SONAR ENUMERATION OF FALL CHUM SALMON ON THE SHEENJEK RIVER, 1993

By

Louis H. Barton

Regional Information Report[1] No. 3A94-24

Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518-1599

October 1994

---

[1]The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports.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 and 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 Commercial Fisheries Management and Development Division.

AUTHOR

Louis H. Barton is the fall chum and coho salmon Yukon Area Research Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, 1300 College Road, Fairbanks, AK 99701.

ACKNOWLEDGEMENTS

Special thanks are extended to those who participated in this project and who are largely responsible for its success: J. Buchanan, and K. Boeck. Critical review of this report was provided by L. Buklis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

A single Bendix side-scanning sonar fish counter was used to estimate fall chum salmon escapement in the Sheenjek River, a second order tributary of the Yukon River in the Porcupine River drainage. The escapement estimate was 42,922 fall chum salmon for the period 8 August through 28 September 1993. The 1993 run was distinctly bimodal with peaks in passage observed during the first and third week of September. The minimum biological escapement goal of 64,000 chum salmon was not achieved in 1993.

Variations in water levels and velocities, together with migration behavior of upstream migrant Sheenjek River chum salmon, affected the ability of the hydroacoustic equipment to accurately estimate salmon passage. However, this factor was addressed by adjusting fish passage estimates as necessary, based upon daily calibrations of the hydroacoustic equipment. Sonar counting range was considered adequate for the detection of the majority of fish passing the sonar site since most were nearshore oriented. Daily upstream migration was primarily confined to periods of darkness with the period of greatest movement occurring on the average between 2400 and 0600 hours (37%).

Based upon vertebrae collections, age 0.3 and age 0.4 chum salmon comprised 98% of the fish sampled. Age 0.3 fish dominated at 64% while age 0.4 fish represented 34%. Less than 1% of the fish sampled were age 0.2.

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

INTRODUCTION

Although five species of Pacific salmon *Oncorhynchus* are found in the Yukon River drainage, chum salmon *O. keta* are the most abundant and constitute the greatest inriver harvest. This species occurs in two distinct runs in the Yukon River; a summer (early) run and a fall (late) run. Fall chum salmon are larger, spawn later, and are less abundant than their summer chum counterpart. They primarily spawn in the upper portion of the drainage in streams which are spring fed, usually remaining ice-free during the winter. Major fall chum salmon spawning areas include the Tanana, Chandalar, and Porcupine River systems, as well as various streams in Yukon Territory, Canada, including the mainstem Yukon River (Figure 1).

Fall chum salmon are in great demand commercially with harvest 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, Y.T., 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. In some more recent years estimated drainage-wide subsistence use has rivaled or exceeded the commercial harvest.

Although the Alaskan commercial fishery for Yukon River fall chum salmon developed in the early 1960's, annual harvest remained relatively low through the early to mid-1970's (JTC 1993). Estimated total inriver utilization (U.S. and Canada commercial and subsistence) of Yukon River fall chum salmon was below 300,000 fish per year prior to the mid 1970's (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 in order 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, while in 1992 commercial fishing in Alaska was restricted to only a portion of the Tanana River during the fall season. Although no commercial fishing was permitted during the fall season in 1993, that year marked the first in State history that a total river closure to subsistence fishing occurred in the Yukon River during the latter portion of the fall season. The fishery closure was in response to the extremely weak fall chum salmon return in that year.

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 enumeration studies were sporadic and limited to only two streams; the Fishing Branch River (Porcupine River drainage) and Delta River (Tanana River drainage). Comprehensive escapement enumeration studies have intensified on major spawning tributaries throughout the drainage during the past decade.

One of the most intensely monitored fall chum spawning streams has been the Sheenjek River. Although observations on escapement date back to 1960 when the USFWS reported chum salmon spawning in September, the best database consists of the 20 year period 1974-1993. Prior to 1981 escapement observations were limited to aerial surveys flown during periods of anticipated peak spawning (Barton 1984a), while hydroacoustic techniques have been used annually since 1981 by the Alaska Department of Fish and Game (ADF&G) to estimate escapement of various portions of the run (Barton 1982, 1983, 1984b, 1985, 1986, 1987, 1988, *In press*). During the latter period, dates of project operation varied annually due to fiscal constraints, resulting in a small portion of annual returns to this river not being monitored. Thus, historic sonar-estimated escapements to this stream should be considered conservative, particularly prior to 1990. This report presents results of studies conducted in 1993.

Study Area

The Sheenjek River, a second order tributary of the Yukon River lying above the Arctic Circle, 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). The project site is located approximately 10 km upstream. 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; 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 Sheenjek River has demonstrated itself to be the single most important documented producer of fall chum spawners in the Yukon River drainage in recent years (Barton *In press*). At present, the minimum biological escapement goal (BEG) for this stream is 64,000 fall chum salmon as estimated hydroacoustically.

Objectives

Overall objectives for the 1993 Sheenjek River study were to determine the timing and magnitude of fall chum salmon escapement and to collect age and sex information on sampled portions of the run. To accomplish this, the following specific objectives were identified:

1. Estimate timing and magnitude of chum salmon escapement using hydroacoustic techniques;

2. Estimate age and sex composition of the spawning population from sampled portions of the escapement;

3. Support ongoing genetic stock identification (GSI) studies by sample collection; and,

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

METHODS

Hydroacoustic Equipment and Site Selection

A 1978-model side-scanning sonar fish counter developed by the Hydrodynamics Division of Bendix Corporation was used to estimate chum salmon abundance in the Sheenjek River in 1993.[2] Physical location of counting operations in 1993 was based upon the best of several river bottom profiles made shortly after arrival at the project site using a recording depth sounder and approximated the same location as in previous years (Figure 3). Once the most favorable location had been identified a more detailed profile of the river's bottom was obtained by stretching a rope across the river and measuring water depth with a pole every 3 m.

Installation and operational procedures of the 1978-model counter varied little from other model Bendix counters used in previous years (Bendix Corporation 1978). The modular aluminum substrate designed for used with Bendix counters was not used due to the relatively smooth river bottom and the salmon avoidance problems observed when the substrate was used in past years (Barton 1985). The transducer was aimed perpendicular to the water current and deployed as far from shore as possible (generally in 0.5 to 1 m of water) in an attempt to maintain a minimum surface water velocity at the point of deployment of approximately 30-45 cm/s.

An artificial target (250 ml, air tight, weighted plastic bottle attached to nylon twine) was allowed to drift downstream along the bottom through each electronic sector of the counting range to determine if the transducer was aimed low enough so that salmon could not travel beneath the insonified water column. When the transducer was properly aimed, the artificial target appeared as a vertical deflection on an oscilloscope screen when it transected the sonar beam and simultaneously registered a count on the counter, unless the current was too swift to allow the artificial target to remain in the beam long enough to register a count.

As in previous years, a fish lead was constructed to shore from the deployed transducer to prevent upstream salmon passage inshore of the transducer. Fish leads were constructed using 5 x 10 cm fencing and 2.5 m metal "T" stakes. Fish leads were constructed so as to include the nearshore "dead range" of the sonar beam. A 5 m aluminum counting tower was also deployed near the transducer to facilitate visual and electronic calibrations when water conditions permitted. The transducer was periodically relocated and reaimed as necessitated by a rise or fall in river water level. On such occasions, the inshore fish lead and counting tower were adjusted appropriately.

---

[2]Use of company's name does not constitute endorsement.

Sonar Calibrations and Count Adjustments

Daily comparisons were made between oscilloscope observations and counter output to determine if the number of fish registered by the sonar counter equaled the number of fish passing through the sonar beam. A minimum of seven 15- to 30-minute calibrations were scheduled daily as follows: 0001-0030 h; 0301-0330 h; 0601-0630 h; 1101-1130 h; 1601-1630 h; 2101-2130 h; and 2301-2330 h. Less calibration effort was placed on periods of the day when passage rates were lowest. Duration of a calibration was based upon the following criteria:

1) Stop calibration at 15 min if less than 10 fish are observed on the oscilloscope.

2) Extend 15-min calibration to 30 min if 10 or more fish are observed on the oscilloscope in the first 15 min.

Hourly blocks of a day's count included in an adjustment (adjustment period) were defined by the time between individual calibrations. An associated adjustment factor (A), specific to each adjustment period (i) was calculated as follows:

$$A_i = \frac{OC}{SC} \quad (1)$$

where:

OC = oscilloscope count; and,
SC = unadjusted sonar count.

Adjustment factors were applied to the unadjusted sonar counts for each hour within an adjustment period. The resulting corrected sonar counts for each hour within a day were summed, yielding the estimated daily passage (D) of fall chum salmon, and is represented by

$$D = \sum (A_i \times SC_i) \quad (2)$$

Additional sonar counts caused by fish other than chum salmon were assumed insignificant based upon historic test fishing records collected at the sonar site. Counts registered by the counter as "debris" were deleted and replaced by interpolated values prior to making adjustments. Interpolated values for a given electronic sector were based upon registered counts for that sector in the preceding and following hour.

Over-counting or under-counting was minimized by adjusting the pulse repetition rate (PRR) or ping rate of the counter. Over- and under-counting primarily resulted from changes in fish velocity which was often a function of fluctuations in water level and velocity, photoperiod, or fish densities. Although a few occasions arose (generally in early season) when the counter's 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 if the oscilloscope count exceeded

a rate of 59 per hour and differed by more than 15% from the sonar count. The new ping rate was calculated as: (sonar count / oscilloscope count) x current PRR setting. If salmon 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, but only if the sum of the sonar counts during the day's calibrations exceeded the sum of the oscilloscope counts during the day's calibrations by more than 15%.

Test Fishing and Salmon Sampling

An adult salmon beach seine (30 m long, 66 meshes deep, 6.4 cm stretch measure) was periodically fished approximately 10 km upstream of the sonar site to sample adult salmon for age and sex composition. The sample goal was 200 chum salmon. A small section of spine (3 vertebrae minimum) was removed in an area posterior to the dorsal fin of each fish for subsequent aging. Vertebrae were cleaned, dried, and read with the aid of a dissecting scope. Ages were reported by the European method: number of freshwater annuli, decimal, number of saltwater annuli. Although sex was determined by external examination of most fish, positive sex determination was made by an incision in the belly when necessary.

Small sections of the liver and heart, eye fluid, and a muscle sample removed from the lateral region of each fish between the operculum and dorsal fin, were collected to support ongoing GSI studies. Individual samples were placed into separate vials and stored in liquid nitrogen prior to shipment to Anchorage for subsequent analyses. The GSI sample goal was 100 chum salmon.

Climatological and Hydrological Observations

A water level gauge was installed at the sonar site and monitored daily, with readings made to the nearest centimeter. Surface water temperature was measured daily with a pocket thermometer. Other daily observations included recording the occurrence of precipitation, as well as the estimated wind velocity, direction, and percent cloud cover. All climatological and hydrological observations were recorded at approximately 1800 h, daily.

RESULTS

River and Sonar Counting Conditions

Initial transducer deployment in 1993 approximated the same place on the point bar used in previous years. River bottom at location of the transducer sloped gently from the convex bank (point bar) with a rate of fall of approximately 12.5 cm/m, to the thalweg; a distance of approximately 3/4 of the channel's width on 9 August (Figure 4). River bottom from the

thalweg to the concave bank (cutbank) was steeper and more irregular. Subsequent to the previous season, much of the cutbank shoreline had fractured and fallen into the river, cluttering much of the nearshore zone with fallen trees and other woody vegetation.

The Sheenjek River at the project site experienced large variations in water level in 1993 (Figure 5 and Appendix A). Between 6 August and 28 September minimum and maximum water level differed by 124 cm. River width at the counting location measured approximately 52 m on 9 August. Water level remained fairly stable throughout August. A net drop of approximately 15 cm occurred through the 17th followed by a net rise and subsequent fall of approximately 30 cm and 15 cm respectively, through the end of the month. However, water level rose 112 cm during the first 7 d of September. It receded by that amount over the course of the following three weeks.

Abundance Estimation

The total 1993 Sheenjek River sonar-estimated escapement of chum salmon from 8 August through 28 September was 42,922 fish. This total passage estimate is based upon daily adjustments to sonar counts from 336 oscilloscope calibrations averaging 20.5 min in duration (Appendix B). This approximated 114 h of calibration time or approximately 9% of the total number of hours the sonar counter was functional. Calibrations were weighted to periods of the day when upstream migration was heaviest (Figure 6). For example, an average of 29% of calibration effort occurred between the hours of 0001 to 0600, corresponding to an average fish passage estimate of 34% for the same block of time. Similarly, an average of 14% calibration effort occurred between 1200 and 1800 hours, corresponding to an average fish passage estimate of 17% for that block of time.

