An Evaluation of Fall Chum Salmon Mark Rates Upriver of the Rampart Mark-Recapture Tagging Site, Yukon River, Alaska, 2003

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by

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Abstract

U. S. Fish and Wildlife Service biologists associated with a fall chum salmon (*Oncorhynchus keta*) mark-recapture study conducted annually near Rampart, Alaska have been aware of observations of unexpectedly low mark rates at upriver locations since the project's inception in 1996. Although a variety of factors could potentially contribute to the apparent reduction in mark rates, an elevated mortality rate caused by one or more aspects of capturing and processing fish appears to be most consistent with all the available information. However, data regarding some potential causative factors were either limited or unavailable. Data on the mark rates of fish in the Chandalar and Sheenjek rivers, both of which are important fall chum salmon systems, were only available in one prior year, so additional data were collected from both tributaries in 2003. Weather precluded sampling within the Black River. Data on mark rates from catches in the Fishing Branch River and fish wheels on the mainstem Yukon River near the international border in Canada were provided by the Department of Fisheries and Oceans Canada, as in past years. Mark rates observed in the Chandalar, Sheenjek, and Fishing Branch rivers and the mainstem Yukon River in Canada did not differ significantly. However, the mark rate of the pooled data from these four locations was significantly different than the mark rate observed at the mark-recapture recapture site on the Yukon River main stem near Rampart, Alaska. In addition, for the first time, gill nets were drifted offshore of the fish wheel at the recapture site to test the hypothesis that mark rates observed in the fish wheel and gill net catches were equal; the observed mark rates did not differ significantly. These results lend additional credence to prior assertions that differential capture probabilities among fish from various upriver spawning locations and violations of mixing assumptions of the mark-recapture abundance estimator are unlikely to have caused the reduced mark rates observed in upriver locations. A delayed and progressive mortality upriver of the study area remains the single potential cause most consistent with the available information. However, existing data are not definitive and the exploration of innovative approaches for investigating the declining mark rates is warranted.

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Introduction

The U. S. Fish and Wildlife Service (USFWS) has conducted a mark-recapture study to estimate the abundance of migrating adult fall chum salmon in the middle and upper portions of the Yukon River drainage annually since 1996 (Gordon et al. 1998). Fish are marked in two fish wheels located approximately 50 km upriver of the Tanana River confluence and recaptured in a single fish wheel 52 km upriver from the marking site near Rampart, Alaska (Figure 1). In 1996, biologists associated with the Rampart mark-recapture project became aware that mark rates, i.e., the proportion of captured fish that have been marked, at upriver locations were lower than mark rates observed at the project's recapture site (Underwood et al. 2000). This observation led to the initiation of varied attempts to identify the cause of the reduced mark rates.

Underwood et al. (2000) developed a fairly complete enumeration of potential causes for the reduced mark rates. In 1996, they found that tag loss was essentially absent in the mainstem Yukon River and fish caught more than once in the mark-recapture fish wheels had a reduced probability of recapture in locations upriver from the study area. They suggest that increased mortality might be the cause and recommend that the plausibility of other potential causes be evaluated. Underwood et al. (2002; 2004b) obtained similar results with data collected in 1997 and 1998. A small-scale pathology study conducted in 1998 was largely uninformative (Burek and Underwood 2002). Project operations evolved continuously, with a primary goal being to reduce negative effects of capturing and handling fish (e.g., Underwood and Bromaghin 2003).

A study to investigate the relationship between measures of how fish were captured and handled at the marking site and both travel time and probability of recapture was conducted in 2001 and 2002 (Bromaghin and Underwood 2003; 2004). The length of time fish were held in a live box was positively related to the travel time between the marking and recapture sites and the probability of recapture at both locations. Increased holding time was associated with a reduced probability of recapture upriver from the study area in 2001 (Bromaghin and Underwood 2003), but that finding was not repeated in 2002 (Bromaghin and Underwood 2004). In addition, digital photographs taken in 2002 provided further documentation that tag loss in the mainstem Yukon River was minimal or absent (Bromaghin and Underwood 2004). Overall, Bromaghin and Underwood (2003; 2004) concluded that holding fish in a live box negatively affected their ability to migrate for at least some portion of time, but they were unable to fully explain the reduced mark rates observed at upriver locations.

In 2003, two specific recommendations for additional data collection made by Bromaghin and Underwood (2004) were implemented. One possible cause for reduced mark rates at upriver locations is that the various fall chum salmon populations have unequal probabilities of capture at the marking site. If this situation existed, one or more populations would have a mark rate approximately equal to or somewhat greater than that observed at the Rampart recapture site. While an increased mark rate has not been observed in prior years (Underwood et al. 2004b), Bromaghin and Underwood (2004) note that data from two important tributaries, the Chandalar and Sheenjek rivers, are only

available from one year, and they recommended that additional data be collected from those systems. In 2003, mark rates observed in the Chandalar and Sheenjek rivers and at two research facilities operated by Fisheries and Oceans Canada were compared to mark rates obtained at the Rampart recapture site. In addition, a potential cause of reduced mark rates that has not been investigated is spatial segregation of fish on and off shore within the mark-recapture study area (Bromaghin and Underwood 2004). In 2003, gill nets were drifted offshore of the Rampart recapture fish wheel and the mark rates observed in the gill net and fish wheel catches were used to test the hypothesis that mark rates in the two locations were equal.

Methods

Mark-Recapture Study

A brief summary of the methods used in the mark-recapture study follows; more detail is provided by Apodaca et al. (2004). Two fish wheels, one on each bank of the river, were used to capture fish at the marking site (Figure 1). Captured fall chum salmon were caught in a dip net as they slid down the chute of the fish wheel and placed into a water-filled neoprene cradle. The sex of captured fish was determined from external morphological characteristics and length from mid-eye to fork-of-tail was measured to the nearest 1 cm. Fish judged to be uninjured were tagged with an individually numbered spaghetti tag, their adipose fin was clipped as a secondary mark, and they were released back into the river. In addition to being numbered, spaghetti tags were color-coded to signify the statistical week in which they were tagged. Fish were tagged during four sessions each day, except Sundays when no fish were tagged.

A single fish wheel was operated on the right bank of the river at the recapture site near Rampart, Alaska (Figure 1). The recapture fish wheel was equipped with a video system that stored images of fish as they slid down the chute; each video image included a date and time stamp. The crew at the recapture site downloaded images three times each day and tallied the number of fish that were unmarked and marked with each color of tag. Tag numbers of recaptured fish were not determined at the recapture site.

Gill Net Sampling

Drift gill nets were fished offshore of the recapture fish wheel near Rampart, Alaska during three, five-day time periods that corresponded to the early, middle, and late portions of the fall chum salmon migration in the area: August 7-11, August 25-29, and September 9-13. Gill nets were 45.7 m long and hung with 15 Momoi MMT netting with depths of 5.5, 6.7, and 7.9 m. The stretch-mesh size of all nets was 14.5 cm. A local fisherman was contracted to operate the boat and to provide one deck hand, and the USFWS supplied two technicians.

