EMUMERATION OF SUMMER CHUM AND KING SALMON BY SIDE-SCANNING SONAR IN THE MELOZITNA RIVER IN 1981

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MELOZITNA RIVER SONAR

Introduction

King and summer chum salmon are the most important commercial species in the lower Yukon River, while fall chum salmon are most important in the upper river, above the Koyukuk River. Whereas king salmon spawning occurs throughout the Yukon River drainage, most summer chum salmon spawn in tributaries to the Yukon River below the confluence of the Koyukuk River, as well as within the Koyukuk River drainage. A lesser percentage spawns in several tributaries of the Yukon River between Galena and Tanana. A few streams in the Tanana River drainage are also utilized. By comparison, most fall chum salmon spawn in the upper Yukon River drainage, particularly the Porcupine and Tanana River systems.

Management of king and summer chum salmon is conservative due to lack of in-season escapement information; salmon cannot be visually enumerated until runs have reached clear-water tributaries, some of which are hundreds of miles above the fishery. To provide more timely in-season escapement data in the lower and middle Yukon River tributaries, two rivers were selected for side-scanning sonar feasibility studies in 1981--the Andreafsky and Melozitna Rivers. The Andreafsky River is the second most important in the Yukon River drainage for summer chum salmon production, while the Melozitna River is believed to be a substantial contributor to summer chum salmon stocks in the middle Yukon River area.

The Melozitna River heads northwest of the Ray Mountains and flows southwest in excess of 135 miles through the Kokrines Hills to its confluence with the Yukon River near the village of Ruby. A unique feature of the river is that the upper river is characterized by a low gradient and slow-moving water. Only within the lower 10 to 15 miles does the river increase in water velocity, after flowing through a large canyon. Although total salmon escapement estimates are lacking, it is known that substantial numbers of summer chum salmon utilize three or four clear-water tributaries to this river., Spawning in the mainstem river is suspected, but the extent is unknown. Few king salmon are believed to utilize the Melozitna River.

This report presents results of the 1981 Melozitna River studies.

Objectives

Overall objectives of the 1981 Melozitna River studies were to examine the feasibility of using side-scanning sonar to determine timing and magnitude of summer chum and king salmon escapements to this stream and to collect salmon age-sex-size information. It is anticipated

that timely data collection will provide information for use in in-season management of the middle and upper Yukon commercial fisheries and that total run size will subsequently reveal the extent of mainstem spawning. The following specific objectives were identified in order to meet overall project objectives:

1. Install a single side-scanning sonar unit and partial adult salmon weir to count upstream migrants;

2. Test fish with gillnets to examine species composition and age-sex-size characteristics of adult salmon escapement; and

3. Monitor selected climatological and hydrological parameters at the sonar site.

Ancillary to these objectives, captured sheefish were to be tagged and released to assist the Sport Fisheries Division in understanding the importance of the Melozitna River as a spawning area for this species.

Methods

Adult salmon escapement to the Melozitna River was enumerated with a side-scanning sonar counter (1978 model) developed by the Hydrodynamics Division of Bendix Corporation (Menin 1976). A single 60-ft aluminum substrate was assembled and deployed on July 3 from the east bank of the Melozitna River (Figures 1 and 2). The substrate was deployed so that the top of the inshore transducer housing rested approximately 6-8 inches below the water surface. The offshore end was approximately 7-8 ft below the water surface. River water velocity was estimated at approximately 5 ft/sec when the substrate was installed.

A partial weir was constructed on both sides of the river--a small section on the east bank to prevent salmon from passing around the inshore end of the sonar substrate, and about a 30-ft section from the west bank. There remained in excess of 100 ft of open river between the west bank weir and offshore end of the sonar substrate. Weir construction was of metal "T" stakes and 2-inch by 4-inch cattle fencing. Additional sections were added or removed from the east bank when necessary due to fluctuations in water level.

Sonar enumeration commenced at 1700 hours on July 3. The counter printed hourly totals, and counts were tabulated for each 24-hour period from 0001-2400 hours. Missing sector counts (illegible, printer malfunction, or debris) were interpolated by averaging sector counts from the hour before and hour after the missing sector. An assembly and operation manual for the 1978 side-scanning sonar system has been prepared by Bendix Corporation (1980).

Fish passing through the sonar beam produce a distinct oscilloscope pattern which can be distinguished from debris. Consequently, sonar counts were calibrated with an oscilloscope on a daily basis.

