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1972 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:
Kenneth P. Parker

1974

ALASKA DEPARTMENT OF FISH AND GAME
Subport Building, Juneau, Alaska 99801

James W. Brooks
Commissioner

ADF&G TECHNICAL DATA REPORTS

This series of reports is designed to facilitate prompt reporting of data from studies conducted by the Alaska Department of Fish and Game, especially studies which may be of direct and immediate interest to scientists of other agencies.

The primary purpose of these reports is presentation of data. Description of programs and data collection methods is included only to the extent required for interpretation of the data. Analysis is generally limited to that necessary for clarification of data collection methods and interpretation of the basic data. No attempt is made in these reports to present analysis of the data relative to its ultimate or intended use.

Data presented in these reports is intended to be final, however, some revisions may occasionally be necessary. Minor revision will be made via errata sheets. Major revisions will be made in the form of revised reports.

1972 Bristol Bay Sockeye Salmon Smolt Studies

A summary of data collected from sockeye salmon (*Oncorhynchus nerka*) smolt programs on the Kvichak, Naknek and Ugashik Rivers

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1972 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The Kvichak River sockeye salmon smolt study was originated in 1955 by the Fisheries Research Institute, University of Washington. In 1961 the program became the responsibility of the Alaska State Department of Fish and Game, Division of Commercial Fisheries Research staff. Since the programs inception, eighteen years ago, annual indices have been obtained of the spring emigration of sockeye salmon smolt (Oncorhynchus nerka) from the Lake Clark - Lake Iliamna nursery grounds.

Information obtained from this program is directed toward forecasting age composition and magnitude of adult returns to the Lake Clark - Lake Iliamna system from an evaluation of smolt production at various levels of adult escapement.

Indices collected over the past years have provided much information on population dynamics of the Lake Clark - Lake Iliamna sockeye salmon populations. Unfortunately, the indices have proven to be of variable reliability as a forecast tool due in part to inherent inefficiencies of fyke net sampling.

In 1965 a federally funded program using funds from Commercial Fisheries Research and Development Act (P.L. 88-309), was initiated to improve the index or obtain an outmigration estimate suitable for forecast application. Beginning the fiscal year 1969-70 the program funding was switched to the Anadromous Fish Act (P.L. 89-304).

Under the federally funded program, research was directed toward the development of hardware and techniques to estimate the total outmigration. In 1970 experiments were conducted testing the feasibility of utilizing underwater sonar counting equipment in the Kvichak River. Initial field experimentation with the sonar counting equipment verified the feasibility of sonar application to smolt enumeration (Paulus and McCurdy, 1972). Sonar counting systems were utilized for smolt enumeration in 1971 and 1972. Information concerning the characteristics, construction, and operation of the sonar equipment in 1971 has previously been published with the 1971 index data (Russell, 1972). However, this report contains the first analysis of the sonar counts collected for the 1971 and 1972 seasons along with total outmigration estimates for both years.

The index program was maintained in 1972 as in the past in the hope that it will eventually prove to be proportional to outmigration estimates in order to utilize historical data. Such a relationship would permit the estimation of total outmigrations from past season fyke net indices.

1971 OUTMIGRATION PROGRAM

Materials and Methods

Sonar Counting Systems. Two sonar counting systems were utilized for smolt enumeration in 1971. In addition to the existing 1970 model, a new sonar system composed of two 12' arrays was built by the Bendix Corporation (Russell, 1972).

Site Selection. The 1971 sonar site was located four miles downstream from the ADF&G field station (Figure 1). At this location the Kvichak River is confined to a single main channel with a relatively small secondary channel passing off to the west side. The main channel, 640' wide, possesses a relatively smooth even bottom averaging 4-1/2 feet deep.

Sonar units were positioned in the main channel using the sonar anchoring procedure as in 1970, (Paulus and McCurdy, 1972). The 1971 sonar system was operated off the east bank and the 1970 system off the west bank, (Figure 2). Tents were placed on both sides of the river to provide shelter for the electronic packages and crews.

Sonar Calibration. Sonar system calibrations in 1971 were conducted using standard 6' x 4' fyke nets with wings positioned 10 feet behind the sonar arrays. Calibrations were first made for the 1971 sonar gear and later in the season for the 1970 gear. Calibration consisted of determining the number of smolt captured per sonar count. This was done by first assessing the number of smolt in a fyke net catch. Due to the large numbers characteristic of catches, a one pound subsample would be extracted and counted. The resulting smolt per pound would then be multiplied by the catch weight producing an estimate of the number in the catch. Next, this calculated number of smolt in the catch would be divided by the corresponding sonar counts accumulated during the calibration period. The calibration periods varied depending upon the smolt passage rates encountered. High passage rates would limit calibration periods to a few minutes to minimize catches.

To determine which calibrations would be considered valid, the design specifications of the sonar counters were considered. These included: (1) at optimal adjustment the sonar would register one count for 10 smolt of a specific biomass, (2) it was mechanically impossible that less than 5 fish could trigger a count, and (3) no more than 20 smolt could cross the unit with only a single count registered. From these specifications it was established that calibrations of under 5 fish per count or over 20 fish per count could be discounted as mechanically invalid. The reasonableness of these limits can be realized when the placement of the net 10 feet behind the sonar array is considered. In that distance schools angling laterally can miss the sonar and be caught in the net or counted and not caught. Consequently, the 5 to 20 fish per count range was adopted as the acceptable limits for valid calibrations.

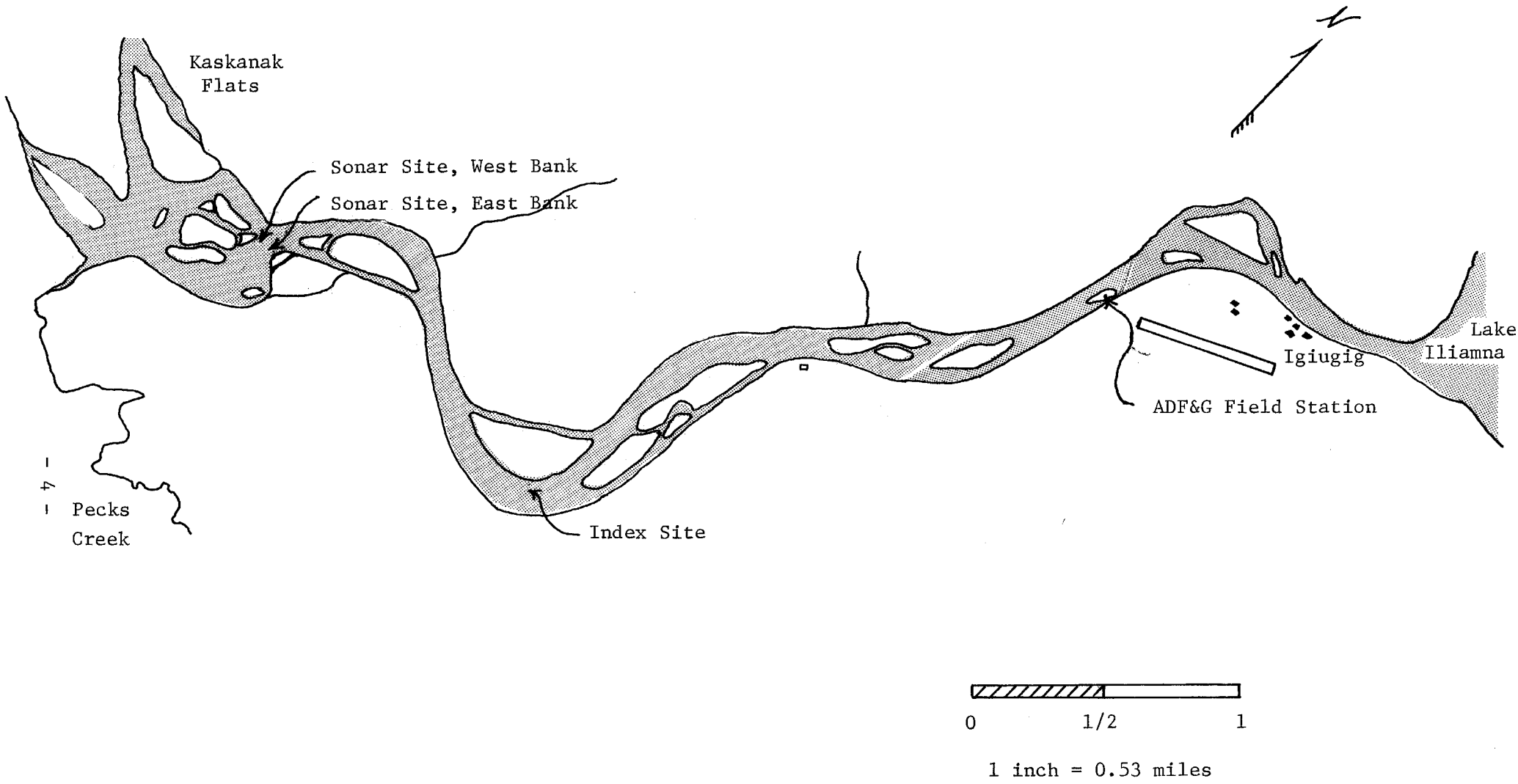

Figure 1. Upper Kvichak River sample sites, 1971 - 1972.

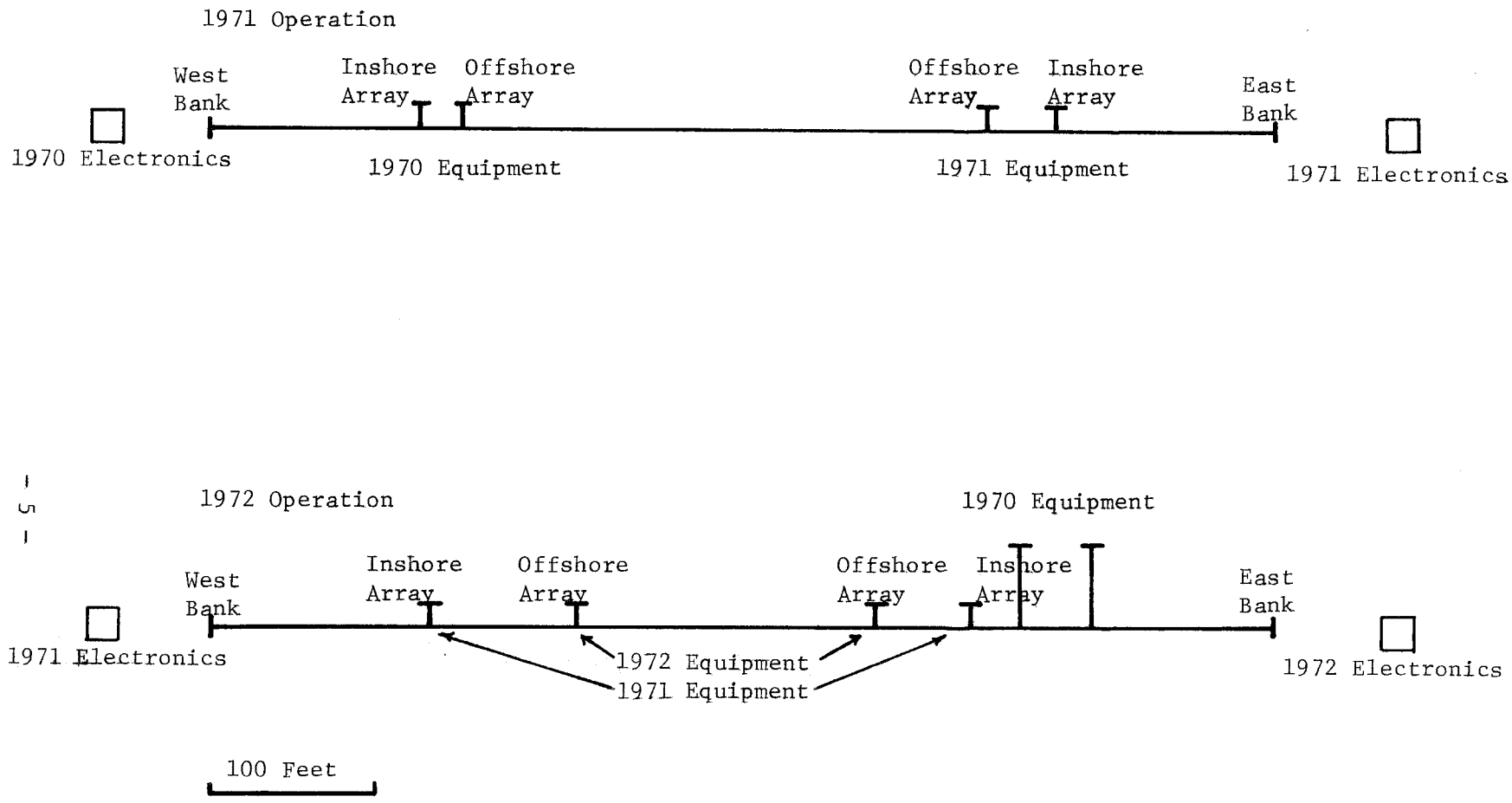

Figure 2. Sonar equipment placement in the Kvichak River for 1971 and 1972.

The average smolt per count for each sonar system was calculated by compiling a summary of all valid consecutive calibrations. The calculated smolt per count for each group was then averaged and expanded by 12/9 to compensate for differences between the length of the sonar arrays and the width of the opening of the calibrating fyke net. This process was repeated for both sonar systems. A calculation was also made for under counting or over counting from the differences between the measured velocity of each array and the velocity set on the electronics; the counts were appropriately adjusted. Additional refinement was planned for sonar calibrations.

After the season, evidence of optimal sampling conditions was sought from an analysis of day-night and high-low passage rate calibration data.

