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YUKON SALMON ESCAPEMENT
REPORT #26

ANVIK AND ANDREAFSKY RIVER SALMON STUDIES, 1985

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

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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 (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. Summer chum salmon spawn in lesser numbers in other tributaries of the Yukon River. Chinook (O. tshawytscha) and pink (O. gorbuscha) salmon occur in the Anvik and Andreafsky Rivers coincidentally with summer chum salmon, while coho salmon (O. kisutch) are known to occur in small numbers in the fall, but their abundance is not monitored.

Commercial and subsistence fisheries that harvest Anvik and Andreafsky River summer chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouths of the respective tributary streams. Set and drift gillnets are the legal fishing gear in Districts 1, 2, and 3, while set gillnets and fishwheels may be used in District 4. Most of the effort and harvest occurs in Districts 1 and 2, and in the lower portion of District 4, near the Anvik River. Fish taken commercially in the lower three districts are fresh frozen, while District 4 is a roe fishery due to market conditions and flesh quality. Commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6 are supported by stocks other than those of the Andreafsky and Anvik Rivers. Very few summer chum salmon are harvested in District 5 due to the lack of significant spawning populations in that portion of the drainage. There are no scale pattern, electrophoretic, or mark-recapture stock identification data available on Yukon River summer chum salmon.

Chinook salmon are the target species of the lower Yukon River (Districts 1, 2, and 3) commercial fishery during June and early July. Fishing is permitted with unrestricted mesh size gillnets until changeover to 6 inch maximum mesh size is required by Emergency Order. In most years the majority of the summer chum salmon run has passed through the lower river districts before the changeover to chum salmon gear. As a result, most of the summer chum salmon commercial harvest in the lower Yukon is taken from the later portion of the run. The Board of Fisheries has directed that, beginning with the 1985 season, there may be special small mesh gear openings during the chinook salmon season to optimize harvest of summer chum salmon. This would require that a relatively large summer chum salmon run is in progress, and that the incidental harvest of chinook salmon would not be substantial enough to have an adverse affect on the management of that species. The District 4 commercial fishery is directed primarily at chum salmon. Subsistence fisheries in all four districts take summer chum salmon primarily for sled dog food.

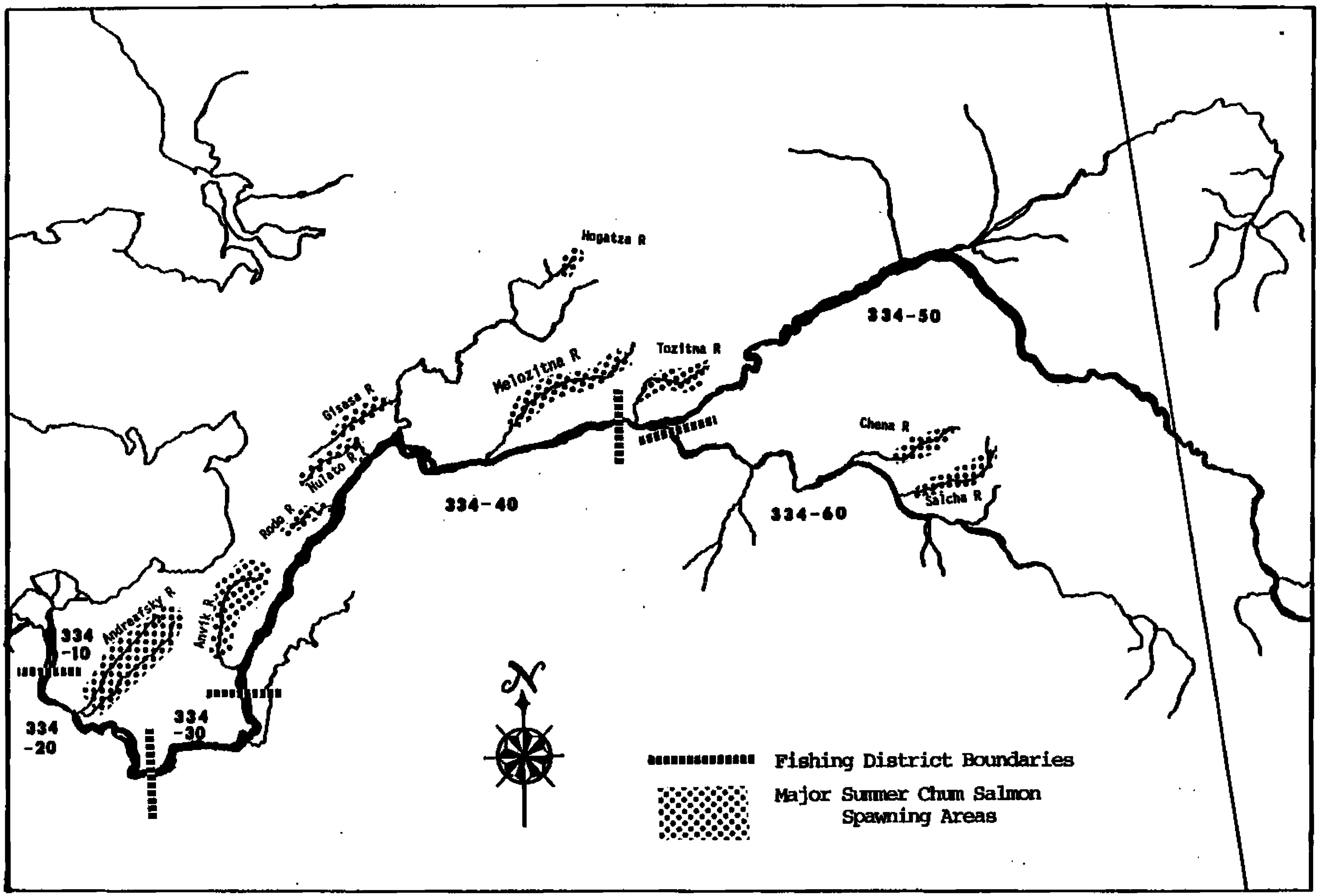

Figure 1. Map of the Yukon River, showing fishing districts and major summer chum salmon spawning areas.

Summer chum salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed wing aircraft on a consistent basis since the early 1970's. Aerial surveys are subject to error and variability due to weather and stream conditions, timing of the survey relative to spawning stage, and subjectivity and experience on the part of the observer. The counts obtained are only indices of abundance since not all salmon present on the day of the survey are usually seen, and earlier and later spawners are not present. However, these indices, if obtained under standardized conditions, can be used to monitor the relative abundance of spawning escapements. Aerial surveys are the most feasible method of assessing salmon escapements in terms of cost and staff limitations in a watershed as immense and remote as that of the Yukon River.

The Alaska Department of Fish and Game (ADF&G) has continued the aerial survey program while intensively studying a few important and representative tributary stream salmon spawning populations. The Anvik and Andreafsky Rivers have been chosen for summer chum salmon research studies. This report presents results of these studies for the 1985 field season, and provides recommendations for 1986 project operations.

ANVIK RIVER SALMON STUDY

The Anvik River (Figure 2) originates at an elevation of 1,300 feet and flows in a southerly direction approximately 120 miles to its mouth at mile 318 of the Yukon River. It is a narrow runoff stream with a substrate of gravel and cobble, except in the upper reach 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 to a low gradient system meandering through a much broader flood plain. Water clarity is reduced downstream of the Yellow River. 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 from 1972 to 1978. A site 5-1/2 miles above the Yellow River was used from 1972 to 1975, and a site at Robinhood Creek, 2-1/2 miles above the Yellow River, was used from 1976 to 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

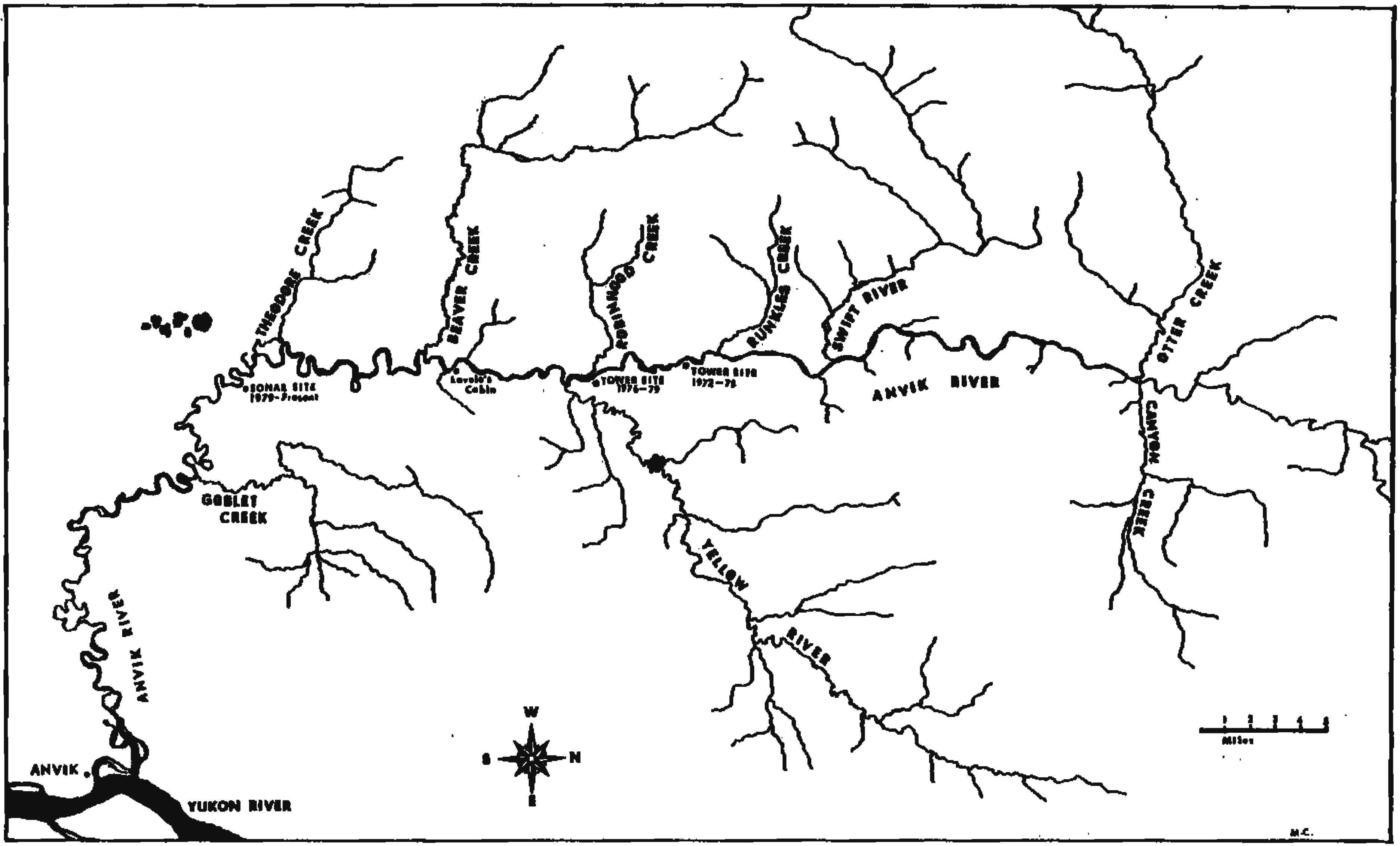

Figure 2. Map of the Anvik River.

tributary streams. The sonar counter is designed to transmit a sonic beam along a 60 foot aluminum tube, or substrate. Echoes from salmon passing through the beam are reflected back to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. Criteria for strength and frequency of the echoes are designed to optimize counting of salmon and minimize any non-salmon counts (ie debris or other fish species). Salmon escapement was enumerated by sonar beginning in 1979, replacing and proving superior to the tower counting method. One sonar counter has been installed on each bank of the Anvik River near Theodore Creek each year. Aerial survey data indicates that virtually all summer chum salmon spawners are found upstream of this site.

Methods and Materials

Two 1978 model sonar counters were operated without artificial aluminum substrate tubes throughout the season for the first time on this river. This was done in an attempt to eliminate sonar counting error associated with salmon milling adjacent to the artificial substrates, or swimming beyond the counting range, as has occurred in the past. Each sonar transducer was mounted in the 4 ft transducer housing and piece. The east and west bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum surfaces for insonification. Transducer housings were rotated downstream until the sonar beam was just above noise from the river bottom. Counting ranges were set such that the entire width of the river was insonified. Weirs prevented salmon passage inshore of the transducer on each bank. Transducers were moved inshore or offshore as required by fluctuating water levels.

Sonar counts were totaled electronically in twelve sectors for each bank and printed hourly. Sector counts missing as a result of debris or printer malfunction were estimated by averaging the counts in the same sector for the hour before and after the sector count in question. Counts were totaled daily for each bank using an electronic calculator, and the east and west bank totals summed to obtain a daily escapement estimate. Since summer chum salmon greatly outnumber chinooks and pinks, and the counters do not distinguish between species of salmon, all sonar counts were attributed to summer chum salmon. A separate escapement estimate for chinook salmon was obtained by aerial survey.

Each sonar counter was calibrated four 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 were related in the formula: $Q=SS/SC$, where SS = side scan sonar counts, and SC = oscilloscope counts. The existing fish velocity setting was multiplied by Q to obtain the correct new setting if the difference between the counts was greater than 15%. The system was then recalibrated at the new setting. A record was kept of all adjustments to the sonar equipment. Fish passage was visually enumerated from 10 ft counting towers during sonar calibration periods as a further check on sonar accuracy whenever water and light conditions allowed. Polaroid sunglasses were worn to reduce water surface glare.

Daily sonar counts were adjusted after the field season based on the calibration data. The daily adjustment factor is the sum of calibration oscilloscope counts for that day divided by the sum of calibration sonar counts for that day. Daily sonar counts were multiplied by the daily adjustment factor to obtain corrected daily sonar counts. Mean and standard deviation of date of passage were calculated following the method presented by Mundy (1982).

Water depth profile at the sonar site was measured at 10 ft intervals across the width of the river by probing with a pole marked in 1 in increments. Climatological data were collected at noon each day at the campsite. A pole 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 degrees centigrade near shore, at a depth of about 1 ft. Daily maximum and minimum air temperatures were recorded in degrees centigrade. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

A beach seine (100 ft long, 66 meshes deep, 2-1/2 in mesh) was set near the sonar site to capture chum and chinook salmon for age, sex, and size measurements. Chum and chinook salmon were placed in a holding pen, identified by sex, measured from mid-eye to fork of tail in mm, 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. Chinook salmon carcasses were sampled in August to supplement the beach seine sample. 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

Two sonar counters were operated from 26 June through 28 July, at approximately the same sites used in previous years (Figure 3). The east bank transducer was located along a cutbank, 10 ft offshore and at a depth of 3 ft. The west bank transducer was located along a gradually sloping gravel bar, less than 100 ft downstream from the east bank site. The transducer was 50 ft

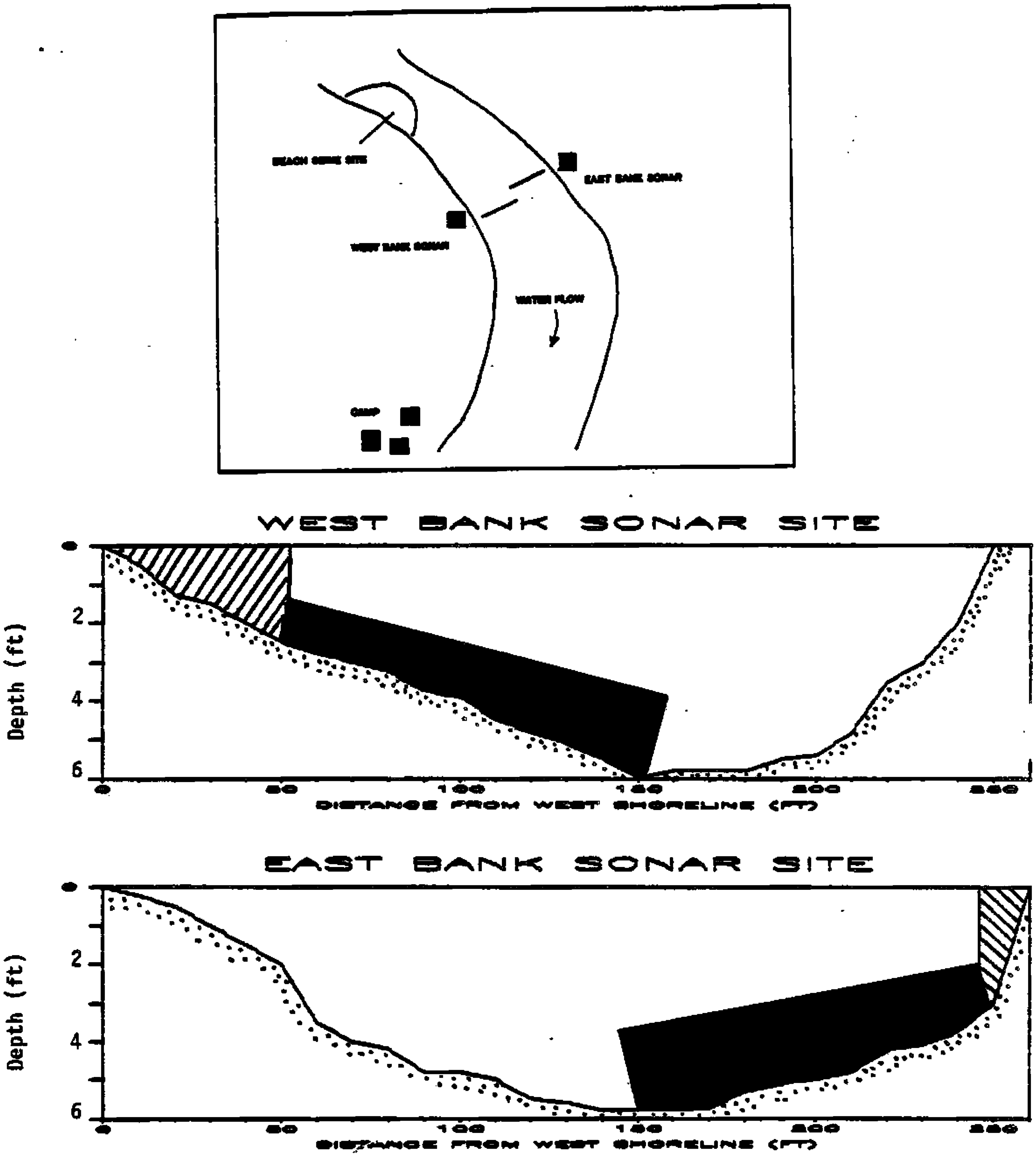

Figure 3. Map of the Anvik River sonar site, and river depth profiles as measured on 23 June, 1985. Shaded areas show approximate range of insonification when hydroacoustics were installed on 26 June, weirs indicated with cross-hatching. Unequal scale of the vertical and horizontal axis distorts the presentation.

offshore and at a depth of 2.5 ft. The entire width of the river between the transducers was insonified. River bottom gradient was smooth, with no obstructions to the sonar beam, and maximum depth was 6 ft as measured on 23 June (Figure 3).

