Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative
Final Report

Project Number: 45224

Project Title: Estimation of Abundance and Distribution of Chinook Salmon in the Yukon River Using Radio Telemetry and Mark Recapture Techniques

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Executive Summary:

A radio telemetry study was conducted on Yukon River chinook salmon during 2003 to provide information on stock composition and timing, migration patterns, and the location of important spawning areas, and to develop an independent estimate of run abundance. A total of 1097 fish were radio tagged in the lower Yukon River near the village of Russian Mission. Most (1081, 98.5%) fish resumed upriver movements and were tracked upriver using remote tracking stations and aerial surveys; 271 fish were harvested in fisheries and 810 fish were tracked to upriver areas. Chinook salmon traveled to areas throughout the basin, with most returning to reaches of the upper basin (61.3%). Canadian fish comprised the largest component of the sample (50.2%), most traveled to reaches of the Yukon River (46.8%) and only a small percentage to the Porcupine River (3.4%). Canadian fish in the Yukon River returned to large headwater tributaries (28.6%), small tributaries associated with the main river (7.4%) and reaches of the Yukon River main stem (8.4%). Chandalar River and Sheenjek River fish (6.4%) were important U.S. stocks in the upper basin, although minor spawning populations were also located in small mainstem tributaries. Tanana River fish were a major component of the sample (21.4%), and were predominantly Chena River, Salcha River, and Goodpaster River stocks (15.1%), with small populations located in other tributaries. Koyukuk, Melozitna, Nowitna, and Tozitna River fish were minor components of the run (4.4%). Fish returning to lower basin tributaries (6.1%) were primarily Anvik River and Nulato River fish (5.2%). Movement rates for radio-tagged fish averaged 51.1 km/day, although stock and regional differences were observed. Upper basin fish generally exhibited faster migration rates (54.8 km/day) than other stocks, although exceptions were observed. Movement rates for lower basin fish were substantially less, averaging 31.4 km/day, possibly due to shorter distances to travel. Movement rates through reaches of the Yukon River main stem were comparable for most stocks, slower swimming speeds recorded as fish approached their natal streams. A mark-recapture estimator was used to estimate run abundance above Russian Mission, with the 2003 return estimated as 277,218 (95%CI: 247,738-306,699).

Purpose of Project:

Large numbers of chinook salmon (*Oncorhynchus tshawytscha*) return to the Yukon River basin to spawn. These returns support important commercial and subsistence fisheries in both the United States (U.S.) and Canada, and have been the focus of numerous discussions between the two countries over management and harvest allocations. The fisheries are managed to maintain essential spawning escapements, support adequate subsistence harvests for local residents, and provide commercial and sport fishing opportunities when appropriate. However, Yukon River chinook salmon runs have declined dramatically in recent years (Joint Technical Committee of the Yukon River U.S./Canada Panel 2002), a phenomenon observed in other major river systems in western Alaska. Information is needed to better understand and manage these returns, and facilitate conservation efforts.

The Yukon River basin drains a watershed of over 855,000 km^2. The main river alone flows for over 3,000 km from its headwaters in Canada to the Bering Sea. Several major tributaries flow into the Yukon River main stem, including the Koyukuk and Tanana Rivers in the U.S., the Stewart, White, Pelly, and Teslin Rivers in Canada, and the Porcupine River, which transects both countries. Most reaches of the drainage consist of a primary river channel with occasional side channels and sloughs, although the Yukon River main stem is extensively braided between the villages of Rampart and Circle, an area commonly referred to as the Yukon Flats. Sections of the Canadian main stem and the White River are also extensively braided. Water visibility in many areas is extremely poor, particularly in the Yukon River main stem, caused by turbidity from the upper reaches of the drainage. The basin is remote with limited access to many areas. Subsistence and commercial fisheries occur throughout the drainage with most fishing effort concentrated near villages along the Yukon River main stem. Fish are also harvested in reaches of the Koyukuk, Tanana, Chandalar, Porcupine, Stewart, Pelly, and Teslin Rivers. Limited sport fishing takes place in a number of clearwater streams within the basin.

