Southeast Sustainable Salmon Fund
Final Report for Approved Projects

Project Number: 45229

Project Title: Distribution of Summer Chum Salmon in the Yukon River Drainage Using Radio Telemetry

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I. Abstract

The goal for this cooperative study between the Alaska Department of Fish and Game and the NOAA Fisheries Service was to investigate the migratory characteristics and 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 aerial surveys. A total of 208 fish were tagged and 124 (60%) fish were recorded moving upriver past the initial tracking stations at Paimiut. Seventy-four (36%) fish were tracked to terminal spawning tributaries, including 59 (80%) in lower basin tributaries, 13 (17%) Koyukuk River, and 2 (3%) middle basin tributaries. Radio-tagged fish traveled an average of 28.8 km/day, 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.

II. Approach

The Yukon River flows over 3,000 km originating from British Columbia, Canada, and covering over 855,000 km^2 of interior Alaska and Canada, including many tributaries such as the Koyukuk, Tanana, and Porcupine Rivers (Figure 1). The study area includes the Yukon River drainage upriver from the village of Russian Mission. 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 in 2004 and the historical average 1995, 1997-2003 of 1.8 million (T. Lingnau, ADF&G,

Anchorage, B. Borba, ADF&G, Fairbanks, personal communication). These returns support important subsistence and commercial fisheries in both the U.S. and Canada. Subsistence fishing occurs from the mouth into Canada and in the major tributaries (Koyukuk, Tanana and Porcupine). Limited information is available on the movement patterns and behavior of salmon during their spawning migration, particularly in large, turbid drainages such as the Yukon River basin.

