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Movements of Summer Chum Salmon Radiotagged in the Lower Yukon River in 2004

by

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and

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

Symbols and Abbreviations

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Weights and measures (metric)

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

Weights and measures (English)

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

Time and temperature

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

Physics and chemistry

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

General

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

Measures (fisheries)

fork length	FL
mideye-to-fork	METF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The goal of this cooperative study between the Alaska Department of Fish and Game and National Oceanic and Atmospheric Administration Fisheries was to investigate the migratory characteristics and provide preliminary information on the escapement distribution of Yukon River summer chum salmon *Oncorhynchus keta*. A small-scale feasibility study was conducted in 2004 in conjunction with a large-scale tagging and basin-wide monitoring program on Chinook salmon *O. tshawytscha*. Summer chum salmon were captured in the lower Yukon River near the village of Russian Mission and marked with spaghetti and radio tags. Information on upriver movements was collected with remote tracking stations and a limited number of aerial surveys. A total of 208 fish were tagged and 119 (57.2%) fish were recorded moving upriver past the initial tracking stations at Paimiut. There were 74 (35.6%) fish tracked to terminal spawning tributaries, including lower basin tributaries (59, 80%), Koyukuk River (13, 17%), and middle basin tributaries (2, 3%). Radiotagged fish traveled an average of 28.8 km/day, with seasonal differences ranging from 38.8 km/day in early June to 16.0 km/day in July. In addition to providing new information on run timing, movement patterns, and spawning distribution, these data will be used to address the management questions regarding the contribution of Anvik River and Tanana River summer chum stocks.

Key words: radiotelemetry, chum, salmon, *Oncorhynchus keta*, Yukon River, drift gillnet.

INTRODUCTION

The Yukon River flows over 3,000 km originating in British Columbia, Canada, and covering over 855,000 km^2 of interior Alaska and Canada. The drainage includes several major (Koyukuk, Tanana, and Porcupine rivers) and numerous minor tributaries (Figure 1). Five species of Pacific salmon *Oncorhynchus spp* return to the Yukon River basin to spawn, with chum salmon *O. keta* the most abundant. Estimates of returning chum salmon were 1.9 million fish in 2004, with a historical average during 1997–2003 of over 1.5 million fish (JTC 2005). These returns support important subsistence and commercial fisheries in both the U.S. and Canada. Annual harvests of chum salmon have averaged almost 875,000 in the U.S. and nearly 20,000 in Canada since the 1960s (JTC 2005). Subsistence fishing occurs from the river mouth into Canada, and in the major tributaries.

There are 2 distinct seasonal runs of chum salmon in the Yukon River. Summer chum salmon return to the Yukon River from early June to mid July, are generally smaller in size than chum salmon returning later in the season, and spawn in lower and middle reaches of the basin. Major summer chum salmon spawning areas have been identified in several lower basin tributaries, most notably the Andreafsky and Anvik rivers, with other spawning populations located in the Tanana River, Koyukuk River, and smaller tributaries including the Nulato, Melozitna, and Tozitna rivers (Sandone 1996). Fall chum salmon enter the Yukon River from mid July to early September and migrate further upstream to middle and upper portions of the drainage. Major fall chum salmon spawning areas include the Tanana, Chandalar, Sheenjek, and Porcupine rivers in Alaska and numerous Canadian reaches (Barton 1992). Chum salmon management is complicated by the mid-July overlap of these summer and fall runs. Reliable information on run strength and run timing is critical for managing these stocks. However, periodic declines in the abundance of summer chum salmon returning to the basin complicates management, and better information is needed to manage returns.

Various studies and assessment projects, although not always comprehensive or detailed, have provided general information on salmon movements within the basin. Basin-wide tagging studies have been conducted on Chinook salmon between 1961–1970 (Geiger 1968; Lebida 1969; Trasky 1973) and 2000–2004, (Eiler et al. 2004; Spencer et al. 2005; Eiler et al. 2006), but tagging information on chum salmon has been limited to regional studies on the Tanana River (Barton 1992), and the Yukon River above Rampart Rapids (Underwood et al. 2002) and above the U.S.-Canada border (Milligan et al. 1986). Limited information is available on the distribution and movements of lower Yukon River chum salmon stocks.

Studies on salmon in large river systems such as the Yukon River basin are difficult because of the vast and geographically remote areas involved, and the need to tag and examine large numbers of highly mobile fish. Tagging studies are complicated by the potential affects handling and tagging procedures may have on migrating fish. Information collected from various studies (Joint Technical Committee 1996, 1998; Underwood et al. 2000; Bernard et al. 1999) indicated that capture and handling methods could negatively affect adult salmon behavior. Telemetry studies in large river systems have the additional challenge of maintaining contact with fish tracked over large areas. However, work during 2000–2003 demonstrated that large-scale radiotagging studies of Chinook salmon in the Yukon River basin were successful (Eiler et al. 2004; Spencer et al. 2005; Eiler et al. 2006) suggesting that telemetry studies on Yukon River summer chum salmon might be feasible.

The Alaska Department of Fish and Game (ADF&G) and the National Oceanic and Atmospheric Administration (NOAA) Fisheries conducted a feasibility study on summer chum salmon in 2004. The principal objective of this cooperative study was to determine the feasibility of radiotagging summer chum salmon in the lower Yukon River. Secondedly to provide preliminary information on the movement patterns and the contribution of Anvik and non-Anvik River fish as a means to resolve management issues arising from sonar counts at Pilot Station and Anvik River.

Currently, management of summer chum salmon uses subsistence harvest reports, the Emmonak test fishery, sonar counts at Pilot Station, and Anvik River sonar escapement estimates (Figure 1) to monitor chum salmon passing through the lower river and estimate inseason abundance. The Emmonak test fishery, located 39 km from the mouth of the Yukon River, has been operating since the 1960s to estimate the drainage-wide run timing of summer chum salmon. Beginning in 1999, drift gillnets replaced set nets to address problems with net saturation and the inability to accurately measure fishing time (S. Hayes, ADF&G, Anchorage, personal communication). Drainage-wide abundance estimates have been provided by sonar counts at Pilot Station (205 km upriver from the mouth) since 1986. However, newer equipment and data analysis procedures have made these counts comparable only since 1995 (Pfisterer 2002). Although questions have been raised regarding Chinook salmon abundance estimates developed from Pilot Station sonar counts, this project is thought to more accurately count summer chum salmon which are migrating through the area at the same time, but in far greater numbers. During 1993–2000, an average of 52.8% of the summer chum salmon passing Pilot Station returned to the Anvik River (based on Pilot Station and Anvik River sonar counts), so managers have assumed that about half of the run of summer chum salmon in the Yukon River are of Anvik River origin (Clark and Sandone 2001). However, the Anvik River sonar estimate was less than 22% of the Pilot Station estimate in 2003 (JTC 2005), and it is unclear whether this observation related to changes in the stock composition of the summer chum salmon return (i.e., a lower proportion of Anvik River fish) or the accuracy of the sonar counts used to make the comparison.

METHODS

Fish Capture and Marking

Adult chum salmon were captured and marked near the village of Russian Mission (Figure 1). The tagging crew consisted of 2 locally hired contract fishers and 2 project personnel. Project personnel were responsible for handling and marking of fish, while the contract fishers were responsible for operating the boat and deploying the net. Operations started 8 June, and ended 18 July. Fishing was conducted daily beginning at 1800 hours from 8 June through 28 June, 0900 hours from 29 June through 14 July, and then again at 1800 hours from 16 July through 18 July; each period was up to 7.5 hours in duration or until the target number of chum salmon for that day had been tagged (Table 1). Two types of drift gillnets were used to capture the fish: nets with 4.5-in mesh size and 38 m in length, and nets with 4.25-in mesh size and 46 m in length. Both net types were constructed with monofilament, and had a depth of 7.6 m and hang ratio of 2:1. These nets were used because of their effectiveness in capturing the target species with minimum injuries. Gillnets were fished along shore in locally known drift locations, with most fishing effort occurring in the immediate vicinity of Russian Mission, although limited fishing also occurred near a summer fish camp called Dogfish (22 km upriver from Russian Mission) on 14 and 16 July.

During a drift, the net was retrieved as soon as a captured fish was detected. If the net was not fully deployed when the fish was detected, an estimate of deployed net length was recorded. The first 3 fish encountered were carefully removed from the net while in the river, brought on board in a dip net constructed with soft, small mesh netting, and placed in a trough of fresh water. The trough was equipped with a pump circulating fresh river water. All remaining fish in the net were released while still in the river to minimize both handling time and potential sampling bias if stocks of fish were poorly mixed. Crew members, wearing neoprene gloves or with bare hands, carefully placed the fish in a neoprene-lined tagging cradle. A maximum of 2 fish (with small or no apparent injuries) were processed. The fish were sampled to determine their age through removal of scales from the preferred area of the body (Welander 1940). The scales were mounted on gummed cards and impressions were made in cellulose acetate. Scale impressions were later projected using a microfiche reader with a 40x lens, and estimated ages were reported in European notation (Moore and Lingnau 2002). Fish were measured from mideye to tail fork (METF) to the nearest 5 mm, and the presence and type of injuries were recorded. Gender was not recorded due to lack of distinct characteristics in the lower river.

The number of chum salmon tagged each day was determined from a tagging schedule developed prior to the field season (Table 1). Each fish was tagged with a uniquely numbered 14-in long external spaghetti tag (Floy Tag and Manufacturing, Inc., Seattle, WA[1]) attached below the dorsal fin (Wydoski and Emery 1983). The tag was filled with a fine cable jeweler's line. All tagged fish were also marked by removing the right axillary process, which was retained for genetic analysis.

