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YUKON SALMON ESCAPEMENT
REPORT # 20

ANVIK AND ANDREAFSKY RIVER SALMON STUDIES, 1982

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INTRODUCTION

The Anvik and Andreafsky Rivers are the two largest producers of summer chum salmon (Oncorhynchus keta) in the Yukon River drainage (Figure 1). Buklis (1982a) estimated that the Anvik River alone accounts for 35% of the total production. Other known major spawning populations occur in the Rodo, Nulato, Gisasa, Hogatza, Melozitna, Tozitna, Chena, and Salcha Rivers (Figure 1). Summer chum salmon spawn in smaller numbers in a few other tributaries of the Yukon River as well. King salmon (O. tshawytscha) and pink salmon (O. gorbuscha) run timing in the Anvik and Andreafsky Rivers coincides with the mid-June to late July escapement of summer chum salmon, while coho salmon (O. kisutch) occur in small numbers after this period.

A total of 1,000,021 salmon were commercially harvested in the Yukon area in 1982. The catch was composed of 123,658 king salmon, 614,166 summer chum salmon, 225,021 fall chum salmon and 37,176 coho salmon. The king and chum salmon catches were below the recent 5 year average while the coho catch was above average. Subsistence harvest data has not yet been compiled, but is expected to total an additional 25,000 kings, 200,000 summer chums, 100,000 fall chums and 30,000 cohos (Geiger 1982).

Anvik River juvenile salmon were studied for the first time in 1982, and daily salmon escapement to the Anvik and Andreafsky Rivers was enumerated by side-scanning sonar. This report presents the results of these studies.

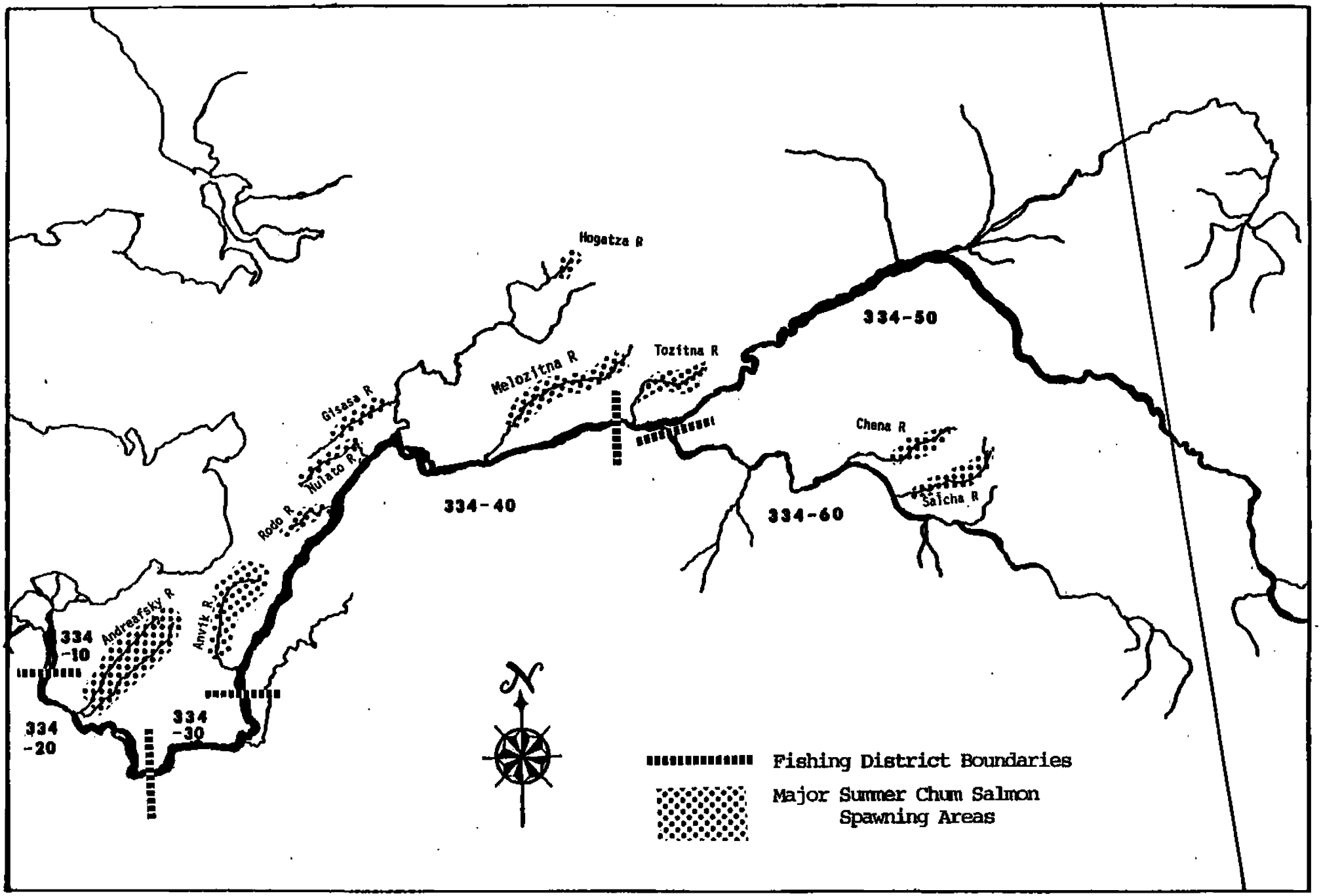


Figure 1. Map of the Yukon River, showing fishing districts and major summer chum salmon spawning areas

ANVIK RIVER JUVENILE SALMON STUDY

Magnitude of the Yukon River summer chum salmon run is assessed in-season based on catch statistics from test fishing gillnets near Emmonak and from the commercial fishery itself. An accurate pre-season forecast of run strength would allow management biologists and the fishing industry to plan for the season accordingly. At the present time only a subjective rating of good, fair or poor is projected for the summer chum salmon run, and is based informally on the strength of the parent year return. A more rigorous forecast might be developed with a statistical treatment of parent year escapement and return data, climatological factors and juvenile salmon production. The feasibility of estimating juvenile salmon production was studied in 1982 as a first step towards development of a forecast model for adult returns. The Anvik River was chosen because it is the largest producer of summer chum salmon in the Yukon River drainage.

The Anvik River (Figure 2) originates at an elevation of 1,300 feet and flows in a southerly direction 120 miles to its mouth at mile 318 of the Yukon River. It is a narrow run-off stream with a substrate of gravel and cobble, except in the upper reaches where bedrock is exposed. The Yellow River is a major tributary of the Anvik and is stained with tannic acid runoff. Downstream of the Yellow River confluence the Anvik River changes from a moderate gradient system confined to a flood plain of 0.75 to 1.5 miles wide to a low gradient system meandering through a much broader flood plain. Water clarity is reduced downstream of the Yellow River confluence. Numerous oxbows, old channel cutoffs and sloughs are found throughout the lower river.

Sampling methods developed on the Anvik River, if successful, could be applied to other major spawning areas in future years. Objectives of the study were to:

1. Determine feasibility of capturing juvenile chum salmon by beach seine and minnow trap in sufficient numbers to accurately index abundance and timing of the outmigration.

2. Determine feasibility of using dye mark and recapture method to estimate abundance of chum salmon fry outmigration. Flagg (1981) successfully applied this method to sockeye salmon (O. nerka) smolt in the Kasilof River.

3. Collect length and weight data from juvenile chum, king, pink and coho salmon, as well as scale samples from king and coho salmon smolt.

Methods and Materials

A two person crew was flown to the sonar site at mile 48 of the Anvik River on 4 May in a Super Cub on skis. Most summer chum salmon spawning occurs upriver from this site. Equipment was stored there from previous adult salmon studies and the storage cache, elevated on 4 foot pilings, provided shelter for the crew during breakup flooding of the river.

Ten minnow traps with 1/4 inch square mesh and 2 with fine screen mesh were baited with preserved Arctic char roe and fished through holes augered in the river ice and in open water leads along shore. A beach seine (40 feet long, 4

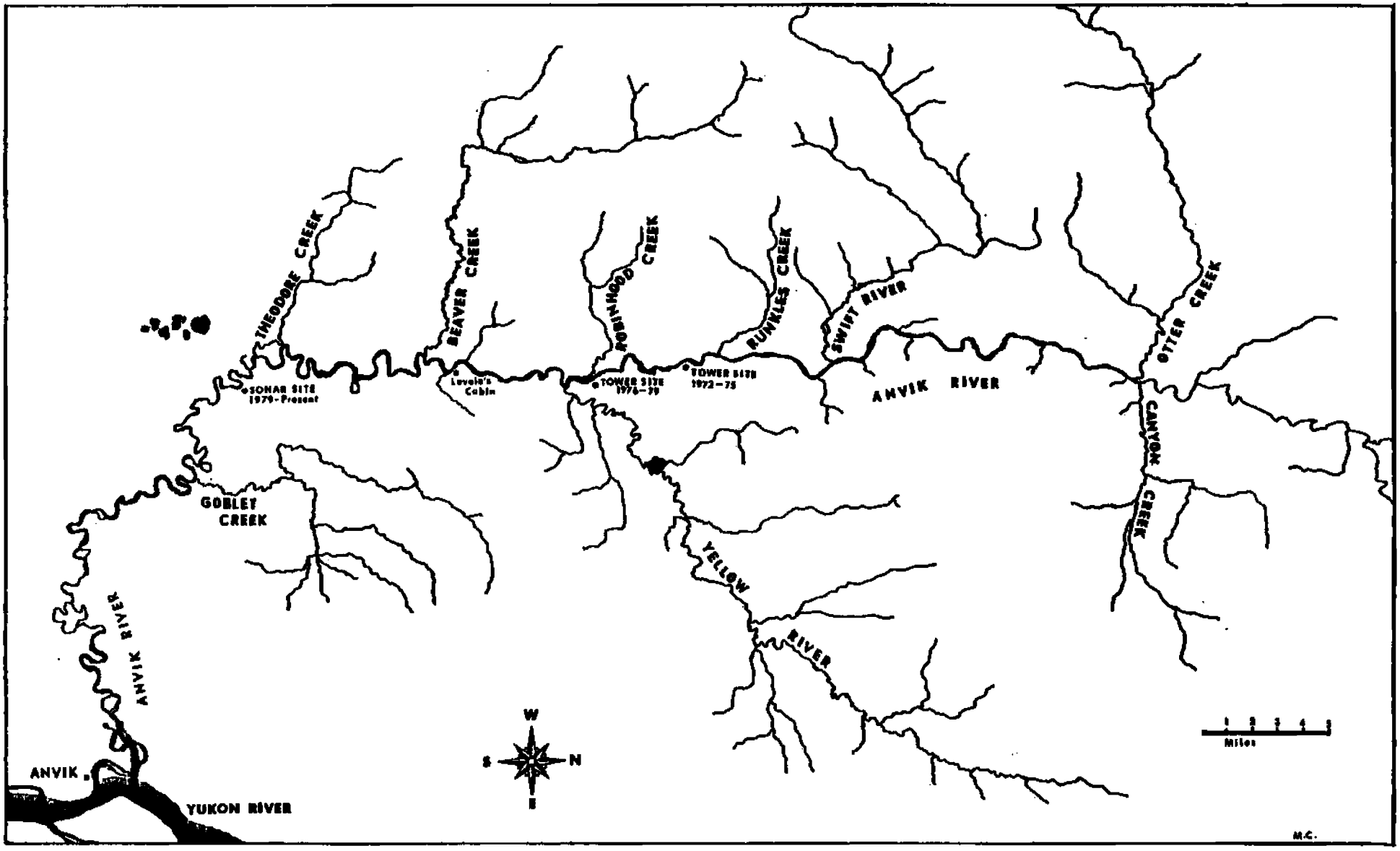


Figure 2. Map of the Anvik River.

feet deep, 1/8" square mesh, dyed green) was fished at the campsite after breakup, and occasionally at other sites upriver. The ends of the beach seine were tied to wooden poles. One person held each pole and walked downriver, parallel to shore, with the inshore end at a water depth of 1 to 2 feet and the offshore end as deep as could be walked in hipwaders. Captured fish were held in buckets of fresh water and counted by species. Thirty juvenile salmon of each species were subsampled from the catch each day, measured for total length (tip of snout to fork of tail) in millimeters and a group weight by species was measured to the nearest 0.1 g on a triple-beam balance. Scale smears were taken from king and coho salmon smolt and mounted between glass microscope slides. Scales were subsequently aged with a microfiche reader in the laboratory.

A minimum of 300 chum salmon fry were to be transferred from the beach seine catch to a holding tank every second day. Oxygen would be supplied from a portable aerator, and Bismark Brown Y stain added at the rate of 1 gram per 8 gallons water. The tank was to be transported 1/2 mile upriver, and the fish released after 30 minutes. Marked fry are a distinct golden color. For purposes of the population estimate, recoveries are attributed to the most recent fry release. The following formula (Ricker, 1975) is used to calculate a population estimate for each 48 hour period:

$$\hat{N} = \frac{(M+1)\ (C+1)}{(R+1)}$$

Where: M = Number of fry marked
C = Number of fry captured during the recovery period
R = Number of marked fry recaptured during the recovery period

The 95% confidence interval (CI) is calculated according to the following formula (Ricker, 1975):

$$95\%\ CI = \hat{N} \pm 1.96 \sqrt{\text{var}\ (\hat{N})}$$

Where:

$$\text{Var}\ (\hat{N}) = \frac{(M+1)2\ (C+1)(C-R)}{(R+1)\ 2\ (R+2)}$$

In addition to calculating a population estimate for each 48 hour period, the data can be pooled to estimate the total population for the entire period of sampling.

Results and Discussion

The Anvik River was frozen when the crew arrived on 4 May. River ice was about 3 feet thick and covered with 2 feet of snow at the campsite. Air temperature ranged between -3°C and 12°C during the first week. By 11 May, 2 to 3 feet of water overflow covered weakening river ice at the campsite. Breakup occurred on 13 May. Repeated ice floes from upriver and ice jams

downriver caused extensive flooding. Water level remained high through 1 June when the crew left,due to the flood stage of the Yukon River at Anvik. The crew was forced to set up housekeeping in the elevated storage cache for extended periods between 13 May and 1 June due to the flooding.

Six baited minnow traps were set on 6 May in an open water lead along a cutbank 1200 feet below camp. Two additional traps were set on 8 May through holes augered in the ice at the center of the river in front of camp. Traps were fished continuously and checked daily. One minnow trap was lost with breakup on 13 May. All other traps were removed. Four were reset along the cutbank 1200 feet below camp and 4 were set in a slough area 2,000 feet below camp. The latter 4 traps were lost to an ice floe on 19 May.

During the period 6 May through 26 May only 1 juvenile chum salmon and no other salmon were captured in minnow traps. This fish was captured in a small mesh trap on 25 May. Water temperature was 3°C. Other fish captured during this period were as follows:

29 slimy sculpin (Cottus cognatus)
8 Arctic lamprey (Lampetra japonica)
2 burbot (Lota lota)
2 whitefish (Coregonus and Prosopium spp.)

Beach seining was difficult and ineffective due to high water. For most of the period 13 May through 1 June the river was flooded into the willows and exposed beaches were nonexistent. Some sampling was attempted in the vicinity of the camp, and also in an area 30 miles upriver. Catches averaged less than 10 chum salmon per beach seine set (Figure 3). No other juvenile salmon species was captured.

The crew returned on 16 June to enumerate adult salmon escapement. Water level had dropped by this time and beaches were exposed. Juvenile salmon beach seining was resumed on a time available basis through 26 July. Minnow traps were not reset. The first beach seine set during this period, on 21 June, produced the largest chum salmon catch and first king salmon catch of the study. This indicates that a significant portion of the juvenile chum salmon outmigration probably occurred between 26 May and 21 June, when no sampling was conducted (Figure 3). Ninety-three chum salmon and 7 king salmon were captured at the campsite in one set on 21 June. Water temperature was 10°C. Daily catches averaged between 0 and 43 chum salmon per beach seine set during the remainder of the study. No chum salmon were captured on 24 and 26 July, the last two days of sampling. King salmon catches remained low until 8 July, when 43 were captured in one set at the campsite (Figure 4). The largest catch occurred on 15 July, when 230 juvenile king salmon were captured in one set near Robinhood Creek, about 40 miles upriver from camp. Forty-nine king salmon were captured in one set at the campsite on 26 July, the last day of sampling. Water temperature was 11°C.

A total of 341 chum salmon and 432 king salmon was captured by beach seine during the entire study, with 229 (66%) of the chum salmon and all of the king salmon captured after 16 June. Three of the king salmon were Age I (one check) smolt, while the remainder were Age 0 fry. Parr marks were evident on the fry, while less distinct on smolts. All of the chum salmon were young of the year fry.

Figure 3. Anvik River chum salmon fry average weight, length, and beach seine catch per unit effort by day, 1982. No sampling was conducted between 26 May and 21 June.