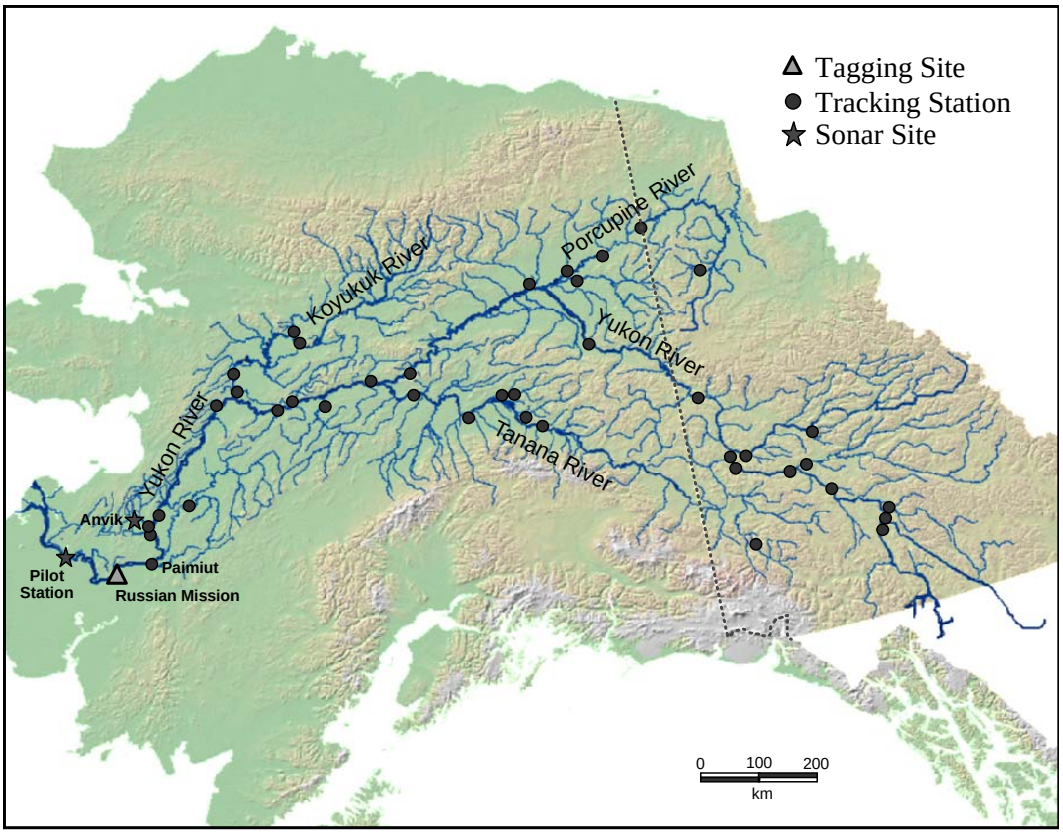

Figure 1. Map of the Yukon River basin showing the Yukon River main stem and major tributaries of the drainage, as well as the tagging site, sonar site and remote tracking stations.

There are two distinct seasonal runs of chum salmon in the Yukon River. Summer chum salmon from early June to mid July, are generally smaller in size than fall chum salmon and spawn in the lower and middle reaches of the basin. Major summer chum salmon spawning areas have been identified in the Anvik and Andreafsky Rivers, with other spawning populations located in the Tanana and Koyukuk rivers and in smaller tributaries including the Nulato, Melozitna, and Tozitna Rivers. 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, and Porcupine rivers in Alaska and Yukon Territory streams in Canada. 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, the number of summer chum salmon returning to the basin has declined dramatically in recent years, and information is needed to better understand and manage these returns.

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; and Bernard et al. 1999) indicated that capture and handling methods could negatively affect adult salmon behaviour. Telemetry studies in large river systems have the additional challenge of maintaining contact with fish tracked over large areas. However, work from 2000-2003 demonstrated large-scale radio-tagging studies of Chinook salmon in the Yukon River basin were successful (Eiler et al. 2004) suggesting that telemetry studies on Yukon River summer chum salmon might be feasible.

Currently, hydroacoustic techniques are being used in the Yukon River at Pilot Station (Figure 1) to monitor the numbers of passing salmon and estimate salmon inseason abundance. 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 abundance. For the years 1993-2000, an average of 52.8% of the summer chum salmon counted at Pilot Station returned to the Anvik River (based on 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 substantially less (22% of the Pilot Station estimate) in 2003 and it is unclear whether this related to changes in stock abundance. This project will compare whether the Pilot Station passage estimate paired with Anvik sonar estimate is reflected in the radio tagged sub-sample of chum salmon and determine if the relationship between the two sonar passage estimates was consistent with 2003 or earlier years.

A large-scale, basin-wide radio telemetry study was conducted in 2004 on Yukon River Chinook salmon to determine stock composition and timing, movement patterns and spawning distribution. Radio-tagged Chinook salmon moving upriver were tracked with 45 remote tracking stations installed at 39 sites throughout the Yukon River basin (Eiler et al. 2004). These stations were located on important migration corridors and spawning tributaries. Twenty-seven sites were in the U.S. section of the drainage, including the gateway station located at Paimiut (Figure 1). The fish were captured with drift gill nets and tagged with radio transmitters in the lower river near the village of Russian Mission. The system of tracking stations was used to track the upriver movements of these fish.

The infrastructure associated with the Chinook salmon study made it possible to incorporate a summer chum salmon component. An additional crew fished near the village of Russian Mission. Adult chum salmon migrating upriver were captured with drift gill nets near the village of Russian Mission. Fish were tagged with pulse-coded radio transmitters inserted through the mouth and into the stomach, and marked externally with yellow spaghetti tags attached below the dorsal fin. The system of tracking stations was used to track the upriver movements of these fish. Limited aerial

surveys were used to locate fish in mainstem areas, unmonitored tributaries, and in terminal spawning areas. Fishers were also encouraged to return radio tags from fish harvested in local fisheries and the Anvik River sonar chum salmon assessment project (located 191 km upstream from the tagging site) also monitored for radio-tagged fish during foot surveys.

