ESTIMATION OF FALL CHUM SALMON ABUNDANCE ON THE TANANA AND KANTISHNA RIVERS USING MARK-RECAPTURE TECHNIQUES, 2001

By

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ABSTRACT

Mark-recapture studies on fall chum salmon *Oncorhynchus keta*, were conducted for the seventh consecutive year on the Tanana River and for the third year on the Kantishna River. In the Tanana River, chum salmon were captured and tagged using a fish wheel located on the right bank of the river, immediately upstream of the Kantishna River mouth, and recaptured in a fish wheel located approximately 76 km upriver on the right bank. In the Kantishna River, chum salmon were captured in a fish wheel on the left bank of the river, approximately 9-km upstream of its terminus on the Tanana River, and recaptured in three fish wheels; two fish wheel were located approximately 113 km upstream in the Toklat River (one on each bank) and the other fish wheel was located 139 km upstream on the Kantishna River. These studies were conducted during August and September 2001.The final Bailey model abundance estimate for the upper Tanana River was 96,556 (SE = 20,955) chum salmon. The final Bailey abundance estimate for the Kantishna River was 22,992 (SE = 2,172) chum salmon.

KEY WORDS: Yukon River, chum salmon, *O. keta*, mark-recapture, population size, escapement, migration rate, run timing

INTRODUCTION

The Yukon River drainage is the largest in Alaska (854,700 km^2), comprising nearly one-third the area of the entire state. Five species of anadromous Pacific salmon return to the Yukon River and its tributaries and are utilized in subsistence, personal use, commercial, and sport fisheries. The Tanana River is the largest tributary of the Yukon River. It flows northwest through a broad alluvial valley for approximately 700 km to the Yukon River, draining an area of 115,250 km^2. Chum salmon *Oncorhynchus keta,* return to the Yukon River in genetically distinct summer and fall runs (Seeb et al. 1995). Summer chum salmon begin to enter the Yukon River in early May, and fall chum salmon enter in mid-July. Fall chum salmon migration typically peaks around mid-September in the Tanana River and continues into early October. Spawning occurs from October through November, primarily in areas where upwelling ground water prevents freezing. Fall chum salmon are larger on average than summer chum salmon, have higher oil content, and are important to subsistence, personal use, and commercial fisheries within the upper Yukon and Tanana Rivers.

The Tanana River drainage is a major producer of Yukon River fall chum salmon and contributes to various inriver fisheries. The most recent 5-year (1996-2000) average total harvest of fall chum salmon in the Tanana River is approximately 21,000 fish and approximately 16% of the entire Yukon River drainage's average catch for those years (Vania et al. 2002). However this average includes years 1997, a year in which the run to the Tanana River was particularly weak, and 1998 and 2000, years in which regulatory restrictions and closures artificially decreased the typical harvest of the area. Additionally this harvest does not include those fish taken downstream of the Tanana River in Districts 1-4 and Subdistrict 5-A.

The Alaska Department of Fish and Game (ADF&G) has management responsibility for fisheries in the Alaska portion of the Yukon River drainage. For management purposes, the drainage is divided into 13 districts and subdistricts. The Tanana River (District 6) is divided into three Subdistricts, 6-A, 6-B, and 6-C and the area upstream of Subdistrict 6-C to the headwaters known as the upper Tanana River (Figure 1). For the purpose of the Tanana tagging project, all areas upstream of Subdistrict 6-A are considered the upper Tanana River because of the tagging projects location in relation to the major fall chum salmon spawning grounds which are upstream of both Subdistricts 6-B and 6-C. Tanana River summer and fall chum salmon are managed as distinct stocks and are divided into summer and fall seasons according to the established date of 16 August in the Upper Yukon Area. Although some overlap in migration does occur, this date has been selected for management purposes based on average historical run timing.

Subsistence and personal use fisheries occur within District 6 and are typically open for two 42-hour periods per week, with the exception of the "Old Minto area" where subsistence fishing is allowed five days a week. Commercial fishing occurs on the Tanana River in Subdistricts 6-B and 6-C by emergency order for not more than 42-hours fishing per week (limited to one 24 hour period per week in Subdistrict 6-A). The Tanana River commercial guideline harvest range is 2,750 to 20,500 fall chum salmon, but the harvest level may be exceeded if assessment of run size indicates that both escapement goals and subsistence needs will be met. In 2001, however, no commercial fishery was permitted because of a weak return of fall chum salmon. In addition,

subsistence fishing on the Tanana River (Subdistricts 6-A and 6-B) was closed most of the season with the exception of two 12-hour periods, one 6-hour period and one 24-hour period when subsistence fishing was directed at coho salmon *O. kisutch*. This fishery was conducted allowing for the use of live-boxes or live chutes on fish wheels to release any chum salmon captured.

Aside from information provided by this project, management decisions for the Tanana River are partially based on catch-per-unit-effort (CPUE) data from department-contracted "test" fish wheels and historical fishery performance data. Information obtained from these sources is used inseason to qualitatively assess run strength. However, these data have serious limitations, and managers are unable to use them to assess absolute run strength. Fish wheels are susceptible to inconsistencies in efficiency, both within and among years. Although attempts are made to fish test fish wheels at the same location each year, conditions at a given location may change annually in relation to water level, current and channel configurations. The Tanana River is dynamic, and these factors are known to fluctuate widely. This variability reduces the reliability of test fish wheel data for making inseason management decisions.

Fishery managers rely on aerial and ground surveys to assess the escapement into select fall chum salmon spawning areas within the Tanana River drainage. ADF&G has recently established biological escapement goal (BEG) ranges for fall chum salmon, which includes 15,000 to 33,000 in the Toklat River, a tributary of the Kantishna River; 6,000 to 13,000 in the Delta River, a tributary to the Tanana River; and 61,000 to 136,000 in the Tanana River (Eggers 2001). Intensive annual ground surveys are conducted on spawning grounds in each of these rivers to estimate salmon escapement. In addition, a sonar project using Bendix sonar gear was operated in the Toklat River from 1994 to 1996 to develop a better assessment of escapement because of its importance as a fall chum salmon tributary (Barton 1997). A main river sonar project located at river mile 123 near the village of Pilot Station estimates passage of all salmon species in the lower Yukon River (Pfisterer 2002). Some existing projects estimate spawning escapement of fall chum salmon in the upper Yukon River tributaries, including the Chandalar, Sheenjek, and Fishing Branch Rivers and the upper Yukon River (JTC 2001). Before 1995, however, no on-going program estimated total fall chum salmon population size in the Tanana River. While estimates provided by the main river sonar project are valuable for the drainage as a whole, operational aspects and the cost of combining acoustic estimates of abundance with stock identification techniques complicate determination of the strength of the Tanana River fall chum salmon component.

In 1996, the U.S. Fish and Wildlife Service (USFWS) implemented a mark-recapture project located at Rampart Rapids on the Yukon River, 58 km upriver of the Tanana-Yukon River confluence, to estimate population size of fall chum salmon in the Yukon River drainage upstream of the village of Rampart (Gordon et al. 1998). Results from these projects have the potential to verify Tanana River population estimates. Although inseason assessment of drainage-wide Yukon River fall chum salmon run strength is extremely important, it may not accurately reflect the strength of the Tanana River run component in a given year because of differences in run strength and run timing between Tanana and non-Tanana stocks. Consequently, a reliable inseason estimate of run strength would prove very useful for management. Previous efforts, limited to one or two years, (Buklis 1982; Barton 1992;

LaFlamme 1990) have been made to estimate population size and identify fall chum salmon spawning areas using mark-recapture.

The fall chum salmon mark-recapture project in the Tanana River was initiated in 1995. Two tag deployment fish wheels and two tag recovery fish wheels were used to sample each riverbank with equal effort. However, the fall chum salmon catch from the left bank recovery fish wheel was approximately 3% of the catch from the right bank recovery fish wheel. After testing for bank orientation, the left bank tag deployment fish wheel was determined unnecessary, and it has not been used since (Cappiello and Bromaghin 1997). In 1996, the Bailey model (Bailey 1951) was used for making inseason population estimates. However, postseason data did not satisfy model assumptions, as the probability of recapture was not constant through time (Cappiello and Bruden 1997; Hebert and Bruden 1998). In 1998, the marked proportion in the recovery fish wheels was not consistent (Cleary and Bruden 2000). Consequently, the Darroch model was used for the Tanana River estimate in those years.

The Kantishna River drainage is known to contain at least one major fall chum salmon stock that spawns in the Toklat River tributary. In 1999 the scope of the project was expanded through the Western Alaska Salmon Fisheries Disaster Mitigation Research Plan (WADG) to estimate the abundance of both upper Tanana and Kantishna River fall chum salmon. In addition to one tagging and one recovery fish wheel operated in the mainstem Tanana River, one tagging fish wheel was operated in the lower Kantishna River and two recovery fish wheels were operated in the Toklat River (Cleary and Bromaghin 2001). In 1999 a large disparity between the Kantishna River fall chum salmon population estimate and the upper Toklat River expanded ground survey estimate became evident. This disparity led to speculation that a larger proportion of chum salmon migrated to the upper Kantishna River (i.e., upstream of the Toklat River) than was previously thought. In an effort to better understand the relative abundance and timing of upper Kantishna River fall chum salmon stocks and to satisfy the closed population premise of the study an additional recovery fish wheel has been operated in the upper Kantishna River since 2000 (Cleary and Hamazaki 2002). By operating recovery fish wheels in each tributary the Kantishna River abundance estimate includes both the Toklat and upper Kantishna River chum salmon components.

Objectives for the 2001 season were to: (1) provide management staff with both inseason and postseason abundance estimates of fall chum salmon in the upper Tanana and Kantishna Rivers; (2) estimate migration rates for fall chum salmon; (3) estimate run timing of fall chum salmon to the Delta River in the Tanana River drainage and to the Toklat River, in the Kantishna River drainage; and to the upper Kantishna River; (4) test the assumption of similar run timing of upper Kantishna and Toklat River fall chum salmon.

METHODS

Sampling

In 2001, one tagging fish wheel and one recovery fish wheel were used in the Tanana River. One tagging fish wheel was operated in the Kantishna River, two recovery fish wheels were used in the Toklat River, and one recovery fish wheel was operated in the upper Kantishna River. The Bailey population model was used to generate Tanana and Kantishna River population estimates both inseason and postseason in 2001.

The Tanana and Kantishna River mark-recapture studies utilized tag deployment and recovery fish wheels. In the Tanana River, one tagging fish wheel was located 9 km upstream of the Kantishna River mouth, and one recovery fish wheel was located 76 km upstream of the tagging sites and downstream from the Nenana River (Figure 2). These two locations were selected because of the absence of main tributaries between the two sites (with the exception of the Tolovana River), which satisfies a 'closed population' (i.e., no immigration, emigration, mortality) assumption, the main premise of the mark-recapture study.

Because the Kantishna River drainage branches 58 km upstream of the tagging site, recovery sites were located in both the Toklat and upper Kantishna River branches. The Toklat River recovery site is located 114 km upstream of the Kantishna River tagging fish wheel where two tag recovery fish wheels were operated on the left and right banks of the river. The upper Kantishna River recovery fish wheel was operated 139 km upstream of the Kantishna River tagging fish wheel on the right bank of the river. By operating recovery fish wheels, in each of the drainages tributaries, the 'closed population' assumption was satisfied. At the recovery fish wheel locations equal vulnerability to capture could be examined by determining the marked to unmarked ratio at each site.

Tag Deployment

The Tanana and Kantishna River tagging fish wheels are owned and operated by private contractors. In the Tanana River, the fish wheel was positioned on the right bank at approximately 8 km upstream from the mouth of the Kantishna River and within 100 meters of the 1995-2000 fish wheel locations (Figure 2). This site has a fairly stable river channel with a moderate to slow current that provides a relatively consistent location for fish wheel operation. In the Kantishna River, a tagging fish wheel funded by the Bering Sea Fishermen's Association (BSFA) was positioned on the left bank at approximately 9 km above the mouth of the river. Both tagging fish wheels were equipped with baskets measuring 2.5-3 m in width with a dip capacity of approximately 4 m and a live box measuring 2.4 x 1.2 x 0.6 m (length, width, depth) constructed of spruce poles and one-half inch plywood submerged on the offshore side of the fish wheel. Fish leads, ranging from 2 to 5 meters in length, were installed shoreward as needed, depending on the distance of the fish wheel from the riverbank. The contractors examined their respective fish wheels at least once a day to determine overall operating efficiency, to check for

damage such as tears, rips or holes in the baskets or live-box, and to remove any accumulated debris. To maximize operating efficiency, the fish wheels were occasionally adjusted by moving the fish wheel laterally, raising or lowering the axle to allow baskets to turn as close to the bottom as possible, lengthening or shortening onshore fish leads, and adding or removing basket paddle boards to accommodate changes in river current.