Sonar Operations. To insure proper recording and labeling of valid sonar counts, instruments were continually monitored. It was noted that winds over 40 m.p.h. and heavy precipitation would entrap air into the river and cause false counts. Such counts were subtracted from the valid sonar counts. Likewise, ice acts as a strong target and without setting the range below the depth of the ice, the ice would produce invalid counts. All invalid counts were subtracted from the recorded sonar counts prior to expansion procedures.

As in index operations, sonar sampling "days" were on a noon to noon basis. To facilitate this, the digital counter totals were logged, cleared and set to "0" at six hour intervals beginning at 12 noon. This prevented error buildup in the timers that trigger interval printing.

Total Outmigration Estimate. The procedure for calculating total outmigration, including expansion for missed area between sonar arrays, is as follows:

1. The season total sonar count for each array is determined.

2. Sonar counts are transposed into numbers of smolt by applying the appropriate calibration and current velocity correction factors.

3. The number of smolt per foot of array is computed for each sonar array fished.

$$\frac{\text{Total smolt over array}}{\text{Array length 12'}}$$

4. The distances between array centers and inshore arrays and river banks are assessed.

5. The number of smolt per foot of sonar array is multiplied by one-half the distances to adjacent array centers.

6. The number of smolt between an inshore array and its adjacent river bank is calculated by multiplying the number of smolt per foot of the inshore array by half the distance to its bank.

7. The total outmigration estimate is derived by summing the calculated number between array centers plus the calculated number of smolt between inshore array centers and the adjacent river banks.

RESULTS

Sonar Sampling. Twenty-four hour sonar sampling began on the east bank May 24 and terminated June 18. West bank operations began June 2 and terminated June 18. Lost fishing time was minimal due to sonar's ability to function under most adverse conditions.

Initial sonar counts recorded from east bank arrays from May 24-29 were disregarded due to false counts from heavy ice, wind, and rain. (Appendix Table A-10).

Calibration. Results from sonar calibrations conducted during 1971 indicate that the 1970 sonar equipment was counting at 247.9 smolt per sonar count (Table 1). The observed low counting efficiency was attributed to obvious shipping damage that occurred while the gear was in transit from Los Angeles to Alaska in the spring of 1971. The 1971 sonar equipment exhibited calibrations close to designed electronic capabilities with an observed 9.96 smolt per sonar count (Table 2).

From a total of 62 calibrations, 52% were within the established acceptable limits as stated in the Materials and Methods section. Post season analysis of calibrations verified the relationship between high passage rates and calibrations accuracy as 70% of calibrations recorded above 50 fish/minute were valid while below the 50 fish/minute passage rate only 39% of the recorded calibrations were valid (Appendix Table A-13).

Day and night sonar calibration showed no significant difference in smolt per count, indicating similar day and night avoidance of the calibrating fyke net (Table 3). Consecutive calibrations were grouped into rather arbitrary 45 to 130 minute groups to do away with variance resulting from pulling the net too soon, before all counted fish have entered, or too late in which case uncounted sub-threshold stragglers may be added to counted smolt. Sub-threshold refers to any smolt group of less than countable biomass. Grouping is most essential to very short calibrations of a few minutes duration.

Outmigration Estimate. Daily sonar counts after expansion by calibration and water velocity factors (Table 4) are represented as daily sockeye salmon smolt numbers over arrays in Table 5. The season total adjusted number of smolt over arrays was 9,513,996 with west bank sonar contributing 92.10% and east bank sonar 7.90%.

Following expansion procedures a total season outmigration of 91,682,813 sockeye salmon smolt was apportioned by day (Table 6) and compared to index results in Figure 3.

Table 1. Calibration summary for 1970 sonar equipment, west bank inshore & offshore sites, 1971.

	Total time minutes	Total sonar counts	Total catch	Average fish/ count/period
	60	73	2059.0	282.0
	50	44	22237.0	505.0
	65	20	3680.0	184.0
	56	29	3318.0	114.0
	73	22	2307.0	105.0
	93	15	1072.0	714.0
	54	20	1885.0	94.0
	59	3	753.0	251.0
	57	12	2800.0	233.0
	57	17	3540.0	208.0
	59	46	8363.0	182.0
	52	18	4831.0	268.0
	59	134	9472.0	70.0
	67	150	9310.0	62.0
	45	28	4650.0	166.0
TOTALS	906	631	80277.0	2796.0

$\bar{\bar{x}}$ fish/count = $\frac{2796}{15}$ = 186.4 x $\frac{12}{9}$ 1/ = 247.9

1/ adjustment to compensate for 12 foot array.

Table 2. Calibration summary for 1971 sonar equipment.

	Total time, minutes	Total sonar counts	Total catch	Average fish/ count/period
	52	888	7293	8.2
	64	745	5172	6.9
	35	344	1703	5.0
	73	334	1703	5.1
	131	45	225	5.0
	40	262	3257	12.4
	61	938	5635	6.0
	32	484	3428	7.1
	106	247	1424	5.8
	64	855	5126	6.0
	44	1968	17204	8.7
	58	381	3580	9.4
	62	375	2170	5.8
	60	28	258	9.2
	60	158	1802	11.4
TOTAL	942	8052	59980	112.0

$\bar{\bar{x}}$ fish/count = $\frac{112}{15}$ = 7.47 x 12/9 1/ = 9.96.

1/ adjustment to compensate for 12 foot array.

Table 3. Day and night sonar calibrations, East bank, 1971.

	Date	Fishing Time Set	Fishing Time Pulled	Fishing Time Min.	Sonar Counts	Catch	Average Calibration
Day Calibrations	6/11	0353	0418	25	247	1401	5.68
		1106	1116	10	125	1463	11.70
		1150	1154	4	444	3025	6.81
		1154	1208	14	382	3323	8.70
		1400	1450	50	363	1849	5.09
		1537	1612	35	344	1703	4.95
		1627	1743	73	334	1703	5.10
	6/12	1652	1804	72	12	96	8.00
		1855	1935	40	262	3257	12.43
		1944	2008	24	375	2351	6.27
	6/13	1505	1528	13	483	2925	6.06
		1528	1545	17	482	3948	8.19
		1621	1626	5	495	2700	5.45
		1626	1638	12	155	840	5.42
		1638	1648	10	872	9716	11.14
		1648	1708	20	172	1376	8.00
	TOTALS			424	5,547	41,676	7.44
Night Calibrations	6/11	0123	0334	131	45	351	7.8
	6/12	2042	2103	21	284	1566	5.51
		2103	2119	16	279	1718	6.16
		2119	2151	32	484	3428	7.08
		2151	2336	106	247	1424	5.77
		2355	0007	13	284	1656	5.83
		0007	0031	24	56	385	6.88
		0134	0148	14	32	160	5.00
		1944	2317	213	70	467	6.67
	TOTALS			570	1,781	11,155	6.30

Table 4. Correction factors applied in calculation of total outmigration, 1971.

	West Bank		East Bank	
Factor	Inshore	Offshore	Offshore	Inshore
Calibration	247.9 f/c	247.9 f/c	9.96 f/c	9.96 f/c
Water Velocity	1.0	0.9964	1.03	0.9706

Table 5. Kvichak River daily sockeye salmon smolt counts by array, 1971. Counts include corrections for water velocity differences between arrays.

Date (noon to noon)	West Bank Inshore	West Bank Offshore	East Bank Offshore	East Bank Inshore	Total	Index 1/
5/22-29						
29-30			1878	1372	3250	36
30-31			93	78	171	40
31- 1			226	425	651	38
6/1 - 2			82	49	131	41
2 - 3	7685	8646	267	203	16801	43
3 - 4	80320	91887	82	19	172308	25
4 - 5	59992	68668	124	174	128958	48
5 - 6	30988	35569	523	396	67476	78
6 - 7	70156	80524	2021	1701	154402	40
7 - 8	11899	13832	1642	4804	32177	441
8 - 9	1239	1235	205	483	3162	150
9 -10	67925	77808	34346	41710	221789	1207
10 -11	915742	1049782	68488	82935	2116947	955803
11 -12	932104	1068554	49170	97048	2146876	318029
12 -13	747666	857116	53315	108224	1766321	285481
13 -14	86765	99544	78674	56418	321401	121448
14 -15	142543	163519	7622	16627	330311	25777
15 -16	690401	791659	5745	7260	1495065	171300
16 -17	186917	213662	7756	7482	415817	46450
17 -18	50820	58293	6976	4389	120478	217
18 -19						1251
19 -20						141
TOTAL	4082665	4680299	319235	431797	9513996	1927984

1/ Daily 24-hour Index catches recorded for 1971.

TABLE 6. Kvichak River sockeye salmon smolt outmigration by day and age group, 1971.

Date noon-noon	Daily total smolt counts		Daily out-migration	Age I Smolt		Age II Smolt	
	number	percent		number	percent	number	percent
5/29-30	3250	0.03	27505	25717	93.5 1/	1788	6.5 1/
30-31	171	.00	0	0	93.5	0	6.5
31-1	651	0.01	9168	8572	93.5	596	6.5
6/1-2	131	0.00	0	0	93.5	0	6.5
2-3	16801	0.18	165029	154302	93.5	10727	6.5
3-4	172308	1.81	1659459	1551594	93.5	107865	6.5
4-5	128958	1.36	1246886	1165838	93.5	81048	6.5
5-6	67476	0.71	650948	608636	93.5	42312	6.5
6-7	154402	1.62	1485262	1388721	93.5	96541	6.5
7-8	32177	0.34	311722	291460	93.5	20262	6.5
8-9	3162	0.03	27505	25717	93.5	1788	6.5
9-10	221789	2.33	2136209	1997355	93.5	138854	6.5
10-11	2116947	22.25	20399426	19073464	93.5	1325962	6.5
11-12	2146876	22.56	20688226	19343491	93.5	1344735	6.5
12-13	1766321	18.56	17020914	15914555	93.5	1106359	6.5
13-14	321401	3.38	3098879	2897452	93.5	201427	6.5
14-15	330311	3.47	3181394	2974603	93.5	206791	6.5
15-16	1495065	15.72	14403370	13467151	93.5	936219	6.5
16-17	415817	4.37	4006539	3746114	93.5	260425	6.5
17-18	120478	1.27	1164372	1088688	93.5	75684	6.5
TOTAL	9,513,996	100.00	91,682,813	85,723,430	93.5	5,959,383	6.5

1/ Season weighted age class percent composition as calculated for Index, 1971.

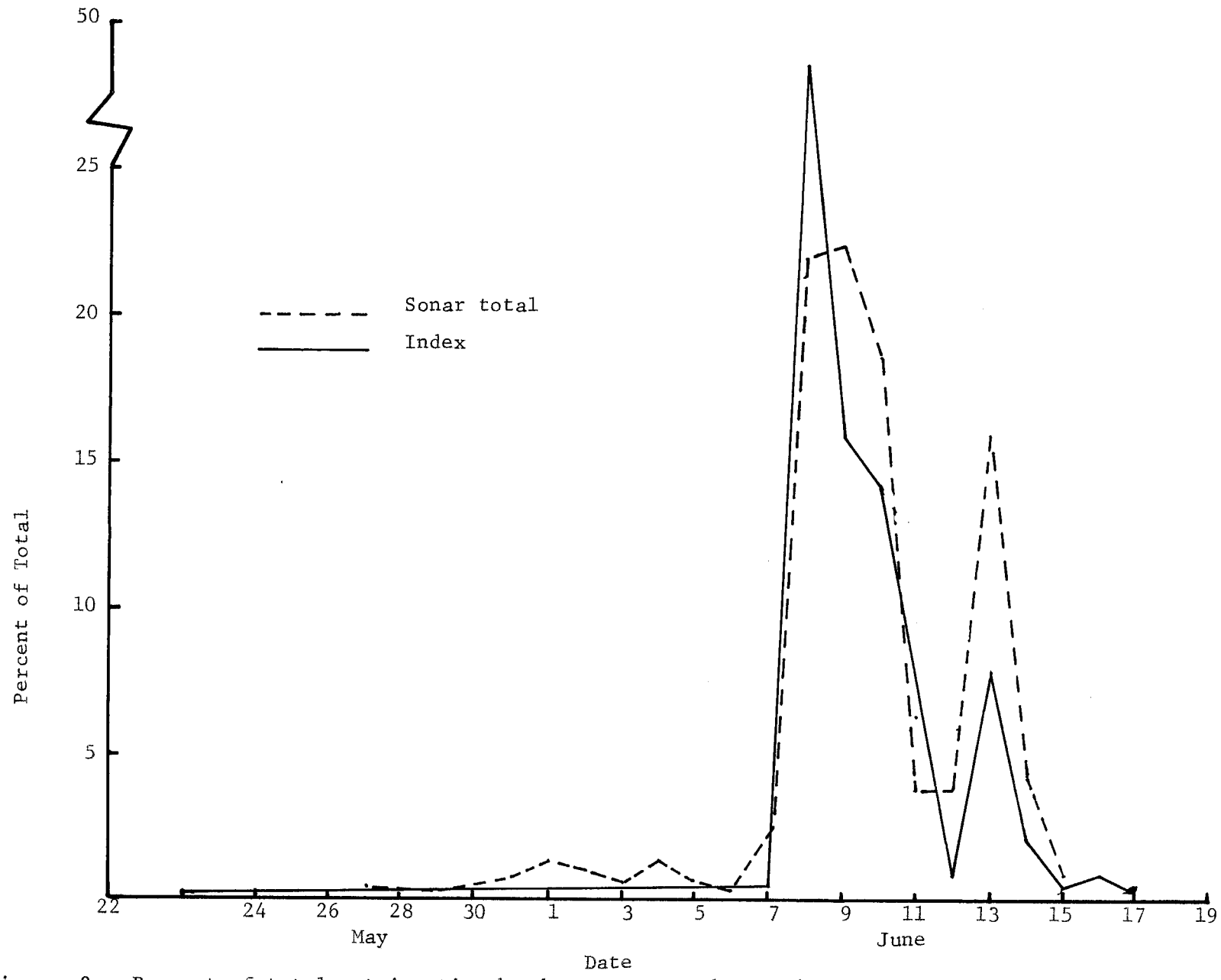

Figure 3. Percent of total outmigration by day as measured at Index and sonar, 1971.