Under terms of the Yukon River Salmon Treaty, the U.S. and Canada agreed to conduct cooperative research to determine the migratory patterns and population status of Yukon River salmon returns. As part of this research effort, a basinwide radio telemetry study was conducted on Yukon River chinook salmon in 2003 by the Alaska Department of Fish and Game (ADF&G) and the National Marine Fisheries Service (NMFS). The primary objective of this study was to improve management and facilitate conservation efforts by providing information on the run characteristics, including stock composition and timing, country of origin, migration patterns, and location of important spawning areas. Information was also collected to evaluate other projects in the basin that assess run abundance. A second goal was to provide an independent estimate of the total abundance of the chinook salmon return. Feasibility work in 2000-2001 (Spencer et al 2003), which focused on the development of suitable capture methods, improved telemetry equipment for tracking fish, and the infrastructure for a study of this size and scope, and a large-scale tagging study in 2002 (Eiler et al. In review) demonstrated that basinwide radio telemetry programs in the Yukon River basin are feasible and provide information useful for managing salmon returns. The 2003 basinwide study was conducted to collect additional information on chinook salmon run characteristics and movements, and address questions related to annual variation. Primary funding for the 2003 study was provided by the U.S.-Canada Yukon River Salmon Treaty Implementation Fund, Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative Fund, ADF&G, and NMFS. Support was also provided by the U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, Department of Fisheries and Oceans

Canada, Bering Sea Fishermans Association, Yukon River Drainage Fisheries Association, National Park Service, U.S.-Canada Yukon River Grant No. 03NMF4380185, and the Restoration and Enhancement Fund of the Yukon River Panel.

Approach:

Adult chinook salmon returning to spawning areas in the Yukon River basin were captured with drift gill nets near the village of Russian Mission (Figure 1). Local fishers were contracted to fish the site during the day (0900-1700) and night (1800-0200) from early June to mid July, while project personnel handled the fish and collected data. Two day shifts and one night shift were fished throughout the tagging period; a second night shift was fished from 16 June to 27 June to increase catches. Fishing effort was divided between the lower and upper sections of the tagging area when two crews were fishing to minimize the potential of recapturing tagged individuals. Gill nets constructed with No. 21 seine twine, 8.5" mesh size, 46 m long, 7.6 m deep, and hung at a 2:1 ratio, were used in 2003. This configuration was effective to capture chinook salmon and minimizing chum salmon (*O. keta*) bycatch. Nets were monitored continually and fish removed immediately after capture. Netting was cut to facilitate removal and minimize injuries. A dip net, constructed with soft, fine-mesh netting, was used to lift fish into the boat for tagging; fish not tagged were released immediately. A maximum of two fish were tagged per drift to minimize handling time and sampling bias. Fish selected for tagging were placed in a neoprene-lined tagging cradle submerged in a trough of fresh water. A pump was used to circulate river water into the trough while fish were being processed. Anesthesia was not used during the tagging procedure.

Fish were tagged with pulse-coded radio transmitters inserted through the mouth and into the stomach, and marked externally with spaghetti tags attached below the dorsal fin. Information on sex, length (mid eye to fork of tail), and condition of the fish was also recorded. A tissue sample was taken from the axillary process for genetic stock identification analysis, and scales were collected to provide age data. Fish were released back into the main river immediately after the tagging procedure was completed. Handling, from removal of the net from the water to release, took from six to eight minutes depending on the number of fish tagged per drift.

Radio-tagged fish that moved upriver were tracked with remote tracking stations (Eiler 1995) located at 39 sites throughout the basin (Figure 1). Sites selected were on important migration corridors and major tributaries of the drainage. Radio-tagged fish within reception range were identified and recorded by the stations. Because of the isolated nature of the sites, the telemetry data collected were transmitted every hour to a geostationary operational environmental satellite (GOES) and relayed to a receiving station near Washington D.C.. Information was accessed daily via the internet, and uploaded into a computerized data base for analysis (Eiler and Masters 2000).