Chum salmon were tagged with pulse-coded radio transmitters in the 150 MHz frequency range (Advanced Telemetry Systems, Isanti, Minnesota). The transmitters were 2.0 cm in diameter, 5.4 cm in length, and weighed 20 g. Transmitters were placed on 3 discrete frequencies spaced a minimum of 20 kHz apart, with up to 100 distinct pulse codes per frequency. Transmitters were

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

also equipped with a motion sensor and activity monitor. Transmitters had a minimum battery life of 90 days. The tag was inserted through the mouth and into the stomach using a plastic tube (0.7 cm diameter) until it was no longer visible. During the insertion, the fish was not anesthetized. The fish were immediately released after processing.

TRACKING PROCEDURES

Radiotagged chum salmon moving upriver were tracked with 46 remote tracking stations (Eiler 1995) installed at 40 sites throughout the Yukon River basin (Eiler et al. 2004). The stations were placed on important travel corridors on the Yukon River mainstem and major tributaries (Figure 1). Stations consisted of a computer-controlled receiver (developed by Advanced Telemetry Systems), satellite uplink (Campbell Scientific, Logan, Utah), and self-contained power system (Figure 2). The receiver detected the presence of radiotagged fish, and recorded the signal strength and activity pattern (active or inactive) of the transmitter, date, time, and location of the fish in relation to the station (i.e., upriver or downriver from the site based on the transition of the strongest transmitter signal from the downriver to upriver antenna). Radiotagged fish that passed the first set of tracking stations, located approximately 62 km upriver from Russian Mission, were considered to have resumed upriver movements. Fish tracked to terminal reaches of the drainage were classified as distinct spawning stocks. Migration rates for radiotagged chum salmon were calculated by comparing the date and time fish past the Paimiut tracking station with distance, date, and time from the station furthest upriver to record the fish. Because tracking sites were located in isolated areas, data were transmitted by satellite uplink to a geostationary operational environmental satellite (GOES) system every hour and relayed to a receiving station near Washington D.C. (Eiler 1995). Data were accessed daily via the Internet and downloaded into an automated database and GIS mapping program (Eiler and Masters 2000).

Two aerial surveys of the lower Yukon River were flown using helicopter and fixed-wing aircraft equipped with a computer-controlled receiver and 4-element Yagi receiving antennas mounted on both sides of the aircraft and oriented forward. Tracking receivers contained an integrated global positioning system to assist in identifying and recording locations. One survey was conducted 28–29 July on the Yukon River mainstem from 10 km below Russian Mission to the Tanana River confluence (Figure 1) to locate both radiotagged Chinook and chum salmon that traveled to areas between station sites and upriver of stations on terminal tributaries. Surveys of the Anvik and Bonasilla rivers were also conducted during this mainstem survey. A second survey was conducted 25 August from 10 km below Russian Mission to Holy Cross (located 106 km above Russian Mission). Fish whose transmitters were detected in villages or fish camps during aerial surveys were considered harvested, even if the recovery was not reported. Commercial and subsistence fishers were encouraged to report any tagged fish they had captured. Information about the importance of returning tags was sent to organizations in villages throughout the Yukon River drainage before the field season, and a letter of appreciation with information about the fish was sent to each person or agency that returned tags. Voluntary returns were important in determining the fate of “unknown” fish for distribution information.

Upriver salmon assessment projects that might encounter tagged chum salmon were contacted and informed about the study, including the Anvik River sonar; weirs on the Koyukuk (Henshaw Creek and Gisasa River), and Tozitna rivers; fishwheels located on the Tanana River at Nenana and Yukon River at Rampart Rapids; and carcass surveys on the Anvik River.

Data Analysis

Catch per unit effort

Catch per unit effort (CPUE) for each drift was calculated as:

$$\text{CPUE} = \frac{c}{(t \times f)} \tag{1}$$

where *c* is the number of chum salmon captured, *t* is fishing time in hours, and *f* is net length in fathoms.

To provide an estimate of chum salmon passing the tagging sites, a CPUE for day *d* was calculated as:

$$\text{CPUE}_d = \frac{\sum c}{f\left(\sum t\right)} \tag{2}$$

where *c* is the number of chum salmon captured, *t* is fishing time in hours, and *f* is net length in fathoms, for all drifts made that day.

RESULTS

Capture and Handling

Numbers Captured and Released

Gillnets were fished 45.8 hours to capture 597 chum salmon between 8 June and 18 July (Figure 3), including 579 fish near the village of Russian Mission and 18 fish at Dogfish (Table 2; Figure 4). Chum salmon were tagged throughout the run (Figure 5), with 208 fish instrumented with radio transmitters, 24 fish died, and 365 fish were released immediately after capture without being examined (Table 2).

Most (114, 62.0%) tagged fish were age 0.4, with smaller proportions of age 0.3 (58, 31.5%), age 0.2 (11, 6.0%) and age 0.5 (1, 0.5%) fish (Table 3). Mean length of marked fish (n=208) was 576 mm (METF) ranging from 455 to 685 mm (SD=40.1).

The number of chum salmon caught resulting from the pre-determined tagging schedule (Table 1) was compared to the daily chum CPUE (Appendix A1). Russian Mission CPUE rose gradually in early June, then rapidly, with distinct peaks on June 25 and June 30–July 1, and then a precipitous decline in July. While overall trends between CPUE and catch were similar, daily discrepancies were observed (Figure 6). Also useful for comparison were the sonar counts from Pilot Station. This project estimates drainagewide passage of fish past Pilot Station, and is used primarily to assess chum salmon abundance (T. Lingnau, Commercial Fisheries Biologist, ADF&G, Anchorage; personal communication). Timing patterns between Pilot Station sonar counts and Russian Mission CPUE (with a 3 day lag time) were relatively consistent over the tagging period (Figure 7).

A comparison of Russian Mission CPUE with the Anvik sonar numbers (McEwen 2006) is shown in Figure 8. The timing pattern between the Anvik sonar counts and Russian Mission CPUE (with a 7 day lag time) were consistent over the tagging period but again, daily comparisons showed some discrepancies.

Distribution

There were 89 (42.8%) fish that did not move upriver past Paimiut. The late July and late August aerial surveys located only 44 fish from below the tagging area to Paimiut. The characteristics of this section of river (i.e., deep, wide, and turbid) made it difficult to determine the status of these fish, although 2 fish were known to have traveled into Kako Creek, just upriver from Russian Mission (Figure 9). The fish that weren't recorded may represent fish that traveled to small, unmonitored tributaries. The status of those located in the mainstem is less clear, and may represent fish that died due to handling, washouts from nearby spawning streams, or unreported fishery recoveries.

Of the 208 chum salmon tagged, 119 (57.2%) were recorded moving upriver past the Paimiut tracking stations. Of these, 72 (34.6%) fish were tracked to terminal tributaries with tracking stations, including the Innoko, Bonasila, Anvik, Nulato, Koyukuk, Melozitna, and Tozitna rivers (Table 4; Figure 10). Anvik River (38, 18.2%), Bonasila River (16, 7.7%), and Koyukuk River (13, 6.2%) fish were the most numerous. There were 45 (21.6%) fish that were not recorded by tributary tracking stations or located during aerial tracking surveys, and may represent fish that traveled to small, unmonitored tributaries. The late July and late August aerial surveys located a total of 118 fish (Figure 11), including 12 detected in the Bonasila River, and 35 in the Anvik River (Figure 12).

Anvik River fish were present throughout the run; while Koyukuk River fish were observed during the early and middle run (Figure 13). Upriver fish that were not located in monitored reaches of the drainage were also abundant during the middle and late run. Aerial surveys were flown over the upper Yukon River mainstem (above the Tanana River confluence) on August 4–6 and September 20–21 that did not detect any radiotagged chum salmon.

The 2004 Pilot Station summer chum passage estimate was 1,357,826 (McIntosh *In prep*) and the Anvik River sonar estimate was 365,353 (McEwen 2006). This results in a ratio of 26.9% for Anvik River fish that is substantially lower than the 50% trend of previous years. The 26.9% estimate is comparable to the proportion of radiotagged fish that moved upriver past the Paimiut tracking station and were tracked to the Anvik River (31.2%), although only 18.3% of the entire radiotagged sample traveled to the Anvik River.

Migration Rates

Radiotagged chum salmon that moved upriver past Paimiut traveled an average of 28.8 km/day, however, differences were observed over the course of the run. Fish tagged early in the return traveled substantially faster than later run fish, with average migration rates ranging from 38.8 km/day during early June to 16.0 km/day during mid July (Table 5).

DISCUSSION

The goal for this study was to determine the feasibility of collecting information on the migratory characteristics and escapement distribution of Yukon River summer chum salmon to be used to assess the relative importance of the Anvik River stock to the entire returns. The small number of chum salmon tagged during the study limited our ability to determine the distribution and timing patterns, since it is likely that the sample would not be representative of the entire run. However, the data does provide some initial information on the movements and stock timing of the return. Anvik River fish were present in every tagging week, while Bonasila River fish were present only during the peak of the run (Figure 13). Koyukuk River fish were found earlier in our sample weeks, while fish that passed the Paimiut stations and traveled to undetermined locations were more prevalent later in the run. Aerial locations in terminal areas provided useful information on spawning distribution and location of specific spawning areas. Information from tracking stations on movement rates provided comparisons between fish captured in different periods (early, peak, and late run) of the run.

