AYK Region
Yukon Salmon Escapement
Report 28

ENUMERATION OF FALL CHUM SALMON BY SIDE-SCANNING SONAR IN THE SHEENJEK RIVER IN 1985

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ABSTRACT

Fall chum salmon escapement in the Sheenjek River was monitored by hydroacoustic techniques for the fifth consecutive year in 1985. The sonar-estimated escapement was 152,768 from 2-29 September. Mean date of run passage was 18 September, being later than the runs in 1981 through 1984.

Sonar-estimated escapements for 1981 through 1984 were expanded to more accurately reflect comparative chum salmon escapement in those years for approximately the same period (late August through late September). Aerial escapement estimates in the Sheenjek River for the years 1974 through 1980 were expanded to cumulative escapements to more accurately examine escapement trends.

Beach seine samples in 1985 were composed of 1% age 3_1; 93% age 4_1; and 6% age 5_1 chum salmon. Fish samples were also collected for subsequent electrophoretic analysis.

INTRODUCTION

Yukon River fall chum salmon are in great demand commercially and are harvested in 6 fishing districts, including portions of the Tanana River. No commercial fishing is permitted in the Koyukuk or Porcupine River drainages. The majority of commercial catches are presently made in the lower river, downstream of the village of Anvik. However, their value as a subsistence item is far greater throughout the upper Yukon River drainage upstream of the village of Koyukuk. Fall chum salmon are larger, spawn later, and are less abundant than their counterpart, summer chum salmon. They primarily spawn in the upper Yukon River drainage (upstream of the village of Tanana) in spring-fed tributaries which usually remain ice-free during the winter.

Total abundance estimates for fall chum salmon returns to the Yukon River are lacking. At best, only various segments of annual returns have been estimated in some years since 1961 from tag and recapture studies. Excluding these tagging studies and apart from aerial assessment of selected tributaries since the early 1970's, comprehensive enumeration studies of fall chum salmon in the Yukon River drainage have been limited to only 3 streams. The Canadian Department of Fisheries and Oceans collected abundance and timing information on fall chum salmon spawning populations in the Fishing Branch River (Porcupine River drainage) from 1972 through 1975 (Elson 1976) and again in 1985 with reinstallation of a weir several miles downstream of the main spawning area. Abundance, timing, and distribution information on spawning populations in the Delta River (Tanana River drainage) was collected from 1973 through 1978 during the construction period of the Trans-Alaska Pipeline (Dinneford 1978) and again in 1985 (Barton 1986). Abundance and timing data on Sheenjek River fall chum salmon escapements have been monitored annually by hydroacoustic techniques since 1981.

The Sheenjek River heads in the glacial ice fields of the Romanzof Mountains, a northeastern extension of the Brooks Range, and flows southward approximately 250 rivermiles to its confluence with the Porcupine River. Although created by glaciers, the river's numerous clearwater tributaries quickly convert it to a clearwater stream. Water clarity is somewhat unpredictable, but generally clearest during periods of low water; water level normally begins dropping in late August and September. Upwelling ground water comprises 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 100 miles of the river.

Prior to 1985, fall chum salmon were enumerated in the Sheenjek River with a single side-scanning sonar counter developed by the Hydrodynamics Division of Bendix Corporation. A 1977-model counter was used in 1984 and 1983, whereas a 1981-model counter was used in 1981 and 1982. Site location was the same in all 4 years, with the sonar counter and artificial aluminum substrate being deployed from a gravel bar on the west riverbank approximately 6 rivermiles upstream of the mouth (Figure 1). During these studies, particularly the 1984 investigations, it was evident that an unknown but relatively small percentage of salmon passed the project site undetected by sonar with only a single sonar counter operating from the west bank (Barton 1985). A large proportion of those fish did so as a

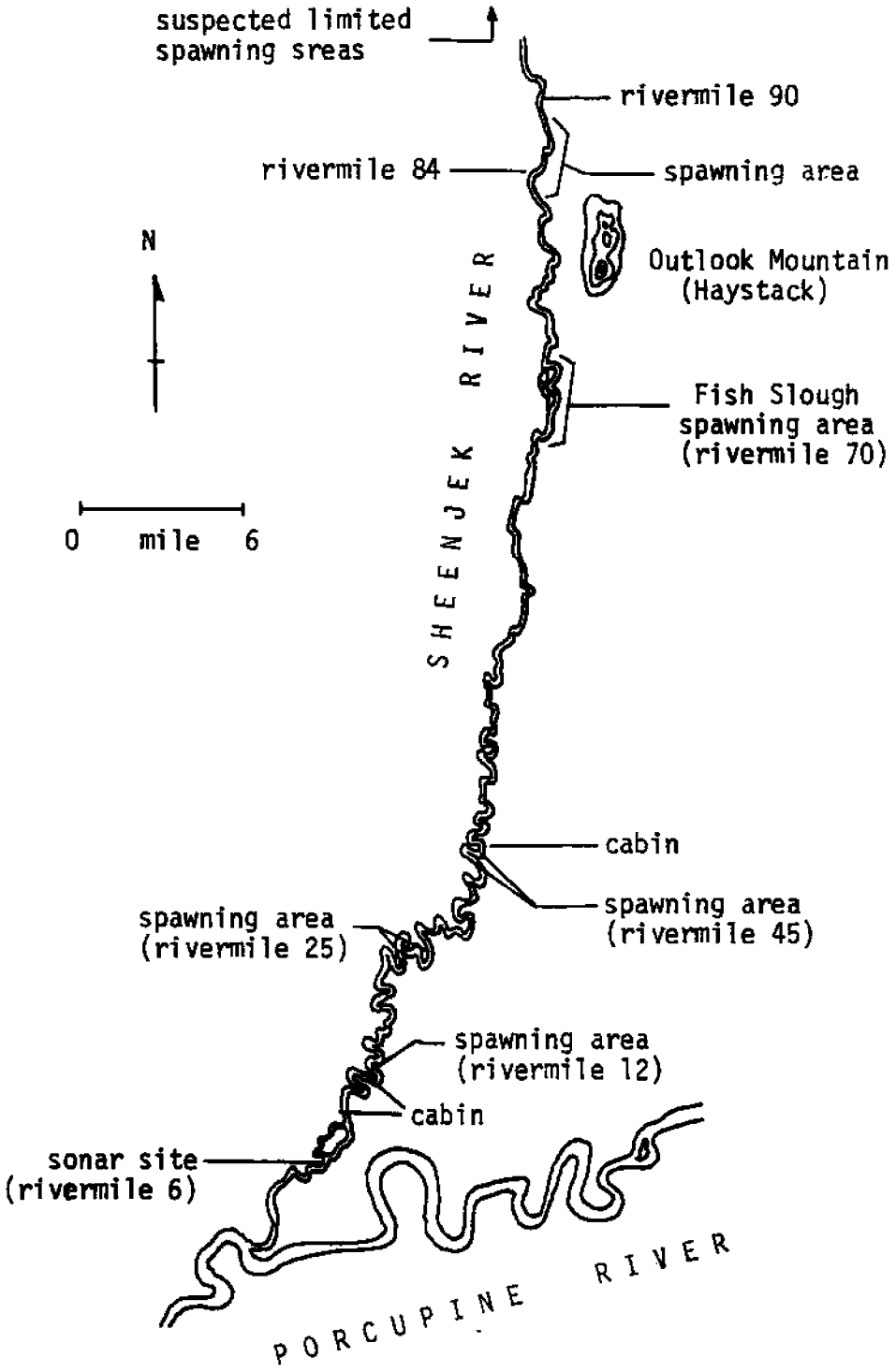

Figure 1. Sheenjek River sonar counting site and important fall chum salmon spawning areas.

result of substrate avoidance. It was hypothesized that upstream-migrant chum salmon oriented along the west bank before reaching the counting site due to physical and hydrological characteristics of the river, although fish were dispersed throughout the river in shallower water zones well below the project site. To address the problem of substrate avoidance, it was recommended that 2 sonar counters be operated (1 from each riverbank) and without the use of artificial substrates in future years if a suitable site could be located. This was attempted in 1985.

OBJECTIVES

Objectives of the 1985 Sheenjek River fall chum salmon study were to determine timing and magnitude of adult salmon escapement and to collect age-sex-size information on sampled portions of the escapement. The following specific objectives were identified:

1. install 2 side-scanning sonar units (1 from either riverbank) to enumerate upstream-migrant chum salmon;

2. collect samples from the escapement with a beach seine to evaluate age-sex-size composition;

3. monitor selected climatological and hydrological parameters daily at the project site for use as baseline reference data.

METHODS

In lieu of attempting to operate 2 side-scan sonar counters without artificial substrates, the river bottom was examined at several locations in the vicinity of the project site to locate an area of the smoothest river contour and bottom substrate. A suitable location was found approximately 100 yards upstream from where the west bank counter had been deployed in previous years (Figure 2). A depth profile was made at this location on September 1 by stretching a one-quarter-inch rope across the river and measuring water depth every 10 feet with a precalibrated spruce pole (Figure 3). Riverbottom at the new location gently sloped from either bank with a shallow thalweg occurring more toward midstream, thus allowing for the deployment of a sonar transducer from either bank. In previous years a single sonar unit was operated from the shallow gravel bar side of a bend in the river; the thalweg was relatively deep and existed along the cut-bank side of the river at that location.