Gill nets were drifted in waters offshore of and adjacent to the fish wheel. Markers were placed on the shore approximately 0.5 km upriver and downriver of the fish wheel to designate the starting and stopping points of drifts, so that the fish wheel was passed at the approximate midpoint of each drift. Depth soundings were taken initially to determine the distance from the shore to start drifts so that water depth was approximately equivalent to net depth. Consistency in the starting point was maintained using sightings of the upriver marker and existing natural landmarks. When the starting point was reached, the float line buoy and lead line were deployed and the boat was backed away from the deployed buoy towards the far river bank and a little upstream. A float was also attached to the offshore end of the net. The net was sometimes stretched or straightened during a drift, but was allowed to hang without tension as much as possible. Retrieval of the net began when the downriver marker was reached. Four times were recorded during each set: 1) start of net deployment; 2) end of net deployment; 3) start of net retrieval; and 4) end of net retrieval. The clocks used for recording time were synchronized with the internal computer clock used to place a time and date stamp on video images at the fish wheel, so that fish wheel and gill net catches could be temporally paired. Water depths in the area fished ranged from approximately 5 to 11 m. Portions of the net often dragged on the bottom, especially at the starting and ending points.

During net retrieval, three crew members pulled the net and one person processed fish. The sex of captured fall chum salmon was assigned based on external morphological characteristics and length from mid-eye to fork-of-tail was measured to the nearest 1 cm. Fish were checked for the presence of both primary and secondary marks, and the tag number of all primary marks was recorded.

The times that net deployment was started and net retrieval was completed were used to identify the subset of the video images that were stored during each drift using the time stamp on the video images. This allowed gill net and fish wheel catches to be closely matched in time. The total number of fish and the number of marked fish captured were enumerated for each gill net drift and for the fish wheel during the time the net was fished.

Tributary Sampling

The objective of tributary sampling was to estimate the proportion of fall chum salmon in the Chandalar, Sheenjek, and Black rivers that had been marked. Sampling efforts were based out of Ft. Yukon, Alaska because of its proximity to these systems. Early and late season sampling trips were scheduled using documented run timing information (Osborne and Melagari 2002; Barton 2002). Spawning areas were accessed using a boat and a chartered helicopter during the early and late sampling periods, respectively. Aerial surveys were conducted along the river corridor at approximately 90 to 240 m above ground level until a sufficient number of carcasses were encountered. Sampling was conducted in areas with the greatest density of carcasses to maximize sampling efficiency.

Sampling was conducted along the shoreline and in water depths that could be waded, and a telescoping barbed gig was used to access fall chum salmon for examination. Each fish sampled was examined for the presence of both primary and secondary marks. A fish with no spaghetti tag and no adipose fin was further inspected to determine if there was an original tag attachment site located at the posterior end and approximately 0.60 cm below the dorsal fin attachment. Hand counters were used to record the numbers of marked and unmarked fall chum salmon sampled, which were used to estimate the mark rate. The date, latitude and longitude where the helicopter landed, start and stop time of sampling at each location, and sex of marked chum salmon were also recorded. In addition, the numbers of fall chum salmon whose tagged status could not be determined with certainty and observations of live tagged fish were noted. Whenever possible, spaghetti tags were collected and the tag number and color were recorded.

Data Analysis

The hypothesis that mark rates in the gill net and fish wheel catches were equal was tested using an exact Cochran-Mantel-Haenszel test (CMH; Agresti 2002) as implemented in version 6.1 of StatXact (Cytel 2003). This test allows mark rates to vary between levels of a stratification variable, but is sensitive to consistent patterns between the experimental variables, capture method and tagged status in this case. The three time periods during which data were collected formed a three-level stratification variable for this test. Monte Carlo methods (Manly 1997), with 100,000 replications, were used to estimate the significance of the test.

The equality of mark rates between locations and between sampling occasions at a single location was evaluated using an exact binomial test, as implemented in version 6.1 of StatXact (Cytel 2003). A likelihood ratio test statistic (Agresti 2002) was used for each test, and significance was estimated using Monte Carlo methods (Manly 1997) with 100,000 replications. Mark rates were compared among the four upriver locations, as well as between the Rampart recapture site and upriver locations.

Because mark rates at the Rampart recapture site typically vary through time (e.g., Apodaca et al. 2004), differences in mark rates among upriver locations could be due to differences in run timing through the mark-recapture study area. For each upriver location, the date of tagging was determined for each marked fish whose tag number could be determined and whose data was included in the computation of a mark rate. The resultant data set was used to test the hypothesis that the distributions of tagging dates were equal for all upriver locations using an exact Smirnov test (Conover 1999). The test was conducted using custom, in-house software using the test statistic implemented in SAS Stat version 8.2 (SAS 1999), i.e.,

$$K = \max_j \sqrt{\frac{1}{n}\sum_i n_i\left(F_i\left(x_j\right) - F\left(x_j\right)\right)^2},$$

where

n_i = the number of observations from the ith location,
n = the total number of observations,
F_i = the empirical distribution of observations from the ith location, and
F = the empirical distribution of all observations pooled into a single sample.

The significance of the test was estimated using Monte Carlo techniques (Manly 1997) and 100,000 replications.

Results

Mark-Recapture Study

Catches of fall chum salmon at the Rampart recapture fish wheel are summarized from Apodaca et al. (2004) in Table 1. Stratum catches ranged from 1,094 to 9,635, with a season total of 34,769. Mark rate estimates ranged from 0.0085 to 0.0174, with an overall mark rate for the season of 0.0121. Mark rates among strata were significantly different (TS = 32.9297, df = 7, $p < 0.0001$).

Comparison of Gill Net and Fish Wheel Mark Rates

Gill net catches and fish wheel catches during the subset of time the gill nets were drifted are summarized in Table 2. Only the nets with depths of 6.7 and 7.9 m were actually fished because of the water depth at the site. Fish wheel catches were 122, 319, and 900 fall chum salmon in the 3 sampling periods, while corresponding gill net catches were 105, 366, and 402 fish. Mark rates in the two gears were nearly identical. The CMH test of mark rate equality was not significant (TS = 0.0011, df = 1, $p > 0.9999$).

Upriver Mark Rates

Observations of fall chum salmon at the upriver sites are summarized in Table 3. In the Chandalar River, sampling conducted from 26 August to 2 October resulted in the examination of 486 fall chum salmon carcasses, one of which had a secondary mark. On 10 October, 3,195 fall chum salmon carcasses were examined and 15 of those had either attached tags or secondary marks. The mark rates from the two Chandalar River samples were not significantly different (TS = 0.8190, df = 1, $p = 0.5063$), so the two samples

were pooled to form a single sample from this tributary (Table 3). Only one sampling trip was made to the Sheenjek River, on 11 October, during which 1 fish with a primary mark was observed among 190 fish. Unfavorable weather conditions precluded sampling of Black River fall chum salmon. Data from two Canadian research sites were provided by staff of Fisheries and Oceans Canada (Table 3). The crew of the Fishing Branch River weir sampled 924 fall chum salmon, 6 of which were marked. Catches in the Border fish wheels totaled 5,582, 39 of which were marked. Mark rates in the upriver samples ranged from 0.0021 in the early Chandalar River sample to 0.0070 in the Border fish wheel catch. The test that mark rates observed in the pooled Chandalar River sample and the other 3 upriver locations were equal was not significant (TS = 2.7858, df = 3, p = 0.5055).

