AYK REGION
YUKON SALMON ESCAPEMENT
REPORT #23

ANVIK AND ANDREAFSKY RIVER SALMON STUDIES, 1983

Lawrence S. Buklis
Alaska Department of Fish and Game
Division of Commercial Fisheries
Anchorage, Alaska

March, 1984

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

LIST OF APPENDICES

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 (1982) 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) are found in both the Anvik and Andreafsky Rivers in lesser numbers, while coho salmon (O.kisutch) are known to occur in small numbers in the fall, but their escapements are not monitored.

Summer chum salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed wing aircraft for many years. Although subject to error due to weather and water conditions, and subjectivity on the part of the observer, aerial surveys are the most feasible method for monitoring escapements in a watershed as large and remote as that of the Yukon River. The Anvik and Andreafsky Rivers have been more intensively studied due to their large summer chum salmon production. Salmon were visually enumerated from counting towers on the Anvik River from 1972 through 1978, and counted by side-scanning sonar since 1979, while side-scanning sonar has been used on the East Fork Andreafsky River since 1981. This report presents the results of these studies for the 1983 field season.

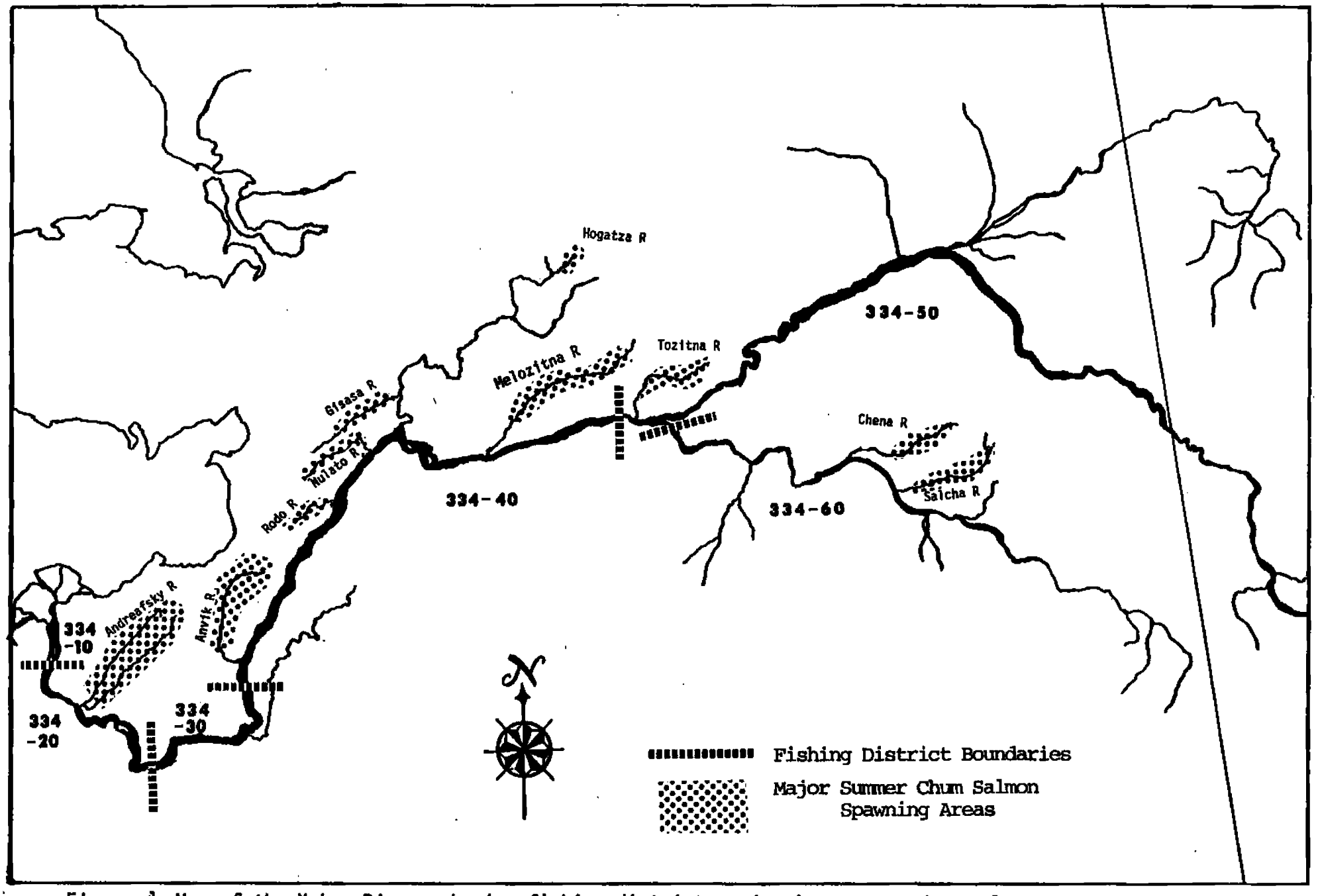


Figure 1. Map of the Yukon River, showing fishing districts and major summer chum salmon spawning areas.

ANVIK RIVER SALMON STUDY

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.

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. 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 sonar 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 aerial survey salmon counts from 1972 through 1978 indicated that virtually all of the summer chum salmon are found upstream of this site.

Methods and Materials

Two 1978 model sonar counters were installed on 20 June, 1983. The 40 foot east bank substrate was placed along a cut bank, with the top of the transducer housing 6 inches underwater and 6 feet from shore. The 60 foot west bank substrate was placed along a gradually sloping gravel bar, 500 feet downriver from the east bank counter. The top of the transducer housing was 1 foot underwater and 20 feet from shore. Weirs prevented salmon passage inshore of the transducer on each bank.

Sonar counts were totaled electronically in twelve sectors for each substrate and printed hourly. Sector counts missing as a result of debris or printer malfuntion were estimated by averaging the counts in the same sector for the hour before and after the questionable sector count. Counts were hand totaled daily for each substrate, summed, and multiplied by the factor 1.10 (Buklis 1981) to account for midstream escapement not covered by the sonar counters. These same methods and type of sonar counters have been used since 1979, except in 1982, when 16-sector 1981 model sonar counters were operated.

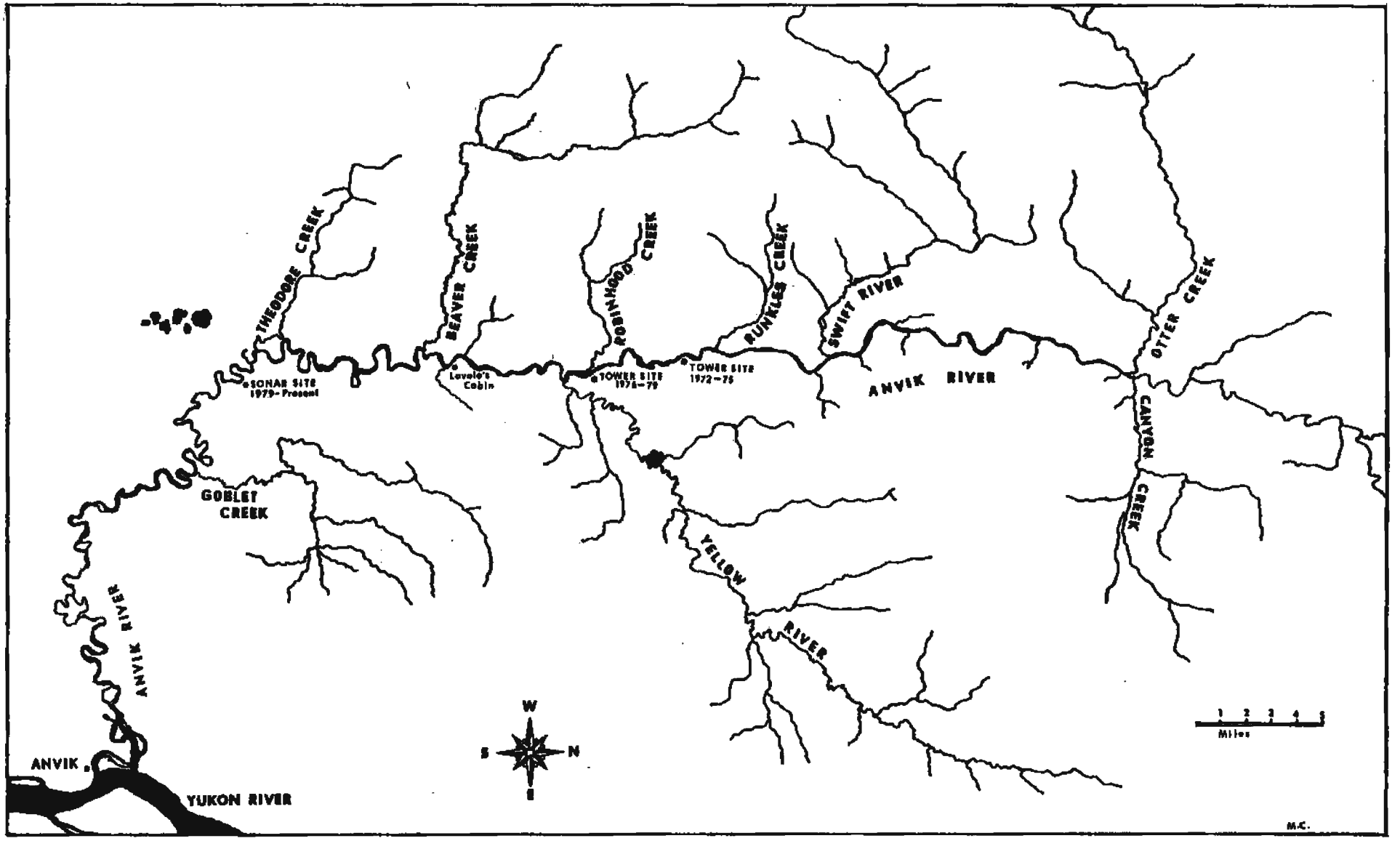


Figure 2. Map of the Anvik River.

Buklis (1983) outlines the difference between the 12-sector and 16-sector models in some detail. Since chum salmon greatly outnumber kings, and the counters do not distinguish between chums and kings, all sonar counts were attributed to chum salmon. A separate escapement estimate for king salmon was obtained by aerial survey. Pink salmon generally do not register sonar counts due to their small size and faster swimming speeds.

Each sonar counter was calibrated three times daily by observing fish passage with an oscilloscope for a 15 minute period. Salmon passing through the sonar beam produce a distinct 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 = Oscilloscope counts

If the difference between the counts was greater than 15% ($0.85 > Q > 1.15$) 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. Mean date of passage was calculated using the daily sonar counts, following the method presented by Mundy (1982). Whenever water and light conditions allowed, fish passage over the substrates was visually enumerated from 10 foot counting towers. Polariod 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.

Water depth profile at the sonar site was measured at 20 foot intervals across the width of the river by probing with a pole marked in 1 cm increments. Water velocities were estimated by floating a stick 30 feet downriver three times, and averaging the time required as measured on a stopwatch to the nearest second. Climatological data was collected at noon each day at the campsite. A fence stake marked in 1 cm increments was set in the river. Changes in water depth are presented as negative or positive from the initial reading of 0 cm. 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 each day to capture chum and king salmon for age, sex, and size measurements. Captured fish were identified by species. King and chum salmon were placed in a holding pen, identified by sex, measured from mid-eye to fork of tail in millimeters, and one scale was 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 on each fish before release to prevent resampling. All king salmon captured were sampled, while some of the larger chum salmon catches were subsampled. In addition, king salmon carcasses were sampled during late July and early August from beaches between the sonar site and

Robinhood Creek. Three scales were taken from each carcass. 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 21 June through 23 July. The river was approximately 180 feet wide at the east bank site and 4 feet deep across most of the channel on 5 July (Figure 3). Surface water velocity was 1.8 ft/sec over sonar sector 1. The river was approximately 270 feet wide at the west bank site, and depth ranged between 2 and 4 feet (Figure 3). Surface water velocity was 4.5 ft/sec over sonar sector 1.

The season escapement estimate was 362,912 summer chum salmon (Table 1). Buklis (1982) 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 1983 escapement was below the 11 year average (1972-1982) of 535,800 summer chum salmon, but greater than the brood year escapements of 307,270 and 280,537 in 1978 and 1979, respectively (Figure 4).

A total of 20.15 hours of sonar calibration was conducted over a 27 day period at the west bank site, and sonar accuracy (sonar count/oscilloscope count) averaged 1.04 (Table 2). Water turbidity and weather conditions (wind, rain, overcast) made it difficult to obtain a visual check on sonar accuracy. For most calibration periods visual counts could only be made over the first few inshore sonar sectors. Although visual counts could not be used to adjust the sonar electronics, they did provide a measure of salmon species composition. It should be stated that offshore species composition may have differed from that oberved over the inshore 20 to 30 feet of the sonar substrate. A net upstream total of 1,099 chum salmon, 5 king salmon, and 7 pink salmon were visually counted at the west bank site during all sonar calibration periods combined (Table 2). Sonar accuracy averaged 0.90 for 20.41 hours of oscilloscope calibration at the east bank site over a period of 33 days (Table 3). A net upstream total of 603 chum salmon, 5 king salmon and no pink salmon were visually counted during these calibration periods (Table 3). Pink salmon returns to the Yukon River are stronger in even numbered years, and this is apparent in the species composition of visual counts at the Anvik River sonar site in 1982 and 1983. Visual counts (east and west bank combined) were 73% chum salmon, 27% pink salmon, and 0% king salmon in 1982 (Buklis 1983), while they were 99% chum salmon, 0.4% pink salmon, and 0.6% king salmon in 1983.

Milling salmon in the offshore sectors caused multiple sonar counts at the west bank site beginning on 19 July, and the problem continued through project termination on 23 July. This did not become a problem at the east bank site. West bank escapement for this period was estimated based on the magnitude of east bank counts, and the relationship between east bank and west bank sonar counts. Contribution of the east bank to total daily sonar counts increased as the season progressed. Stratifying the season into the three periods 6/21-6/27, 6/28-7/9, and 7/10-7/18 yields an average east bank contribution of 9%, 17% and 29%, respectively (Appendix A).

Figure 3. River depth profile at the Anvik River sonar site as measured on 5 July, 1983.