The methods used to capture, tag, and track the salmon during their upriver migration are well established, and over 200 radio tags were deployed. However, several procedural problems occurred during the initial phase of the study. Tagging protocols from the Operational Plan were not strictly adhered to during the initial tagging periods, although proper procedures were followed after June 20. The system of tracking stations was effective for tracking fish to upper reaches of the basin, and 119 fish traveled to upriver areas above Paimiut. However, 89 fish remained downriver from Paimiut, and 47 of these fish (52.8%) were not located during aerial surveys of the area.

The limited number of surveys conducted, 1 in late July and a partial survey in late August was insufficient to adequately monitor the movements and status of these radiotagged fish. Although radiotagged fish were observed in Kako Creek just upriver from the tagging site, other small tributary streams located in the vicinity of the tagging area may support spawning chum salmon; these tributaries were not monitored during the aerial surveys. Radiotagged fish in local streams may also have drifted back or been flushed out of these tributaries and drifted downriver. The concentration of fish last located near the mouth or just downriver from Kako Creek (Figure 9) would support this hypothesis. Other possibilities include tag regurgitation and handling mortality, however, a small feasibility study on chum salmon in 2001 (JTC 2001) showed good post-tagging response (Table 6). Although the 17 fish tagged were fall chum salmon, the tagging procedures, tagging location, and radio tag size were similar to those used in the 2004 summer chum salmon study. Although fall chum salmon migrate farther upriver than summer chum salmon, it is noteworthy that 94% of the radiotagged fish moved upriver past the Paimiut site and 13 fish (76%) were tracked to the middle basin or above. However, returning salmon caught near spawning areas may differ physically and physiologically from fish destined for areas farther upriver, and may respond differently to handling, which could account for the higher proportion of summer chum salmon observed downriver from Paimiut.

Of the 208 chum salmon tagged, 119 fish moved past Paimiut and 47 (39.5%) of those were assigned to mainstem locations. Of these 47, only 19 were located during aerial surveys in the Yukon River mainstem. Since the number of aerial surveys was limited, the flight surveys were not able to adequately monitor fish movements above Paimiut. The fate of these other fish may include mortality, movements into small local spawning tributaries that were not surveyed, unreported fishery harvests, tag regurgitation, or tag malfunction.

Sonar counts at Pilot Station and the Anvik River are currently used to estimate the relative abundance of the Anvik River stock. The 2004 Pilot Station and Anvik River summer chum sonar passage estimates resulted in a ratio of 26.9% for Anvik River fish that is substantially lower than the 50% trend of previous years. The 26.9% estimate is comparable to the proportion of radiotagged fish that moved upriver past the Paimiut tracking station and were tracked to the Anvik River (31.2%). However, our results also suggest a sampling bias at the tagging site. We did not have any tagged fish returning to the Tanana River, a known summer chum salmon spawning area. Moreover, we had a much lower percentage of tagged fish than expected pass the gateway station at Paimiut when compared to Chinook salmon (Eiler et al. 2006) and fall chum salmon (JTC 2001). A substantial number of tagged fish remained in the vicinity of Kako Creek, a small tributary located just upriver from Russian Mission. While chum salmon are known to spawn in this tributary, its contribution to the run is undoubtedly small.

Bank orientation is well documented in returning adult chum salmon as they approach their natal streams (Mauney 1980; Mauney and Buklis 1980). It is possible that we were sampling a disproportionate number of fish destined for small, local tributaries near Russian Mission due to the location of the drifts being fished and the nature of the river in the immediate area. Because of the limited number of aerial surveys conducted, we were not able to assess the status of fish below Paimiut, and determine their pattern of movement in the immediate area.

Our second tagging site at Dogfish (22 km upriver) is above some of these local salmon streams and may offer a better site for radiotagging chum salmon. Although the small sample (12 fish) tagged at this site exhibited a similar passage ratio as the Russian Mission fish, with only 58% of the fish passing Paimiut, these fish were all tagged late in the season (16–18 July), and possibly represent a late run bias (i.e., comprised primarily of fish destined for streams lower in the basin).

The primary objective of this project was to determine the feasibility of radiotagging and tracking summer chum salmon in the lower river. The study was relatively successful considering that it was conducted in conjunction with an existing large-scale, basin-wide project. Different capture methods were tried, and adequate numbers of fish were captured. However, future investigation on summer chum salmon would benefit from:

1) A larger sample of tagged fish;
2) A more representative tagging schedule or methods to account for relative changes in run abundance (e.g., estimates from Pilot Station sonar);
3) Moving the tagging site to Dogfish to eliminate potential sources of sampling bias near Russian Mission;
4) Intensive boat tracking within the tagging area to determine the post-tagging response of the fish after release;
5) Test tagging chum salmon of different lengths and condition (e.g., bright coloration vs. pre-spawning coloration) at the capture site with "dummy" tags of various sizes to determine if there are any negative impacts (e.g., stomach ruptures); and
6) Conduct additional aerial surveys during and after the tagging period. These extra, intensive aerial surveys would help determine the status and identify final locations for the lower mainstem fish and monitor lower river tributaries that may contain spawning populations of summer chum salmon.

This study has provided preliminary information on chum salmon distribution and movement patterns within the Yukon River basin, and a similar trend is suggested by the comparison of Pilot Station and Anvik River sonar counts (i.e., substantially less than 50% of the summer chum salmon return). Aerial surveys in terminal tributaries also provided information on the location of specific spawning area. Additional years of tagging and monitoring, particularly during years with differing run sizes, will provide a better understanding of chum salmon distribution.

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TABLES AND FIGURES

Table 1.–Schedule for radiotagging summer chum salmon, 2004.

Capture Week	Dates	Scheduled	Tagged
24	6–12 June	7	5
25	13–19 June	35	37
26	20–26 June	49	53
27	27 June – 3 July	49	47
28	4–10 July	35	36
29–30	11–19 July	28	30
Total		**203**	**208**

Table 2.–Number of summer chum salmon captured, radiotagged, mortalities, and released untagged at tagging sites in drift gillnets at the Russian Mission tagging sites, 2004.

Tagging Site	Captured	Radiotagged	Mortalities	Released Untagged
Dogfish [a]	18	12	0	6
Russian Mission	579	196	24	359
Total	**597**	**208**	**24**	**365**

[a] Field campsite located 22 km upstream from Russian Mission.

Table 3.–Age composition of summer chum salmon tagged, 2004.

	Combined (n = 184)		Dogfish (n = 11)		Russian Mission (n = 173)	
Age [a]	Estimate	SE	Estimate	SE	Estimate	SE
0.2	0.060	0.018	0.455	0.150	0.035	0.014
0.3	0.315	0.034	0.364	0.145	0.312	0.035
0.4	0.620	0.036	0.182	0.116	0.647	0.036
0.5	0.005	0.005	0.000	0.000	0.006	0.006

[a] Age designation using the European notation.

Table 4.–Final location of summer chum salmon radiotagged in the lower Yukon River near the village of Russian Mission, 2004.

		Final Location		Percentage	
Region	**Area**	**General Area**	**Terminal Tributary**	**All Fish**	**Fish Moved Past Paimiut**
Lower Basin [a]	Yukon River below Paimiut	87 [b]		41.8	
	Kako Creek		2	1.0	
	Yukon River	45 [c]		21.6	37.8
	Innoko River		2	1.0	1.7
	Bonasila River		16	7.7	13.5
	Anvik River		38	18.2	32.0
	Nulato River		1	0.5	0.8
Middle Basin [d]	Yukon River	1 [c]		0.5	0.8
	Koyukuk River		13	6.2	11.0
	Melozitna River		1	0.5	0.8
	Tozitna River		1	0.5	0.8
Upper Basin [e]	Yukon River	1 [c]	0	0.5	0.8
Total		134	74	100	100

[a] Section of the Yukon River from below Russian Mission to the Yukon-Koyukuk River confluence.

[b] Remained downriver of Paimiut; fish status may include mortality due to handling or predation, movements into small local spawning tributaries, unreported fisheries, tag regurgitation, or tag malfunctions.

[c] Specific location and fish status not determined.

[d] Section of the Yukon River from Galena to the Yukon-Tanana River confluence.

[e] Section of the Yukon River from the Yukon-Tanana River confluence to the Canadian headwaters.

Table 5.–Movement rates (km/day) of summer chum salmon radiotagged in the lower Yukon River near the village of Russian Mission, 2004.

Capture Week	**Dates**	**N**	**Migration Rate [a]**
24	6–12 June	5	38.8
25	13–19 June	26	36.7
26	20–26 June	33	31.3
27	27 June – 3 July	29	26.2
28	4–10 July	10	22.8
29	11–17 July	16	16.0
30	18–19 July	1	31.7

[a] Based on fish passage by tracking stations located at Paimiut and the farthest upriver station site.

Table 6.–Final location of fall chum salmon radiotagged in the lower Yukon River near the village of Russian Mission, 2001.

Region	Area	Final Location		Percentage	
		General Area	Terminal Tributary	All Fish	Fish Moved Past Paimiut
Lower Basin[a]	Yukon River Below Paimiut	1 [b]		5.9	
	Yukon River	3 [c]		17.6	18.7
Middle Basin [d]	Yukon River	2 [c]		11.8	12.5
	Tanana River		8	47.1	50.0
Upper Basin [e]	Yukon River	3 [c]		17.6	18.8
Total		17		100	100

[a] Section of the Yukon River from below Russian Mission to the Yukon-Koyukuk River confluence.

[b] Remained downriver of Paimiut; fish status may include mortality due to handling or predation, movements into small local spawning tributaries, unreported fisheries, tag regurgitation or tag malfunctions.

[c] Specific location and fish status not determined.

[d] Section of the Yukon River from Galena to the Yukon-Tanana River confluence.

[e] Section of the Yukon River from the Yukon-Tanana River confluence to the Canadian headwaters.

