	Sport harvest	Subsistence harvest	Escapement	Total run
1963	7,880	3,670	ND	14,384	18,054
1964	5,330	3,550	ND	12,695	16,245
1965	9,720	10,030	ND	21,514	31,544
1966	18,280	14,950	ND	16,658	31,608
1967	16,960	7,240	ND	13,710	20,950
1968	17,280	6,920	ND	9,192	16,112
1969	14,930	5,870	ND	5,000	10,870
1970	10,700	5,750	ND	5,451	11,201
1971	15,120	2,810	ND	2,654	5,464
1972	25,700	5,040	ND	9,273	14,313
1973	30,690	6,740	ND	13,120	19,860
1974	21,120	6,440	ND	13,164	19,604
1975	16,510	1,400	ND	5,645	7,045
1976	26,310	3,380	ND	14,736	18,116
1977	69,510	20,400	ND	16,061	36,461
1978	69,860	37,720	ND	34,240	71,960
1979	55,000	8,400	ND	19,749	28,149
1980	56,330	27,220	ND	28,624	55,844
1981	51,030	10,720	ND	21,142	31,862
1982	51,480	34,500	ND	56,106	90,606
1983	31,860	8,360	ND	21,272	29,632
1984	49,550	35,880	ND	28,908	64,788

-continued-

Table 1.–Page 2 of 2.

Year	Effort	Sport harvest	Subsistence harvest	Escapement	Total run
1985	50,770	12,300	ND	30,605	42,905
1986	52,250	35,100	ND	36,338	71,438
1987	113,010	154,200	ND	61,513	215,713
1988	72,030	54,780	ND	50,406	105,186
1989	60,570	11,290	ND	15,278	26,628
1990	84,710	30,215	ND	25,144	56,931
1991	85,741	65,390	ND	31,660	97,779
1992	60,499	30,512	ND	37,117	67,629
1993	58,093	37,261	ND	39,857	77,118
1994	64,134	48,923	ND	44,872	93,795
1995	48,185	23,572	ND	28,603	52,175
1996	50,122	39,075	ND	52,905	91,980
1997	46,914	36,788	ND	36,280	73,068
1998	47,942	42,711	ND	34,143	76,854
1999	64,536	34,283	ND	36,607	70,890
2000	69,864	40,732	ND	32,736	73,468
2001	55,972	35,400	ND	78,255	113,655
2002	68,263	52,139	ND	85,943	138,082
2003	50,448	22,986	ND	23,650	46,636
2004	60,784	32,727	ND	56,582	89,309
2005	55,801	37,139	ND	52,903	90,042
2006	70,804	51,167	ND	80,524	131,691
2007	57,755	36,805	380	27,298	64,483
2008	55,444	42,492	928	30,989	74,409
2009	64,518	59,097	605	52,178	111,880
2010	39,873	23,412	615	27,074	51,101
2011	47,264	22,697	684	29,129	52,510
2012	41,152	15,231	867	24,115	40,213
2013	59,682	27,162	768	35,776	63,706
2014	57,544	35,870	1,276	44,920	82,066
2015	55,420	29,997	989	50,226	81,212
2016	NA	NA	NA	38,739	NA
Average					
1963–2015	47,948	28,084		31,640	59,903
2006–2015	54,946	34,393	790	40,223	75,327

Note: ND means that data were not collected. NA means that the estimate is not available yet.

The Russian River sockeye salmon sport fishery is one of the most actively managed sport fisheries in Alaska. The Division of Sport Fish has closed all or part of the fishery on 27 occasions since 1969 to achieve escapement goals. The most recent fishery restriction was in 2010. In many other years, the fishery has been liberalized by opening the sanctuary area (Figure 2) prior to 15 July and by liberalizing the daily bag limit from 3 per day, 6 in possession to 6 per day, 12 in possession from the Russian Fly Fishing Only area downstream to Skilak Lake.

