ANVIK, ANDREAFSKY AND TANANA RIVER SALMON ESCAPEMENT STUDIES, 1981

by

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ABSTRACT

The 1981 season was a record year for chum and king salmon harvest and escapement in the Yukon River drainage. Escapements were enumerated by side scan sonar counters on the Anvik and Andreafsky Rivers, important tributary streams in the lower Yukon, and the feasibility of using side scan sonar on the Tanana River was examined at a site near Fairbanks.

The Anvik River escapement was estimated at 1,479,582 summer chums and 2,306 kings. Chums were predominantly age 5_1, while age 6_2 was the strongest age class for kings. King salmon production is expected to be good in that 59% of the 1981 escapement sample was female.

The Andreafsky River (East Fork) escapement was estimated at 147,312 summer chums and 5,343 kings. Beach seine catches were not a valid index of run timing as compared to daily sonar counts, nor did they reflect species composition as compared to visual counts. Similar to the Anvik River, chums were predominantly age 5_1, while age 6_2 was the stongest age class for kings.

Only 3,568 fall chums were counted by sonar on the Tanana River between 9 and 22 September. Aerial survey estimates of fall chum salmon above the sonar site were 18,000 on 8 October and 36,000 on 3 November. It does not appear feasible to enumerate salmon by side scan sonar on the Tanana River at the 1981 site due to the wide, braided nature of the river, heavy river silt and debris loads, and the suspected migration of fall chums across the entire width of the river.

INTRODUCTION

The Yukon River (Figure 1) is the largest river in Alaska, and fourth largest in North America, flowing over 2,000 miles from its source in British Columbia, Canada, to its mouth on the Bering Sea. It drains an area of approximately 330,000 square miles. All five species of Pacific salmon are found in the drainage, although only chum (Oncorhynchus keta), king (O. tshawytscha), and coho (O. kisutch) salmon are abundant and support commercial and subsistence fisheries.

Chum salmon occur in two distinct runs. Summer chums are distinguished from fall chums by their earlier run timing (early June to mid-July entry into mouth of Yukon River), smaller body size (6 to 7 lb), and mottled coloration. Summer chums spawn primarily in runoff streams in the lower 500 miles of the drainage. Major spawning areas have been identified in the Andreafsky, Anvik, Nulato and Melozitna Rivers. Fall chums are distinguished by their later run timing (mid-July to late August entry), larger body size (7 to 9 lb), and bright silvery appearance. Fall chums spawn primarily in spring fed streams and sloughs in the upper portion of the drainage. Major spawning areas have been identified in the Chandalar, Sheenjek and Fishing Branch Rivers in the upper Yukon drainage, and the Toklat, Delta and main Tanana River and sloughs near Big Delta in the Tanana drainage. Upper Yukon fall chums are distinguished from Tanana fall chums by their earlier entry into the mouth of the Yukon (Michael Geiger, personal communication) and their orientation along the north bank of the Yukon River near Galena, as opposed to the south bank orientation of Tanana drainage fall chums (Buklis 1980a). Chums are the most abundant salmon in the Yukon River, but have only been intensively sought by commercial fishermen for the past ten years.

King salmon enter the Yukon River from late May to mid-July, and spawn throughout the drainage. Major spawning areas have been identified in the Andreafsky, Anvik, Nulato, Chena, Salcha, Nisutlin, Big Salmon and Ross Rivers. Kings are a high quality fish, averaging over 20 lbs and bringing the top price per pound from processors. The Lower Yukon commercial fishery began in 1918, and kings are the target species to this day.

Coho salmon are less abundant than chums and kings, and are caught incidental to the more abundant fall chums. Cohos enter the Yukon River during August and September. Spawning occurs primarily in the Tanana drainage, although small spawning populations are found in other Yukon tributary streams.

The 1981 season was a record year for both king and chum salmon catches and escapements in the Yukon area. The commercial harvest of 1,866,132 salmon was composed of 1,199,354 summer chums, 485,791 fall chums, 157,509 kings, and 23,478 cohos. Value to the fishermen totalled approximately $10,207,000. Subsistence harvests are anticipated to total an additional 695,000 salmon, including 450,000 summer chums, 175,000 fall chums, 50,000 kings and 20,000 cohos.

Poor weather conditions in the Alaskan portion of the drainage hampered efforts to estimate escapements by aerial survey in 1981. However, king salmon escapements were at record levels in selected Yukon Territory spawning areas, and the Whitehorse fishway count of 1,539 kings was also a new record.

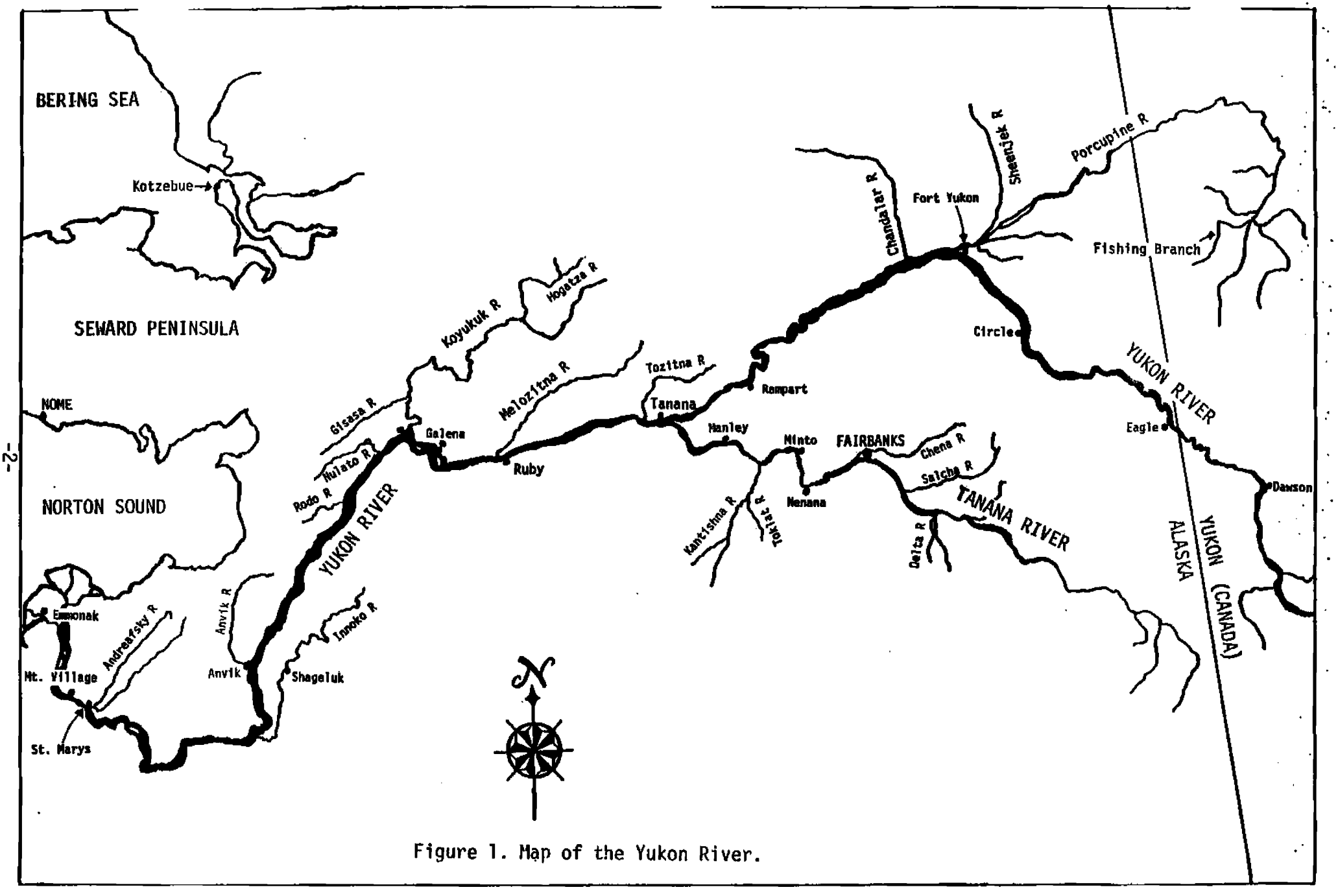


Figure 1. Map of the Yukon River.

Increased effort and funding has recently been allocated to sonar enumeration of salmon escapements at several index streams. This report presents detailed analysis of salmon escapement data collected at the Anvik, Andreafsky and Tanana Rivers in 1981.

ANVIK RIVER STUDY

Introduction

The Anvik River (Figure 2) is located 318 miles upstream from the mouth of the Yukon, and is the single most important summer chum salmon producer in the entire Yukon River drainage. In addition, the Anvik River ranks third in king salmon production within the Alaska portion of the drainage, following the Salcha and Andreafsky Rivers.

Anvik River salmon escapements were visually enumerated from counting towers located above the Yellow River confluence between 1972 and 1978. 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 counter is designed to transmit a sonar beam along a 60 foot aluminum substrate. The system electronics interpret the strength of the echoes, and tally salmon counts. The sonar counter was tested in conjunction with visual counting at the tower site in 1976. Results indicated that accuracy of the sonar counter exceeded 95% as compared to visual counts (Bendix 1976). The sonar counter was installed at mile 48 of the Anvik River in 1979, and has been used to enumerate salmon escapements at the same site through the 1981 season.

Methods and Materials

Two side scan sonar counters were installed on 20 June at mile 48 of the Anvik River near Theodore Creek. The river is approximately 200 feet wide at this site. The 40 foot east bank substrate was placed along a cut bank, with the transducer housing 2 feet underwater and 5 feet from shore. A small weir was built to prevent fish passage inshore of the tranducer. The 60 foot west bank substrate was placed along a gradually sloping gravel bar, 150 feet downriver from the east bank counter. The transducer housing was 2 feet underwater and 20 feet from shore, with a weir preventing fish passage inshore of the transducer.

Sonar counts were totalled electronically in twelve sectors for each substrate and printed hourly. Sector counts missing as a result of debris or printer malfunction were estimated by averaging the counts for the hour before and after the questionable count. Counts were hand totalled daily for each substrate, summed, and multiplied by the factor 1.10 (Buklis 1981b) to account for midstream escapement not covered by the sonar counters. Since chum salmon greatly outnumber kings, and the counters do not distinguish between chums and kings, all sonar counts were attributed to chums. A separate escapement estimate for king salmon was obtained by aerial survey.

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 counts were compared to oscilloscope counts on a daily basis, and the fish velocity setting of the

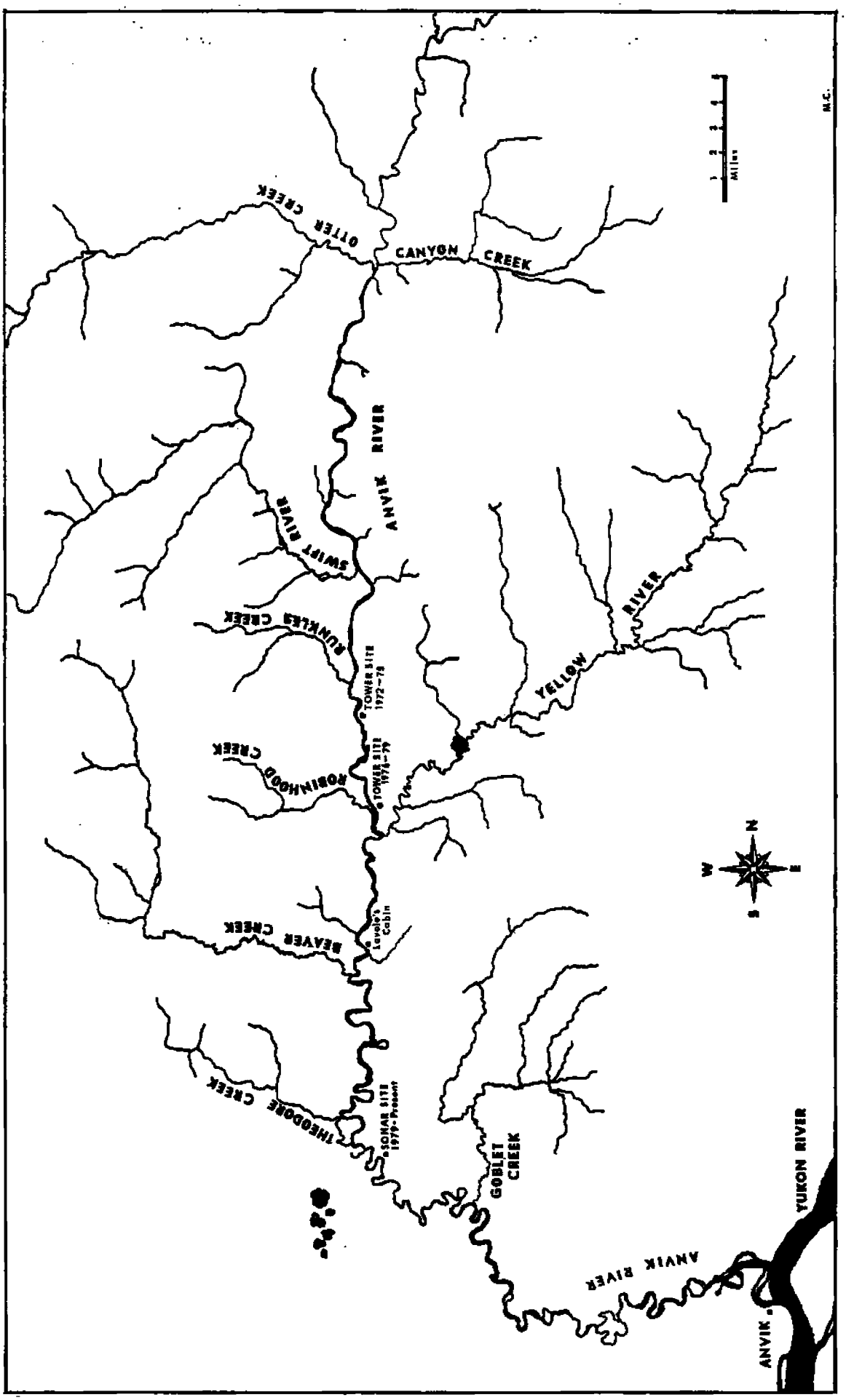


Figure 2. Map of the Anvik River.

sonar counter was adjusted accordingly. In addition, whenever water and light conditions allowed, fish passage over the substrates was visually enumerated from a 10 foot counting tower. Polaroid sunglasses were worn to reduce water surface glare. Visual counts are reported as the net upstream passage, or the number of fish passing upstream across the substrate minus the number of fish drifting back downstream across the substrate.