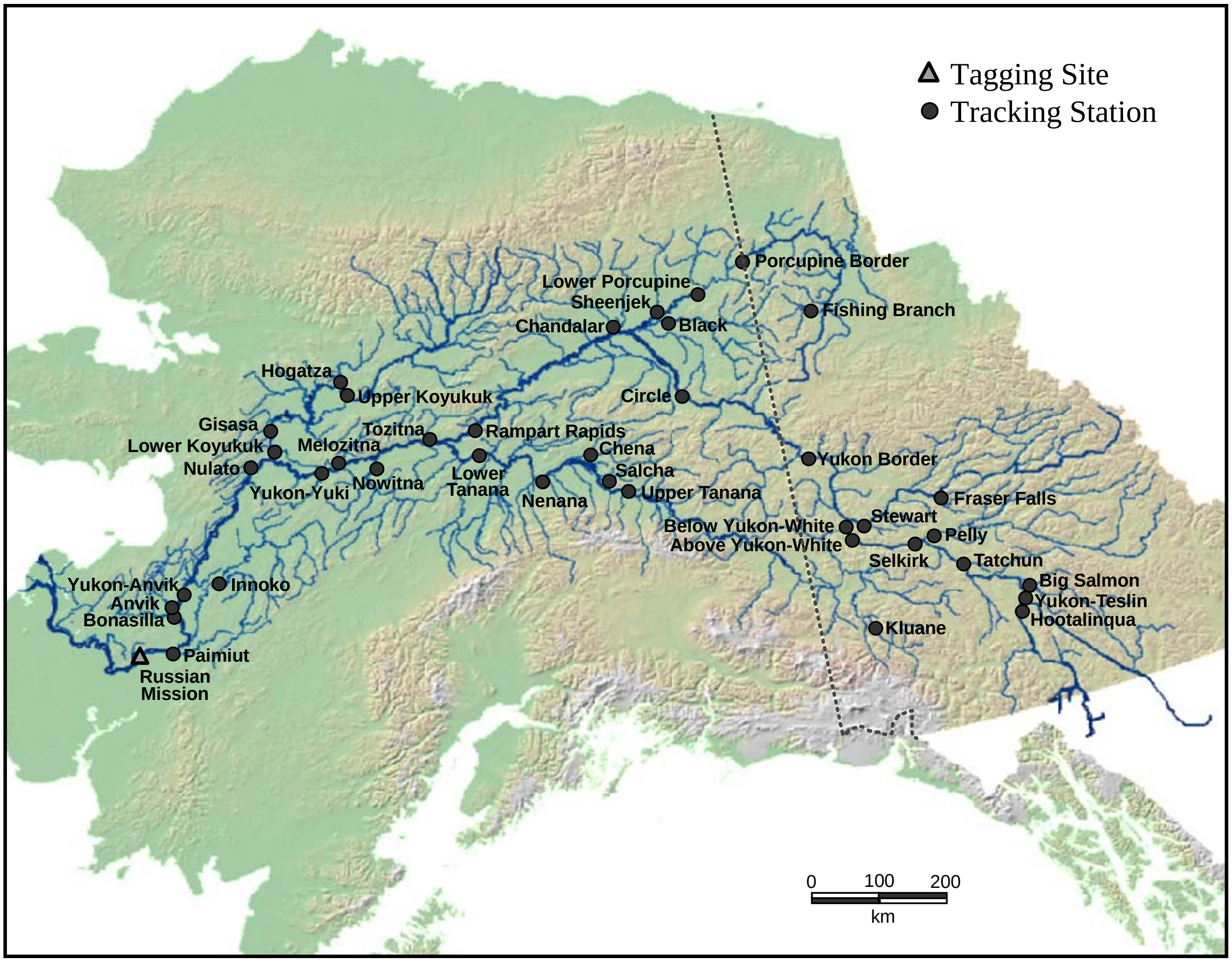

Figure 1. Map of the Yukon River drainage showing the location of the tagging site and remote tracking stations used to track the upriver movements of radio-tagged chinook salmon in 2003.

Aerial surveys were conducted in selected reaches of the drainage to locate radio-tagged fish that traveled to areas between station sites and upriver of stations on terminal tributaries. Fish were tracked from fixed-wing aircraft and helicopters equipped with 4-element yagi receiving antennas. Tracking receivers contained an integrated global positioning system (GPS) receiver to assist in identifying and recording locations. Areas surveyed in the U.S. included the Yukon River main stem from Russian Mission to the Yukon border, and reaches of the Anvik, Innoko, Nulato, Koyukuk, Nowitna, Tanana, Chandalar, Sheenjek, Black, Kandik, Nation, and Charley Rivers, and Beaver Creek. In Canada, surveys were flown along reaches of the Yukon River main stem, and in numerous mainstem tributaries including the Chandindu, Klondike, White, Stewart, Pelly, Nordenskiold, Little Salmon Big Salmon, and Teslin Rivers, and Tatchun Creek. Surveys were also flown in Canadian reaches of the Porcupine River, including Old Crow, Whitestone, Miner and Fishing Branch Rivers.