Unless interrupted by debris accumulation or fish wheel relocation, the two tag deployment fish wheels were operated 24 hours per day. The tagging fish wheels operated from 16 August until 2 October on the Tanana River and from 16 August to 29 September on the Kantishna River. At each location, a daily 12-hour tag deployment schedule was maintained from 08:00 to 20:00, with a 24-hour catch-day designated as 08:00 to 08:00 the following day. The sampling crew checked the live-box at each fish wheel in approximately 4-hour intervals (07:30, 12:00, 16:00 and 19:30). Using a dip net, all chum salmon in the live-box were individually transferred to a sampling tub. The fish were tagged with a 30 cm, hollow core, individually numbered spaghetti tag (Floy Tag and Manufacturing Inc., Seattle, WA)[2] inserted with a 16 cm applicator needle into the dorsal musculature, posterior to the dorsal fin, and secured with an overhand knot tied close to the body. Orange tags were used on the Tanana River and pink tags on the Kantishna River. The right pelvic fin was also partially clipped as a secondary mark. Other data recorded were: (1) length, measured from mid-eye to fork-of-tail (MEFT) at nearest five cm; (2) sex, determined by external physical appearance; (3) condition, determined by external physical aberrations subjectively judged as having the potential to affect survival or migration; and (4) exterior color, graded by light or dark. Because of the possible effect on the abundance estimate, chum salmon that had severe wounds (bleeding, large gashes, head injuries, fungus etc.) were not tagged. Fish caught between 08:00 and 20:00 were categorized as day-fish, while fish caught between 20:00 and 08:00 and held in the live-box for up to 12 hours were categorized as night-fish. Total handling time per fish was approximately one minute. All chinook salmon *O. tshawytsha,* and coho salmon were enumerated by sex and released, while other species were identified, enumerated, and released.

To monitor fish wheel efficiency, fish wheel revolutions occurring over 15-minute intervals were recorded daily. In addition, meteorological data, water temperature and level were recorded once a day at the tagging camp at approximately 10:00. Measurements collected after each sampling session were entered into a computer spreadsheet. A data summary for the previous 24-hour tagging day was reported daily to the ADF&G Fairbanks office via cellular or satellite telephone.

Tag Recovery

The recovery fish wheels in the upper Tanana River and upper Kantishna River were owned and operated by private contractors, while the Toklat River recovery fish wheel was operated by ADF&G. In the upper Tanana River, one fish wheel was positioned on the right bank approximately 76 km upstream from the tagging fish wheel, while two fish wheels were positioned on each bank of the Toklat River 114 km upstream and one fish wheel on the right bank of the Kantishna River 139 km upstream (Figure 2). Design, size and construction materials

[2] Mention of trade names does not constitute endorsement by ADF&G.

of the recovery fish wheels and live-boxes were similar to those of the tag deployment fish wheels. The Tanana River recovery fish wheel also served as an ADF&G management test fish wheel and was operated during both the summer and fall chum salmon migrations.

All recovery fish wheels started on 16 August and operated through 2 October on the Tanana River, through 30 September on the Toklat River, and through 8 October on the upper Kantishna River. Like the tag deployment fish wheels, recovery fish wheels were inspected daily and adjusted as necessary. All chum salmon were enumerated by sex and released. The color and identification numbers of all recaptured tags were recorded. All chum salmon not bearing tags were examined for the secondary mark, a right pelvic fin clip. Additionally, all chinook and coho salmon were enumerated by sex, while other species were enumerated daily. The ADF&G office in Fairbanks was contacted daily via satellite or cellular telephone to report summary data for the previous 24-hour catch. ADF&G personnel recovered tags on the Toklat and Delta Rivers.

Because of concerns over possible delayed mortality, blood plasma samples were collected at the Kantishna River tagging wheel and from the Toklat River recovery fish wheels from tagged and untagged chum salmon in 2000. In 2001, blood samples were collected from tagged and untagged chum salmon at the same locations and also at the upper Kantishna River recovery wheel site. Samples were analyzed to determine if effects of tagging and fish wheel capture are evident in fall chum salmon after migration to the recovery fish wheels. Stress parameters and lipid energy were measured (Cleary in prep).

Data Analysis

Abundance Estimation

Two run size estimates were generated inseason and postseason. The purpose of the inseason estimates was to provide management staff with preliminary run size for fall chum salmon. The inseason estimates, along with other run assessment data were used by fisheries managers for decision-making. The inseason estimates were produced without adjusting for assumptions required to make an accurate and unbiased estimate. For the final postseason estimate all the assumptions were tested and adjustments were made to provide unbiased estimates.

Bailey's modified Peterson estimate was employed to estimate the total run size of the Tanana and Kantishna Rivers.

Bailey's estimation equation is:

$$\hat{N} = \frac{(C+1)(M)}{R+1} \qquad (1)$$

$$V\left[\hat{N}\right] \cong \frac{M^2(C+1)(C-R)}{(R+1)^2(R+2)} \tag{2}$$

Where:

$\hat{N}$ = Total run estimate.

M = The number of fish tagged and released at the tagging fish wheels.

C = The number of fish caught at the recovery fish wheels.

R = The number of tagged fish recaptured at the recovery fish wheels.

Data Reduction and Adjustment

The numbers of marked and unmarked fish were adjusted using the distribution of travel times for marked fish. This adjustment was necessary because some unmarked fish were between tagging and recovery fish wheels when the study began (August 18-27 for the Tanana River, August 16-27 for the Kantishna-Toklat Rivers), and some marked fish would not reach the recovery fish wheel when the study ended. For each day the number of unmarked fish was multiplied by the appropriate cumulative proportion, which resulted in a final vector of the daily number of unmarked fish captured in the recovery fish wheels (Tables 1-4). The distribution of travel times of marked fish was assumed to be an accurate representation of the distribution of travel times of unmarked fish. Note that travel times of marked fish could differ from that of unmarked fish because of possible stress from capture and tagging.

Migration Rate

Migration rate between the tagging and recovery fish wheels was calculated as:

$$\hat{M} = \frac{RD}{D} \tag{3}$$

Where:

RD= Distance between tagging fish wheel and recovery fish wheel (76 km on the Tanana River, 113 km from the Kantishna River to the Toklat River recovery fish wheels, and 139 km from the Kantishna River tagging fish wheel to the upper Kantishna River recovery fish wheel).

D = Number of days taken for a tagged fish being recaptured at recovery fish wheel.

Diagnostic Statistical Tests

Bailey's closed population model requires the following assumptions: (1) no immigration, emigration, and mortality between the tagging and recovery sites; (2) all marked fish mix completely with unmarked fish; and (3) all fish have an equal probability of recapture. These conditions were examined before estimating abundance.

While mortality induced by tagging and handling is unknown, a mortality rate of 5% has been used in all years of the study. This number is similar to the 5.2% of radio-tagged fall chum salmon in the Tanana River that did not proceed upstream (Barton 1992). For the analysis, the number of tags deployed was decreased by 5% before use in the abundance estimate.

If the equal recapture rate for size or sex is violated (logistic regression test), the data will be stratified by size and sex, and estimation will be conducted separately for each strata. Whenever the complete mixture assumption is violated, Darroch's (1961) estimation method will be used. However, Darroch's (1961) method employs a maximum-likelihood estimation technique that requires abundant recapture data to stabilize estimation. Thus, when recapture data are not sufficient, even though the complete mixture assumption is violated, Darroch's (1961) method will not be used.

To examine the assumption of complete mixture of marked and unmarked fish, the following were tested: (1) equal travel time from release to recapture sites between day fish and night fish; (2) equal recapture rate (i.e., marked-unmarked ratio) between left and right bank fish wheels, between Toklat and (3) Kantishna River recapture sites, (4) and across time. The Kolmogorov-Smirnov test was employed to examine equality of travel time (days) from release to recapture sites between day fish and night fish. Chi-square tests were used to test for equal recapture rates between left and right bank fish wheels at the Toklat and Kantishna River recapture sites, for proportion of recaptures between day and night chum salmon and to test for equal recapture rates across weeks. Finally, to examine the assumption that all fish have an equal probability of recapture, logistic regression (Hosmer and Lemeshow 1989) was utilized in which fish of marked (0) and recaptured (1) were regressed with sex and size.

Stock Timing

ADF&G personnel conducted ground surveys of the Delta and Toklat Rivers, the escapement counts consisted of the number of live and dead chum and coho salmon. On the Delta River, nine replicate surveys were conducted from 3 October through 30 November. On the Toklat River one intensive survey was conducted of the fall chum spawning area 14 through 16 October. USFWS and ADF&G personnel conducted two ground surveys in September during the peak of spawning activity on Bluff Cabin Slough on the upper Tanana River. Whenever possible, tags were retrieved at these locations.

RESULTS

Sampling

Tag Deployment

The tagging fish wheels operated from 16 August until 25 September on the Tanana River and from 16 August to 29 September on the Kantishna River. At the Tanana River tagging fish wheel, a total of 1,115 fall chum salmon were tagged (Appendix A) of which 519 were day fish and 596 were night fish. The peak chum salmon CPUE of 4.3 fish/hour occurred on 6 September on the Tanana River (Figures 3 and 4). A total of 116 chum salmon were not tagged because of injuries that might have affected their swimming ability, death in the live-box or escape. At the Kantishna River tagging fish wheel, 2,188 chum salmon were tagged (Appendix B) of which 1,099 were day fish and 1,089 were night fish. The peak chum salmon catch of 5.25 fish/hour occurred on 30 August (Figure 3). A total of 444 chum salmon were not tagged for the same reasons as above, however, this season extra measures were taken to screen out fish with debilitating injuries that may affect their traversal to the recovery wheel site and thus affect the abundance estimate. Additionally, two tags were recaptured at the Kantishna River tagging fish wheel site that were tagged at Russian Mission and one tag was recaptured from the Rampart Rapids tagging study on the mainstem of the upper Yukon River.

Tag Recovery

At the Tanana River recovery fish wheel, a total of 1,827 chum salmon were examined for marks of which 1% (19) were tagged (Appendix C). In the Toklat River recovery fish wheels, 1,700 chum salmon were examined of which 5.6 % (96) were tagged (Appendix D). The number of fish examined included three chum salmon, not included in the final abundance estimate, that were tagged at the Tanana River tag deployment wheel. In the upper Kantishna River recovery fish wheels, 228 chum salmon were examined of which 4.0% (9) were tagged (Appendix E). Four chum salmon with missing tags were detected at the Kantishna River recovery fish wheel. A total of 267 chum salmon tags were recaptured from various sources of which most (96) were recovered from the Toklat River recovery fish wheels. One chum salmon tagged in the Tanana River on 4 September was captured near the village of Grayling. Chum salmon tags were also recovered during foot surveys on the Delta and Toklat Rivers. Thirty-three tags were recovered from nine foot surveys on the Delta River, eight tags were recovered from two surveys of Bluff Cabin Slough, while 88 tags (including one tag that was deployed in September of 2000) were recovered from foot surveys on the Toklat River springs during surveys conducted 14 through 16 October (Table 5).

Water conditions on the Tanana and Kantishna River did not appear to affect fish wheel efficiency until late September when weak current caused some minor stalling problems (Figure

5). The catch-per-unit-effort (CPUE) at the Tanana River tagging fish wheel was low until approximately the first week in September when CPUE began to increase markedly, which has been the precedent for all years of the project.

Data Analysis

Abundance Estimate

Inseason estimates (Table 6) for the Tanana River were 97,985 (SE 21,791) and 96,793 (SE 21,006) fall chum salmon and were provided to management staff as of 25 September and 2 October respectively. For the Kantishna River inseason estimates were 36,663 (SE 3,598) and 37,425 (SE 3,517) fall chum salmon and were provided to management staff as of 25 September and 30 September respectively (Figure 6).

The final abundance estimates were adjusted using the cumulative proportion of travel time between the tag deployment and recovery wheels (Tables 1 and 2), the adjusted number of tag releases and the adjusted number of unmarked catches (Tables 3 and 4). The final population estimate using the Bailey model was 96,556 (SE 20,955) fall chum salmon for the Tanana River with 95% confidence interval (55,485; 137,627) and coefficient of variation (CV) approximately 0.22; and 22,992 (SE 2,172) fall chum salmon for the Kantishna River with 95% confidence interval (18,734; 27,250) and coefficient of variation approximately 0.09 (Tables 7, 8 and 9).

