KOGRUKLUK RIVER WEIR SALMON ESCAPEMENT REPORT, 1997

By

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ABSTRACT

The Kogrukluk River weir is the oldest continuing salmon escapement assessment project in the Kuskokwim River drainage. Since 1976, the weir has been used to assess chinook, chum and sockeye salmon escapements; coho salmon assessment began in 1981. For periods when the weir is ineffective either due to high water or lack of funds, daily total counts and, thus, total escapement, are estimated by using historical run-timing information. Minimum biological escapement goals (BEGs) have been established for chinook (10,000), chum (30,000) and coho salmon (25,000). Temporally-stratified age, sex, and length (ASL) samples are collected on chinook, chum, and coho salmon caught in a trap at the weir. This report covers the project operation during 1997.

The BEG for chinook salmon was achieved in 1997 with total estimate of 13,286 fish. Females were 33% of the actual counts and 31% of the ASL samples. The midpoint of the chinook run at the weir occurred on 8 July, four days earlier than normal. The estimated age composition of the chinook escapement was 34% age 1.2, 20% age 1.3, 45% age 1.4, 0.4% age 1.5.

The estimated total sockeye salmon escapement was 13,078 fish which exceeded the historical average of 10,000. Females were 33% of the actual counts. The midpoint of sockeye passage at the weir occurred on 15 July, two days later than normal.

The BEG for chum salmon was not achieved in 1997 with a total estimate of 7,958 fish, the lowest in this project's history. Females were 12% of the actual counts and 4% of the ASL samples. The estimated age composition of the chum escapement was 0.4% age 0.2, 43% age 0.3, 56% age 0.4 and 0.6% age 0.5. The midpoint of fish passage at the weir occurred on 13 July, one day later than normal.

The BEG for coho salmon was not achieved 1997 with a total estimate of 12,237 fish. Females were 36% of the actual counts. Adequate ASL information on coho was not obtained in 1997. The midpoint of fish passage at the weir occurred on 31 August, one day earlier than normal.

Weir operation in 1997 was characterized by chronically below average water levels, above average water temperatures, and poor runs of chum and coho salmon. Weir operation benefited from low water levels with few days of missing counts; however, ASL data collection was hindered by fish avoiding the trap and low numbers of chum and coho salmon.

INTRODUCTION

The Kogrukluk River is a headwater tributary of the Holitna River, which is formed by the confluence of the Kogrukluk and either the Chukowan River or Shotgun Creek. Orth (1971) claims that Shotgun Creek joins the Kogrukluk River to form the Holitna; however, general local acceptance is that the Chukowan and Kogrukluk Rivers form the Holitna River. This report will use the latter definition. The Holitna River, with a drainage area of approximately 10,826 km^2 (Brown 1983) is the largest salmon-producing tributary of the Kuskokwim River. Recorded evidence of salmon escapements in the Holitna has been documented since 1961 (Schneiderhan 1983, Burkey 1994) when the earliest aerial survey of the Holitna River was documented. The importance of the Holitna River as a salmon producer and the necessity to more closely monitor salmon escapement motivated the Alaska Department of Fish and Game (ADF&G) to establish a weir on the Kogrukluk River in 1976 (Figure 1).

Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, sockeye *O. nerka*, coho *O. kisutch*, and pink salmon *O. gorbuscha* spawn in the Kogrukluk River. Although Kogrukluk River salmon escapements are a low percentage of the overall escapement in the Kuskokwim River drainage, relatively high numbers of chinook, sockeye, and coho salmon pass the Kogrukluk River weir, compared with the few other past and present escapement assessment projects in the Kuskokwim River drainage. Typical sockeye rearing habitat, i.e. large volume lakes, are absent in the Kogrukluk River drainage, although there are some small headwater lakes with an unknown capability for sockeye production. Sockeye are observed spawning in the mainstem and in backwaters and sloughs. The rearing ecology of these "river-type" sockeye is unknown; apparently they have adapted well to a lotic environment. The importance of river-type sockeye in the Kuskokwim drainage should not be overlooked. Wood et al. (1987) found that river-type sockeye contributed 39-48%, in 1984 and 1985, to the total return of sockeye to the Stikine River. The relative abundance of pink salmon is unknown in the Kogrukluk River because they are able to swim between the weir pickets but the annual numbers observed are usually very low. Considering that the Kogrukluk River weir is approximately 750 km from the mouth of the Kuskokwim River, these pink salmon are among the furthest-inland spawning pink salmon in the world (Morrow 1980; Groot and Margolis 1991).

Subsistence and commercial fishermen who live along the Kuskokwim River place major cultural and economic importance on harvests of salmon. Commercial fisheries occur in two non-contiguous districts (Districts 1 and 2) in the Kuskokwim River stretching from the river mouth to Chuathbaluk (Figure 1). The 10-year average (1988-1997) commercial harvest for both districts combined is approximately 31,000 chinook, 64,000 sockeye, 451,000 chum, and 545,000 coho salmon (Burkey et al. *in prep.*). The 1988-1996 average subsistence harvest of chinook and chum salmon in the Kuskokwim River is approximately 83,000 and 100,000 respectively (Burkey et al. *in prep.*).

In the early 1980s, commercial fisheries management began to shift from a guideline-harvest-based strategy to an escapement-objective-based strategy. ADF&G established escapement objectives by species for streams that had sufficient historical information (Buklis 1993). In most cases, these objectives, later termed biological escapement goals (BEGs), represent simple averages or medians of historical information. The underlying principle in establishing BEGs was that maintenance of average or above average spawning escapement should provide for sustained yield consistent with historical levels. Although commercial fisheries harvests usually occur before many escapements can be fully assessed, postseason escapement assessments are useful for evaluating the effectiveness of fishery

management plans and inseason management decisions.

In 1983, BEGs for the Kogrukluk River weir were established for chinook, (10,000), chum (20,000), sockeye (2,000), and coho salmon (20,000). In 1984, BEGs were increased to 30,000 for chum, and to 25,000 for coho salmon. The Kogrukluk River weir is the only salmon escapement assessment project in the Kuskokwim River drainage with a BEG for coho salmon. The BEG for sockeye was eliminated in 1993 because sockeye are not actively managed in the Kuskokwim River and commercial harvests are incidental to other species. In most years, the sockeye salmon BEG was exceeded without direct management actions.

Long term escapement information at the Kogrukluk River weir has allowed the development of run-timing models. These models pattern the historical passage rates at the weir and are used to estimate missing counts and total escapement. The models are also used as inseason predictors of total escapement, and play an important role in management decisions, particularly for coho salmon.

Study Site

The Kogrukluk River is formed by surface runoff from the north side of the plateau that divides the Tikchik Lakes and Nushagak River drainages from the Kuskokwim River drainage. From a point about five miles from Nishlik Lake, the uppermost lake of the Tikchiks, the Kogrukluk River flows northerly for about 69 km before it joins the Chukowan River about 1.5 km above the site of Kashegelok village (Figure 1). The Kogrukluk River weir is located about 3 km upstream from the Chukowan confluence and 1 km below the confluence of Shotgun Creek.

Project History

The Kogrukluk River weir is the oldest continuing salmon escapement assessment project in the Kuskokwim area, and has been operated under a number of different names by various project leaders (Appendix A). The project began as a salmon counting tower in 1969. The tower was originally located about 2 km above the confluence of Shotgun Creek. Due to annual changes in the river channel the tower was moved in some years to different locations but remained above the confluence of Shotgun Creek. A weir was attempted in 1971 but was destroyed by high water early in the season. Tower (and weir) operation in this section of the Kogrukluk River was persistently hindered by log jams and shifting channels. The presence of a suitable weir site below the confluence of Shotgun Creek resulted in the replacement of the tower by a weir between 1976 and 1978. Because the weir was located below the confluence of Shotgun Creek, the tower and weir were operated concurrently from 1976 to 1978 to compare escapement estimates between projects. Only the 1978 operations provided an acceptable set of data from each project. In 1978, the tower counts of chinook, chum, and sockeye were 56%, 37% and 47%, respectively, of the weir counts (Baxter 1979). Beginning in 1981, the weir operation period was extended to count coho salmon in addition to the other species.

Objectives

The objectives of the Kogrukluk River weir project are to:

1. Provide daily counts of the spawning escapement of chinook, sockeye, coho, and chum salmon by sex.

2. Describe the migratory timing of chinook, sockeye, coho and chum salmon spawning escapements.

3. Estimate the age, sex and length (ASL) composition of the chinook, chum and coho salmon escapements.

4. Index gillnet fishing intensity by comparing the frequency of gillnet-marked salmon at the weir with prior years.

5. Estimate carcass wash-out rate and timing by species.

6. Monitor variability in stream hydrological and meteorological conditions to provide information relating to potential environmental effects on salmon production.

METHODS

Weir Operation

The weir (Figure 2) consists of pickets made of black iron pipe held in position by two angle-iron stringers. Each stringer is 3 m in length and perforated to receive about 45 pickets (2 cm black iron pipe). The stringers are overlapped and braced by "A" shaped steel pipe support pods at each ten foot juncture to span the 70 m wide river. The triangular "A" pods are constructed of 3.8 cm black iron pipe (schedule 80) and Kee Klamps™[1]. The trap is constructed of pickets and stringers to dimensions of 1.8 m wide, 3 m long, and 1.2 m deep. It has a funnel shaped entrance and is placed just upstream of an opening in the weir. Other details of weir construction may be found in *Ignatti Weir Construction Manual* (Baxter 1981).

[1] Not an endorsement.

Salmon Counts

Between 0730 and 2400 hours, salmon were enumerated periodically from an observation position either from a boardwalk on the weir or on top of the trap. If fish were not needed for ASL sampling , four or five pickets were pulled out of the weir to allow salmon to pass. Generally, salmon were allowed to pass 4 to 8 times a day, with the frequency depending on behavior and run magnitude. The weir and trap are normally closed from 2400 to 0730 hours because few salmon migrate upstream during this time. However, because of low numbers of chum and coho salmon during 1997, the trap was left open overnight on numerous occasions to collect fish for ASL sampling. When ASL data was needed, salmon in the trap were sampled and allowed to proceed upstream. Visibility and definition are enhanced by yellow plywood panels placed on the stream bottom. Thirteen data categories are tallied on different counters. Categories were (1) male chinook, (2) jack chinook, (3) female chinook, (4) male chum, (5) female chum, (6) male sockeye, (7) female sockeye, (8) gillnet-marked male chinook, (9) gillnet-marked female chinook, (10) gillnet-marked male chum, (11) gillnet-marked female chum, (12) gillnet-marked male sockeye, and (13) gillnet-marked female sockeye salmon. During the coho migration, the above data is maintained for the few remaining chinook, sockeye, and chum migrants; however, the primary objective is to count (1) male coho, (2) female coho, (3) gillnet-marked male coho, and (4) gillnet-marked female coho. Salmon carcasses which washed down the river and were stopped by the weir were counted by species during daily weir cleaning.

Escapement Estimation / Migration-Timing Database

Every year the Kogrukluk River weir has experienced one or more periods of ineffective operation due to high water levels or lack of funds. Schneiderhan (1989) used a methodology for estimating daily counts and, hence, total escapement. After the 1988 field season, he subjectively expanded the historical salmon counts to produce a run-timing database with as many years represented as possible. The run-timing database then consisted of nine years of data for chinook, sockeye, and chum salmon (1976, 1978, 1979, 1981, 1982, 1984, 1985, 1986, and 1988) and eight years of data for coho salmon (1981-1988). For each species, the salmon migrations in each year were characterized as early, normal, or late depending on the relationships each years' mean passage to the mean date of all years combined. Early-, normal- and late-run models were used in subsequent years to estimate missing or partial daily counts and total escapement. Since 1988, the migration-timing database has been updated annually and consists of daily and daily cumulative proportions of actual and estimated weir counts of each species for all years with "adequate" operational duration. Years with actual counts less than 50% of total estimated escapement were considered inadequate and omitted from the database.

In 1991, the methodology for establishing run-timing models was altered. For each salmon species mentioned above, the historical daily proportions (from actual and estimated counts) were ranked across years. Run-timing models were then based on the 25th (late-run model), 50th (normal-run model), and 75th (early-run model) percentiles of the ranked daily proportions. This modeling method attempts to incorporate both the relative timing of the midpoint of the run and the rate at which the run

develops (i.e., number of days between quartiles).