Recently, the Kenai River Chinook salmon sonar site was moved from RM 8.6 to RM 13.7 and a new Adaptive Resolution Imaging Sonar (ARIS) sonar was deployed (Miller et al. 2016). At this new site and with the new sonar technology, nearly the entire cross section of river is ensonified and fish passage is enumerated by size. The majority of fish that pass the RM 13.7 sonar during the early run that are less than 75 cm mid eye to tail fork (MEFT) length are sockeye salmon and the majority of those are thought to be bound for the Russian River. Thus, early-run sonar counts of fish less than 75 cm METF at RM 13.7 provide a course maximum estimate of Russian River early-run sockeye salmon passage at this site. However, the amount of time it takes sockeye salmon to migrate from RM 13.7 to the inriver sport fishery near RM 73.0 is not known. This project will assess the migration timing of Russian River sockeye salmon from RM 13.7 to both the Russian River area sport fishery beginning at RM 73.0, and to the Russian River weir in an effort provide management with an inseason tool to more effectively manage Russian River early-run sockeye salmon to meet the BEG and provide for sustained yield.

OBJECTIVES

PRIMARY OBJECTIVES

1) Estimate the mean migration time of early-run sockeye salmon from Kenai River RM 13.7 to the inriver sport fishery at Kenai River RM 73.0 such that the estimate is within 0.5 days of the true value 90% of the time.
2) Estimate the mean migration time of sockeye salmon from Kenai River RM 13.7 the lower Russian River weir such that the estimate is within 0.1 days of the true value 90% of the time.

SECONDARY OBJECTIVE

1) Determine fates (drop-out, censor, regurgitate, migrant) and approximate final destinations (i.e., spawning locations) of radiotagged sockeye salmon.

METHODS

SOCKEYE SALMON CAPTURE

Sockeye salmon will be captured by an existing inriver gillnetting study conducted daily in the lower Kenai River near RM 8.6 (Pershbacher 2017) and a supplemental tagging effort 2 days each week in the same area. The existing inriver gillnetting study will capture and deploy a sample of spaghetti-tagged sockeye salmon. The supplemental tagging effort will be responsible for radiotransmitter deployments and will also spaghetti-tag sockeye salmon. The existing inriver gillnetting study will be conducted daily beginning May 16 from 7:00 AM to 1:00 PM using 60 ft long drift gillnets. Gillnets will consist of either 5.0-inch or 7.5-inch stretched mesh web. Netting effort will be approximately equal with respect to mesh size, bank, and distance offshore to ensure that fish of all sizes and locations throughout the sampling area have an approximately equal probability of capture. See Perschbacher (2017) for a more detailed description of the inriver gillnetting project that will spaghetti tag a sample of sockeye salmon. The supplemental tagging effort will be conducting in the afternoons 2 times per week after the existing gillnetting study is done for the day. The study design of the supplemental tagging study will be the same as the existing inriver gillnetting study except that gillnets with 4.0-inch mesh will be deployed.

RADIO TRANSMITTER DEPLOYMENTS

Radio transmitters will be implanted in sockeye salmon between 25 May and 30 June 2017 to represent approximately all of the Russian River sockeye salmon early run timing. A sample of 50 captured sockeye salmon will be implanted with model 1835B pulse-coded esophageal radio transmitters, manufactured by Advanced Telemetry Systems (Isanti, Minnesota)[1]. Radio transmitters will be 48 mm in length, 17 mm wide, have a 30.5 cm long antenna and weigh 16 grams. Battery capacity will be 96 days with a warranty life of 48 days and each transmitter will be programmed to transmit a mortality signal after 24 consecutive hours of no movement. The minimum fish size will be set at 400 mm mid eye to fork of tail (METF) length for radio transmitter implantation. Given that tag weight should not exceed 2% of the fish weight (Winter 1996), fish as small as 0.8 kg (2.75 lb) may be tagged; therefore, sockeye salmon 400 mm METF or longer may be tagged. To determine the tag deployment rate that best represents the entire early run, the catch per unit of effort (CPUE) of sockeye salmon at RM 8.6 was analyzed for the years 2012–2016 (Figure 3). During these years, sockeye salmon were captured primarily after 24 May. Highest average peak CPUE was observed during 2–7 June with the peak occurring on 4 June (Figure 3). The radio tag deployment schedule to best represent the recent 5-year average sockeye salmon capture rate from 16 May–30 June is outlined in Table 2.