In 1985 2 side-scan sonar counters were operated at the new location and without deployment of the artificial aluminum substrates. A 1977-model counter was operated on the west bank and a 1981-model counter from the east bank. Each transducer was mounted to a holding pod constructed of 3/4" copper tubing and 1/2" plywood (Figure 4). Once positioned, transducer pods were secured in place with sandbags. Pre-drilled holes in a 1/2" piece of plywood secured to the transducer pod facilitated optimum placement of the transducer plate with respect to distance off riverbottom. Transducer aiming was accomplished by adjusting the handwheel/tension spring assembly.

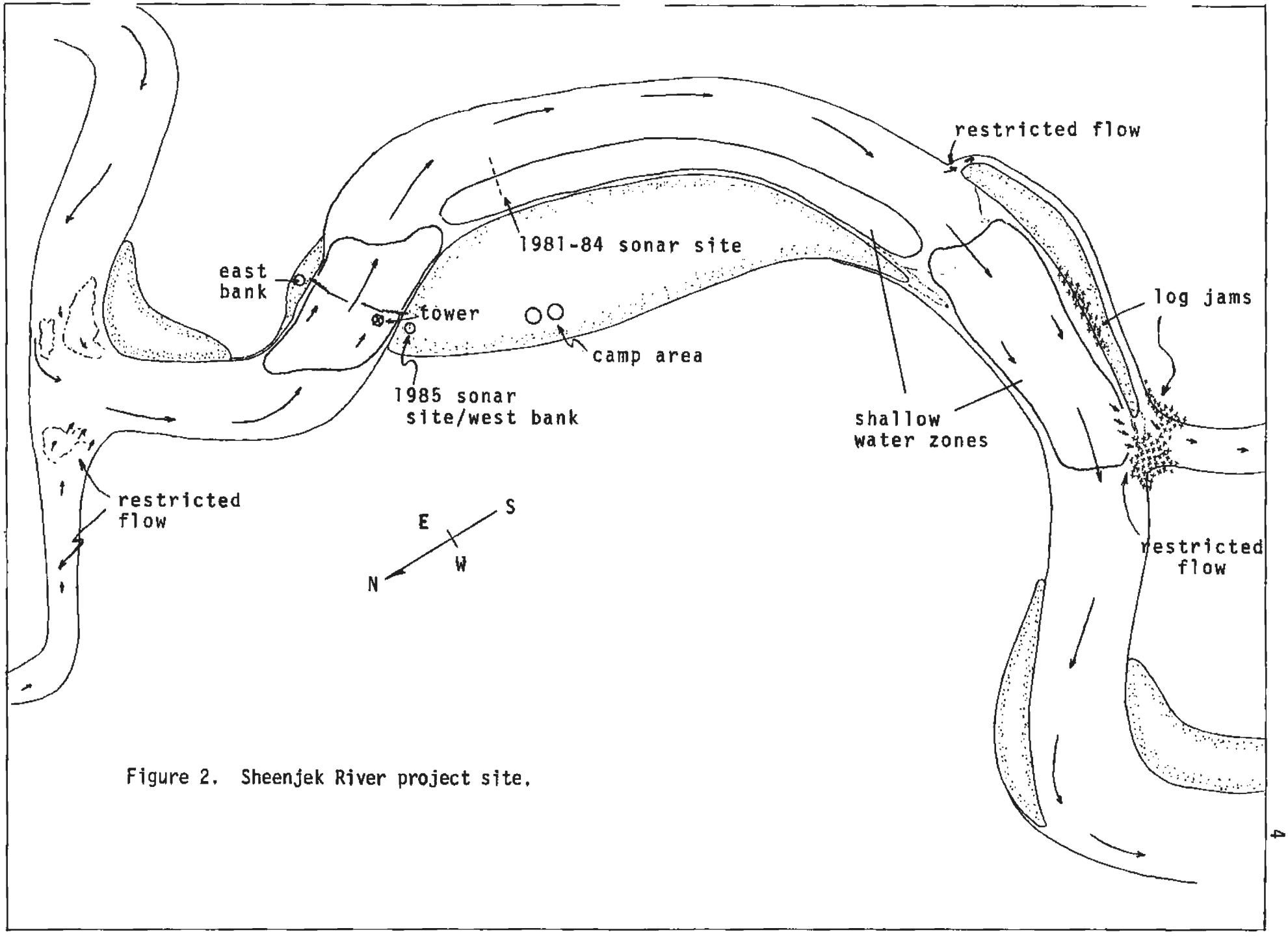

Figure 2. Sheenjek River project site.

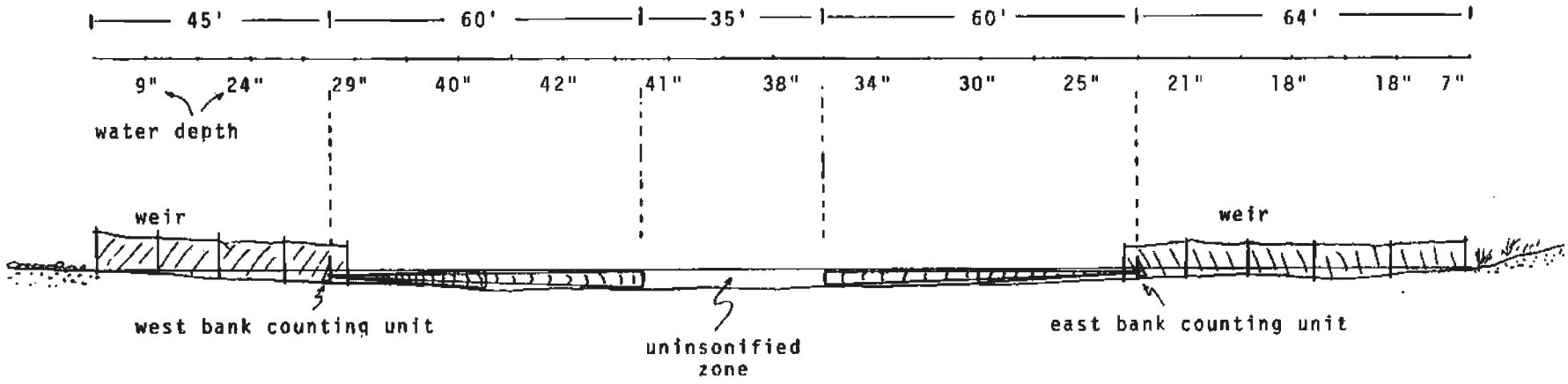

Figure 3. Sheenjek River depth profile at the sonar counting site on September 1, 1985.

