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Abundance and Run Timing of Adult Salmon in the Tozitna River, Alaska, 2005

Annual Report for Study 04-206

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REPORT SUMMARY

Title: Abundance and Run Timing of Adult Salmon in the Tozitna River, Alaska, 2005

Study Number: 04-206

Investigator(s)/Affiliation(s): Jason Post, Carl Kretsinger, and Bob Karlen, U.S. Department of Interior, Bureau of Land Management, Fairbanks District Office; Stephanie Nicholia, Tanana Tribal Council.

Geographic Area: Middle Yukon River

Information Type: Stock Status and Trends

Issue(s) Addressed: Lack of escapement and run timing data in middle Yukon River Basin tributaries for Chinook *Oncorhynchus tshawytscha* and summer chum salmon *O. keta* to support Federal subsistence fishery management.

Study Cost: $144,000 ($66,000 contributed by the Office of Subsistence Management and $78,000 funded by the Bureau of Land Management).

Study Duration: 1 April 2005 to 1 May 2006

Abstract: The Tozitna River project is a multi-agency study to determine escapement, run timing, and age-sex-length (ASL) composition of adult Chinook and summer chum salmon in a middle Yukon River Basin tributary. A resistance board weir was operated from 29 June to 12 August 2005. The escapement for Chinook salmon was 1,611. The age composition was 21 % age-4, 46 % age-5, and 33 % age-6. The sex composition from readable scales was 30.2 % female. The escapement for summer chum salmon was 39,700. The age composition was 96 % age-4, and 4 % age-5. The sex composition from readable scales was 50.7 % female.

Key Words: Chinook salmon, chum salmon, *Oncorhynchus tshawytscha, O. keta,* resistance board weir, sex ratio, spawning adults, stock status and trend, subsistence fishery, Tozitna River, Yukon River drainage.

Project Data: *Description* - Data for this study consist of escapement counts, age (scales), sex, and length information for Chinook and summer chum salmon. *Format* – Escapement, age, sex, length and genetic data are stored in Microsoft Access and Excel. Scale impressions were created on cellulose acetate cards. *Custodians* - Escapement, age, sex, and length data: Bureau of Land Management (BLM), Fairbanks District Office, 1150 University Avenue, Fairbanks, Alaska 99709 and the Alaska Department of Fish and Game (ADFG), Division of Commercial Fisheries (ADF&G-DCF), 333 Raspberry Road, Anchorage, Alaska 99518. *Availability* - Access to the data is available from the custodians upon request.

Report Availability: Please contact either the author(s) or Alaska Resources Library and Information Services to obtain a copy of this report.

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INTRODUCTION

Conservation of salmon in the Yukon River drainage is complex and challenging for fisheries managers because of several biological and social factors: mixed-stocks, large geographic spawning distribution, overlapping and compressed run timing, recent declines in escapement, multiple user groups, and multi-agency management. Several plans and policies have been created to manage the Yukon River salmon escapement (see Holder and Senecal-Albrecht 1998). Mostly, the Yukon River salmon escapement is managed based on sustained yield, defined as the average annual yield resulting from an escapement level that can be maintained on a continuing basis.

In 1998, the Yukon River Comprehensive Salmon Plan for Alaska (YRCSPA) was developed to improve salmon management in the Yukon Area. On October 1, 1999, the Federal government joined the State of Alaska in managing Yukon River fisheries, assuming responsibility for subsistence fisheries management in inland navigable waters on, and adjacent to, Federal conservation lands (Buklis 2002).

In 2000, BLM in Alaska received a Congressional appropriation for Yukon River salmon restoration. In response to this appropriation, the BLM convened interagency coordination meetings to determine the most beneficial use of the funding. Emphasis was placed on funding projects that would satisfy both the BLM and Yukon River fisheries management. Yukon River fisheries managers placed a priority on addressing escapement and run timing data gaps in the middle Yukon River Sub-Basin for Chinook *Oncorhynchus tshawytscha* and summer chum *O. keta* salmon, as identified in the YRCSPA (Holder and Senecal-Albrecht 1998). After interagency coordination meetings, the BLM chose the Tozitna River as the site for an escapement study. The BLM, had in 1986, designated the Tozitna River an Area of Critical Environmental Concern for the protection of salmon spawning habitat and had identified acquisition of baseline resource data as a management objective (BLM 1986; Knapman 1989). In addition to addressing data gaps identified in the YRCSPA, salmon escapement and run timing data collected on the Tozitna River would assist the BLM in fulfilling its management objectives.

Accurate escapement estimates from spawning tributaries are an important fisheries management tool used to assist in the determination of production, marine survival, harvest, and spawner recruit relationships (Neilson and Geen 1981; Labelle 1994). Although aerial escapement surveys on the Tozitna River have been conducted by ADF&G since 1959, results of aerial surveys are inherently variable (Schultz et al. 1993) and should only be used to examine trends in relative escapement abundance (Barton 1984). Samples taken at weirs are considered to be the least biased and most accurate data available for assessing escapement and age composition of a mixed stock fishery (Halupka et al. 2000).

To accurately assess escapement of Chinook and summer chum salmon in the Middle Yukon River Sub-Basin, the BLM has operated a resistance board weir on the Tozitna River since 2002. The objectives of the project are:

(1) Determine escapement of Chinook and summer chum salmon;
(2) Describe the run timing of Chinook and summer chum salmon;
(3) Estimate relative abundance of Chinook and summer chum salmon downstream of the weir and document spawning locations using aerial survey techniques; and
(4) Estimate the weekly age and sex proportions of Chinook salmon so that the simultaneous estimates have a probability of 95 % of being within .05 of the population proportion; and so that estimates for chum salmon have an $\alpha = .10$ and d = .10.

Additional project tasks are:

(1) Measure water temperature, turbidity, precipitation, stream stage, and determine daily stream discharge and;
(2) Provide ADF&G with scale samples from Chinook salmon to assist in their scale pattern analysis program.

In addition, BLM seeks to provide ADF&G with 6 to 10 years of accurate estimates of total abundance for adult Chinook and summer chum salmon in the Tozitna River so that escapement goals for this system can be addressed.

STUDY AREA

The Tozitna River is a large, clear-water, northern tributary to the middle Yukon River, with a watershed area of 4, 215 km^2, 90 % of which the BLM manages (Figure 1). The watershed originates in the southeastern Ray Mountains at 1,676 m and flows southwesterly approximately 207 km to its confluence with the Yukon River (1,096 river km), 16 km downstream of Tanana. The average yearly precipitation is 32 cm [(1)] with 62 % occurring between June and September. Average monthly ambient temperature ranges from -28 to 22 °C [(1)]. The river is usually ice-free in May, and freeze-up commonly occurs by November (J. Blume, Tozitna River homesteader, Fairbanks, personal communication). Peak discharge is correlated with spring snowmelt or high-intensity rainstorms during the summer. Water turbidity remains low for the period from late June through early August, except for periods of high-intensity precipitation. Fish species in the Tozitna River include Chinook salmon, summer and fall chum salmon (Barton, 1984), coho salmon *O. kisutch*, sockeye salmon *O. nerka*, Dolly Varden *Salvelinus malma*, Arctic grayling *Thymallus arcticus*, northern pike *Esox lucius*, burbot *Lota lota*, round whitefish *Prosopium cylindraceum*, slimy sculpin *Cottus cognatus*, and longnose sucker *Catostomus catostomus*.

The weir site is approximately 80 km upstream from the mouth of the Tozitna River. The weir is located between a downstream riffle and upstream deep meander pool. At this location the average wetted width at summer flows is 52 m with an average depth of 0.6 m. This site is downstream of most Chinook salmon spawning (Kretsinger and Sundlov 2001, in preparation). The cross section is gradually sloping and the substrate consists of sand to cobble.

