Regional Operational Plan CF.3A.2014.01

Feasibility of Lower Kuskokwim River Chinook Salmon Radio Tagging

by

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And

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March 2014

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

Symbols and Abbreviations

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

Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Mathematics, statistics

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

REGIONAL OPERATIONAL PLAN CF.3A.2014.01

FEASIBILITY OF LOWER KUSKOKWIM RIVER CHINOOK SALMON RADIO TAGGING

by

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Commercial Fisheries Division

March 2014

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SIGNATURE/TITLE PAGE

Project Title:	Feasibility of Lower Kuskokwim River Chinook Salmon Radio Tagging
Project leader(s):	Joshua Clark, Kevin Schaberg, and Zachary Liller
Division, Region and Area	Commercial Fish, Region III, Kuskokwim Area
Project Nomenclature:	
Period Covered:	May 1, 2014 – January 30, 2015
Field Dates:	May 15, 2014 – July 15, 2014
Plan Type:	Category III

Approval

Title	Name	Signature	Date
Project leader	Joshua Clark		3/17/14
Area Biologist	Kevin Schaberg		3/17/14
Biometrician	Hamachan Hamazaki		3/17/14
Research Coordinator	Jan Conitz		3-17-2014
Regional Supervisor	John Linderman		3/21/14

Chinook Salmon Research Initiative Approval

Title	Name	Signature	Date
Fish and Game Coordinator	Ed Jones		3.25.14
Fisheries Scientist	Robert Clark		3/25/14
Fisheries Scientist	Eric Volk		3.26.14

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PURPOSE

The Kuskokwim River is one of 12 indicator stocks chosen by ADF&G to index Chinook salmon *Oncorhynchus tshawytscha* health statewide. Commercial Fish Division would like to evaluate the feasibility of capturing and tagging Chinook salmon near the mouth of the Kuskokwim River (Figure 1). The purpose of this study is to evaluate capture efficiency and identify optimal sites for using drift gillnets to capture adult Chinook salmon in the lower Kuskokwim River and to determine if captured individuals can be successfully tagged with esophageal radio tags.

INTRODUCTION

There has been ongoing interest for a Chinook salmon tagging project in the lower Kuskokwim River to evaluate migration speed from the mouth of the river through commercial fishing district W1, and to identify stock specific run timing through the same area. However; the lower Kuskokwim River is a large and complex area which has left researchers less than confident of the success of a tagging project in the area. It is approximately 5.1km wide near Tuntutuliak, tidally influenced, and has multiple channels. These factors and the lack of data have deterred further investigation of this portion of the river until now. Commercial Fish Division believes that investigating capture efficiency and tagging success in the lower portions of the river below Bethel would provide the context to evaluate the potential of additional studies.

The tagging area of this study was selected because it is below the most significant harvest areas, thus sampling the entire population, and is low enough to evaluate specific management questions about run timing and speed from the mouth. Near Tuntutuliak an average of 8,000 Chinook salmon is harvested annually, which is about 9% of the Kuskokwim River Chinook salmon subsistence harvest (Carroll and Hamazaki 2012). If locations could be identified where Chinook salmon could be caught and tagged with adequate survival, the stage could be set for future studies to attain run timing, swim speed, and potentially a large scale mark–recapture project to determine abundance for the entire population.

Alternative locations for capture have been considered for this and other lower river tagging studies. Many have proposed tagging operations near Bethel. While this location could be fairly easily provisioned and operated, and has more ideal capture locations because the river is more confined, tagging in the Bethel area would fall short of addressing management questions. Capturing fish near Bethel would also sample from a significantly reduced population in most years. Subsistence harvest data shows an average of 51,000 (61% of total subsistence harvest) Chinook salmon are harvested in the subsistence fishery from Bethel down river, of which 50% (26,000) is harvested in the immediate Bethel area (Carroll and Hamazaki 2012). Abundance estimates from a tagging study would therefore be germane to the number of fish at that location and would require additional reconstruction with harvest data. Captured fish may also display different compositions than the total population in both size and sex as well, since the subsistence fishery operates with large (~8” mesh) gillnets.