Migration Rate

The Tanana River mean migration rate for day-tagged (day) fish was 24 km/day (n = 10) and 49 km/day (n = 7) for night-tagged (night) fish with a combined mean of 37 km/day (excluding two chum salmon with extreme migration rates). This migration rate is greater than combined mean migration rates from previous years: 21 km/day in 1997, 30 km/day in 1998, and 23 km/day in 1999. While the average migration rate was three days from the tagging to recovery fish wheel, the maximum migration rate was 33 days, which was not included in estimating the average migration rate (Table 10).

The mean migration rate between the Kantishna River tagging fish wheel and the Toklat River recovery fish wheels was 25 km/day (n = 52) for day fish and 28 km/day (n = 37) for night fish with a combined mean of 27 km/day excluding four fish with extreme migration rates. The migration rate between the Kantishna River tagging fish wheel and the upper Kantishna River recovery fish wheel was 31 km/day (n = 2) for day fish and 28 km/day (n = 3) for night fish with a combined mean of 30 km/day. The average migration rate was four days from the tagging to recovery fish wheels on the Toklat River with a maximum migration rate of 54 days, which was not included in estimating the average migration. The average migration rate was five days between the Kantishna River tagging fish wheel and the upper Kantishna recovery fish wheel (Table 10).

Diagnostic Statistical Tests

The mean migration rate for day-tagged fish was significantly slower than the night-tagged fish in Tanana River (24 and 49 km/day, KS test $D = 0.318$, df 18, $P<0.05$), while it was similar in the Toklat River (25 and 28 km/day, KS test $D = 0.144$, df 22, $P<0.05$) for day and night fish respectively. The KS test was not conducted for the chum salmon recaptured at the Kantishna River recovery fish wheel because of the low tag recoveries.

Chi-square tests indicated no significant difference in recapture rates between left and right bank fish wheels on the Toklat River (Chi-square 0.0105, df 1, $P = 0.918$), for day and night fish on the Tanana River (Chi-square 0.0234, df 1, $P = 0.878$), for day and night fish on the Toklat River (Chi-square 2.373, df 1, $P = 0.123$) and between the Toklat and Kantishna River recapture sites (Chi-square 0.00251, df 1, $P = 0.960$). In addition, chi square tests showed no significance across weeks in the Tanana River (Chi-square = 6.059, df 4, $P = 0.195$), Toklat River (Chi-square = 0.692, df 1, $P = 0.406$), and Kantishna River (Chi-square = 7.615, df 4, $P = 0.107$). Nor was there a significant difference between recapture rates between the goodness-of-fit test of multiple logistic regression models with predictor variables of size and sex (Hosmer-Lemeshow test $P < 0.001$) for the Tanana, Kantishna, and Toklat Rivers. Since the tests indicate that all assumptions were met, the Bailey's method was used for the abundance estimate.

No commercial chum salmon fishery occurred in Subdistricts 6-B and 6-C in 2001, and the preliminary subsistence harvest estimate was approximately 1,995 fall chum salmon (Brase and Hamner 2002).

Stock Timing

Thirty-three chum salmon tags were recovered during surveys of spawning grounds in the Delta River conducted between 3 October and 30 November 2001. The median tag deployment date for tags recovered in the Delta River was 8 September, and tagging dates ranged from 28 August through 25 September. The median tag deployment date for tags recovered in the Delta River was 14 September in 1995-1997, 27 September in 1998, 20 September in 1999 and 30 August in 2000. The median tag deployment date for tags recovered in the Toklat River was 11 September and the tag deployment dates ranged from 20 August to 28 September. The median tag deployment date for tags recovered in the Toklat River was 15 September in 1999 and 11 September in 2000.

DISCUSSION

The Tanana River mean migration rates for tagged fish were quite different and ranged from 24 km/day (n = 10) and 49 km/day (n = 7) for day and night fish respectively, and the KS tests indicated that there was a significant difference between these groups. The migration rates on the Tanana River are opposite of what was expected as it was presumed that night fish would have reduced migration rates due to stress from longer holding durations. However, because of the small sample size in 2001 (n = 17), and based on the results from past years of the project, the results of the KS are probably not consequential. Like the results from previous years of this study, no correlation was detected between holding time and reduced migration rates (Table 10). Thus, to make universal statements on the effects of holding time is difficult.

The Kantishna River mean migration rates for tagged fish were similar, 25 km/day (n = 52) and 28 km/day (n = 37) for day and night fish respectively and the KS test indicated a significant difference between these two groups. Like the Tanana River, night fish migration rates were greater than day fish migration rates, which suggests holding time does not reduce migration rates. In both 1999 and 2000 the night fish migration rates were greater on the Kantishna River (Cleary, P. M. and J. F. Bromaghin. 2001, Cleary, P. M. and T. Hamazaki. 2002.). While a significant difference in mean migration rates indicates violation of the Bailey population estimation, this violation is not believed to significantly influence the population estimates given no significant difference in marked-unmarked ratio between night and day tagged fish.

The 2001, Tanana River abundance estimate of 96,556 fall chum salmon (similar to the 1999 estimate of 97,843 fish) is only 87% of the 1995-2000 mean escapement of 111,516 fish (Table 9, Figure 7). Other indicators of poor run strength in 2001 were identified throughout the drainage by the following projects. The 2001 preliminary estimate of 360,356 fall chum salmon at Pilot Station sonar is the second lowest on record for the project. The historical average (1995-2000) escapement at the Yukon River Sonar project is 520,922 (JTC 2001). Furthermore, the ADF&G test fish wheel located on the left bank of the Yukon River near the village of Tanana caught 2,739 fall chum salmon which is approximately 19% of its 1994-2000 average annual catch. Additionally, the 2001 spawning ground surveys in the Toklat River revealed an escapement of approximately 6,000, fall chum salmon which is only 18% of the minimum escapement objective of 33,000 fish (BOF regulation 5AAC 01.248), and one of the lowest escapements on record. Other indications of poor run strength in 2001 include the preliminary Delta River escapement (based on foot survey counts) of approximately 7,900 fall chum salmon, which is 61% of the upper end of the biological escapement goal (Bonnie Borba, personal communication).

The Tanana River recovery fish wheel was operated at a new location the first ten days of the season in 2001. The fish wheel was subsequently moved to its historical location and the fish wheel catches of fall chum salmon began to increase. The overall low number of tags deployed at the Tanana River tagging fish wheel resulted in low tag recovery rates. Water levels on the Tanana and Kantishna River were very low in late September, which caused both tagging fish wheels to stall occasionally. In September, water levels dropped so rapidly that the fish wheels were stalling despite almost constant adjustment by the contractors during the daily inspections.

The combination of a new recovery site in the beginning of the project, low numbers of tags deployed, below average water level and low recapture rate led to a wide confidence interval for the Tanana River abundance estimate and a large CV at the end of the project compared to previous years.

On the Kantishna River, the tagging fish wheel was very efficient for most of the season regardless of water level, and had the highest capture rate since the project's inception, and almost twice the total catch of the Tanana River tagging fish wheel. Although CPUE at the Kantishna River was greater than the Tanana River fish wheel, the Kantishna River tagging fish wheel is a three-basket fish wheel, which may be more efficient than two-basket fish wheels. In addition, conditions at the tagging fish wheel site on the Kantishna River are quite different than the Tanana River, for example the channel is narrow and tends to be shallower than the Tanana River tagging fish wheel site which probably affects chum salmon catch.

The tag losses (4) detected at the upper Kantishna River recovery fish wheel are a cause for concern because of the possible effect on the abundance estimate. This season was the first time more than two tag losses were detected at any of the recovery fish wheels. Tag loss may occur because of the greater migration distance (139 km) between the Kantishna River tagging fish wheel and the upper Kantishna River recovery fish wheel. The difference between the sites is an additional 63 km longer than the distance between tagging and recovery fish wheels on the Tanana River and 49 km longer than the distance between Kantishna River tagging fish wheel and the Toklat River recovery fish wheels.

RECOMMENDATIONS

Efforts should be made to minimize injury to captured salmon by modifying fish wheels to include padding on the fish wheel baskets and live boxes including raised sides to ensure retention of all fish captured by the fish wheels. As tag retention is critical to abundance estimation, it should be stressed that all operators of the recovery fish wheels make an intensive effort to inspect all fall chum salmon for tag losses by examining fish for a secondary mark. Because of the low number of tags recovered this season, a three-basket fish wheel may be operated on the Tanana River in 2002 to increase the number of tags deployed. In addition, consideration should be given to operating a three-basket fish wheel at the Tanana River recovery site to increase the efficiency and consequently the number of tags recovered. However, the low number of tags recovered in 2001 was likely because of the CPUE at the tag deployment fish wheel rather than the CPUE at the recovery fish wheel.

Continued development of models to provide more refined inseason and postseason tools for abundance estimation should be pursued. Other data analysis tools should be explored and developed to test as many assumptions as possible. We recommend the project continue to include both day and night captured fish in the abundance estimation to maintain the highest possible sample size. Pooling data from day and night fish substantially increases the number of marked fish, which significantly reduces the variance of the abundance estimate. Day and night

fish should be pooled only after tests are performed to verify no differences exist between them. However, based on results from 1998-2001, tagging fish held in a live-box overnight for up to 12 hours has not had a detectable effect on their probability of recapture when the number of fish in the livebox is low. In years of low abundance and correspondingly low live box densities, to separate and track day and night fish, may be unnecessary. In addition, in years of high abundance, more frequent attendance to the fish wheels may be necessary to tag and release fish from the live-boxes at each tag deployment fish wheel.

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Table 1. Counts and cumulative proportions of travel time between tag deployment and recovery fish wheels on the Tanana River used in the data reduction for the Bailey estimator, 2001.

Travel Time (days)	Day Tag Count	Day Tag Cumulative Proportion	Night Tag Count	Night Tag Cumulative Proportion	Combined Count	Combined Cumulative Proportion
0	0	0.00	0	0.00	0	0.00
1	0	0.00	3	0.43	3	0.18
2	2	0.20	2	0.71	4	0.41
3	4	0.60	0	0.71	4	0.65
4	3	0.90	2	1.00	5	0.94
5	0	0.90	0	1.00	0	0.94
6	0	0.90	0	1.00	0	0.94
7	0	0.90	0	1.00	0	0.94
8	0	0.90	0	1.00	0	0.94
9	1	1.00	0	1.00	1	1.00
Total	10		7		17	

Table 2. Counts and cumulative proportions of travel time between the tag deployment fish wheel on the Kantishna River and recovery fish wheels on the Toklat and Kantishna Rivers used in the data reduction for the Bailey estimator, 2001.

Travel Time (days)	Day Tag Count	Day Tag Cumulative Proportion	Night Tag Count	Night Tag Cumulative Proportion	Combined Count	Combined Cumulative Proportion
0	0	0.00	2	0.05	2	0.02
1	0	0.00	2	0.11	2	0.04
2	0	0.00	14	0.49	14	0.20
3	10	0.19	7	0.68	17	0.39
4	25	0.67	6	0.84	31	0.74
5	7	0.81	3	0.92	10	0.85
6	5	0.90	2	0.97	7	0.93
7	2	0.94	0	0.97	2	0.96
8	2	0.98	0	0.97	2	0.98
9	0	0.98	1	1.00	1	0.99
10	0	0.98	0	1.00	0	0.99
11	1	1.00	0	1.00	1	1.00
Total	52		37		89	

Table 3. Observed and adjusted number of releases at the tag deployment fish wheel and observed and adjusted number of unmarked catches at the recovery fish wheel used in the Bailey model to estimate the abundance of fall chum salmon in the Tanana River, 2001.