King and chum salmon carcasses were sampled from mid-July to mid-August. Sampled fish were measured from mid-eye to fork of tail in millimeters. Three 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 body cavity was opened for positive sex identification and to prevent sampling the same fish on subsequent surveys. 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 20 June through 27 July. A record total of 1,479,582 chums was enumerated (Table 1), the largest escapement since studies were initiated on the Anvik River in 1972 (Figure 3). The 1981 escapement was 4.2 times greater than the 1972-1980 average of 351,000 chums, and 1.75 times greater than the previous best escapement of 845,000 in 1975. Peak daily counts of 115,356 and 111,356 chums occurred on 25 and 29 June, respectively. Run timing was early in 1981, with 50% run passage occurring by 2 July, as opposed to 8 July in 1979 and 11 July in 1980 (Figure 4). It is thought that the magnitude of the return is due to recent mild winter weather, resulting in good survival of both freshwater juveniles and maturing marine fish. Early run timing may have been due to early breakup of the winter ice pack and early warming of marine waters.

Examination of hourly sonar counts reveals a distinct diurnal salmon migration pattern in 1981, with passage lowest at noon and highest at midnight (Figure 5). The migration pattern was not as well defined in 1979 or 1980 (Figure 5).

The majority of the fish have been counted along the west bank each year, although the relative contribution of east bank sectors was greater in 1981 than in previous years (Figure 6). Salmon passage over the west bank substrate has been greatest over the inner and outer sectors each year, with relatively few fish counted in the middle sectors. This pattern was most pronounced in 1981, when over 30% of the total escapement was counted in sector 1, while sector 3 through 9 counted less than 1% each. Chum salmon follow the slower water along the gradually sloping west bank shoreline. It is not clear why counts increase again in the outer sectors, but may indicate that some fish are spooked by the weir and substrate, and stray toward the offshore sectors before crossing.

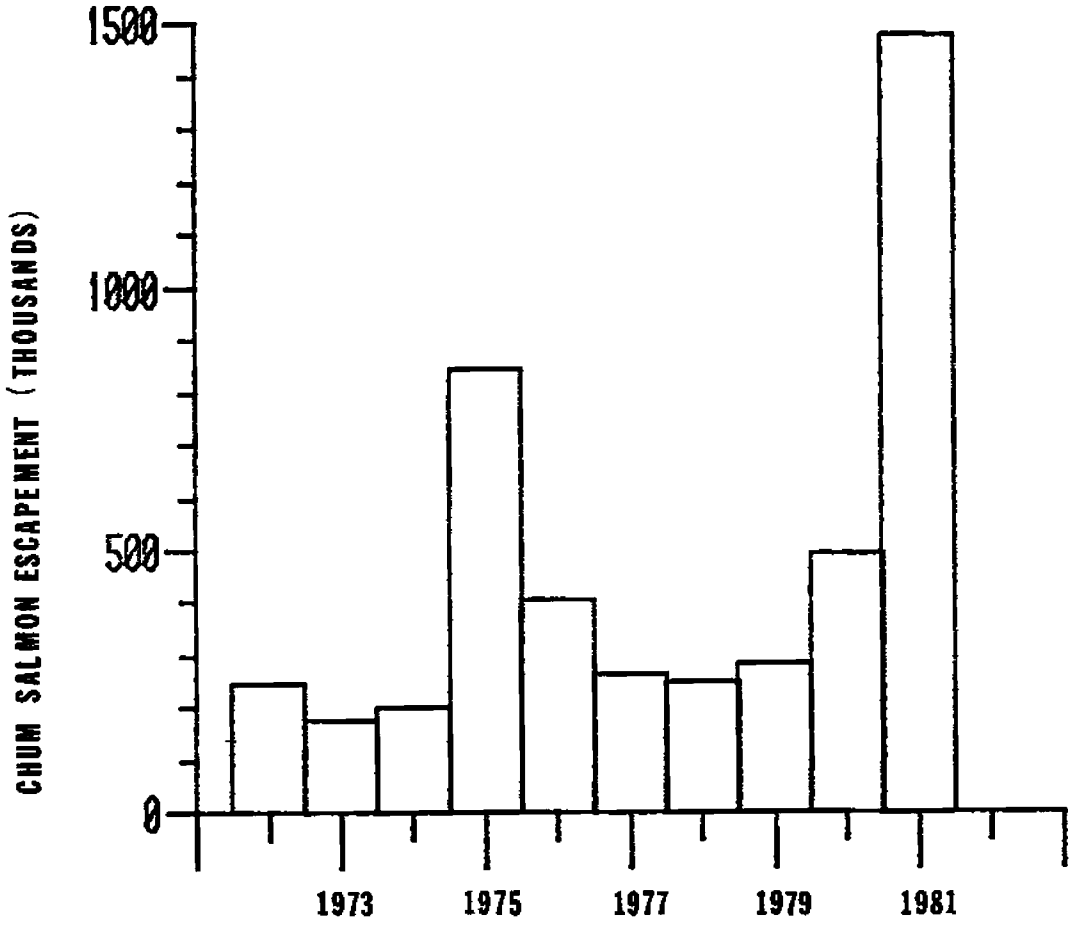
Chum salmon did not mill over the sonar substrate and cause multiple counts in 1981 as they had in 1980 (Buklis 1981b). Sonar counts of chum salmon passage over the substrates in 1981 were closely correlated with visual counts (Figure 7). The slopes of the regression of sonar count on visual count for each substrate are greater than 1. This does not reflect overcounting by sonar, but rather the fact that not all fish counted by sonar were visually enumerated due to high passage rates and less than ideal viewing conditions. The milling salmon problem was avoided by installing the substrate along a

Table 1. Anvik River chum salmon sonar counts by river bank and date, 1981.

Date	West Bank	East Bank	Expanded Count 1/ Daily	Expanded Count 1/ Cumulative	Percent of Season Total Daily	Percent of Season Total Cumulative
6/20	1,321	1,188	2,760	2,760	-	-
6/21	4,332	936	5,795	8,555	-	-
6/22	4,112	3,366	8,226	16,781	1	1
6/23	30,263	18,916	54,097	70,878	4	5
6/24	50,612	32,866	91,826	162,704	6	11
6/25	62,188	42,679	115,356	278,060	8	19
6/26	50,975	24,398	82,910	360,970	6	25
6/27	34,111	6,335	44,491	405,461	3	28
6/28	13,364	20,033	36,737	442,198	2	30
6/29	57,404	43,829	111,356	553,554	8	38
6/30	39,478	23,777	69,581	623,135	5	43
7/1	53,169	28,642	89,992	713,127	6	49
7/2	55,287	17,724	80,312	793,439	5	54
7/3	41,178	28,586	76,740	870,179	5	59
7/4	46,175	34,262	88,481	958,660	6	65
7/5	44,251	26,687	78,032	1,036,692	5	70
7/6	18,378	20,650	42,931	1,079,623	3	73
7/7	18,459	18,277	40,410	1,120,033	3	76
7/8	13,249	10,257	25,857	1,145,889	2	78
7/9	13,095	12,954	28,654	1,174,543	2	80
7/10	12,528	20,213	36,015	1,210,558	2	82
7/11	16,975	39,036	61,612	1,272,170	4	86
7/12	15,830	19,133	38,459	1,310,629	3	89
7/13	7,773	8,726	18,149	1,328,778	1	90
7/14	6,551	12,521	20,979	1,349,757	1	91
7/15	12,473	14,866	30,072	1,379,829	2	93
7/16	10,101	11,326	23,569	1,403,398	2	95
7/17	7,859	6,253	15,523	1,418,921	1	96
7/18	4,030	3,030	7,766	1,426,687	1	97
7/19	-	3,920	9,809	1,436,496	1	98
7/20	-	3,965	9,922	1,446,418	1	99
7/21	-	2,414	6,041	1,452,459	-	99
7/22	-	2,556	6,397	1,458,856	-	99
7/23	-	4,021	10,063	1,468,919	1	100
7/24	-	2,029	5,078	1,473,997	-	100
7/25	-	1,153	2,885	1,476,882	-	100
7/26	-	683	1,709	1,478,591	-	100
7/27	-	396	991	1,479,582	-	100

1/ Estimate 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. Breakdown of west bank counter on 7/19 required expansion to be based solely on east bank counts for remainder of season. East bank counts were multiplied by 2.50. Expansion factor based on average of east bank contribution to daily total before 7/19.

Figure 3. Anvik River chum salmon escapement, 1972-1981.1/



1/ Escapement estimated by tower count and aerial survey, 1972-1978, and by sonar count, 1979-1981. Regression analysis of aerial survey counts (Y) on tower counts (X) used to estimate 1973 escapement due to poor survey conditions.

Figure 4. Daily chum salmon escapement past the Anvik River sonar site, 1979-1981. The date of 50% run passage is indicated by dashed line.

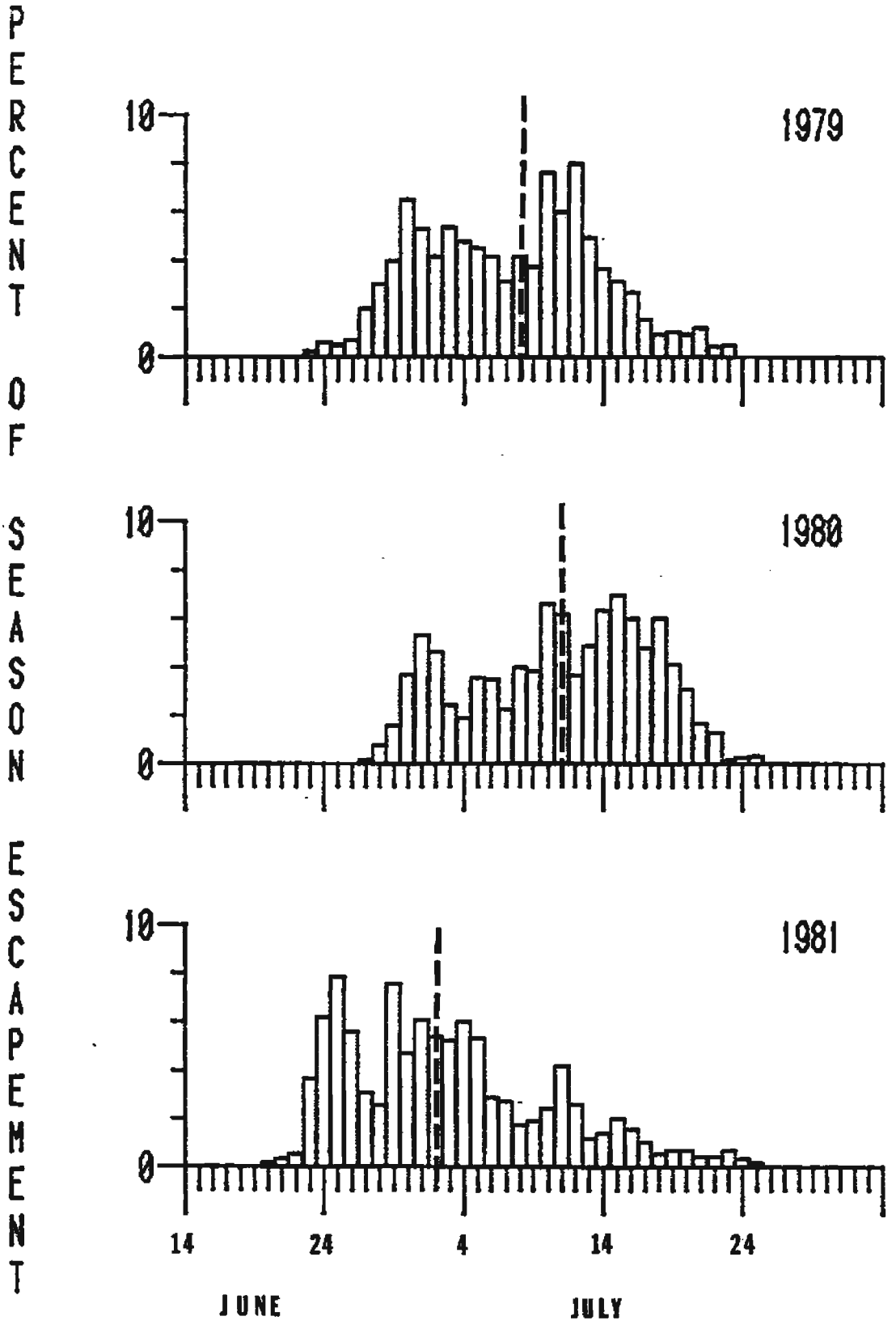


Figure 5. Chum salmon escapement past the Anvik River sonar site by hour, 1979-1981.

