

2003 Yukon River Chinook Telemetry Surveys in the Tr'ondek Hwech'in Traditional Territory

CRE-02-03

Prepared By:

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ABSTRACT

The overall goal of the basin-wide study conducted by the Alaska Department of Fish and Game (ADF&G) and the National Marine Fisheries Service (NMFS) study, "Stock composition and movement patterns of chinook salmon returning to the Yukon River Basin in 2003" (Eiler et al. in prep.), was to gain knowledge of the migratory characteristics and distribution of Yukon River chinook salmon in the Yukon River watershed. A total of 1,097 Radio tags were applied to chinook salmon near the Alaskan villages of Marshal and Russian Mission; 1,081 of these fish moved upriver (98.5%). The upriver movements were monitored through a network of remote tracking stations, aerial surveys, and, through recaptures in various fisheries.

This project (CRE-02-03) was initiated to detect the locations of radio tagged fish that were tagged as part of the basin-wide study (1,081 radio tagged fish) and was intended to contribute to the understanding of salmon spawning distributions within the Tr'ondek Hwech'in traditional territory and the Canadian Upper Yukon River North Mainstem (YRNM) Sub-basin. In total, 413 radio tagged fish crossed the CAN/US border and 371 migrated upstream without being recaptured in a local fishery. In total, 31 individual radio tagged fish that were not captured in fishery or deemed to be in transit (migrating) were tracked within the Tr'ondek Hwech'in Traditional Territory. Twenty-four of these radio tagged fish were determined to be terminal in this area, with 19 tagged fish recovered on the Klondike River (18, Klondike River) and North Klondike Rivers (1, North Klondike River), and 5 on the Chandindu River. The remainder of the radio tagged fish (347) were likely in transit on the Yukon River Mainstem, migrating to upriver spawning areas.

Information gathered in this study has increased our understanding of chinook distribution within the YRNM Sub-basin and earlier physical, archival, and, local and traditional knowledge studies (Cox et al. 1997). This study also compliments similar work completed in 2002 (CRE-02-02) and is intended to contribute to overall sub-basin planning.

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INTRODUCTION

General

In 2003, the United States National Marine Fisheries Service (NMFS), and the Alaska Department of Fish and Game (ADF&G), and the Yukon River Panel's Restoration and Enhancement Fund (YRP-R&E) initiated a large-scale radio telemetry study on the run characteristics of chinook salmon (*Oncorhynchus tshawytscha*) in the Yukon River basin (Eiler et al. in prep.). The study's intent was to tag and release up to 1,000 migrating adult chinook salmon captured throughout the run in the vicinity of the Alaskan villages of Marshall and Russian Mission. These radio tagged fish were to be tracked throughout the Yukon River drainage, both in Alaska and Canada, through the use of remote tracking stations (RTS) and aerial tracking (Eiler 1995). The RTS's were situated near the mouths of principle tributaries and at four sites on the mainstem Yukon River. The RTS's that were located within the survey area of this project included the Yukon River near the confluence of the Fortymile River, the mouth of the Stewart River, and the Yukon River at the mouth of the White River. The aerial telemetry surveys conducted during this project were intended to obtain higher resolution information on the migration and distribution of radio tagged fish between these sites and in terminal areas.

As a result of consultations with John Eiler (NMFS) and exposure to the larger basin-wide chinook study, it became clear that there was both an opportunity to collect data within the Tr'ondek Hwech'in traditional territory and a need to locate these fish to compliment the basin-wide study. Information gathered during this project is considered valuable for the purposes of planning, specifically; gaining a better understanding of chinook distribution within the study area, sub-basin restoration and enhancement planning, and priority setting. Increased understanding of the distribution of chinook salmon within the Yukon River North Mainstem Sub-basin and Tr'ondek Hwech'in traditional territory as a result of this

study is intended to compliment previously completed physical, archival, and, traditional and local knowledge study (Cox, et al. 1997). The information gathered as a result of this study is intended to contribute to overall area sub-basin planning.

Objectives

The objectives of this project were to:

1. Obtain precise information on the number of radio-tagged chinook salmon in streams within the Upper Yukon River North Mainstem, Canadian Sub-Basin.
2. Obtain precise information on the location of radio-tagged chinook salmon in streams within the Upper Yukon River North Mainstem Canadian Sub-Basin.
3. Locate and document previously undocumented spawning areas within the Upper Yukon River North Mainstem Canadian Sub-Basin.
4. Gather information as it relates to the assessment of the relative distribution of radio-tagged chinook salmon within the Upper Yukon River North Mainstem Canadian Sub-Basin.
5. Provide data to the larger, more comprehensive study being carried-out concurrently by ADF&G, NMFS, and the Yukon River Panel R&E Fund.

Study Area

The Yukon River North Mainstem sub-basin is one of 8 sub-basins that, when combined, form the Canadian portion of the Yukon River drainage basin (Figure 1). The sub-basin is primarily located within the traditional lands of the Tr'ondek Hwech'in First Nation (Figure 2). Larger rivers that flow into the Yukon River in

the survey area include: the Klondike River; the Chandindu River (Twelvemile); the Fifteenmile River; Coal Creek; the Fortymile River; the Sixtymile River; the White River; the Stewart River; the McQuesten River; the Indian River; and, the upper Tatonduk River. Populations of spawning chinook have been documented in many of these streams (Cox et al. 1997).

The Upper Yukon River watershed in Canada drains 262,600 km². Annual mean flows measured by the United States Geological Service at Eagle Alaska are 2,387m³/s with an extreme peak discharge of 15,433m³/s (June 12, 1964) for the 53 years of record (USGS, 2004). The estimated average mid-channel depth is approximately 4.5m during high water, but is as deep as 20m (Cliff Creek) and as shallow as 1.8-2.5m in sections of the study area. Average channel width (for the purposes of navigation) is approximately 180m, but narrows to approximately 90m (Cliff Creek) and widens to approximately 360m in some areas. The Klondike River, a tributary to the Yukon River within the study area with a gauge station, has annual mean discharges averaging 64.3m³/s with instantaneous peak discharges of 702m³/s (June 1, 1998) and an average peak discharge of 412 m³/s, for the 39 years on record (Water Survey of Canada, 2004).

Background

Aquatic resources found in the study area include: Freshwater fish -- Arctic Lamprey, Inconnu, Lake Whitefish, Broad Whitefish, Least Cisco, Bering Cisco, Round Whitefish, Pygmy Whitefish, Arctic Grayling, Lake Trout, Dolly Varden/Bull Trout, Rainbow Trout, Northern Pike, Lake Chub, Longnose Sucker, Burbot, and Slimy Sculpin; Salmon species include -- Chum salmon, Chinook salmon and some evidence of Coho salmon in the Upper Yukon River (Al von Finster, pers. comm.). The use of aquatic resources includes native subsistence use of most freshwater species and all salmon species (as defined in Chapter 16 of the

Umbrella Final Agreement and individual First Nation Final Agreements) and commercial, domestic, and recreational use of salmon species.

Many streams with spawning populations of chinook salmon have been identified within the Tr'ondek Hwech'in traditional territory in archival and traditional knowledge studies (Cox, et al. 1997). As a result of these earlier studies, rivers of primary interest to the Tr'ondek Hwech'in (TH) First Nation and the Yukon River Commercial Fishing Association (YRCFA) for salmon restoration purposes include, but are not limited to, the Klondike River, the Chandindu River, the Fifteenmile River and Coal Creek. However, little is known regarding the distribution and abundance of these sub-populations of chinook salmon, as well as salmon resources from other streams in the area.