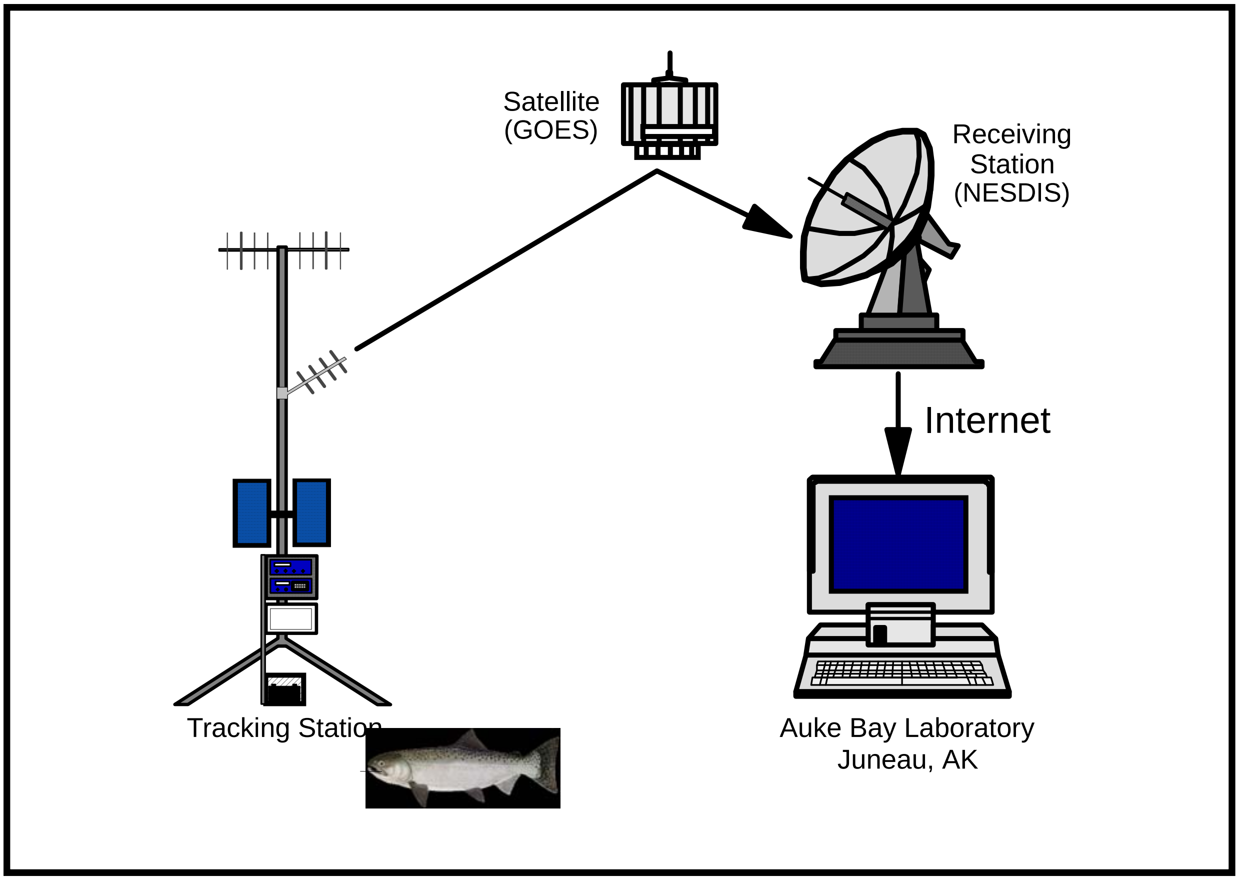

Figure 2. Remote tracking station and satellite uplink used to collect and access telemetry data for radio-tagged chinook salmon in the Yukon River basin

Tagged fish were recovered by salmon monitoring projects within the basin, during tracking surveys of spawning areas, and by subsistence, commercial and sport fishers. A postseason lottery was conducted for fishers that reported the tags recovered to encourage local cooperation. A letter of appreciation was also sent to each person or agency that returned tags with information about the fish caught.

Chapman's closed population two-sample, mark-recapture estimator (Seber 1982) was employed to estimate the drainagewide chinook population abundance. The Chapman closed population estimator is based upon these assumptions:

a) recruitment, immigration and emigration of untagged fish does not occur between tagging and recapture events,
b) tagging does not affect the fate (mortality, probability of recapture) of a fish,
c) tagged fish do not lose their marks and all marks are recognized,
d) all fish have an equal probability of capture at the capture sites, or all fish have an equal probability of capture at the recapture locations, or marked fish mix completely with unmarked fish between capture locations.

Mark-recapture estimates of abundance were compared with other estimates as well as indices of abundance for chinook salmon in the Yukon River. ADF&G has operated numerous escapement-monitoring projects, which include towers, weirs, aerial surveys, mark-recapture, and hydroacoustic methodologies. Most are operated on tributaries of the Yukon River, estimating stock specific escapements. Only the hydroacoustic project, located near the village of Pilot Station (river kilometer 205), estimates drainagewide passage (Rich 2001, Pfisterer 2002, JTC 2004) comparable to this project's mark-recapture estimate at Russian Mission. Catch plus escapement of chinook salmon upstream of the mark-recapture project is only an index because not all tributaries are monitored. It is useful in trend comparison or in comparison with a drainagewide estimate to highlight the potential number of chinook salmon spawning in unmonitored systems. Catches have been estimated from postseason subsistence surveys (Brase and Hamner 2003) and tallied from sales receipts (fish tickets) collected after every commercial fishing period.