Catch per unit effort (CPUE) for each drift (i.e., number of chum salmon caught/hour/100-fathom net) was calculated as

$$\text{CPUE} = \frac{c \cdot 6000}{f \cdot t}$$

where c is the number of chum salmon captured, f is net length in fathoms, t is fishing time in minutes, and 6000 is a convenient factor for standardization.

To provide an estimate of the relative abundance of chum salmon passing the tagging sites, a weighted average CPUE for day d was calculated as

$$\text{CPUE}_d = \frac{\left(\sum c\right) \cdot 6000}{\sum \left(f \cdot t\right)}$$

for all drifts made that day.

Sustainable Salmon Initiative funds were used to support tagging and recovery efforts and other aspects of the project.

III. Results and Findings

A total of 518 chum salmon were captured and 208 radio tagged from June 8 to July 18 (Figure 2). Of these, 124 radio-tagged fish moved upriver past Paimiut and were tracked as they migrated upriver.

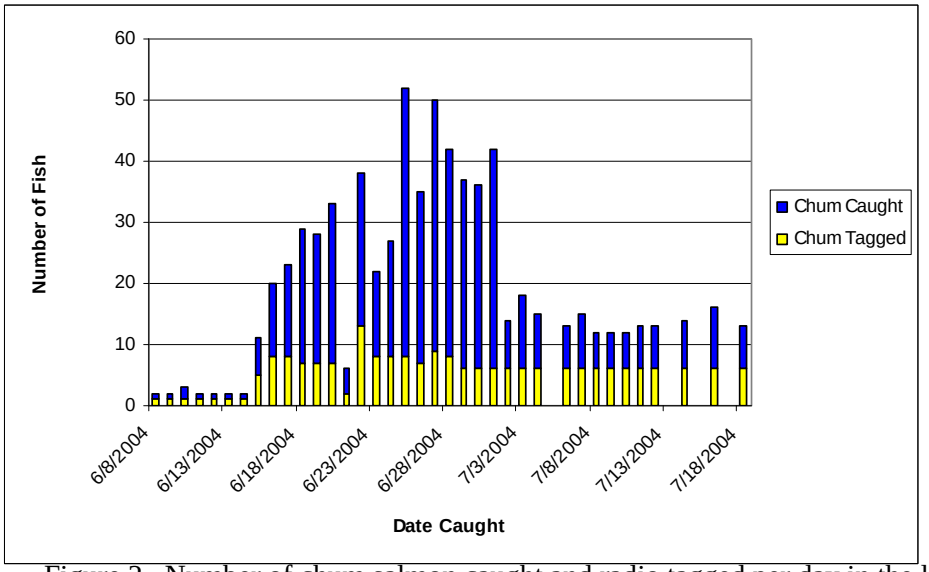

Figure 2. Number of chum salmon caught and radio tagged per day in the lower Yukon River near the village of Russian Mission in 2004.

Most captured fish were age-5: 61.6% (n=114) with smaller proportions of age-4 (58, 31.9%), age-3 (11, 5.9%) and age-6 (1, 0.5%) fish. Information on sex was not collected for fish marked at the tagging site because of difficulties in distinguishing the sexes in the lower river due to the lack of distinct external characteristics. A similar approach was adopted for Yukon River Chinook salmon when information from upriver fisheries indicated that the gender of a large proportion of the tagged fish was identified incorrectly.

Mean lengths of tagged fish were 576 mm ranging from 455 mm to 685 mm (n=208).

Also useful for comparison is the hydroacoustic project located near the village of Pilot Station (205 km upriver from the mouth). This project estimates drainagewide passage of fish at Pilot Station and is primarily used to assess chum salmon numbers and only used as an index for Chinook salmon numbers (T. Lingnau, ADF&G, Anchorage, personal communication). Russian Mission CPUE rose gradually in June, then rapidly, with distinct peaks on June 18, 25, and 30 and a precipitous decline in early July (Figure 3). A comparison of timing patterns between Pilot Station sonar counts (B. McIntosh, ADF&G, Fairbanks, personal communication) and Russian Mission CPUE (with a 3 day lag time) were fairly consistent over the tagging period.

