REGIONAL INFORMATION REPORT 3A02-27

Alaska Department of Fish and Game
Division of Commercial Fisheries
333 Raspberry Road
Anchorage, Alaska 99518

April 2002

Sonar Estimation of Fall Chum Salmon Abundance In the Sheenjek River, 2001

by

Roger Dunbar

State of Alaska | Tony Knowles, Governor

SONAR ESTIMATION OF FALL CHUM SALMON ABUNDANCE IN THE SHEENJEK RIVER, 2001

By

Roger Dunbar

Regional Information Report[1] No. 3A02-27

Alaska Department of Fish and Game
Division of Commercial Fisheries
Arctic-Yukon-Kuskokwim Region
333 Raspberry Road
Anchorage, Alaska 99518

April 2002

---

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

The Alaska Department of Fish and Game administers all programs and activities free from discrimination on the bases of race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information please write to ADF&G, P.O. Box 25526, Juneau, AK 99802-5526; U.S. Fish and Wildlife Service, 4040 N. Fairfield Drive, Suite 300, Arlington, VA 22203 or O.E.O., U.S. Department of the Interior, Washington DC 20240.

For information on alternative formats for this and other department publications, please contact the department ADA Coordinator at (voice) 907-465-4120, (TDD) 907-465-3646, or (FAX) 907-465-2440.

AUTHOR

Roger Dunbar is the Anvik River and Sheenjek River sonar projects Fisheries Biologist for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 1300 College Road, Fairbanks, AK 99701.

ACKNOWLEDGMENTS

The author wishes to acknowledge Mr. Albert Menin, formerly of Bendix Electrodynamics Division and currently a private consultant, for his continued efforts to advance sonar counting technology and his specific assistance to the Sheenjek River project. Thanks to Kevin Boeck, and Bonnie Borba for their logistical support. Special thanks to Louis Barton for sharing his past experience of the project with me. The sonar field camp personnel also deserve recognition for their dedication to the project: Brandon Holton, and Jason Manthey. Finally, I thank Linda Brannian, Bonnie Borba, Susan McNeil and Carl Pfisterer, for their review and editorial comments on this manuscript.

SPONSOSHIP

This investigation was partially funded by U.S./Canada salmon research Cooperative Agreement Award Number NAO6FP0075.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Fixed-location, single-beam, sonar was used to estimate chum salmon *Oncorhynchus keta* escapement in the Sheenjek River during the period from 11 August through 23 September 2001. The sonar-estimated escapement was 53,932 chum salmon, and was considerably higher than the past two years. The 2001 escapement estimate was at the low end of the revised Sheenjek River biological escapement goal (BEG) of 50,000 to 104,000 chum salmon. Based on historical data, the timing of the 2001 chum salmon run was average. The median day of passage was observed on 8 September. There was no bimodal entry pattern observed as in some previous years. A diel migration pattern was observed, with a majority of the chum salmon passing the sonar site during periods of darkness or suppressed light.

Range of ensonification was considered adequate for detection of the majority of fish passing the sonar site and most fish passing through the acoustic beam were nearshore oriented. However, the passage estimate should be considered conservative since it does not include fish passing beyond the counting range (including along the unensonified far bank), fish present before sonar equipment was in operation, or fish passing upstream after counting ceased. Variations in Sheenjek River water levels and velocities, together with migration behavior of upstream migrant chum salmon, can affect the ability of hydroacoustic equipment to enumerate salmon passage. However, these deviations were accounted for by regularly comparing sonar counter output to visual observations on an oscilloscope.

Based upon vertebrae collections, age-4 and age-5 chum salmon comprised 100% of the fish sampled. Age-5 fish dominated at 65% while age-4 fish represented 35%. Male chum salmon comprised 53% of the sample while 47% were female. Only 73 vertebrae samples were collected in 2001 due to the distribution and availability of the salmon for sampling, and difficulties operating the seine.

KEY WORDS: Chum salmon, *Oncorhynchus keta,* sonar, hydroacoustics, escapement, enumeration, Yukon River, Porcupine River, Sheenjek River

INTRODUCTION

Although five species of anadromous Pacific salmon *Oncorhynchus* are found in the Yukon River drainage, chum salmon *O. keta* are the most abundant and occur in genetically distinct summer and fall runs (Wilmot et al. 1992; Seeb et al. 1995). Fall chum salmon are larger, spawn later, and are less abundant than summer chum salmon. They primarily spawn in the upper portion of the drainage in streams that are spring fed, usually remaining ice-free during the winter (Buklis and Barton 1984). Major fall chum salmon spawning areas occur within the Tanana, Chandalar, and Porcupine River systems, as well as portions of the upper Yukon River in Canada (Figure 1).

Inriver Fisheries

Fall chum salmon are in great demand for commercial and subsistence uses. Commercial harvest is permitted along the entire mainstem river in Alaska as well as in the lower portion of the Tanana River. No commercial harvest is permitted in any other tributaries of the drainage including the Koyukuk and Porcupine River systems. Although commercial harvest also occurs in the Canadian portion of the Yukon River near Dawson, the majority of fish taken commercially occurs in the lower river, downstream of the village of Anvik. Fall chum salmon use as a subsistence item is greatest throughout the upper river drainage, upstream of the village of Koyukuk.

Although the Alaskan commercial fishery for Yukon River fall chum salmon developed in the early 1960's, annual harvests remained relatively low through the early to mid-1970s. Estimated total in-river utilization (U.S. and Canada commercial and subsistence) of Yukon River fall chum salmon was below 300,000 fish per year before the mid-1970s (Table 1). However, inriver commercial fisheries became more fully developed during the late 1970's and early 1980's, with total utilization averaging 536,000 fish from 1979-1983. Harvest peaked in 1979 at 615,000 and in 1981 at 677,000 fish. Since the mid-1980's management strategies have been implemented to reduce commercial exploitation on fall chum stocks to improve upon low escapements observed throughout the drainage during the early 1980's. In 1987 a complete closure of the commercial fall chum fishery occurred in the Alaskan portion of the drainage. In 1992 commercial fishing in Alaska was restricted to a portion of the Tanana River during the fall season. In addition to a commercial fishery closure in 1993, that year also marked the first in State history that a total closure to subsistence fishing occurred in the Yukon River. The closure was in effect during the latter portion of the fall season in response to the extremely weak fall chum salmon run.

Yukon River fall chum salmon runs improved somewhat from 1994 through 1996. While limited commercial fishing was permitted in 1994 in the Alaskan portion of the upper Yukon River, as well as in the Tanana River, commercial fishing was permitted in all districts throughout the Alaska portion of the drainage in 1995. In 1996, limited commercial fishing was only permitted in selected districts of the mainstem Yukon River, with no commercial fishing permitted in the Tanana River. Poor salmon runs to Western Alaska from 1997 to 2001 resulted in partial or total closures to commercial and subsistence fishing in the Alaskan and Canadian portions of the drainage. Commercial fishing was only permitted in the Tanana River and Canada in 1997. A total commercial fishery closure and limited subsistence fishing was required in 1998. Limited commercial harvest was permitted in 1999, and a total commercial fishery closure and severe subsistence fishing restrictions was required in 2000 and 2001.

Escapement Assessment

During the period 1960 through 1980, only various segments of annual runs of Yukon River fall chum salmon were occasionally estimated from mark-and-recapture studies (Buklis and Barton 1984). Excluding these tagging studies and apart from aerial assessment of selected tributaries since the early 1970's, comprehensive escapement estimation studies were sporadic and limited to only two streams, the Delta River (Tanana River drainage) and the Fishing Branch River (Porcupine River drainage). However, comprehensive escapement assessment studies intensified on major spawning tributaries throughout the drainage subsequent to the early 1980s.

In the Canadian portion of the drainage, the Canadian Department of Fisheries and Oceans (DFO) has estimated abundance of fall chum salmon crossing the US/Canada border of the mainstem river into Yukon Territory annually since 1982, excluding 1984, using mark-and-recapture techniques (Milligan et al. 1984, JTC 2001). In addition, DFO reinstalled a weir in the Fishing Branch River in 1985 that was previously operated from 1971 through 1975, and has monitored chum salmon escapements to this stream annually since then, excluding 1990.

In the Alaskan portion of the drainage, the United States Fish and Wildlife Service (USFWS) estimated annual fall chum salmon escapement to the Chandalar River from 1986 through 1990 using fixed-location, single-beam hydroacoustic techniques (Daum et al. 1992). Results of that work revealed that fall chum salmon production there was similar to that of the nearby Sheenjek River. Subsequently, in 1994, the USFWS initiated a five-year study to reassess the population status of fall chum salmon with a newly developed split-beam hydroacoustic system. The initial year, 1994, was used to develop site-specific operational methods, evaluate site characteristics, and describe possible data collection biases (Daum and Osborne 1995). The project was fully operational from 1995 through 2001 with annual escapement estimates ranging from a low of 65,894 in 2000 to a high of 280,999 in 1995 (Daum and Osborne 1996, Osborne and Daum 1997, Daum and Osborne 1998, Daum and Osborne 1999, JTC 2001).

The Alaska Department of Fish and Game (ADF&G) initiated an experimental main river sonar project near Pilot Station (rivermile 123) in 1978, for estimating salmon passage by species. During the developmental years of 1978 through 1985, data acquisition and sampling designs were investigated using various models of scientific fisheries hydroacoustic systems. The project has operated annually since 1986, except for 1992 when it was operated for experimental purposes with upgraded sonar equipment and 1996 when it was operated for training purposes only. However, because of recent improvements in methodologies, historic data are not comparable to improved assessments available since 1995 (JTC 1999). In addition to the Pilot Station sonar project operated by ADF&G, the USFWS has conducted a mark-and-recapture project annually since 1996 at an area known locally as "The Rapids", a narrow canyon near Rampart, 1,176 kilometers from the mouth of the Yukon River. The purpose of this project is to provide abundance estimates of adult fall chum salmon bound for the upper Yukon River (Gordon et al. 1998, Underwood et al. 2000).

ADF&G has conducted annual mark-and-recapture studies in the Tanana River since 1995 to estimate the abundance of fall chum salmon bound for the upper river, upstream of the Kantishna River (Cappeillo and Bromaghin 1997, Capiello and Bruden 1997, Herbert and Bruden 1998, Cleary and Bruden 2000, Cleary and Hamazaki *in press*). ADF&G also conducts replicate ground surveys of the major fall chum spawning area in the Delta River of the upper Tanana River. Intensive ground surveys are also done annually, covering the major spawning area in the upper Toklat River. Total abundance estimates are derived from the Toklat and Delta surveys, using spawner residence time data collected from the Delta River (Barton 1997, JTC 2001). Hydroacoustic assessment of fall chum salmon escapement in the Toklat River was investigated in 1994, 1995, and 1996 (Barton 1997, Barton 1998). The Toklat River sonar project was reinstated in 2001 (B. Borba, Alaska Department of Fish and Game, personal communication).

One of the most intensely monitored spawning streams in recent years has been the Sheenjek River. Although escapement observations date back to 1960 when the USFWS reported chum salmon spawning in September, the best database consists of the 27-year period 1974-2000. Before 1981 escapement observations in the Sheenjek River were limited to aerial surveys flown in late September and early October (Barton 1984a). Subsequent to 1980, escapements were monitored annually using fixed location, single beam, side looking sonar systems (Barton 1982, 1983, 1984b, 1985, 1986, 1987, 1988, 1994, 1995, 1999, 2002). However, an early segment of the fall chum salmon run was not included by sonar counting operations from 1981 through 1990 due to late project startups centered around 25 August. By comparison, average startup during the period 1991 through 2001 was 8 August, more than two weeks earlier than in previous years. However, sonar-estimated escapements for the years 1986 through 1990 were subsequently expanded to include fish passing prior to sonar operations (Barton 1995). Termination of sonar counting was more consistent during the period 1981 through 1999, averaging 25 September. In 2000, the project was terminated early because of extremely low water (Barton 2002). This report presents results of studies conducted in 2001.

Study Area

The Sheenjek River is one of the most important producers of fall chum salmon in the Yukon River. Located above the Arctic Circle, it heads in the glacial ice fields of the Romanzof Mountains, a northern extension of the Brooks Range, and flows southward approximately 400 km to its terminus on the Porcupine River (Figure 2). Although created by glaciers, the river has numerous clearwater tributaries. Water clarity in the lower river is somewhat unpredictable, but is generally clearest during periods of low water. The water level normally begins to drop in late August and September. Upwelling ground water composes a significant proportion of the river flow volume, especially in winter, and it is in these spring areas that fall chum salmon spawn, particularly within the lower 160 km. The sonar project site is located approximately 10 km upstream from the mouth of the river. Annual escapement estimates averaged 106,000 spawners for the period 1986-1995 and approximately 81,000 spawners for the most recent 5-year period of 1996-2000. Since 1992 the minimum biological escapement goal (BEG) established for this river was 64,000 fall chum salmon, based upon hydroacoustic assessment of the run from 1974 to 1990 (Buklis 1993). In 2001 the department completed a review of the escapement goal for Yukon River fall chum stocks of which the Sheenjek River assessment is a component. Based on this review of long term escapement, catch, and age composition data, the BEG for the Sheenjek River is now set at a range of 50,000 to 104,000 fall chum salmon (Eggers 2001).

Objectives

Overall goals for the 2001 Sheenjek River fall chum salmon study were to estimate the timing and magnitude of adult salmon escapement and to characterize its age and sex composition. To accomplish this, the following specific objectives were identified:

- Estimate timing and magnitude of chum salmon escapement using fixed-location, single-beam, side looking hydroacoustic techniques,

- Estimate age and sex composition of the spawning population from sampled portions of the escapement using a beach seine as the capture technique, and

- Monitor selected climatological and hydrological parameters daily at the project site for use as baseline data.

METHODS

Hydroacoustic Equipment

A fixed-location, single-beam, fisheries hydroacoustic system developed by the Hydrodynamics Division of Bendix Corporation[2] was used to estimate chum salmon abundance in the Sheenjek River in 2001. Fish passage was monitored with a 1985-model transceiver and transducer deployed from a right-bank[3] point bar at the historic sonar site (Figures 3 and 4).

Bendix side-looking transducers have co-axial, circular cross-section narrow (2°) and wide (4°) beam dimensions. Sampling ranges for the narrow and wide beams are each variable to 30 m but designed for optimum performance at 18.3 m and 9.1 m, respectively. The transceiver can be operated on either the narrow or wide beam independently, or by alternating acoustic pulse transmissions between the two beams. In the latter mode (that used on the Sheenjek River) the narrow and wide beams monitor fish passage in the outer and inner halves of the sampling range, respectively.

The transceiver maintains a record of the spatial distribution of fish estimates based upon distance of the acoustic target from the transducer. Fish estimates were tallied and stored into dynamic memory by 16 equal range intervals or sectors. A tape printout showing the number of tallies (counts) by sector was printed each hour. The transceiver was designed such that 24

[2] Reference to trade names does not imply endorsement by the Alaska Department of Fish and Game.

[3] Right bank refers to the bank on the right when looking downstream.

counts in any one electronic sector in a 35-second period are not necessarily fish. Under such conditions, the system operator is alerted by the presence of a "debris" code appearing on the printout tape next to the suspect counts for the sector and hour in which they occurred. Examples of factors that can result in "debris counts" appearing on printout tapes include passage of debris through the ensonified water column include: boat wake, driving rain, snowfall, misaimed beam toward river bottom or water surface, high density of fish passage, and holding or spawning fish. In addition, a "rock inhibit" feature was designed into this counter to facilitate the system operator in maintaining aim of the acoustic beam as close to the natural bottom substrate as possible.

While other operational characteristics of Bendix hydroacoustic systems and procedures can be found in Bendix Corporation (1978) and Ehrenberg (undated), the 1985-model transceiver used in 2001 was modified after production to allow the system operator to lower the pulse repetition rate to a level that would not have previously been possible. This alteration was to better accommodate relatively slow chum salmon swimming speeds (A. Menin, Hydroacoustic Consulting, Sylmar, California, personal communication). This modification has increased the system operator's ability to reduce the degree of positive bias associated with over-counting.

Site Selection and Transducer Deployment

The modular aluminum substrate designed for use with Bendix sonar systems has not been used on the Sheenjek River since 1984, because of the salmon avoidance problems observed when the substrate was in use (Barton 1985). The relatively gentle-sloping river bottom at the historic counting location has accommodated this. A detailed bottom profile was obtained after initial transducer placement at the counting location by stretching a rope across the river and measuring water depth with a pole every 3-m. The transducer was mounted on a pod made of galvanized steel water pipe (Barton 1997) and deployed from the right-bank point bar. The pod was secured in place with sandbags and designed to permit raising and lowering of the acoustic beam by using the two riser pipes that extended above the water. Fine adjustments were made with the knurled knobs that attached the transducer plate to the pod. The transducer was deployed in water ranging from approximately 0.5 to 1.0 m in depth, and aimed perpendicular to the current along the natural gravel substrate. An attempt was made to ensure the transducer was deployed at locations where minimum surface water velocities did not fall below approximately 30-45 cm/s.

The system operator used an artificial acoustic target during deployment to ensure transducer aim was low enough to prevent salmon from passing undetected beneath the acoustic beam. The target, an airtight 250 ml weighted plastic bottle, was allowed to drift downstream along the river bottom and through the acoustic beam. Several drifts were made with the target in an attempt to pass it through each electronic sector of the counting range. When the transducer was properly aimed, the target appeared as a vertical deflection (spike) on an oscilloscope screen as it transected the acoustic beam at any given distance. The target may or may not have simultaneously registered a count (or multiple counts) on the sonar counter, depending upon the length of time it remained in the acoustic beam as it drifted downstream along the river bottom.