Before an appropriate model was chosen, the normal model was used to estimate missing daily counts. The sum of the model daily proportions, for days with actual counts during the current season, was assumed to be the proportion of the total escapement that was actually counted. Estimates of missing counts were then calculated by multiplying the actual cumulative count by the ratio of the daily model proportion to the total proportion assumed to be actually counted. The final step was a subjective choice of the model. The model chosen was based on a visual "best-fit" of the actual data. This was accomplished by comparing midpoints of the normal model and the reconstructed run, and, to a lesser extent, by comparing the daily estimates to actual counts on days before and after. If the midpoint of the reconstructed run was closer to the midpoint of either the early or late model, then the estimates were again calculated with the appropriate model. No attempt was made to partition the estimated daily counts by sex.

Age, Sex and Length

Beginning in 1992, the age, sex and length (ASL) sampling plan was altered to a "pulse" sampling design. The goal of pulse sampling is to collect the samples from each temporal stratum in as short a time as possible and from as many strata as possible. Sample size goals for each time stratum were 210 chinook, 200 chum, and 170 coho salmon. These sample sizes, based on the requirements for multinomial distributions described by Bromaghin (1993), are needed to estimate the true age composition for a given time interval within 10% of the true value ($d = 0.10$) 95% of the time ($\alpha = 0.05$). After the sample size for a species has been reached for a particular stratum, another species is sampled.

ASL information was taken from salmon that were caught in the trap. Length was measured from mid eye to fork of tail to the nearest 5 mm and sex was determined by inspection of external characteristics. After being sampled, salmon were released on the upstream side of the weir. Scales were taken from the preferred area (INPFC 1963) and mounted on gum cards. Gum cards were pressed in acetate using methods described by Clutter and Whitesel (1956). Scale impressions were viewed through a microfiche reader and age was determined by visual identification of annuli. Ages were recorded on mark-sense forms which also contained the sex and length data. Completed mark-sense forms were processed through an OPSCAN machine to produce ASCII computer files. These files were then summarized using various custom computer programs. Age, sex, and length compositions of each stratum were weighted by fish passage to provide estimates for the entire escapement.

Meteorological and Hydrological Factors

Water temperature was measured to the nearest 1° C with a non-calibrated thermometer. Precipitation for the prior 24 hour period was measured to the nearest 1 mm using a standard precipitation gauge (10

to 1 ratio). The amount of cloud cover and wind speed and direction were estimated by the observer. Water level was measured to the nearest 5 mm from a meter stick set at an arbitrary point in the river. A standardized water level is obtained by measuring the distance between the water level and a benchmark height of 5 m (Baxter 1981). In 1996, this benchmark was inadvertently lost and had to be reestablished in 1997. Although all attempts were made to reestablish the benchmark as close as possible to the previous location, future water levels may not be comparable. The time was recorded when the meteorological and hydrological measurements were made. Generally, measurements were taken at 1700 hours.

RESULTS

Weir Operation

The weir was installed and "fish tight" at 1700 hours on 27 June and was pulled out for the season on 22 September. During this operational period the weir was ineffective due to high water levels from 12 through 13 August and on 18 September.

Salmon Counts and Estimates

Chinook Salmon

The actual count of chinook salmon was 8,749 males (which included 1,199 jacks) and 4,363 females (Table 1). An early-run model (Table 2) was used to estimate counts prior to weir installation (before 28 June) and for 12-13 August. The sum of these daily estimates was 174 fish for a total escapement estimate of 13,286 fish. The midpoint of the run occurred on 8 July, with daily counts higher during the first half of the run than the latter half (Figure 3). A total of 397 female chinook salmon, or 9.1% of all females counted, were observed with gillnet marks (Table 3). A total of 749 carcasses were counted (Table 4). The midpoint of carcass washout occurred on 8 August; 31 days after the upstream migration midpoint.

Sockeye Salmon

The actual count of sockeye salmon was 9,336 males and 3,723 females (Table 1). A late-run model (Table 2) was used to estimate counts for days prior to weir installation and for 12-13 August. The estimated portion was 19 fish for a total escapement estimate of 13,078 fish. The midpoint of the run occurred on 16 July, with daily counts generally higher in the second half of the run (Figure 4). A total

of 157 sockeye salmon, or 1.2% of the total actual count, were observed with gillnet marks (Table 3). A total of 470 carcasses were counted (Table 4). The midpoint carcass washout occurred on 17 August; 32 days after the upstream migration midpoint.

Chum Salmon

The actual count of chum salmon was 6,967 males and 935 females (Table 1). A late-run model (Table 2) was used to estimate total counts for days prior to weir installation and for 12-13 August. The estimated portion was 56 fish for a total escapement estimate of 7,958 fish, which was the lowest escapement on record (Appendix B). The midpoint of the run occurred on 13 July, with daily counts extremely low, compared to the historical average, throughout the entire run (Figure 5). A total of 155 chum salmon, or 2% of the total actual count, were observed with gillnet marks (Table 3). A total of 2,621 carcasses were counted (Table 4). The midpoint of carcass washout occurred on 27 July; 14 days after the upstream migration midpoint.

Coho Salmon

The actual count of coho salmon was 7,390 males and 4,221 females (Table 1). A normal-run model (Table 2) was used to estimate counts for 12-13 August and for days after the weir was pulled out (22 September-5 October). A linear interpolation was used estimate the daily count on 18 September. The estimated portion was 626 fish or 5% of the total escapement estimate of 12,237 fish, which was less than 50% of the BEG. The midpoint of the run occurred on 31 August, and the overall pattern of fish passage closely followed the normal-run model except that daily counts were generally much lower than the historical average (Figure 6). A total of 174 coho salmon (1.5% of all counted) were observed with gillnet marks (Table 3). Twelve carcasses were counted, however, the weir was pulled out well before many coho salmon died (Table 4).

Age, Sex and Length

Chinook Salmon

ASL data was obtained from 472 live specimens in three temporal strata. The estimated age composition of the total escapement was 33.7% age 1.2, 20.4% age 1.3, 45.4% age 1.4, and 0.4% age 1.5 (Table 5). The weighted mean lengths of females ages 1.3, 1.4, and 1.5, were 764 mm, 884 mm and 888 mm (Table 6). The weighted mean lengths of males ages 1.2, 1.3, and 1.4, were 613 mm, 726 mm, 842 mm. The sex composition, estimated from the ASL samples, was 31.4% female and 68.6% male.

Chum Salmon

ASL data was obtained from 641 live specimens in five temporal strata. The estimated age composition of the escapement was 0.4% age 0.2, 42.9% age 0.3, 56% age 0.4, and 0.6% age 0.5 (Table 7). The weighted mean lengths of females age 0.3 and 0.4 were 584 mm and 585 mm (Table 8). The weighted mean lengths of males age 0.2, 0.3, 0.4, 0.5 were 542 mm, 590 mm, 615 mm, and 616 mm. The sex composition, estimated from the ASL samples, was 4.1% female and 95.9% male.

Coho Salmon

Only three coho were sampled for ASL data. Due to the low sample size these data are not presented.

Meteorological and Hydrological Factors

Although the benchmark for gauging water levels was lost in 1996, making subsequent comparisons questionable, water levels during 1997 were well below the 1988-1996 average (Figure 7). Local residents, Evan and Ignatti Ignatti of Kashegelok, observed that they had not seen the river so low in about twenty years. Total rainfall for the weir operational period was 113 mm, also well below the 1988-1996 average (Figure 7). Water temperatures were above average throughout the operational period.

In 1997-1998 a very strong El Nino/Southern Oscillation (ENSO) event began and was blamed for many abnormal natural events. This ENSO event began in the late spring/ early summer and caused the highest Pacific Ocean temperatures recorded during the months of March through November (K. Wolter and M. Timlin, NOAA-CIRES Climate Diagnostics Center, University of Colorado, unpublished data). Large and extensive seabird mortalities from the western Gulf of Alaska to the Chukchi sea were associated with unusual oceanographic conditions which may have been caused by ENSO (Vivian Mendenhall, U.S Fish and Wildlife Service, Anchorage, personal communication). The provisional explanation for the die-off is starvation. The main diet of these birds is forage fish and whether the forage fish were entirely absent or inaccessible to the birds is unknown. If there was a lack of forage fish, it is possible, but highly speculative, that returning adult salmon may have also been affected. The heterogeneity in location and species of poor salmon runs in the Kuskokwim Area and in other areas of Alaska leaves many questions about how ENSO may have affected certain salmon fisheries

DISCUSSION

Annual Escapements

Chinook Salmon

In 1997, a very poor return of chum salmon in the Kuskokwim River resulted in only two commercial fishing periods prior to 1 August. Consequently, the incidental catch of chinook salmon was very low. Similar circumstances in 1993 also led to fewer commercial periods and the chinook BEG was achieved at the Kogrukluk River weir in that year. The estimated subsistence harvest of chinook salmon in 1997 was about average at approximately 81,500 (Charles Utermohle, Alaska Department of Fish and Game, Anchorage, personal communication)

Due to conservation and subsistence concerns, chinook salmon have not been targeted in the Kuskokwim River commercial fishery since 1987. Since then, the chinook BEG at the Kogrukluk River weir has been achieved in seven of ten years (Appendix B). The 1995 escapement estimate (20,630) was the highest recorded. With the BEG achieved in most recent years and average or above percentages of females, the status of Kogrukluk River chinook appears good.

Sockeye Salmon

Annual escapements of sockeye at the Kogrukluk River weir have been highly variable ranging from 1,670 in 1978 to 29,358 in 1993 (Appendix B). The 1997 escapement estimate exceeded the average (9,839) by 33%. The lack of commercial fishing periods in the Kuskokwim River likely contributed to the above average escapement of sockeye.

Sockeye escapement at the Kogrukluk River in the 1990s has been much higher than most previous years. The higher than normal escapement could be partially accounted for by the slight reduction of commercial periods in the Kuskokwim River during June to conserve chinook stocks. There is a weak inverse relationship (NSC) between the June commercial harvest in District 1 and Kogrukluk River escapement. Escapement tends to be higher when commercial harvests are low. Although aerial surveys have not particularly focused on sockeye and are not as definitive as ground-based assessments, aerial survey counts of sockeye have increased somewhat in the Aniak River, Holitna River (below Kogrukluk River), and Tevyaraq Lake (Holokuk drainage). There also appears to be increases of sockeye productivity in the Kanektok River, which drains directly into Kuskokwim Bay. The 1981-1989 average District 4 commercial harvest, primarily composed of Kanektok River stocks is about 16,500, whereas, the 1990-1997 average is about 68,000 sockeye. Aerial surveys of the Kanektok River show a slight increase in sockeye escapement. The 1983-1989 average aerial count is about 23,000 whereas, the 1991-1997 average is about 26,000.

Chum Salmon

The chum salmon escapement at the Kogrukluk River weir in 1997 was the lowest recorded for years with adequate data (Appendix B). Record low commercial catches and low counts observed in other escapement projects suggest that the overall run of chum salmon in the Kuskokwim River was extremely poor (Burkey et al. 1997). Chum runs throughout the Kuskokwim Area appeared below average. Despite the poor run in 1997, escapement objectives have been in achieved in the previous five years. Barring any catastrophic marine foraging conditions or severe winters, the overall status of Kogrukluk River chum appears good, apart from the 1997 brood year.

Coho Salmon

Throughout Alaska, with Kuskokwim Area drainages being no exception, run timing and escapement information on coho salmon is difficult to obtain and often incomplete because their migration coincides with months having the most precipitation. Few escapement estimates of coho at the Kogrukluk River weir are based on actual counts of greater than 80% of what is assumed to be the entire run. In 1997, only two days of counts were missed due to high water. Weir operation ended for the season on 21 September when an estimated 97% of the run had passed, based on a normal run-timing model. Due to the poor run of coho, only three commercial fishing periods were allowed in the Kuskokwim River after 1 August. The commercial coho catch was the lowest recorded since 1976 (Burkey et al. *in prep.*). The low escapement at the Kogrukluk River (50% of the BEG) and poor commercial catch indicate that overall the coho run in the Kuskokwim River was poor. The BEG for coho salmon at the Kogrukluk River weir has been achieved in the previous three years, and the outlook and status of coho is positive, except for the 1997 brood year.