Temporal and Spatial Distribution

Entry of Sheenjek River fall chum salmon in 1993 was distinctly bimodal with a first peak observed during the first week of September and a second peak centered around 21 September (Figure 7). Fifteen chum salmon were counted on the first day of operations between 1800 h and midnight. This count was subsequently expanded to only 45 fish based upon the average percent passage of fish for the next 3 days between the hours of 0001-1800 h, indicating that few fish were in the river prior to initiation of the project. Daily chum salmon passage estimates remained extremely low throughout the month of August, averaging only 278 per day. Total passage during this period was approximately 6,700 fish. Between 1 and 9 September daily passage increased to an average of 1,836 fish per day. Approximately 39% of the run (16,530 fish) was estimated passing during this period with a peak count of 2,720 fish on 8 September. Chum salmon daily passage estimates then decreased dramatically during the following seven days (10-16 September), averaging less than 400 per day. However, subsequent to 16 September, daily passage estimates again increased, averaging 1,410 fish per day through the end of the project on 28 September. Approximately 39% of the run (16,931 fish) was also

estimated passing during this second peak. The highest single count occurred on 21 September (3,382). An estimated 497 chum salmon were estimated passing the project site on the last day of counting on 28 September, indicating that some fish were still passing upon termination of the project.

While the affect wind and water levels have upon the migration of Sheenjek River chum salmon is unquantifiable, it is interesting to note that the first peak in passage (centered around the first week in September) coincided with peak water levels and velocities in 1993. Accompanied with this were relatively strong prevailing 3rd quadrant winds ($\approx$ 10-15 knots with gusts to 25 knots). Third quadrant winds flow from the south to southwest; an upstream direction at the Sheenjek River project site. Although water level fell subsequent to the first peak in passage in 1993, i.e., subsequent to 7 September, the second peak in fish passage centered around 21 September also coincided with extremely high winds from the third quadrant. Gusts of up to 35 to 50 knots were estimated on 17 and 21 September.

A diel pattern in migration of Sheenjek River chum salmon has been observed in most years. Upstream migration is heaviest in periods of darkness or suppressed light, with fish moving in greater numbers close to shore. With the ensuing hours of daylight, upstream migration greatly subsides and fish move farther from shore. The temporal pattern of movement observed in 1993 is shown in Figure 8 and Appendix C (see Figure 6 also). On the average, the period of greatest upstream migration occurred between midnight and 0600 hours (34%), followed by the period 1800 hours to midnight (26%). The period of least movement occurred between 1200 and 1800 hours (17%).

Data collected during sonar calibrations were used to adjust the counter's ping rate and to adjust sonar counts. For the season, sonar counts exceeded oscilloscope counts by 54% during these calibration periods. However, during the period 8 August through 17 September when 63% of the run was passed (27,167), sonar counts exceeded oscilloscope counts by only 15% during calibration periods. During the last 10 d of operation between 18 and 28 September, when water levels and associated water velocities dropped, sonar counts exceeded oscilloscope counts by 118% during calibration periods. During this period approximately 37% (15,755 fish) of the season passage estimate was made.

Distance or range of river insonification varied depending upon initial placement and subsequent relocation of the transducer as necessitated by fluctuations in river water level. Consequently, extent of uninsonified zones also varied. The average uninsonified distance in 1993, measured from the cutbank, approximated 17 m. No attempt was made to estimate fish passage in the uninsonified zone, but it is believed to have been relatively small based upon a review of the spatial distribution of fish by electronic sector. An examination of fish passage by electronic sector indicates nearly all upstream migrants passed nearshore along the point bar in 1993 (Figure 9 and Appendix D). Approximately 91% of the fish counted were estimated passing through the first 4 electronic sectors.

Age and Sex Composition

A total of 226 chum salmon (130 males; 96 females), 16 Arctic grayling *Thymallus arcticus signifer*, and 5 sheefish *Stenodus leucichthys nelma* were captured in 55 seine hauls during the period 14 September through 23 September (Table 2). All seine hauls were made along gravel bars between river kilometers (rkm) 4 and 20. A subsample of 201 chum salmon was dominated by age 0.3 fish (64%) (Appendix E). Age 0.4 fish represented 34% of the subsample, followed by age 0.5 fish at 1.6%. Less than 1% was age 0.2. Additionally, tissue samples were collected from 64 of the chum salmon for subsequent GSI analysis.

It should be pointed out that samples were collected throughout a 10 day period toward the latter part of the chum salmon run. Thus, resulting age and sex composition may not be entirely representative of 1993 Sheenjek River escapement.

DISCUSSION

Sonar estimated escapements in the Sheenjek River must be viewed in context with dates of project operation (Tables 3 and 4). During the period 1981-1993 when hydroacoustic techniques were used to monitor fall chum salmon escapement in the Sheenjek River, project ending dates were fairly consistent (excluding 1992), generally occurring during the last week of September. However, initiation of counting varied widely, occurring near the end of August during the years 1981-1985, centered around mid-August from 1986-1990, and in early August from 1991-1993. It is quite evident that a smaller portion of annual escapements was monitored by sonar prior to 1991. However, it should be pointed out that it was from sonar estimated escapements during that period (1981-1990), which provided the foundation upon which the existing BEG ($>64,000$) was established (JTC 1990). Between 1981 and 1990 the sonar project operated for a period of time approximating 26 August through 25 September. Thus, the current Sheenjek River BEG should be viewed as a minimum desired number of chum salmon passing the sonar site subsequent to 25 August. Given this, it is quite apparent that the goal was not achieved in 1993. Only 42,922 chum salmon were estimated to have passed the project site during the operational period of 8 August to 28 September; 39,002 were estimated passing subsequent to 25 August.

The 1993 escapement of chum salmon to the Sheenjek River was likely the poorest on record for this stream, given the length of time the project operated. The project operated 51 days in 1993, whereas the next longest running operations were in 1991 (46 d) and 1992 (42 d). A need exists to examine methods by which former estimates of annual escapement to the Sheenjek River can be expanded to estimates for a standardized time period, or if the earlier estimates will need remain merely as a conservative measure of escapement for those years. Expansion of former data to estimates for a standardized time period would allow for a more accurate evaluation of abundance trends, provide an expanded database from which to derive a BEG for

total spawning abundance, and prove vital to the eventual goal of measuring total returns and stock productivity for this river.

The Sheenjek River escapement monitoring project played a key role in management of the Yukon River fall season in 1993. Timely inseason reporting of daily passage estimates at the project site corroborated other inseason indicators that the 1993 fall chum salmon return was extremely weak, prompting a total closure to subsistence salmon fishing in the Alaskan portion of the Yukon River during the latter portion of the season. Although a weak return of five year-old (age 0.4) chum salmon was anticipated in 1993, based upon the performance of that year class (1988 brood year) in 1992 as age 0.3 fish, the fishery closures in 1993 were in response to an unanticipated poor return throughout the Yukon River drainage of four year-old (age 0.3) chum salmon (ADF&G *In press*). Although the reasons are unknown, failure of the 1989 year class was widespread in 1993, being manifested throughout all of Western Alaska (Buklis 1994).

LITERATURE CITED

ADF&G (Alaska Department of Fish and Game). In press. Annual management report Yukon Area, 1993. Commercial Fisheries Management and Development Division, Anchorage.

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. In Press. Sonar enumeration of fall chum salmon on the Sheenjek Alaska River, 1988-1992. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Juneau.

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.

Buklis, L.S, 1994. Information on the catch and escapement of chum salmon in the Arctic-Yukon-Kuskokwim Region in 1993, with a historical perspective. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Regional Information Report No. 3A94-13, 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.

JTC (The Joint United States/Canada Yukon River Technical Committee). 1990. Yukon River salmon season review for 1990 and technical committee report. Anchorage, Alaska.

JTC (The Joint United States/Canada Yukon River Technical Committee). 1993. Yukon River salmon season review for 1993 and technical committee report. Whitehorse, Yukon Territory, Canada. November.

Table 1. Alaskan and Canadian total utilization of Yukon River fall chum salmon, 1961–1993.[a]

Year	Canada [b]	Alaska [c,d]	Total
1961	9,076	144,233	153,309
1962	9,436	140,401	149,837
1963	27,696	99,031 [e]	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	14,493	303,485	317,978
1987	44,480	361,663 [e]	406,143
1988	33,565	320,666	354,231
1989	23,020	511,225	534,245
1990	33,622	321,059	354,681
1991	35,418	403,738	439,156
1992 [f]	20,680	128,237 [g]	148,917
1993 [f]	13,417	76,980 [e]	90,397
Average			
1961–82	13,645	266,435	280,080
1983–87	31,799	403,589	435,388
1988–92	29,261	336,985	366,246

[a] Taken from JTC 1993.
[b] Commercial, Indian Food, and Domestic catches combined.
[c] Catch in number of salmon. Includes estimated number of salmon harvested for commercial production of salmon roe.
[d] Commercial, subsistence, and personal–use catches combined.
[e] Subsistence catch only; commercial fishery did not operate.
[f] Preliminary.
[g] Commercial fishery operated only in District 6, the Tanana River.

Table 2. Sheenjek River test fishing results, 1993.[a]

Date	Seine Sets	Chum Salmon			Arctic Grayling	Sheefish	Remarks
		Males	Females	Total			
14–Sep	9	3	1[b]	4	2		All seine sets made between river–kilometer (Rkm) 19 and 26.
15–Sep	16	7	5	12	6		Seine sets made between rkm 4 and 19.
16–Sep	14	9	12	21	7	1	Seine sets made between rkm 4 and 13.
17–Sep	5	18	9	27	1	1	Seine sets between rkm 10 (sonar site) and rkm 11.
18–Sep	5	9	11	20			Seine sets made between rkm 19 and 20.
20–Sep	3	41	38	79			Seine sets at rkm 10 (sonar site).
21–Sep	2	5	7	12		3	Seine sets at rkm 10 (sonar site).
23–Sep	1	38	13	51			Seine sets at rkm 10 (sonar site). Twenty–five fish released.
Total	55	130	96	226	16	5	

[a] The first 201 chum salmon captured were sampled for ASL. The first 64 chums captured (14–17 September) were also sampled for GSI.
[b] This chum salmon possessed a DFO orange spaghetti tag (No. S02798). Both eyes had been poked out.

Table 3. Sonar estimated escapement of fall chum salmon in the Sheenjek River, 1981–1993.

Date	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	Date
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											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					446	2,347	466	20–Aug
21–Aug						1,178		961			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		1,825	1,754	1,189	157	23–Aug
24–Aug						1,733		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			1,453			5,150	993	756	733	1,605	1,196	463	369	29–Aug
30–Aug			1,139	278		4,336	1,400	914	1,265	881	905	943	647	30–Aug
31–Aug	528	1,401	1,096	543		3,889	1,639	1,512	933	1,609	1,676	840	999	31–Aug
01–Sep	2,044	1,134	785	1,985		2,101	3,937	1,548	1,598	1,570	2,164	835	1,045	01–Sep
02–Sep	2,364	1,162	677	1,902	2,445	2,230	3,295	1,492	1,759	1,695	1,749	830	632	02–Sep
03–Sep	6,086	1,281	1,066	1,172	1,225	1,819	7,585	2,203	1,739	1,002	1,808	1,217	2,092	03–Sep
04–Sep	6,533	1,000	760	1,132	2,069	2,406	11,386	1,991	2,819	1,159	2,026	2,023	2,557	04–Sep
05–Sep	6,914	1,176	1,199	703	2,784	1,645	10,962	1,309	2,571	955	2,476	2,093	2,097	05–Sep
06–Sep	7,224	1,284	1,247	1,381	4,122	2,265	5,439	1,286	2,936	1,339	1,241	3,154	1,673	06–Sep
07–Sep	9,224	1,675	2,640	1,447	5,912	2,849	10,182	1,542	4,210	1,259	3,490	4,200	2,414	07–Sep
08–Sep	8,582	1,039	1,796	1,126	4,641	2,760	11,122	1,297	3,581	1,071	2,680	3,092	2,720	08–Sep
09–Sep	5,165	605	2,096	2,233	4,296	2,469	8,487	1,443	4,858	1,411	4,201	4,274	1,300	09–Sep
10–Sep	2,391	438	1,729	1,096	3,132	1,131	5,561	1,073	4,051	854	3,541	3,209	580	10–Sep
11–Sep	1,855	1,053	1,946	775	5,821	1,461	4,882	696	3,551	1,746	2,236	3,815	401	11–Sep
12–Sep	1,301	1,129	1,941	658	2,808	2,500	6,294	340	3,414	1,726	3,136	3,816	465	12–Sep
13–Sep	1,977	997	2,516	904	3,488	1,751	5,831	673	3,227	1,803	3,139	4,047	373	13–Sep
14–Sep	1,740	1,254	2,289	725	2,609	2,866	4,485	703	2,797	2,196	3,145	6,347	351	14–Sep
15–Sep	1,754	1,786	1,912	632	4,637	2,290	3,963	1,037	2,027	2,065	4,823	4,289	197	15–Sep
16–Sep	1,622	2,657	3,005	950	7,457	1,099	4,118	1,275	2,498	2,175	4,240	3,232	407	16–Sep
17–Sep	1,000	2,010	2,298	841	5,418	1,488	4,763	1,943	3,035	2,867	2,729	2,473	1,176	17–Sep
18–Sep	2,064	1,787	1,912	664	3,958	1,481	4,326	1,637	2,090	1,909	2,734	2,158	1,053	18–Sep
19–Sep	713	2,162	1,401	796	5,653	1,548	2,635	1,209	1,839	2,020	3,119	2,406	1,359	19–Sep
20–Sep	810	1,724	1,228	818	6,872	679	3,160	1,151	2,321	2,372	3,319	1,007	1,192	20–Sep
21–Sep	797	1,371	3,483	804	6,849	704	3,223	716	1,273	2,444	2,461		3,382	21–Sep
22–Sep	693	1,296	4,107	656	10,528	577	1,988	743	1,384	2,667	1,924		2,005	22–Sep
23–Sep	729		2,456	765	9,406	587	2,878	583	2,434	1,848	2,071		1,803	23–Sep
24–Sep	450		1,215	1,079	10,314	653	3,324	522	2,965	1,819	1,430		1,655	24–Sep
25–Sep				1,065	9,672			365	2,672	1,923			1,083	25–Sep
26–Sep					6,133			344		1,392			1,158	26–Sep
27–Sep					5,924			319		1,478			568	27–Sep
28–Sep					7,425					798			497	28–Sep
29–Sep					7,170									29–Sep
Totals	74,560	31,421	49,392	27,130	152,768	83,197	140,086	40,866	79,116	62,200	86,496	78,808	42,922	

Table 4. Salmon escapement enumeration project operational dates for the Sheenjek River, 1981–1993.