Date	Day Tags Released	Estimated Proportion at Recovery Wheels	Night Tags Released	Estimated Proportion at Recovery Wheels	Adjusted Tags Released	Unmarked Catch	Estimated Proportion at Tagging Wheel	Adjusted Unmarked Catch	Adjusted Cumulative Tags Released	Cumulative Catch Unmarked
8/16	1	0.95	5	0.95	6	0	0.00	0	6	0
8/17	5	0.95	5	0.95	10	0	0.18	0	15	0
8/18	7	0.95	3	0.95	10	0	0.41	0	25	0
8/19	13	0.95	7	0.95	19	1	0.65	1	44	1
8/20	3	0.95	3	0.95	6	0	0.94	0	49	1
8/21	2	0.95	7	0.95	9	0	0.94	0	58	1
8/22	4	0.95	0	0.95	4	0	0.94	0	62	1
8/23	2	0.95	6	0.95	8	0	0.94	0	69	1
8/24	2	0.95	1	0.95	3	0	0.94	0	72	1
8/25	0	0.95	3	0.95	3	0	1.00	0	75	1
8/26	4	0.95	5	0.95	9	19	1.00	19	84	20
8/27	9	0.95	12	0.95	20	40	1.00	40	104	60
8/28	6	0.95	12	0.95	17	46	1.00	46	121	106
8/29	10	0.95	12	0.95	21	56	1.00	56	142	162
8/30	3	0.95	26	0.95	28	64	1.00	64	169	226
8/31	20	0.95	6	0.95	25	126	1.00	126	194	352
9/1	8	0.95	5	0.95	12	124	1.00	124	206	476
9/2	11	0.95	15	0.95	25	100	1.00	100	231	576
9/3	12	0.95	33	0.95	43	124	1.00	124	274	700
9/4	37	0.95	38	0.95	71	105	1.00	105	345	805
9/5	48	0.95	53	0.95	96	90	1.00	90	441	895
9/6	46	0.95	58	0.95	99	95	1.00	95	540	990
9/7	37	0.95	41	0.95	74	107	1.00	107	614	1,097
9/8	34	0.95	32	0.95	63	83	1.00	83	676	1,180
9/9	11	0.95	26	0.95	35	94	1.00	94	712	1,274
9/10	18	0.95	14	0.95	30	84	1.00	84	742	1,358
9/11	16	0.95	32	0.95	46	65	1.00	65	788	1,423
9/12	17	0.95	17	0.95	32	46	1.00	46	820	1,469
9/13	30	0.95	24	0.95	51	48	1.00	48	871	1,517
9/14	18	0.95	31	0.95	47	24	1.00	24	918	1,541
9/15	18	0.95	18	0.95	34	46	1.00	46	952	1,587
9/16	10	0.95	16	0.95	25	29	1.00	29	977	1,616
9/17	19	0.95	11	0.95	29	18	1.00	18	1,005	1,634
9/18	15	0.95	1	0.95	15	18	1.00	18	1,020	1,652
9/19	6	0.95	6	0.95	11	17	1.00	17	1,032	1,669
9/20	3	0.95	0	0.95	3	7	1.00	7	1,035	1,676
9/21	4	0.95	1	0.95	5	8	1.00	8	1,039	1,684
9/22	5	0.95	3	0.95	8	14	1.00	14	1,047	1,698
9/23	3	0.95	1	0.41	3	16	1.00	16	1,050	1,714
9/24	1	0.86	1	0.68	2	12	1.00	12	1,052	1,726
9/25	1	0.86	6	0.68	5	12	1.00	12	1,057	1,738
9/26	0	0.86	0	0.95	0	12	1.00	12	1,057	1,750
9/27	0	0.86	0	0.95	0	11	1.00	11	1,057	1,761
9/28	0	0.86	0	0.95	0	12	1.00	12	1,057	1,773
9/29	0	0.57	0	0.68	0	8	1.00	8	1,057	1,781
9/30	0	0.19	0	0.68	0	16	1.00	16	1,057	1,797
10/1	0	0.00	0	0.41	0	8	1.00	8	1,057	1,805
10/2	0	0.00	0	0.00	0	3	1.00	3	1,057	1,808

Table 4. Observed and adjusted number of releases at the tag deployment fish wheel and observed and adjusted number of unmarked catches at the recovery fish wheel used in the Bailey model to estimate the abundance of fall chum salmon in the Kantishna River, 2001.

Date	Day Tags Released	Estimated Proportion at Recovery Wheels	Night Tags Released	Estimated Proportion at Recovery Wheels	Adjusted Tags Released	Toklat Wheels Unmarked Catch	Estimated Proportion at Tagging Wheel	Toklat Wheels adjusted Unmarked Catch	Upper Kantishna Wheel Unmarked Catch	Estimated Proportion at Kantishna Tagging wheel	Kantishna Adjusted Unmarked Catch
8/16	24	0.95	18	0.95	40	2	0.00	0	2	0.00	0
8/17	24	0.95	17	0.95	39	4	0.02	0	2	0.02	0
8/18	14	0.95	15	0.95	28	4	0.04	0	3	0.04	0
8/19	15	0.95	16	0.95	29	2	0.30	1	1	0.30	0
8/20	23	0.95	18	0.95	39	4	0.66	3	2	0.66	1
8/21	21	0.95	17	0.95	36	3	0.82	2	2	0.82	2
8/22	18	0.95	11	0.95	28	0	0.91	0	1	0.91	1
8/23	24	0.95	30	0.95	51	0	0.96	0	4	0.96	4
8/24	24	0.95	49	0.95	69	2	0.98	2	0	0.98	0
8/25	43	0.95	43	0.95	82	3	0.98	3	3	0.98	3
8/26	16	0.95	27	0.95	41	5	0.99	5	0	0.99	0
8/27	44	0.95	56	0.95	95	3	1.00	3	7	1.00	7
8/28	51	0.95	47	0.95	93	2	1.00	2	7	1.00	7
8/29	57	0.95	50	0.95	102	7	1.00	7	9	1.00	9
8/30	61	0.95	65	0.95	120	5	1.00	5	3	1.00	3
8/31	54	0.95	50	0.95	99	11	1.00	11	3	1.00	3
9/1	56	0.95	46	0.95	97	12	1.00	12	3	1.00	3
9/2	29	0.95	33	0.95	59	14	1.00	14	3	1.00	3
9/3	46	0.95	48	0.95	89	15	1.00	15	2	1.00	2
9/4	41	0.95	41	0.95	78	14	1.00	14	9	1.00	9
9/5	46	0.95	41	0.95	83	12	1.00	12	1	1.00	1
9/6	24	0.95	50	0.95	70	14	1.00	14	6	1.00	6
9/7	44	0.95	37	0.95	77	13	1.00	13	0	1.00	0
9/8	37	0.95	32	0.95	66	20	1.00	20	9	1.00	9
9/9	23	0.95	5	0.95	27	39	1.00	39	7	1.00	7
9/10	25	0.95	34	0.95	56	61	1.00	61	5	1.00	5
9/11	21	0.95	19	0.95	38	35	1.00	35	11	1.00	11
9/12	18	0.95	15	0.95	31	37	1.00	37	11	1.00	11
9/13	19	0.95	22	0.95	39	48	1.00	48	9	1.00	9
9/14	24	0.95	26	0.95	48	39	1.00	39	13	1.00	13
9/15	28	0.95	18	0.95	44	47	1.00	47	16	1.00	16
9/16	12	0.95	12	0.95	23	37	1.00	37	8	1.00	8
9/17	16	0.95	15	0.95	29	39	1.00	39	11	1.00	11
9/18	23	0.95	13	0.05	23	46	1.00	46	15	1.00	15
9/19	17	0.93	11	0.10	17	34	1.00	34	14	1.00	14
9/20	4	0.93	4	0.44	5	46	1.00	46	10	1.00	10
9/21	11	0.90	7	0.64	14	15	1.00	15	24	1.00	24
9/22	9	0.86	13	0.85	19	38	1.00	38	19	1.00	19
9/23	6	0.77	4	0.92	8	35	1.00	35	8	1.00	8
9/24	3	0.64	3	0.97	5	28	1.00	28	3	1.00	3
9/25	0	0.18	0	0.97	0	21	1.00	21	5	1.00	5
9/26	0	0.00	0	0.97	0	18	1.00	18	5	1.00	5

Table 5. Number of tags recovered by location from fall chum salmon tagged in the Tanana and Kantishna Rivers, 2001

Recapture Location	Number of Tags
Bluff Cabin Slough [a]	8
Delta River [a]	33
Toklat Springs [a]	88
Tanana River recovery wheels	19
Toklat River recovery wheels [b]	96
Kantishna River recovery wheels [c]	9
Kantishna River [d]	6
Nenana [d]	7
Grayling [d]	1
Total	267

[a] Tags recovered from foot surveys of spawning streams.

[b] Includes three tags from the Tanana River tagging wheel.

[c] Includes four tags that were considered tag losses.

[d] Tags recovered from subsistence catches.

Table 6. Abundance estimates using the Bailey model for fall chum salmon in the Tanana and Kantishna Rivers, 2001.

Tanana River

Date	Point Estimate	S.E.	95% Lower Bound	95% Upper Bound	CV
9/25/2001	97,985	21,791	55,274	140,696	0.22
10/2/2001	96,793	21,006	55,621	137,965	0.21
Final [a]	96,556	20,955	55,485	137,627	0.22

Kantishna River

Date	Point Estimate	S.E.	95% lower bound	95% upper bound	CV
9/25/2001	36,663	3,598	29,611	43,715	0.09
9/30/2001	37,425	3,517	30,532	44,318	0.09
Final [a]	22,992	2,172	18,734	27,250	0.09

a The postseason estimates are different than the inseason estimates because of data reduction using Tables 1 through 4.

Table 7. Daily and cumulative catch statistics and Bailey abundance estimates of fall chum salmon in the Tanana River, 2001.

Date	Adjusted (Releases)	Examined For Tags	Recaptures	Abundance	95% Confidence Bounds Lower	95% Confidence Bounds Upper	Standard Error	CV
8/16	6	0	0					
8/17	15	0	0					
8/18	25	0	0					
8/19	44	1	0					
8/20	49	1	0					
8/21	58	1	0					
8/22	62	1	0					
8/23	69	1	0					
8/24	72	1	0					
8/25	75	1	0					
8/26	84	20	0					
8/27	104	60	0					
8/28	121	106	0					
8/29	142	162	0					
8/30	169	226	0					
8/31	194	352	0					
9/1	206	476	0					
9/2	231	578	2	44,527	1,004	88,050	22,206	0.50
9/3	274	703	3	48,129	6,062	90,196	21,463	0.45
9/4	345	809	4	55,841	11,297	100,385	22,727	0.41
9/5	441	899	4	79,313	16,026	142,600	32,289	0.41
9/6	540	994	4	107,342	21,666	193,018	43,712	0.41
9/7	614	1,102	5	112,782	29,459	196,105	42,512	0.38
9/8	676	1,185	5	133,662	34,895	232,429	50,391	0.38
9/9	712	1,281	7	113,994	39,750	188,238	37,879	0.33
9/10	742	1,368	10	92,315	40,293	144,337	26,542	0.29
9/11	788	1,435	12	86,973	41,621	132,325	23,139	0.27
9/12	820	1,482	13	86,825	43,093	130,557	22,312	0.26
9/13	871	1,531	14	88,953	45,580	132,326	22,129	0.25
9/14	918	1,555	14	95,174	48,764	141,584	23,679	0.25
9/15	952	1,602	15	95,347	50,249	140,445	23,009	0.24
9/16	977	1,631	15	99,592	52,482	146,702	24,036	0.24
9/17	1,005	1,649	15	103,629	54,606	152,652	25,011	0.24
9/18	1,020	1,667	15	106,344	56,034	156,654	25,668	0.24
9/19	1,032	1,684	15	108,628	57,235	160,021	26,221	0.24
9/20	1,035	1,691	15	109,381	57,631	161,131	26,403	0.24
9/21	1,039	1,700	16	103,970	56,179	151,761	24,383	0.23
9/22	1,047	1,714	16	105,592	57,053	154,131	24,765	0.23
9/23	1,050	1,731	17	101,028	55,837	146,219	23,057	0.23
9/24	1,052	1,744	18	96,570	54,477	138,663	21,476	0.22
9/25	1,057	1,756	18	97,690	55,108	140,272	21,726	0.22
9/26	1,057	1,769	19	93,492	53,731	133,253	20,286	0.22
9/27	1,057	1,780	19	94,073	54,064	134,082	20,413	0.22
9/28	1,057	1,792	19	94,707	54,427	134,987	20,551	0.22
9/29	1,057	1,800	19	95,130	54,669	135,591	20,643	0.22
9/30	1,057	1,816	19	95,975	55,152	136,798	20,828	0.22
10/1	1,057	1,824	19	96,398	55,395	137,401	20,920	0.22
10/2	1,057	1,827	19	96,556	55,485	137,627	20,955	0.22

[a] The number of tags deployed was adjusted by 5% for mortality.

Table 8. Daily and cumulative catch statistics and Bailey abundance estimates of fall chum salmon in the Kantishna River, 2001.