Assessments of salmon habitats and stocks within the TH Traditional Territory and the Yukon River North Mainstem Sub-Basin have been conducted by many organizations including: the Tr'ondek Hwech'in First Nation, the Government of Canada (DFO), consultants retained by various industries or natural resource agencies of government, the Yukon River Commercial Fishing Association, other non-governmental organizations, and by the Dawson District Renewable Resources Council (DDRRC).

Additional details regarding the basin-wide telemetry study, such as tagging sites and methodologies have been reported (Eiler 1995, Eiler and Holder 2000, Eiler et al. in prep.). Preliminary data from the 2003 basin-wide chinook radio tagging project is presently available (at time of writing), however a detailed report of findings is in progress.

METHODS AND MATERIALS

Prior to conducting aerial radio-telemetry surveys in the region, the project aircraft, a Citabria 150h.p. on floats (Photo 1), was retrofitted with two 4-element Yagi antennas and wired for the Advanced Telemetry Systems (ATS) 4500 receivers. A global positioning system (GPS) antenna was also fixed to the plane and utilized by the ATS receiver. Training flights were conducted in the area on July 31st and a workshop was held to orient surveyors. Antenna, mounts, ATS receivers and the GPS were tested on this flight using reference tags to ensure proper operation.

The project aircraft was supplied and flown by Donjek Upton on a volunteer basis. The light, 2-place aircraft has a gross weight of 1,750 lbs/794kgs and a maximum cruising airspeed of 115 miles/185km per hour. Brackets were constructed to hold the antennas on the plane's struts and were made from 90 degree steel angle brackets that were bolted together and held to the strut with 6-inch diameter stainless steel pipe clamps. The aluminum pipe was fastened perpendicular to each wing of the aircraft by bolting to the angle brackets and the antennas were mounted by inserting the stem of the antenna into the aluminum pipe and cross-bolting them through pre-drilled holes to maintain their connection. All connections were checked and all coaxial wire was fastened to the wing-struts with electrical tape. The antennas were mounted vertically for best reception through water (Photo 2).

Prior to conducting surveys, flight planning was conducted. It was determined that some flights such as the Chandindu and Fifteenmile surveys could be combined for efficiency, while other surveys like those on the Klondike River would be done on their own. Coordination with John Eiler took place to best determine the timing of the surveys. The initial surveys were conducted between August 1st and August 4th to correspond with the first general pulse of radio tagged fish crossing the border. The second round of surveys was conducted

between August 10th and the 14th, to correspond generally with a second pulse of radio-tagged fish crossing the border.

The ATS receivers were pre-programmed to scan 12 frequencies ranging from 150.684 MHz to 151.033 MHz for 2-second intervals and to record GPS waypoints each time the receivers locked on to individual pulse-coded radio tags. Many tags that were later identified as being captured in a fishery were recorded during the surveys, especially in the Dawson City area. Post-season data analysis included: sorting tags that were captured in a fishery vs. migrating; sorting individual radio tags per survey; and designating tags as Terminal to those with a final location within the survey area (final spawning locations).

It is important to note that the GPS waypoints recorded by the ATS receivers, once the units have detected an individual tag code, are the positions of the receiver and the aircraft, and not the exact position of the radio-tag. Tag locations (by survey) were determined by averaging the recorded latitudes and longitudes at the highest signal strength recorded (Appendix A). The points that are plotted (Figures 3 through 5) are the mean latitude and longitude coordinates of the aircraft while recording tag codes at the highest signal strength.

Although there is a possibility that radio tagged fish with positions recorded on the Yukon River Mainstem may be spawning or have died and were detected while drifting downstream, for the purposes of this study these fish were considered to be in transit. Radio tagged fish with their last known locations detected on the Klondike River, and the Chandindu River system were determined to be Terminal. The determination of "Terminal" (or radio tags with final migratory locations in presumed spawning areas) to "Non-Terminal" tags was done by determining individual tags by tag code and recording each of their last known positions.



Photo 1. Aircraft (Citabria) with antennas mounted on struts.



Photo 2. Refueling the project aircraft at the Dawson City float plane dock.

RESULTS AND DISCUSSION

Between July 31st and August 14th flights were performed on 10 days for a total of 32.25 hours spent in the aerial surveys (Table 1). Three flights were made on the Klondike system. All other rivers were surveyed twice: once earlier in run timing; and once later after peak migration had occurred. Survey timing was coordinated with tag migration information from the remote tracking stations (Eiler 1995, Yukon River Joint Technical Committee 2003). The Chandindu River, Fifteenmile River (both forks), Coal Creek (both forks), Fortymile River (including both forks on U.S. side of border), Sixtymile River, White River (from the mouth to approximately Eighteenmile Creek), Indian River, Swede Creek, Rock Creek and Flat Creek were surveyed (Table 2, Figures 3-5).

A total of 24 radio tagged fish were identified in terminal spawning areas within the survey area. These were individual radio tagged fish that were not removed by fisheries, were in the survey area and considered to be escapement. Of the 24 tags identified, 19 were located in the Klondike River system (5.1% of the total migrating tags in Canada) with 1 tag located in the North Klondike. Five radio tags were identified in the Chandindu River (1.3% of the total migrating tags in Canada). Other radio tags were located in the study area. The remaining tags identified were located on the mainstem Yukon River downstream of Thistle Creek and considered to be in-transit (migrating) through the survey area and not in terminal spawning areas.

In-season data was forwarded to John Eiler (NMFS) for incorporation into the larger basin-wide database. This information will be used in the determination of overall distribution of chinook salmon and in verifying data gathered from telemetry towers. Results from this study are not currently available (Eiler et al. in prep.).

It should be noted that, during the 2003 Radio Tag Recovery effort, water levels were much lower than average which may have contributed to the relative ease of distinguishing frequencies and tag codes encountered in the 2002 & 2003 field surveys (Figure 6).

Coordination with other similar projects being performed in 2003 was conducted. The ability to coordinate with people from Old Crow was considered to be valuable and contributed to the success of the 2003 project on rivers in the Porcupine system (Anderton 2003, in prep.). Pre-season preparations, training flights, retrofitting of project aircraft with antennas, and flight planning preparations were performed well. All preparations were conducted in consultation with John Eiler of the National Marine Fisheries Service, Clive Osborne of Haldane Environmental Services, and, Patrick Milligan of DFO. Their input and expertise contributed greatly to this project's success.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, a number of radio tags were located in the area during the surveys and much training occurred during the course of this project thanks to the involvement of John Eiler and Clive Osborne. The capacity for conducting this type of work in the area has greatly increased. Future telemetry studies will benefit from this training.

Although many of the radio tags were found on the Yukon River and were likely in transit, the Klondike River system (19, 5.1%) and the Chandindu River system (5, 1.3%) had fish with radio tags that were located in terminal spawning areas. This information will contribute to our understanding of the distribution of spawning chinook salmon on these rivers and within the study area.

The surveys conducted on the Fortymile River were much more thorough in 2003 and included the US sections of this river. Much organization went into these

flights as fuel had to be freighted overland to the mouth of the Fortymile River and arrangements had to be made with US Customs officials. Even given these conditions, it is recommended that provisions be made to survey the entire Fortymile River system should future tagging and surveying efforts be continued.

Surveys conducted on the White River were reduced in 2003 from those conducted in 2002 due to the presence of a stationary tower at the mouth of this river in 2003.