METHODS

Weir and Trap

Salmon escapement, run timing, and composition were assessed by counting and sampling fish as they passed through the resistance board weir fitted with a live trap. Construction and installation of the weir were as described by Tobin (1994). The trap (fabricated by Mackey Lake Co., Soldotna, AK) was incorporated into the weir on the upstream side. The weir was 57 m in width and was operational on 28 June. The weir was cleaned and inspected on a daily basis to remove debris and ensure the only avenue for fish passage was through the trap.

Escapement

All salmon passing through the weir and live trap were counted and identified to species. Observers wore polarized sunglasses to facilitate in fish identification. The counting schedule was 24 hours /day, 7 days / week and consisted of four 5 hour shifts and one 4 hour shift. During daily sampling efforts the trap could be closed for up to 45 minutes. On average, salmon were able to pass through the trap within 15 minutes after entering. Hourly counts were summed to achieve a daily count (0000 – 2359 hours). Run timing was calculated by the proportion of daily to cumulative passage to determine quartile (25, 50, and 75 %) dates and peak and median date of passage.

Data Analysis

Chinook Salmon

Temporally stratified random sampling design (Cochran 1977) was used to collect and analyze ASL data, with statistical weeks defining strata. Strata began on Wednesday and ended the following Tuesday with a weekly sample size target of 112 Chinook salmon distributed uniformly throughout the week (16 fish/day). The weekly sample goal allowed up to 5 % of the scales to be illegible. An overall sample goal of 448 fish was established so that there was a probability of .95 that all of the estimates were simultaneously within .05 of the population proportions (Thompson 1987). All target species within the trap at the time of sampling were sampled to avoid bias. The first and last sampling strata are greater than a week because of low escapement for those periods.

Summer Chum Salmon

Sampling for chum salmon was done in much the same manner as Chinook. The only difference was the weekly sample goal was established using the method described by Bromaghin (1993) so that simultaneous interval estimates of sex and age proportions for each week had .90 probability of being within .10 of population proportions. Strata began on Thursday and ended the following Wednesday with a weekly sample size target of 175 chum salmon distributed uniformly throughout the week (25 fish/day). The first sampling strata is greater than a week because of low escapement for that period and the last sampling strata was lengthened to include the final two days of sampling. The weekly sample goal allowed up to 15 % of the scales to be illegible.

Within a given stratum m, the proportion of species i passing the weir that are of sex j and age k (p_{ijkm}) is estimated as

$$P_{ijkm} = n_{ijkm} \;/\; n_{i++m}$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of P_{ijkm} is estimated as

$$v(P_{ijkm}) = (1 - n_{i++m} \;/\; N_{i++m})\; (P_{ijkm}\,(1 - P_{ijkm}) \,/\, n_{i++m} - 1),$$

where N_{i++m} denotes the total number of species i fish passing the weir in stratum m. The estimated number of fish of species i, sex j, age k passing the weir in stratum m (N_{ijkm}) is

$$N_{ijkm} = N_{i++m}\, P_{ijkm}\,,$$

with estimated variance

$$v(N_{ijkm}) = N^2_{i++m}\, v(P_{ijkm})$$

Estimates of proportions for the entire period of weir operation are computed as weighted sums of the stratum estimates, i.e.,

$$P_{ijk} = \sum_m (N_{i++m} \,/\, N_{i+++})\; P_{ijkm}$$

and

$$v(P_{ijk}) = \sum_{\mathrm{m}} (N_{i++m} \,/\, N_{i+++})^2\; v(P_{ijkm})$$

The total number of fish in a species, sex, and age category passing the weir during the entire period of operation is estimated as

$$N_{ijk} = \sum_{m} N_{ijkm} \ ,$$

with estimated variance

$$v(N_{ijk}) = \sum_{m} v(N_{ijkm})$$

Abundance Downstream of the Weir

An aerial survey (by helicopter) to document spawning areas on the Tozitna River was flown on 25 July beginning at the weir (~ 300 meters above Dagislakhna Creek) and ending approximately 35 kilometers upstream (Figures 2, 3). Aerial surveys were not performed below the weir due to extremely poor visibility due to high turbidity from Dagislakhna Creek. Approximately 90 % of the Dagislakhna Creek watershed burned in 2004 during the North Dag Fire (BLM 2004). Low water levels in the Tozitna River at the time of the survey provided very good observation conditions.

Results

A total of 191 Chinook redds were observed during the survey of which 82% were found within the first 18 km (Figure 2). The last Chinook redd observed was approximately 1.5 km upstream of Gishna Creek (Figure 2). A total of 469 summer chum redds were observed of which 87% were found within the first 6 km of the survey (Figure 3).

Age-Sex-Length

The live trap was used to capture salmon sampled for age, sex, and length. The upstream gate of the trap was closed for periods to obtain an adequate sample size. During sampling, a dip-net was used to capture salmon in the live trap. Salmon were then placed in a partially submerged, aluminum cradle for identifying species and sex, measuring, and removing scale(s). Lengths were measured to the nearest 5 mm from mid-eye to fork of the caudal fin. Morphological maturation characteristics were used to determine sex. One scale for chum and three scales for Chinook salmon were removed from the left side, two rows above the lateral line and on a diagonal line from the posterior end of the dorsal fin to the anterior end of the anal fin (Anas 1963; Mosher 1968). Scales were then placed on numbered gum cards and sent to ADF&G-DCF in Anchorage for aging. Aging was conducted by creating impressions on cellulose acetate cards with a heated hydraulic press (Clutter and Whitsel 1956) and then examining the scale annuli patterns (Gilbert 1922). European notation (Koo 1962) was used to record the ages. A holding pen (6 m x 2 m) was constructed adjacent to the trap, and after sampling, fish were transferred and held for 0.5 hours. The holding pen allowed sampled fish to recover in an area out of the main current.

Abiotic Measurements

Water temperature, turbidity, precipitation, and stream stage (water surface elevation) measurements were collected daily from the period 19 June to 11 August. Water temperature was monitored with an Onset® Tidbit temperature logger placed on the stream bottom in a shaded location within a deep (>1 m) meander pool upstream from the weir. Water temperature was recorded every hour. Turbidity was measured using a HACH model 2100P turbidimeter. Precipitation was measured daily for the previous 24 hours with a rain gauge. A staff gauge was used to record daily variation in stream stage.

To determine stream discharge, water velocity was measured over a range of stream stage elevations using a Price AA current meter. Stream stage was used as the independent variable to estimate stream discharge for days when discharge was not measured. An annual stream stage versus discharge rating was developed by combining the direct discharge measurements and computer-simulated peak flow using log-log regression (Rantz et al. 1982).

RESULTS

Weir and Trap

In 2005, the Tozitna River weir was relocated approximately 200 meters downstream from its previous (2002-2004) location. The ever changing stream channel at the original site became too deep preventing installation of the weir.

Weather systems in the summer often bring periods of rain to the interior of Alaska and result in elevated stream discharge in the Tozitna River. During these periods of increased discharge, weir panels can be submerged and allow salmon to migrate over the weir undetected. A strong precipitation event occurred in the upper Tozitna River watershed in mid July (Figure 4). This event resulted in submerged weir panels from 11 to 12 July, preventing sampling efforts for these 2 days. However, the weir was closely monitored during the event and zero salmon were observed migrating over the weir, i.e. the weir remained "fish tight". The trap was re-opened at 1700 hours on 12 July once again allowing upstream migration. On 12 August, less than 1% of the cumulative escapement of Chinook and summer chum salmon migrated through the trap indicating the end of the run. The trap was closed at 2400 hours 12 August and weir removal was complete on 13 August.

Escapement

Chinook Salmon

Chinook salmon (N = 1,611) passed through the weir from 2 July to 12 August (Table 1). Daily Chinook escapement during the last week of counting was < 1 % of the cumulative escapement. The quartile days (25, 50, and 75%) of cumulative passage for Chinook salmon were 14, 15, and 18 July, respectively (Table 1; Figure 5). The date of peak passage was 14 July (n = 443), and the five day period of 14-18 July accounted for 57 % of the escapement.