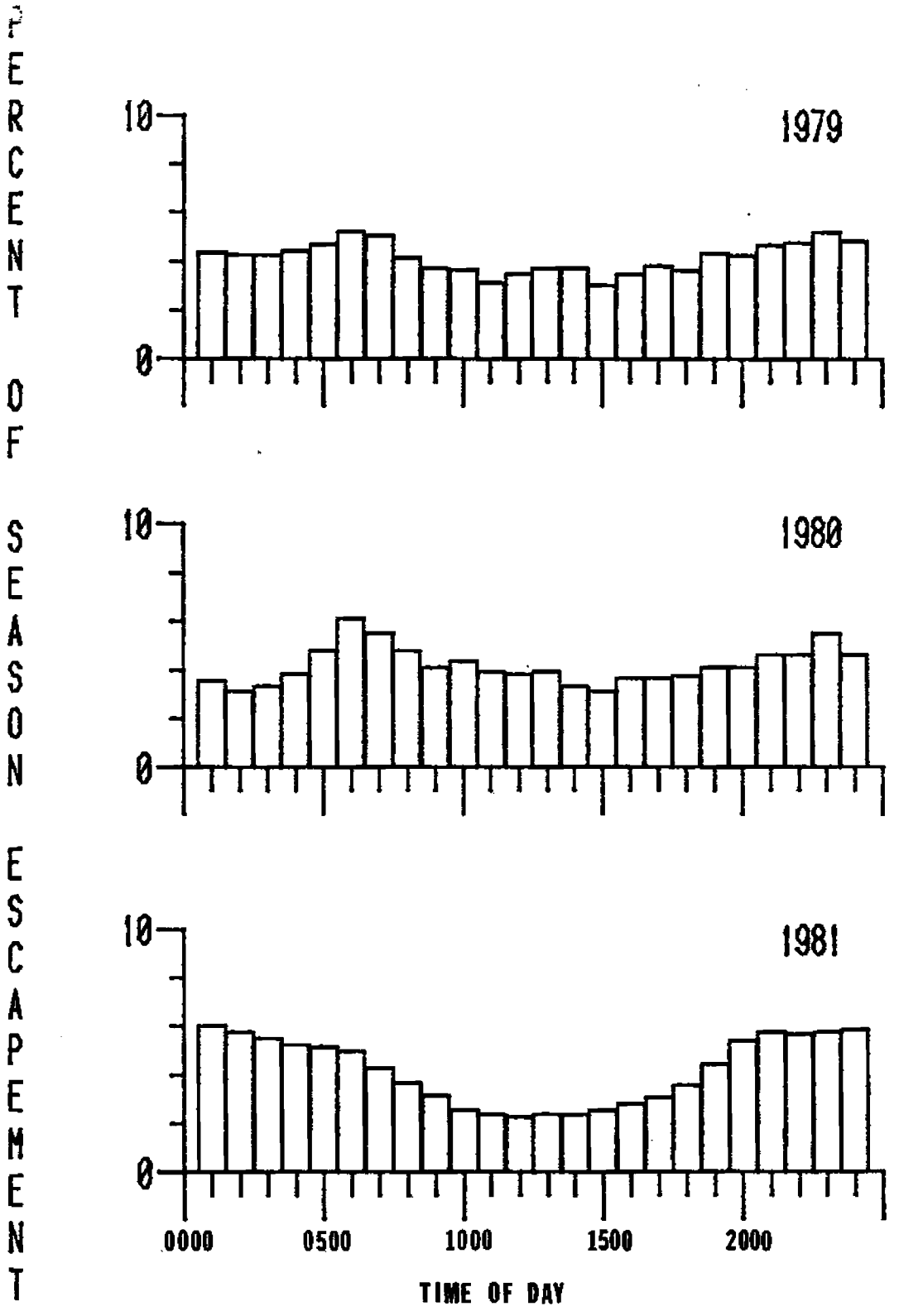


Figure 6. Chum salmon escapement past the Anvik River sonar site by sonar sector, 1979-1981.

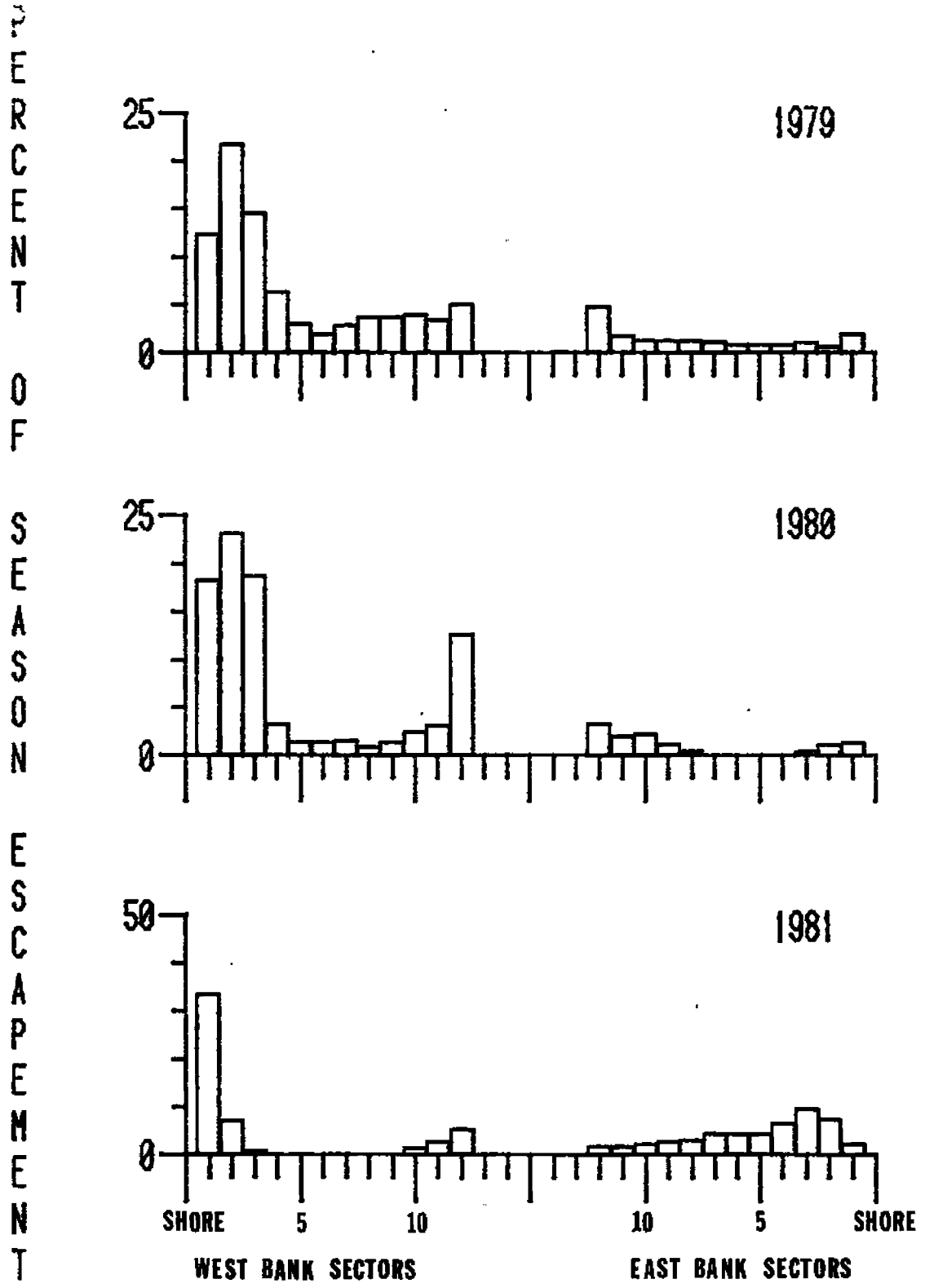
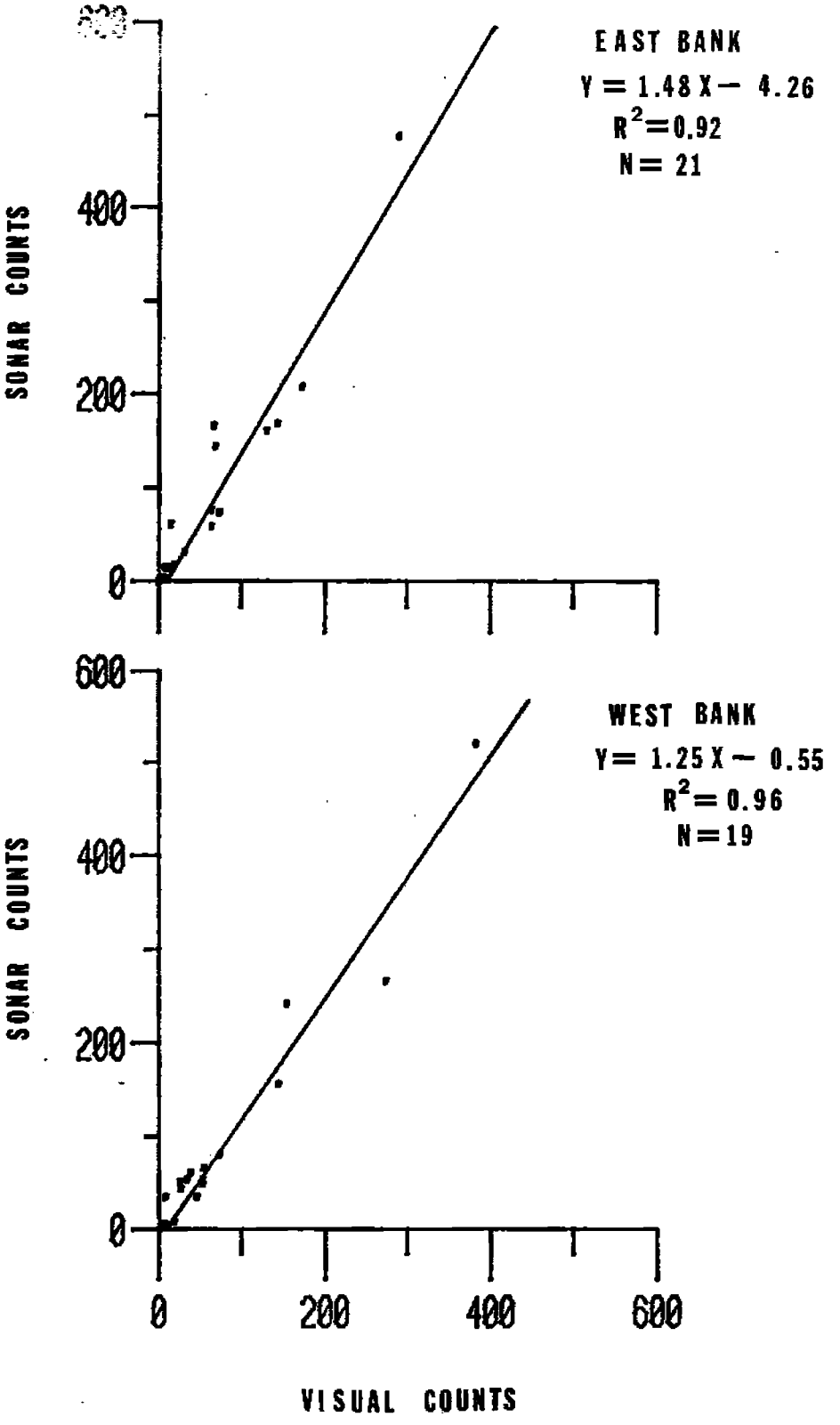


Figure 7. Visual observation of chum salmon passage correlated with sonar counts, Anvik River, 1981.



straighter stretch of the shoreline and farther offshore than the previous year, thus forcing fish to pass through the sonar beam against swifter current.

A total of 333 chum salmon carcasses was sampled for age and length. No age 3_1 fish were found in the sample. There were 116 (35%) age 4_1, 214(64%) age 5_1, and only 3 (1%) age 6_1 chums (Table 2). Fifty-five percent were females and 45% males. Males were larger than females in each age class, with males averaging 600 mm and females 551 mm for all age classes combined (Table 2). A total of 5,168 chums have been sampled from the Anvik River since 1972, with a combined sample breakdown of 261 (5%) age 3_1, 3,260 (63%) age 4_1, 1,625 (31%) age 5_1 and 22 (1%) age 6_1 fish (Appendix 1). Age 5_1 was the dominant age class in 1972, 1976 and 1981, while age 4_1 was dominant in 1973-1975 and 1977-1980. The data base is currently being analyzed to determine if fluctuations in run magnitude, timing, age and sex composition, can be incorporated into a model for predicting future chum salmon returns.

An aerial survey of the Anvik River was flown under poor to fair conditions on 24 July. Only 524,685 chums and 807 kings were counted, the chum count being 35% of the number enumerated by sonar. The aerial survey estimate is lower than the sonar count for several reasons:

1) The survey was flown under poor to fair water and light conditions, and fish could have been present without being observed.

2) Not all chum and king spawning areas in the drainage can be surveyed effectively from fixed wing aircraft. Some isolated groups of spawners were probably not counted.

3) A single aerial survey can, at best, only count the number of fish present on the day of the survey. Early and late spawners are not included. Neilson and Geen (1981) conducted eight helicopter surveys of the Morice River in British Columbia throughout the king salmon spawning run. The total king salmon count from all eight surveys was divided by residence time to arrive at an escapement estimate. They found that the peak single survey count was only 52% of the total run estimate.

Discrepancy between aerial and sonar chum counts may indicate the magnitude by which the aerial survey underestimated king salmon escapement. If the king count of 807 is only 35% of the true escapement, expansion to 100% would result in an estimate of 2,306 kings, a more realistic estimate of the true escapement. The 1981 escapement estimate of 2,306 kings is 2.2 times greater then the 1972-1980 average of 1,069 and 1.6 times greater than the 1979 record escapement of 1,474 kings.