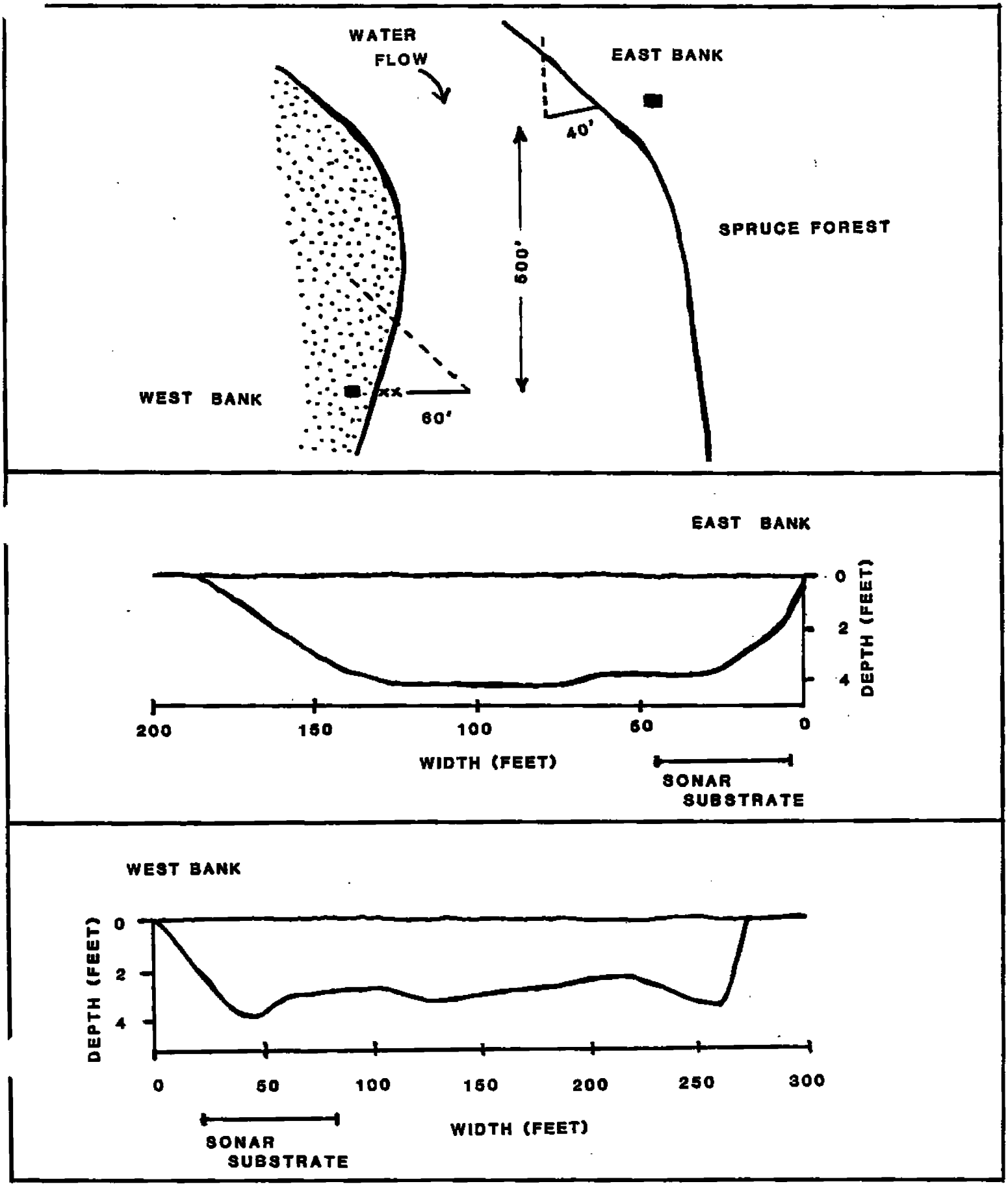


Table 1. Anvik River chum salmon sonar counts by date, 1983.

Date	West Bank	East Bank	Expanded Count 1/ Daily	Expanded Count 1/ Cumulative	% of Season Total Daily	% of Season Total Cumulative
6/21	168	29	217	217	0.1	0.1
6/22	951	277	1,351	1,568	0.4	0.5
6/23	1,190	110	1,430	2,998	0.4	0.9
6/24	2,921	73	3,293	6,291	0.9	1.8
6/25	9,508	343	10,836	17,127	3.0	4.8
6/26	10,394	1,000	12,533	29,660	3.5	8.3
6/27	8,791	420	10,132	39,792	2.8	11.1
6/28	13,112	1,684	16,227	56,019	4.5	15.6
6/29	8,903	1,001	10,894	66,913	3.0	18.6
6/30	18,632	2,405	23,141	90,054	6.4	25.0
7/01	17,860	1,715	21,533	111,586	5.9	30.9
7/02	8,458	1,675	11,146	122,732	3.1	34.0
7/03	11,892	2,568	15,906	138,638	4.4	38.4
7/04	9,661	2,765	13,669	152,307	3.8	42.2
7/05	7,576	3,018	11,653	163,960	3.2	45.4
7/06	6,475	2,166	9,505	173,465	2.6	48.0
7/07	8,926	1,794	11,792	185,257	3.2	51.2
7/08	13,460	2,448	17,499	202,756	4.8	56.0
7/09	14,762	3,745	20,358	223,114	5.6	61.6
7/10	13,827	6,989	22,898	246,012	6.3	67.9
7/11	13,919	6,808	22,800	268,812	6.3	74.2
7/12	10,261	6,890	18,866	287,678	5.2	79.4
7/13	9,682	4,516	15,618	303,296	4.3	83.7
7/14	10,170	4,692	16,348	319,644	4.5	88.2
7/15	4,581	1,757	6,972	326,616	1.9	90.1
7/16	6,066	1,778	8,628	335,244	2.4	92.5
7/17	7,104	2,260	10,300	345,544	2.8	95.3
7/18	5,524	1,207	7,404	352,948	2.0	97.3
7/19	(2,879) 2/	1,176	4,460	357,408	1.2	98.5
7/20	(1,591)	650	2,465	359,873	0.7	99.2
7/21	(1,126)	460	1,745	361,618	0.5	99.7
7/22	(544)	222	843	362,461	0.2	99.9
7/23	(291)	119	451	362,912	0.1	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 parenthesis for west bank from 7/19 through 7/23 are estimated based on east bank counts due to milling salmon on west bank substrate. Estimation methods are outlined in Appendix A.

Figure 4. Anvik River summer chum salmon escapement, 1972-1983.

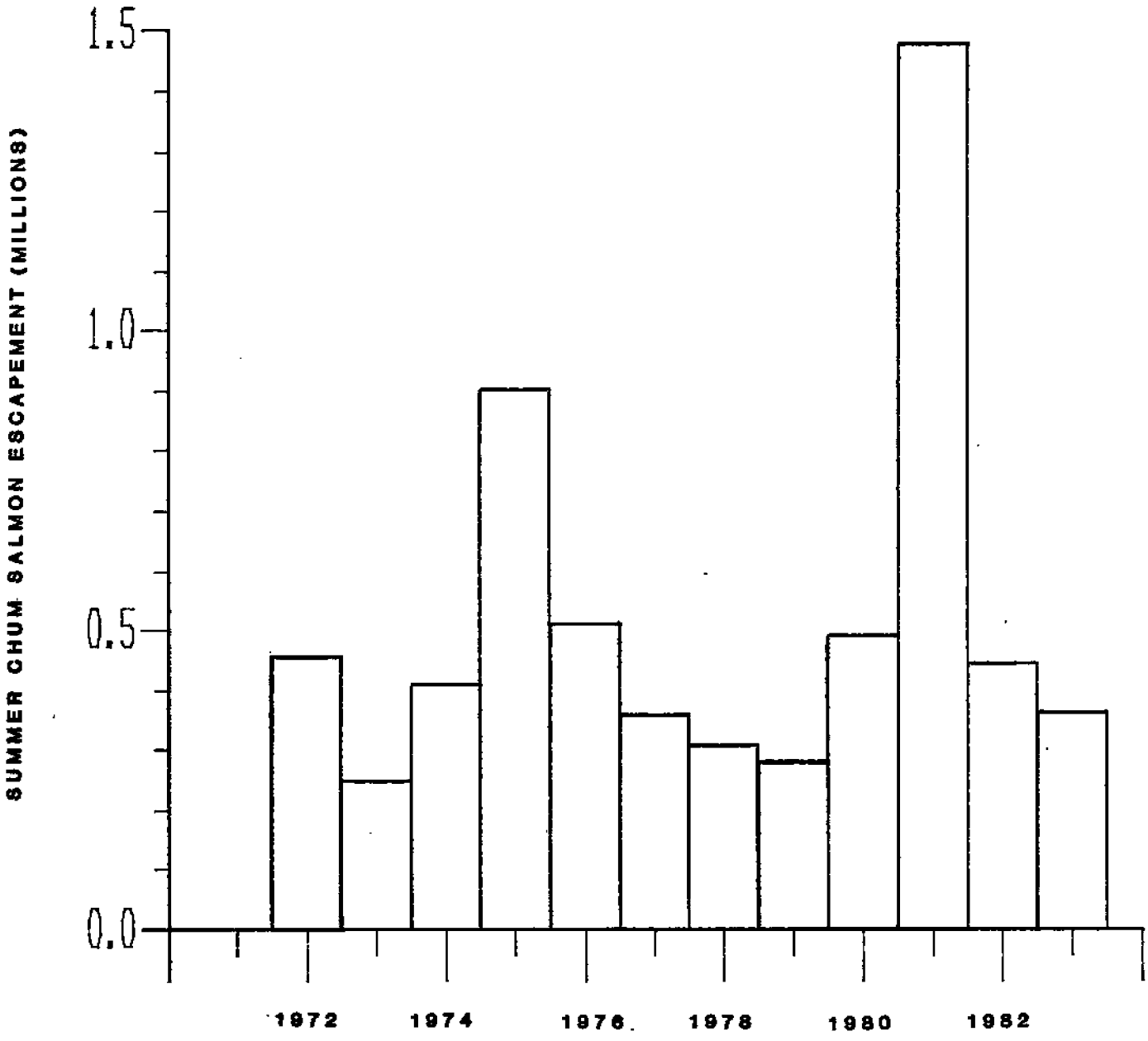


Table 2. Oscilloscope and visual calibration of salmon sonar counts at the Anvik River west bank site, 1983.

Date	Hours Counted	Sonar Count	Scope Count	Sonar/ Scope	Visual Count 1/								
					Chum Salmon			King Salmon			Pink Salmon		
					Up	Down	Net	Up	Down	Net	Up	Down	Net
6/22	0.17	7	6	1.17	0	0	0	0	0	0	0	0	0
6/23	0.25	46	56	0.82	7	0	7	0	0	0	0	0	0
6/24	0.50	18	31	0.58	13	0	13	0	0	0	0	0	0
6/25	0.50	233	197	1.18	100	0	100	0	0	0	0	0	0
6/26	0.75	284	272	1.04	99	0	99	0	0	0	0	0	0
6/27	0.83	199	194	1.03	102	0	102	0	0	0	0	0	0
6/28	0.83	200	213	0.94	96	0	96	0	0	0	0	0	0
6/29	0.67	135	142	0.95	5	0	5	0	0	0	0	0	0
6/30	0.92	501	454	1.10	9	0	9	0	0	0	0	0	0
7/01	1.08	249	215	1.16	8	0	8	0	0	0	0	0	0
7/02	0.83	125	132	0.95	18	0	18	0	0	0	4	0	4
7/03	0.50	79	65	1.22	35	0	35	0	0	0	1	0	1
7/04	0.88	260	301	0.86	-	-	-	NO VISUAL COUNTS			-		-
7/05	0.67	113	100	1.13	21	0	21	0	0	0	0	0	0
7/06	0.67	112	133	0.84	20	0	20	0	0	0	0	0	0
7/07	0.65	239	241	0.99	17	1	16	0	0	0	0	0	0
7/08	0.92	287	297	0.97	0	0	0	0	0	0	0	0	0
7/09	0.58	297	336	0.88	118	0	118	0	0	0	0	0	0
7/10	0.83	424	427	0.99	141	2	139	4	0	4	0	0	0
7/11	0.95	681	600	1.14	51	3	48	0	0	0	0	0	0
7/12	0.75	220	240	0.92	76	1	75	0	0	0	0	0	0
7/13	0.75	232	240	0.97	44	1	43	0	0	0	1	0	1
7/14	0.67	304	298	1.02	50	3	47	0	0	0	0	0	0
7/15	1.25	312	256	1.22	12	6	6	0	0	0	0	0	0
7/16	0.92	148	144	1.03	8	3	5	0	0	0	0	0	0
7/17	1.00	217	161	1.34	43	2	41	1	0	1	2	0	2
7/18	0.83	459	391	1.17	28	0	28	0	0	0	0	1	-1
Totals	20.15	6,381	6,142	1.04	1,121	22	1,099	5	0	5	8	1	7

1/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the difference between the two. Due to poor visibility (water turbidity, wind, overcast, rain) visual counts were often obtainable only for the first few sectors, or not at all, and therefore cannot be used to assess sonar accuracy.

Table 3. Oscillscope and visual calibration of salmon sonar counts at the Anvik River east bank site, 1983.

Date	Hours Counted	Sonar Count	Scope Count	Sonar/ Scope	Visual Count 1/ Chum Salmon Up	Chum Salmon Down	Chum Salmon Net	King Salmon Up	King Salmon Down	King Salmon Net
6/21	0.25	0	0	-	0	0	0	0	0	0
6/22	0.17	1	1	1.00	0	0	0	0	0	0
6/23	0.25	0	0	-	0	0	0	0	0	0
6/24	0.25	0	0	-	0	0	0	0	0	0
6/25	0.75	13	37	0.35	4	0	4	0	0	0
6/26	0.75	37	118	0.31	46	0	46	0	0	0
6/27	0.75	25	39	0.64	0	0	0	0	0	0
6/28	0.75	36	64	0.56	23	0	23	0	0	0
6/29	0.83	28	45	0.62	19	0	19	0	0	0
6/30	0.75	53	72	0.74	0	0	0	0	0	0
7/01	0.75	67	63	1.06	5	0	5	0	0	0
7/02	0.92	56	59	0.95	5	0	5	0	0	0
7/03	0.83	30	46	0.65	7	0	7	0	0	0
7/04	0.38	17	23	0.74	-	-	NO VISUAL COUNT-			-
7/05	0.67	33	43	0.77	56	0	56	0	0	0
7/06	0.67	41	57	0.72	19	0	19	0	0	0
7/07	0.75	37	36	1.03	17	1	16	0	0	0
7/08	0.75	67	76	0.88	35	0	35	0	0	0
7/09	0.75	106	197	0.54	117	0	117	2	0	2
7/10	0.75	218	164	1.33	59	1	58	0	0	0
7/11	0.75	193	165	1.17	21	0	21	0	0	0
7/12	0.67	312	238	1.31	48	0	48	1	0	1
7/13	0.67	105	96	1.09	45	0	45	1	0	1
7/14	0.67	48	46	1.04	26	0	26	0	0	0
7/15	0.75	15	15	1.00	5	0	5	1	0	1
7/16	0.75	47	49	0.96	3	0	3	0	0	0
7/17	0.75	25	32	0.78	17	0	17	0	0	0
7/18	0.67	31	53	0.58	11	0	11	0	0	0
7/19	0.67	29	22	1.32	11	0	11	0	0	0
7/20	0.67	11	10	1.10	7	0	7	0	0	0
7/21	0.17	6	7	0.86	0	1	-1	0	0	0
7/22	0.25	0	0	-	0	0	0	0	0	0
7/23	0.25	0	0	-	0	0	0	0	0	0
Totals	20.41	1,687	1,873	0.90	606	3	603	5	0	5

1/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the difference between the two. Due to poor visibility (water turbidity, wind, overcast, rain) visual counts were often obtainable only for the first few sectors, or not all, and therefore cannot be used to assess sonar accuracy. No pink salmon were seen during visual calibration periods.