Summer Chum Salmon

Summer chum salmon (N = 39,700) migrated through the weir from 29 June to 12 August (Table 1). Daily chum escapement for the last two complete days of counting was < 2% of the cumulative escapement. The quartile days (25, 50, and 75 %) of cumulative passage for summer chum salmon were 19, 25, and 31 July, respectively (Table 1; Figure 6). The date of peak passage was 27 July (n = 1,932), and the thirteen day period of 19-31 July accounted for 53 % of the escapement.

Sockeye Salmon

This year 88 sockeye salmon migrated through the weir from 14 July to 12 August. This is a significant increase as the highest number of sockeye salmon previously recorded at the Tozitna River was 8 (2004). Age, sex, and length data was not taken for sockeye salmon.

Age-Sex-Length

Chinook Salmon

The sex composition of Chinook salmon was 30.1 % female, ranging from 15.4 % (29 June - 12 July) to 40.6 % (20 July - 26 July) throughout weekly sampling stratum (Table 2). Four age groups were identified from 296 readable scale samples. Overall, Chinook salmon were predominantly age 1.3 (46 %) and 1.4 (33 %), followed by age 1.2 (21 %) (Table 3). Females were generally older (58 % age 1.4 and 42 % age 1.3) than males (47 % age 1.3 and 38 % age1.2). The age structure of the run was reflected in size with mean length of females age 1.3

and 1.4 greater than that of same-age males. Females ranged from 660 mm to 920 mm and the males ranged from 325 mm to 900 mm (Table 4).

Summer Chum Salmon

The sex composition of summer chum salmon was 50.7 % female, ranging from 22.5 % (29 June - 8 July) to 66.7 % (30 June - 5 August) throughout weekly sampling stratum (Table 5). Two age groups were identified from 827 readable scale samples. Overall, chum salmon were predominantly age 0.3 (96 %) followed by age 0.4 (4 %) (Table 6). Female chum salmon ranged from 465 to 615 mm and male chum salmon ranged from 470 to 670 mm (Table 7).

Abiotic Measurements

Hourly water temperatures (°C) ranged from 7.7 – 14.8. The mean daily water temperature (°C) was 11.8, slightly above the five year (2001-2005) average of 11.2. During a majority (78 %) of the monitoring period, water temperatures remained within those favorable for the migration, spawning, and incubation of salmon (Environmental Protection Agency 2001 and 1999, Hale 1981, Bell 1973, Combs and Burrows 1957). However, water temperatures did exceed the State standard for maximum water temperature during spawning and egg incubation (13 °C), temperatures considered to cause elevated disease rates (14 – 17 °C), and reduced gamete viability (13-16 ° C) in salmon (EPA 2001; Table 8). The maximum duration in which 13 °C was exceeded was 13 hours during any one 24-hour period; 24 hours in a 48-hour period, and 58 hours in a 120-hour (5 day) period.

Turbidity (NTU) ranged from 0.46 to 9.42 and averaged 1.36. Total precipitation for the period was 6.5 cm. Stream stage (cm) fluctuated from 42.7 to 114.6 and averaged 68.7. Daily discharge (m^3/s) ranged from 10 to 60.6 and averaged 22.1 (Figure 4).

DISCUSSION

The 2005 Pilot Station passage estimate for Yukon River summer chum salmon was 2.4 million, well above the 1995, 1997-2004 average of 1.4 million fish (Eggers, 2006.). The 2005 Summer chum salmon escapement levels were above average in most tributaries (Eggers, 2006.). The 2005 Tozitna River summer chum salmon escapement was 52% greater than the 3 year average of 2001- 2002, 2004 (2003 was an incomplete count) bringing the 4 year average to 24,067. Quartile dates for 2005 were similar to the 3-year average differing by no more than 2 days. On average, the quartile dates of passage for chum salmon have been about 7 days later than those for Chinook salmon.

The 2005 Chinook salmon run was anticipated to be lower or similar to the run experienced in 2004 based upon the lower proportion of five-year-old fish in 2004 (Eggers, 2006). The 2005 Tozitna River Chinook escapement was 21 % below the 4–year average (2001-2004) bringing the 5 year average to 1,952. Quartile dates in 2005 were similar to the 4-year average differing by no more than one day.

One conspicuous component of the Chinook escapement is the low number of returning females (estimated 485 fish; Table 2). The Tozitna River had the lowest proportion (30.1 %) of female Chinook salmon of the four Yukon River Basin weir projects monitoring Chinook salmon in 2005 (Figure 7 and Table 9). This compares with 14 % Chinook females returning in 2002 (first year of the project using a weir), 18 % in 2003, and 17.5% females returning in 2004**.** However, in 2005 the Tozitna River experienced a 13.5 % increase in the number of female Chinook salmon (30.1 %) when compared to the previous 3 year average of 16.6 %. The low proportion of female Chinook salmon is not unique to the Tozitna River and has been documented for other Yukon River tributaries. From 1996 - 1998, the Gisasa River averaged 20 % female, ranging from 17 – 23 %, and the East Fork of the Andreafsky River from 1994 - 1998 had female returns ranging from 25 – 42 % (Wiswar 2000, Tobin and Harper 1999).

There is currently no conclusive explanation for the low numbers of returning female Chinook. It is likely that there is a combination of factors influencing female returns. Given that the field identification of Chinook salmon sex at the Tozitna River weir has proven to be accurate (Sundlov et al. 2004), we offer several other plausible explanations.

Since the Tozitna River weir has only been in operation for four years, it is possible that the low number of females recorded for the years 2002 - 2005 are statistical outliers. However, with four consecutive years of low female returns this possibility is becoming less likely.

The influence of harvest on Chinook returns is also a possible factor in the low number of females returning to spawn. Low female Chinook sex ratios reported by weir escapement projects are largely the result of the low proportion of age 1.4 fish, the predominant age class among females (Harper and Watry 2001; Table 3). In 2005, preliminary data indicate age 1.4 Chinook salmon represented 15 – 28 % of the escapement at the four weir projects monitoring Chinook salmon in the Yukon River Basin (Table 9). In 2004, preliminary data indicate age 1.4 Chinook salmon represented 70 % of the combined commercial harvest (preliminary data, ADF&G 2004 a) while the escapement of age 1.4 female Chinook from the four weirs mentioned above ranged from 17-26 % (Sundlov et al. 2004) in 2004. The 2005 commercial harvest data is not yet available from ADFG to make this same comparison.

Chinook salmon harvest in the Yukon River is comprised predominately of commercial and subsistence gillnet fisheries. In 2005, 94 % of the Alaskan commercial harvest (preliminary data, ADF&G 2005 b) occurred in the lower Yukon River. Small mesh size gear was not used in the lower Yukon River commercial fishery due to a lack of a summer chum market. Gillnets are also the gear of choice for subsistence fishing as demonstrated by the 2003 subsistence harvest in which 87 % of the Chinook salmon were taken with gillnets (preliminary data, ADF&G 2004a).

There were no gillnet mesh restrictions for the subsistence fishery in 2005, although it is thought the majority of Yukon River gillnet subsistence fishers use eight inch mesh or greater.

Chinook populations are heterogeneous in age, size, and sex, and all individuals are not equally vulnerable to harvest. For example, Tozitna River female Chinook exhibited sexual dimorphism, with females longer than males of the same age (Table 4). Large mesh gillnets select for larger Chinook salmon and harvests during unrestricted mesh-size openings generally include a much larger proportion of females than fishing periods restricted to small mesh size (ADF&G 2002). As they migrate upstream to their natal streams, salmon encounter gillnets from the Yukon River mouth up to and beyond the confluence with the Tozitna River. With the large mesh nets in use today, the largest, and generally the oldest, fish are continuously selected. This may explain why the Tozitna River escapement project, which is the furthest upstream of the four weir projects monitoring Chinook salmon in the Yukon River basin, had the lowest female sex ratio for Chinook salmon for the last three years (Table 9; Sundlov et al. 2003, 2004).