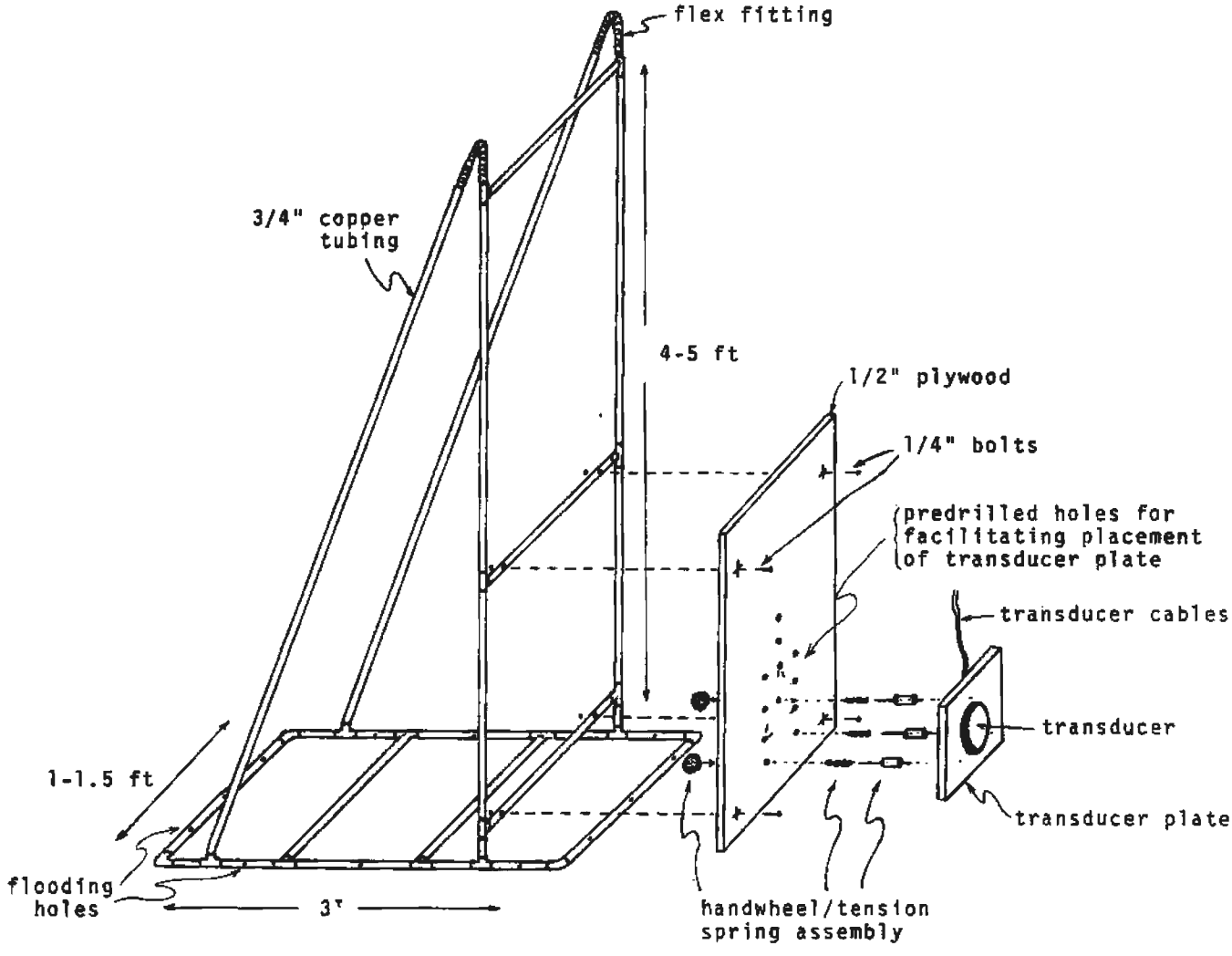

Figure 4. Prefabricated transducer holding pod.

An adult salmon weir was constructed to shore from each transducer pod, preventing salmon from passing upstream, inshore of the transducers. Weirs were constructed of 1"x2" cattle fencing and 8-foot metal "T" stakes. In addition, a 20-foot aluminum counting tower was assembled and deployed near the west bank transducer pod to facilitate visual and oscilloscope calibrations of the west bank sonar counter.

Daily oscilloscope-sonar calibrations were made for each counter and calibration procedures were the same as described by Barton (1983a). Important differences between the 1977- and 1981-model sonar counter can be found in Barton (1983b and 1985).

A beach seine (100 feet long, 66 meshes deep, 2.5-inch stretch measure mesh) was periodically fished approximately 6 miles upstream of the sonar site to sample adult salmon for age-sex-size composition. Captured fish were identified by species. Chum salmon were sexed by external examination, measured to the nearest 5 millimeters from mid-eye to fork of tail and 1 scale removed from each for subsequent age determination. Scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish. The adipose fin was clipped on each salmon to prevent resampling.

One hundred fifty chum salmon were further sampled for subsequent electrophoretic analysis. Tissue samples collected from each of these fish included muscle, heart, liver, and eye. The tissue samples from each fish were placed into sample bags. Sample bags were then placed into coolers containing dry ice before being flown back to Fairbanks where the containers were labeled according to population sampled, species, and dates collected. The containers were forwarded to the Canadian Department of Fisheries and Oceans in Nanaimo, B.C. for subsequent analysis.

A river water-level gauge (meter stick) was installed at the sonar site on September 2. Daily changes in water level and surface water temperature were measured at noon (Appendix Table 1). Surface water velocity was measured daily at each sonar transducer with a digital flow meter (Appendix Table 2 and Figure 5). Other daily observations included recording the occurrence of precipitation and percent cloud cover.

Three aerial surveys were flown of the Sheenjek River in 1985; one by ADF&G on September 6 and two by USFWS on August 14 and September 25 to determine abundance and distribution of adult salmon.

RESULTS AND DISCUSSION

Timing

Dates of Sheenjek River sonar operations in 1985 differed slightly from those in previous years. Counting commenced on September 2 and ended on September 29 due to budget constraints. This represents 2 to 4 days later in start-up and 4 to 7 days later in project termination. Operations began on August 30, 29, and 31 for the years 1984, 1983, and 1982-81, respectively. Project termination occurred on September 25 due to budget

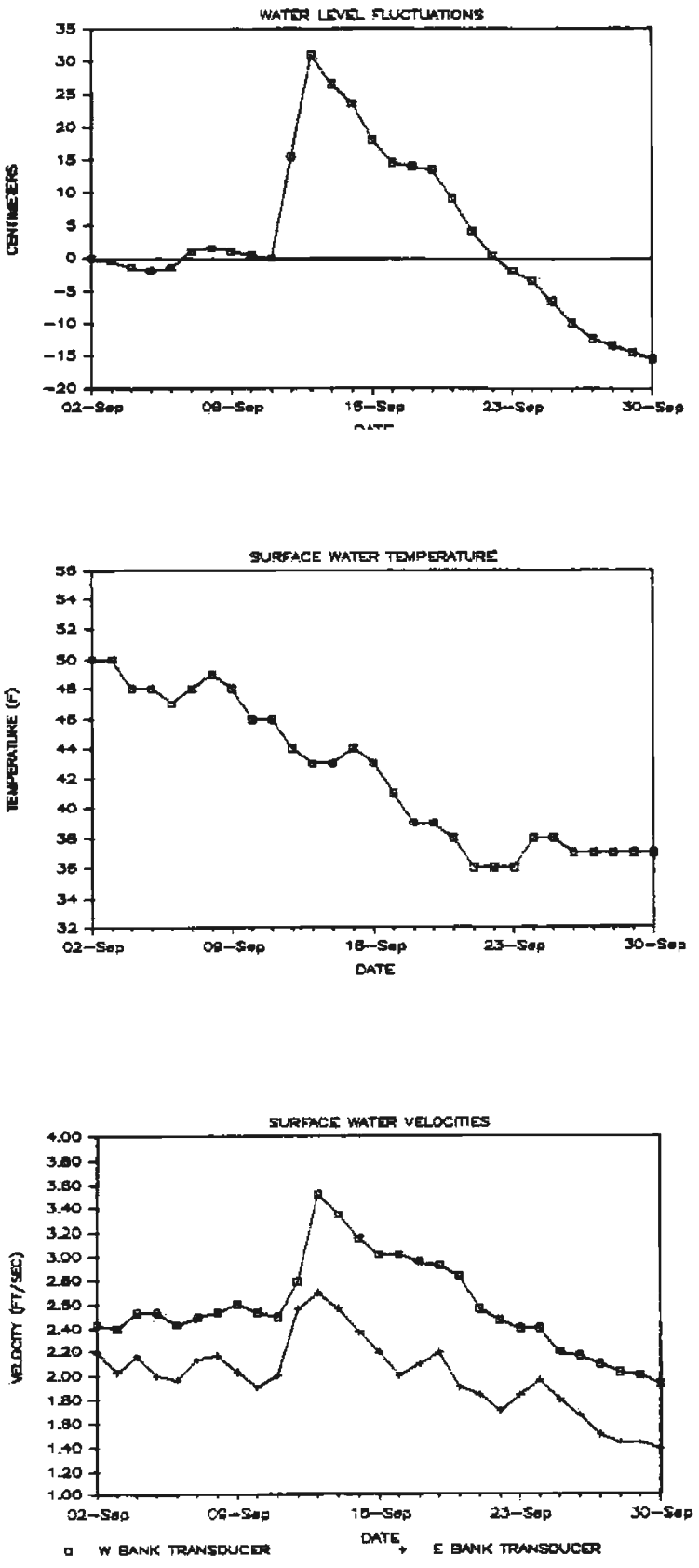

Figure 5. Water level fluctuations, surface temperatures, and surface velocities at the Sheenjek River project site from 2-30 September 1985.

constraints in 1984, September 24 due to river icing in 1983, September 22 due to high water conditions in 1982, and September 24 due to inclement weather in 1981.

Barton (1983a) pointed out that there is evidence the fall chum salmon run to the Sheenjek River commences sometime prior to or near mid-August; i.e., at least 2 weeks prior to the beginning of sonar operations. An aerial survey flown by USFWS on August 14 of this year revealed 700 chum salmon in the lower 8 to 10 miles of the Sheenjek River. These fish were not associated with redds and appeared to have recently entered the river, moving upstream (John Hawkinson, personal communications, USFWS). Thus, it is unlikely these fish were summer chums, which are normally well into spawning by this date, but rather the forerunners of the fall chum salmon run to the Sheenjek River. Forty-three spawning king salmon, 2 king salmon carcasses, and 20 king salmon redds were also documented in the vicinity of Outlook Mountain during this survey. This was the first documented report of king salmon by a State or Federal agency in the Sheenjek River since 2 king salmon carcasses were observed on October 3, 1978 (Barton 1984).

Sonar operations have also terminated each year prior to the end of the salmon run by an unknown number of days. It is hypothesized, however, that a relatively small portion of the total run passes subsequent to the termination of annual sonar operations in most years based upon results of historic aerial surveys of the Sheenjek River. Generally, salmon are present and spawning at most major spawning areas by late September.