A total of 263 king salmon carcasses was sampled for age and length. There were 34 (13%) age 4_2, 96 (37%) age 5_2, 1 age 5_3, 131 (50%) age 6_2 and 1 age 7_2 king (Table 3). Females were larger than males in each age class, with females averaging 848 mm and males 705 mm for all age classes combined (Table 3). A total of 664 kings have been sampled from the Anvik River since 1972, with a combined sample breakdown of 95 (14%) age 4_2, 241 (36%) age 5_2, 313 (47%) age 6_2 and 15 (2%) age 7_2 fish (Appendix 2). The 1981 sample of 263 kings was the largest ever collected from the Anvik River. The sex composition of 59% females and 41% males is the largest percentage of females

Table 2. Age, length and sex ratio of chum salmon carcasses sampled from the Anvik River in July, 1981. 1/

	Age 4_1			Age 5_1			Age 6_1			Total		
		Length			Length			Length			Length	
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Male	49 (15%)	579	28	99 (30%)	611	25	3 (1%)	607	20	151 (45%)	600	30
Female	67 (20%)	536	19	115 (34%)	560	24	0 (-)	-	-	182 (55%)	551	25
Total	116 (35%)	554	31	214 (64%)	583	35	3 (1%)	607	20	333 (100%)	573	37

1/ Ages designated by Gilbert-Rich formula: years of total life in superscript, years of freshwater life in subscript. Lengths measured from mid-orbit to fork of tail in millimeters. Numbers in parentheses are percent of total sample made up by the given age-sex group.

Table 3. Age, length and sex ratio of king salmon carcasses sampled from the Anvik River in July and August, 1981. 1/

	Age 4_2			Age 5_2 2/			Age 6_2			Age 7_2			Total		
		Length			Length			Length			Length			Length	
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Male	33 (13%)	561	52	61 (23%)	750	65	15(6%)	834	54	0 (-)	-	-	109 (41%)	705	115
Female	1 (-)	520	-	36 (14%)	802	46	116(44%)	865	45	1 (-)	845	-	154 (59%)	848	59
Total	34 (13%)	560	51	97 (37%)	769	63	131(50%)	862	47	1 (-)	845	-	263(100%)	789	112

1/ Ages designated by Gilbert-Rich formula: years of total life in superscript, years of freshwater life in subscript. Lengths measured from mid-orbit to fork of tail in millimeters. Numbers in parentheses are percent of total sample made up by the given age-sex group.

2/ Includes one age 5_3 male with fork length of 574 mm.

ever recorded for the Anvik, and suggests that good production will result from the 1981 escapement.

ANDREAFSKY RIVER STUDY

Introduction

The Andreafsky River (Figure 8) includes two main branches, the East and West Forks, and is located 100 miles upstream from the mouth of the Yukon River. It is second to the Anvik River in summer chum production and second to the Salcha River in king salmon production. It also supports a small run of pink salmon (O. gorbuscha). Escapements have been estimated by aerial survey continuously since 1972, but poor weather and water conditions have occasionally resulted in low estimates. Escapement was enumerated by sonar for the first time in 1981. The Andreafsky was selected for sonar enumeration both because of its large chum and king runs and its value as a timely indicator of escapement above the intensive lower Yukon fishery.

The Andreafsky River below the confluence of the East and West Forks is wide and slow moving, not suitable for side scan sonar operation. The East Fork was chosen for site selection because it averages larger salmon escapements than the West Fork.

Methods and Materials

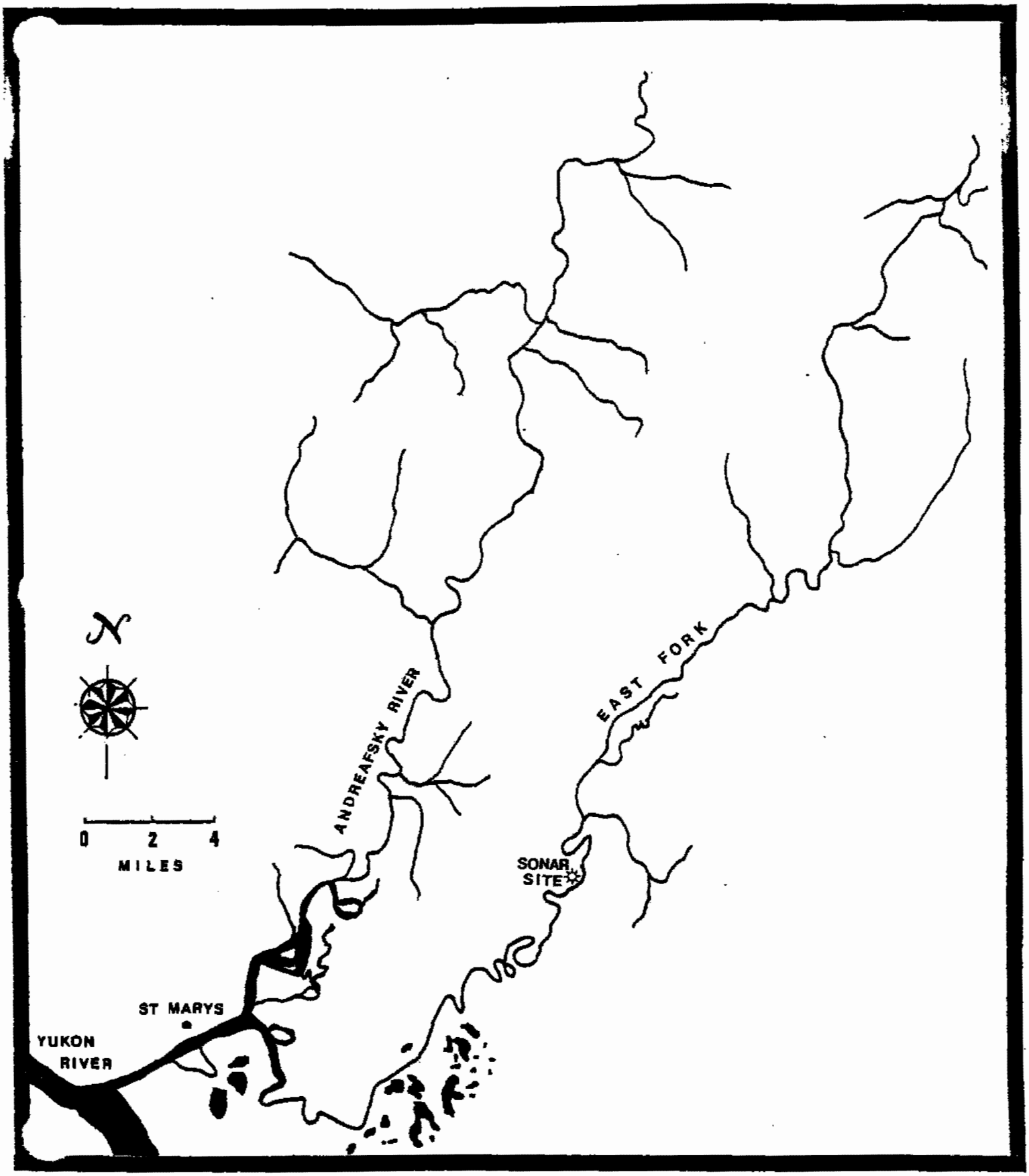
A sonar site was located at mile 20 of the East Fork of the Andreafsky River. A single 60 foot substrate was installed approximately 25 feet out from the west bank. No weir was needed to the inshore end of the substrate because the water was very shallow over a gravel bar, and no fish were seen to move through this area at any time. A weir was installed from the offshore end of the substrate to the east bank, a distance of approximately 45 feet with a maximum depth of 3 1/2 feet.

Functioning of the sonar electronics was the same as that described for the Anvik River. Since the entire width of the river that was suitable for salmon passage was either covered by sonar or blocked with a weir, there was no need to expand the daily counts for uncounted salmon escapement.

Three times daily the equipment was calibrated by counting fish passage on an oscilloscope for a 15 minute period. Adjustments were made in the fish velocity setting if sonar counts were significantly different than oscilloscope counts. In addition, whenever water and light conditions allowed, fish passage over the substrate was visually enumerated from a 10 foot counting tower. Polaroid sunglasses were worn to reduce water surface glare. Visual counts are reported as net upstream passage.

A beach seine (100 feet long, 66 meshes deep, 2 1/2 inches stretch measure mesh) was set near the sonar site three times daily, at 0930, 1530, and 2130 hours. Captured fish were identified by species and released. All king salmon captured were identified by sex, measured from mid-eye to fork of tail and three scales were taken from each for age determination. The adipose fin was clipped before release to prevent sampling the fish a second time. The purpose of beach seining was to obtain an index of run magnitude independent of sonar counts, and to estimate relative contribution of chum, king and pink

Figure 8. Map of the Andreafsky River.



salmon to the total escapement.

King and chum salmon carcasses were sampled from both the East and West Forks between mid-July and mid-August. Sampling procedures were the same as those described for the Anvik River.

Results and Discussion

The sonar counter was operated from 23 June through 23 July. Conditions were generally very good for visual observation of fish passage over the substrate. Two important observations were made:

1) Chum and king salmon registered sonar counts when they passed over the substrate, but the smaller and faster pinks were not counted.

2) Chum salmon milling over the substrate between 26 June and 13 July caused multiple sonar counts.

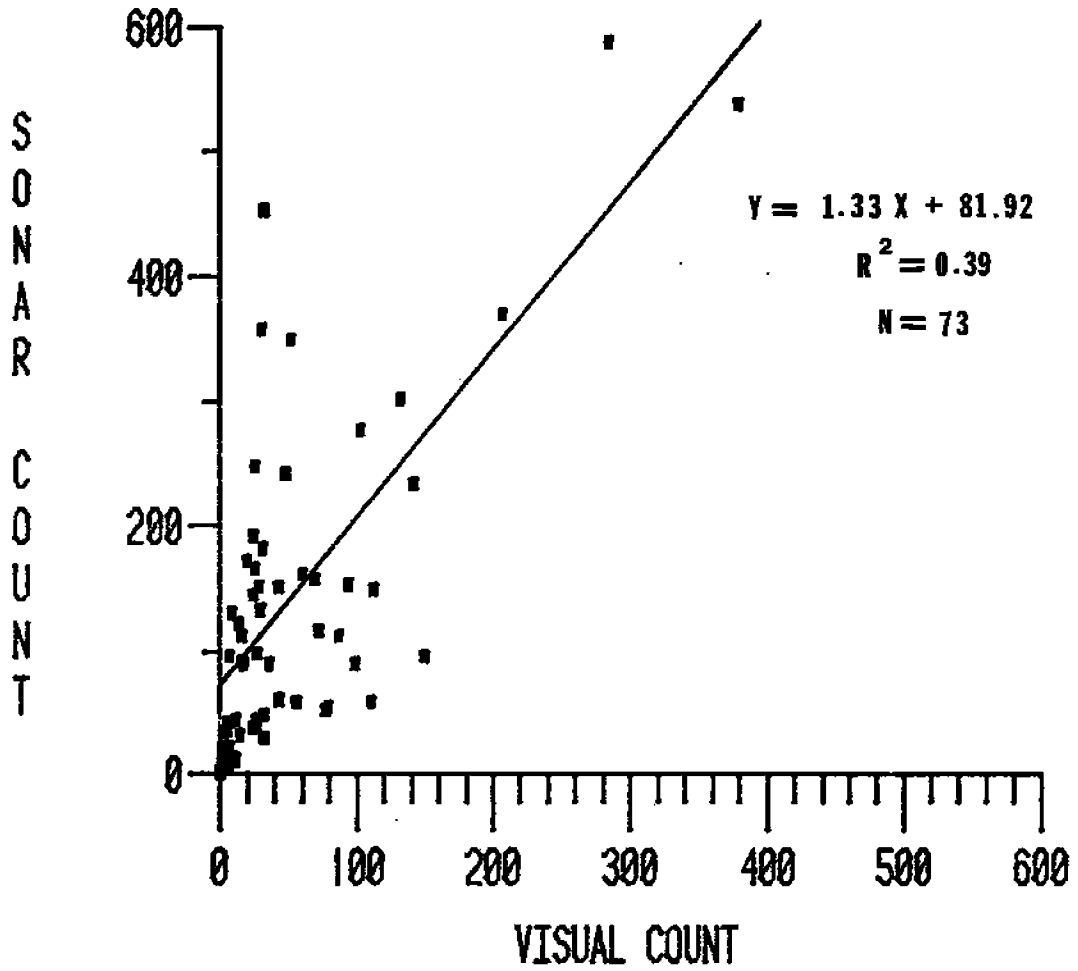
Regression of sonar counts on visual counts (Figure 9) resulted in a significant linear relationship ($Y = 1.33 x + 81.92$, $r^2 = 0.39$, $n = 73$). The large positive y-intercept and slope greater than 1 are due to chums milling over the substrate and causing multiple counts. Correction factors were developed to adjust daily sonar counts based on the ratio of visual to sonar counts (Appendix 3). The correction factors were calculated for a variable number of days depending on the number of hours of visual observation.

An adjusted total of 152,655 salmon were counted by sonar (Table 4). Since chums greatly outnumber kings, and the sonar counter does not distinguish between the two species, all counts were attributed to chum salmon during the field season. Visual counts were often too brief and seine catches too small to accurately assess species composition on a daily basis in-season. However, species composition as determined by the sum of all visual counts or the sum of all seine catches can be applied to the total sonar count to get a separate chum and king salmon escapement estimate for the season.

Eighty-five percent of the salmon visually enumerated over the sonar substrate were chums, 3% kings and 12% pinks (Table 5). Excluding pinks since they weren't counted by sonar, and setting the chum and king total to 100%, results in a 96.5% chum and 3.5% king count. Pink salmon were under-represented in beach seine catches, with 92% of the salmon catch chums, 4% kings and only 4% pinks (Table 5). The smaller and faster pinks were probably able to escape from the seine while it was being bagged more easily than the chums or kings. However, setting the chum and king total to 100% results in a species composition estimate similar to the one determined by visual counts: 96.0% chum and 4.0% king. The visual counts are the better estimate of species composition because of larger sample size.