As in previous years, a fish lead was constructed shoreward from the transducer to prevent upstream salmon passage inshore of the transducer. Fish leads were constructed using 5 cm x 5 cm by 1.2-m high Tuflink-brand fencing and 2.5 m metal "T" stakes. Leads were constructed to include the nearfield "dead range" of the sonar transducer. Whenever a transducer was relocated because of rising or falling water level, the inshore lead was shortened or lengthened as appropriate, and the artificial target used to ensure proper re-aiming. A 5-m aluminum counting tower was also deployed near the transducer to facilitate visual and electronic calibrations when water conditions permitted.

Sonar Calibrations and Count Adjustments

Daily comparisons (termed calibrations) were made between oscilloscope observations and automated counter output to determine if the number of fish registered by the sonar counter equaled the number of fish observed passing through the acoustic beam. A minimum of six, 15 to 30 minute calibrations were targeted each day within the following time periods: 0001-0100 hours; 0300-0400 hours; 0600-0700 hours; 1100-1200 hours; 1600-1700 hours; and 2100-2200 hours. Duration of calibrations was based upon the following criteria: 1) stop calibration at 15 minutes if less than 10 fish are observed; and, 2) extend 15-minute calibration to 30 minutes if 10 or more fish are observed in the first 15 minutes.

Calibration results were used to adjust automated passage estimates on a daily basis for positive or negative bias. Adjustment periods were defined by the time between individual calibrations. An associated adjustment factor (A), specific to each adjustment period (i) was calculated as follows:

$$A_i = \frac{OC_i}{SC_i} \qquad (1)$$

where:

OC_i = oscilloscope count; and,
SC_i = sonar count for adjustment period $_i$.

Unadjusted hourly sonar passage estimates were multiplied by adjustment factors for each hour within the associated adjustment period. The resulting corrected hourly sonar estimates were summed, yielding the estimated daily passage ($\hat{D}$) of fall chum salmon, and is calculated as

$$\hat{D} = \sum (A_i SC_i) \qquad (2)$$

Sonar counts caused by fish other than salmon were assumed insignificant based upon historic test fishing records collected at the site. Counts identified as "debris" on printout tapes were deleted and replaced by linearly interpolated values before making adjustments. Linear interpolation was also used to estimate missing sector counts caused by occasional printer malfunctions. Interpolated values for a given electronic sector were based upon registered counts for that sector in the preceding and following hour. Missing hourly blocks for a given day, resulting from powering down the sonar counter to relocate the transducer or operations-tent due to changes in water level, were estimated by extrapolation using seasonal average hourly passage rates from days when sonar functioned 24 hours.

Adjustments to the pulse repetition rate (PRR) or ping rate of the sonar counter were made to minimize over-counting (positive bias) or under-counting (negative bias). Over or under counting primarily results from changes in salmon swimming speeds that may be related to fluctuations in water level and velocity, photoperiod, or fish densities (Barton 1985, 1986, 1987, 1995). Although a few occasions arose when the ping rate was subjectively changed based upon a qualitative evaluation of fish passage rates, the ping rate was generally changed at the end of any calibration when the oscilloscope count exceeded 59 per hour and differed by more than 15% from the sonar count. The new ping rate was calculated as the sonar count divided by oscilloscope count, times the current PRR setting. If passage rates during calibrations on any given day never exceeded 59 fish per hour, the ping rate was changed at 2400 hours of that particular day. However, this change was made only if the sum of sonar counts during all of the day's calibrations differed from the sum of oscilloscope counts from all calibrations by more than 15%. Otherwise, the dial setting was left unchanged.

Test Fishing and Salmon Sampling

Region-wide standards have been set for the sample size needed to describe the age composition of a salmon population. These apply to the time period or stratum in which the sample is collected. Sample size goals are based on a one-in-ten chance (precision) of not having the true age proportion (pi) within the interval pi ± 0.05 for all i ages (accuracy).

Based upon age determination from scales, a sample size of 160 fish per stratum is needed for chum salmon assuming two major age classes with minor ages pooled, and no unreadable scales. The preferred method of aging Yukon River fall chum salmon when in close proximity to their natal streams is from vertebrae collections (Clark 1986). Allowing for 20% unreadable vertebrae, the Sheenjek River sample size goal was to sample approximately 30-35 chum salmon per week up to a maximum of 200.

An adult salmon beach seine was periodically fished at different locations between the sonar site and approximately 10-12 km upstream to collect adult salmon for age and sex composition. The beach seine (3-inch stretch measure) was 30 m in length by 55 meshes deep (~3 m). The seine was dyed green, constructed of #18 twine, possessed 3x5-inch high-density, non-grommet oval poly floats spaced approximately 45 cm apart, had a 115-120 lb lead line and 1/2 in (1.3 cm) float line. Chum salmon were collected with the beach seine, enumerated by sex using external characteristics, and measured in millimeters from mid-eye to fork of tail. Additionally, one vertebra was taken from each fish for age determination.

Climatological and Hydrological Observations

A water level gauge was installed at the sonar site and monitored daily with readings made to the nearest centimeter. Instantaneous surface water temperature was measured daily with a pocket thermometer. Minimum and maximum air temperatures, maximum wind chill factor, and wind velocity and direction were measured daily with a Weather Wizard III weather station. Other daily observations included recording the occurrence of precipitation and estimating percent cloud cover. Climatological observations were recorded at approximately 1800 hours daily.

RESULTS

River and Sonar Counting Conditions

Location of transducer deployment in 2001 approximated the same place on the point bar used in most previous years. River bottom at the counting location sloped gently from the convex bank (right-bank, point bar) at a rate of approximately 9.1 cm/m (bottom slope ≈ 9%) to the shelf-break that lay approximately two-thirds of the way across the channel on 8 August (Figure 5). River width measured 52 m and much of the nearshore zone along the concave, left cutbank was cluttered with fallen trees and other woody vegetation.

The water level remained fairly low at the project site through the 2001, with the lowest level recorded on 23 September (Figure 6 and Appendix A). Except for one major increase between 16 and 19 August to a point of 36.2 cm above the zero datum mark, the water level dropped continuously during the duration of the project. Overall, between 8 August and 23 September minimum and maximum water level differed by 90 cm. Water temperature at the project site ranged from 6 to 13°C based upon instantaneous surface measurements, and averaged 10.1°C (Appendices A).

Fluctuations in water level affected placement of the transducer with respect to shore, and in turn the proportion of the river ensonified. While no attempt was made to estimate fish passage beyond the counting range, an expansion of sonar counts by extrapolation was made to estimate fish passage for hours when raw data were missing. Missing data may occur because of unforeseen circumstances, or powering down the sonar counter to facilitate repositioning the transducer in response to changes in water level. The average unensonified river zone in 2001 measured from the cutbank approximated 19 m, ranging from a minimum of 5 m on 13 August to a maximum of 31 m on 18 August.

Abundance Estimation

The 2001 sonar-estimated escapement was 53,932 chum salmon for the 43-day period 11 August through 23 September (Table 2 and Appendix B). During the period of operation, sonar counts were adjusted daily for positive or negative bias based upon oscilloscope calibrations. A total of 252 calibrations averaging 20 minutes in duration were made (Appendix C). This approximated 85 hours or approximately 8% of the total number of hours the sonar counter was functional. An attempt was made to weight calibrations to periods of the day when upstream migration was heaviest (Figure 7). Although protocol was the same as past years, it appears that more effort should have been placed on the calibrations during hours of darkness and less during daylight hours. An average of 26% of the calibrations was made between 0001 and 0600 hours, corresponding to an average daily fish passage estimate of 45% for the same block of time. Similarly, an average of 36% of the calibrations was made between 0600 and 1200 hours, corresponding to an average daily fish passage estimate of 15% for that period.

Temporal and Spatial Distribution

Very few chum salmon were present in the river when sonar counting was initiated on 11 August, as evidenced by only 49 fish estimated passing. The entry pattern of the 2001 chum salmon run was not bimodal as has been seen in past years (Figure 8), although there was one small bump of fish around 19 August, coinciding with a surge of high water. Chum salmon passage estimates gradually increased through August, surpassing 1,000 fish per day by August 31. Salmon escapement continued to increase until 12 September when passage reached a peak of 3,536 fish. The middle portion of the run was observed from 1 September through 13 September, with the median day of passage occurring on 8 September. The average passage rate during this period approximated 2,350 fish per day, decreasing to 1,135 fish per day for the remainder of the season. An estimated 622 chum salmon passed the project site on 23 September, the final day of sonar sampling. Factors affecting termination of sonar counting in 2001 included declining fish passage rates, logistics associated with closing down camp, and budgetary constraints.

The diel pattern of migration of Sheenjek River chum salmon typically observed in most years was again manifested in 2001 (Figure 9 and see Appendix B). Upstream migration was heaviest in periods of darkness or suppressed light, with fish moving in greater numbers close to shore. On average, the period of greatest upstream migration occurred between 2000 hours and 0700 hours the following day (77%). With ensuing hours of daylight, upstream migration lessened and fish moved farther from shore. The period of least movement in 2001 occurred between approximately 1000 and 1900 hours (11%).

For the most part, migrating chum salmon were shore-oriented, passing through the nearshore sectors of the acoustic beam. Approximately 99% of the fish counted were estimated passing through the first ten electronic sectors, or within approximately 15 m of the transducer (Figure 10). Less than 1% was observed in the outer-most six sectors.

Age and Sex Composition

Although an attempt was made to sample portions of annual escapement for age and sex composition in 2001, only 73 chum salmon (39 males; 34 females) were obtained due to the distribution and availability of the salmon for sampling, and difficulties operating the seine. (Table 3). Twelve seine hauls were made during the period 4 September through 19 September along gravel bars between river kilometers 11 and 15. Of the samples collected, only five were from the beach seine, and the remainder was from scavenged carcasses. Two of the 73 vertebrae collected were unreadable. From the remaining 71 samples it was determined that age-5 predominated (65%), and the proportion of age-4 fish observed was approximately 35% (Appendix D). No age-2, age-3 or age-6 fish were observed in the samples.

DISCUSSION

The 2001 sonar-estimated escapement of chum salmon in the Sheenjek River is considered conservative because fish that passed the site before or after sonar sampling were not included, nor were fish that passed beyond the range of the acoustic beam, including along the unensonified far bank. Drift gillnetting results during the period 1981-1983 at the historic sonar sampling site demonstrated that distribution of upstream migrant chum salmon was primarily confined to the right side of the river, with only a small (but unknown) proportion passing beyond the sonar counting range (Barton 1982, 1983, 1984b). Barton (1985) further concluded from investigations in 1984 that although dispersed throughout the river well below the sonar site, upstream-migrant chum salmon orient toward the right bank before reaching the sonar sampling location because of physical and hydrologic conditions of the river. While no attempt was made to estimate fish passage in the unensonified river zone in 2001, it is believed to have been comparatively small based upon a review of the spatial distribution of fish by electronic sector.

Although sonar has been used to monitor chum salmon escapements in the Sheenjek River since 1981, only since 1991 have estimates been obtained for comparable time periods i.e., for the period approximating 8 August through 25 September (Barton 1999). However, Barton (1995) used run timing data collected from the nearby Chandalar River to expand Sheenjek River run size estimates for the years 1986-1988, and 1990 to a comparable time period, while the 1989 estimate was expanded based upon aerial survey observations made before sonar operations in that year (Appendix E). Barton (2002) used historic run timing data from 1986 to 1999 to expand the estimated escapement for 2000, when the sonar operations were terminated early. Based upon average run timing data for 1986-1999, approximately 85% of the Sheenjek River fall chum salmon run (through the end of September) materializes subsequent to 24 August, with the middle portion of the run passing from 30 August through 17 September (Appendix F). The historical median day of passage is 8 September. Thus, timing of the 2001 run was judged average, with the median day of passage in 2001 corresponding to that of the historical average.

While it is believed to be small, an unknown portion of the Sheenjek River fall chum salmon run in 2001 passed the sonar site subsequent to sonar counting. Historical run timing data for 1986-1999 suggests that approximately 5% of the run (through the end of September) passes subsequent to 23 September.

Barton (1995) pointed out that sonar-estimated escapements in the Sheenjek River should be viewed in context with dates of project operation (Table 4). The escapement estimate in 2001 approximated 53,932 chum salmon for the 43-day period 10 August through 23 September. This places the 2001 escapement estimate at the low end of the revised BEG of 50,000 to 104,000 chum salmon. Although the escapement estimate was within the acceptable range (Figure 11), a total closure of the Yukon River commercial fisheries as well as severe restrictions imposed on subsistence users was required to accomplish this. This is considered a weak run given the major parent year escapement levels of 246,889 in 1996 (returning age-5 fish) and 80,423 in 1997 (returning age-4 fish) (Figure 12).

The weak 2001 Sheenjek River escapement estimate was consistent with escapement trends for other upper Yukon River areas. Escapement in the Chandalar River was estimated at 109,829 chum salmon for the 50-day period of 8 August through 26 September, with run timing characteristics similar to those observed in the Sheenjek River (B. Osborne, USFWS, Fairbanks, personal communication). The run was slightly bimodal with the median day of passage recorded on 3 September, five days earlier than the Sheenjek River. The central half of the run was observed between 23 August and 11 September. While the estimated escapement in 2001 (using split beam sonar) was 39% higher than the 2000 estimate (65,894 fish), it is 53% below the 1995-1997 average of 229,700 chum salmon. The (BEG) has been set at 74,000 to 152,000 fall chum salmon for the Chandalar River (Eggers 2001).

Low numbers of returning salmon were also reported in the Canadian portion of the Yukon River drainage in 2001. In the Fishing Branch River, only 20,326 chum salmon passed the DFO weir during the 41-day period of 3 September through 13 October. The count was expanded to 21,556, because of a late start for the project and an early chum salmon return (JTC 2001). Similar to the Sheenjek River, this was a low escapement, well below the interim escapement goal range of 50,000 to 120,000 fish. The 2001 estimate of spawning escapement for Canadian mainstem Yukon River fall chum salmon was approximately 34,000 fish, 58% below the minimum escapement goal of 80,000 chum salmon.

The 2001 season marked the fifth consecutive year characterized by very low salmon runs to some western Alaska river systems. While exact reasons for the region-wide failure are unknown, scientist speculate poor marine survival results from or is accentuated by localized weather conditions in the Bering Sea (Kruse 1998). The weak salmon runs to Western Alaska have been attributed to reduced productivity (i.e., returns per spawner), and not the result of low levels of parental escapement. The magnitude and distribution of escapements in 1996 and 1997, the major parent years contributing to the 2001 run, were among the best on record. However, total run size in 2001 was poor based on run reconstruction which was estimated to be approximately 366,000 fall chum salmon (JTC 2001).

Timely reporting of daily passage estimates at the Sheenjek River project site corroborated other inseason indicators that the 2001 fall chum salmon run was extremely weak. Although some fall chum salmon BEG's were achieved within the Yukon River drainage in 2001, severe commercial and subsistence restrictions were necessary to achieve these goals.

LITERATURE CITED

Barton, L.H. 1982. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1981. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 13, Fairbanks.

Barton, L.H. 1983. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1982. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 19, Fairbanks.

Barton, L.H. 1984a. A catalog of Yukon River salmon spawning escapement surveys. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report No. 121, Juneau.

Barton, L.H. 1984b. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 22, Fairbanks.

Barton, L.H. 1985. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 25, Fairbanks.

Barton, L.H. 1986. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1985. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 28, Fairbanks.

Barton, L.H. 1987. Sheenjek River salmon escapement enumeration, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Yukon Salmon Escapement Report No. 33, Fairbanks.

Barton, L.H. 1988. Sheenjek River salmon escapement enumeration in 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report No. 3F88-15, Fairbanks.

Barton, L.H. 1994. Sonar enumeration of fall chum salmon on the Sheenjek River, 1993. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 4A94-24, Anchorage.

Barton, L.H. 1995. Sonar enumeration of fall chum salmon on the Sheenjek River, 1988-1992. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Technical Fishery Report 95-06, Juneau.

Barton, L.H. 1997. Sonar escapement assessment in the Toklat River, 1994. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A97-35, Anchorage.

Barton, L.H. 1998. Sonar escapement assessment in the Toklat River, 1995 and 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A98-22, Anchorage.

Barton, L.H. 1999. Sonar estimation of fall chum salmon abundance in the Sheenjek River, 1994-1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A99-28, Anchorage.

Barton, L.H. 2002. Sonar estimation of fall chum salmon abundance in the Sheenjek River, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-26, Anchorage.

Bendix Corporation. 1978. Installation and operation manual, side-scan salmon counter (1978 model). Electrodynamics Division, Report No. SP-78-017, North Hollywood, California. Prepared for the State of Alaska, Department of Fish and Game, Anchorage.

Bergstrom, D.J. and ten co-authors. 2001. Annual management report Yukon Area, 1999. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report No. 3A99-26, Anchorage.

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

Buklis, L.S. and Barton, L.H. 1984. Yukon River fall chum salmon biology and stock status. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet No. 239, Juneau.

Cappiello, T.A. and J.F. Bromaghin. 1997. Mark-recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1995. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Alaska Fishery Research Bulletin, 4(1):12-35.

Cappiello, T.A. and D.L. Bruden. 1997. Mark-recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1996. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A97-37, Anchorage.

Clark, R.A. 1986. Sources of variability in three ageing structures for Yukon River fall chum salmon (*Oncorhynchus keta* Walbaum) escapement samples. Alaska Department of Fish and Game, Division of Sport Fish, (Region III unpublished report), Fairbanks.

Cleary, P.M. and D.L. Bruden. 2000. Estimation of fall chum salmon abundance on the upper Tanana River using mark recapture techniques, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, AYK Region, Regional Information Report No. 3A00-03, Anchorage.

Daum, D.W., R.C. Simmons, and K.D. Troyer. 1992. Sonar enumeration of fall chum salmon on the Chandalar River, 1986-1990. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No.16, Fairbanks.

Daum, D.W. and B.M. Osborne. 1995. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1994. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Progress Report No. 95-4, Fairbanks.

Daum, D.W. and B.M. Osborne. 1996. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1995. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Progress Report No. 96-2, Fairbanks.