Additionally, tagged salmon often exhibit a behavior known as “sulking” after being tagged with esophageal radio tags. These tagged individuals fall back down river and hold in areas of the river for an extended period of time while recovering from capture, tagging, and handling stress. Because of the amount of fishing effort in the Bethel area, this delayed migration may increase their chance of being caught in the fishery, thus violating equal probability assumptions. For these reasons we feel it is more appropriate, and increases the likelihood of success, to avoid tagging in this area, and focus further down river.

OBJECTIVES

1. Evaluate capture efficiency (Catch Per Unit Effort) at three locations in the lower Kuskokwim River using drift gillnets.
2. Evaluate tagging success using esophageal radio tags.

METHODS

EXPERIMENTAL DESIGN

In this feasibility study, medium to large size adult Chinook salmon will be targeted in the various channels of the lower Kuskokwim River. Drift gillnets will be fished by a three person crew from a 20' skiff across three sites that have been chosen for availability of deep channels in narrower parts of the river. At each site three drift locations will be selected for optimal depth with preference given to those with minimal snags and debris. Each site will be fished two days per week, with each day approximating 3 hours of fishing effort. Fishing effort will be held as a constant, though sites may be adjusted inseason based on results as a goal of this study is to find the best fishing locations possible. Five locations have been chosen for stationary tracking of radio tagged fish. These telemetry sites will be used to evaluate survival of the fish and swim speed if there is adequate survival.

Study Area

The three drift fishing sites on the Lower Kuskokwim River have been selected within Subdistrict W1B. The portion of Subdistrict W1B that will be fished is defined by an upper bound of the confluence of the Johnson River (rkm 77) and a lower bound of Tuntutuliak (rkm 45). The first upstream capture site will be just upstream of the confluence of the Kinak River on the right bank, across to Helmick Point on the left bank. The middle capture site will be halfway between the first and third sites. The third and most upstream capture site will be located between the area directly south of the Johnson River on the right bank directly across to the left bank.

Fishing

Drift gillnets will be constructed of multi-fiber mono, mesh sizes will be 7.5" and 8.0" stretched, 45 meshes deep. All nets will be hung at a 2:1 ratio to a finished length of 25 fathoms (45.7 m). The depth of nets is adequate to ensure that majority of the water column is sampled, across the range of expected water levels, regardless of where the net is fished in the variable channels. Each day of fishing will begin approximately one hour after high tide according the National Oceanic and Atmospheric Administration (NOAA) tide predictions schedule published for Apokak Creek entrance. A day of fishing will consist of 3 hours of fishing effort and will be rotated between each of the lower, middle and upper river sites twice per week. The sequential order of the drift locations that are fished will rotate each day a given site is fished. This schedule will be followed unless unforeseen circumstances forbid it. As each site will be fished two days per week, net sizes will be rotated. On the first rotation day for a site, the 8" mesh net will be fished, the 7.5" mesh net will be fished on the second rotation day. Fishing events will last for 30 minutes per drift location for each round, according to the drift fishing schedule and decision matrix (Figure 2). As the first objective is to determine the feasibility of capturing Chinook salmon, fishing locations may be adjusted inseason to more effectively target these fish. As a part of the first objective, we aim to capture Chinook salmon as efficiently as possible with the wellbeing of the salmon in mind. We will evaluate efficiency as Catch Per Unit Effort (CPUE). All non-target species (i.e. - sockeye salmon *O. nerka*, chum salmon *O. keta*, pink salmon *O. gorbuscha*, and coho salmon *O. kisutch*) will be recorded, and live released with the same care as Chinook salmon, and CPUE will be calculated as well.