Mundy (1982, 1984) developed a time-density model to describe salmon migration run timing. The pattern of the migration is described by the mean date of passage (a measure of the central tendency) and the standard deviation (a measure of dispersion). These statistics are calculated from the proportion of the total escapement occurring each day. Further, the median date is the date by which 50% of the sonar estimate was made during each year. These statistical parameters are given below for the migration of fall chum salmon into the Sheenjek River during the past 5 years based on sonar counts from roughly late August through late September:

Year	Mean date(md)	Md standard deviation	Median date	Dates of sonar operation
1981	September 8	5.12	September 7	8/31-9/24
1982	September 12	6.50	September 14	8/31-9/22
1983	September 13	7.26	September 14	8/29-9/24
1984	September 11	7.67	September 9	8/30-9/25
1985	September 18	7.46	September 20	9/2-9/29

Realizing that actual counting dates have varied slightly from year to year, these data, nonetheless, suggest run timing to have been the earliest in 1981, and the latest in 1985. It is thus likely that a higher

proportion of the run in 1981 was unsampled in the 2 weeks prior to sonar operations than in 1982 through 1985. Figure 6 illustrates run timing for each year.

Relative run timing differences observed in the Sheenjek River from 1981 through 1985, using sonar data for common days monitored each year (September 2-22), are somewhat similar to relative timing differences of fall chum salmon migrations in the mainstem Yukon River past the Ruby area based upon north bank test fishwheel catches from August 13 to 31 (common days sampled in each year) (Table 1). Past tagging studies have indicated fall chum salmon are largely bank-oriented by the time they reach the Ruby area, with those along the north bank mostly bound for spawning streams in the upper Yukon River drainage (including the Porcupine River system) (Buklis 1981a). North bank catches peaked earliest in 1981 and latest in 1983 and 1985.

The distinct diel pattern in salmon movement observed in the Sheenjek River in previous years was not as pronounced in 1985, particularly along the west bank (Figure 7). Reason for the higher percentage of upstream migration during daylight hours in 1985 is not clearly understood. Several factors may have contributed to the apparent change in this upstream migration behavior.

Salmon holding or milling in the immediate counting area prior to moving to upstream spawning areas or spawning in the immediate vicinity could not only contribute to such a phenomenon, but also result in major overcounting problems. However, this was not observed at the new counting site to any great extent. Milling problems, as experienced in 1981, created from slow water velocities across the artificial aluminum substrate (Barton 1982), were eliminated in 1985 since substrates were not used. Thus, it seems more reasonable to speculate that the increase in upstream migration during periods apart from those of suppressed light or darkness may have been related to density-dependent factors; i.e., a large run size coupled with late run timing. In any respect, highest counts were made, on the average, between 2000 and 2200 hours and between 0700 and 0800 hours in 1985.

Abundance

Both sonar counters were installed by late evening September 1 in 1985. However, actual counting did not begin until midnight due to the time required for trouble-shooting both systems and ensuring transducers were properly aimed. Whereas the west bank, 1977-model counter functioned properly throughout the duration of the project, the 1981-model, east bank counter was inoperable for 8 days during the period September 3 to 12 due to electronic failure. It was replaced with a second 1981-model counter on September 13 which remained operable through September 29.

Sonar estimates were adjusted daily and based upon oscilloscope calibrations of each counter. A total of 167 calibration periods averaging 25 minutes each occurred with the west bank counter, while 113, 25-minute calibration periods occurred with the east bank counter. The lower number of periods on the east bank reflect the 8 days the east bank unit was

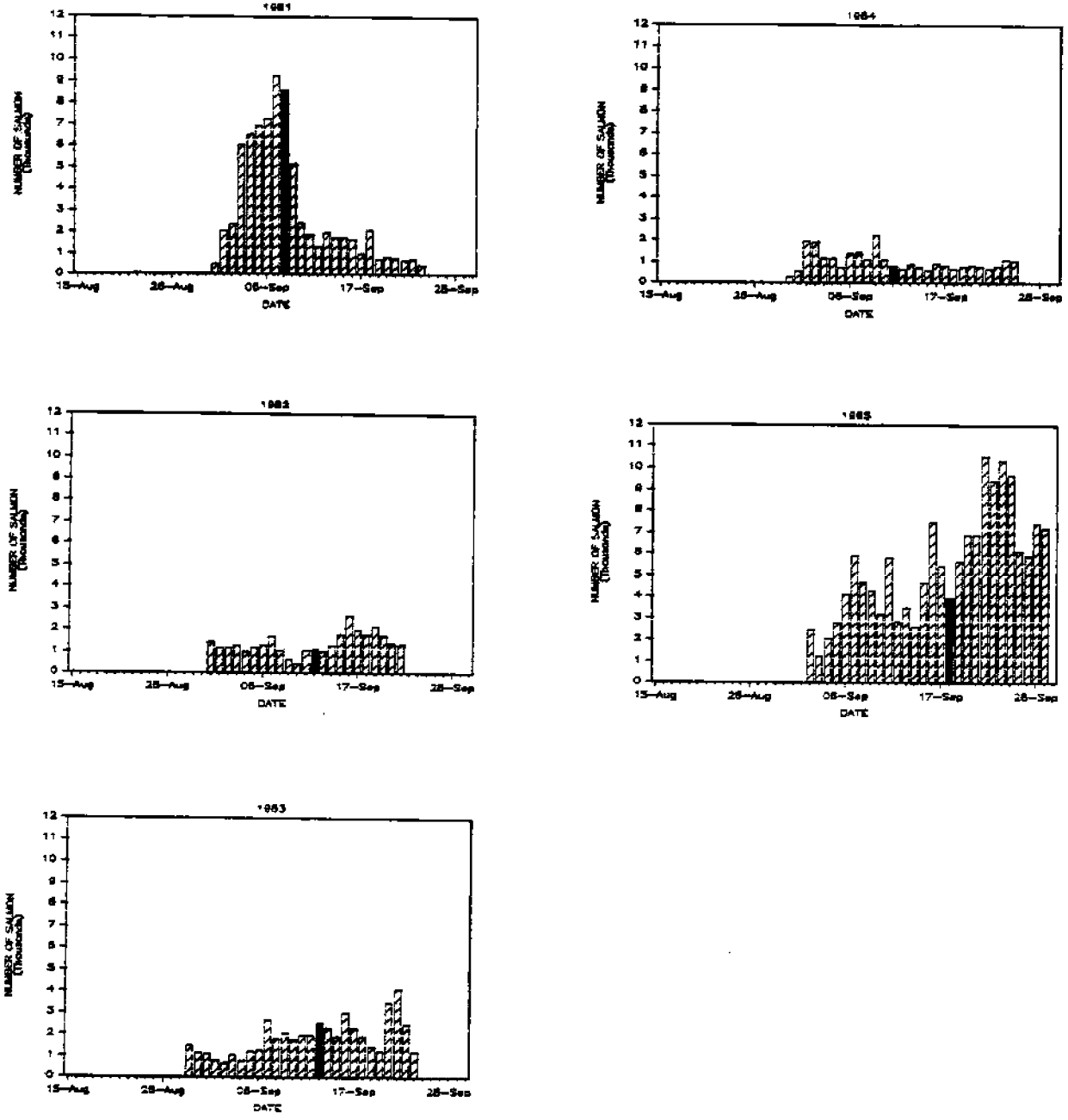

Figure 6. Fall chum salmon escapement timing in the Sheenjek River, 1981-1985. Mean date of passage is represented by shaded bar.

Table 1. Comparison of fall chum salmon run timing between north bank test fishwheel catches near Ruby and Sheenjek River sonar counts based upon mean date of passage, 1981-1985.[a]

YEAR	RUBY NORTH BANK [b]		SHEENJEK SONAR [c]		DIFFERENCE BETWEEN MEAN DATES
	MEAN DATE	STANDARD DEVIATION	MEAN DATE	STANDARD DEVIATION	
1981	19-Aug	4.22	08-Sep	4.68	20
1982	22-Aug	6.42	13-Sep	6.05	22
1983	25-Aug	4.63	13-Sep	5.74	19
1984	21-Aug	5.96	10-Sep	5.98	20
1985	23-Aug	6.10	14-Sep	5.95	22

a Test fishing data from Andersen (1983a, 1983b, In Prep).

b Includes data from only 13-31 August; days fished common to each year.

c Includes data from only 2-22 September; days monitored common to each year.