River water level was very high when the crew arrived to begin project operations due to late river ice breakup, deep snowpack, and rain (Figure 4). Two pulses of even greater runoff peaked on 2 and 8 July, causing difficulties maintaining the accurate aiming of the sonar transducers. A large spruce tree floating downriver severed the transducer cable on the east bank on 2 July, and the inshore weirs were washed out several times. Water levels declined steadily after 8 July through termination of sonar enumeration, then began to rise again on 7 August as a result of steady rain and overcast weather. Water temperature ranged from a low of 9 C on 25 June to a high of 18 C on 5 August, while air temperature ranged from a low daily minimum of 2 C on 26 June to a high daily maximum of 28 C on 20 July.

Summer chum salmon were not passing the sonar site in significant numbers until 5 July. The round housing tubes used to deploy the transducers were not effective in high water conditions for several reasons. First, rising water levels altered the orientation and washed out gravel from beneath the tubes, even though they were tied in position as securely as possible. Secondly, once the water had risen substantially, it became impossible to adjust the transducer aiming without completely removing the entire assembly and redeploying it in shallower water. Recommendations for an improved transducer deployment assembly are discussed in the final section of this report (Conclusions and Recommendations). Daily counts for 8-10 July were interpolated using the daily counts for the day before and after this period.

The season escapement estimate for the entire period 5-28 July was 1,080,243 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 (Figure 5). The 1985 escapement was second only to the 1981 parent year escapement of nearly 1.5 million fish, was 2.2 times greater than the escapement objective of 487,000 fish (ADFG 1984), and was 2.0 times greater than the long term average (1972-1984) of 549,827 fish.

Summer chum salmon escapement to the Anvik River is a function of harvest management strategy, primarily in Districts 1 and 2, which is in turn a function of chinook salmon run timing and harvest management strategy for that species. The very late run timing of chinook salmon in 1984 and 1985, and consequent late changeover dates to chum salmon gear in the commercial fishery, contributed to the largest consecutive year escapements ever

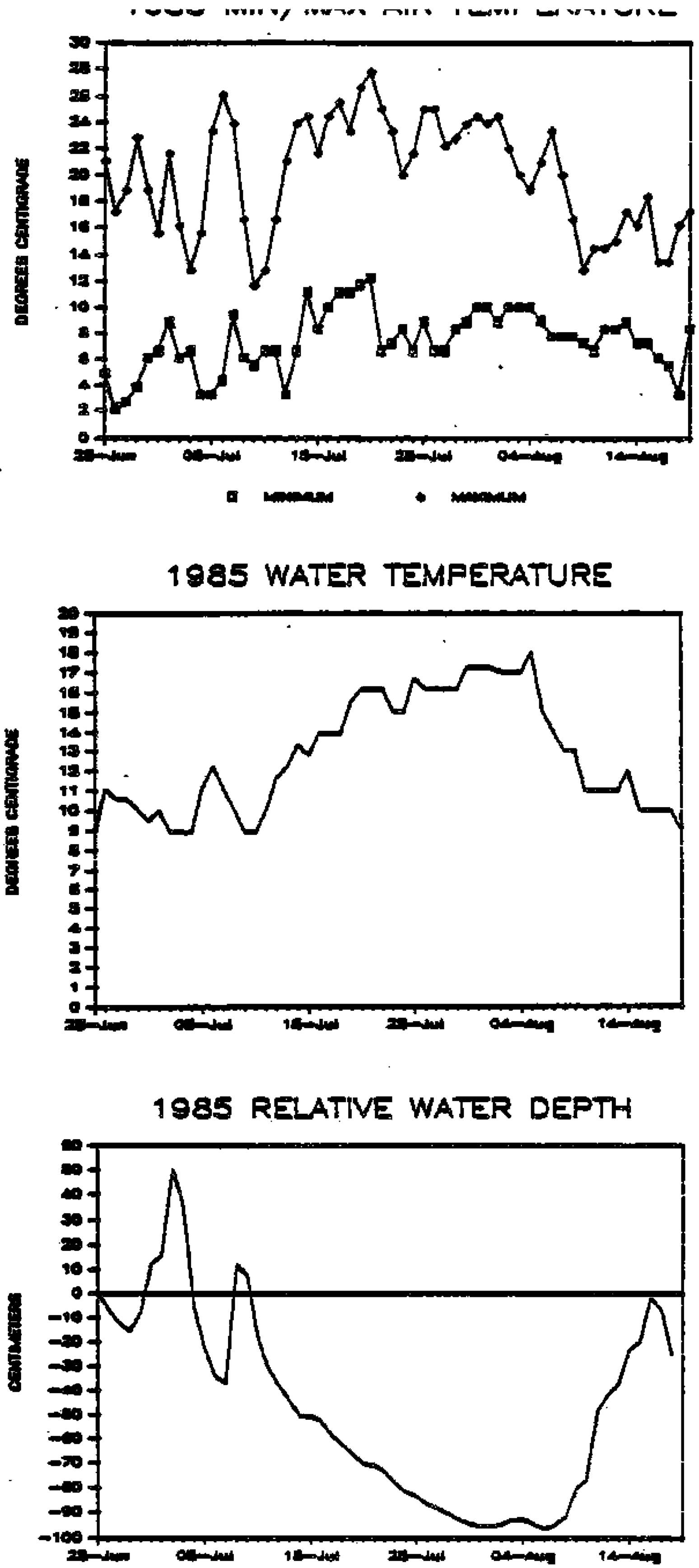

Figure 4. Air temperature (daily minimum and maximum), water temperature, and relative water depth measured at noon daily at the Anvik River sonar site, 1985.

Table 1. Anvik River summer chum salmon sonar counts by date, 1985.

Date	West Bank			East Bank			Entire River			
	Raw Daily	Adjust Factor a	Correct Daily	Raw Daily	Adjust Factor a	Correct Daily	Daily Count	Season Count	Daily Prop	Season Prop
05-Jul	6,515	0.87	5,668	124	b	2,330	7,998	7,998	0.0074	0.0074
06-Jul	41,751	1.02	42,586	5,120	0.91	4,659	47,245	55,243	0.0437	0.0511
07-Jul	45,328	1.00	45,328	10,763	1.00	10,763	56,091	111,334	0.0519	0.1031
08-Jul	8,617	b	47,186	7,165	b	11,392	58,578	169,912	0.0542	0.1573
09-Jul	7,217	b	49,044	4,993	b	11,221	60,265	230,177	0.0558	0.2131
10-Jul	34,427	b	50,902	6,819	b	11,050	61,952	292,129	0.0574	0.2704
11-Jul	77,589	0.68	52,761	14,703	0.74	10,880	63,641	355,770	0.0589	0.3293
12-Jul	91,762	0.72	66,069	31,542	0.97	30,596	96,664	452,434	0.0895	0.4188
13-Jul	103,812	0.87	90,316	37,794	1.00	37,794	128,110	580,544	0.1186	0.5374
14-Jul	77,745	1.07	83,187	28,385	0.93	26,398	109,585	690,129	0.1014	0.6389
15-Jul	63,214	0.91	57,525	18,434	1.08	19,909	77,433	767,562	0.0717	0.7105
16-Jul	37,167	1.01	37,539	25,216	1.01	25,468	63,007	830,569	0.0583	0.7689
17-Jul	25,601	1.10	28,161	17,986	0.90	16,187	44,349	874,918	0.0411	0.8099
18-Jul	24,071	1.00	24,071	12,911	1.04	13,427	37,498	912,416	0.0347	0.8446
19-Jul	16,909	1.00	16,909	9,614	1.07	10,287	27,196	939,612	0.0252	0.8698
20-Jul	23,080	0.95	21,926	13,570	1.03	13,977	35,903	975,515	0.0332	0.9030
21-Jul	19,024	1.01	19,214	7,811	1.01	7,889	27,103	1,002,618	0.0251	0.9281
22-Jul	17,302	1.01	17,475	5,103	0.94	4,797	22,272	1,024,890	0.0206	0.9488
23-Jul	12,543	0.91	11,414	3,194	1.05	3,354	14,768	1,039,658	0.0137	0.9624
24-Jul	9,548	0.99	9,453	2,416	0.87	2,102	11,554	1,051,212	0.0107	0.9731
25-Jul	9,060	0.90	8,154	2,157	0.87	1,877	10,031	1,061,243	0.0093	0.9824
26-Jul	6,729	0.98	6,594	1,315	1.17	1,539	8,133	1,069,376	0.0075	0.9899
27-Jul	4,970	0.95	4,722	1,395	0.90	1,256	5,977	1,075,353	0.0055	0.9955
28-Jul	1,691	c	3,618	684	c	1,272	4,890	1,080,243	0.0045	1.0000
Totals	765,672		799,821	269,214		280,423		1,080,243		1.0000

a Adjustment factor is the daily sum of calibration oscilloscope counts divided by the daily sum of calibration sonar counts. See Tables 2 and 3 for sonar calibration data.

b Raw sonar count is only a partial count due to high water and washed out weir. Corrected count calculated by interpolating the corrected count for the day before and after the period in question.

c Sonar counters were operated for 12 hours only (0000-1200). Correction factors based on sonar calibrations (West Bank=1.07, East Bank=0.93) were applied to raw counts, and corrected 12 hour counts were then multiplied by 2 to obtain daily estimates.

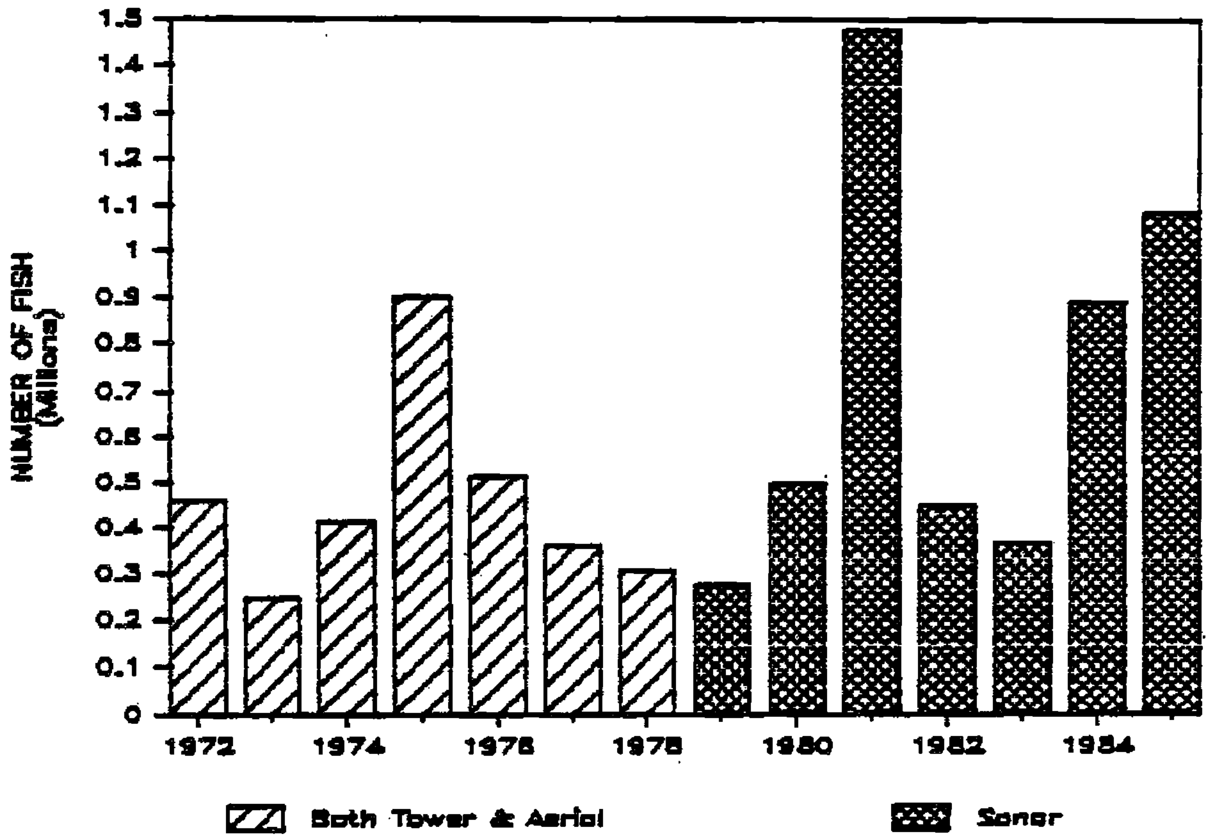

Figure 5. Anvik River summer chum salmon escapement estimated by combined tower and aerial survey counts, 1972-1978, and by side-scanning sonar, 1979-1985.

documented to the Anvik River.

A total of 20.06 hours of sonar calibration was conducted over a 24 day period at the west bank site, and sonar accuracy (sonar count/oscilloscope count) averaged 1.11 (Table 2). High and turbid water made it difficult to obtain a visual check on sonar accuracy. Although visual counts could not be used to calibrate the sonar electronics, they did provide a measure of salmon species composition. A net upstream total of 6,570 chum salmon, 12 chinook salmon, and 11 pink salmon was visually enumerated at the west bank site during all calibration periods combined. Sonar accuracy averaged 1.04 for 18.69 hours of oscilloscope calibration at the east bank site over a period of 23 days (Table 3). A net upstream total of 2,700 chum salmon, 17 chinook salmon, and 3 pink salmon was visually enumerated during these calibration periods. Daily calibration oscilloscope and sonar counts for each bank were used to adjust the daily sonar counts for that bank, which were then summed to obtain corrected daily escapement estimates.

Peak daily counts of 128,110 and 109,585 summer chum salmon occurred on 13 and 14 July, respectively. These daily counts represented 11.9% and 10.1% of the total season escapement count (Figure 6). Mean date of passage occurred on 14 July, with a standard deviation of 4.78 days. Run timing was clearly the latest ever documented for the Anvik River escapement. The timing pattern was very compressed and for the first time was essentially unimodal. Reasonable inseason projections of total escapement could not be generated in 1985 using the historical run timing data base since the 1985 escapement timing pattern was so atypical.

Temporal distribution of the combined east and west bank sonar counts by hour does not indicate a distinct diel pattern for the entire season as a whole (Figure 7). However, stratification of the season into early (5-12 July), middle (13-20 July), and late (21-28 July) components indicates that while the pattern is still not strong for any of the state, it is more distinct for the late strata than for either of the others. This is probably due to the greater diel variability in light intensity as the season advances after the summer solstice. Counts were lowest during 1000-1100 (3.2% of daily total) and greatest during 0300-0400 (5.8% of daily total) during the late strata.

Spatial distribution of sonar counts by sector indicates that virtually all salmon passage occurred in the first and second sectors of the west bank and the first sector of the east bank (Figure 8). Two factors account for this. First, the sonar counters were operated without the aluminum substrate tubes for the first time at this site, and salmon apparently followed a more natural inshore migration route than has been documented in the past using the artificial substrates. Second, very high water

Table 2. Oscilloscope and visual calibration of salmon sonar counts at the Anvik River west bank site, 1985.