Results and Findings:

Drift gill nets were an effective method for capturing large numbers of adult chinook salmon in suitable condition for tagging. Adequate numbers (2313 fish) were captured at the Russian Mission tagging site, and 1097 fish were radio tagged and released (Table 1). Six-year old fish were the dominant age class in the tagged sample (69.2%). The remaining fish were primarily 5-year olds (22.2%), with smaller percentages of 7-year olds (8.1%), 4-year olds (0.4%), and 8-year olds (0.1%). Radio-tagged fish averaged 849 mm in length, ranging from 530 mm to 1075 mm.

Table 1. Weekly and total numbers of chinook salmon captured with drift gill nets and radio tagged in the lower Yukon River near the village of Russian Mission during 2003.

Capture Dates	Fish Capture	Fish Tagged
3-7 June	144	78
8-14 June	378	168
15-21 June	949	390
22-28 June	423	236
29 June – 5 July	274	148
6-14 July	144	77
Total	2312	1097

Chinook salmon responded well to the capture and tagging procedures, most fish resumed upriver movements after release (Table 2). A total of 1081 (98.5%) radio-tagged fish moved passed the Paimiut tracking stations, and traveled to upriver reaches (810, 73.8%) or were caught in upriver fisheries (271, 24.7%). Sixteen (1.5%) fish did not resume upriver movements, and either regurgitated their tags or died because of handling, predation or undocumented encounters with fisheries. Radio-tagged fish averaged 1.9 days after release to move past the first tracking stations (Paimiut), traveling an average of 33.0 km/day.

Table 2. Tracking results for chinook salmon radio tagged in the lower Yukon River near the village of Russian Mission during 2003. Percentages of the total are in parentheses.

Final Status	Number of Fish (%)
Moved upriver past Paimiut tracking station	1081 (98.5)
Upriver location	810 (73.8)
Harvested in fishery	271 (24.7)
Not located upriver	16 (1.5)
Total	1097

A total of 271 radio-tagged fish were harvested during their spawning migration (Table 2), most (226, 83.4%) were caught in U.S. fisheries. Harvest rates differed between regions, 27 (10.0%) fish were caught from Russian Mission to Holy Cross, 60 (22.1%) fish were caught from Anvik to Ruby, and 114 (42.4%) fish were caught in the upper Yukon River from the Yukon-Tanana River confluence to Eagle. With the exception of the fishery near Eagle, these fish were likely comprised of both U.S. and Canadian stocks. Fish caught near Eagle were assumed to be destined for spawning areas in Canada. Twenty-five (9.2%) fish were harvested in the Tanana River; with most (22, 8.1%) caught near Nenana and Fairbanks. Forty-five (16.6%) fish were harvested in Canadian reaches of the basin (Table 3). Forty-two (15.5%) fish were destined for spawning areas in the Yukon River, with most of recoveries from Dawson, Carmacks, Pelly River and Teslin River. Three (1.1%) fish were caught in the Porcupine River fishery near the village of Old Crow.

A total of 884 fish were tracked to upriver areas or recovered in terminal fisheries. Upper basin fish comprised the largest component of the sample, with 541 (61.3%) fish returning to the upper Yukon and Porcupine Rivers. A substantial number of these fish traveled to Canadian reaches, including 413 (46.8%) Yukon River fish and 30 (3.4%) Porcupine River fish (Figure 3). Most (318, 36.0%) Canadian fish were tracked to tributaries of the Yukon River main stem (Table 3), including the Stewart (31, 3.5%), Pelly (79, 9.0%), Big Salmon (59, 6.7%), and Teslin (71, 8.0%) Rivers. Small numbers of fish were located in Chandindu River (5, 0.6%), Klondike River (19, 2.2%), White River (12, 1.4%), Big Creek (1, 0.1%), Tatchun Creek (3, 0.3%), Nordenskiold River (8, 0.9%), Little Salmon River (17, 1.9%), and headwater areas upriver of the Yukon-Teslin River confluence (13, 1.5%). Seventy-four (8.4%) fish remained in reaches of the Yukon River main stem or traveled to associated tributaries not monitored by tracking stations or surveyed by aircraft. Canadian fish in the Porcupine River were tracked to headwater tributaries in the Miner (13, 1.5%), Whitestone (1, 0.1%) and Fishing Branch (1, 0.1%) Rivers. Radio-tagged fish were also located in upper reaches of the Old Crow River (2, 0.2%). Ten (1.1%) fish that passed the Porcupine Border, and not harvested in the Old Crow fishery, were not located during the survey flights, suggesting chinook salmon may utilize other spawning areas in the Porcupine River drainage.