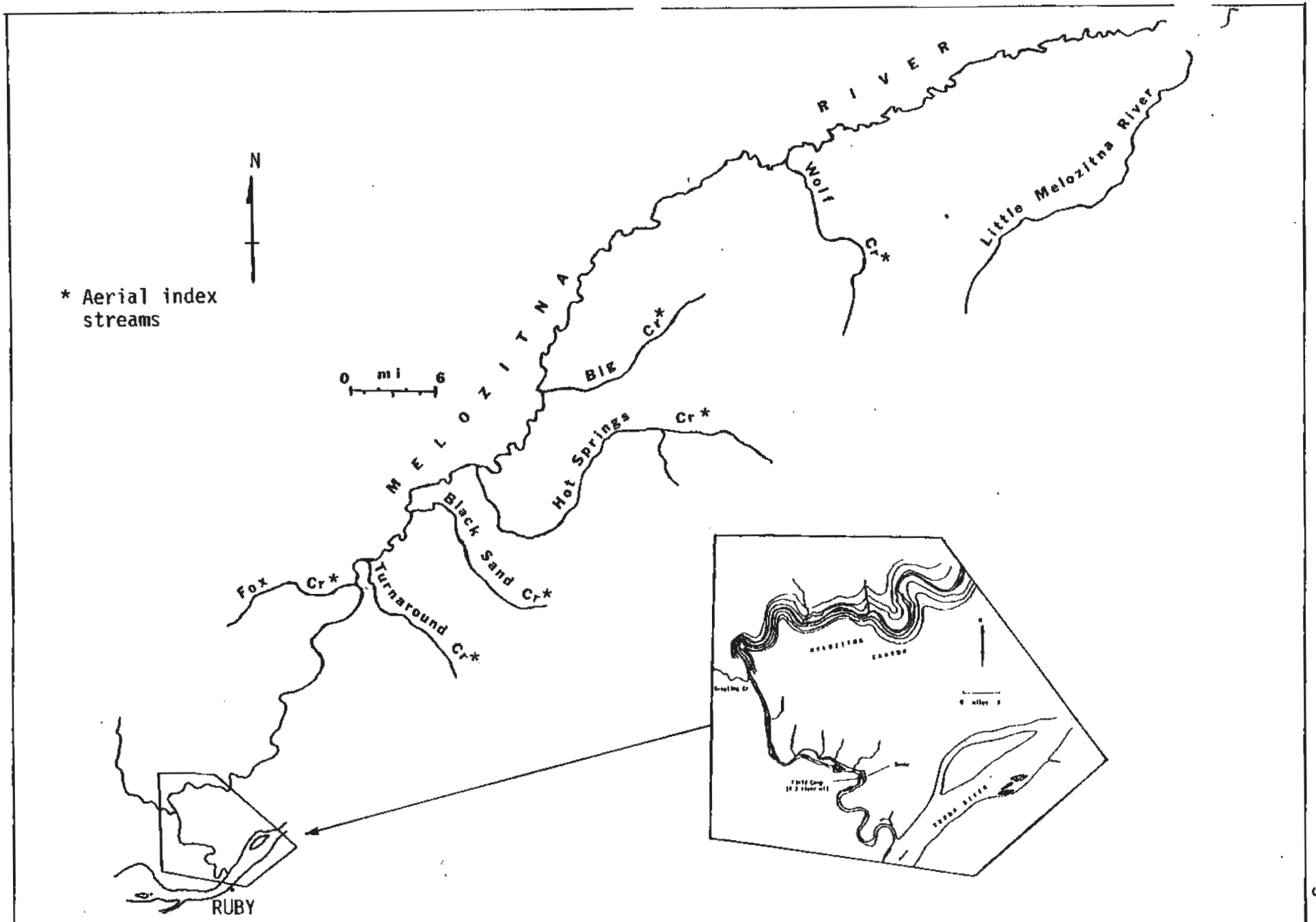

Figure 1. Melozitna River drainage and 1981 sonar study site.

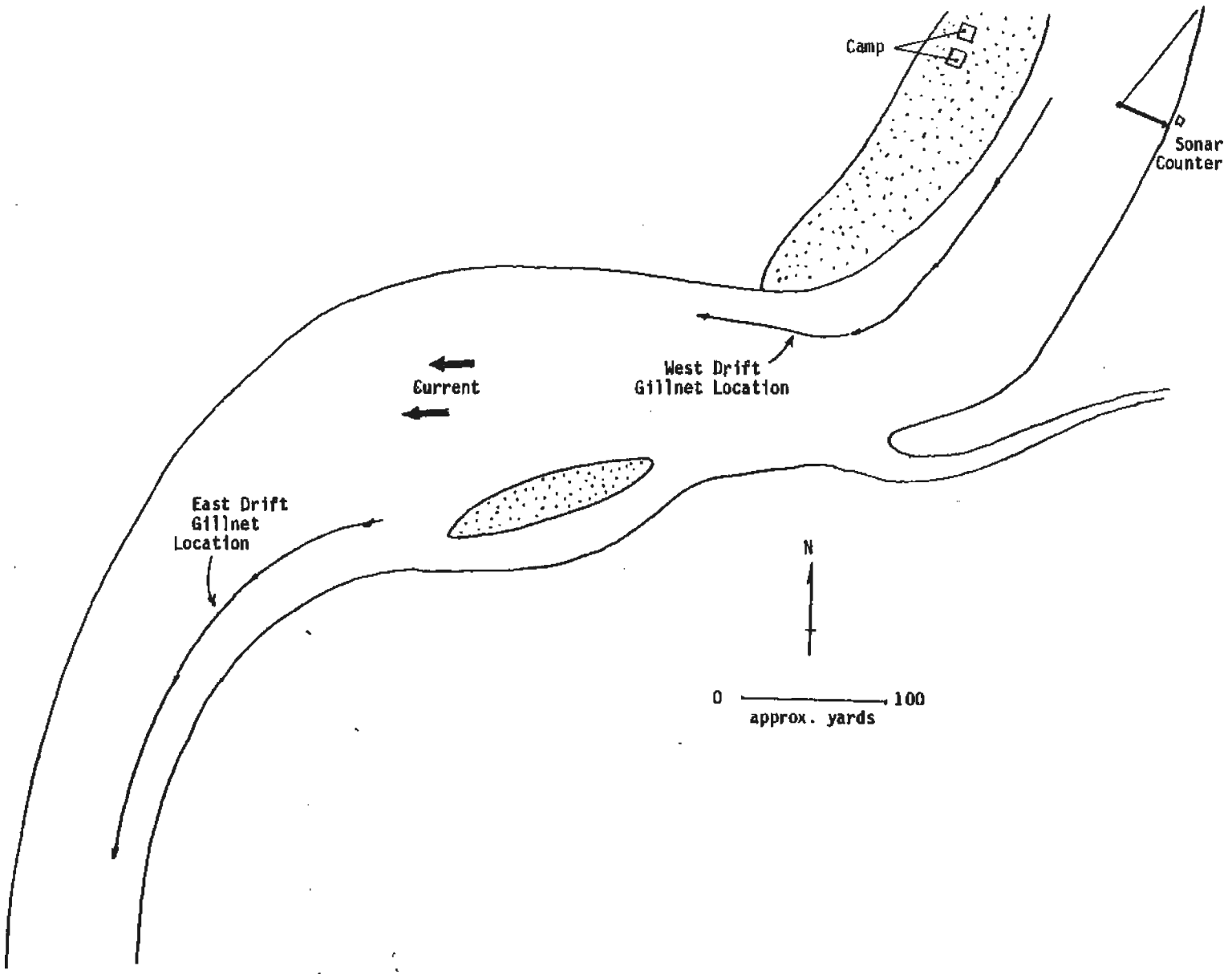

Figure 2. Melozitna River sonar and test fish study site, 1981.