					Visual Count a								
					Chum			Chinook			Pink		
Date	Hours Count	Sonar Count	Scope Count	Sonar/ Scope	Up	Down	Net	Up	Down	Net	Up	Down	Net
05-Jul	0.58	591	514	1.15	304	0	304						
06-Jul	1.00	1,305	1,337	0.98									
07-Jul	1.17	1,624	1,619	1.00									
08-Jul	0.67	392	336	1.17									
09-Jul	0.92	739	757	0.98									
10-Jul	0.83	1,218	923	1.32	105	0	105						
11-Jul	0.67	1,423	971	1.47	457	0	457				2	0	2
12-Jul	1.25	2,585	1,851	1.40	1,196	6	1,190	6	0	6	1	0	1
13-Jul	0.62	1,295	1,124	1.15	688	1	687						
14-Jul	0.67	1,297	1,385	0.94	797	3	794						
15-Jul	0.42	921	837	1.10	172	1	171						
16-Jul	0.67	672	677	0.99	549	4	545						
17-Jul	0.92	584	644	0.91	466	8	458				1	0	1
18-Jul	0.75	432	430	1.00	307	13	294				1	0	1
19-Jul	1.00	390	391	1.00	338	16	322	1	0	1			
20-Jul	0.58	326	311	1.05	142	10	132						
21-Jul	0.67	277	281	0.99	151	17	134						
22-Jul	0.75	244	246	0.99	138	10	128						
23-Jul	1.42	436	395	1.10	318	25	293	2	0	2	2	0	2
24-Jul	1.00	290	287	1.01	214	11	203	2	0	2	2	0	2
25-Jul	1.00	231	209	1.11	112	2	110				2	0	2
26-Jul	1.00	197	193	1.02	157	10	147						
27-Jul	1.00	169	160	1.06	87	5	82	1	0	1			
28-Jul	0.50	41	44	0.93	15	1	14						
Totals	20.06	17,679	15,922	1.11	6,713	143	6,570	12	0	12	11	0	11

a Visual counts are listed as upstream or downstream with "net" being the difference between the two. Due to poor water clarity, visual counts were often obtainable only for the first few sectors of the sonar counting range. Errors in species identification may have been made, especially between chums and pinks, due to poor water clarity and lack of background contrast against the natural river bottom.

Table 3. Oscilloscope and visual calibration of salmon sonar counts at the Anvik River east bank site, 1985.

					Visual Count a								
					Chum			Chinook			Pink		
Date	Hours Count	Sonar Count	Scope Count	Sonar/ Scope	Up	Down	Net	Up	Down	Net	Up	Down	Net
06-Jul	0.73	663	603	1.10									
07-Jul	1.25	493	493	1.00									
08-Jul	0.75	173	190	0.91									
09-Jul	0.97	214	158	1.35									
10-Jul	0.67	144	120	1.20									
11-Jul	0.75	492	362	1.36	58	1	57						
12-Jul	0.83	590	574	1.03	282	1	281						
13-Jul	0.58	964	966	1.00									
14-Jul	0.75	765	712	1.07	191	0	191	1	0	1			
15-Jul	0.42	253	274	0.92									
16-Jul	0.67	811	819	0.99	474	0	474	4	0	4			
17-Jul	0.75	512	463	1.11	259	1	258	1	0	1	1	0	1
18-Jul	0.67	334	349	0.96	325	1	324	2	0	2	2	0	2
19-Jul	0.82	362	387	0.94	394	3	391	1	0	1			
20-Jul	0.58	455	467	0.97	171	3	168						
21-Jul	0.75	245	247	0.99	124	2	122						
22-Jul	0.83	157	148	1.06	111	6	105	3	0	3			
23-Jul	1.00	154	162	0.95	103	3	100						
24-Jul	1.17	108	94	1.15	124	2	122	3	0	3			
25-Jul	1.00	135	118	1.14	34	8	26						
26-Jul	1.25	29	34	0.85	53	5	48	1	0	1			
27-Jul	1.00	77	69	1.12	38	4	34	1	0	1			
28-Jul	0.50	14	13	1.08	0	1	(1)						
Totals	18.69	8,144	7,822	1.04	2,741	41	2,700	17	0	17	3	0	3

a Visual counts are listed as upstream or downstream with "net" being the difference between the two. Due to poor water clarity, visual counts were often obtainable only for the first few sectors of the sonar counting range. Errors in species identification may have been made, especially between chums and pinks, due to poor water clarity and lack of background contrast against the natural river bottom.

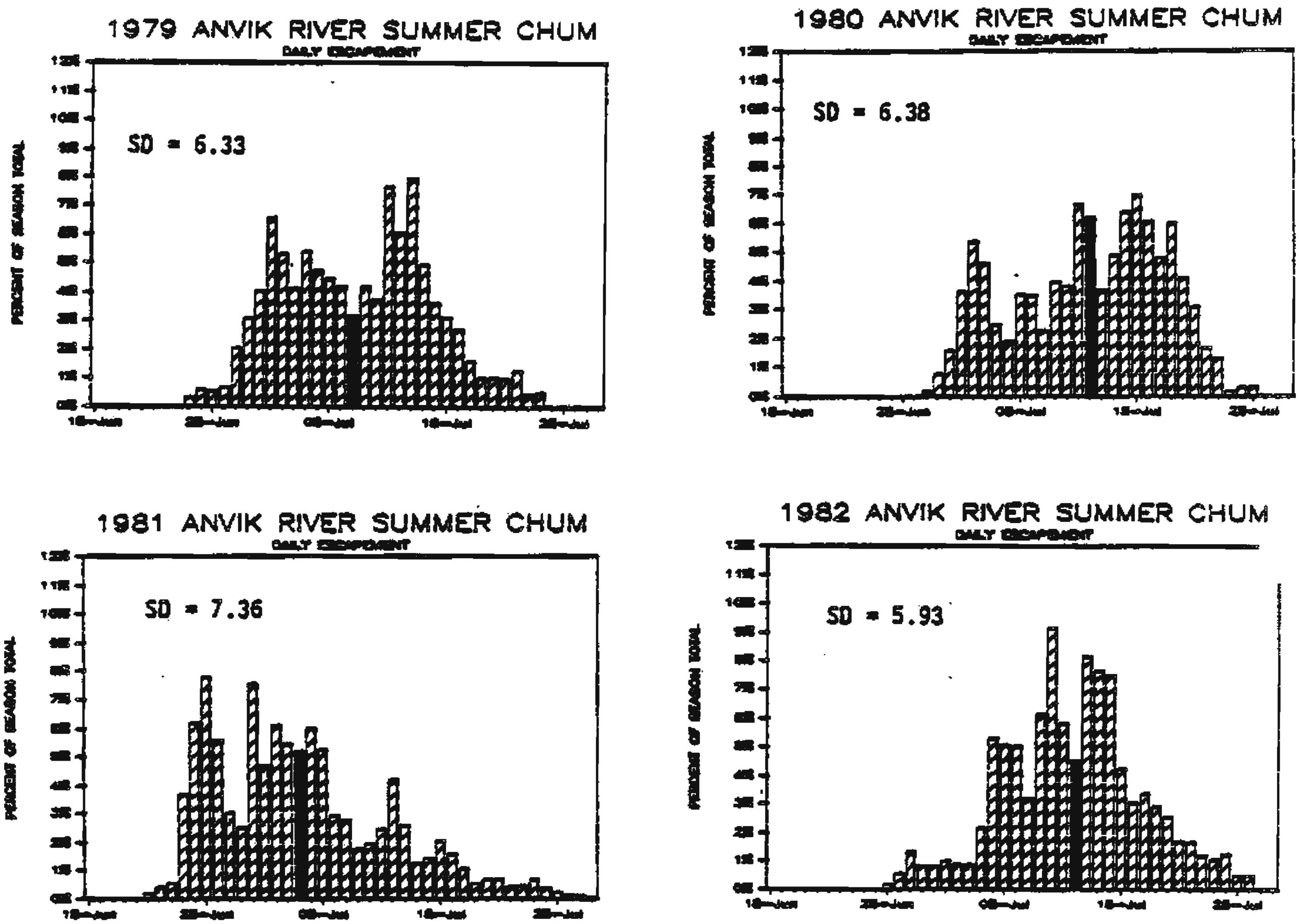

Figure 6. Anvik River summer chum salmon sonar counts by day, 1979-1985. Mean date of run passage (calculated with Day 1 = 16 June) is indicated by shaded bar, and standard deviation (SD) of the mean is given.

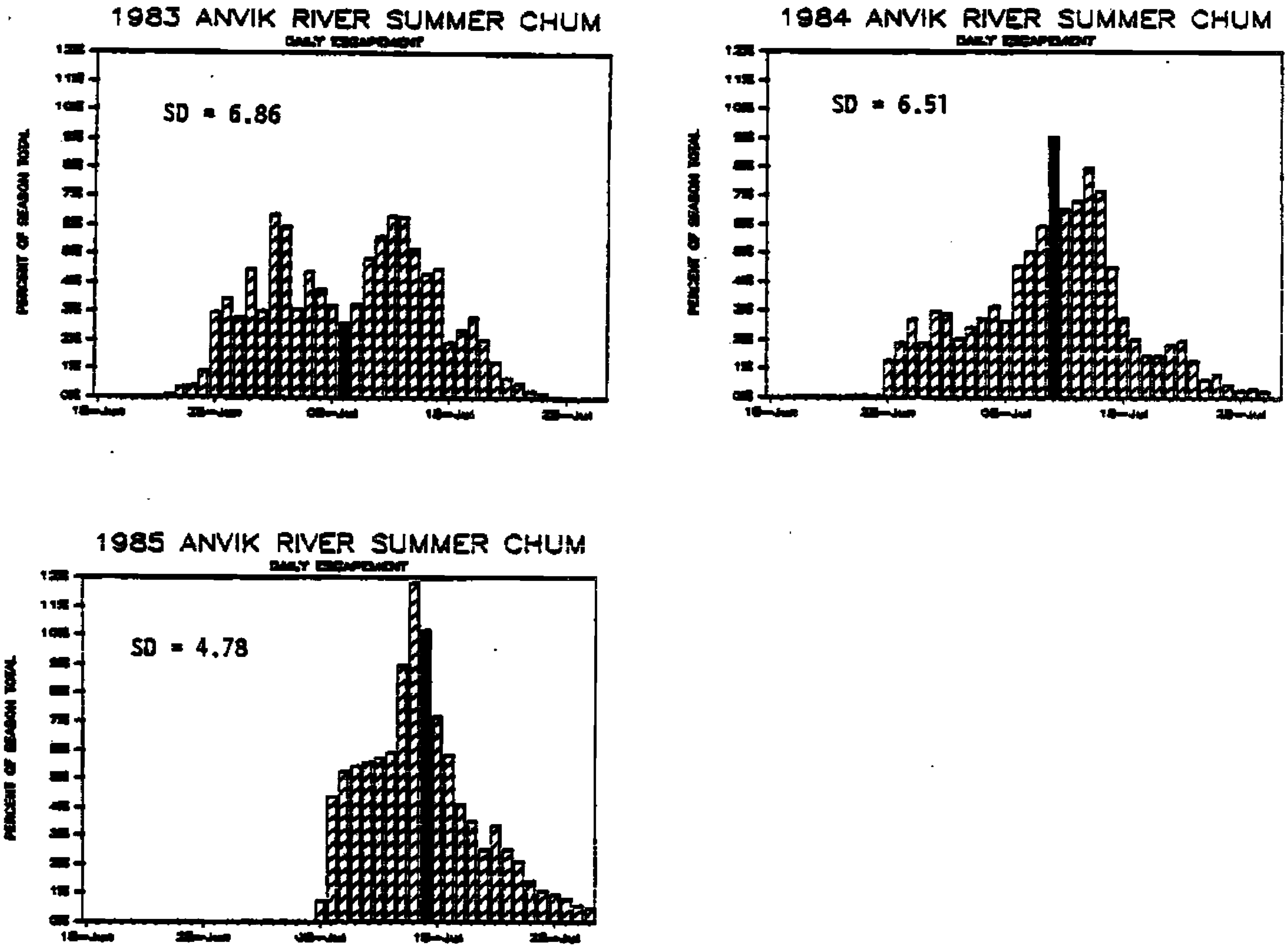

Figure 6. (Continued) Anvik River summer chum salmon sonar counts by day, 1979-1985. Mean date of run passage (calculated with Day 1 = 16 June) is indicated by shaded bar, and standard deviation (SD) of the mean is given.

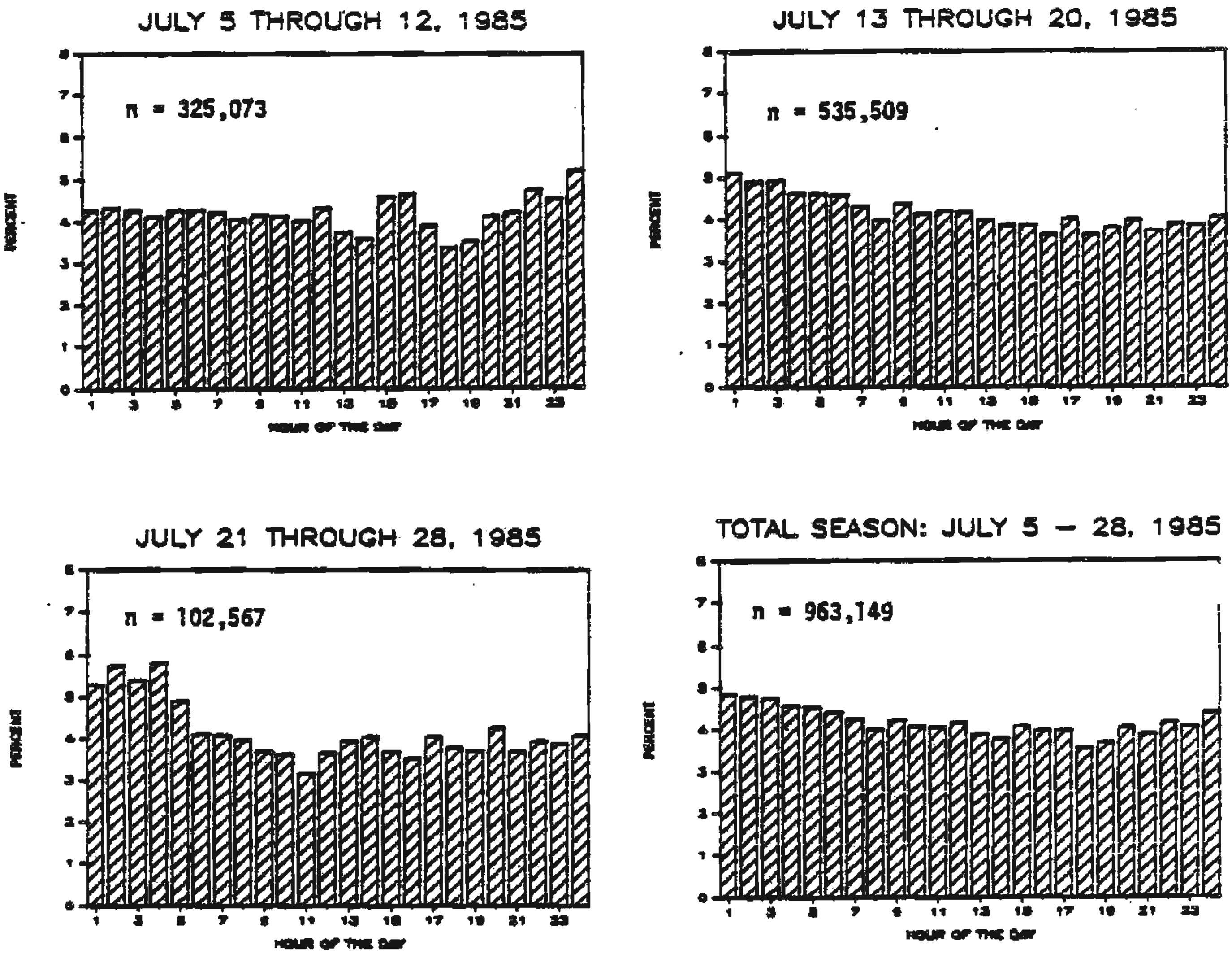

Figure 7. Anvik River summer chum salmon sonar counts by hour of the day for the early (5-12 July), middle (13-20 July), and late (21-28 July) portion of the season, and for the entire 1985 season combined. Total sonar counts (n) used for this analysis are given for each period.