Daum, D.W. and B.M. Osborne. 1997. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1996. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No. 42, Fairbanks.

Daum, D.W. and B.M. Osborne. 1998. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1997. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No. 47, Fairbanks.

Daum, D.W. and B.M. Osborne. 1999. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1998. U.S. Fish and Wildlife Service, Fishery Resource Office, Fairbanks.

Eggers, D.M. 2001. Biological escapement goals for Yukon River fall chum salmon. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 3A-01-10, Anchorage.

Ehrenberg, J.E., Ph.D. *Undated.* An evaluation of the acoustic enumeration of upstream salmon in Cook Inlet Rivers in 1989. Prepared for the Trans-Alaska Pipeline Liability Fund.

Gordon, J.A. and three co-authors. 1998. Estimated abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1996. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No. 45, Fairbanks.

Hebert, P.H. and D.L. Bruden. 1998. Mark-recapture population size estimate of fall chum salmon in the upper Tanana River, 1997. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, AYK Region, Regional Information Report No. 3A98-21, Anchorage.

JTC (The Joint United States/Canada Yukon River Technical Committee). 1999. Yukon River salmon season review for 1999 and technical committee report. Whitehorse, YT, Canada, 27-29 October.

JTC (The Joint United States/Canada Yukon River Technical Committee). 2001. Yukon River salmon season review for 2001 and technical committee report. Whitehorse, YT, Canada, 5-7 November.

Kruse, G.H. 1998. Salmon run failures in 1997-1998: A link to anomalous ocean conditions? Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Alaska Fishery Research Bulletin 5(1): 55-63.

Milligan, P.A. and three co-authors. 1984. The distribution and abundance of chum salmon *Oncorhynchus keta* in the upper Yukon River basin as determined by a radio-tagging and spaghetti tagging program: 1982-1983. Department of Fisheries and Oceans, Yukon River Basin Study, Technical Report No. 35, Whitehorse, Yukon.

Osborne, B.M. and D.W. Daum. 1997. Enumeration of Chandalar River fall chum salmon using split-beam sonar, 1996. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No.42, Fairbanks.

Seeb, L.W., P.A. Crane, and R.B. Gates. 1995. Progress report of genetic studies of Pacific Rim chum salmon and preliminary analysis of the 1993 and 1994 South Unimak June fisheries. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 5J95-07, Juneau.

Underwood, T.J. and four co-authors. 2000. Estimated abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1997. U.S. Fish and Wildlife Service, Fishery Resource Office, Alaska Fisheries Technical Report No. 56, Fairbanks.

Wilmot, R.L. and three co-authors. 1992. Genetic stock identification of Yukon River chum and chinook salmon 1987 to 1990. Progress Report, U.S. Fish and Wildlife Service, Anchorage.

Table 1. Alaskan and Canadian total utilization of Yukon River fall chum salmon, 1961-2001 (taken from JTC 2001).

Year	Canada [a]	Alaska [b,c]	Total
1961	9,076	144,233	153,309
1962	9,436	140,401	149,837
1963	27,696	99,031 [d]	126,727
1964	12,187	128,707	140,894
1965	11,789	135,600	147,389
1966	13,192	122,548	135,740
1967	16,961	107,018	123,979
1968	11,633	97,552	109,185
1969	7,776	183,373	191,149
1970	3,711	265,096	268,807
1971	16,911	246,756	263,667
1972	7,532	188,178	195,710
1973	10,135	285,760	295,895
1974	11,646	383,552	395,198
1975	20,600	361,600	382,200
1976	5,200	228,717	233,917
1977	12,479	340,757	353,236
1978	9,566	331,250	340,816
1979	22,084	593,293	615,377
1980	22,218	466,087	488,305
1981	22,281	654,976	677,257
1982	16,091	357,084	373,175
1983	29,490	495,526	525,016
1984	29,267	383,055	412,322
1985	41,265	474,216	515,481
1986	14,543	303,485	318,028
1987	44,480	361,663 [d]	406,143
1988	33,565	319,677	353,242
1989	23,020	518,157	541,177
1990	33,622	316,478	350,100
1991	35,418	403,678	439,096
1992	20,815	128,031 [f]	148,846
1993	14,090	76,925 [d]	91,015
1994	38,008	131,217	169,225
1995	45,600	415,547	461,147
1996	24,354	236,569	260,923
1997	15,580	154,479 [f]	170,059
1998	7,901	62,869 [d]	70,770
1999	19,506	110,369	129,875
2000	9,236	18,920 [d]	28,156
2001	9,512	34,992 [d,g]	44,504 [g]
Average			
1961-91	18,867	304,436	323,302
1992-01	20,460	136,992	157,452
1997-01	12,347	76,326	88,673

[a] Catch in number of salmon. Includes commercial, Aboriginal, domestic and sport catches combined.

[b] Catch in number of salmon. Includes estimated number of salmon harvested for commercial production of salmon roe.

[c] Commercial, subsistence, personal-use and ADF&G test fish catches combined.

[d] Commercial fishery did not operate in Alaskan portion of drainage.

[f] Commercial fishery operated only in District 6 (Tanana River).

[g] Data are Preliminary.

Table 2. Sonar-estimated passage of fall chum salmon in the Sheenjek River, 2001.

Date	Number of Salmon daily	Number of Salmon cum	Proportion daily	Proportion cum
11-Aug	49	49	0.00	0.00
12-Aug	78	127	0.00	0.00
13-Aug	79	206	0.00	0.00
14-Aug	73	279	0.00	0.01
15-Aug	121	400	0.00	0.01
16-Aug	126	526	0.00	0.01
17-Aug	90	616	0.00	0.01
18-Aug	567	1,183	0.01	0.02
19-Aug	948 [a]	2,131	0.02	0.04
20-Aug	584 [a]	2,715	0.01	0.05
21-Aug	313 [a]	3,028	0.01	0.06
22-Aug	507	3,535	0.01	0.07
23-Aug	689	4,224	0.01	0.08
24-Aug	884	5,108	0.02	0.09
25-Aug	1,050	6,158	0.02	0.11
26-Aug	967	7,125	0.02	0.13
27-Aug	964	8,089	0.02	0.15
28-Aug	892	8,981	0.02	0.17
29-Aug	995	9,976	0.02	0.18
30-Aug	970	10,946	0.02	0.20
31-Aug	985	11,931	0.02	0.22
01-Sep	1,481	13,412	0.03	0.25 [b]
02-Sep	1,925	15,337	0.04	0.28
03-Sep	1,374	16,711	0.03	0.31
04-Sep	1,235	17,946	0.02	0.33
05-Sep	1,968	19,914	0.04	0.37
06-Sep	2,574	22,488	0.05	0.42
07-Sep	1,537	24,025	0.03	0.45
08-Sep	3,378	27,403	0.06	**0.51** [c]
09-Sep	3,098	30,501	0.06	0.57
10-Sep	2,575	33,076	0.05	0.61
11-Sep	3,286	36,362	0.06	0.67
12-Sep	3,536	39,898	0.07	0.74
13-Sep	2,679	42,577	0.05	0.79
14-Sep	2,130	44,707	0.04	0.83
15-Sep	1,833	46,540	0.03	0.86
16-Sep	900 [a]	47,440	0.02	0.88
17-Sep	1,482	48,922	0.03	0.91
18-Sep	430	49,352	0.01	0.92
19-Sep	1,110	50,462	0.02	0.94
20-Sep	813	51,275	0.02	0.95
21-Sep	1,017	52,292	0.02	0.97
22-Sep	1,018	53,310	0.02	0.99
23-Sep	622	53,932	0.01	1.00
Total	53,932		1.00	

[a] Counting operations interupted. Count was interpolated.

[b] Single boxed area identifies central half of the run.

[c] Bold box indentifies median day of passage.

Table 3. Sheenjek River test fishing (beach seine) and carcauss collection results, 2001.

Date	Number of Sets	Location (rkm)[a]	Chum Salmon Seine Male	Seine Female	Carcass's [b] Male	Carcass's Female	Total Male	Total Female	Arctic Grayling
4-Sep	1	15			5	5	5	5	
6-Sep	4	16 &25							2
9-Sep	2	11							1
11-Sep	0				6	3	6	3	
12-Sep	1	18							3
15-Sep	1	18			3	3	3	3	
17-Sep	1	18	1	3	19	14	20	17	
19-Sep	2	18		1	4	5	4	6	1
21-Sep	0				1		1		
Total	12		1	4	38	30	39 (53%)	34 (47%)	7

[a] Location of seine set is at river kilometer(rkm).

[b] No information on carcass collection sites.

Table 4. Operational dates of sonar sampling in the Sheenjek River for the period 1981-2001.

Year	Starting Date	Ending Date	Project Duration	Sonar Estimate	Expanded Estimate
1981	31-Aug	24-Sep	24	74,560	
1982	31-Aug	22-Sep	22	31,421	
1983	29-Aug	24-Sep	26	49,392	
1984	30-Aug	25-Sep	26	27,130	
1985	02-Sep	29-Sep	27	152,768	
1986	17-Aug	24-Sep	38	83,197 [a]	84,207
1987	25-Aug	24-Sep	30	140,086	153,267
1988	21-Aug	27-Sep	37	40,866	45,206
1989	24-Aug	25-Sep	32	79,116	99,116
1990	22-Aug	28-Sep	37	62,200	77,750
1991	09-Aug	24-Sep	46	86,496	
1992	09-Aug	20-Sep	42	78,808	
1993	08-Aug	28-Sep	51	42,922	
1994	07-Aug	28-Sep	52	150,565	
1995	10-Aug	25-Sep	46	241,855	
1996	30-Jul	24-Sep	56	246,889	
1997	09-Aug	23-Sep	45	80,423	
1998	17-Aug	30-Sep	44	33,058	
1999	10-Aug	23-Sep	44	14,229	
2000	08-Aug	12-Sep	35	18,652 [b]	30,084
2001	11-Aug	23-Sep	43	53,932	
Averages:					
1981-85	30-Aug	24-Sep	25	67,054	
1986-90	21-Aug	25-Sep	35	81,093	91,909
1991-01	08-Aug	23-Sep	46	95,257	96,296

[a] The sonar-estimated escapement in these years was subsequently expanded to include fish passing prior to sonar operations (Barton 1995). Expansions for 1986-1988 and 1990 were based upon run timing data collected in the nearby Chandalar River. The 1989 estimate was expanded based upon aerial survey observations made in the Sheenjek River prior to sonar operations in that year.

[b] The sonar-estimated escapement was expanded to include fish passing after sonar operations terminated (Barton 2002). Expansions for 2000 were based upon average run time data from the Sheenjek River 1986 - 1999.

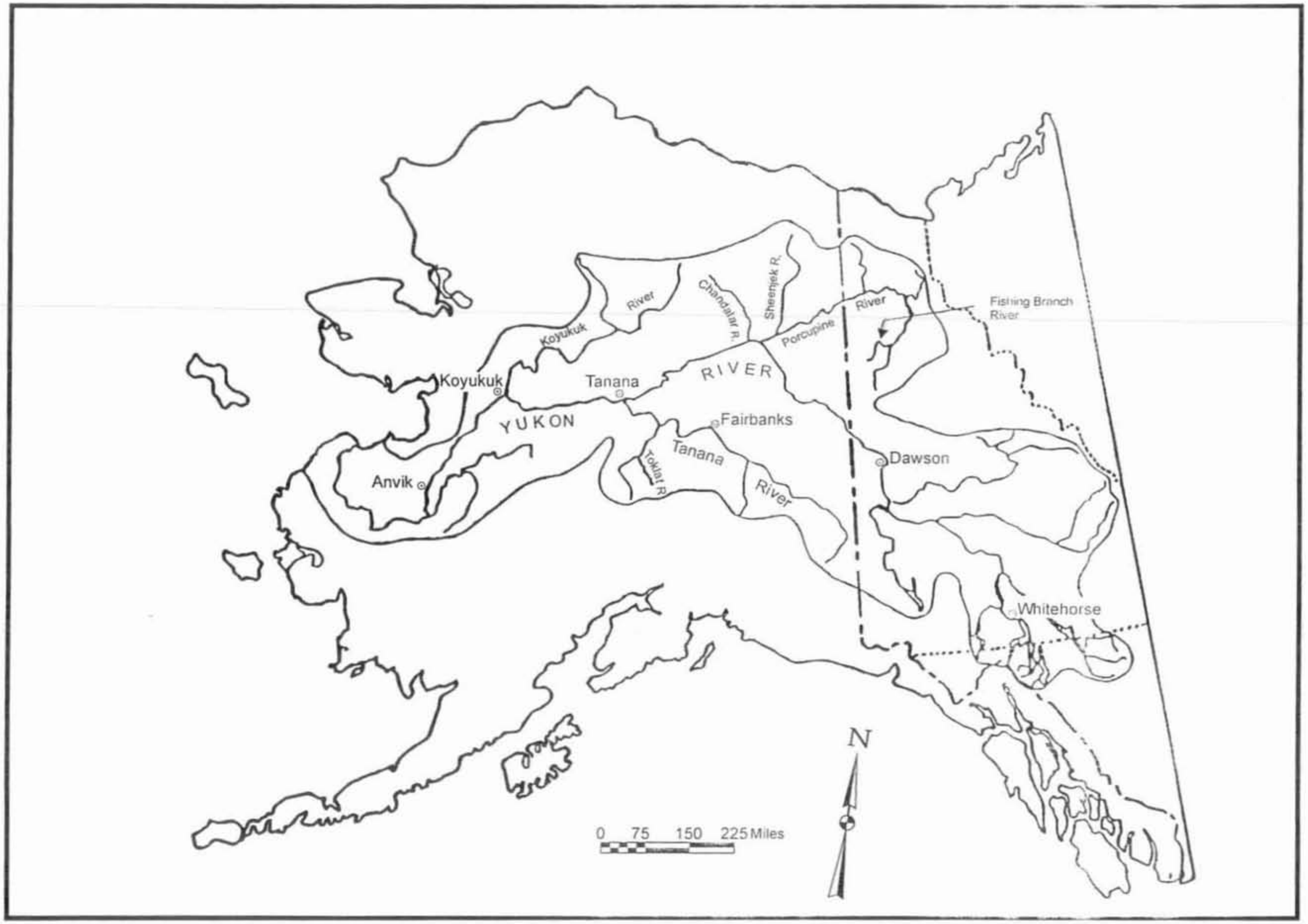


Figure 1. The Yukon River drainage showing selected locations.

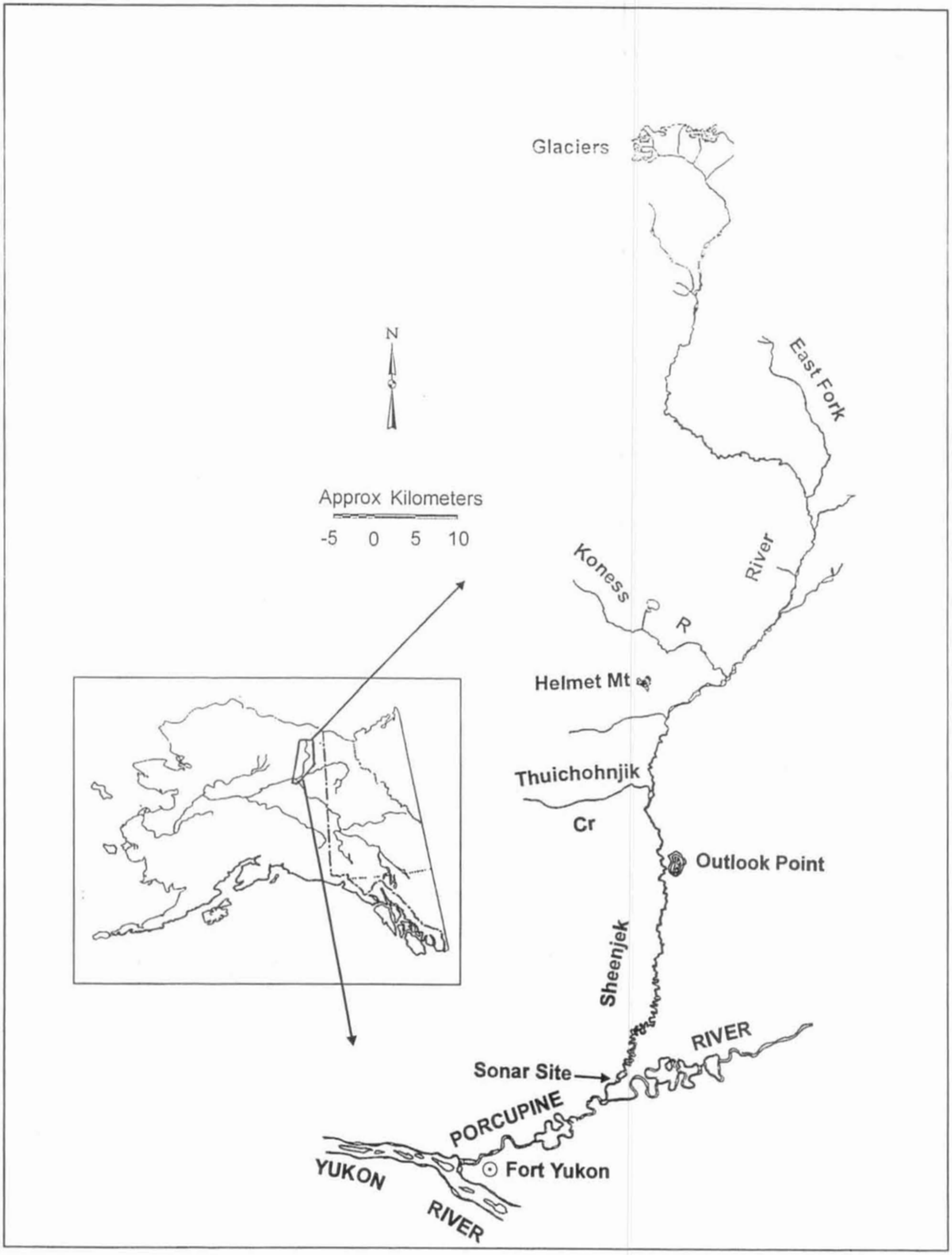


Figure 2. The Sheenjek River drainage.