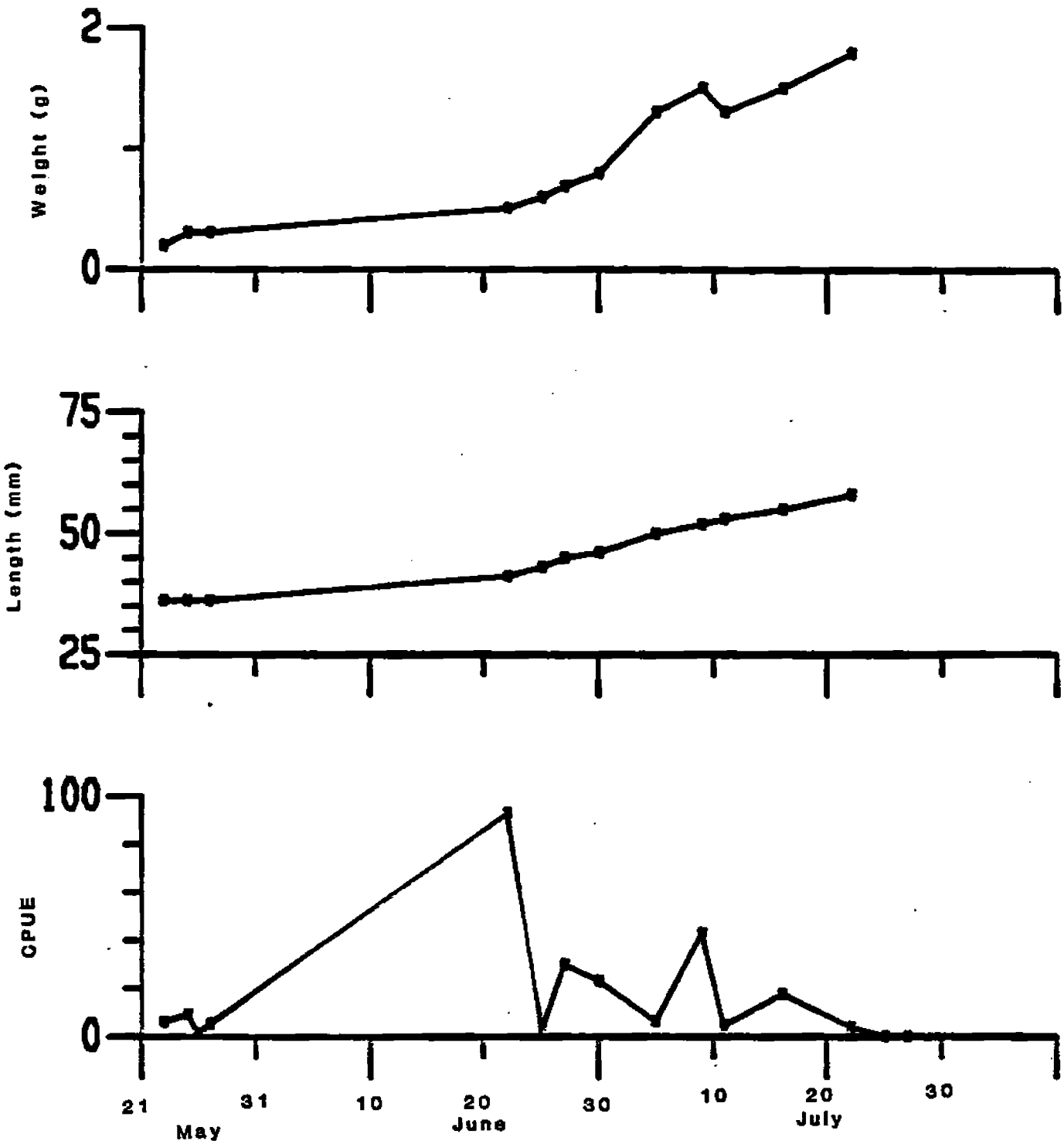
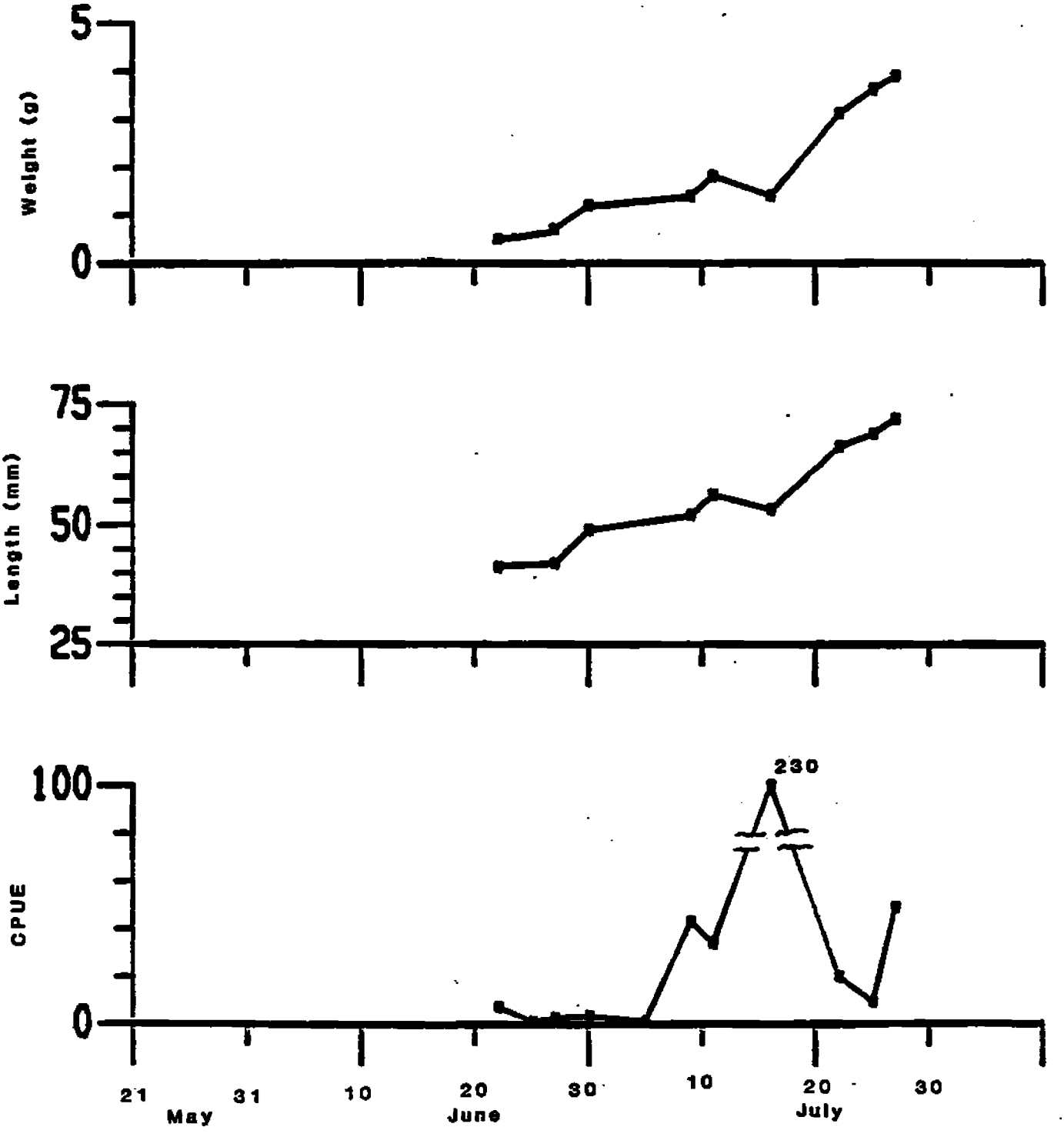


Figure 4. Anvik River king salmon fry average weight, length, and beach seine catch per unit effort by day, 1982.



The ventral surface of those caught in May showed a line of clear tissue, evidence of having recently absorbed their yolk sac. Those caught later in the summer showed no such marking and were silvery sided. Only 4 coho salmon fry were captured: 2 on 26 June, and 1 each on 8 and 26 July. No pink salmon were captured.

Weight and length of chum and king salmon fry increased steadily during the summer. Chum salmon average weight was 0.2g on 22 May and 1.8g on 21 July, while average length was 36mm and 58mm, respectively (Figure 3). King salmon fry average weight was 0.5g on 21 June and 3.9g on 26 July, while average length was 41mm and 72mm, respectively (Figure 4). The 3 king salmon smolt, caught on 24 June, 26 June and 4 July, averaged 8.9g in weight and 93mm in length. The coho salmon fry were 1.0g and 46mm on 26 June and 5.1g and 78mm on 26 July.

Too few juvenile salmon were captured to test feasibility of the dye mark and recapture technique to estimate population size. In addition, the catch data is not a good index of timing or abundance of the outmigration. High water made beach seining ineffective in May, and effort was infrequent from mid-June through late July. Future studies of Anvik River juvenile salmon should use fyke nets and/or inclined plane traps. This gear can be operated during high water immediately after ice breakup and is capable of catching large numbers of juvenile salmon, providing a more meaningful index of timing and magnitude of the outmigration (Seiler, Neuhauser and Ackley 1981; Todd 1966).

It is apparent from this initial study in 1982 that chum and king salmon fry are found in the Anvik River over 2 months after breakup of river ice. Chum salmon outmigration probably peaks in early June, whereas king salmon fry may overwinter in the Anvik River. Too few smolts were captured to make any conclusion regarding timing of the king salmon outmigration.

ANVIK RIVER ADULT SALMON STUDY

Anvik River salmon escapement was enumerated from counting towers located above the Yellow River confluence between 1972 and 1978. A site 5-1/2 miles above the Yellow River was used from 1972 through 1975, and a site at Robinhood Creek, 2-1/2 miles above the Yellow River, was used from 1976 through 1978 (Figure 2). Aerial surveys were flown each year (except 1974) in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often affects the accuracy of visual salmon enumeration from counting towers and aircraft.

The Electrodynamics Division of the Bendix Corporation developed a side scanning hydroacoustic counter during the 1970's capable of detecting and counting salmon migrating along the banks of tributary streams. The side scan sonar counter is designed to transmit a sonic beam along a 60 foot aluminum pipe, or substrate. Echoes from fish passing through the beam are reflected to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. The counter was tested at the Robinhood Creek tower site from 1976 through 1978, and proved to be both feasible and accurate. Salmon escapement was enumerated by sonar beginning in 1979, replacing and proving superior to the tower counting method. One sonar counter was installed on each bank of the Anvik River at mile 48, near Theodore Creek, each year.

Distribution of salmon counts from 1972 through 1978 indicated that virtually all of the summer chum salmon are found upstream of this site. The 1982 season was the fourth consecutive year of successful sonar enumeration, and extended the Anvik River data base to 11 years.

Methods and Materials

Two 1981 model side scan sonar counters were installed on 22 June at mile 48 of the Anvik River. These units differed from the 1978 models previously used on the Anvik River in the following ways (Menin 1982):

1. The 1978 model divided the counting range into 12 sectors, while the new model divides it into 16. This results in less data lost if counts from one sector must be excluded due to debris.

2. Number of hits required by the 1978 model to register one salmon were: sectors 1 to 3-3, sector 4-4, sector 5-5, sector 6-6, sectors 7 and 8-4, sectors 9 and 10-5, sectors 11 and 12-6. The 1981 model requirements are: sectors 1 to 4-4, sectors 5 to 7-5, sector 8-6, sectors 9 and 10-4, sector 11-5, sectors 12 and 13-6, sectors 14 to 16-7. The reason for the step function change in hits required is that a 4° beam covers the first half of the counting range and a 2° beam the second half.

3. The new system transmits 1.33 times more frequently.

4. The old sytem considered any echo that exceeded a certain target strength a hit. The new system has the additional criterion that the returned echo pulse width must exceed 120μsec. This eliminates most reflections from the substrate and some debris.

5. The 1978 model permitted three misses between valid hits. The new system permits only one miss. This criterion significantly reduces false counts due to intermittant debris or fish sporadically poking snout or tail into the beam.

6. The old system criterion for debris was 24 counts in any one sector in a 35 second period. The new system requires 32 counts in a 42 second period. This reduces the number of debris flags during a large fish migration.

7. A new feature was introduced with the 1981 model to distingush between king salmon and the other salmon species. Any returning echoes exceeding 275μ sec are routed to a separate totalizer. Salmon counts (large and small salmon combined) for each sector are printed out hourly, as well as the total for all 16 sectors. The number of large salmon counts that contributed to the total is listed, but is not broken out by sector.

The river is approximately 200 feet wide at the sonar site. The 40 foot east bank substrate was deployed perpendicular from a cutbank, with the transducer housing 1 foot underwater and 5 feet from shore. A small weir was built to prevent fish passage inshore of the transducer. The 60 foot west bank substrate was deployed from a gradually sloping gravel bar, 150 feet downriver from the east bank counter. The transducer housing was 1 foot underwater and 25 feet from shore, with a weir constructed to prevent fish passage inshore of

the transducer.

Barton (1982a) and McBride and Mesiar (1982) have documented that the large fish counting feature of the 1981 model sonar counter does not provide an accurate count of king salmon escapement. Since chum salmon greatly outnumber king salmon (by more than 250 to 1) in the Anvik River, all sonar counts were attributed to chum salmon. A separate escapement estimate for king salmon would be obtained by aerial survey. The sensitivity and fish velocity settings on the sonar counters were set such that pink salmon, smaller and faster swimming than the other salmon species, were generally not counted. A small percentage of the pink salmon probably registered sonar counts due to lingering in the beam before moving upriver.

Sector counts missing due to debris or printer malfunction were estimated by averaging the counts for the hour before and after the missing data. Sonar counts for the two substrates were added together daily, and the total multiplied by 1.10 (Buklis 1981) to account for midstream escapement not covered by the sonar counters. Each sonar counter was calibrated three times daily (at 0700, 1500 and 2300 hours) with an oscilloscope for a 15 minute period. Salmon passing through the sonar beam produce a distinctive oscilloscope trace. Sonar and oscilloscope counts for each calibration period are related in the following formula:

$$Q = \frac{SS}{SC}$$

where: SS = Side scan counts
SC = Scope counts

If the difference between the counts was greater than 15% ($0.85 \leq Q \leq 1.15$) then the existing fish velocity setting was multiplied by Q to obtain the correct new setting. The system was then recalibrated for 5 minutes at the new setting. A record was kept of all adjustments to the sonar equipment. Whenever water and light conditions allowed, fish passage over the substrates was visually enumerated from a 10 foot counting tower. Polaroid sunglasses were worn to reduce water surface glare. Visual counts are reported as the net upstream passage, or the number of fish passing upstream across the substrate minus the number drifting back downstream across the substrate.

Climatological data was collected each day at noon at the campsite. A fence stake marked in 1 cm increments was set in the river. Changes in water depth are presented here as negative or positive from the initial reading of 0cm. Water temperature was measured in °C near shore, at a depth of about 1 foot. Air temperature is the average of the daily maximum and minimum in °C. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

A beach seine (100 feet long, 66 meshes deep, 2-1/2 inch stretch measure mesh) was set near the sonar site to capture salmon for age, sex and size measurements. Captured fish were identified by species, while king and chum salmon were further identified by sex, measured from mid-eye to fork of tail in millimeters, and three scales taken for 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 before release to prevent later sampling of the same individual fish. In addition, king and chum salmon carcasses were sampled during late July and early August from beaches between the sonar site and Robinhood Creek. These fish were measured as described above. Scale samples were later pressed on acetate cards and the resulting impressions viewed on a microfiche reader for age determination.

Results and Discussion

The sonar counters were operated from 22 June through 26 July. The season escapement was 444,581 summer chum salmon (Table 1). Buklis (1982a) expanded the season escapement estimates for 1972 through 1978, making it possible to more directly compare visual count estimates from those years with the more recent sonar count estimates. The 1982 escapement was below the previous 10 year average of 544,923 summer chum salmon, but similar in magnitude to those of 1972, 1974 and 1980 (Figure 5). Water turbidity and weather conditions (wind, rain, overcast) made it difficult to obtain an accurate visual check on the accuracy of the sonar counters. The degree of accuracy appeared to be erractic for any given calibration period but was acceptable for all periods combined. A total of 4.6 hours of visual counts were obtained over a period of 28 days for the east bank sonar counter, and sonar accuracy (sonar counts/net visual counts) averaged 1.12 (Table 2). Only 3.8 hours of visual counts were obtained over a similar period for the west bank, and sonar accuracy averaged 0.76 (Table 3). Oscilloscope calibrations were used to monitor the accuracy of the fish velocity settings, which were changed as necessary.

Breakdown of the electronics in the west bank sonar counter on 4 July made it necessary to estimate daily escapement based on the one operational counter. Difficulties with the equipment persisted until 14 July, and derivation of salmon escapement estimates for this 11 day period are outlined in Appendix A. A problem adjusting the sonar counter was encountered on the west bank (60 foot substrate) but not on the east bank (40 foot substrate). Some fish would pass over the substrate but not register a sonar count or a spike on the oscilloscope trace. These fish were apparently swimming over the sonar beam near the water surface, or between the bottom of the sonar beam and the surface of the substrate. Such a gap might be created if the substrate was sagging. A third possibility is that the substrate was bowed downriver by the current to such a degree that salmon could swim over the substrate but then drop to the river bottom and pass below the sonar beam before encountering it. Extensive adjustments were made in the aiming of the transducer, fish velocity and system sensitivity settings of the electronics, and positioning of the substrate. The problem was eventually resolved. A second source of counting error may have been the criterion required by the electronics to register a salmon count. Barton (1982a) described a similar problem with a 1981 model sonar counter used on the Sheenjek River in 1982. It is difficult to adjust the system electronics to accurately count salmon in all sectors. When properly counting in sectors 1 and 2, then sectors 9 and 10 appear to overcount. The problem has not been clearly documented, but should be investigated before the 1983 field season.

Table 1. Anvik River chum salmon sonar counts by date, 1982.

Date	West Bank	East Bank	Expanded Count 1/ Daily	Expanded Count 1/ Cumulative	% of Season Total Daily	% of Season Total Cumulative
6/25	545	105	715	715	0.2	0.2
6/26	1,941	274	2,436	3,151	0.5	0.7
6/27	4,433	1,045	6,026	9,177	1.4	2.1
6/28	2,028	1,376	3,744	12,921	0.8	2.9
6/29	1,446	1,889	3,669	16,590	0.8	3.7
6/30	2,354	1,687	4,445	21,035	1.0	4.7
7/1	1,731	1,719	3,795	24,830	0.9	5.6
7/2	2,615	805	3,762	28,592	0.8	6.4
7/3	3,367	5,425	9,671	38,263	2.2	8.6
7/4	(8,866) 2/	(12,627)	23,642	61,905	5.3	13.9
7/5	13,113	(7,300)	22,454	84,359	5.1	19.0
7/6	(12,891)	(7,346)	22,261	106,620	5.0	24.0
7/7	(8,300)	4,730	14,333	120,953	3.2	27.2
7/8	(15,804)	9,006	27,291	148,244	6.1	33.3
7/9	(23,469)	13,374	40,527	188,771	9.1	42.5
7/10	(14,988)	8,541	25,882	214,653	5.8	48.3
7/11	(11,575)	6,596	19,988	234,641	4.5	52.8
7/12	(20,961)	11,945	36,197	270,838	8.1	60.9
7/13	(9,846)	20,914	33,836	304,674	7.6	68.5
7/14	(14,280)	15,931	33,232	337,906	7.5	76.0
7/15	9,487	7,565	18,757	356,663	4.2	80.2
7/16	6,329	6,100	13,672	370,335	3.1	83.3
7/17	5,441	8,179	14,982	385,317	3.4	86.7
7/18	5,494	6,297	12,970	398,287	2.9	89.6
7/19	4,187	6,178	11,402	409,689	2.6	92.2
7/20	3,845	3,033	7,566	417,255	1.7	93.9
7/21	4,099	2,678	7,455	424,710	1.7	95.5
7/22	2,983	1,882	5,352	430,062	1.2	96.7
7/23	2,911	1,348	4,685	434,747	1.1	97.8
7/24	2,953	(2,074)	5,530	440,277	1.2	99.0
7/25	1,157	(813)	2,167	442,444	0.5	99.5
7/26	1,141	(802)	2,137	444,581	0.5	100.0

1/ Actual count expanded to account for escapement in middle portion of river by multiplying sum of east and west bank counts by 1.10. Expansion factor based on visual observation of fish passage in 1978.