Ninety-eight (11.1%) fish were tracked to the U.S. reaches of the upper basin, including 76 (8.6%) Yukon River fish and 22 (2.5%) Porcupine River fish. Forty-five (5.1%) fish in the upper Yukon River were tracked to tributaries (Figure 3, Table 3). Most of these fish returned to the Chandalar River (36, 4.1%), although small numbers were located in Beaver Creek (3, 0.3%), and the Charley (3, 0.3%), Kandik (1, 0.1%) and Nation (2, 0.2%) Rivers. Thirty-one (3.5%) fish remained in reaches of the Yukon River main stem or traveled to associated tributaries not monitored by tracking stations or surveyed by aircraft. Most Porcupine River fish returned to the Sheenjek River (20, 2.3%), while two (0.2%) fish were tracked to upper reaches of the Black River.

Tanana River fish comprised a major component of the sample, 190 (21.4%) fish returned to this section of the basin (Figure 3). Most (159, 18.0%) Tanana River fish traveled to tributaries in the middle and upper reaches of the drainage (Table 3), including the Chena (40, 4.5%), Salcha (58, 6.6%), and Goodpaster (36, 4.1%) Rivers. Fish were also located in reaches of the Kantishna (15, 1.7%) Tolovana (5, 0.6%), and Nenana (3, 0.3%) Rivers. Twelve (1.4%) fish remained in reaches of the Tanana River main stem or traveled to associated tributaries not surveyed. Nineteen (2.1%) fish were harvested in fisheries in the Tanana River main stem, most (18, 2.0%) were caught near Nenana and Fairbanks.

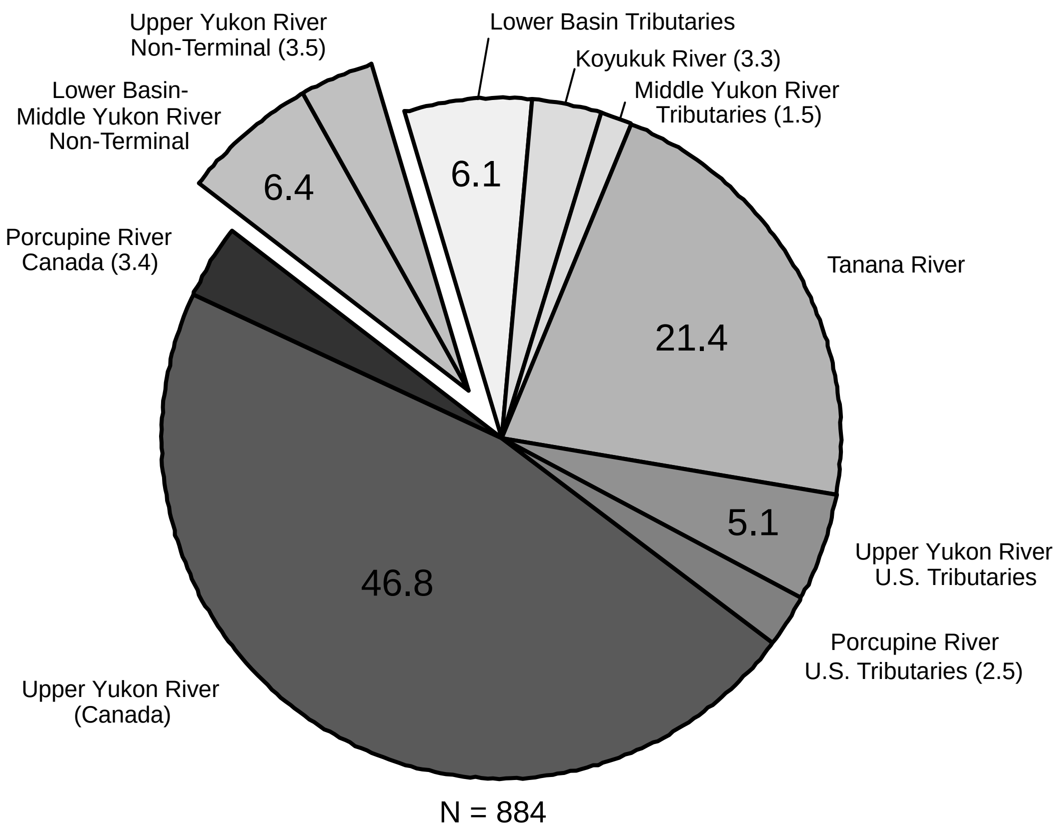

Figure 3. Distribution of chinook salmon radio tagged in the lower Yukon River near the village of Russian Mission during 2003. Percentage of the total number of fish that moved upriver and were not caught in non-terminal fisheries are indicated