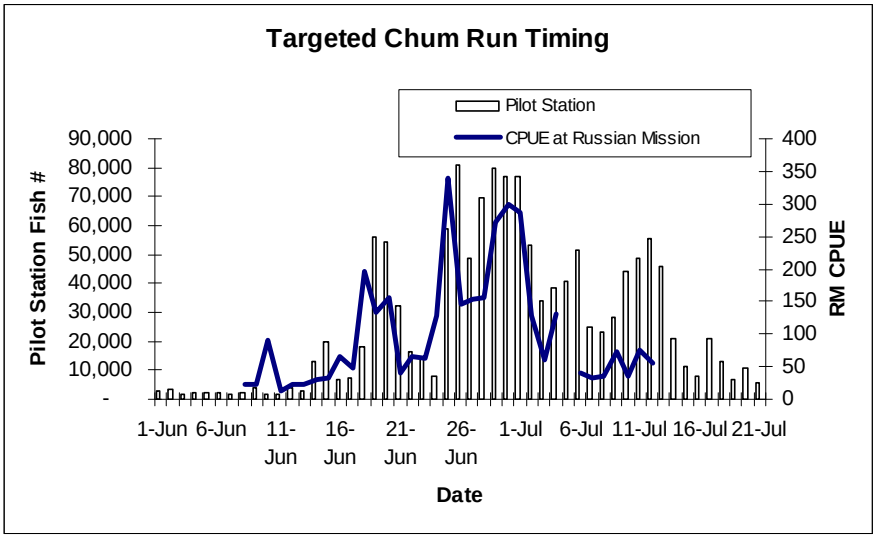

Figure 3. Targeted daily chum salmon CPUE at Russian Mission compared with three-day delay at Pilot Station counts in 2004.

A comparison of targeted chum salmon CPUE with the Anvik sonar numbers (R. Dunbar, ADF&G, Fairbanks, personal communication) is shown in Figure 4. Timing patterns between the Anvik sonar counts and Russian Mission CPUE (with a 9 day lag time) were also consistent over the tagging period.

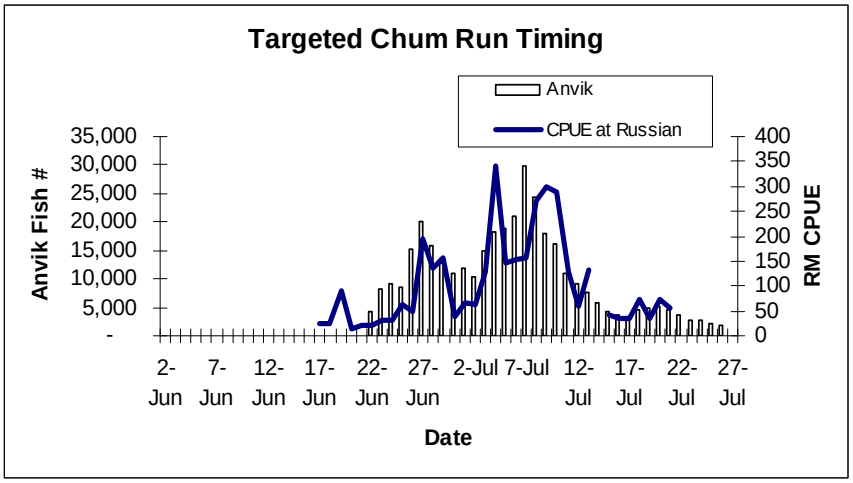

Figure 4. Nine day delay of targeted daily chum salmon CPUE at Russian Mission compared with Anvik River sonar counts in 2004.

The radio-tagged fish traveled to areas throughout the lower and middle basin (Table 1, Figure 5). Seventy-four fish were tracked to terminal spawning tributaries, including 59 tags recorded in Kako Creek, Innoko River, Bonasila River, Anvik River and Nulato River in the Lower Basin, and 15 tags recorded in the Koyukuk River, Melozitna River and Tozitna River in the Middle Basin.