2/ Daily counts in parentheses are estimated due to breakdown of sonar counter or milling salmon. Estimation methods are outlined in Appendix A.

Figure 5. Anvik River summer chum salmon escapement, 1972-1982.

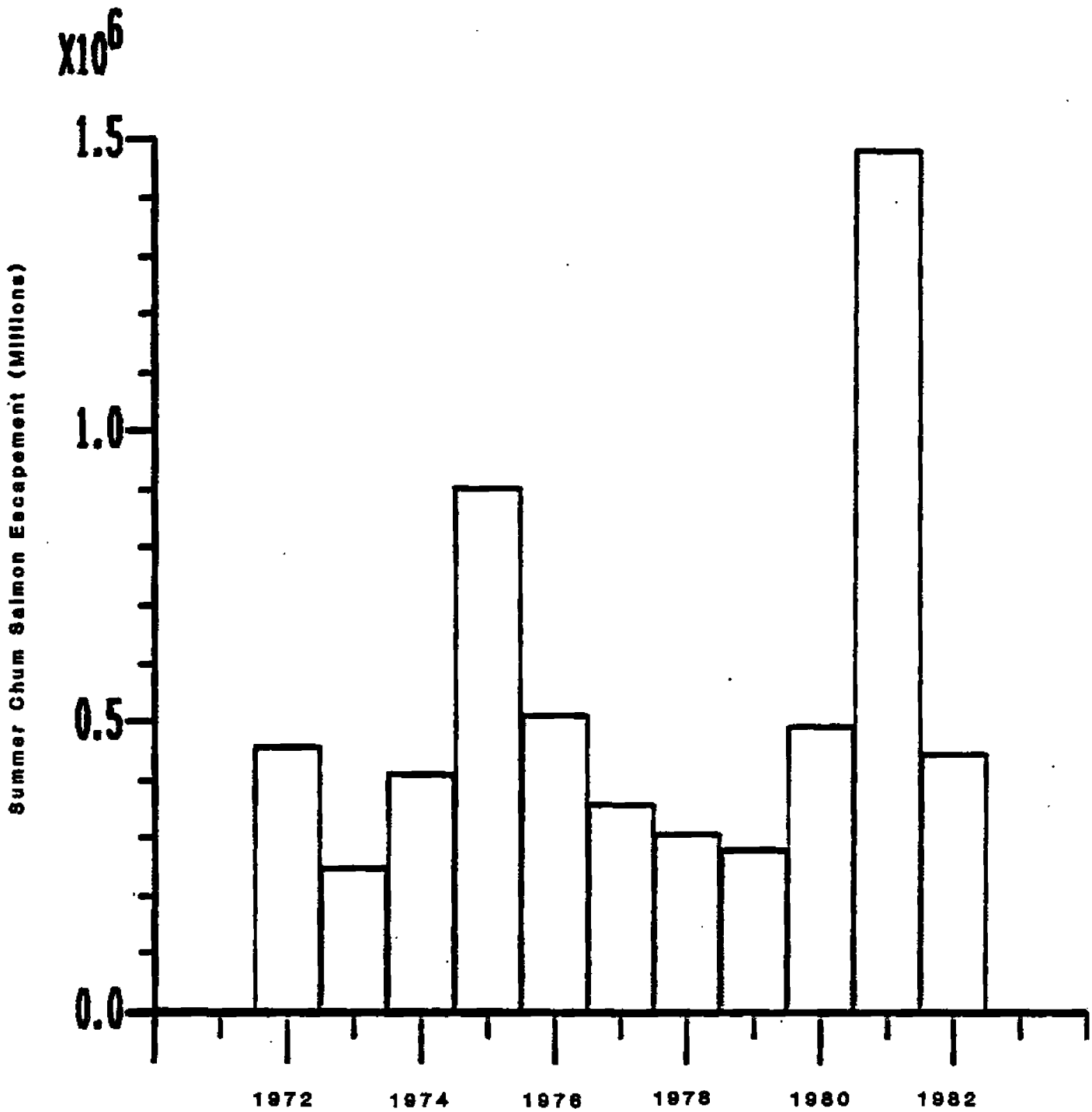


Table 2. Visual calibration of salmon sonar counts at the Anvik River east bank site, 1982.

Date	Time	Sonar Count	Visual Count 1/						Sonar Accuracy 2/
			Chum Salmon			Pink Salmon			
			Up	Down	Net	Up	Down	Net	
6/27	2315-2330	0	0	0	0	0	0	0	-
6/28	1510-1525	0	0	0	0	0	0	0	-
6/29	1530-1540	0	0	0	0	0	0	0	-
6/30	1517-1525	0	0	0	0	0	0	0	-
7/3	1718-1733	29	38	0	38	0	0	0	0.76
7/9	1600-1615	16	24	2	22	0	0	0	0.73
7/9	2205-2220	10	19	0	19	0	0	0	0.53
7/13	1318-1333	37	37	1	36	0	0	0	1.03
7/13	2252-2303	63	34	0	34	0	0	0	1.85
7/14	2230-2245	62	23	1	22	3	0	3	2.82
7/15	0940-0955	5	5	0	5	4	0	4	1.00
7/15	2205-2220	13	11	0	11	1	0	1	1.18
7/17	1005-1018	25	26	0	26	1	0	1	0.96
7/18	0807-0822	40	28	1	27	15	0	15	1.48
7/18	1619-1632	5	10	0	10	8	0	8	0.50
7/19	0855-0906	32	32	1	31	27	0	27	1.03
7/19	1506-1520	17	16	1	15	16	0	16	1.13
7/20	0824-0837	14	12	1	11	15	0	15	1.27
7/20	1614-1625	8	32	1	31	21	0	21	0.26
7/23	0952-1004	2	2	0	2	2	0	2	1.00
7/24	1450-1500	5	2	0	2	1	0	1	2.50
TOTALS	4.60 hours	383	351	9	342	114	0	114	1.12

1/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the differnce between the two. No king salmon were seen during visual calibration periods.

2/ Sonar accuracy is calculated by dividing the sonar counts for any given period by the net visual count of chum salmon for that period.

Table 3. Visual calibration of salmon sonar counts at the Anvik River west bank site, 1982.

Date	Time	Sonar Count	Visual Count 1/ Chum Salmon Up	Chum Salmon Down	Chum Salmon Net	Pink Salmon Up	Pink Salmon Down	Pink Salmon Net	Sonar Accuracy 2/
6/27	2300-2310	1	0	0	0	0	0	0	-
6/28	1445-1500	0	0	1	-1	0	0	0	-
6/29	1510-1525	0	0	0	0	0	0	0	-
6/30	1505-1515	0	0	0	0	0	0	0	-
7/3	0950-1005	3	9	0	9	0	0	0	0.33
7/3	1517-1532	3	6	0	6	0	0	0	0.50
7/15	0905-0920	24	27	1	26	4	0	4	0.92
7/15	2139-2154	9	7	0	7	0	0	0	1.29
7/17	0920-0935	24	27	2	25	3	0	3	0.96
7/18	0833-0848	17	27	1	26	22	0	22	0.65
7/18	1552-1607	8	8	2	6	9	0	9	1.33
7/19	0823-0838	12	18	1	17	12	0	12	0.71
7/19	1528-1543	3	9	2	7	6	0	6	0.43
7/20	0945-1000	0	4	0	4	3	0	3	-
7/20	1550-1605	13	34	4	30	8	0	8	0.43
7/24	1420-1435	5	1	3	-2	4	0	4	-
TOTALS	3.83 hours	122	177	17	160	71	0	71	0.76

1/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the difference between the two. No king salmon were seen during visual calibration periods.

2/ Sonar accuracy is calculated by dividing the sonar counts for any given period by by the net visual count of chum salmon for that period.

Milling chum salmon caused false counts on the east bank from 24 to 26 July, the last three days of the project. Poor visibility made it difficult to visually document the extent of this behavior with any accuracy. Milling was not a problem on the west bank, where water current was faster and fish passage remained normal. Escapement estimates for this period are based on west bank sonar counts, as outlined in Appendix A. The first salmon were counted on 25 June. Peak daily counts of 40,527 and 36,197 summer chum salmon occurred on 9 and 12 July, respectively. Run timing was similar to that of 1980, with mean date of passage on 11 July (Figure 6). Buklis (1982a) postulated a 20 day lag time for summer chum salmon migration between the fishery at Emmonak and the Anvik River sonar site. If correct, this would mean that 50% of the Anvik River stock had passed through the Emmonak area by 21 June. The large mesh gillnet season in Y-1 and Y-2 ended by emergency order on 2 July, indicating that once again the majority of the Anvik River stock had passed through the intensive lower Yukon River fishery before mandatory changeover to chum salmon gear.

There is no clear diurnal migration pattern apparent in the hourly sonar counts (Figure 7). For the 4 years in which sonar enumeration has been conducted on the Anvik River, only the 1981 run demonstrated a diurnal pattern. Passage was lowest at mid-day and greatest at midnight for that year. The majority of the fish have been counted along the west bank each year. The count distribution by sector for the west bank substrate in 1982 shows an uncharacteristic pattern (Figure 8), with a sudden increase in counts from sector 8 to sector 9. This possible error in the count criteria of the sonar electronics was mentioned earlier. Most of the sonar counts registered by the east bank counter were in sectors 8 through 16. Although the same counting error may have been operating on the east bank as on the west bank, it is also true that most of the fish passage was occurring offshore at this site.

A total of 185 pink salmon were visually counted crossing the east bank (Table 2) and west bank (Table 3) sonar substrates between 14 and 26 July. During this same period, 337 chum salmon were visually counted. The total chum salmon escapement estimate for this period was 139,907 (Table 1). The ratio of visual chum salmon counts to total escapement is 0.0024. Expansion of the 185 pink salmon visual counts based on this ratio yields a total escapement estimate of 76,800 pink salmon. There is no way to evaluate the accuracy of this expansion estimate, but it is probably a good approximation of the actual magnitude. Fishermen in Anvik Village reported that it was the largest pink salmon run they had seen in many years.

No aerial survey of the Anvik River was flown to estimate king salmon escapement due to high, turbid water conditions and overcast, rainy weather during late July and early August. No king salmon were visually counted over the sonar substrates during the period 27 June to 26 July. There is no data upon which to estimate the Anvik River king salmon escapement in 1982. Based on the low number of king salmon captured by beach seine and encountered during carcass surveys, the escapement was probably less than 2,000 king salmon.

Figure 6. Daily summer chum salmon escapement past the Anvik River sonar site, 1979-1982. The mean date of run passage is indicated by dashed line.

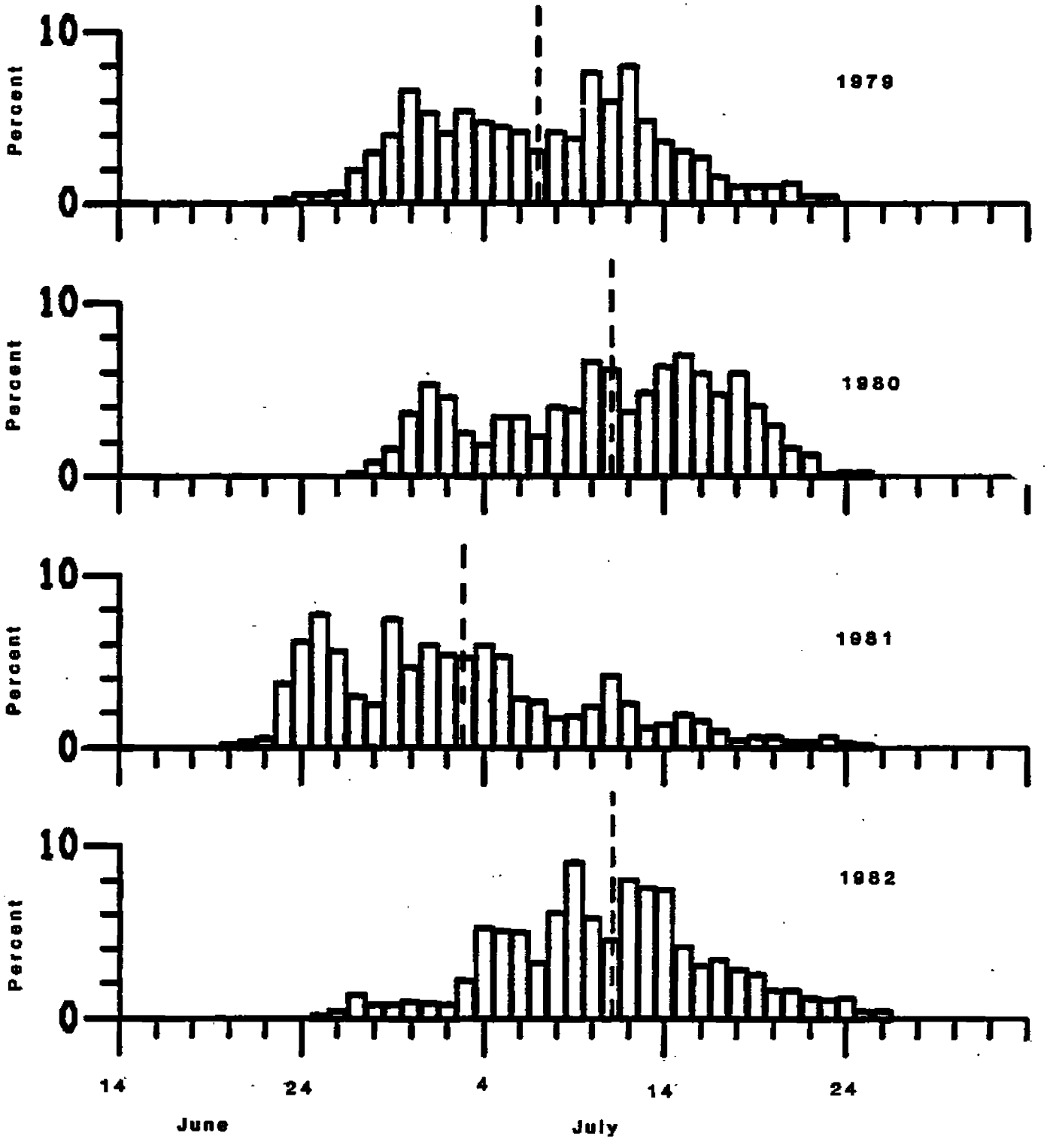


Figure 7. Summer chum salmon escapement past the Anvik River sonar site by hour, 1979–1982.

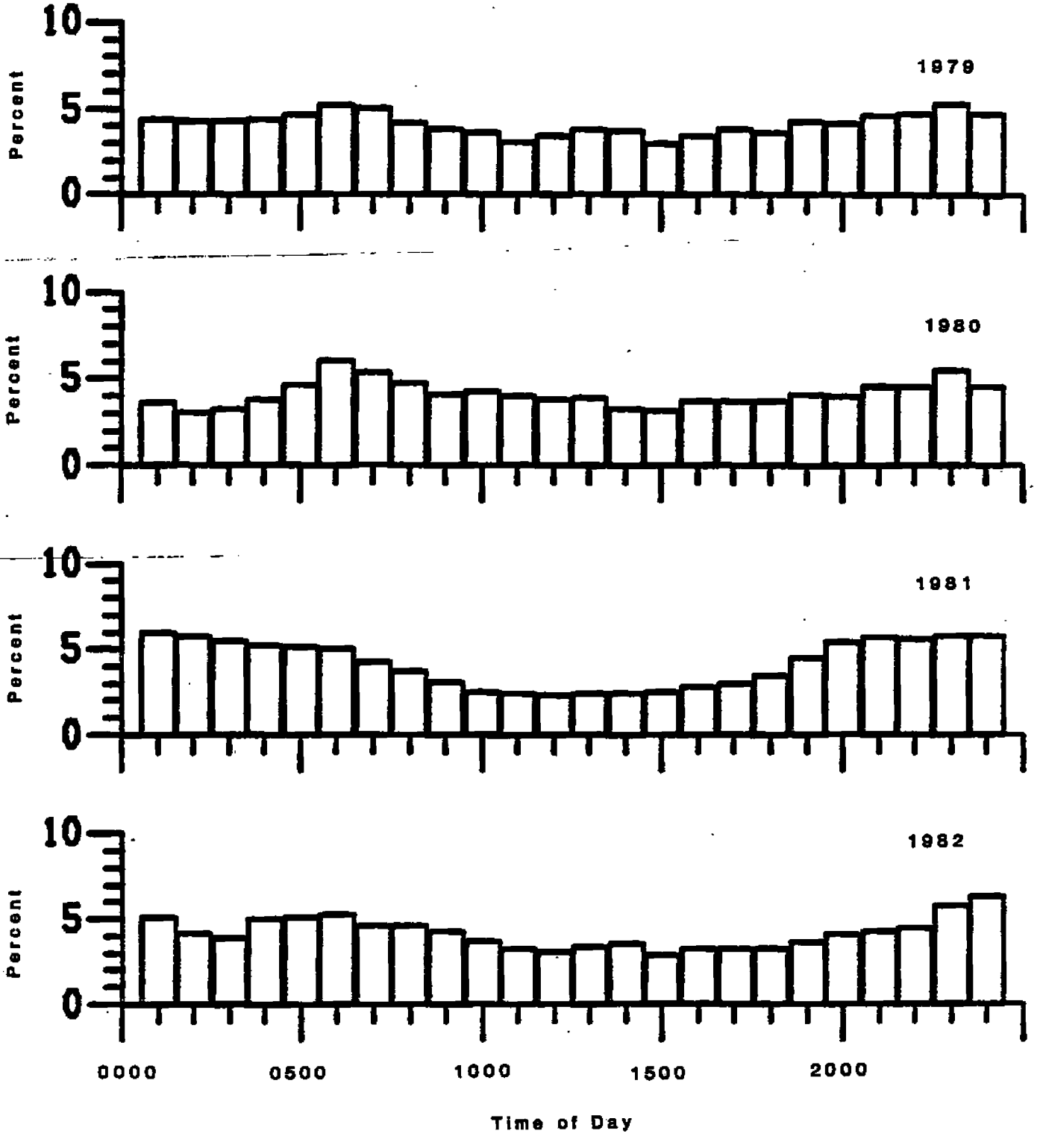
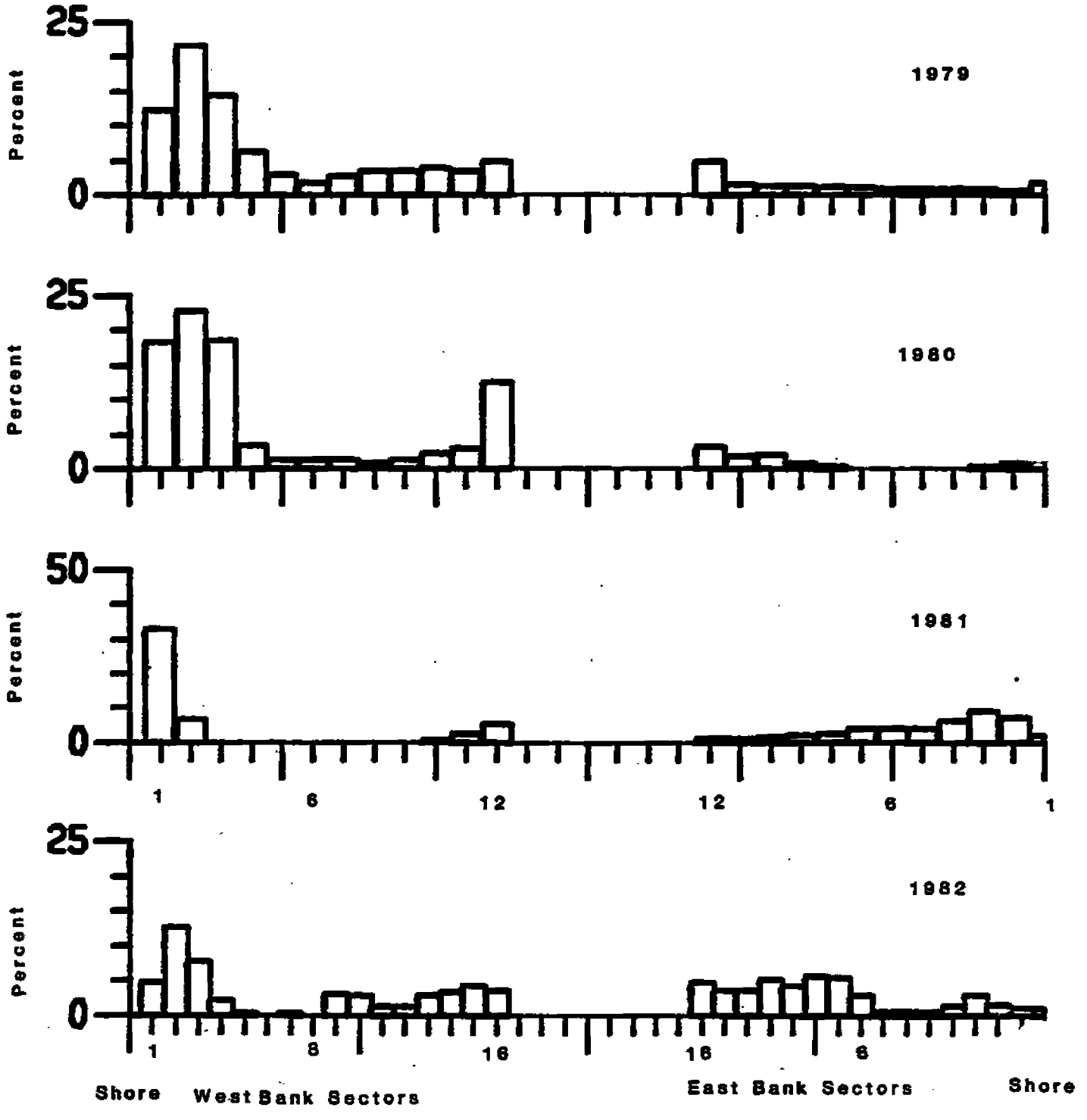