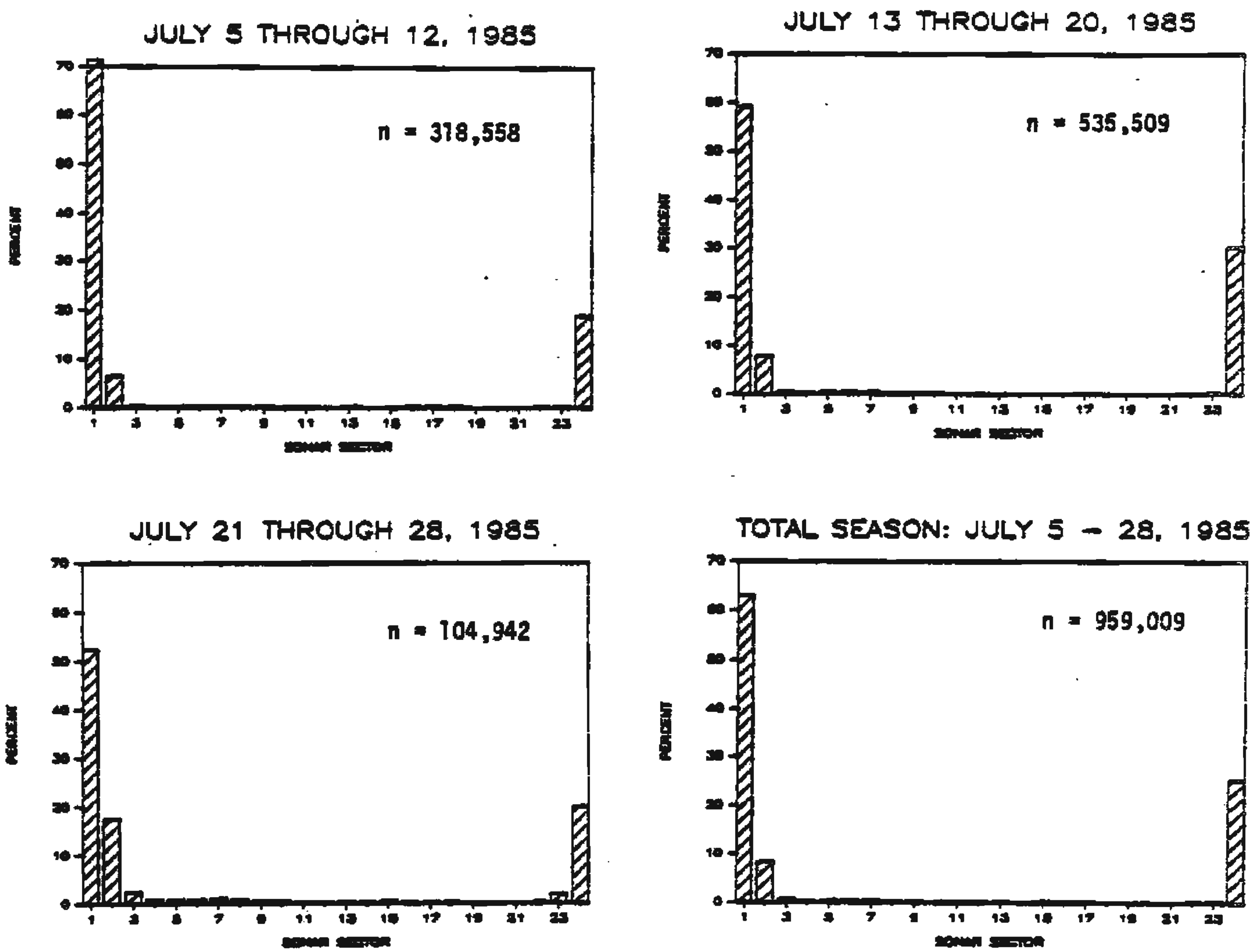

Figure 8. Anvik River summer chum salmon sonar counts by sonar sector for the early (5-12 July), middle (13-20 July), and late (21-28 July) portion of the season, and for the entire 1985 season combined. Sector 1 is west bank sector 1, 12 is west bank sector 12, 13 is east bank sector 12, and 24 is east bank sector 1. Total sonar counts (n) used for this analysis are given for each period.

conditions throughout much of the counting period may have resulted in greater inshore salmon passage than would have been observed in low water conditions. Sector count distribution for the early, middle, and late season strata described above support this theory. Relative contribution of the first sector declined, as did river water level, as the season progressed. For the entire season and both banks combined, west bank sector 1 accounted for 63.1% of all sonar counts, west bank sector 2 8.4%, and east bank sector 1 25.4%.

An aerial survey of the Anvik River (including Beaver Creek, Canyon Creek, Otter Creek, Swift River, and Yellow River) was flown on 23 July under fair survey conditions. A total of 1,051 chinook salmon and 426,195 chum salmon was enumerated. This was the largest chinook salmon escapement count for the Anvik River drainage since 1980. The count of 720 chinook salmon in the mainstem Anvik River between Yellow River and McDonald Creek exceeded the aerial survey escapement objective of 300 to 500 chinook salmon for this index area (ADFG 1984).

Thirty-one beach seine sets were made from 5 to 28 July, and a total of 637 chum salmon, 1 chinook salmon, and 3 pink salmon was captured (Appendix Table 1). An attempt was made to collect additional chinook salmon samples by carcass survey. However, due to both very late chinook salmon spawning timing and high water conditions, only 37 chinook salmon were sampled by carcass survey through August 18.

Of the 637 chum salmon sampled for age-sex-size data, 527 (83%) later proved to have ageable scales. Age composition was 75% age 4, 22% age 5, 2% age 3, and less than 1% age 6 (Appendix Table 2). Females accounted for 56% of the sample. Age 4 usually accounts for the majority of the Anvik River escapement. Age 5 was stronger in 1972, 1976, and 1981, but in all other years since 1972 age 4 has been the predominant age class (Figure 9).

The unrestricted mesh size gillnet fishery directed at chinook salmon during the first portion of the commercial fishing season took a higher proportion of male chum salmon than females due to the larger size of males (Buklis and Wilcock, In Prep). Female contribution to commercial harvest increased with changeover to 6 in maximum mesh size gillnets. Age composition of the commercial catch varied by mesh size and progression of the run, but a strong age 4 component was apparent, similar to the escapement sample.

Of the 38 chinook salmon sampled for age-sex-size data, 33 (87%) later proved to have ageable scales. Age composition was 39% age 5, 30% age 4, and 30% age 6 (Appendix Table 3). Females accounted for only 24% of the sample. The sample size was much smaller than had been desired, and may very well not be a good representation of the chinook salmon escapement. However, age and sex

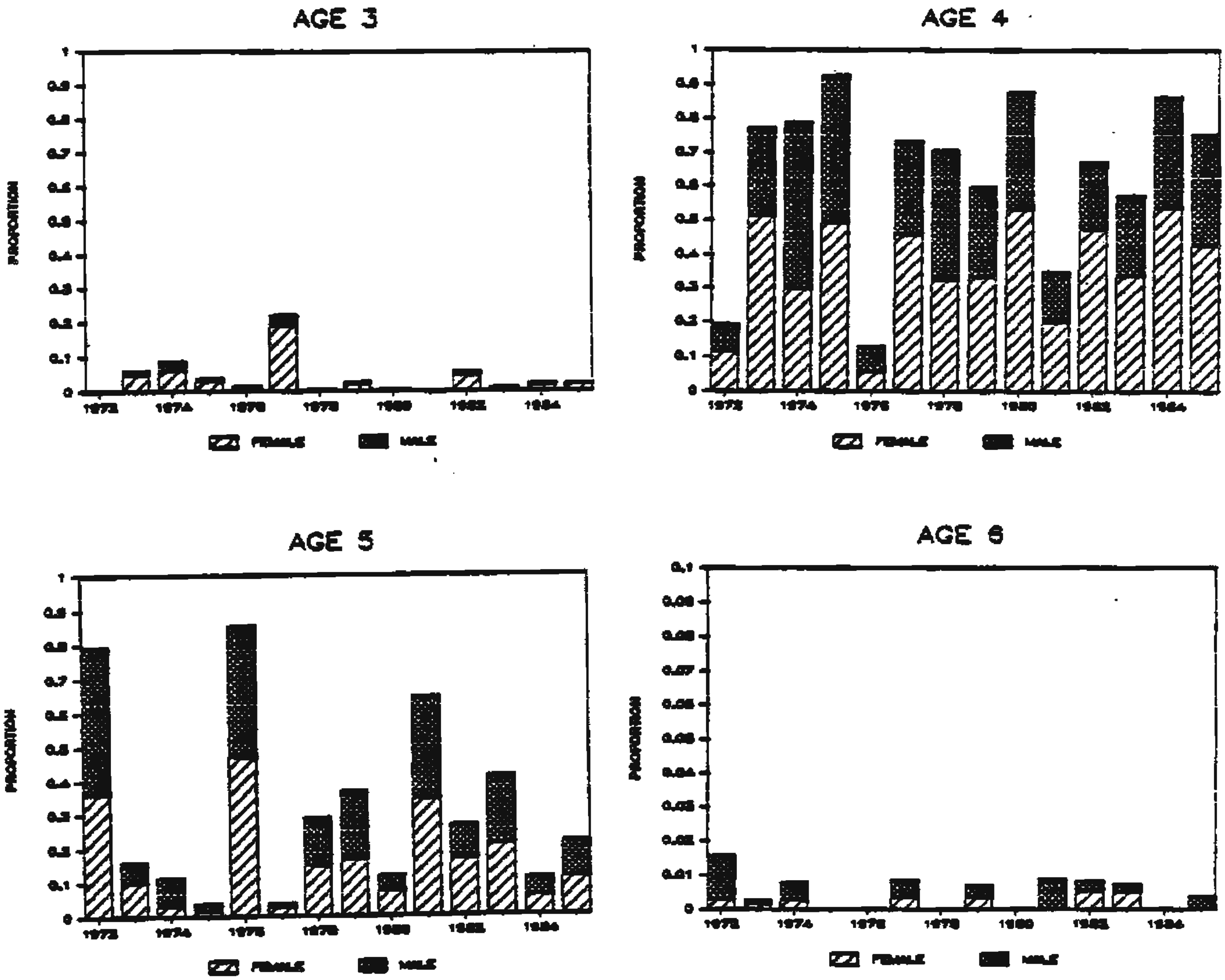

Figure 9. Age and sex composition of Anvik River summer chum salmon, 1972-1985, presented as proportion of total sample for each year by age class. Note different scale for age 6.

composition is relatively similar to that of recent years (Figure 10). Ages 5 and 6 account for the majority of the escapement each year, and males generally outnumber females.

Both the unrestricted and 6 in maximum mesh size gillnet commercial fisheries took a high proportion of age 6 chinook salmon, and an unusually low proportion of age 5 fish, in 1985 (Buklis and Wilcock, In Prep). Reasons for the poor age 5 contribution to fishery harvests will be better understood after scale patterns analysis has been applied to the chinook salmon scale samples and catches have been apportioned to region of origin. Results from these analyses will be available May, 1986.

ANDREAFSKY RIVER SALMON STUDY

The Andreafsky River (Figure 11) includes two main branches, the East and West Forks, and is located 100 miles upstream from the mouth of the Yukon River. It typically ranks second to the Anvik River in summer chum salmon escapement, second to the Salcha River in chinook salmon escapement, and supports the largest pink salmon population in the Yukon River drainage. Salmon escapements were estimated annually in each fork by aerial survey from fixed wing aircraft prior to 1981. A side-scanning sonar counter was installed in the East Fork for the first time in 1981 to obtain more complete and accurate escapement information than could be obtained by aerial survey.

The mainstem Andreafsky River, below the confluence of the East and West Forks, is not suitable for side-scanning sonar operation due to its width and slack current. 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 historical aerial survey data. In addition, a feasible sonar site could be located lower on the East Fork than on the West Fork, potentially enumerating a greater proportion of the spawners and simplifying logistics. 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

Two 1981 model sonar counters were available, with the same rounded transducer deployment housings as described for the Anvik River study. The 1981 model counters divide the counting range into 16 sectors, unlike the 1978 models used on the Anvik River which have only 12 sectors. Buklis (1983) describes other

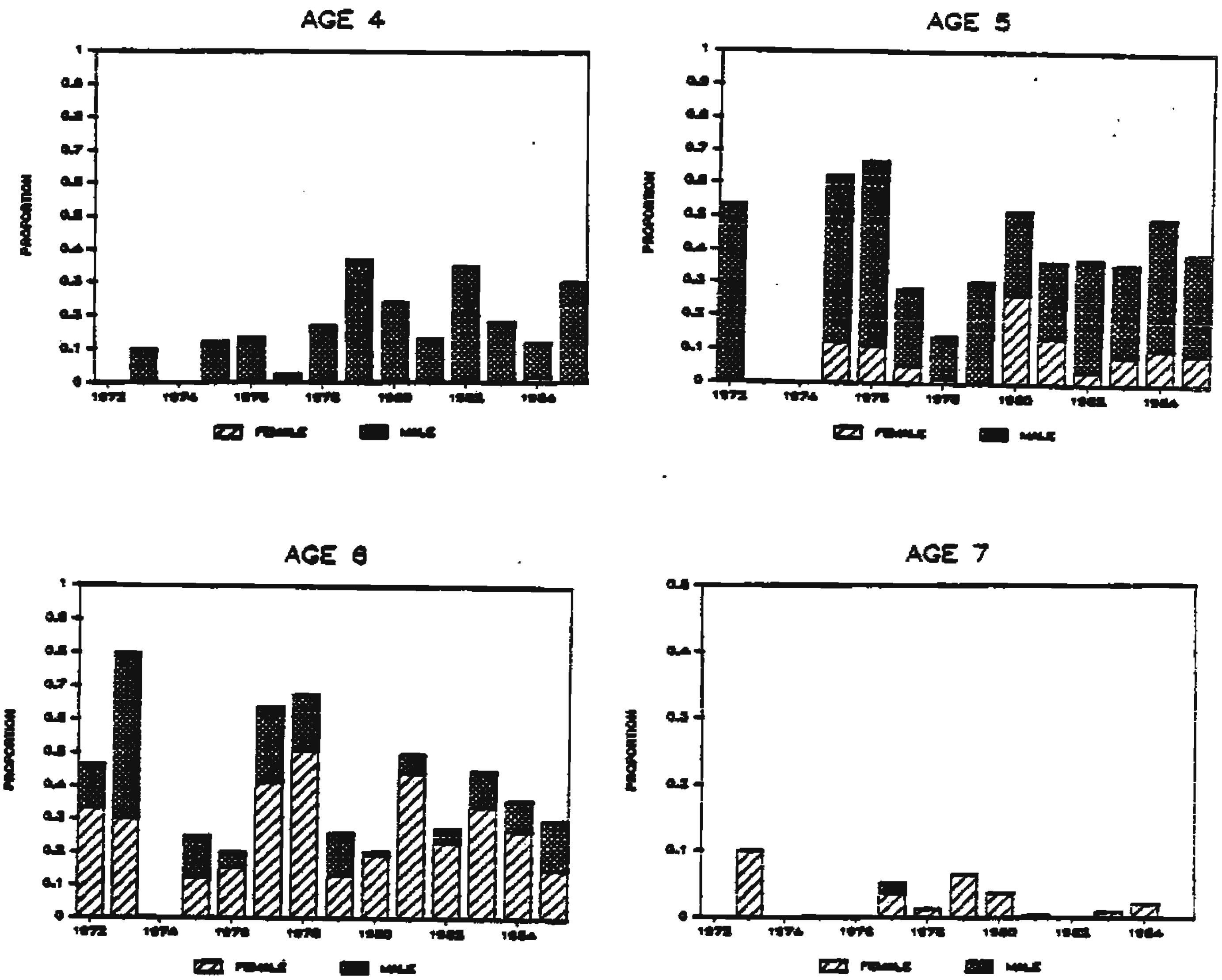

Figure 10. Age and sex composition of Anvik River chinook salmon, 1972-1985, presented as proportion of total sample for each year by age class. Note different scale for age 7.

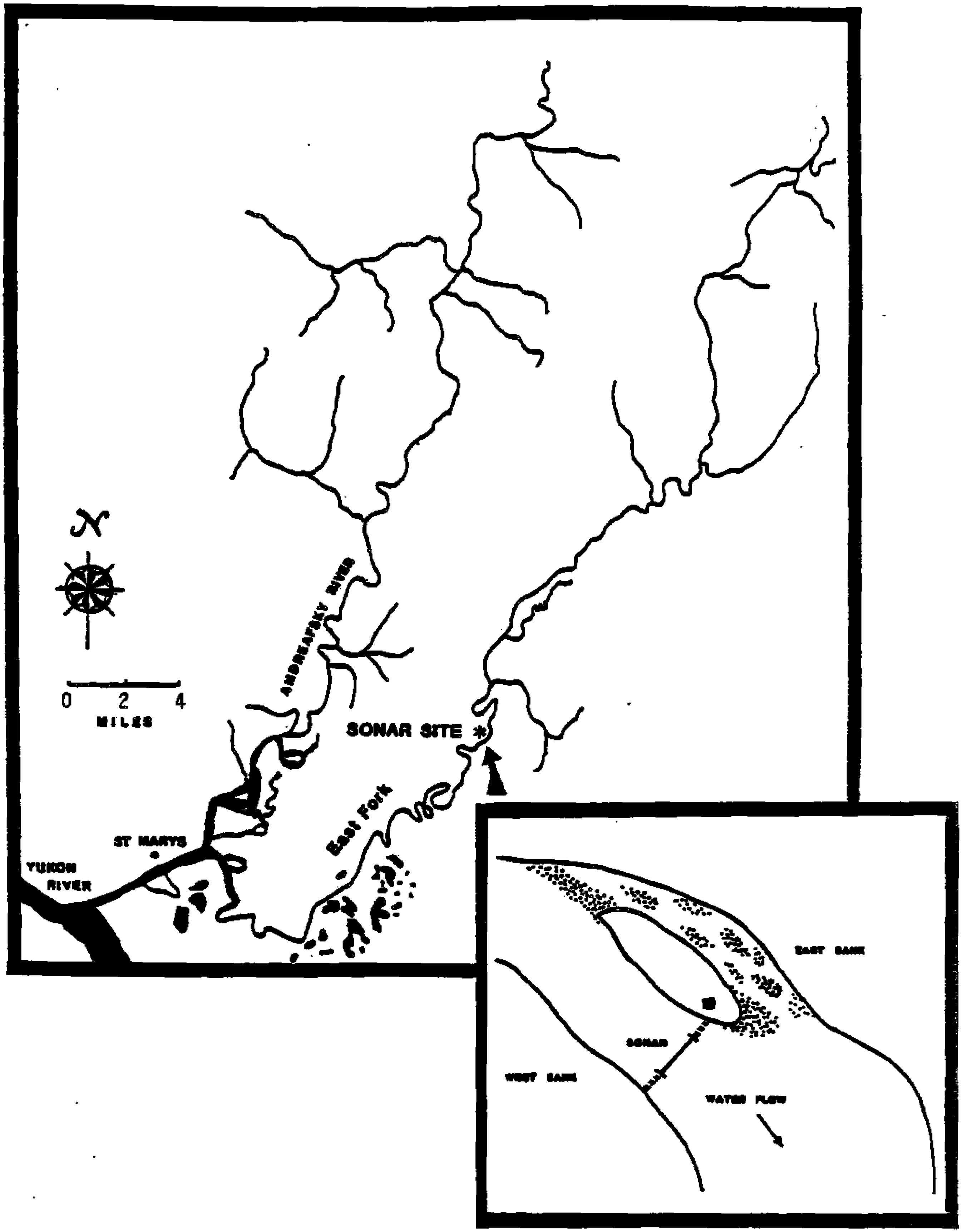

Figure 11. Map of the Andreafsky River, and of the sonar site (inset) located at river mile 20 of the East Fork.

differences between the two sonar counter models in greater detail. This was the first time that the artificial substrate tubes were not used on this river. Weirs were built to prevent inshore salmon passage.