Chinook salmon were tracked to reaches of the basin downstream of the Yukon-Tanana River confluence. Fifty-four (6.1%) fish traveled to tributaries in the lower basin (Figure 3). Anvik River (31, 3.5%) and Nulato River (15, 1.4%) fish were most prevalent, with smaller numbers of fish traveling to the Innoko (2, 0.2%) and Bonasila (6, 0.7%) Rivers. Thirteen (1.5) fish returned to tributaries associated with the middle Yukon River (Table 3), including the Melozitna (1, 0.1%), Nowitna (2, 0.2%), and Tozitna (10, 1.1%) Rivers. Twenty-nine (3.3%) fish returned to the Koyukuk River, including eleven (1.2%) Gisasa River fish, two fish (0.2%) that traveled to middle reaches, and 12 (1.4%) fish that returned to the upper reaches of the drainage, including the Hogatza (1, 0.1%), Henshaw (1, 0.1%), South Fork (3, 0.3%) and Middle Fork (2, 0.2%) Rivers. Fifty-seven (6.4%) fish were last recorded in non-terminal reaches of the Yukon River main stem, including 49 (5.5%) fish in the lower basin and eight (0.9%) fish in the middle Yukon River.

Table 3. Regional distribution of chinook salmon radio tagged in the Yukon River basin during 2003. Fish harvested in terminal reaches of the basin are included. Percentages of the total are in parentheses.

Region	Final Location	Number of Fish
Lower Basin	Yukon River main stem[1]	49 (5.5)
	Tributaries	54 (6.1)
Koyukuk River	Upper Koyukuk River main stem[1]	7 (0.8)
	Koyukuk River fishery	4 (0.5)
	Tributaries	18 (2.0)
Middle Yukon River	Yukon River main stem[1]	8 (0.9)
	Tributaries	13 (1.5)
Tanana River	Tanana River main stem[1]	12 (1.4)
	Tanana River fishery	19 (2.1)
	Tributaries	159 (18.0)
Upper Basin	Yukon River main stem (U.S.)[1]	31 (3.5)
	Yukon River tributaries (U.S.)	45 (5.1)
	Yukon River main stem (Canada.)[1]	74 (8.4)
	Yukon River main stem fishery (Canada)	21 (2.4)
	Yukon River tributaries (Canada)	318 (36.0)
	Porcupine River tributaries (U.S.)	22 (2.5)
	Porcupine River (Canada)	10 (1.1)
	Porcupine River fishery (Canada)	3 (0.3)
	Porcupine River tributaries (Canada)	17 (1.9)
Total		884

[1] Includes associated tributaries not monitored with tracking stations or aerial surveys

Radio-tagged fish traveled an average of 51.1 km/day in 2003. Tracking station coverage within the basin provided movement information for specific chinook salmon stocks. Upper basin fish traveled an average of 54.8 km/day. Fish returning to the Yukon River in Canada averaged 53.8 km/day. Similar rates were observed for stocks traveling to U.S. reaches in the upper basin, with averages of 59.0 km/day for tributary fish and 55.5 km/day for fish remaining in non-terminal areas (i.e., reaches of the main stem or associated tributaries not monitored during the study). Porcupine River fish traveled substantially faster than Yukon River fish, averaging 60.1 km/day. Tanana River fish exhibited slower average migration rates (47.8 km/day), with Chena River, Salcha River, and Goodpaster River fish ranging from 44.9 km/day to 47.2 km/day, while fish remaining in main stem areas and associated tributaries averaged 52.3 km/day. Tributary fish returning to the middle Yukon River averaged 47.2 km/day, while Koyukuk River ranged from 43.5 km/day (Gisasa River fish) to 63.1 km/day (upper headwaters fish). Chinook salmon returning to reaches in the lower basin moved substantially slower than middle and upper basin stocks, fish located in lower river tributaries averaged 31.4 km/day.

Migration rates recorded for Chena River, Salcha River, and Goodpaster River fish were substantially slower than most middle and upper basin stocks. However, the tracking stations used to monitor these tributaries were located relatively close to spawning areas, and the lower rates reflect slower swimming speeds as the fish approached their natal streams. When comparing swimming rates based on movements from Paimiut to the lower Tanana River, these stocks averaged between 54.7 km/day and 60.2 km/day, movement rates comparable to upper basin fish. A similar phenomenon was observed for other stocks, including fish traveling to the

Gisasa and Nulato Rivers. In contrast, tracking stations on tributaries associated directly with the Yukon River main stem, such as the Chandalar, Sheenjek, Stewart, and Pelly Rivers, were typically placed near the confluence, and often located a substantial distance from areas used for spawning. The average movement rates for fish passing these stations were comparable to rates observed lower in the basin.

Regional differences in run timing were observed in 2003 for chinook salmon stocks passing through the lower Yukon River. Canadian Yukon and Tanana River stocks were present throughout the return, but most abundant early in the run, while fish traveling to lower basin tributaries were more abundant during late June and July.