Another possible explanation of low abundance of age 1.4 female Chinook is their possible differential exposure to ocean mortality. The average age of maturity for Yukon River Chinook is 6.12 years for females and 5.64 years for males (McBride et al. 1983). The longer duration of ocean residency may increase the mortality rate of females, however, the issue of when mortality occurs in the marine environment remains unresolved. Currently most information seems to suggest that mortality is greatest during the first summer at sea with declining rates as fish grow (Quinn 2005).

Recently, there has been speculation that the disease-induced mortality caused by the internal parasite *Icthyophonus* has played a role in the selective mortality of female Chinook salmon in the Yukon River. Kocan et al. (2003) reported that significantly more Yukon River females than males were infected during 1999 – 2002, however, in 2003 the infection in females was not significantly different from males. It appears that *Icthyophonus* may play a role in selective mortality but not on a consistent basis. Because of this, *Icthyophonus* does not fully explain the low female Chinook salmon returns to the Tozitna River that we have observed from 2002 - 2004. Studies continue to investigate this disease as a potential cause of mortality.

Lastly, BLM has investigated the possibility that a number of Chinook are spawning below the weir and possibly skewing the sex ratios. In 2004 and 2005, we planned to conduct an aerial survey to estimate the number of fish spawning downstream of the weir. We were unable to conduct the survey due to turbid water coming from Dagislakhna Creek which is located directly below the weir. However, in the past, BLM has conducted two aerial surveys using a helicopter to count the number of Chinook salmon spawning below the weir. In 2001, an aerial survey was conducted on 31 July (from the mouth of the Tozitna River upstream to weir) and 10 live Chinook and 1 Chinook carcass were counted. In 2002, on 30 July, 30 live Chinook and 4 Chinook carcasses were counted in this same reach. Based on these assessments, it appears that the majority of Chinook spawning occurs upstream of the weir. In the future, BLM plans to conduct aerial spawning assessments downstream of the weir on an annual basis.

One issue that remains a concern to BLM is the low return of older age class female Chinook salmon. Reduction and removal of the largest and potentially most successful spawners reduces the overall fitness of a population and reduces the ability to compensate for environmental and anthropogenic impacts (Livingston 1998). Currently, it is unclear what is contributing to the low proportion of female Chinook salmon in the Tozitna River escapement. Given that long-term weir escapement data is not available on the Tozitna River and there is no conclusive data for selective harvest, disease and/or differential mortality, the low proportion of returning Chinook females warrants further evaluation and ongoing monitoring.

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FOOTNOTES

[1] 1949 - 2003 average monthly temperature and precipitation data for the Tanana FAA Airport, Alaska, supplied by Western Regional Climate Center, Reno, Nevada.

Table 1. Daily and cumulative counts for Chinook and summer chum salmon with the second quartile, median, and third quartile highlighted; Tozitna River, Alaska, 2005.

	Chinook			Summer chum		
	Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Proportion	Count	Count	Proportion
6/29	0	0	0.00	1	1	0.00
6/30	0	0	0.00	1	2	0.00
7/1	0	0	0.00	4	6	0.00
7/2	1	1	0.00	1	7	0.00
7/3	1	2	0.00	4	11	0.00
7/4	1	3	0.00	1	12	0.00
7/5	3	6	0.00	15	27	0.00
7/6	4	10	0.01	24	51	0.00
7/7	6	16	0.01	90	141	0.00
7/8	8	24	0.01	69	210	0.01
7/9	44	68	0.04	154	364	0.01
7/10	30	98	0.06	220	584	0.01
7/11	25	123	0.08	-65	519	0.01
7/12	25	148	0.09	218	737	0.02
7/13	153	301	0.19	763	1500	0.04
7/14	443	744	0.46	1751	3251	0.08
7/15	164	908	0.56	1755	5006	0.13
7/16	132	1040	0.65	1771	6777	0.17
7/17	111	1151	0.71	1415	8192	0.21
7/18	66	1217	0.76	1279	9471	0.24
7/19	70	1287	0.80	1541	11012	0.28
7/20	34	1321	0.82	1858	12870	0.32
7/21	65	1386	0.86	1790	14660	0.37
7/22	42	1428	0.89	1323	15983	0.40
7/23	29	1457	0.90	1604	17587	0.44
7/24	37	1494	0.93	1863	19450	0.49
7/25	17	1511	0.94	1256	20706	0.52
7/26	9	1520	0.94	1607	22313	0.56
7/27	13	1533	0.95	1932	24245	0.61
7/28	20	1553	0.96	1705	25950	0.65
7/29	6	1559	0.97	1743	27693	0.70
7/30	13	1572	0.98	1362	29055	0.73

-Continued-

Table 1. (Continued)

	Chinook			Summer chum		
	Daily	Cumulative		Daily	Cumulative	
Date	Count	Count	Proportion	Count	Count	Proportion
7/31	8	1580	0.98	1313	30368	0.76
8/1	5	1585	0.98	1178	31546	0.79
8/2	3	1588	0.99	1162	32708	0.82
8/3	6	1594	0.99	1196	33904	0.85
8/4	0	1594	0.99	1212	35116	0.88
8/5	-1	1593	0.99	862	35978	0.91
8/6	5	1598	0.99	940	36918	0.93
8/7	4	1602	0.99	608	37526	0.95
8/8	0	1602	0.99	585	38111	0.96
8/9	4	1606	1.00	398	38509	0.97
8/10	1	1607	1.00	511	39020	0.98
8/11	2	1609	1.00	449	39469	0.99
8/12	2	1611	1.00	231	39700	1.00

Table 2. Female Chinook salmon composition for the Tozitna River, Alaska, 2005. SE = Standard Error.

	Sample			Escapement			
Stratum Dates	n	# Females	% Female	Weir Count	Estimated # Females	% Female (of total escapement)	SE
6/29 - 7/12	52	8	15.4	148	23	1.5	5.1
7/13 - 7/19	93	27	29.0	1139	331	21	4.7
7/20 - 7/26	96	39	40.6	233	95	5.5	5.0
7/27 - 8/12	55	22	40.0	91	36	2.2	6.7
All Strata	296	96	-	1,611	485	30.2	3.5

Table 3. Age composition of the Tozitna River Chinook salmon escapement by stratum and sex; Alaska, 2005. Standard error in parenthesis.

				Brood Year and Age										
				2002		2001		2000		1999		1998		
				1.1		1.2		1.3		1.4		1.5		
Strata Dates	Weir Count	Sex	# Fish Sampled	%		%		%		%		%		% Escapement
6/29 - 7/12	148	M	44	0.0		5.1		4.8		1.3		0.0		9.2
		F	8	0.0		0.0		1.2		3.5		0.0		
		Subtotal	52											
7/13 - 7/19	1139	M	66	0.0		28.3		32.6		10.9		0.0		70.7
		F	27	0.0		0.0		30.3		37.9		0.0		
		Subtotal	93											
7/20 - 7/26	233	M	57	0.0		3.7		6.9		1.7		0.0		14.5
		F	39	0.0		0.0		6.5		13.0		0.0		
		Subtotal	96											
7/27 - 8/10	91	M	33	0.1		1.2		2.6		0.9		0.0		5.6
		F	22	0.0		0.0		3.8		3.8		0.0		
		Subtotal	55											100.0
Combined Strata	1,126[a]	M	200	0.1	(0.7)	38.2	(6.3)	47.0	(6.8)	14.7	(4.8)	0	(0)	100.0
	485[a]	F	96	0.0	(0)	0	(0)	41.7	(10.3)	58.2	(10.3)	0	(0)	100.0
Total	1,611		296	-		-		-		-		-		-
Age Composition With Sexes Combined				0.1	(0.4)	20.9	(4.4)	46.4	(5.4)	32.6	(5.0)	0	0	100.0

[a] Estimated number of male and female salmon derived from strata weighted ASL data.

Table 4. Chinook salmon mid-eye to fork length (mm) by age and sex; Tozitna River, Alaska, 2005. SE = Standard Error.