Smolt length frequency data collected for both east and west bank sonar units, show significant similarities (Figure 4 and 5) with both stations recording 87mm average per Age I smolt with a mean weight of 5.8 grams. Age II smolt had a mean length of 111mm and a weight of 11.1 grams. Age class composition of the outmigration was calculated as planned from index data to prevent duplicity of effort, however, observed differences between sonar spot samples and index samples indicate sonar will have to be sampled separately in the future.

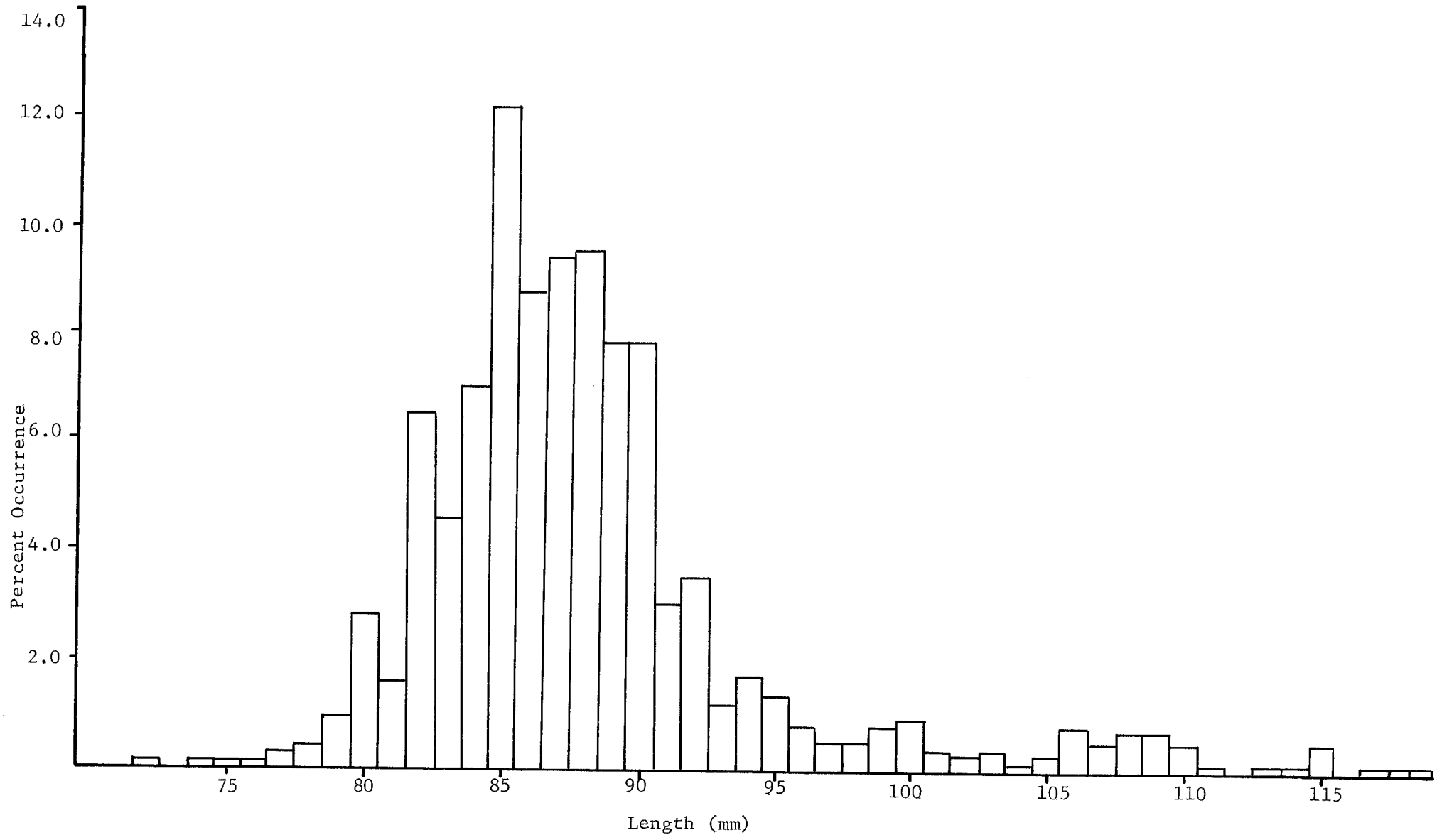

Figure 4. Length frequency summary of sockeye salmon smolt, East bank, Kvichak River, 1971.

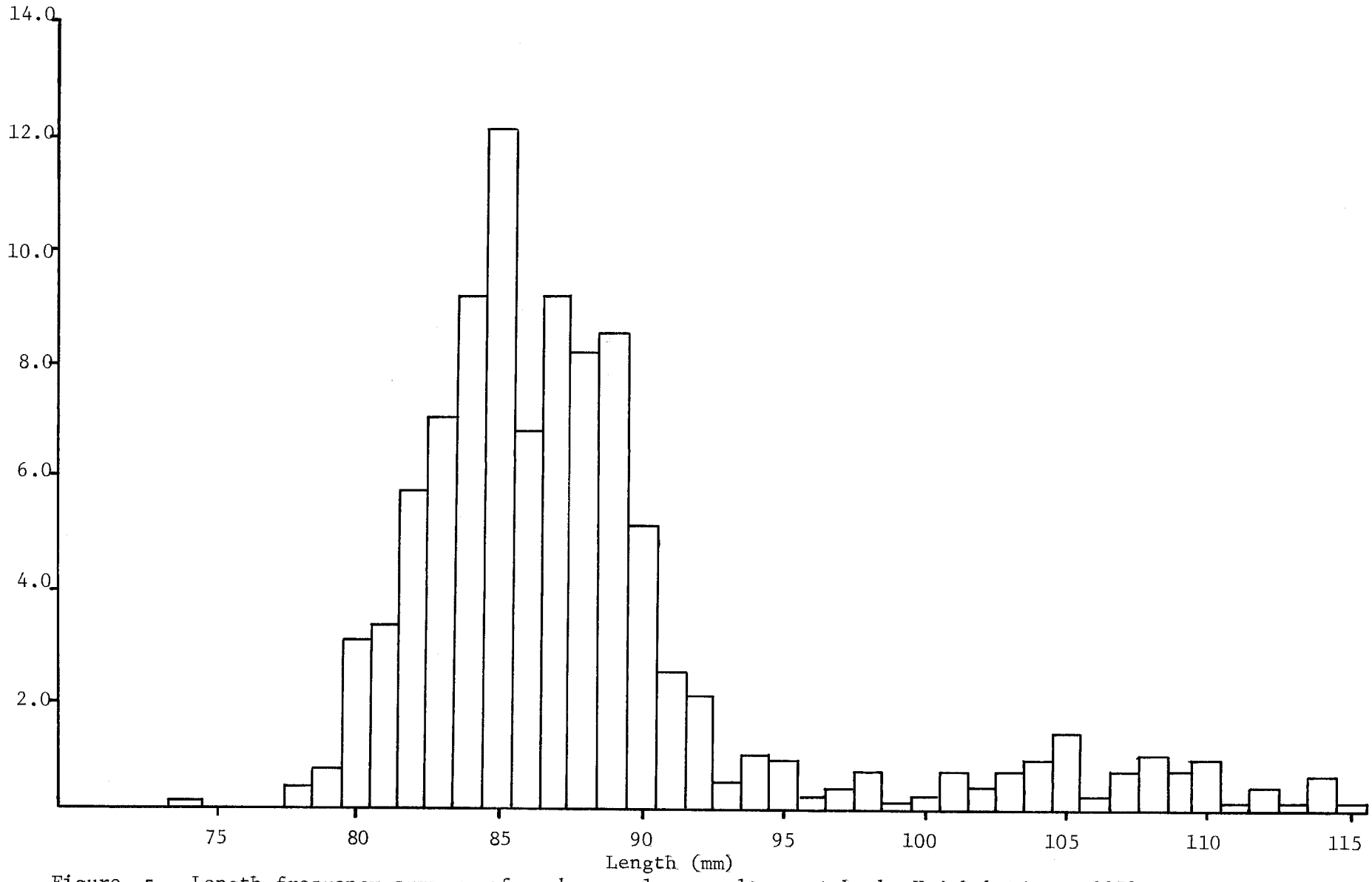

Figure 5. Length frequency summary of sockeye salmon smolt, west bank, Kvichak River, 1971.

1972 INDEX PROGRAM

Materials and Methods

Materials and methods used for the 1972 index program remained unchanged from those described for previous years (Paulus and McCurdy, 1969; McCurdy and Paulus, 1972; Paulus and McCurdy, 1972; Russell, 1972). The index fishing site likewise remained unchanged (Figure 1).

Results and Discussion

Fyke net fishing at the index site in 1972 began May 27 and terminated June 17. Loss of fishing time due to heavy ice and gale winds (Table 7) resulted in the least number of successful fishing days ever recorded for the index program. A total of 14 days of fishing was attempted after June 4 when the first catch adequate for a standard one pound sample was obtained. During this period 139 hours of successful fishing was accomplished averaging 9.9 hours per day (Table 8). The season catch totaled 61,736 smolt but proved too erratic to permit an estimate of outmigration index. An estimate of 1,421,104 smolt for the outmigration index was calculated from the sonar total outmigration data by use of the 1971 sonar-index relationship (Tables 5 and 14).

Catches were adequate to provide mean length-weight-age samples with 32 length frequency samples and six age separation samples taken during the 14 day indexing operation (Table 9). The age class separation point was determined to be between the lengths of 87mm to 88mm (Figure 6). Age I smolt comprised .89 percent (33 smolts) of the individuals measured and Age II 99.11 percent (3,667 smolt).

The seasons weighted mean length by age class was determined by applying the 33 length frequency samples to their corresponding days outmigration as measured at sonar. The resulting daily outmigrants by age class were totaled to produce the weighted average lengths of 80mm for Age I smolt and 106mm for Age II smolt (Table 15).

Weights and lengths were recorded for 33 smolt and a linear regression run on the data. The regression of the length-weight ($y = -13.71 + .223273x$) was applied to the seasons weighted mean length to estimate mean weight. This procedure was followed because the mean length in the weight sample differed from the season mean length. The mean weight for Age I smolt was 4.2 grams; for Age II smolt 10.0 grams.

Photo-electric calibrations were conducted from June 6 to June 10 with a total of 17 calibrations taken (Table 10). The seasonal average of 3.61 smolt per count was calculated from the daily smolt per count averages.

Table 7. Weather observations, Kvichak River, May 18 - June 18, 1972.

Date	Sky 0900	Sky 2000	Wind Dir.-Vel. 0900	Wind Dir.-Vel. 2000	Air temp. °F Max.	Air temp. °F Min.	Water temp. °F 0900	Water temp. °F 2000	Water gauge (in.)	Turbidity 0900
5/18	4	4	SW 30	SW 10				33.5	12	A
19	4	4	SW 15	SW 30-15	42		35.0	34.0	11.5	A
20	4	3	SW 20	SW 12	38	31	34.0	33.0	12	A
21	2	1	SW 10	SW 5	44	28	34.0	33.0	12	A
22	1	4	NE 10	NE 10	46	32	33.0	34.0	12	A
23	4	4	NE 30	NE 25-40	50	37	35.0	35.0	12	C
24	4	4	NE 25-35	NE 20	45	36	34.0	33.0	13	A
25	4	2	NE 15	NE 5	44	38	35.0		14	A
26	1	0	NE 10	0	62	31	38.0		13-1/2	A
27	3	4	NE 10	NE 7	64	34	35.0		15-1/2	A
28	4	3	SW 20	0	44	37	35.0		15-1/2	A
29	2	1	NW 5-10	0	48	36	35.0	35.0	15-1/2	A
30	4	2	SW 15-20	NW 5	67	42	36.0	34.0	15-3/4	A
31	1	3	N 15	NW 5	68	32	37.0	36.0	16-1/2	A
6/ 1	4	4	SW 20	S 15	67	32	37.0	38.0	18-1/2	B
2	4	3	SW 20	S 5	46	34	38.0	37.0	19-3/4	B
3	4	2	0	N 5	45	32	37.0	38.0	19-1/2	B
4	1	3	NE 10	E 5	56	34	39.0	40.0	21-1/2	B
5	4	4	0	E 10	62	36	38.0	39.0	21-1/4	A
6	3	2	E 5	SW 15	57	38	39.0	40.5	22-1/4	A
7	4	2	SW 20	0	68	35	37.0	40.0	21	A
8	2	3	N 10	NE 20	62	37	40.0	40.0	23-1/2	A
9	4	4	NE 10	NE 20	68	42	41.0		25-1/2	C
10	4	4	NE 30	NE 20	48	42	39.0	39.0	24-1/2	B
11	4	4	NE 20	NE 15	48	42	38.0	40.0	25	B
12	3	3	NE 20	NE 5	57	42	40.0	40.0	26	B
13	2	4	NE 5	NE 15	62	42	40.0	38.5	24-1/2	A
14	2	1	NE 20	NE 10	56	43	38.0	40.0	26-1/2	C
15	1	2	NE 15	NE 20	65	38	39.5	37.0	28	B
16	1	1	NE 30		65	41	37.0		28-1/4	C

(continued)

Table 7. Weather observations, Kvichak River, May 18 - June 18, 1972. (continued)

Date	Sky 0900	Sky 2000	Wind Dir.-Vel. 0900	Wind Dir.-Vel. 2000	Air temp. °F Max.	Air temp. °F Min.	Water temp. °F 0900	Water temp. °F 2000	Water gauge (in.)	Turbidity 0900
6/17	4	1	E 20		55	45	41.0		28-1/2	C
18	1	4	NE 10	E 15	65	42	39.5	38.0	30	B

Codings:

Sky

1 - Clear sky, cloud covering not more than 1/10.
2 - Cloud covering not more than 1/2 sky.
3 - Cloud covering more than 1/2 sky.
4 - Complete overcast.
5 - Fog or thick haze.