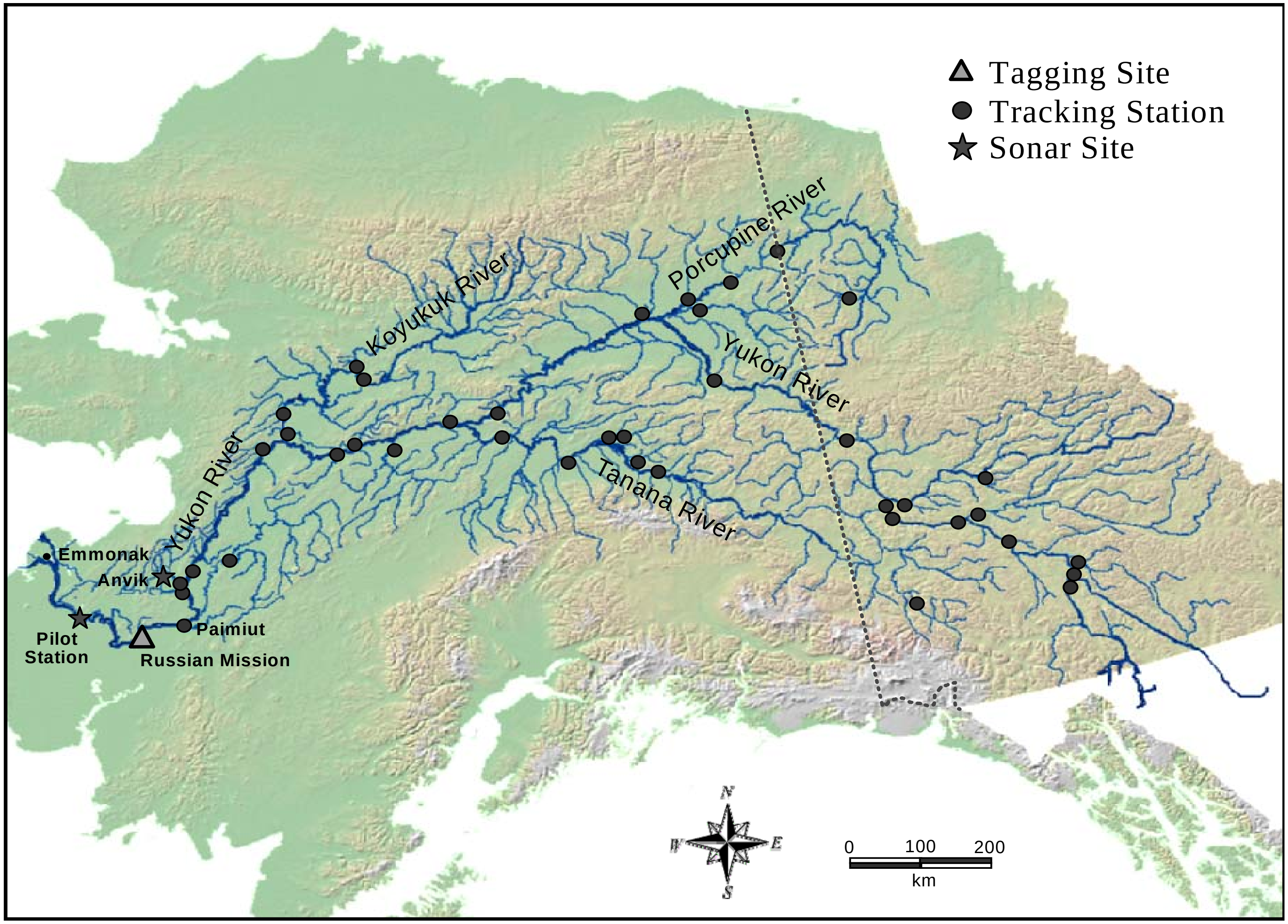


Figure 1.–Yukon River basin showing the Yukon River mainstem and major tributaries of the drainage, as well as the tagging site, sonar sites, and remote tracking stations.

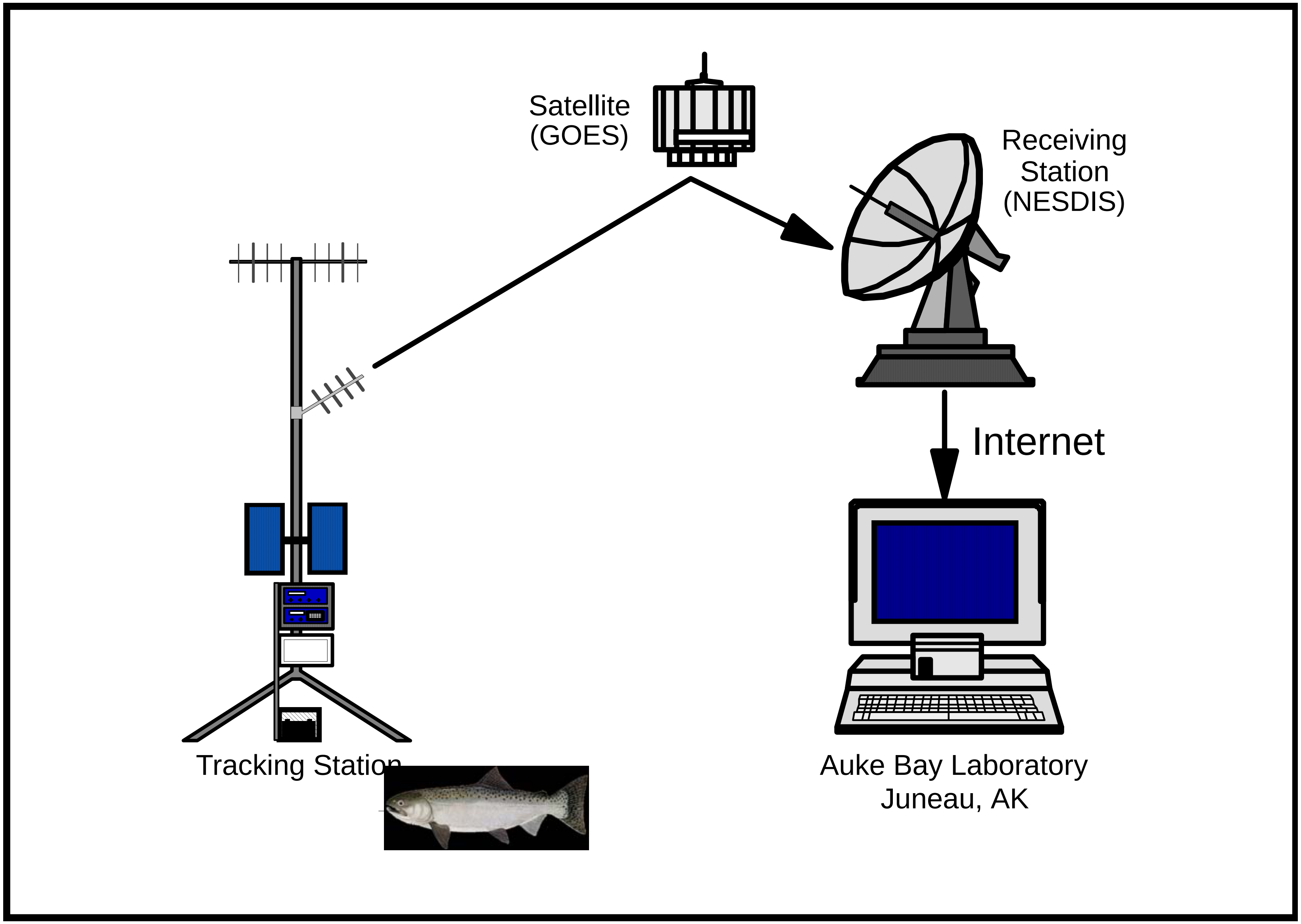


Figure 2.–Remote tracking station and satellite uplink diagram used to collect and access movement information of chum salmon in the Yukon River basin.

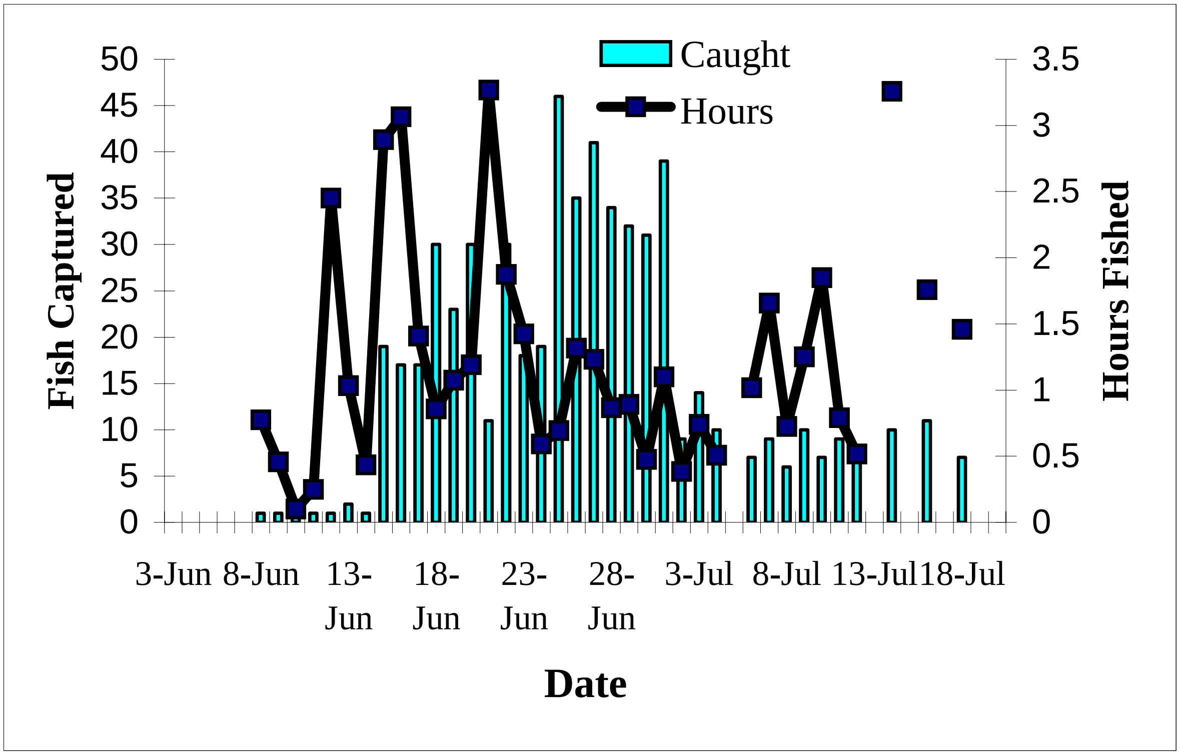


Figure 3.–Daily numbers of summer chum salmon caught at Russian Mission, and the number of hours fished per day, 2004.