The tag numbers of fall chum salmon recaptured at the upriver locations were used to determine the date each had been tagged. Dates of tagging are plotted, by location, in Figure 2 and empirical cumulative distributions are presented in Figure 3. An exact Smirnov test that the distributions were equal was not significant (TS = 0.1304, p = 0.4783); the Sheenjek River was excluded from this test because of the single recovery observed.

Comparing Rampart and Upriver Mark Rates

Although mark rates at the Rampart recapture site varied significantly throughout the season, they were consistently between approximately 0.009 and 0.017 and differences appeared to be random rather than trending through time (Table 1). Fish from upriver locations were present throughout the duration of the mark-recapture study and no significant differences in run timing were observed (p = 0.4783; Figure 2, 3). Furthermore, as was previously described, mark rates from the 4 upriver locations did not differ significantly. For those reasons, the mark rate data from the 4 upriver locations were pooled (Table 3) and compared to the mark rate data from the Rampart recapture site pooled across all 8 strata (Table 1). The two mark rates were significantly different (TS = 31.3586, df = 1, p < 0.0001).

Discussion

The mark rates observed in the onshore fish wheel catches and the offshore gill net catches were not significantly different, and in fact were nearly identical (Table 2). This finding contributes to existing evidence that tagged and untagged fall chum salmon mix between the marking and recapture sites. A test that marked fish mix between banks of the river was conducted annually as a part of the mark-recapture study prior to 2003 (e.g., Underwood et al. 2004a) and no strong evidence of a lack of mixing has been detected. However, the possibility that some fall chum salmon exhibit fidelity to either bank, at random, while others exhibit fidelity to offshore areas, which the annual test would not

detect, remained (Bromaghin and Underwood 2004). These results suggest that such spatial segregation did not exist in 2003.

The mark rates observed at upriver locations were substantially less than the rate at the Rampart recapture site in 2003. The approximate 50% reduction in the mark rate (Table 1, 3) is of the same order of magnitude as reductions observed in past years (e.g., Underwood et al. 2004b). Bromaghin and Underwood (2003, 2004) found that holding fish in a live box at the marking site increased their capture probability at the recapture site in 2001 and 2002, artificially inflating mark rates at that location. Bromaghin and Underwood (2003) also found that holding fish decreased their capture probabilities at upriver locations in 2001, leading to a reduction in mark rates, though that finding was not repeated in 2002 (Bromaghin and Underwood 2004). Given that no fish were held in live boxes in 2003 (Apodaca et al. 2004), one might have expected to see less of a reduction in mark rates than was observed. However, Bromaghin and Underwood (2004) concluded that holding fall chum salmon in a live box did not fully explain the reduction in mark rates upriver, and that conclusion appears to remain valid.

Two general explanations of the reduction in mark rates appear to be plausible. One potential explanation is that one or more aspects of capturing and tagging fall chum salmon at the marking site elevates their mortality rate upriver of the mark-recapture study area. This explanation is partially supported by the finding that mark rates in past years were positively correlated with distance from the marking site from 1996 to 1998 and in 2001, and that fish caught in fish wheels more than once had reduced probabilities of recapture upriver (Underwood et al. 2004b). However, note that mark rates at upriver locations did not appear to be correlated with distance in 2002 (Bromaghin and Underwood 2004) and appeared to be negatively correlated with distance in 2003 (Table 3), though the rates were not significantly different. Overall, the existing body of information is most consistent with this explanation.

The second potential explanation is that one or more assumptions of the mark-recapture model have been violated, without being detected. There is very little information to support this explanation. Although Bromaghin and Underwood (2004) present a detailed discussion of the available information, we provide a brief summary here. Tag loss within the Yukon River main stem or in tributaries below the spawning grounds appears to be essentially absent. Tests of mixing assumptions, including the results of this study, have not detected meaningful violations. All large fall chum salmon populations that have been identified have been monitored during the course of these studies, and mark rates from all populations have been substantially less than the rates observed at the recapture site. In addition, run reconstructions from upriver data sources are similar to mark-recapture abundance estimates (Apodaca et al. 2004). In summary, while the occurrence of assumption violations can not be dismissed with certainty, information to support to this explanation is extremely limited.

Additional investigations of the sort conducted in 2001 and 2002 (Bromaghin and Underwood 2003; 2004) and this study are unlikely to provide meaningful insights into the cause of these phenomena. Work to date has conclusively documented that holding

fall chum salmon in live boxes at the marking site should be avoided, and holding fish was discontinued in 2003, but other causative factors are clearly operating. Use of radio telemetry might prove useful in future studies, but conducting a definitive telemetry study in a region of this size is a daunting challenge. One difficulty in conducting research of this type is obtaining a true control; fish that are studied must first be captured. If the capture event itself has an effect, then no true control can be obtained. Bioelectrical impedance analysis (BIA; Lukaski 1987) is one technology only recently applied in fishery research that might advance our capability in this regard. BIA has been successfully used to measure the energy content of some fish species (F. Joseph Margraf, U. S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska, Fairbanks, Alaska, personal communication). If fish wheel capture and tagging of fall chum salmon increases their mortality rate, one might hypothesize that their energy content at upriver locations would be less than that of untagged fish of a similar size and sex (Cleary 2003). A valid comparison between fish that have been captured and tagged and fish that have not been captured could be obtained by sampling tagged and untagged fish at an upriver location and comparing their energy reserves using BIA. Plans are underway to initiate such work in the summer of 2004.

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Table 1. Catches and mark rates observed at the Rampart recapture site, by stratum.

Stratum	Dates	Sample Size	Number Marked	Mark Rate
1	07/29 – 08/04	1,094	19	0.0174
2	08/05 – 08/11	1,704	29	0.0170
3	08/12 – 08/18	3,056	26	0.0085
4	08/19 – 08/25	4,186	45	0.0108
5	08/26 – 09/01	3,984	34	0.0085
6	09/02 – 09/08	9,635	99	0.0103
7	09/09 – 09/15	8,896	149	0.0167
8	09/16 – 09/21	2,214	21	0.0095
Total	Season	34,769	422	0.0121

Table 2. Catch statistics and mark rates observed in the temporally paired gill net and fish wheel catches at the Rampart recapture site, by sampling period.

	Gill Net				Fish Wheel		
Dates	Number of Drifts	Sample Size	Number Marked	Mark Rate	Sample Size	Number Marked	Mark Rate
08/07 – 08/11	83	105	1	0.0095	122	1	0.0082
08/25 – 08/29	90	366	0	0.0000	319	0	0.0000
09/09 – 09/13	76	402	4	0.0100	900	9	0.0100

Table 3. Catches and mark rates observed at the upriver sampling sites.