Table 1. Final location of chum salmon radio tagged in the lower Yukon River near the village of Russian Mission during 2004.

				Percentage	
Region	Area	**Undetermined** [a]	**Located**	**All Fish**	**Fish Moved Past Paimiut**
Before Paimiut		84		40.2	
Kako Creek			2	1.0	
Lower Basin[b]	Yukon River	48		23.1	39.4
	Innoko River		2	1.0	1.6
	Bonasila River		16	7.7	13.1
	Anvik River		38	18.3	31.2
	Nulato River		1	0.5	0.8
Middle Basin[c]	Yukon River	1		0.5	0.8
	Koyukuk River		13	6.2	10.7
	Melozitna River		1	0.5	0.8
	Tozitna River		1	0.5	0.8
Upper Basin[d]	Yukon River	1	0	0.5	0.8
Total		134	74	100	100

[a] unknown fate: died, went to un-surveyed small tributaries, unreported fisheries, tag regurgitation or tag malfunctions
[b] Section of the Yukon River from Russian Mission to the Yukon-Koyukuk River confluence.
[c] Section of the Yukon River from Galena to the Yukon-Tanana River confluence.
[d] Section of the Yukon River from the Yukon-Tanana River confluence to the Canadian headwaters.

Radio-tagged 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 2).

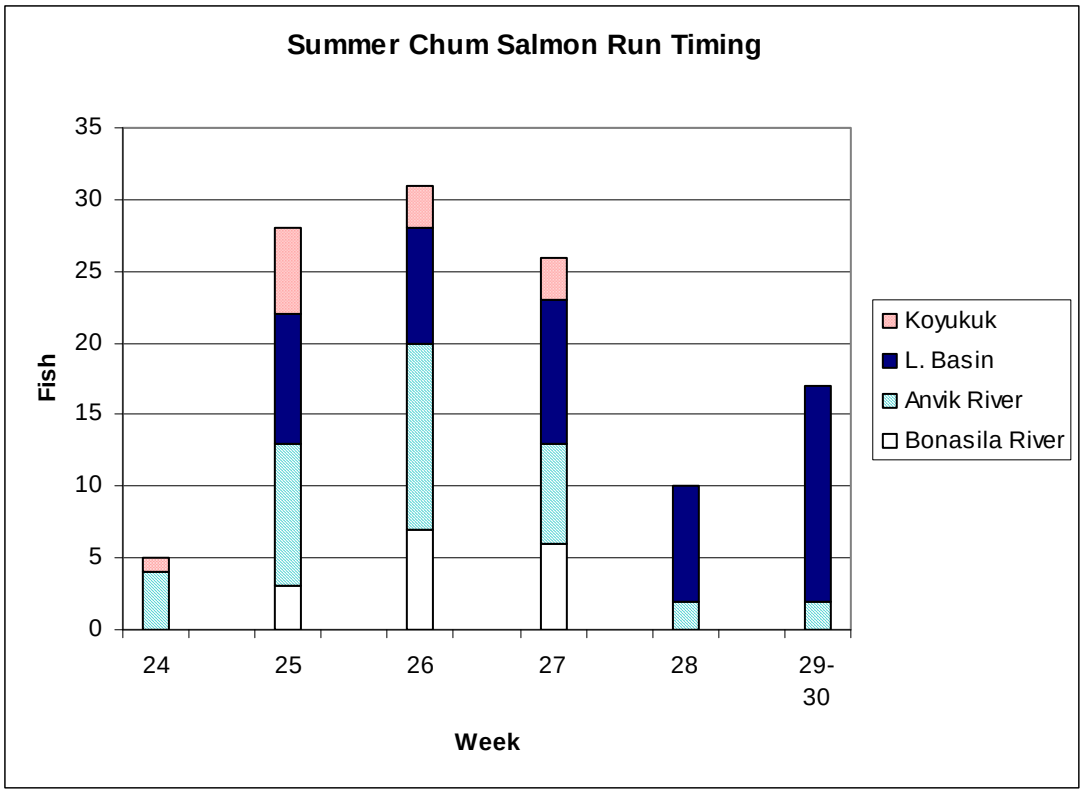

Figure 5. Run timing of chum salmon tagged near Russian Mission in 2004.