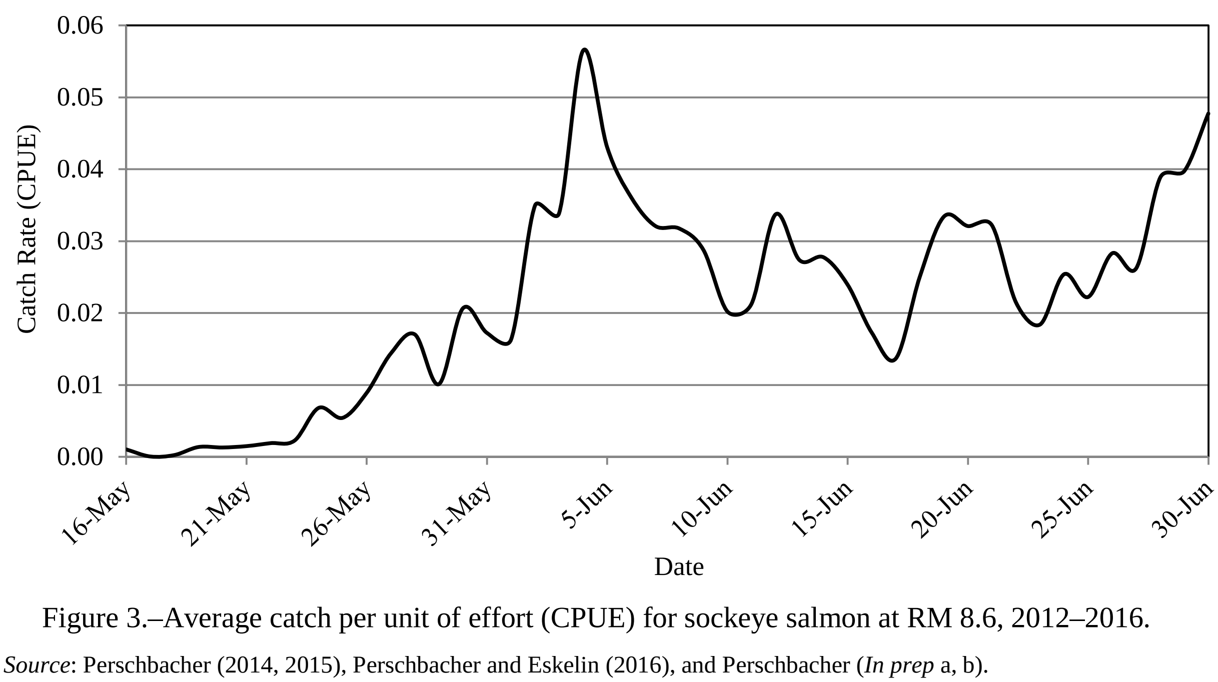

Figure 3.–Average catch per unit of effort (CPUE) for sockeye salmon at RM 8.6, 2012–2016.

Source: Perschbacher (2014, 2015), Perschbacher and Eskelin (2016), and Perschbacher (*In prep* a, b).

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[1] Product names used in this publication are included for completeness and do not constitute product endorsement.

Table 2.–Sockeye salmon radiotransmitter deployment schedule, 2017.

Date range	Number of radio transmitters
25 May–2 June	7
3–9 June	14
10–16 June	9
17–23 June	9
24–30 June	11
Total	50

Only captured sockeye salmon deemed healthy will be fitted with a transmitter. Transmitters will be inserted through the esophagus and into the fish's stomach with an applicator made from 2 concentric pipes of polyvinyl chloride. The outer pipe is three-quarter inch outside diameter with rounded edges and one end split into quarters. The inner pipe fits snugly inside the outer pipe but slides with minimal effort. Likewise, the narrow end of the transmitter fits snugly within the split end of the outer pipe. Each transmitter will be fitted with a retention device (e.g., a modified "hoochie" lure skirt or a rubber band) around the main body of the tag to prevent the salmon from regurgitating the transmitter. Transmitters, lubricated with glycerin, will be inserted by gently pressing the tag against the esophageal sphincter until the sphincter relaxes, allowing the tag to pass into the stomach. The transmitter will then be dislodged from the applicator using the inner pipe as a plunger. The mouth of each tagged fish will be inspected to ensure the transmitter is not visible and is inside of the stomach. Prior to the first deployment, a series of tag placement tests will be conducted to ensure proper tag placement into the fish's stomach.