Turbidity

A - Clear
B - Partly cloudy
C - Cloudy
D - Debris

Table 8. Kvichak River index site actual fishing time by date, smolt catches and samples taken, 1972.

Date	Fishing period Start	Fishing period Stop	Total fishing time Hours	Total fishing time Minutes	Length Samples	Calib.	Smolt Caught	Cause of Interrupt
5/23	0000	2400	3	0				No smolt
24	0000	0100	1	0				No smolt
25	1105	2400	12	55				No smolt
26	0000	2400	5	0				No smolt
27	0000	2400	5	0			1	Ice
28	2305	2334		29				Ice
29	2211	2400		69				Ice
30	0045	2400	14	57			2	Gear damage
31	0000	2002	9	28			32	Ice
6/1	1100	2400	8	24			12	Ice
2	0000	2400	18	30			12	Anchors slid
3	0000	2400	24	0	1		22	-
4	0000	2400	23	30	4		350	Net cleaning
5	0000	2400	23	5	3		304	-
6	0000	2400	22	58	4	3	4,573	-
7	0000	2400	19	33	5	5	7,156	-
8	0004	2326	18	37	4	12	8,607	Anchors slid
9	0053	2400	7	22	2		2,991	Anchors slid
10	0002	2400	9	16	4	13	2,941	Ice
11	0000	2235	9	58	2	1	4,017	Ice
12	1010	2332		68	1		1,018	Ice
13	0145	2400	4	48	1	1	12,954	Ice
14	0000	2228	3	28			15,327	Ice
15	0231	0655		13				Ice
16								Ice
17	1307	1740	2	26	1		1,417	Ice

Table 9. Kvichak sockeye salmon smolt sample age frequency from length distribution by day at Index, 1972.

Date	Time	Age Class #I	#II	%I	%II
6/4/72	0100	0	72	0	100
	2100	0	34	0	100
	2400	3	87	3.0	97.00
5	0500	0	80	0	100
	1500	1	110	.90	99.10
6	0200	0	78	0	100
	0300	0	78	0	100
	0400	0	86	0	100
	1800	1	44	2.22	97.78
	2300	0	70	0	100
7	0300	0	71	0	100
	0400	0	74	0	100
	0915	0	84	0	100
	1300	1	87	1.14	98.86
8	0045	0	73	0	100
	0120	1	81	1.22	98.78
	0155	0	62	0	100
	1300	3	94	3.09	96.91
	2311	0	72	0	100
9	0159	0	84	0	100
	0217	1	84	1.18	98.82
	1200	0	90	0	100
	2355	0	77	0	100
10	1300	1	73	1.35	98.65
	2200	0	71	0	100
	2219	0	82	0	100
11	0225	0	84	0	100
	1100	0	85	0	100
	1800	0	95	0	100
12	1057	5	110	4.35	95.65
	2217	0	71	0	100
	2332	0	74	0	100
13	0146	0	84	0	100
	0400	0	83	0	100
14	0420	1	93	1.06	98.94
17	?	0	99	0	100
24	2200	3	101	2.88	97.12
	2250	2	87	2.25	97.75
	2340	2	107	1.83	98.17
26	0105	0	105	0	100
	0300	2	93	2.11	97.89
	2300	0	99	0	100
	2400	1	95	1.04	98.96
29	2300	5	104	4.59	95.41
27	0100				

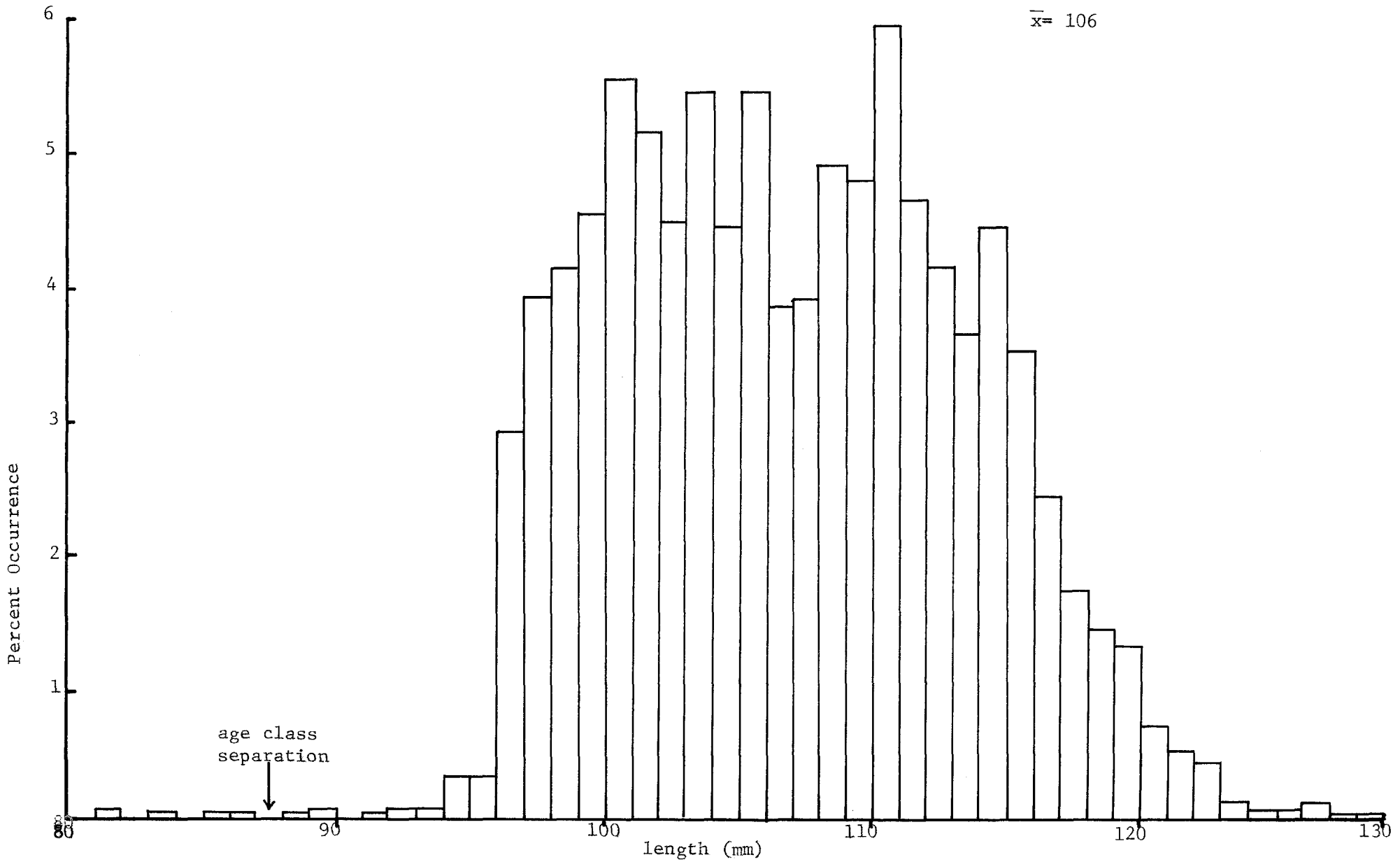

Figure 6. Length frequency summary of sockeye salmon smolt, index, Kvichak River, 1972.

Table 10. Kvichak River sockeye salmon smolt photo-counter calibration data, index site, 1972.

Date	Hour	Fishing Time 1/	Weight 2/	Fish per Pound	Total Fish	Counts	Counts Per Minute	Fish Per Minute	Daily Average Fish/Count
6/6/72	0100	55	11.3	39	441	107	1.93	8.02	
	0200	55	11.8	39	460	101	1.84	8.36	
	0300	52	74.1	43	3186	826	15.88	61.27	3.95
6/7/72	0200	55	7.5	35	263	127	2.31	4.78	
	0400	57	45.8	36	1649	566	9.93	28.93	
	0700	57	62.4	36	2246	703	12.33	39.40	2.98
6/8/72	0000	6	12.4	37	459	127	21.17	76.50	
	0100	4	13.7	40.5	555	119	29.75	138.75	
	0100	6	21.9	34	745	195	32.50	124.17	
	1100	45	4.6	42	193	74	1.64	4.29	
	1200	52	6.1	52	265	93	1.79	5.10	
	2200	4	13.3	37	492	103	25.75	123.00	
	2300	2	13.7	42	575	117	58.50	287.50	3.97
6/9/72	0100	2	9.7	42	407	111	55.50	203.50	
	0200	7	4.6	42	193	59	8.43	27.57	3.53
6/10/72	0000	7	11.3	38	426	120	17.14	60.86	
	0000	27	3.2	43	138	35	1.30	5.11	3.64
								Season Average	3.61

1/ Minutes 2/ Pounds

1972 OUTMIGRATION PROGRAM

Materials and Methods

Sonar Counting System. In 1972 three sonar counting systems were utilized for smolt enumeration in the Kvichak River. In addition to the 1970 and 1971 models, a slightly modified 1972 model was operated. The newest unit was similar electronically to the 1971 model but modified to include the following refinements: 1) cable length between electronics and transducer array was extended to 300 feet, 2) individual transducer illuminate were installed which light when a return echo is received to aid in identification of problem transducers and investigate school patterns, 3) external test points were increased to include one set to each bank of transducers and key circuit points in the electronics package, 4) an electronic alarm was incorporated as a plug-in option to alert crew when smolt counts are occurring.

Two oscilloscope were used with the sonar systems in 1972 to monitor school depth, thickness and orientation within the channel during day and night outmigrations.

Site Selection. The sonar enumeration site remained unchanged from 1971. (Figure 1). As a result of increased cable length on the 1972 sonar arrays, the fishing stations could be spaced more uniformly across the river channel (Figure 2).

Water velocity measurements were taken periodically throughout the season for adjusting the velocity setting on the sonar electronics. The velocity setting regulates the repetition rate of the sonar signals so each group of fish is "sounded" only once.

Sonar Calibrations and Operation. Sonar calibration techniques and sonar operating procedures remained identical to the 1971 program. With the use of the transducer lights, however, schools over the extreme outside ends of the sonar gear, which could miss the net entirely, were omitted and calibrations generally fell within the limits set by the engineer as previously discussed.

Total Outmigration Estimate. Expansion techniques remained unchanged from that described for 1971, although distances between array centers were changed. Since the ice run out was continuous throughout the duration of the smolt emigration, data gathering required almost constant observation of the river and ice conditions. During the daylight hours the smolt traveled below the depth to which the ice reached, so the range of the sonar was pulled in to miss the ice. At night, when smolt were at the surface, the range was set within 1/10 foot of the surface, and became susceptible to false counts from ice. Visual observations were required to clear ice "counts" from the equipment. Observations of the light bank and oscilloscope on the 1972 equipment, provided information on target depth, strength, and spatial distribution which could be relied upon heavily to separate smolt from ice counts during the few hours on unusually dark nights when visual ice observations were impossible.

Data on numbers of fish per school and schools per minute was gathered during evenings with high outmigration rates. Ice thickness readings were also made so sonar range could be safely set during daylight smolt counting.

Results

Sonar Sampling. Twenty-four hour outmigration enumeration began May 29 on the west bank and May 30 on the east. Fishing operations were terminated on the east bank June 18 when rising water and scarcity of smolt made the east site unnecessary and untenable. The 1972 sonar equipment was transferred to the west bank to replace the 1971 sonar equipment. The transducer signal lights on the 1972 equipment facilitated distinction between valid smolt counts and ice during darkest hours. West bank operations were finally terminated June 28.

Due to limited manpower, it was not possible to monitor the 1970 sonar equipment on the east bank. It was the least important gear since this equipment was in an area of few smolt and continuous deep ice. Since it was not monitored constantly, the data was not used for outmigration estimation.

Calibration. Calibration was limited to assessing variability of the 1972 sonar electronics. Results indicated the unit was functioning at designed capability with an observed 11.81 smolt per sonar count (Table 11). Calibrations were added together in the same manner as in 1971. Fish per count ratio for the 1971 sonar equipment was applied to the 1972 counts for this system since no field calibrations were made in 1972 (Table 12).

A total of 24 calibrations were recorded for the 1972 sonar electronics with 67% within acceptable limits. Analysis of the 1972 calibration in relation to passage rates shows similarity to the 1971 results as 83% of calibrations recorded above 50 fish/minute were valid while below the 50 fish/minute passage rate 45% of the recorded calibrations were valid (Appendix Table A-14).

Day-night separation of valid calibrations show a significant increase in smolt per count during night calibrations (Table 13). Results suggest that the calibrating net is more efficient at night and probably produces smolt avoidance during the day. High winds produce turbidity which will influence net efficiency, as will light intensity. Factors in 1971 and 1972 were not necessarily similar during calibrations, and could explain the fact that no difference in day-night calibrations was observed in 1971.