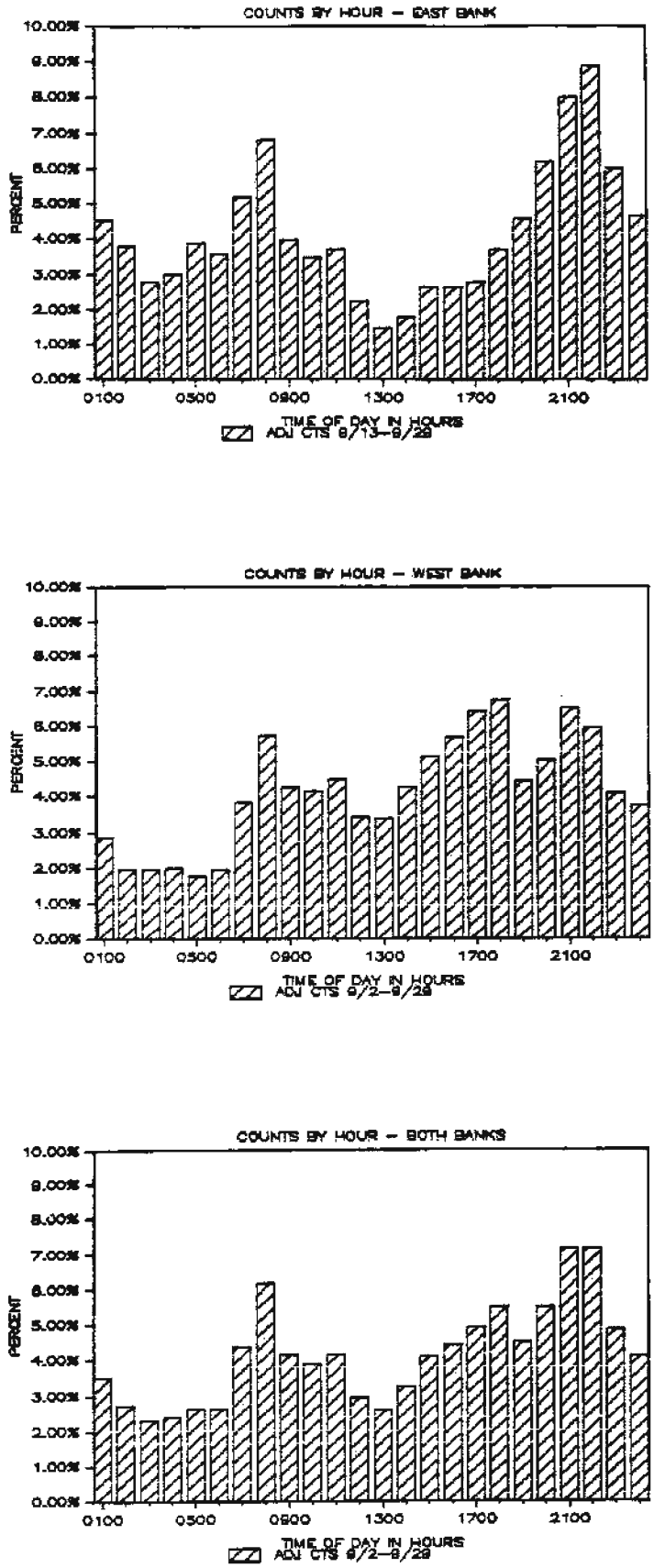

Figure 7. Average migration (percent) of fall chum salmon past the sonar site by time of day in the Sheenjek River from 2-29 September 1985.

inoperable. Calibration effort with each counter was placed on periods of the day when upstream salmon migration was heaviest. Together, 117 hours were devoted to sonar calibration as follows:

Time of day	West bank	East bank	Total
0001-0600 hrs	5% (4 hrs)	7% (3 hrs)	6% (7 hrs)
0601-1200 hrs	33% (23 hrs)	32% (15 hrs)	32% (38 hrs)
1201-1800 hrs	20% (14 hrs)	17% (8 hrs)	19% (22 hrs)
1801-2400 hrs	42% (29 hrs)	44% (21 hrs)	43% (50 hrs)
Total	70 hrs	47 hrs	117 hrs

The east bank sonar adjusted counts averaged 93% of the west bank sonar adjusted counts on those days both units were operable. Thus, estimates for the east bank were made for those days it was inoperable by multiplying the west bank adjusted counts on those days by a factor of 0.93. The resulting total adjusted sonar count from September 2-29 was 118,267 chum salmon (Table 2).

Both sonar units operated at the 60-foot counting range with a distance of 35 feet remaining uninsonified in midstream between the outer ends of each 60-foot beam (Figure 3). Unfortunately, distribution of fish crossing sonar beams could not be accurately determined by examining counts by electronic sector. It was observed, during calibration, that when the pulse repetition rate was adjusted to accurately count fish in the nearshore sectors, gross overcounts often occurred in the offshore sectors. This was most pronounced with the east bank, 1981 counting unit (Figure 8). Thus, whereas the overall adjusted count is accurate for each counting unit, the oscilloscope screen was too small to permit accurate calibration of counts by electronic sector for either unit. Therefore, these data cannot be used to accurately examine salmon distribution across the river.

Since it was apparent from visual observations from the counting tower that numerous salmon were indeed passing upstream in the uninsonified zone, the following technique was used to estimate that number:

$$\chi = \left(\frac{C_w + C_e}{r} \right) z$$

where χ = number of salmon in uninsonified zone
C_w = adjusted west bank count
C_e = adjusted east bank count
r = total counting range (120 ft)
z = uninsonified zone (35 ft)

Adjusted counts for the west and east bank were 45,162 and 42,715, respectively, for the period September 13 through 29. Substitution in the above equation results in an estimate of 25,630 salmon passing upstream in the uninsonified zone for a total of 113,507 salmon passing the project site during this period. Since 74.3% of the total September 2-29 adjusted sonar count occurred from September 13-29, expansion reveals a total estimate of 152,768 salmon passing the sonar site from September 2-29, of which 34,502 are estimated to have passed upstream in the uninsonified zone.

Table 2. Daily and cumulative sonar counts in the Sheenjek River from 2-29 September 1985.

DATE	EAST BANK	WEST BANK	DAILY	CUMULATIVE
02-Sep	1,066	827	1,893	1,893
03-Sep a	457	491	948	2,841
04-Sep a	772	830	1,602	4,443
05-Sep	816	1,339	2,155	6,598
06-Sep	1,248	1,943	3,191	9,789
07-Sep a	2,206	2,371	4,577	14,366
08-Sep a	1,732	1,861	3,593	17,959
09-Sep a	1,603	1,723	3,326	21,285
10-Sep a	1,169	1,256	2,425	23,710
11-Sep a	2,172	2,334	4,506	28,216
12-Sep a	1,048	1,126	2,174	30,390
TOTALS	14,289	16,101	30,390	
13-Sep	1,489	1,211	2,700	33,090
14-Sep	1,039	981	2,020	35,110
15-Sep	1,398	2,192	3,590	38,700
16-Sep	2,879	2,894	5,773	44,473
17-Sep	1,803	2,391	4,194	48,667
18-Sep	1,786	1,278	3,064	51,731
19-Sep	1,810	2,566	4,376	56,107
20-Sep	1,924	3,396	5,320	61,427
21-Sep	3,227	2,075	5,302	66,729
22-Sep	3,545	4,605	8,150	74,879
23-Sep	2,595	4,687	7,282	82,161
24-Sep	3,602	4,383	7,985	90,146
25-Sep	3,997	3,491	7,488	97,634
26-Sep	3,013	1,735	4,748	102,382
27-Sep	2,364	2,222	4,586	106,968
28-Sep	2,978	2,770	5,748	112,716
29-Sep	3,266	2,285	5,551	118,267
TOTALS	42,715	45,162	87,877	
GRAND TOTAL	57,004	61,263	118,267	118,267

a Days on which east bank counts were estimated due to electronic failure of that counter. East bank counts were estimated as 93% of the west bank counts.