Methods for conducting oscilloscope and visual calibrations of the sonar equipment, compiling sonar counts, measuring stream profile, recording climatological data, and sampling fish for age, sex, and size data were the same as those described previously for the Anvik River study.

Results and Discussion

River water level was higher than had ever been previously observed by project personnel when the crew arrived to begin project operations in 1985. High water was due to late river ice breakup, deep snowpack, and substantial rainfall in late May and early June.

One sonar counter was operated from 26 June through 28 July, at approximately the same site used in previous years at mile 20 of the East Fork Andreafsky River (Figure 11). The transducer was located along the gradually sloping gravel beach of an island, initially 30 ft offshore and at a depth of 2.5 ft. River bottom gradient was smooth, with no obstructions to the sonar beam, and maximum depth was 5 ft as measured on 27 June (Figure 12). The counting range limit of 100 ft prevented insonification of the entire river width, which was approximately 190 ft on 27 June. The second sonar counter could not be installed along the oppposite cutbank due to river depth and bottom contour as well as limitations of the transducer deployment housing. There were no better potential sonar sites within several river miles.

In previous years a single 60 ft aluminum substrate tube has been deployed in midstream at this site, with weirs preventing salmon passage around either end. It was decided this year that the transducer without artificial substrate would be set to the maximum counting range distance of 100 ft, and moved offshore from the gravel island as declining water levels allowed until the entire channel was insonified. Weirs would be built out from either shore as water levels allowed. The channel on the other side of the island is usually not passable to salmon due to many gravel bars, being essentially a backwater of the main channel. For much of this season it remained flooded sufficiently to permit salmon navigation, although the current was slack and salmon passage was thought to be minimal based on limited observations.

River water level declined during the first few days of sonar operation, but then increased rapidly to peak flows on 3 and 8 July, each of which substantially exceeded the initial level

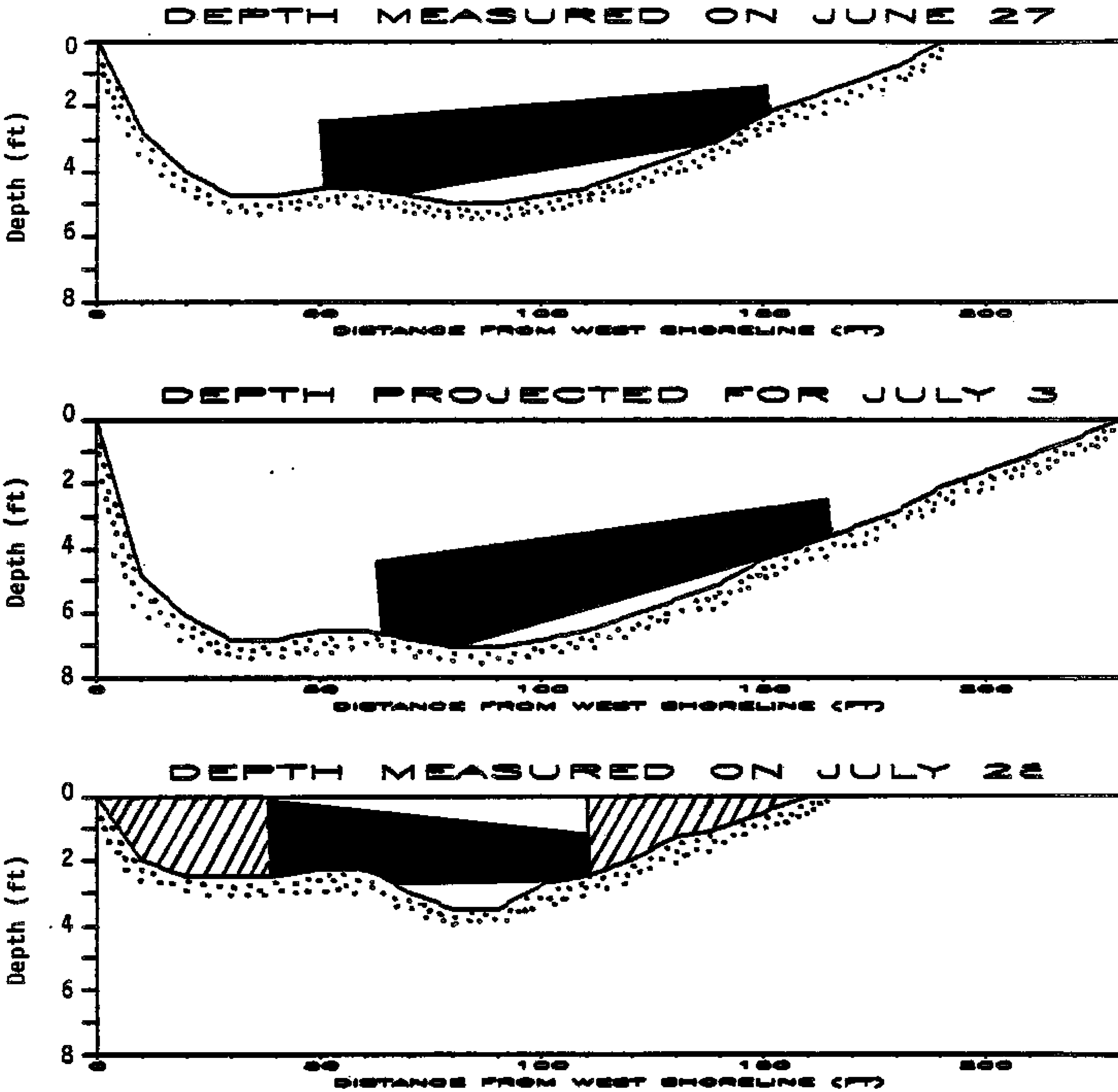

Figure 12. River depth profiles of the East Fork Andreafsky River sonar site as measured on 27 June and 28 July, and projected for 3 July, 1985. Shaded areas show approximate range of insonification, cross-hatching indicates weirs. Unequal scale of the vertical and horizontal axis distorts the presentation. Sonar transducer was actually located 15 ft upriver from the site of these profiles during the period 11-28 July.

(Figure 13). Water temperature ranged from a low of 8 C on 2 July to a high of 18 C on 20 July, while air temperature ranged from a low daily minimum of 2 C on 10 July to a high daily maximum of 30 C on 24 July.

The floods which peaked on 3 and 8 July altered transducer aiming, washed out weirs, and increased the uninsonified area of the river available to salmon passage. The sonar transducer was improperly aimed and unretreivable from 2 through 4 July due to high water. The main channel of the river was estimated to be 230 ft wide, with a maximum depth of 7.1 ft on 3 July (Figure 12). Water levels declined steadily after 8 July, and by termination of sonar enumeration on 28 July had finally reached the low level normally encountered at project start up in mid to late June.

An aerial survey was flown of the East and West Fork Andreafsky River by an experienced observer under fair conditions on 23 July. A total of 66,146 chum salmon and 1,617 chinook salmon was enumerated above the sonar site on the East Fork, and 52,750 chum salmon and 2,248 chinook salmon on the entire West Fork. The East Fork chum salmon count was only 87% of the low end of the aerial survey escapement objective range of 76,000 to 109,000 fish (ADFG 1984). The West Fork chum salmon count was only 85% of the low end of the aerial survey escapement objective range of 62,000 to 116,000 fish. Chinook salmon escapements, however, appeared to be strong, exceeding the upper end of the aerial survey escapement objective range on both the East Fork (1,100 to 1,600) and West Fork (700 to 1,000).

A total of 12,992 salmon was enumerated by sonar from 26 June through 28 July (Table 4), which is only 19% of the combined chum and chinook salmon aerial survey estimate for the East Fork. Sonar accuracy (sonar count/oscilloscope count) averaged 0.84 for 30.76 hours of calibration from 26 June to 28 July (Table 5). However, only 470 salmon traces were seen on the oscilloscope, and only 362 chum and 28 chinook salmon were visually enumerated from counting towers during all calibrations combined. It is apparent that the majority of the salmon were not enumerated by the sonar counter due to passage outside of the hydroacoustic beam. Furthermore, since run timing was probably very late and compressed, as was evident on the Anvik River, the majority of the escapement may have passed the sonar site in a short period of time. Over 38% of the Anvik River escapement passed during the four day period 12-15 July. If a substantial proportion of the Andreafsky River escapement passed during the flooding in early July, it might not have been detected by the sonar electronics due to problems already discussed. Recommendations for improving sonar counting methodology so that the conditions encountered this year can be successfully overcome in the future are presented in the final section of this report (Conclusions and Recommendations).

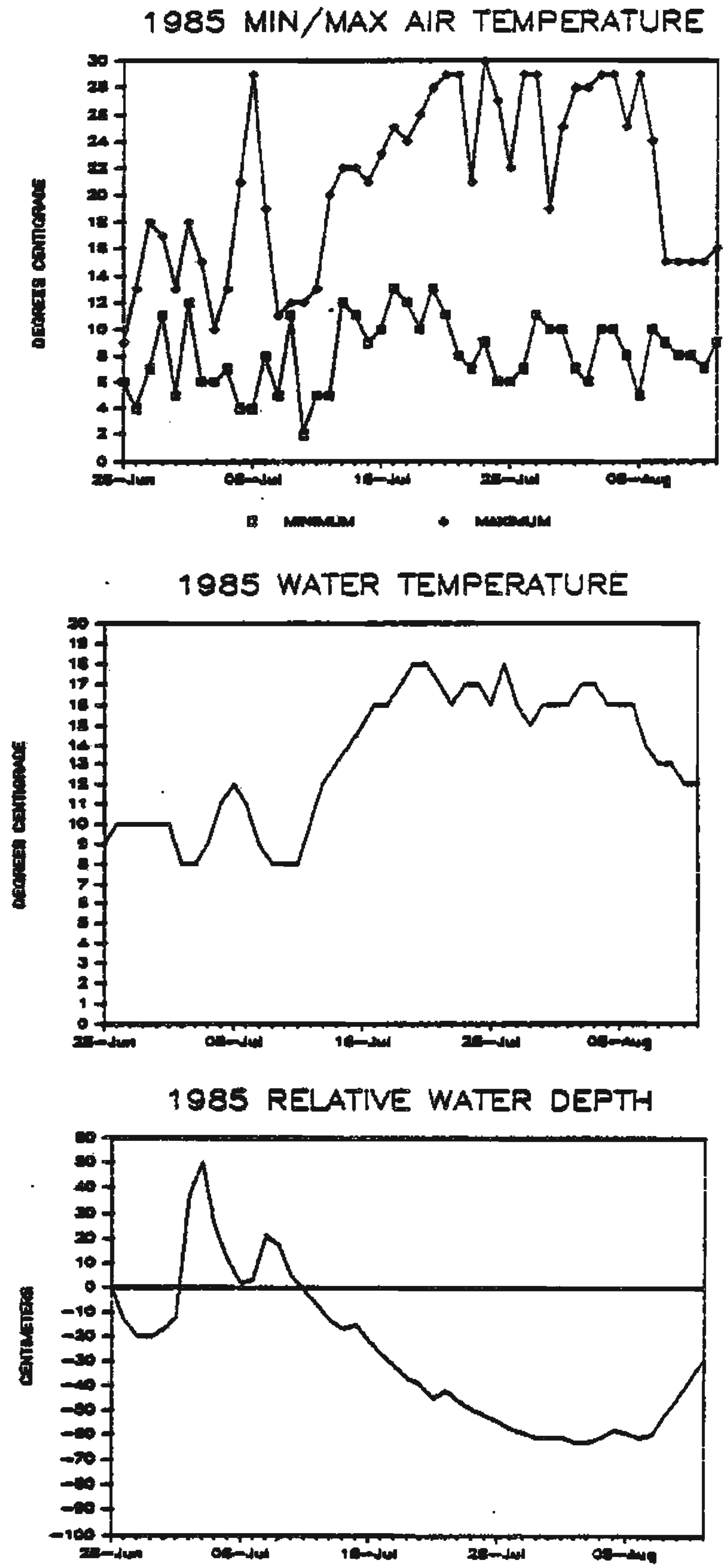

Figure 13. Air temperature (daily minimum and maximum), water temperature, and relative water depth measured at noon daily at the East Fork Andreafsky River sonar site, 1985.

Table 4. East Fork Andreafsky River salmon sonar counts by date, 1985. a

Date	Daily Count	Season Count	Daily Prop	Season Prop
26-Jun	81	81	0.0062	0.0062
27-Jun	64	145	0.0049	0.0111
28-Jun	196	341	0.0151	0.0262
29-Jun	26	367	0.0020	0.0282
30-Jun	24	391	0.0018	0.0301
01-Jul	10	401	0.0008	0.0308
02-Jul	b	401	0.0000	0.0308
03-Jul	b	401	0.0000	0.0308
04-Jul	b	401	0.0000	0.0308
05-Jul	12	413	0.0009	0.0318
06-Jul	40	453	0.0031	0.0348
07-Jul	32	485	0.0025	0.0373
08-Jul	106	591	0.0082	0.0455
09-Jul	26	617	0.0020	0.0475
10-Jul	30	647	0.0023	0.0498
11-Jul	64	711	0.0049	0.0547
12-Jul	172	883	0.0132	0.0679
13-Jul	348	1,231	0.0268	0.0947
14-Jul	297	1,528	0.0229	0.1176
15-Jul	105	1,633	0.0081	0.1257
16-Jul	120	1,753	0.0092	0.1349
17-Jul	746	2,499	0.0574	0.1923
18-Jul	92	2,591	0.0071	0.1994
19-Jul	488	3,079	0.0376	0.2370
20-Jul	1,036	4,115	0.0797	0.3167
21-Jul	1,697	5,812	0.1306	0.4474
22-Jul	2,187	7,999	0.1683	0.6157
23-Jul	524	8,523	0.0403	0.6560
24-Jul	994	9,517	0.0765	0.7325
25-Jul	796	10,313	0.0613	0.7938
26-Jul	706	11,019	0.0543	0.8482
27-Jul	938	11,957	0.0722	0.9204
28-Jul	1,035	12,992	0.0797	1.0000
Totals		12,992		1.0000

a Virtually all sonar counts attributed to summer chum salmon based on limited visual count data (see Table 5).

b High water during the period 2 to 4 July disabled sonar equipment.

Table 5. Oscilloscope and visual calibration of salmon sonar counts at the East Fork Andreafsky River sonar site, 1985.