Outmigration Estimate. A total of 6,649,760 smolt were counted in 1972 with 80.71% enumerated over the west bank arrays and 19.29% over the east bank arrays (Table 14). Expansion of the enumerated smolt gave a total season outmigration estimate of 67,575,075 smolt with 570,750 Age I and 67,004,325 Age II smolt (Table 15). The bulk of the 1972 smolt outmigration occurred from June 6 to June 18 with the peak on June 10 (Figure 7). The limited length frequency information collected at sonar (Figure 8) shows similarity to the more complete

Table 11. Calibration summary for 1972 sonar equipment east bank inshore & offshore sites, 1972.

	Total time minutes	Total sonar counts	Total catch	Average fish/ count/period
	60	42	332	7.9
	60	15	175.5	11.7
	60	115	745.5	6.5
	60	1437	13364	9.3
	55	701	6969.5	9.9
	55	537	4563.5	8.5
	46	286	2889.5	10.1
	61	447	3180.6	7.1
TOTAL	457	3580	32220.1	71.0

$\bar{\bar{x}}$ fish/count = $\frac{71.0}{8}$ = 8.88 x 12/9 1/ = 11.81.

1/ adjustment to compensate for 12 foot array.

Table 12. Correction factors applied in calculation of total outmigration, 1972.

	West Bank		East Bank	
	Inshore	Offshore	Inshore	Offshore
Factor				
Calibration	9.96	9.96	11.81	11.81
Water Velocity	.9849	1.0	1.0	.9235

Table 13. Day and night sonar calibrations, east bank, 1972.

	Date	Fishing Time Set	Fishing Time Pulled	Fishing Time Min.	Sonar Counts	Catch	Average Calibration
Day Calibration (0230-2100)	6/7	0300	0400	60	15	175.5	
		0400	0436	36	927	7800	
		0500	0600	60	115	745.5	
		1305	1335	30	510	3237	
		1340	1405	25	74	879	
	6/8	0216	0235	29	148	1678.5	
		0235	0241	6	130	892.0	
		0241	0316	35	156	1997.5	
		0316	0337	41	182	976.6	
		0337	0347	10	228	1764	
		1733	1742	9	37	440	
	TOTALS			340	2,522	20585.6	8.16
Night Calibration (2100-0230)	6/6	0100	0200	60	42	332	
	6/7	2100	2110	10	203	1974	
		2120	2234	74	424	4116	
		0145	0203	18	270	2071	
	6/10	2300	2315	15	86	1575	
		2315	2351	36	121	1575	
		2351	0006	15	25	539	
		0006	0024	18	76	1370	
		0024	0055	31	76	1265	
		0130	0239	69	191	2600	
	TOTALS			346	1,514	17,417	11.50

Table 14. Kvichak River sockeye salmon smolt counts by day and array, 1972 Counts include corrections for current velocity differences.

Date noon-noon	West Bank Inshore	West Bank Offshore	East Bank Offshore	East Bank Inshore	Total	Index
5/29-30	271	1826			2097	
30-31	706	1305	685	633	3329	
31-1	1540	6225	15140	31749	54654	
6/ 1-2	815	8665	0	120	9600	
2-3	1236	2410	189	175	4010	
3-4	3904	5737	1547	490	11678	
4-5	10065	8277	2551	523	21416	
5-6	7220	12012	5433	1658	26323	
6-7	54649	45059	22085	5540	127333	
7-8	108024	157936	37154	40812	343926	
8-9	153314	147737	34048	33952	369051	
9-10	100863	95706	3295	27244	227108	
10-11	297603	300593	211682	341168	1151046	
11-12	43633	105108	42858	67380	258979	
12-13	536890	320632	10346	22326	890194	
13-14	321988	346120	968	17571	686647	
14-15	282026	309686	69833	106437	767982	
15-16	191131	250454	41205	62800	545590	
16-17	100234	191222	35	2846	294337	
17-18	343316	248203	11763	8485	611767	
18-19	50218	17736			67954	
19-20	11946	2421			14367	
20-21	15598	6141			21739	
21-22	8247	16109			24356	
22-23	210	732			942	
23-24	7131	6047			13178	
24-25	32324	15814			48138	
25-26	8119	9755			17874	
26-27	3874	6625			10499	
27-28	3780	9070			12850	
28-29	2210	8586			10796	
TOTAL	2,703,085	2,663,949	510,817	771,909	6,649,760	1,421,104 1/

1/ Est. from ratio of 1971 Index to 1971 total outmigration estimate.

TABLE 15. Kvichak River sockeye salmon smolt outmigration by day and age group, 1972.

Date noon-noon	Daily total smolt counts		Daily out-migration	Age I Smolt		Age II Smolt	
	number	percent		number	percent	number	percent
5/29-30	2097	0.03	21310	326	1.53	20984	98.47
30-31	3329	0.05	33829	518	1.53	33311	98.47
31-1	54654	0.82	555396	8498	1.53	546898	98.47
6/1-2	9600	0.14	97556	1493	1.53	96063	98.47
2-3	4010	0.06	40750	623	1.53	40127	98.47
3-4	11678	0.18	118672	1816	1.53	116856	98.47
4-5	21416	0.32	217630	3330	1.53	214300	98.47
5-6	26323	0.40	267495	1418	.53	266077	99.47
6-7	127333	1.92	1293962	3623	.28	1290339	99.72
7-8	343926	5.17	3494987	11184	.32	3483803	99.68
8-9	369051	5.55	3750308	39003	1.04	3711305	98.96
9-10	227108	3.42	2307879	6924	.30	2300955	99.70
10-11	1151046	17.31	11696966	51467	.44	11645499	99.56
11-12	258979	3.89	2631753	0	.0	2631753	100.00
12-13	890194	13.39	9046180	173687	1.92	8872493	98.08
13-14	686647	10.33	6977729	0	.0	6977729	100.00
14-15	767982	11.55	7804258	82725	1.06	7721533	98.94
15-16	545590	8.21	5544303	0	.0	5544303	100.00
16-17	294337	4.43	2991062	0	.0	2991062	100.00
17-18	611767	9.19	6216796	144229	2.32	6072567	97.68
18-19	67954	1.02	690551	10634	1.54	679917	98.46
19-20	14367	0.22	145998	2248	1.54	143750	98.46
20-21	21739	0.32	220912	3402	1.54	217510	98.46
21-22	24356	0.37	247506	3812	1.54	243694	98.46
22-23	942	0.01	9574	147	1.54	9427	98.46
23-24	13178	0.20	133915	2062	1.54	131853	98.46
24-25	48138	0.72	489180	7533	1.54	481647	98.46
25-26	17874	0.27	181636	2797	1.54	178839	98.46
26-27	10499	0.16	106691	811	.76	105880	99.24
27-28	12850	0.19	130582	3500	2.68	127082	97.32
28-29	10796	0.16	109709	2940	2.68	106769	97.32
TOTAL	6,649,760	100.00	67,575,075	570,750	0.84	67,004,325	99.16

1/ Percentages taken from length frequency data collected at Index site.

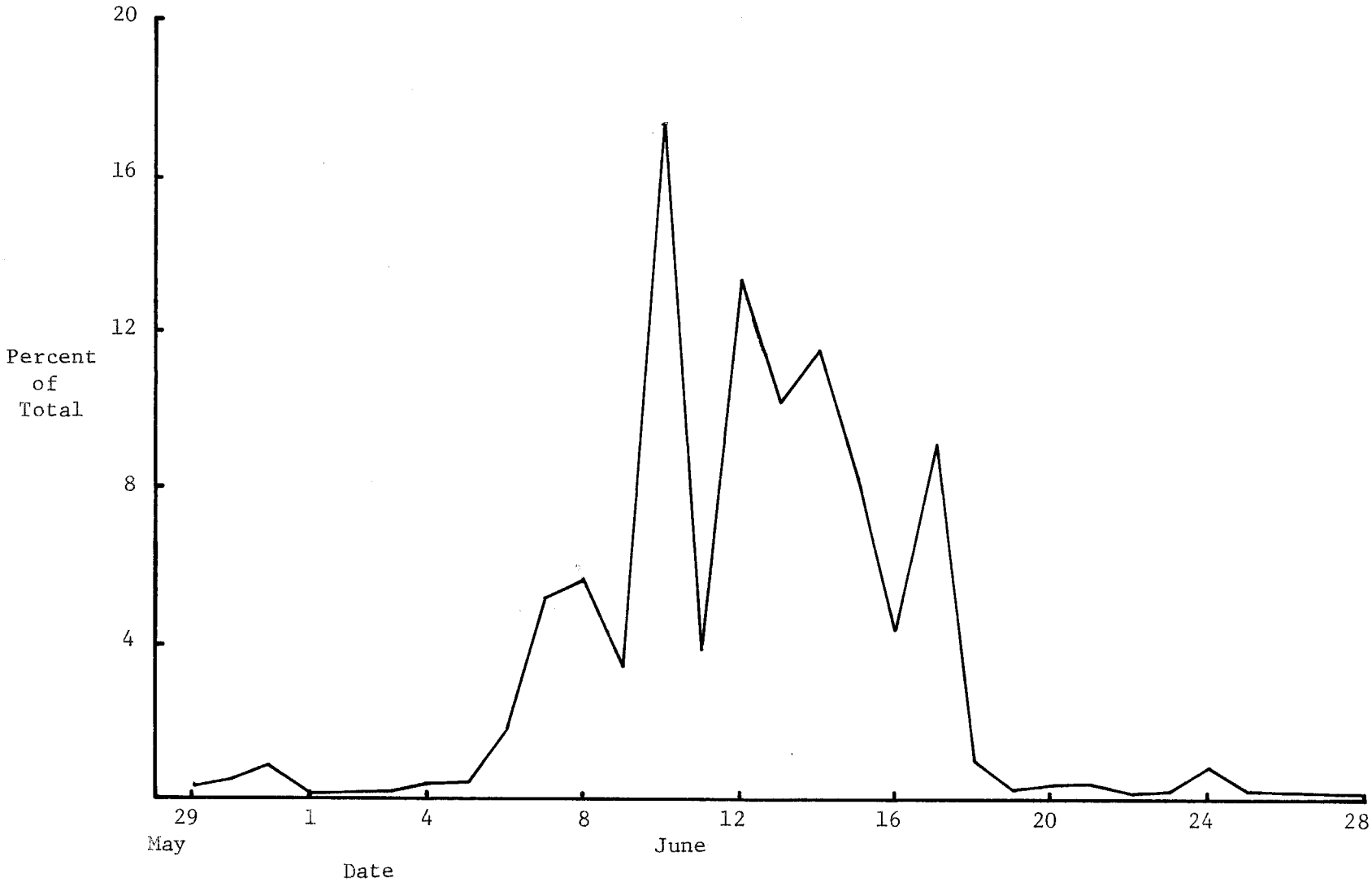

Figure 7. Percent of total outmigration by day as measured by sonar, 1972.

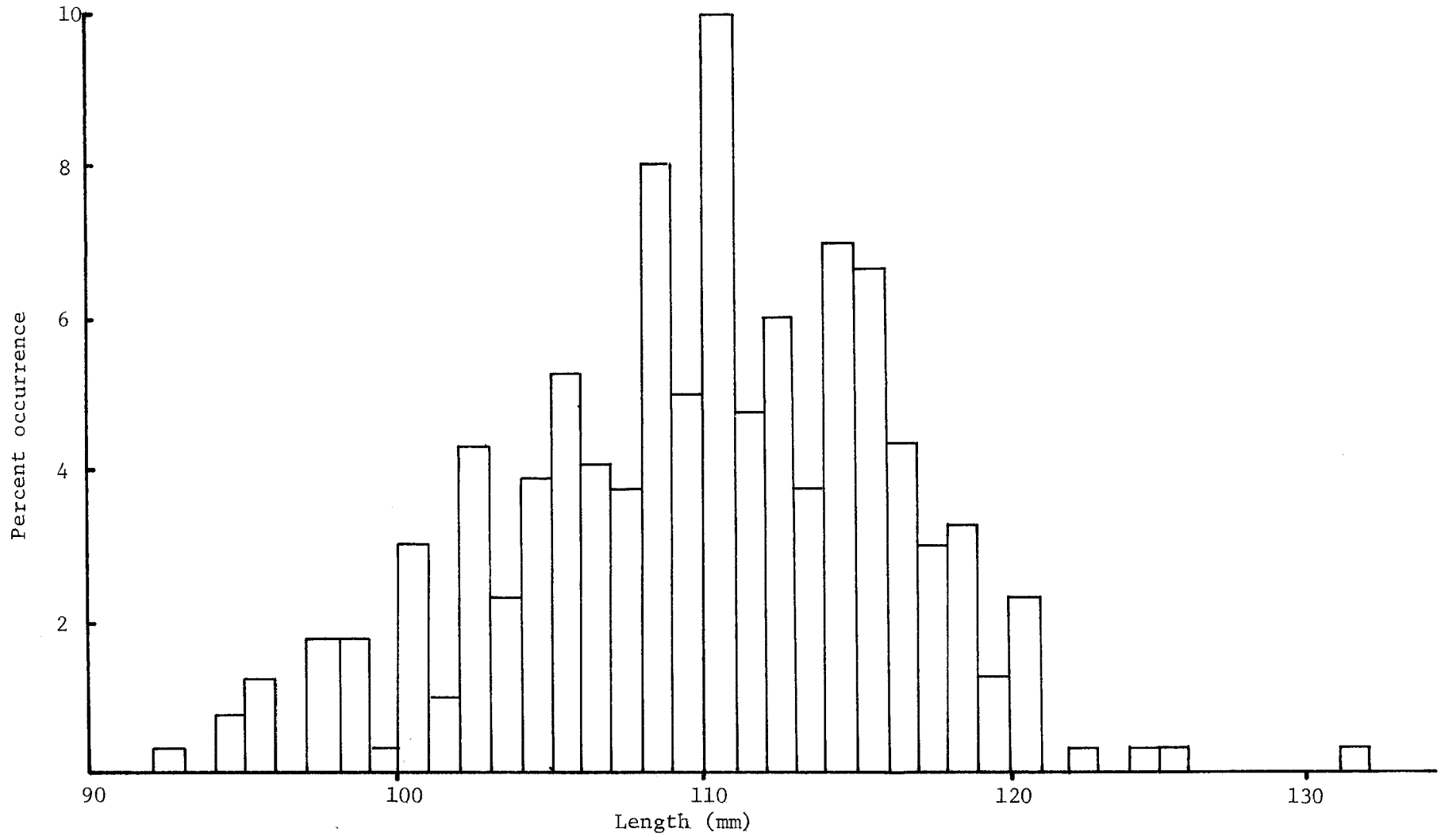

Figure 8. Length frequency summary of sockeye salmon smolt, east bank, Kvichak River, 1972.

index length frequency data with an average length of 107mm for Age II smolt. Since the index data was intended as the standard for daily age apportionment, it was applied to the total season sonar estimate of outmigration.