A single 5-7/8"-mesh gillnet, 50 ft long by 12 ft deep, was fished in the vicinity of the sonar site to capture adult salmon for age-sex-size sampling. Four drifts per day (two on either side of the river) were made below the sonar counter. Resulting catches were examined to estimate the proportion of sonar counts generated by different fish species.

All king salmon and no more than 30 chum salmon were sampled daily for age-sex-size data. Each fish was sexed by external examination, measured from mid-eye to fork of tail to the nearest 5 mm, scale sampled for subsequent age analysis, and the adipose fin clipped to prevent resampling. Duration of each gillnet drift, resulting catch, and age-sex-size data were recorded. Salmon carcasses were also sampled in a similar manner once they began to appear in the area as the season progressed.

A river water-level gauge (meter stick) was installed at the sonar site on July 1. Daily changes in water level and water temperature were monitored at noon. Other daily observations included recording the occurrence of precipitation and percent cloud cover.

Sheefish were captured by hook and line. Floy tube tags were applied, with the tag color and number recorded along with the date tagged. A scale sample was taken from each fish and given to the Sport Fisheries Division for subsequent age analysis.

Results and Discussion

Timing: The sonar counter became operable at 1700 hours on July 3, and in excess of 4,900 salmon adjusted count) had passed by midnight of July 4 (Table 1). Daily counts for July 3 and 4 were not possible since the printer was inadvertently turned off during a portion of this period (from 1100 hours on July 3 through 1000 hours on July 4). By midnight of July 4, the number of salmon which had passed the sonar site represented 25.2% of the total number enumerated during the entire counting period (Figure 3). Subsequent to July 4, sonar counts steadily declined each day, indicating that the peak of the run occurred either on July 4 or prior to that date.

Numerous chum salmon were observed in the Melozitna River from the mouth upstream to the sonar site when the field crew first arrived on June 27. River water level was at the lowest point observed in 1981, and water conditions were very clear, permitting good visibility from the riverboat. An aerial survey of the Melozitna River could have been made on that date, judging from water clarity in the lower river.

The first summer rain occurred on June 26, and from that date through July 26 (a 31-day period) 10 days each of continuous and intermittent rain were encountered (Figure 4). This not only resulted in a dramatic rise in water level of the Melozitna River but also high

able 1. Percent daily and cumulative sonar counts and test gillnet catch and catch per unit effort on Melozitna River from July 3 through 26, 1981.

Date	Unadjusted Sonar Count	Percent Daily	Percent Cumulative	Gillnet Catch by Riverbank[1] East	West	Total	Gillnet CPUE[2] East	West	Both
7/3 }				NF[4]	NF	--			
7/4 }	4392[3]	25.2	25.2	NF	NF				
5	2203	12.6	37.8	NF	28	28		1.87	1.87
6	978	5.6	43.4	NF	NF	--			
7	799	4.6	48.0	NF	NF	--			
8	1083	6.2	54.2	0	20[5]	20[5]	0.0	0.33	0.29
9	1005	5.8	60.0	NF	NF	--			
10	537	3.1	63.1	2	16	18	0.07	0.27	0.20
11	1009	5.8	68.9	4	8	12	0.11	0.27	0.18
12	678	3.9	72.8	6	21[6]	27[6]	0.15	0.53	0.34
13	492	2.8	75.6	3	25	28	0.09	0.63	0.38
14	379	2.2	77.8	1	30	31	0.02	0.75	0.31
15	512	2.9	80.7	5	26	31	0.11	0.65	0.37
16	500	2.9	83.6	2	14	16	0.04	0.26	0.15
17	375	2.2	85.8	1	12	13	0.03	0.34	0.19
18	344	2.0	87.8	NF	NF	--			
19	396	2.3	90.1	1	6	7	0.03	0.17	0.09
20	517	2.9	93.0	1	5	6	0.03	0.14	0.08
21	265	1.5	94.5	0	2	2	0.0	0.07	0.04
22	291	1.6	96.1	0	2	2	0.0	0.20	0.07
23	283	1.6	97.7	1	1	2	0.03	0.03	0.03
24	150	0.9	98.6	0	2[6]	2[6]	0.0	0.08	0.04
25	93	0.5	99.1	0	0	0	0.0	0.0	0.0
26	159[7]	0.9	100.0	NF	NF	--			
Total	17,440[8]	100.0	100.0	27	218	245	0.05	0.37	0.22

1/ All catches are adult chum salmon (unless specified), captured in drift gillnet sets.
2/ Gillnet catch per effort (CPUE) expressed as number of fish per gillnet minute.
3/ Count is from 1700 hrs on July 3 through 2400 hrs on July 4.
4/ NF means not fished.
5/ This catch is from a set gillnet.
6/ These figures include one adult king salmon.
7/ Count is from 0001 through 1815 hrs on July 26.
8/ The final adjusted sonar count, based on oscilloscope calibration, was 19,707.