Location	Dates	Sample Size	Number Marked	Mark Rate
Chandalar	08/26 – 10/02	486	1	0.0021
Chandalar	10/10	3,195	15	0.0047
Chandalar (total)	08/26 – 10/10	3,681	16	0.0042
Sheenjek	10/11	190	1	0.0053
Fishing Branch	Season	924	6	0.0065
Border	Season	5,582	39	0.0070
Total		10,315	62	0.0060

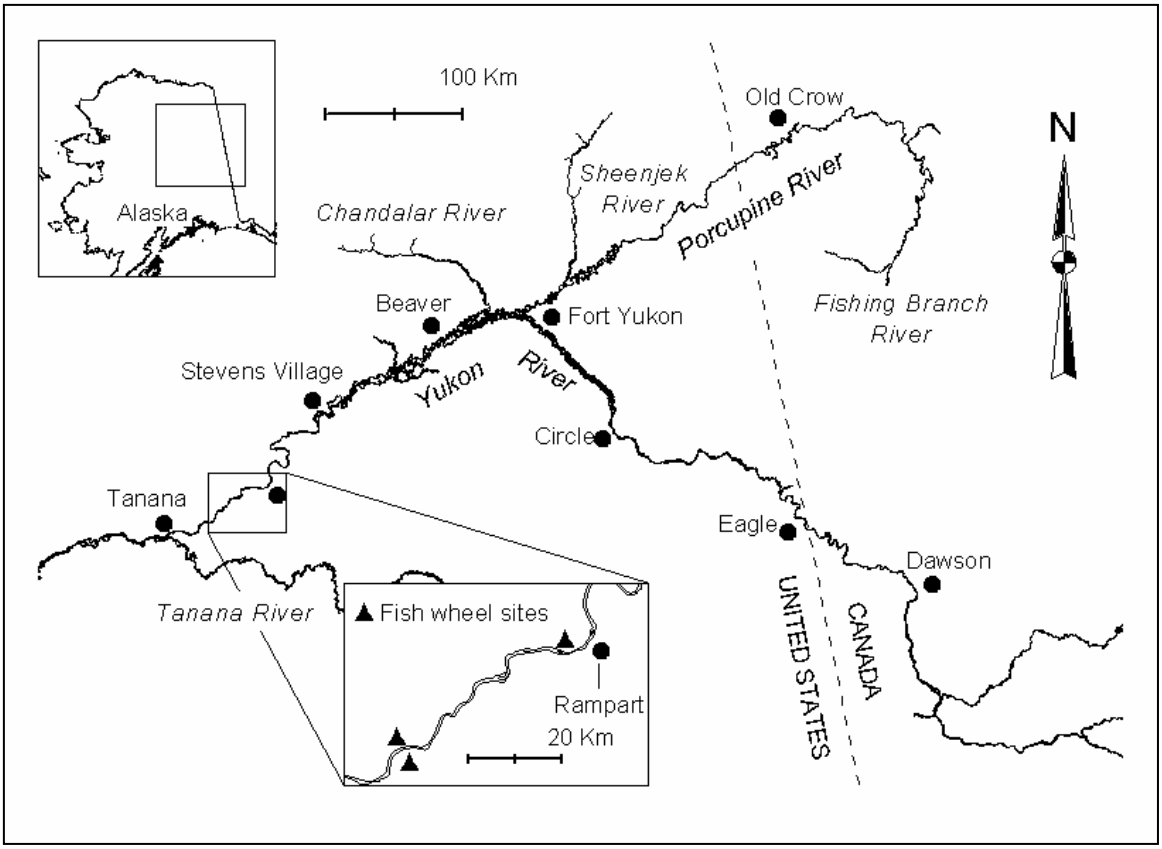

Figure 1. Map of the Rampart mark-recapture study area within the upper Yukon River drainage.

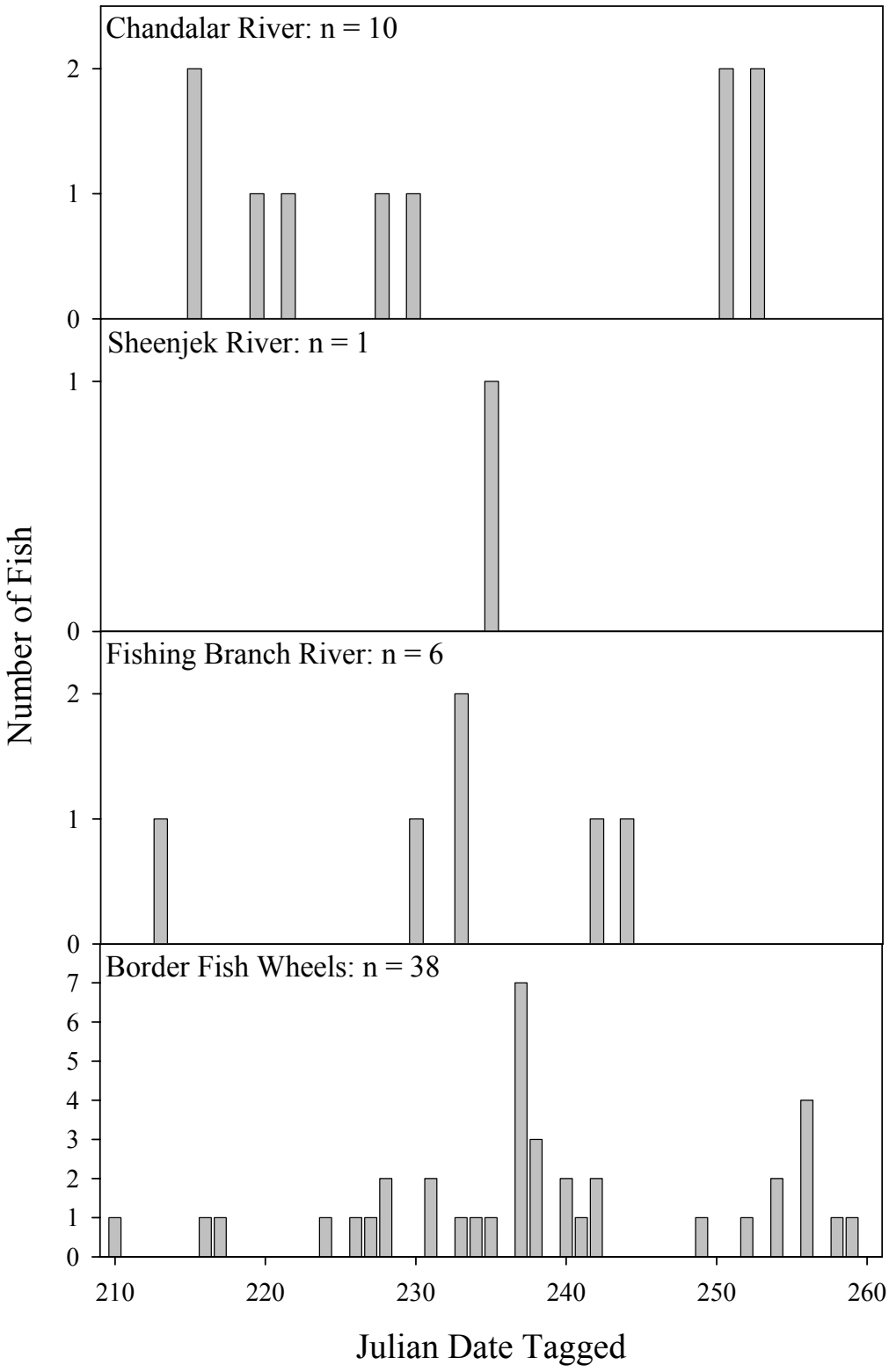

Figure 2. Julian date that recaptured fish were tagged, by recapture location.