Date	Adjusted (Releases)	Examined For Tags	Recaptures	Abundance	95% Confidence Bounds Lower	95% Confidence Bounds Upper	Standard Error	CV
8/16	40	0	0					
8/17	39	0	0					
8/18	28	0	0					
8/19	29	1	0	266	9	523	131	0.49
8/20	39	3	2	343	108	578	120	0.35
8/21	36	9	3	697	186	1,208	260	0.37
8/22	28	9	3	789	212	1,366	295	0.37
8/23	51	13	5	920	356	1,484	288	0.31
8/24	69	20	5	1,540	541	2,539	510	0.33
8/25	82	26	6	2,052	792	3,312	643	0.31
8/26	41	34	7	2,552	1,050	4,054	766	0.30
8/27	95	43	7	3,689	1,475	5,903	1,130	0.31
8/28	93	45	8	4,032	1,750	6,314	1,164	0.29
8/29	102	53	9	4,874	2,231	7,517	1,348	0.28
8/30	120	59	11	5,286	2,666	7,906	1,337	0.25
8/31	99	66	19	4,266	2,667	5,865	816	0.19
9/1	97	86	24	4,833	3,197	6,469	835	0.17
9/2	59	105	32	4,797	3,390	6,204	718	0.15
9/3	89	126	37	5,336	3,868	6,804	749	0.14
9/4	78	143	41	5,789	4,268	7,310	776	0.13
9/5	83	162	45	6,316	4,722	7,910	813	0.13
9/6	70	180	46	7,085	5,300	8,870	911	0.13
9/7	77	196	49	7,596	5,735	9,457	950	0.13
9/8	66	219	57	7,686	5,942	9,430	890	0.12
9/9	27	267	64	8,355	6,547	10,163	922	0.11
9/10	56	337	67	10,076	7,907	12,245	1,107	0.11
9/11	38	383	70	11,060	8,713	13,407	1,197	0.11
9/12	31	422	77	11,288	9,001	13,575	1,167	0.10
9/13	39	486	83	12,213	9,815	14,611	1,223	0.10
9/14	48	533	86	13,165	10,615	15,715	1,301	0.10
9/15	44	583	88	14,278	11,530	17,026	1,402	0.10
9/16	23	625	91	14,915	12,085	17,745	1,444	0.10
9/17	29	668	93	15,749	12,784	18,714	1,513	0.10
9/18	34	718	96	16,605	13,519	19,691	1,574	0.09
9/19	26	758	97	17,490	14,248	20,732	1,654	0.09
9/20	7	812	97	18,662	15,189	22,135	1,772	0.09
9/21	16	832	97	19,229	15,646	22,812	1,828	0.10
9/22	20	876	97	20,341	16,541	24,141	1,939	0.10
9/23	7	917	98	21,074	17,150	24,998	2,002	0.10
9/24	2	946	99	21,503	17,515	25,491	2,035	0.09
9/25	3	970	99	22,026	17,936	26,116	2,087	0.09
9/26	0	993	99	22,502	18,319	26,685	2,134	0.09
9/27	0	1,006	99	22,769	18,534	27,004	2,161	0.09
9/28	0	1,027	100	22,992	18,734	27,250	2,172	0.09

Table 9. Tanana and Kantishna River abundance estimates, using the Bailey model, 1995-2001.

Year	Point estimate	S.E.	95% Lower Bound	95% Upper bound
1995	268,173	21,597	225,842	310,503
1996	134,563	16,945	101,351	167,775
1997	71,661	11,876	48,384	94,937
1998	62,014	6,556	49,164	74,863
1999	97,843	19,362	59,893	135,792
2000	34,844	4,970	25,104	44,584
2001	96,556	20,955	55,484	137,627
1995-2000 Mean	111,516			

Kantishna River

Year	Point estimate	S.E.	95% Lower Bound	95% Upper bound
1999	27,199	3,562	20,218	34,180
2000	21,450	3,031	15,510	27,390
2001	22,992	2,172	18,734	27,250
1999-2000 Mean	24,325			

Table 10. Estimated fall chum salmon migration rates (km/day) for day and night caught fall chum salmon in the Tanana and Kantishna Rivers, 1995-2001.

Tanana River tagging fish wheel to Tanana River recovery fish wheel (76 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
1995	-	-	-	-	26	166
1996	-	-	-	-	31	187
1997	-	-	-	-	21	104
1998	29	49	31	30	30	79
1999	29	8	16	14	23	22
2000	25	25	20	20	23	45
2001	24	10	49	7	37	17
mean	27	23	29	18	27	89

Kantishna River tagging fish wheel to Toklat River recovery fish wheels (114 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
1999	20	26	22	28	21	54
2000	25	24	29	9	27	33
2001	25	52	28	37	27	89
mean	23	34	26	25	25	59

Kantishna River tagging fish wheel to upper Kantishna River recovery fish wheel (139 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
2000	26	10	27	1	27	11
2001	31	2	28	3	30	5
mean	29	6	28	2	28	8

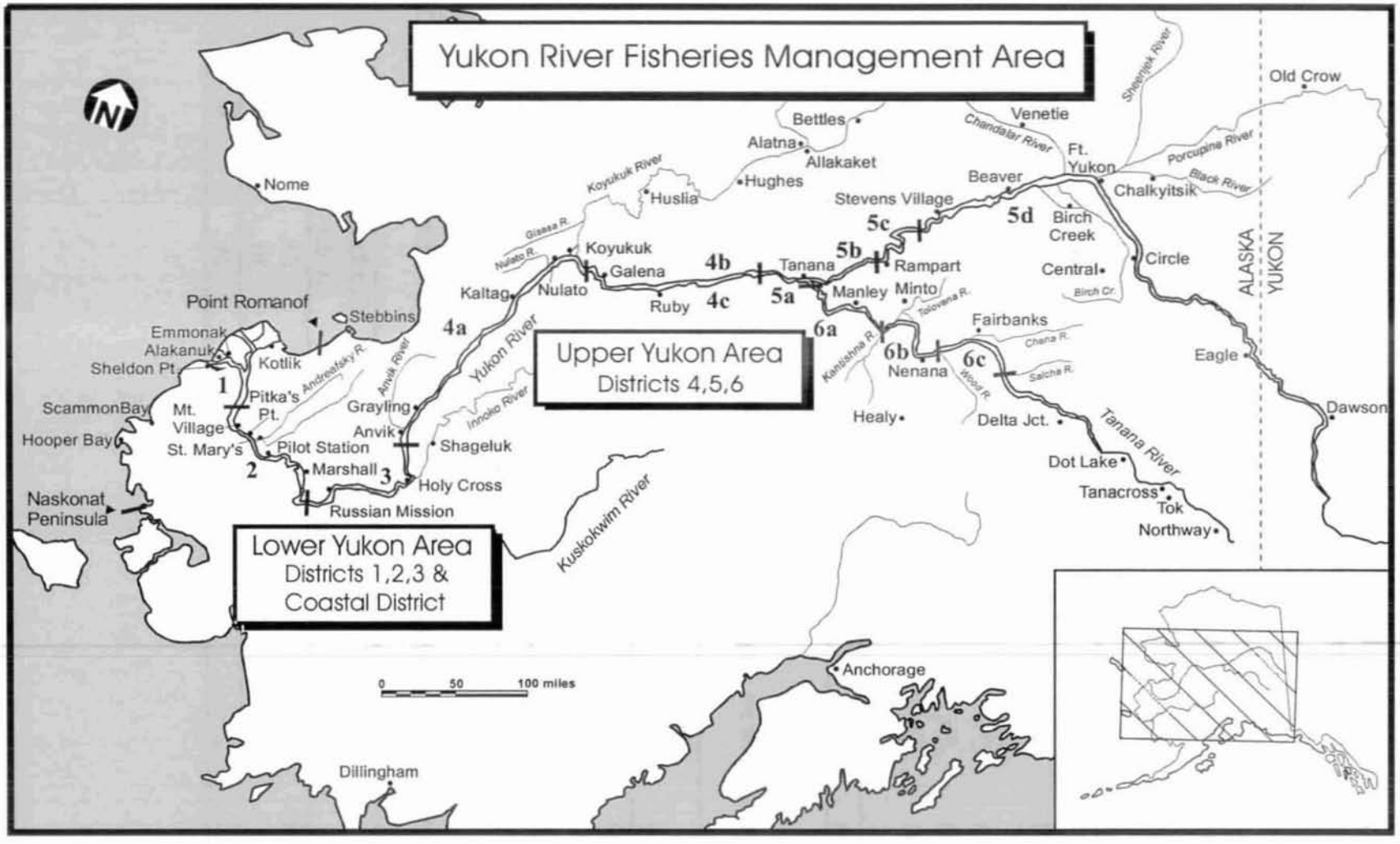

Figure 1. Fisheries management districts and subdistricts in the Yukon and Tanana River drainages.

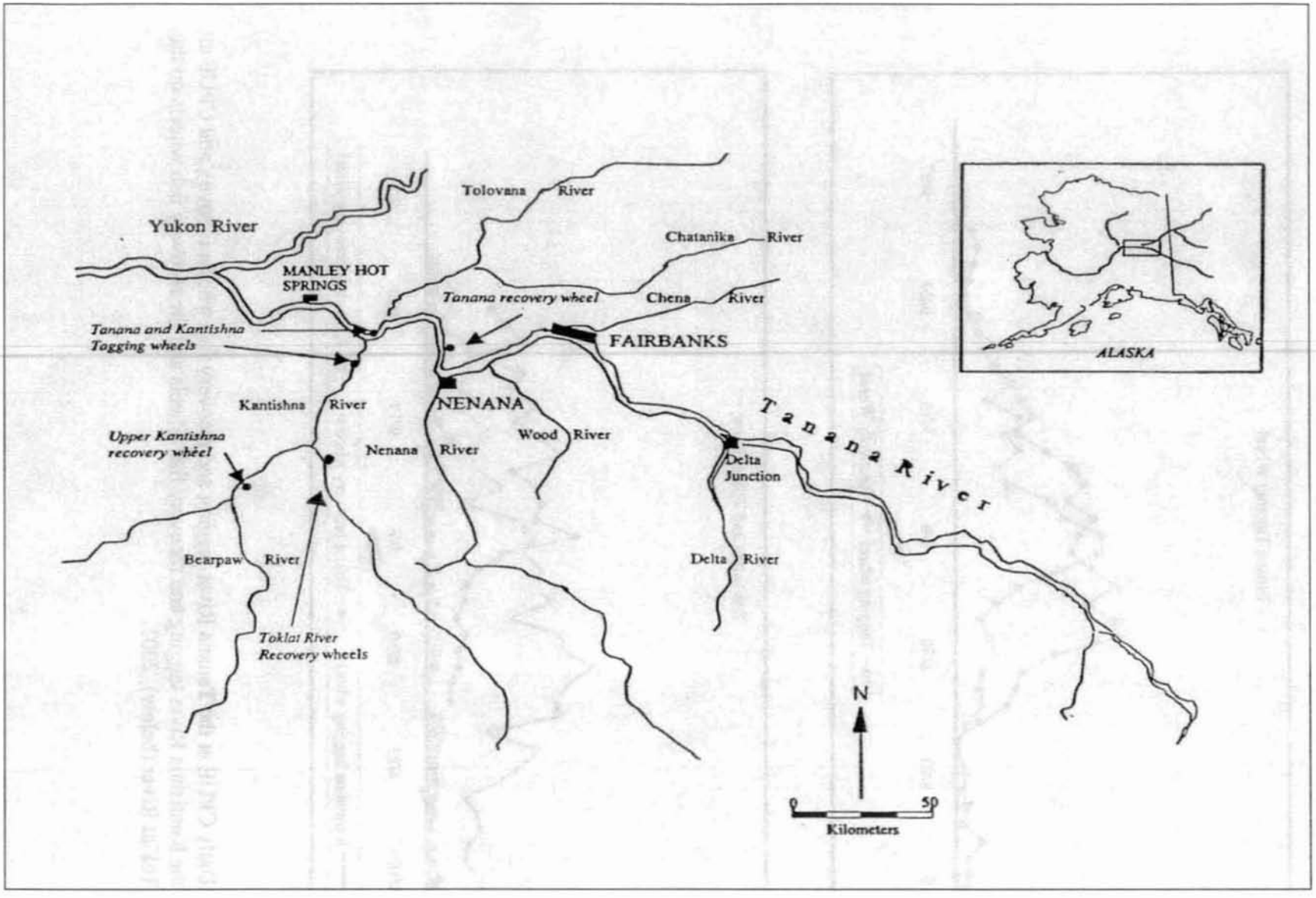

Figure 2. Location of tag deployment and recovery fish wheels used in the Tanana River fall chum salmon tagging project.