Year	Starting Date	Ending Date	Project Duration	Sonar 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
1987	25–Aug	24–Sep	30	140,086
1988	21–Aug	27–Sep	37	40,866
1989	24–Aug	25–Sep	32	79,116
1990	22–Aug	28–Sep	37	62,200
1991	09–Aug	24–Sep	46	86,496
1992	09–Aug	20–Sep	42	78,808
1993	08–Aug	28–Sep	51	42,922
Averages:				
1981–85	30–Aug	24–Sep	25	67,054
1986–90	21–Aug	25–Sep	35	81,093
1991–93	08–Aug	24–Sep	46	69,409
1981–90	26–Aug	25–Sep	30	74,074
1981–93	22–Aug	24–Sep	34	72,997

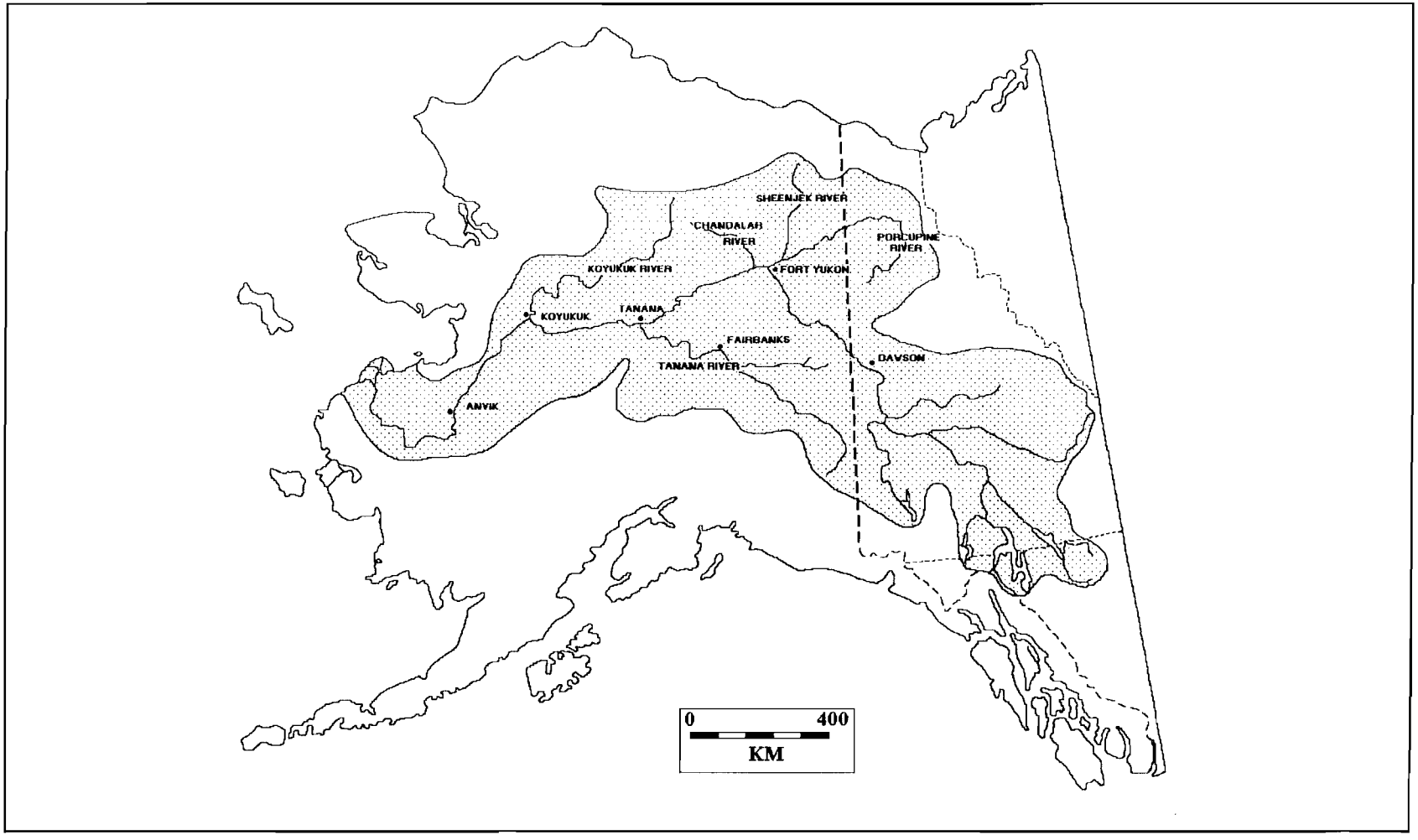

Figure 1. Yukon River drainage showing selected locations.

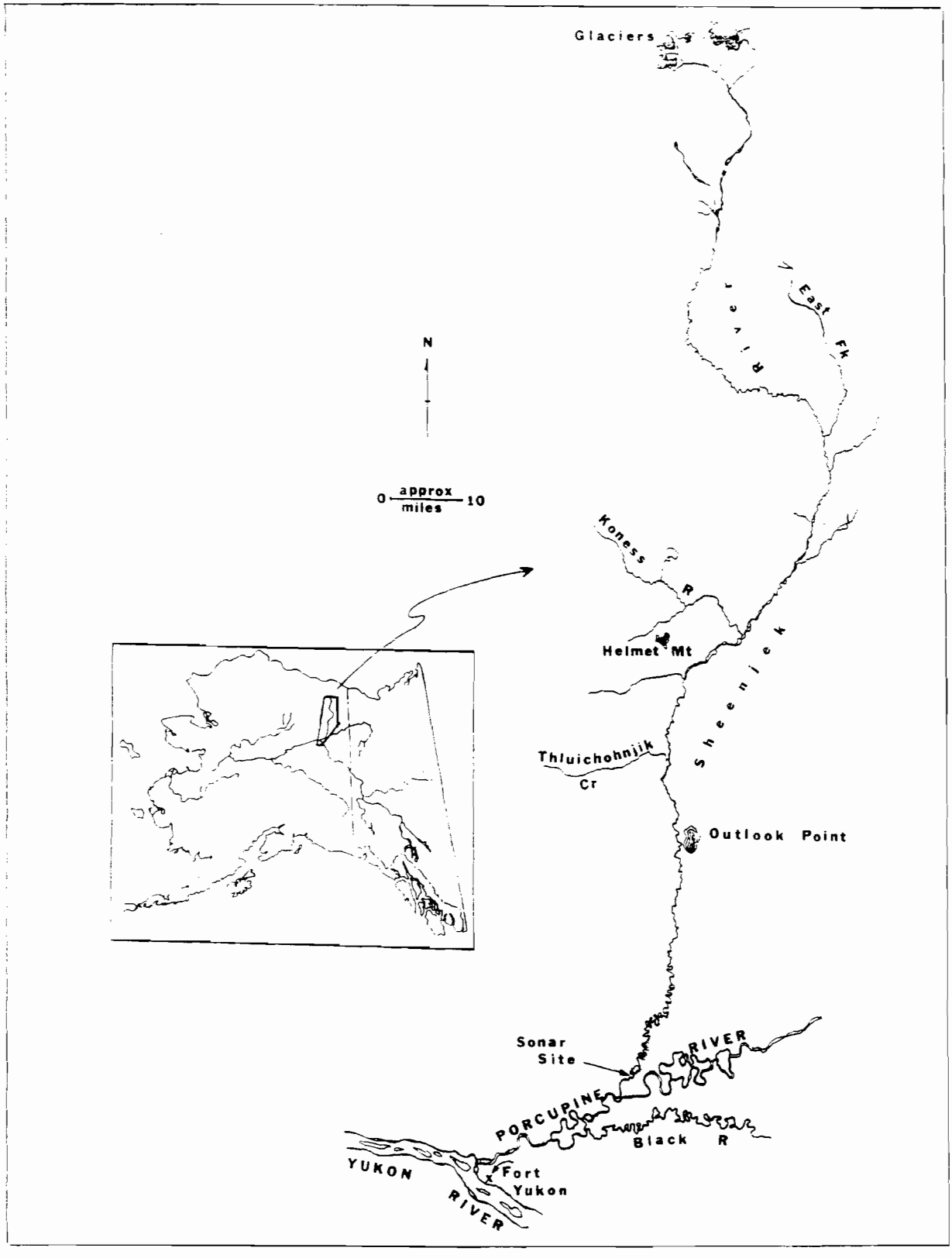

Figure 2. Sheenjek River drainage.

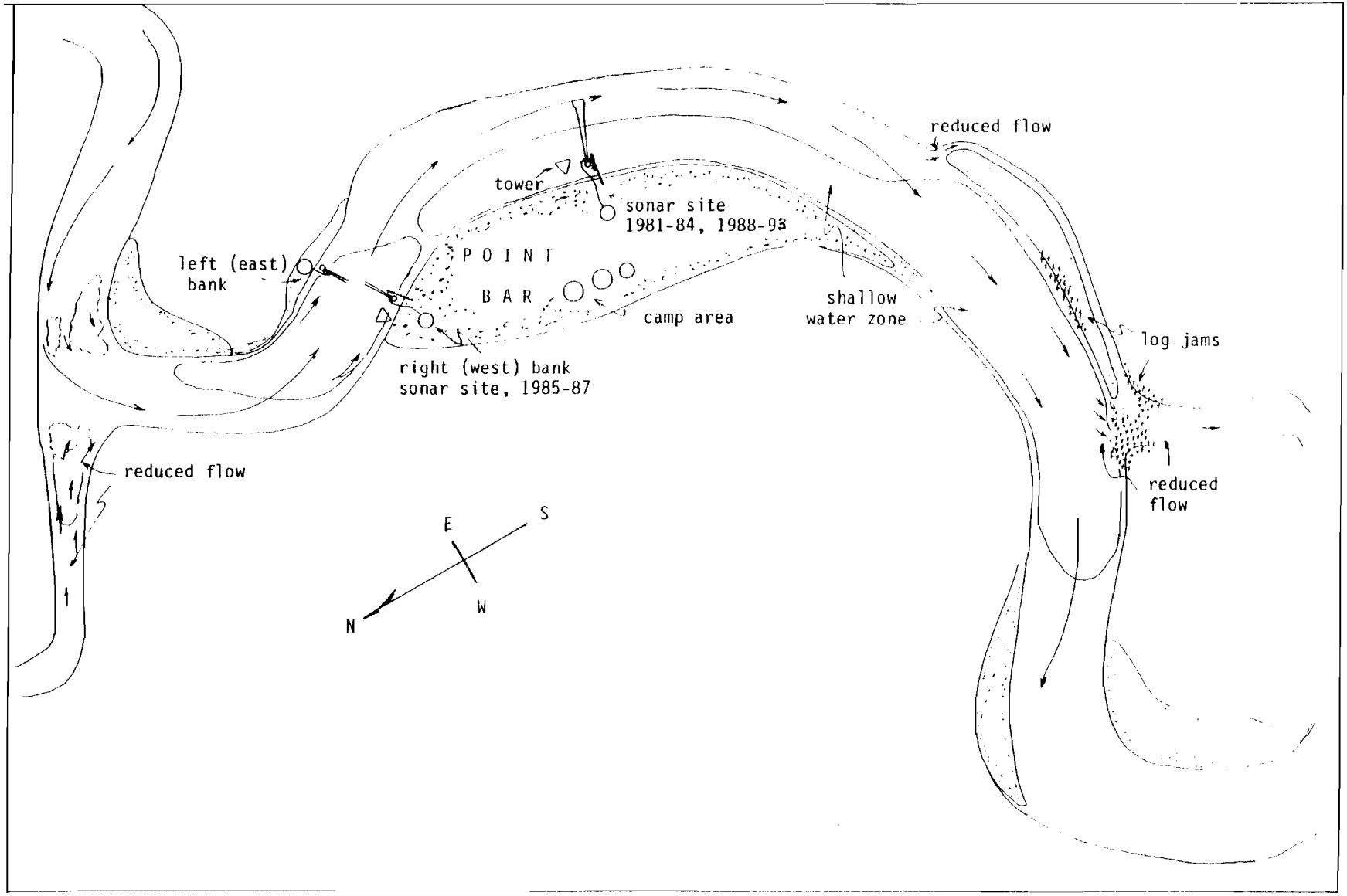

Figure 3. Sheenjek River sonar project site.