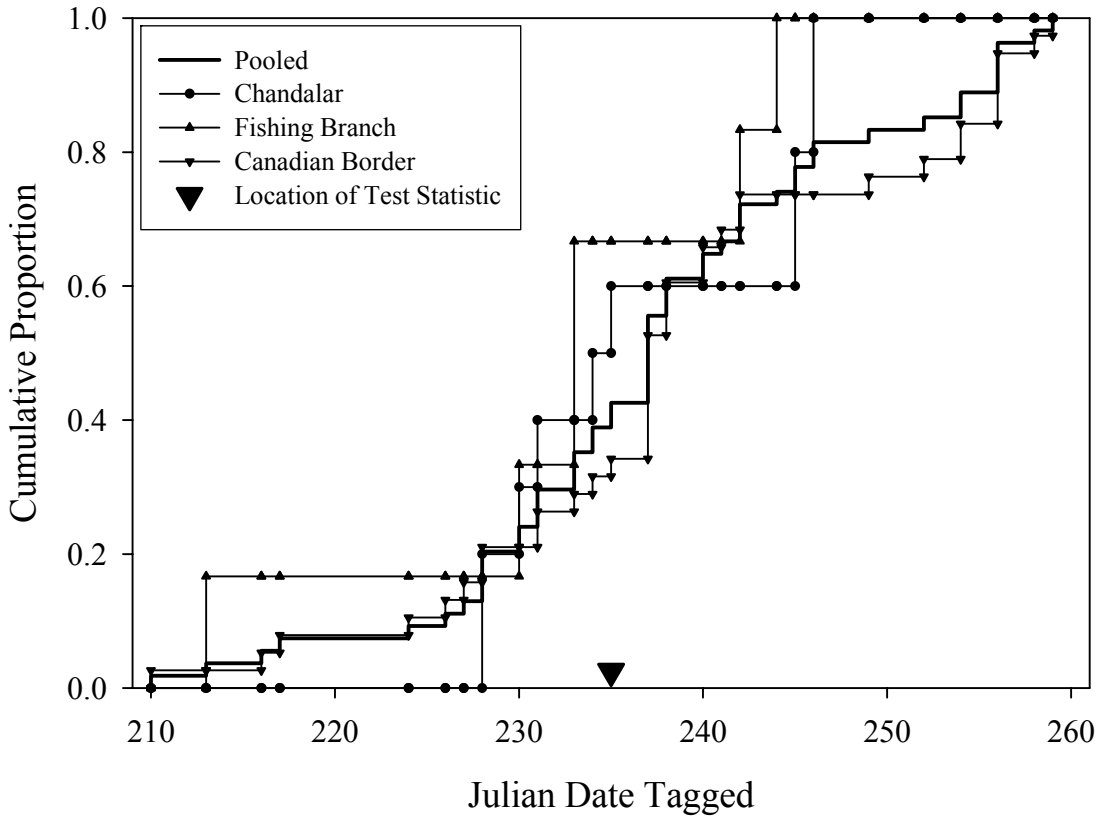

Figure 3. Empirical cumulative distributions of tag date for fish recaptured at upriver sampling locations.

Appendix A

Tributary Sampling Trip Report

Marked to unmarked Yukon River fall chum salmon carcass surveys on the Chandalar, Sheenjek and Black Rivers in Yukon Flats National Wildlife Refuge, 2003.

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December 2003

Introduction

The Assessment and Monitoring Branch of the Fairbanks Fish and Wildlife Field Office in cooperation with the Council of Athabascan Tribal Governments (CATG) conducted carcass surveys on the Chandalar, Sheenjek and Black Rivers to ascertain a marked to unmarked ratio of fall chum salmon. Chum salmon were marked with color coded and individually numbered spaghetti tags at the Rapids marking fish wheels in the middle Yukon River as part of a mark-recapture study that estimates abundance in the mainstem Yukon River upstream of the Tanana River confluence. The distance from the Rapids marking fish wheels to the Chandalar and Sheenjek Rivers spawning areas that were surveyed is approximately 480 and 670 km. The Black River was omitted due to weather related travel limitations. These data will be compared to similar data from previous surveys and used to assess tagging related mortality.

Methods

Surveys were based out of Ft. Yukon. To determine appropriate timing for the surveys we relied on documented run timing information (Osborne and Melagari 2002 and Barton 2002). Early and late season surveys were conducted and access to spawning areas was by boat and chartered helicopter using known GPS coordinates from previous surveys. Areas adjacent to the known spawning sites were briefly canvassed by helicopter during the late season surveys to determine if there may be new areas available with suitable numbers of carcasses for examination.

Aerial surveys were conducted along the river corridor at approximately 90 – 240 meters above ground level until a sufficient number of carcasses were encountered. Surveys were conducted in areas with the greatest density of carcasses to maximize the number we could examine in the available time.

Survey

The main objective was to examine chum salmon carcasses to identify and enumerate marked and unmarked chum salmon. Each individual chum salmon was examined for the presence or absence of a

spaghetti tag. If no spaghetti tag was visible we searched for a secondary mark consisting of a missing adipose fin. A chum salmon with no spaghetti tag and no adipose fin was further inspected to determine if there was an original tag attachment site located at the posterior end and approximately 0.60 cm below the dorsal fin attachment. We used hand counters to enumerate the marked and unmarked chum salmon carcasses that we encountered. We also noted the date, start and stop time at each site, the latitude and longitude where the helicopter landed, spaghetti tag color and unique number, sex of marked chum salmon, unidentifiable chum salmon (no remains of an adipose or dorsal fin but a definite single fish) and live tagged fish. We walked along the river edge, waded and used a telescoping barbed gig to access chum salmon for examination. All spaghetti tags were collected and the color and individual number was recorded.

Spaghetti tags encountered that had no associated fish and live marked chum salmon were enumerated separately but not included in the calculations.

Results

Chandalar River

Early Boat Survey*s*

From 26 August to 2 October 2003 surveys were conducted at sites 5 – 12 (Figure 1) and there were 486 chum salmon carcasses examined and 1 (0.002%) of those had a secondary mark (Table 1) (Appendix 1 and 4). These surveys took a total of fifteen hours and thirty minutes to complete excluding travel time.