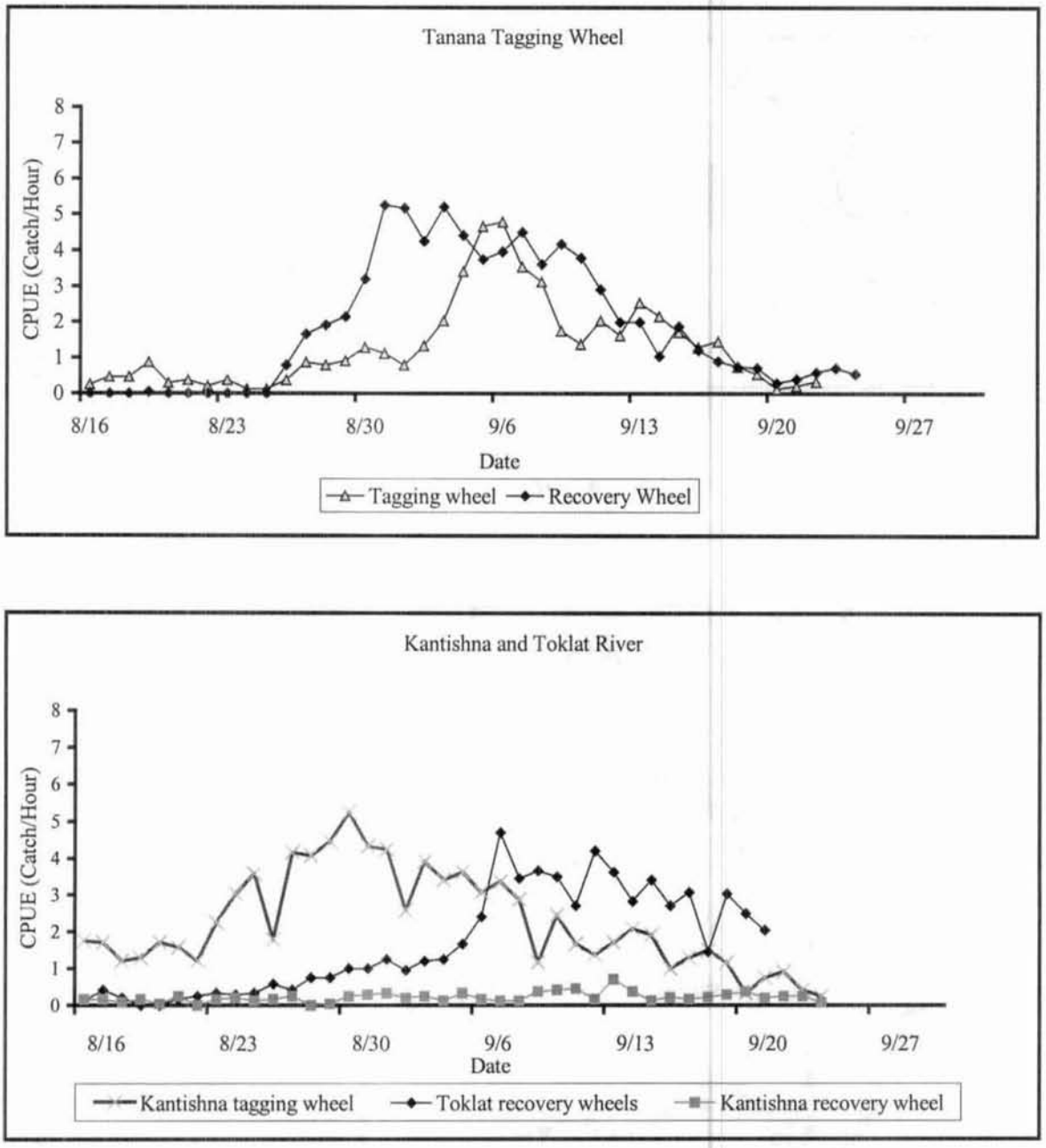

Figure 3. Daily CPUE at the Tanana River tagging and recovery fish wheels (above), and CPUE at the Kantishna River tagging and recovery fish wheels and the recovery fish wheels on the Toklat River (below), 2001.

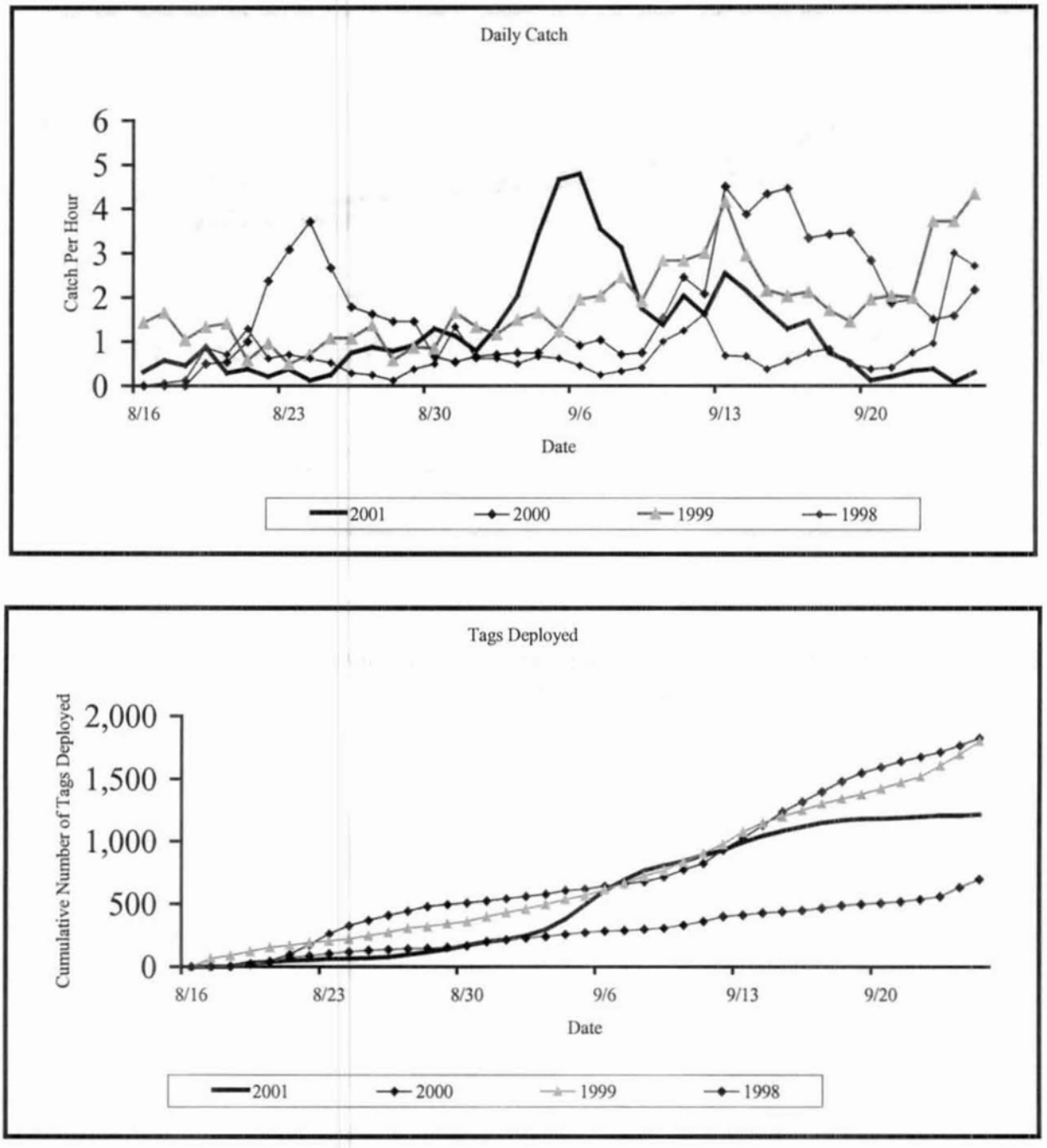

Figure 4. Daily CPUE at the Tanana River tag deployment fish wheel (above) and the cumulative number of tags deployed at the same location (below), 1998-2001.

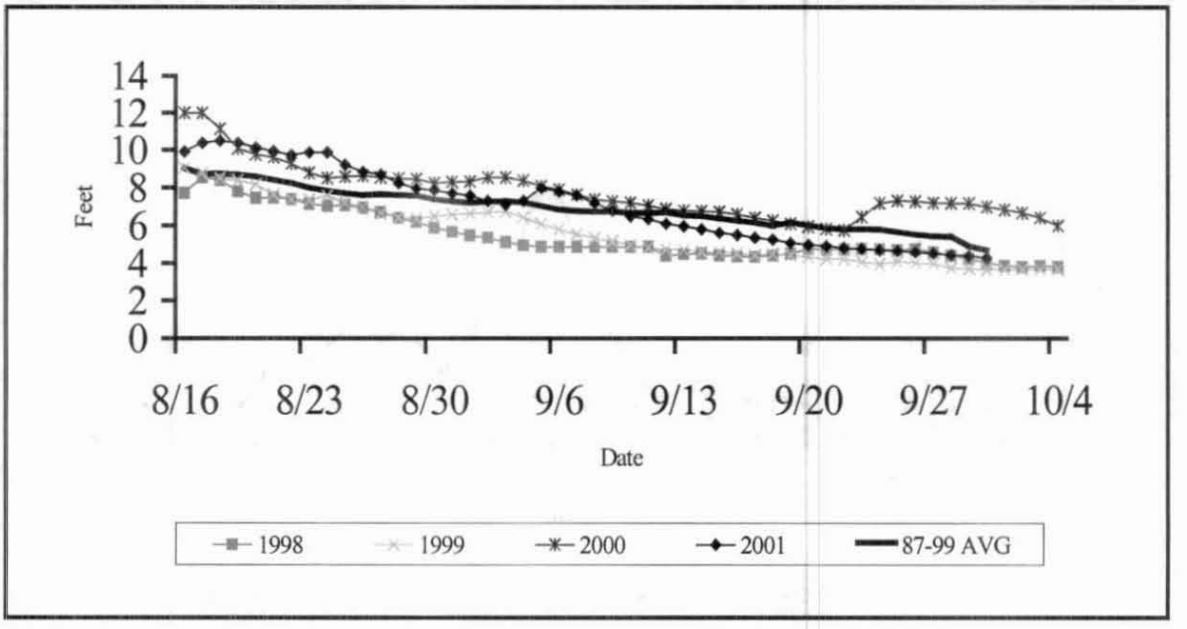

Figure 5. Daily water levels on the Tanana River as measured by a United States Geological survey gauge located near Nenana, 1998-2001.

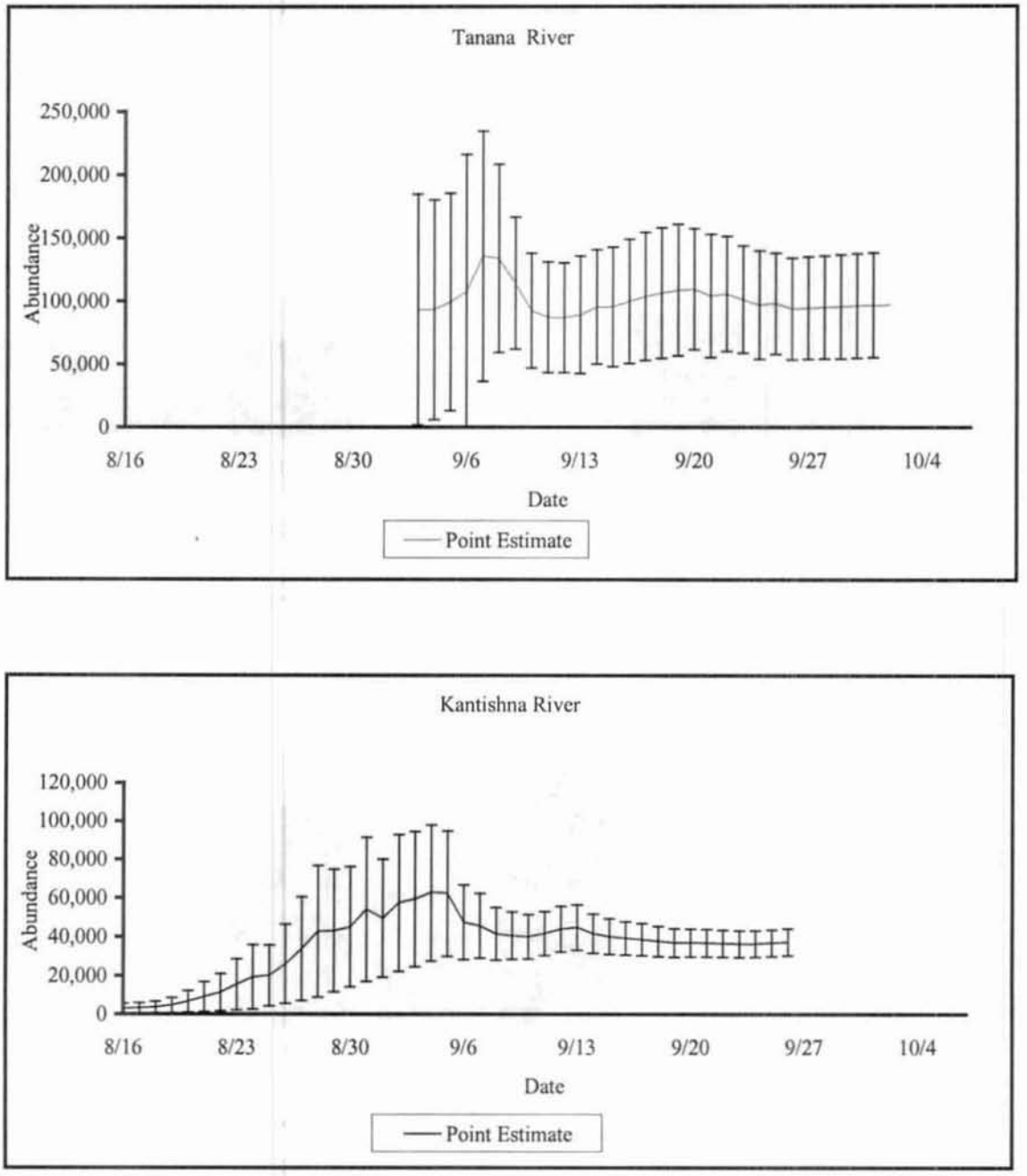

Figure 6. Inseason abundance estimates and associated confidence bounds using the Bailey model for fall chum salmon tagged on the Tanana River (above) and Kantishna River (below), 2001.