					Visual Count a								
					Chum			Chinook			Pink		
Date	Hours Count	Sonar Count	Scope Count	Sonar/ Scope	Up	Down	Net	Up	Down	Net	Up	Down	Net
26-Jun	1.00	7	4	1.75	0	0	0	0	0	0	0	0	0
27-Jun	1.00	11	10	1.10	0	0	0	0	0	0	0	0	0
28-Jun	1.00	0	1	0.00	0	0	0	0	0	0	0	0	0
29-Jun	1.00	0	1	0.00	0	0	0	0	0	0	0	0	0
30-Jun	1.00	4	0	0.00	0	0	0	0	0	0	0	0	0
01-Jul	1.00	1	0	0.00	0	0	0	0	0	0	0	0	0
02-Jul	0.00												
03-Jul	0.00												
04-Jul	0.00												
05-Jul	1.00	0	0	0.00	0	0	0	0	0	0	0	0	0
06-Jul	1.00	0	0	0.00	0	0	0	0	0	0	0	0	0
07-Jul	1.00	4	2	2.00	0	0	0	0	0	0	0	0	0
08-Jul	1.00	2	2	1.00	0	0	0	0	0	0	0	0	0
09-Jul	1.00	1	0	0.00	0	0	0	0	0	0	0	0	0
10-Jul	1.00	0	0	0.00	1	0	1	0	0	0	0	0	0
11-Jul	1.00	7	5	1.40	1	0	1	0	0	0	0	0	0
12-Jul	0.50	5	6	0.83	46	1	45	0	0	0	0	0	0
13-Jul	0.50	7	16	0.44	36	0	36	0	0	0	0	0	0
14-Jul	1.00	11	38	0.29	58	2	56	0	0	0	0	0	0
15-Jul	1.00	3	46	0.07	6	0	6	0	0	0	0	0	0
16-Jul	1.00	1	19	0.05	45	0	45	1	0	1	1	0	1
17-Jul	1.17	26	43	0.60	36	0	36	1	0	1	0	0	0
18-Jul	1.00	8	21	0.38	30	0	30	6	0	6	1	0	1
19-Jul	1.42	87	53	1.64	31	0	31	11	0	11	0	0	0
20-Jul	1.00	22	25	0.88	14	0	14	6	0	6	0	0	0
21-Jul	2.00	44	67	0.66	28	0	28	1	0	1	5	0	5
22-Jul	1.00	88	44	2.00	4	0	4	0	0	0	1	0	1
23-Jul	1.25	19	24	0.79	11	2	9	0	0	0	4	0	4
24-Jul	0.92	11	10	1.10	10	2	8	0	0	0	0	0	0
25-Jul	1.00	5	4	1.25	0	1	(1)	0	0	0	0	0	0
26-Jul	1.00	16	21	0.76	10	1	9	2	0	2	4	0	4
27-Jul	1.00	1	2	0.50	6	1	5	0	0	0	0	0	0
28-Jul	1.00	6	6	1.00	0	1	(1)	0	0	0	1	0	1
Totals	30.76	397	470	0.84	373	11	362	28	0	28	17	0	17

a Counting towers were located on both the east and west bank. Water clarity was generally poor, especially during the first half of the season. Visual counts were often obtainable for only a small portion of the river width, or not at all. Counts listed are for salmon moving across the sonar site, whether within or beyond the sonar counting range. Before the west bank weir was installed on 7/20, salmon moving along the west bank might be visually enumerated, but not counted by the sonar electronics or seen on the oscilloscope.

The best estimate of total season escapement for the East Fork Andreafsky River in 1985 is the aerial survey count of 66,146 summer chum salmon. The 1985 aerial survey estimate is only 62% of the 1972-1980 average aerial survey escapement estimate of 106,924 summer chum salmon, and 52% of the 1981-1984 average sonar escapement estimate of 127,349 fish (Figure 14). This is the second consecutive year in which summer chum salmon escapement to the East Fork Andreafsky River has been poor while escapement objectives have been exceeded by twofold in the Anvik River. Clearly there is a need to regulate harvest exploitation on a more stock specific basis to optimize sustainable yield from each contributing stock.

Sonar counts of salmon passage were very low from 26 June through 18 July, averaging only 130 salmon per day (Figure 15). Water clarity was poor due to muddy runoff, making it impossible to visually calibrate sonar counts or document salmon passage beyond the sonar counting range. The crew conducted daily boat surveys of the five river miles immediately upstream of the sonar site during this period, but few salmon were seen even when and where water clarity was good. Aerial survey conditions were generally poor, and only small numbers of fish were observed on informal fly overs during this period. Beach seining was difficult due to the high water, and few salmon were captured. Run timing is usually similar between the Anvik and Andreafsky River escapements. Significant numbers of chum salmon were present at the Anvik River site by 5 July. While there was concern that salmon may have been passing the Andreafsky River site undetected by the sonar counter, the presence of substantial numbers of salmon could not be confirmed until late July.

Declining water levels permitted weiring of the cut bank side of the channel on 19 July, resulting in transducer deployment and counting range similar to that used in previous years. Sonar counts during the period 19 through 28 July were substantially greater, averaging 1,040 salmon per day. The increase in salmon sonar counts after 19 July was not due to chum salmon escapement just beginning to build, but rather to the fact that the sonar electronics were more accurately counting salmon passage during the tail end of the run. Mean date of passage based on sonar counts was 21 July.

Temporal and spatial distribution of sonar counts are best analyzed by stratification of the season into early (26 June-10 July), middle (11-19 July), and late (20-28 July) components. The early strata was the period of high water with two floods, the middle strata the period of declining water levels, and the late strata the period most resembling previous studies, in which the entire channel open to salmon passage was insonified.

Temporal distribution of sonar counts by hour demonstrated a diel pattern only for the last strata (Figure 16). Counts were lowest

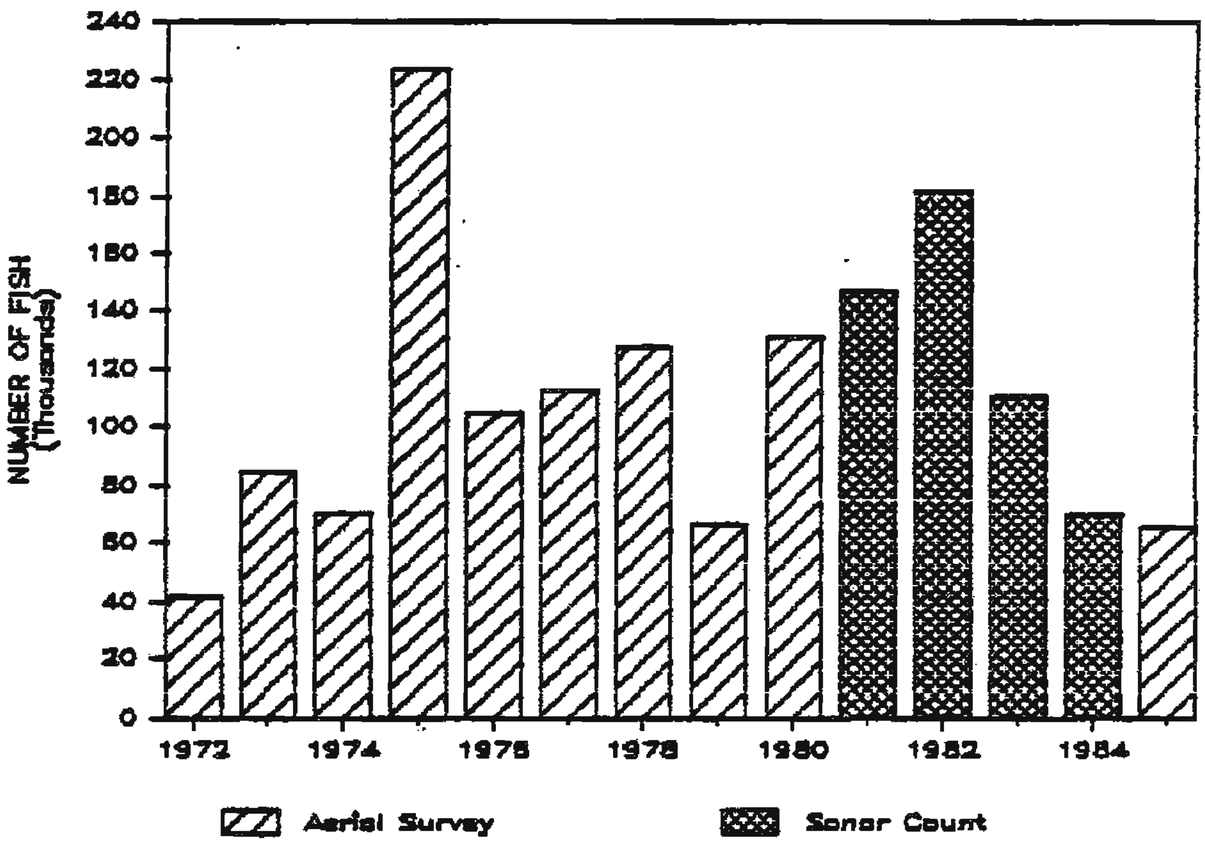

Figure 14. East Fork Andreafsky River summer chum salmon escapement as estimated by aerial survey, 1972-1980 and 1985, and by side-scanning sonar, 1981-1984.

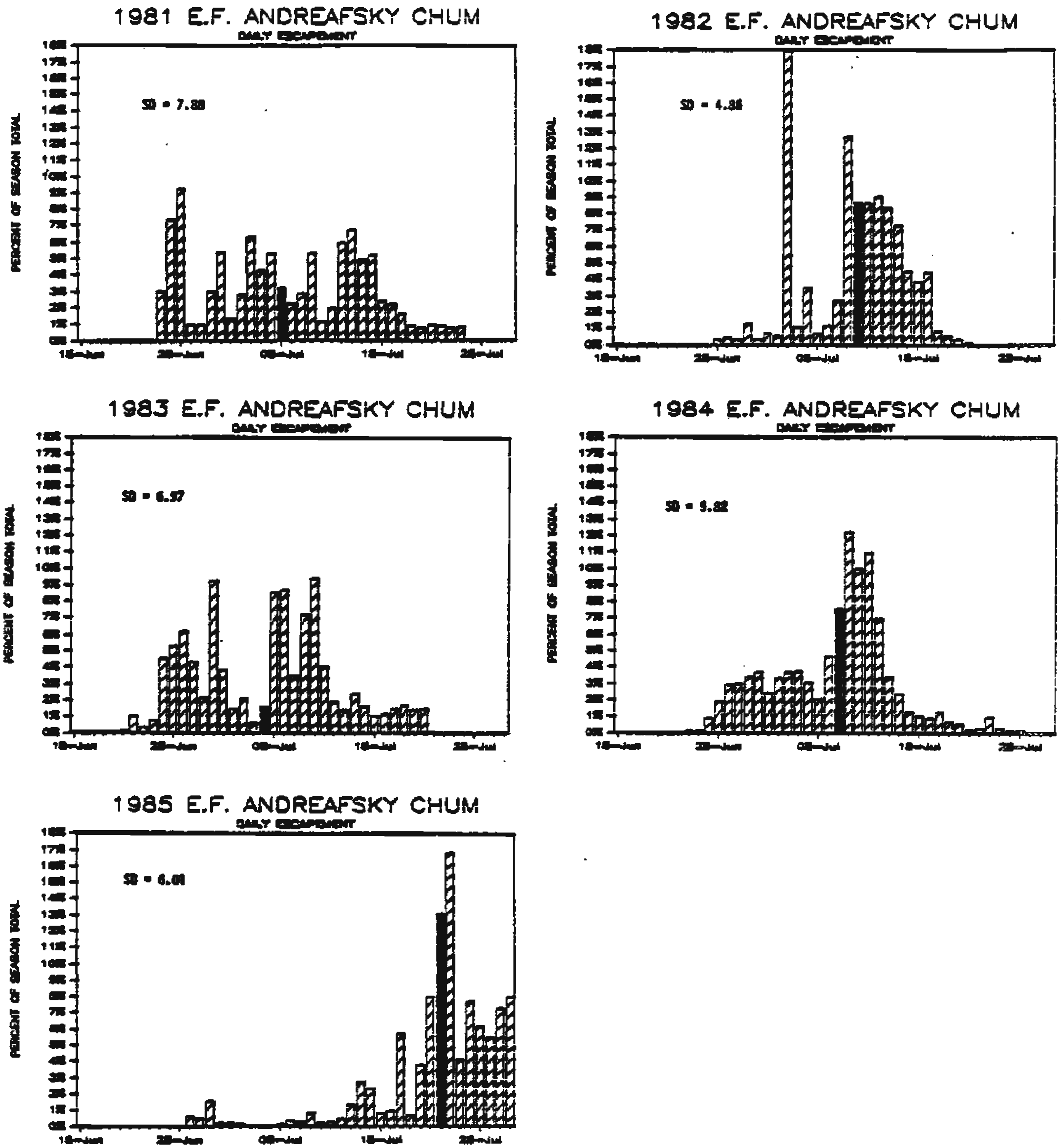

Figure 15. East Fork Andreafsky River summer chum salmon sonar counts by day, 1981-1985. Mean date of run passage (calculated with Day 1=16 June) is indicated by shaded bar, and standard deviation (SD) of the mean is given.

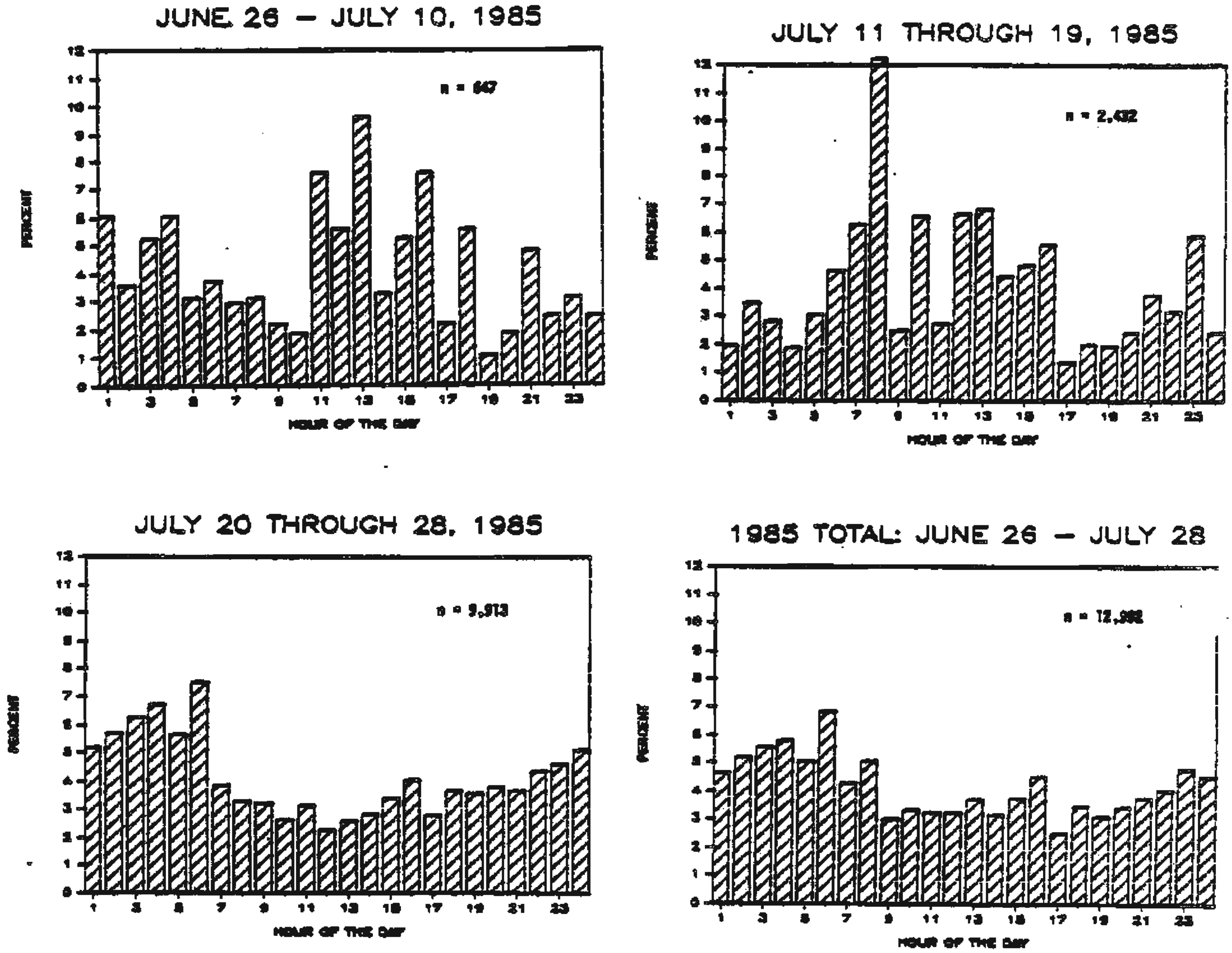

Figure 16. East Fork Andreafsky River salmon sonar counts by hour of the day for the early (26 June-10 July), middle (11-19 July), and late (20-28 July) portion of the season, and for the entire 1985 season combined. Total sonar counts (n) used for this analysis are given for each period. A weir on the west bank blocked salmon passage beyond the sonar counting range only during the period 20-28 July.

during 1200-1300 (2.2% of daily total) and greatest during 0500-0600 (7.6% of daily total). Spatial distribution of sonar counts by sector indicates that substantial numbers of salmon were probably moving upstream beyond the sonar counting range during the early and middle season strata, when there was no weir on the cutbank side of the channel (Figure 17). The last three offshore sectors accounted for 43% of all sonar counts during the early strata, and 32% during the middle strata. Sector distribution of sonar counts during the late season strata, when weirs were in place on both sides of the channel, was more typical of the distribution observed in previous years at this site.

Forty-six beach seine sets were made from 8 to 24 July, and a total of only 32 chum salmon, 19 chinook salmon, and 6 pink salmon was captured (Appendix Table 4). An additional 561 chum salmon and 519 chinook salmon were sampled by carcass survey (374 of the chinook salmon carcasses were sampled from the West Fork). To provide some perspective on how ineffective beach seining was in 1985, 35 sets were made in 1983 and 1,029 chum salmon, 113 chinook salmon, and 93 pink salmon were captured (Buklis 1984).