The most recent (7/10-7/18) average of 29% was used to expand east bank sonar counts during the period of milling salmon and account for west bank escapement (Appendix A). Daily escapement estimates for the period 19-23 July, therefore, are the sum of east bank sonar counts and estimated west bank counts, expanded by 1.10 to account for midstream escapement (Table 1).

Peak daily counts of 23,141 and 22,898 summer chum salmon occurred on 30 June and 10 July, respectively. These daily peaks represented 6.4% and 6.3% of the total season escapement count (Figure 5). Mean date of passage occurred on 6 July (Day 16.4), with a standard deviation of 6.87 days. Run timing and the bimodal pattern of the 1983 escapement is similar to that of 1979 (mean date 7 July), and is in the middle of the range in timing for the five years of sonar count data. The 1981 escapement was early, with a mean date of 3 July, while 1980 and 1982 escapements were late, with mean passage occurring on 11 July each year (Figure 5). Buklis (1982) postulated a 20 day lag time for summer chum salmon migration between the lower Yukon River fishery at Emmonak (District Y-1) 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 16 June in 1983. The large mesh (8-1/2 inch) gillnet season in Y-1 ended by emergency order on 21 June, 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.

Distribution of the combined east and west bank sonar counts by hour indicates a distinct diel pattern (Figure 6). Salmon passage was highest at 0100-0200 hours, accounting for 6.3% of total sonar counts for the season, while a low of 2.9% passage occurred at 1600-1700 hours. Seventy-nine percent of the sonar counts occurred on the west bank, only 21% on the east bank. Distribution of sonar counts were fairly uniform over the east bank substrate, but west bank counts were high in the inshore and offshore sectors and near zero in sectors 4 through 8 (Figure 6). Sector 2 of the west bank accounted for 30% of all sonar counts by both substrates combined.

An aerial survey of the Anvik River was flown on 23 July under windy, partly cloudy conditions and 653 king salmon were counted. This was a very minimal estimate due to poor survey conditions and the fact that none of the tributary creeks were surveyed. The high density of the king salmon spawning groups that were seen, however, indicated a very good escapement.

River water depth declined from the initial zero reading on 15 June to a low of -66 cm on 25 July (Figure 7). Heavy rainfall during the period 7 to 9 August resulted in a season high reading of +15 cm on 14 August, the last day of data collection. Water temperature was 12°C on 15 June, reached a high of 17°C on 30 June, and a low of 8°C on 13 August (Figure 7). Air temperature ranged from a low of 6°C on 13 August to a high of 17°C on 24 July (Figure 7).

Beach seining was much more effective in capturing chum salmon for age-sex-size data this year than it had been in 1982, the first year it was attempted. The same site was used, located approximately 300 yards above the west bank sonar site, but the method of deployment was different. The seine was stacked on the bow of the boat in 1982, with an end rope anchored to shore.

Figure 5. Daily summer chum salmon escapement past the Anvik River sonar site, 1979-1983. The mean date of run passage is indicated by dashed line.

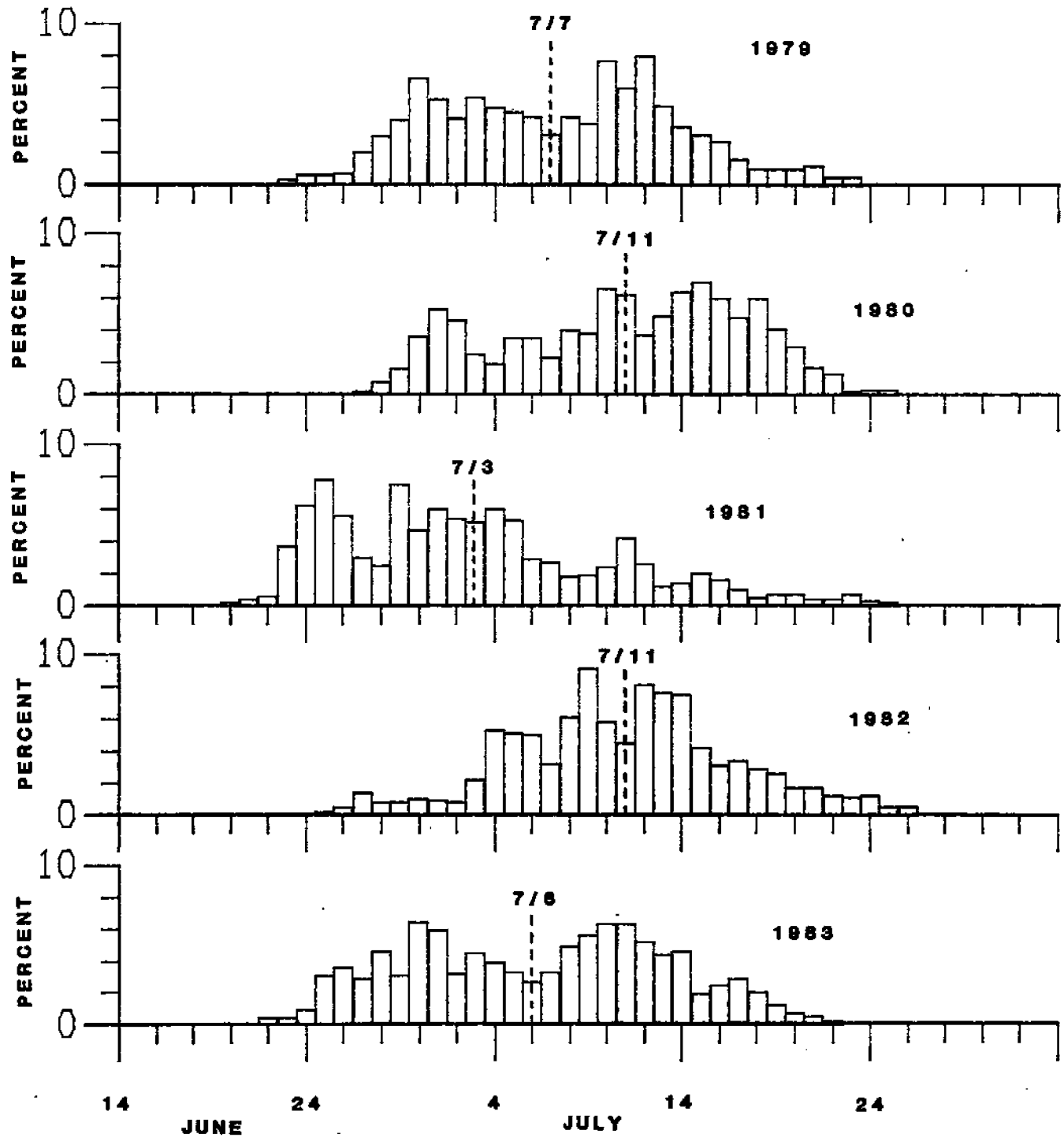


Figure 6. Summer chum salmon escapement past the Anvik River sonar site by hour (above), and by sonar sector (below), in 1983.

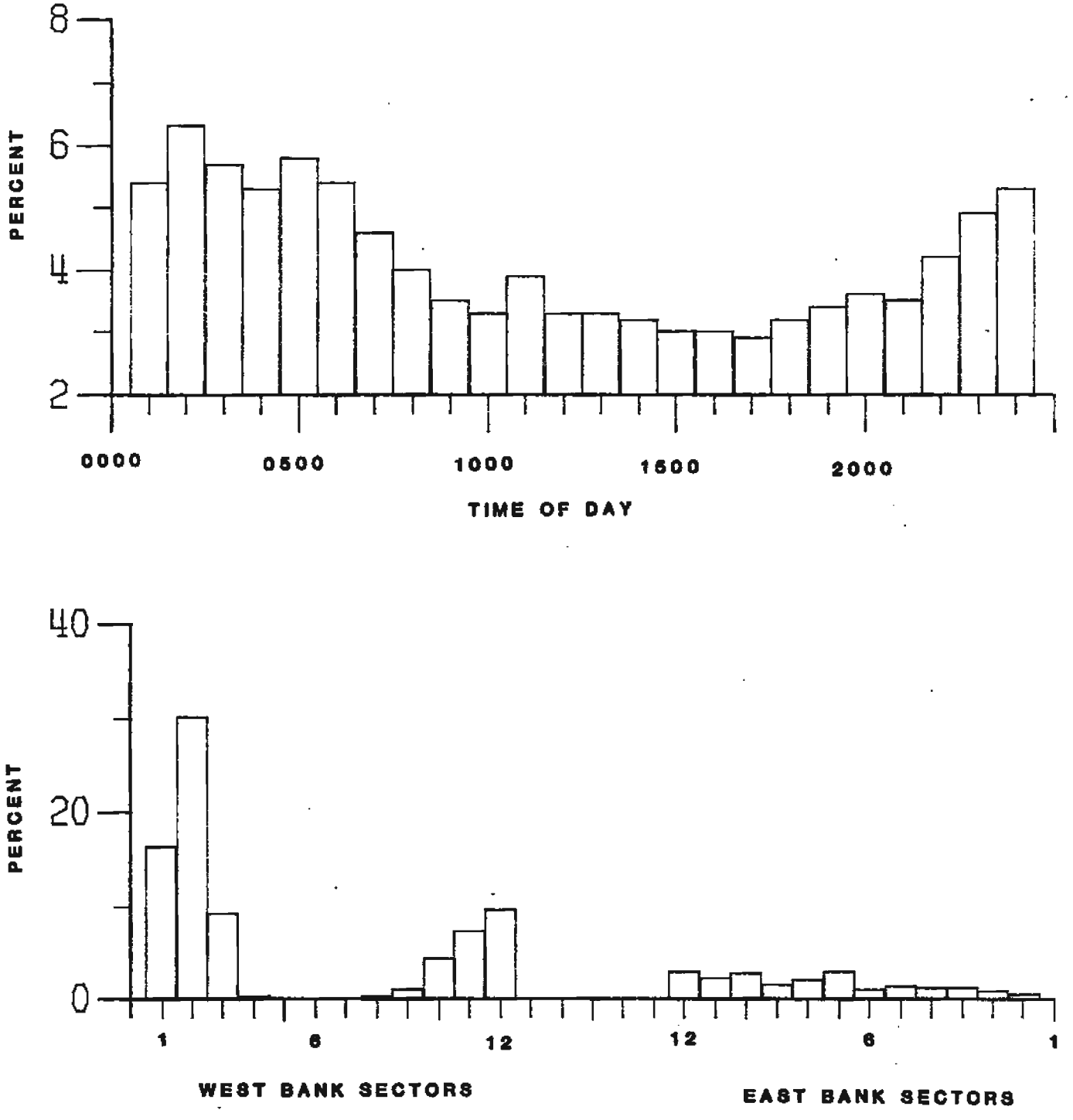
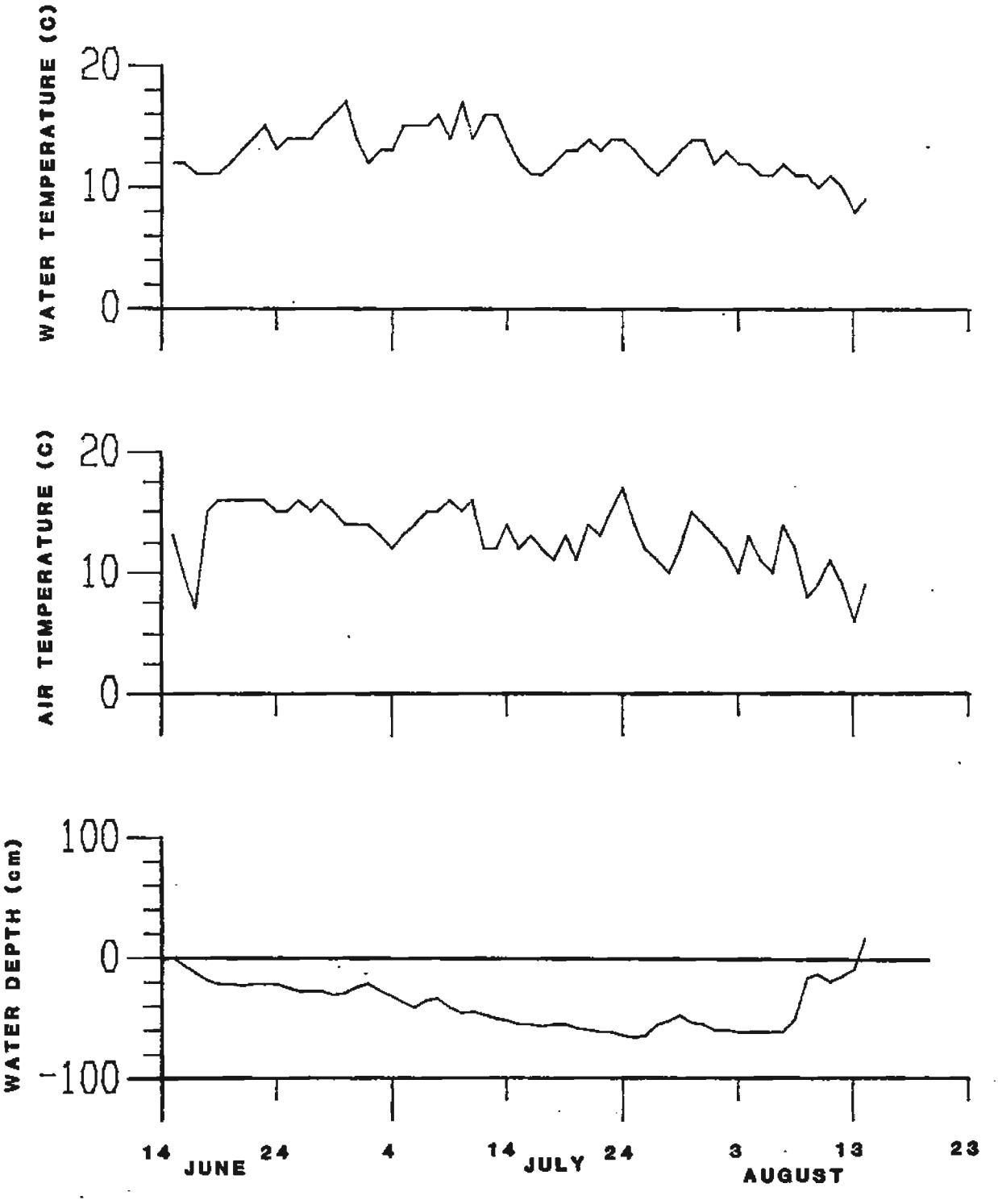


Figure 7. Water temperature, air temperature (max/min average), and water depth measured at noon daily at the Anvik River sonar site, 1983.