RADIO TRACKING

Radiotagged sockeye salmon will be located passively by stationary radio receiving stations. Pulse-coded radio transmitters broadcasting on 5 frequencies (151.200–151.800 MHz, 10 pulse codes per frequency) will be used for this project. During stationary radio tracking, the scan time for each frequency will be 3 s with a 15 s timeout. Thus, each frequency will be scanned for 3 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 15 s (5 frequencies * 3 s/frequency) when no signals are detected to 225 s (5 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 stationary tracking in past years for radiotagged Chinook salmon in the Kenai River (Eskelin and Reimer 2017). Fixed telemetry stations will be placed at the Kenai River Chinook salmon sonar site (RM 13.7), Skilak Lake outlet (RM 49.1), near Skilak Lake inlet (RM 66.2), Kenai River RM 73.0, Russian River confluence (Kenai River RM 73.6), and Russian River weir near lower Russian Lake (Table 3 and Figure 4). All fixed telemetry stations will be equipped with 2 antennas, 1 pointing downstream and 1 pointing upstream, except the station at the Russian River confluence, which will have 3 antennas: 1 pointing downstream, 1 pointing upstream, and 1 pointing up the Russian River. The direction of fish movement and the time when a fish passes a station will be discerned by comparing signal strengths between antennas within the chronological data.

Radiotagged fish will also be tracked approximately weekly via boat surveys to further assess sockeye salmon migration patterns and to validate fixed station data. In addition, up to 2 aerial surveys will be conducted in mid to late July and early to mid-August to determine approximate final destinations of early-run radiotagged fish within the drainage.

Table 3.–Location and purpose of fixed telemetry stations in the Kenai and Russian river drainages.

Fixed station location	Kenai River RM	Purpose
Chinook salmon sonar	13.7	Entry site for study, migration past RM 13.7 sonar
Skilak Lake outlet	49.3	Migration into Skilak Lake
Skilak Lake inlet	66.2	Migration through Skilak Lake and into upper Kenai River
Russian River area sport fishery	73.0	Migration into Russian River area sport fishery
Russian River confluence	73.6	Migration into Russian River or upstream of Russian River
Russian River weir	–	Migration past Russian River weir

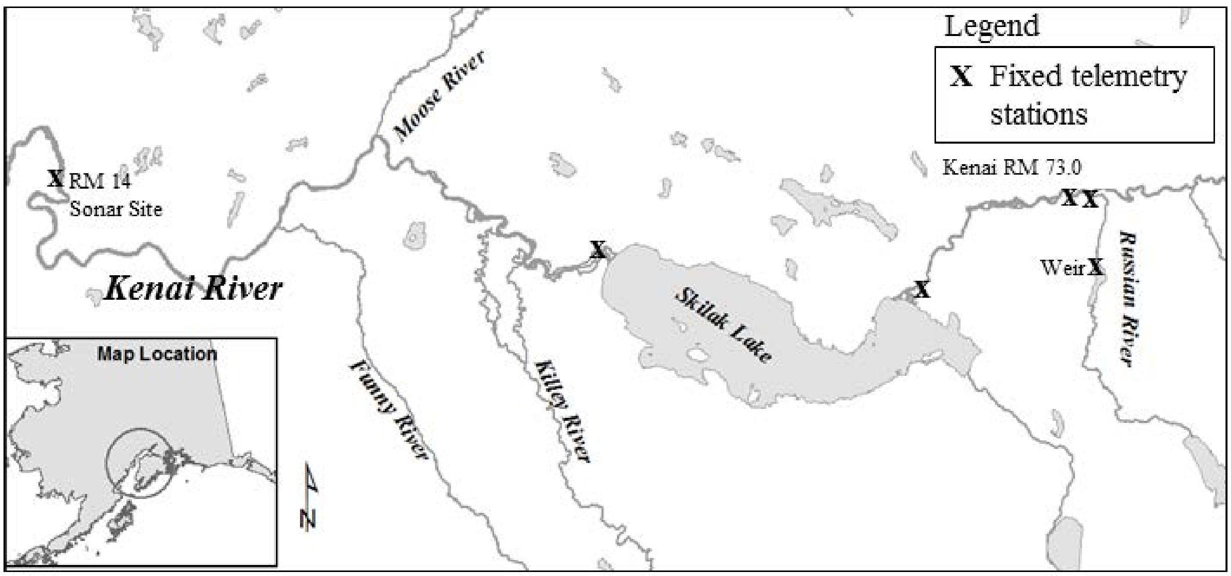

Figure 4.–Map of Kenai River showing location of fixed telemetry stations.