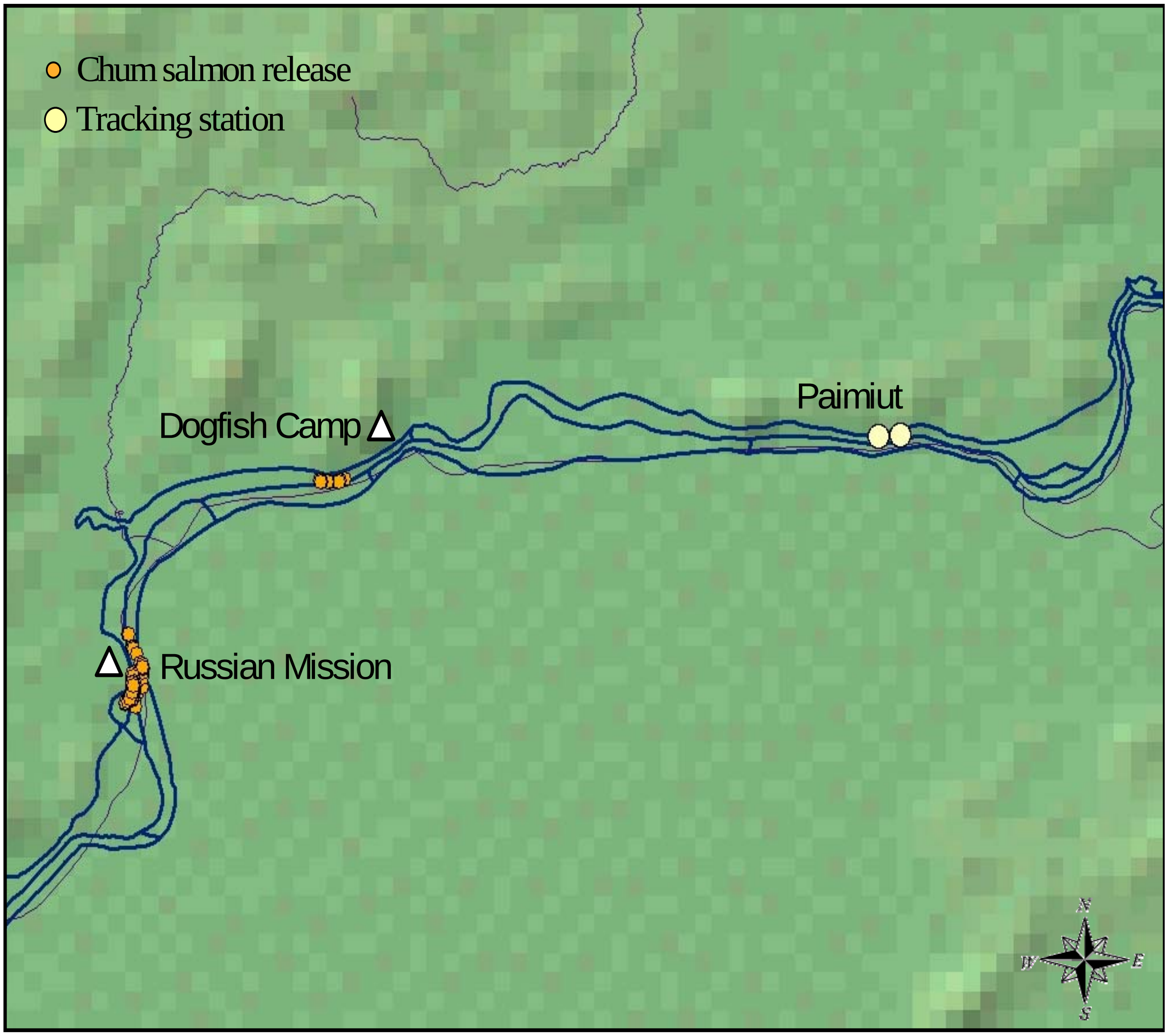


Figure 4.–Release locations for summer chum salmon tagged with radio transmitters in the lower Yukon River near the village of Russian Mission, 2004.

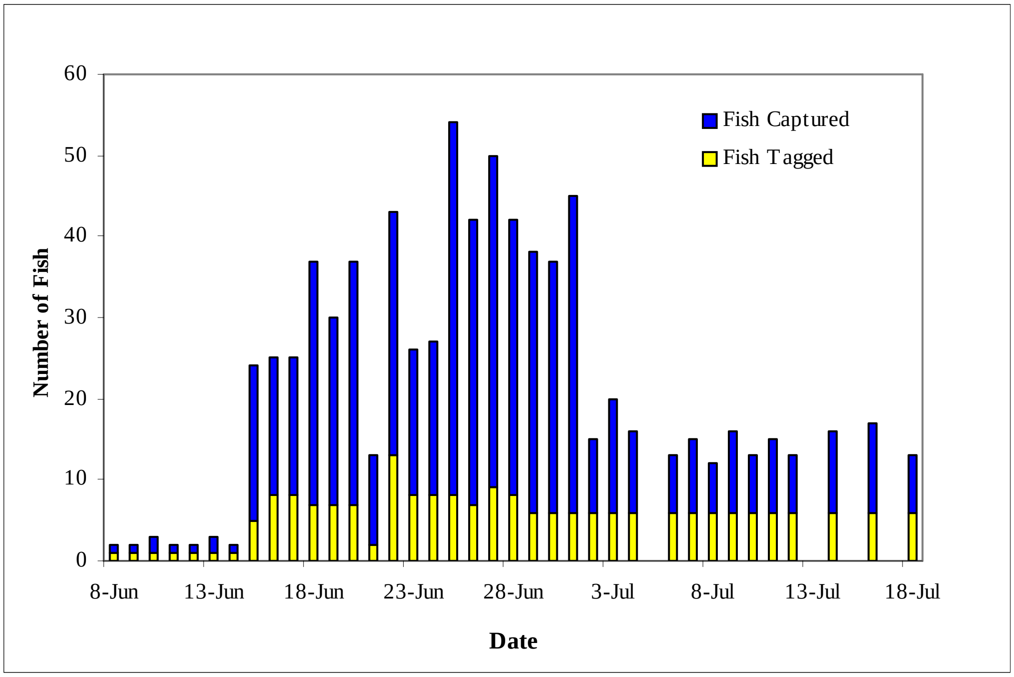


Figure 5.–Daily numbers of summer chum salmon caught in the lower Yukon River near the village of Russian Mission, and marked with radio tags, 2004.