Multiplying the 152,655 sonar counts by the percent composition figures (visual count data) results in an escapement estimate of 147,312 chums and 5,343 kings. The chum escapement is second only to the 1975 escapement of 223,000, and is 1.4 times greater than the 1972-1980 average of 107,000 chums (Figure 10). Previous escapements were estimated by aerial survey, and may not be directly comparable to the sonar estimate. Peak daily counts of

Figure 9. Visual observation of chum and king salmon passage correlated with sonar counts, Andreafsky River, 1981. 1/



1/ Three data points with x,y coordinates of 851,1290; 8,2010; and 798,1162 were included in calculation of the regression equation but were not plotted on graph.

Table 4. Andreafsky River sonar counts by date, 1981.

Date	Daily Count	Correction Factor 1/	Adjusted Count 2/ Daily	Adjusted Count 2/ Cumulative	Percent of Season Total Daily	Percent of Season Total Cumulative
6/23	4,585	-	4,585	4,585	3	3
6/24	11,172	-	11,172	15,757	7	10
6/25	14,069	-	14,069	29,826	9	19
6/26	3,402	0.420	1,429	31,255	1	20
6/27	3,456	0.420	1,452	32,707	1	21
6/28	10,947	0.420	4,598	37,305	3	24
6/29	19,548	0.420	8,210	45,515	5	29
6/30	4,694	0.420	1,971	47,486	1	30
7/1	10,091	0.420	4,238	51,724	3	33
7/2	22,673	0.420	9,523	61,247	6	39
7/3	15,520	0.420	6,518	67,765	4	43
7/4	19,309	0.420	8,110	75,875	5	48
7/5	11,555	0.420	4,853	80,728	3	51
7/6	7,986	0.420	3,354	84,082	2	53
7/7	10,259	0.420	4,309	88,391	3	56
7/8	19,230	0.420	8,077	96,468	5	61
7/9	10,012	0.173	1,732	98,200	1	62
7/10	14,266	0.204	2,910	101,110	2	64
7/11	29,462	0.308	9,074	110,184	6	70
7/12	30,384	0.337	10,239	120,423	7	77
7/13	22,094	0.337	7,446	127,869	5	82
7/14	7,840	-	7,840	135,709	5	87
7/15	3,604	-	3,604	139,313	2	89
7/16	3,261	-	3,261	142,574	2	91
7/17	2,439	-	2,439	145,013	2	93
7/18	1,345	-	1,345	146,358	1	94
7/19	1,110	-	1,110	147,468	1	95
7/20	1,490	-	1,490	148,958	1	96
7/21	1,301	-	1,301	150,259	1	97
7/22	1,158	-	1,158	151,417	1	98
7/23	1,238	-	1,238	152,655	1	100

1/ Milling salmon caused multiple counts and inflated daily estimates from 6/26 through 7/13. Correction factors to adjust counts are based on visual observation of fish passage, as outlined in Appendix 3.

2/ Adjusted count is product of daily count and correction factor.

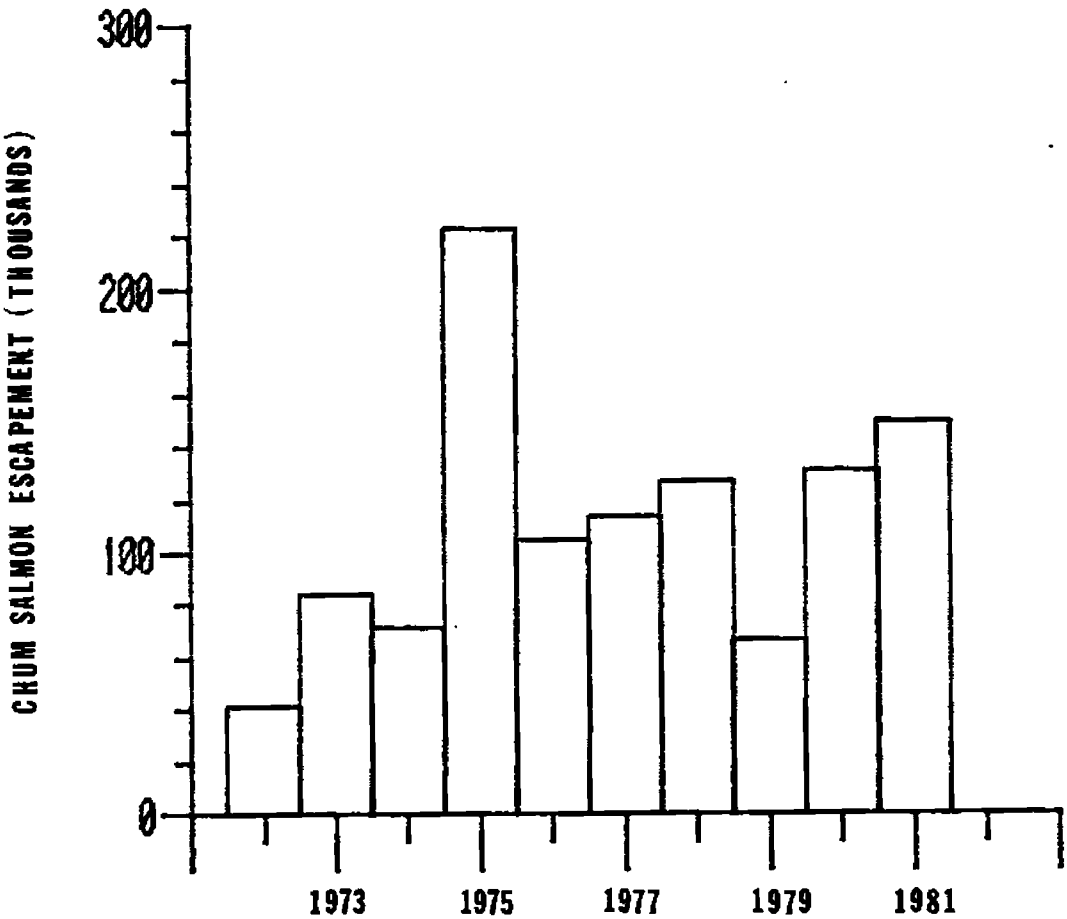
Table 5. Species composition of the Andreafsky River salmon escapement, as determined by visual counts and beach seine catches at the sonar site, 1981.

Date	Visual Count 1/			Beach Seine Catch 2/		
	Chum	King	Pink	Chum	King	Pink
6/24	179	0	0	4	0	0
6/25	55	0	0	-	-	-
6/26	18	0	0	2	0	1
6/27	4	0	0	8	0	0
6/28	851	0	0	39	0	0
6/29	15	0	0	1	1	0
6/30	25	1	0	1	0	1
7/1	168	16	2	41	0	0
7/2	64	5	0	0	0	0
7/3	162	9	0	6	3	0
7/4	398	11	5	9	2	0
7/5	129	1	2	11	1	2
7/6	129	6	4	7	0	0
7/7	220	14	21	0	0	0
7/8	-	-	-	2	0	0
7/9	141	4	27	17	0	0
7/10	185	7	6	16	0	0
7/11	1273	42	75	17	0	0
7/12	21	4	67	5	0	0
7/13	-	-	-	5	2	0
7/14	318	27	157	46	2	4
7/15	285	15	107	9	0	0
7/16	106	1	28	0	0	0
7/17	36	0	11	3	0	0
7/18	6	1	18	1	0	0
7/19	41	0	16	5	0	2
7/20	32	2	26	2	0	1
7/21	30	7	41	7	0	0
7/22	0	1	1	1	0	0
7/23	6	1	57	0	0	0
Total	4,897	175	671	265	11	11
Percent	85%	3%	12%	92%	4%	4%

1/ Visual count is the net upstream passage over the sonar substrate observed for variable periods of time daily.

2/ Three sets were made daily, although fewer sets were made on some days.

Figure 10. East Fork Andreafsky River chum salmon escapement, 1972-1981. 1/



1/ Escapement estimated by aerial survey, 1972-1980, and by sonar count in 1981. Regression analysis of East Fork aerial survey counts (Y) on West Fork aerial survey counts (X) used to estimate East Fork escapements in 1973, 1974 and 1980 due to poor survey conditions.

14,069, 9,523 and 10,239 chums [1] occurred on 25 June, 2 and 12 July, respectively. As for the Anvik River, run timing was early, with 50% passage occurring by 5 July (Figure 11). The large number of fish counted during the first three days of the project indicate that a substantial number of chums may have passed through the area before the sonar counter was installed. The true 50% point of the migration may have occurred several days earlier than the date based on sonar counts. It would be advisable to begin sonar enumeration a few days earlier in 1982 to include the early portion of the run.

Beach seine catches did not prove to be a reliable index of run magnitude (Figure 11). Regression of daily chum and king salmon beach seine catches on daily sonar counts resulted in no significant linear relationship ($r^2 = 0.02$, $n = 29$).

Examination of hourly sonar counts reveals a distinct diurnal salmon migration pattern, similar to that seen on the Anvik River in 1981. Counts were lowest between 0800 and 1500, and highest at midnight (Figure 12). The spatial pattern was similar to that recorded on the Anvik west bank in that few fish passed over the middle sectors (Figure 13). Unlike the Anvik, however, the outer sectors had a greater percentage of the counts than the inner sectors. This was due to the weir blocking passage beyond the offshore end of the substrate, and forcing fish to cross over the outer sonar sectors.

A total of 351 chum salmon carcasses was sampled for age and length. There were 5 (1%) age 3_1, 166 (47%) age 4_1, 175 (50%) age 5_1 and 5 (1%) age 6_1 chums (Table 6). Fifty-two percent were females, 48% males. Males were larger than females in each age class, with males averaging 598 mm and females 536 mm for all age classes combined (Table 6). Age 4_1 and age 5_1 were more nearly equally represented in the Andreafsky River sample than for the Anvik River. There were five age 3_1 chums in the Andreafsky sample, none for the Anvik, while age 6_1 contributed about 1% of each escapement.

The 1981 escapement estimate of 5,343 kings is 4.2 times greater than the 1972-1980 average of 1,258 and is 2.1 times greater than the 1978 record escapement of 2,487 kings. It should be noted that previous escapements were estimated by aerial survey, and may not be directly comparable.

An aerial survey of the East Fork of the Andreafsky River was flown under poor to fair conditions on 23 July. Only 81,555 chums and 2,146 kings were counted, 55% and 40% of the sonar estimate of chums and kings, respectively. This indicates that previous aerial survey counts were probably underestimates of chum and king escapements as well. The West Fork of the Andreafsky River was not surveyed in 1981 due to poor weather.

A total of 297 king salmon carcasses was sampled for age and length. There were 29 (10%) age 4_2, 102 (34%) age 5_2, 165 (56%) age 6_2, and only 1 age 7_2

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1 All sonar counts are attributed to chums for the purpose of describing temporal and spatial pattern of chum salmon migration.

Figure 11. Daily chum salmon escapement past the Andreafsky River sonar site, 1981, as indicated by sonar counts (above) and beach seine catches (below). The date of 50% run passage is shown with dashed line.

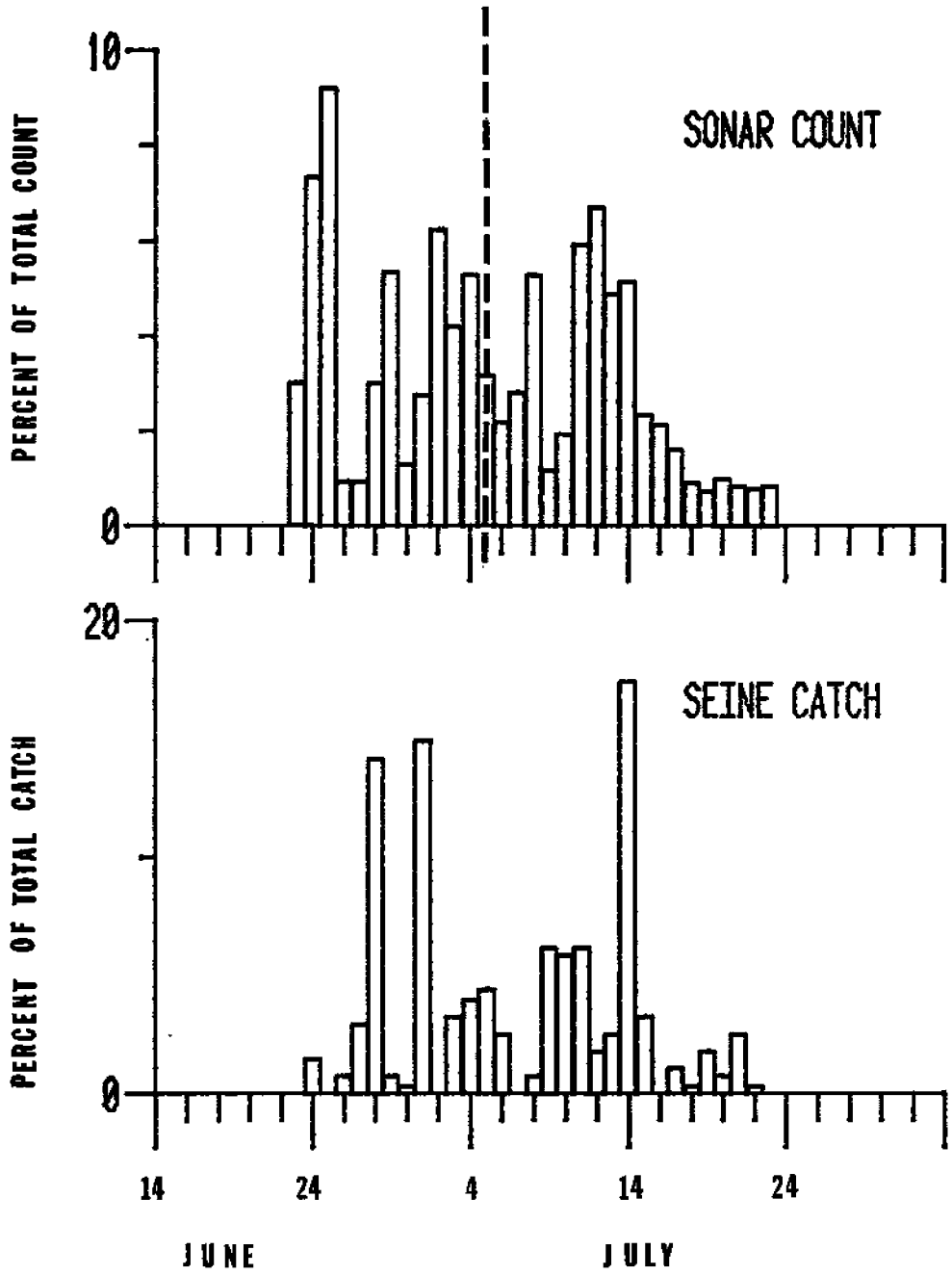


Figure 12. Chum salmon escapement past the Andreafsky River sonar site by hour, 1981.