DEPLOYMENT OF SPAGHETTI TAGS IN SOCKEYE SALMON

It is estimated that on average, 40% of the Russian River early-run sockeye salmon that migrate to the inriver sport fishery at RM 73.0 are harvested in the Russian River area sport fishery. To increase the sample size needed to estimate migration time to the weir, sockeye salmon will also be tagged with spaghetti tags. Uniquely-numbered, 30 cm (12 inch), Floy FT-4 plastic spaghetti tags will be inserted into each fish below the posterior insertion of the dorsal fin with a standard spaghetti-tagging needle (hollow barrel, solid point) and secured with an overhand knot. The goal will be to deploy a minimum of 200 sockeye salmon with spaghetti tags from 16 May to 5 July; however, we may tag more than 200 sockeye salmon with spaghetti tags. Spaghetti tag deployments in the existing inriver gillnetting study will be determined by the number of fish captured and how much time it takes to tag fish such that it does not interfere with the inriver gillnetting study design for Chinook salmon. The inriver gillnetting study will begin the season by spaghetti tagging all captured healthy sockeye salmon until more than 5 sockeye salmon are captured in a day. At that time, we will reassess the time it takes to spaghetti tag sockeye salmon and determine how many spaghetti-tagged sockeye salmon will be deployed each day. The extended study design (16 May–5 July) compared to the radiotag deployments (24 May–30 June) will help to determine if Russian River early-run sockeye salmon are captured after 30 June and to determine the migration rate of the earliest captured sockeye salmon prior to 24 May. Sockeye salmon will also be spaghetti tagged with supplementary inriver gillnetting that will be responsible for deployment of radiotransmitters. A sample of captured sockeye salmon will be spaghetti tagged after radio deployments are done for the day. Sample size will be dependent on capture rates and crew availability.

RUSSIAN RIVER WEIR

A weir at the outlet of Lower Russian Lake will be used to census the spawning escapement of sockeye salmon in the Russian River drainage upstream of lower Russian River. Due to water clarity and low water depth in the Russian River, salmonid species are easily counted and differentiated by the weir attendants. Spaghetti-tagged sockeye salmon will be observed and trapped by weir attendants and the tag number and date of capture will be recorded. Biological samples (age, sex, and METF length) of sockeye salmon will be also collected at the weir to represent each run. In addition, weir personnel will collect climatological and river discharge data, operate the Russian River fish pass when necessary, and visually count late-run sockeye salmon that spawn downstream from the weir site.

The weir and field camp will be installed on or about 6 June. The weir site will be staffed by 2 permanent seasonal Fishery Technician IIIs. Several supplemental personnel from the Alaska Department of Fish and Game (ADF&G) Soldotna office will be assigned to the weir as needed for weir installation, maintenance, scale sampling, and other weir-related activities. The weir will be in operation from approximately 6 June to early September so the weir will provide a census of essentially the entire Russian River sockeye salmon early run. See Pawluk (2015) for more details regarding operation of the Russian River weir, daily duties, and data collection procedures at the weir.

SAMPLE SIZES TO ESTIMATE MIGRATION RATE

We will deploy 50 sockeye salmon with radio transmitters in the lower Kenai River near RM 8. Due to handling mortality, we estimate the survival rate from RM 8 to the fishery at RM 73 will be 80% and we expect the migration time will be between 9 and 17 days. Given those parameters, the estimated mean migration time should be within 0.5 days of the true mean 90% of the time.