Two technicians were needed for deployment. One operated the motor, backing the skiff away from shore until most of the net was payed out, then switched to forward gear and drove to shore about 100 feet downstream. The second person stood in the front of the skiff paying out the net, then held the lead rope when heading for shore with all of the net out. Once in shallow water the bow man jumped out and started pulling in the net, while the motor man beached the skiff and ran upstream to bring in the other end. This method allowed too much time for fish to escape, and salmon catches were small. The seine was stacked on the beach in 1983, and a shorter end rope was anchored to shore. The lead rope was wrapped around a handle in the stern of the skiff and held by the motor operator as he drove away from shore in forward gear. The other technician was waiting 100 feet downstream in shallow water. The skiff was piloted straight out from shore, then turned and headed back when all of the net had payed out. As the skiff came in to shallow water, the waiting technician grabbed the lead rope and pulled in the net as the motor man continued in to shore and beached the skiff. This method produced quicker sets and resulted in better salmon catches.

Sixty-two sets were made from 24 June through 23 July, and a total of 765 salmon was captured. Species composition was 760 (99%) chum salmon (60% female), 4 (0.5%) king salmon (75% female), and 1 (0.1%) pink salmon (a male). Only 5 fin-clipped chum salmon were recaptured. Each of these recaptures occurred when a set was made within one hour of the previous beach seine catch and release of fish.

Of the 505 chum salmon sampled for age-sex-size data, 421 (83%) later proved to have ageable scales. Age composition was 57% age 4, 41% age 5, 1% age 3, and 0.7% age 6 (Appendix Table 1). Females accounted for 56% of the sample, and average lengths (mid-orbit to fork of tail) ranged from a low of 527 mm for age 3 females to a high of 616 mm for age 5 males. Sex composition was similar to that for commercial catch samples from the Emmonak gillnet fishery (Buklis and Wilcock, In Prep.). Age composition of the commercial catch samples varied according to mesh size used and progression of the run, but showed increasing contribution of age 4 fish. Commercial catch samples collected during the period 9-14 June were 46% age 4 and 53% age 5, while those collected 4-15 July were 67% age 4 and only 30% age 5.

Age 4 usually accounts for the majority of the summer chum salmon escapement to the Anvik River. Age 5 was the strongest age class in 1972, 1976 and 1981, but in all other years since 1972 age 4 has been predominant (Figure 8). The above average showing of age 3 fish in 1982 and age 4 fish in 1983 indicates a strong 1979 brood year return, even though the 1979 escapement was only 280,537 summer chum salmon. The 1984 escapement is expected to have a strong 5 year old component.

Only 4 king salmon were captured by beach seine, but an additional 351 carcasses were sampled by boat survey of the river between the sonar camp and Robinhood Creek, a distance of 40 miles. Of the 355 king salmon sampled for age-sex-size data, 306 (91%) later proved to have ageable scales. Age composition was 45% age 6, 36% age 5, 18% age 4, 1% age 7, and 0.3% age 3 (Appendix Table 2). Females accounted for 43.5 % of the sample, and average lengths ranged from a low of 340 mm for an age 3 male to 876 mm for age 7 females. The commercial gillnet fishery at Emmonak selects for the larger fish, with ages 6 and 7, and females, making up a greater share of the

commercial catch in 1983 than was found for the Anvik River escapement (Buklis and Wilcock, In Prep.). The commercial catch was 50% female.

Age and sex composition of the Anvik River escapement in 1983 was very similar to that of the 1981 escapement (Figure 9). No trends in brood year strength are apparent, and ages 5 and 6 are expected to account for the majority of the escapement in 1984.

Figure 8. Age and sex composition of Anvik River summer chum salmon, 1972-1983.

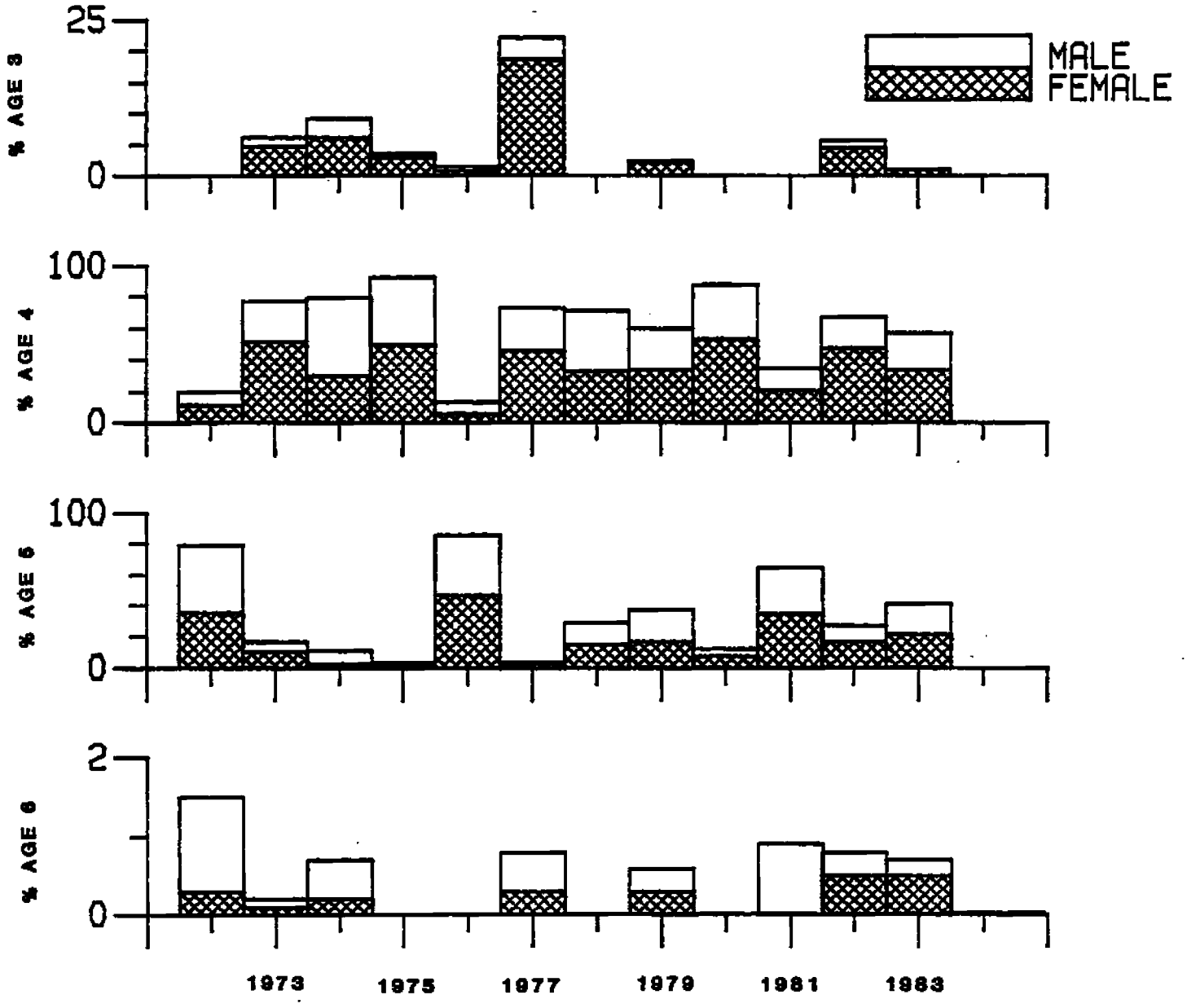
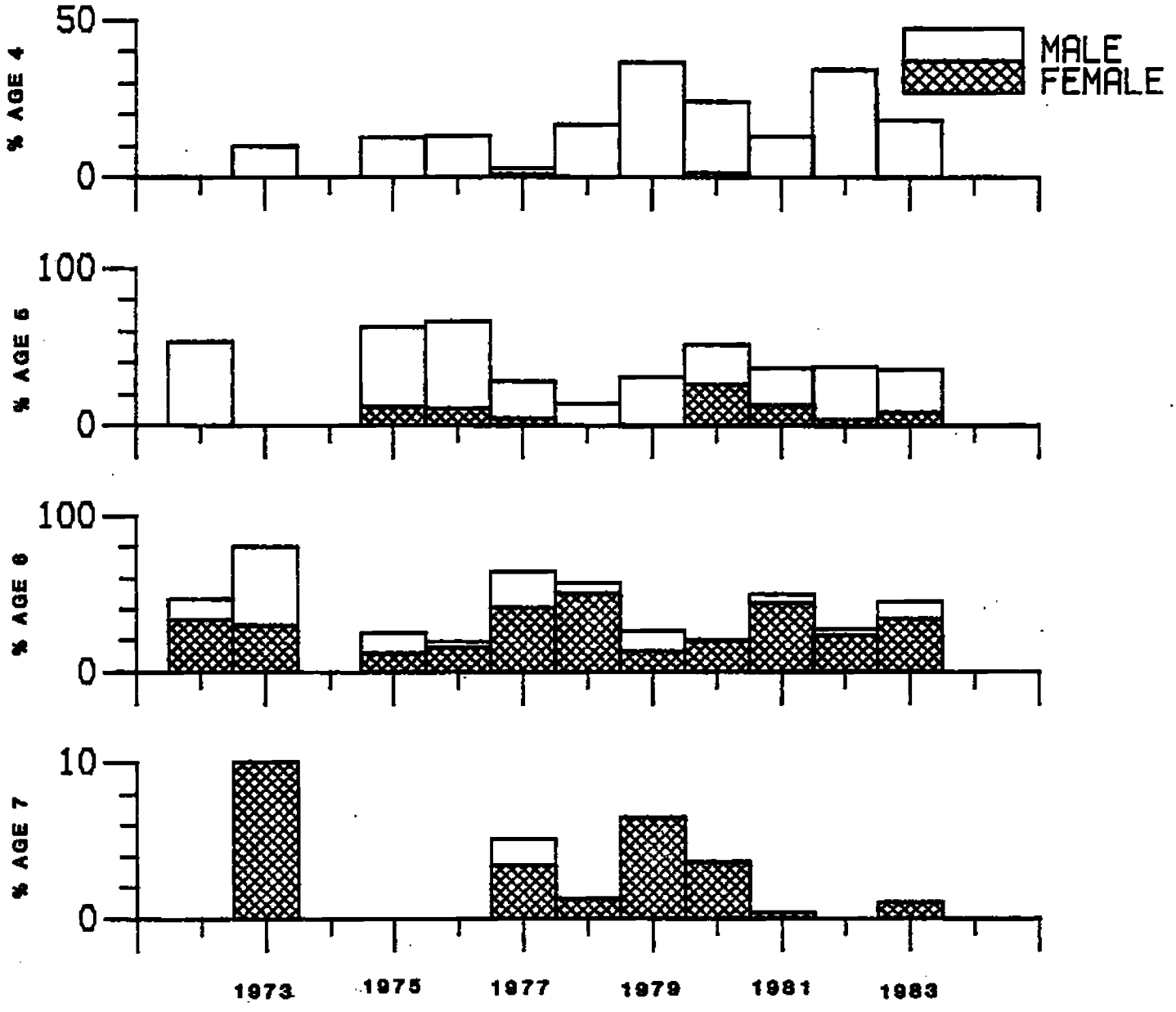


Figure 9. Age and sex composition of Anvik River king salmon, 1972-1983. 1/



1/No samples were collected in 1974. There was one age 3_2 male in the 1983 sample that is not shown in the figure.

ANDREAFSKY RIVER SALMON STUDY

The Andreafsky River (Figure 10) includes two main branches, the East and West Forks, and is located 100 miles upstream from the mouth of the Yukon River. It ranks 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 in both forks by aerial survey from fixed-wing aircraft prior to 1981. In that year 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 aerial surveys in some years. Furthermore, even when weather and water conditions are good, aerial surveys provide only an index of salmon escapement, as opposed to the total enumeration possible with side-scanning sonar.

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 because it supports a greater average summer chum salmon escapement than the West Fork, based on previous aerial survey data. There is also less recreational use of the East Fork by the residents of St. Marys, a village of 500 people located near the confluence of the Andreafsky and Yukon Rivers.

Methods and Materials

The same sonar site used in 1981 and the later half of the 1982 season, located at mile 20 of the East Fork Andreafsky River, was used in 1983. One 60 foot sonar substrate was deployed in the middle of the channel between the west bank of the river and a small island (Figure 11). Weirs prevented salmon passage around either end of the substrate. The channel on the oppostie side of the island was not navigable to salmon due to shallow water and numerous gravel bars. A 1981 model sonar counter was used, which divides the counting range into 16 sectors, unlike the 1978 models used on the Anvik River which have 12 sectors. Other differences between the two models are described in detail by Buklis (1983). No expansion factors for the daily sonar counts were necessary since the entire river passable to salmon was either weired or covered by the sonar counter.

One 10 foot counting tower was built in shallow water near each end of the substrate for visual calibrations. Visual and oscilloscope calibrations were conducted in the same manner as described for the Anvik River. A beach seine site was located about 1/4 mile below the sonar site. The seine was set across the channel from a small gravel island to the east bank of the river and back. Methods and materials for beach seine deployement, age-sex-size sampling, measuring river velocity, depth profile, and climatological data were similar to those described for the Anvik River study.

Results and Discussion

The sonar counter was operated from 15 June through 20 July. The river was approximately 120 feet wide between the west bank and island at the sonar site, and ranged to a maximum depth of 3.4 feet on 27 June (Figure 11). Surface water velocity was 4 ft/sec over the target end and midpoint of substrate, but only 2 ft/sec at the transducer end, which was located off the gradually sloping shore of the island.

Figure 10. Map of the Andreafsky River.