Gillnet-Marked Salmon

The number of salmon with gillnet marks is collected primarily to index the relative intensity of the commercial and subsistence fisheries. After gillnets were restricted to 6 inch (15 cm) maximum stretch mesh in 1985, there was a slight increase in the mean percentage of gillnet-marked female chinook salmon observed passing the weir (Burkey 1995; Appendix C). Since 1993, the percentage of gillnet-marked female chinook salmon has been relatively low, with the lowest percentage (4.4%) recorded in 1996. The 9.1% observed in 1997 was the second lowest recorded. Annual changes in frequency of gillnet-marked salmon could be caused by several confounding factors such as mean length at age, age composition, run timing, the amount of commercial effort directed at the particular stock, subsistence fishing effort, and variability in the skill of observers at the weir. Therefore, changes or apparent trends in the percentage of gillnet-marked salmon at the weir are difficult , if not impossible to interpret. The

lack of commercial fishing effort during 1997 may help explain the lower than average percentage of gillnet-marked fish observed at the weir. In previous years, limited attempts to analyze counts of gillnet-marked fish were inconclusive (Schneiderhan 1989). Gillnet-mark data does not seem to be useful, and future collection of this information should be discontinued.

Age, Sex, and Length

Age compositions of escapements can be useful for developing stock-recruitment models which can be used to project run size. Unfortunately this is not possible for any one spawning stock or the entire Kuskokwim River drainage because stock specific exploitation and total run size, for most years, is unknown. Still, age composition information can help predict the relative magnitude of future runs. Strong or weak returns from the younger returning adults may be indicative of the survival of those cohorts, hence, strength of spawner returns from those cohorts in following years. Such interpretations should be made with caution for several reasons: (1) there is a tendency in some species for the age compositions to shift towards younger fish as the run progresses, therefore, thoroughness of the sampling regimen is important, (2) disparate removal of age classes in the commercial and subsistence fisheries may occur, (3) seemingly high percentages of one age class could also be caused by low percentages of another, and (4) scale aging error within and among readers has not been fully assessed.

Comparisons between ASL data collected at the Kogrukluk River weir and other escapement projections should be made with the weir's locality in mind. The Kogrukluk River weir is in an upper reaches area (altitude ~107 m) 205 km from the confluence of the Holitna and Kuskokwim Rivers. A majority of the salmon that enter the Holitna River drainage spawn in the mainstem and tributaries downstream from the Kogrukluk River. How these factors come into play is uncertain but most escapement assessment projects are located closer to the Kuskokwim River or Bay and downstream of the major spawning grounds, hence may be more representative of the entire primary-tributary spawning aggregates.

Chinook Salmon

Most chinook salmon return to the Kuskokwim River as 4, 5, and 6-year-old fish (age classes 1.2, 1.3 and 1.4). For the Kogrukluk River, the historical (years 1984 through 1995) mean composition for both sexes combined is 17.8% age 1.2, 42.1% age 1.3, and 37.1% age 1.4 (Molyneaux and DuBois 1996). Females are typically older and fewer in number, historically composing 0.3% of age 1.2, 6.9% of age 1.3, 23.7% of age 1.4, and 69% of age 1.5.

The 1997 proportion of age-1.2 chinook (33.7%, most of which were males or "jacks") was almost twice the historical average (17.8%), and the proportion of age-1.3 fish (20.4%) was less than half the historical average (42.1%). The percentage of age-1.4 fish (45.4%) was somewhat higher than the historical average of 37.1%. The higher than average percent of age-1.2 chinook could be attributed to the lack of commercial fishing, or a strong return of this age class, or both. Because commercial fishing

is limited to gillnets with a mesh size of 6 inches or less, smaller chinook salmon are more vulnerable to harvest in the commercial fishery. Since 1985, age-1.2 chinook have usually been the largest component (overall 35%) of the commercial catch in District 1 and age 1.3 the second largest (33%). The low composition of 1.3 at the weir was probably due to a combination of a below average brood year escapement (6,755 in 1992) and poor marine survival rather than fishery harvests. A lack of age-1.3 chinook also occurred in the 1997 commercial catch in District 4 and in the escapement at the Kanektok River (Menard and Caole *in prep.*). Both the 1992 Kanektok River escapement (by aerial survey counts) and District 4 commercial catch of chinook were also below average.

The 1997 estimated percent females from the ASL samples (31%) and the weir counts (33%) were very close to average. Historically, female composition (by weir counts), has ranged from 16 to 49%. Prior to 1985, when gillnet mesh size was unrestricted, the average female composition at the Kogrukluk weir was 30% (Appendix C). The average female composition since 1985 has risen slightly to 33%.

Chum Salmon

Most chum salmon return as 4 and 5 year old fish (age classes 0.3 and 0.4). For the Kogrukluk River, the historical (years 1971 through 1995) mean percent of age 0.3 is 47.8% and of age 0.4 is 50.2% (Molyneaux and DuBois 1996). In 1997, the proportion of 0.3 (42.9%) and 0.4 (56.8%) age classes was shifted slightly towards the older age class. Age compositions between male and female chum salmon are usually similar. The poor chum escapement at the Kogrukluk River weir in 1997 can not be attributed to high mortality of one age cohort; and parent year escapements (1992 and 1993) were both above the BEG (Appendix B). An above average proportion of 0.2 and 0.3 chum with an above average escapement was observed in 1996 indicating that the 1997 run would have an average or better 0.3 and 0.4 component and escapement.

The paucity of female chum salmon at the Kogrukluk River weir is chronic and has been a concern, particularly in the last 10 years. The 12% females observed in 1997 was the second lowest recorded. The lowest ever recorded was 9.6% in 1980. For reasons not understood, the low proportion of females at the weir may not be a good representation of the entire Holitna River drainage, but other areas of the drainage have not been sampled. Commercial catches and other escapement assessment projects in the Kuskokwim River drainage generally have a more even percentage of males and females (Molyneaux and DuBois 1996).

Coho Salmon

A change in channel morphology, low water and low numbers of coho caused an inability to collect ASL information for 1997. A gravel bar has been forming where the fish trap is usually located, exacerbating the effects of low water. The coho salmon avoided the shallow to enter the trap. The crew tried beach seining near the weir, but channel morphology and water velocity where fish typically hold was not conducive to successful beach seining. Because of the large size and heavy weight of the fish trap, moving it to different parts of the weir is not practical for the two-person crew. A lighter more portable trap is needed to accommodate low-water conditions or the weir may have to be installed in a

different location if this problem of ASL data collection continues.

Most coho salmon return to the Kuskokwim River as 4-year-old fish (age class 2.1). For the Kogrukluk River, the average (years 1991; 1993-1995) age composition is 3% age 1.1, 90% age 2.1, and 7% age 3.1 (Molyneaux and DuBois 1996). There has been little variability in age composition among these years with the composition age 2.1 ranging from of 89% in 1995 to 96% in 1991. Age compositions of male and female coho salmon are usually similar. The historical average sex composition, based on ASL samples, is 56% male and 44% female (Molyneaux and DuBois 1996). Few escapement projects in the Kuskokwim Area have provided ASL information on coho for making comparisons with the Kogrukluk River. There is little variability in the age and sex compositions among locations with multiple years of data. The average age composition of trap-caught coho at the Tuluksak River weir for years 1991-1994 is 3% age 1.1, 81% age 2.1, 4% age 2.2, and 12% age 3.1 (Molyneaux and DuBois 1996). The average sex composition for the same years is 56% males and 44% females. The average age composition in the Kuskokwim River (District 1) commercial catch for the years 1984-1995 is 7% age 1.1, 87% age 2.1, and 6% age 3.1. The average sex composition for the same years is 54% males and 46% females.

LITERATURE CITED

Baxter, R. 1979. Holitna River salmon studies, 1978. A-Y-K Region Kuskokwim Salmon Escapement Report No. 15. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1981. Ignatti weir construction manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region Kuskokwim Escapement Report 28, Anchorage.

Bromaghin, J.F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician 47 (3): 203-206.

Brown, M.C. 1983. Alaska's Kuskokwim River Region A history. Bureau of Land Management. Anchorage, Alaska.

Buklis, L.S. 1993. Documentation of Arctic-Yukon-Kuskokwim region salmon escapement goals in effect as of the 1992 fishing season. Regional Information Report No. 3A93-03. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

Burkey, C.E. Jr., editor. 1994. Kuskokwim Area salmon escapement observation catalog, 1984-1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

Burkey, C.E. Jr. 1995. Kogrukluk River weir salmon escapement report, 1991-1994. Regional Information Report No. 3A95-24. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage.

Burkey, C.E. Jr., and five other authors. 1996. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 1996. Regional Information Report No. 3A98-11. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage.

Burkey, C.E. Jr., and three other authors. 1997. Report to the Alaska Board of Fisheries Kuskokwim Area, 1997. Regional Information Report No. 3A97-44. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division , Anchorage.

Clutter, R., and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International North Pacific Fisheries Commission 9.

INFPC (International North Pacific Fisheries Commission). 1963. Annual Report, 1961. Vancouver, British Columbia.

Groot, C., and L. Margolis, editors. 1991. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

LITERATURE CITED (continued)

Menard, J. and A. Caole. *In prep.* Kanektok River counting tower cooperative project, 1997. Alaska Department of Fish and Game and Native Village of Kwinhagak joint report.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska.

Molyneaux, D. and L. DuBois. 1996. Salmon age, sex, and length, catalog for the Kuskokwim area, 1971-1995. Regional Information Report No. 3A96-31. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

Orth, D.J. 1971. Dictionary of Alaska place names. Geological Survey Professional Paper 567. United States Printing Office, Washington D.C.

Schneiderhan, D.J. 1989. Kogrukluk weir salmon escapement study, 1988. Regional Information Report No. 3A89-09. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schneiderhan, D.J., editor. 1983. Kuskokwim stream catalog, 1954-1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Wood, C.C., B.E. Riddell, and D.T. Rutherford. 1987. Alternative juvenile life histories of sockeye salmon (*Oncorhynchus nerka*) and their contribution to production in the Stikine River, Northern British Columbia. Pages 12-24 *in* H.D Smith, L. Margolis, and C.C Wood, editors. Sockeye Salmon (*Oncorhynchus nerka*) population biology and future management. Canadian Special Publication of Fisheries and Aquatic Sciences. 96.

Table 1. Daily counts of salmon by sex, and total count estimates of chinook salmon at the Kogrukluk River weir, 1997.