Four live marked chum salmon and one tag with no associated fish was observed.

Late Helicopter Surveys

On 10 October 2003 at sites 1 - 4 (Figure 1) we examined 3,193 chum salmon carcasses and 15 (0.005%) of those had either attached tags or secondary marks (Table 1) (Appendix 2 and 4). Including travel time, we surveyed for seven hours and thirty minutes on the Chandalar River.

We observed four live marked chum salmon and encountered two tags with no associated fish. We observed 186 unidentifiable chum salmon.

We also observed five coho salmon in spawning colors at Chandalar site 3 (Figure 1). They were not obviously spawning but seemed to be holding in a deep pool among chum salmon. The dead to live chum salmon ratio was estimated to be about five to one based on general air and ground observations.

Sheenjek River

The Sheenjek River was surveyed only during the late period on 11 October 2003. At three separate sites (Figure 2) we examined 193 chum salmon carcasses and 1 (0.005%) of those had an attached tag (Table 1) (Appendix 3 and 4). No chum salmon with secondary marks were found. Including travel time, we surveyed for two hours and forty-five minutes on the Sheenjek River.

We observed one live marked chum salmon, encountered three tags with no associated fish and observed 568 unidentifiable chum salmon.

There was a great amount of scavenging activity from bears, wolves and foxes that rendered a large proportion of the carcasses useless in regards to identifying if they were marked or not. The dead to live chum salmon ratio was estimated to be about one to one based on general air and ground observations.

Black River

High water conditions during the early survey period and low cloud ceilings and fog conditions during the late period prevented successful Black River surveys.

Survey Conditions

River visibility conditions were good to fair except for deep holes that were obscured by cloudy water in the deepest parts. The Chandalar and Sheenjek Rivers were completely ice free in the portions that were worked and explored during the late period survey.

The entire time spent in the Fort Yukon area during the late survey was dominated by fog and low cloud ceilings and temperatures ranged from approximately –6° to 2°C with intermittent rain, freezing rain and snow showers. These conditions hampered helicopter operations due to the potential for rotor ice buildup.

Discussion

During the 2003 carcass surveys only half of the total number of surveys were completed due to weather related limitations or poor river conditions. Maximizing on-the-ground survey time may be accomplished by adhering to known spawning area locations. Comments from persons associated with past surveys and the resulting data indicated that the information gained from the 2003 surveys was good compared to past efforts. Helicopter use is the most efficient method to maximize time and site accessibility but it is more costly than boat access.

Overall evaluation of the surveys will be the result of the combination of these data with other related projects that are being used to build a more comprehensive estimate of potential handling mortality.

References

Osborne, B. M. and J.L. Melagari. 2002. Use of split-beam sonar to enumerate Chandalar River fall chum salmon, 2000. USFWS, Alaska Fisheries Technical Report Number 61. Fairbanks, Alaska.

Barton, L. H. 2002. Sonar estimation of fall chum salmon abundance in the Sheenjek River, 2000. ADFG, Regional Information Report 3A02-26. Fairbanks, Alaska.

Table 1. Chandalar and Sheenjek River marked chum salmon carcass ratio.

River	Date 2003	Number of primary and secondary marks	Number of unmarked	Total	Percent of marked chum salmon
Chandalar	26 Aug. – 2 Oct	1	485	486	0.002
Chandalar	10 Oct.	15	3180	3195	0.005
Sheenjek	11 Oct.	1	189	190	0.005

Figure 1. Chandalar River chum salmon carcass survey sites 1 - 12.