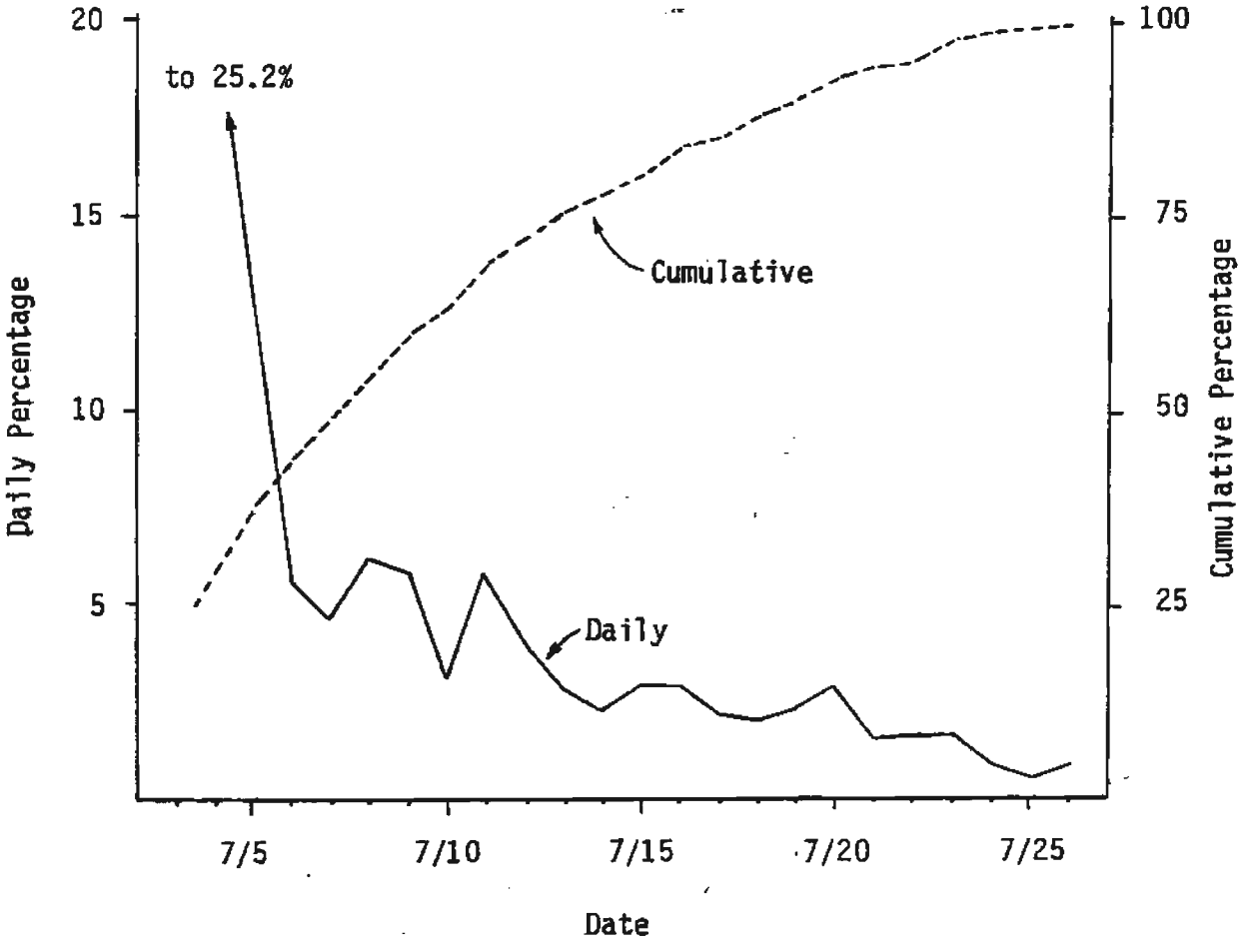

Figure 3. Relative timing of Melozitna River salmon escapement based on side-scan sonar, 1981.

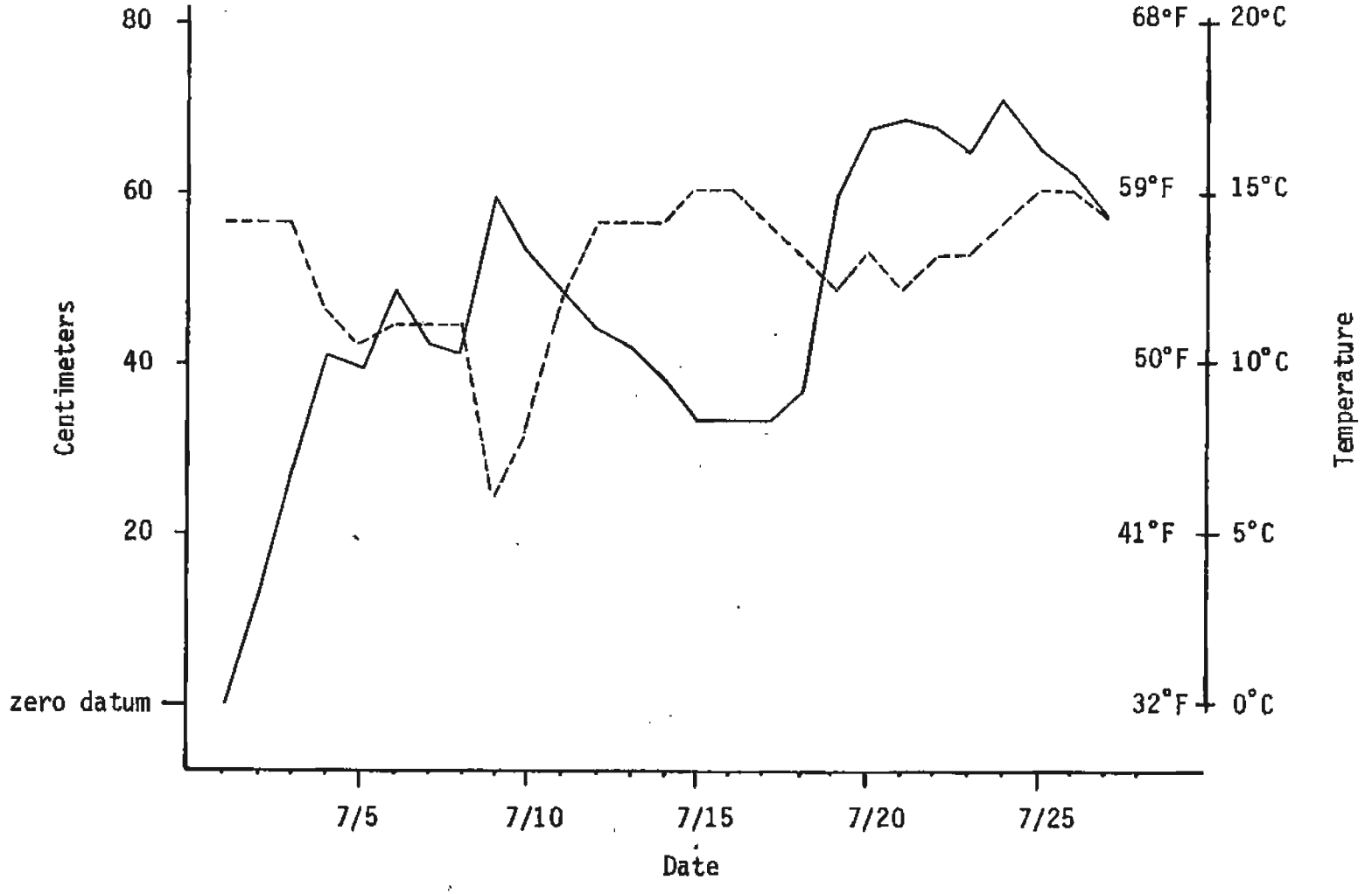

Figure 4. Daily changes in water level (solid line) and water temperature (broken line) at the Melozitna River sonar site, July 1-27, 1981.

turbidity levels. As a result, by July 1 turbidity was already at a point which prevented any successful attempts to survey the lower river.