	Chinook				Sockeye			Chum			Coho		
Date	Male	Female	Jack	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
6/19				1 [a]			0 [a]			0 [a]			
6/20				1 [a]			0 [a]			0 [a]			
6/21				2 [a]			0 [a]			0 [a]			
6/22				4 [a]			0 [a]			1 [a]			
6/23				9 [a]			0 [a]			1 [a]			
6/24				15 [a]			0 [a]			2 [a]			
6/25				28 [a]			0 [a]			6 [a]			
6/26				34 [a]			0 [a]			8 [a]			
6/27				67 [a]			0 [a]			7 [a]			
6/28	33	18	3	51	4	4	8	35	9	44	0	0	0
6/29	419	191	14	610	56	27	83	102	114	216	0	0	0
6/30	396	200	39	596	13	17	30	121	36	157	0	0	0
7/1	353	154	32	507	78	26	104	140	16	156	0	0	0
7/2	118	54	13	172	66	25	91	153	12	165	0	0	0
7/3	639	288	72	927	213	106	319	219	32	251	0	0	0
7/4	385	202	31	587	208	83	291	225	20	245	0	0	0
7/5	699	326	109	1,025	358	179	537	421	78	499	0	0	0
7/6	578	212	96	790	333	241	574	280	66	346	0	0	0
7/7	854	288	101	1,142	412	165	577	354	35	389	0	0	0
7/8	377	109	83	486	409	140	549	322	40	362	0	0	0
7/9	479	229	34	708	188	73	261	145	12	157	0	0	0
7/10	122	97	10	219	218	112	330	177	15	192	0	0	0
7/11	150	74	10	224	296	81	377	195	15	210	0	0	0
7/12	358	174	35	532	307	121	428	240	32	272	0	0	0
7/13	181	122	11	303	302	119	421	306	28	334	0	0	0
7/14	347	205	58	552	483	185	668	295	34	329	0	0	0
7/15	275	123	57	398	539	287	826	335	56	391	0	0	0
7/16	232	92	39	324	312	131	443	287	17	304	0	0	0
7/17	239	138	33	377	622	333	955	222	25	247	0	0	0
7/18	343	134	51	477	559	292	851	283	30	313	0	0	0
7/19	223	134	42	357	602	274	876	290	30	320	0	0	0
7/20	225	167	39	392	484	127	611	157	17	174	0	0	0
7/21	195	151	39	346	459	107	566	237	26	263	0	0	0
7/22	85	123	27	208	186	88	274	117	11	128	0	0	0
7/23	44	66	16	110	371	140	511	151	12	163	0	0	0
7/24	25	28	4	53	106	46	152	61	10	71	0	0	0
7/25	11	23	4	34	97	32	129	51	4	55	0	0	0
7/26	54	46	15	100	165	28	193	117	6	123	0	0	0
7/27	6	7	2	13	130	31	161	94	6	100	0	0	0
7/28	44	37	8	81	164	18	182	187	5	192	0	0	0
7/29	19	18	7	37	111	16	127	121	2	123	2	0	2
7/30	30	17	5	47	82	7	89	74	3	77	0	0	0
7/31	18	18	4	36	79	10	89	35	1	36	1	0	1
8/1	12	8	3	20	56	6	62	43	5	48	3	1	4
8/2	8	22	1	30	52	2	54	47	3	50	4	1	5
8/3	12	13	1	25	28	9	37	52	4	56	2	1	3
8/4	7	6	0	13	36	2	38	31	7	38	3	1	4
8/5	10	8	3	18	37	4	41	29	4	33	13	10	23
8/6	10	9	0	19	13	3	16	36	6	42	12	10	22
8/7	10	3	1	13	24	2	26	27	5	32	31	16	47
8/8	9	1	1	10	12	3	15	16	5	21	6	5	11
8/9	18	5	9	23	8	6	14	25	3	28	15	11	26
8/10	23	5	9	28	17	3	20	22	5	27	40	25	65
8/11	31	2	13	33	26	6	32	59	9	68	51	38	89

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Table 1. (page 2 of 2)

	Chinook				Sockeye			Chum			Coho		
Date	Male	Female	Jack	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
8/12				9 [a]			14 [a]			15 [a]			57 [a]
8/13				4 [a]			5 [a]			16 [a]			73 [a]
8/14	4	0	4	4	2	2	4	6	1	7	12	9	21
8/15	12	1	3	13	4	1	5	7	4	11	41	23	64
8/16	6	0	1	6	2	0	2	11	4	15	62	61	123
8/17	4	1	4	5	3	1	4	2	3	5	34	50	84
8/18	1	0	1	1	1	0	1	0	2	2	58	35	93
8/19	4	1	0	5	0	1	1	0	2	2	71	46	117
8/20	2	2	0	4	0	0	0	2	2	4	139	99	238
8/21	0	1	0	1	0	0	0	0	1	1	288	161	449
8/22	2	0	0	2	1	0	1	0	0	0	327	101	428
8/23	0	1	0	1	0	0	0	0	0	0	342	137	479
8/24	0	0	0	0	0	0	0	0	0	0	303	122	425
8/25	2	0	1	2	0	0	0	0	1	1	384	227	611
8/26	2	2	0	4	1	0	1	0	0	0	393	192	585
8/27	1	3	0	4	1	0	1	0	0	0	253	148	401
8/28	0	0	0	0	0	0	0	1	1	2	222	128	350
8/29	0	2	0	2	0	0	0	0	0	0	189	111	300
8/30	0	1	0	1	0	0	0	0	1	1	491	216	707
8/31	0	1	0	1	0	0	0	0	0	0	565	343	908
9/1	0	0	0	0	0	0	0	0	1	1	383	181	564
9/2	0	0	0	0	0	0	0	0	0	0	144	107	251
9/3	0	0	0	0	0	0	0	0	0	0	282	149	431
9/4	0	0	0	0	0	0	0	0	0	0	47	22	69
9/5	0	0	0	0	0	0	0	0	0	0	338	202	540
9/6	0	0	0	0	0	0	0	0	0	0	142	92	234
9/7	0	0	0	0	0	0	0	1	1	2	422	300	722
9/8	0	0	0	0	0	0	0	0	0	0	344	253	597
9/9	0	0	0	0	0	0	0	0	0	0	241	174	415
9/10	0	0	0	0	0	0	0	1	0	1	222	120	342
9/11	0	0	0	0	0	0	0	0	0	0	119	76	195
9/12	0	0	0	0	0	0	0	0	0	0	57	45	102
9/13	0	0	0	0	0	0	0	0	0	0	51	29	80
9/14	1	0	1	1	0	0	0	0	0	0	36	26	62
9/15	0	0	0	0	0	0	0	0	0	0	32	20	52
9/16	1	0	0	1	0	0	0	0	0	0	68	21	89
9/17	0	0	0	0	0	0	0	0	0	0	56	33	89
9/18							0 [a]			0 [a]			64 [a]
9/19	0	0	0	0	0	0	0	0	0	0	15	23	38
9/20	0	0	0	0	0	0	0	0	0	0	17	11	28
9/21	1	0	0	1	0	1	1	0	0	0	17	9	26
9/22													140 [a]
9/23													62 [a]
9/24													73 [a]
9/25													26 [a]
9/26													24 [a]
9/27													14 [a]
9/28													24 [a]
9/29													17 [a]
9/30													6 [a]
10/1													8 [a]
10/2													11 [a]
10/3													10 [a]
10/4													10 [a]
10/5													8 [a]
Total	8,749	4,363	1,199	**13,286**	9,336	3,723	**13,078**	6,967	935	**7,958**	7,390	4,221	**12,237**

[a] Estimates based on run-timing models.

Table 2. Run-timing models (cumulative proportion) used in 1997 to calculate missing total daily counts of salmon at the Kogrukluk River weir.

Date	Chinook (early)	Sockeye (late)	Chum (late)	Coho Date	Coho (normal)
19-Jun	0.000	0.000	0.000	03-Aug	0.000
20-Jun	0.000	0.000	0.000	04-Aug	0.001
21-Jun	0.000	0.000	0.000	05-Aug	0.001
22-Jun	0.001	0.000	0.000	06-Aug	0.001
23-Jun	0.001	0.000	0.000	07-Aug	0.002
24-Jun	0.003	0.000	0.001	08-Aug	0.003
25-Jun	0.005	0.000	0.001	09-Aug	0.004
26-Jun	0.007	0.000	0.002	10-Aug	0.006
27-Jun	0.012	0.000	0.003	11-Aug	0.009
28-Jun	0.019	0.000	0.004	12-Aug	0.013
29-Jun	0.030	0.000	0.009	13-Aug	0.019
30-Jun	0.039	0.001	0.015	14-Aug	0.027
1-Jul	0.070	0.004	0.026	15-Aug	0.035
2-Jul	0.129	0.011	0.038	16-Aug	0.046
3-Jul	0.182	0.019	0.053	17-Aug	0.051
4-Jul	0.215	0.029	0.082	18-Aug	0.068
5-Jul	0.273	0.043	0.103	19-Aug	0.080
6-Jul	0.355	0.065	0.137	20-Aug	0.099
7-Jul	0.422	0.077	0.192	21-Aug	0.127
8-Jul	0.478	0.107	0.241	22-Aug	0.156
9-Jul	0.523	0.141	0.285	23-Aug	0.178
10-Jul	0.602	0.178	0.340	24-Aug	0.204
11-Jul	0.643	0.207	0.401	25-Aug	0.232
12-Jul	0.708	0.245	0.455	26-Aug	0.279
13-Jul	0.739	0.355	0.500	27-Aug	0.309
14-Jul	0.773	0.461	0.539	28-Aug	0.343
15-Jul	0.800	0.545	0.591	29-Aug	0.374
16-Jul	0.830	0.622	0.628	30-Aug	0.417
17-Jul	0.861	0.682	0.690	31-Aug	0.466
18-Jul	0.888	0.717	0.729	01-Sep	0.516
19-Jul	0.905	0.740	0.756	02-Sep	0.568
20-Jul	0.917	0.768	0.786	03-Sep	0.611
21-Jul	0.929	0.809	0.817	04-Sep	0.677
22-Jul	0.945	0.848	0.836	05-Sep	0.708

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Table 2. (page 2 of 2)

Date	Chinook (early)	Sockeye (late)	Chum (late)	Coho Date	Coho (normal)
23-Jul	0.954	0.869	0.865	06-Sep	0.735
24-Jul	0.960	0.888	0.876	07-Sep	0.766
25-Jul	0.966	0.906	0.889	08-Sep	0.794
26-Jul	0.971	0.918	0.896	09-Sep	0.817
27-Jul	0.976	0.933	0.906	10-Sep	0.837
28-Jul	0.979	0.942	0.919	11-Sep	0.872
29-Jul	0.982	0.952	0.931	12-Sep	0.890
30-Jul	0.986	0.965	0.940	13-Sep	0.899
31-Jul	0.989	0.969	0.947	14-Sep	0.909
1-Aug	0.990	0.975	0.954	15-Sep	0.915
2-Aug	0.991	0.981	0.961	16-Sep	0.924
3-Aug	0.993	0.987	0.968	17-Sep	0.937
4-Aug	0.994	0.989	0.976	18-Sep	0.940
5-Aug	0.995	0.991	0.980	19-Sep	0.951
6-Aug	0.996	0.993	0.983	20-Sep	0.959
7-Aug	0.996	0.994	0.986	21-Sep	0.965
8-Aug	0.997	0.995	0.988	22-Sep	0.976
9-Aug	0.998	0.996	0.989	23-Sep	0.981
10-Aug	0.998	0.996	0.991	24-Sep	0.987
11-Aug	0.999	0.997	0.992	25-Sep	0.989
12-Aug	0.999	0.998	0.994	26-Sep	0.991
13-Aug	1.000	0.998	0.996	27-Sep	0.992
14-Aug		0.999	0.997	28-Sep	0.994
15-Aug		0.999	0.997	29-Sep	0.996
16-Aug		0.999	0.998	30-Sep	0.996
17-Aug		0.999	0.998	01-Oct	0.997
18-Aug		0.999	0.999	02-Oct	0.998
19-Aug		0.999	0.999	03-Oct	0.999
20-Aug		0.999	0.999	04-Oct	0.999
21-Aug		1.000	1.000	05-Oct	1.000

Table 3. Daily counts of gillnet-marked salmon at the Kogrukluk River weir, 1997.