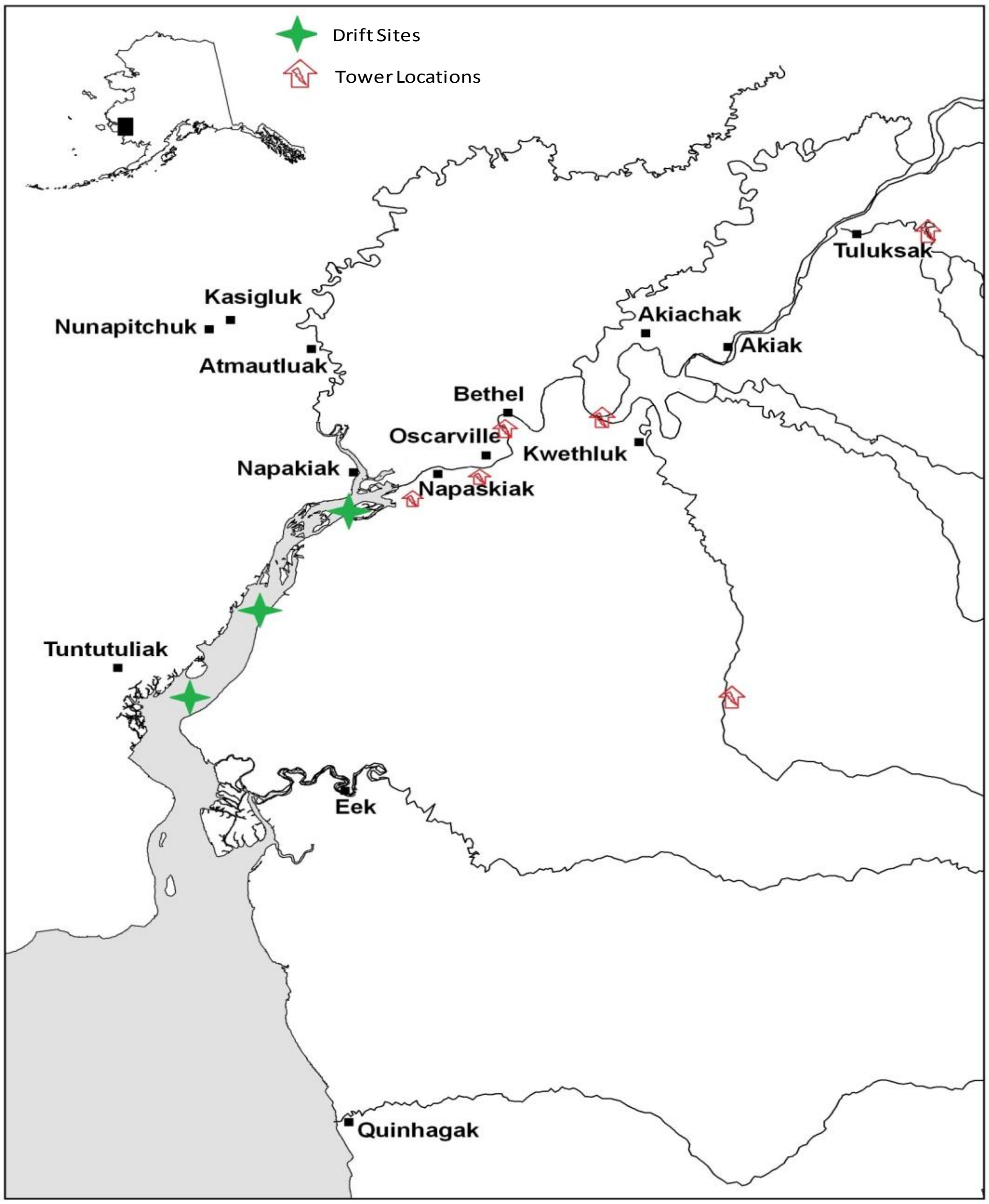

Figure 1- Depiction of Research Area.

Figure 2- Drift success/ fail decision plot for a 3 drift location schedule.