If expected survival rate of radiotagged fish from RM 8 to the fishery is 80%, and the expected survival rate of these fish through the fishery is 60% of those that make it to the fishery, it is estimated the survival rate of radiotagged fish from RM 8 to the Russian River weir will be 48%. The expected survival rate of spaghetti-tagged fish will be approximately 60% if we assume there is no mortality from RM 8 until the fishery. If we estimate 124 tagged fish (both radio- and spaghetti tagged) will reach the weir, and we expect the migration time to be between 15 and 22 days, then the estimate of mean migration time will be within 0.1 days of the true mean 90% of the time. Because we may spaghetti tag more than 200 sockeye salmon, we should easily meet this precision estimate.

We do not know what the survival rate will be for radiotagged sockeye salmon but we are assuming a survival rate of at least 80% from the sonar site to the fishery and a survival rate of 60% in the fishery. With 50 radiotagged and 200 spaghetti-tagged fish, we expect detailed migration timing of 24 radiotagged and 96 spaghetti-tagged sockeye salmon to the Russian River weir during the entire early run.

Assessment of Fates and Final Destinations of Radiotagged Sockeye Salmon

Radiotagged fish will be assigned 1 of 4 fates based on their behavior after tagging: dropout, regurgitation, censor, or migrant. All of the telemetry data will be consolidated into 1 graphic per fish before deciding on a fate. Dropouts, regurgitations, and censors are similar in their failure to provide useful spawning destination or migratory timing information. The following list defines these behaviors:

1) Dropouts: Fish categorized as dropouts probably entered salt water almost immediately after tagging. These fish are either never observed again in the study or are only observed downstream of the tagging location. Because radio tags cannot transmit a signal through salt water, dropouts are rarely located after being deployed and are most likely direct handling mortalities.
2) Regurgitation: Tags that are permanently stationary immediately after deployment and are in close proximity of the tagging site will be categorized as regurgitations. Regurgitated tags will be presumed ejected from the esophagus and are distinguishable from mortalities because dead radiotagged fish often have rapid downstream movement. Because radio tags will be deployed in the tidally influenced zone, some fish classified as regurgitations may be dropouts that are not flushed out to salt water due to a lack of current. This error will have little influence on our primary results because neither fate will used in the spawning destination analysis or migratory timing analysis.
3) Censor: Fish that display upstream migration that is insufficient in length, distance, or duration after tagging and can not be placed in a likely spawning area will be censored from the analysis. Tagged fish are censored if they do not enter a tributary, do not migrate upstream of RM 46.0, or are classified as mortalities prior to 15 July.
4) Migrant: Fish that migrate upstream of the tagging site and enter known spawning areas during known spawning periods will be considered migrants. Fish that enter a Kenai River tributary will be considered migrants to that tributary. Tributary use will verified by both station (Russian River only) and aerial tracking data.

Final destinations will be determined for radiotagged sockeye salmon as the most upstream location observed. Whereas determining final destinations and fates is not a primary objective of this pilot study, knowing the final destinations will assist in development of future studies of early-run sockeye salmon.

Data Collection

Biological Data

The inriver gillnetting program (Perschbacher 2017) and the supplementary netting crew will record the number of sockeye salmon captured by set and date. Biological data will also be recorded for all sockeye salmon implanted with both radio transmitters and spaghetti tags. Technicians will record METF length, tag number if spaghetti tagged, frequency and pulse code if radiotagged, sex, and assessed condition of all tagged fish.

Telemetry Data

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 May prior to tag deployments. 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 B2).

Mobile telemetry surveys will be conducted on the mainstem of the Kenai River approximately once per week by boat (downstream from Skilak Lake) or truck (upstream from Skilak Lake) to verify data collected at fixed stations. Data will be collected automatically on a R4500 ATS receiver and manually on the Allegro CX field computer. Collected data will include the date, start and stop location, time, and location (GPS coordinates) of each radiotracked fish, the frequency, pulse code, and river kilometer (to the nearest 0.2 RKM). Transmitters on mortality mode will also be noted.

An ATS R4520 receiver with dual H-style antennas will be used for up to 2 airplane surveys to determine final destinations of radiotagged sockeye salmon within the Kenai River drainage. The airplane will be flown slowly adjacent to the stream or river of interest while the receiver 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 will continue 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 highest signal strength will be considered the approximate location.