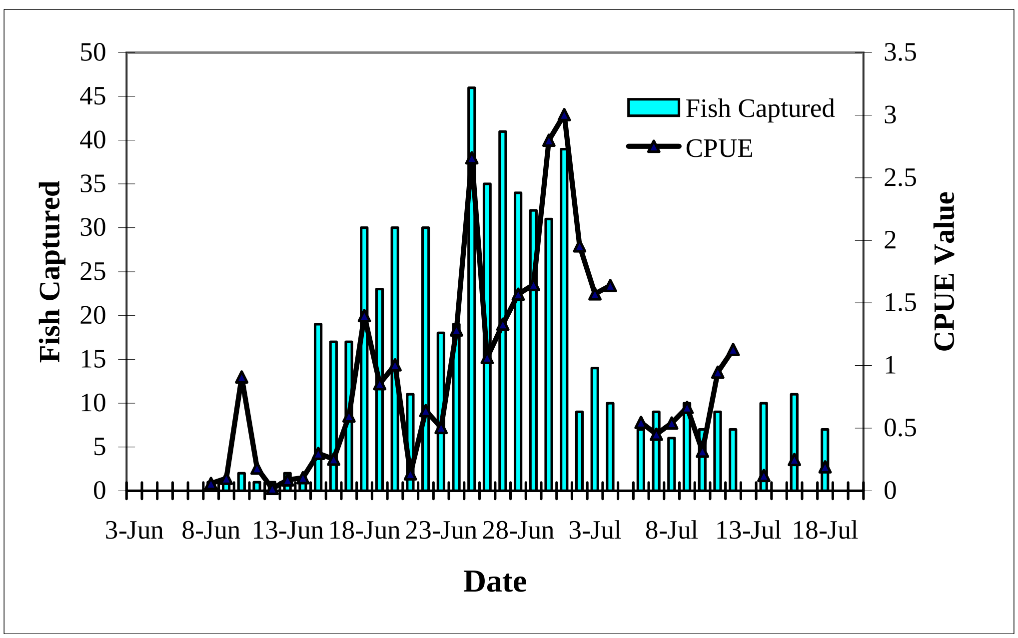
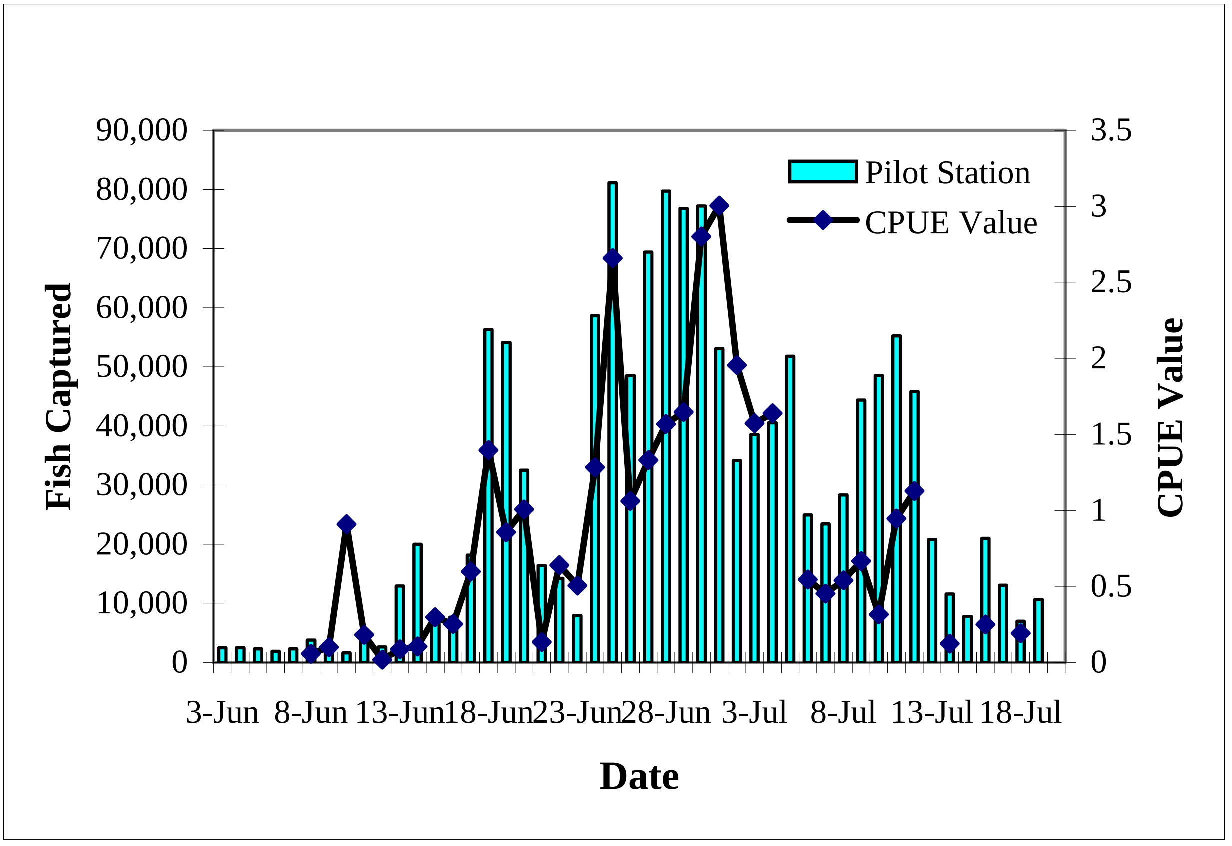
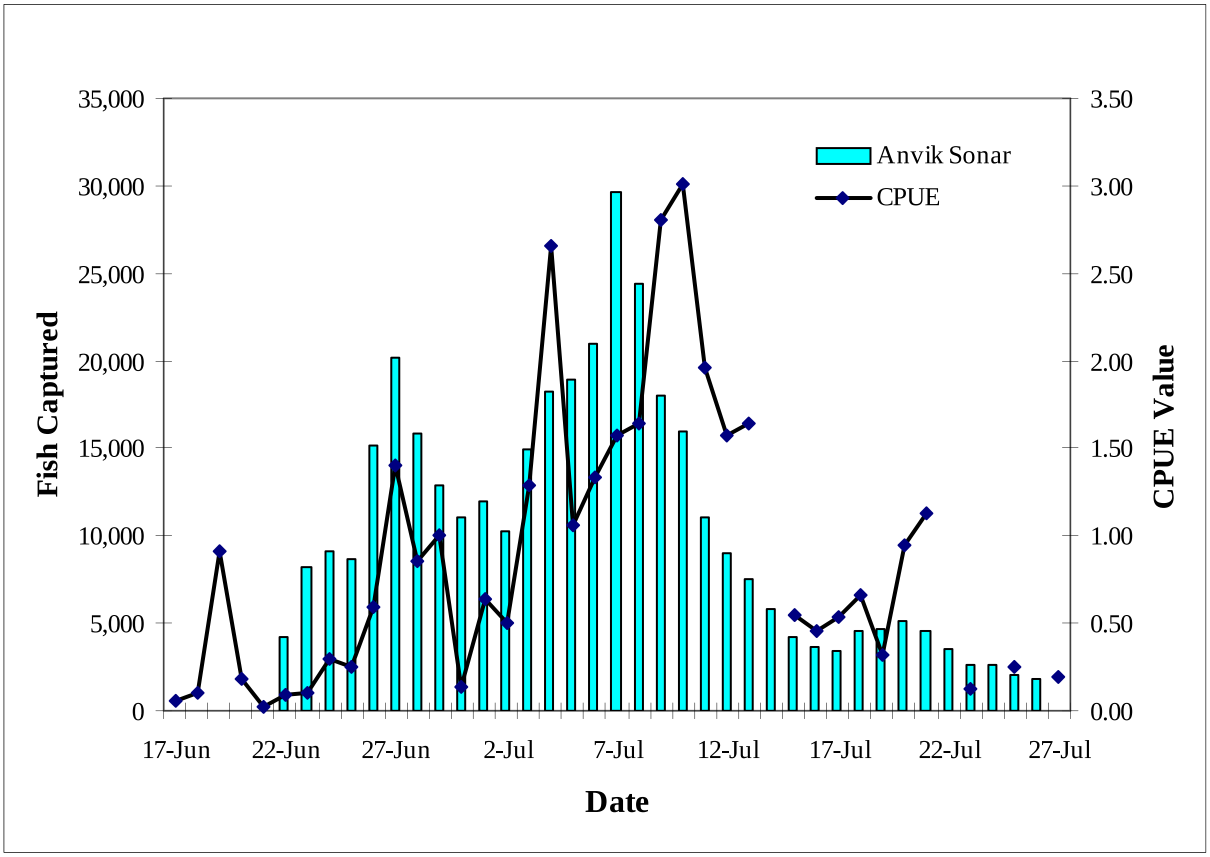


Figure 6.–Daily summer chum salmon CPUE at Russian Mission compared with daily summer chum salmon capture numbers, 2004.



Source: McIntosh *In prep.*

Figure 7.–Daily summer chum salmon CPUE at Russian Mission compared with Pilot Station sonar counts adjusted to account for travel time between the 2 sites (assumed 3-day lag time), 2004.



Source: McEwen 2006.

Figure 8.–Daily summer chum salmon CPUE at Russian Mission compared with Anvik River sonar counts adjusted to account for travel time between the 2 sites (assumed 7-day lag time), 2004.