	Age I	Age II
1972 Outmigration	570,750 (0.84%)	67,004,325 (99.16%)
Mean length	80mm	106mm
Mean weight (grams)	4.2 grams	10.0 grams

Age class composition of the outmigration was calculated from index daily age class percentages (Table 9). Expansion of this data to compensate for missed days was accomplished by averaging previous and following age class percentages.

Vertical Diurnal Migration. Vertical diurnal migration of emigrating sockeye salmon smolt has been described previously from visual observations (Russell, 1972). To verify this hypothesis an analysis of hourly upper and lower sonar counts was conducted on the 1971 sonar equipment over a 7 day period. This was facilitated by separation of counts recorded by vertically aimed transducers which sampled mid-water to the surface and horizontally aimed transducers which sampled mid-water to the bottom. Counts were also separated by array with hourly totals converted to percent upper counts. The resulting daily plots of the hourly percentages show significant concentration of smolt in the surface waters during the hours 2200 to 0200 and an increase in smolt occurrence in the bottom waters in the evening hours 1400 to 1800 and early morning hours 0200 to 0400 (Figures 9 and 10).

Negative phototaxis may be one of the major behavioral factors controlling vertical migration as shallowing of the smolt distribution pattern was apparent during days with completely cloudy skies and turbid water (Figures 9 and 10, June 9, 10, and 11). Such conditions produced significantly lower levels of incident light in the aquatic habitat. Conversely, clear skies and water were observed June 7, 8, 12, and 13 when vertical migration was pronounced and high incident light levels exists.

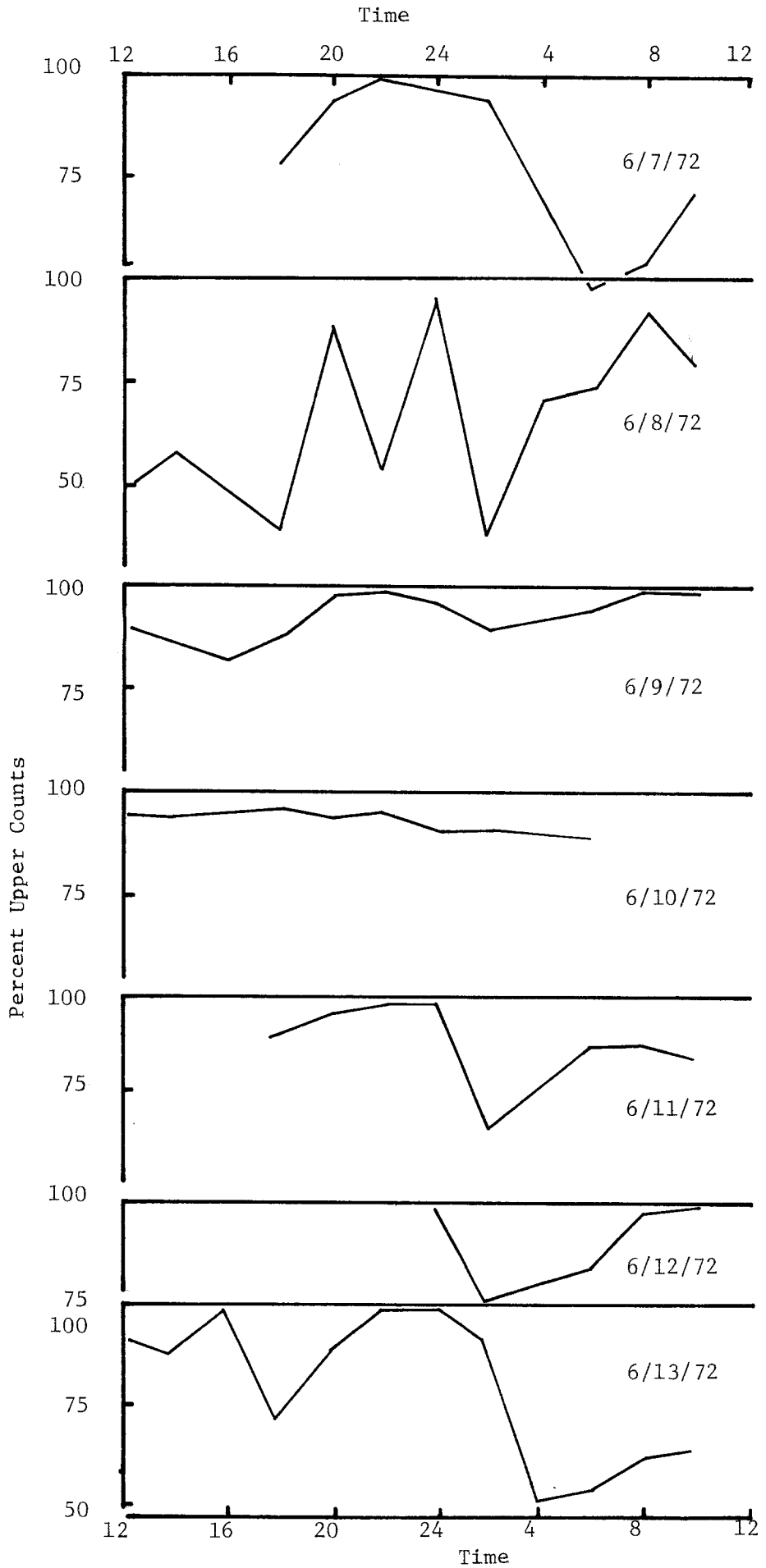

Figure 9. Vertical distribution of sonar counts by hour, recorded June 7-13, Kvichak River, west bank inshore array, 1972.

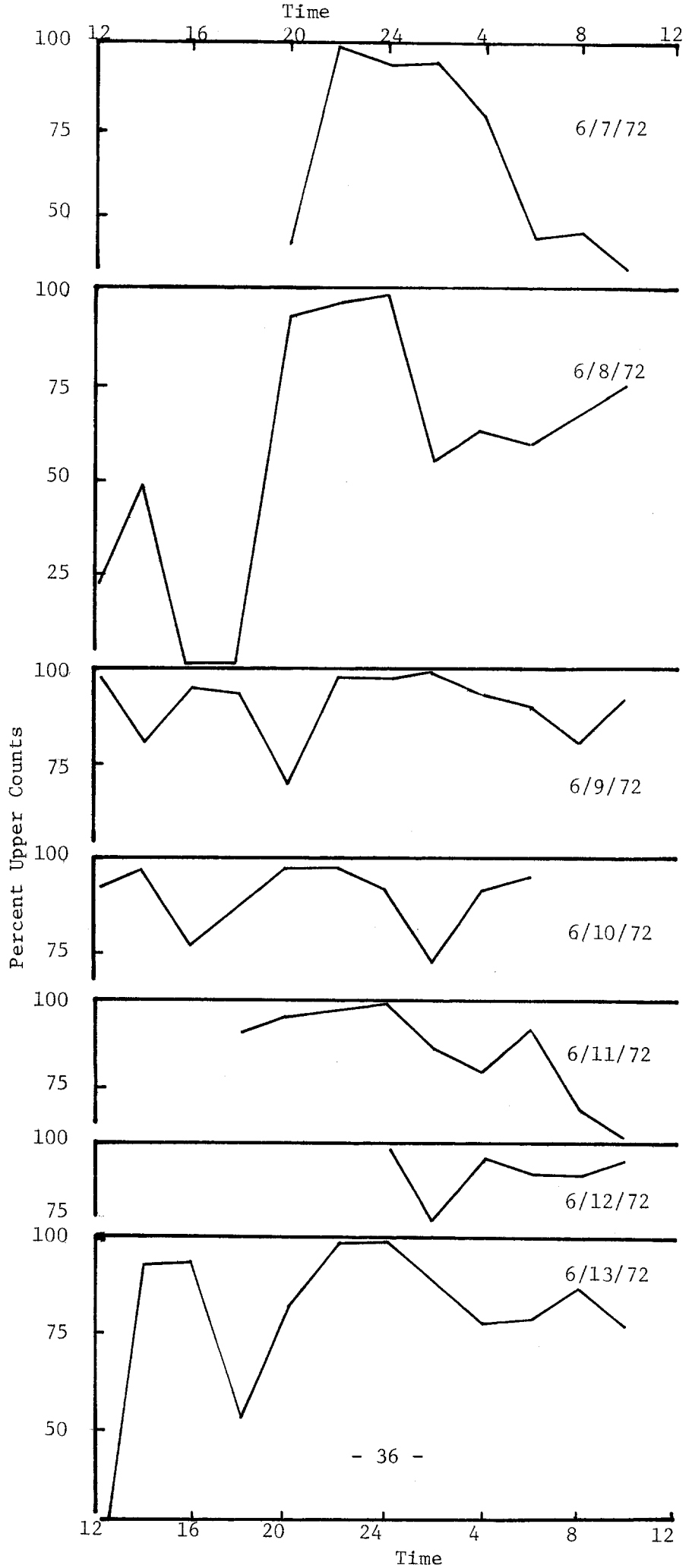

Figure 10. Vertical distribution of sonar counts by hour recorded June 7-13, Kvichak River, west bank offshore array, 1972.

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1972 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

This was the seventeenth year that the Naknek River sockeye salmon (*Oncorhynchus nerka*) smolt study has been conducted.

The objective of the Naknek River smolt program is to obtain an outmigration estimate on, and the age composition of sockeye salmon smolt.

MATERIALS AND METHODS

The methods for data gathering and analysis of age composition, average lengths and weights, and general environmental data were the same as in previous years (McCurdy, 1972).

RESULTS

Table 1 contains mean water and air temperature data gathered during the outmigration period.

The random schedule was initiated on June 9 and terminated on July 6. The total random catch was 125,921 (Table 2). Sixty-one percent of the catch occurred from June 9 to June 13. A minor peak also occurred on June 17-18. A total of 134,499 smolt were caught during the index portion of the program (Table 3). During the random sampling hours, 2100-0600, the index net caught 71.29 percent of the total 24-hour catch.

The outmigration estimate for 1972 was 10,990,739. The estimate was obtained as follows:

TABLE 1. Mean water and air temperatures by day, Naknek River, 1972 1/

Date	Mean water temperature °F	Mean air temperature °F
June 8-9	47	48
9-10	44	45
11-12	48	45
12-13	50	46
14-15	50	44
15-16	*	*
17-18	50	46
18-19	48	46
20-21	49	*
21-22	*	*
23-24	49	42
24-25	50	44
26-27	51	47
27-28	53	44
29-30	53	49
30-July 1	51	46
2-3	51	48
3-4	53	50
5-6	58	53

1/ Both water and air temperatures were recorded six times daily.

* No temperatures recorded.

TABLE 2. Naknek River random sampling catches of sockeye salmon smolt by fishing site, 1972

Date	Sites 1	2	3	4	5	6	Total	Percentage of total catch
June 8-9	0	0	645	4,935	482	752	6,814	5.41
9-10	721 1/	1,783 1/	8,016 1/	5,288 1/	4,838	607	21,253 1/	16.88
11-12	1,918	1,917	24,796	6,130	3,399	796	38,956	30.93
12-13	337	2,853	3,482	4,653	5,008	113	16,446	13,06
14-15	141	388	1,184	2,029	2,204	1,808	7,754	6.16
15-16	214	1,299	1,573	1,196	3,064	67	7,413	5.89
17-18	365	682	3,542	1,722	4,066	137	10,514	8.35
18-19	128	855	299	1,170	1,025	160	3,637	2.89
20-21	1	17	152	300	9	64	543	0.43
21-22	44	223	419	680	643	157	2,166	1.72
23-24	181	9	185	1,180	37	1,173	2,765	2.20
24-25	29	315	2,134	302	987	242	4,009	3.18
26-27	24	27	271	1,034	38	178	1,572	1.25
27-28	83	30	35	342	211	375	1,076	0.85
29-30	29	0	152	14	311	0	506	0.40
30-July 1	14	37	138	2	0	7	198	0.16
2-3	0	0	29	5	62	4	100	0.08
3-4	0	22	0	36	3	5	66	0.05
5-6	0	16	5	25	79	8	133	0.11
Total	4,229	10,473	47,057	31,043	26,466	6.653	125,921	100.00
Percent	3.36	8.32	37.37	24.65	21.02	5.28	100.00	

1/ Interpolated data. Daily catch taken as a line-point estimate between the previous and following days. Site catches based on percent of total season's catch.

TABLE 3. Naknek River index net catches of sockeye salmon smolt by 90 minute periods, June 9-July 6, 1972.