Water temperature at the sonar site ranged from 42.8°F to 59°F throughout the counting period (Figure 4). The average was 54.9°F. Observations revealed an inverse relationship between water level and water temperatures, with high water levels accompanied by lower water temperatures.

Aerial escapement surveys have been flown since 1975 of several clear-water index streams of the Melozitna River. Surveys are generally conducted within the last 2 weeks of July. During this period estimates of salmon spawning within the mainstem river are hindered due to dark-stained and turbid water conditions. Consequently, only a general statement on spawn timing can be made and, at best, applies only to chum salmon in those clear-water streams where aerial surveys have been successful. Little can be said in reference to king salmon spawn timing due to the low numbers of individuals that have been observed in the Melozitna River drainage.

Observations since 1975 reveal chum salmon spawning in the aerial index streams to have occurred during the latter part of July. However, in 1981 some spawning occurred in early July, as revealed from the first appearance of spawned-out chum salmon carcasses on July 10 on the gravel bar at the sonar site. It is probable that some spawning was occurring in the mainstem Melozitna River due to the distance between the sonar site and aerial index streams (40 to 60 miles). Actual location and extent of this spawn are not known.

Distribution: It is estimated that approximately one-third of the river (from the east bank) was sampled by the sonar counter when installed on July 3. Percentage of the river being sampled continually decreased as the season progressed due to rising water level. A west-bank weir was installed on July 5 but had washed out by July 7.

A substantial number of salmon is believed to have passed the sonar site on the west side of the river beyond the counting range of the sonar unit. Distribution of upstream migrants over the sonar substrate was primarily confined to the inshore 15 ft (sectors 1-3) and outer 25 ft (sectors 8-12) of the counting range (Figure 5). The largest percentage (26.1) migrated across the substrate through sector 12, the last 5 ft of the counting range.

Catch per unit effort was consistently higher in west-side drift gillnet sets as opposed to east-side sets (Figure 6). Results showed 89% of the season's test-fish catch to have been taken from drifts on the west side of the river. East-side drifts accounted for only 11%. However, no east-side drifts could be made immediately below the sonar unit due to underwater snags. The east-side drifts were made approximately 1/2 mile below the counting site (Figure 2). An unknown number

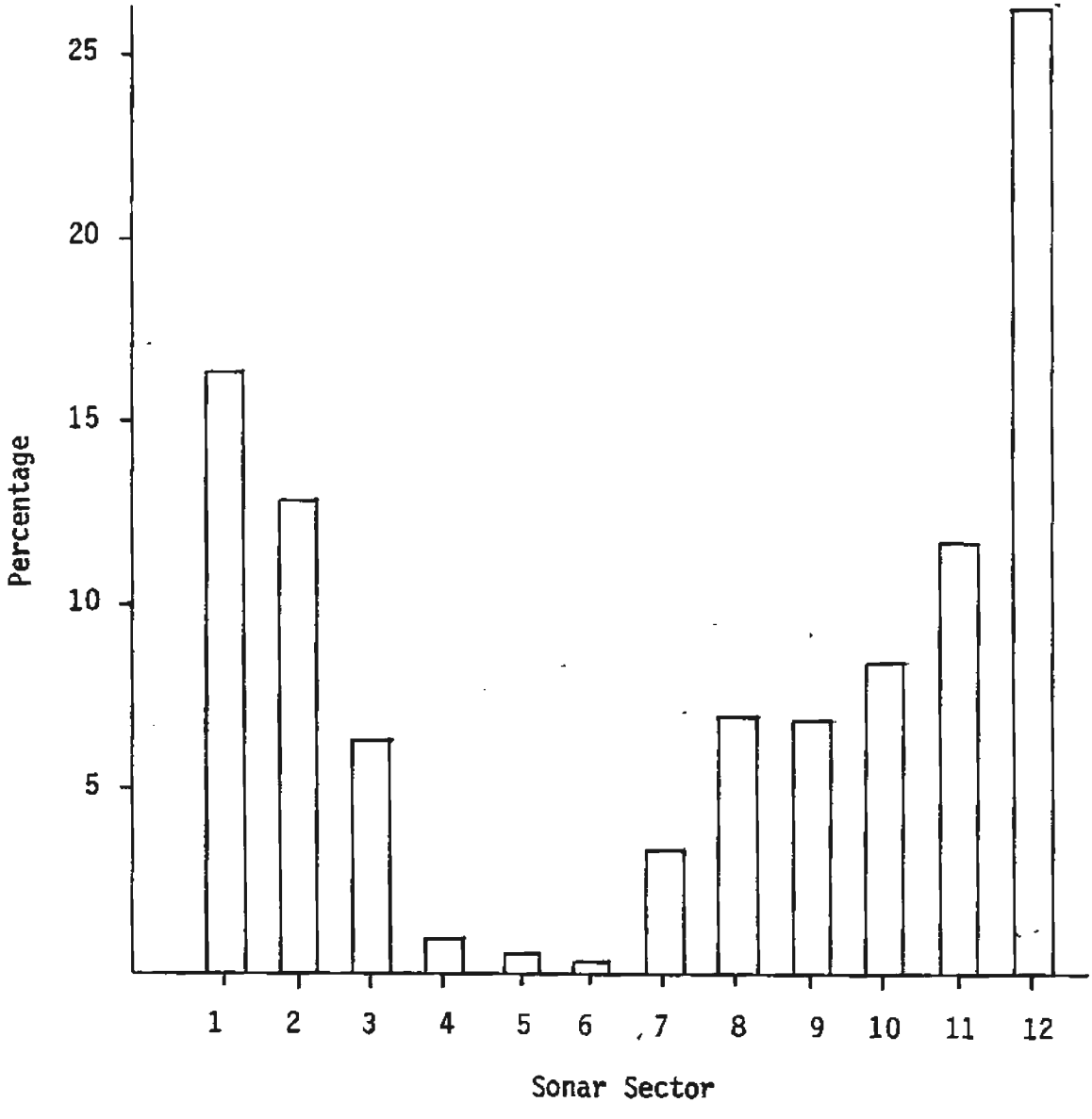

Figure 5. Distribution of salmon sonar counts by sector in the Melozitna River, July 5-25, 1981.