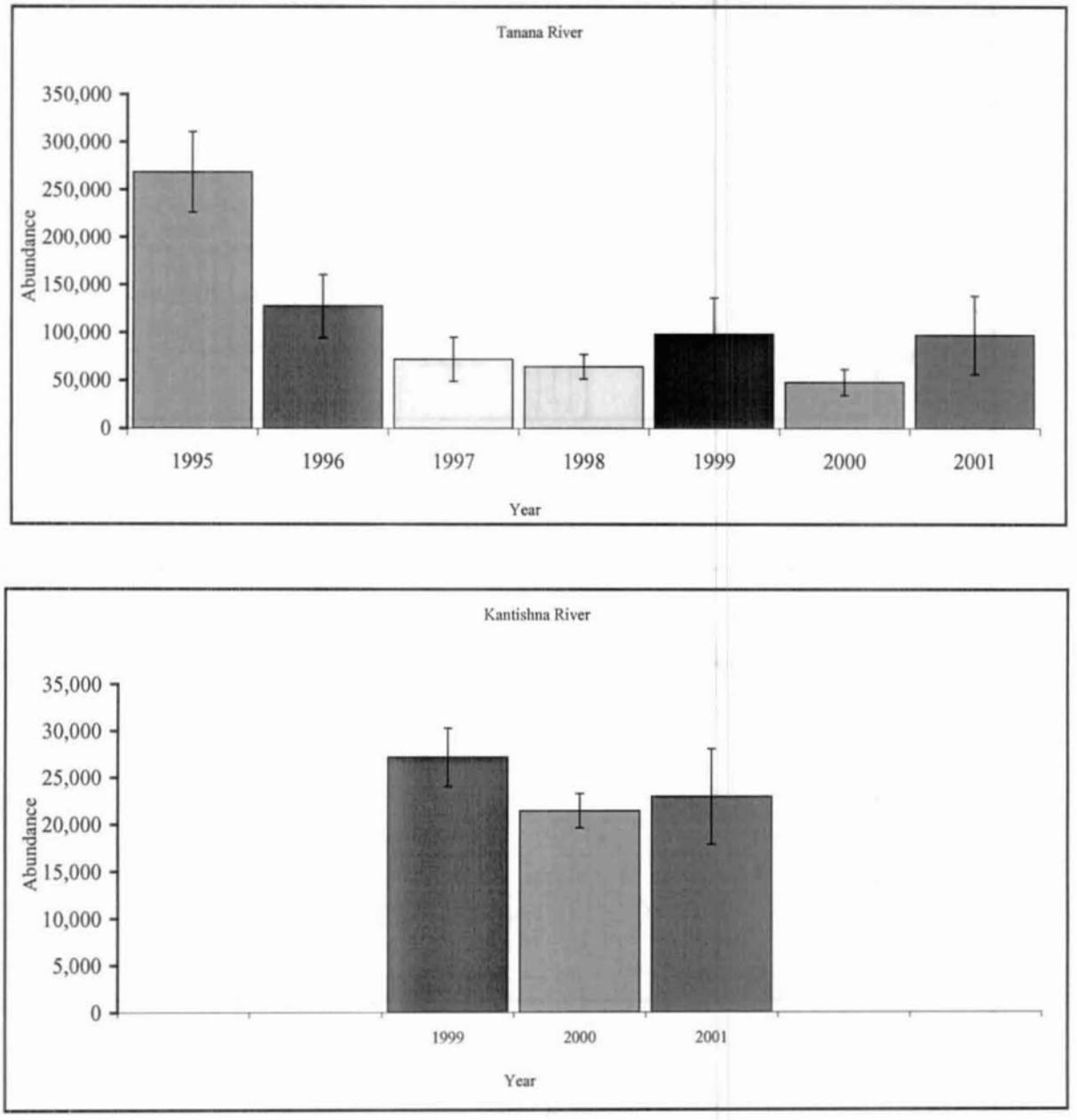

Figure 7. Abundance estimates and 95% confidence bounds for fall chum salmon on the Tanana River, 1995-2001 (above) and for the Kantishna River, 1999-2001 (below).

Appendix A. Daily effort and catch of fall chum salmon in the Tanana River tagging fish wheel, 2001.

		Tagged				Not Tagged				Total			
Date	Hours Fished	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative
8/16	19	3	3	6	6	0	0	0	0	3	3	6	6
8/17	19	4	6	10	16	0	1	1	1	4	7	11	17
8/18	24	4	6	10	26	0	1	1	2	4	7	11	28
8/19	24	12	8	20	46	1	0	1	3	13	8	21	49
8/20	24	5	1	6	52	0	0	0	3	5	1	6	55
8/21	24	5	4	9	61	0	0	0	3	5	4	9	64
8/22	24	3	1	4	65	0	1	1	4	3	2	5	69
8/23	24	4	4	8	73	0	1	1	5	4	5	9	78
8/24	24	2	1	3	76	0	0	0	5	2	1	3	81
8/25	12	2	1	3	79	0	0	0	5	2	1	3	84
8/26	12	6	3	9	88	0	0	0	5	6	3	9	93
8/27	24	11	10	21	109	0	0	0	5	11	10	21	114
8/28	24	6	12	18	127	0	1	1	6	6	13	19	133
8/29	24	12	10	22	149	0	0	0	6	12	10	22	155
8/30	24	16	13	29	178	1	1	2	8	17	14	31	186
8/31	24	11	15	26	204	0	1	1	9	11	16	27	213
9/1	24	7	6	13	217	0	1	1	10	7	7	14	227
9/2	24	13	13	26	243	3	3	6	16	16	16	32	259
9/3	24	19	26	45	288	1	5	6	22	20	31	51	310
9/4	24	40	35	75	363	3	1	4	26	43	36	79	389
9/5	24	40	61	101	464	4	3	7	33	44	64	108	497
9/6	24	53	51	104	568	3	8	11	44	56	59	115	612
9/7	24	27	51	78	646	6	5	11	55	33	56	89	701
9/8	24	28	38	66	712	1	6	7	62	29	44	73	774
9/9	24	20	17	37	749	2	7	9	71	22	24	46	820
9/10	24	12	20	32	781	2	3	5	76	14	23	37	857
9/11	24	17	31	48	829	1	0	1	77	18	31	49	906
9/12	24	18	16	34	863	0	1	1	78	18	17	35	941
9/13	24	27	27	54	917	1	4	5	83	28	31	59	1,000
9/14	24	20	29	49	966	2	5	7	90	22	34	56	1,056
9/15	24	11	25	36	1,002	1	2	3	93	12	27	39	1,095
9/16	24	12	14	26	1,028	3	2	5	98	15	16	31	1,126
9/17	24	9	21	30	1,058	3	2	5	103	12	23	35	1,161
9/18	24	5	11	16	1,074	2	3	5	108	7	14	21	1,182
9/19	24	4	8	12	1,086	2	0	2	110	6	8	14	1,196
9/20	24	1	2	3	1,089	0	1	1	111	1	3	4	1,200
9/21	24	2	3	5	1,094	0	0	0	111	2	3	5	1,205
9/22	24	5	3	8	1,102	0	0	0	111	5	3	8	1,213
9/23	24	1	3	4	1,106	0	0	0	111	1	3	4	1,217
9/24	24	0	2	2	1,108	1	4	5	116	1	6	7	1,224
9/25	23	1	6	7	1,115	0	0	0	116	1	6	7	1,231
Total		498	617	1,115		43	73	116		541	690	1,231	

Appendix B. Daily effort and catch of fall chum salmon at the Kantishna River tagging fish wheel, 2001.

		Tagged				Not Tagged				Total			
Date	Hours Fished	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative
8/16	24	19	23	42	42	1	2	3	3	20	25	45	45
8/17	24	28	13	41	83	1	2	3	6	29	15	44	89
8/18	24	20	9	29	112	1	2	3	9	21	11	32	121
8/19	24	19	12	31	143	2	3	5	14	21	15	36	157
8/20	24	25	16	41	184	1	0	1	15	26	16	42	199
8/21	24	30	8	38	222	1	1	2	17	31	9	40	239
8/22	24	20	9	29	251	2	3	5	22	22	12	34	273
8/23	24	31	23	54	305	1	1	2	24	32	24	56	329
8/24	24	44	29	73	378	8	2	10	34	52	31	83	412
8/25	24	52	34	86	464	2	5	7	41	54	39	93	505
8/26	24	24	19	43	507	5	3	8	49	29	22	51	556
8/27	24	51	49	100	607	4	7	11	60	55	56	111	667
8/28	24	57	41	98	705	8	17	25	85	65	58	123	790
8/29	24	53	54	107	812	3	5	8	93	56	59	115	905
8/30	24	70	56	126	938	4	10	14	107	74	66	140	1,045
8/31	24	54	50	104	1,042	7	14	21	128	61	64	125	1,170
9/1	24	65	37	102	1,144	7	8	15	143	72	45	117	1,287
9/2	24	42	20	62	1,206	8	9	17	160	50	29	79	1,366
9/3	24	53	41	94	1,300	9	8	17	177	62	49	111	1,477
9/4	24	43	39	82	1,382	4	5	9	186	47	44	91	1,568
9/5	24	48	39	87	1,469	9	5	14	200	57	44	101	1,669
9/6	24	50	24	74	1,543	8	3	11	211	58	27	85	1,754
9/7	24	48	33	81	1,624	11	10	21	232	59	43	102	1,856
9/8	24	39	30	69	1,693	13	4	17	249	52	34	86	1,942
9/9	24	11	17	28	1,721	0	6	6	255	11	23	34	1,976
9/10	24	30	29	59	1,780	6	3	9	264	36	32	68	2,044
9/11	24	25	15	40	1,820	6	0	6	270	31	15	46	2,090
9/12	24	16	17	33	1,853	6	3	9	279	22	20	42	2,132
9/13	24	15	26	41	1,894	6	7	13	292	21	33	54	2,186
9/14	24	22	28	50	1,944	7	9	16	308	29	37	66	2,252
9/15	24	19	27	46	1,990	11	12	23	331	30	39	69	2,321
9/16	24	10	14	24	2,014	8	4	12	343	18	18	36	2,357
9/17	24	12	19	31	2,045	9	7	16	359	21	26	47	2,404
9/18	24	18	18	36	2,081	4	5	9	368	22	23	45	2,449
9/19	24	14	14	28	2,109	10	9	19	387	24	23	47	2,496
9/20	24	0	8	8	2,117	6	3	9	396	6	11	17	2,513
9/21	24	3	15	18	2,135	7	9	16	412	10	24	34	2,547
9/22	24	7	15	22	2,157	3	8	11	423	10	23	33	2,580
9/23	24	2	8	10	2,167	5	4	9	432	7	12	19	2,599
9/24	24	1	5	6	2,173	1	2	3	435	2	7	9	2,608
9/25	24	4	8	12	2,185	2	4	6	441	6	12	18	2,626
9/26	24	1	2	3	2,188	2	1	3	444	3	3	6	2,632
9/27	24	0	0	0	2,188	0	0	0	444	0	0	0	2,632
9/28	24	0	0	0	2,188	0	0	0	444	0	0	0	2,632
9/29	24	0	0	0	2,188	0	0	0	444	0	0	0	2,632
Total		1,195	993	2,188		219	225	444		1,414	1,218	2,632	

Appendix C. Daily effort and catch of tagged and untagged fall chum salmon in the Tanana River recovery fish wheel, 2001.