Scenario 1	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	success	success	success
Round 2	fail	fail	fail
Round 3	n/a	n/a	n/a
Round 4	n/a	n/a	n/a

Scenario 2	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	fail	fail	fail
Round 2	success	success	success
Round 3	n/a	n/a	n/a
Round 4	n/a	n/a	n/a

Scenario 3	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	fail	fail	fail
Round 2	success	n/a	n/a
Round 3	success	n/a	n/a
Round 4	success	n/a	n/a

Scenario 4	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	fail	fail	fail
Round 2	fail	fail	fail
Round 3	n/a	n/a	n/a
Round 4	n/a	n/a	n/a

Scenario 5	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	success	fail	fail
Round 2	success	n/a	n/a
Round 3	fail	success	n/a
Round 4	n/a	n/a	n/a

Scenario 6	Drift Location 1	Drift Location 2	Drift Location 3
Round 1	success	success	fail
Round 2	success	success	n/a
Round 3	choose drift location that previously had the most Chinook		
Round 4	n/a	n/a	n/a

Note- Each fishing event per round by drift location will be completed in 30 minutes. Six events total no matter how many rounds are needed will be made for 3 hours of total fishing time.

Stage 1- In the first round, all drift locations will be fished in sequence. If no Chinook salmon are caught in round 1, all drift locations will be fished in sequence again in the second round ending that round when a Chinook salmon is caught (scenarios 1,2,3), or when no fish are caught in round 1 or 2 which will complete 3 hours of fishing (Scenerio 4).

Stage 2- A "success" will be entered to signify where Chinook salmon were caught for each drift location in the given round, resulting in that drift location being fished again in the following round. A "fail" will be entered to signify where no Chinook salmon were caught for drift location in the given round, this drift location will not be immediately fished again in the following round. However, if upon fishing a subsequent round there are no Chinook salmon caught, the next drift location in sequence will be fished for that same round (Scenario 5). A drift location will continue to be fished if it is successful (scenario 3). If the fourth and fifth fishing events are both successful to close the round, the sixth and final fishing event will be repeated at the drift location where the most Chinook salmon were caught (scenario 6).

Estimation of effort for calculation of CPUE will consist of two components. Setting and retrieving the net will be estimated as half effort, since the entire net is not in the water. The time to set and retrieve the net will be divided by two for each set. Once the net is fully deployed, the effort is maximized and the time will be consistent with the effort. If a fish is caught while the net is completely out, the effort for that period will be estimated as:

½ set time + full out time + ½ retrieval time.

If a fish is caught during the setting of the net, the effort will be estimated as:

½ deployment time + ½ retrieval time.

Time management of fishing effort will occur as follows:

1. The time will start and be recorded when the moment the net begins to be offloaded.
2. The moment the net is completely in the water the time will again be recorded (set time).
3. As soon as a “bump” is noticed on the net corks the time will again be recorded, and the net immediately retrieved (full out time).
4. Once the net is completely out of the water the time will be recorded again (retrieval time).

Tagging and Handling Methods

Esophageal radio tags and T-bar anchor tags will be used in this study. Pulse encoded esophageal radio tags manufactured by Advanced Telemetry Systems (ATS) will be used as the primary mark. These radio tags will be programed with a duty cycle that renders the tag inert after 180 days of continuous operation – this eliminates potential confusion associated with using the same tag frequencies and pulse codes in future study years. A total of 10 frequencies with 30 codes per frequency yield 300 uniquely identifiable tags. Different size radio tags will be used to ensure that tags do not exceed 2% of the fish’s body weight (Winter 1983). Model F1845 (26 grams total weight) will be used to mark fish 550mm (mid eye to tail fork, MEF) or larger, and model F1840 (22 grams total weight) will be used to tag fish smaller than 550mm (MEF). Approximately 10% of the Kuskokwim River Chinook salmon are smaller than 550mm in length, based on data from the Bethel Test Fishery (Figure 3). To ensure that an adequate supply of small tags were available 20% (n=60) of the available tags will be Model F1840.