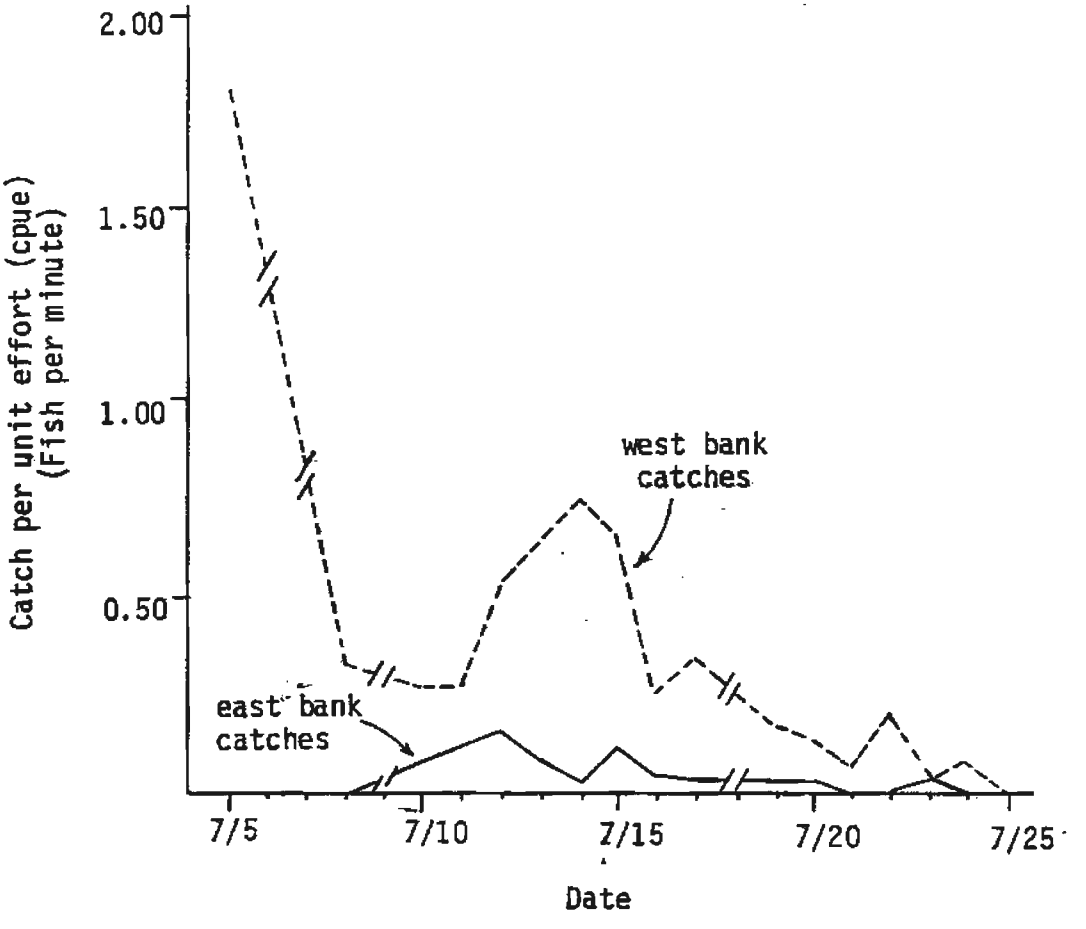

Figure 6. Relative timing and abundance of adult salmon by riverbank in Melozitna River based on gillnet test fishing, 1981.

of salmon may have crossed from the west side at this location to the east side by the time they arrived at the sonar site. However, test fishing results, when taken with the distribution of fish counts across the sonar substrate, strongly suggest that a substantial number of salmon passed the sonar site beyond the counting range of the sonar unit.

No distinct diurnal movement pattern of salmon moving by the sonar site was observed (Figure 7).

Knowledge of salmon spawning distribution within the Melozitna River drainage is primarily confined to observations made on six clear-water index streams (Figure 1). Aerial surveys of these streams have been flown as weather permits each year since 1975. From 1975-1980, king salmon have only been observed in two of the index streams, Blacksand Creek and Melozi Hot Springs Creek, while chum salmon occur in all six streams. A few observations have revealed both species occupying the mainstem Melozitna River between Fox Creek and Melozi Hot Springs Creek. Whether these fish were spawning in this area or migrating to tributary streams is not known.

Personnel from the Bureau of Land Management (BLM) reported the presence of numerous chum salmon carcasses in the Little Melozitna River in September 1980 and 1981 (Joe Webb, personal communication).

Based on aerial survey observations, Melozi Hot Springs Creek is the most important for both king and chum salmon spawning, followed by Blacksand Creek. Fox, Turnaround, and Wolf creeks are the next in importance for chum salmon spawning. The fewest number of chum salmon has been observed in Big Creek. Extent and importance of king and chum salmon spawning in the mainstem Melozitna River are unknown.

Abundance: Observer errors associated with oscilloscope calibration of sonar counts occurred during this feasibility study. Images of passing fish as they appeared on the oscilloscope screen were overcounted by observers. This was particularly the case from July 3 through July 12 when large numbers of fish were passing the sonar substrate during calibration periods. Consequently, calibration data obtained prior to July 13 were discarded.

Fewer numbers of salmon were counted in any given calibration period subsequent to July 12. Sample sizes were in fact too small to allow adjustment to the sonar counts on a daily basis. This lower rate of passage did, however, reduce the error associated with interpreting fish images as they appeared on the oscilloscope screen. Consequently, all calibration observations were pooled from July 13 through July 26 to calculate an adjustment to the total, raw sonar count. An agreement of 113% resulted between oscilloscope counts and sonar counts. The final estimate of salmon passing the sonar counter in 1981 from July 3 through 26 was 19,707 salmon (113% of 17,440).