Figure 8. Summer chum salmon escapement past the Anvik River sonar site by sonar sector, 1979-1982. Note that there were 12 sectors for each substrate in 1979-1981, and 16 sectors in 1982.



River water depth declined steadily from 18 June (0cm) to 21 July, when it reached a low for the season of -84 cm (Figure 9). Intermittent to heavy rainfall during the period 20 to 31 July resulted in rapidly rising water levels. River water depth increased from -84 cm on 21 July to +112 cm on 31 July, a vertical gain of 196 cm (6'-5") in 10 days. Horizontal gain depended, of course, on slope of the shoreline, but in many places the river was flooded to the willows along gravel beaches and near the top of cutbanks. Water was extremely turbid. Water temperature dropped during the flood period, and air temperatures were low due to the cloud cover (Figure 9). Water temperature was 14°C on 18 June, 9°C on 31 July, and back up to 13°C on 8 August. Air temperature was 15°C on 18 June, 10°C on 31 July, and 18°C on 8 August.

Beach seining was conducted at the sonar site, but was not very effective in capturing salmon for age, sex and size sampling. Thirty-five sets were made between 21 June and 21 July, and only 63 chum salmon, 1 king salmon and 6 pink salmon were captured. An additional 325 chum salmon and 137 king salmon were sampled by carcass survey between mid-July and mid-August. Chum salmon sampled by beach seine were 61% female and evenly divided between age 4 (51%) and age 5 (46%), while carcass samples were 71% female and 70% age 4 (Appendix Table 1). Average length of beach seine samples tended to be slightly larger than carcass samples for a given age and sex group, but were well within the range of 1 standard deviation, and the differences are therefore not statistically significant (Appendix Table 1). The small sample size obtained by beach seine makes it difficult to make a rigorous comparison of the two methods, and all samples are pooled to compare with the age and sex composition of carcass samples collected in previous years. Greater effort should be made to collect an adequate sample by beach seine in 1983. This may require extensive seining at several locations near the sonar site to locate an effective beach seine site.

The pooled summer chum salmon sample was 69% female, with an age breakdown of 6% age 3, 67% age 4, 27% age 5 and 1% age 6. This is similar to the age and sex composition of the 1979 escapement, but contrasts markedly with 1981, when age 5 was predominant (Figure 10). Age class 4 or 5 predominates in any given year, but there is no apparent pattern or cycle in the age of the return. Strength of the 1971 and 1976 brood years can be traced through all age classes.

King salmon carcass samples were only 28% female, with an age breakdown of 35% age 4, 38% age 5 and 28% age 6 (Appendix Table 2). Average length ranged from a low of 560mm for age 4 males to 840mm for age 6 females. No age 7 king salmon were found in the sample. The age and sex composition of the 1982 escapement differed greatly from that of the previous year (Figure 11). The 1981 escapement sample was 59% female, including fewer of the age 4 and age 5 males that dominated the 1982 escapement. Production is expected to be low from the 1982 escapement due to the small number of females.

One sockeye salmon and one coho salmon were found while surveying the river by boat for king and chum salmon carcasses. The sockeye salmon was moribund when captured on 7 August near the confluence with the Yellow River, and was an age 7_3 male 590mm in length. This is the first sockeye salmon documented in the Anvik River. The coho salmon carcass was found at mile 2.5 of the Yellow River on 14 August, and was a male with a length of 495mm. The scale sample from this fish was not readable.

Figure 9. Water temperature, air temperature (max/min average), and water depth measured at noon daily at the Anvik River sonar site, 1982.

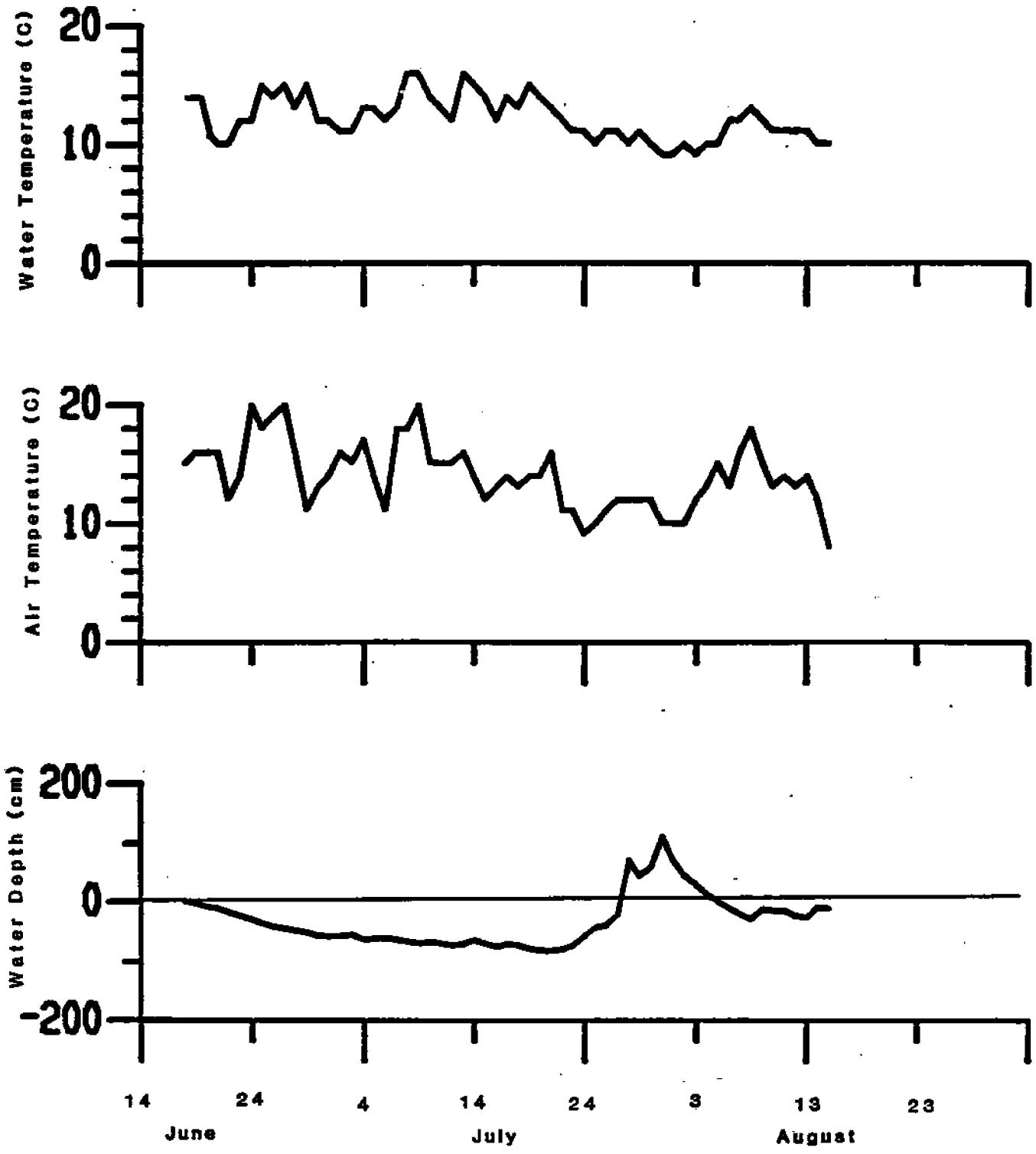
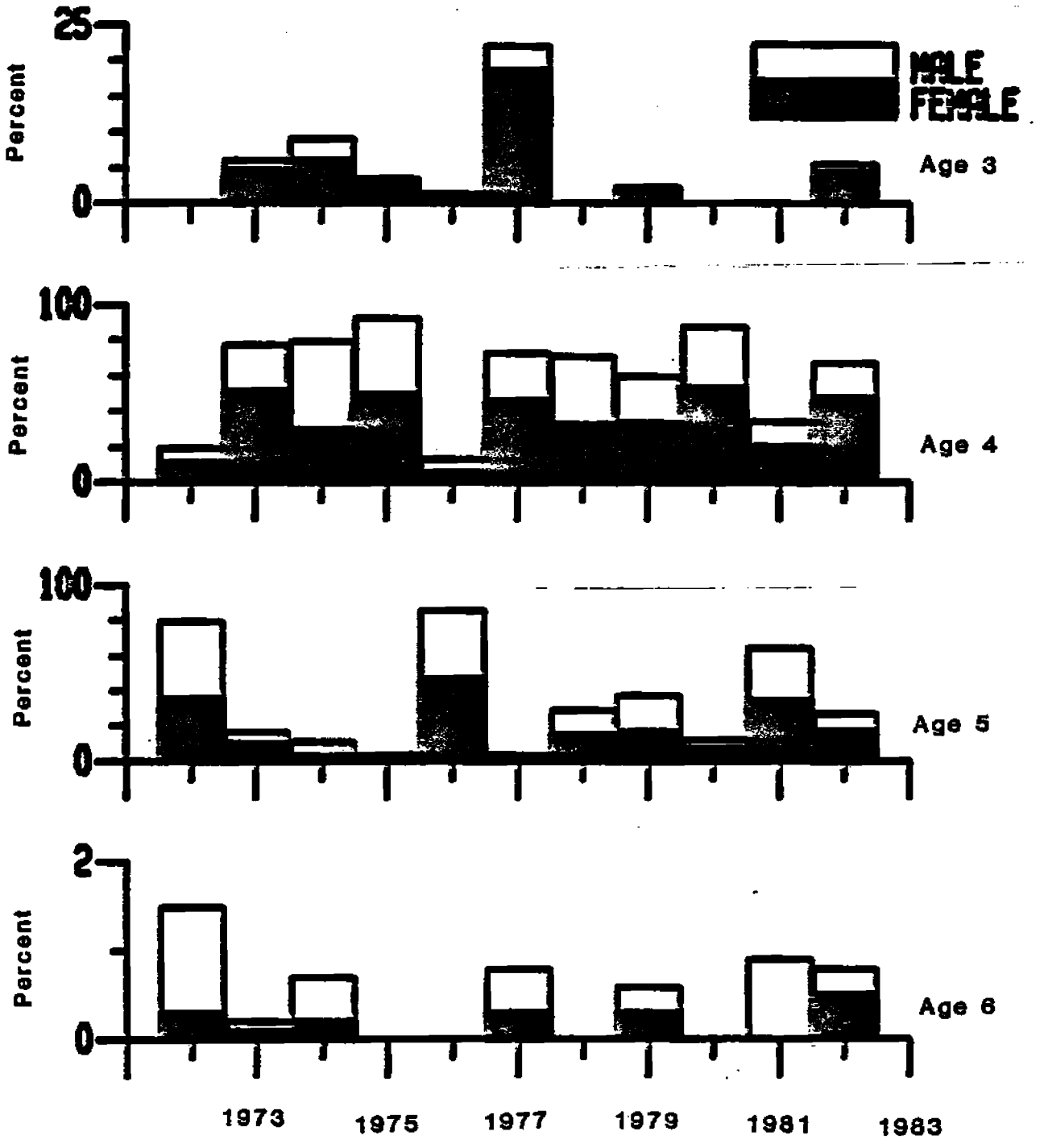
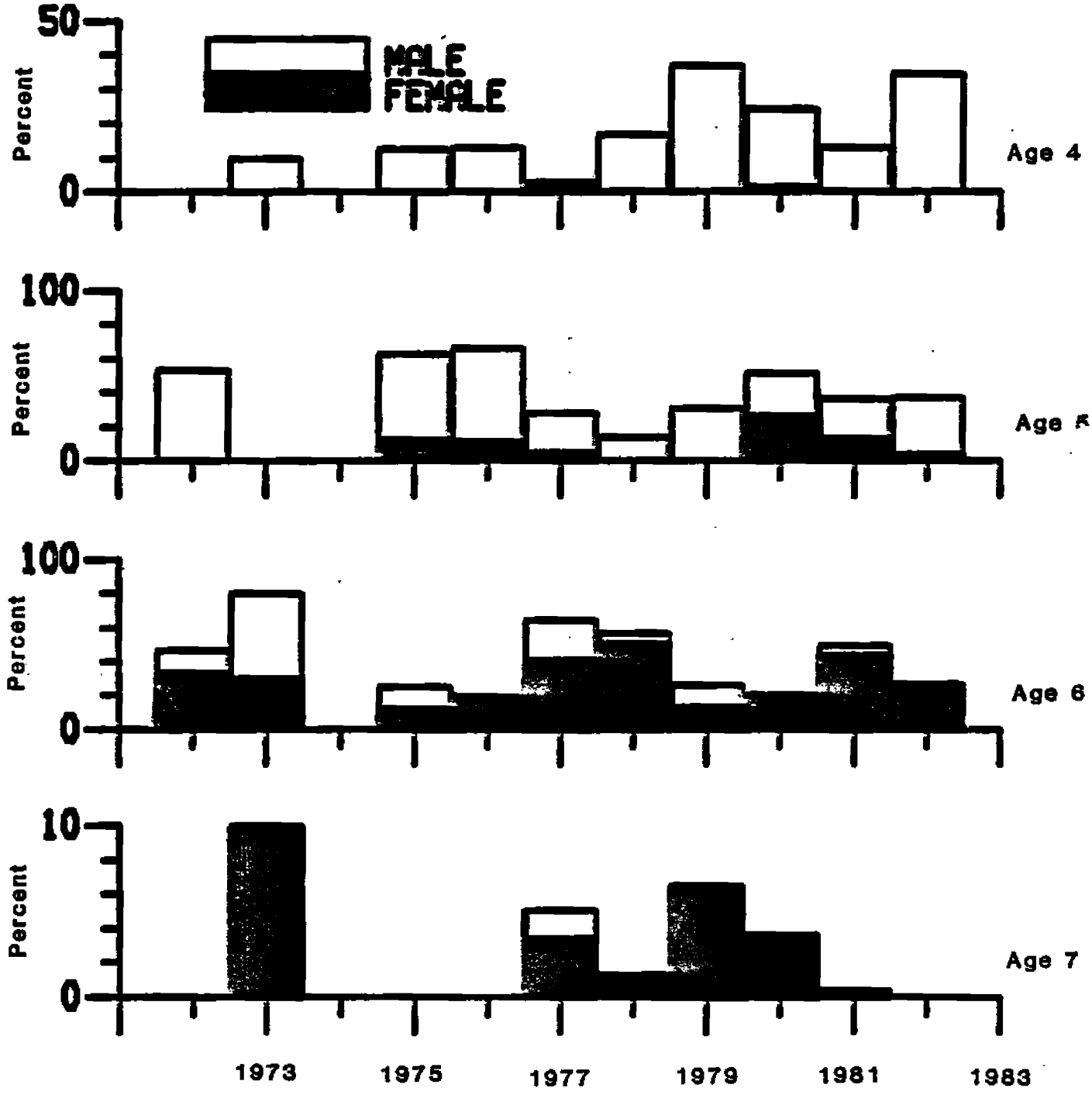


Figure 10. Age and sex composition of Anvik River summer chum salmon, 1972-1982. 1/



1/ Includes 57 (15%) beach seine samples in 1982. All other samples were carcasses.

Figure 11. Age and sex composition of Anvik River king salmon carcass samples, 1972-1982.1/



1/ No samples were collected in 1974.