As the information gathered from 2002 and 2003 are from a limited period of study and interannual fluctuations in results would be expected, future work is desirable. If the Yukon River basin-wide study continues in 2004, it is highly recommended that surveys in the Tr'ondek Hwech'in traditional territory continue. The study of spawning areas within the Tr'ondek Hwech'in traditional territory would benefit from future work of this kind.

Finally, this study would benefit from a better in-season, locally based (Dawson City), system to collect radio-tags captured in fisheries. Having in-season data from these captured tags during the season would assist surveyors in testing equipment, tracking individual tags, and sorting out post-season data. A new system could include an education component that would have positive results in the overall management of the resource. The Dawson District Renewable Resources Council or the Tr'ondek Hwech'in are groups that could assist with a system to collect radio tags.

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APPENDICES

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| Appendix A | Summary of Radio-Telemetry Records |
|------------|------------------------------------|

Table 1 - Flight Log

| Date | Location/Flight Description | Pilot/Surveyor | Time | | Logbook Flight time | Comments: | Associated Telemetry File |
|-----------|---|----------------|----------|----------|------------------------|------------------------------|------------------------------|
| | | | START | Time END | | | |
| 31-Jul-03 | Klondike & North Klondike Rivers | Upton/Duncan | 11:50:00 | 13:55:00 | 2:05:00 | First Flight, test equipment | C073103JD.csv |
| 31-Jul-03 | Klondike & North Klondike Rivers | Upton/Bricker | 16:30:00 | 18:55:00 | 2:25:00 | First Flight, test equipment | C073103JB2.csv |
| 1-Aug-03 | Chandindu & Fifteenmile & Yukon | Upton/Bricker | 10:45:00 | 12:45:00 | 2:00:00 | Radio telemetry | C080103JB1.csv |
| 1-Aug-03 | Fifteenmile & Coal Creek & Yukon | Upton/Bricker | 14:15:00 | 16:00:00 | 1:45:00 | Radio telemetry | C080103JB2.csv |
| 2-Aug-03 | Sixtymile System | Upton/Bricker | 10:30:00 | 12:50:00 | 2:20:00 | Radio telemetry | C080203JB.csv |
| 3-Aug-03 | Yukon/Indian/White | Upton/Bricker | 10:25:00 | 13:35:00 | 3:10:00 | Radio telemetry | C080303JB1.csv |
| 4-Aug-03 | Klondike & North Klondike Rivers | Upton/Bricker | 15:00:00 | 17:00:00 | 2:00:00 | Radio telemetry | C080303JB2.csv |
| 10-Aug-03 | Yukon/Fifteenmile/Coal Creek | Upton/Bricker | 10:15:00 | 11:30:00 | 1:15:00 | Radio telemetry | C081003JB1.csv |
| 10-Aug-03 | Yukon/Chandindu | Upton/Bricker | 13:50:00 | 15:00:00 | 1:10:00 | Radio telemetry | C081003JB2.csv |
| 11-Aug-03 | Fortymile (South Fork) | Upton/Bricker | 11:25:00 | 13:25:00 | 2:00:00 | Radio telemetry | C081103JB1.csv |
| 11-Aug-03 | Fortymile (North Fork) | Upton/Bricker | 14:30:00 | 16:45:00 | 2:15:00 | Radio telemetry | C081103JB2.csv |
| 12-Aug-03 | Klondike & North Klondike | Upton/Bricker | 10:20:00 | 12:15:00 | 1:55:00 | Radio telemetry | C081203JB1.csv |
| 13-Aug-03 | Indian / White / Yukon (down to Dawson) | Upton/Bricker | 11:00:00 | 14:20:00 | 3:20:00 | Radio telemetry | C081303JB1.csv |
| 13-Aug-03 | Yukon (Alaska border up to Dawson) | Upton/Bricker | 15:45:00 | 18:00:00 | 2:15:00 | Radio telemetry | C081303JB2.csv |
| 14-Aug-03 | Sixtymile System | Upton/Bricker | 10:00:00 | 12:20:00 | 2:20:00 | Aborted survey (forest fire) | N/A |
| | | | | | 32:15:00 | | |

Table 2. 2003 Radio Telemetry Survey Waypoints

| 2003 TELEMETRY SURVEY POINTS | North | West |
|------------------------------------|-------------|---------------|
| CHANDINDU RIVER BOTTOM SURVEY | 64° 15.191' | -139° 42.895' |
| CHANDINDU RIVER TOP SURVEY | 64° 36.908' | -138° 57.081' |
| COAL CREEK BOTTOM SURVEY | 64° 28.739' | -140° 25.577' |
| COAL CREEK TOP SURVEY | 64° 36.796' | -139° 52.935' |
| DAWSON AIRPORT YDA | 64° 2.516' | -139° 7.864' |
| FIFTEENMILE RIVER BOTTOM SURVEY | 64° 17.037' | -139° 48.834' |
| FIFTEENMILE RIVER TOP SURVEY | 64° 37.679' | -139° 35.421' |
| FLAT CREEK BOTTOM SURVEY | 63° 56.768' | -138° 37.478' |
| FLAT CREEK TOP SURVEY | 63° 51.225' | -138° 9.499' |
| FORTYMILE RIVER BOTTOM SURVEY | 64° 25.588' | -140° 31.955' |
| FORYMILE RIVER TOP SURVEY (N.FORK) | 64° 04.585' | -141° 45.780' |
| FORYMILE RIVER TOP SURVEY (S.FORK) | 64° 30.151' | -142° 10.667' |
| INDIAN RIVER BOTTOM SURVEY | 63° 46.937' | -139° 43.665' |
| INDIAN RIVER TOP SURVEY | 63° 44.549' | -138° 31.625' |
| KLONDIKE BOTTOM SURVEY | 64° 2.167' | -139° 10.692' |
| KLONDIKE TOP SURVEY | 64° 4.78' | -137° 26.935' |
| N. KLONDIKE BOTTOM SURVEY | 63° 57.713' | -138° 41.531' |
| N. KLONDIKE TOP SURVEY | 64° 26.786' | -138° 13.585' |
| ROCK CREEK BOTTOM SURVEY | 64° 3.736' | -139° 5.466' |
| ROCK CREEK TOP SURVEY | 64° 13.219' | -138° 58.991' |
| SIXTYMILE BOTTOM SURVEY | 63° 33.83' | -139° 45.71' |
| SIXTYMILE TOP SURVEY | 64° 1.694' | -140° 21.796' |
| STEWART RIVER BOTTOM SURVEY | 63° 17.495' | -139° 24.968' |
| STEWART RIVER TOP SURVEY | 63° 10.855' | -138° 59.245' |
| SWEDE CREEK BOTTOM SURVEY | 64° 1.374' | -139° 33.995' |
| SWEDE CREEK TOP SURVEY | 64° 11.761' | -140° 13.768' |
| WHITE RIVER BOTTOM SURVEY | 63° 11.008' | -139° 35.774' |
| WHITE RIVER TOP SURVEY | 63° 12.236' | -140° 8.541' |
| YUKON RIVER BOTTOM SURVEY | 64° 40.907' | -141° 0.024' |
| YUKON RIVER TOP SURVEY | 63° 3.587' | -139° 30.714' |