Date	Chinook			Sockeye			Chum			Coho		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
6/29	36	18	54	1	0	1	7	0	7	0	0	0
6/30	40	19	59	0	1	1	8	0	8	0	0	0
7/1	29	16	45	0	0	0	11	0	11	0	0	0
7/2	12	9	21	1	0	1	5	0	5	0	0	0
7/3	47	29	76	4	3	7	3	0	3	0	0	0
7/4	16	7	23	4	6	10	5	0	5	0	0	0
7/5	37	28	65	7	2	9	11	3	14	0	0	0
7/6	43	16	59	7	5	12	9	1	10	0	0	0
7/7	71	23	94	6	4	10	10	2	12	0	0	0
7/8	30	6	36	4	1	5	4	1	5	0	0	0
7/9	29	26	55	4	3	7	3	0	3	0	0	0
7/10	8	6	14	3	2	5	5	0	5	0	0	0
7/11	7	7	14	4	1	5	6	0	6	0	0	0
7/12	33	17	50	4	0	4	5	1	6	0	0	0
7/13	16	13	29	2	1	3	7	1	8	0	0	0
7/14	20	21	41	4	2	6	2	0	2	0	0	0
7/15	21	15	36	11	4	15	4	1	5	0	0	0
7/16	19	10	29	2	2	4	3	1	4	0	0	0
7/17	20	10	30	8	3	11	2	0	2	0	0	0
7/18	36	12	48	3	4	7	4	0	4	0	0	0
7/19	13	12	25	1	2	3	5	3	8	0	0	0
7/20	17	11	28	2	2	4	1	1	2	0	0	0
7/21	5	17	22	3	3	6	2	0	2	0	0	0
7/22	11	18	29	3	1	4	1	0	1	0	0	0
7/23	4	6	10	1	1	2	4	0	4	0	0	0
7/24	2	4	6	0	1	1	2	0	2	0	0	0
7/25	1	2	3	1	0	1	2	1	3	0	0	0
7/26	4	5	9	1	0	1	2	0	2	0	0	0
7/27	0	0	0	2	0	2	0	0	0	0	0	0
7/28	2	6	8	3	0	3	4	0	4	0	0	0
7/29	0	1	1	2	0	2	0	0	0	0	0	0
7/30	1	0	1	1	0	1	1	0	1	0	0	0
7/31	0	0	0	1	0	1	1	0	1	0	0	0
8/1	0	3	3	0	1	1	0	0	0	0	0	0
8/2	0	2	2	2	0	2	0	0	0	0	0	0
8/3	0	0	0	0	0	0	0	0	0	0	0	0
8/4	0	0	0	0	0	0	0	0	0	0	0	0
8/5	0	1	1	0	0	0	0	0	0	0	0	0
8/6	0	0	0	0	0	0	0	0	0	0	0	0
8/7	0	0	0	0	0	0	0	0	0	0	0	0
8/8	0	0	0	0	0	0	0	0	0	0	0	0
8/9	0	0	0	0	0	0	0	0	0	0	0	0
8/10	0	0	0	0	0	0	0	0	0	0	0	0
8/11	0	0	0	0	0	0	0	0	0	0	0	0
8/12	-	-	-	-	-	-	-	-	-	-	-	-
8/13	-	-	-	-	-	-	-	-	-	-	-	-
8/14	0	0	0	0	0	0	0	0	0	0	0	0
8/15	0	0	0	0	0	0	0	0	0	0	0	0
8/16	0	0	0	0	0	0	0	0	0	1	1	2
8/17	0	0	0	0	0	0	0	0	0	1	1	2
8/18	0	0	0	0	0	0	0	0	0	0	0	0

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Table 3. (page 2 of 2)

	Chinook			Sockeye			Chum			Coho		
Date	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
8/19	0	0	0	0	0	0	0	0	0	2	0	2
8/20	0	0	0	0	0	0	0	0	0	0	0	0
8/21	0	0	0	0	0	0	0	0	0	1	2	3
8/22	0	0	0	0	0	0	0	0	0	2	1	3
8/23	0	0	0	0	0	0	0	0	0	2	2	4
8/24	0	0	0	0	0	0	0	0	0	6	1	7
8/25	0	0	0	0	0	0	0	0	0	0	5	5
8/26	0	0	0	0	0	0	0	0	0	4	3	7
8/27	0	0	0	0	0	0	0	0	0	2	3	5
8/28	0	0	0	0	0	0	0	0	0	2	2	4
8/29	0	1	1	0	0	0	0	0	0	2	2	4
8/30	0	0	0	0	0	0	0	0	0	1	3	4
8/31	0	0	0	0	0	0	0	0	0	6	6	12
9/1	0	0	0	0	0	0	0	0	0	6	1	7
9/2	0	0	0	0	0	0	0	0	0	6	2	8
9/3	0	0	0	0	0	0	0	0	0	1	3	4
9/4	0	0	0	0	0	0	0	0	0	0	1	1
9/5	0	0	0	0	0	0	0	0	0	6	6	12
9/6	0	0	0	0	0	0	0	0	0	4	6	10
9/7	0	0	0	0	0	0	0	0	0	14	6	20
9/8	0	0	0	0	0	0	0	0	0	3	11	14
9/9	0	0	0	0	0	0	0	0	0	7	2	9
9/10	0	0	0	0	0	0	0	0	0	4	4	8
9/11	0	0	0	0	0	0	0	0	0	3	4	7
9/12	0	0	0	0	0	0	0	0	0	1	2	3
9/13	0	0	0	0	0	0	0	0	0	3	2	5
9/14	0	0	0	0	0	0	0	0	0	1	1	2
9/15	0	0	0	0	0	0	0	0	0	0	0	0
9/16	0	0	0	0	0	0	0	0	0	2	0	2
9/17	0	0	0	0	0	0	0	0	0	1	0	1
9/18	-	-	-	-	-	-	-	-	-	-	-	-
9/19	0	0	0	0	0	0	0	0	0	0	1	1
9/20	0	0	0	0	0	0	0	0	0	0	0	0
9/21	0	0	0	0	0	0	0	0	0	0	0	0
Total	630	397	1,027	102	55	157	139	16	155	91	83	174
Percent	7.2	9.1	7.8	1.1	1.5	1.2	2.0	1.7	2.0	1.1	4.1	1.5

Table 4. Daily and cumulative salmon carcass counts at the Kogrukluk River weir, 1997.

	Chinook			Sockeye			Chum			Coho	
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.
6/28	0	0	0	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0	0	0	0
7/1	0	0	0	0	0	0	0	0	0	0	0
7/2	0	0	0	0	0	0	2	2	0	0	0
7/3	0	0	0	0	0	0	1	3	0	0	0
7/4	0	0	0	0	0	0	2	5	0	0	0
7/5	0	0	0	0	0	0	4	9	0	0	0
7/6	1	1	0	0	0	0	5	14	1	0	0
7/7	0	1	0	0	0	0	7	21	1	0	0
7/8	0	1	0	0	0	0	10	31	1	0	0
7/9	0	1	0	0	0	0	13	44	2	0	0
7/10	0	1	0	0	0	0	13	57	2	0	0
7/11	0	1	0	0	0	0	28	85	3	0	0
7/12	0	1	0	0	0	0	12	97	4	0	0
7/13	0	1	0	0	0	0	22	119	5	0	0
7/14	0	1	0	0	0	0	33	152	6	0	0
7/15	0	1	0	0	0	0	44	196	7	0	0
7/16	0	1	0	0	0	0	53	249	10	0	0
7/17	0	1	0	0	0	0	49	298	11	0	0
7/18	0	1	0	0	0	0	110	408	16	0	0
7/19	3	4	1	0	0	0	75	483	18	0	0
7/20	1	5	1	1	1	0	82	565	22	0	0
7/21	0	5	1	0	1	0	107	672	26	0	0
7/22	2	7	1	0	1	0	197	869	33	0	0
7/23	2	9	1	0	1	0	94	963	37	0	0
7/24	1	10	1	0	1	0	67	1,030	39	0	0
7/25	4	14	2	3	4	1	136	1,166	44	0	0
7/26	5	19	3	0	4	1	99	1,265	48	0	0
7/27	4	23	3	0	4	1	84	1,349	51	0	0
7/28	5	28	4	0	4	1	105	1,454	55	0	0
7/29	22	50	7	1	5	1	179	1,633	62	0	0
7/30	17	67	9	1	6	1	177	1,810	69	0	0
7/31	-	67	9	-	6	1	-	1,810	69	0	0
8/1	21	88	12	3	9	2	67	1,877	72	0	0
8/2	20	108	14	5	14	3	81	1,958	75	0	0
8/3	34	142	19	3	17	4	101	2,059	79	0	0
8/4	24	166	22	6	23	5	60	2,119	81	0	0
8/5	51	217	29	10	33	7	81	2,200	84	0	0
8/6	61	278	37	12	45	10	69	2,269	87	0	0
8/7	63	341	46	12	57	12	63	2,332	89	0	0
8/8	33	374	50	13	70	15	28	2,360	90	0	0
8/9	25	399	53	24	94	20	31	2,391	91	0	0
8/10	65	464	62	23	117	25	57	2,448	93	0	0

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Table 4. (page 2 of 2)

	Chinook			Sockeye			Chum			Coho	
Date	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.	%	Daily	Cum.
8/11	41	505	67	49	166	35	32	2,480	95	0	0
8/12	-	505	67	-	166	35	-	2,480	95	0	0
8/13	-	505	67	-	166	35	-	2,480	95	0	0
8/14	17	522	70	14	180	38	25	2,505	96	0	0
8/15	38	560	75	8	188	40	6	2,511	96	0	0
8/16	40	600	80	37	225	48	19	2,530	97	0	0
8/17	34	634	85	38	263	56	14	2,544	97	0	0
8/18	31	665	89	42	305	65	11	2,555	97	0	0
8/19	21	686	92	25	330	70	7	2,562	98	0	0
8/20	20	706	94	20	350	74	8	2,570	98	0	0
8/21	8	714	95	17	367	78	6	2,576	98	0	0
8/22	9	723	97	18	385	82	7	2,583	99	0	0
8/23	6	729	97	25	410	87	5	2,588	99	0	0
8/24	5	734	98	14	424	90	8	2,596	99	0	0
8/25	2	736	98	9	433	92	7	2,603	99	0	0
8/26	5	741	99	13	446	95	6	2,609	100	0	0
8/27	3	744	99	3	449	96	0	2,609	100	0	0
8/28	0	744	99	2	451	96	2	2,611	100	0	0
8/29	0	744	99	1	452	96	2	2,613	100	0	0
8/30	0	744	99	2	454	97	1	2,614	100	0	0
8/31	0	744	99	1	455	97	2	2,616	100	0	0
9/1	0	744	99	3	458	97	2	2,618	100	0	0
9/2	1	745	99	1	459	98	1	2,619	100	0	0
9/3	0	745	99	2	461	98	1	2,620	100	0	0
9/4	0	745	99	2	463	99	0	2,620	100	0	0
9/5	1	746	100	0	463	99	0	2,620	100	0	0
9/6	0	746	100	0	463	99	0	2,620	100	0	0
9/7	0	746	100	0	463	99	1	2,621	100	0	0
9/8	0	746	100	0	463	99	0	2,621	100	0	0
9/9	0	746	100	2	465	99	0	2,621	100	1	1
9/10	0	746	100	2	467	99	0	2,621	100	2	3
9/11	0	746	100	1	468	100	0	2,621	100	0	3
9/12	0	746	100	0	468	100	0	2,621	100	0	3
9/13	0	746	100	0	468	100	0	2,621	100	0	3
9/14	0	746	100	0	468	100	0	2,621	100	0	3
9/15	0	746	100	0	468	100	0	2,621	100	1	4
9/16	0	746	100	1	469	100	0	2,621	100	0	4
9/17	3	749	100	1	470	100	0	2,621	100	2	6
9/18	-	749	100	-	470	100	-	2,621	100	-	6
9/19	0	749	100	0	470	100	0	2,621	100	2	8
9/20	0	749	100	0	470	100	0	2,621	100	2	10
9/21	0	749	100	0	470	100	0	2,621	100	2	12

Table 5. Escapement of chinook salmon partitioned by age, sex, and time stratum based on trap-caught samples at the Kogrukluk River weir, 1997.[ab]

Sample Dates	Sample		1.2		1.3		1.4		1.5		Total		Actual	
(Stratum Dates)	Size	Sex	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%	Esc.	%
7/3, 5, 6	200	M	2,167	33.0	1,281	19.5	952	14.5	0	0.0	4,401	67.0	4,474	69.8
(6/19 - 7/7)		F	0	0.0	131	2.0	2,036	31.0	0	0.0	2,167	33.0	1,933	30.2
		Subtotal	2,167	33.0	1,412	21.5	2,988	45.5	0	0.0	6,568	100.0	6,407	100.0
7/10 - 15	204	M	1,047	27.9	716	19.1	808	21.6	0	0.0	2,571	68.6	2,521	67.3
(7/8 - 16)		F	0	0.0	19	0.5	1,102	29.4	55	1.5	1,175	31.4	1,225	32.7
		Subtotal	1,047	27.9	735	19.6	1,910	51.0	55	1.5	3,746	100.0	3,746	100.0
7/19, 20	68	M	1,224	41.2	481	16.2	437	14.7	0	0.0	2,143	72.1	1,754	59.3
(7/17 - 9/21)		F	42	1.4	86	2.9	698	23.5	0	0.0	829	27.9	1,205	40.7
		Subtotal	1,267	42.6	568	19.1	1,136	38.2	0	0.0	2,972	100.0	2,959	100.0
Season	472	M	4,437	33.4	2,478	18.6	2,197	16.5	0	0.0	9,112	68.6	8,749	66.7
		F	44	0.3	237	1.8	3,837	28.9	55	0.4	4,173	31.4	4,363	33.3
		Total	4,481	33.7	2,715	20.4	6,034	45.4	55	0.4	13,285	100.0	13,112	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in season summaries are the strata sums; season percentages are derived from the sums.