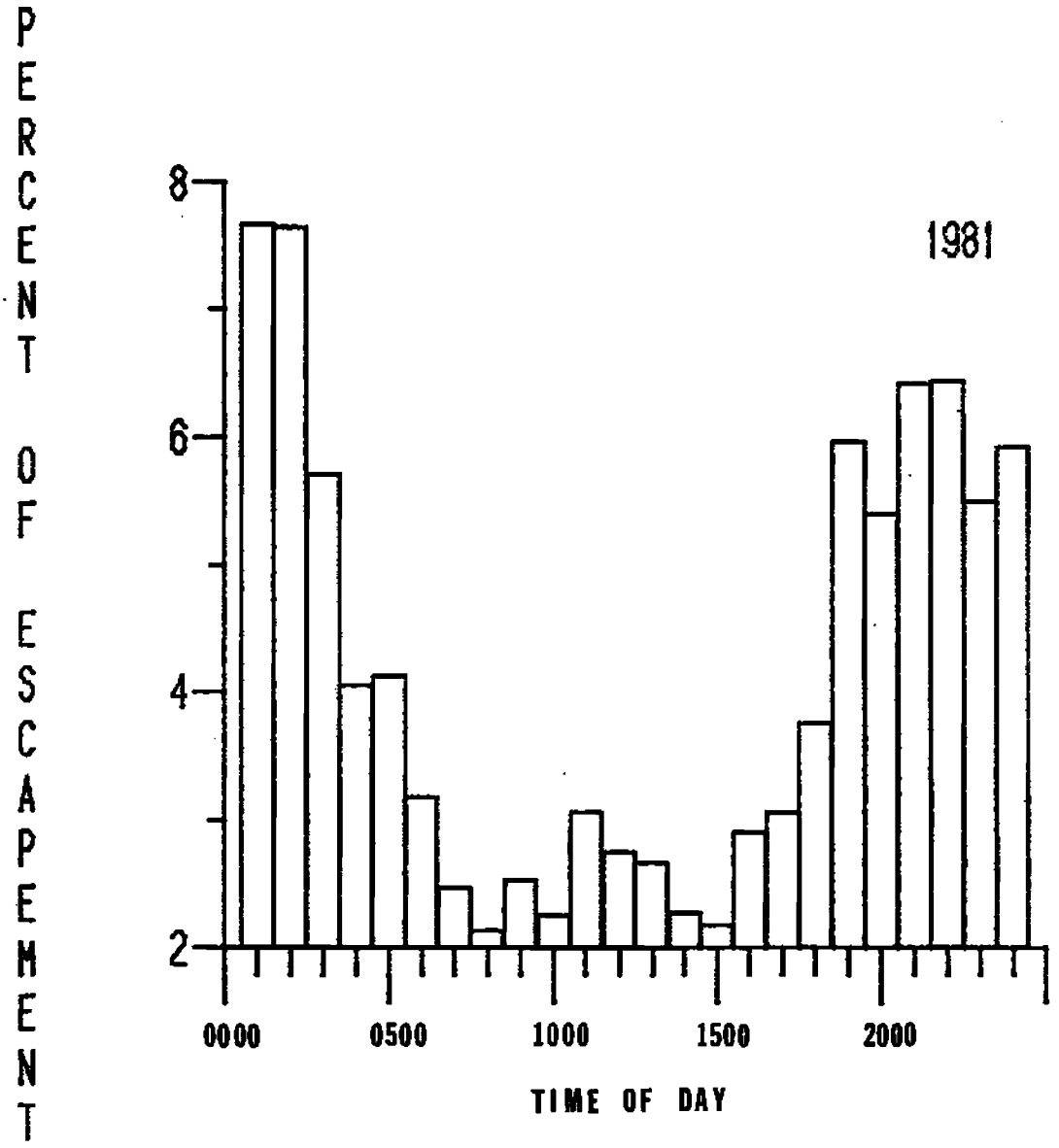


Figure 13. Chum salmon escapement past the Andreafsky River sonar site by sonar sector, 1981.

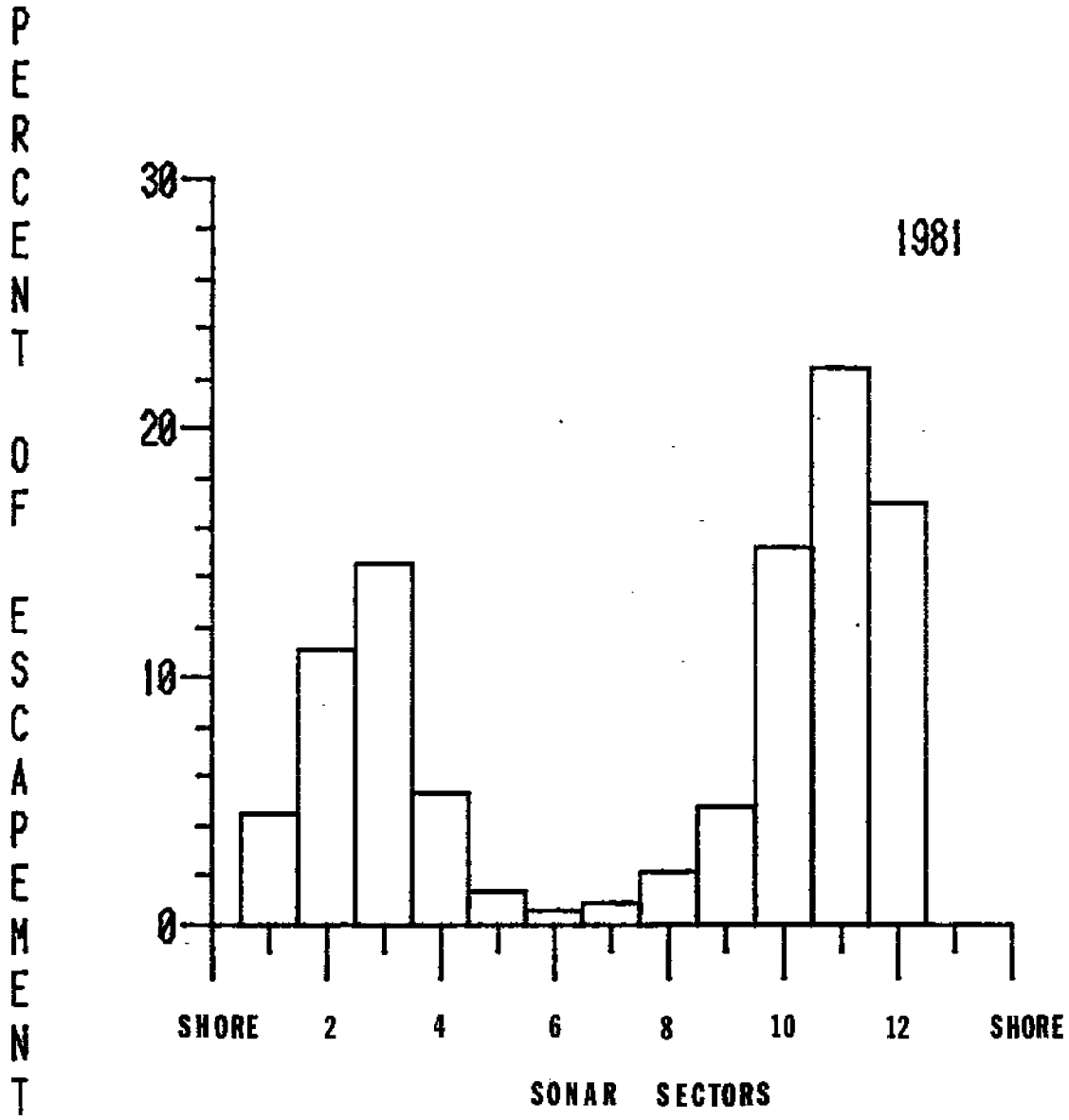


Table 6. Age, length and sex ratio of chum salmon carcasses sampled from the Andreafsky River in July and August, 1981. 1/

	Age 3_1			Age 4_1			Age 5_1			Age 6_1			Total		
	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD
Male	2 (1%)	523	13	58 (17%)	582	24	106(30%)	607	29	4 (1%)	623	33	170 (48%)	598	31
Female	3 (1%)	516	15	108 (31%)	527	23	69(20%)	551	26	1 (-)	563	-	181 (52%)	536	27
Total	5 (1%)	519	13	166 (47%)	546	35	175(50%)	585	39	5 (1%)	611	39	351 (100)	566	42

1/ Ages designated by Gilbert-Rich formula: years of total life in superscript, years of freshwater life in subscript. Lengths measured from mid-orbit to fork of tail in millimeters. Numbers in parentheses are percent of total sample made up by the given age-sex group.

king (Table 7). Females were larger than males in each age class, with females averaging 859 mm and males 739 mm for all age classes combined (Table 7). Fifty-two percent of the fish were male, 48% female. Age composition was similar in both the Anvik and Andreafsky samples, with age 6_2 the predominant age class. Females made up a greater percentage of the Anvik sample than the Andreafsky, although female escapement was still relatively good for the Andreafsky River.

TANANA RIVER STUDY

Introduction

The Tanana River (Figure 14) is a major tributary of the Yukon, and supports runs of king, summer and fall chum, and coho salmon. The Salcha and Toklat Rivers, tributaries of the Tanana, have the largest king and fall chum salmon escapements, respectively, in the Alaska portion of the Yukon River drainage.

Fall chum salmon studies in recent years have centered on tagging to determine timing and migration routes (Buklis 1981a) and test fishing near Ruby on the Yukon River to index run magnitude. Escapements in the glacially turbid Tanana drainage are estimated by aerial survey from fixed wing aircarft. Large disagreement between past tag and recapture population estimates and aerial survey estimates have suggested that a substantial number of fall chums are not being counted by aerial survey. In an attempt to more accurately document fall chum escapements, a side scan sonar counter was installed on the Tanana River near Fairbanks in September, 1981. The feasibility study was designed to test the sonar counter under the adverse conditions of a wide braided river capable of large fluctuations in water depth, with a heavy silt and debris load. In addition, the degree of bank orientation by fall chum salmon in this area was not known.

Major fall chum spawning areas include the Toklat River, in the Kantishna drainage below Nenana, and the Delta River and several streams and sloughs in the upper Tanana near Big Delta. The sonar counter was intended to index upper Tanana River escapement.

Methods and Materials

A 60 foot sonar substrate was installed on the north bank of the Tanana River near the Fairbanks Airport. The substrate was deployed on a gradually sloping gravel bar, with the inshore end 15 feet from shore and 2 feet underwater. The offshore end was 5 feet underwater. A weir was built to prevent salmon passage inshore of the transducer. There was about 120 feet of open water between the offshore end of the substrate and a midstream sand bar. The river channel was approximately 600 feet wide between the sand bar and the south bank of the river. Water depth was 11 feet along the south cutbank.

Functioning of the sonar electronics was the same as that described for the Anvik River. No attempt was made to expand the sonar counts to estimate escapement across the entire width of the river. Visual calibration of sonar counts was not possible due to the turbidity of the water.

A multifilment gillnet (150 feet long, 45 meshes deep, 6 inches stretch measure mesh) was drifted near the sonar site to determine the extent of chum

Table 7. Age, length and sex ratio of king salmon carcasses sampled from the Andreafsky River in July and August, 1981. 1/

	Age 4_2			Age 5_2			Age 6_2			Age 7_2			Total		
	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD	N	Length Mean	SD
Male	29 (10%)	561	42	80 (27%)	737	55	45(15%)	857	51	0 (-)	-	-	154 (52%)	739	113
Female	0 (-)	-	-	22 (7%)	782	56	120(40%)	872	47	1 (-)	950	-	143 (48%)	859	59
Total	29 (10%)	561	42	102 (34%)	747	58	165(56%)	868	49	1 (-)	950	-	297 (100%)	797	109

1/ Ages designated by Gilbert-Rich formula: years of total life in superscript, years of freshwater life in subscript. Lengths measured from mid-orbit to fork of tail in millimeters. Numbers in parentheses are percent of total sample made up by the given age-sex group.