ANDREAFSKY RIVER ADULT SALMON STUDY

The Andreafsky River (Figure 12) includes two main branches, the East and West Forks, and is located 100 miles upstream from the mouth of the Yukon River. It is second to the Anvik River in summer chum salmon production, second to the Salcha River in king salmon production, and supports the largest pink salmon run in the Yukon River drainage. Salmon escapements were estimated annually by aerial survey from fixed-wing aircraft prior to 1981, when a side-scan sonar counter was installed in the East Fork for the first time. Water clarity is generally good, but high water, rain, wind and cloud cover have resulted in poor surveys in some years. Aerial surveys are still flown to estimate escapement to the West Fork of the river, and to evaluate the accuracy of the sonar counter on the East Fork.

Below the confluence of the East and West Forks, the Andreafsky River is wide and slow moving, not suitable for side-scan sonar operation. The East Fork was chosen for the initial feasibility study in 1981 (Buklis 1982b), and the study was continued in 1982.

Methods and Materials

A sonar site was located at mile 20 of the East Fork Andreafsky River in 1981. One sonar counter and substrate was available for the initial feasibility study, and it was placed in the middle of a 100 foot wide channel between the west bank and an island (Figure 13). Weirs prevented fish passage around either end of the substrate, which was situated on a gravel shelf approximately 3 feet deep on 23 June, 1981. The channel on the opposite side of the island was not navigable by salmon due to low water and numerous sandbars.

A second sonar counter and substrate was brought to the Andreafsky River in 1982. When the crew arrived at the sonar site on 11 June the water level was significantly higher than it had been the previous year. Water was flowing on both sides of the island, and was 6 feet deep across the gravel shelf. Since two sonar counters were available, it was decided not to try to install one substrate in the middle of the channel as in 1981, but instead to put one substrate on the west bank and one on the east bank of the river (Figure 13). The west bank substrate was situated on a gradually sloping gradient in front of the campsite, about 800 feet downriver from the 1981 sonar site. The transducer housing was 1 foot underwater and 15 feet from shore, with a weir preventing inshore fish passage. The offshore end was 7 feet deep. The east bank substrate was situated on a steeper gradient 150 feet downriver from the west bank substrate. The transducer housing was 1 foot underwater and 5 feet from shore, with a weir preventing inshore fish passage. The offshore end was 7 feet deep. The river is 200 feet wide at this site and characterized by a slow water eddy area along each bank. Water flow was only about 2 feet/sec even in the center of the channel. The west bank substrate was situated at the upper end of a slow water area, and the east bank substrate at the lower end, thus the substrates were installed as close together as possible while still avoiding the eddies.

Sonar counters were the 1978 model, which divide the counting range into 12 sectors and do not have a "large fish" counting feature. Oscilloscope and visual calibrations were conducted as described for the Anvik River. King and chum salmon were sampled by beach seine and carcass survey for age, sex and

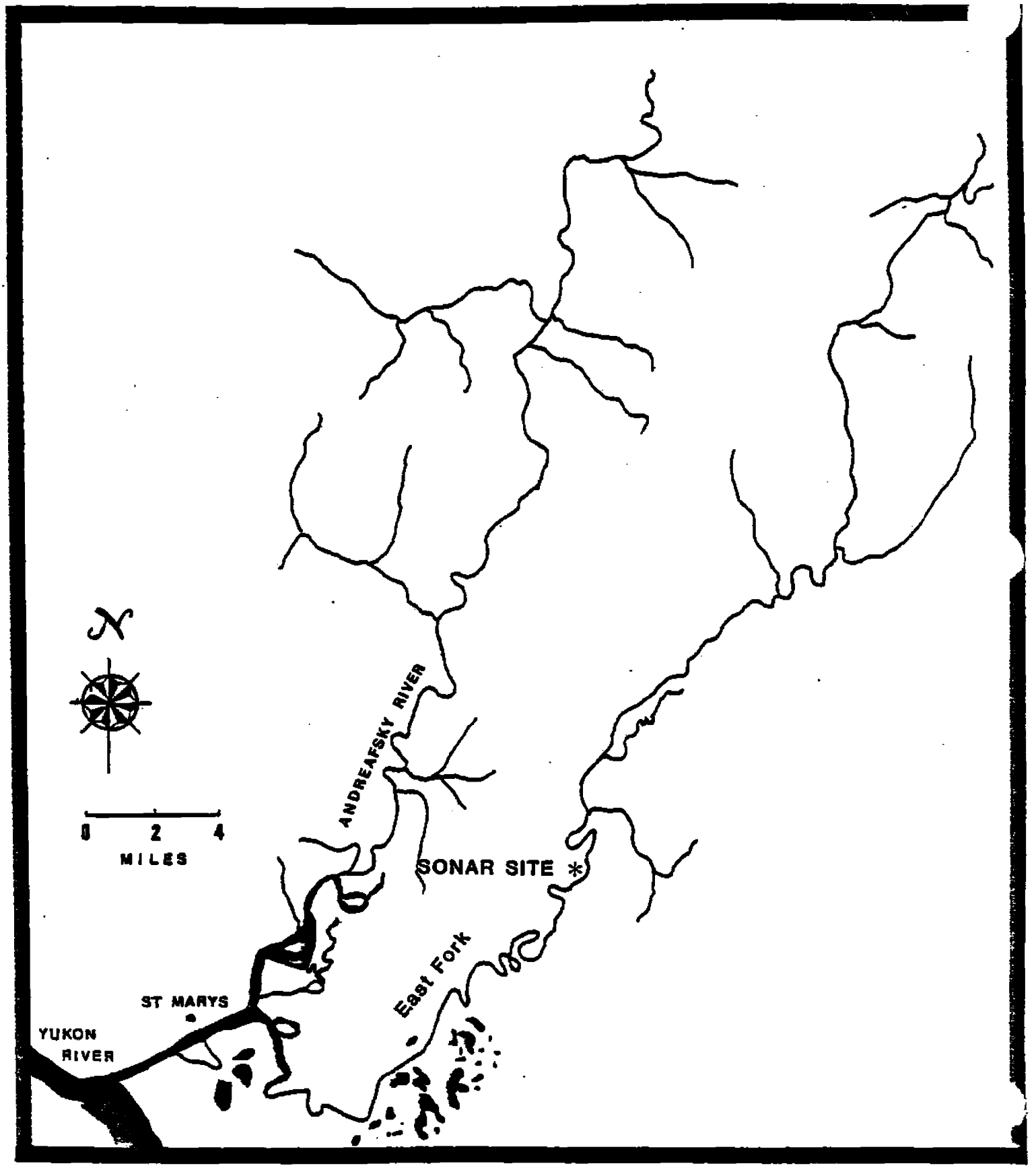


Figure 12. Map of the Andreafsky River.

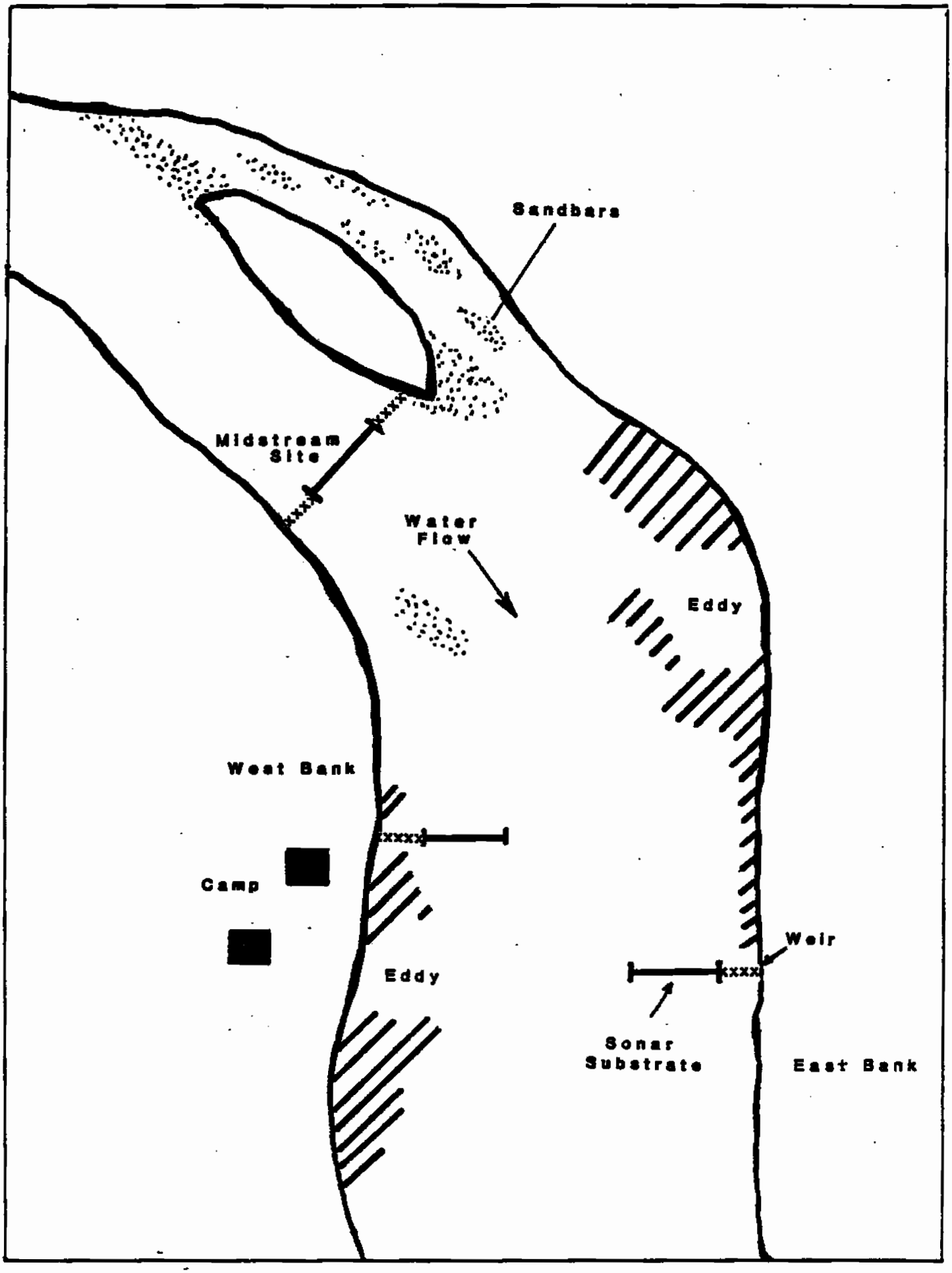


Figure 13. Map of the East Fork Andreafsky River sonar site.

size composition data as described for the Anvik River study. Salmon carcasses were also sampled from the West Fork Andreafsky River.

Results and Discussion

The sonar counters were operational on 18 June, and the first salmon were counted on 25 June. The electronics were adjusted such that pink salmon generally were not counted, but a small percentage probably did register counts due to milling behavior near the substrate. A total of 181,352 salmon were counted between 25 June and 20 July (Table 4). As will be discussed later, it is not possible to accurately estimate the number of king or pink salmon that contributed to the total, although both species combined probably accounted for less than 5% of the sonar counts. Therefore, all sonar counts are attributed to summer chum salmon for the purpose of comparing to historical escapement trends. Escapement estimates prior to 1981 are based on aerial surveys, and may not be directly comparable.

The 1982 East Fork Andreafsky River escapement of 181,352 summer chum salmon was 1.6 times greater than the previous 10 year average (1972-1981) of 110,963 and second only to the 1975 escapement of 223,485 summer chum salmon (Figure 14). Distribution of daily escapement counts in 1981 (Figure 15) indicated that an early segment of the run may have been missed, so that the total escapement count of 147,312 summer chum salmon was a minimum estimate. The actual escapement for 1981 and 1982 was more similar than the sonar estimates indicate because of the two factors mentioned: (1) The 1982 estimate was inflated by as much as 5% due to king and pink salmon counts, and (2) the 1981 estimate is low due to not counting an early segment of the run.

Sonar counts remained low from 25 June through 1 July, averaging 1,017 per day for the 7 day period. On 2 July 32,572 salmon counts were registered by the two sonar counters. Virtually all of these counts occurred in the offshore half of the west bank substrate, and between the hours of 1300 to 1700 (Figure 16). Unfortunately, the crew was in St. Marys purchasing supplies during this time, and thus no direct confirmation of these sonar countsis available. The crew did observe that there were many more chum salmon above the campsite upon their return than there had been previously. The weather was cloudy and windy, and may have triggered the upstream migration of chum salmon milling in the lower Andreafsky River. Fish were seen finning and breaching the water surface as the crew made their way downriver to St. Marys in the morning. There was no other boat traffic on the river to cause false counts and no debris was near the substrate when the crew returned. Transducer aiming and equipment settings were checked and found to be correct. This sudden appearance of such a large number of salmon (18% of season total) seems unprecedented, but there is no justification for rejecting the sonar count data.

The distribution of sonar counts on 2 July indicated that a substantial number of chum salmon may have been migrating in midstream between the two sonar substrates. Beginning on 3 July, slow water current at the east bank site resulted in milling fish behavior and the growth of vegetation on the substrate. For these reasons it was decided to move the east bank substrate to the midstream site used in 1981. By this time water depth had dropped about 2 feet, making sonar substrate installation more feasible.

Table 4. East Fork Andreafsky River chum and king salmon sonar counts by date, 1982.

Date	East Bank	West Bank	Midstream Site	Total Count Daily	Total Count Cumulative	% Season Total Daily	% Season Total Cumulative
6/25	168	382	-	550	550	0.3	0.3
6/26	317	545	-	862	1,412	0.5	0.8
6/27	174	434	-	608	2,020	0.3	1.1
6/28	334	1,905	-	2,239	4,259	1.2	2.3
6/29	218	430	-	648	4,907	0.4	2.7
6/30	668	523	-	1,191	6,098	0.7	3.4
7/1	338	685	-	1,023	7,121	0.6	3.9
7/2	1,656	30,916	-	32,572	39,693	18.0	21.9
7/3	(214) 1/	1,770	-	1,984	41,677	1.1	23.0
7/4	(684)	5,646	-	6,330	48,007	3.5	26.5
7/5	(131)	1,085	-	1,216	49,223	0.7	27.1
7/6	(224)	1,853	-	2,077	51,300	1.1	28.3
7/7	(528)	4,362	-	4,890	56,190	2.7	31.0
7/8	-	-	22,993	22,993	79,183	12.7	43.7
7/9	-	-	15,637	15,637	94,820	8.6	52.3
7/10	-	-	15,575	15,575	110,395	8.6	60.9
7/11	-	-	16,268	16,268	126,663	9.0	69.8
7/12	-	-	15,017	15,017	141,680	8.3	78.1
7/13	-	-	13,172	13,172	154,852	7.3	85.4
7/14	-	-	8,118	8,118	162,970	4.5	89.9
7/15	-	-	6,952	6,952	169,922	3.8	93.7
7/16	-	-	7,999	7,999	177,921	4.4	98.1
7/17	-	-	1,528 2/	1,528	179,449	0.8	99.0
7/18	-	-	1,027	1,027	180,476	0.6	99.5
7/19	-	-	646	646	181,122	0.4	99.9
7/20	-	-	230	230	181,352	0.1	100.0

1/ Slow water velocity, milling grayling and salmon, and vegetation along the substrate resulted in false counts at the east bank site beginning on 7/3. Daily east bank counts in parentheses are estimated based on the west bank count for that day. The east bank averaged 10.8% of the daily escapement for the period 6/25 through 7/2.

2/ Milling salmon resulted in false counts at the midstream site beginning on 7/16. Daily escapement estimates for the period 7/17 through 7/20 are based on expansion of visual counts, as presented in Appendix Table 3.

Figure 14. East Fork Andreafsky River summer chum salmon escapement, 1972-1982.

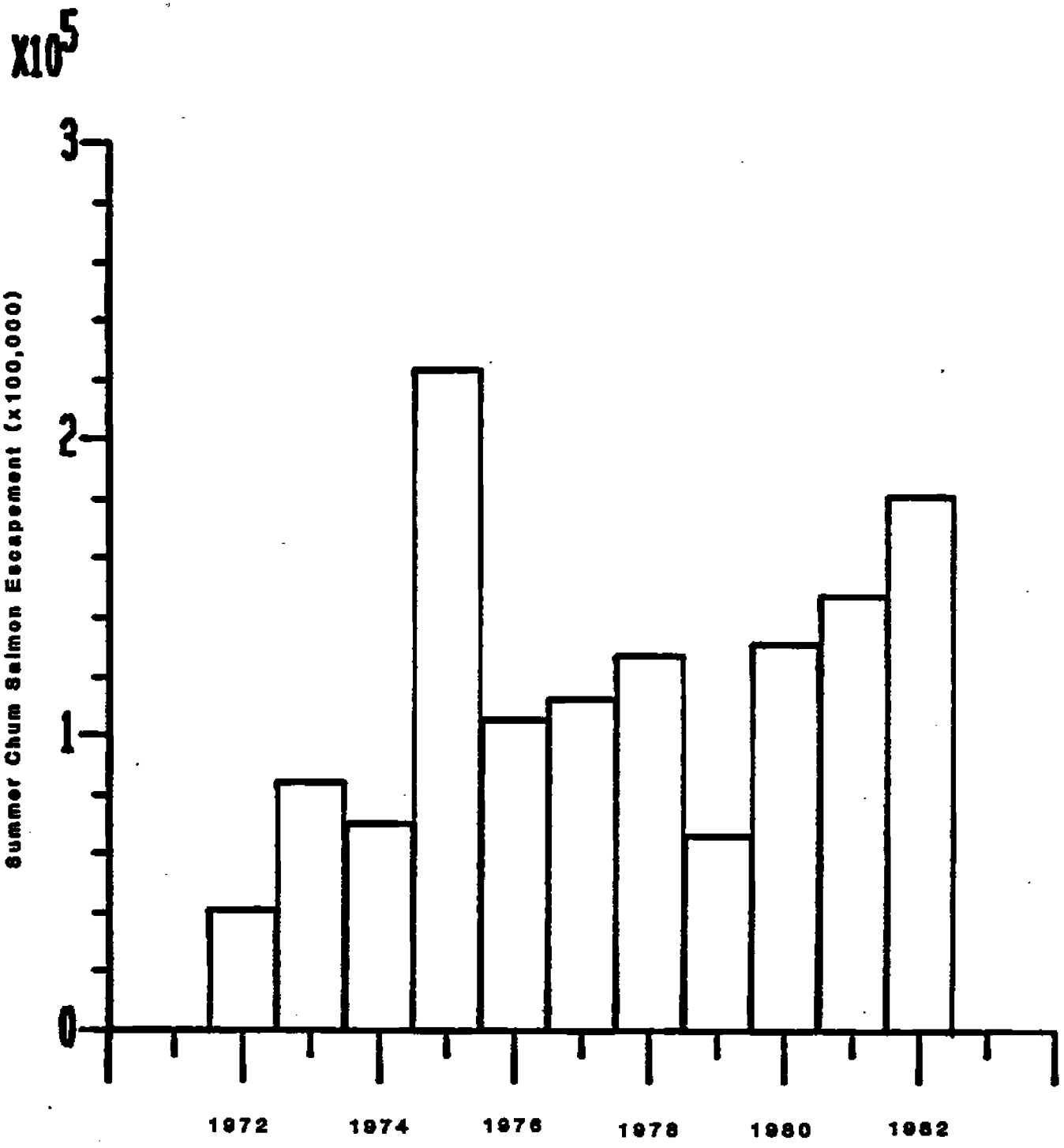


Figure 15. Daily summer chum salmon escapement past the East Fork Andreafsky River sonar site, 1981-1982. The mean date of run passage is indicated by dashed line.