Table 2. Movement rates (km/day) of chum salmon radio tagged in the lower Yukon River near the village of Russian Mission during 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.

The small number of chum salmon tagged during the study makes discerning distribution and timing trends difficult and raises concerns whether the sample is representative of the entire run. However, some general observations can be made. Anvik River fish were present in every tagging week while Bonasila River fish only during the peak of the run

(Figure 5). Koyukuk River fish were found earlier in our sample weeks, while Lower Basin fish heading to undetermined locations were more prevalent later in the run. The methods used to capture, tag and track the fish during their upriver migration are well established, and few problems were experienced during this phase of the study. Although the system of tracking stations is more effective in tracking fish to their terminal tributaries above the Paimiut gateway stations (located 62 km upriver from Russian Mission), many summer chum salmon used sites downriver from Paimiut. Those summer chum salmon were not recorded moving upriver or located during the extensive, upriver aerial surveys for Chinook salmon. The failure to locate tagged fish, especially those below Paimiut, may be partially explained because only two aerial surveys were conducted in the area (late July and late August) and only the late July survey was complete. The final locations for fish from aerial surveys are shown in Figure 6. Detailed locations for Anvik and Bonasila River fish are shown in Figure 7.

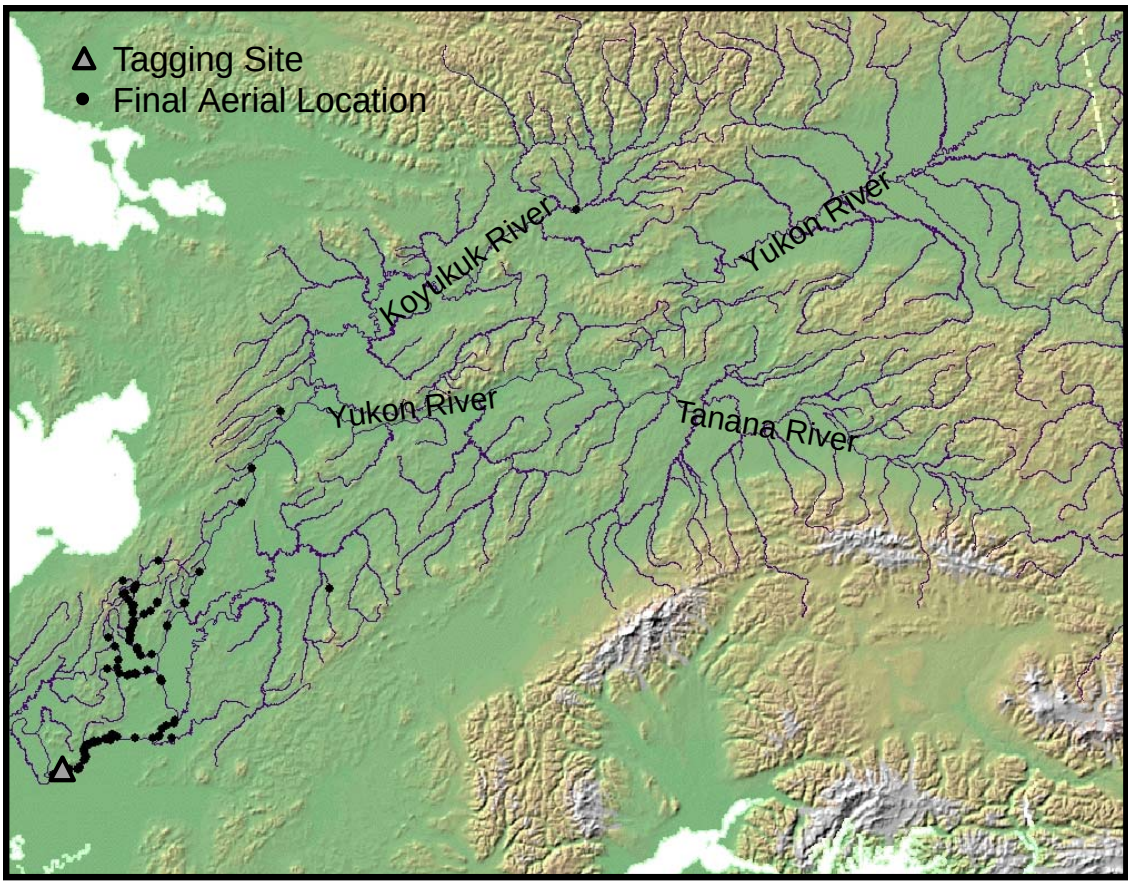

Figure 6. Final location of summer chum salmon radio tagged in the lower Yukon River near the village of Russian Mission and tracked upriver during their spawning migration based on aerial tracking surveys in 2004.