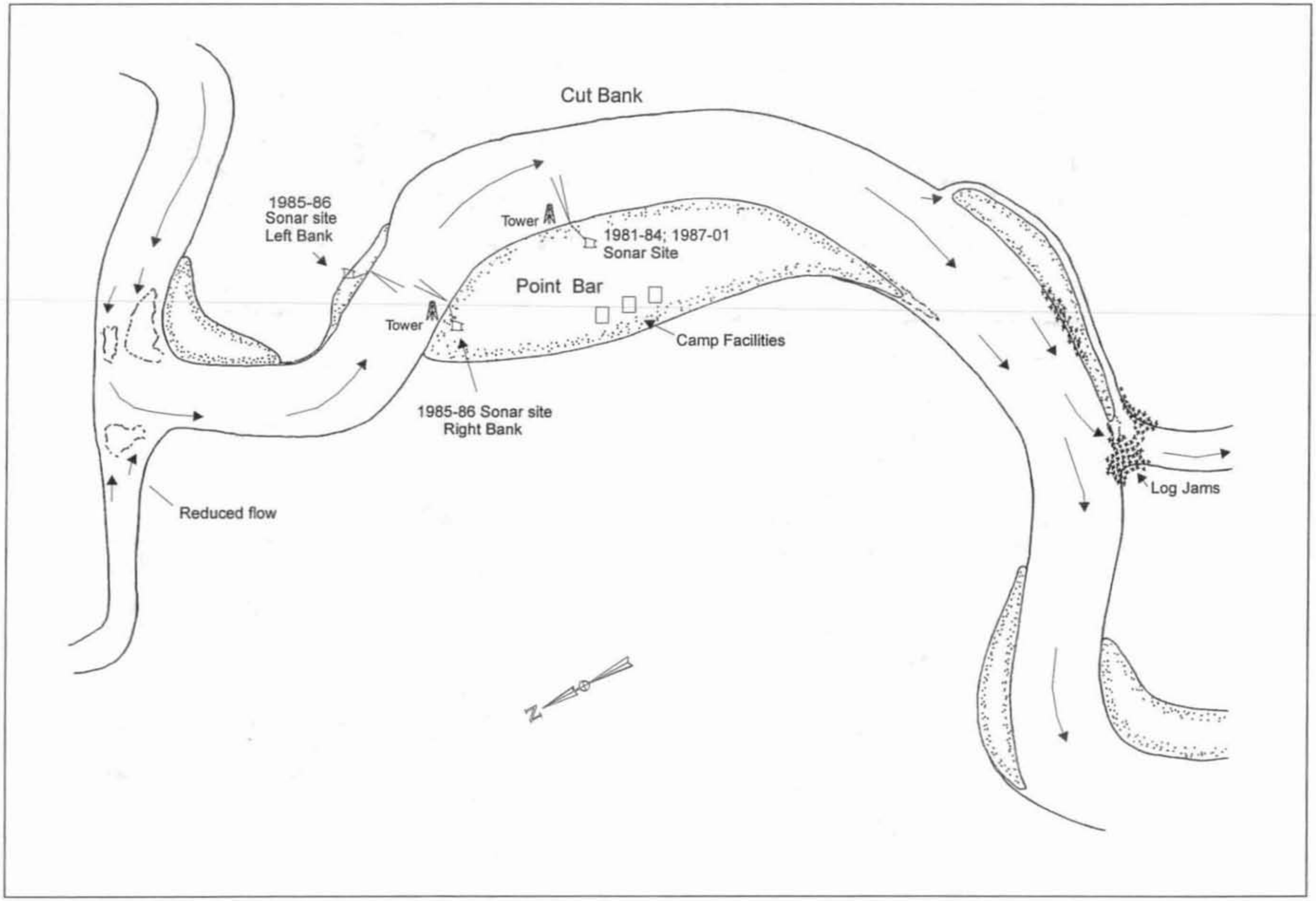
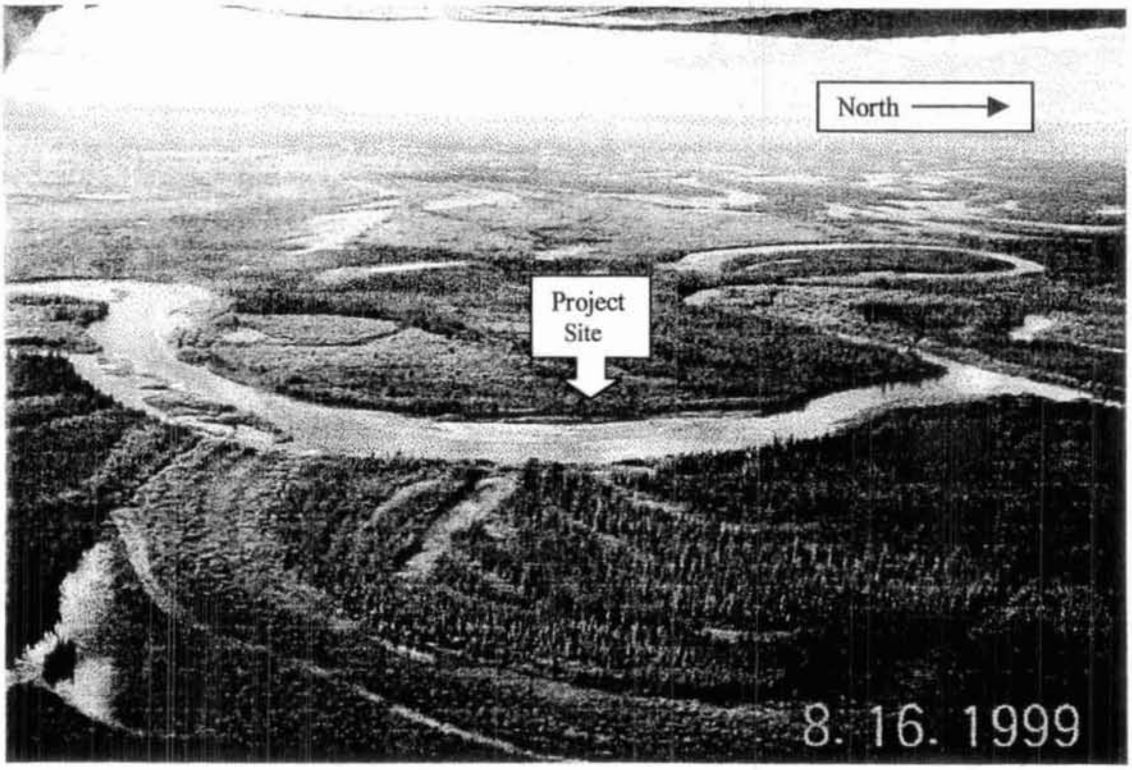


Figure 3. The Sheenjek River sonar project site.



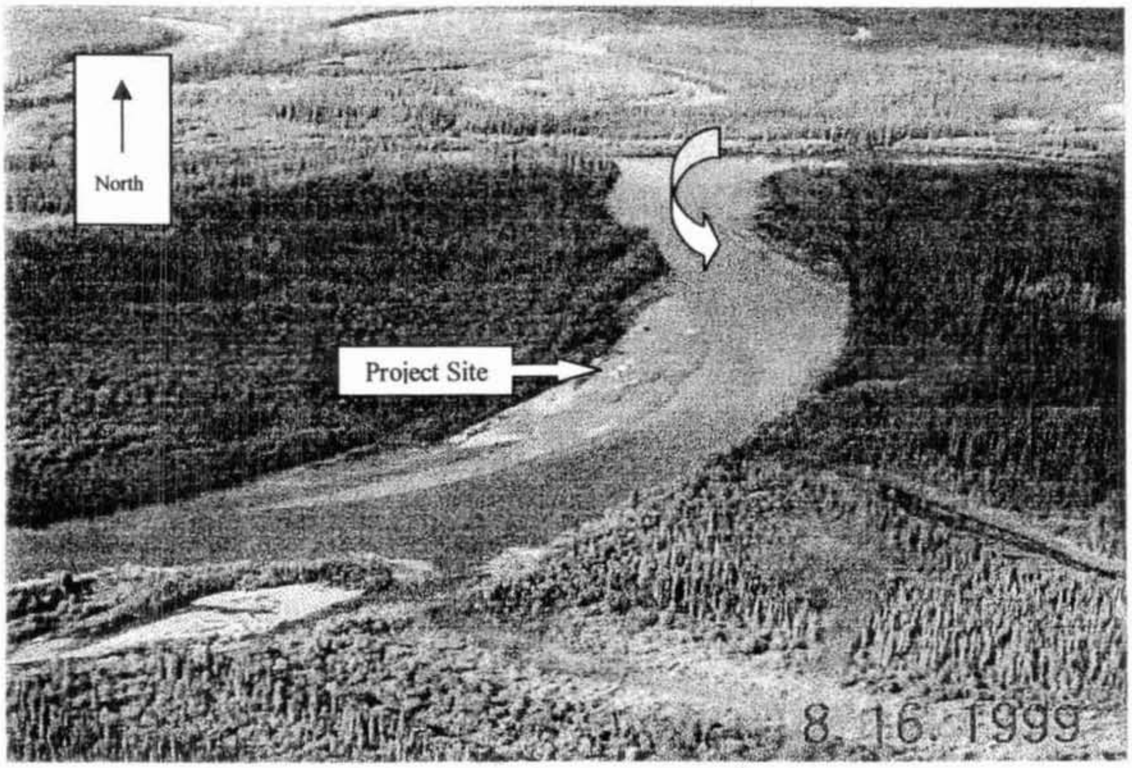


Figure 4. Aerial photographs of the Sheenjek River sonar project site taken 16 August 1999.

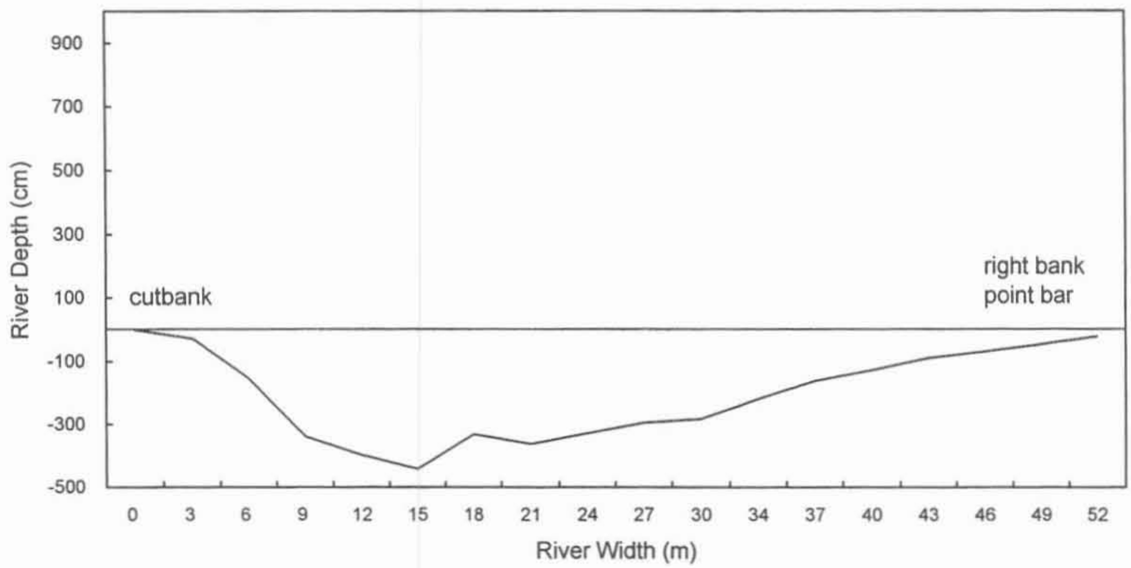


Figure 5. Depth profile (downstream view) made 8 August 2001 at the Sheenjek River sonar project site.

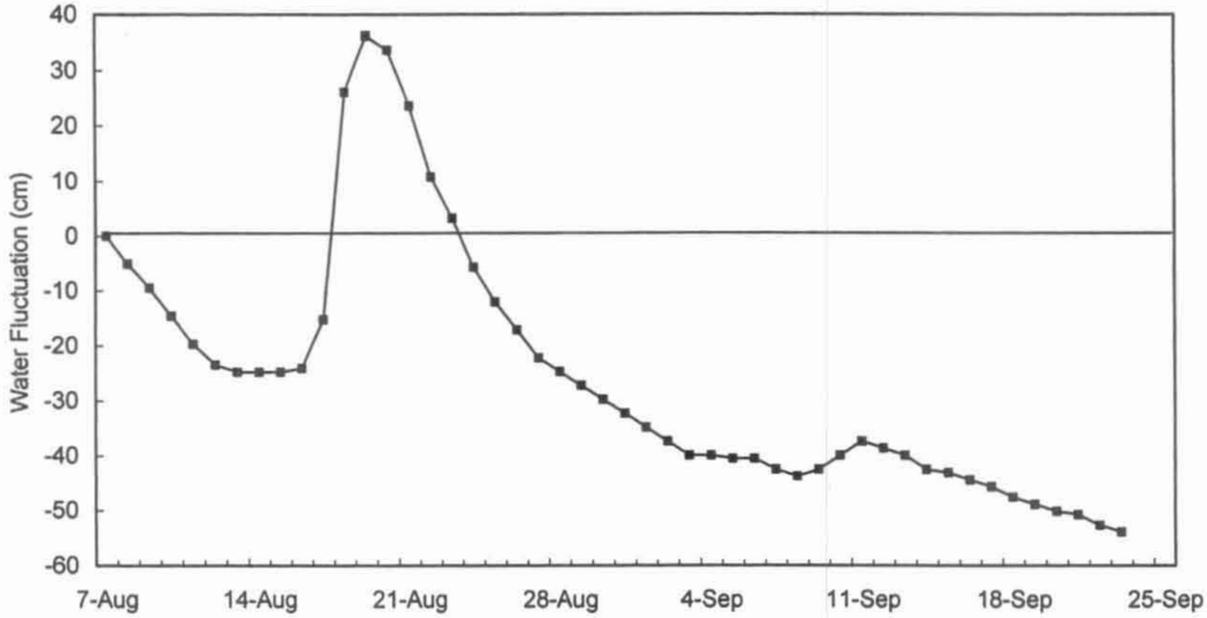


Figure 6. Changes in daily water elevation relative to 7 August measured at the Sheenjek River sonar project site, 2001.

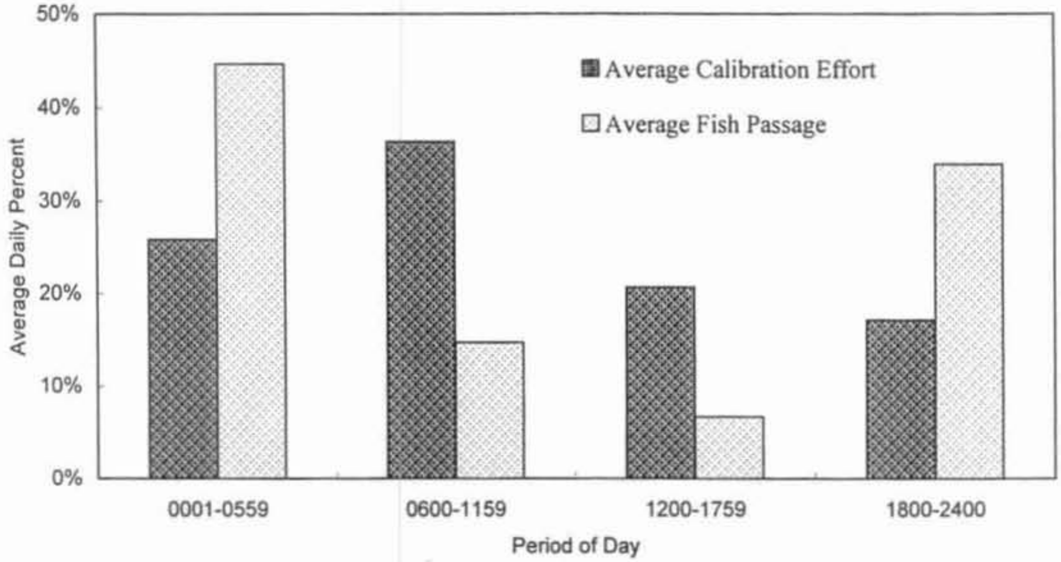


Figure 7. Comparative average sonar calibration effort versus average fish passage in the Sheenjek River, 2001.

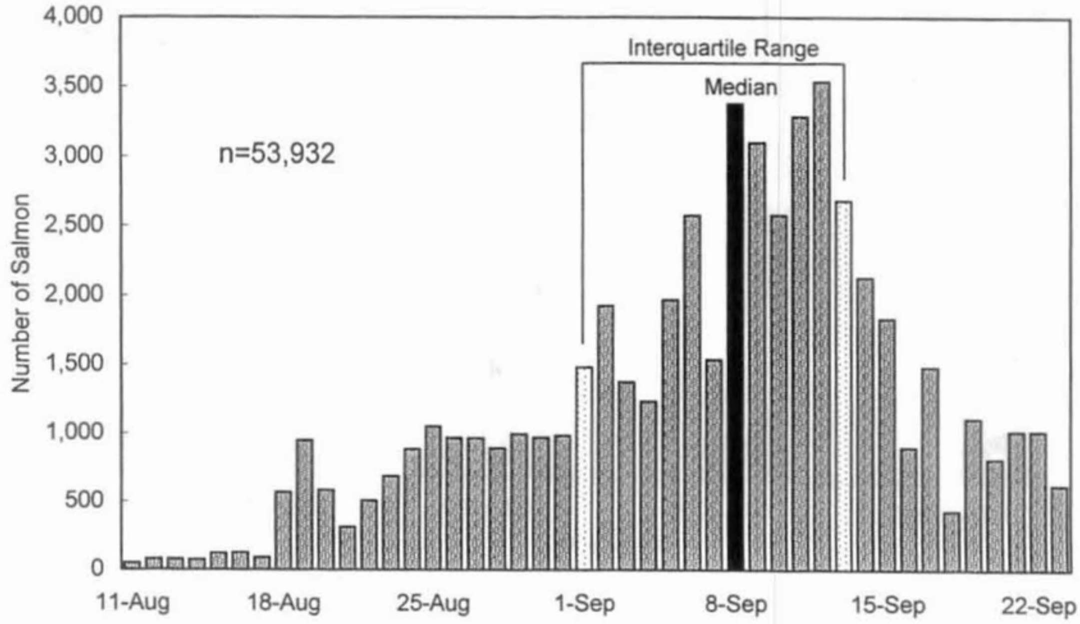


Figure 8. Adjusted sonar counts attributed to fall chum salmon by date, Sheenjek River, 2001.