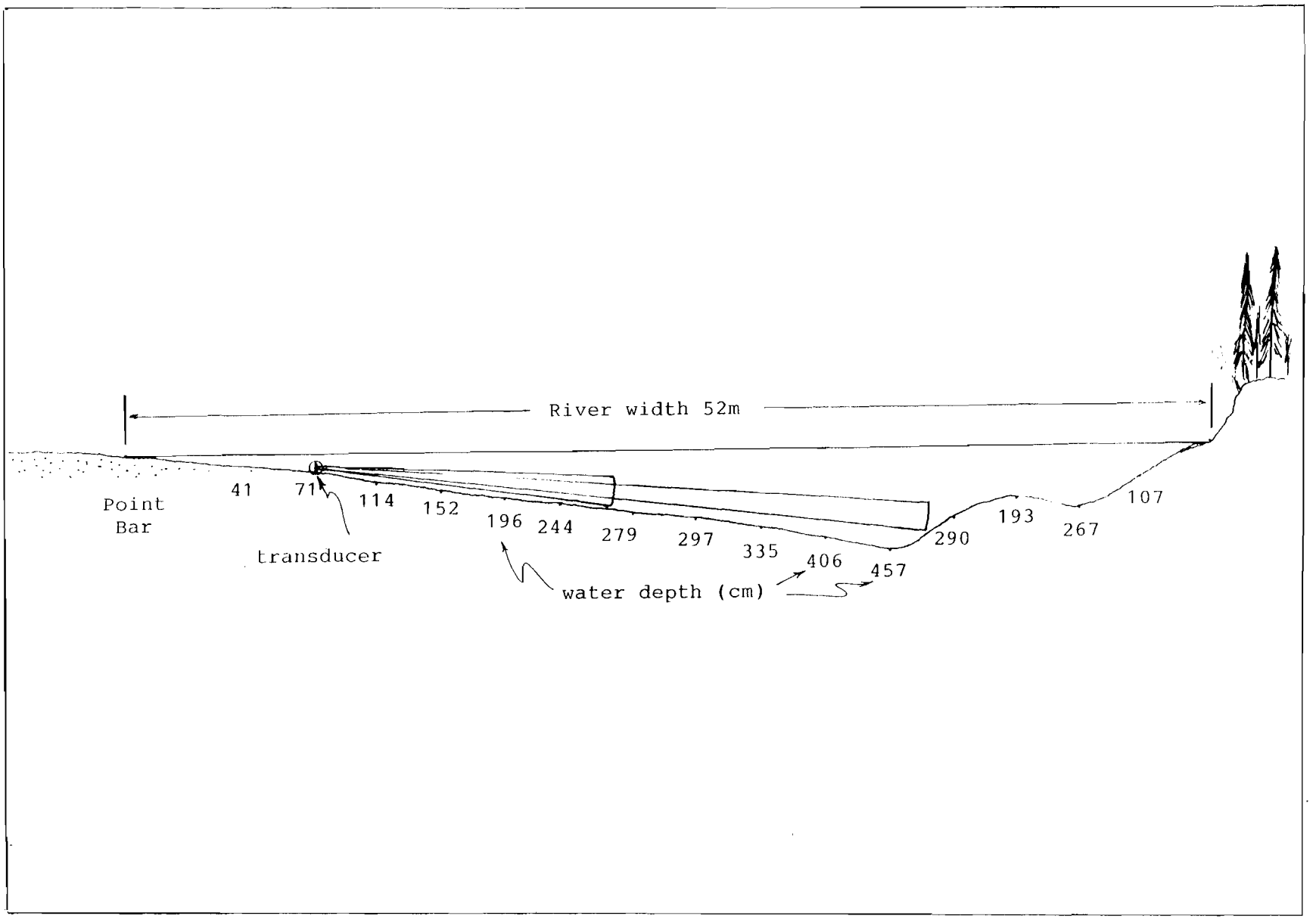

Figure 4. Depth profile made at the Sheenjek River project site on 9 August 1993.

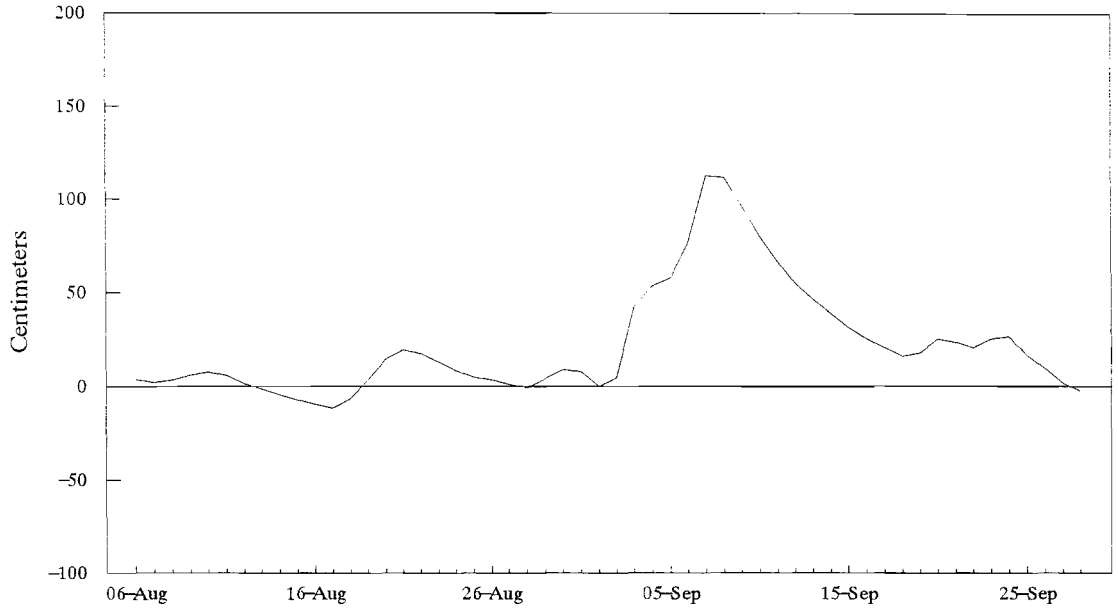

Figure 5. Water depth relative to 1 September, measured at approximately 1800 h daily at the Sheenjek River sonar project site, 1993.

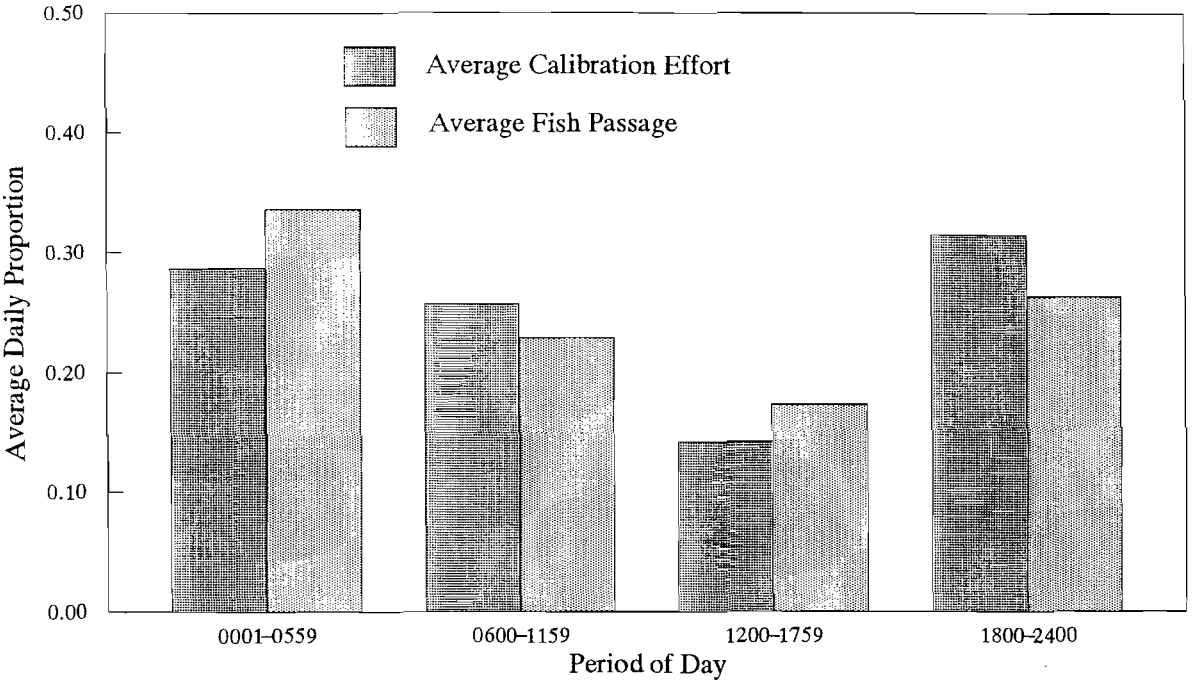

Figure 6. Comparative average daily percent calibration effort versus average daily percent salmon passage in the Sheenjek River, 1993.

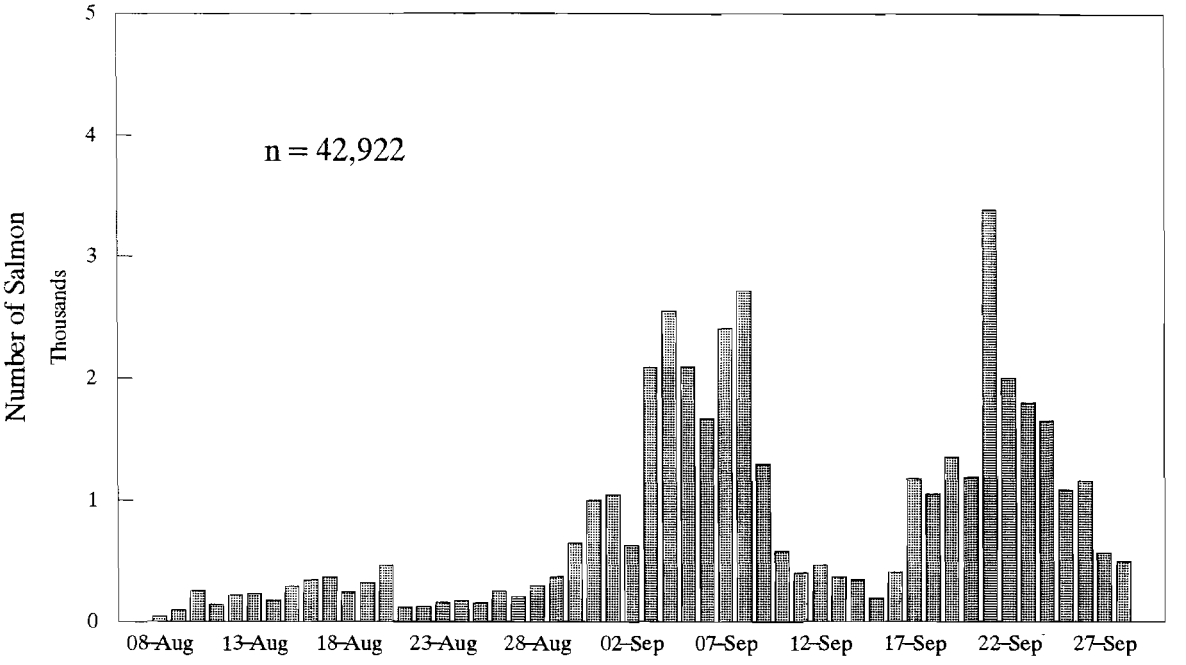

Figure 7. Sheenjek River fall chum salmon run timing based upon sonar estimated daily passage, 1993.

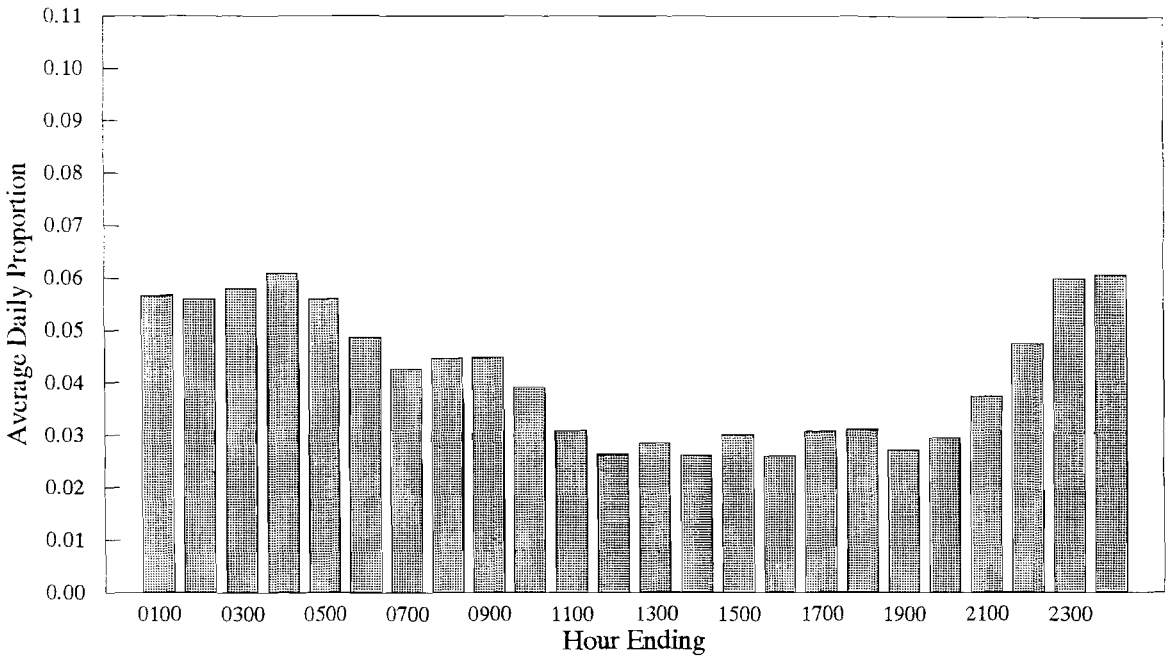

Figure 8. Average temporal migration pattern of fall chum salmon observed in the Sheenjek River, 1993.