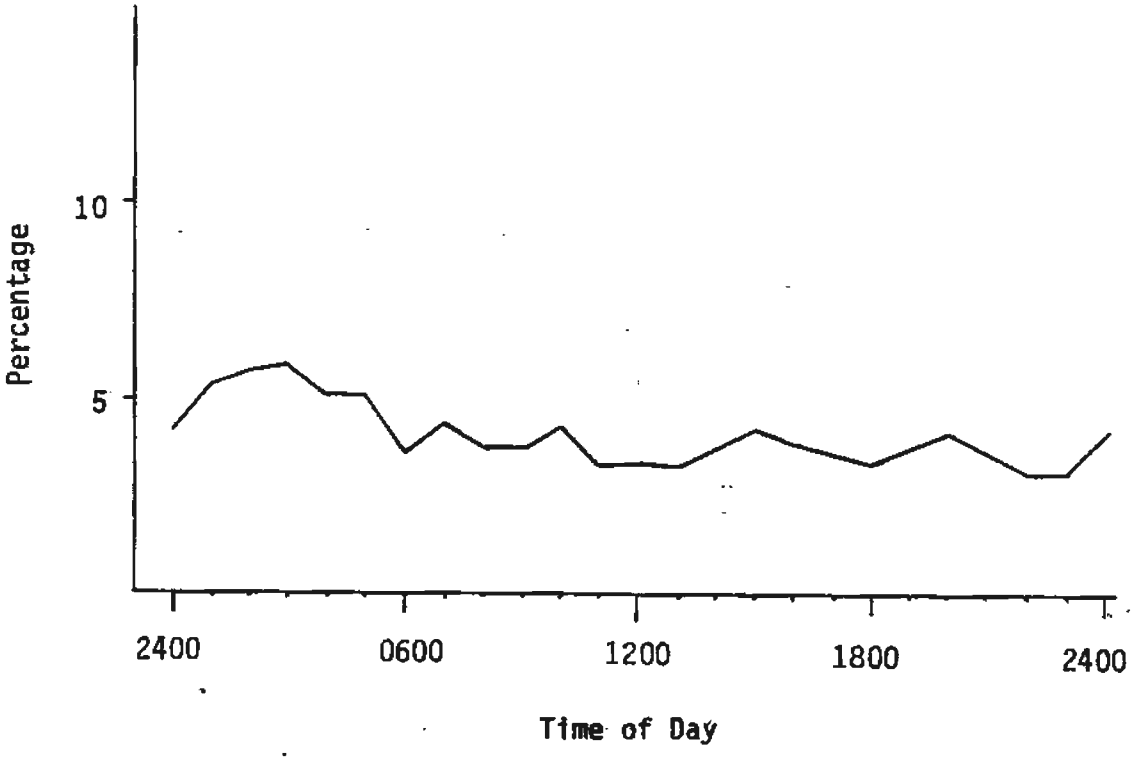

Figure 7. Distribution of salmon sonar counts by time of day in Melozitna River, July 5-25, 1981.

Whereas the fish velocity control setting remained at 0.571 sec/ft for the duration of counting in 1981, in retrospect an adjustment allowing for a faster fish swim speed should have been made. The above setting assumes a swim speed of 1.75 ft/sec.

The 19,707 estimate is known to be low and is considered, at best, to represent a minimal escapement of salmon into the Melozitna River for two reasons. First, sonar counting was initiated after the peak of the run, and, second, a substantial number of salmon is believed to have passed the sonar site undetected as previously discussed. Although 89% of the test fish catches were made on the west side of the river, the sonar estimate cannot be expanded by this percentage since test catches on the east side of the river were made substantially below the sonar counting site.

The proportion of the sonar counts caused by king salmon is not known but is believed to be small. Test-net catch results on species composition cannot be directly applied to the sonar estimate since gillnet mesh size selected toward chum salmon. Only two king salmon were captured, both in west-side drifts.

That relatively few king salmon utilize the Melozitna River drainage is illustrated by aerial surveys of index streams from 1975-1980 (Table 2). The largest number of king salmon observed (136) was in 1975, of which 77% were in Melozi Hot Springs Creek. However, until an accurate sonar or other total escapement estimate (by species) can be made, or the extent of mainstem spawning defined, importance of the Melozitna River in terms of king and chum salmon production will remain unknown. Since it will probably remain unlikely that aerial observations alone will determine the distribution and extent of mainstem spawning due to turbid water conditions, sonar enumeration accompanied by aerial surveys appears to be the most feasible method to pursue.

Age, Sex, and Size Composition: A total of 254 chum salmon was gillnetted from July 5 through 24. From these, 200 were examined for age, sex, and size composition. Twenty-one percent of the samples were not ageable. Results revealed a sex ratio of 45% males and 55% females. Further, the catch was predominated by age 5_1 fish (73.5%), followed by 4_1 fish (24.5%). Ages 3_1 and 6_1 fish composed less than 2% each of the catch.

Chum salmon carcasses were sampled at the sonar site from July 18 through 26. Nineteen percent of the samples were not ageable. From the remaining 103 samples, the sex ratio was found to be 43% male and 57% female, being similar to gillnet catch sampling results. However, percent age composition differed markedly from gillnet samples, with the carcass samples being predominated by age 5_1 at the 52% level followed by age 4_1 fish at 47%. Only 1% were age 3_1, and no other age class was represented. Results from carcass sampling revealed a much higher proportion of age 4_1 fish in the chum salmon escapement

Table 2. Comparative king and summer chum salmon escapement estimates based on aerial surveys of selected index streams in the Melozitna River drainage, 1975-1980.[1/]

	1975		1976		1977		1978		1979		1980	
	Kings	Chums	Kings	Chums	Kings	Chums	Kings	Chums	Kings	Chums	Kings	Chums
Mainstem Melozitna R.	31	2068	1	200								
Blacksand Cr.		2971	3	450	2	75	1	1054		625(23)		
Fox Creek		1835				41		309		57(16)		73(17)
Turnaround Cr.		863		40				196		268(16)		
(Melozi) Hot Springs Cr.	105	4196	9	1768	13	1014	8	4012	9	1469(16)	11	6345(29)
Wolf Creek										160(16)		
Big Creek										4(20)		
Totals	136	11,933 (29)	13	2458 (25)	15	1130 (20)	9	5571 (13)	9	2583 (16,20,23)	11	6418 (17,29)

[1/] Numbers in parentheses show days in July that observations were made.

than indicated from gillnet samples. This is attributed to the tendency of gillnets to select toward larger fish. Likewise, the mean size at age for each sex was larger for gillnet samples than for the carcass samples (Table 3).