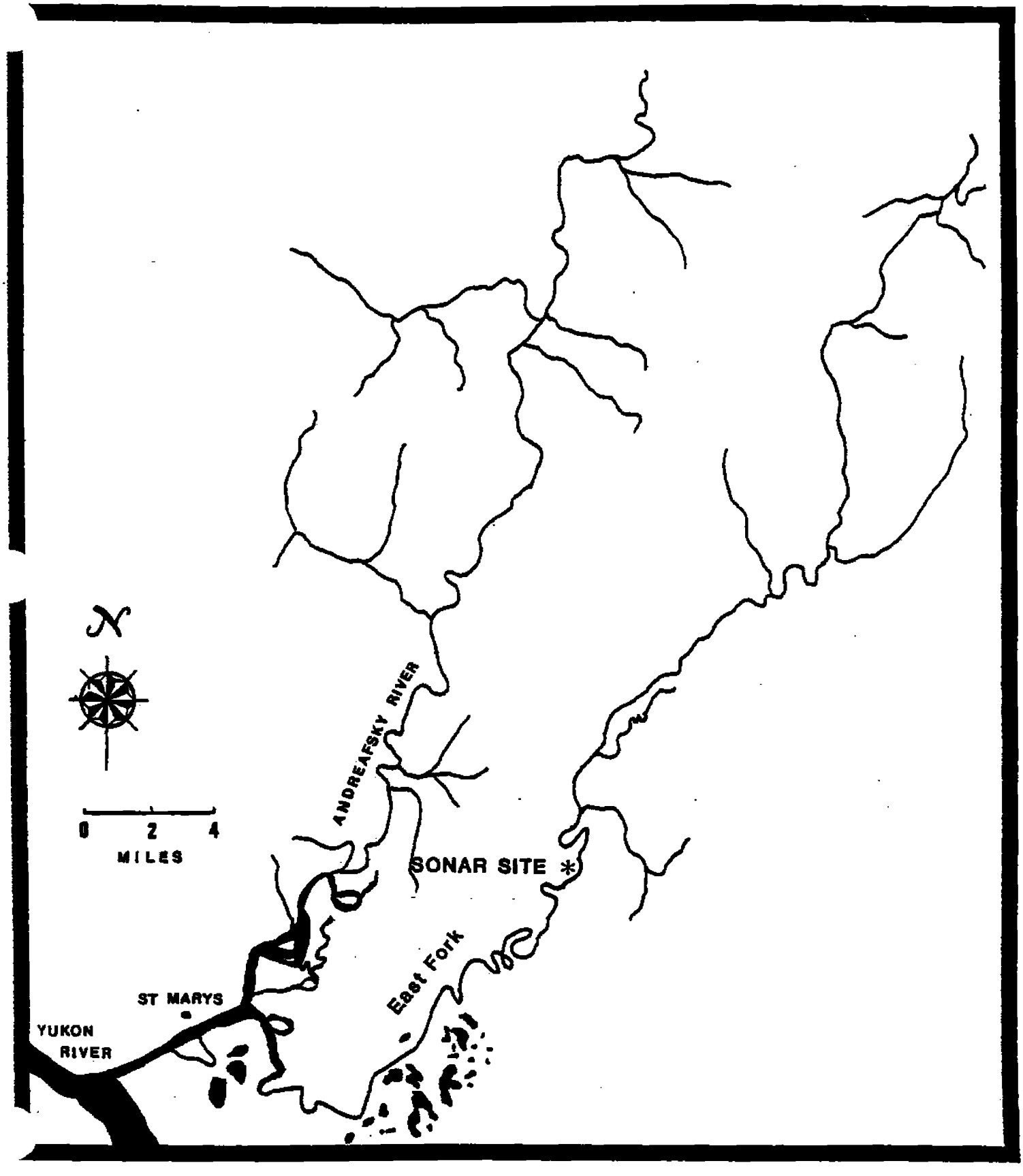
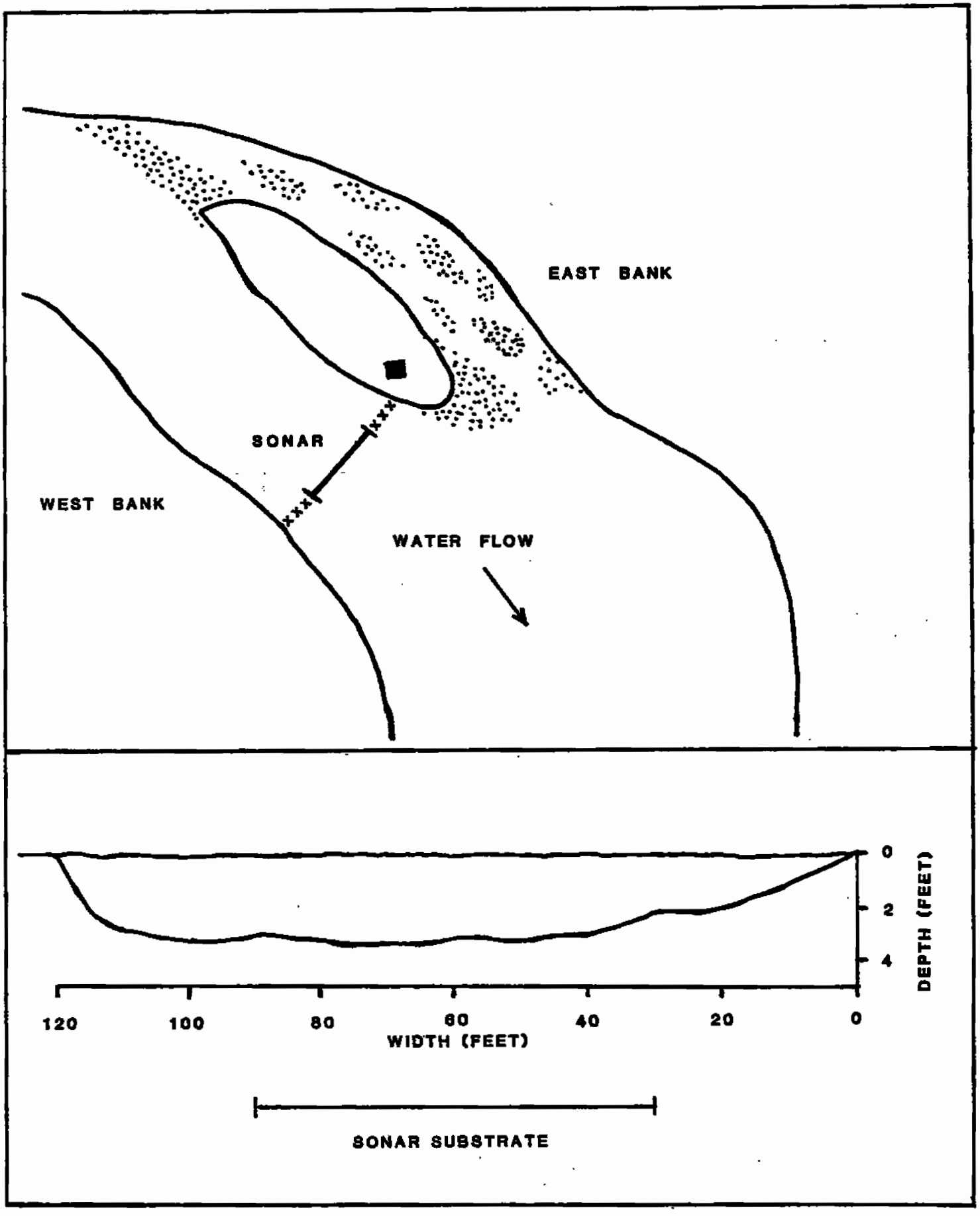


Figure 11. River depth profile at the East Fork Andreafsky River sonar site as measured on 27 June, 1983.



A season total of 113,328 summer chum and king salmon were counted by sonar (Table 4). Pink salmon were present in much smaller numbers than the large 1982 return, and generally did not register sonar counts. Sonar accuracy averaged 0.95 as assessed by 31.38 hours of oscilloscope calibration over a 35 day period (Table 5). Visual counts during this same period totalled 2,451 chum salmon, 60 king salmon, and 428 pink salmon (Table 5). Visibility was better at this site than at the Anvik River, but visual counts did not provide a consistent check on sonar accuracy due to occasional periods of wind, rain, overcast, and water surface glare. Visual counts do, however, provide an estimate of species composition. The 2,511 salmon visually counted, excluding pinks, were 97.6% chum salmon and 2.4% king salmon (Table 5). Applying these proportions to the season sonar count of 113,328 yields escapement estimates of 110,608 chum salmon and 2,720 king salmon. No aerial surveys of the Andreafsky River were flown to evaluate these escapement estimates for the East Fork nor obtain index counts for the West Fork. Salmon did not linger over the sonar substrate and cause false counts to any significant extent until 20 July, by which time increasing numbers of pink salmon were milling in the area. Escapement counting was terminated at this point, both because of milling pinks and the low passage rate of chum salmon (Table 5).

The 1983 East Fork Andreafsky River escapement of 110,608 summer chum salmon was slightly below the previous 11 year average (1972-1982) of 117,362 summer chum salmon, and within the range of the 1978 and 1979 parent year escapements (Figure 12). It should be remembered that escapements were estimated by aerial survey from 1972 through 1980, and by sonar only since 1981. It may not be appropriate to directly compare escapement estimates from the two methods. The 1983 escapement was lower than the 1981 and 1982 sonar estimated escapements of 147,312 and 181,352 summer chum salmon, respectively.

Peak daily sonar counts of 10,407 and 10,612 summer chum salmon occurred on 29 June and 9 July, respectively. These daily peaks represented 9.2% and 9.4% of the total season sonar count (Figure 13), and were each one day earlier than those which occurred at the Anvik River sonar site. Mean date of passage was on 4 July (Day 20.3), with a standard deviation of 6.96 days. Problems with the previous two year data base should be mentioned before comparing the mean dates of passage for the three years. The early segment of the run may have been missed in 1981, based on the fact that the third day of counting was the peak day of the season. This results in a later mean date for the sonar counts than may have been true for the total chum salmon run. Due to high water in 1982, two sonar counters were used during the early part of the season. They were located 800 feet below the midstream sonar site described in this report. Water depth decreased sufficiently by 7 July to allow transfer of one of the sonar counters to the midstream site and removal of the second counter. Daily sonar counts were consistently higher after moving to the midstream site, indicating that salmon may have passed uncounted between the two counters earlier in the season. A second weakness in the 1982 run timing data is the sudden occurrence of a large number of counts on 2 July, when 18% of the total season escapement was counted. Buklis (1983) discusses this at greater length, concluding that the sonar counts were due to a large group of salmon and not debris or some other source of false counts. The resulting season run timing pattern for 1982 is extremely irregular. It is not known what the combined effect was of (1) missing fish between the two sonar counters early in the season, and (2) the large number of counts on 2 July, on calculated mean date of passage for 1982.

Table 4. East Fork Andreafsky River chum and king salmon sonar counts by date, 1983.

Date	Sonar Count		% of Season Total	
	Daily	Cumulative	Daily	Cumulative
6/15	14	14	0.0	0.0
6/16	37	51	0.0	0.0
6/17	20	71	0.0	0.1
6/18	25	96	0.0	0.1
6/19	40	136	0.0	0.1
6/20	98	234	0.1	0.2
6/21	1,128	1,362	1.0	1.2
6/22	337	1,699	0.3	1.5
6/23	850	2,549	0.8	2.2
6/24	5,140	7,689	4.5	6.8
6/25	5,967	13,656	5.3	12.0
6/26	7,043	20,699	6.2	18.3
6/27	4,888	25,587	4.3	22.6
6/28	2,410	27,997	2.1	24.7
6/29	10,407	38,404	9.2	33.9
6/30	4,304	42,708	3.8	37.7
7/01	1,672	44,380	1.5	39.2
7/02	2,323	46,703	2.0	41.2
7/03	723	47,426	0.6	41.8
7/04	1,826	49,252	1.6	43.5
7/05	9,621	58,873	8.5	51.9
7/06	9,817	68,690	8.7	60.6
7/07	3,969	72,659	3.5	64.1
7/08	8,143	80,802	7.2	71.3
7/09	10,612	91,414	9.4	80.7
7/10	4,548	95,962	4.0	84.7
7/11	2,110	98,072	1.9	86.5
7/12	1,551	99,623	1.4	87.9
7/13	2,701	102,324	2.4	90.3
7/14	1,828	104,152	1.6	91.9
7/15	1,125	105,277	1.0	92.9
7/16	1,331	106,608	1.2	94.1
7/17	1,605	108,213	1.4	95.5
7/18	1,904	110,117	1.7	97.2
7/19	1,592	111,709	1.4	98.6
7/20	1,619	113,328	1.4	100.0

Table 5. Oscilloscope and visual calibration of salmon sonar counts at the East Fork Andreafsky River sonar site, 1983. 1/

Date	Hours Counted	Sonar Count	Scope Count	Sonar/ Scope	Visual Count 2/ 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
6/16	1.00	0	0	-	0	0	0	0	0	0	0	0	0
6/17	1.67	3	3	1.00	0	0	0	0	0	0	0	0	0
6/18	1.50	4	4	1.00	0	0	0	0	0	0	0	0	0
6/19	1.50	0	0	-	0	0	0	0	0	0	0	0	0
6/20	1.50	1	1	1.00	0	0	0	0	0	0	0	0	0
6/21	1.50	1	2	0.50	0	0	0	0	0	0	0	0	0
6/22	1.00	3	3	1.00	0	0	0	0	0	0	0	0	0
6/23	1.83	104	121	0.86	40	0	40	0	0	0	0	0	0
6/24	1.67	116	163	0.71	150	2	148	2	0	2	0	0	0
6/25	1.70	1,291	1,189	1.09	285	0	285	2	0	2	0	0	0
6/26	1.42	152	208	0.73	212	0	212	3	0	3	0	0	0
6/27	0.92	164	200	0.82	213	1	212	8	0	8	1	0	1
6/28	1.17	66	74	0.89	61	0	61	2	0	2	0	0	0
6/29	0.92	396	428	0.93	507	3	504	5	0	5	3	0	3
6/30	0.57	143	126	1.13	-	-	-	-	-	-	-	-	-
7/01	0.37	48	63	0.76	54	3	51	1	1	0	0	0	0
7/02	0.67	11	12	0.92	4	1	3	0	0	0	0	0	0
7/03	0.42	7	10	0.70	0	1	-1	0	0	0	0	0	0
7/04	0.00	-	-	-	-	-	-	-	-	-	-	-	-
7/05	0.42	106	148	0.72	144	0	144	2	0	2	13	0	13
7/06	1.22	193	215	0.90	202	4	198	12	0	12	23	0	23
7/07	0.50	58	69	0.84	47	2	45	0	0	0	11	0	11
7/08	1.03	182	205	0.89	160	1	159	7	0	7	17	0	17
7/09	0.30	157	120	1.31	91	0	91	4	0	4	30	0	30
7/10	0.33	28	29	0.97	19	1	18	4	0	4	3	0	3
7/11	0.83	36	43	0.84	32	0	32	2	0	2	9	0	9
7/12	1.00	58	60	0.97	48	3	45	0	0	0	6	0	6
7/13	0.17	12	13	0.92	17	0	17	0	0	0	8	0	8
7/14	0.00	-	-	-	-	-	-	-	-	-	-	-	-
7/15	0.25	18	20	0.90	13	1	12	0	0	0	11	0	11
7/16	0.50	108	120	0.90	36	2	34	0	0	0	3	0	3
7/17	0.00	-	-	-	-	-	-	-	-	-	-	-	-
7/18	0.83	-	-	- 3/	87	3	84	0	0	0	183	0	183
7/19	1.67	-	-	-	54	7	47	6	0	6	88	2	86
7/20	1.00	-	-	-	19	9	10	0	0	0	21	0	21
Totals	31.38	3,466	3,649	0.95	2,495	44	2,451	61	1	60	430	2	428

1/ The electronics were adjusted to count only chum and king salmon.