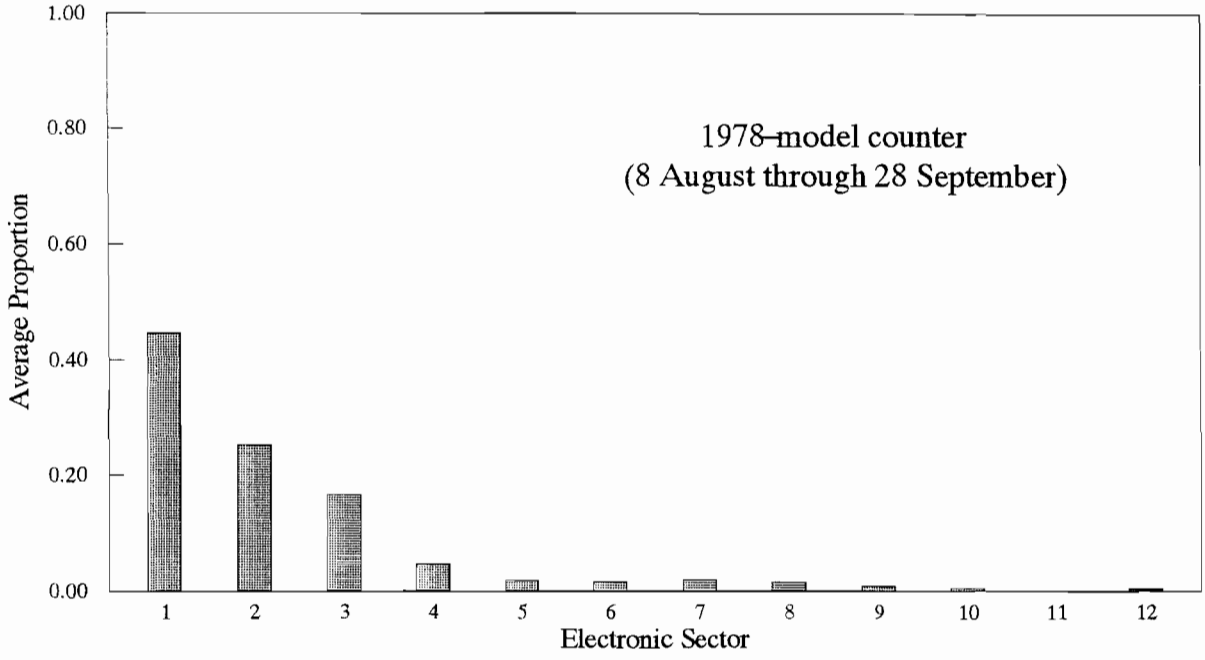

Figure 9. Estimated average proportion of fall chum salmon passing the Sheenjek River project site by electronic sector, 1993.

Appendix A Climatological and hydrological observations made at the Sheenjek River project site, 1993.

Date	Time	Precip (code) [a]	Cloud Cover (code) [b]	Wind (Direction and Velocity)	Temperature (C°) Air	Temperature (C°) Water Surface	Water Guage (cm) Guage Reading	Water Guage (cm) ± 24 h Change	Water Color (code) [c]	Remarks
06-Aug	1530	A	B	SE 5S-8			0.0	0.0	A	Arrive at project site; water guage installed.
07-Aug	1300	B	B	NE 2-3			-1.2	-1.2	A	Camp setup; made several river profiles; bear visit last night-paw prints on sleep tent.
08-Aug	1600	B	B	NE 3-5			0.2	1.4	B	Installed sonar counter.
09-Aug	1900	B	S	SW 3-5		13	2.8	2.6	B	Water up some; rain last night.
10-Aug	1900	A	S	Calm		13	4.6	1.8	A-B	Water up some; rain last night.
11-Aug	1930	A	C	Calm		13	2.4	-2.2	A-B	
12-Aug	1800	A	S	SE 10	12	13	-1.8	-4.2	B	SE winds all day; black bear entered camp 2030 h.
13-Aug	1800	B	O	N 5	11	12	-4.8	-3.0	B	Steady rain started at 1500 h; drift downstream 2-3 rm, no sign of chums.
14-Aug	1900	B	O	N 0-5	17	12	-7.8	-3.0	B	Very few fish passing.
15-Aug	1800	B	O-B	SE 0-5	10	12	-10.6	-2.8	B	Black bear across river from sonar.
16-Aug	1800	B	B	S 5-10	12	12	-13.0	-2.4	A-B	
17-Aug	1800	B	B	N 0-5	18	12	-15.0	-2.0	A-B	
18-Aug	1800	A	S	S 0-5	20	13	-10.0	5.0	A-B	Grizzly bear swam river to our bar; disappered behind camp.
19-Aug	1815	A	C	Calm	21	13	0.2	10.2	B	Grizzly spotted behind camp.
20-Aug	1805	A	C	N 0-5	18	13	11.6	11.4	C	Heard "Old Ephriam" crunching around behind camp.
21-Aug	1820	B	B	SSE 5-15	16	13	16.2	4.6	C	
22-Aug	1815	B	D	SE 0-5	9	11	14.2	-2.0	D	Two grizzles arrive at camp; one appears at sauna and one behind mess tent.
23-Aug	1800	C-B	O	SW 5	9	11	9.8	-4.4	B	Low fish passage continues.
24-Aug	1745	B-A	O-B	SE 5	12	11	5.4	-4.4	B	Low fish passage.
25-Aug	1745	A	S	SE 0-5	16	11	1.4	-4.0	B	
26-Aug	1800	A	B	NE 5-10	11	11	-0.0	-1.4	B	
27-Aug	1800	A	S	S 0-5	13	11	-2.2	-2.2	B	Great display of Northern Lights.
28-Aug	1805	A	S	S 5	19	11	-4.2	-2.0	B	Big bright moon; stars starting to appear through thinning clouds.
29-Aug	1810	B	O	S 0-5	16	11	0.8	5.0	B	Black bear across from camp on east bank.
30-Aug	1800	A	O	N 0-5	14	11	5.6	4.8	B	Fish passage picking up; full moon tonight.
31-Aug	1740	B	O-C	NW 5-10	14	11	4.6	-1.0	B	Rained hard this morning; wind gusts to 40 mph; somewhat steady fish passage.
01-Sep	1800	B	O	Calm	5	9	-3.4	-8.0	B	Some fish holding/milling observed.
02-Sep	1800	B	O	SW 10-15	7	9	1.2	4.6	C	At 0800 h fish are lining the bar; straggling through.
03-Sep	1805	B	B	SSW 5-20	9	9	38.6	37.4	B	Water rising; moved transducer inshore; fishing passage good.
04-Sep	1810	B	O	SW 10-15	11	9	50.0	11.4	C	Water rising; flashlight watch for bear; bluegreen eyes seen near outhouse at 2315 h.
05-Sep	1800	B	S	NE 5-10	13	9	54.0	4.0	C	
06-Sep	1800	B	C	Calm	17		72.4	18.4	C	Rising water reached sonar tent; relocated gear to sauna house; fish passage steady,
07-Sep	1800	A	S	SSW 0-15	17	9	108.6	36.2	D	moved transducer closer to shore twice on 6th and 7th; winds gusting to 20.
08-Sep	1800	A	C	S Var.	12	9	108.0	-0.6	D	Winds continue; fish passage continues steady; water appears to have crested.
09-Sep	1800	A	B	Calm	12	8	93.0	-15.0	D	Water dropping rapidly; moved transducer out.
10-Sep	1800	B	C	SW 10-15	13	9	76.4	-16.6	C	Moved back to sonar tent.
11-Sep	1800	B	C	SW 5	12	8	62.8	-13.6	C	Moved transducer out.
12-Sep	1815	A	O	Calm	9	8	51.4	-11.4	B	Fall is on way out.
13-Sep	1800	B	B	Calm	13	8	42.6	-8.8	B	Frost this AM; snow throughout day. Fish holding problems.
14-Sep	1800	A	C	Calm	14	8	35.4	-7.2	B-C	
15-Sep	1830	A	B	Calm	12	8	28.4	-7.0	B-C	
16-Sep	1800	B	O	N 0-5	10	8	22.4	-6.0	B-C	Red fox on bar; steady rain with wind picking up.
17-Sep	1915	E	O	S 10-15	3	7	17.4	-5.0	B-C	Snow flurries, windy w/ gusts to 35 mph, cold; strong SW wind all last night to 25 mph
18-Sep	1750	E	B	S 5-10	3	7	13.0	-4.4	B-C	Cold w/ snow flurries; some overcounting due to slow swimming fish/holding.
19-Sep	1815	D	O	S 10-15	6	7	14.6	1.6	B-C	Light snow accumulation last night; rain most of day; fish milling problems.
20-Sep	1800	B	O	Calm	10	6	22.2	7.6	B-C	
21-Sep	1800	D	O	S 20-50	1	6	20.4	-1.8	C	Extremely high winds, gusts 40-50 mph w/ blizzard conditions (1600-1700 h). Fish
22-Sep	1830	A	S	SW 0-10	2	6	17.4	-3.0	C	moving in increased numbers - could be wind pushing them upsream.
23-Sep	1830	A	C	Calm	3	2	22.2	4.8	B	Fish lining bar up- and downstream of transducer; overcounting problems.
24-Sep	1800	E	O	SW 5-10	0	2	23.4	1.2	B	Ice forming along shore - not a good sign.
25-Sep	1800	E	C	N 10	2	1	13.6	-9.8	B	Raw day; wind from north; fish moving slowly; passage has slowed considerably.
26-Sep	1800	A	C	SW 10	0	1	6.2	-7.4	B	Fish holding/milling problems somewhat lessoned.
27-Sep	1800	A	C	SSW 10	2	1	-1.6	-7.8	B	Fish over counting.
28-Sep	1000	A	D	Calm	-5	1	-5.6	-4.0	B	Fish over counting; terminated sonar operation.
Average					10	9		-0.1		

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. Oscilloscope calibrations made to the 1978–model sonar salmon counter at the Sheenjek River project site, 1993.

Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
10–Aug	1145	10	0	0	--	0.400	1.5	98.0	99.5	0
	2340	15	5	7	0.714	0.400	1.5	98.0	99.5	20
11–Aug	1125	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	2110	15	5	7	0.714	0.400	1.5	98.0	99.5	20
	2340	15	2	3	0.667	0.400	1.5	98.0	99.5	8
12–Aug	15	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	605	15	1	2	0.500	0.400	1.5	98.0	99.5	4
	1105	15	2	1	2.000	0.400	1.5	98.0	99.5	8
	1605	15	2	2	1.000	0.400	1.5	98.0	99.5	8
	2115	15	3	2	1.500	0.400	1.5	98.0	99.5	12
	2310	15	4	6	0.667	0.400	1.5	98.0	99.5	16
13–Aug	10	15	7	8	0.875	0.400	1.5	98.0	99.5	28
	605	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	1105	15	3	4	0.750	0.400	1.5	98.0	99.5	12
	1805	15	1	2	0.500	0.400	1.5	98.0	99.5	4
	2112	15	4	4	1.000	0.400	1.5	98.0	99.5	16
	2335	15	7	9	0.778	0.400	1.5	98.0	99.5	28
14–Aug	20	15	9	12	0.750	0.400	1.5	98.0	99.5	36
	605	15	0	0	--	0.400	1.5	98.0	99.5	0
	1125	15	0	0	--	0.400	1.5	98.0	99.5	0
	1602	15	3	5	0.600	0.400	1.5	98.0	99.5	12
	2130	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	2320	15	4	3	1.333	0.400	1.5	98.0	99.5	16
15–Aug	20	15	3	2	1.500	0.400	1.5	98.0	99.5	12
	602	15	0	0	--	0.400	1.5	98.0	99.5	0
	1131	15	0	0	--	0.400	1.5	98.0	99.5	0
	1617	15	4	4	1.000	0.400	1.5	98.0	99.5	16
	2105	15	2	4	0.500	0.400	1.5	98.0	99.5	8
	2327	15	10	14	0.714	0.400	1.5	98.0	99.5	40
16–Aug	20	15	4	3	1.333	0.400	1.5	98.0	99.5	16
	617	15	5	5	1.000	0.400	1.5	98.0	99.5	20
	1110	30	23	27	0.852	0.400	1.5	98.0	99.5	46
	1620	15	2	3	0.667	0.400	1.5	98.0	99.5	8
	2115	15	0	0	--	0.400	1.5	98.0	99.5	0
	2320	15	4	5	0.800	0.400	1.5	98.0	99.5	16
17–Aug	20	15	2	2	1.000	0.400	1.5	98.0	99.5	8
	620	15	6	8	0.750	0.400	1.5	98.0	99.5	24
	1110	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	1610	15	0	0	--	0.400	1.5	98.0	99.5	0
	2105	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	2318	15	4	2	2.000	0.400	1.5	98.0	99.5	16
18–Aug	17	15	6	5	1.200	0.400	1.5	98.0	99.5	24
	635	15	3	2	1.500	0.400	1.5	98.0	99.5	12
	1120	15	5	9	0.556	0.400	1.5	98.0	99.5	20
	1615	15	0	0	--	0.400	1.5	98.0	99.5	0
	2130	15	3	2	1.500	0.400	1.5	98.0	99.5	12
	2335	15	2	3	0.667	0.400	1.5	98.0	99.5	8
19–Aug	35	15	5	6	0.833	0.400	1.5	98.0	99.5	20
	616	15	2	2	1.000	0.400	1.5	98.0	99.5	8
	1125	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	1625	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	2108	15	4	6	0.667	0.400	1.5	98.0	99.5	16
	2320	15	4	3	1.333	0.400	1.5	98.0	99.5	16
20–Aug	10	15	1	1	1.000	0.400	1.5	98.0	99.5	4
	625	15	4	6	0.667	0.400	1.5	98.0	99.5	16
	1117	15	4	5	0.800	0.400	1.5	98.0	99.5	16
	1635	15	6	12	0.500	0.400	1.5	98.0	99.5	24
	2130	15	3	8	0.375	0.400	2.0	98.0	100.0	12
	2325	15	0	0	--	0.400	2.5	98.0	100.5	0
21–Aug	20	15	0	0	--	0.400	2.5	98.0	100.5	0
	643	15	2	2	1.000	0.400	2.5	98.0	100.5	8
	1115	15	2	3	0.667	0.400	2.5	98.0	100.5	8
	1611	15	2	2	1.000	0.400	3.5	98.0	101.5	8
	2116	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	2316	15	0	0	--	0.400	3.5	98.0	101.5	0