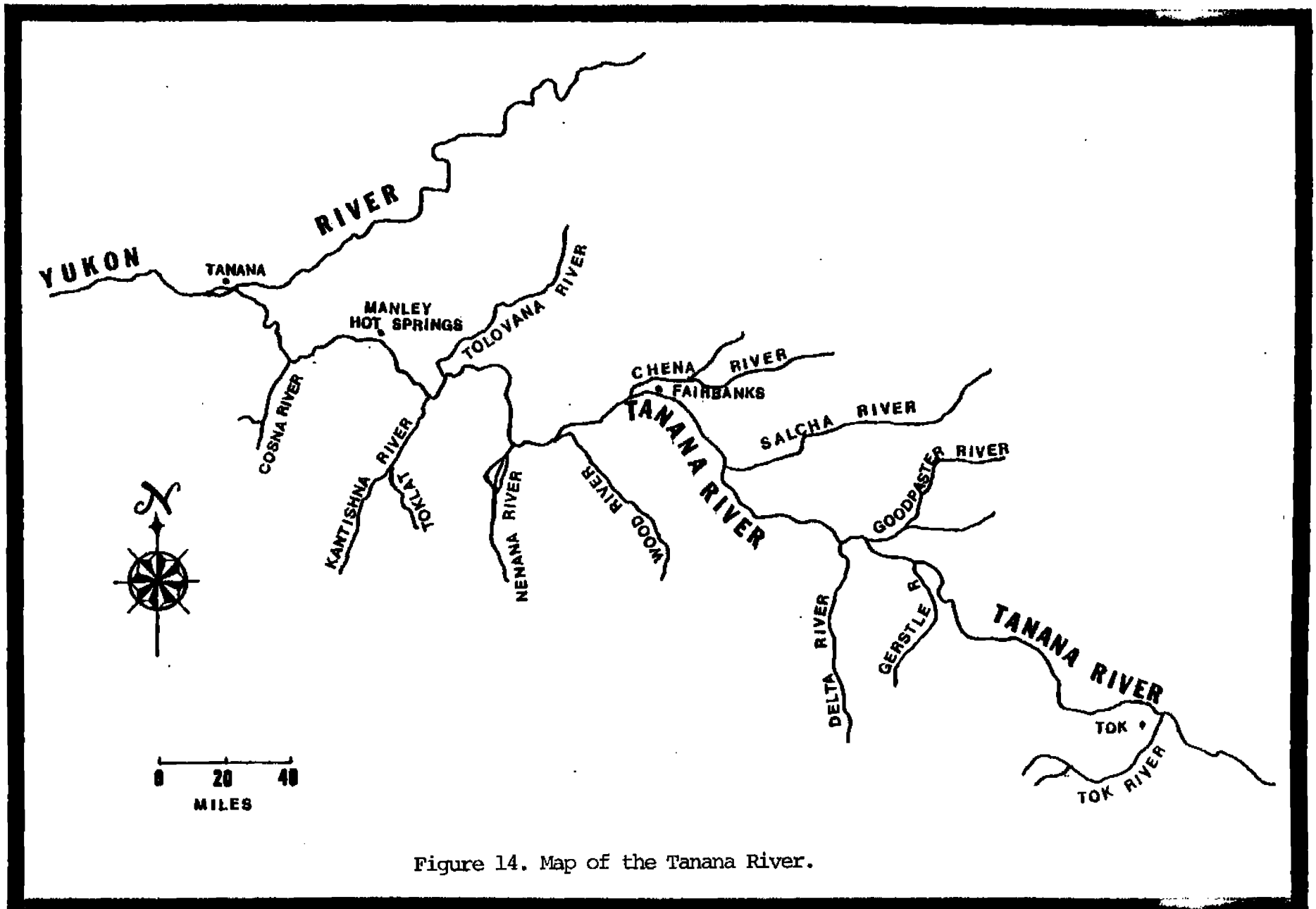


Figure 14. Map of the Tanana River.

salmon passage beyond the counting range of the sonar unit.

Results and Discussion

The sonar counter was operated between 9 and 22 September, during which time a total of 3,568 fall chums were counted (Table 8). Peak daily counts of 391 and 356 chums occurred on 15 and 17 September, respectively (Figure 15). The diurnal pattern, eratic due to the low number of counts, indicates low salmon passage during midafternoon and peak passage at 0600 and 2100 (Figure 16). The majority of the counts occurred over the first three inshore sectors (Figure 17).

The sonar counting range was originally the full 60 feet of the substrate. Debris floating downriver would occassionally hang up on the substrate and cause false counts. At such times, the sonar beam was ranged inshore of the debris until the obstruction could be removed. On 14 September, false count echoes were seen on the oscilloscope in the outer sectors, but no debris could be found. The aiming of the transducer was checked, the substrate was repeatedly raised to the surface, all cables were checked, and the river bottom was probed for obstructions. The false count echoes persisted, and the sonar beam was ranged in to 40 feet for the remainder of the study. The false counts were probably due to an underwater obstruction upstream of the substrate, or to torque on the substrate causing an uneven bowing in the pipe.

Salmon passage rates were so low that oscilloscope calibration could not be done on a scheduled basis. Fish echoes were observed and the velocity setting adjusted when possible.

Attempts to index salmon passage by gillnet were unsuccessful. No eddies could be found in the vicinity suitable for a set net site, and there were too many underwater snags in the river bed to drift a net. One drift net attempt took 45 seconds to deploy and several hours to recover.

The sonar counter enumerated only a small portion of the fall chum escapement. Although the 14 days of counting probably includes only about one-third of the migration period, the 3,568 chums counted was far less than one-third of the total escapement. Aerial surveys of the upper Tanana spawning areas on 8 October enumerated 18,000 fall chums, while aerial and foot surveys on 3 November enumerated 36,000. The sonar count was only one-fifth of the early aerial count and one-tenth of the peak aerial count. While it is believed that the sonar unit accurately counted those salmon that passed over the substrate, a substantial number of salmon no doubt migrated past the sonar site beyond the counting range of the sonar unit.

The site selected was one of the few in the area suitable for a side scanner. Water along the cutbanks was 11 feet deep and much of the shoreline was eroding. Many of the gradually sloping beaches were soft silt, incapable of supporting the sonar substrate. Even on the gravel beach used for this study, the substrate became half-filled with silt. Hand winches had to be used to remove the substrate from the river.

The side scan sonar counter does not appear to be suitable for enumeration of fall chums on the Tanana river near Fairbanks. The fan scan sonar counter (Bendix 1979) is currently being tested on the Kuskokwim River, and may prove

Table 8. Tanana River fall chum salmon sonar counts by date, 1981.

Date	Daily	Cumulative	Percent of Season Total	
			Daily	Cumulative
9/9	169 1/	169	5	5
9/10	271	440	8	13
9/11	258	698	7	20
9/12	271	969	8	28
9/13	179	1,148	5	33
9/14	153	1,301	4	37
9/15	391	1,692	11	48
9/16	309	2,001	9	57
9/17	356	2,357	10	67
9/18	303	2,660	8	75
9/19	261	2,921	7	82
9/20	225	3,146	6	88
9/21	265	3,411	7	95
9/22	157 2/	3,568	4	100

1/ Noon to Midnight

2/ Midnight to Noon.

Figure 15. Daily fall chum salmon escapement past the Tanana River sonar site, 1981.

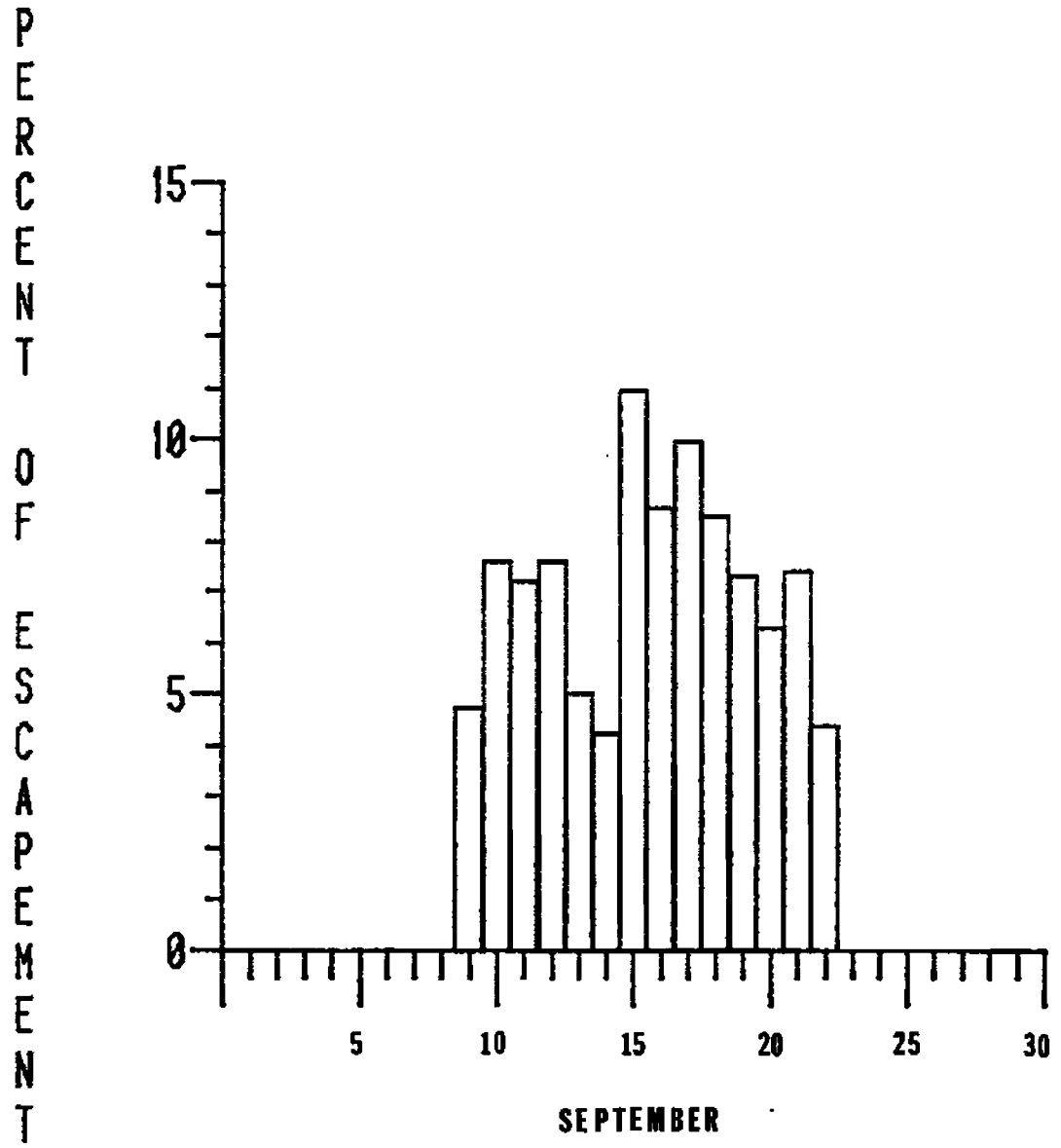


Figure 16. Fall chum salmon escapement past the Tanana River sonar site by hour, 1981.