2/ Visual salmon counts are listed as upstream or downstream passage over the sonar substrate, with "net" being the differnece between the two. Visibility was generally good for obtaining counts. However, for some calibration periods no visual counts were made. At high passage rates, some fish may have been misidentified by species.

3/ High passage rate of pink salmon from 7/18 through 7/20 made it difficult to distinguish oscilloscope spikes, and calibration by oscilloscope was discontinued. Visual counting was contined through 7/20 to document species composition.

Figure 12. East Fork Andreafsky River summer chum salmon escapement, 1972-1983.

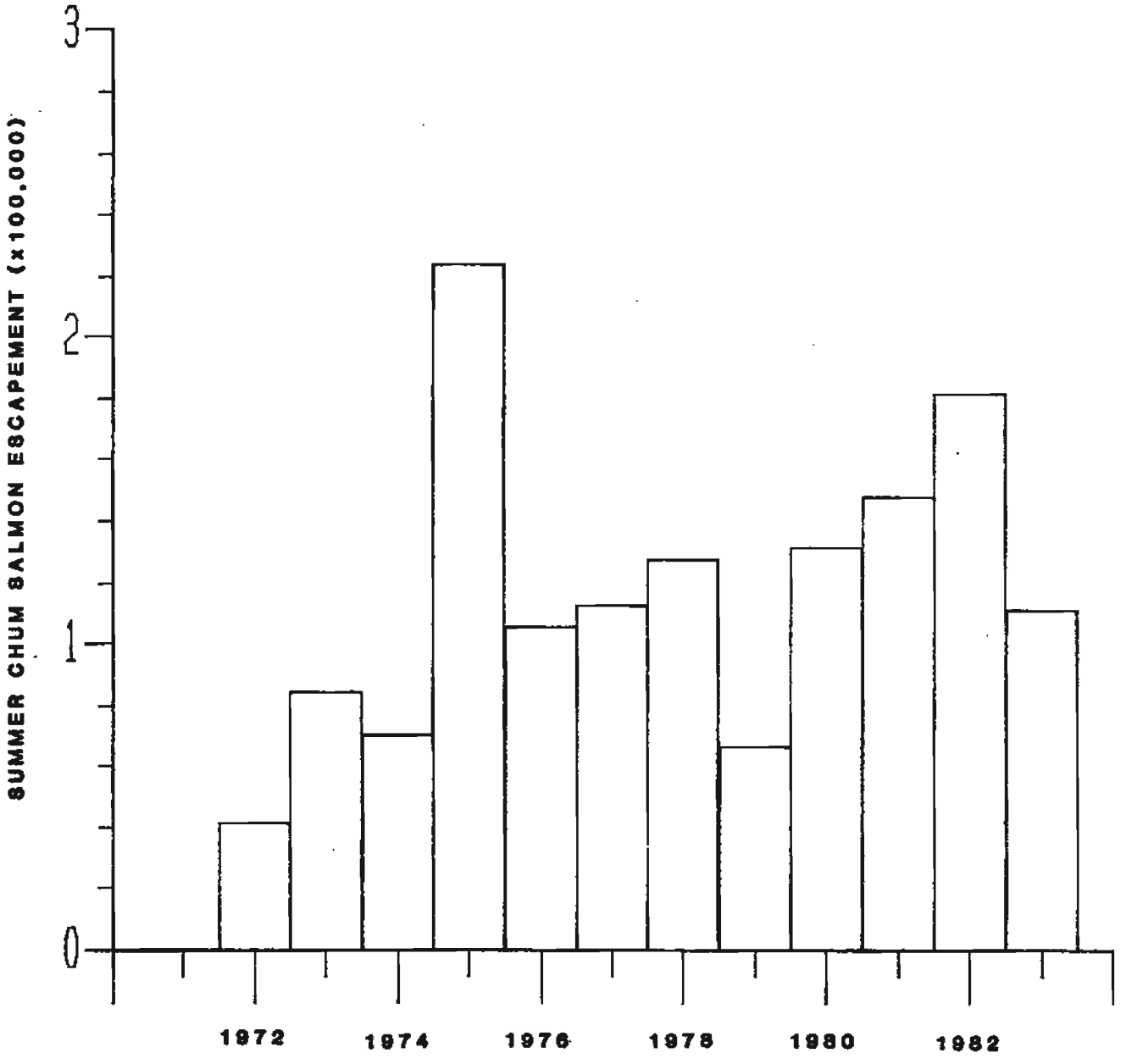
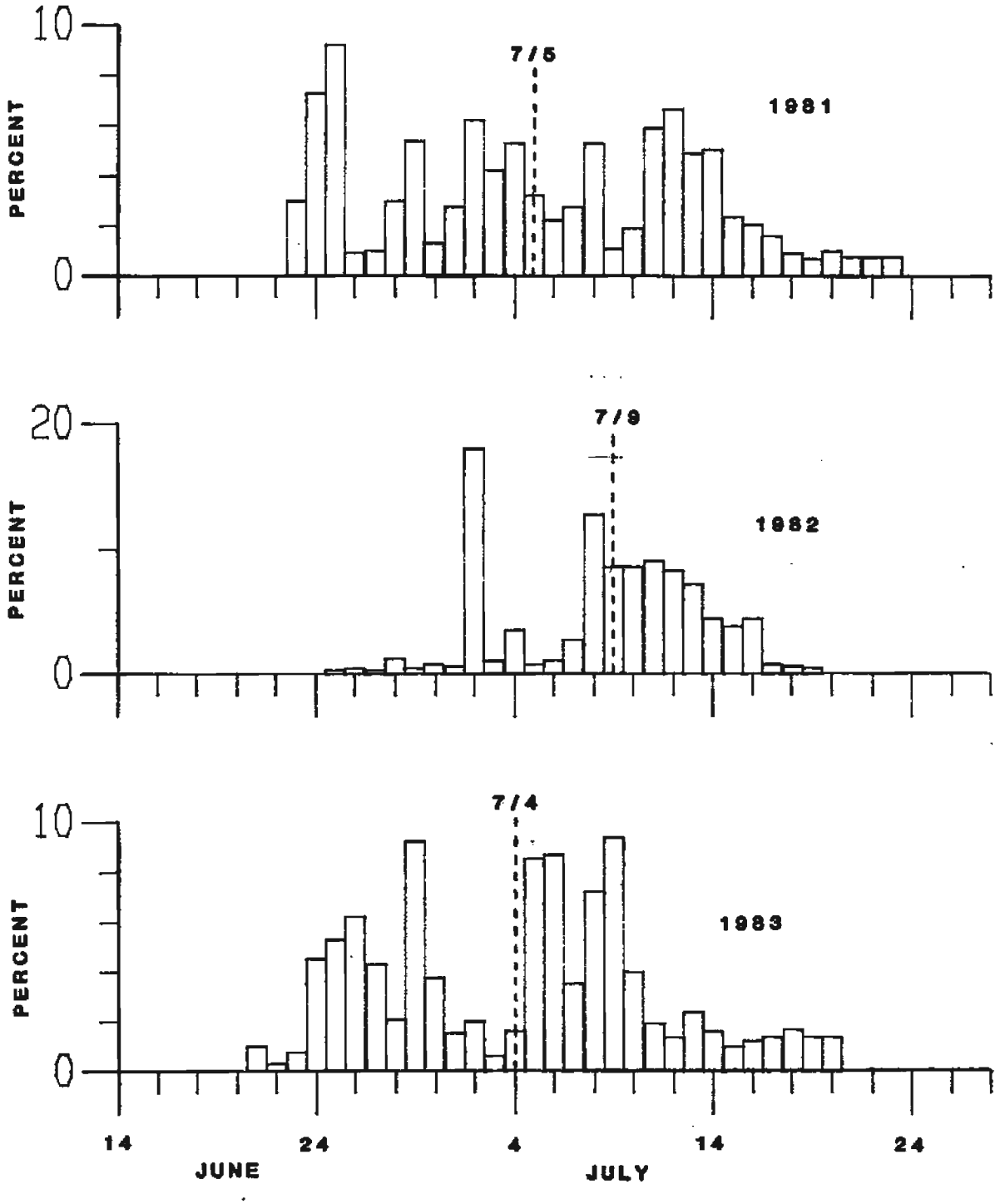


Figure 13. Daily summer chum salmon escapement past the East Fork Andreafsky River sonar site, 1981-1983. The mean date of run passage is indicated by dashed line.



The 4 July mean date of passage in 1983 was earlier than that of either 1981 (5 July) or 1982 (9 July), and was two days earlier than that for the Anvik River in 1983.

Distribution of sonar counts by hour (Figure 14) indicates a distinct diel pattern, as was seen for the Anvik River. Counts were highest at 0100-0200 hours (8%) and 1800-1900 hours (7.4%), while they were lowest at 0800-0900 hours (0.6%). The sonar substrate was deployed such that the transducer end was on the eastern side of the channel, along the gradually sloping shore of the island, while the target end was on the western cutbank side of the channel. Distribtuion of counts by sonar sector indicates that virtually all of the salmon passage occurred over the outer sectors (Figure 14). Salmon were moving upstream along the cutbank side of of the channel, and the weir directed fish over the outer sonar sectors. Eighty-nine percent of all sonar counts for the season were registered in the outer 15 feet of the sonar substrate, sectors 13 through 16.

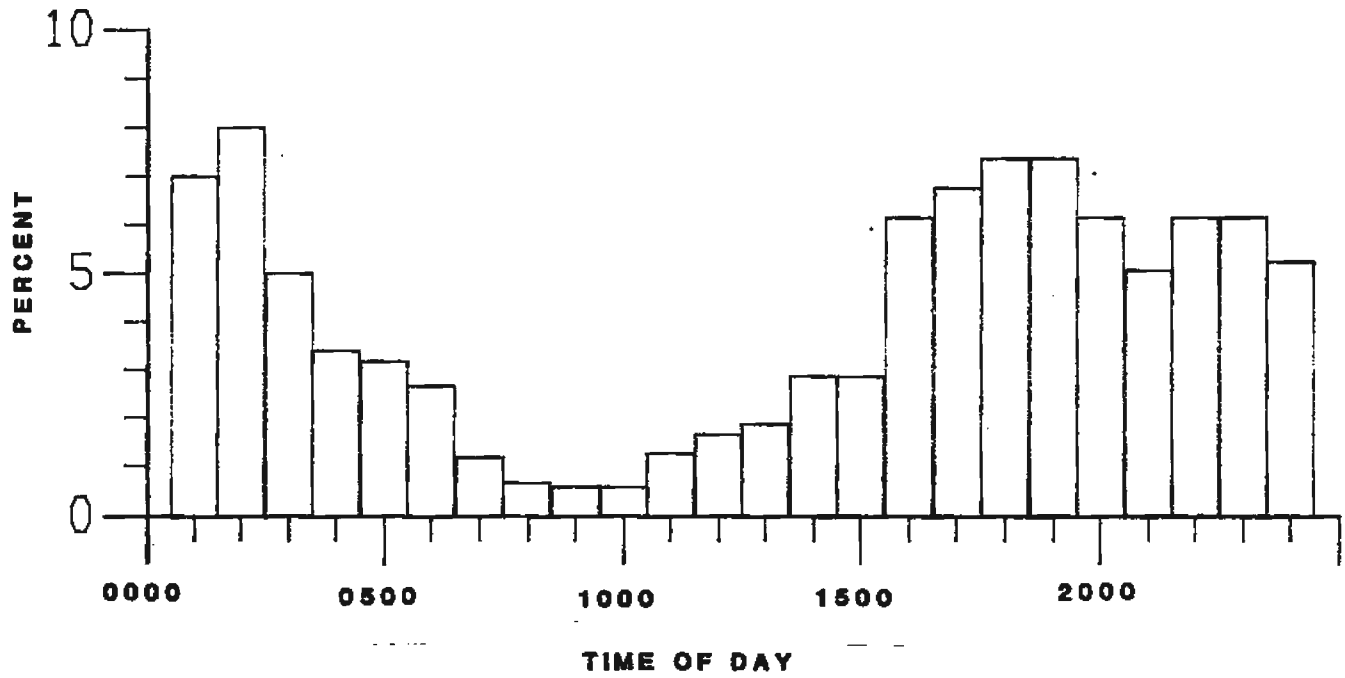
River water depth did not fluctuate much in 1983. From the initial zero reading on 15 June water depth declined to -18 cm on 29 June, increased to +10 cm on 3 July, declined to -18 cm again on 24 July, and rose to a season high of +36 cm on 9 August (Figure 15). Water temperature was 12°C on 15 June, reached a high of 16°C on 21 June, and a low of 9°C on 10 August (Figure 15). Air temperature ranged from a low of 8°C on 15 June and 9 August to a high of 18°C on 22 June and 6 July (Figure 15).

The beach seine site used in 1983 produced consistently larger catches of chum and king salmon than the site used in 1981 and 1982. The channel was narrow and shallow enough at the 1983 site for the seine net to block upstream salmon passage. Quick pursing of the net resulted in large catches. Thirty-five sets were made from 21 June through 19 July, and a total of 1,235 salmon were captured. Species composition was 1,029 (83%) chum salmon (57% female), 113 (9%) king salmon (47% female), and 93 (8%) pink salmon (26% female). Only seven finclipped chum salmon and 1 king salmon were recaptured, indicating that fish were not milling in the area.

Of the 916 chum salmon sampled for age-sex-size data, 834 (91%) later proved to have ageable scales. Age composition was 65% age 5, 33% age 4, 1.3% age 6, and 0.5% age 3 (Appendix Table 3). Females accounted for 56% of the sample, and average length ranged from a low of 489 mm for an age 3 female to 621 mm for age 6 males. Sex composition was the same as that found for the Anvik River, but age composition differed between the two stocks. The Andreafsky River escapement sample had a greater percentage of age 5 summer chum salmon and fewer age 4 fish than the Anvik River sample.

Age and sex composition of the Andreafsky River sample demonstrated a shift to younger age classes and females as the escapement progressed. Age compostion was 81% age 5, 17% age 4 and 0% age 3 for the period 21 June through 1 July, while it was 48% age 5, 50% age 4, and 1% age 3 for the period 2-18 July (Table 6). Sex composition increased from 51% female in the first period to 62% in the second period. Sampling periods for this analysis were defined such that sample sizes were similar for the two periods.