Table 3. A Summary of Radio Tagged Fish by Frequency, Code, and River

| River System | Fishno | FREQ | CODE | AVG LAT | AVG LONG |
|----------------------|--------|------|------|-------------|--------------|
| Chandindu River | 231 | 982 | 400 | 64.29587733 | -139.2229174 |
| Chandindu River | 274 | 942 | 480 | 64.29405217 | -139.4291003 |
| Chandindu River | 408 | 922 | 700 | 64.30459087 | -139.1735074 |
| Chandindu River | 512 | 722 | 980 | 64.25839125 | -139.7144234 |
| Chandindu River | 683 | 702 | 350 | 64.29138411 | -139.518957 |
| Klondike River | 3 | 722 | 220 | 63.98831896 | -138.2535816 |
| Klondike River | 44 | 982 | 200 | 63.97805163 | -138.3940636 |
| Klondike River | 61 | 842 | 160 | 64.05612292 | -138.9098021 |
| Klondike River | 79 | 702 | 240 | 64.04892271 | -138.8712152 |
| Klondike River | 100 | 682 | 160 | 64.02624777 | -137.9526568 |
| Klondike River | 147 | 742 | 460 | 64.02237443 | -138.038358 |
| Klondike River | 164 | 942 | 420 | 63.97201361 | -138.4316964 |
| Klondike River | 176 | 982 | 430 | 63.97157693 | -138.4164352 |
| Klondike River | 190 | 722 | 420 | 63.95997549 | -138.5659418 |
| Klondike River | 209 | 982 | 480 | 64.02076313 | -138.873435 |
| Klondike River | 237 | 842 | 470 | 63.97770129 | -138.3944372 |
| Klondike River | 242 | 982 | 420 | 64.02050648 | -137.8021235 |
| Klondike River | 258 | 782 | 390 | 63.97326056 | -138.4145034 |
| Klondike River | 299 | 702 | 670 | 64.05241114 | -138.8896846 |
| Klondike River | 318 | 942 | 650 | 63.98526168 | -138.289642 |
| Klondike River | 405 | 842 | 670 | 63.9597941 | -138.6785501 |
| Klondike River | 645 | 902 | 0 | 63.9629846 | -138.6421415 |
| Klondike River | 651 | 722 | 60 | 64.06265003 | -139.0027567 |
| North Klondike River | 273 | 922 | 370 | 64.12114205 | -138.518829 |

Table 4. Summary of Terminal Radio Tagged fish to Total Radio Tagged Fish in Migration and Percentages

| | 2002 | | 2003 | |
|--|------|--------|------|--------|
| | # | % | # | % |
| Radio Tags in migration on the Yukon River, Canada (crossing CAN/US border - not captured in fishery): | 181 | 100.0% | 371 | 100.0% |
| Radio tagged fish recovered in the Klondike River system | 6 | 3.3% | 19 | 5.1% |
| Radio tagged fish recovered in the Chandindu River system | 1 | 0.6% | 5 | 1.3% |
| Radio tagged fish recovered in Coal Creek system | 1 | 0.6% | 0 | 0.0% |
| Total radio tagged fish recovered in area: | 8 | 4.4% | 24 | 6.5% |
| Radio tagged fish remaining in migration on the Yukon River, Canada: | 173 | 95.6% | 347 | 93.5% |