		Tagged				Not Tagged				Total			
Date	Hours Fished	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0
8/17	24	0	0	0	0	0	0	0	0	0	0	0	0
8/18	10	0	0	0	0	0	0	0	0	0	0	0	0
8/19	24	0	0	0	0	0	1	1	1	0	1	1	1
8/20	16	0	0	0	0	0	0	0	1	0	0	0	1
8/21	24	0	0	0	0	0	0	0	1	0	0	0	1
8/22	24	0	0	0	0	0	0	0	1	0	0	0	1
8/23	24	0	0	0	0	0	0	0	1	0	0	0	1
8/24	24	0	0	0	0	0	0	0	1	0	0	0	1
8/25	24	0	0	0	0	0	0	0	1	0	0	0	1
8/26	24	0	0	0	0	19	0	19	20	19	0	19	20
8/27	24	0	0	0	0	26	14	40	60	26	14	40	60
8/28	24	0	0	0	0	17	29	46	106	17	29	46	106
8/29	26	0	0	0	0	30	26	56	162	30	26	56	162
8/30	20	0	0	0	0	35	29	64	226	35	29	64	226
8/31	24	0	0	0	0	67	59	126	352	67	59	126	352
9/1	24	0	0	0	0	63	61	124	476	63	61	124	476
9/2	24	1	1	2	2	57	43	100	576	58	44	102	578
9/3	24	1	0	1	3	65	59	124	700	66	59	125	703
9/4	24	1	0	1	4	57	48	105	805	58	48	106	809
9/5	24	0	0	0	4	57	33	90	895	57	33	90	899
9/6	24	0	0	0	4	61	34	95	990	61	34	95	994
9/7	24	1	0	1	5	56	51	107	1,097	57	51	108	1,102
9/8	23	0	0	0	5	50	33	83	1,180	50	33	83	1,185
9/9	23	1	1	2	7	39	55	94	1,274	40	56	96	1,281
9/10	23	2	1	3	10	45	39	84	1,358	47	40	87	1,368
9/11	23	1	1	2	12	35	30	65	1,423	36	31	67	1,435
9/12	23.5	0	1	1	13	22	24	46	1,469	22	25	47	1,482
9/13	24.5	0	1	1	14	25	23	48	1,517	25	24	49	1,531
9/14	23	0	0	0	14	11	13	24	1,541	11	13	24	1,555
9/15	25	1	0	1	15	16	30	46	1,587	17	30	47	1,602
9/16	24	0	0	0	15	13	16	29	1,616	13	16	29	1,631
9/17	20	0	0	0	15	10	8	18	1,634	10	8	18	1,649
9/18	24	0	0	0	15	7	11	18	1,652	7	11	18	1,667
9/19	24	0	0	0	15	4	13	17	1,669	4	13	17	1,684
9/20	24	0	0	0	15	2	5	7	1,676	2	5	7	1,691
9/21	22.5	1	0	1	16	4	4	8	1,684	5	4	9	1,700
9/22	24	0	0	0	16	7	7	14	1,698	7	7	14	1,714
9/23	24	0	1	1	17	7	9	16	1,714	7	10	17	1,731
9/24	24	0	1	1	18	4	8	12	1,726	4	9	13	1,744
9/25	24	0	0	0	18	4	8	12	1,738	4	8	12	1,756
9/26	24	1	0	1	19	6	6	12	1,750	7	6	13	1,769
9/27	26	0	0	0	19	2	9	11	1,761	2	9	11	1,780
9/28	24	0	0	0	19	6	6	12	1,773	6	6	12	1,792
9/29	24	0	0	0	19	2	6	8	1,781	2	6	8	1,800
9/30	24	0	0	0	19	8	8	16	1,797	8	8	16	1,816
10/1	30	0	0	0	19	4	4	8	1,805	4	4	8	1,824
10/2	19	0	0	0	19	1	2	3	1,808	1	2	3	1,827
Total		11	8	19		943	862	1808		955	872	1827	

Appendix D. Daily effort and catch of tagged and untagged fall chum salmon in the Toklat River recovery fish wheels (both wheels combined), 2001.

		Tagged				Not Tagged				Total			
Date	Hours Fished	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative
8/16	24	0	0	0	0	6	4	10	10	6	4	10	10
8/17	24	0	0	0	0	2	5	7	17	2	5	7	17
8/18	24	0	0	0	0	2	1	3	20	2	1	3	20
8/19	24	0	0	0	0	1	1	2	22	1	1	2	22
8/20	24	2	0	2	2	4	4	8	30	6	4	10	32
8/21	24	0	1	1	3	1	4	5	35	1	5	6	38
8/22	24	0	0	0	3	0	0	0	35	0	0	0	38
8/23	24	0	0	0	3	0	0	0	35	0	0	0	38
8/24	24	0	0	0	3	2	2	4	39	2	2	4	42
8/25	24	0	0	0	3	3	3	6	45	3	3	6	48
8/26	24	0	0	0	3	3	5	8	53	3	5	8	56
8/27	24	0	0	0	3	4	3	7	60	4	3	7	63
8/28	24	0	0	0	3	6	2	8	68	6	2	8	71
8/29	24	1	0	1	4	6	7	13	81	7	7	14	85
8/30	24	0	0	0	4	5	5	10	91	5	5	10	95
8/31	24	0	0	0	4	11	7	18	109	11	7	18	113
9/1	24	0	0	0	4	6	12	18	127	6	12	18	131
9/2	24	1	0	1	5	9	14	23	150	10	14	24	155
9/3	24	1	0	1	6	8	15	23	173	9	15	24	179
9/4	24	0	0	0	6	16	14	30	203	16	14	30	209
9/5	24	1	0	1	7	10	12	22	225	11	12	23	232
9/6	24	0	0	0	7	15	14	29	254	15	14	29	261
9/7	24	1	0	1	8	15	14	29	283	16	14	30	291
9/8	24	1	0	1	9	19	20	39	322	20	20	40	331
9/9	24	2	0	2	11	17	39	56	378	19	39	58	389
9/10	24	5	3	8	19	44	61	105	483	49	64	113	502
9/11	24	4	1	5	24	43	35	78	561	47	36	83	585
9/12	24	2	5	7	31	44	37	81	642	46	42	88	673
9/13	24	1	4	5	36	31	48	79	721	32	52	84	757
9/14	24	3	1	4	40	22	39	61	782	25	40	65	822
9/15	24	0	4	4	44	50	47	97	879	50	51	101	923
9/16	24	0	2	2	46	32	54	86	965	32	56	88	1,011
9/17	24	2	1	3	49	26	39	65	1,030	28	40	68	1,079
9/18	24	6	3	9	58	27	47	74	1,104	33	50	83	1,162
9/19	24	3	3	6	64	25	34	59	1,163	28	37	65	1,227
9/20	24	3	2	5	69	23	41	64	1,227	26	43	69	1,296
9/21	24	1	3	4	73	16	15	31	1,258	17	18	35	1,331
9/22	24	4	3	7	80	28	38	66	1,324	32	41	73	1,404
9/23	24	0	6	6	86	19	35	54	1,378	19	41	60	1,464
9/24	24	1	1	2	88	19	28	47	1,425	20	29	49	1,513
9/25	24	0	2	2	90	22	21	43	1,468	22	23	45	1,558
9/26	24	2	1	3	93	14	18	32	1,500	16	19	35	1,593
9/27	24	0	1	1	94	10	11	21	1,521	10	12	22	1,615
9/28	24	0	2	2	96	15	18	33	1,554	15	20	35	1,650
9/29	24	0	0	0	96	8	12	20	1,574	8	12	20	1,670
9/30	24	0	0	0	96	8	22	30	1,604	8	22	30	1,700
Total		47	49	96		697	907	1,604		744	956	1,700	

Appendix E. Daily effort and catch of tagged and untagged fall chum salmon in the Kantishna River recovery fish wheel, 2001.

		Tagged				Not Tagged				Total			
Date	Hours Fished	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative	Males	Females	Total	Cumulative
8/16	24	0	0	0	0	4	0	4	4	4	0	4	4
8/17	24	0	0	0	0	3	1	4	8	3	1	4	8
8/18	24	0	0	0	0	2	0	2	10	2	0	2	10
8/19	24	0	0	0	0	2	2	4	14	2	2	4	14
8/20	24	0	0	0	0	1	0	1	15	1	0	1	15
8/21	24	0	0	0	0	4	2	6	21	4	2	6	21
8/22	24	0	0	0	0	0	0	0	21	0	0	0	21
8/23	24	0	0	0	0	2	2	4	25	2	2	4	25
8/24	24	0	0	0	0	2	3	5	30	2	3	5	30
8/25	24	0	0	0	0	1	2	3	33	1	2	3	33
8/26	24	0	0	0	0	1	3	4	37	1	3	4	37
8/27	24	0	0	0	0	3	3	6	43	3	3	6	43
8/28	24	0	0	0	0	0	0	0	43	0	0	0	43
8/29	24	0	0	0	0	0	1	1	44	0	1	1	44
8/30	24	0	0	0	0	4	2	6	50	4	2	6	50
8/31	24	0	0	0	0	5	2	7	57	5	2	7	57
9/1	24	0	0	0	0	5	3	8	65	5	3	8	65
9/2	24	0	0	0	0	3	2	5	70	3	2	5	70
9/3	24	0	0	0	0	1	5	6	76	1	5	6	76
9/4	24	0	0	0	0	2	1	3	79	2	1	3	79
9/5	24	1	0	1	1	4	3	7	86	5	3	8	87
9/6	24	0	0	0	1	2	2	4	90	2	2	4	91
9/7	24	0	0	0	1	3	0	3	93	3	0	3	94
9/8	24	0	0	0	1	1	2	3	96	1	2	3	97
9/9	24	0	0	0	1	3	6	9	105	3	6	9	106
9/10	24	1	0	1	2	5	4	9	114	6	4	10	116
9/11	24	0	0	0	2	1	10	11	125	1	10	11	127
9/12	12	0	0	0	2	2	0	2	127	2	0	2	129
9/13	24	1	0	1	3	9	7	16	143	10	7	17	146
9/14	24	1	0	1	4	3	5	8	151	4	5	9	155
9/15	23.5	0	0	0	4	2	1	3	154	2	1	3	158
9/16	23	0	0	0	4	3	2	5	159	3	2	5	163
9/17	24	0	0	0	4	3	1	4	163	3	1	4	167
9/18	18	0	0	0	4	1	3	4	167	1	3	4	171
9/19	24	1	0	1	5	3	3	6	173	4	3	7	178
9/20	24	1	0	1	6	3	5	8	181	4	5	9	187
9/21	24	0	0	0	6	2	3	5	186	2	3	5	192
9/22	24	0	0	0	6	1	5	6	192	1	5	6	198
9/23	24	0	0	0	6	3	3	6	198	3	3	6	204
9/24	24	1	0	1	7	0	1	1	199	1	1	2	206
9/25	24	0	1	1	8	1	2	3	202	1	3	4	210
9/26	24	0	0	0	8	2	3	5	207	2	3	5	215
9/27	24	1	0	1	9	1	1	2	209	2	1	3	218
9/28	24	0	0	0	9	1	2	3	212	1	2	3	221
9/29	24	0	0	0	9	0	0	0	212	0	0	0	221
9/30	24	0	0	0	9	0	1	1	213	0	1	1	222
10/1	24	0	0	0	9	0	1	1	214	0	1	1	223
10/2	24	0	0	0	9	0	1	1	215	0	1	1	224
10/3	25	0	0	0	9	1	1	2	217	1	1	2	226
10/4	26	0	0	0	9	0	1	1	218	0	1	1	227
10/5	27	0	0	0	9	0	0	0	218	0	0	0	227
10/6	28	0	0	0	9	1	0	1	219	1	0	1	228
10/7	29	0	0	0	9	0	0	0	219	0	0	0	228
10/8	30	0	0	0	9	0	0	0	219	0	0	0	228
Total		8	1	9		106	113	219		114	114	228	