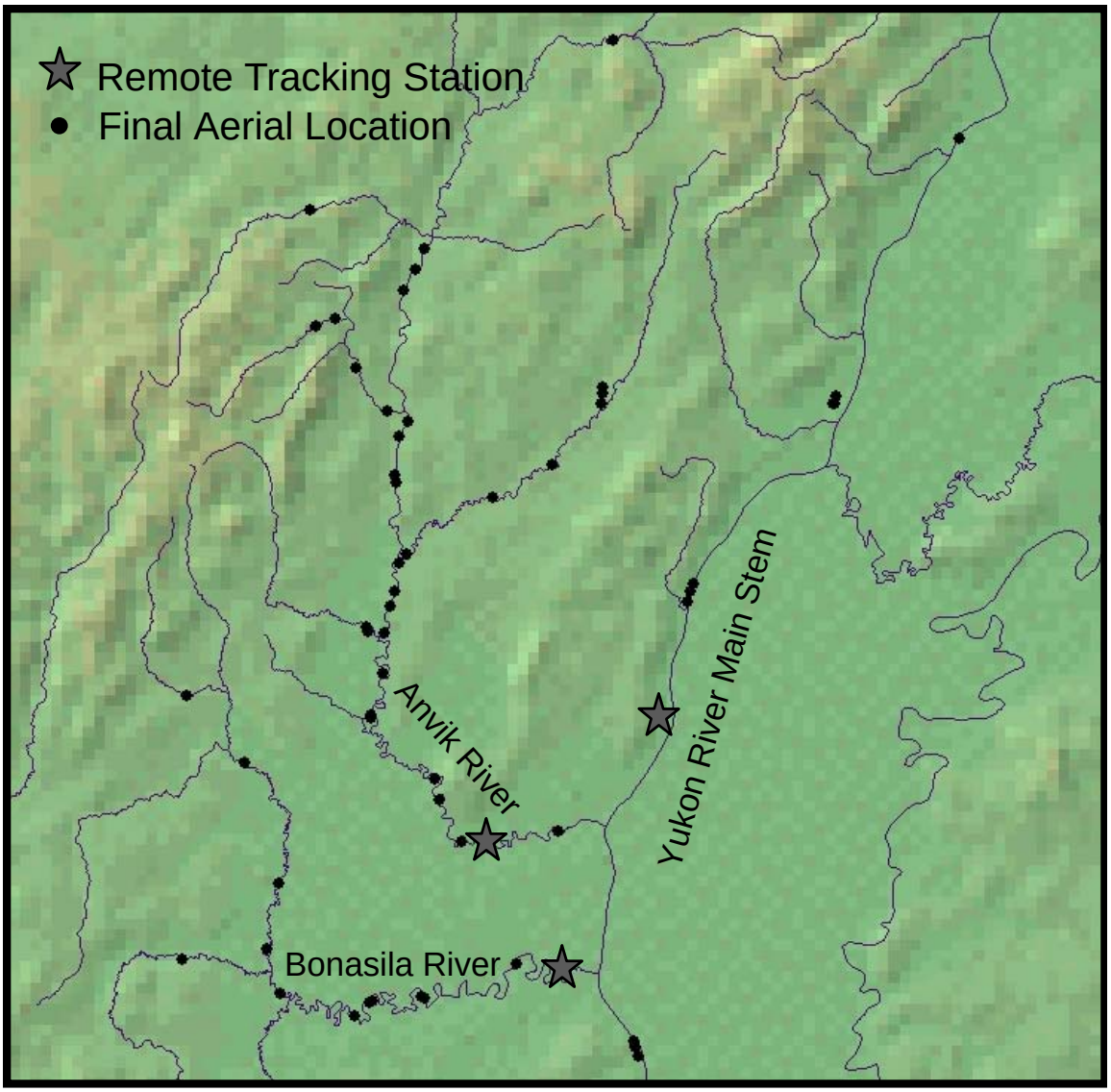

Figure 7. Final location of summer chum salmon radio tagged in the lower Yukon River near the village of Russian Mission and tracked upriver during their spawning migration to reaches of the Bonasila River and Anvik River based on aerial tracking surveys in 2004.

The comparison between the Pilot Station summer chum passage estimate and those of Anvik River was 1,329,696 for Pilot Station (B. McIntosh, ADF&G, Fairbanks, personal communication) and 365,353 for Anvik sonar (R. Dunbar, ADF&G, Fairbanks, personal communication). This results in a ratio of 26.9% for Anvik River fish that is substantially lower than the 50% of previous trends. This estimate (26.9%) is comparable to the 31.2% of our tagged fish that went past the gateway station to the Anvik River, although only 18.3% of all tagged fish continued to the Anvik River.

IV. Evaluation

This project was an initial look at summer chum distribution and movement patterns. The primary objectives of the project were met. Over 200 radio tags were deployed, and a substantial number (n=124) were recorded upriver. The 74 tags located in terminal spawning areas provided the distribution information for our small sample, which was similar to the trend suggested by the comparison of Pilot Station and Anvik River sonar counts (i.e., substantially less than 50% of the summer chum salmon return). However, our results also indicate a possible sampling bias. We did not have any tagged fish returning to the Tanana River, a known summer chum salmon producer. 