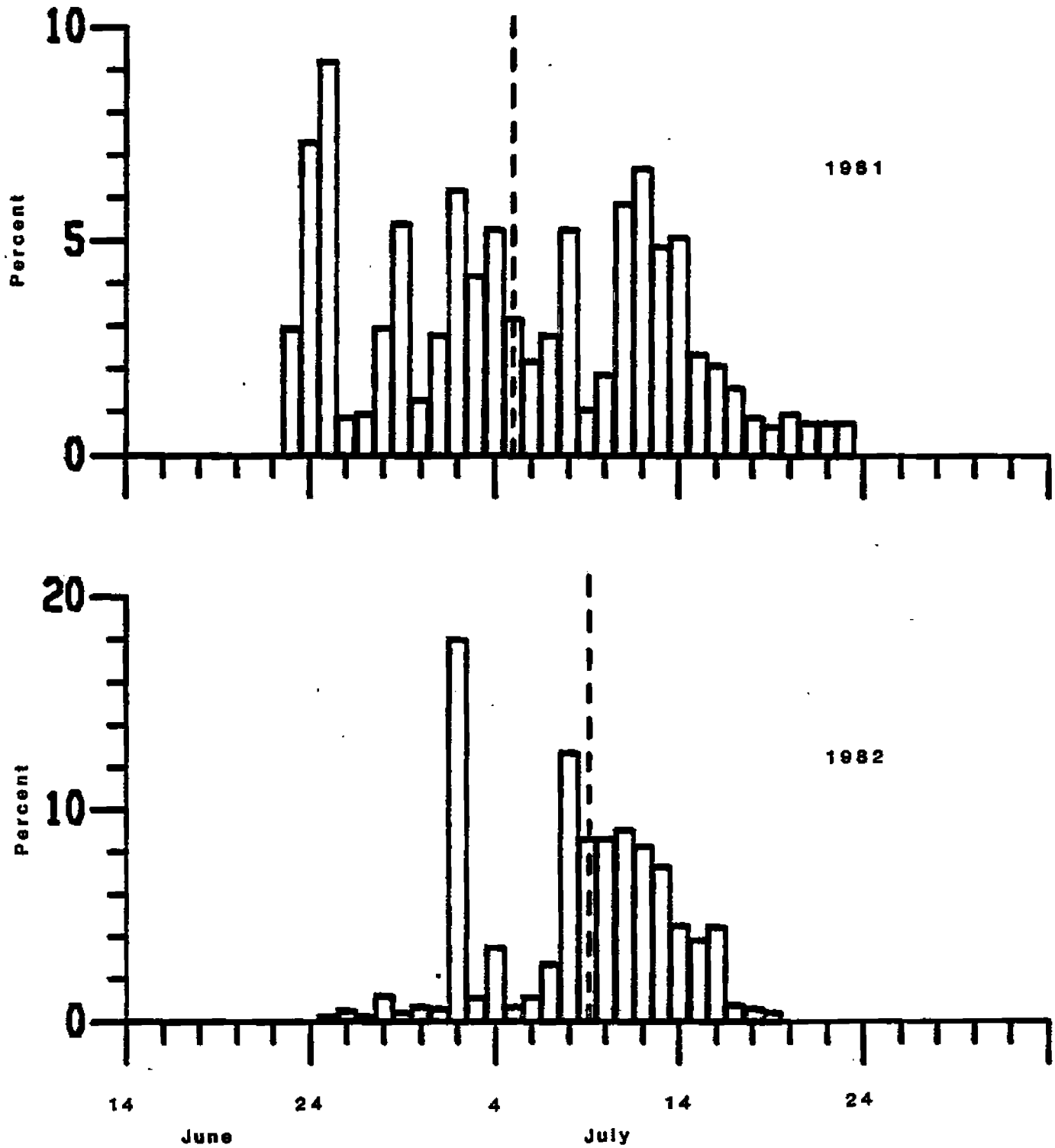
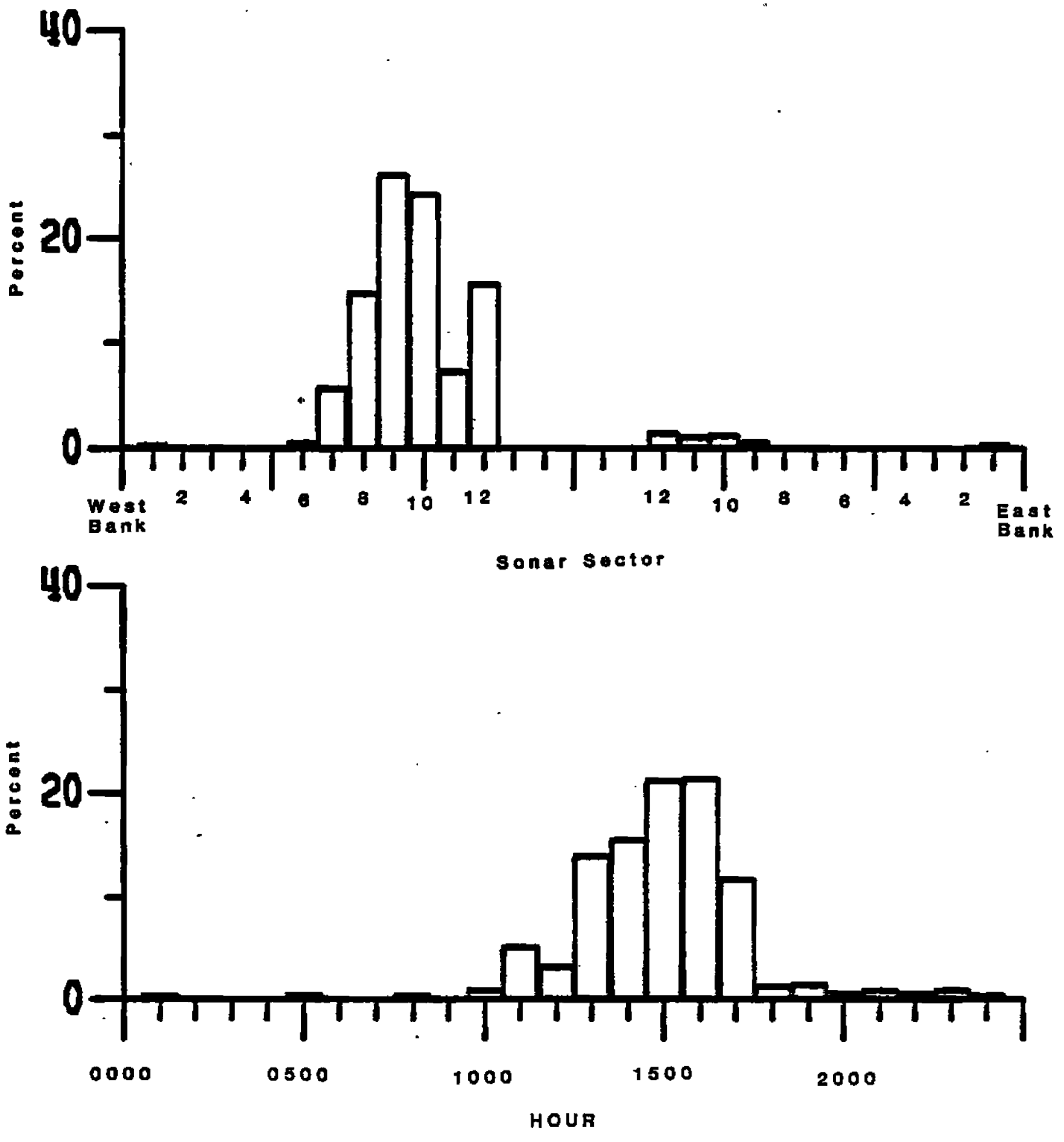


Figure 16. East Fork Andreafsky River sonar count distribution by sonar sector (above) and by hour (below) on 2 July, 1982. A total of 32,572 sonar counts were registered on this date, 18% of the total for the season.



The channel on the other side of the island was blocked to salmon passage by exposed sand bars. Daily escapement estimates for the period 3 July through 7 July are derived by expanding the west bank sonar counts (Table 4). Salmon escapement was counted from the midstream site beginning on 8 July until project termination on 20 July. Weirs prevented fish passage around either end of the substrate. Daily escapement counts were consistently higher at the midstream site than they had been at the two previous sites, supporting the hypothesis that some chum salmon had been passing uncounted between the two substrates.

Water turbidity and weather conditions had prevented visual calibration of sonar counts at the east and west bank sites, but conditions were occasionally more suitable at the midstream site. Between 8 and 16 July a total of 4.67 hours of visual counting was conducted, and sonar accuracy averaged 86% (Table 5). Accuracy for any given period was extremely variable, as had been found at the Anvik River. Milling salmon resulted in false counts beginning on 16 July. Visual counting was increased and daily escapement estimates for the period 17 through 20 July are based on expanded visual counts, not sonar counts. A total of 18.6 hours of visual counting was conducted between 17 and 20 July, and a net upstream total of 10,840 pink salmon, 475 chum salmon and 43 king salmon were counted (Table 6). Hourly passage rates were taken to be representative of time blocks within the day, and expanded by the number of hours in the time block (Appendix Table 3). Resulting escapement estimates were 1,528 summer chum salmon on 17 July, 1,027 on 18 July, 646 on 19 July, and 230 on 20 July.

Mean date of run passage was 9 July in 1982 and 5 July in 1981 (Figure 15). Peak daily counts in 1982 of 32,572(18%) and 22,993 (13%) occurred on 2 and 8 July, respectively. Distribution of sonar counts at the midstream site by hour in 1982 does not demonstrate the diurnal pattern that was apparent in 1981 (Figure 17). Counts were lowest at mid-day and highest at midnight in 1981. The distribution of sonar counts by sector was also different between the two years. The substrate was positioned in 1981 such that sector 1 was on the west and sector 12 was on the east. Positioning was reversed in 1982, with sector 1 on the east end and sector 12 on the west. Sonar counts were high in the inner and outer sectors in 1981, dropping to a low in the middle sectors (Figure 18). In 1982, sonar counts were low in the inner and middle sectors, building to high counts in the outer sectors (Figure 18). The reason for the difference in count distribution is not known. A change in hydrology of the site or the large number of pink salmon in the 1982 run are two possible causes for the shift in the migration pattern of summer chum salmon.

Visual counts were obtained for only a portion of the salmon escapement period, and therefore cannot be expanded to accurately determine species composition (Figure 19). Pink salmon accounted for 90% of all visual counts, chum salmon 9.5% and king salmon 0.5%. Excluding pink salmon, chum salmon made up 95.4% and king salmon 4.6% of the remaining visual counts. This is similar to the 1981 percentages (excluding pink salmon): 96.5% chum salmon and 3.5% king salmon. Hourly passage rates based on visual counts indicate that the chum salmon escapement was similar in magnitude for the two years, that king salmon escapement was lower in 1982, and that pink salmon escapement was much greater in 1982 (Figure 19). The pink salmon escapement may have approached 1 million fish in the East Fork Andreafsky River.

Table 5. Visual calibration of salmon sonar counts at the East Fork Andreafsky River midstream site, 8-16 July, 1982.

Date	Time	Sonar Count	Visual Count 1/ Chum Salmon Up	Chum Salmon Down	Chum Salmon Net	King Salmon Up	King Salmon Down	King Salmon Net	Pink Salmon Up	Pink Salmon Down	Pink Salmon Net	Sonar Accuracy 2/
7/8	1005-1015	93	30	8	22	3	0	3	50	0	50	3.72
7/8	1610-1625	71	156	0	156	9	0	9	155	0	155	0.43
7/8	2050-2100	52	128	0	128	0	0	0	190	0	190	0.41
7/8	2112-2122	85	94	0	94	0	0	0	186	0	186	0.90
7/8	2125-2135	138	138	0	138	0	0	0	not counted			1.00
7/8	0.92 hours	439	546	8	538	12	0	12	581	0	581	0.80
7/9	1950-2000	15	19	0	19	2	0	2	154	0	154	0.71
7/9	0.17 hours	15	19	0	19	2	0	2	154	0	154	0.71
7/10	1540-1545	14	88	0	88	8	0	8	157	0	157	0.15
7/10	1600-1610	55	84	0	84	1	0	1	125	0	125	0.65
7/10	2020-2030	11	12	0	12	0	0	0	53	0	53	0.92
7/10	0.42 hours	80	184	0	184	9	0	9	335	0	335	0.41
7/11	1115-1125	1	1	0	1	0	0	0	86	0	86	1.00
7/11	1127-1137	4	8	0	8	0	0	0	105	0	105	0.50
7/11	0.33 hours	5	9	0	9	0	0	0	191	0	191	0.56
7/12	1030-1040	3	5	0	5	1	0	1	111	0	111	0.50
7/12	2310-2320	26	35	0	35	0	0	0	128	0	128	0.74
7/12	0.33 hours	29	40	0	40	1	0	1	239	0	239	71
7/13	2250-2300	10	17	0	17	0	0	0	53	0	53	0.59
7/13	0.17 hours	10	17	0	17	0	0	0	53	0	53	0.59
7/14	1000-1015	17	7	0	7	1	0	1	21	0	21	2.12
7/14	1040-1055	6	6	2	4	0	0	0	16	0	16	1.50
7/14	1850-1855	15	4	0	4	0	0	0	30	0	30	3.75
7/14	1900-1910	78	13	1	12	0	0	0	119	0	119	6.50
7/14	2245-2300	30	23	0	23	0	0	0	118	0	118	1.30
7/14	1.00 hours	146	53	3	50	1	0	1	304	0	304	2.86
7/15	1350-1405	1	28	0	28	0	0	0	134	0	134	0.04
7/15	1500-1515	16	11	0	11	0	0	0	136	0	136	1.45
7/15	1517-1532	5	12	0	12	0	0	0	212	0	212	0.42
7/15	1535-1550	13	11	0	11	0	0	0	136	0	136	1.18
7/15	1.00 hours	35	62	0	62	0	0	0	618	0	618	0.56
7/16	1035-1045	14	8	0	8	0	0	0	114	0	114	1.75
7/16	2240-2250	63	20	2	18	0	0	0	138	0	138	3.50
7/16	0.33 hours	77	28	2	26	0	0	0	252	0	252	2.96
Totals	4.67 hours	836	958	13	945	25	0	25	2,727	0	2,727	0.86

1/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the difference between the two.

2/ Sonar accuracy is calculated by dividing the sonar counts for any given period by the sum of the chum and king salmon net visual counts for that period.

Table 6. Visual salmon counts at the East Fork Andreafsky River midstream site, 17-20 July, 1982.

Date	Time	Chum Salmon			King Salmon			Pink Salmon		
		Up	Down	Net	Up	Down	Net	Up	Down	Net
7/17	1130-1145	4	2	2	0	0	0	18	0	18
7/17	1450-1620	57	14	43	5	0	5	746	1	745
7/17	1855-1935	87	5	82	1	0	1	811	4	807
7/17	2005-2020	15	1	14	0	0	0	343	1	342
7/18	0835-0900	2	0	2	1	0	1	219	0	219
7/18	0900-1000	10	2	8	4	0	4	499	1	498
7/18	1215-1315	27	0	27	3	0	3	502	2	500
7/18	1510-1610	56	4	52	2	0	2	592	0	592
7/18	1810-1910	55	2	53	1	0	1	445	0	445
7/18	2215-2315	73	1	72	6	0	6	1,140	2	1,138
7/19	0555-0655	20	0	20	3	0	3	1,181	1	1,180
7/19	0910-1010	7	2	5	0	0	0	682	0	682
7/19	1210-1310	12	2	10	1	0	1	374	3	371
7/19	1550-1650	18	2	16	3	0	3	344	3	341
7/19	1800-1900	27	0	27	4	0	4	513	2	511
7/19	2110-2210	11	0	11	0	0	0	383	0	383
7/20	0700-0730	2	0	2	0	0	0	255	4	251
7/20	0910-1010	2	0	2	0	0	0	421	6	415
7/20	1300-1400	8	0	8	7	0	7	345	0	345
7/20	1530-1630	10	5	5	2	0	2	519	4	515
7/20	1800-1900	15	1	14	0	0	0	545	3	542
Totals	18.6 hours	518	43	475	43	0	43	10,877	37	10,840

Figure 17. Summer chum salmon escapement past the East Fork Andreafsky River sonar site by hour, 1981-1982.