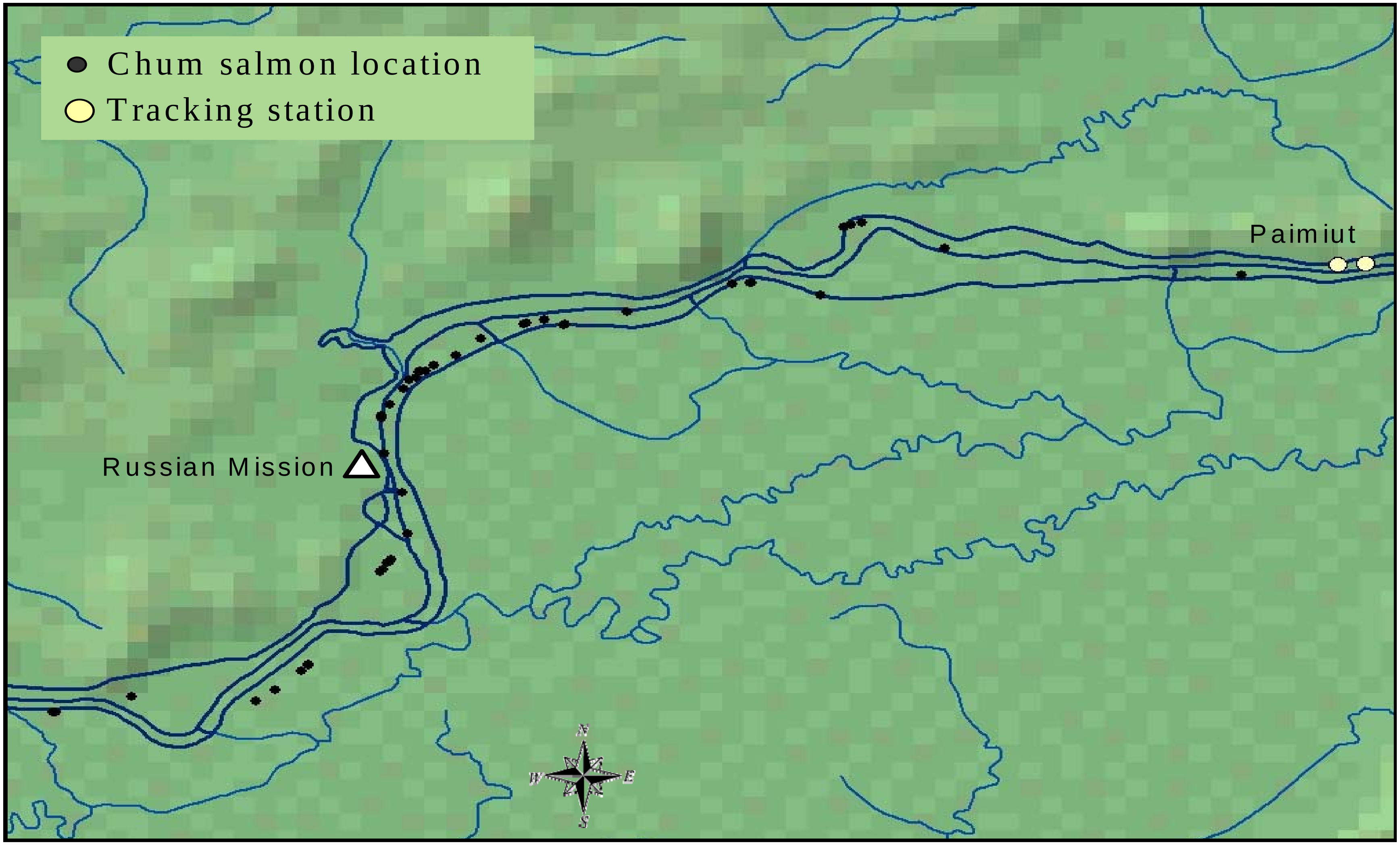


Figure 9.–Location of summer chum salmon radiotagged in the lower Yukon River near the village of Russian Mission and recorded upriver that did not pass the Paimiut tracking stations based on aerial tracking surveys, 2004.

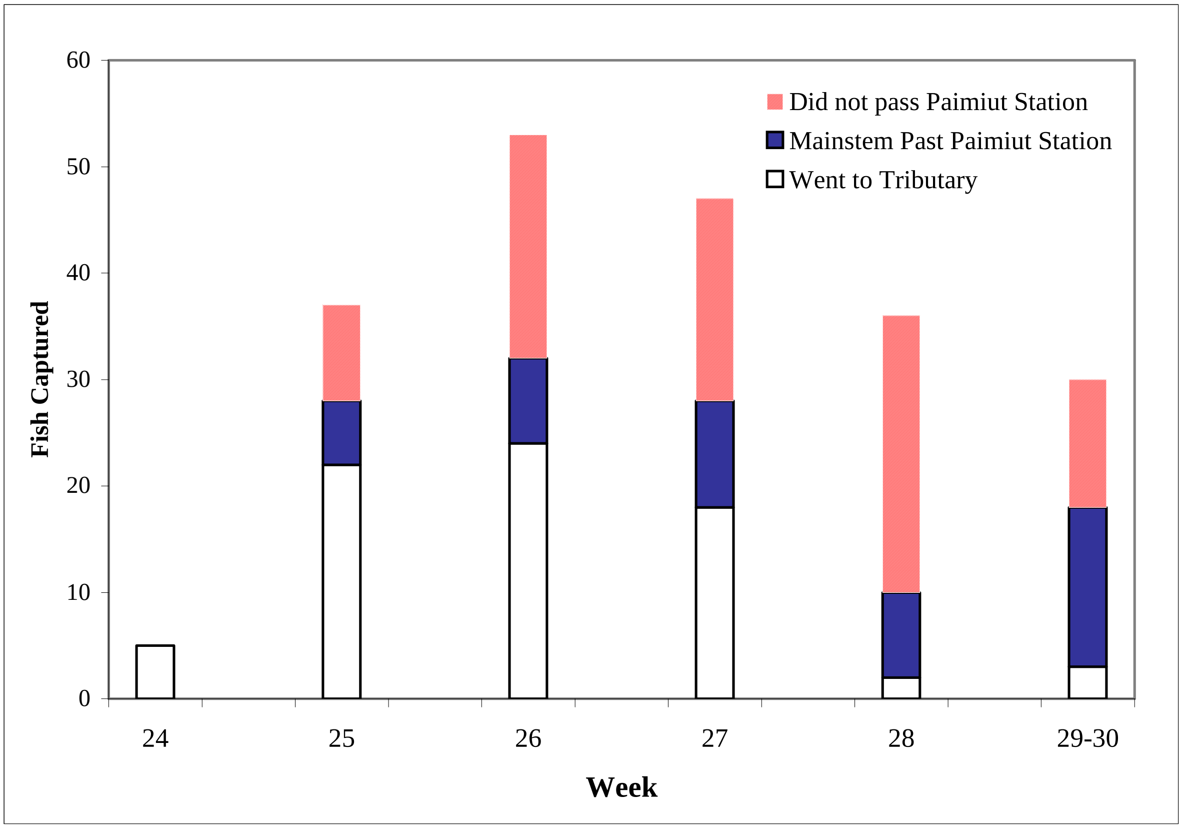


Figure 10.–Final location of summer chum salmon tagged near Russian Mission, 2004.

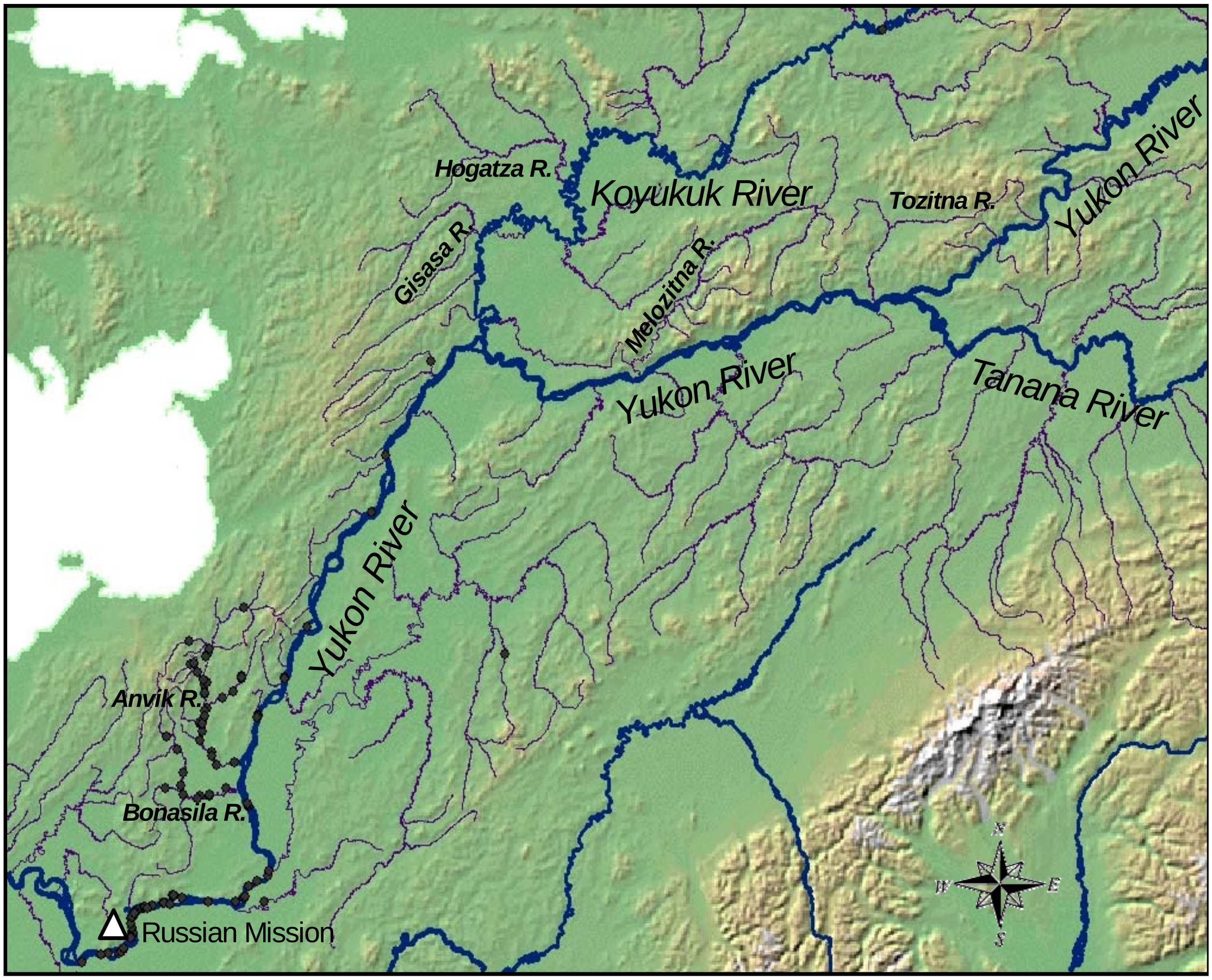


Figure 11.–Final location of summer chum salmon radiotagged in the lower Yukon River near the village of Russian Mission and tracked upriver during their spawning migration based on aerial tracking surveys, 2004.