Age	Sex	Sample	Mean	SE	Range
1.1	Male	1	325	-	325.0
	Female	0	-	-	-
1.2	Male	71	542	6.1	410-655
	Female	0	-	-	-
1.3	Male	99	693	6.1	530-850
	Female	38	768	6.0	685-850
1.4	Male	29	753	11.1	600-900
	Female	58	809	6.8	660-920
1.5	Male	0	-	-	-
	Female	0	-	-	-

Table 5. Female summer chum salmon composition for the Tozitna River, Alaska, 2005. SE = Standard Error.

	Sample			**Escapement**			
Stratum Dates	n	# Females	% Female	Weir Count	Estimated # Females	% Female (of total escapement)	SE
6/29-7/8	71	16	22.5	210	47	0.12	5
7/9-7/15	125	49	39.2	4796	1880	4.74	4.4
7/16-7/22	182	83	45.6	10977	5006	12.61	3.7
7/23-7/29	152	70	46.1	11710	5393	13.58	4.1
7/30-8/5	150	100	66.7	8285	5523	13.91	3.9
8/6-8/12	147	90	61.2	3722	2278	5.74	4
All Strata	827	408	-	39,700	20,128	50.7	1.7

Table 6. Age composition of the Tozitna River summer chum salmon escapement by stratum and sex; Alaska, 2005. Standard error in parenthesis.

				Brood Year and Age								
				2002 0.2		2001 0.3		2000 0.4		1999 0.5		
Strata Dates	Weir Count	Sex	# Fish Sampled	%		%		%		%		% Escapement
6/29-7/8	210	M	55	0.0		0.5		0.3		0.0		0.8
		F	16	0.0		0.2		0.0		0.0		
		Subtotal	71									
7/9-7/15	4,796	M	76	0.0		11.4		3.5		0.0		14.9
		F	49	0.0		8.4		1.0		0.0		
		Subtotal	125									
7/16-7/22	10,977	M	99	0.0		28.7		1.8		0.0		30.5
		F	83	0.0		24.3		0.6		0.1		
		Subtotal	182									
7/23-7/29	11,710	M	82	0.0		32.3		0.0		0.0		32.3
		F	70	0.0		26.4		0.4		0.0		
		Subtotal	152									
7/30-8/5	8,285	M	50	0.0		14.1		0.0		0.0		14.1
		F	100	0.0		27.4		0.0		0.0		
		Subtotal	150									
8/6-8/12	3,722	M	57	0.0		7.2		0.1		0.0		7.4
		F	90	0.0		11.2		0.1		0.0		
		Subtotal	147									100.0
Combined Strata	19,572[a]	M	419	0.0	(0)	94.2	(2.2)	5.8	(2.2)	0.0	(0)	100.0
	20,128[a]	F	408	0.0	(0)	97.9	(2.0)	2.1	(2.0)	0.1	(0)	100.0
Total	39,700		827	-			-		-		-	-
Age Composition With Sexes Combined				0.0	(0)	96.1	(1.6)	3.9	(1.6)	0	(0)	100.0

[a] Estimated number of male and female salmon derived from strata weighted ASL data.

Table 7. Summer chum salmon mid-eye to fork length (mm) by age and sex; Tozitna River, Alaska, 2005. SE = Standard Error.

Age	Sex	Sample	Mean	SE	Range
0.2	Male	0	-	-	-
	Female	0	-	-	-
0.3	Male	375	567	1.6	470-670
	Female	398	543	1.3	465-610
0.4	Male	44	606	3.7	555-665
	Female	10	576	10.7	520-615
0.5	Male	0	-	-	-
	Female	0	-	-	-

Table 8. Number of days, average hours per day, and percent of the monitoring period (16 June to15 August 2005) in which the water temperatures of the Tozitna River at the weir site exceeded water temperature threshold values considered to have an effect on salmon health and reproduction. The water quality standards and health and reproduction temperature threshold values are from 18 Alaska Administrative Code 70 and EPA (2001).

	State Water Qual Standard for Max Migration Temp (>15 °C)	State Water Qual Standard for Max Spawning and Egg Incubation Temp (>13 ºC)	Reduced Gamete Viability (13-16 °C)	Elevated Disease Rate (14-17 ºC)	50% Pre-Hatch Mortality (≥16 ºC)
No. days exceeding the parameter during the monitoring period	0	42	42	13	0
Avg. hours /day exceeding the parameter	0	7.5	7.5	4.1	0
% of monitoring period exceeding the parameter (hourly basis)	0	21.5	21.5	3.6	0

Table 9. Comparison of preliminary Chinook salmon age composition by sex at the East Fork Andreafsky River, Gisasa River, Henshaw Creek, and the Tozitna River, Alaska, 2005.

				Brood year and Age						
				2002	2001	2000	1999	1999	1998	Total
		Sample		1.1	1.2	1.3	1.4	2.3	1.5	
Location	River (km) [a]	Size	Sex	%	%	%	%	%		%
EF Andreafsky			Males	0	12.2	31.2	6.4	0	0	49.8
Weir	167	389 [b]	Females	0	2.8	33.1	13.8	0	0.5	50.2
			Subtotal	0	15	64.3	20.2	0	0.5	100
Gisasa			Males	0	25.1	37	3.9	0	0	66
Weir	908	591 [b]	Females	0	3.4	18.3	11.7	0.2	0.4	34
			Subtotal	0	28.5	55.3	15.6	0.2	0.4	100
Henshaw			Males	0	21.9	29.2	7.5	0	0	58.6
Weir	1,539	127 [b]	Females	0	6	20.1	15.3	0	0	41.4
			Subtotal	0	27.9	49.3	22.8	0	0	100
Tozitna			Males	0.1	26.4	33.1	10.3	0	0	69.9
Weir	1,096	296	Females	0	0	12.5	17.6	0	0	30.1
			Subtotal	0.1	26.4	45.6	27.9	0	0	100

[a] Kilometers from the Flat Island test fishing site near the south mouth of the Yukon River to the confluence of the listed tributary.

[b] Age data (preliminary) obtained from ADF&G, 2005.