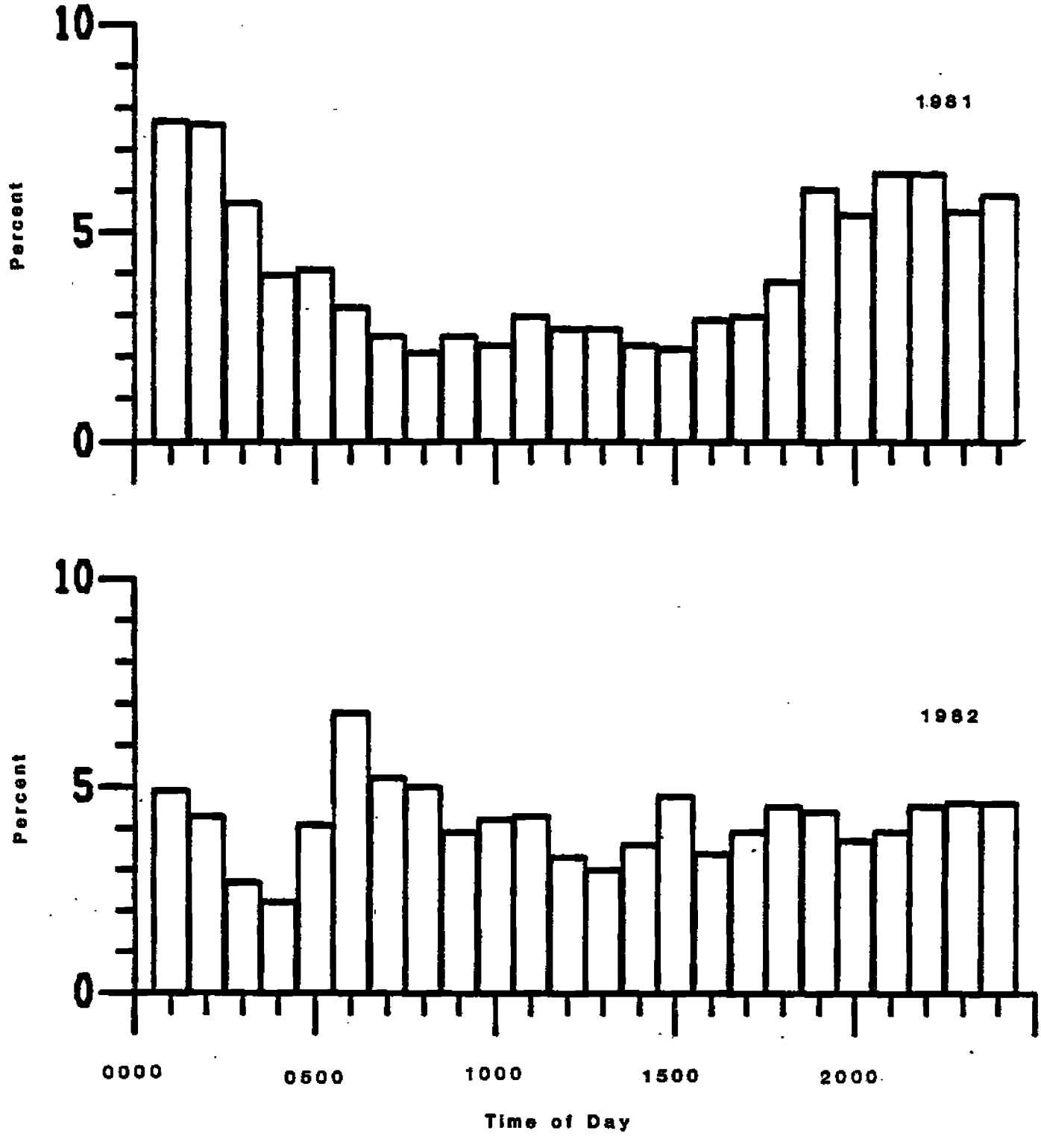


Figure 18. Summer chum salmon escapement past the East Fork Andreafsky River sonar site by sonar sector, 1981-1982. Note that sector 1 was on the west end in 1981 and on the east end in 1982.

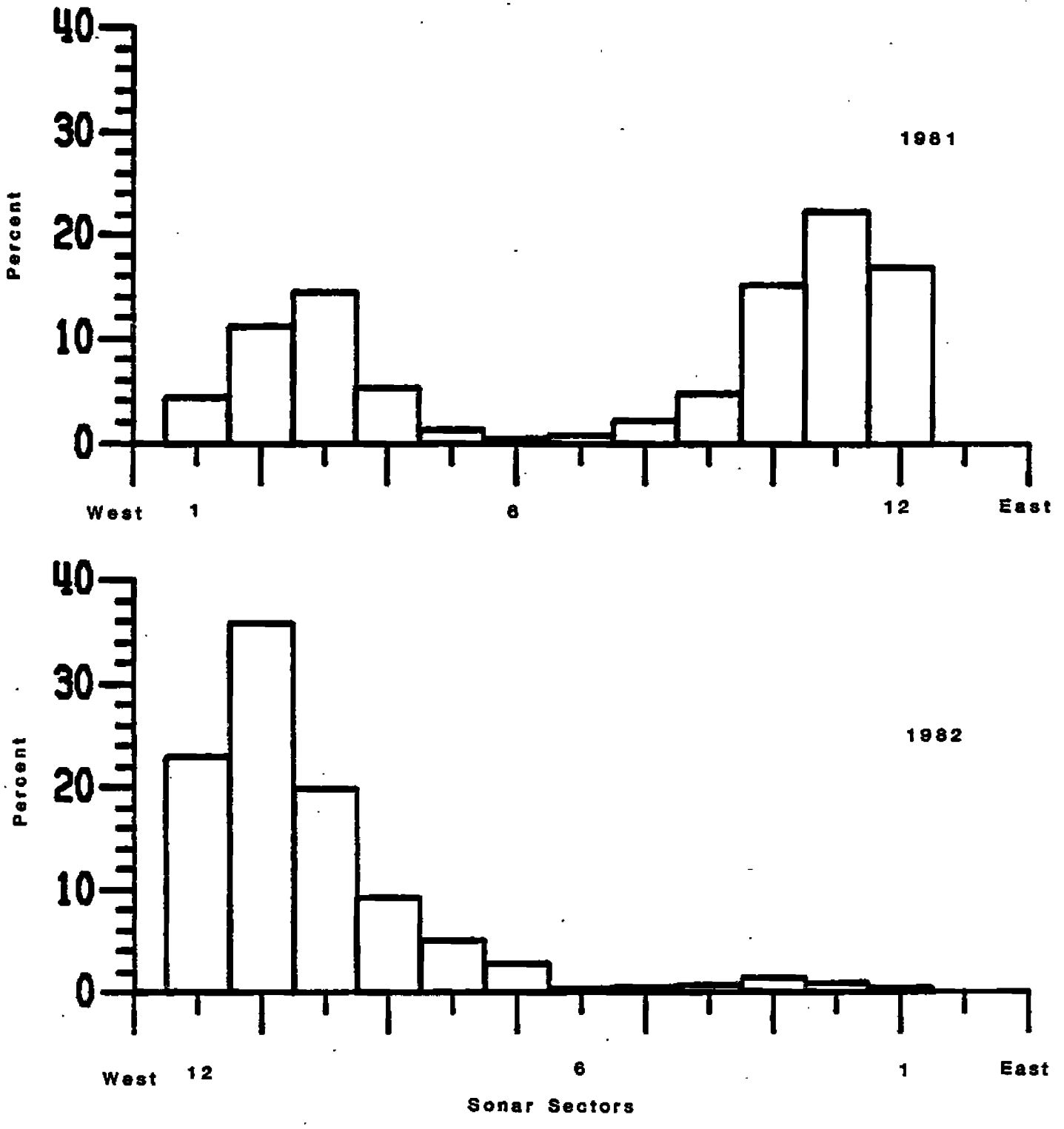
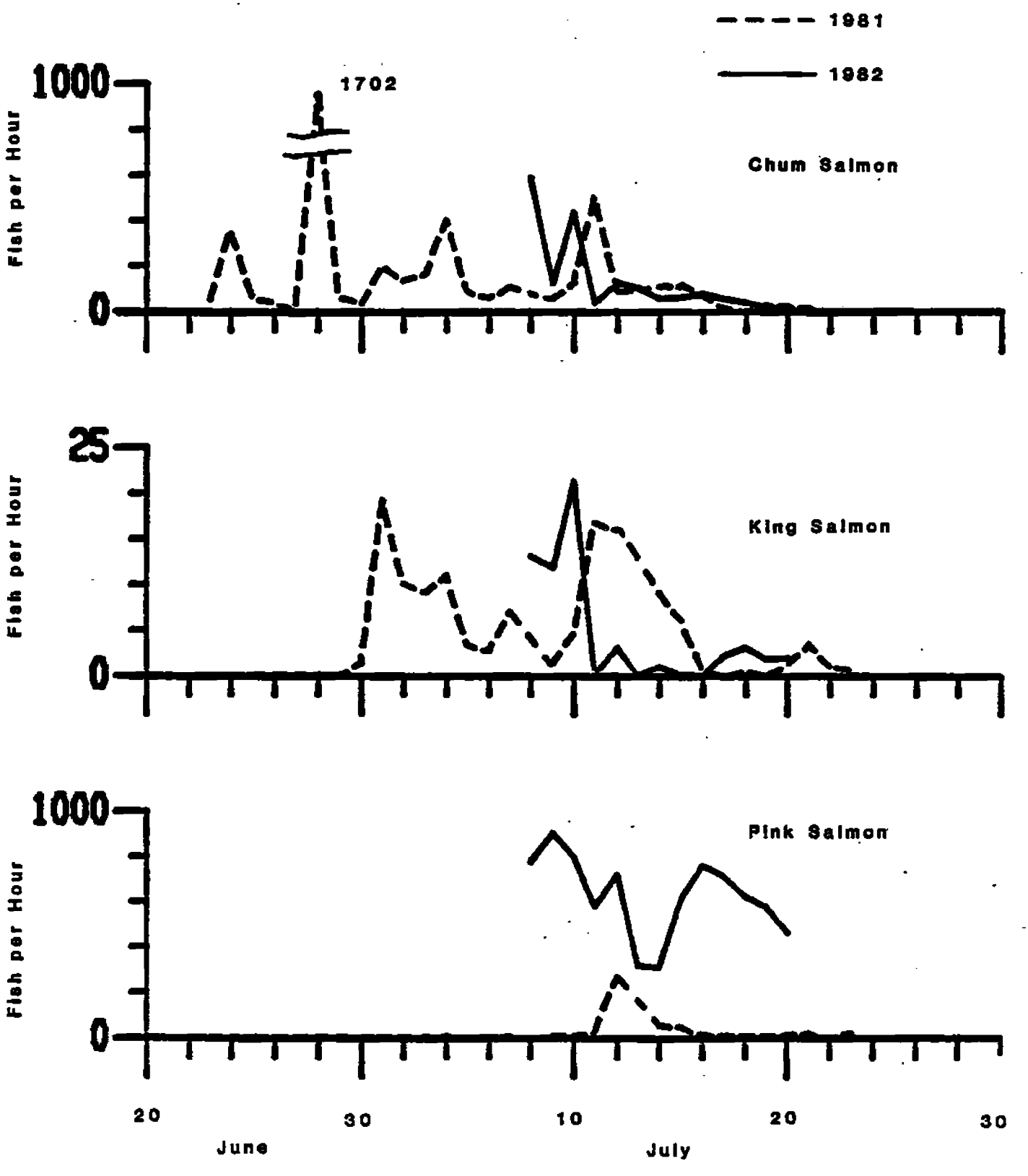


Figure 19. Hourly passage rate of chum, king, and pink salmon at the East Fork Andreafsky River sonar site based on visual counts, 1981-1982.



An aerial survey was flown of both the East and West Fork of the Andreafsky River on 20 July. Under fair conditions, 699 king salmon were counted on the West Fork and 1,274 on the East Fork. Cloud cover and wind reduced accuracy on the East Fork portion of the survey, which was the latter fork surveyed. The large number of pink salmon prohibited enumeration of summer chum salmon, and probably affected accuracy of the king salmon estimate as well. Survey counts should be considered minimum estimates. A second survey of the West Fork only on 6 August resulted in a count of 836 live king salmon and 15 carcasses. Once again survey conditions were only rated fair.

Similar to the Anvik River, water level at the East Fork Andreafsky River sonar site declined steadily from the initial 0 cm reading on 15 June to -106 cm on 13 July (Figure 20). Water level was relatively stable for a 10 day period, then rose from -75 cm on 22 July to +15 cm on 31 July. This was a vertical gain of 90 cm (3 feet) in 9 days. Water temperature ranged between 8°C and 16° C, while average daily air temperature ranged between 8°C and 18°C during the period 15 June to 15 August (Figure 20).

Beach seining was somewhat more effective on the East Fork Andreafsky River than it was on the Anvik River, but catches were lower than anticipated. Thirty-two sets were made between 20 June and 17 July, and 131 chum salmon, 33 king salmon and 81 pink salmon were captured. An additional 330 chum salmon and 296 king salmon were sampled by carcass survey. The age, sex and size composition of summer chum salmon sampled by beach seine and carcass survey were very similar (Appendix Table 4). Age 4 females dominated both samples, accounting for 43% of the beach seine catch and 52% of the carcasses. Although a larger beach seine sample would be desirable, it appears that there is no significant difference between the beach seine and carcass sample composition, and the data is pooled to compare with the 1981 escapement. The pooled sample is 65% female, and has an age breakdown of 2% age 3, 73% age 4, 23% age 5 and 2% age 6. By comparison, 1981 escapement was equally divided between age classes 4 and 5, and was 52% female (Figure 21). Strength of the age 4 return was apparent for both the Anvik and East Fork Andreafsky Rivers in 1982.

Too few king salmon were captured by beach seine to allow for a meaningful comparison with the age, sex and size composition of carcasses. Pooling the 29 samples from the beach seine catch, 208 carcasses from the East Fork and 88 carcasses from the West Fork results in a total sample of 325 king salmon from the Andreafsky River. The pooled sample was only 15% female, and had an age breakdown of 2% age 3, 35% age 4, 49% age 5, 12% age 6 and 2% age 7 (Appendix Table 5). The weak return of females was similar to the sex composition of the Anvik River stock. Length ranged from a low of 380mm for age 3 males to 937mm for age 7 females. The primary differences between king salmon escapement in 1981 and 1982 is the weak showing of age 6 fish in 1982, the presence of age 3 males, which were not found in 1981, and the overall poor return of females (Figure 22).

Figure 20. Water temperature, air temperature (max/min average), and water depth measured at noon daily at the East Fork Andreafsky River sonar site, 1982.

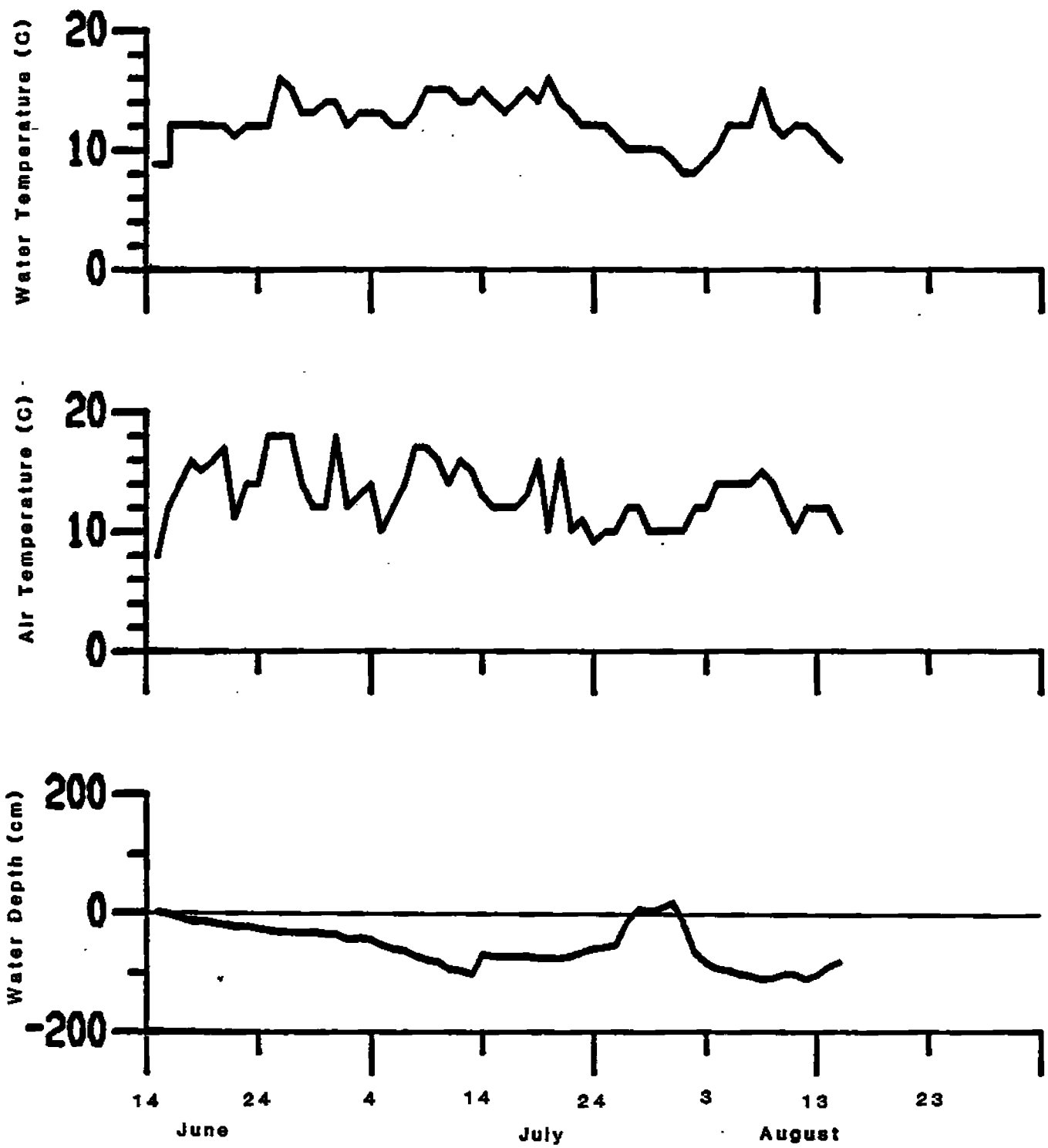
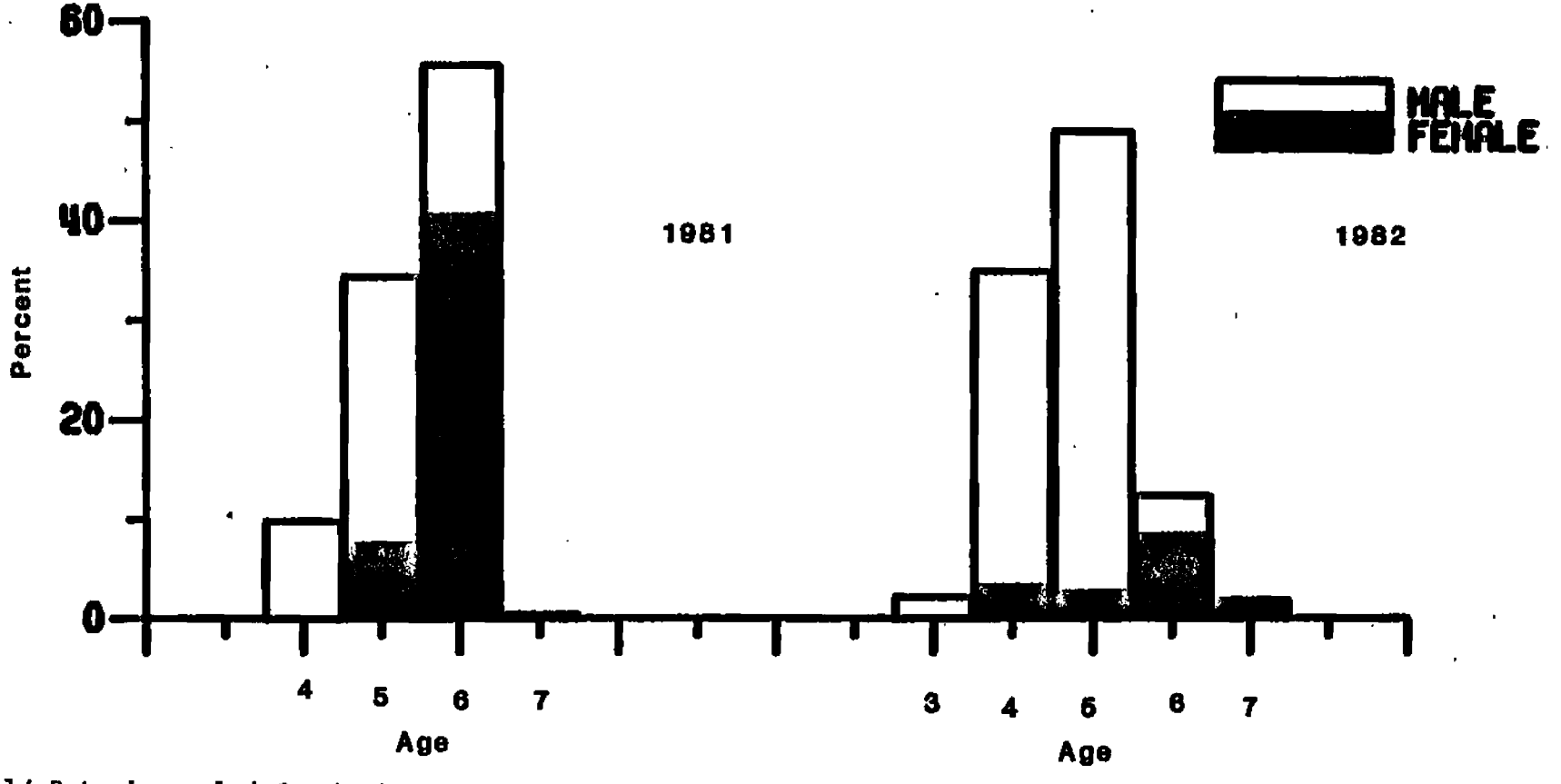


Figure 21. Age and sex composition of East Fork Andreafsky River summer chum salmon, 1981-1982. 1/

1/ Includes 126 (28%) beach seine samples in 1982. All other samples were carcasses.