Figure 14. Summer chum salmon escapement past the East Fork Andreafsky River sonar site by hour (above), and by sonar sector (below), in 1983.



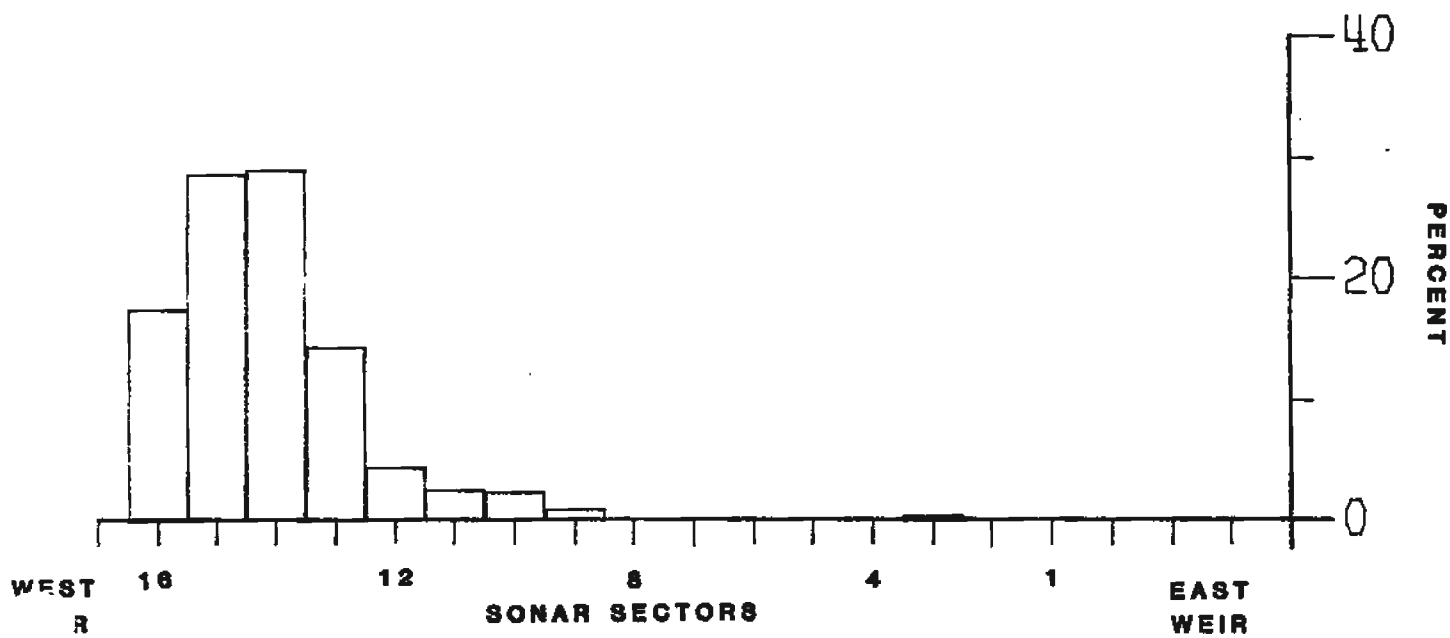


Figure 15. Water temperature, air temperature (max/min average), and water depth measured at noon daily at the East Fork Andreafsky River sonar site, 1983.

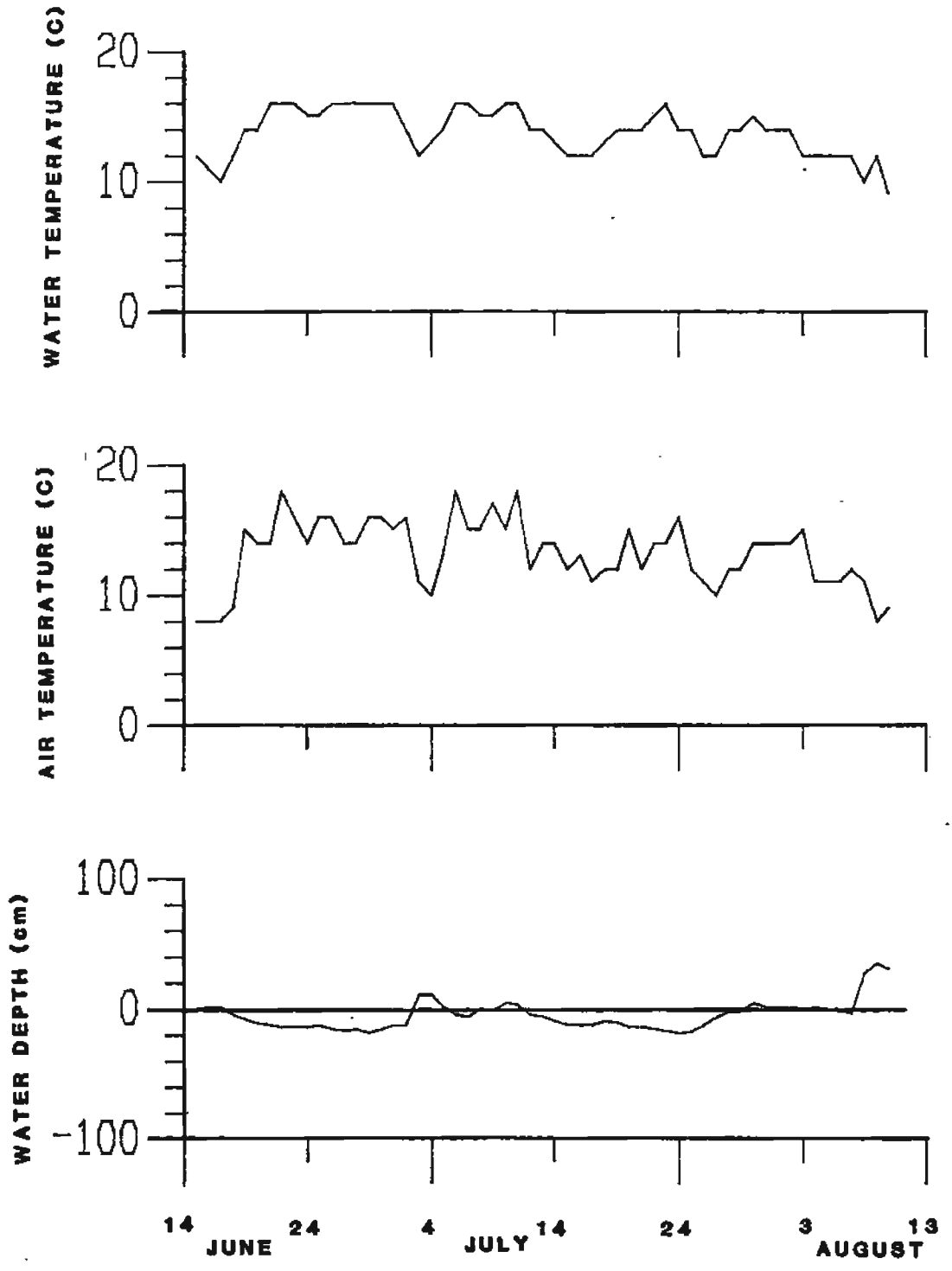


Table 6. Age and sex composition of East Fork Andreafsky River summer chum salmon beach seine samples, by sample period, 1983.

	AGE GROUP				
	31	41	51	61	TOTAL
SAMPLE PERIOD 1 6/21/83-7/01/83					
MALE					
SAMPLE NUMBER	0	44	163	3	210
PERCENT	0.00	10.33	38.26	0.70	49.30
FEMALE					
SAMPLE NUMBER	0	29	184	3	216
PERCENT	0.00	6.81	43.19	0.70	50.70
SEXES COMBINED					
SAMPLE NUMBER	0	73	347	6	426
PERCENT	0.00	17.14	81.46	1.41	100.00
SAMPLE PERIOD 2 7/02/83-7/18/83					
MALE					
SAMPLE NUMBER	3	70	80	3	156
PERCENT	0.74	17.16	19.61	0.74	38.24
FEMALE					
SAMPLE NUMBER	1	135	114	2	252
PERCENT	0.25	33.09	27.94	0.49	61.76
SEXES COMBINED					
SAMPLE NUMBER	4	205	194	5	408
PERCENT	0.98	50.25	47.55	1.23	100.00
COMBINED PERIODS 6/21/83-7/18/83					
MALE					
SAMPLE NUMBER	3	114	243	6	366
PERCENT	0.36	13.67	29.14	0.72	43.94
FEMALE					
SAMPLE NUMBER	1	164	298	5	468
PERCENT	0.12	19.66	35.73	0.60	56.06
SEXES COMBINED					
SAMPLE NUMBER	4	278	541	11	834
PERCENT	0.48	33.33	64.87	1.32	100.00

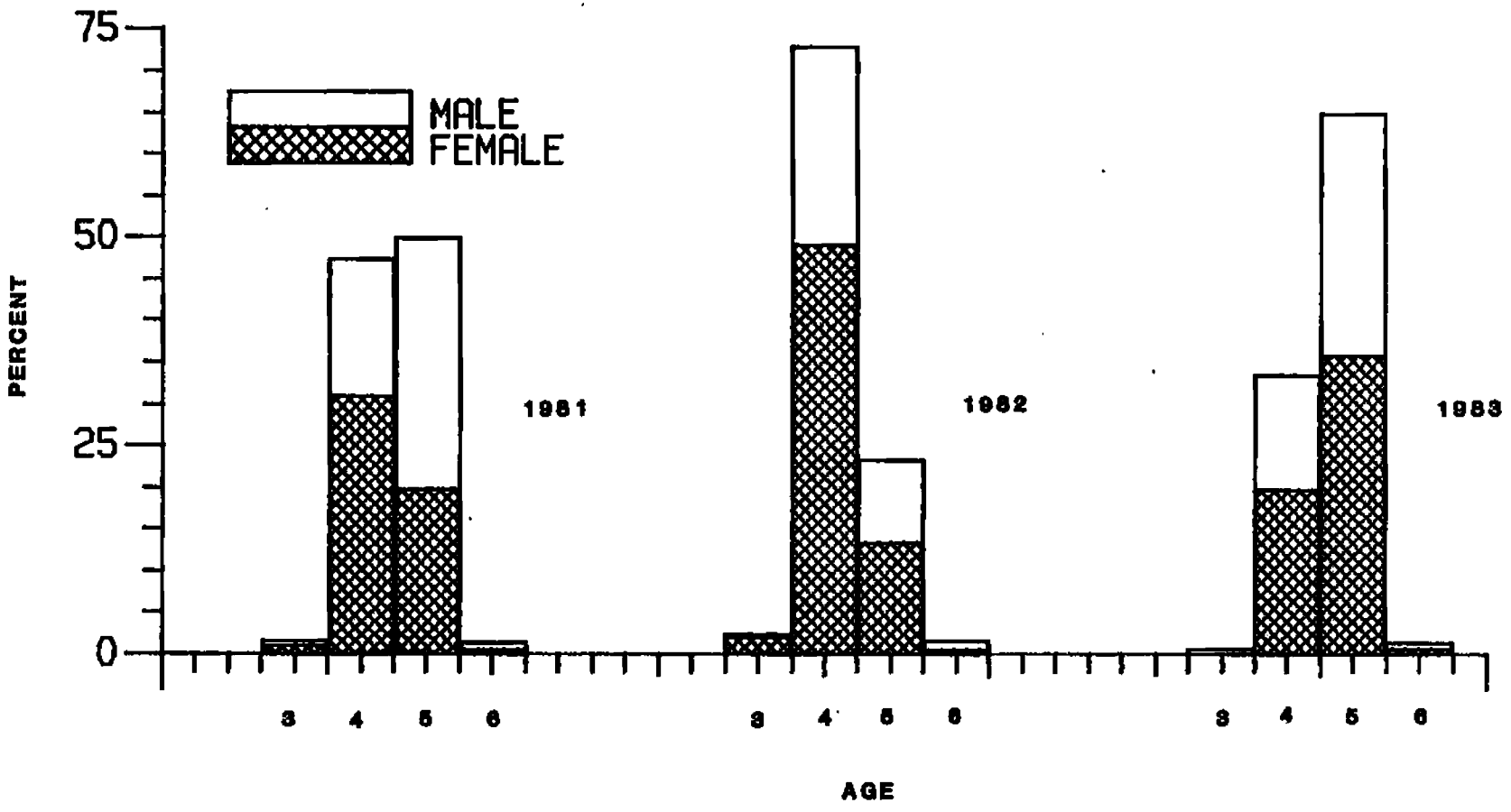


Figure 16. Age and sex composition of East Fork Andreafsky River summer chum salmon, 1981-1983.

Strength of the 1978 brood year can be seen in the large return of age 4 summer chum salmon to the Andreafsky River in 1982 and age 5 fish in 1983 (Figure 16). The 1978 escapement of 127,050 (aerial survey estimate) was slightly above average in magnitude. With only three years of age and sex composition data it is difficult to predict the age composition of the 1984 return.

One hundred thirteen (113) king salmon were sampled for age-sex-size data from beach seine catches at the sonar site, and between 19 and 30 July an additional 39 samples were collected by beach seine at several locations upriver where milling kings were observed. Two hundred nine (209) carcasses were sampled from the East Fork and 77 from the West Fork by boat survey, resulting in a total sample of 438 king salmon. This was the largest king salmon escapement sample ever collected in the lower Yukon River drainage. Only 355 (81%) of the scales were ageable. Age composition for the pooled sample was 46% age 6, 38% age 5, 15% age 4, and 0.3% age 7 (Appendix Table 4). Females made up only 29% of the sample, and average length ranged from a low of 528 mm for age 4 males to 895 mm for an age 7 female. Age compositon was very similar to that of the Anvik River escapement sample, but the percentage of females was much lower.

Sex compostion of the East Fork Andreafsky River beach seine sample (44% female) was identical to that of Anvik River carcasses, but significantly different from East Fork (26% female) and West Fork (15% female) carcass samples. The best estimate of the sex composition for the Andreafsky River is probably the pooled estimate of 29% female based on 355 samples (Appendix Table 4). The beach seine sample has the advantage of having been collected over the duration of the escapement, but suffers from small sample size. The carcass survey of the West Fork was conducted over a period of only a few days and was also a small sample. The East Fork carcass sample was the largest of the three, and was collected over a two week period of intensive survey effort. However, sex composition of carcass samples may be affected by differential die-off of male and female fish and the timing of both fluctuating water levels, which can flush carcasses from the system, and termination of the study, which ended while many king salmon were still spawning.