Table 6. Mean lengths (mm), by sex and time statum based on samples of trap-caught chinook salmon sampled at the Kogrukluk River weir.

Sample Dates (Stratum Dates)	Sex		Age Class 1.2	1.3	1.4	1.5
7/3, 5, 6 (6/19 - 7/7)	M	Mean Length	611	718	846	
		Std. Error	6	9	17	
		Range	510- 715	605- 845	655-1,050	
		Sample Size	66	39	29	0
	F	Mean Length		753	887	
		Std. Error		16	6	
		Range		720- 795	800-1,000	
		Sample Size	0	4	62	0
7/10 - 15 (7/8 - 16)	M	Mean Length	623	707	821	
		Std. Error	8	7	9	
		Range	480- 730	625- 790	690- 965	
		Sample Size	57	39	44	0
	F	Mean Length		760	871	888
		Std. Error		-	7	3
		Range		760- 760	735-1,005	885- 895
		Sample Size	0	1	60	3
7/19, 20 (7/17 - 9/21)	M	Mean Length	607	778	872	
		Std. Error	9	11	26	
		Range	540- 760	700- 830	745-1,000	
		Sample Size	28	11	10	0
	F	Mean Length	620	783	900	
		Std. Error	-	28	11	
		Range	620- 620	755- 810	820- 960	
		Sample Size	1	2	16	0
Season [a]	M	Mean Length	613	726	842	
		Range	480- 760	605- 845	655-1,050	
		Sample Size	151	89	83	0
	F	Mean Length	620	764	884	888
		Range	620- 620	720- 810	735-1,005	885- 895
		Sample Size	1	7	138	3

[a] Season mean lengths are weighted by the escapement passage in each stratum.

Table 7. Escapement of chum salmon partitioned by age, sex, and time stratum based on trap-caught samples at the Kogrukluk River weir, 1997.[ab]

Sample Dates (Stratum Dates)	Sample Size	Sex	Age Class 0.2 Esc.	0.2 %	0.3 Esc.	0.3 %	0.4 Esc.	0.4 %	0.5 Esc.	0.5 %	Total Esc.	Total %	Actual Esc.	Actual %
7/3 - 6	167	M	0	0.0	478	19.2	1,836	73.6	15	0.6	2,329	93.4	2,050	83.1
(6/22 - 7/7)		F	0	0.0	15	0.6	149	6.0	0	0.0	164	6.6	418	16.9
		Subtotal	0	0.0	493	19.8	1,985	79.6	15	0.6	2,493	100.0	2,468	100.0
7/10 - 13	182	M	12	0.5	778	34.6	1,333	59.3	25	1.1	2,148	95.6	2,015	89.7
(7/8 - 15)		F	0	0.0	49	2.2	50	2.2	0	0.0	99	4.4	232	10.3
		Subtotal	12	0.5	827	36.8	1,383	61.5	25	1.1	2,247	100.0	2,247	100.0
7/18 - 22	189	M	10	0.5	1,083	56.6	759	39.7	0	0.0	1,851	96.8	1,744	91.2
(7/16 - 23)		F	0	0.0	20	1.1	40	2.1	0	0.0	61	3.2	168	8.8
		Subtotal	10	0.5	1,103	57.7	799	41.8	0	0.0	1,912	100.0	1,912	100.0
7/26, 29	68	M	11	1.5	503	64.7	251	32.4	11	1.5	777	100.0	740	95.2
(7/24 - 31)		F	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	37	4.8
		Subtotal	11	1.5	503	64.7	251	32.4	11	1.5	777	100.0	777	100.0
8/3 - 5	35	M	0	0.0	479	94.3	29	5.7	0	0.0	508	100.0	418	83.9
(8/1 - 9/10)		F	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	80	16.1
		Subtotal	0	0.0	479	94.3	29	5.7	0	0.0	508	100.0	498	100.0
Season	641	M	34	0.4	3,320	41.8	4,209	53.0	51	0.6	7,613	95.9	6,967	88.2
		F	0	0.0	84	1.1	239	3.0	0	0.0	324	4.1	935	11.8
		Total	34	0.4	3,404	42.9	4,448	56.0	51	0.6	7,937	100.0	7,902	100.0

[a] The number of fish in each stratum age and sex category are derived from the sample percentages; discrepancies in sums are attributed to rounding errors.

[b] The number of fish in season summaries are the strata sums; season percentages are derived from the sums.

Table 8. Mean lengths (mm),by sex and time statum based on samples of trap-caught chum salmon at the Kogrukluk River weir.

Sample Dates (Stratum Dates)	Sex		Age Class 0.2	0.3	0.4	0.5
7/3 - 6 (6/22 - 7/7)	M	Mean Length		597	621	600
		Std. Error		5	2	-
		Range		555- 665	545- 695	600- 600
		Sample Size	0	32	123	1
	F	Mean Length		625	590	
		Std. Error		-	8	
		Range		625- 625	555- 635	
		Sample Size	0	1	10	0
7/10 - 13 (7/8 - 15)	M	Mean Length	555	595	617	628
		Std. Error	-	4	2	3
		Range	555- 555	540- 665	555- 680	625- 630
		Sample Size	1	63	108	2
	F	Mean Length		569	584	
		Std. Error		10	8	
		Range		550- 595	570- 605	
		Sample Size	0	4	4	0
7/18 - 22 (7/16 - 23)	M	Mean Length	540	594	605	
		Std. Error	-	3	3	
		Range	540- 540	535- 670	530- 670	
		Sample Size	1	107	75	0
	F	Mean Length		593	569	
		Std. Error		3	13	
		Range		590- 595	540- 590	
		Sample Size	0	2	4	0
7/26, 29 (7/24 - 31)	M	Mean Length	530	584	605	610
		Std. Error	-	3	5	-
		Range	530- 530	545- 630	575- 660	610- 610
		Sample Size	1	44	22	1
	F	Mean Length				
		Std. Error				
		Range				
		Sample Size	0	0	0	0
8/3 - 5 (8/1 - 9/10)	M	Mean Length		574	570	
		Std. Error		4	10	
		Range		515- 635	560- 580	
		Sample Size	0	32	2	0
	F	Mean Length				
		Std. Error				
		Range				
		Sample Size	0	0	0	0
Season [a]	M	Mean Length	542	590	615	616
		Range	530- 555	515- 670	530- 695	600- 630
		Sample Size	3	278	330	4
	F	Mean Length		584	585	
		Range		550- 625	540- 635	
		Sample Size	0	7	18	0

[a] Season mean lengths are weighted by the escapement passage in each stratum.

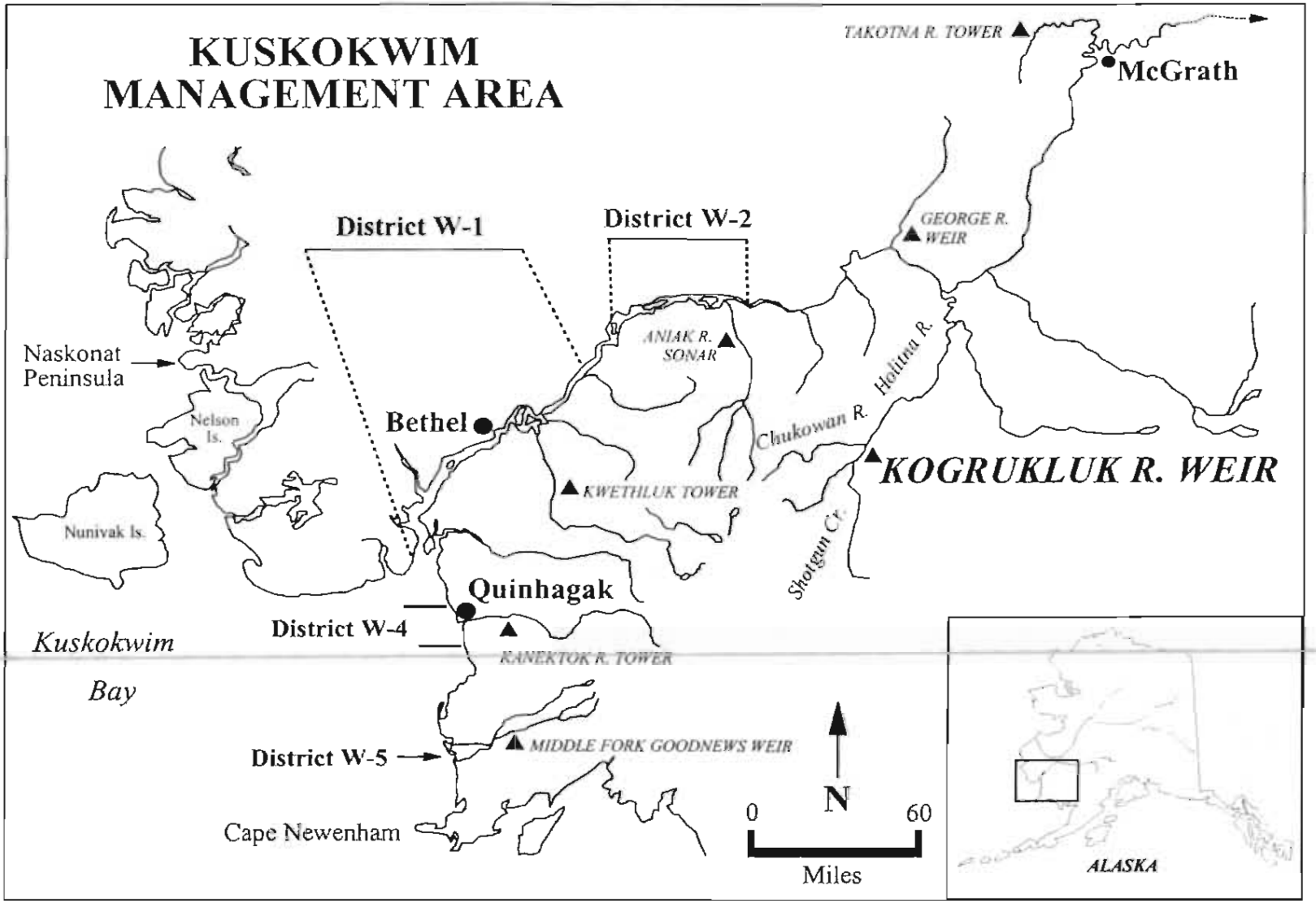

Figure 1. Kuskokwim Area map showing commercial salmon managment districts and escapement monitoring projects.