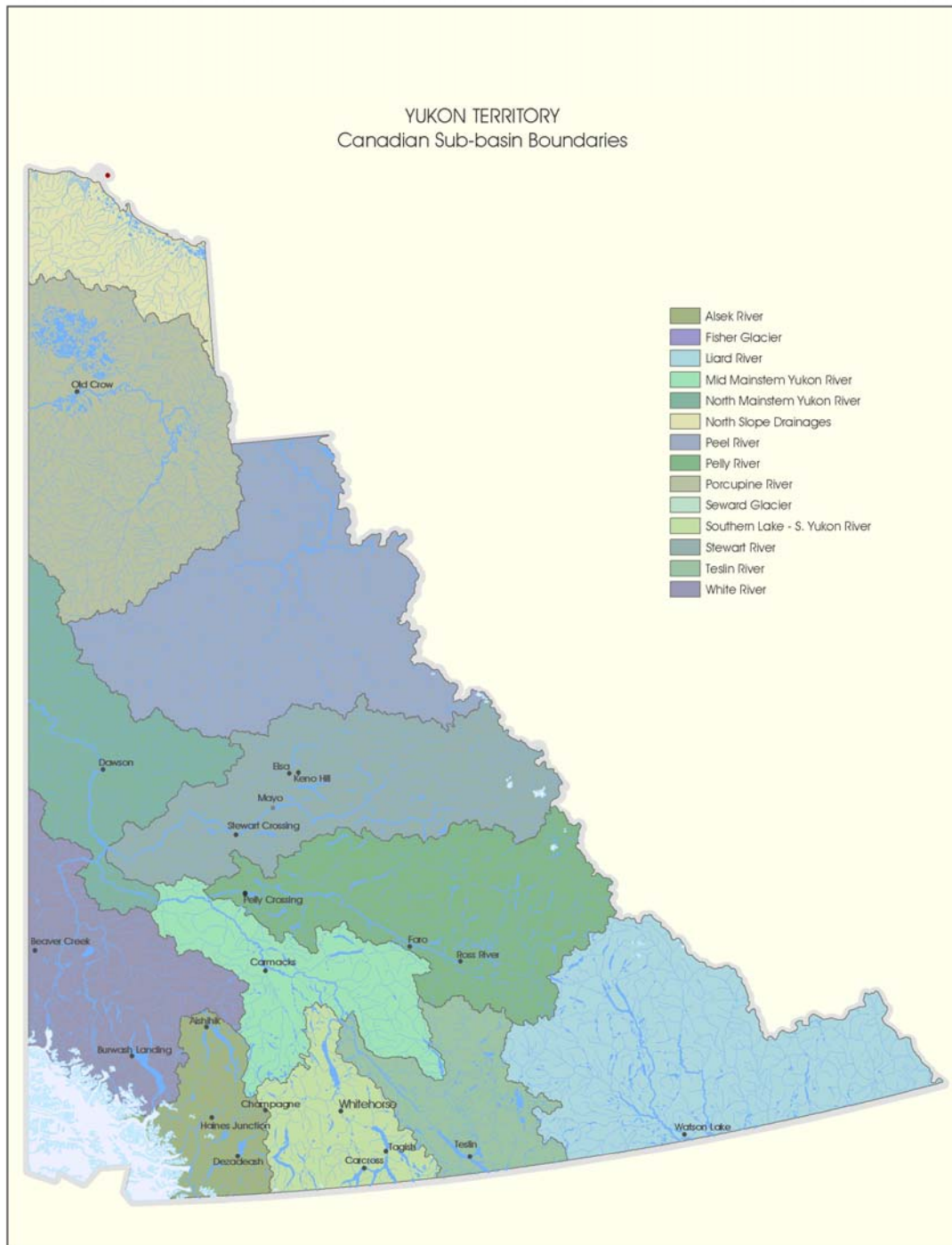


Figure 1. Map of Canadian Sub-basin boundaries



Figure 2. Map of Yukon First Nation Traditional Territories

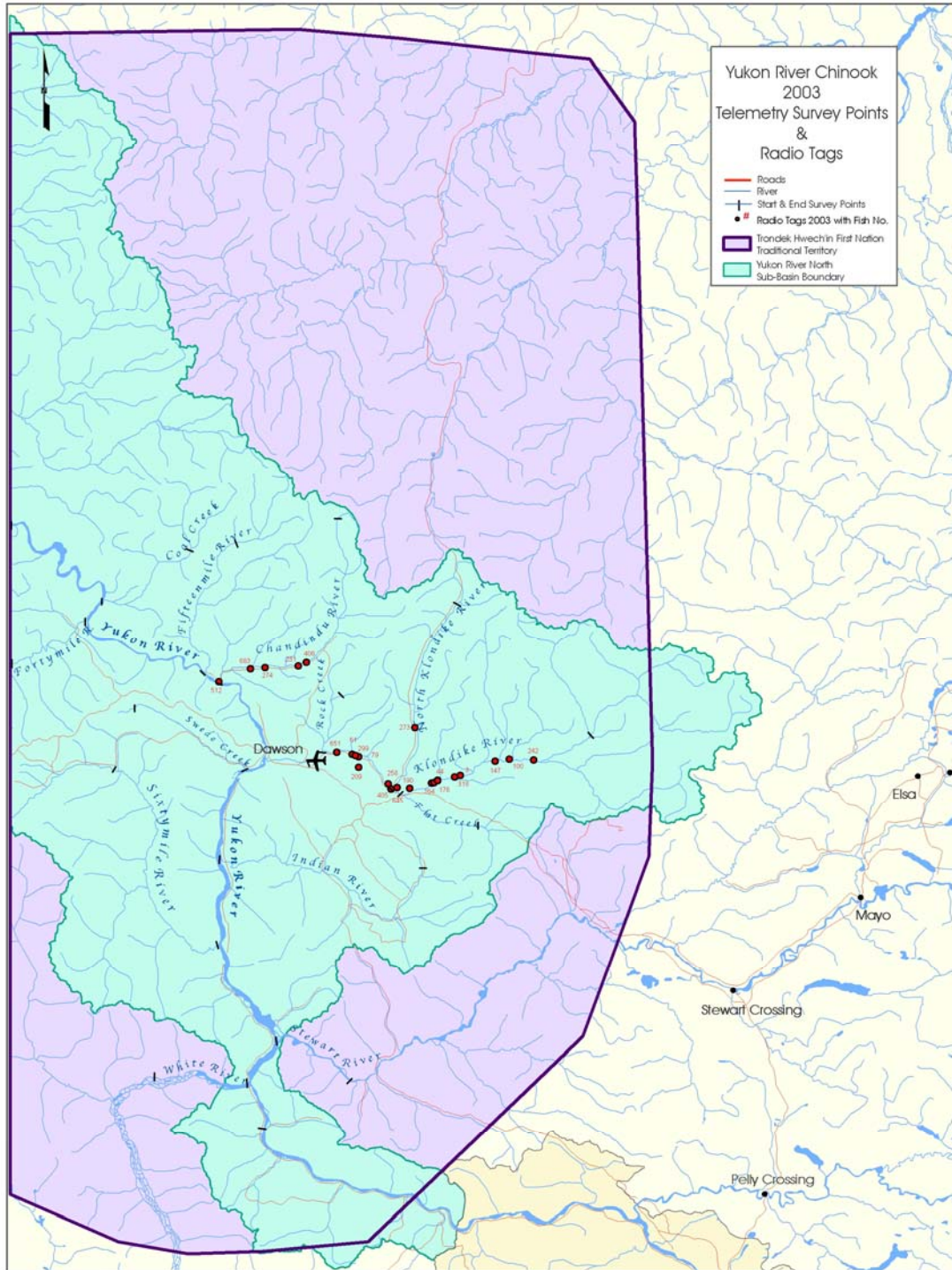


Figure 3. Map of the Yukon River North Mainstem Sub-basin, the Tr'ondek Hwech'in Traditional Territory and 2003 Radio Telemetry Survey Points

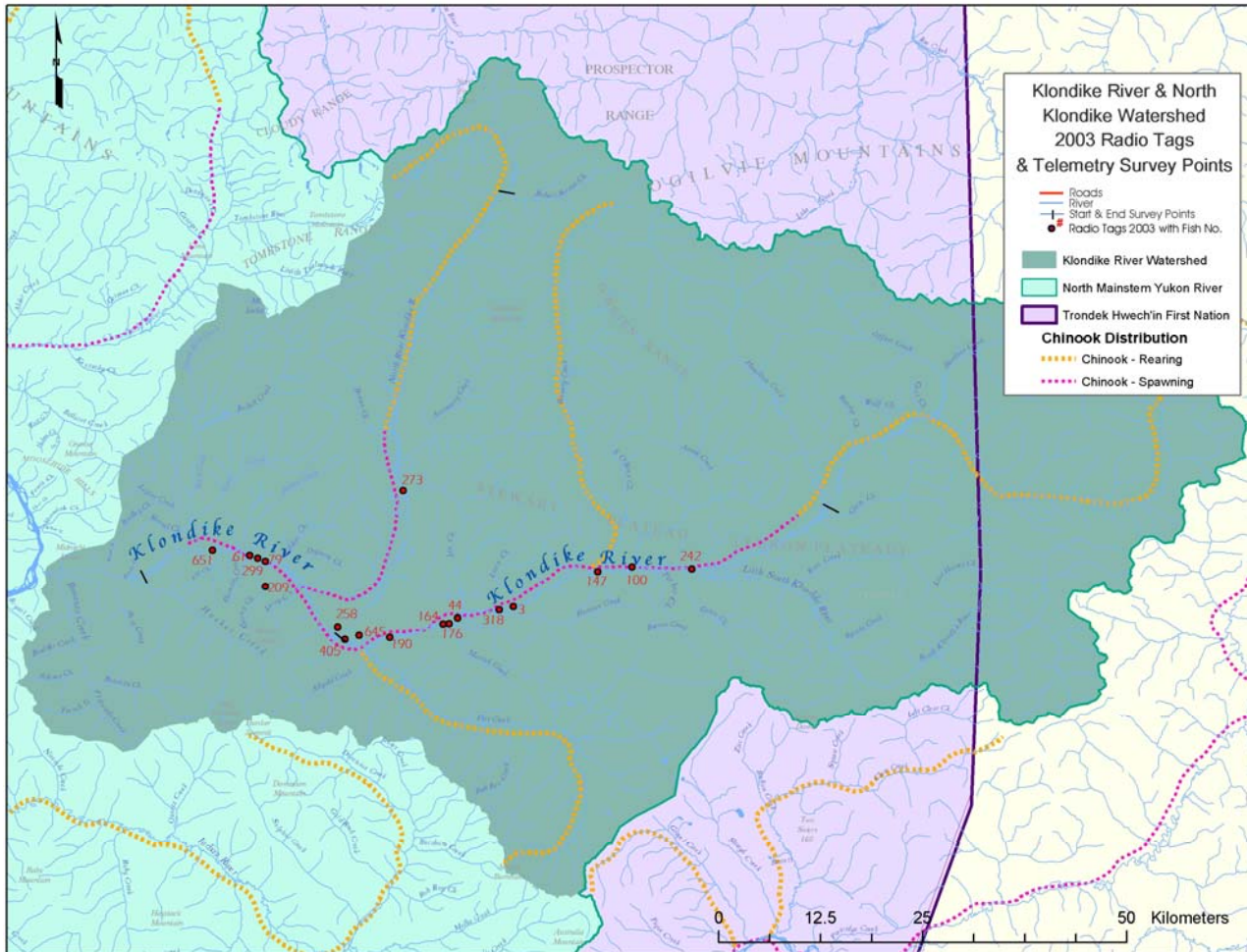


Figure 4. Map of the Klondike River Watershed, with 2003 Radio Telemetry Survey Points