Age composition of the 1983 escapement was similar to that of 1981 (Figure 17). The strong showing of age 5 in 1982 and age 6 in 1983 indicates a good return of the 1977 brood year, although the age 4 component was relatively weak in 1981. Female escapement in 1983 was improved over the extremely poor showing in 1982, but weaker than that of the 1981 escapement (Figure 17). The low percentage of females in 1982 (15%) and 1983 (29%) could result in lower production for the Andreafsky River stock, and should be of concern to fisheries managers.

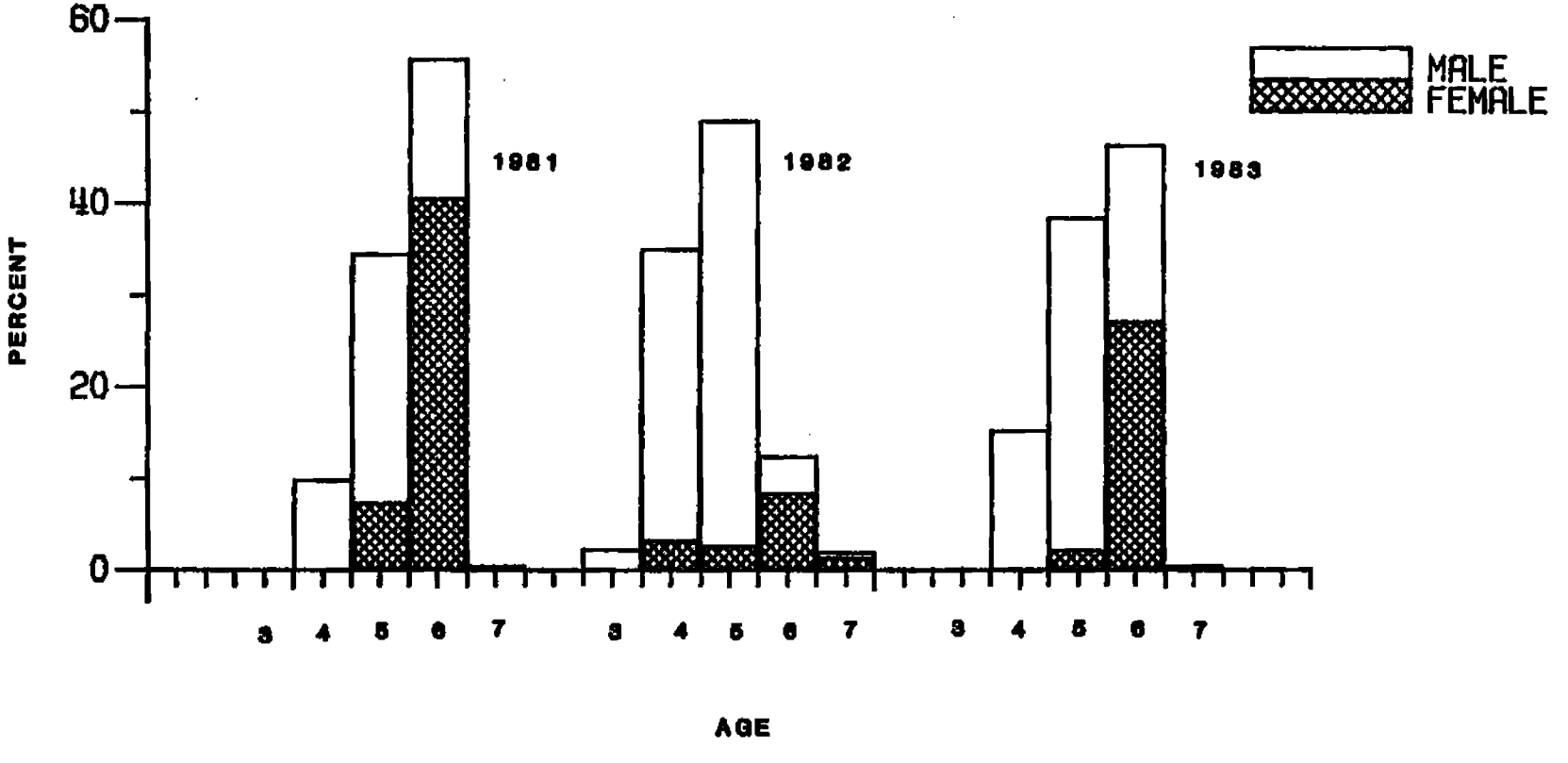


Figure 17. Age and sex composition of Andreafsky River king salmon, 1981-1983.

CONCLUSIONS AND RECOMMENDATIONS

1. Escapement to the Anvik River in 1983 was estimated by side-scan sonar to be 362,912 summer chum salmon. Age composition was 57% age 4, 41% age 5, and females accounted for 56% of the fish sampled. An aerial survey was flown under poor conditions and 653 king salmon were counted. Ages 6 (45%) and 5 (36%) dominated king salmon carcass samples, and 44% were female.

2. Beach seining proved to be an effective method of sampling chum salmon for age-sex-size data from both the Anvik and Andreafsky Rivers. Only 4 king salmon were captured by beach seine at the Anvik River, but over 100 were captured at the Andreafsky River. Additional samples were obtained by carcass survey at both locations.

3. Escapement to the East Fork Andreafsky River in 1983 was estimated by side-scan sonar to be 110,608 chum salmon and 2,720 king salmon. Sonar counts were apportioned between the two species based on visual counts. No aerial surveys were flown due to poor weather conditions. Chum salmon age composition was 65% age 5, 33% age 4, and females accounted for 56% of the fish sampled. King salmon were 46% age 6, 38% age 5, and ony 29% of the sample was female. This was the second year of low female return to the Andreafsky River, and may result in weak king salmon returns for these brood years.

4. Accuracy of sonar count data from the Andreafsky River in 1983 was improved by:

   a) Installing one substrate at the midstream site and weiring the rest of the channel before salmon passage had begun.

   b) Conducting scheduled daily visual calibrations of the sonar equipment to monitor accuracy, fish behavior, and species compostion.

   c) Low escapement of pink salmon, which when present in large numbers can interfere with sonar enumeration of chum and king salmon. Returns are strong in even-numbered years, and may prove to be a problem in 1984.

5. Buklis (1983) encountered difficulties with the 1981 model sonar counters on the Anvik River in 1982, and recommended testing on the Andreafsky River, where visual observation is more easily accomplished. The counter proved to be accuate and performed dependably throughout the study in 1983. Therefore, problems with counting accuracy on the Anvik River in 1982 must have been due to substrate positioning (bowing in the strong current or sagging due to irregular contour of the stream bed) or to fish swimming behavior. No problems in counting accuracy were encountered with the two 1978 model sonar counters used on the Anvik River in 1983.

6. A large pink salmon escapement to the Andreafsky River in 1982 and high water early in the season at the midstream site led Buklis (1983) to conclude that sonar counting may not be appropriate for this river, and

that potential weir sites should be evaluated. Due to low water levels in 1983, many sites appeared feasible for weir installation. However, success of the 1983 sonar project demonstrates that sonar enumeration can be successful at this site. The most accurate escapement data in the 3 year history of the study was obtained. A sonar substrate should be installed at the mid-stream site from the start of the season, and weirs installed from both ends to shore as soon as water depth allows. Close monitoring of the sonar counter and intensive visual counting will be necessary during peak pink salmon passage in years of high abundance.

LITERATURE CITED

Buklis, Lawrence S. 1981. Yukon River salmon studies. Anadromous Fish Conservation Act completion report for period July 1, 1977 to June 30, 1981. Alaska Department of Fish and Game, Juneau. 50 pp.

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

_____. 1983. Anvik and Andreafsky River salmon studies, 1982. Yukon Salmon Escapement Report No. 20. Alaska Department of Fish and Game, Commercial Fisheries Division, Anchorage. 40 pp.

Buklis, Lawrence S. and John Wilcock. In Prep. Age, sex, and size of Yukon River salmon catch and escapement, 1983. Alaska Department of Fish and Game, Technical Data Report, Juneau.

Mundy, P.R. 1982. Computation of migratory timing statistics for adult chinook salmon in the Yukon River, Alaska, and their relevance to fisheries management. North American Journal of Fisheries Management 4: 359-370.

Appendix A. Method of estimating Anvik River west bank sonar counts during period of chum salmon milling, 19-23 July, 1983.

Sonar counts at the Anvik River west bank site during the period 19-23 July were inaccurate due to multiple counting of milling chum salmon. This problem did not develop at the east bank site. West bank sonar counts for this period were estimated based on east bank counts and the relationship between east and west bank sonar counts during the previous period of accurate enumeration. The following table lists sonar counts for each river bank previous to 19 July:

Date	East Bank	West Bank	(E/E + W) (100)	
6/21	29	168	14.7	
6/22	277	951	22.6	
6/23	110	1,190	8.5	$\bar{x}$ = 9%
6/24	73	2,921	2.4	S = 7.2%
6/25	343	9,508	3.5	n = 7
6/26	1,000	10,394	8.8	
6/27	420	8,791	4.6	
6/28	1,684	13,112	11.4	
6/29	1,001	8,903	10.1	
6/30	2,405	18,632	11.4	
7/01	1,715	17,860	8.8	
7/02	1,675	8,458	16.5	
7/03	2,568	11,892	17.8	$\bar{x}$ = 17%
7/04	2,765	9,661	22.2	S = 6.2%
7/05	3,018	7,576	28.5	n = 12
7/06	2,166	6,475	25.1	
7/07	1,794	8,926	16.7	
7/08	2,448	13,460	15.4	
7/09	3,745	14,762	20.2	
7/10	6,989	13,827	33.6	
7/11	6,808	13,919	32.8	
7/12	6,890	10,261	40.2	
7/13	4,516	9,682	31.8	$\bar{x}$ = 29%
7/14	4,692	10,170	31.6	S = 6.7%
7/15	1,757	4,581	27.7	n = 9
7/16	1,778	6,066	22.7	
7/17	2,260	7,104	24.1	
7/18	1,207	5,524	17.9	

East bank contribution to total daily sonar counts increased as the season progressed, and can be divided into three strata: low 21-27 June (average 9%), moderate 28 June - 9 July (average 17%), and a strong contribution 10-18 July (average 29%). The most recent strata (10-18 July) was chosen as representative of the relationship between east and west bank counts for the period of chum salmon milling. The east bank averaged 29% of the total daily counts for this period (S = 6.7% , n = 9). Expanding daily east bank sonar counts for the period 19-23 July based on a 29% contribution yields the following estimates for the west bank sonar site:

Date	East Bank	Estimated West Bank
7/19	1,176	2,879
7/20	650	1,591
7/21	460	1,126
7/22	222	544
7/23	119	291

Appendix Table 1. Age, sex and size composition of Anvik River summer chum salmon beach seine samples, 1983.

	Age 3_1				Age 4_1				Age 5_1				Age 6_1				Combined Ages			
			Length (mm)				Length (mm)				Length (mm)				Length (mm)				Length (mm)	
	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD
Male	0	-	-	-	99	23.5	593	29	83	19.7	616	29	1	0.2	590	-	183	43.5	604	31
Female	4	1.0	527	18	142	33.7	554	28	90	21.4	575	27	2	0.5	586	12	238	56.5	562	30
Total	4	1.0	527	18	241	57.2	570	35	173	41.1	595	35	3	0.7	588	9	421	100.0	580	37

Appendix Table 2. Age, sex and size composition of Anvik River king salmon carcass samples, 1983. 1/

	Age 3_2				Age 4_2				Age 5_2				Age 6_2				Age 7_2				Combined Ages			
			Length (mm)				Length (mm)				Length (mm)				Length (mm)				Length (mm)				Length (mm)	
	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD
Male	1	0.3	340	-	55	18.0	518	61	84	27.5	708	75	33	10.8	804	89	0	-	-	-	173	56.5	664	132
Female	0	-	-	-	0	-	-	-	26	8.5	788	53	104	34.0	828	41	3	1.0	876	113	133	43.5	821	49
Total	1	0.3	340	-	55	18.0	518	61	110	35.9	727	78	137	44.8	822	57	3	1.0	876	113	306	100.0	732	130

1/ Includes 4 live samples collected by beach seine.

Appendix Table 3. Age, sex and size composition of East Fork Andreafsky River summer chum salmon beach seine samples, 1983.

	Age 3_1				Age 4_1				Age 5_1				Age 6_1				Combined Ages			
			Length (mm)				Length (mm)				Length (mm)				Length (mm)				Length (mm)	
	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD
Male	3	0.4	530	33	114	13.7	584	20	243	29.1	609	30	6	0.7	621	61	366	43.9	601	31
Female	1	0.1	489	-	164	19.7	545	21	298	35.7	570	25	5	0.6	585	24	468	56.1	561	27
Total	4	0.5	520	34	278	33.3	561	28	541	64.9	588	33	11	1.3	605	49	834	100.0	578	35

Appendix Table 4. Age, sex and size composition of East and West Fork Andreafsky River king salmon beach seine and carcass samples, 1983.

	Age 4_2				Age 5_2				Age 6_2				Age 7_2				Combined Ages			
			Length (mm)				Length (mm)				Length (mm)				Length (mm)				Length (mm)	
	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD	N	%	Mean	SD
East Fork Beach Seine																				
Male	18	17.5	524	54	25	24.3	705	60	15	14.6	830	56	0	-	-	-	58	56.3	681	130
Female	0	-	-	-	5	4.9	793	48	40	38.8	855	43	0	-	-	-	45	43.7	848	47
Total	18	17.5	524	54	30	29.1	719	67	55	53.4	848	47	0	-	-	-	103	100.0	754	132
East Fork Carcasses																				
Male	32	17.1	531	47	66	35.3	713	57	40 [1/]	21.4	832	60	0	-	-	-	138	73.8	705	122
Female	0	-	-	-	2	1.1	848	81	47	25.1	841	44	0	-	-	-	49	26.2	842	44
Total	32	17.1	531	47	68	36.4	717	61	87	46.5	837	52	0	-	-	-	187	100.0	741	123
West Fork Carcasses																				
Male	4	6.2	520	21	38	58.5	721	68	13	20.0	836	44	0	-	-	-	55	84.6	734	98
Female	0	-	-	-	0	-	-	-	9	13.8	851	55	1	1.5	895	-	10	15.4	855	54
Total	4	6.2	520	21	38	58.5	721	68	22	33.8	842	48	1	1.5	895	-	65	100.0	752	102
Combined Gear and Location																				
Male	54	15.2	528	47	129	36.3	714	61	68 [1/]	19.2	832	56	0	-	-	-	251	70.7	706	120
Female	0	-	-	-	7	2.0	809	58	96	27.0	848	44	1	0.3	895	-	104	29.3	846	46
Total	54	15.2	528	47	136	38.3	719	64	164	46.2	841	50	1	0.3	895	-	355	100.0	747	122

1/ Includes one age 6_3 male with length of 892 mm.