All healthy Chinook salmon larger than 450mm (MEF) will be tagged. Tagging will occur without anesthesia. Fish will be placed in a cradle suspended in a sampling tub filled with circulating river water. Radio tags will be inserted through the esophagus and into the upper stomach using a 30 cm plastic tube with a diameter less than that of the radio tags. The radio transmitter will be pushed through the esophagus such that the antenna end of the radio tag will be seated 0.5 cm beyond the posterior base of the pectoral fin. All radio tagged fish will also be marked externally with a uniquely numbered Floy model FD-68BC T-bar anchor tag. Tags will be placed approximately 1cm below and 2 fin rays anterior to the posterior insertion of the dorsal fin. Anchor tags will be brightly colored and will differ in color from those tags used upriver by the Kalskag fishwheels tagging project. If a fish is not of adequate health it will not be tagged. In the event of mortality, fish will be donated locally.

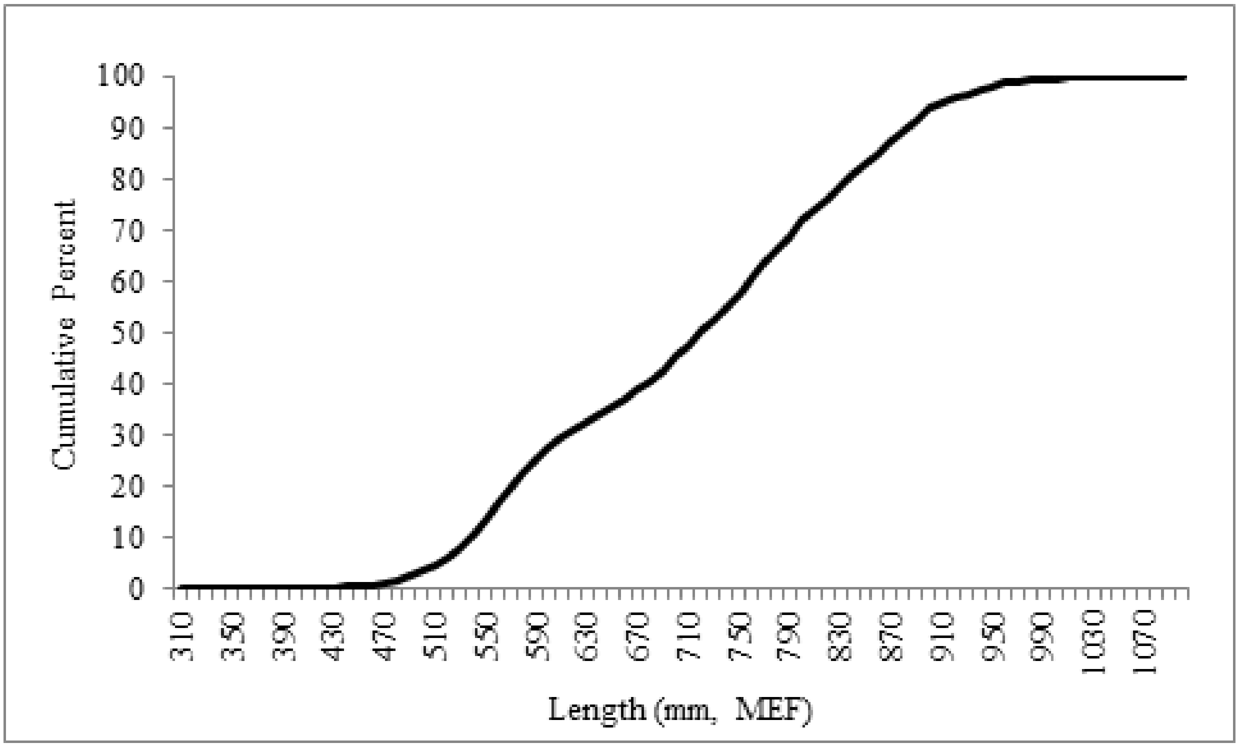

Figure 3.–Cumulative distribution of Chinook salmon length harvested in the Bethel Test Fishery 1981—2012.

Note: Bethel Test Fishery is located upstream of the 2014 tag site. Harvest occurs using drift gillnets with a stretch mesh size of 4in., 5in., and 8.0in.