Of the 593 chum salmon sampled for age-sex-size data, 566 (95%) later proved to have ageable scales. Age composition was 72% age 4, 26% age 5, 2% age 3, and less than 1% age 6 (Appendix Table 5). Females accounted for 58% of the sample. Age 4 accounted for the majority of samples in 1982, 1984, and 1985, while age 5 was predominant in 1981 and 1983 (Figure 18). Age and sex composition of the Andreafsky River escapement in 1985 was similar to that of the Anvik River.

Of the 538 chinook salmon sampled for age-sex-size data, 443 (82%) later proved to have ageable scales. Age composition was 44% age 6, 40% age 4, 13% age 5, and 4% age 7 (Appendix Table 6). Females accounted for 33% of the sample. Ages 4 and 7 accounted for a relatively greater proportion of the sample in 1985, and age 5 a relatively smaller proportion, than for any year since sampling was initiated in 1981 (Figure 19). The female component was the strongest since the 1981 escapement, which was 48% female. Andreafsky River chinook salmon production from the 1985 brood year is expected to be good given escapement greater than objectives and the second best female contribution documented for this system to date.

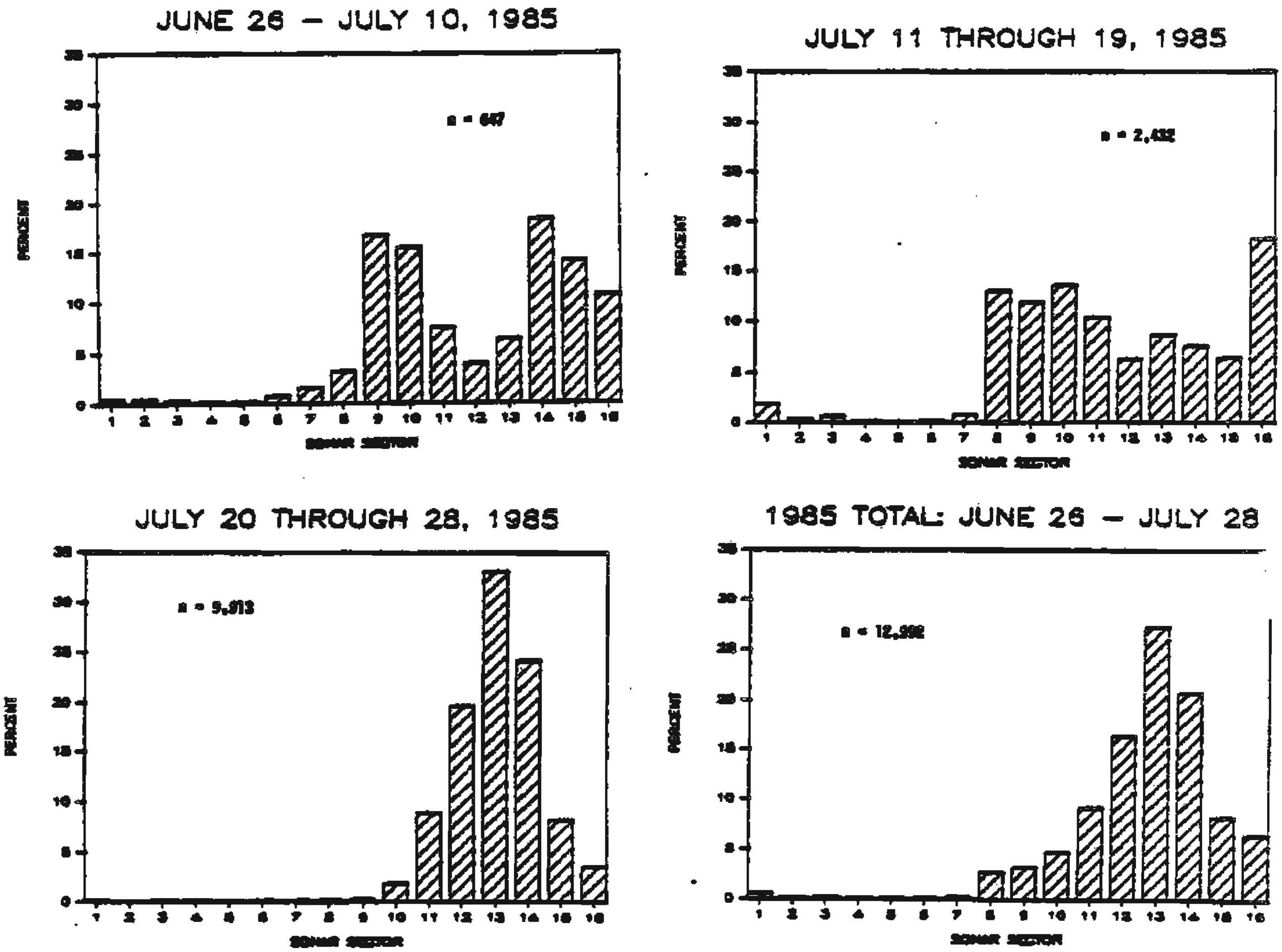

Figure 17. East Fork Andreafsky River salmon sonar counts by sonar sector for the early (26 June-10 July), middle (11-19 July), and late (20-28 July) portion of the season, and for the entire 1985 season combined. Total sonar counts (n) used for this analysis are given for each period. A weir on the west bank blocked salmon passage beyond the sonar counting range only during the period 20-28 July.

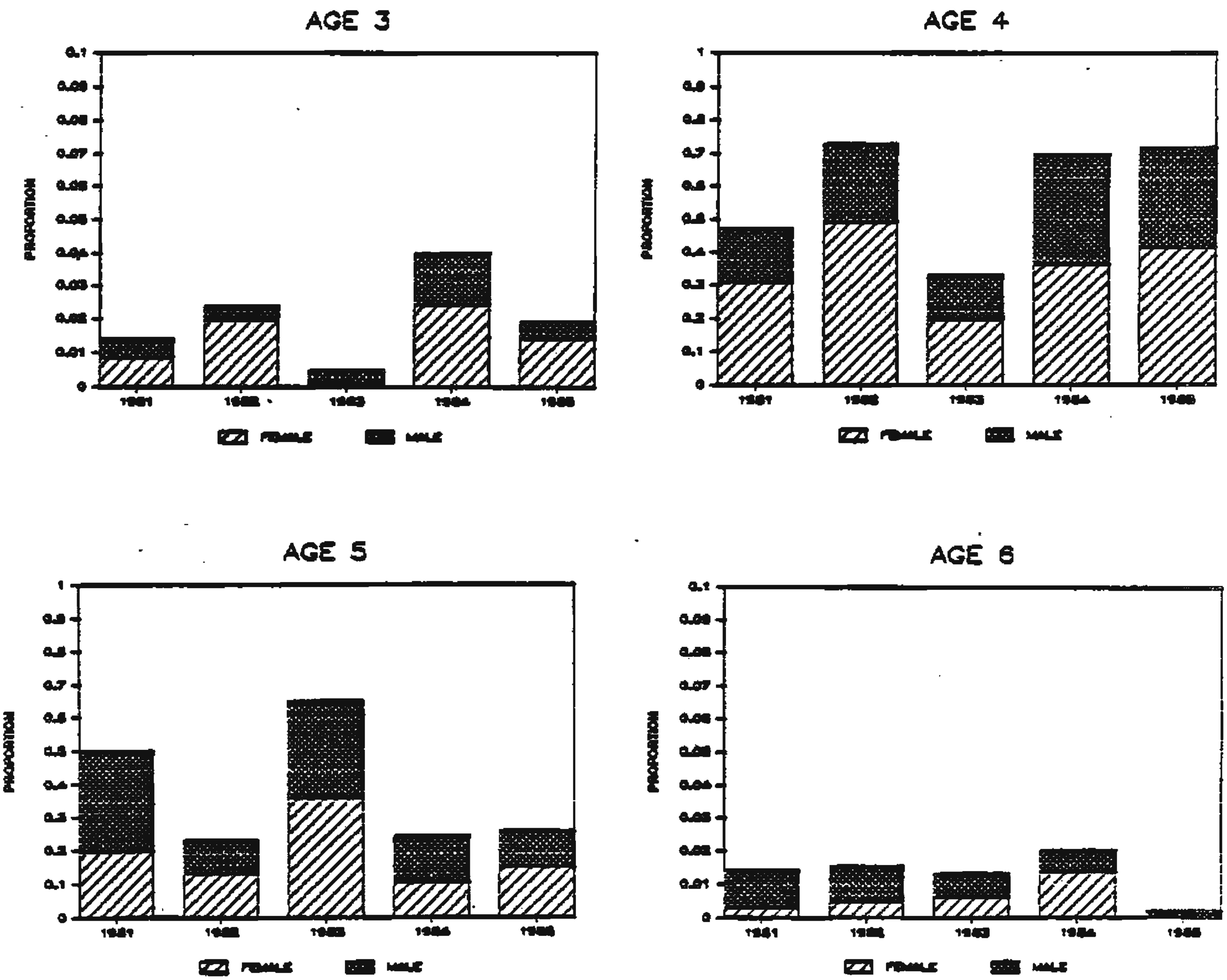

Figure 18. Age and sex composition of East Fork Andreafsky River summer chum salmon, 1981-1985, presented as proportion of total sample for each year by age class. Note different scale for ages 3 and 6.

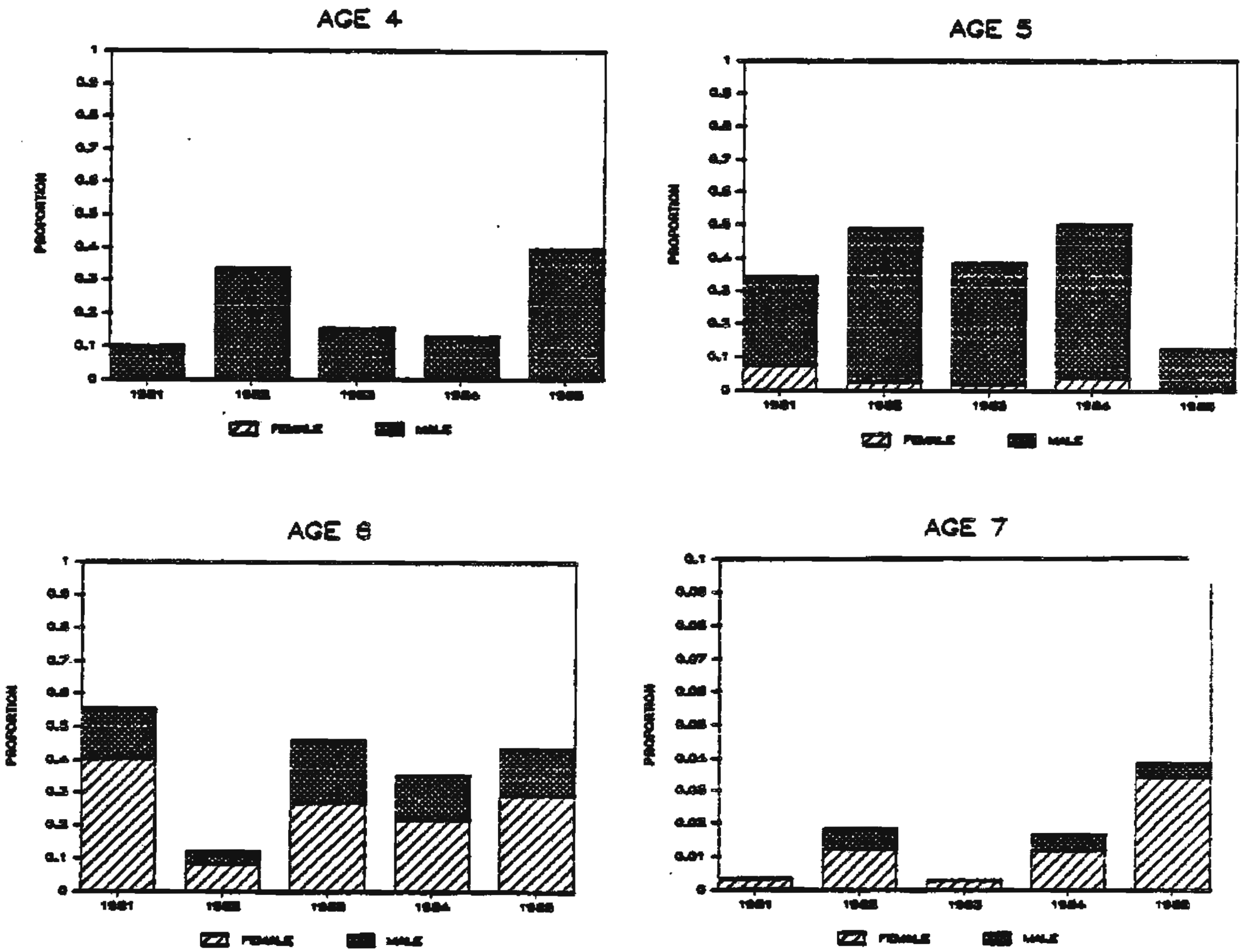

Figure 19. Age and sex composition of Andreafsky River chinook salmon, 1981-1985, presented as proportion of total sample for each year by age class. Note different scale for age 7.

CONCLUSIONS AND RECOMMENDATIONS

Escapement to the Anvik River was estimated by side-scanning sonar to be 1,080,243 summer chum salmon in 1985, which is 2.2 times greater than the sonar count escapement objective of 487,000 fish. The aerial survey index count of only 66,146 summer chum salmon for the East Fork Andreafsky River, however, was only 87% of the lower end of the aerial survey escapement objective range of 76,000 to 109,000 fish. This was the second consecutive year in which summer chum salmon escapement was relatively poor to the East Fork Andreafsky River, while Anvik River escapement objectives were exceeded by twofold.

Chinook and summer chum salmon run timing was very late in 1985 for the second consecutive year, with a consequently late changeover to chum salmon gear in the lower Yukon River commercial gillnet fishery. There is no stock identification data available for the Yukon River summer chum salmon fisheries, so that stock specific run timing through these fisheries is not known. However, if the Anvik River stock does move through the lower river districts relatively early, it may support only a moderate exploitation rate during the large mesh chinook salmon season. Conversely, if the East Fork Andreafsky River stock enters the Yukon River relatively late, it may sustain a significantly higher exploitation rate in the targeted chum salmon fishery.

Commercial fishery management regulation should attempt to distribute harvest of summer chum salmon in the lower river districts throughout the entire run, such that contributing stocks bear a more uniform exploitation rate. Secondly, research is required to gain a better understanding of stock specific run timing of summer chum salmon in the lower Yukon River fisheries, in order to optimize harvest of each stock for maximum sustainable yield. Without this information, commercial exploitation will need to be managed on a conservative basis such that escapement objectives are met for the weakest contributing stock.

Chinook salmon escapements to the East and West Fork Andreafsky River and to the Anvik River exceeded escapement objectives. Sex composition of escapement samples indicated the strongest female component for the Andreafsky River, which is dominated by males, since 1981. Too few samples were collected from the Anvik River to draw any significant conclusions for that system.

Side-scanning sonar counters were operated at both the Anvik and East Fork Andreafsky Rivers without artificial substrates for the first time in 1985. Problems previously encountered with fish milling in the sonar beam and generating multiple counts, or swimming along the artificial tube and going around the offshore end were successfully avoided. Correction factors for false counts and expansion factors for fish not counted beyond the offshore end of the artificial substrates were not neccessary. However, problems were encountered in attempting to use the inshore end piece from the artificial substrates to deploy the transducers. The housings were not stable, especially in conditions of rising water levels. Secondly, they could not be deployed in deep water since aiming required fine adjustments underwater at the river bottom, where the transducer housing rested. These limitations caused problems at both sites, but especially at the Andreafsky River, where only a portion of the river could be insonified, and the majority of the salmon passed undetected.

A new method of deploying the transducers is recommended for use in 1986. Each transducer should be mounted on a flat, square steel plate, using the springs and knurled knobs used previously with the artificial substrates. There should only be about 1 in between the bottom of the transducer face and the bottom edge of the square plate, so that when deployed the transducer face can rest very close to the river bottom, if neccessary. A round metal sleeve on each side of the plate will allow the assembly to be lowered down two metal conduits driven into the river bottom. A rope tied to a bracket mounted to the top edge of the plate will permit deployment of the transducer assembly at any point in the water column between the river bottom and surface in any depth of water (providing that conduits are of suitable length). Fine adjustments to transducer aiming can be accomplished by raising the transducer to the surface, adjusting the knurled knobs, and lowering the assembly back down to the deployment depth desired (usually the river bottom). Had this equipment been available for the 1985 field season, two transducers could have been deployed on the East Fork Andreafsky River and the entire channel insonified. Adjustments to transducer aiming could have been accompished during floods providing conduits of suitable length were used.