Figure 22. Age and sex composition of Andreafsky River king salmon, 1981-1982. 1/



1/ Data is pooled for both East and West Forks for each year. Includes 29 (9%) beach seine samples in 1982. All other samples were carcasses.

CONCLUSIONS AND RECOMMENDATIONS

1) Minnow traps and beach seines were not feasible for capturing large numbers of juvenile salmon on the Anvik River. High water after river ice breakup flooded beaches and restricted attempts to beach seine. Future juvenile salmon studies should test the feasibility of fyke nets and inclined plane traps, both of which are stationary floating gear which could be operated in high water.

2) Chum salmon fry are still present in the Anvik River two months after breakup of river ice. Large catches of king salmon fry occurred in late July, and suggests that they may overwinter in the Anvik River before moving into the Yukon River the following spring. Only 3 king salmon smolt were captured, but sampling was ineffective during spring breakup and flooding, when most of the smolt may have been outmigrating.

3) Escapement to the Anvik River was estimated by side-scan sonar to be 444,581 summer chum salmon. Age 4 was predominant, accounting for 67% of all samples and females outnumbered males 2 to 1. King salmon escapement was not estimated due to poor aerial survey conditions. Carcass samples indicate that the king salmon escapement was only 28% female, with age classes 4 and 5 accounting for the majority of the fish. Low returns from the 1982 brood year may result due to the low number of female spawners. The pink salmon run was one of the largest in recent years according to local fishermen, and escapement was estimated to be 76,800 based on expansion of visual counts.

4) The accuracy of the 1981 model sonar counter should be investigated. This may be better accomplished at the East Fork Andreafsky River, where all salmon passage can be directed over the sonar substrate, and water conditions are usually better for visual observation of fish passage than at the Anvik River.

5) More samples of adult chum and king salmon should be collected by beach seine at both the Anvik and East Fork Andreafsky Rivers to test the difference between the age, sex and size composition of beach seine and carcass samples.

6) Escapement to the East Fork Andreafsky River in 1982 was estimated by side-scan sonar to be 181,352 summer chum salmon. King and pink salmon were probably responsible for less than 5% of the sonar counts. The chum salmon escapement was 65% female, and 73% age 4. An accurate estimate of the king salmon escapement was not obtained, but was lower than the 1981 escapement of 5,343. King salmon beach seine and carcass samples were only 15% female, and age 5 accounted for 49% of the total. Pink salmon escapement was at a record level, and approached 1 million fish based on visually observed passage rates.

7) Accuracy of salmon escapement data from the East Fork Andreafsky River can be improved by implementing the following procedures:

a) One sonar substrate should be installed at the midstream site at the start of the season, regardless of water conditions. Weir fencing should be installed as soon as possible to prevent salmon passsage around the ends of the substrate.

b) Visual counting periods should be scheduled throughout the day, and the crew held responsible for attempting visual counts during those periods. This will insure that the equipment is not left unattended for more than a few hours at any one time, which was a problem in 1982 when a large number of salmon apparently passed over the sonar counters while the crew was purchasing supplies in the village.

c) Species composition is an important factor affecting the accuracy of the sonar data, especially in even numbered years when pink salmon can outnumber summer chums by five to one. Increased visual counting may help to improve allocation of sonar counts. Fishing a trammel net may be a feasible method of estimating species composition and also provide an unbiased estimate of age, sex and size composition for chum and king salmon. A trap with funnel opening and weir lead-in made from fence stakes and rectangular fencing may accomplish these same objectives. All three methods of estimating species compostion should be conducted in 1983.

8) The feasibility of installing a full weir across the East Fork Andreafsky River should be investigated in 1983 by locating potential weir sites and monitoring water depth and velocity throughout the season. A weir could provide daily salmon escapement data by species, age, sex and size as opposed to the limited information obtained by side-scan sonar in 1981 and 1982.

LITERATURE CITED

Barton, Louis H. 1982a. Enumeration of fall chum salmon by side-scanning sonar in the Sheenjek River in 1981. Yukon Salmon Escapement Report No. 13. Alaska Dept. of Fish and Game, Commercial Fisheries Division, Fairbanks. 22 pp.

_____. 1982b. Side scan sonar (1981-16 sector model). Unpublished memorandum dated 8 December. Alaska Dept. of Fish and Game, Commercial Fisheries Division, Fairbanks. 6 pp.

Buklis, Lawrence S. 1981. Yukon River Salmon Studies. Anadromous Fish Conservation Act Completion report for period July 1, 1977 to June 30, 1981. Alaska Dept. of Fish and Game, Juneau. 50 pp.

_____. 1982a. Anvik River summer chum salmon stock biology. Informational Leaflet No. 204. Alaska Dept. of Fish and Game, Juneau. 50 pp.

_____. 1982b. Anvik, Andreafsky and Tanana River salmon escapement studies, 1981. Yukon Salmon Escapement Report No. 15. Alaska Dept. of Fish and Game, Commercial Fisheries Division, Anchorage. 40 pp.

Flagg, Loren B. 1981. Sockeye salmon smolt dye marking and recovery tests in the Kasilof River. Alaska Dept. of Fish and Game, F.R.E.D. Division, Soldotna. 8 pp.

Geiger, Michael F. 1982. Yukon salmon season summary report. Unpublished memorandum dated 11 October. Alaska Dept. of Fish and Game, Commercial Fisheries Division, Anchorage. 19 pp.

McBride, Doug and David Mesiar. 1982. Nushagak sonar enumeration project, 1981. Bristol Bay Data Report No. 88. Alaska Dept. of Fish and Game, Commercial Fisheries Division, Anchorage. 24 pp.

Menin, Albert. 1982. Letter to Bill Arvey, Alaska Dept. of Fish and Game, Commercial Fisheries Division, Anchorage dated 25 February. Bendix Oceanics Division, Sylmar, California. 4 pp.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Department of Environment, Fisheries and Marine Bulletin No. 191. Ottawa, Canada. 382 pp.

Seiler, David, Steve Neuhauser and Mike Ackley. 1981. Upstream/downstream salmonid trapping project 1977-1980. Progress Report No. 144. Dept. of Fisheries, Washington. 191 pp.

Todd, I.S. 1966. A technique for the enumeration of chum salmon fry in the Fraser River, British Columbia. Can. Fish. Cult. 38: 3-35.

Appendix A. Method of adjusting daily sonar counts for periods of defecti equipment or milling salmon at the Anvik River sonar site, 1982.

4 July

East bank sonar counter operational from 0000 to 1000, west bank sonar counter operational from 1200 to 2400. Sonar counts expanded to full 24 hour equivalent based on the average passage for that bank and time period during the preceeding 9 day period.

East Bank

7/4:	0000-1000 4,230 Actual Count
6/25-7/3:	0000-1000 33.5% Average % of Daily East Bank total.
	12,627 Estimated East Bank Total for 4 July.

West Bank

7/4:	1200-2400 5,187 Actual Count
6/25-7/3:	1200-2400 58.5% Average % of Daily West Bank total.
	8,866 Estimated West Bank Total for 4 July.

5 July

West bank sonar counter operational all day, with a total sonar count of 13,113. East bank sonar counter inoperable all day. The west bank averaged 58.4% of the daily total escapement for the period 25 Jur through 3 July. Expanding the west bank count to the daily tot escapement, and then subtracting the west bank and midstrea contribution, results in an estimated east bank count of 7,300 salmon.

6 July

East bank sonar counter operational from 1700 to 2400, with a total sonar count of 2,145. This time period averaged 29.2% of the daily east bank escapement for the period 25 June through 3 July. Expanding the 7 hour count to the full 24 hour equivalent results in an estimated east bank count of 7,346.

The west bank sonar counter was inoperable all day. The east bank averaged 33% of the total daily escapement for the period 25 June through 3 July. Expanding the east bank count (7,346) to the daily total escapement and then subtracting the east bank and midstream contribution, results in an estimated west bank count of 12,891.

7 July - 12 July

East bank sonar counter operational continuously from 7 July through 12 July, while the west bank counter was inoperable. The east bank averaged 33% of the total daily escapement for the period 25 June through 3 July. Expanding the daily east bank count to the daily total escapement, and then subtracting the east bank and midstream contribution, results in an estimated west bank count for each day as follows:

7 July	8,300
8 July	15,804
9 July	23,469
10 July	14,988
11 July	11,575
12 July	20,961

13 July

East bank sonar counter operational all day. West bank sonar counter operational from 0000 to 1200. This time period averaged 41.5% of the daily west bank count for the period 25 June through 3 July. Expanding the 12 hour count to the full 24 hour equivalent results in an estimated west bank count of 9,846 salmon.

14 July

East bank sonar counter operational all day. West bank sonar counter operational from 1200 to 2400. This time period averaged 58.5% of the daily west bank count for the period 25 June through 3 July. Expanding the 12 hour count to the full 24 hour equivalent results in an estimated west bank count of 14,280 salmon.

24 July - 26 July

East bank sonar counts were inflated due to milling salmon, but west bank counts continued to be accurate due to faster water velocity and normal salmon swimming speeds. Poor weather conditions prohibited visual calibration of sonar counts. Daily escapement estimates were obtained by expanding west bank sonar counts. The west bank averaged 53.4% of total daily escapement for the period 25 June - 3 July and 15 July - 23 July. Expanding the west bank count to the daily total escapement, and then subtracting the west bank and midstream contribution, results in an estimated east bank count of 2,074 salmon on 24 July, 813 on 25 July, and 802 on 26 July.

Appendix Table 1. Age, sex and size composition of Anvik River summer chum salmon beach seine and carcass samples, 1982.

	Age 3				Age 4				Age 5				Age 6				Combined Ages			
	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD
Beach Seine																				
Male	0	-	-	-	13	23	598	21	9	16	609	33	0	-	-	-	22	39	602	27
Female	2	4	528	11	16	28	540	28	17	30	568	25	0	-	-	-	35	61	553	29
Total	2	4	528	11	29	51	566	38	26	46	582	34	0	-	-	-	57	100	572	37
Carcass Survey																				
Male	4	1	521	19	62	19	580	22	28	9	618	36	1	-	645	-	95	29	590	35
Female	15	5	520	23	165	51	541	28	48	15	560	26	2	1	550	0	230	71	544	29
Total	19	6	520	22	227	70	552	31	76	23	581	41	3	1	582	55	325	100	557	37
Combined Gear																				
Male	4	1	521	19	75	20	583	22	37	10	615	35	1	-	645	-	117	31	592	34
Female	17	4	521	22	181	47	541	28	65	17	562	26	2	-	550	0	265	69	545	29
Total	21	6	521	21	256	67	554	32	102	27	582	39	3	1	582	55	382	100	559	37

Appendix Table 2. Age, sex and size composition of Anvik River king salmon carcass samples, 1982. 1/

	Age 4 2				Age 5 2				Age 6 2				Combined Ages			
	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD
Male	47	34	560	59	47	34	679	54	6	4	814	130	100	72	631	97
Female	1	1	660	-	5	4	792	82	32	23	840	48	38	28	829	61
Total	48	35	562	60	52	38	690	65	38	28	836	66	138	100	686	125

1/ Includes one live sample collected by beach seine.

Appendix Table 3. Expansion of chum and king salmon visual counts at the East Fork Andreafsky River midstream site to estimate daily escapement, 17-20 July, 1982. 1/

Date	Time Period	Hourly Passage Rate			No. of Hours	Estimated Escapement
		Chum	King	Total		
7/17	0000-0700	108	0	108	7	756
7/17	0700-1300	8	0	8	6	48
7/17	1300-1700	29	3	32	4	128
7/17	1700-2000	123	1	124	3	372
7/17	2000-2400	56	0	56	4	224
7/17	0000-2400	64.8	0.8	65.6	24	1,528
7/18	0000-0400	56	0	56	4	224
7/18	0400-1100	7	4	11	7	77
7/18	1100-1400	27	3	30	3	90
7/18	1400-1700	52	2	54	3	162
7/18	1700-2000	53	1	54	3	162
7/18	2000-2400	72	6	78	4	312
7/18	0000-2400	44.5	2.7	47.2	24	1,027
7/19	0000-0400	72	6	78	4	312
7/19	0400-0800	20	3	23	4	92
7/19	0800-1100	5	0	5	3	15
7/19	1100-1400	10	1	11	3	33
7/19	1400-1700	16	3	19	3	57
7/19	1700-2000	27	4	31	3	93
7/19	2000-2400	11	0	11	4	44
7/19	0000-2400	23.0	2.4	25.4	24	646
7/20	0000-0400	11	0	11	4	44
7/20	0400-0800	4	0	4	4	16
7/20	0800-1100	2	0	2	3	6
7/20	1100-1400	8	7	15	3	45
7/20	1400-1700	5	2	7	3	21
7/20	1700-2400	14	0	14	7	98
7/20	0000-2400	7.3	1.5	8.8	24	230

1/ Hourly passage rates are based on visual counts as presented in Table 6. Passage rates listed are the net upstream passage rate, and are taken to be representative of time periods of 3 to 7 hours duration depending upon the frequency of visual counting conducted each day.

Appendix Table 4. Age, sex and size composition of East Fork Andreafsky River summer chum salmon beach seine and carcass samples, 1982.

	Age 3				Age 4				Age 5				Age 6				Combined Ages			
	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD
Beach Seine																				
Male	0	-	-	-	35	28	569	34	11	9	611	31	3	2	582	30	49	39	580	37
Female	3	2	545	38	54	43	539	29	19	15	562	30	1	1	580	-	77	61	545	31
Total	3	2	545	38	89	71	551	34	30	24	580	38	4	3	581	25	126	100	559	37
Carcass Survey																				
Male	2	1	495	7	73	22	576	27	35	11	598	32	2	1	622	39	112	34	582	33
Female	6	2	524	14	170	52	526	22	41	12	544	29	1	-	620	-	218	66	530	25
Total	8	2	517	18	243	74	541	33	76	23	569	41	3	1	622	28	330	100	547	38
Combined Gear																				
Male	2	-	495	7	108	24	574	29	46	10	602	32	5	1	598	36	161	35	581	34
Female	9	2	531	24	224	49	529	25	60	13	550	30	2	-	600	28	295	65	534	28
Total	11	2	524	26	332	73	543	34	106	23	572	40	7	2	599	32	456	100	550	38

Appendix Table 5. Age, sex and size composition of East and West Fork Andreafsky River king salmon beach seine and carcass samples, 1982.

	Age 3$_2$				Age 4$_2$				Age 5$_2$				Age 6$_2$				Age 7$_2$				Combined Ages			
	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD	N	%	Length (mm)	SD
East Fork Beach Seine																								
Male	1	4	355	–	9	31	492	53	9	31	671	45	0	–	–	–	0	–	–	–	19	66	569	113
Female	0	–	–	–	9	31	500	54	1	4	620	–	0	–	–	–	0	–	–	–	10	35	512	63
Total	1	4	355	–	18	62	496	52	10	34	666	45	0	–	–	–	0	–	–	–	29	100	550	101
East Fork Carcass Survey																								
Male	2	1	370	35	61	29	551	38	105	50	697	54	11	5	777	59	2	1	868	11	181	87	651	97
Female	0	–	–	–	0	–	–	–	4	2	768	41	20	10	820	41	3	1	920	46	27	13	823	56
Total	2	1	370	35	61	29	551	38	109	52	700	55	31	15	805	51	5	2	899	44	208	100	673	109
West Fork Carcass Survey																								
Male	4	4	391	16	33	38	549	42	37	42	706	51	2	2	844	49	0	–	–	–	76	86	624	110
Female	0	–	–	–	1	1	466	–	3	3	773	29	7	8	832	53	1	1	988	–	12	14	800	126
Total	4	4	391	16	34	39	546	44	40	45	710	53	9	10	835	49	1	1	988	–	88	100	648	127
Combined Gear and Location																								
Male	7	2	380	24	103	32	545	43	151	46	698	53	13	4	788	61	2	1	868	11	276	85	638	104
	0	–	–	–	10	3	497	52	8	2	751	61	27	8	823	43	4	1	937	51	49	15	754	147
Total	7	2	380	24	113	35	540	46	159	49	700	54	40	12	812	52	6	2	914	53	325	100	656	118