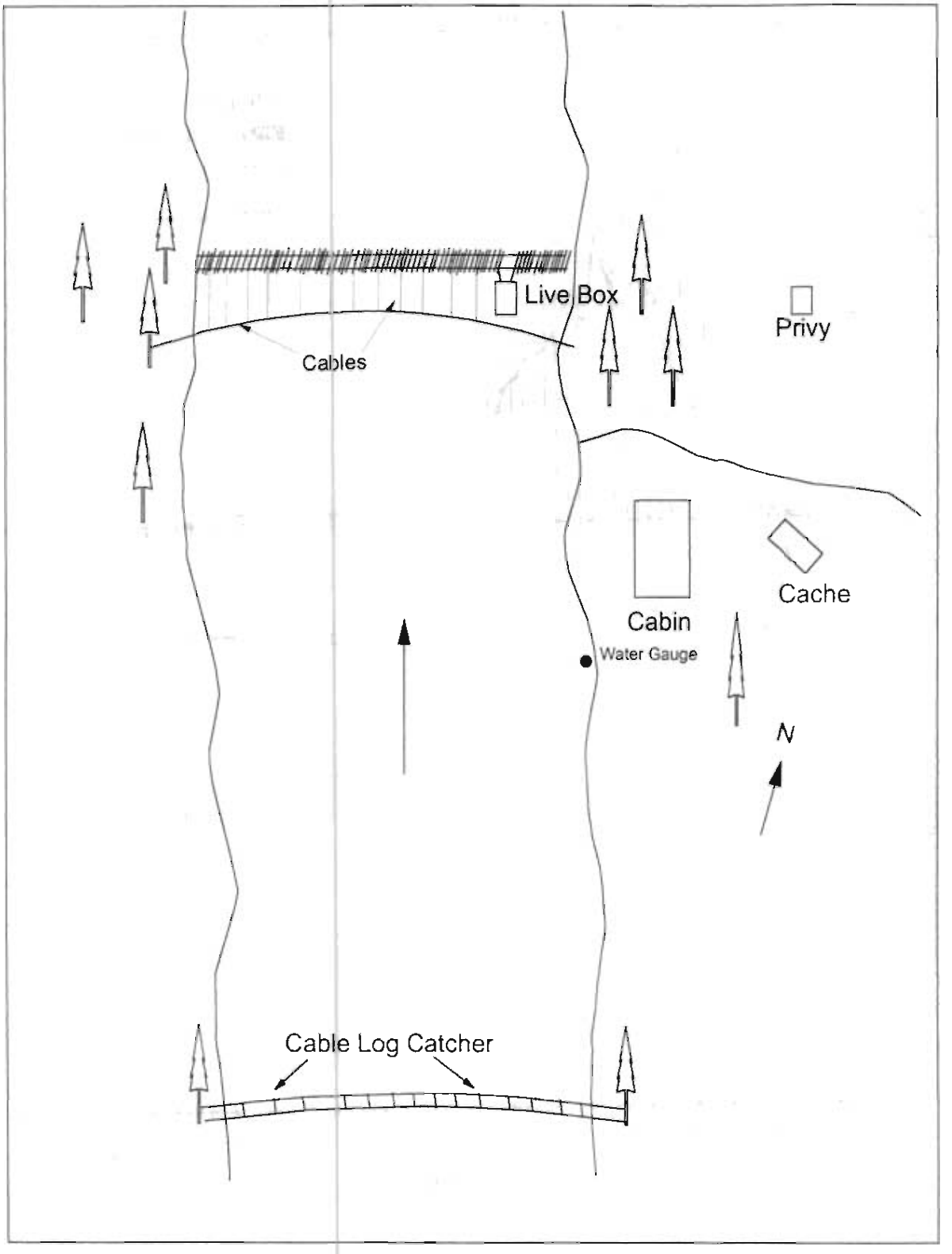

Figure 2. Schematic of the Kogrukluk River weir.

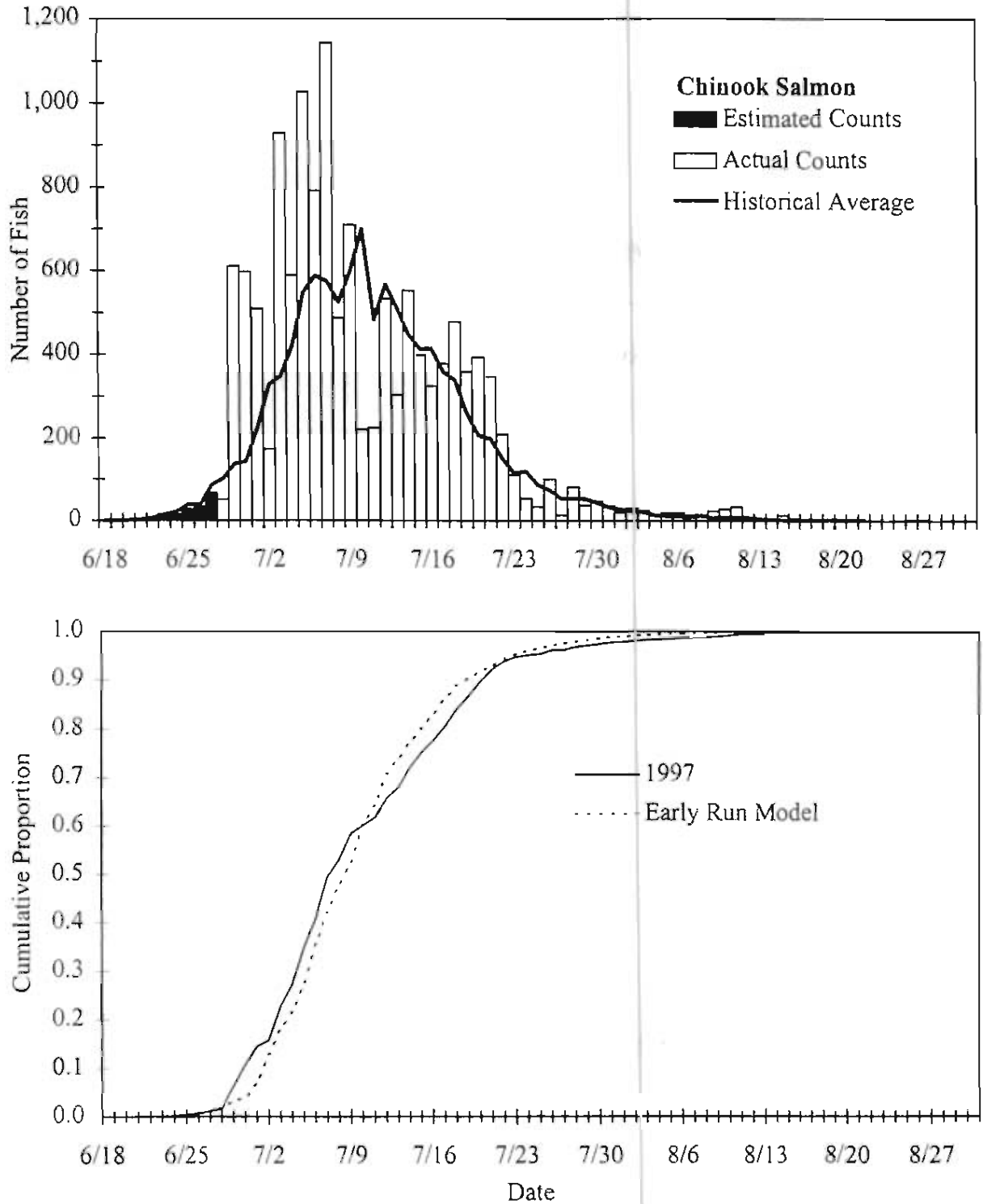

Figure 3. Daily counts of chinook salmon (top) and cumulative proportion compared with the run timing model used to estimate missing daily counts (bottom) at the Kogrukluk River weir, 1997.

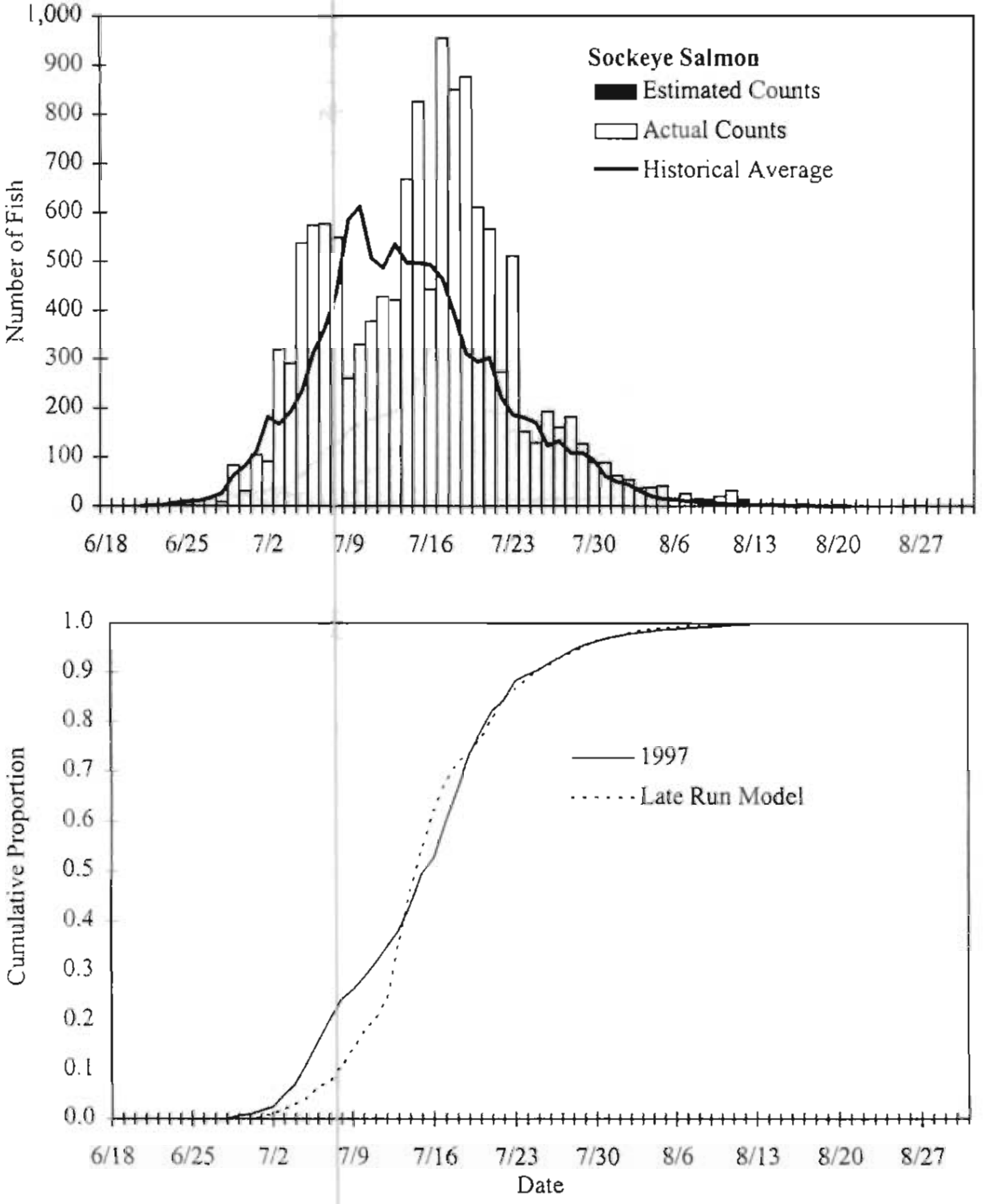

Figure 4. Daily counts of sockeye salmon (top) and cumulative proportion compared with the run timing model used to estimate missing daily counts (bottom) at the Kogrukluk River weir, 1997.

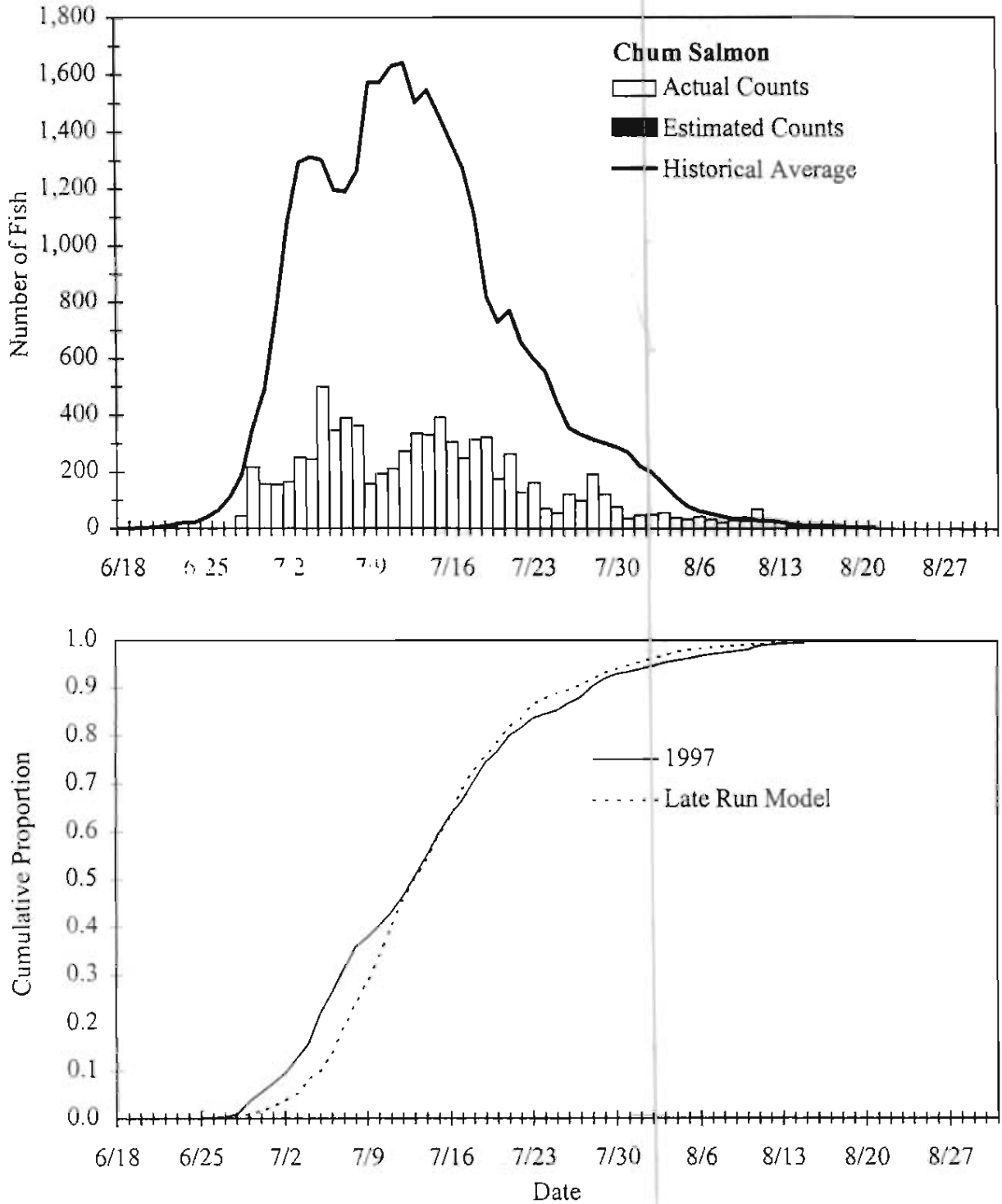

Figure 5. Daily counts of chum salmon (top) and cumulative proportion compared with the run timing model used to estimate missing daily counts (bottom) at the Kogrukluk River weir, 1997.