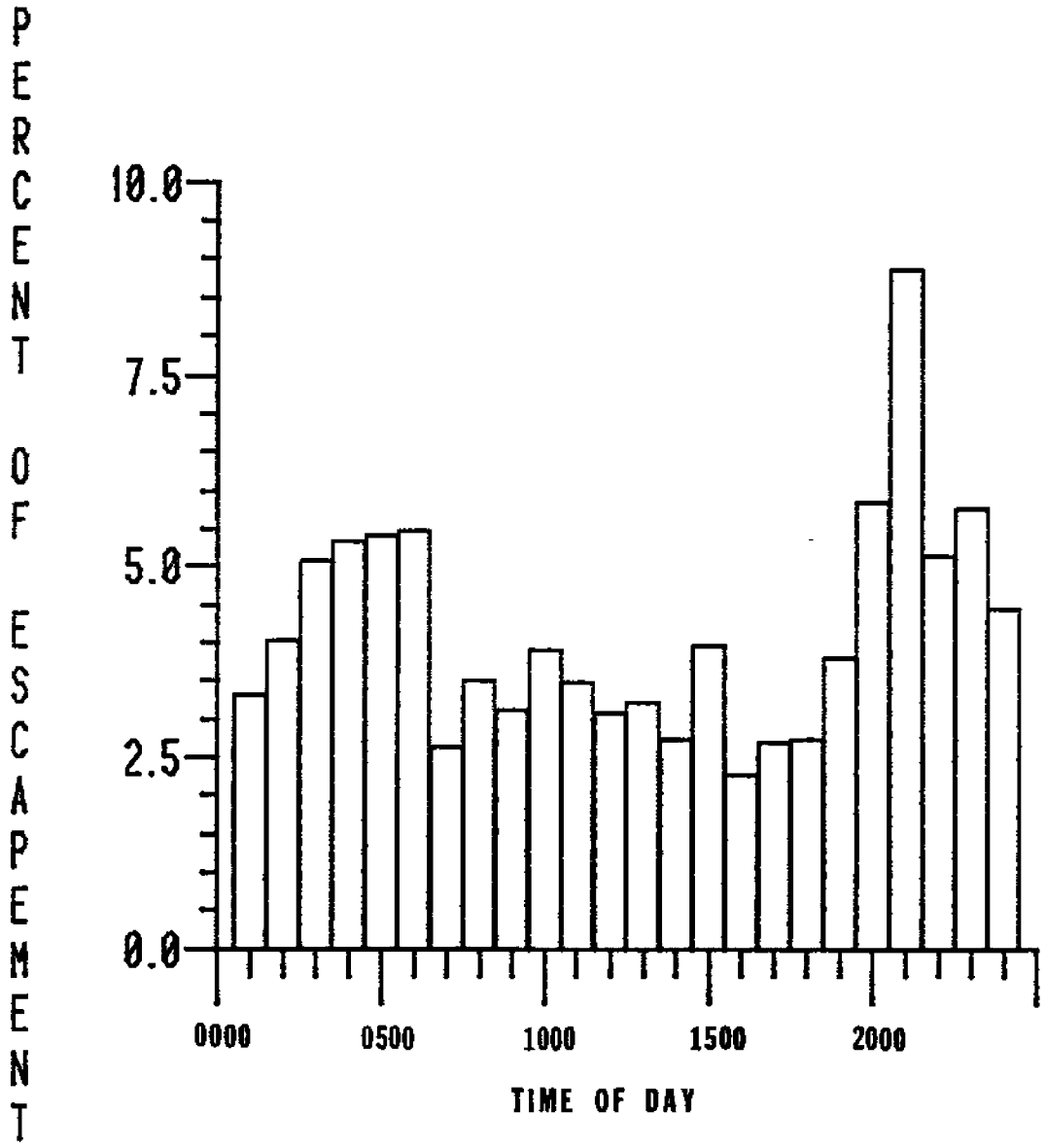
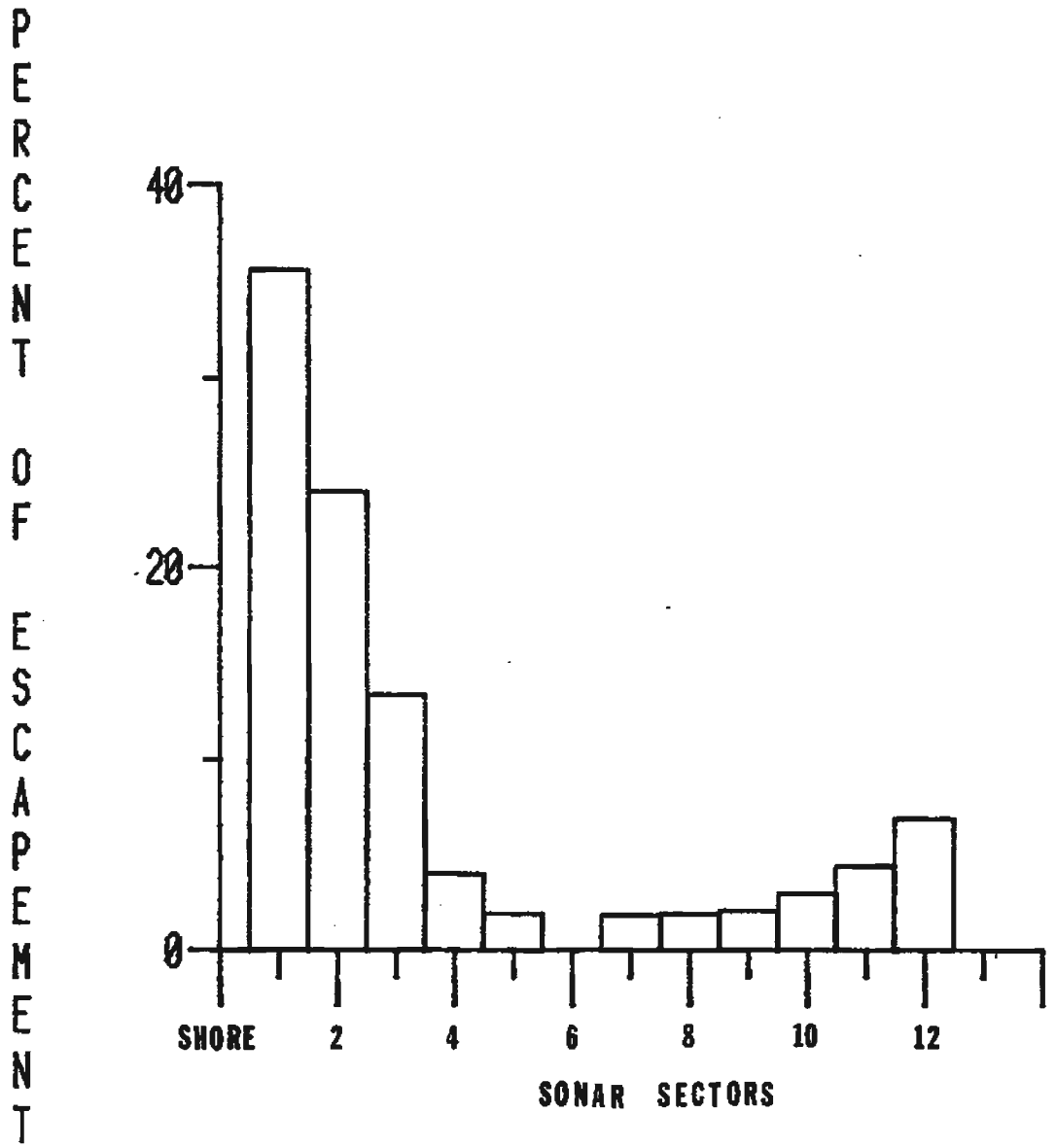


Figure 17. Fall chum salmon escapement past the Tanana River sonar site by sonar sector, 1981.



feasible for the Tanana river as well, although the relatively shallow depth of the Tanana may prove to be a problem. The Toklat and Delta Rivers are the two most important fall chum salmon producers in the Tanana drainage, accounting for over 80% of the escapement. Either of these two tributaries may prove feasible for sonar or visual enumeration, and would be an important indicator of the magnitude of Tanana fall chum escapements. Future feasibility studies should focus on the Delta and Toklat Rivers.

DISCUSSION

Commercial fishing effort in the lower Yukon area is directed at king salmon with 8 1/2" mesh gillnets until late June, when gear is restricted to 6" or smaller mesh by emergency order. Effort then shifts to summer chum salmon. Test fishing with 5 1/2" set gillnets is conducted by Department personnel near Emmonak in early June, but catches do not always reflect summer chum salmon run strength (Mike Geiger, personal communication). Therefore, the early portion of the summer chum salmon run can pass through the lower Yukon fishery without adequate assessment.

Summer chum salmon escapement to the Anvik River has been accurately enumerated by side scan sonar each year since 1979. The data base indicates that the Anvik River is the largest chum salmon producer in the entire Yukon River drainage, and that the mid-point of the escapement accurs between 2 and 11 July. The Anvik River stock probably accounts for a substantial portion of the lower Yukon summer chum harvest. Daily escapement counts are potentially an important means of assessing in-season management strategies and regulating fishing effort. For those years with poor test fishing data, Anvik River summer chum escapement counts may be the only index of early run strength for the Yukon River.

The Andreafsky River project was successful in enumerating the summer chum salmon escapement, although extensive visual calibration was neccessary to adjust for milling fish. The magnitude of the escapement was second only to the Anvik River in the entire Yukon River drainage, and the peak daily counts occurred in late June. Timing of the peak escapement counts coincides with the change over to chum salmon gear in the commercial fishery. The proximity of the sonar site to the intensive lower Yukon fishery and the early timing indicate that the Andreafsky River sonar project has great potential for in-season management application. Increasing confidence can be placed in the daily escapement counts as a data base is accumulated over the next several years.

The Tanana River sonar project did not prove feasible. Future escapement studies of Tanana drainage fall chum salmon should be directed at the Delta and Toklat Rivers, which account for about 80% of the production. Sonar enumeration and/or intensive foot surveys of the spawning areas may prove successful in terms of estimating the timing and magnitude of the escapement, although the data will not be timely enough for in-season management application.

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Appendix 1. Age and sex composition of chum salmon carcasses sampled from the Anvik River, 1972-1981.[1/]

	Age 3_1			Age 4_1			Age 5_1			Age 6_1			Total		
Year	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
1972	0(-)	0(-)	0(-)	25(8)	37(12)	62(19)	138(43)	115(36)	253(79)	4(1)	1(-)	5(2)	167(52)	153(48)	320(100)
1973	11(1)	37(5)	48(6)	204(26)	401(51)	605(77)	49(6)	79(10)	128(16)	1(-)	1(-)	2(-)	265(34)	518(66)	783(100)
1974	12(3)	24(6)	36(9)	197(49)	120(30)	317(79)	34(8)	12(3)	46(11)	2(-)	1(-)	3(1)	245(61)	157(39)	402(100)
1975	4(1)	17(3)	21(4)	253(43)	288(49)	541(83)	13(2)	9(2)	22(4)	0(-)	0(-)	0(-)	270(46)	314(54)	584(100)
1976	5(1)	4(1)	9(2)	43(7)	35(6)	78(13)	233(39)	281(47)	514(86)	0(-)	0(-)	0(-)	281(47)	320(53)	601(100)
1977	20(3)	111(19)	131(22)	161(27)	270(46)	431(73)	7(1)	15(2)	22(4)	3(1)	2(-)	5(1)	191(32)	398(68)	589(100)
1978	0(-)	1(-)	1(-)	210(38)	180(33)	390(71)	79(14)	82(15)	161(29)	0(-)	0(-)	0(-)	289(52)	263(48)	552(100)
1979	2(-)	12(2)	14(2)	154(27)	193(33)	347(60)	115(20)	99(17)	214(37)	2(-)	2(-)	4(1)	273(47)	306(53)	579(100)
1980	0(-)	1(-)	1(-)	147(35)	226(53)	373(88)	20(5)	31(7)	51(12)	0(-)	0(-)	0(-)	167(39)	258(61)	425(100)
1981	0(-)	0(-)	0(-)	49(15)	67(20)	116(35)	99(30)	115(34)	214(64)	3(1)	0(-)	3(1)	151(45)	182(55)	333(100)
Total	54(1)	207(4)	261(5)	1,443(28)	1,817(35)	3,260(63)	787(15)	838(16)	1,625(31)	15(-)	7(-)	22(-)	2,299(44)	2,869(56)	5,168(100)

1/ Ages designated by Gilbert-Rich formula: Total years of life in superscript, years of freshwater life in subscript. Numbers in parentheses are percent of total sample made up by the given age-sex group.

Appendix 2. Age and sex composition of king salmon carcasses sampled from the Anvik River, 1972-1981.[1/]

	Age 4_2			Age 5_2			Age 6_2			Age 7_2			Total		
Year	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total
1972	0(-)	0(-)	0(-)	8(53)	0(-)	8(53)	2(13)	5(33)	7(47)	0(-)	0(-)	0(-)	10(67)	5(33)	15(100)
1973	1(10)	0(-)	1(10)	0(-)	0(-)	0(-)	5(50)	3(30)	8(80)	0(-)	1(10)	1(10)	6(60)	4(40)	10(100)
1974 [2/]															
1975	1(12)	0(-)	1(12)	4(50)	1(12)	5(62)	1(12)	1(12)	2(25)	0(-)	0(-)	0(-)	6(75)	2(25)	8(100)
1976	6(13)	0(-)	6(13)	25(56)	5(11)	30(67)	2(4)	7(16)	9(20)	0(-)	0(-)	0(-)	33(73)	12(27)	45(100)
1977	2(2)	1(1)	3(3)	27(23)	6(5)	33(28)	27(23)	48(41)	75(64)	2(2)	4(3)	6(5)	58(50)	59(50)	117(100)
1978	13(17)	0(-)	13(17)	10(13)	1(1)	11(14)	13(17)	39(51)	52(68)	0(-)	1(1)	1(1)	36(47)	41(53)	77(100)
1979	17(37)	0(-)	17(37)	14(30)	0(-)	14(30)	6(13)	6(13)	12(26)	0(-)	3(7)	3(7)	37(80)	9(20)	46(100)
1980	19(23)	1(1)	20(24)	21(25)	22(26)	43(51)	1(1)	16(19)	17(20)	0(-)	3(4)	3(4)	41(49)	42(51)	83(100)
1981	33(13)	1(-)	34(13)	61(23)	36(14)	97(37) [3/]	15(6)	116(44)	131(50)	0(-)	1(-)	1(-)	109(41)	154(59)	263(100)
Total	92(14)	3(-)	95(14)	170(26)	71(11)	241(36)	72(11)	241(36)	313(47)	2(-)	13(2)	15(2)	336(51)	328(49)	664(100)

1/ Ages designated by Gilbert-Rich formula: Total years of life in superscript, years of freshwater life in subscript. Numbers in parentheses are percent of total sample made up by the given age-sex group.

2/ No samples were collected in 1974.

3/ Includes one age 5_3 male.

Appendix 3. Correction factors for adjusting sonar counts on the Andreafsky River, 1981, based on visual observation of chum salmon milling.

Date	Time	Chum Salmon Counts Visual (net upstream)	Sonar	Visual/Sonar
6/26	1535-1605	18	89	0.202
6/27	0910-0925	1	13	0.077
6/27	1650-1720	3	11	0.273
6/28	2030-2045	851	1290	0.660
6/29	1715-1730	15	30	0.500
6/30	1515-1530	3	34	0.088
6/30	1745-1800	23	38	0.605
7/1	1725-1755	97	148	0.655
7/1	2040-2100	71	115	0.617
7/2	1515-1545	64	156	0.410
7/3	1255-1325	29	132	0.220
7/3	1620-1650	133	233	0.571
7/4	1140-1210	25	356	0.070
7/4	1815-1845	373	538	0.693
7/5	1305-1335	90	153	0.588
7/5	1825-1855	14	112	0.125
7/5	2220-2250	25	145	0.172
7/6	0945-1015	7	95	0.074
7/6	1415-1445	14	122	0.115
7/6	1610-1640	16	91	0.176
7/6	1915-1945	59	161	0.366
7/6	2245-2300	33	88	0.375
7/7	0845-0915	30	182	0.165
7/7	1300-1330	47	349	0.135
7/7	1500-1530	46	241	0.191
7/7	1655-1725	97	277	0.350
7/8	Poor Visibility 1/			
Period Total	11.33 Hours	2184	5199	0.420
7/9	1050-1120	5	41	0.122
7/9	1215-1245	19	172	0.110
7/9	1400-1430	25	165	0.152
7/9	1645-1715	24	191	0.126
7/9	1720-1750	25	96	0.260
7/9	2225-2245	43	151	0.285
Period Total	2.83 Hours	141	816	0.173
7/10	1030-1100	27	151	0.179
7/10	1250-1320	31	454	0.068
7/10	1445-1515	127	301	0.422
Period Total	1.50 Hours	185	906	0.204
7/11	1035-1105	8	2010	0.004
7/11	1335-1405	194	370	0.524
7/11	1730-1830	798	1162	0.687
7/11	1855-1925	273	587	0.465
Period Total	2.50 Hours	1273	4129	0.308
7/12	2250-2305	21	248	0.085
7/13	Poor Visibility 2/			
Grand Total	18.42 Hours	3804	11298	0.337

1/ Poor visibility on 7/8, no visual counts possible. Used average value of 0.420 as correction factor for that day.

2/ Poor visibility on 7/13, no visual counts possible. Used average value of 0.337 as correction factor for 7/12 and 7/13 based on overall average of all observations from 6/26 through 7/12.