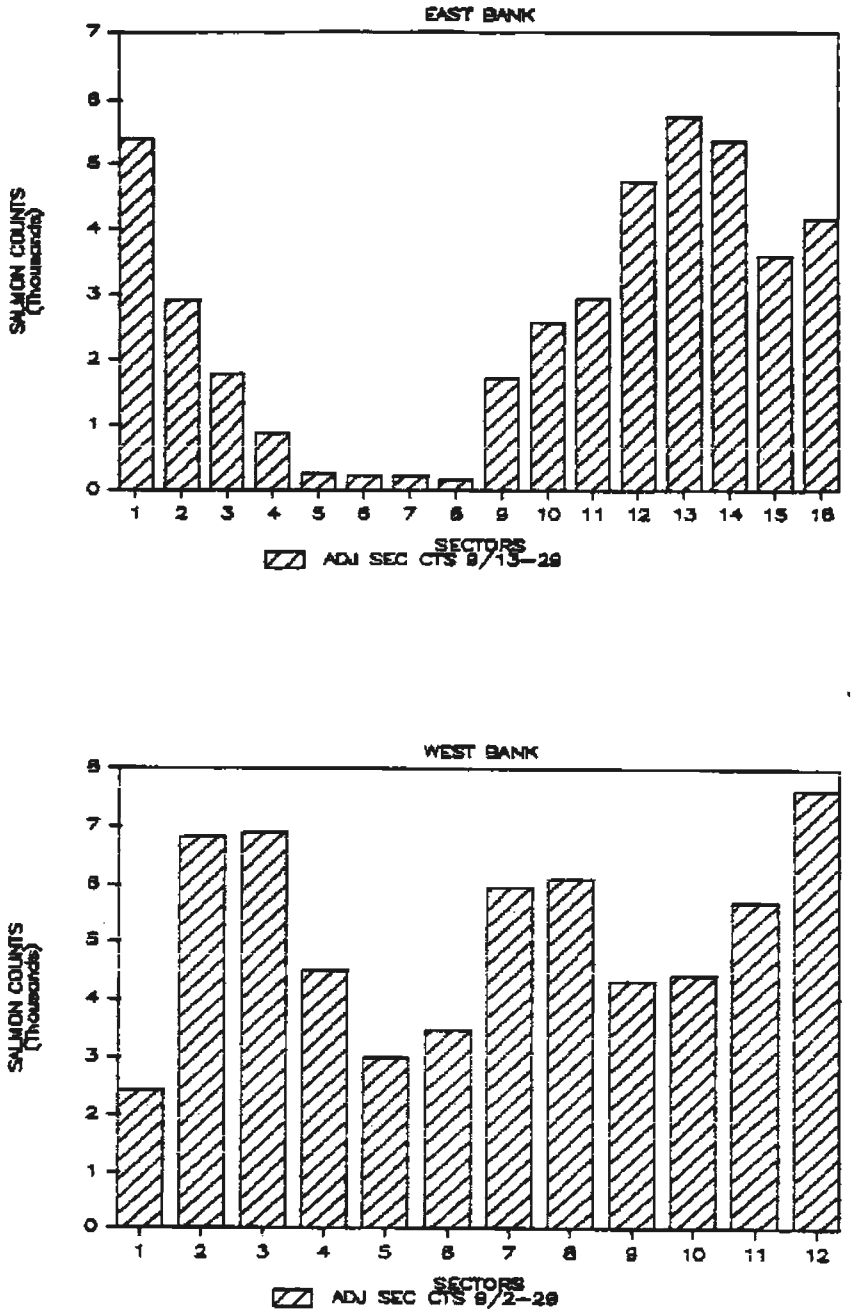

Figure 8. East and west bank sonar sector counts from 2-29 September in the Sheenjek River.

An aerial survey of the Sheenjek River was attempted in a Cessna 185 under excellent survey conditions on September 6. River level was low and water conditions exceptionally clear for this river. The survey began at the sonar site and ended at approximately rivermile 50 due to low aircraft fuel supply. An estimated 6,925 chum salmon were observed. The adjusted sonar count at the time of the survey was approximately 9,600 fish. Thus, the aerial estimate was approximately 72% of the sonar estimate, with only about half of the river's major salmon spawning areas surveyed on that date. In actuality, the proportion of chum salmon in the river observed during the aerial survey was lower than 72% by an unknown amount since sonar operations began at least 2 weeks subsequent to the beginning of the fall chum salmon run.

Another aerial survey was flown on September 25 in a Cessna 185 equipped with floats. Although survey weather and water conditions were good, the surveyor rated the survey poor due to observer visibility from the float-equipped aircraft (Glesne, personal communication, USFWS). An estimate of 14,200 live chum salmon was made and spawning was judged to be near peak as nearly 60% of the chum salmon observed were associated with redds. No estimate was made of chum salmon carcasses.

Age-sex-size

A total of 10 beach seine sets on 5 separate days from September 4 to 21 resulted in a catch of 830 chum salmon, 13 Arctic grayling, and 1 longnose sucker (Appendix Table 3). The male-to-female ratio was 1.00:0.57 or 63% males and 37% females. Seven hundred-five chum salmon were sampled for age and size composition by sex. Results from 513 readable scales (73%) revealed age 4_1 fish predominated, representing 93%. Age 5_1 fish represented 6% of the sample followed by 1% age 3_1 fish.

Table 3 contains available age composition data from Sheenjek River chum salmon escapement samples. Age 3_1 fish predominated the 1974 samples (66%), reflecting a very large year class that returned predominantly in 1975. In subsequent years, excluding 1979 and 1980 when no samples were collected, age 4_1 fish usually predominated, followed by age 5_1 fish. Age composition samples were collected with gillnets in 1981, 1982, and 1983 and consequently, age 3_1 fish may be under-represented in those years.

Historic fall chum salmon age-sex-size composition data for the Porcupine River drainage are shown in Appendix Table 4.

Escapement Trends

Barton (1985) presented data that suggested at least 8% of the salmon passing the sonar site in 1984 were not counted; doing so largely as a result of substrate avoidance. Since a single sonar unit and substrate was operated at the same west bank location from 1981-84 adjusted sonar counts for those years are expanded based on the 1984 findings to more accurately reflect comparative chum salmon escapements in those years for approximately the same period; i.e., late August through late September. Results are shown below along with the 1985 estimate:

Table 3. Comparative age composition of Sheenjek River fall chum salmon escapements, 1974-1985.

YEAR	AGE 0.2	AGE 0.3	AGE 0.4	AGE 0.5	SAMPLE SIZE
1974 a	66%	30%	3%	0%	137
1975 a	3%	95%	2%	1%	197
1976 a	2%	44%	54%	0%	118
1977 a	11%	73%	16%	0%	178
1978 a	8%	82%	10%	0%	190
1979	—	—	—	—	—
1980	—	—	—	—	—
1981 b	3%	85%	12%	Trace	340
1982 b	3%	47%	50%	Trace	109
1983 b	6.5%	87%	6.5%	0%	108
1984 c	10%	81%	9%	0%	297
1985 c	1%	93%	6%	0%	513

a Carcass samples from spawning grounds.

b Escapement samples taken with 5-7/8 inch mesh gillnets at sonar site. Thus results are biased towards older age fish.

c Escapement samples taken with beach seine at rivermile 12.

Year	Sonar estimate[a]	Expanded estimate[b]
1981	69,043	74,560
1982	29,093	31,421
1983	45,733	49,392
1984	25,120	27,130
1985	118,266	152,768

[a] Sonar counts adjusted from oscilloscope calibrations.
[b] Expanded estimate to compensate for salmon undetected by sonar.

Sonar-estimated escapements of fall chum salmon to the Sheenjek River are conservative due to sampling only a portion of the run. However, when taken as an index of relative abundance, it can be said that the 1985 escapement was the highest observed since sonar operations began in 1981 (Figure 9). Although sonar operations in 1985 extended to September 29, being 4 to 7 days later than in previous years, magnitude of the run through September 22 (96,724 including midriver estimate) was still greater than any year monitored.

Fall chum salmon escapements were monitored by aerial surveys in the Sheenjek River from 1973 through 1980. The survey flown in 1973 was well before peak spawning occurred and as such is not a good indicator of escapement in that year. Sonar has been used each year subsequent to 1980 to monitor escapements and whereas sonar tends to give a more complete estimate of total escapements, aerial survey point-estimates are much lower than actual stream abundance.

To more accurately view annual escapement trends in the Sheenjek River, an attempt was made to expand aerial escapement estimates for the years 1974-1980 by a factor based upon the relationship between the sonar and aerial survey estimates obtained in 1983. In 1983 an aerial survey flown on September 21 (slightly prior to peak spawning) resulted in an estimate of 22,230 chum salmon. Sonar-estimated escapement (through September 24) in that year was 49,392 or 2.221 times greater than the aerial estimate. Elson (1976) reported similar results for aerial estimates of fall chum salmon in the Fishing Branch River in 1975. Aerial estimates ranged from 29% to 50% of weir counts in that year. Thus, an expansion factor of 2.221 was used to expand Sheenjek River aerial survey estimates for the years 1974-1980, while sonar escapement estimates were used from 1981-85 (Table 4 and Figure 10). Results show that subsequent to 1974, low escapements have consistently occurred in even-numbered years.

There has been a decline in fall chum salmon escapements in recent years (since 1980) to known major spawning areas throughout the Yukon River drainage (ADF&G, 1985 Board of Fisheries Report; Buklis and Barton 1984; Barton 1983a). Both commercial and subsistence harvests of fall chum salmon have increased during the same period. Escapements in 1982 and 1984 were the lowest ever recorded to most streams, particularly 1982.

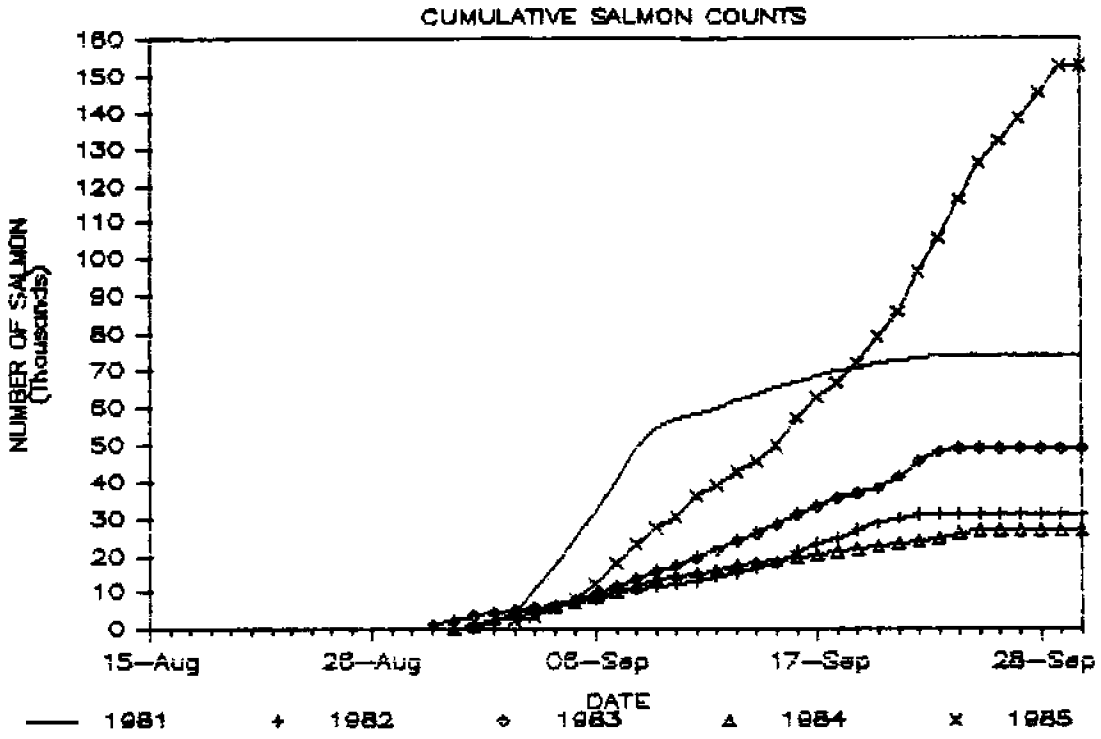

Figure 9. Cumulative sonar counts in the Sheenjek River, 1981-1985.