Radiotelemetry Tracking

Stationary radiotelemetry towers are considered the most ideal for tracking Chinook salmon in this study. We plan to use a network of five ground-based tracking towers in the Lower Kuskokwim River to assess tag success (Figure 1). The lower bounds of this monitoring will start near the confluence of the Johnson and Kuskokwim rivers where a station will be located on the left bank of the Kuskokwim River. Moving upriver a station will be located on the bend below Steamboat Slough in Bethel, one on the downriver tip of Kuskokuak Slough, one at Kwethluk River weir, and one at Tuluksak River weir. These radiotelemetry towers will be used to evaluate survival and will be downloaded at a minimum of once every seven days during resupply trips to Bethel.

Because of the potential for delayed mortality, incorporating additional tracking upstream of the lower river sites is important for a more complete evaluation of survival. These stations will be monitored and installed by an additional crew as a part of the study “2014–2016 Kuskokwim River Chinook salmon mark–recapture”. A network of 17 similarly equipped ground-based radiotelemetry towers programmed to identify the tag frequencies described in this study, will be used to monitor upriver areas. The first of these sites (rkm 233) will be located downriver of the Kalskag fishwheels tagging site, approximately 38 rkm upstream from the village of Tuluksak. The subsequent 11 towers will be spaced approximately 50 rkm apart along the mainstem Kuskokwim River from Aniak (rkm 307) to Medfra (rkm 863). Additionally, one tower will be located at each of the four upriver weir recapture sites.

Each tower will include an ATS Model 4500 receiver that has an integrated data logger. Receivers will be powered by two, 12 V deep cycle batteries charged with a solar array. The receiver and batteries will be housed in a water-resistant steel box along with all associated components. Antenna arrangements will vary by the area of the river being monitored. The first of the sites near Johnson River, which is the also the widest location being monitored (2.6 km), will have two long range six-element Yagi antennas used in conjunction with two standard range four-element Yagi antennas. All sites beyond this will use four-element Yagi antennas, with Kuskokuak Slough having four antennas each to cover multiple channels. The antennas will be mounted on masts elevated 2-10 m above the ground assuring they will monitor the entire width of the river, and will be aimed upstream and downstream in varying combinations based on the conditions of the river in that particular area to identify direction of passage. Each receiver will be programmed to receive from the antennas simultaneously and scan through the list of tag frequencies at 6 s intervals. When a signal of sufficient strength is encountered, the receiver will pause for up to 12 s on each antenna to decode and record tag information. The relatively short cycle period will help minimize the chance that a radio tagged fish will swim past the receiver site without being detected.

If land permitting restrictions prevent towers from being installed, aerial survey flights will take place. They will be conducted with a fixed wing aircraft, pilot, and surveyor who will operate a R4500 data logger. Scan time for each frequency will be 2 s. A single H-antenna will be mounted on each wing strut such that the antennas detect peak signals perpendicular to the direction of travel. Surveys will be flown at approximately 120 km/h at an altitude between 100 and 300 m above the center of the river. Once a tag is detected, the surveyor will prompt the data logger to record tag information. We will focus our efforts on the stretch of river from the mouth to Kalskag, as areas above this will be monitored with an existing tower array.

A volunteer tag lottery will be conducted to encourage reporting of tagged fish harvested in the subsistence fishery by local fishermen upriver of the tag site. The lottery will be advertised using mailers sent to rural business, and with printed labels on all tags.

Data Collection

Tag numbers, fish length (MEF), sex, and fish condition will be collected at the time of tagging and recorded in a logbook. Other fishing information will be recorded including: date, set time, full out time, retrieval time, end time, gear type, location, and crew. MEF length will be recorded in mm using a rigid meter stick, and sex will be determined using visual observation of secondary sexual characteristics. The relative health of Chinook salmon will be determined, by visually examining physical condition (e.g., color, external wounds), and recorded. For each tagged fish, radio tag frequency and code will be recorded along with corresponding anchor tag color and number. During the first sampling event of each tagging shift, environmental data will be collected. Data includes: cloud cover, wind direction, wind speed, turbidity, and water depth. Lead and assistant project leaders will review data and consult with crews to rectify and correct data entry errors inseason. Telemetry tracking data will be recorded using an ATS R4500 data logger. The data logger will record date, time, tag frequency, tag code, and signal strength for each radio tag fish within range. In addition, the data logger will record location when operated in aerial mode.