–Continued–

Appendix B. (p 2 of 5)

Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
22–Aug	5	15	0	0	--	0.400	3.5	98.0	101.5	0
	611	15	0	0	--	0.400	3.5	98.0	101.5	0
	1135	15	0	0	--	0.400	3.5	98.0	101.5	0
	1602	15	0	0	--	0.400	3.5	98.0	101.5	0
	2125	15	2	2	1.000	0.400	3.5	98.0	101.5	8
	2342	15	3	3	1.000	0.400	3.5	98.0	101.5	12
23–Aug	15	15	4	6	0.667	0.400	3.5	98.0	101.5	16
	635	15	0	0	--	0.400	3.5	98.0	101.5	0
	1110	15	0	0	--	0.400	3.5	98.0	101.5	0
	1610	15	2	2	1.000	0.400	3.5	98.0	101.5	8
	2108	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	2319	15	2	4	0.500	0.400	3.5	98.0	101.5	8
24–Aug	2	15	2	2	1.000	0.400	3.5	98.0	101.5	8
	621	15	2	1	2.000	0.400	3.5	98.0	101.5	8
	1140	15	0	0	--	0.400	3.5	98.0	101.5	0
	1615	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	2125	15	0	0	--	0.400	3.5	98.0	101.5	0
	2335	15	0	0	--	0.400	3.5	98.0	101.5	0
25–Aug	21	15	0	0	--	0.400	3.5	98.0	101.5	0
	640	15	0	0	--	0.400	3.5	98.0	101.5	0
	1115	15	0	0	--	0.400	3.5	98.0	101.5	0
	1620	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	2120	15	2	1	2.000	0.400	3.5	98.0	101.5	8
	2331	15	2	4	0.500	0.400	3.5	98.0	101.5	8
26–Aug	20	15	5	7	0.714	0.400	3.5	98.0	101.5	20
	625	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	1116	15	0	0	--	0.400	3.5	98.0	101.5	0
	1608	15	0	0	--	0.400	3.5	98.0	101.5	0
	2130	15	0	0	--	0.400	3.5	98.0	101.5	0
	2343	15	10	8	1.250	0.400	3.5	98.0	101.5	40
27–Aug	20	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	301	30	16	18	0.889	0.400	3.5	98.0	101.5	32
	635	15	0	0	--	0.400	3.5	98.0	101.5	0
	1116	15	0	0	--	0.400	3.5	98.0	101.5	0
	1615	15	2	1	2.000	0.400	3.5	98.0	101.5	8
	2132	15	0	0	--	0.400	3.5	98.0	101.5	0
	2315	30	4	3	1.333	0.400	3.5	98.0	101.5	8
28–Aug	20	15	6	4	1.500	0.400	3.5	98.0	101.5	24
	301	15	4	3	1.333	0.400	3.5	98.0	101.5	16
	638	15	1	1	1.000	0.400	3.5	98.0	101.5	4
	1131	15	0	0	--	0.400	3.5	98.0	101.5	0
	1617	15	3	4	0.750	0.400	3.5	98.0	101.5	12
	2115	15	2	1	2.000	0.400	3.5	98.0	101.5	8
	2323	15	1	1	1.000	0.400	3.5	98.0	101.5	4
29–Aug	35	15	3	2	1.500	0.400	3.5	98.0	101.5	12
	301	15	0	0	--	0.400	3.5	98.0	101.5	0
	640	15	5	6	0.833	0.400	3.5	98.0	101.5	20
	1137	15	0	0	--	0.400	3.5	98.0	101.5	0
	1630	15	0	0	--	0.400	3.5	98.0	101.5	0
	2113	30	25	28	0.893	0.400	3.5	98.0	101.5	50
	2329	30	56	59	0.949	0.400	3.5	98.0	101.5	112
30–Aug	27	30	40	44	0.909	0.400	3.5	98.0	101.5	80
	302	15	8	8	1.000	0.400	3.5	98.0	101.5	32
	701	15	9	11	0.818	0.400	3.5	98.0	101.5	36
	1115	15	0	0	--	0.400	3.5	98.0	101.5	0
	1605	15	1	2	0.500	0.400	3.5	98.0	101.5	4
	2128	15	2	2	1.000	0.400	3.5	98.0	101.5	8
	2325	30	22	19	1.158	0.400	3.5	98.0	101.5	44
31–Aug	22	30	21	25	0.840	0.400	3.5	98.0	101.5	42
	304	30	39	42	0.929	0.400	3.5	98.0	101.5	78
	601	30	58	83	0.699	0.400	3.5	98.0	101.5	116
	1105	15	6	19	0.316	0.400	3.5	98.0	101.5	24
	1605	15	0	0	--	0.400	3.5	98.0	101.5	0
	2114	30	82	108	0.759	0.400	3.5	98.0	101.5	164
	2150	10	19	21	0.905	0.525	3.5	98.0	101.5	114
	2312	30	31	28	1.107	0.525	3.5	98.0	101.5	62

–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	17	30	54	50	1.080	0.525	3.5	98.0	101.5	108
	305	30	25	27	0.926	0.525	3.5	98.0	101.5	50
	623	30	60	102	0.588	0.525	3.5	98.0	101.5	120
	655	5	8	6	1.333	0.890	3.5	98.0	101.5	96
	1120	15	1	0	--	0.890	3.5	98.0	101.5	4
	1620	30	10	24	0.417	0.890	3.5	98.0	101.5	20
	2110	15	8	4	2.000	0.890	3.5	98.0	101.5	32
	2305	30	31	49	0.633	0.890	3.5	98.0	101.5	62
02–Sep	10	30	31	20	1.550	0.890	3.5	98.0	101.5	62
	301	30	20	24	0.833	0.890	3.5	98.0	101.5	40
	617	30	30	59	0.508	0.890	3.5	98.0	101.5	60
	1117	15	0	0	--	0.890	3.5	98.0	101.5	0
	1628	30	73	196	0.372	0.890	3.5	98.0	101.5	146
	1704	10	7	11	0.636	0.990	3.5	98.0	101.5	42
	2105	15	9	7	1.286	0.990	3.5	98.0	101.5	36
	2326	15	4	2	2.000	0.990	3.5	98.0	101.5	16
03–Sep	20	30	28	19	1.474	0.990	3.5	98.0	101.5	56
	310	30	40	30	1.333	0.990	3.5	98.0	101.5	80
	614	30	18	15	1.200	0.990	3.5	98.0	101.5	36
	1415	30	88	66	1.333	0.400	3.5	90.0	93.5	176
	1615	30	60	84	0.714	0.400	3.5	90.0	93.5	120
	1655	10	22	19	1.158	0.560	3.5	90.0	93.5	132
	2110	30	56	37	1.514	0.560	3.5	90.0	93.5	112
	2145	10	15	17	0.882	0.370	3.5	90.0	93.5	90
	2315	30	45	49	0.918	0.370	3.5	90.0	93.5	90
04–Sep	10	30	66	68	0.971	0.370	3.5	90.0	93.5	132
	305	30	50	72	0.694	0.370	3.5	90.0	93.5	100
	340	10	22	19	1.158	0.532	3.5	90.0	93.5	132
	616	30	47	58	0.810	0.532	3.5	90.0	93.5	94
	647	10	10	9	1.111	0.600	3.5	90.0	93.5	60
	1128	30	39	46	0.848	0.600	3.5	90.0	93.5	78
	1625	30	67	58	1.155	0.600	3.5	90.0	93.5	134
	2109	30	44	45	0.978	0.600	3.5	90.0	93.5	88
	2310	30	5	7	0.714	0.600	3.5	90.0	93.5	10
05–Sep	15	30	31	33	0.939	0.600	3.5	90.0	93.5	62
	304	30	84	87	0.966	0.600	3.5	90.0	93.5	168
	628	30	48	48	1.000	0.600	3.5	90.0	93.5	96
	1112	30	28	19	1.474	0.600	3.5	90.0	93.5	56
	1710	15	4	2	2.000	0.600	3.5	90.0	93.5	16
	2109	30	23	20	1.150	0.600	3.5	90.0	93.5	46
	2318	30	80	93	0.860	0.600	3.5	90.0	93.5	160
06–Sep	15	30	85	100	0.850	0.600	3.5	90.0	93.5	170
	305	30	101	124	0.815	0.600	3.5	90.0	93.5	202
	355	10	23	27	0.852	0.736	3.5	90.0	93.5	138
	630	30	37	49	0.755	0.736	3.5	90.0	93.5	74
	1130	30	41	37	1.108	0.736	3.5	90.0	93.5	82
	1615	15	0	0	--	0.736	3.5	100.0	103.5	0
	2214	30	46	52	0.885	0.736	3.5	100.0	103.5	92
	2333	27	34	41	0.829	0.736	3.5	100.0	103.5	76
07–Sep	25	30	52	60	0.867	0.886	3.5	100.0	103.5	104
	309	30	56	61	0.918	0.886	3.5	100.0	103.5	112
	620	30	38	44	0.864	0.886	3.5	100.0	103.5	76
	1203	30	51	59	0.864	0.886	4.0	100.0	104.0	102
	1601	30	30	58	0.517	0.886	4.0	100.0	104.0	60
	2110	30	68	79	0.861	0.886	4.0	100.0	104.0	136
	2315	30	64	91	0.703	0.886	4.0	100.0	104.0	128
08–Sep	10	30	60	60	1.000	0.886	4.0	100.0	104.0	120
	301	30	67	95	0.705	0.886	4.0	100.0	104.0	134
	629	30	56	56	1.000	0.886	4.0	100.0	104.0	112
	1110	30	44	41	1.073	0.886	4.0	100.0	104.0	88
	1618	30	52	46	1.130	0.886	4.0	100.0	104.0	104
	2110	30	37	37	1.000	0.886	4.0	100.0	104.0	74
	2310	30	35	36	0.972	0.886	4.0	100.0	104.0	70
09–Sep	10	30	56	64	0.875	0.886	4.0	100.0	104.0	112
	325	30	55	64	0.859	0.886	4.0	100.0	104.0	110
	623	15	7	9	0.778	0.886	4.0	100.0	104.0	28
	1115	15	8	8	1.000	0.886	4.0	100.0	104.0	32
	1605	15	2	1	2.000	0.886	4.0	100.0	104.0	8
	2110	30	36	40	0.900	0.886	4.0	100.0	104.0	72

–Continued–

Appendix B. (p 4 of 5)

Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
	2310	30	39	49	0.796	0.886	4.0	100.0	104.0	78
10–Sep	5	30	39	45	0.867	0.886	4.0	100.0	104.0	78
	305	30	37	43	0.860	0.886	4.0	100.0	104.0	74
	640	15	6	5	1.200	0.886	4.0	100.0	104.0	24
	1105	15	1	1	1.000	0.886	4.0	100.0	104.0	4
	1610	15	0	0	--	0.886	4.0	100.0	104.0	0
	2116	15	7	10	0.700	0.886	4.0	100.0	104.0	28
	2304	30	22	26	0.846	0.886	4.0	100.0	104.0	44
11–Sep	20	30	27	31	0.871	0.886	4.0	100.0	104.0	54
	305	30	21	22	0.955	0.886	4.0	100.0	104.0	42
	605	15	0	0	--	0.886	4.0	100.0	104.0	0
	1123	15	0	0	--	0.886	4.0	100.0	104.0	0
	1605	15	0	0	--	0.886	4.0	100.0	104.0	0
	2115	15	5	7	0.714	0.886	4.0	100.0	104.0	20
	2319	30	19	24	0.792	0.886	4.0	100.0	104.0	38
12–Sep	7	15	9	9	1.000	0.925	4.0	100.0	104.0	36
	305	30	30	43	0.698	0.925	4.0	100.0	104.0	60
	340	10	5	6	0.833	0.990	4.0	100.0	104.0	30
	605	15	2	1	2.000	0.990	4.0	100.0	104.0	8
	1105	15	0	0	--	0.990	4.0	100.0	104.0	0
	1625	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	2105	15	5	5	1.000	0.990	4.0	100.0	104.0	20
	2342	15	2	3	0.667	0.990	4.0	100.0	104.0	8
13–Sep	8	30	17	14	1.214	0.990	4.0	100.0	104.0	34
	305	30	29	25	1.160	0.990	4.0	100.0	104.0	58
	632	15	0	0	--	0.990	4.0	100.0	104.0	0
	1115	15	0	0	--	0.990	4.0	100.0	104.0	0
	1611	15	0	0	--	0.990	4.0	100.0	104.0	0
	2101	15	0	0	--	0.990	4.0	100.0	104.0	0
	2305	15	4	3	1.333	0.990	4.0	100.0	104.0	16
14–Sep	10	30	15	17	0.882	0.990	4.0	100.0	104.0	30
	315	15	6	5	1.200	0.990	4.0	100.0	104.0	24
	620	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	1115	15	0	0	--	0.990	4.0	100.0	104.0	0
	1620	15	0	0	--	0.990	4.0	100.0	104.0	0
	2114	15	1	0	--	0.990	4.0	100.0	104.0	4
	2315	15	2	1	2.000	0.990	4.0	100.0	104.0	8
15–Sep	10	15	2	2	1.000	0.990	4.0	100.0	104.0	8
	335	15	7	7	1.000	0.990	4.0	100.0	104.0	28
	635	15	0	0	--	0.990	4.0	100.0	104.0	0
	1105	15	0	0	--	0.990	4.0	100.0	104.0	0
	1630	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	2127	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	2314	30	16	18	0.889	0.990	4.0	100.0	104.0	32
16–Sep	14	15	5	4	1.250	0.990	4.0	100.0	104.0	20
	301	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	615	15	1	1	1.000	0.990	4.0	100.0	104.0	4
	1118	15	0	0	--	0.990	4.0	100.0	104.0	0
	1605	15	0	0	--	0.990	4.0	100.0	104.0	0
	2125	15	6	6	1.000	0.990	4.0	100.0	104.0	24
	2315	15	8	9	0.889	0.990	4.0	100.0	104.0	32
17–Sep	10	15	6	8	0.750	0.990	4.0	100.0	104.0	24
	301	31	48	55	0.873	0.990	4.0	100.0	104.0	93
	620	30	36	40	0.900	0.990	4.0	100.0	104.0	72
	1430	15	8	13	0.615	0.990	4.0	100.0	104.0	32
	1617	15	0	0	--	0.990	4.0	60.0	64.0	0
	2110	30	14	14	1.000	0.990	4.0	60.0	64.0	28
	2315	15	7	9	0.778	0.990	4.0	60.0	64.0	28
18–Sep	5	15	9	8	1.125	0.990	4.0	60.0	64.0	36
	315	30	27	27	1.000	0.990	4.0	60.0	64.0	54
	638	15	8	9	0.889	0.990	4.0	60.0	64.0	32
	1101	15	1	1	1.000	0.990	4.0	60.0	64.0	4
	1610	25	48	64	0.750	0.990	4.0	60.0	64.0	115
	2129	30	33	46	0.717	0.990	4.0	60.0	64.0	66
	2205	10	6	10	0.600	0.999	4.0	70.0	74.0	36
	2328	30	48	234	0.205	0.999	4.0	70.0	74.0	96

–Continued–

Appendix B. (p 5 of 5)

Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (fish/hour)
19–Sep	27	30	47	136	0.346	0.999	4.0	70.0	74.0	94
	310	30	19	35	0.543	0.999	4.0	70.0	74.0	38
	725	30	31	70	0.443	0.999	4.0	70.0	74.0	62
	1115	15	2	3	0.667	0.999	4.0	70.0	74.0	8
	1610	15	6	19	0.316	0.999	4.0	70.0	74.0	24
	2107	30	42	82	0.512	0.999	4.0	70.0	74.0	84
	2335	25	38	60	0.633	0.999	4.0	70.0	74.0	91
20–Sep	8	30	38	74	0.514	0.999	4.0	70.0	74.0	76
	320	30	42	91	0.462	0.999	4.0	70.0	74.0	84
	615	15	6	13	0.462	0.999	4.0	70.0	74.0	24
	1127	15	3	3	1.000	0.999	4.0	70.0	74.0	12
	1605	15	6	8	0.750	0.999	4.0	70.0	74.0	24
	2125	30	33	53	0.623	0.999	4.0	70.0	74.0	66
	2302	30	40	75	0.533	0.999	4.0	70.0	74.0	80
21–Sep	8	30	30	36	0.833	0.999	4.0	70.0	74.0	60
	337	30	47	65	0.723	0.999	4.0	70.0	74.0	94
	625	30	133	166	0.801	0.999	4.0	70.0	74.0	266
	1134	15	2	2	1.000	0.999	4.0	70.0	74.0	8
	1229	30	29	71	0.408	0.999	4.0	70.0	74.0	58
	1610	30	49	101	0.485	0.999	4.0	70.0	74.0	98
	2105	30	112	139	0.806	0.999	4.0	70.0	74.0	224
	2305	30	104	140	0.743	0.999	4.0	70.0	74.0	208
22–Sep	20	30	71	152	0.467	0.999	4.0	70.0	74.0	142
	310	30	52	100	0.520	0.999	4.0	70.0	74.0	104
	627	30	36	119	0.303	0.999	4.0	70.0	74.0	72
	1102	15	6	13	0.462	0.999	4.0	70.0	74.0	24
	1604	15	4	3	1.333	0.999	4.0	70.0	74.0	16
	2105	30	62	98	0.633	0.999	4.0	70.0	74.0	124
	2310	30	48	121	0.397	0.999	4.0	70.0	74.0	96
23–Sep	10	30	58	79	0.734	0.999	4.0	70.0	74.0	116
	310	30	56	104	0.538	0.999	4.0	70.0	74.0	112
	627	30	24	110	0.218	0.999	4.0	70.0	74.0	48
	1129	15	9	31	0.290	0.999	4.0	70.0	74.0	36
	1606	15	9	15	0.600	0.999	4.0	70.0	74.0	36
	2115	30	72	131	0.550	0.999	4.0	70.0	74.0	144
	2305	30	88	173	0.509	0.999	4.0	70.0	74.0	176
24–Sep	202	30	57	143	0.399	0.999	4.0	70.0	74.0	114
	310	30	15	24	0.625	0.999	4.0	70.0	74.0	30
	635	25	30	98	0.306	0.999	4.0	70.0	74.0	72
	1130	15	4	8	0.500	0.999	4.0	70.0	74.0	16
	1610	30	58	132	0.439	0.999	4.0	70.0	74.0	116
	2110	30	59	223	0.265	0.999	4.0	70.0	74.0	118
	2303	30	30	75	0.400	0.999	4.0	70.0	74.0	60
25–Sep	4	30	22	38	0.579	0.999	4.0	70.0	74.0	44
	328	30	19	41	0.463	0.999	4.0	70.0	74.0	38
	640	15	3	7	0.429	0.999	4.0	70.0	74.0	12
	1105	30	21	44	0.477	0.999	4.0	70.0	74.0	42
	1602	30	5	8	0.625	0.999	4.0	70.0	74.0	10
	2108	15	9	16	0.563	0.999	4.0	70.0	74.0	36
	2319	30	29	100	0.290	0.999	4.0	70.0	74.0	58
26–Sep	5	15	8	12	0.667	0.999	4.0	70.0	74.0	32
	315	15	2	3	0.667	0.999	4.0	70.0	74.0	8
	615	15	2	2	1.000	0.999	4.0	70.0	74.0	8
	1130	30	22	76	0.289	0.999	4.0	70.0	74.0	44
	1605	30	16	22	0.727	0.999	4.0	70.0	74.0	32
	2114	30	25	48	0.521	0.999	4.0	70.0	74.0	50
	2322	30	22	28	0.786	0.999	4.0	70.0	74.0	44
27–Sep	7	30	20	57	0.351	0.999	4.0	70.0	74.0	40
	305	15	30	5	6.000	0.999	4.0	70.0	74.0	120
	605	15	7	7	1.000	0.999	4.0	70.0	74.0	28
	1116	15	7	93	0.075	0.999	4.0	70.0	74.0	28
	1602	15	4	20	0.200	0.999	4.0	70.0	74.0	16
	2105	30	36	83	0.434	0.999	4.0	70.0	74.0	72
	2305	30	53	226	0.235	0.999	4.0	70.0	74.0	106
28–Sep	45	15	5	9	0.556	0.999	4.0	70.0	74.0	20
	315	30	20	108	0.185	0.999	4.0	70.0	74.0	40
	640	15	4	112	0.036	0.999	4.0	70.0	74.0	16
	1000	15	0	0	--	0.999	4.0	70.0	74.0	0
Total	334	6,853	5,134	9,414	0.652					

Appendix C. Temporal distribution of daily sonar counts attributed to fall chum salmon in Sheenjek River, 1993.

Hour	08–Aug	09–Aug	10–Aug	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
0100	1 [a]	1	10	3	3	17	15	8	18	28	31	7	22	0	0	14	8
0200	4	1	21	17	8	12	12	21	8	38	8	9	20	2	2	13	8
0300	2	1	5	16	10	34	6	17	7	35	12	33	41	3	11	9	24
0400	3	1	24	12	13	15	13	17	24	40	18	24	50	7	15	10	27
0500	3	1	23	10	14	17	25	30	42	26	6	15	55	3	14	17	15
0600	1	1	10	5	14	20	7	21	18	38	26	27	26	3	0	17	13
0700	1	1	4	6	32	5	14	2	14	15	15	4	21	3	9	12	7
0800	2	2	11	5	12	6	2	18	7	22	4	27	26	5	0	6	4
0900	2	11	6	2	11	3	1	30	2	7	7	3	42	1	1	1	2
1000	1	4	1	2	13	2	0	3	4	13	1	7	11	0	0	0	2
1100	0	2	0	2	7	8	8	3	12	5	16	3	30	0	0	0	0
1200	1	4	10	2	2	6	6	3	32	2	18	7	12	3	0	1	0
1300	1	2	7	2	5	6	4	9	23	5	18	2	9	2	3	0	0
1400	2	3	12	2	0	8	5	3	22	12	1	8	14	2	9	2	0
1500	1	2	2	2	15	3	2	0	22	8	6	5	14	21	1	11	0
1600	1	0	2	8	0	7	11	30	18	0	4	7	19	23	1	0	0
1700	2	6	6	7	5	16	3	20	18	10	1	3	20	3	0	4	1
1800	2	9	1	8	10	9	7	5	8	10	3	5	1	0	0	8	1
1900	3	11	28	5	3	5	2	6	3	1	0	3	5	1	0	0	1
2000	2	5	19	2	5	2	4	0	2	4	3	4	6	14	0	1	1
2100	10	0	2	2	1	7	4	5	4	4	9	9	8	0	1	0	0
2200	0	3	2	13	8	5	2	6	1	12	8	33	9	3	6	3	0
2300	0	15	31	4	11	2	9	10	0	17	22	39	5	10	26	14	21
2400	0	9	19	6	15	12	13	24	37	15	8	32	0	8	25	14	42
	45	95	256	143	217	227	175	291	346	367	245	316	466	117	124	157	177

[a] Expanded by average percent passage on subsequent 3 days.
[b] Expanded by average percent passage on previous 3 days.

– continued –

Appendix C. (p 2 of 3)

Hour	25–Aug	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	10–Sep	11–Sep
0100	3	14	21	27	23	80	38	69	50	49	112	82	171	96	142	118	79	41
0200	2	14	4	54	29	54	36	99	49	32	120	76	160	76	106	111	86	44
0300	8	8	19	24	5	58	33	101	50	33	154	132	149	84	148	94	60	36
0400	7	18	32	21	8	42	113	53	37	61	115	179	173	110	127	86	58	40
0500	57	51	20	29	12	39	103	76	8	61	141	123	110	107	143	72	57	45
0600	5	9	8	15	17	62	76	55	27	86	140	106	112	121	154	58	39	25
0700	0	2	5	9	11	78	116	90	28	40	123	101	100	74	133	60	22	7
0800	0	1	22	0	0	49	90	26	17	26	83	108	96	60	81	47	22	8
0900	0	0	9	0	0	30	55	62	27	217	82	86	100	38	108	30	19	1
1000	6	2	0	2	0	18	24	77	30	79	81	123	82	52	147	37	11	0
1100	1	0	0	0	0	8	9	21	29	139	134	97	46	86	109	37	7	5
1200	0	0	0	0	2	7	23	14	4	134	131	53	117	118	97	27	5	6
1300	0	0	0	0	0	1	3	23	13	140	116	93	6	116	93	30	8	7
1400	2	0	0	1	2	1	10	26	1	128	57	59	6	96	143	23	3	0
1500	3	2	2	0	0	1	9	22	6	147	121	125	1	85	86	20	6	1
1600	0	11	8	9	0	1	3	32	26	59	108	58	14	98	86	26	0	0
1700	1	0	4	7	0	2	6	16	34	145	99	12	7	105	160	48	1	1
1800	3	0	10	17	0	1	1	0	66	60	111	12	8	147	114	54	1	6
1900	2	1	6	15	6	2	1	0	4	57	127	39	14	89	98	28	0	0
2000	0	2	0	14	28	9	7	8	6	49	97	74	16	134	103	20	6	11
2100	0	0	0	16	12	2	6	8	16	88	80	44	22	185	62	19	3	11
2200	6	2	8	4	53	10	114	27	49	100	60	57	8	126	95	72	13	23
2300	38	75	25	23	89	43	70	90	45	46	90	119	87	113	83	115	41	36
2400	12	36	5	9	72	49	53	50	10	116	75	139	68	98	102	68	33	47
	156	248	208	296	369	647	999	1,045	632	2,092	2,557	2,097	1,673	2,414	2,720	1,300	580	401

[a] Expanded by average percent passage on subsequent 3 days.
[b] Expanded by average percent passage on previous 3 days.