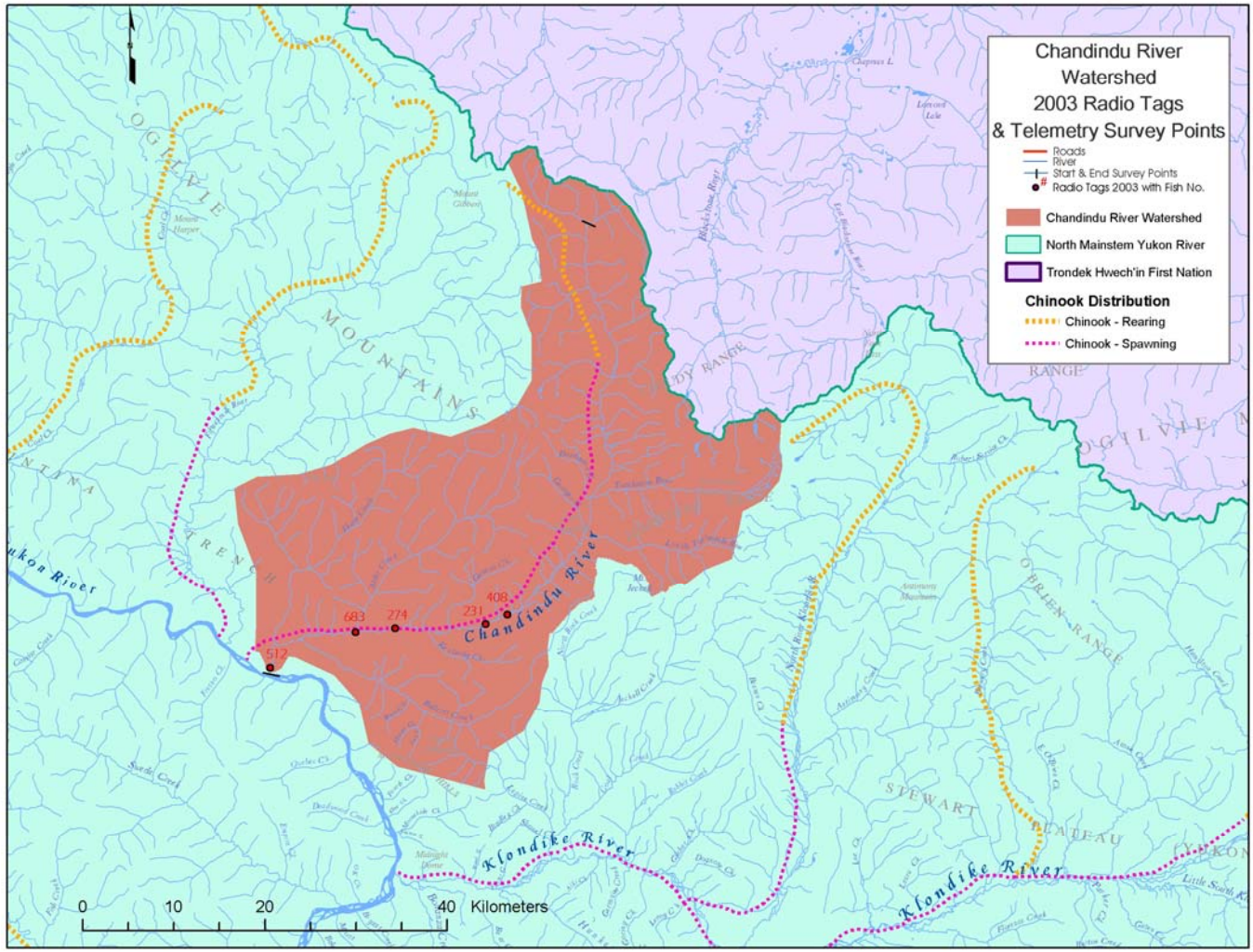


Figure 5. Map of the Chandindu River Watershed, with 2003 Radio Telemetry Survey Points.