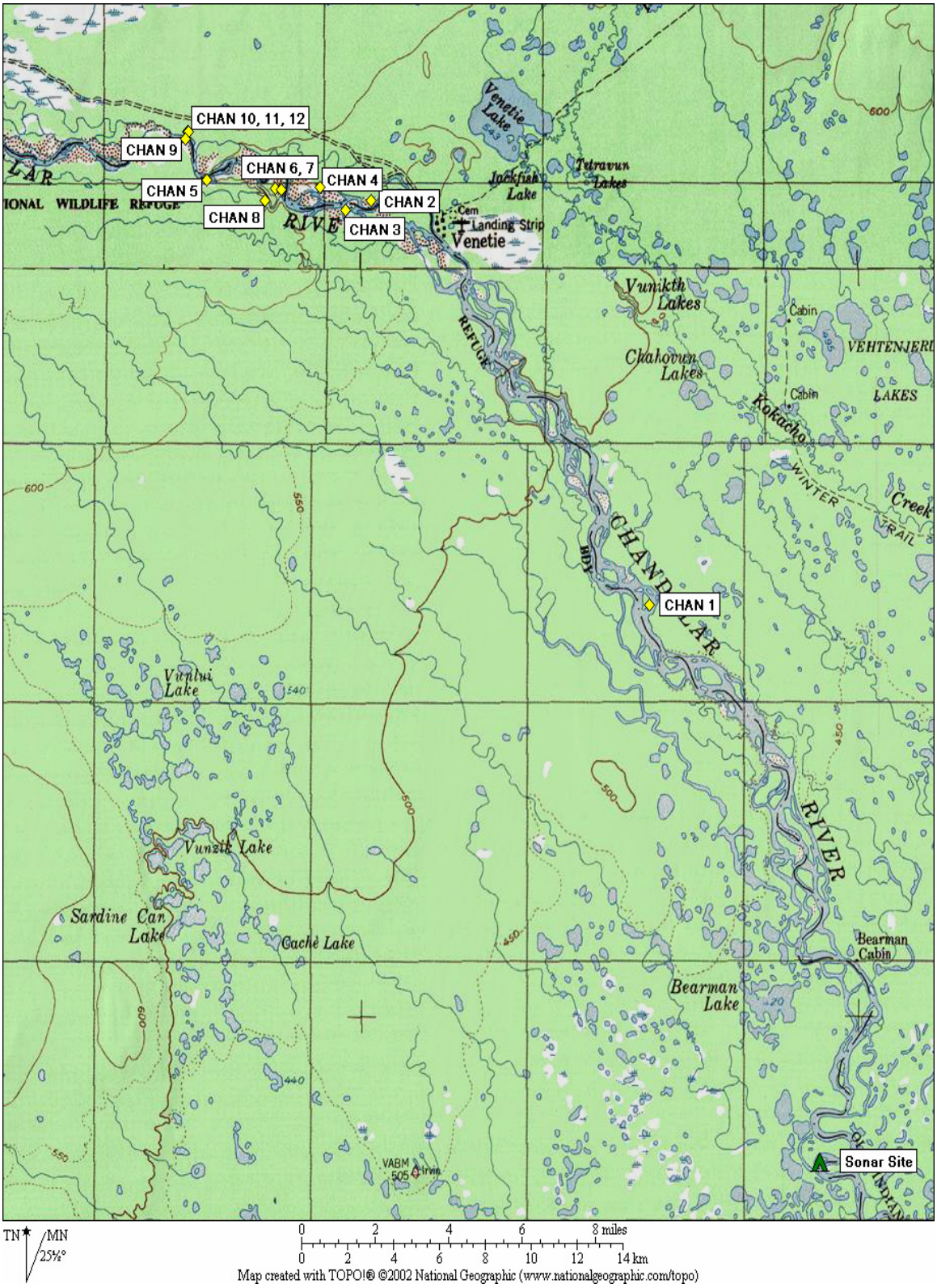
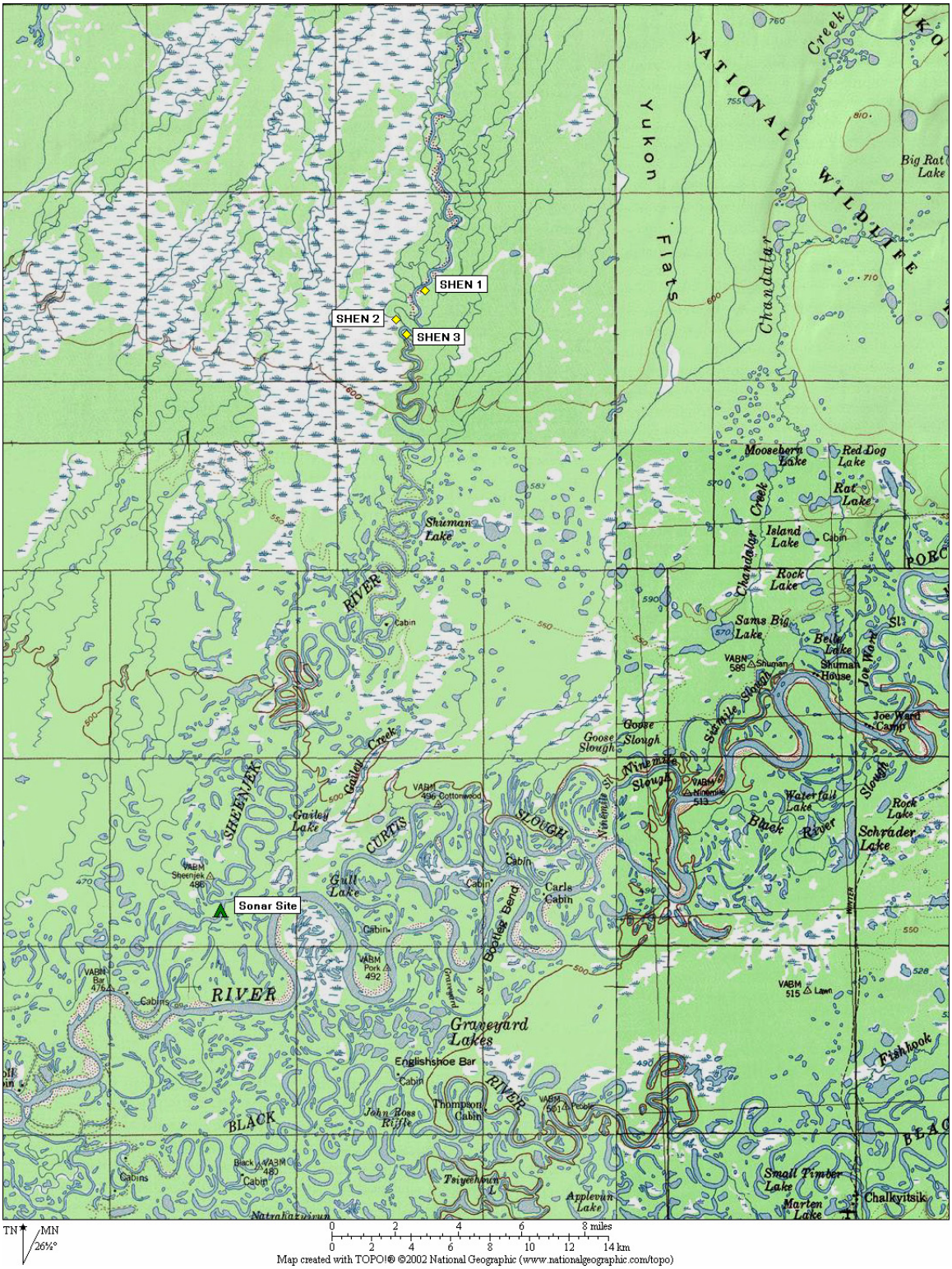


Figure 2. Sheenjek River chum salmon carcass survey sites 1 - 3.



Appendix 1. Chandalar River early chum salmon carcass boat surveys.

US Fish and Wildlife, Fairbanks Fish and Wildlife Field Office
Field Data Form: Chandalar River Fall Chum Salmon Tag Recovery and Carcass Survey, 2003
(See reverse for header definitions) Surveyors: Joe Shlosman, Gary Simple, Stacy Titus, Curtis Eric

Date (Mo/Day)	Location	Time (24 h) Start	Time (24 h) Stop	Latitude D.M.S	Longitude D.M.S	Tag Color	Tag Number	Tag Attached Y or N	Sex M F U	Number of Secondary Marks	Tagged Fish Out of Reach Color (LIVE)	Number of Untagged	Percent Marked	UNID	TOTAL
26-Aug	Chan5Nuntii	0915	1630	67.01.45	146.39.17	FG	35455	N	U M = 5 F = 2 no data = 1	none	0	8	0		8
30-Sep	Chan6Nuntii	1349	1547	67.01.361 67.01.364	146.35.100 146.35.088				M = 9 F = 17		0	26	0		26
1-Oct	Chan7Nuntii	0924	1410	67.01.350 67.01.179	146.35.077 146.35.44			Y	M M = 26 F = 29 U = 5		FG 60	0			60
1-Oct	Chan8Nuntii	1436	1519	67.01.192 67.01.489	146.35.46 146.35.855			N	F M = 45 F = 23 U = 9	1	0 77	0.013			78
2-Oct	Chan9Nuntii	1031	1056	67.02.329 67.02.423	146.39.938 146.40.229	FG		Y	F M = 40 F = 27		FG 67	0			67
2-Oct	Chan10Shoctie	1058	1115	67.02.423 67.02.918	146.40.229 146.40.308				M = 9 F = 4 no data = 1		0 14	0			14

US Fish and Wildlife, Fairbanks Fish and Wildlife Field Office

Field Data Form: Chandalar River Fall Chum Salmon Tag Recovery and Carcass Survey, 2003

(See reverse for header definitions) Surveyors: Joe Shlosman, Gary Simple, Stacy Titus, Curtis Eric

Date (Mo/Day)	Location	Time (24 h) Start	Stop	Latitude D.M.S	Longitude D.M.S	Tag Color	Tag Number	Tag Attached Y or N	Sex M F U	Number of Secondary Marks	Tagged Fish Out of Reach Color (**LIVE**)	Number of Untagged	Percent Marked	UNID	TOTAL
2-Oct	Chan10Shoctie	1120	1125	67.02.432	146.40.257				M = 10		0	13	0		13
				67.02.426	146.40.272				F = 2						
									no data = 1						
2-Oct	Chan10Shoctie	1130	1147	67.02.423	146.40.228	FG		Y	F		FG				
				67.02.474	146.40.570	FG		Y	U		FG				
									M = 150			220	0		220
									F = 62						
									U = 8						
					Grand total					1	4	485	0.002		486

Appendix 2. Chandalar River late chum salmon carcass aerial surveys.