– continued –

Appendix C. (p 3 of 3)

Hour	12–Sep	13–Sep	14–Sep	15–Sep	16–Sep	17–Sep	18–Sep	19–Sep	20–Sep	21–Sep	22–Sep	23–Sep	24–Sep	25–Sep	26–Sep	27–Sep	28–Sep	Total	Percent
0100	35	38	29	7	30	47	35	109	81	80	171	120	86	54	20	56	33	1,031	0.055
0200	36	58	12	16	37	54	64	59	94	131	168	114	69	57	22	14	41	1,046	0.056
0300	67	47	6	37	24	87	81	36	82	105	144	125	54	33	29	28	42	1,027	0.055
0400	124	74	12	36	27	88	69	58	90	101	108	100	18	37	26	14	39	1,021	0.055
0500	61	49	38	16	22	111	37	40	58	110	82	32	31	19	54	51	23	834	0.045
0600	23	42	23	19	11	84	76	44	40	130	44	28	34	11	36	68	17	730	0.039
0700	4	7	6	0	3	70	21	85	54	189	65	53	30	20	38	7	16	668	0.036
0800	2	7	0	0	1	100	2	61	151	224	147	56	65	95	84	27	4	1,026	0.055
0900	2	0	0	0	1	109	12	68	51	167	132	48	125	115	74	25	5	934	0.050
1000	14	1	0	0	0	139	32	43	46	190	97	43	90	60	66	24	4	849	0.045
1100	8	0	0	4	0	25	1	29	32	81	30	42	70	84	52	19	27[a]	504	0.027
1200	0	2	0	0	0	27	5	14	30	5	40	17	23	29	47	27	18	284	0.015
1300	1	0	1	0	1	58	7	23	0	87	43	16	71	36	101	6	25	476	0.025
1400	0	0	0	0	12	39	14	27	2	71	14	71	75	36	80	2	21	464	0.025
1500	3	1	0	1	35	24	116	25	5	73	12	49	124	27	33	3	11	542	0.029
1600	3	2	9	0	23	7	14	43	13	82	19	33	91	43	46	2	16	446	0.024
1700	1	1	0	1	16	2	66	53	15	66	47	95	116	13	30	18	11	551	0.029
1800	1	0	0	0	12	5	19	52	22	241	44	43	81	31	58	11	18	638	0.034
1900	0	0	0	1	7	14	27	56	30	249	39	16	47	32	53	14	18	603	0.032
2000	4	1	2	1	14	2	62	35	26	140	69	74	60	49	34	14	17	604	0.032
2100	5	2	6	10	26	14	99	121	44	135	120	144	87	76	28	26	23	966	0.052
2200	22	5	30	8	20	31	70	58	73	168	149	172	120	43	58	47	26	1,100	0.059
2300	18	8	63	18	32	15	27	124	83	302	90	138	58	34	42	32	19	1,103	0.059
2400	31	28	114	22	53	24	97	96	70	255	131	174	30	49	47	33	23	1,277	0.068
	465	373	351	197	407	1,176	1,053	1,359	1,192	3,382	2,005	1,803	1,655	1,083	1,158	568	497	16,724	

[a] Expanded by average percent passage on subsequent 3 days.
[b] Expanded by average percent passage on previous 3 days.

Appendix D. Spatial distribution of sonar counts attributed to chum salmon in the Sheenjek River, 1993.

Date	Electronic Sector [a] 1	2	3	4	5	6	7	8	9	10	11	12	Total	Daily Percent	Cumulative Percent	Date
09-Aug	65	14	2	6	0	1	2	1	3	2	0	0	96	0.002	0.002	09-Aug
10-Aug	160	10	21	6	2	4	3	25	14	15	1	2	263	0.006	0.008	10-Aug
11-Aug	82	13	13	9	1	0	1	5	7	9	0	0	140	0.003	0.012	11-Aug
12-Aug	63	21	68	20	2	1	3	15	16	10	2	2	223	0.005	0.017	12-Aug
13-Aug	62	16	50	32	5	3	10	13	22	10	1	0	224	0.005	0.022	13-Aug
14-Aug	70	20	18	5	4	2	4	10	33	10	0	0	176	0.004	0.026	14-Aug
15-Aug	82	18	21	24	6	9	19	25	34	43	2	11	294	0.007	0.033	15-Aug
16-Aug	75	8	32	38	9	5	12	62	38	35	0	29	343	0.008	0.041	16-Aug
17-Aug	93	29	26	34	5	2	29	26	28	28	8	60	368	0.009	0.050	17-Aug
18-Aug	59	9	24	39	4	7	23	38	11	5	0	27	246	0.006	0.056	18-Aug
19-Aug	159	19	41	72	6	4	6	4	3	2	0	0	316	0.007	0.063	19-Aug
20-Aug	265	36	63	19	2	1	32	29	13	5	1	2	468	0.011	0.074	20-Aug
21-Aug	47	52	5	2	1	1	5	3	1	0	1	0	118	0.003	0.077	21-Aug
22-Aug	54	32	19	1	0	0	3	4	2	3	6	0	124	0.003	0.080	22-Aug
23-Aug	50	46	48	4	0	0	4	3	1	0	1	0	157	0.004	0.083	23-Aug
24-Aug	32	71	61	6	1	0	0	2	2	0	0	0	175	0.004	0.088	24-Aug
25-Aug	48	15	70	13	1	1	4	0	1	0	1	2	156	0.004	0.091	25-Aug
26-Aug	20	107	93	18	4	2	3	3	1	0	1	2	254	0.006	0.097	26-Aug
27-Aug	20	41	96	33	4	6	1	3	5	1	0	0	210	0.005	0.102	27-Aug
28-Aug	37	116	118	13	0	1	0	1	5	2	2	0	295	0.007	0.109	28-Aug
29-Aug	10	77	203	35	5	5	10	10	6	5	2	3	371	0.009	0.118	29-Aug
30-Aug	47	188	317	40	1	3	13	5	15	8	2	5	644	0.015	0.133	30-Aug
31-Aug	76	377	405	43	3	5	23	32	25	11	0	2	1,002	0.024	0.156	31-Aug
01-Sep	63	336	507	42	2	2	33	35	11	8	0	1	1,040	0.024	0.181	01-Sep
02-Sep	125	229	168	35	2	4	38	21	6	1	2	1	632	0.015	0.196	02-Sep
03-Sep	1,070	496	441	11	0	0	46	24	3	3	1	0	2,095	0.049	0.245	03-Sep
04-Sep	1,202	683	469	10	2	3	4	2	1	2	0	0	2,578	0.061	0.305	04-Sep
05-Sep	899	582	595	8	0	0	1	1	2	0	1	1	2,090	0.049	0.354	05-Sep
06-Sep	1,035	467	171	1	0	0	0	1	1	0	0	0	1,675	0.039	0.394	06-Sep
07-Sep	672	469	341	289	215	206	125	66	10	10	9	6	2,416	0.057	0.450	07-Sep
08-Sep	276	499	571	530	290	250	216	87	3	0	0	0	2,721	0.064	0.514	08-Sep
09-Sep	222	202	290	182	89	140	135	36	1	0	0	1	1,298	0.030	0.545	09-Sep
10-Sep	233	148	106	53	31	5	0	3	0	1	0	0	580	0.014	0.558	10-Sep
11-Sep	136	89	102	42	28	4	0	0	0	0	0	1	402	0.009	0.568	11-Sep
12-Sep	207	137	70	26	3	4	6	5	6	0	0	0	464	0.011	0.579	12-Sep
13-Sep	115	155	94	11	0	0	0	0	0	0	0	0	375	0.009	0.588	13-Sep
14-Sep	157	105	82	6	0	1	0	0	0	0	0	0	351	0.008	0.596	14-Sep
15-Sep	17	80	77	13	0	0	1	0	0	0	0	9	197	0.005	0.600	15-Sep
16-Sep	232	73	86	8	0	0	4	5	0	0	0	0	408	0.010	0.610	16-Sep
17-Sep	917	117	48	9	0	0	0	47	39	0	0	0	1,177	0.028	0.638	17-Sep
18-Sep	683	347	17	0	0	0	0	0	0	0	1	0	1,048	0.025	0.662	18-Sep
19-Sep	980	358	9	0	0	0	0	0	0	0	0	0	1,347	0.032	0.694	19-Sep
20-Sep	790	388	11	1	0	0	0	0	0	0	0	0	1,190	0.028	0.722	20-Sep
21-Sep	2,750	576	46	3	0	1	0	0	1	1	0	0	3,378	0.079	0.801	21-Sep
22-Sep	1,210	635	140	12	2	0	0	0	0	0	0	0	1,999	0.047	0.848	22-Sep
23-Sep	1,105	510	156	22	6	1	1	1	0	1	1	0	1,804	0.042	0.890	23-Sep
24-Sep	1,065	467	101	17	1	0	0	0	1	0	0	0	1,652	0.039	0.929	24-Sep
25-Sep	442	392	204	29	7	0	0	0	0	0	0	0	1,074	0.025	0.954	25-Sep
26-Sep	491	419	184	53	13	1	1	0	0	0	0	0	1,162	0.027	0.982	26-Sep
27-Sep	183	190	141	35	9	4	0	0	0	0	0	1	563	0.013	0.995	27-Sep
28-Sep [b]	72	96	39	9	2	0	0	0	0	0	0	0	218	0.005	1.000	28-Sep
Total	19,024	10,779	7,080	1,968	768	689	820	653	371	231	46	168	**** [c]			
Percent	0.447	0.253	0.166	0.046	0.018	0.016	0.019	0.015	0.009	0.005	0.001	0.004				

[a] Sector 1 is nearest shore.
[b] Partial count.
[c] Totals do not match those of Appendix C due to rounding differences in daily totals as well as exclusion of expanded counts on 8 August and 28 September.

Appendix E. Comparative age and sex composition of fall chum salmon sampled iin the Sheenjek River, 1974–1993. [a]

Year	Age 0.2	Age 0.3	Age 0.4	Age 0.5	Sample Size	Male:Female ratio of Age Sample	Total Fish Collected	Male:Female ratio of fish Collected
1974 [b]	0.660	0.300	0.030	0.000	137	1.00:1.32		
1975 [b]	0.035	0.950	0.015	0.000	197	1.00:1.37		
1976 [b]	0.020	0.440	0.540	0.000	118	1.00:1.19		
1977 [b]	0.110	0.730	0.160	0.000	178	?		
1978 [b]	0.080	0.820	0.100	0.000	190	?		
1979	--	--	--	--	--	--		
1980	--	--	--	--	--	--		
1981 [c]	0.030	0.850	0.120	Tr	340	1.00:0.93		
1982 [c]	0.030	0.470	0.500	Tr	109	1.00:1.79		
1983 [c]	0.065	0.870	0.065	0.000	108	1.00:0.86		
1984 [d]	0.100	0.810	0.090	0.000	297	1.00:0.65		
1985 [d]	0.010	0.930	0.060	0.000	513	1.00:0.70		
1986 [d]	0.080	0.410	0.500	0.010	442	1.00:1.15		
1987 [d,f]	0.020	0.900	0.070	0.010	431	1.00:1.97		
1988 [d,f]	0.025	0.683	0.292	0.000	120	1.00:4.30	122	1.00:4.55
1989 [d]	0.052	0.766	0.169	0.013	154	1.00:1.44	340	1.00:1.31
1990 [d]	0.028	0.706	0.252	0.014	143	1.00:0.95	326	1.00:1.06
1991 [d]	0.000	0.592	0.395	0.014	147	1.00:0.77	406	1.00:1.14
1992 [d]	0.000	0.179	0.806	0.015	134	1.00:1.13	138	1.00:1.16
1993 [d,f]	0.005	0.640	0.339	0.016	201	1.00:0.79	226	1.00:0.74

[a] Age determination from scales 1974–1985 and from vertebrae 1986–1993. Age designation is European.
[b] Carcass samples from spawning grounds.
[c] Escapement samples taken with 5–7/8 in gillnets at rkm 10.
[d] Escapement samples taken with beach seine rkm 5–20.
[f] Escapement samples were predomiantly taken late in run.