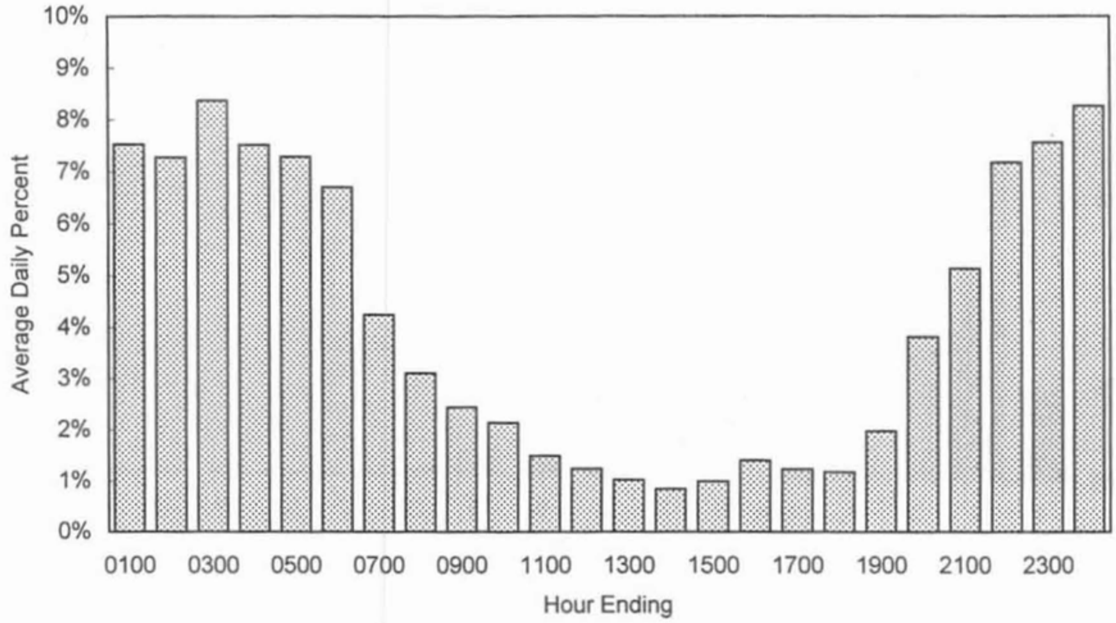


Figure 9. Temporal migration pattern of fall chum salmon observed in the Sheenjek River, 11 August through 23 September 2001.

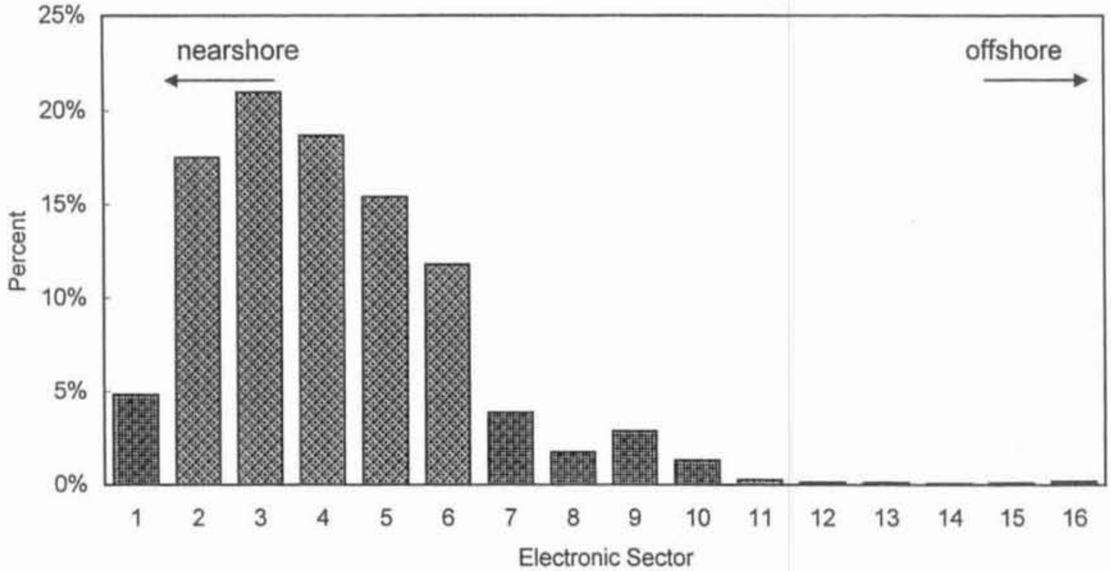


Figure 10. Average distribution of sonar counts by electronic sector attributed to fall chum salmon in the Sheenjek River, 2001.

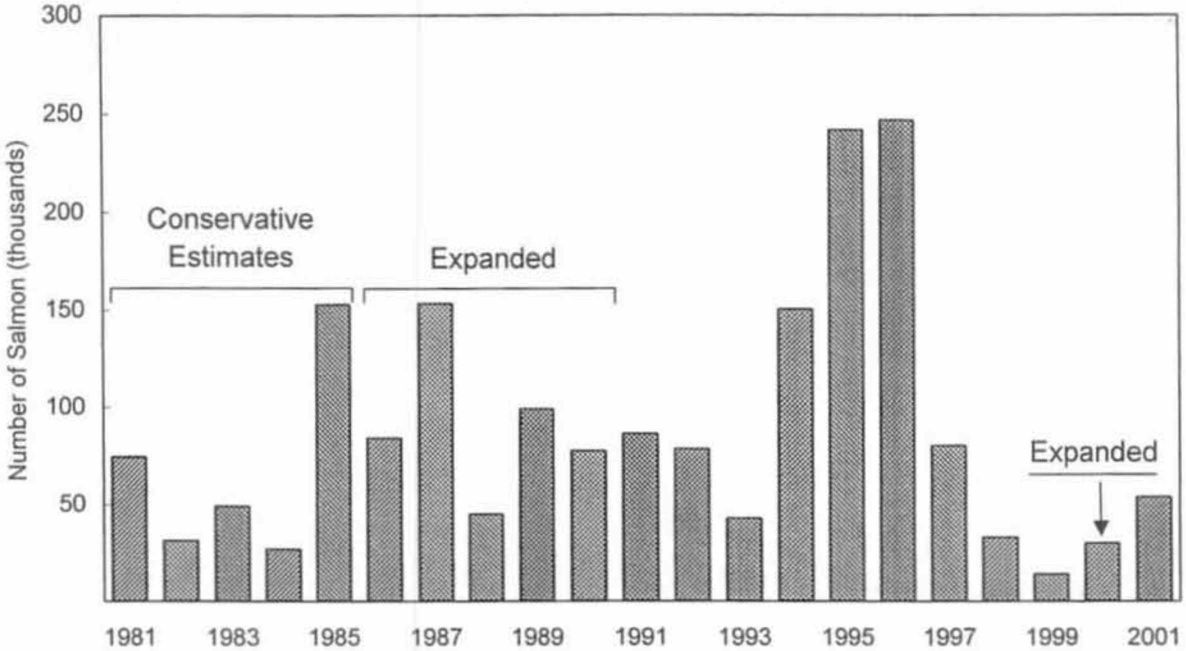


Figure 11. Sonar-estimated escapement of fall chum salmon in the Sheenjek River, 1981-2001.

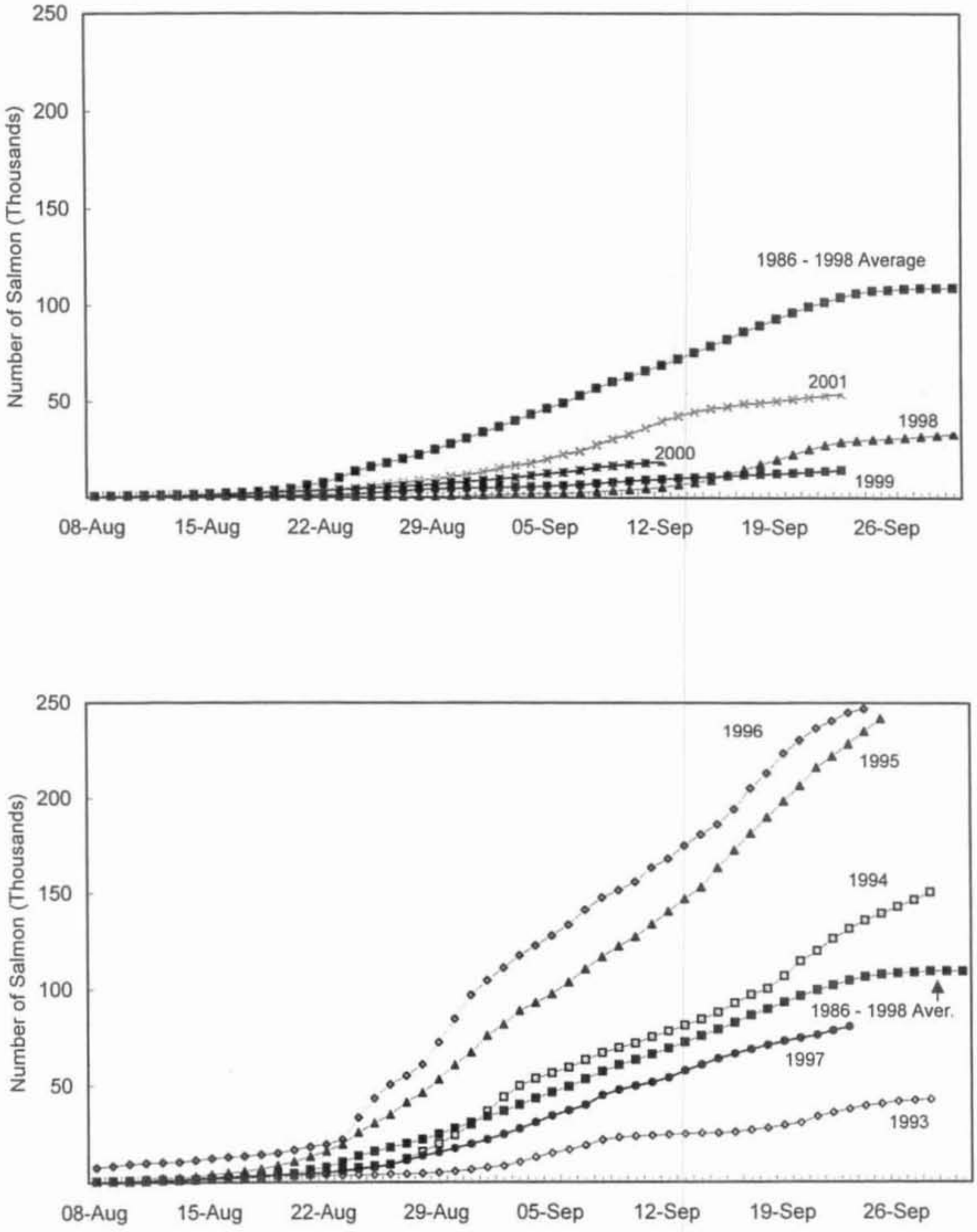


Figure 12. Fall chum salmon cumulative estimated escapement from sonar counts, Sheenjek River, 1998-2001 (top) and 1993-1997 (bottom).

Appendix A. Climatological and hydrologic observations and miscellaneous comments made at the Sheenjek River project site, 2001.

Date	Observation Time	Precipitation (code) [a]	Cloud Cover (code) [b]	Wind: Current Direction and velocity (mph)	Wind: Maximum (mph)	Wind: Maximum time	Temperature (C°): Water Surface	Temperature (C°): Air Minimum	Temperature (C°): Air Maximum	Water Level (cm): ± 24 h Change	Water Level (cm): relative to zero datum	Water Color (code) [c]	Remarks
										zero datum			
08-Aug	1830	A	S							-5.1	-5.1	A	Completed river profile.
09-Aug	1830	B	O	SW 15	20	1835	13	12		-4.4	-9.5	A	
10-Aug	2021	B	S	SW 10	10	2021	13	11	14	-5.1	-14.6	A	Rainy morning and sunny afternoon. Water dropping, moved ducer out.
11-Aug	1800	B	S	SW 10	15	1100	13	11	15	-5.1	-19.7	A	First full day of counts.
12-Aug	1800	B	S	SW 5 - 15	15	1700	12	11	14	-3.8	-23.5	A	Problem with ducer cable connector. Erected tower.
13-Aug	1745	B	S	SW 15 - 25	25	1700	12	11	15	-1.3	-24.8	A	Still problems with connector. Swithced printers.
14-Aug	1745	B	B	SW 15 - 25	25	1300	12	14	18	0.0	-24.8	A	
15-Aug	1745	B	O	SW 5 - 10	10	1400	12	12	16	0.0	-24.8	A	
16-Aug	1800	A	S	NE 5	10	1200	12	7	14	0.6	-24.1	A	
17-Aug	1800	A	C	NE 5 - 15	15	1600	12	4	16	8.9	-15.2	A	
18-Aug	2000	B	O	NE <5	15	1100	10	3	13	41.3	26.0	B	Fish numbers picking up.
19-Aug	1400	A	C	N 5	10	1200	10	6	18	10.2	36.2	C	Log took out tower and weir. Removed ducer 1400. Reset water gauge.
20-Aug	2000	A	C	N 5	10	1200	10	7	23	-2.5	33.7	C	Beautiful day.
21-Aug	1800	A	C	N 5	10	1400	11	7	23	-10.2	23.5	C	1600 ducer back in river.
22-Aug	1800	A	C	N 5	5	1200	12	6	22	-12.7	10.8	B	Reset water gauge again. Bears in camp.
23-Aug	1900	A	C	N 5 - 10			12	7	21	-7.6	3.2	A	
24-Aug	1800	A	C	N >5	5	0900	12	8	22	-8.9	-5.7	A	Moved ducer out 22 ft.
25-Aug	1800	A	C	N 0 - 5	5	1300	12	3	23	-6.4	-12.1	A	
26-Aug	1800	A	C	N 0 - 5	5	1400	12	5	21	-5.1	-17.1	A	
27-Aug	1900	A	C	N 0 - 5	5	1100	12	6	24	-5.1	-22.2	A	
28-Aug	1900	A	C	ENE 5 - 10	10	1900	12	6	26	-2.5	-24.8	B	Moved ducer out 18 ft.
29-Aug	1800	B	S	N 5 - 10	10	1300	12	9	22	-2.5	-27.3	A	
30-Aug	1800	B	B	S 5 - 10			12	6	24	-2.5	-29.8	A	
31-Aug	1900	B	B	S 5			11	10	19	-2.5	-32.4	A	
01-Sep	1800	A	C	N <5			11	0	19	-2.5	-34.9	A	
02-Sep	1800	A	B				11	3	16	-2.5	-37.5	A	
03-Sep	1800	B	O	N 5 - 10	10	1100	11	5	18	-2.5	-40.0	A	
04-Sep	1900	A	B	N 5 - 10	10	0900	11	6	18	0.0	-40.0	A	
05-Sep	1800	B	O	SW 5 - 15	15	1100	11	8	15	-0.6	-40.6	A	Ducer cable connector loose again.
06-Sep	1800	A	C	SW 5 - 10	10	1200	10	4	13	0.0	-40.6	A	
07-Sep	1900	A	C	S 5 - 10	10	0900	9	-2	14	-1.9	-42.5	A	
08-Sep	1900	B	B	S 5 - 10	10	1000	8	0	13	-1.3	-43.8	A	
09-Sep	2000	A	B	SW 5	5	1400	8	5	13	1.3	-42.5	A	
10-Sep	2000	A	C	N <5	5	0900	8	0	18	2.5	-40.0	A	
11-Sep	1900	A	C	N <5	5	1700	8	-1	19	2.5	-37.5	A	
12-Sep	1800	A	C	SW 5 - 10	10	1200	8	-1	18	-1.3	-38.7	A	
13-Sep	1900	A	S	SW 5 - 15	15	1700	8	-2	16	-1.3	-40.0	A	
14-Sep	1800	A	S	SW 10 - 15	15	900	8	-1	16	-2.5	-42.5	A	
15-Sep	1900	A	C	SW 10 - 15	15	1100	8	2	16	-0.6	-43.2	A	Loose connection.
16-Sep	1900	A	C	N 5			8	-1	15	-1.3	-44.5	A	Found break in cable. Switched ducer.
17-Sep	1800	A	C	NE 5 - 10	10	1200	8	1	13	-1.3	-45.7	A	Too windy for visual counts.
18-Sep	1800	A	C	NE 5 - 10	10	1400	7	1	15	-1.9	-47.6	A	
19-Sep	1800	A	C	N <5			7	-2	13	-1.3	-48.9	A	Reset water gauge.
20-Sep	1800	A	C	NE 5 - 10	10	1700	7	-1	13	-1.3	-50.2	A	
21-Sep	1900	A	C	NE <5			7	0	16	-0.6	-50.8	A	
22-Sep	1900	A	B	N 10 - 15	15	1400	7	2	14	-1.9	-52.7	A	
23-Sep	1900	B	S	N 5 - 10	10	1200	6	0	13	-1.3	-54.0	A	Breaking camp. Sonar off at 2400.
	Average						10.1	5	17				

[a] Precipitation code for the preceding 24-hr period: A = None; B = Intermittent rain; C = Continuous rain; D = snow and rain mixed; E = light snowfall; F = Continuous snowfall; G = Thunderstorm w/ or w/o precipitation.