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. Also, we had a much lower percentage of tagged fish than expected pass the gateway station at Paimiut when compared with that of Chinook salmon. This raises questions of how representative our sample and perhaps introducing a bias with our tagging site. It is possible we were sampling a disproportionate number of fish destined for small, local tributaries near Russian Mission and this proximity to their natal stream may have affected bank orientation. Also because of the limited number of aerial surveys conducted, we were not able to assess the status of fish below Paimiut and last located in the mainstem area. These fish could have accessed these local tributaries, spawned and drifted or washed back out to mainstem areas where they were recorded. Our second tagging site at Dogfish (22 km upriver) is above some of these local salmon streams and may offer a better site for radio-tagging chum salmon.

With sample sizes so small, this project was considered as a feasibility year and our results a first look at summer chum salmon distribution. While relatively successful as an addition to an existing project, a separate future investigation for summer chum salmon would benefit from 1) a larger sample size, 2) tag fish representative of the run (with Pilot Station numbers), 3) move tagging site to Dogfish and 4) additional aerial surveys during and after the tagging period. These extra, intensive aerial surveys would help identify final locations for the lower mainstem fish and monitor lower river tributaries that may contain spawning populations of summer chum salmon.

V. Project Products:

These results will be summarized and presented as final reports to natural resource agencies and fishing organizations within the basin.

VI. Key Words:

chum salmon, Yukon River, radio telemetry, drift gillnet, radio tags

VII. Literature Cited:

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