	June 9-10 1/	June 12-13	June 15-16	June 18-19	June 21-22
2100-2230	2,212	1,006	1,412	1,170	805
2230-2400	3,193	1,921	245	1,113	382
0000-0130	6,768	4,759	671	1,205	581
0130-0300	8,771	8,113	4,207	1,118	1,048
0300-0430	7,012	6,277	3,055	1,860	714
0430-0600	5,263	4,653	2,131	917	680
0600-0730	3,837	4,059	3,525 3/	120	34
0730-0900	2,136	2,679	1,962 3/	119	0
0900-1030	623	147	572 3/	394	0
1030-1200	968	572	889 3/	392	2
1200-1330	386	99	355 3/	308	0
1330-1500	293	209	269 3/	72	2
1500-1630	377	347	346 3/	34	22
1630-1800	1,004	1,447	922 3/	4	74
1800-1930	653	440	599 3/	125	50
1930-2100	915	699	840 3/	168	41
Totals	44,411	34,427	22,000 2/	9,119	4,435

1/ Interpolated data. Index catch based on ratio of random catches of June 9-10 and June 12-13. $\frac{21,253}{16,446} = 1.29$. (1.29) (34,427) = 44,411.

2/ Interpolated data. Total catch is a line point estimate between the previous and following index catches.

3/ Interpolated data. Catches from 0600 June 15 to 2100 June 16 based on the difference between total estimated catch and actual catches. 22,000-11,721 = 10,279.

TABLE 3. (continued)

	June 24-25	June 27-28	June 30 July 1	July 3-4	Total	Percent of total catch
2100-2230	302	59	1	46	7,013	5.21
2230-2400	1,103	239	130	10	8,336	6.20
0000-0130	2,631	1,062	99	38	17,814	13.25
0130-0300	2,066	725	344	36	26,428	19.65
0300-0430	1,588	295	2	17	20,820	15.48
0430-0600	1,426	342	52	0	15,464	11.50
0600-0730	1,547	78	47	0	13,247	9.85
0730-0900	221	259	0	0	7,376	5.48
0900-1030	112	244	52	1	2,145	1.59
1030-1200	504	0	12	0	3,339	2.48
1200-1330	184	0	1	0	1,333	0.99
1330-1500	123	40	0	0	1,008	0.75
1500-1630	163	12	0	0	1,301	0.97
1630-1800	12	0	0	0	3,463	2.57
1800-1930	384	3	0	0	2,254	1.68
1930-2100	484	11	0	0	3,158	2.35
Totals	12,850	3,369	740	148	134,499	100.00

1. Calculate the seasonal average random catch per 90 minute set:

   Total season catch = 125,921
   No. of sites fished = 6

   No. of sampling days fished during the season = 19

   Therefore, the seasonal average catch per 90-minute set is derived by: 125,921 /(6)(19) = 1,105

2. Estimate the average migration past the sampled section of the river during a 90-minute period within a sampling period:

   Average catch per 90-minute period = 1,105
   No. of sites fished = 6
   No. of subsites for which the migration is estimated from the catch at each fishing site = 6

   Therefore, the estimated average migration past the sampled section of the river during a 90-minute period within a sampling period is derived by (1,105) [(6) (6)] = 39,780

3. Estimate the average migration past the sampled section of the river per sampling period:

   No. of 90-minute periods within a sampling period = 6

   Therefore, the estimated average migration past the sampled section of the river per sampling period is derived by:

   (39,780) (6) = 238,680

4. Estimate the average migration past the entire width of the river at the sampling location per sampling period:

   Estimated proportion of migration occurring within the section of the river presently sampled = 88.34%

   Therefore, the estimated average migration past the entire width of the river at the sampling location per sampling period is derived by:

   238,680/.8834 = 270,183

5. Estimate the average daily migration past the sampling location.

   Estimated proportion of daily migration occurring during the sampling period derived by adding the percentages of the total season's index net catch for the hours 2100-0600 = 71.29%

   Therefore, the estimated average daily migration past the sampling location is derived by:

   270,183/.7129 = 378,991

6. Estimate the total seasonal migration past the sampling location:

No. of days fished = 29

Therefore, the estimated total seasonal migration past the sampling location is derived by:

(378,991) (29) = 10,990,739

The age composition of the outmigration estimate was 6.52 percent Age I's (716,596) and 93.48 percent Age II's (10,274,143). This is the lowest estimate for Age I fish since the initiation of the program while the numbers of Age II fish is the second highest estimate since the program's initiation. Table 4 gives the age composition by date.

A total of 689 smolt were sampled to determine average lengths and weights by age class (Tables 5 and 6). Age I smolt averaged 98 millimeters in length and 9.1 grams in weight. Age II smolt average 110 millimeters and 11.9 grams. This sample was also used to determine age composition.

Historical data is presented in Appendix Tables B-1 through B-3.

TABLE 4. Age composition of the random sampling catches of sockeye salmon smolt, by date, Naknek River, 1972.

	Random Catch	Percent		Number	
		Age I	Age II	Age I	Age II
June 8-9	6,814	10.0	90.0	681	6,133
9-10	21,253	0.0	100.0	0	21,253
11-12	38,956	0.0	100.0	0	38,956
12-13	16,446	10.0	90.0	1,645	14,801
14-15	7,754	10.0	90.0	775	6,979
15-16	7,413	0.0	100.0	0	7,413
17-18	10,514	10.0	90.0	1,051	9,463
18-19	3,637	17.5	82.5	637	3,000
20-21	543	12.5	87.5	68	475
21-22	2,166	12.5	87.5	271	1,895
23-24	2,765	22.5	77.5	622	2,143
24-25	4,009	35.0	65.0	1,403	2,606
26-27	1,572	20.0	80.0	314	1,258
27-28	1,076	42.5	57.5	457	619
29-30	506	22.5	77.5	114	392
30-July 1	198	37.1	62.9	74	124
2-3	100	20.0	80.0	20	80
3-4	66	15.4	84.6	10	56
5-6	133	46.4	53.6	62	71
Total	125,921			8,204	117,717
Percent				6.52	93.48

TABLE 5. Naknek River sockeye salmon smolt mean weight in grams, 1972.

Date	Age I		Age II	
	Percent of total season's catch	Mean weight	Percent of total season's catch	Mean weight
June 8-9	8.34	11.2	5.22	13.6
9-10	0.00	----	18.08	13.9
11-12	0.00	----	33.13	11.2
12-13	20.14	7.9	12.59	12.2
14-15	9.49	9.4	5.94	11.3
15-16	0.00	----	6.31	13.2
17-18	12.87	9.9	8.05	10.4
18-19	7.43	9.1	2.43	10.0
20-21	0.83	9.9	0.40	10.7
21-22	3.32	9.3	1.61	11.7
23-24	7.61	8.1	1.82	9.3
24-25	17.18	9.2	2.22	9.7
26-27	3.84	8.0	1.07	9.1
27-28	5.59	8.8	0.53	10.0
29-30	1.31	10.4	0.31	10.2
30-July 1	0.93	10.4	0.11	12.9
2-3	0.24	10.5	0.07	12.0
3-4	0.12	9.4	0.05	14.1
5-6	0.76	10.5	0.06	10.6
	Age I mean weight = 9.1		Age II mean weight = 11.9	

TABLE 6. Naknek River sockeye salmon smolt mean length in millimeters, 1972

Date	Age I		Age II	
	Percent of total season's catch	Mean length	Percent of total season's catch	Mean length
June 8-9	8.34	106	5.22	116
9-10	0.00	---	18.08	112
11-12	0.00	---	33.13	110
12-13	20.14	98	12.59	113
14-15	9.49	101	5.94	109
15-16	0.00	---	6.31	116
17-18	12.87	105	8.05	107
18-19	7.43	102	2.43	105
20-21	0.83	104	0.40	107
21-22	3.32	101	1.61	110
23-24	7.61	97	1.82	102
24-25	17.18	85	2.22	101
26-27	3.84	96	1.07	100
27-28	5.59	101	0.53	103
29-30	1.31	106	0.31	104
30-July 1	0.93	104	0.11	111
2-3	0.24	106	0.07	111
3-4	0.12	100	0.05	110
5-6	0.76	104	0.06	106

Age I mean length = 98 Age II mean length = 110

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1972 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The Ugashik River sockeye salmon smolt enumeration and sampling program was initiated in 1956 and has been operated every year since then with the exception of 1966 and 1971. Data obtained from this program is used to estimate relative abundance, age composition and average lengths and weights by age class of sockeye salmon smolt migrating to sea. These data are used to estimate optimum escapement ranges and to forecast returning adults by age composition.

MATERIALS AND METHODS

Standard winged fyke nets were used to catch red salmon smolt during their seaward migration (Schroeder, 1972). Catches from a random sampling scheme are used to estimate the total red salmon smolt outmigration. This method developed in 1958, consists of fishing five sites positioned along a cable extended across the river bottom (Nelson, 1965). The five sites are fished on a random basis between 9 p.m. and 2 a.m. The index site #4 is fished every third day for 24 hours to determine the percentage of fish migrating to sea outside the random fishing hours.

Fyke net operations were conducted between May 28 and June 20. The smolt fishing season was shortened by a late ice breakup which occurred between May 15-27. Age, weight, and length samples were taken as described in Schroeder, 1972. The deep channel in the river, still present from a severe storm in 1969, caused the nets to fish poorly and created problems with fishing procedures (Figure 1).

RESULTS

The random sampling scheme was fished 21 days of the 24 day season and caught a total of 10,693 smolt. Smolt outmigration occurred between June 6 and June 20 with peak outmigration June 10 and 17 (Figure 2). Site five caught the majority of the smolt, 46.34 percent (Table 1).

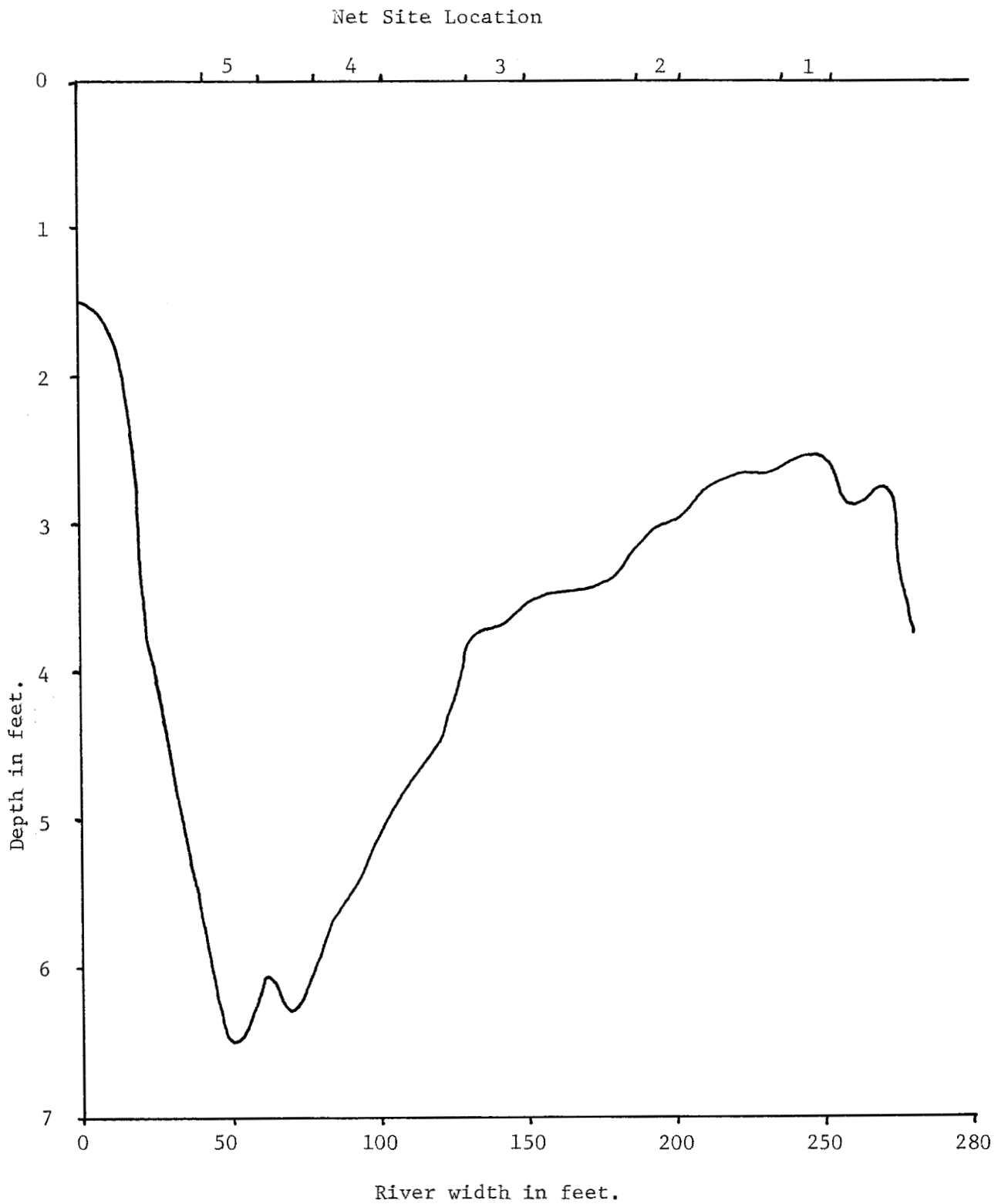

Figure 1. Ugashik River bottom contour taken at 10 foot intervals, 1972.