[b] Instanteous cloudcover code: C = Clear and visibility unlimited (CAVU); S = Scattered (<60%); B = Broken (60-90%); O = Overcast (100%); F = Fog or thick haze or smoke.

[c] Instanteous water color code: A = Clear; B = Slightly murky or glacial; C = Moderately murky or glacial; D = Heavily murky or glacial; E = Brown, tanic acid stain.

Appendix B. Temporal distribution of daily sonar counts attributed to fall chum salmon in Sheenjek River, 2001.

Hour	11-Aug	12-Aug	13-Aug	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	23-Aug	24-Aug	25-Aug
0100	2	2	2	2	2	7	6	79	57	[b]	[a]	55	63	122	73
0200	1	2	1	2	3	2	14	64	49			65	122	115	96
0300	3	5	3	5	6	6	6	52	84			48	93	121	130
0400	6	12	6	21	28	6	11	42	60			50	58	93	120
0500	0	0	0	11	13	11	6	42	32			23	57	36	68
0600	7	0	7	3	8	39	9	12	39			4	44	49	15
0700	0	0	0	2	3	6	2	11	38			14	7	14	19
0800	5	4	9	2	13	5	0	17	36			12	11	14	4
0900	11	3	21	2	0	3	0	8	35			6	15	7	14
1000	8	9	15	9	10	1	0	14	39		23.0%	0	3	19	3
1100	0	3	0	2	3	7	1	9	40	100%	241	0	10	0	1
1200	3	1	6	1	8	2	12	4	31	584		0	23	5	1
1300	2	9	3	0	2	2	0	8	20			0	3	3	2
1400	2	3	3	0	0	8	0	5	20			3	2	20	10
1500	2	3	3	2	4	6	0	3	[a]			0	2	0	1
1600	0	1	0	2	0	2	3	1				0	0	0	10
1700	0	4	0	0	7	1	2	2				0	1	3	2
1800	0	3	0	0	0	1	5	10				0	2	13	9
1900	0	0	0	0	1	1	0	9	61.2%			7	0	8	1
2000	0	0	0	0	1	0	0	10	368			6	3	1	21
2100	0	0	0	0	0	2	2	23				11	15	37	139
2200	0	0	0	0	1	1	1	46			12	24	18	38	107
2300	0	6	0	6	3	2	4	48			28	75	77	80	109
2400	0	9	0	1	5	5	6	48			32	104	60	86	95
	49	78	79	73	121	126	90	567	948	584	313	507	689	884	1,050
	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	1.1%	1.8%	1.1%	0.6%	0.9%	1.3%	1.6%	1.9%

- continued -

Appendix B. (p 2 of 3)

Hour	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep
0100	171	124	150	85	81	95	114	112	95	82	33	102	62	75	127
0200	156	139	130	126	54	93	156	187	90	73	33	41	31	57	168
0300	147	110	125	113	149	79	263	242	119	123	112	143	32	91	171
0400	123	115	93	107	136	70	167	200	85	112	177	149	37	108	338
0500	65	60	77	70	61	135	135	180	161	88	226	515	52	223	233
0600	75	58	57	46	49	62	82	153	138	57	65	352	137	518	267
0700	8	46	44	25	14	55	36	70	76	74	127	308	162	244	114
0800	2	7	17	36	27	34	35	51	31	11	56	142	146	139	111
0900	1	7	7	6	22	16	11	43	39	69	84	36	39	59	160
1000	0	5	2	14	3	8	18	6	58	17	161	110	23	60	101
1100	1	0	2	2	5	5	2	10	45	20	82	47	16	6	146
1200	1	1	3	11	5	13	10	11	34	9	89	3	22	32	44
1300	1	1	3	11	7	8	10	5	27	20	92	1	3	31	65
1400	0	0	0	9	16	8	10	10	10	5	49	40	11	11	21
1500	3	2	0	16	16	7	6	6	14	11	33	17	9	49	30
1600	18	18	4	15	19	2	4	24	7	19	19	20	2	69	76
1700	0	4	1	9	1	1	14	22	15	5	56	40	2	64	38
1800	4	5	1	0	21	5	8	7	21	6	46	32	4	67	87
1900	1	3	1	2	34	6	6	34	19	26	19	43	46	72	82
2000	1	2	0	0	10	5	11	24	73	25	63	59	139	185	154
2100	18	28	0	39	26	33	50	51	26	45	69	54	198	199	154
2200	33	42	2	29	99	82	87	174	68	136	139	156	135	340	131
2300	80	108	69	116	81	70	119	133	46	150	72	103	116	299	127
2400	58	79	104	108	34	93	127	170	77	52	66	61	113	380	153
	967	964	892	995	970	985	1,481	1,925	1,374	1,235	1,968	2,574	1,537	3,378	3,098
	1.8%	1.8%	1.7%	1.8%	1.8%	1.8%	2.7%	3.6%	2.5%	2.3%	3.6%	4.8%	2.8%	6.3%	5.7%

- continued -

Appendix B. (p 3 of 3)

	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	Total	Percent
0100	118	324	267	353	200	187	95	144	76	56	34	42	62	42	3,980	0.075
0200	79	176	243	335	239	204	36	123	92	50	33	46	67	52	3,845	0.073
0300	203	165	257	293	151	208	[a]	152	94	81	66	54	80	41	4,426	0.084
0400	148	211	172	208	143	147		81	61	64	25	67	65	50	3,972	0.075
0500	60	128	198	169	139	141		94	47	61	66	52	65	53	3,853	0.073
0600	60	166	74	77	109	188	58.20%	89	65	75	88	122	53	25	3,543	0.067
0700	55	33	66	71	108	33	376	61	54	52	51	84	29	29	2,245	0.042
0800	113	66	107	96	54	28		46	34	23	25	29	27	17	1,642	0.031
0900	56	178	46	27	30	34		43	22	43	14	21	42	15	1,295	0.024
1000	63	153	44	38	7	5		17	10	23	8	13	10	27	1,134	0.021
1100	38	72	35	40	2	6	23	23	3	27	17	18	16	6	791	0.015
1200	45	19	15	16	2	18	6	41	21	16	16	38	11	7	656	0.012
1300	20	6	7	12	14	14	4	16	3	22	32	24	24	7	544	0.010
1400	3	5	13	14	14	17	2	21	5	9	11	20	10	27	447	0.008
1500	14	12	36	51	3	11	17	9	13	42	13	22	18	20	526	0.010
1600	10	17	35	65	32	7	4	34	9	70	6	22	36	63	745	0.014
1700	6	11	68	11	149	14	22	7	14	24	5	6	21	2	654	0.012
1800	19	14	24	23	24	35	26	15	5	26	6	10	15	25	624	0.012
1900	75	95	85	12	127	42	22	45	4	24	22	13	49	10	1,046	0.020
2000	257	405	172	36	53	13	14	17	4	60	80	59	45	9	2,017	0.038
2100	346	279	298	53	38	46	35	49	40	84	58	47	96	27	2,715	0.051
2200	184	381	320	177	130	172	63	64	118	44	46	70	84	41	3,795	0.072
2300	156	172	505	288	171	115	58	123	64	57	41	62	33	27	3,999	0.076
2400	447	198	449	214	191	148	96	168	72	77	50	76	60	0	4,372	0.083
															52,862 [c]	
	2,575	3,286	3,536	2,679	2,130	1,833	900	1,482	430	1,110	813	1,017	1,018	622	53,932 [d]	
	4.8%	6.1%	6.6%	5.0%	3.9%	3.4%	1.7%	2.7%	0.8%	2.1%	1.5%	1.9%	1.9%	1.2%		100%

[a] Indicates time when passage was estimated by interpolation, based upon average hourly distribution for days when sonar operated 24 hours.

[b] No counts for 24 hours, interpolated using daily totals from two days before and after.

[c] Totals include only days with 24 hours counts.

[d] Total estimated passage, including days with expanded counts.

Appendix C. Field calibrations for 1985-model Bendix sonar salmon counter, Sheenjek River 2001.

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
11-Aug	0	15	0	0	---	0.400	1.0	79.0	80.0	0
	625	15	0	0	---	0.400	1.0	79.0	80.0	0
	1100	20	2	3	0.667	0.400	1.0	79.0	80.0	6
	1600	15	0	0	---	0.400	1.0	79.0	80.0	0
	2100	15	0	0	---	0.400	1.0	79.0	80.0	0
12-Aug	620	15	0	0	---	0.350	1.0	79.0	80.0	0
	1145	15	1	1	1.000	0.350	1.0	79.0	80.0	4
	1600	30	3	3	1.000	0.350	1.0	79.0	80.0	6
	2100	15	0	0	---	0.450	1.0	84.0	85.0	0
13-Aug	0	20	0	0	---	0.450	1.0	84.0	85.0	0
	300	15	1	1	1.000	0.450	1.0	84.0	85.0	4
	630	15	0	0	---	0.450	1.0	84.0	85.0	0
	1100	20	2	1	2.000	0.500	1.0	84.0	85.0	6
	1630	20	0	0	---	0.500	1.0	84.0	85.0	0
	2100	15	0	0	---	0.500	1.0	44.0	45.0	0
14-Aug	0	20	1	0	---	0.400	1.0	44.0	45.0	3
	300	15	0	0	---	0.400	1.0	44.0	45.0	0
	630	20	1	0	---	0.400	1.0	44.0	45.0	3
	1100	20	1	1	1.000	0.400	1.0	44.0	45.0	3
	1600	30	0	0	---	0.400	1.0	44.0	45.0	0
	2120	20	0	0	---	0.400	0.5	44.5	45.0	0
15-Aug	0	20	2	2	1.000	0.400	0.5	44.5	45.0	6
	300	15	0	0	---	0.400	0.5	44.5	45.0	0
	630	30	4	1	4.000	0.400	0.5	44.5	45.0	8
	1100	30	0	0	---	0.350	0.5	44.5	45.0	0
	1620	30	0	0	---	0.350	0.5	44.5	45.0	0
	2100	20	0	0	---	0.350	0.5	44.5	45.0	0
16-Aug	0	20	1	1	1.000	0.350	0.5	44.5	45.0	3
	300	20	0	0	---	0.350	0.5	44.5	45.0	0
	630	30	2	3	0.667	0.350	0.5	44.5	45.0	4
	1055	40	2	1	2.000	0.400	0.5	44.5	45.0	3
	1640	20	2	1	2.000	0.400	0.5	44.5	45.0	6
	2100	25	1	2	0.500	0.400	0.5	44.5	45.0	2
17-Aug	0	15	0	0	---	0.400	0.5	44.5	45.0	0
	300	15	2	2	1.000	0.400	0.5	44.5	45.0	8
	630	30	0	0	---	0.400	0.5	44.5	45.0	0
	1100	40	0	0	---	0.400	0.5	44.5	45.0	0
	1615	30	2	1	2.000	0.400	0.5	44.5	45.0	4
	2100	25	0	0	---	0.400	0.5	44.5	45.0	0

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
18-Aug	0	20	7	8	0.875	0.400	0.5	44.5	45.0	21
	300	20	11	18	0.611	0.400	0.5	44.5	45.0	33
	645	15	4	5	0.800	0.450	0.5	44.5	45.0	16
	1100	50	3	3	1.000	0.500	0.5	44.5	45.0	4
	1600	30	0	0	---	0.450	2.0	98.0	100.0	0
	2100	30	8	33	0.242	0.450	2.0	98.0	100.0	16
19-Aug	5	15	25	24	1.042	0.500	2.0	98.0	100.0	100
	300	15	15	31	0.484	0.500	2.0	98.0	100.0	60
	630	15	16	26	0.615	0.500	2.0	98.0	100.0	64
	1115	20	13	17	0.765	0.600	2.0	98.0	100.0	39
20-Aug	Sonar inoperable, no calibrations.									
21-Aug	1600	15	1	0	---	0.450	2.0	98.0	100.0	4
	2100	25	5	10	0.500	0.450	2.0	98.0	100.0	12
22-Aug	5	20	12	14	0.857	0.550	2.0	98.0	100.0	36
	314	15	25	34	0.735	0.600	2.0	98.0	100.0	100
	615	15	2	2	1.000	0.600	2.0	98.0	100.0	8
	1115	30	0	0	---	0.600	2.0	98.0	100.0	0
	1600	20	0	0	---	0.600	2.0	98.0	100.0	0
	2130	20	4	4	1.000	0.600	2.0	98.0	100.0	12
23-Aug	7	17	23	27	0.852	0.600	2.0	98.0	100.0	81
	310	15	14	15	0.933	0.600	2.0	98.0	100.0	56
	630	30	4	6	0.667	0.600	2.0	98.0	100.0	8
	1130	20	2	1	2.000	0.600	2.0	98.0	100.0	6
	1610	20	0	0	---	0.600	2.0	98.0	100.0	0
	2045	15	14	14	1.000	0.600	2.0	98.0	100.0	56
24-Aug	1	20	21	22	0.955	0.600	2.0	98.0	100.0	63
	317	15	10	10	1.000	0.630	2.0	98.0	100.0	40
	630	20	8	7	1.143	0.630	2.0	98.0	100.0	24
	1100	30	4	6	0.667	0.630	2.0	98.0	100.0	8
	1600	30	1	1	1.000	0.500	2.0	98.0	100.0	2
	2110	15	20	29	0.690	0.500	2.0	98.0	100.0	80
25-Aug	10	15	24	27	0.889	0.550	2.0	98.0	100.0	96
	305	15	25	32	0.781	0.600	2.0	98.0	100.0	100
	645	15	14	16	0.875	0.680	2.0	98.0	100.0	56
	1110	20	0	0	---	0.680	2.0	98.0	100.0	0
	1600	25	3	3	1.000	0.680	2.0	98.0	100.0	7
	2045	15	23	22	1.045	0.680	2.0	98.0	100.0	92
	2102	15	40	47	0.851	0.680	2.0	98.0	100.0	160

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
26-Aug	5	15	39	36	1.083	0.700	2.0	98.0	100.0	156
	305	15	49	51	0.961	0.690	2.0	98.0	100.0	196
	630	20	4	4	1.000	0.700	2.0	98.0	100.0	12
	1105	20	0	0	---	0.700	2.0	98.0	100.0	0
	1610	30	0	0	---	0.700	2.0	98.0	100.0	0
	2100	20	21	17	1.235	0.700	2.0	98.0	100.0	63
27-Aug	0	15	15	14	1.071	0.700	2.0	98.0	100.0	60
	300	15	21	20	1.050	0.700	2.0	98.0	100.0	84
	715	20	0	0	---	0.700	2.0	98.0	100.0	0
	1105	25	0	0	---	0.700	2.0	98.0	100.0	0
	1625	30	1	1	1.000	0.700	2.0	98.0	100.0	2
	2105	30	21	22	0.955	0.700	2.0	98.0	100.0	42
28-Aug	0	20	45	39	1.154	0.700	2.0	98.0	100.0	135
	320	15	22	16	1.375	0.700	2.0	98.0	100.0	88
	630	20	10	8	1.250	0.700	2.0	98.0	100.0	30
	1120	30	2	2	1.000	0.700	2.0	98.0	100.0	4
	1610	30	1	1	1.000	0.700	2.0	93.0	95.0	2
	2120	30	3	2	1.500	0.700	2.0	93.0	95.0	6
29-Aug	0	20	27	24	1.125	0.700	2.0	93.0	95.0	81
	300	15	32	26	1.231	0.700	2.0	93.0	95.0	128
	630	20	3	3	1.000	0.700	2.0	93.0	95.0	9
	1145	15	3	2	1.500	0.700	2.0	93.0	95.0	12
	1630	30	2	2	1.000	0.700	2.0	93.0	95.0	4
	2110	30	16	14	1.143	0.700	2.0	93.0	95.0	32
30-Aug	0	15	20	16	1.250	0.700	2.0	93.0	95.0	80
	305	15	11	8	1.375	0.700	2.0	93.0	95.0	44
	630	30	4	3	1.333	0.700	2.0	93.0	95.0	8
	1120	30	4	2	2.000	0.700	2.0	93.0	95.0	8
	1600	30	3	1	3.000	0.650	2.0	93.0	95.0	6
	2120	20	34	32	1.063	0.650	2.0	93.0	95.0	102
31-Aug	0	15	22	19	1.158	0.650	2.0	93.0	95.0	88
	305	15	24	22	1.091	0.650	2.0	93.0	95.0	96
	640	20	20	10	2.000	0.650	2.0	93.0	95.0	60
	1110	30	9	8	1.125	0.600	2.0	93.0	95.0	18
	1600	30	3	3	1.000	0.600	2.0	93.0	95.0	6
	2115	20	51	47	1.085	0.600	2.0	93.0	95.0	153