US Fish and Wildlife, Fairbanks Fish and Wildlife Field Office
Field Data Form: Chandalar River Fall Chum Salmon Tag Recovery and Carcass Survey, 2003
(See reverse for header definitions) Surveyors: Chrissy Apodaca, Ray Hander

Date (Mo/Day)	Location	Time (24 h) Start	Stop	Latitude D.M.S	Longitude D.M.S	Tag Color	Tag Number	Tag Attached Y or N	Sex M F U	Number of Secondary Marks	Tagged Fish Out of Reach Color	Number of Untagged	Percent Marked	UNID	TOTAL
10-Oct	Chandalar 1	1038	1130	66.53.02.2	146.12.30.2	none	none	N	M	1	0	154	0.006	30	155
					Tags w/no fish =		0								
					Number of secondary marks =		**1**								
					Marked fish with tag attached =		**0**								
					Total =		1								
10-Oct	Chandalar 2	1216	1312	67.01.13.4	146.29.27.2	none	none	N	M	1	0	280	0.004	19	281
					Tags w/no fish =		0								
					Number of secondary marks =		**1**								
					Marked fish with tag attached =		**0**								
					Total =		1								
Live marked chum salmon observed:						FG		Y	U						
						FP		Y	U						
10-Oct	Chandalar 3	1329	1440	67.01.04.9	146.30.53.4	FG	60531	Y	M		0	474	0.008	42	478
						FP	33140	Y	F						
						W	28137	Y	M						
						none	none	N	F	1					
					Tags w/no fish =		0								
					Number of secondary marks =		**1**								
					Marked fish with tag attached =		**3**								
					Total =		4								

US Fish and Wildlife, Fairbanks Fish and Wildlife Field Office
Field Data Form: Chandalar River Fall Chum Salmon Tag Recovery and Carcass Survey, 2003
(See reverse for header definitions) Surveyors: Chrissy Apodaca, Ray Hander

Date (Mo/Day)	Location	Time (24 h) Start	Stop	Latitude D.M.S	Longitude D.M.S	Tag Color	Tag Number	Tag Attached Y or N	Sex M F U	Number of Secondary Marks	Tagged Fish Out of Reach Color	Number of Untagged	Percent Marked	UNID	TOTAL
Live marked chum salmon observed:						W		Y	U						
						FG		Y	M						
10-Oct	Chandalar 4	1512	1740	67.01.32.2	146.32.25.7	FP	33161	N	U		0	2272	0.004	95	2281
						FG	60125	Y	M						
						W	28346	Y	F						
						FG	60039	Y	F						
						none	none	N	M	1					
						FP	33155	Y	F						
						FG	60641	Y	F						
						FG	04805	N	U						
						none	none	N	F	1					
						W	28401	Y	M						
						W	28138	Y	F						
					*Tags w/no fish =		2								
					Number of secondary marks =		**2**								
					Marked fish with tag attached =		**7**								
						Total =	11								
					Grand total of chum salmon with secondary marks and chum salmon with tags attached =		**15**					3180	0.005	186	3195

*Tags w/ no fish were not factored into the Number of Untagged fish or the Total
Live marked chum salmon are only noted and are not part of any calculations.

Appendix 3. Sheenjek River late chum salmon carcass aerial surveys.

US Fish and Wildlife, Fairbanks Fish and Wildlife Field Office

Field Data Form: Sheenjek River Fall Chum Salmon Tag Recovery and Carcass Survey, 2003

(See reverse for header definitions) Surveyors: Chrissy Apodaca, Ray Hander

Date		Time (24 h)		Latitude	Longitude	Tag	Tag	Tag Attached	Sex			Number of Secondary	Tagged Fish Out of Reach	Number of	Percent		
(Mo/Day)	Location	Start	Stop	D.M.S	D.M.S	Color	Number	Y or N	M	F	U	Marks	Color	Untagged	Marked	UNID	TOTAL
11 Oct.	Sheenjek 1	1536	1620	67.04.8.5	144.12.81	FG	06619	Y		F		0	0	140	0.007	445	141
						FP	33126	N		U							
						FG	05966	N		U							
						FG	07219	N		U							
					*Tags w/no fish =		3										
					Number of secondary marks =		**0**										
					Marked fish with tag attached =		**1**										
					Total =		4										
Live marked chum salmon observed:						W		Y		U							
11 Oct.	Sheenjek 2	1655	1710	67.03.23.9	144.14.84.0	none	none					0	0	26	0	59	26
					*Tags w/no fish =		0										
					Number of secondary marks =		**0**										
					Marked fish with tag attached =		**0**										
					Total =		0										
11 Oct.	Sheenjek 3	1718	1725	67.02.59.6	144.14.43.6	none	none					0	0	23	0	64	23
					*Tags w/no fish =		0										
					Number of secondary marks =		**0**										
					Marked fish with tag attached =		**0**										
					Total =		0										
Grand total of chum salmon with secondary marks and chum salmon with tags attached =							**1**							189	0.005	568	190

*Tags w/ no fish were not factored into the Number of Untagged fish or the Total Live marked chum salmon are only noted and are not part of any calculations.

Appendix 4. Field data form instructions and definitions.

Field Data Form Header Definitions

Location:	Stream Name
Time, Start and Stop:	Note the start time at the beginning of when you start surveying a section of the stream and when you stop. Do for each site surveyed.
Tag Color:	Choices are: white, fluorescent green, fluorescent pink, fluorescent yellow, dark green w/ white band W = white, FG = fluorescent green, FP = fluorescent pink, FY = fluorescent yellow, DGW = dark green w/ white band
Tag number:	Use the last five digits of the tag number. Each tag number begins with a "0" so you don't need to report it each time.
Tag Attached:	Circle the proper letter. Y = yes, there was a tag attached to the chum salmon N = no there was not a chum salmon associated with the tag.
Sex:	Circle the proper letter. Male Female Unknown
Number of Secondary Marks:	Secondary mark is the absence of the adipose fin that is clipped in the tagging process. Be sure to look and see if there is a wound at the posterior end and ~ 1/4" below the dorsal fin attachment for where the tag was inserted for further confirmation if there is a question of whether the adipose fin has decayed or was clipped.
Tagged Fish out of Reach:	You should be able to get to most all fish but if you can't at least note the color and all other possible data sheet information.
Number of Untagged:	The tally of all untagged carcasses. (This number along with the number of tagged carcasses may be use to calculate "Percent Marked".)
Total	The total number of tagged and untagged chum salmon observed.
UNID	Carcasses that could not be confirmed as marked or secondarily marked due to flesh degradation or scavenging.