Since the East Fork Andreafsky River study was initiated in 1981, accuracy of sonar estimates of summer chum salmon escapement have been affected by large pink salmon escapements in 1982 and 1984, and by very high water conditions in 1985. The use of the new transducer deployment assembly should overcome the problem of high water conditions. However, a large pink salmon escapement is expected for the Andreafsky River in 1986. It is recommended that a contingency enumeration method be made ready for 1986 and all subsequent years in which large pink salmon runs are anticipated. Escapement should be enumerated visually from counting towers if water conditions are suitable. If the water is too deep and/or turbid to permit visual enumeration, the side-scanning sonar counters should be installed using the new transducer deployment assemblies. Since pink salmon enter the river during the later half of the chum and chinook salmon migration, water conditions may improve and permit changeover to a tower counting operation before pink salmon pose a significant problem.

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Appendix Table 1. Anvik River salmon beach seine catch by species, sex, and date, 1985. a

Date	Number Of Sets	Chum			Chinook			Pink		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
05-Jul	3	28	15	43						
06-Jul										
07-Jul										
08-Jul										
09-Jul										
10-Jul										
11-Jul	3	30	45	75						
12-Jul	2	18	42	60				1	0	1
13-Jul										
14-Jul	3	32	87	119				1	0	1
15-Jul										
16-Jul	2	34	30	64						
17-Jul	1	27	15	42						
18-Jul	2	17	22	39						
19-Jul	2	21	27	48				0	1	1
20-Jul	2	21	13	34						
21-Jul	1	14	17	31						
22-Jul	1	18	14	32						
23-Jul	1	7	8	15						
24-Jul	1	7	9	16	0	1	1			
25-Jul	1	1	5	6						
26-Jul	2	0	4	4						
27-Jul	2	2	4	6						
28-Jul	2	1	2	3						
Totals	31	278	359	637	0	1	1	2	1	3

a All beach seining was conducted at a site on the west bank approximately 300 meters upstream from the sonar site. Not included in the catch totals are 17 chums that escaped from the seine before being placed in the holding pen.

Appendix Table 2. Age and sex composition of Anvik River summer chum salmon escapement samples, 1972-1985. a

NUMBERS OF FISH

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 31 MALE	AGE 31 FEMALE	AGE 31 TOTAL	AGE 41 MALE	AGE 41 FEMALE	AGE 41 TOTAL	AGE 51 MALE	AGE 51 FEMALE	AGE 51 TOTAL	AGE 61 MALE	AGE 61 FEMALE	AGE 61 TOTAL
1972	167	153	320	0	0	0	25	37	62	138	115	253	4	1	5
1973	265	518	783	11	37	48	204	401	605	49	79	128	1	1	2
1974	245	157	402	12	24	36	197	120	317	34	12	46	2	1	3
1975	270	314	584	4	17	21	253	288	541	13	9	22	0	0	0
1976	281	320	601	5	4	9	43	35	78	233	281	514	0	0	0
1977	191	398	589	20	111	131	161	270	431	7	15	22	3	2	5
1978	289	263	552	0	1	1	210	180	390	79	82	161	0	0	0
1979	273	306	579	2	12	14	154	193	347	115	99	214	2	2	4
1980	167	258	425	0	1	1	147	226	373	20	31	51	0	0	0
1981	151	182	333	0	0	0	49	67	116	99	115	214	3	0	3
1982	117	265	382	4	17	21	75	181	256	37	65	102	1	2	3
1983	183	238	421	0	4	4	99	142	241	83	90	173	1	2	3
1984	138	215	353	2	6	8	117	189	306	19	20	39	0	0	0
1985	233	294	527	0	11	11	172	225	397	59	58	117	2	0	2

PERCENT OF TOTAL SAMPLE b

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 31 MALE	AGE 31 FEMALE	AGE 31 TOTAL	AGE 41 MALE	AGE 41 FEMALE	AGE 41 TOTAL	AGE 51 MALE	AGE 51 FEMALE	AGE 51 TOTAL	AGE 61 MALE	AGE 61 FEMALE	AGE 61 TOTAL
1972	52.19%	47.81%	100.00%	0.00%	0.00%	0.00%	7.81%	11.56%	19.38%	43.13%	35.94%	79.06%	1.25%	0.31%	1.56%
1973	33.84%	66.16%	100.00%	1.40%	4.73%	6.13%	26.05%	51.21%	77.27%	6.26%	10.09%	16.35%	0.13%	0.13%	0.26%
1974	60.95%	39.05%	100.00%	2.99%	5.97%	8.96%	49.00%	29.85%	78.86%	8.46%	2.99%	11.44%	0.50%	0.25%	0.75%
1975	46.23%	53.77%	100.00%	0.68%	2.91%	3.60%	43.32%	49.32%	92.64%	2.23%	1.54%	3.77%	0.00%	0.00%	0.00%
1976	46.76%	53.24%	100.00%	0.83%	0.67%	1.50%	7.15%	5.82%	12.98%	38.77%	46.76%	85.52%	0.00%	0.00%	0.00%
1977	32.43%	67.57%	100.00%	3.40%	18.85%	22.24%	27.33%	45.84%	73.17%	1.19%	2.55%	3.74%	0.51%	0.34%	0.85%
1978	52.36%	47.64%	100.00%	0.00%	0.18%	0.18%	38.04%	32.61%	70.65%	14.31%	14.86%	29.17%	0.00%	0.00%	0.00%
1979	47.15%	52.85%	100.00%	0.35%	2.07%	2.42%	26.60%	33.33%	59.93%	19.86%	17.10%	36.96%	0.35%	0.35%	0.69%
1980	39.29%	60.71%	100.00%	0.00%	0.24%	0.24%	34.59%	53.18%	87.76%	4.71%	7.29%	12.00%	0.00%	0.00%	0.00%
1981	45.35%	54.65%	100.00%	0.00%	0.00%	0.00%	14.71%	20.12%	34.83%	29.73%	34.53%	64.26%	0.90%	0.00%	0.90%
1982	30.63%	69.37%	100.00%	1.05%	4.45%	5.50%	19.63%	47.38%	67.02%	9.69%	17.02%	26.70%	0.26%	0.52%	0.79%
1983	43.47%	56.53%	100.00%	0.00%	0.95%	0.95%	23.52%	33.73%	57.24%	19.71%	21.38%	41.09%	0.24%	0.48%	0.71%
1984	39.09%	60.91%	100.00%	0.57%	1.70%	2.27%	33.14%	53.54%	86.69%	5.38%	5.67%	11.05%	0.00%	0.00%	0.00%
1985	44.21%	55.79%	100.00%	0.00%	2.09%	2.09%	32.64%	42.69%	75.33%	11.20%	11.01%	22.20%	0.38%	0.00%	0.38%

a Samples collected by carcass survey 1972-1981, by beach seine 1983-1985, and by both methods combined in 1982.
b Sample percentages not weighted by time period or escapement counts.

Appendix Table 3. Age and sex composition of Anvik River chinook salmon escapement samples, 1972-1985. a

NUMBERS OF FISH

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 4 MALE	AGE 4 FEMALE	AGE 4 TOTAL	AGE 5 MALE	AGE 5 FEMALE	AGE 5 TOTAL	AGE 6 MALE	AGE 6 FEMALE	AGE 6 TOTAL	AGE 7 MALE	AGE 7 FEMALE	AGE 7 TOTAL
1972	10	5	15	0	0	0	8	0	8	2	5	7	0	0	0
1973	6	4	10	1	0	1	0	0	0	5	3	8	0	1	1
1974	NO SAMPLES COLLECTED														
1975	6	2	8	1	0	1	4	1	5	1	1	2	0	0	0
1976	33	12	45	6	0	6	25	5	30	2	7	9	0	0	0
1977	58	59	117	2	1	3	27	6	33	27	48	75	2	4	6
1978	36	41	77	13	0	13	10	1	11	13	39	52	0	1	1
1979	37	9	46	17	0	17	14	0	14	6	6	12	0	3	3
1980	41	42	83	19	1	20	21	22	43	1	16	17	0	3	3
1981	109	154	263	33	1	34	61	36	97	15	116	131	0	1	1
1982	100	38	138	47	1	48	47	5	52	6	32	38	0	0	0
1983	173	133	306	56 b	0	56	84	26	110	33	104	137	0	3	3
1984	162	114	276	29	4	33	108	30	138	25	74	99	0	6	6
1985	25	8	33	10	0	10	10	3	13	5	5	10	0	0	0

PERCENT OF TOTAL SAMPLE c

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 4 MALE	AGE 4 FEMALE	AGE 4 TOTAL	AGE 5 MALE	AGE 5 FEMALE	AGE 5 TOTAL	AGE 6 MALE	AGE 6 FEMALE	AGE 6 TOTAL	AGE 7 MALE	AGE 7 FEMALE	AGE 7 TOTAL
1972	66.67%	33.33%	100.00%	0.00%	0.00%	0.00%	53.33%	0.00%	53.33%	13.33%	33.33%	46.67%	0.00%	0.00%	0.00%
1973	60.00%	40.00%	100.00%	10.00%	0.00%	10.00%	0.00%	0.00%	0.00%	50.00%	30.00%	80.00%	0.00%	10.00%	10.00%
1974	NO SAMPLES COLLECTED														
1975	75.00%	25.00%	100.00%	12.50%	0.00%	12.50%	50.00%	12.50%	62.50%	12.50%	12.50%	25.00%	0.00%	0.00%	0.00%
1976	73.33%	26.67%	100.00%	13.33%	0.00%	13.33%	55.56%	11.11%	66.67%	4.44%	15.56%	20.00%	0.00%	0.00%	0.00%
1977	49.57%	50.43%	100.00%	1.71%	0.85%	2.56%	23.08%	5.13%	28.21%	23.08%	41.03%	64.10%	1.71%	3.42%	5.13%
1978	46.75%	53.25%	100.00%	16.88%	0.00%	16.88%	12.99%	1.30%	14.29%	16.88%	50.65%	67.53%	0.00%	1.30%	1.30%
1979	80.43%	19.57%	100.00%	36.96%	0.00%	36.96%	30.43%	0.00%	30.43%	13.04%	13.04%	26.09%	0.00%	6.52%	6.52%
1980	49.40%	50.60%	100.00%	22.89%	1.20%	24.10%	25.30%	26.51%	51.81%	1.20%	19.28%	20.48%	0.00%	3.61%	3.61%
1981	41.44%	58.56%	100.00%	12.55%	0.38%	12.93%	23.19%	13.69%	36.88%	5.70%	44.11%	49.81%	0.00%	0.38%	0.38%
1982	72.46%	27.54%	100.00%	34.06%	0.72%	34.78%	34.06%	3.62%	37.68%	4.35%	23.19%	27.54%	0.00%	0.00%	0.00%
1983	56.54%	43.46%	100.00%	18.30%	0.00%	18.30%	27.45%	8.50%	35.95%	10.78%	33.99%	44.77%	0.00%	0.98%	0.98%
1984	58.70%	41.30%	100.00%	10.51%	1.45%	11.96%	39.13%	10.87%	50.00%	9.06%	26.81%	35.87%	0.00%	2.17%	2.17%
1985	75.76%	24.24%	100.00%	30.30%	0.00%	30.30%	30.30%	9.09%	39.39%	15.15%	15.15%	30.30%	0.00%	0.00%	0.00%

a Samples collected by carcass survey each year, with a very few fish also taken by beach seine or hook and line in some years.

b Includes one age 3 male.

c Sample percentages not weighted by time period or escapement counts.

Appendix Table 4. East Fork Andreafsky River salmon beach seine catch by species, sex, and date, 1985. a

Date	Number Of Sets	Chum Male	Chum Female	Chum Total	Chinook Male	Chinook Female	Chinook Total	Pink Male	Pink Female	Pink Total
08-Jul	3									
09-Jul	1									
10-Jul										
11-Jul	2	1	0	1						
12-Jul	2									
13-Jul										
14-Jul										
15-Jul	2									
16-Jul	1									
17-Jul	2									
18-Jul	9	7	12	19	3	5	8			
19-Jul	4	3	2	5	1	1	2			
20-Jul	4	0	3	3	1	2	3			
21-Jul	3	0	1	1	1	0	1	2	1	3
22-Jul	3	1	0	1	2	0	2	1	2	3
23-Jul	5	0	1	1	1	0	1			
24-Jul	5	0	1	1	2	0	2			
Totals	46	12	20	32	11	8	19	3	3	6

a Beach seining was conducted at several locations within 1/4 mile of the sonar site from 7/8 to 7/16, and at a site about 1/2 mile above the sonar site from 7/17 to 7/24. Not included in the catch totals are 3 chums and 1 chinook that escaped from the seine before being placed in the holding pen.

Appendix Table 5. Age and sex composition of East Fork Andreafsky River summer chum salmon escapement samples, 1981-1985. a

NUMBERS OF FISH

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 31 MALE	AGE 31 FEMALE	AGE 31 TOTAL	AGE 41 MALE	AGE 41 FEMALE	AGE 41 TOTAL	AGE 51 MALE	AGE 51 FEMALE	AGE 51 TOTAL	AGE 61 MALE	AGE 61 FEMALE	AGE 61 TOTAL
1981	170	181	351	2	3	5	58	108	166	106	69	175	4	1	5
1982	161	295	456	2	9	11	108	224	332	46	60	106	5	2	7
1983	366	468	834	3	1	4	114	164	278	243	298	541	6	5	11
1984	222	229	451	7	11	18	149	165	314	63	47	110	3	6	9
1985	237	329	566	3	8	11	172	235	407	61	86	147	1	0	1

PERCENT OF TOTAL SAMPLE b

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 31 MALE	AGE 31 FEMALE	AGE 31 TOTAL	AGE 41 MALE	AGE 41 FEMALE	AGE 41 TOTAL	AGE 51 MALE	AGE 51 FEMALE	AGE 51 TOTAL	AGE 61 MALE	AGE 61 FEMALE	AGE 61 TOTAL
1981	48.43%	51.57%	100.00%	0.57%	0.85%	1.42%	16.52%	30.77%	47.29%	30.20%	19.66%	49.86%	1.14%	0.28%	1.42%
1982	35.31%	64.69%	100.00%	0.44%	1.97%	2.41%	23.68%	49.12%	72.81%	10.09%	13.16%	23.25%	1.10%	0.44%	1.54%
1983	43.88%	56.12%	100.00%	0.36%	0.12%	0.48%	13.67%	19.66%	33.33%	29.14%	35.73%	64.87%	0.72%	0.60%	1.32%
1984	49.22%	50.78%	100.00%	1.55%	2.44%	3.99%	33.04%	36.59%	69.62%	13.97%	10.42%	24.39%	0.67%	1.33%	2.00%
1985	41.87%	58.13%	100.00%	0.53%	1.41%	1.94%	30.39%	41.52%	71.91%	10.78%	15.19%	25.97%	0.18%	0.00%	0.18%

a Samples collected by carcass survey in 1981, by beach seine in 1983, and by both methods combined in 1982, 1984, and 1985.
b Sample percentages not weighted by time period or escapement counts.

Appendix Table 6. Age and sex composition of Andreafsky River chinook salmon escapement samples, 1981-1985. a

NUMBERS OF FISH

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 4 MALE	AGE 4 FEMALE	AGE 4 TOTAL	AGE 5 MALE	AGE 5 FEMALE	AGE 5 TOTAL	AGE 6 MALE	AGE 6 FEMALE	AGE 6 TOTAL	AGE 7 MALE	AGE 7 FEMALE	AGE 7 TOTAL
1981	154	143	297	29	0	29	80	22	102	45	120	165	0	1	1
1982	276	49	325	110 b	10	110	151	8	159	13	27	40	2	4	6
1983	251	104	355	54	0	54	129	7	136	68	96	164	0	1	1
1984	307	112	419	54 c	0	54	194	15	209	57	92	149	2	5	7
1985	296	147	443	175	0	175	55	2	57	64	130	194	2	15	17

PERCENT OF TOTAL SAMPLE d

YEAR	SAMPLE MALE	SAMPLE FEMALE	SAMPLE TOTAL	AGE 4 MALE	AGE 4 FEMALE	AGE 4 TOTAL	AGE 5 MALE	AGE 5 FEMALE	AGE 5 TOTAL	AGE 6 MALE	AGE 6 FEMALE	AGE 6 TOTAL	AGE 7 MALE	AGE 7 FEMALE	AGE 7 TOTAL
1981	51.85%	48.15%	100.00%	9.76%	0.00%	9.76%	26.94%	7.41%	34.34%	15.15%	40.40%	55.56%	0.00%	0.34%	0.34%
1982	84.92%	15.08%	100.00%	33.85%	0.00%	33.85%	46.46%	2.46%	48.92%	4.00%	8.31%	12.31%	0.62%	1.23%	1.85%
1983	70.70%	29.30%	100.00%	15.21%	0.00%	15.21%	36.34%	1.97%	38.31%	19.15%	27.04%	46.20%	0.00%	0.28%	0.28%
1984	73.27%	26.73%	100.00%	12.89%	0.00%	12.89%	46.30%	3.58%	49.88%	13.60%	21.96%	35.56%	0.48%	1.19%	1.67%
1985	66.82%	33.18%	100.00%	39.50%	0.00%	39.50%	12.42%	0.45%	12.87%	14.45%	29.35%	43.79%	0.45%	3.39%	3.84%

a Samples collected by carcass survey of the East Fork and West Fork each year, with additional samples collected by beach seine from the East Fork only, 1982-1985.

b Includes 7 age 3 males.

c Includes 1 age 3 male.

d Sample percentages not weighted by time period or escapement counts.