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
01-Sep	30	20	45	42	1.071	0.600	2.0	93.0	95.0	135
	300	15	46	42	1.095	0.600	2.0	93.0	95.0	184
	630	15	27	32	0.844	0.600	2.0	93.0	95.0	108
	1100	30	1	1	1.000	0.630	2.0	93.0	95.0	2
	1630	30	9	8	1.125	0.630	2.0	93.0	95.0	18
	2130	20	25	19	1.316	0.630	2.0	93.0	95.0	75
02-Sep	15	15	18	17	1.059	0.630	2.0	93.0	95.0	72
	300	15	24	20	1.200	0.630	2.0	93.0	95.0	96
	630	15	17	15	1.133	0.630	2.0	93.0	95.0	68
	1145	30	3	3	1.000	0.630	2.0	93.0	95.0	6
	1630	30	3	2	1.500	0.630	2.0	93.0	95.0	6
	2105	20	57	21	2.714	0.630	2.0	93.0	95.0	171
03-Sep	0	20	35	37	0.946	0.630	2.0	93.0	95.0	105
	305	15	21	18	1.167	0.630	2.0	93.0	95.0	84
	630	20	10	9	1.111	0.630	2.0	93.0	95.0	30
	1105	25	12	8	1.500	0.630	2.0	93.0	95.0	29
	1600	20	5	4	1.250	0.630	2.0	93.0	95.0	15
	2125	15	14	13	1.077	0.630	2.0	93.0	95.0	56
04-Sep	9	15	19	15	1.267	0.630	2.0	93.0	95.0	76
	309	15	29	31	0.935	0.630	2.0	93.0	95.0	116
	630	20	39	41	0.951	0.630	2.0	93.0	95.0	117
	1100	30	5	5	1.000	0.630	2.0	93.0	95.0	10
	1640	20	9	7	1.286	0.630	2.0	93.0	95.0	27
	2100	20	17	14	1.214	0.630	2.0	93.0	95.0	51
05-Sep	12	15	14	12	1.167	0.630	2.0	93.0	95.0	56
	310	15	43	45	0.956	0.630	2.0	93.0	95.0	172
	640	20	26	30	0.867	0.630	2.0	93.0	95.0	78
	1115	35	40	37	1.081	0.630	2.0	93.0	95.0	69
	1345	15	12	10	1.200	0.630	2.0	93.0	95.0	48
	1635	20	15	18	0.833	0.630	2.0	93.0	95.0	45
	2103	15	43	30	1.433	0.630	2.0	93.0	95.0	172
06-Sep	12	15	14	7	2.000	0.600	2.0	93.0	95.0	56
	300	15	27	18	1.500	0.600	2.0	93.0	95.0	108
	630	20	45	39	1.154	0.600	2.0	93.0	95.0	135
	1105	35	2	2	1.000	0.600	2.0	93.0	95.0	3
	1605	25	11	8	1.375	0.600	2.0	93.0	95.0	26
	2120	15	49	45	1.089	0.600	2.0	93.0	95.0	196

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
07-Sep	7	15	11	8	1.375	0.600	2.0	93.0	95.0	44
	307	15	16	12	1.333	0.600	2.0	93.0	95.0	64
	645	15	34	30	1.133	0.600	2.0	93.0	95.0	136
	1100	20	11	14	0.786	0.600	2.0	93.0	95.0	33
	1605	15	3	2	1.500	0.500	2.0	93.0	95.0	12
	2129	30	46	40	1.150	0.550	2.0	93.0	95.0	92
08-Sep	7	15	40	39	1.026	0.600	2.0	93.0	95.0	160
	300	15	42	44	0.955	0.600	2.0	93.0	95.0	168
	625	30	87	102	0.853	0.620	2.0	93.0	95.0	174
	1100	20	1	1	1.000	0.620	2.0	93.0	95.0	3
	1605	15	26	22	1.182	0.620	2.0	93.0	95.0	104
	2100	15	63	55	1.145	0.600	2.0	93.0	95.0	252
09-Sep	5	15	42	38	1.105	0.600	2.0	93.0	95.0	168
	307	15	36	37	0.973	0.600	2.0	93.0	95.0	144
	645	15	16	11	1.455	0.600	2.0	93.0	95.0	64
	1100	20	9	7	1.286	0.600	2.0	93.0	95.0	27
	1600	15	10	5	2.000	0.600	2.0	93.0	95.0	40
	1645	15	15	14	1.071	0.500	2.0	93.0	95.0	60
	2100	15	61	60	1.017	0.550	2.0	93.0	95.0	244
10-Sep	0	15	27	24	1.125	0.550	2.0	93.0	95.0	108
	300	15	36	51	0.706	0.550	2.0	93.0	95.0	144
	645	15	14	13	1.077	0.600	2.0	93.0	95.0	56
	1100	15	19	13	1.462	0.600	2.0	93.0	95.0	76
	1600	15	4	3	1.333	0.600	2.0	93.0	95.0	16
	2110	15	81	72	1.125	0.500	2.0	93.0	95.0	324
11-Sep	10	15	39	42	0.929	0.500	2.0	93.0	95.0	156
	300	20	63	58	1.086	0.500	2.0	93.0	95.0	189
	630	20	24	25	0.960	0.500	2.0	93.0	95.0	72
	1115	15	12	14	0.857	0.500	2.0	93.0	95.0	48
	1630	15	3	1	3.000	0.500	2.0	93.0	95.0	12
	2100	30	167	158	1.057	0.500	2.0	93.0	95.0	334
12-Sep	10	15	20	18	1.111	0.500	2.0	93.0	95.0	80
	330	15	29	23	1.261	0.500	2.0	93.0	95.0	116
	630	15	29	30	0.967	0.500	2.0	93.0	95.0	116
	1107	15	9	3	3.000	0.500	2.0	93.0	95.0	36
	1610	30	36	42	0.857	0.500	2.0	93.0	95.0	72
	2130	20	50	50	1.000	0.500	2.0	93.0	95.0	150

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
13-Sep	5	15	51	46	1.109	0.500	2.0	93.0	95.0	204
	300	15	44	52	0.846	0.500	2.0	93.0	95.0	176
	640	20	46	57	0.807	0.500	2.0	93.0	95.0	138
	1130	15	6	2	3.000	0.500	2.0	93.0	95.0	24
	1610	20	1	1	1.000	0.500	2.0	93.0	95.0	3
	2100	20	79	72	1.097	0.500	2.0	93.0	95.0	237
14-Sep	10	15	30	29	1.034	0.500	2.0	93.0	95.0	120
	300	15	46	43	1.070	0.500	2.0	93.0	95.0	184
	630	20	19	18	1.056	0.500	2.0	93.0	95.0	57
	1030	20	2	1	2.000	0.500	2.0	93.0	95.0	6
	1610	20	24	37	0.649	0.500	2.0	93.0	95.0	72
	2100	15	28	19	1.474	0.600	2.0	93.0	95.0	112
15-Sep	5	15	44	38	1.158	0.550	2.0	93.0	95.0	176
	305	15	42	40	1.050	0.550	2.0	93.0	95.0	168
	630	20	7	7	1.000	0.550	2.0	93.0	95.0	21
	1130	15	7	8	0.875	0.550	2.0	93.0	95.0	28
	1400	30	4	6	0.667	0.550	2.0	93.0	95.0	8
	1630	30	11	15	0.733	0.550	2.0	93.0	95.0	22
	2110	15	11	8	1.375	0.550	2.0	93.0	95.0	44
16-Sep	0	20	31	30	1.033	0.550	2.0	93.0	95.0	93
	1040	20	11	12	0.917	0.550	2.0	93.0	95.0	33
	1620	30	2	2	1.000	0.550	2.0	93.0	95.0	4
	2125	15	11	10	1.100	0.550	2.0	93.0	95.0	44
17-Sep	0	15	17	7	2.429	0.550	2.0	93.0	95.0	68
	300	15	8	5	1.600	0.500	2.0	93.0	95.0	32
	630	15	9	4	2.250	0.500	2.0	93.0	95.0	36
	1030	15	11	10	1.100	0.500	2.0	93.0	95.0	44
	1700	30	5	3	1.667	0.500	2.0	93.0	95.0	10
	2100	30	28	22	1.273	0.500	2.0	93.0	95.0	56
18-Sep	0	20	17	14	1.214	0.500	2.0	93.0	95.0	51
	305	15	13	11	1.182	0.500	2.0	93.0	95.0	52
	645	15	8	6	1.333	0.500	2.0	93.0	95.0	32
	1110	30	3	2	1.500	0.500	2.0	93.0	95.0	6
	1615	20	0	0	---	0.500	2.0	93.0	95.0	0
	2100	30	30	23	1.304	0.500	2.0	93.0	95.0	60
19-Sep	10	20	24	14	1.714	0.500	2.0	93.0	95.0	72
	310	20	33	28	1.179	0.450	2.0	93.0	95.0	99
	630	20	14	11	1.273	0.450	2.0	93.0	95.0	42
	1105	25	5	4	1.250	0.450	2.0	93.0	95.0	12
	1610	15	8	6	1.333	0.450	2.0	93.0	95.0	32
	2110	20	21	13	1.615	0.450	2.0	93.0	95.0	63

- continued -

Date	Time Start	Duration (min.)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
20-Sep	15	15	7	6	1.167	0.450	2.0	93.0	95.0	28
	300	20	10	8	1.250	0.450	2.0	93.0	95.0	30
	645	15	4	3	1.333	0.450	2.0	93.0	95.0	16
	1100	30	4	4	1.000	0.450	2.0	93.0	95.0	8
	1605	15	3	2	1.500	0.450	2.0	93.0	95.0	12
	2105	15	13	8	1.625	0.450	2.0	93.0	95.0	52
21-Sep	3	20	16	14	1.143	0.450	2.0	93.0	95.0	48
	300	15	11	6	1.833	0.450	2.0	93.0	95.0	44
	645	15	9	6	1.500	0.450	2.0	93.0	95.0	36
	1120	20	8	7	1.143	0.450	2.0	93.0	95.0	24
	1600	20	4	4	1.000	0.450	2.0	93.0	95.0	12
	2130	20	21	18	1.167	0.450	2.0	93.0	95.0	63
22-Sep	5	20	10	8	1.250	0.400	2.0	93.0	95.0	30
	305	15	8	7	1.143	0.400	2.0	93.0	95.0	32
	640	20	6	5	1.200	0.400	2.0	93.0	95.0	18
	1100	30	2	2	1.000	0.400	2.0	93.0	95.0	4
	1600	25	5	3	1.667	0.400	2.0	93.0	95.0	12
	2105	15	21	16	1.313	0.400	2.0	93.0	95.0	84
23-Sep	7	20	13	10	1.300	0.400	2.0	93.0	95.0	39
	310	15	19	21	0.905	0.400	2.0	93.0	95.0	76
	640	20	10	16	0.625	0.450	2.0	93.0	95.0	30
	1110	20	1	1	1.000	0.450	2.0	93.0	95.0	3
	1610	20	0	0	---	0.450	2.0	93.0	95.0	0
	2100	25	10	13	0.769	0.450	2.0	93.0	95.0	24
	2321	15	11	13	0.846	0.450	2.0	93.0	95.0	44
Total	252	5,077	4,072	3,856	1.056					

Appendix D. Age composition estimates of Sheenjek River fall chum salmon, 1974 - 2001.

Year [a]	Sample (readable)	Age 3	Age 4	Age 5	Age 6	Estimated Escapement
1974 [b]	136	0.669	0.301	0.029	0.000	89,966
1975 [b]	197	0.036	0.949	0.015	0.000	173,371
1976 [b]	118	0.017	0.441	0.542	0.000	26,354
1977 [b]	178	0.112	0.725	0.163	0.000	45,544
1978 [b]	190	0.079	0.821	0.100	0.000	32,449
1979	none					91,372
1980	none					28,933
1981 [c]	340	0.029	0.850	0.118	0.003	74,560
1982 [c]	109	0.030	0.470	0.490	0.010	31,421
1983 [c]	108	0.065	0.870	0.065	0.000	49,392
1984 [d]	297	0.101	0.805	0.094	0.000	27,130
1985 [d]	508	0.012	0.927	0.061	0.000	152,768
1986 [d]	442	0.081	0.412	0.500	0.007	84,207
1987 [d]	431	0.021	0.898	0.072	0.009	153,267
1988 [d, e]	120	0.025	0.683	0.292	0.000	45,206
1989 [d, e]	154	0.052	0.766	0.169	0.013	99,116
1990 [d]	143	0.028	0.706	0.252	0.014	77,750
1991 [d]	147	0.000	0.592	0.395	0.014	86,496
1992 [d]	134	0.000	0.179	0.806	0.015	78,808
1993 [d, e]	192	0.005	0.640	0.339	0.016	42,922
1994 [d]	173	0.012	0.561	0.405	0.023	153,000
1995 [d]	166	0.012	0.542	0.386	0.060	235,000
1996 [d]	191	0.016	0.330	0.618	0.037	248,000
1997	none					80,423
1998	only 3 fish					33,058
1999	none					14,229
2000	none					30,084
2001 [f]	71	0.000	0.352	0.648	0.000	53,932
Avg 1974-01		0.064	0.628	0.298	0.010	83,527
Avg 1974-85		0.115	0.716	0.168	0.001	68,605
Avg 1986-01		0.021	0.555	0.407	0.017	94,719
Even Years		0.096	0.519	0.375	0.010	70,455
Odd years		0.031	0.737	0.221	0.010	96,599

[a] Age determination from scales for years 1974-1985; and from vertebrae 1986-2001.
[b] Carcass samples from spawning grounds.
[c] Escapement samples taken with 5-7/8 inch gillnets at rkm 10
[d] Escapement samples taken with beach seine rkm 5-20.
[e] Escapement samples were predominantly taken late in run.
[f] 68 carcass samples and 5 beach seine samples collected between rkm 11 and 25.

Appendix E. Sonar-estimated escapement of fall chum salmon in the Sheenjek River, 1986-2001.

Date	1986	1987	1988	1989	1990	1991	1992	1993	Date
30-Jul									30-Jul
31-Jul									31-Jul
01-Aug									01-Aug
02-Aug									02-Aug
03-Aug									03-Aug
04-Aug									04-Aug
05-Aug									05-Aug
06-Aug									06-Aug
07-Aug									07-Aug
08-Aug								45	08-Aug
09-Aug	‖	‖	‖	‖	‖	255	136	95	09-Aug
10-Aug	‖	‖	‖	‖	‖	301	172	256	10-Aug
11-Aug	‖	‖	‖	‖	‖	179	102	143	11-Aug
12-Aug	‖	‖	‖	‖	‖	173	272	217	12-Aug
13-Aug	‖	‖	‖	‖	‖	178	216	227	13-Aug
14-Aug	‖	‖	‖	‖	‖	282	337	175	14-Aug
15-Aug	‖	‖	‖	‖	‖	551	670	291	15-Aug
16-Aug	1,010 [a]	‖	‖	‖	‖	521	571	346	16-Aug
17-Aug	68	‖	‖	‖	‖	418	1,100	367	17-Aug
18-Aug	345	‖	‖	‖	‖	591	1,570	245	18-Aug
19-Aug	769	‖	‖	‖	‖	668	1,003	316	19-Aug
20-Aug	1,576	‖	4,340 [a]	‖	‖	446	2,347	466	20-Aug
21-Aug	1,178	‖	961	‖	15,550 [a]	1,012	1,767	117	21-Aug
22-Aug	3,023	‖	1,027	‖	1,718	1,990	1,353	124	22-Aug
23-Aug	1,177	‖	884	20,000 [b]	1,825	1,754	1,189	157	23-Aug
24-Aug	1,733	13,181 [a]	744	2,685	1,940	889	1,390	177	24-Aug
25-Aug	5,374	168	810	2,321	1,620	1,591	1,147	156	25-Aug
26-Aug	4,875	314	1,528	1,392	1,047	1,684	893	248	26-Aug
27-Aug	3,712	795	1,203	1,129	1,055	1,846	1,032	208	27-Aug
28-Aug	4,633	951	1,087	1,009	1,337	1,508	778	296	28-Aug
29-Aug	5,150	993	756	733	1,605	1,196	463	369	29-Aug
30-Aug	4,336	1,400	914	1,265	881	905	943	647	30-Aug
31-Aug	3,889	1,639	1,512	933	1,609	1,676	840	999	31-Aug
01-Sep	2,101	3,937	1,548	1,598	1,570	2,164	835	1,045	01-Sep
02-Sep	2,230	3,295	1,492	1,759	1,695	1,749	830	632	02-Sep
03-Sep	1,819	7,585	2,203	1,739	1,002	1,808	1,217	2,092	03-Sep
04-Sep	2,406	11,386	1,991	2,819	1,159	2,026	2,023	2,557	04-Sep
05-Sep	1,645	10,962	1,309	2,571	955	2,476	2,093	2,097	05-Sep
06-Sep	2,265	5,439	1,286	2,936	1,339	1,241	3,154	1,673	06-Sep
07-Sep	2,849	10,182	1,542	4,210	1,259	3,490	4,200	2,414	07-Sep
08-Sep	2,760	11,122	1,297	3,581	1,071	2,680	3,092	2,720	08-Sep
09-Sep	2,469	8,487	1,443	4,858	1,411	4,201	4,274	1,300	09-Sep
10-Sep	1,131	5,561	1,073	4,051	854	3,541	3,209	580	10-Sep
11-Sep	1,461	4,882	696	3,551	1,746	2,236	3,815	401	11-Sep
12-Sep	2,500	6,294	340	3,414	1,726	3,136	3,816	465	12-Sep
13-Sep	1,751	5,831	673	3,227	1,803	3,139	4,047	373	13-Sep
14-Sep	2,866	4,485	703	2,797	2,196	3,145	6,347	351	14-Sep
15-Sep	2,290	3,963	1,037	2,027	2,065	4,823	4,289	197	15-Sep
16-Sep	1,099	4,118	1,275	2,498	2,175	4,240	3,232	407	16-Sep
17-Sep	1,488	4,763	1,943	3,035	2,867	2,729	2,473	1,176	17-Sep
18-Sep	1,481	4,326	1,637	2,090	1,909	2,734	2,158	1,053	18-Sep
19-Sep	1,548	2,635	1,209	1,839	2,020	3,119	2,406	1,359	19-Sep
20-Sep	679	3,160	1,151	2,321	2,372	3,319	1,007	1,192	20-Sep
21-Sep	704	3,223	716	1,273	2,444	2,461	**early**	3,382	21-Sep
22-Sep	577	1,988	743	1,384	2,667	1,924	**freezeup**	2,005	22-Sep
23-Sep	587	2,878	583	2,434	1,848	2,071		1,803	23-Sep
24-Sep	653	3,324	522	2,965	1,819	1,430		1,655	24-Sep
25-Sep			365	2,672	1,923			1,083	25-Sep
26-Sep			344		1,392			1,158	26-Sep
27-Sep			319		1,478			568	27-Sep
28-Sep					798			497	28-Sep
29-Sep									29-Sep
30-Sep									30-Sep
Totals	84,207	153,267	45,206	99,116	77,750	86,496	78,808	42,922	