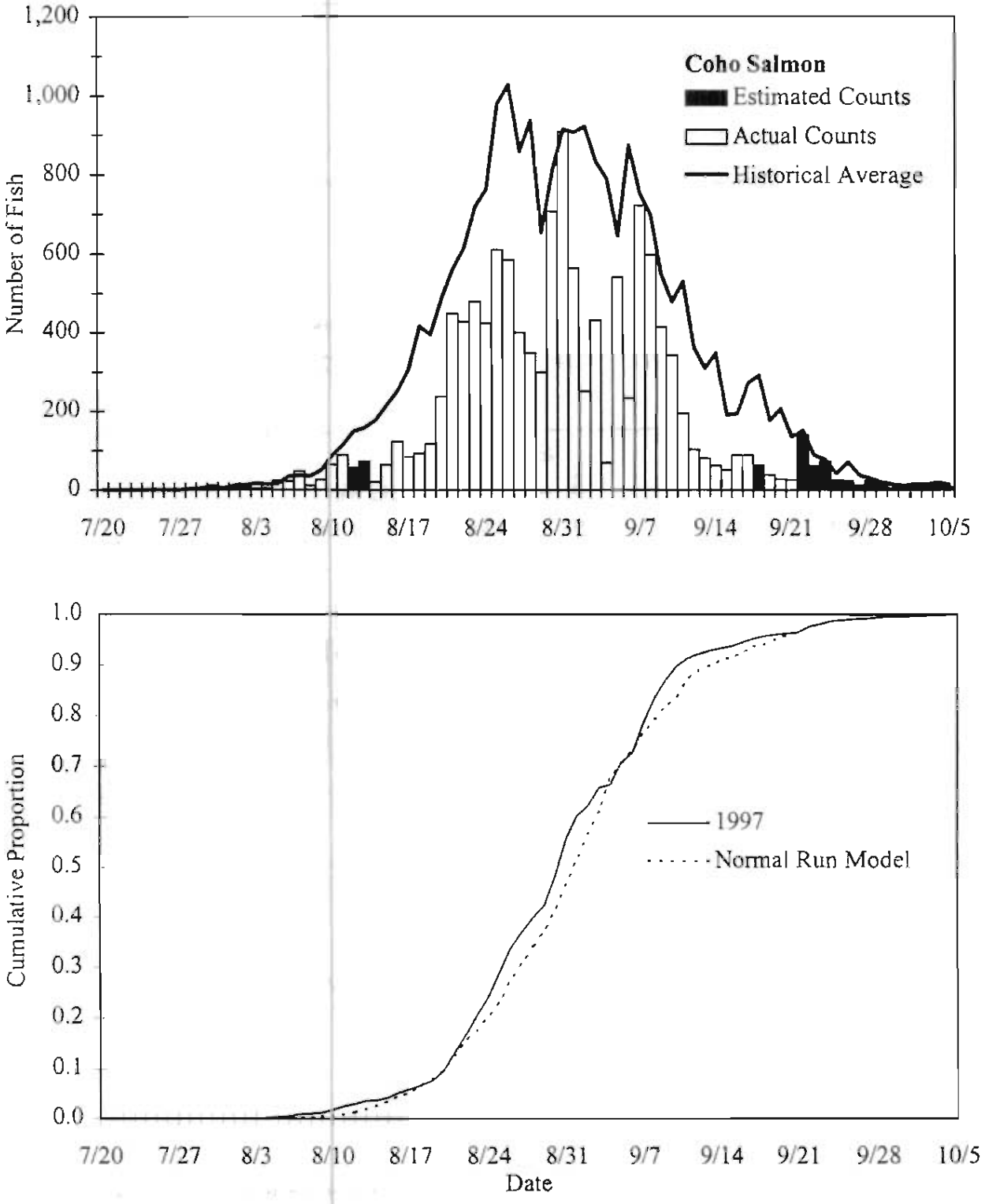

Figure 6. Daily counts of coho salmon (top) and cumulative proportion compared with the run timing model used to estimate missing daily counts (bottom) at the Kogrukluk River weir, 1997.

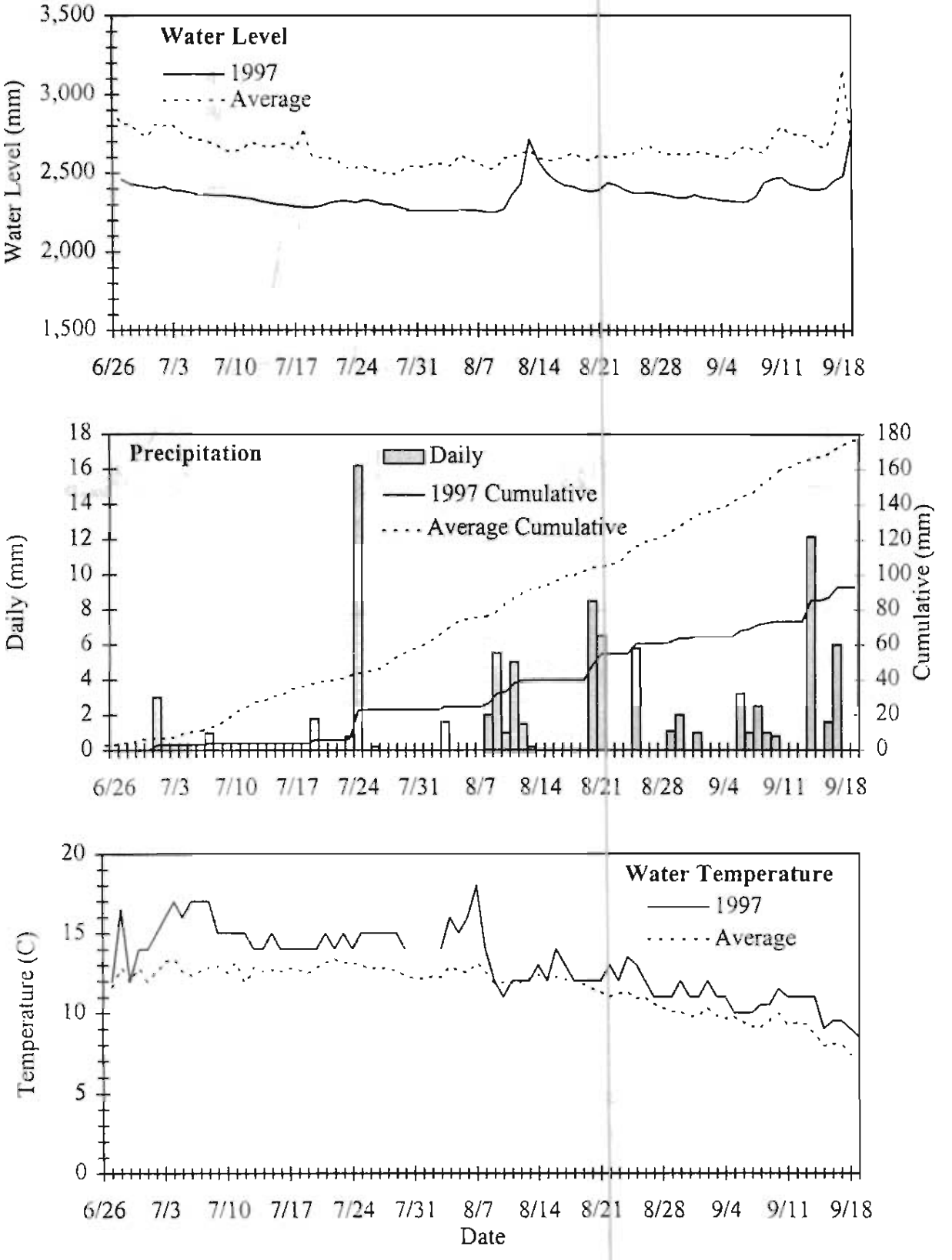

Figure 7. Selected meteorological and hydrological observations at the Kogrukluk River weir, 1997.

Appendix

Appendix A. Bibliography of the Kogrukluk River weir salmon escapement project in chronological order.

Yanagawa, C.M. 1972. Kogrukluk River weir project 1971. A-Y-K Region Kuskokwim Salmon Escapement Report No. 5. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Yanagawa, C.M. 1973. Kogrukluk River counting tower project 1972. A-Y-K Region Kuskokwim Salmon Escapement Report No. 6. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Kuhlman, F.W. 1974. Kogrukluk River counting tower project 1973. A-Y-K Region Kuskokwim Salmon Escapement Report No. 7. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Kuhlman, F.W. 1975. Kogrukluk River counting tower project 1974. A-Y-K Region Kuskokwim Salmon Escapement Report No. 8. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Kuhlman, F.W. 1976. Kogrukluk River counting tower project 1975. A-Y-K Region Data Report No. ?. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1976. Holitna weir developmental project, 1976. A-Y-K Region Kuskokwim Salmon Escapement Report No. 11. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1977. Holitna River salmon studies, 1977. A-Y-K Region Kuskokwim Salmon Escapement Report No. 13. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1979. Holitna River salmon studies, 1978. A-Y-K Region Kuskokwim Salmon Escapement Report No. 15. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1979. Holitna River salmon studies, 1979. A-Y-K Region Kuskokwim Salmon Escapement Report No. 17. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Baxter, R. 1980. Holitna River salmon studies, 1980. A-Y-K Region Kuskokwim Salmon Escapement Report No. 20. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

- continued -

Baxter, R. 1982. Ignatti weir study, 1981. A-Y-K Region Kuskokwim Salmon Escapement Report No. 25. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schneiderhan, D.J. 1984. 1982 Ignatti weir study. A-Y-K Region Kuskokwim Salmon Escapement Report No. 30. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schneiderhan, D.J. 1984. 1983 Ignatti weir study. A-Y-K Region Kuskokwim Salmon Escapement Report No. 31. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schneiderhan, D.J. 1985. Salmon escapement study Kogrukluk River weir, 1984. A-Y-K Region Kuskokwim Salmon Escapement Report No. 35. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Schneiderhan, D.J. 1988. Kogrukluk weir salmon escapement study 1985-1987. Regional Information Report No. 3A88-16. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Schneiderhan, D.J. 1989. Kogrukluk weir salmon escapement study 1988. Regional Information Report No. 3A89-09. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Schneiderhan, D.J. 1989. Kogrukluk weir salmon escapement study 1989. Regional Information Report No. 3A89-27. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Burkey, C. Jr. 1991. Kogrukluk weir salmon escapement report 1990. Regional Information Report No. 3B91-19. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Burkey, C. Jr. 1995. Kogrukluk weir salmon escapement report 1991-1994. Regional Information Report No. 3A95-24. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Anchorage.

Cappiello, T. and C. Burkey, Jr. 1997. Kogrukluk River weir salmon escapement report, 1995-1996. Regional Information Report No. 3A97-18. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.