Table 4. Expanded escapement estimates of Sheenjek River fall chum salmon, 1974-1985.[a]

YEAR	SURVEY [b]	EXPANSION FACTOR [c]	SEASON ESTIMATE	REMARKS
1974	40,507 A	2.221	89,966	SURVEYED 9/18
1975	78,060 A	2.221	173,371	SURVEYED 10/8
1976	11,866 A	2.221	26,354	SURVEYED 9/25
1977	20,506 A	2.221	45,544	SURVEYED 9/30
1978	14,610 A [d]	2.221	32,449	SURVEYED 10/3
1979	41,140 A	2.221	91,372	SURVEYED 9/26
1980	13,027 A	2.221	28,933	SURVEYED 10/2
1981	74,560 S	0	74,560	SONAR CTS THRU 9/24
1982	31,421 S	0	31,421	SONAR CTS THRU 9/22
1983	49,392 S	0	49,392	SONAR CTS THRU 9/24
1984	27,130 S	0	27,130	SONAR CTS THRU 9/25
1985	152,768 S	0	152,768	SONAR CTS THRU 9/29

a Includes aerial counts in the index area from Sheenjek River mouth to vicinity of Haystack Mountain.

b Aerial index counts (A) and sonar counts (S).

c Expansion factor of 2.221 is based on relationship between sonar and aerial survey counts in 1983. [In 1983 total sonar estimate of 49,392 divided by aerial estimate on September 21 (early) of 22,230 equals 2.221. Season estimates for 1981-1985 are based on sonar counts; no expansion factor is used.

d Poor survey.

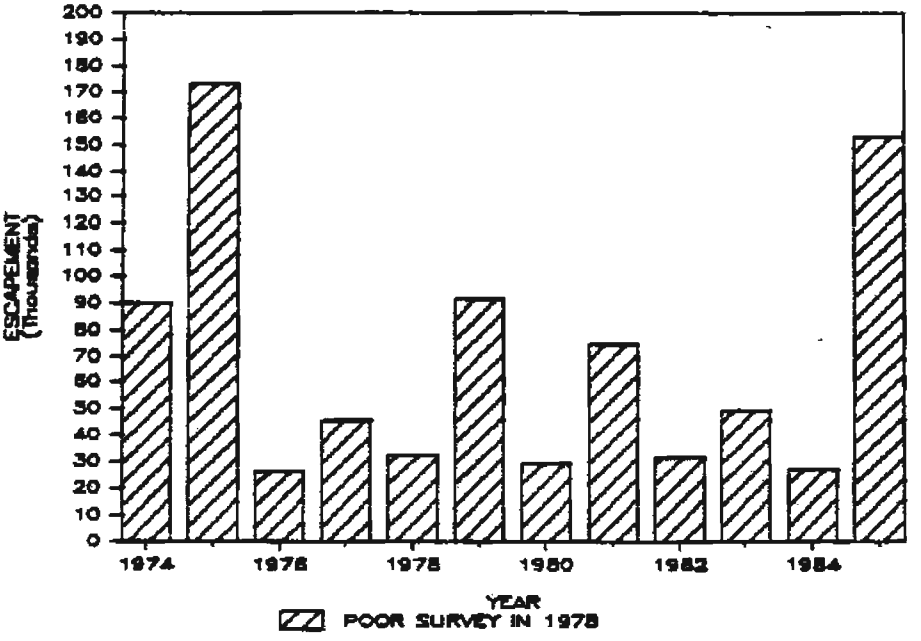

Figure 10. Comparative Sheenjek River fall chum salmon expanded escapement estimates, 1974-1985.

The majority of fall chum salmon returning to the Yukon River annually are 4-year-old fish. Magnitude of the 1982 run (4-year-olds) was judged to be very poor based upon comparative catch and escapement data. Return of 4-year-olds in 1986 is expected to be of similar magnitude assuming average survival. It is not known if the unseasonally high water levels occurring throughout Interior Alaska in 1982 had an adverse effect upon survival of salmon of that brood year.[a] However, the return of 5-year-olds (1981 brood year) may also contribute to the 1986 return based upon an apparent average to above average return of 4-year-olds to some streams (e.g., Sheenjek River) in 1985. In summary, based upon evaluation of the 1982 brood year escapement and assuming average survival, a poor return to the Yukon River is expected in 1986, including the Sheenjek River.

SUMMARY

1. Two side-scan sonar counters were operated in the Sheenjek River in 1985 and without deployment of artificial aluminum substrates. The sonar-estimated escapement from September 2 through 29 was 152,768 fall chum salmon, including an estimated 34,502 which passed upstream between counting units in the uninsonified zone. Mean and median dates of run passage were September 18 and 20, respectively.

2. A higher percentage of upstream salmon migration during daylight hours was observed in 1985 than in previous years.

3. A good aerial survey of the Sheenjek River to estimate fall chum salmon spawning escapement was not obtained in 1985.

4. Sonar-estimated escapements for 1981 through 1984 were expanded to more accurately reflect comparative chum salmon escapements in those years for approximately the same period, i.e., late August through late September. Expansion was based upon results of 1984 investigations which suggested at least 8% of salmon passing the sonar site were not counted when only 1 counting unit was operated from the west bank.

5. Aerial escapement estimates in the Sheenjek River for the years 1974 through 1980 were expanded, based upon the relationship between the sonar and aerial survey estimates obtained in 1983, to more accurately examine escapement trends.

6. The chum salmon sex ratio was 1.00:0.57 (63% males; 37% females) in 1985 based upon beach seine samples collected at rivermile 12 from September 4 to 21. Age composition was 1% age 3_1 fish; 93% age 4_1 fish; and 6% age 5_1 fish.

7. One hundred fifty chum salmon were sampled and forwarded to the Canadian Department of Fisheries and Oceans for subsequent electrophoretic analysis.

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[a] The Sheenjek River sonar project terminated in 1982 due to high water washing out the sonar substrate, counting tower, and weir.

CONCLUSIONS

1. Operating 2 sonar counting units without the use of aluminum substrates at the 1958 Sheenjek River project site was feasible.

2. All sonar-estimated escapements of fall chum salmon to the Sheenjek River are conservative due to sampling only a portion of the run. However, when taken as an index of relative abundance, the 1985 escapement was the highest observed since sonar operations began in 1981 and most similar in magnitude to the large escapement observed in 1975.

3. While realizing actual sonar counting dates have varied annually since 1981, results still suggest run timing to have been the earliest in 1981, followed closely by 1984. Runs were later in 1983 and particularly in 1985.

4. Although sonar operations in 1985 extended to September 29, being 4 to 7 days later than in previous years, it is likely that the sonar-estimated escapement through that date is comparable to previous years' estimates due to the late run timing observed in 1985.

5. The Sheenjek River historic data base shows lowest escapements have occurred in even-numbered years (since 1974) and based upon evaluation of the 1982 brood year escapement, a poor return is expected in 1986 unless a substantial contribution is made from the 1981 brood year escapement.

RECOMMENDATIONS

To more accurately document total fall chum salmon escapement to the Sheenjek River, sonar enumeration should begin no later than mid-August, if funding is available, and continue as late as weather or water conditions permit (generally into the last week of September). Subsequent sonar operations should continue at the 1985 site with a counter operated from each river bank. Artificial aluminum substrates should not be used unless a dramatic change occurs to the river bottom during spring breakup.

Replicate aerial surveys (two or more) should be flown of the Sheenjek River during periods of peak spawning and results compared to the sonar-estimated escapement, in order to develop the best expansion factor for adjusting historic point estimates of escapements.

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PERSONAL COMMUNICATIONS

Glesne, Reed. U.S. Fish and Wildlife Service, Fairbanks.

Hawkinson, John. U.S. Fish and Wildlife Service, Fairbanks.

Appendix Table 1. Daily changes in water level and surface water temperature at the 1985 Sheenjek River project site.