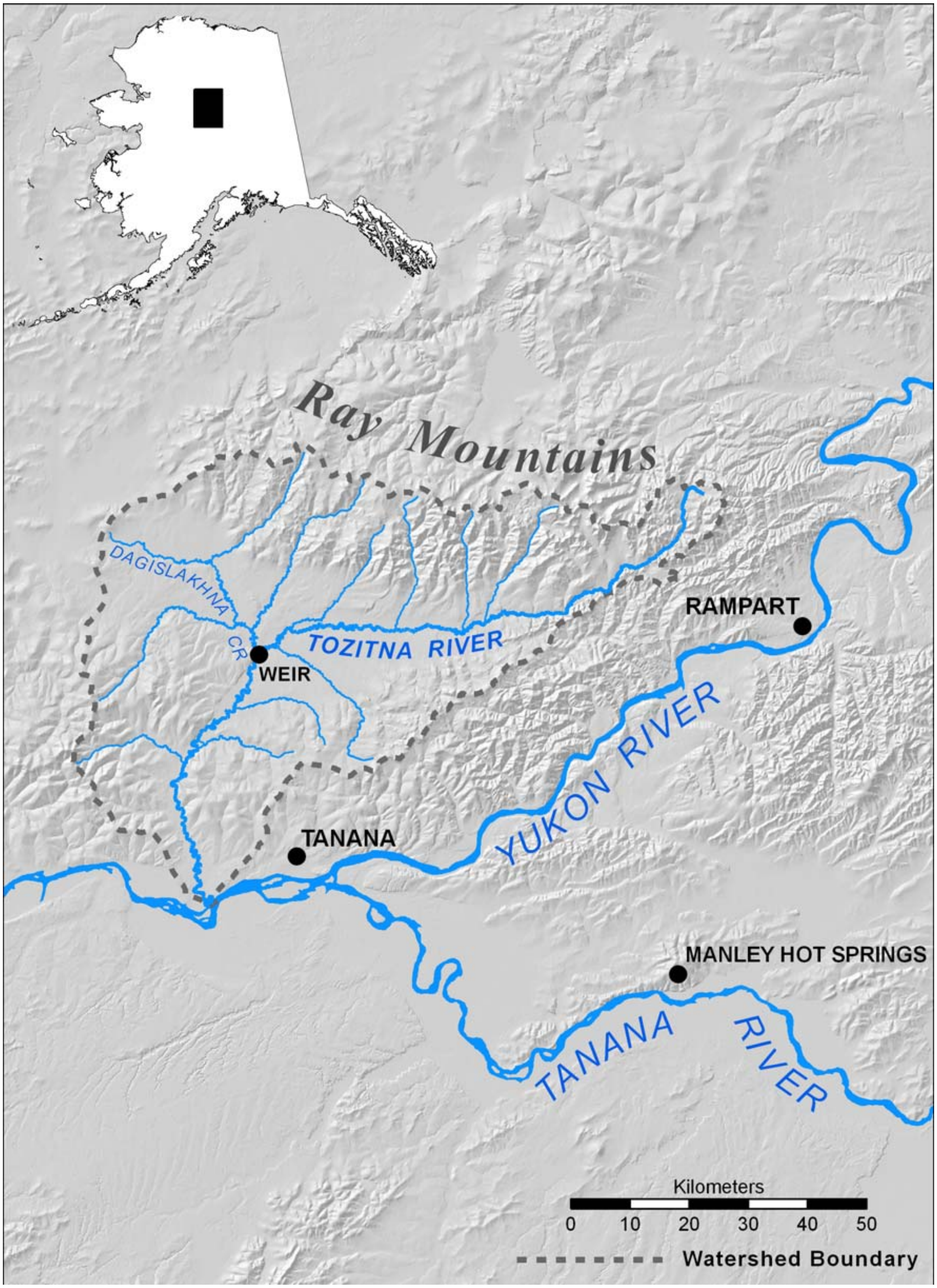

Figure 1. Location of the Tozitna River weir, Alaska 2005.

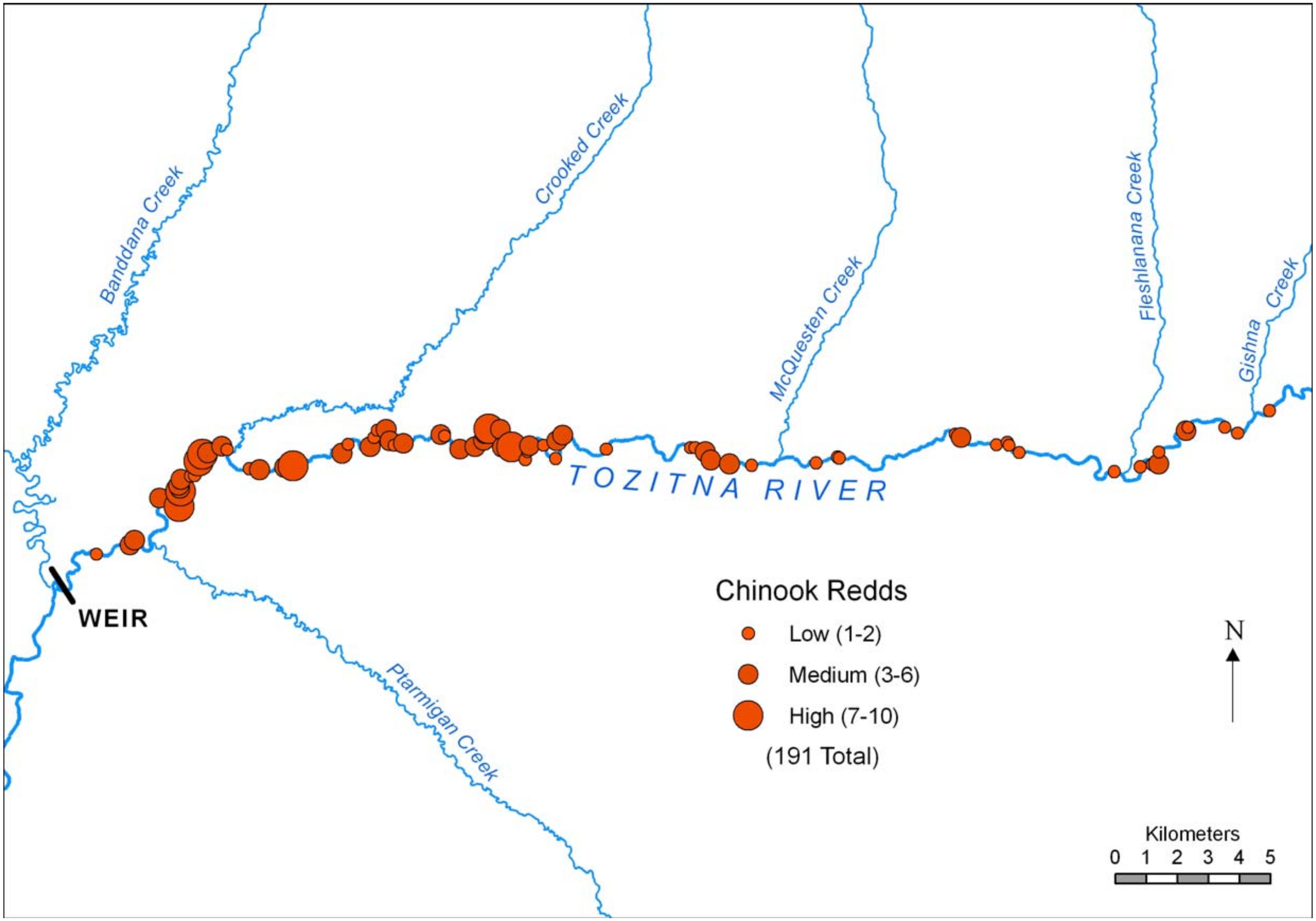

Figure 2. Frequency and distribution of Chinook salmon spawning areas (redds) found upstream of the Tozitna River weir, 2005.