Only two king salmon were captured in gillnets and no king salmon carcasses were sampled. The two gillnetted were a 730-mm, age 5_2 male and a 930-mm, age 6_2 female.

Sheefish Observations: A total of five sheefish was captured by hook and line in the Melozitna River approximately 1/4 mile upstream from the river mouth. Four of these fish were tagged and released. Pertinent sample data is given below:

Date	Sex	Fork Length	Tag Number	Tag Color
7/22	-	735 mm	0426	yellow
7/23	-	659 mm	0428	yellow
7/23	F	841 mm	(no tag applied)	
7/24	-	810 mm	0429	yellow
7/24	-	720 mm	0430	yellow

One of the four tagged sheefish was recovered 22 miles below the Yukon River haul road bridge on August 26.

Summary

1. A sonar estimate of 19,707 salmon was obtained along the east bank of the Melozitna River from July 3 through 26. The majority of this estimate was attributed to chum salmon. The sonar counting period was subsequent to the peak of upstream salmon migration.

2. Distribution of test-net catches revealed an unknown proportion of upstream migrant salmon passed the sonar site undetected along the west bank.

3. A 113% correlation between oscilloscope and acoustic counts was obtained for the duration of the counting period.

4. River water temperature ranged from 42.8°F to 59°F and averaged 54.9°F at the sonar site from July 3 through 26.

5. No distinct diurnal salmon movement pattern at the sonar site was observed.

6. An unknown percentage of chum salmon spawned in early July. Precise location of the spawning is not known.

Table 3. Comparative age, sex, and size composition of summer chum salmon sampled at river mile 4 of the Melozitna River, July 1981.[1/]

	Age 3_1			Age 4_1				Age 5_1				Age 6_1			Total			
	n	(%)	$\bar{x}$	n	(%)	$\bar{x}$	SD	n	(%)	$\bar{x}$	SD	n	(%)	$\bar{x}$	n	(%)	$\bar{x}$	SD
Gillnet[2/] Samples																		
male	-			14	(7)	602	24	73	(36.5)	621	29	3	(1.5)	622	90	(45)	618	28
female	1	(0.5)	515	35	(17.5)	565	22	74	(37.0)	590	24	-			110	(55)	581	27
Total	1	(0.5)	515	49	(24.5)	576	28	147	(73.5)	605	31	3	(1.5)	622	200	(100)	598	33
Carcass Samples																		
male	1	(1.0)	510	17	(16.5)	586	31	26	(25.2)	614	35	-			44	(43)	601	38
female	-			31	(30.1)	528	19	28	(27.2)	552	24	-			59	(57)	540	25
Total	1	(1.0)	510	48	(46.6)	549	37	54	(52.4)	582	43	-			103	(100)	566	43

[1/] Age designated by Gilbert-Rich formula: total years of life in superscript; years of freshwater life in subscript. All lengths are mid-eye to fork of tail.
[2/] Samples collected in 5-7/8 inch gillnet.

7. The male-to-female ratio of chum salmon approached 1:1 in both gillnet catch samples and carcass samples.

8. Age 5_1 chum salmon predominated in both gillnet catch samples and carcass samples. However, catch samples underestimated the proportion of age 4_1 chum salmon present and in all cases showed a larger mean size of fish by age and sex than carcass samples.

9. No aerial escapement surveys of the Melozitna River drainage could be flown in 1981 due to excessive rain and resulting turbid river conditions.

10. Four sheefish were tagged and released on July 22, 23, and 24 at the mouth of the Melozitna River. One was recaptured 22 miles below the Yukon River haul road bridge crossing on August 26.

Conclusions

Although the exact proportion of the salmon run counted by sonar is not known, escapement to the Melozitna River is considered to have been well in excess of 19,700. This conclusion is based on the counting period having been subsequent to the peak of the run and test fishing results which suggested a substantial number of salmon passed the sonar site undetected along the west side of the river.

Gillnet catch results could not be directly applied to the sonar estimate to apportion counts by species. However, catch results and past aerial surveys (1975-1980) of selected index streams in the Melozitna River drainage suggest that the salmon escapement in 1981 was mostly composed of chum salmon, with only a few king salmon present (possibly less than 1% of the run).

It was considered that site location was conducive to the side-scanning sonar system and that sonar can be effectively used to monitor salmon escapements in the Melozitna River at the 1981 location. However, two counting units, one deployed from either riverbank, should be operated to more precisely estimate total salmon escapement to this river. A second unit could be operated from the west bank at the present site if river water level does not rise substantially from that experienced in 1981.

Successful sonar enumeration of salmon escapement in the Melozitna River, with the aid of aerial surveys of selected index streams, is probably the most feasible method to pursue in understanding importance of mainstem river spawning. Further, sonar enumeration can provide run timing and relative strength criteria useful for in-season management of the Yukon River fishery. Such information would be obtained 3 to 4 weeks earlier than would otherwise be available from aerial escapement surveys alone.

Since the advent of these studies, several local communities are pursuing the possibility of construction of a hydroelectric dam on the Melozitna River. Enumeration of salmon escapement to this river system would be essential in assessing the possible impact to the fishery resource if such a construction project were to occur.

Recommendations

It is recommended that side-scanning sonar be used to monitor Melozitna River salmon escapements. Two counting units should be installed at the present site, one from either side of the river, to ensure adequate sampling coverage. However, if only one unit is available for use it should be operated from the west bank at the present site as opposed to the east bank. Sonar enumeration should commence not later than about June 24 and earlier, if possible, based on run timing information obtained in 1981.

Daily water velocities should be estimated at the sonar site to serve as an indicator of necessary changes in the fish velocity control setting on the side-scan sonar counter(s).

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