Figure 6. Yukon River Flows (m³/s), USGS 15356000 at Eagle AK

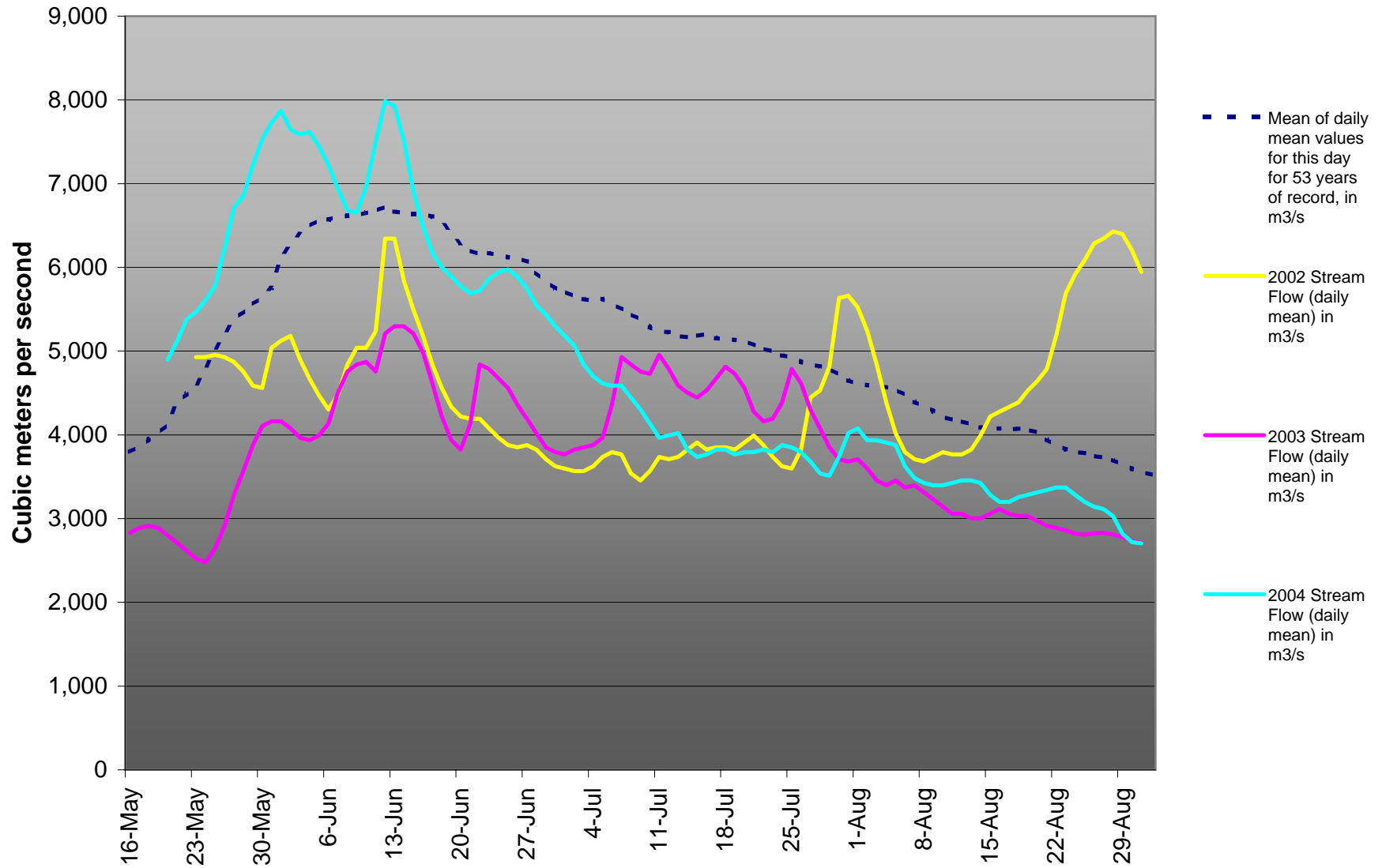
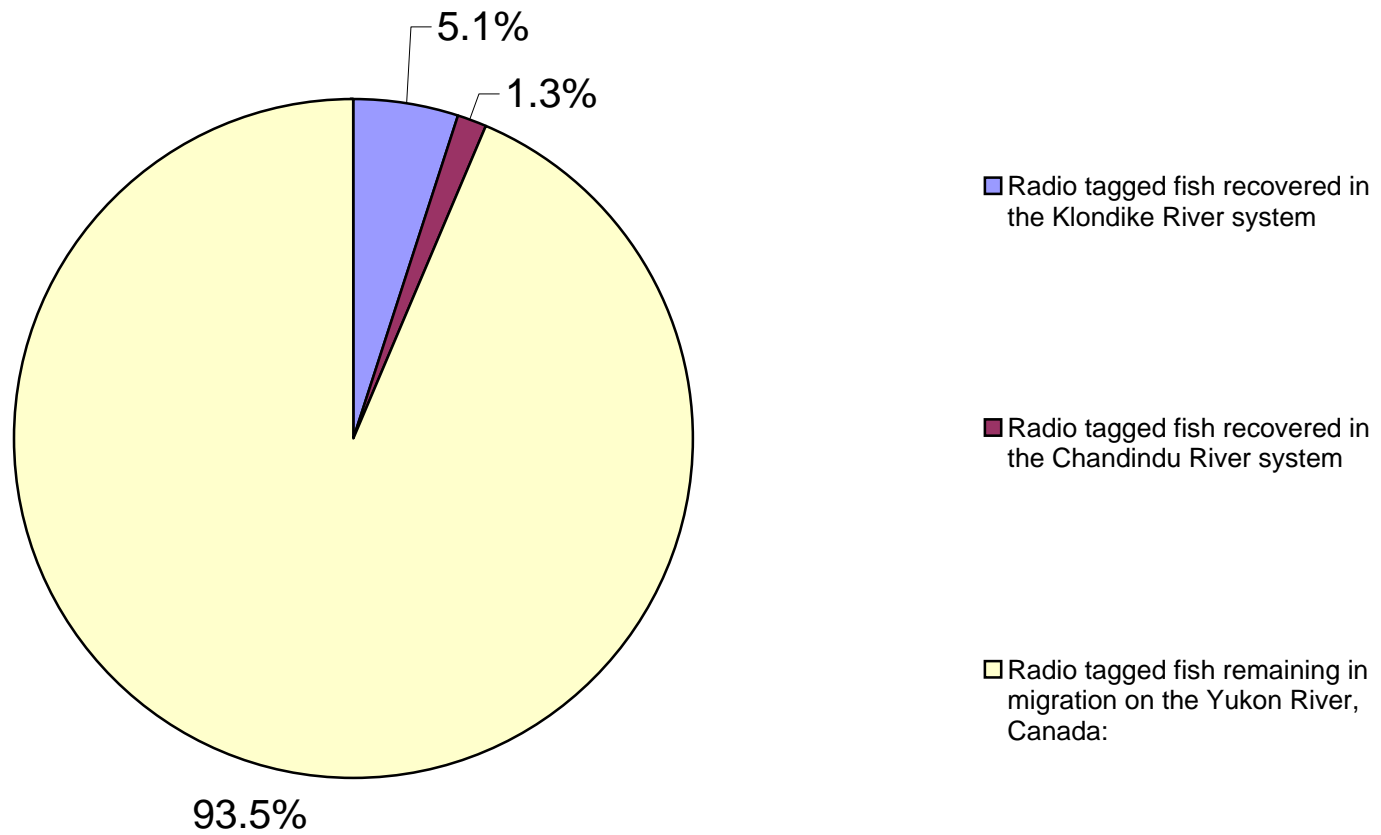


Figure 7. Comparison of terminal radio tag recoveries in the Tr'ondek Hwech'in traditional territory to the total number of radio tags migrating on the Yukon River in Canada



APPENDIX A

| DATE | FLIGHT_ID | RIVER_SYSTEM | FREQ | CODE | SIG_STR | LAT | LONG | COMMENTS |
|-----------|---------------|-----------------|------|------|---------|----------|-----------|----------|
| 7/31/2003 | KLONDIKE1 | Klondike R. | 682 | 16 | 112 | 64.02451 | -137.9149 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 702 | 24 | 103 | 64.04745 | -138.8614 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 702 | 65 | 94 | 64.06482 | -139.4358 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 702 | 67 | 91 | 64.04737 | -138.8579 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 722 | 60 | 87 | 64.06235 | -138.9547 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 722 | 22 | 85 | 63.99104 | -138.2238 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 722 | 42 | 87 | 63.96307 | -138.5199 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 742 | 46 | 89 | 64.02287 | -137.9943 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 782 | 39 | 95 | 63.98561 | -138.3109 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 842 | 16 | 93 | 64.06164 | -138.9358 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 842 | 47 | 92 | 63.98047 | -138.3894 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 842 | 67 | 74 | 63.95176 | -138.6516 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 902 | 00 | 93 | 63.96155 | -138.5771 | |
| 7/31/2003 | KLONDIKE1 | N. Klondike R. | 922 | 37 | 83 | 64.12372 | -138.52 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 942 | 65 | 98 | 63.98748 | -138.267 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 982 | 14 | 85 | 64.04874 | -139.4551 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 982 | 20 | 63 | 63.97329 | -138.4084 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 982 | 43 | 94 | 63.97077 | -138.4164 | |
| 7/31/2003 | KLONDIKE1 | Klondike R. | 1183 | 12 | 133 | 64.06422 | -139.4347 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 682 | 16 | 112 | 64.02826 | -137.9718 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 682 | 16 | 112 | 64.03218 | -137.9902 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 682 | 16 | 112 | 64.03194 | -137.9863 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 702 | 24 | 99 | 64.05039 | -138.8811 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 702 | 65 | 81 | 64.06693 | -139.4299 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 702 | 67 | 110 | 64.04489 | -138.8456 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 722 | 60 | 60 | 64.06295 | -138.9523 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 722 | 22 | 97 | 63.98717 | -138.268 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 722 | 22 | 91 | 63.98727 | -138.2673 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 722 | 22 | 95 | 63.98686 | -138.2709 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 722 | 42 | 92 | 63.96052 | -138.5466 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 742 | 46 | 74 | 64.02381 | -138.0286 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 842 | 16 | 101 | 64.05463 | -138.9002 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 842 | 47 | 94 | 63.97281 | -138.4077 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 842 | 67 | 85 | 63.96301 | -138.6719 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 902 | 00 | 81 | 63.95213 | -138.6102 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 922 | 37 | 110 | 64.11781 | -138.5145 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 942 | 42 | 95 | 63.97718 | -138.3948 | |
| 7/31/2003 | KLONDIKE2 | N. Klondike R. | 942 | 65 | 113 | 63.98523 | -138.287 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 20 | 92 | 63.98133 | -138.3865 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 20 | 92 | 63.98182 | -138.3847 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 20 | 92 | 63.98182 | -138.3847 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 42 | 122 | 64.01778 | -137.7829 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 43 | 91 | 63.96805 | -138.4292 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 982 | 48 | 88 | 63.98959 | -138.2357 | |
| 7/31/2003 | KLONDIKE2 | Klondike R. | 1183 | 12 | 110 | 64.06423 | -139.4346 | TEST |
| 8/1/2003 | CHANDINDU1 | Chandindu River | 702 | 35 | 111 | 64.29136 | -139.5021 | |
| 8/1/2003 | CHANDINDU1 | Chandindu River | 922 | 70 | 118 | 64.30589 | -139.1648 | |
| 8/1/2003 | CHANDINDU1 | Chandindu River | 942 | 48 | 124 | 64.29556 | -139.3955 | |
| 8/1/2003 | CHANDINDU1 | Chandindu River | 982 | 40 | 115 | 64.29322 | -139.2399 | |
| 8/2/2003 | 60MILE/SWEDE1 | Sweed Cr. | 702 | 24 | 121 | 64.04941 | -139.4535 | Yukon R. |
| 8/2/2003 | 60MILE/SWEDE1 | Sweed Cr. | 702 | 65 | 125 | | | Yukon R. |
| 8/2/2003 | 60MILE/SWEDE1 | Sweed Cr. | 982 | 14 | 120 | 64.04225 | -139.4525 | Yukon R. |
| 8/2/2003 | 60MILE/SWEDE1 | Sweed Cr. | 982 | 32 | 120 | 64.04265 | -139.4526 | Yukon R. |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 682 | 16 | 124 | 64.02136 | -137.8939 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 682 | 16 | 104 | 64.01953 | -138.1055 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 682 | 16 | 130 | 64.02405 | -137.9766 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 702 | 67 | 116 | 64.05358 | -138.8994 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 722 | 60 | 98 | 64.06421 | -138.997 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 722 | 22 | 114 | 63.98614 | -138.2751 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 722 | 42 | 86 | 63.95371 | -138.6629 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 742 | 46 | 110 | 64.02045 | -138.0922 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 782 | 39 | 119 | 63.96118 | -138.538 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 782 | 39 | 91 | 63.96 | -138.6869 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 782 | 39 | 123 | 63.9646 | -138.4935 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 16 | 94 | 64.06138 | -139.0266 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 16 | 94 | 64.0615 | -139.0259 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 16 | 96 | 64.04968 | -138.8837 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 47 | 123 | 63.97951 | -138.3829 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 47 | 123 | 63.97959 | -138.3825 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 47 | 123 | 63.97936 | -138.3836 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 842 | 67 | 113 | 63.96186 | -138.6924 | |