-continued-

Appendix E. (page 2of 2)

Date	1994	1995	1996	1997	1998	1999	2000	2001	Date
30-Jul			670						30-Jul
31-Jul			706						31-Jul
01-Aug			541						01-Aug
02-Aug			793						02-Aug
03-Aug			685						03-Aug
04-Aug			577						04-Aug
05-Aug			469						05-Aug
06-Aug			724						06-Aug
07-Aug	146		918						07-Aug
08-Aug	75		1,554				19		08-Aug
09-Aug	112		930	114			74		09-Aug
10-Aug	38	964	963	248		32	153		10-Aug
11-Aug	214	882	479	332		60	160	49	11-Aug
12-Aug	243	468	315	306		37	186	78	12-Aug
13-Aug	328	344	315	421		76	237	79	13-Aug
14-Aug	215	359	903	473		41	179	73	14-Aug
15-Aug	261	1,045	762	420		43	205	121	15-Aug
16-Aug	333	863	753	534		70	342	126	16-Aug
17-Aug	378	891	602	341	56	86	286	90	17-Aug
18-Aug	524	1,172	724	307	98	101	487	567	18-Aug
19-Aug	497	1,656	753	430	63	290	570	948	19-Aug
20-Aug	257	2,105	1,662	354	35	217	407	584	20-Aug
21-Aug	594	2,632	1,594	291	23	224	333	313	21-Aug
22-Aug	642	2,677	1,178	506	27	59	318	507	22-Aug
23-Aug	1,673	3,525	2,472	688	58	138	341	689	23-Aug
24-Aug	1,035	6,301	11,459	996	43	279	319	884	24-Aug
25-Aug	848	4,745	9,966	1,059	95	730	386	1050	25-Aug
26-Aug	791	4,445	7,034	1,179	93	395	499	967	26-Aug
27-Aug	2,934	6,358	4,545	2,329	59	645	597	964	27-Aug
28-Aug	3,677	4,839	5,778	2,320	114	676	512	892	28-Aug
29-Aug	4,082	6,842	11,457	1,884	47	410	552	995	29-Aug
30-Aug	4,487	7,436	12,249	2,067	143	247	755	970	30-Aug
31-Aug	5,472	6,517	12,522	2,250	274	207	593	985	31-Aug
01-Sep	6,912	8,782	7,597	2,433	248	115	662	1481	01-Sep
02-Sep	7,196	5,856	6,326	2,616	234	164	785	1925	02-Sep
03-Sep	5,918	7,049	6,457	2,799	117	203	726	1374	03-Sep
04-Sep	3,666	4,185	5,113	3,404	301	327	1,023	1235	04-Sep
05-Sep	2,832	4,525	5,214	3,352	118	186	961	1968	05-Sep
06-Sep	2,952	6,084	5,763	2,761	277	422	599	2574	06-Sep
07-Sep	3,928	6,852	7,871	2,904	254	416	1,073	1537	07-Sep
08-Sep	3,587	6,318	6,333	4,842	590	742	1,518	3378	08-Sep
09-Sep	2,598	5,403	3,718	2,849	412	555	785	3098	09-Sep
10-Sep	2,341	4,957	4,364	1,995	416	594	856	2575	10-Sep
11-Sep	3,382	6,758	7,409	1,971	594	514	641	3286	11-Sep
12-Sep	2,796	6,597	4,735	2,323	722	470	710	3536	12-Sep
13-Sep	3,066	6,561	6,974	3,602	1,348	589	11,235 [c]	2679	13-Sep
14-Sep	3,294	6,184	5,944	2,983	1,120	343	‖	2130	14-Sep
15-Sep	3,522	10,161	5,406	3,294	1,201	309	‖	1833	15-Sep
16-Sep	4,764	9,026	7,871	2,376	2,850	303	‖	900	16-Sep
17-Sep	4,413	9,097	11,181	2,379	2,492	430	‖	1482	17-Sep
18-Sep	3,249	8,525	7,850	2,101	2,607	542	‖	430	18-Sep
19-Sep	6,500	8,468	10,474	2,096	2,526	294	‖	1110	19-Sep
20-Sep	7,583	8,065	6,755	1,613	2,692	290	‖	813	20-Sep
21-Sep	5,287	9,590	6,170	1,612	2,756	389	‖	1017	21-Sep
22-Sep	6,520	5,943	3,924	2,249	2,120	533	‖	1018	22-Sep
23-Sep	5,153	6,518	4,486	2,020	1,594	436	‖	622	23-Sep
24-Sep	4,523	6,432	1,902		811		‖		24-Sep
25-Sep	3,607	6,853			529		‖		25-Sep
26-Sep	3,458				430				26-Sep
27-Sep	3,600				487				27-Sep
28-Sep	4,062				736				28-Sep
29-Sep					587				29-Sep
30-Sep					661				30-Sep
Totals	150,565	241,855	246,889	80,423	33,058	14,229	30,084	53,932	

[a] Early portion of Sheenjek River fall chum salmon run estimated from run timing and entry pattern observed in the Chandalar River (Barton 1995).

[b] Early portion of Sheenjek River fall chum salmon run estimated from aerial survey (Barton 1995).

[c] Late portion of Sheenjek River fall chum salmon run estimated from average run time data observed in the Sheenjek River, 1986 - 1999 (Barton 2002).

Appendix F. Cumulative proportion of Sheenjek River sonar counts, 1986-2001.

Date	1986	1987	1988	1989	1990	1991	1992	1993	Date
30-Jul									30-Jul
31-Jul									31-Jul
01-Aug									01-Aug
02-Aug									02-Aug
03-Aug									03-Aug
04-Aug									04-Aug
05-Aug									05-Aug
06-Aug									06-Aug
07-Aug									07-Aug
08-Aug								0.00	08-Aug
09-Aug	||	||	||	||	||	0.00	0.00	0.00	09-Aug
10-Aug	||	||	||	||	||	0.00	0.00	0.01	10-Aug
11-Aug	||	||	||	||	||	0.01	0.01	0.01	11-Aug
12-Aug	||	||	||	||	||	0.01	0.01	0.02	12-Aug
13-Aug	||	||	||	||	||	0.01	0.01	0.02	13-Aug
14-Aug	||	||	||	||	||	0.01	0.02	0.03	14-Aug
15-Aug	||	||	||	||	||	0.02	0.02	0.03	15-Aug
16-Aug	0.01 [a]	||	||	||	||	0.03	0.03	0.04	16-Aug
17-Aug	0.01	||	||	||	||	0.03	0.05	0.05	17-Aug
18-Aug	0.02	||	||	||	||	0.04	0.07	0.06	18-Aug
19-Aug	0.03	||	||	||	||	0.04	0.08	0.06	19-Aug
20-Aug	0.04	||	0.10 [a]	||	||	0.05	0.11	0.07	20-Aug
21-Aug	0.06	||	0.12	||	0.20 [a]	0.06	0.13	0.08	21-Aug
22-Aug	0.09	||	0.14	||	0.22	0.08	0.15	0.08	22-Aug
23-Aug	0.11	||	0.16	0.20 [b]	0.25	0.10	0.16	0.08	23-Aug
24-Aug	0.13	0.09 [a]	0.18	0.23	0.27	0.12	0.18	0.09	24-Aug
25-Aug	0.19	0.09	0.19	0.25	0.29	0.13	0.19	0.09	25-Aug
26-Aug	0.25 [c]	0.09	0.23	0.27	0.30	0.15	0.21	0.10	26-Aug
27-Aug	0.29	0.09	0.25	0.28	0.32	0.17	0.22	0.10	27-Aug
28-Aug	0.35	0.10	0.28	0.29	0.34	0.19	0.23	0.11	28-Aug
29-Aug	0.41	0.11	0.30	0.30	0.36	0.21	0.23	0.12	29-Aug
30-Aug	0.46	0.12	0.32	0.31	0.37	0.22	0.25	0.13	30-Aug
31-Aug	0.51 [d]	0.13	0.35	0.32	0.39	0.24	0.26	0.16	31-Aug
01-Sep	0.53	0.15	0.38	0.33	0.41	0.26	0.27	0.18	01-Sep
02-Sep	0.56	0.17	0.42	0.35	0.43	0.28	0.28	0.19	02-Sep
03-Sep	0.58	0.22	0.46	0.37	0.44	0.30	0.29	0.24	03-Sep
04-Sep	0.61	0.30	0.51	0.40	0.46	0.32	0.32	0.30	04-Sep
05-Sep	0.63	0.37	0.54	0.42	0.47	0.35	0.35	0.35	05-Sep
06-Sep	0.66	0.40	0.57	0.45	0.49	0.37	0.39	0.39	06-Sep
07-Sep	0.69	0.47	0.60	0.50	0.50	0.41	0.44	0.45	07-Sep
08-Sep	0.72	0.54	0.63	0.53	0.52	0.44	0.48	0.51	08-Sep
09-Sep	0.75	0.60	0.66	0.58	0.54	0.49	0.53	0.54	09-Sep
10-Sep	0.77	0.64	0.68	0.62	0.55	0.53	0.57	0.55	10-Sep
11-Sep	0.78	0.67	0.70	0.66	0.57	0.55	0.62	0.56	11-Sep
12-Sep	0.81	0.71	0.71	0.69	0.59	0.59	0.67	0.57	12-Sep
13-Sep	0.83	0.75	0.72	0.72	0.61	0.63	0.72	0.58	13-Sep
14-Sep	0.87	0.78	0.74	0.75	0.64	0.66	0.80	0.59	14-Sep
15-Sep	0.90	0.80	0.76	0.77	0.67	0.72	0.86	0.60	15-Sep
16-Sep	0.91	0.83	0.79	0.80	0.70	0.77	0.90	0.61	16-Sep
17-Sep	0.93	0.86	0.83	0.83	0.73	0.80	0.93	0.63	17-Sep
18-Sep	0.94	0.89	0.87	0.85	0.76	0.83	0.96	0.66	18-Sep
19-Sep	0.96	0.90	0.90	0.87	0.78	0.87	0.99	0.69	19-Sep
20-Sep	0.97	0.93	0.92	0.89	0.82	0.91	1.00	0.72	20-Sep
21-Sep	0.98	0.95	0.94	0.90	0.85	0.93		0.80	21-Sep
22-Sep	0.99	0.96	0.95	0.92	0.88	0.96		0.84	22-Sep
23-Sep	0.99	0.98	0.97	0.94	0.90	0.98		0.88	23-Sep
24-Sep	1.00	1.00	0.98	0.97	0.93	1.00		0.92	24-Sep
25-Sep			0.99	1.00	0.95			0.95	25-Sep
26-Sep			0.99		0.97			0.98	26-Sep
27-Sep			1.00		0.99			0.99	27-Sep
28-Sep					1.00			1.00	28-Sep
29-Sep									29-Sep
30-Sep									30-Sep

-continued-

Appendix F. (page 2 of 2)

Date	1994	1995	1996	1997	1998	1999	2000	2001	Date	1986-99 average
30-Jul			0.00						30-Jul	
31-Jul			0.01						31-Jul	
01-Aug			0.01						01-Aug	
02-Aug			0.01						02-Aug	
03-Aug			0.01						03-Aug	
04-Aug			0.02						04-Aug	
05-Aug			0.02						05-Aug	
06-Aug			0.02						06-Aug	
07-Aug	0.00		0.02				0.00		07-Aug	
08-Aug	0.00	0.00	0.03	0.00	0.00		0.00		08-Aug	
09-Aug	0.00	0.00	0.03	0.00	0.00		0.00		09-Aug	
10-Aug	0.00	0.00	0.04	0.00	0.00	0.00	0.01		10-Aug	
11-Aug	0.00	0.01	0.04	0.01	0.00	0.01	0.01	0.00	11-Aug	
12-Aug	0.01	0.01	0.04	0.01	0.00	0.01	0.02	0.00	12-Aug	
13-Aug	0.01	0.01	0.04	0.02	0.00	0.01	0.03	0.00	13-Aug	
14-Aug	0.01	0.01	0.05	0.02	0.00	0.02	0.03	0.01	14-Aug	
15-Aug	0.01	0.02	0.05	0.03	0.00	0.02	0.04	0.01	15-Aug	
16-Aug	0.01	0.02	0.05	0.04	0.00	0.03	0.05	0.01	16-Aug	
17-Aug	0.02	0.02	0.06	0.04	0.00	0.03	0.06	0.01	17-Aug	
18-Aug	0.02	0.03	0.06	0.04	0.00	0.04	0.08	0.02	18-Aug	
19-Aug	0.02	0.04	0.06	0.05	0.01	0.06	0.10	0.04	19-Aug	
20-Aug	0.02	0.04	0.07	0.05	0.01	0.07	0.11	0.05	20-Aug	
21-Aug	0.03	0.06	0.07	0.06	0.01	0.09	0.12	0.06	21-Aug	
22-Aug	0.03	0.07	0.08	0.06	0.01	0.09	0.13	0.07	22-Aug	
23-Aug	0.04	0.08	0.09	0.07	0.01	0.10	0.14	0.08	23-Aug	
24-Aug	0.05	0.11	0.14	0.08	0.01	0.12	0.15	0.09	24-Aug	0.12
25-Aug	0.06	0.13	0.18	0.10	0.02	0.17	0.17	0.11	25-Aug	0.15
26-Aug	0.06	0.15	0.20	0.11	0.02	0.20	0.18	0.13	26-Aug	0.16
27-Aug	0.08	0.17	0.22	0.14	0.02	0.25	0.20	0.15	27-Aug	0.19
28-Aug	0.11	0.19	0.25	0.17	0.02	0.30	0.22	0.17	28-Aug	0.21
29-Aug	0.13	0.22	0.29	0.19	0.02	0.32	0.24	0.18	29-Aug	0.23
30-Aug	0.16	0.25	0.34	0.22	0.03	0.34	0.26	0.20	30-Aug	0.25
31-Aug	0.20	0.28	0.39	0.25	0.04	0.36	0.28	0.22	31-Aug	0.26
01-Sep	0.24	0.31	0.42	0.28	0.04	0.36	0.30	0.25	01-Sep	0.30
02-Sep	0.29	0.34	0.45	0.31	0.05	0.38	0.33	0.28	02-Sep	0.32
03-Sep	0.33	0.37	0.48	0.34	0.06	0.39	0.36	0.31	03-Sep	0.35
04-Sep	0.36	0.38	0.50	0.39	0.06	0.41	0.39	0.33	04-Sep	0.38
05-Sep	0.37	0.40	0.52	0.43	0.07	0.43	0.42	0.37	05-Sep	0.41
06-Sep	0.39	0.43	0.54	0.46	0.08	0.46	0.44	0.42	06-Sep	0.43
07-Sep	0.42	0.46	0.57	0.50	0.08	0.48	0.48	0.45	07-Sep	0.47
08-Sep	0.44	0.48	0.60	0.56	0.10	0.54	0.53	0.51	08-Sep	0.51
09-Sep	0.46	0.50	0.61	0.59	0.11	0.58	0.55	0.57	09-Sep	0.54
10-Sep	0.48	0.53	0.63	0.62	0.13	0.62	0.58	0.61	10-Sep	0.56
11-Sep	0.50	0.55	0.66	0.64	0.14	0.65	0.60	0.67	11-Sep	0.59
12-Sep	0.52	0.58	0.68	0.67	0.17	0.69	0.63	0.74	12-Sep	0.62
13-Sep	0.54	0.61	0.71	0.72	0.21	0.73	0.37 [f]	0.79	13-Sep	0.65
14-Sep	0.56	0.63	0.73	0.75	0.24	0.75		0.83	14-Sep	0.68
15-Sep	0.58	0.68	0.75	0.80	0.28	0.77		0.86	15-Sep	0.71
16-Sep	0.62	0.71	0.79	0.83	0.36	0.80		0.88	16-Sep	0.74
17-Sep	0.64	0.75	0.83	0.85	0.44	0.83		0.91	17-Sep	0.78
18-Sep	0.67	0.79	0.86	0.88	0.52	0.86		0.92	18-Sep	0.81
19-Sep	0.71	0.82	0.91	0.91	0.59	0.88		0.94	19-Sep	0.84
20-Sep	0.76	0.85	0.93	0.93	0.68	0.90		0.95	20-Sep	0.87
21-Sep	0.79	0.89	0.96	0.95	0.76	0.93		0.97	21-Sep	0.89
22-Sep	0.84	0.92	0.97	0.97	0.82	0.97		0.99	22-Sep	0.92
23-Sep	0.87	0.95	0.99	1.00	0.87	1.00		1.00	23-Sep	0.95
24-Sep	0.90	0.97	1.00		0.90				24-Sep	0.96
25-Sep	0.93	1.00			0.91				25-Sep	0.96
26-Sep	0.95				0.93				26-Sep	
27-Sep	0.97				0.94				27-Sep	
28-Sep	1.00				0.96				28-Sep	
29-Sep					0.98				29-Sep	
30-Sep					1.00				30-Sep	

[a] Early portion of Sheenjek River fall chum salmon run estimated from run timing and entry pattern observed in the Chandalar River (Barton 1995).

[b] Early portion of Sheenjek River fall chum salmon run estimated from aerial survey (Barton 1995).

[c] Interquartile range and median day of passage ([d]) are shown for each year.

[f] Late portion of Sheenjek River fall chum salmon run estimated from average run time data observed in the Sheenjek River, 1986 - 1999 (Barton 2002).