DATA ANALYSIS

Capture efficiency will be evaluated by comparing CPUE's for each site and drift location. Optimal sites will display the highest CPUE, and also have capture success throughout the run. We will rank all sites, based on these efficiency criteria.

Survival will be assessed through identification of tagged fish at each radiotelemetry tower. A fish will be determined to have immediately survived tagging after it is recorded at an upstream telemetry site or identified above the tagging location through aerial surveys. A successful tagging event will be determined after the fish has been documented passing additional telemetry sites or aerial survey documentation upriver of the lower river tower locations. Ideally, any fish recaptured at a weir would support survival to spawning from the tagging event. Fish recaptured with an external tag but without a radio tag will be assumed to have expelled the tag, and noted. Run timing and swim speed can potentially be determined, however, this is dependent on the ability to catch and successfully tag adult Chinook salmon. The success of this feasibility study would provide support for further investigations such as these.

SCHEDULE AND DELIVERABLES

All information from this project will be summarized in a Fisheries Data Series Report. Important project activities and the dates they will be conducted and completed are given below.

Date(s)	Project Activity
March–May	Recruit and hire two Fish and Wildlife Tech IIs.
March–May	Procurement of project supplies
March–May	Obtain telemetry tower site permits
May 2014	Ship field supplies to Bethel
May 17–18	Joshua Clark, Zachary Liller, and Jordan Head travel to Bethel and transport boat to Aniak, installing upriver towers along the way. Set Kwethluk and Tuluksak River weir crews up with stations to install on tributaries.
May 19	Joshua Clark fly Aniak to Bethel
May 20–24	Joshua Clark and Glen Lindsey install remaining mainstem stationary tracking towers.
May 25–May 30	Joshua Clark, Glen Lindsey, and two FWT IIs select drift sites, look for camping locations.
June 1–July 15	Tagging and tracking operations
July 16–July 31	Winterize tagging gear and stationary tracking towers
August–November, 2015	Data analysis
December, 2015	Draft report to Area Biologist and Biometrician
January, 2015	Draft report to Regional Research Supervisor

RESPONSIBILITIES

Alaska Department of Fish and Game, Division of Commercial Fisheries

Kevin Schaberg, Fishery Biologist III. – Kuskokwim Area Fishery Biologist, provides project design and operations oversight.

Hamachan Hamazaki, Biometrician III. – Operational planning and data analysis support.

Joshua Clark, Fishery Biologist I. – Project leader, project design and budget development, and leads field preparations, data collection, telemetry tracking, data analysis, author final reports, and oversees project budget and personnel.

John Chythlook, Fishery Biologist III. – Kuskokwim Area Sport Fishery Manager, assists with field preparations, field operations, logistics, telemetry tracking, and data analysis and reporting.

Zachary Liller, Fishery Biologist II. – Assistant Project leader, assists with field preparations, telemetry tracking, and data analysis and reporting.

Glen Lindsey, Fish and Wildlife Tech III. – Drift site consultant, assists with tower installation.

Vacant, Fish and Wildlife Tech. II. – Operation of drift gillnets, tagging, assists with maintenance of telemetry stations.

Vacant, Fish and Wildlife Tech. II. – Operation of drift gillnets, tagging, assists with maintenance of telemetry stations.

United States Fish and Wildlife Service (USFWS)

Kwethluk River weir crew – Downloading and maintenance of telemetry station.

Tuluksak River weir crew – Downloading and maintenance of telemetry station.

REFERENCES CITED

Carroll, H. C., and T. Hamazaki. 2012. Subsistence salmon harvests in the Kuskokwim area, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 12-38, Anchorage.

Winter, J. D. 1983. Underwater biotelemetry. Pages 371–395 [In]: L. A. Nielsen and D. L. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.