APPENDIX A

| DATE | FLIGHT_ID | RIVER_SYSTEM | FREQ | CODE | SIG_STR | LAT | LONG | COMMENTS |
|-----------|------------|----------------|------|------|---------|----------|-----------|----------|
| 8/3/2003 | KLONDIKE3 | Klondike R. | 902 | 00 | 101 | 63.95221 | -138.6365 | |
| 8/3/2003 | KLONDIKE3 | N. Klondike R. | 922 | 37 | 115 | 64.12458 | -138.5204 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 942 | 42 | 101 | 63.97086 | -138.4311 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 942 | 65 | 124 | 63.98777 | -138.2595 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 942 | 65 | 124 | 63.98774 | -138.2599 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 942 | 65 | 136 | 63.98395 | -138.3029 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 20 | 110 | 63.97284 | -138.418 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 20 | 110 | 63.97328 | -138.4153 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 20 | 110 | 63.9741 | -138.4104 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 42 | 129 | 64.02096 | -137.8017 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 43 | 106 | 63.97424 | -138.4095 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 43 | 106 | 63.97457 | -138.4076 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 43 | 105 | 63.97406 | -138.4107 | |
| 8/3/2003 | KLONDIKE3 | Klondike R. | 982 | 48 | 109 | 64.03528 | -139.2012 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 702 | 35 | 130 | 64.29141 | -139.5358 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 722 | 98 | 112 | 64.25839 | -139.7144 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 742 | 50 | 82 | | | Yukon R. |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 922 | 70 | 132 | 64.30322 | -139.1825 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 922 | 70 | 132 | 64.30323 | -139.1825 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 922 | 70 | 132 | 64.3035 | -139.1811 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 942 | 48 | 133 | 64.29254 | -139.4627 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 982 | 40 | 123 | 64.29857 | -139.2057 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 982 | 40 | 115 | 64.29123 | -139.3119 | |
| 8/10/2003 | CHANDINDU2 | Chandindu R | 982 | 40 | 123 | 64.2984 | -139.2067 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 682 | 16 | 134 | 64.0251 | -137.9369 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 682 | 16 | 134 | 64.02514 | -137.9347 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 682 | 16 | 134 | 64.02507 | -137.9338 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 65 | 88 | 64.04937 | -139.4313 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 67 | 102 | 64.0638 | -138.9559 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 722 | 60 | 119 | 64.06111 | -139.1067 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 60 | 119 | 64.06116 | -139.1061 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 60 | 119 | 64.06108 | -139.1071 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 22 | 131 | 63.98887 | -138.2477 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 22 | 131 | 63.98892 | -138.2459 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 22 | 131 | 63.98887 | -138.2491 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 42 | 92 | 63.95449 | -138.6449 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 42 | 92 | 63.95864 | -138.5935 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 702 | 42 | 123 | 63.9626 | -138.5343 | |
| 8/12/2003 | KLONDIKE4 | N. Klondike R. | 782 | 39 | 113 | 63.96346 | -138.5257 | |
| 8/12/2003 | KLONDIKE4 | N. Klondike R. | 782 | 39 | 113 | 63.96351 | -138.5251 | |
| 8/12/2003 | KLONDIKE4 | N. Klondike R. | 782 | 39 | 125 | 63.96958 | -138.4391 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 16 | 97 | 64.06466 | -138.9826 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 16 | 87 | 64.06388 | -139.0108 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 16 | 117 | 64.05855 | -138.9194 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 47 | 134 | 63.97806 | -138.3975 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 67 | 129 | 63.96244 | -138.6979 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 67 | 123 | 63.96343 | -138.6918 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 842 | 67 | 129 | 63.96261 | -138.6985 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 902 | 00 | 99 | 63.98604 | -138.7448 | |
| 8/12/2003 | KLONDIKE4 | N. Klondike R. | 922 | 37 | 120 | 64.11846 | -138.5204 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 42 | 120 | 63.97151 | -138.417 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 42 | 114 | 63.96053 | -138.5581 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 42 | 136 | 63.968 | -138.4692 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 65 | 131 | 63.98439 | -138.3017 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 65 | 127 | 63.98442 | -138.3045 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 942 | 65 | 121 | 63.98485 | -138.3078 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 14 | 90 | 64.05259 | -139.4385 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 20 | 123 | 63.98269 | -138.372 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 42 | 131 | 64.02298 | -137.8247 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 42 | 132 | 64.02278 | -137.8217 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 42 | 129 | 64.02306 | -137.8262 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 43 | 95 | 63.97318 | -138.4111 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 43 | 95 | 63.97357 | -138.4099 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 43 | 95 | 63.97262 | -138.4129 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 48 | 121 | 64.03742 | -139.1834 | |
| 8/12/2003 | KLONDIKE4 | Klondike R. | 982 | 48 | 94 | 64.03982 | -139.159 | |