Russian River Weir Passage of Spaghetti-tagged Sockeye Salmon

Weir attendants will be instructed to trap and record tag numbers and time of passage from all spaghetti-tagged sockeye salmon that pass the weir. It is likely there will be some spaghetti-tagged sockeye salmon that pass through the weir without their tag being observed or recorded. Although these occurrences happen, we expect them to be rare. The weir crew will be diligent in looking for tagged fish, and a daily record will be kept of the number of fish that are noticed to have a tag but the tag number could not be observed.

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

Mean migration time will be estimated for radiotagged sockeye salmon from the RM 13.7 sonar to the Russian River area sport fishery at RM 73.0. Mean migration time will also be estimated for radiotagged sockeye salmon from RM 13.7 to the Russian River weir. Although spaghetti-tagged fish will be tagged downstream of RM 13.7, we will have no way of knowing when those fish pass the RM 13.7 sonar, so we will assume that spaghetti-tagged fish migrate from RM 8.6 to RM 13.7 at the same rate as radiotagged fish. We will also compare the migration timing of spaghetti-tagged fish and radiotagged fish from RM 8.6 to the Russian River weir as a means to assess migration time of spaghetti-tagged fish with respect to radiotagged fish. All means and associated variances will be calculated using standard statistical procedures (Sokal and Rohlf 1981). 25 May and 30 June 2017

SCHEDULE AND DELIVERABLES

Dates	Activity	Responsible Personnel
Apr–May 2017	Operational planning	Tony Eskelin, Pat Hansen
25 May–30 Jun 2017	Deploy radiotags in sockeye salmon	Jeff Perschbacher
May–Jul 2017	Inriver gillnetting and spaghetti tagging	Jeff Perschbacher
May–Aug 2017	Radio telemetry	Tony Eskelin
Fall–winter 2017	Postseason data reduction	Tony Eskelin
Winter 2017–2018	Complete FDS report	Tony Eskelin

RESPONSIBILITIES

Project Leader
Tony Eskelin, Fishery Biologist II

Duties: Responsible for field installation and removal of telemetry equipment, maintenance, downloading telemetry data, and conducting boat and aerial surveys. Responsible for postseason data reduction to determine migration rates of radiotagged sockeye salmon escapement and spawning distribution of radiotagged sockeye salmon. Authors the 2017 Russian River sockeye salmon migration timing FDS report.

Biometrician
Pat Hansen, Biometrician IV

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

Project Leader Supervisor
Robert Begich, Fishery Biologist III

Duties: Supervises project leader and oversees planning, analysis, and reporting.

Inriver Gillnetting Project Leader
Jeff Perschbacher, Fishery Biologist I

Duties: Responsible for RM 8 spaghetti tagging with the existing inriver gillnetting study and radiotagging with supplemental gillnetting. Responsible for supervising the technicians that will tag sockeye salmon.

Technicians
Ivan Karic, Fish and Wildlife Technician III

Duties: Assists with field installation of fixed telemetry stations in early May.

Johnna Elkins, Kirsten Duran, Vacant, Fish and Wildlife Technician II

Duties: Conduct inriver gillnetting that will spaghetti tag sockeye salmon and supplemental gillnetting that will radiotag sockeye salmon.

Tim Johnson, Tom Rhyner, Fish and Wildlife Technician III

Duties: Responsible for Russian River weir operation, trapping spaghetti-tagged sockeye salmon, and recording associated data such as tag number and date.

BUDGET SUMMARY

FY 17

Line item	Category	Budget ($K)
100	Personal Services	2.3
200	Travel	0.0
300	Contractual	0.5
400	Commodities	11.2
500	Equipment	0.0
Total		14.2

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APPENDIX A: SAMPLING FORMS

Appendix A1.–Fixed station site log.

Sockeye 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.–Sockeye salmon fixed station download form.

Name: ________________________

Name	Date	Rec/ DCC	Batt. voltage	Blocks	filename	Comments
Chinook Sonar						
Funny River						
Skilak Lake outlet						
Skilak Lake inlet						
Russian River area fishery (RM 73)						
Russian River weir						

APPENDIX B: DATA MAPS

Appendix B1.–Fixed station telemetry data map.

Data map for files:

ssstation 17.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:
ssboat17.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