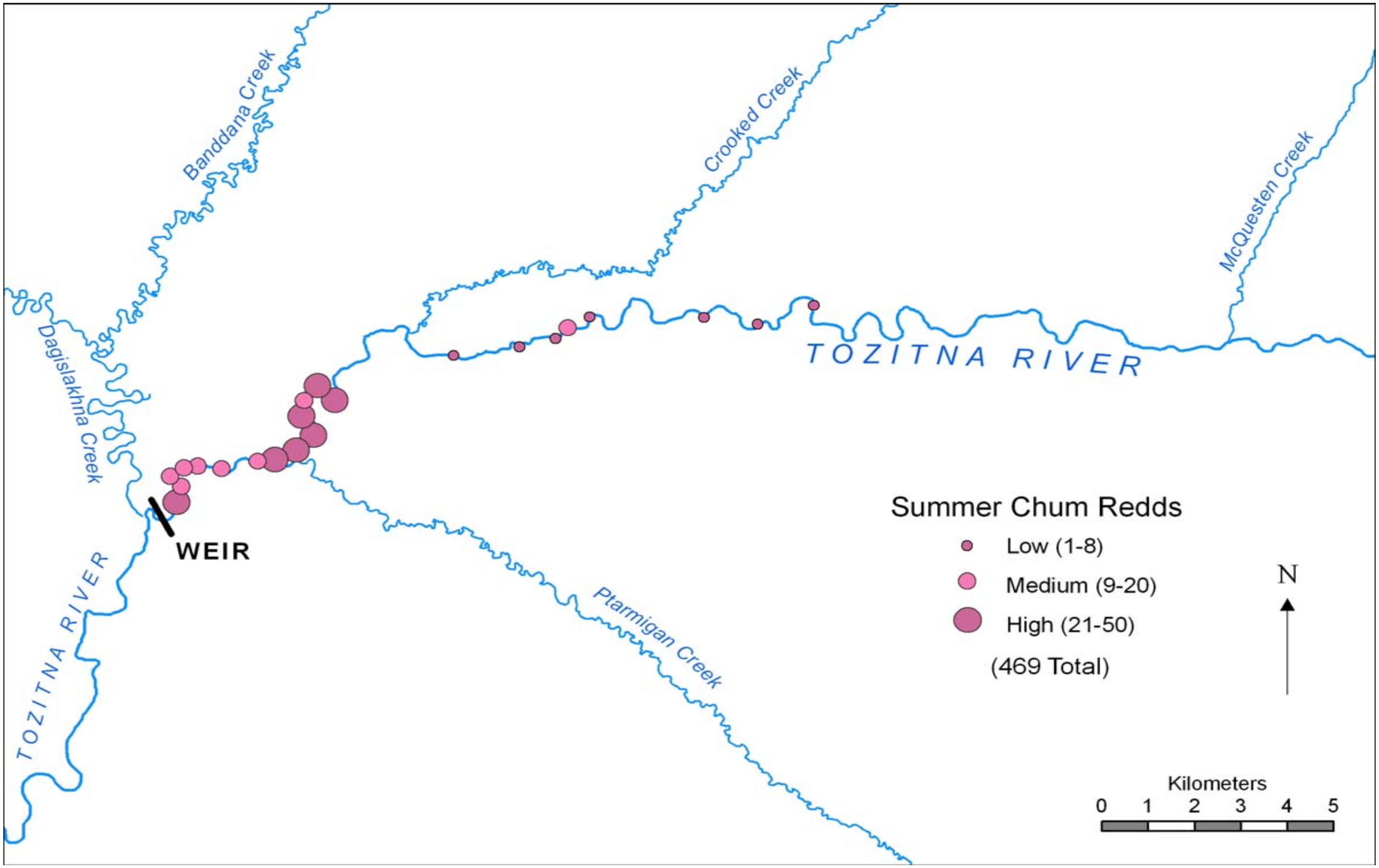

Figure 3. Frequency and distribution of summer chum salmon spawning areas (redds) found upstream of the Tozitna River weir, 2005.

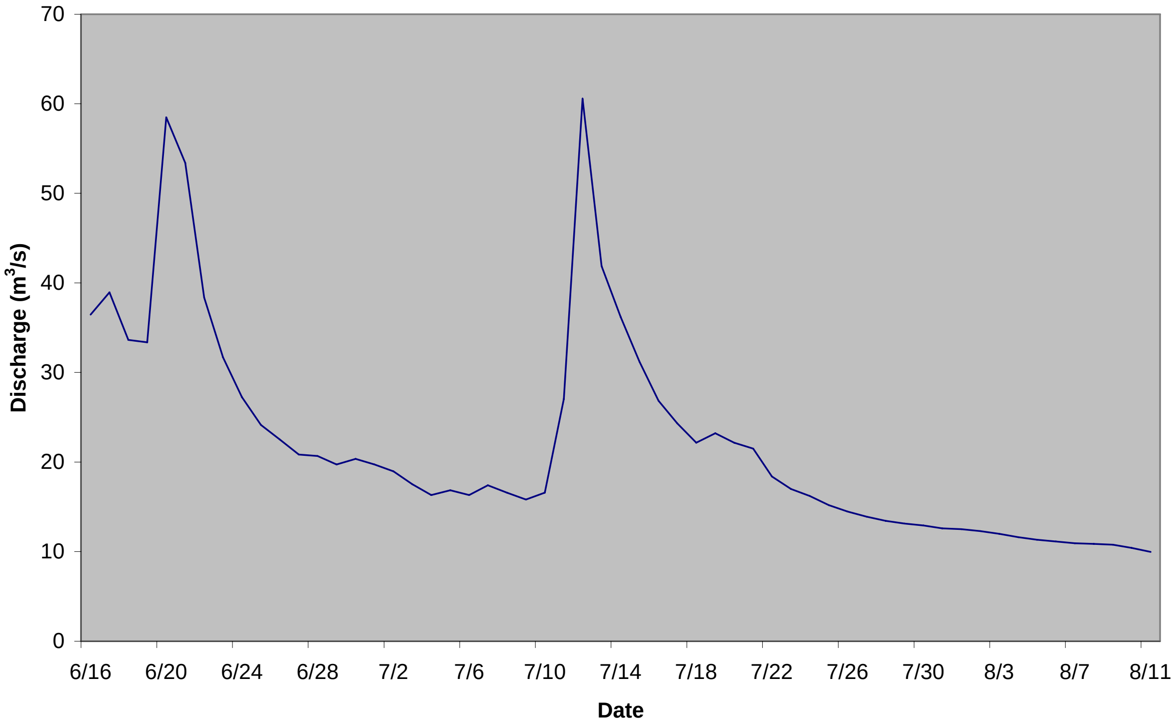

Figure 4. Daily discharge (m^3/s) for the period 16 June - 12 August 2005, Tozitna River, Alaska.

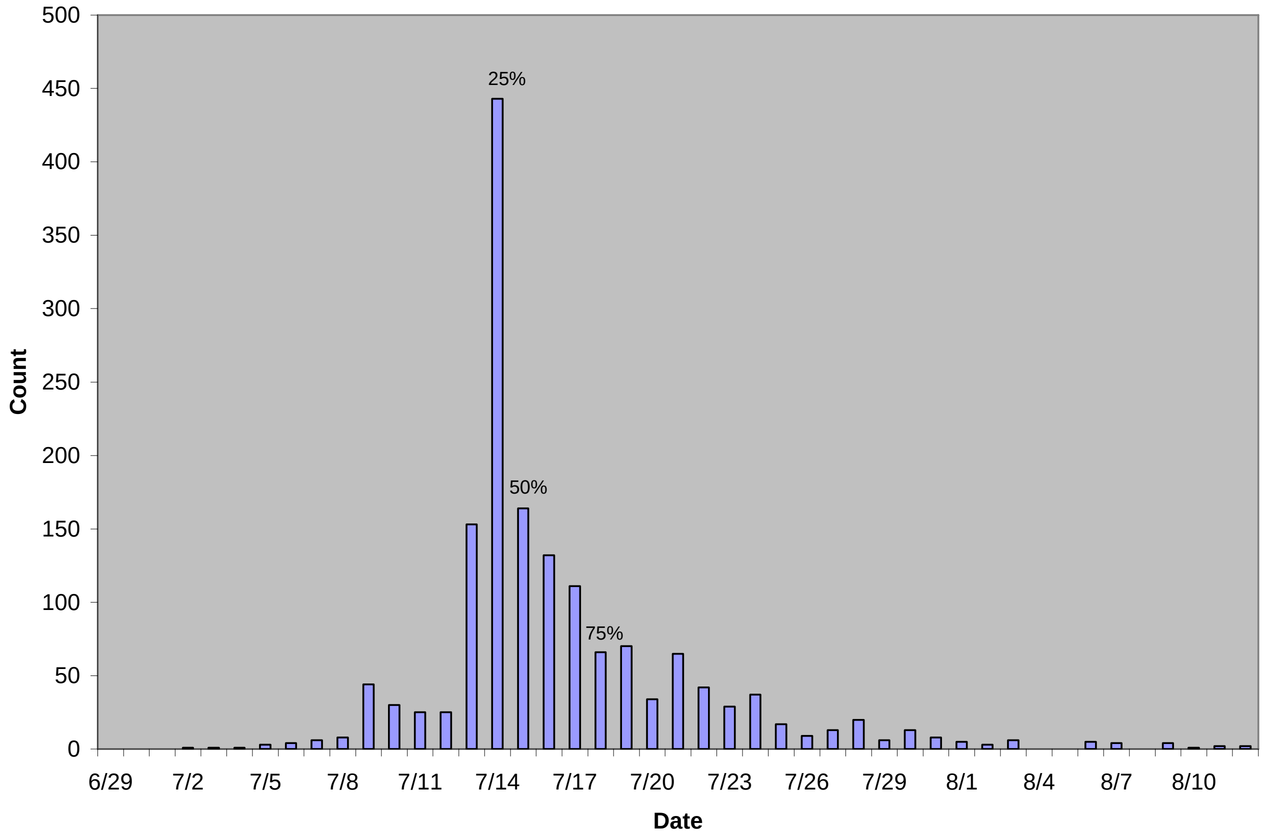

Figure 5. Chinook salmon daily counts with quartiles shown (25, 50, 75 %) of cumulative escapement for the period 29 June - 12 August, 2005, Tozitna River, Alaska.