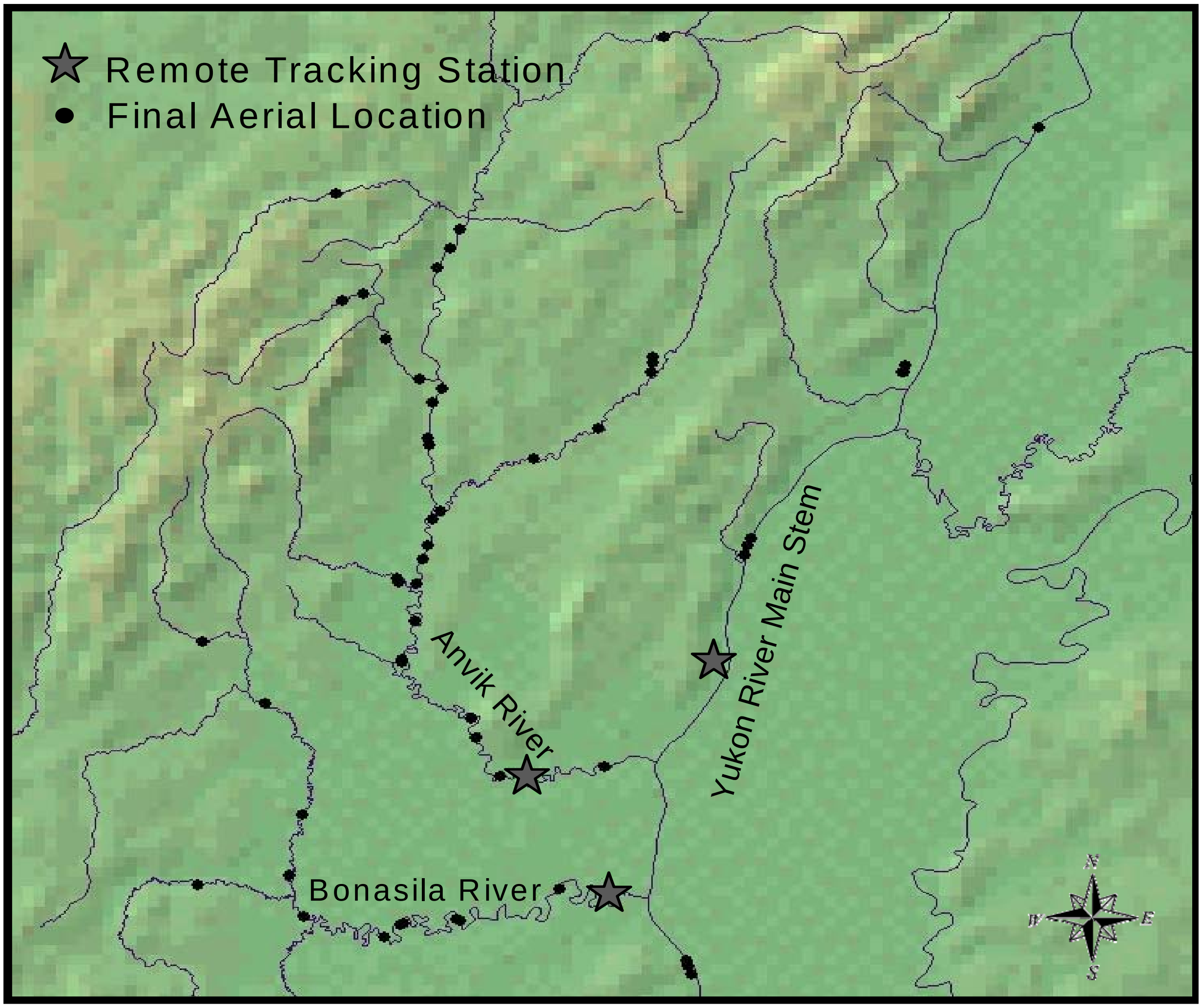


Figure 12.–Final location of summer chum salmon radiotagged in the lower Yukon River near the village of Russian Mission and tracked upriver during their spawning migration to reaches of the Bonasila River and Anvik River based on aerial tracking surveys, 2004.

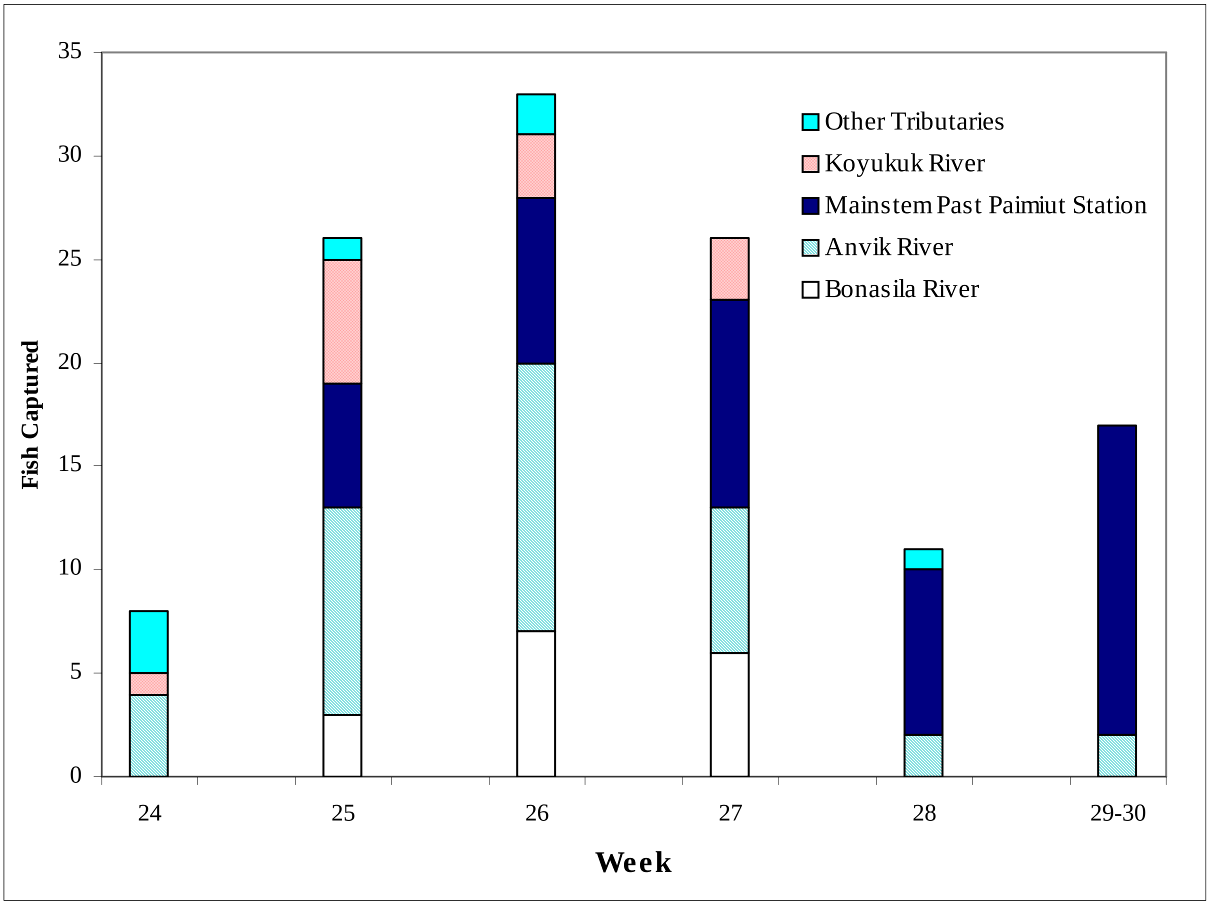


Figure 13.–Run timing of summer chum salmon tagged near Russian Mission, 2004.

APPENDIX A. CPUE INFORMATION

Appendix A1.–Chum salmon CPUE information from the Russian Mission tagging site, 2004.

Date	No. chums	Net	Hours	Daily CPUE
6/02/04				
6/03/04				
6/04/04				
6/05/04				
6/06/04				
6/07/04				
6/08/04	1	22	0.7750	0.0587
6/09/04	1	22	0.4583	0.0992
6/10/04	2	22	0.1000	0.9091
6/11/04	1	22	0.2500	0.1818
6/12/04	1	22	2.4500	0.0186
6/13/04	2	22	1.0333	0.0880
6/14/04	1	22	0.4333	0.1049
6/15/04	19	22	2.8917	0.2987
6/16/04	17	22	3.0667	0.2520
6/17/04	17	20.2	1.4083	0.5976
6/18/04	30	25	0.8583	1.3981
6/19/04	23	25	1.0750	0.8558
6/20/04	30	25	1.1917	1.0070
6/21/04	11	25	3.2667	0.1347
6/22/04	30	25	1.8750	0.6400
6/23/04	18	25	1.4250	0.5053
6/24/04	19	25	0.5917	1.2845
6/25/04	46	25	0.6917	2.6602
6/26/04	35	25	1.3167	1.0633
6/27/04	41	25	1.2333	1.3297
6/28/04	34	25	0.8667	1.5692
6/29/04	32	21.8	0.8917	1.6462
6/30/04	31	23.3	0.4750	2.8010
7/01/04	39	11.8	1.1000	3.0046
7/02/04	9	12	0.3833	1.9565
7/03/04	14	12	0.7417	1.5730
7/04/04	10	12	0.5083	1.6393
7/05/04				
7/06/04	7	12.6	1.0167	0.5464
7/07/04	9	12	1.6583	0.4523
7/08/04	6	15.3	0.7250	0.5409
7/09/04	10	12	1.2500	0.6667
7/10/04	7	12	1.8500	0.3153
7/11/04	9	12	0.7917	0.9474
7/12/04	7	12	0.5167	1.1290
7/13/04				
7/14/04	10	25	3.2583	0.1228
7/15/04				
7/16/04	11	25	1.7583	0.2502
7/17/04				
7/18/04	7	25	1.4583	0.1920
7/19/04				
7/20/04				