		WATER LEVEL			
DAY	DATE	METER READING a	DAILY CHANGE	ZERO DATUM	WATER TEMP b
1	02-Sep	26.00	0.00	0.0	50
2	03-Sep	25.50	-0.50	-0.5	50
3	04-Sep	24.50	-1.00	-1.5	48
4	05-Sep	24.00	-0.50	-2.0	48
5	06-Sep	24.50	0.50	-1.5	47
6	07-Sep	27.00	2.50	1.0	48
7	08-Sep	27.50	0.50	1.5	49
8	09-Sep	27.00	-0.50	1.0	48
9	10-Sep	26.50	-0.50	0.5	46
10	11-Sep	26.00	-0.50	0.0	46
11	12-Sep	41.50	15.50	15.5	44
12	13-Sep	57.00	15.50	31.0	43
13	14-Sep	52.50	-4.50	26.5	43
14	15-Sep	49.50	-3.00	23.5	44
15	16-Sep	44.00	-5.50	18.0	43
16	17-Sep	40.50	-3.50	14.5	41
17	18-Sep	40.00	-0.50	14.0	39
18	19-Sep	39.50	-0.50	13.5	39
19	20-Sep	35.00	-4.50	9.0	38
20	21-Sep	30.00	-5.00	4.0	36
21	22-Sep	26.50	-3.50	0.5	36
22	23-Sep	24.00	-2.50	-2.0	36
23	24-Sep	22.50	-1.50	-3.5	38
24	25-Sep	19.50	-3.00	-6.5	38
25	26-Sep	16.00	-3.50	-10.0	37
26	27-Sep	13.50	-2.50	-12.5	37
27	28-Sep	12.50	-1.00	-13.5	37
28	29-Sep	11.50	-1.00	-14.5	37
29	30-Sep	10.50	-1.00	-15.5	37

a Meter reading in centimeters.

b Temperature in Fahrenheit.

Appendix Table 2. Surface water velocities measured daily at the east and west bank sonar transducers, Sheenjek River, 1985.

		SURFACE WATER VELOCITY			
		CM/SEC		FT/SEC	
DAY	DATE	WEST BANK	EAST BANK	WEST BANK	EAST BANK
1	02-Sep	74	67	2.43	2.20
2	03-Sep	73	62	2.40	2.03
3	04-Sep	77	66	2.53	2.17
4	05-Sep	77	61	2.53	2.00
5	06-Sep	74	60	2.43	1.97
6	07-Sep	76	65	2.49	2.13
7	08-Sep	77	66	2.53	2.17
8	09-Sep	79	62	2.59	2.03
9	10-Sep	77	58	2.53	1.90
10	11-Sep	76	61	2.49	2.00
11	12-Sep	85	78	2.79	2.56
12	13-Sep	107	82	3.51	2.69
13	14-Sep	102	78	3.35	2.56
14	15-Sep	96	72	3.15	2.36
15	16-Sep	92	67	3.02	2.20
16	17-Sep	92	61	3.02	2.00
17	18-Sep	90	64	2.95	2.10
18	19-Sep	89	67	2.92	2.20
19	20-Sep	86	58	2.82	1.90
20	21-Sep	78	56	2.56	1.84
21	22-Sep	75	52	2.46	1.71
22	23-Sep	73	56	2.40	1.84
23	24-Sep	73	60	2.40	1.97
24	25-Sep	67	55	2.20	1.80
25	26-Sep	66	51	2.17	1.67
26	27-Sep	64	46	2.10	1.51
27	28-Sep	62	44	2.03	1.44
28	29-Sep	61	44	2.00	1.44
29	30-Sep	59	42	1.94	1.38

Appendix Table 3. Sheenjek River beach seine catches, September 1985.

DATE	SET NUMBER	CHUM SALMON		ARCTIC GRAYLING	REMARKS
		MALE	FEMALE		
04-Sep	1	32	40	3	ALSO CAPTURED 1 LONGNOSE SUCKER.
04-Sep	2	8	3	2	2 CHUM SALMON RECAPTURES.
04-Sep	3	6	5	1	2 CHUM SALMON RECAPTURES.
04-Sep	4	5	1	1	LEAD LINE CAUGHT ON CORK LINE - SEX BIASED.
04-Sep	5	2	1	0	1 CHUM SALMON RECAPTURE. NET SNAGGED.
09-Sep	6	53	66	3	1 CHUM SALMON RECAPTURE.
09-Sep	7	7	0	1	1 CHUM SALMON RECAPTURE. NET SNAGGED.
15-Sep	8	80	47	1	ALL SALMON SAMPLED FOR ELECTROPHORETIC ANALYSIS.
17-Sep	9	132	58	0	COLD, BLOWING - POOR SAMPLING CONDITIONS. 22 SALMON ALSO SAMPLED FOR ELECTOPHORETIC ANALYSIS.
21-Sep	10	202	82	1	SNOWING AND COLD.
	TOTALS	527	303	13	

Appendix Table 4. Comparative age, sex, and size composition of fall chum salmon at various locations in the Porcupine River drainage, 1972, 1975, and 1981-1985.[a]

	AGE 0.2				AGE 0.3				AGE 0.4				AGE 0.5				TOTAL	
			LENGTH				LENGTH				LENGTH				LENGTH			
	SAMPLE SIZE	%	MEAN	STD	SAMPLE SIZE	%	MEAN	STD	SAMPLE SIZE	%	MEAN	STD	SAMPLE SIZE	%	MEAN	STD	SAMPLE SIZE	%
1972 FISHING BRANCH RIVER b																		
MALES	1	1.7%	610	—	20	34.5%	620	31.8	1	1.7%	649	—	—	—	—	—	22	37.9%
FEMALES	4	6.9%	561	—	29	50.0%	590	23.2	3	5.2%	614	—	—	—	—	—	36	62.1%
TOTAL	5	8.6%	571	25.3	49	84.5%	607	29.0	4	6.9%	623	—	—	—	—	—	58	100.0%
1975 SHEENJEK RIVER c																		
MALES	2	1.0%	599	—	79	40.1%	599	34.2	2	1.0%	654	—	—	—	—	—	83	42.1%
FEMALES	5	2.5%	544	23.0	108	54.8%	582	27.8	1	0.5%	520	—	—	—	—	—	114	57.9%
TOTAL	7	3.6%	559	35.7	187	94.9%	589	31.7	3	1.5%	642	—	—	—	—	—	197	100.0%
1981 SHEENJEK RIVER d																		
MALES	2	0.6%	547	—	139	40.9%	620	27.5	32	9.4%	637	42.4	1	0.3%	620	—	174	51.2%
FEMALES	8	2.4%	574	17.2	150	44.1%	596	25.6	8	2.4%	613	19.7	—	—	—	—	166	48.8%
TOTAL	10	2.9%	569	25.9	289	85.0%	608	29.1	40	11.8%	632	40.4	1	0.3%	620	—	340	100.0%
1982 SHEENJEK RIVER d																		
MALES	1	0.9%	570	—	15	13.8%	615	22.9	22	20.2%	651	30.5	1	0.9%	640	—	39	35.8%
FEMALES	2	1.8%	525	—	36	33.0%	601	22.9	32	29.4%	621	22.0	—	—	—	—	70	64.2%
TOTAL	3	2.8%	540	—	51	46.8%	605	24.4	54	49.5%	633	29.8	1	0.9%	640	—	109	100.0%
1983 SHEENJEK RIVER d																		
MALES	3	2.8%	603	44.5	52	48.1%	612	25.5	3	2.8%	609	41.7	—	—	—	—	58	53.7%
FEMALES	4	3.7%	554	23.8	42	38.9%	592	22.3	4	3.7%	625	25.7	—	—	—	—	50	46.3%
TOTAL	7	6.5%	575	40.3	94	87.0%	603	28.2	7	6.5%	618	31.4	—	—	—	—	108	100.0%
1984 SHEENJEK RIVER e																		
MALES	22	7.4%	563	18.7	139	46.8%	614	34.4	19	6.4%	621	27.2	—	—	—	—	180	60.6%
FEMALES	8	2.7%	508	45.8	100	33.7%	581	28.2	9	3.0%	600	32.4	—	—	—	—	117	39.4%
TOTAL	30	10.1%	548	37.0	239	80.5%	601	33.5	28	9.4%	614	33.5	—	—	—	—	297	100.0%
1985 SHEENJEK RIVER e																		
MALES	1	0.2%	570	—	283	55.7%	619	28.4	15	3.0%	654	29.5	—	—	—	—	299	58.9%
FEMALES	5	1.0%	568	24.9	188	37.0%	598	25.8	16	3.1%	613	17.9	—	—	—	—	209	41.1%
TOTAL	6	1.2%	568	22.3	471	92.7%	611	29.5	31	6.1%	633	31.6	—	—	—	—	508	100.0%

a Age designated by European formula: freshwater life followed by ocean life. All lengths are mid-eye to fork-of-tail measurements in millimeters.

b Samples collected by Canadians at weir. Data modified from Elson (1973). Fish were initially measured from tip-of-snout to fork-of-tail; lengths shown here were converted to mid-eye to fork-of-tail estimates based upon fall chum salmon conversions derived from tagging at Galena and Ruby (Buklis 1981).

c Carcass samples collected at Russell's cabin and Fish Slough.

d Samples collected with 5-7/8 inch gillnets at the sonar site (rivermile 6).

e Samples collected with beach seine at rivermile 12.