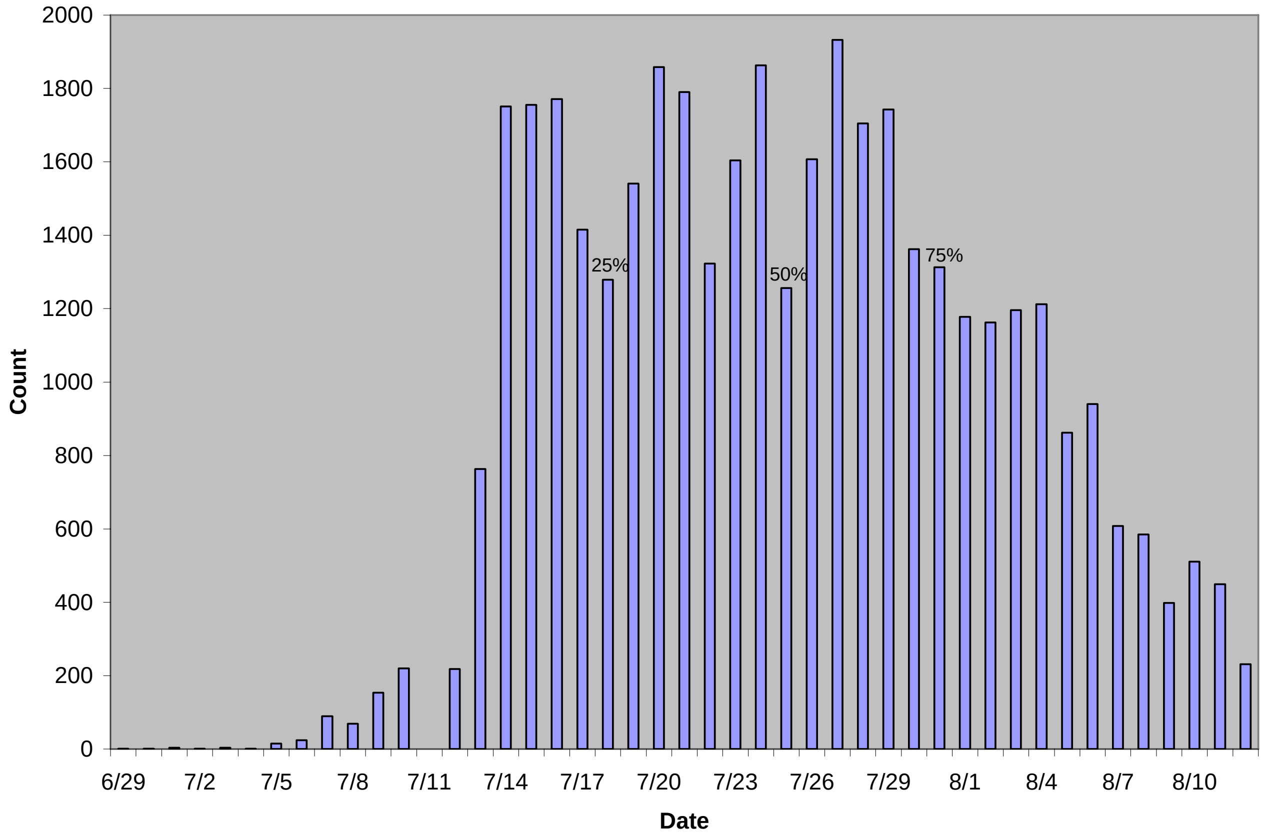

Figure 6. Summer chum salmon daily counts with quartiles shown (25, 50, 75 %) of cumulative escapement for the period 29 June - 12 August, 2005, Tozitna River, Alaska.

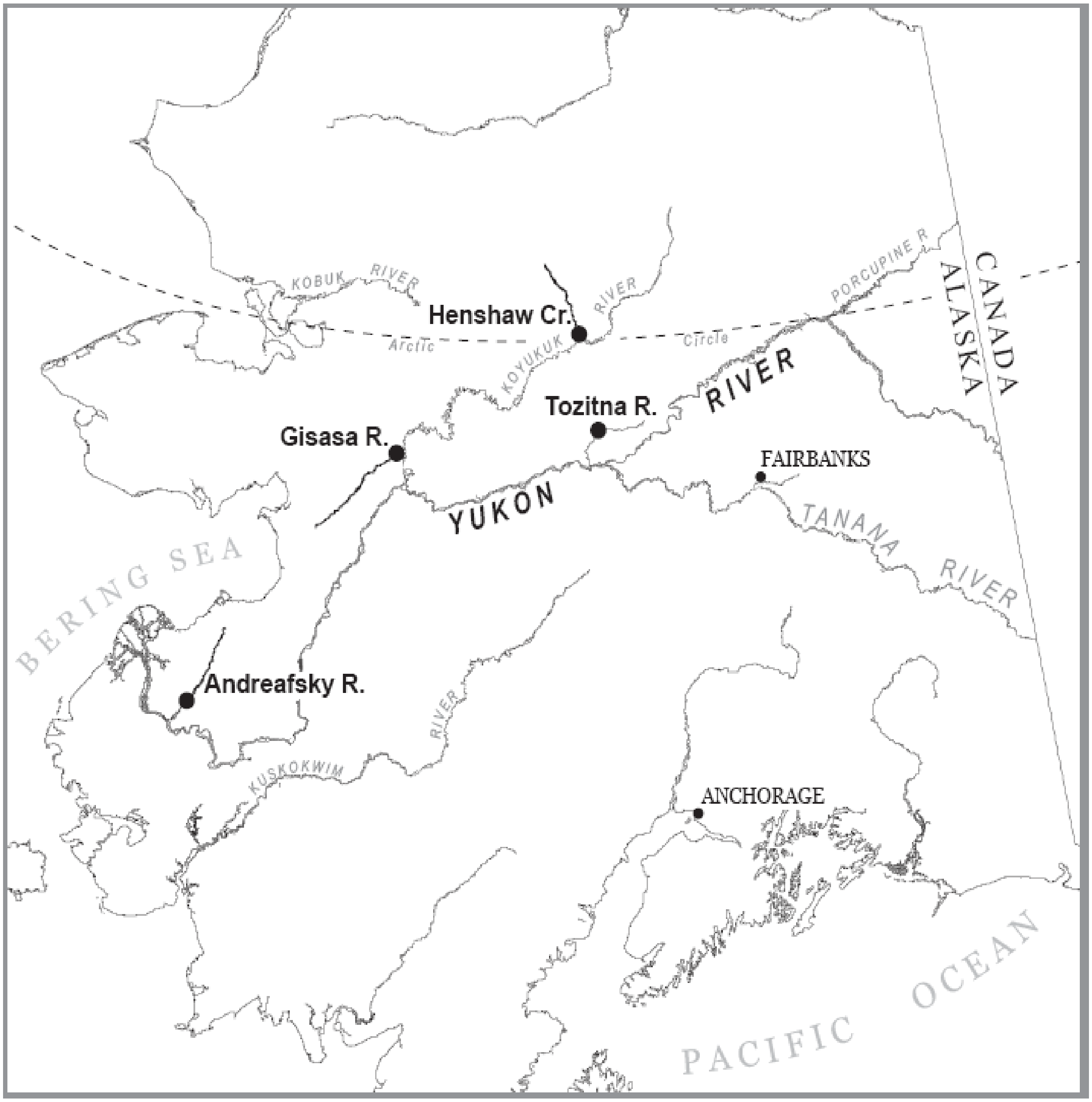

Figure 7. Location of the four weir projects monitoring Chinook salmon escapement in the Alaska portion of the Yukon River Basin in 2005. The projects were located on the East Fork Andreafsky River, Henshaw Creek, Gisasa River, and the Tozitna River.

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