Most assumptions of the mark-recapture population estimation were met during the study. Tagged fish that did not move upriver were identified and removed from the calculations (Assumption A). Although Assumption B was not directly testable, the response of the tagged fish (i.e., the number that resumed upriver movements, and the migration and distribution pattern exhibited) suggests that adverse impacts from tagging were negligible. Radio-tagged fish did not appear to regurgitate radio tags or lose their external spaghetti tags after resuming upriver movement (Assumption C). Chi-square test was used to examine equality of marked-unmarked ratio among recapture sites to address Assumption D. Recapture projects were combined into three regions: upriver, mid-river, and downriver, and equality of the pooled ratio among the three regions was tested. However the marked-unmarked ratio differed among the different regions, ranging from 0.24 % in Tanana River, 0.49 % in Koyukuk River, and 0.65 % in the Canadian Yukon River. The total tag ratio ranged from 0.39% to 0.61% conservatively, excluding the Tanana River. The low tag ratio in the Tanana River is partially explained by the flooding of the Chena River and Salcha River recovery projects. This low ratio resulted in liberal estimates of 277,218 (95%CI: 247,738-306,699), and conservative estimates of 176,899 (95%CI: 152,289-201,510). For individual river systems, the mark-recapture estimates were 5,674 (95%CI: 3,442-7,905) for Koyukuk River, 79,798 (95%CI: 68,727-90,868) for Tanana River, and 63,524 (95%CI: 55,417-71,631) for Canadian Yukon River.

One of the difficulties of an abundance estimation project is verification of results. In a field situation, some statistical assumptions may be violated if assumed without verification. Violation of these assumptions leads to biased estimation; however, examining the magnitude of the bias is difficult. In this study, mark-recapture and mainriver hydroacoustic sonar with species apportionment were employed for comparison. The estimates from the mark-recapture study were 277,218 ± 29,481 in 2003 above the Russian Mission tagging site. The Pilot Station sonar project estimated drainage-wide chinook salmon abundance above the site at 257,636 ± 29,540 (JTC 2004). Results of the 2003 study were similar to those of Pilot Station and suggests radio telemetry may successfully estimate abundance of chinook salmon drainage wide and in tributaries.

<u>Evaluation:</u>

The basinwide telemetry study was successful obtaining new information on the distribution, timing, movement patterns and run abundance of Yukon River chinook salmon. Adequate numbers of fish were captured in suitable condition for tagging. The system of satellite-linked tracking stations, combined with aerial surveys of selected reaches of the basin, made it possible to monitor the upriver movements of tagged fish and determine their final location. The tagged fish appeared to respond well to the capture and handling procedures based on the number that resumed upriver movements, and the migration and distribution patterns exhibited. Distribution data was used to identify and compare the principle components of the return. Stock composition and run timing estimates derived from these data will provide a detailed look at the temporal and spatial dynamics of the 2003 return. The status of fish in non-terminal areas was difficult to determine because of turbid river conditions in reaches of the Yukon River main stem, and limited funding and personnel to survey associated tributaries in some sections. Evidence suggests at least a portion of these fish may include non-reported fishery recoveries, and better outreach to local fishers may help address this question. Information from this study was used to develop a drainagewide abundance estimation for the 2003 return.

The information from this study has been used to address conservation and harvest allocation issues, expand the genetic stock identification baseline, and evaluate abundance estimates from other assessment projects in the basin. This information has also provided movement and behavioral data to address concerns such as the impacts of the fish disease *Ichthyophonus* on chinook salmon returns. The automated data base and mapping program used during the study, collected and summarized telemetry data in season, making it possible to prioritize field activities and address management issues within the basin. The infrastructure from this study, particularly the system of remote tracking stations, enabled project leaders to obtain information on other fish species within the basin. Large-scale tagging studies in 2002 and 2003 (present study) have provided an initial look at the run characteristics of Yukon River chinook salmon. Additional information is needed to further address questions related to study findings and annual variation.

Products:

Results from the 2000-2001 feasibility phase of the study are summarized in Spencer et al. (2003) and Eiler et al. (In review). Results from the 2002 basinwide study are reported in Eiler et al. (In review). Information from the study is summarized in annual reports of the Yukon River Joint Technical Committee (JTC 2000, JTC 2001, JTC 2002,JTC 2004). Information from the 2003 study on the stock composition and timing, spawning distribution and movement patterns of radio-tagged chinook salmon will be published in the National Oceanic and Atmospheric Administration Technical Memorandum series. Results from the mark-recapture experiment based on the tagging information and chinook enumeration programs within the drainage will be published in the ADF&G Regional Information Report series. The study has been described for the public at various regional advisory councils, Yukon River Panel meetings, annual meetings of the Yukon River Drainage Fisheries Association, and weekly teleconferences organized by Yukon River Drainage Fisheries Association during the summer fishing season.

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Key Words:

Chinook salmon, radio telemetry, mark-recapture, drift gill net, Yukon River, Tanana River