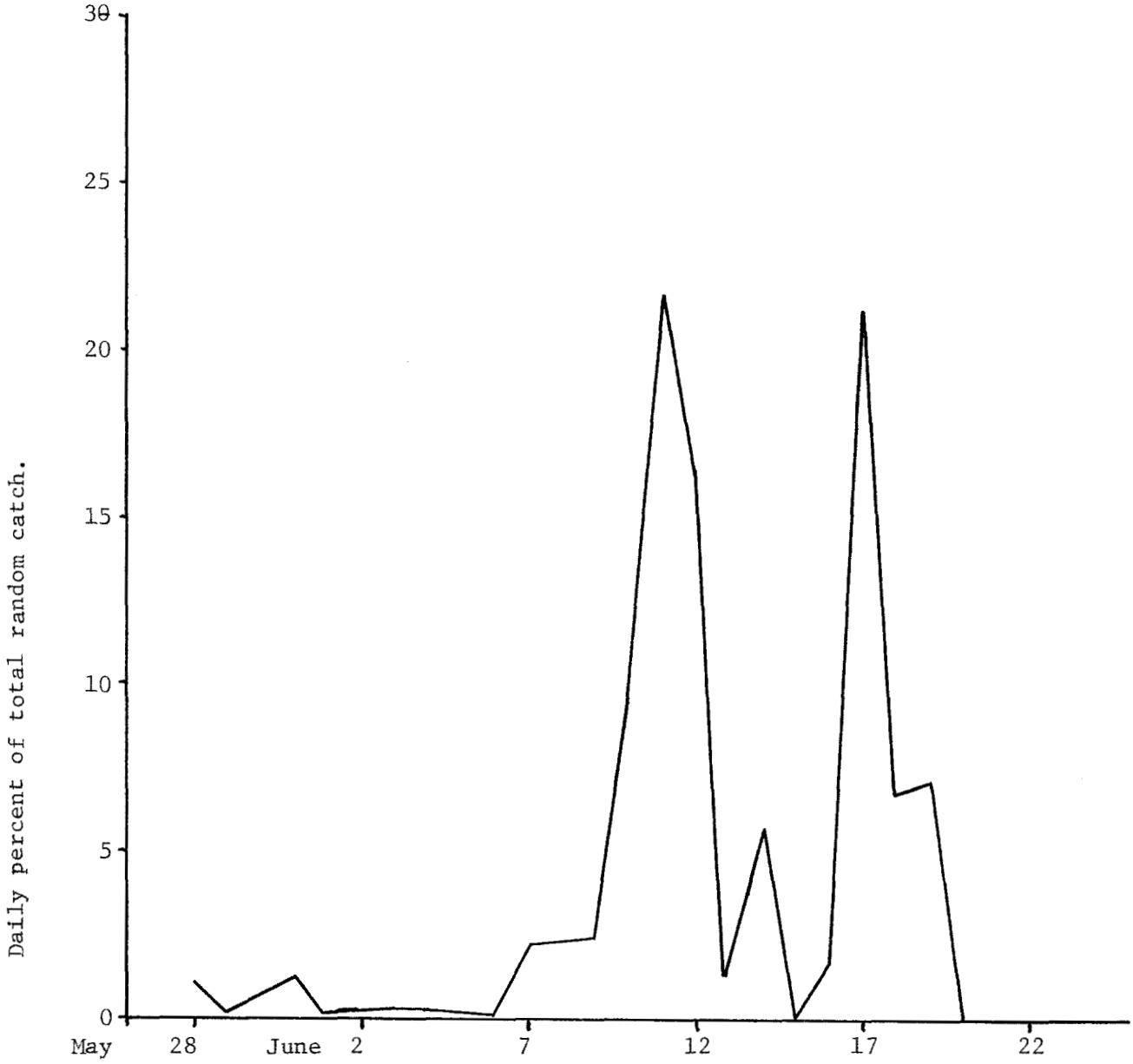

Figure 2. Daily random net catches of sockeye salmon smolt in percent of total random net catch, Ugashik River, 1972.

TABLE 1. Ugashik River red salmon smolt catches in the random sampling scheme by fishing site, 1972.

Date	Random Sampling Site 1	2	3	4	5	Daily Total	Accumulated Total
May 28	15	102	0	0	0	117	117
29	8	0	0	8	0	16	133
31	2	0	83	54	0	139	272
June 1	0	1	0	0	1	2	274
3	1	2	1	19	0	23	297
4	0	1	6	19	3	29	326
5	1	3	1	5	2	12	338
6	1	0	4	3	1	9	347
7	2	3	0	173	59	237	584
9	1	0	10	36	225	272	856
10	0	0	2	835	192	1,029	1,885
11	8	2	10	1,632	667	2,319	4,204
12	4	0	7	1,088	647	1,746	5,950
13	0	1	0	144	17	162	6,112
14	2	0	2	68	522	594	6,706
15	0	0	0	5	6	11	6,717
16	1	0	126	18	48	193	6,910
17	3	0	10	365	1,891	2,269	9,179
18	3	3	0	229	498	733	9,912
19	0	350	53	202	173	778	10,690
20	0	0	0	0	3	3	10,693
Total	52	468	315	4,903	4,955	10,693	10,693
Percent	0.49	4.38	2.94	45.85	46.34	100.00	100.00

Twenty-four hour sampling conducted 7 days in site four, indicated that 64.49 percent of the smolt outmigration occurred during the random fishing hours of 9 p.m. and 2 a.m. yielding an expansion coefficient of 1.55 (Table 2). Smolt samples were separated into two fishing periods with 55.6 percent of the total catch recorded during the first period (Table 3). A total of 300 scales were read during the season to determine the age class composition of the outmigrants. The total smolt outmigration estimate for 1972 was 662,718 and consisted of 93,443 Age I smolt (14.1 percent), 556,021 Age II smolt (83.9 percent) and 13,254 Age III smolt (2.0 percent).

Age I smolt averaged 80.8 mm in length and 5.0 grams in weight and were the smallest on record. Age II smolt averaged 111.5 mm and 11.2 grams and Age III smolt average 129.0 mm and 14.3 grams (Table 4).

DISCUSSION

The 1972 smolt outmigration estimate of 662,718 is the smallest on record. Age II smolt comprised 83.9 percent of the outmigration and was the third highest percentage of Age II smolt since the start of the program (Appendix Table 3).

The severe winters of 1970-71 and 1971-72 caused the late ice breakups, and may have caused low food abundance and poor growth of red salmon smolt. The Age I smolt set record lows for average length and weight of 80.8 mm and 5.0 grams respectively. This poor growth probably caused a hold-over of smolt for an additional year in freshwater resulting in the record low outmigration of smolt.

Further comparative data are contained in Appendix Tables 1-3.

TABLE 2. Ugashik River red salmon smolt catch in index site during 24 hour fishing periods, 1972.

Time Period	Date May 29-30	June 1-2	June 4-5	June 10-11	June 13-14	June 16-17	June 19-20	Total	%
2200-2300	9	2	19	835	280	1	216	1,362	15.34
2300-2400	8	6	34	17	189	20	160	434	4.89
2400-0100	6	2	7	21	144	116	55	351	3.95
0100-0200	3	1	3	5	77	292	196	577	6.50
0200-0330	2	1	1	4	10	29	15	62	0.70
0330-0500	1	0	0	2	1	5	8	17	0.19
0500-0630	0	0	0	2	0	0	0	2	0.02
0630-0800	0	0	0	3	0	0	3	6	0.07
0800-0930	0	0	1	4	2	75	3	85	0.99
0930-1100	0	0	0	5	10	3	2	20	0.22
1100-1230	0	1	0	1	3	115	12	132	1.48
1230-1400	0	0	0	18	4	8	0	30	0.34
1400-1530	0	0	0	172	6	79	0	257	2.89
1530-1700	0	0	0	28	398	29	0	455	5.12
1700-1830	1	0	1	337	4	233	0	576	6.48
1830-2000	0	0	0	293	562	312	0	1,167	13.14
2000-2100	12	0	0	35	60	237	0	344	3.87
2100-2200	1	2	0	2,006	628	365	0	3,002	33.81
Totals	43	15	66	3,788	2,378	1,919	670	8,879	100.00

TABLE 3. Ugashik River red salmon smolt sampling data, 1972.

Period No.	Date	Random Smolt Catch	% of Seasons Total	# 1 lb. Samples Measured	# of Fish Measured	# of Scales Read
1	May 28-June 12	5,950	55.6	9	394	180
2	June 13-20	4,743	44.4	6	221	120
Totals		10,693	100.0	15	615	300

TABLE 4. Age, length and weight of red salmon smolt by sampling period from the Ugashik River system, 1972.

		Mean length in mm of age group			Mean weight in grams of age group			Percentage of of age group		
Period No.	Date	I	II	III	I	II	III	I	II	III
1	May28-June 12	80.9	110.3	129.3	5.0	10.9	14.7	19.3	79.7	1.0
2	June 13-20	80.6	112.9	128.6	4.9	11.6	13.7	7.7	89.1	3.2
Season Weighted Totals		80.8	111.5	129.0	5.0	11.2	14.3	14.1	83.9	2.0

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APPENDIX

Appendix Table A-1. Kvichak River 24-hour sockeye salmon smolt index catches, average lenghts and weights, 1955-1972.

	Age I				Age II					
Outmigration	Number	Percent 2/	Average length	Weight	Number	Percent 2/	Average length	Weight	Total number	Total 24-hr. index 1/
1955	18,198	7	89 mm	-	241,780	93	109 mm	-	(259,978) 3/	7.8
1956	30,287	39	92 mm	-	47,373	61	116 mm	-	(77,660) 3/	2.3
1957	22,287	72	96 mm	7.3 g	8,654	28	120 mm	14.4 g	30,907	0.9
1958	3,267,274	98	84 mm	4.6 g	66,679	2	114 mm	-	3,333,953	100.0
1959	85,916	3	80 mm	-	2,777,960	97	99 mm	7.6 g	(2,863,876) 3/	85.9
1960	61,400	10	91 mm	6.3 g	552,603	90	108 mm	10.3 g	(614,003) 4/	18.4
1961	26,038	72	92 mm	6.8 g	10,126	28	117 mm	13.1 g	(36,164) 3/	1.1
1962	1,130,820	94	82 mm	4.3 g	72,180	6	110 mm	9.9 g	1,203,000	36.1
1963	113,338	3	83 mm	4.8 g	4,116,093	97	98 mm	7.5 g	4,229,431	126.9
1964	458,122	22	87 mm	5.2 g	1,603,464	78	108 mm	9.8 g	2,061,586	61.8
1965	64,377	4	90 mm	6.8 g	1,748,178	97	109 mm	11.3 g	1,812,555	54.4
1966	252,384	92	94 mm	7.4 g	23,377	8	114 mm	12.6 g	275,761	8.3
1967	2,866,214	93	86 mm	5.9 g	222,528	7	118 mm	14.2 g	3,088,742	92.6
1968	648,321	11	88 mm	5.5 g	5,475,362	89	104 mm	9.2 g	6,123,683	183.6
1969	594,327	52	92 mm	5.7 g	541,017	48	109 mm	10.6 g	1,135,344	34.0
1970	185,356	38	91 mm	6.0 g	298,882	62	110 mm	11.0 g	483,638	14.5
1971	1,803,040	94	90 mm	5.8 g	124,944	6	111 mm	11.1 g	1,927,984	57.8
1972	11,937 5/	1	80 mm	-	1,409,167 5/	99	106 mm	10.0 g	1,421,104 5/	42.6
Eighteen-year average.	646,646	45	88 mm	5.9 g	1,074,465	55	110 mm	10.8 g	1,721,076	51.6

1/ One index point = 33,340 smolt.

2/ Numbers of Age I and Age II fish derived from rounded-off season percentages except in 1963, 1964, 1965 and 1966 when rounded percentages were derived from numbers of smolts obtained by weighting length frequency distribution by daily catches.

3/ 24-hour index catch estimated by ratios with years of actual 24-hour fishing and from visual observations of smolt migration outside the 3-hour index period.

4/ 24-hour index catch estimated from ratios with the 3-hour index period catch obtained during only 2 days of actual 24-hour fishing.

5/ Estimated from ratio of 1971 index to 1971 total outmigration applied to 1972 total outmigration.

Appendix Table A-2. Percent of sockeye salmon smolt outmigration occurring during index hours (2200-0100), Kvichak River, 1955-1972.

Year	Outmigration[1/]	Percent outmigration during index hours (2200-0100)
1955	259,978	82.3%
1956	77,660	82.3
1957	30,907	82.3
1958	3,333,953	57.4
1959	2,863,876	57.4
1960	614,003	74.1
1961	36,164	82.3
1962	1,203,000	25.1
1963	4,229,431	32.6
1964	2,061,586	38.3
1965	1,812,555	46.9
1966	275,761	39.5[2/]
1967	3,088,742	30.1
1968	2,295,023	37.5
1969	543,351	47.9
1970	218,951	45.3
1971	212,328	11.0
1972	-	-
Averages	1,362,192	51.3[3/]

1/ The methods used to expand the 3-hour index catches to 24-hour catches for the years 1955, 1956, 1959, 1960, and 1961 are explained in the 1964 smolt report.

2/ This figure is nearly meaningless since ice flow precluded any estimate of comparative migration by period.

3/ Note that the average 51.3% migration during the index hours is probably high as the percent for three of the four years showing 82.3% was assumed on the basis that 82.3% of the smolt in 1957 migrated during the index hours. Sampling was not on a 24-hour basis for the years, 1955, 1956, 1959, 1960 and 1961.

Appendix Table A-3. Kvichak River 3-hour sockeye salmon smolt catches, 1955-1969, (3-hour index catches).

Year of outmigration	Age I Number	Age I Percent	Age II Number	Age II Percent	Total number	Total 3-hr. index 1/
1955	14,971	7	198,897	93	213,868	6.4
1956	24,916	39	38,970	61	63,886	1.9
1957	18,306	72	7,119	28	25,425	0.8
1958	1,874,512	98	38,255	2	1,912,767	57.4
1959	49,292	3	1,593,781	97	1,643,073	49.3
1960	45,478	10	409,305	90	454,783	13.6
1961	21,420	72	8,330	28	29,750	0.9
1962	283,328	94	18,085	6	301,413	9.0
1963	41,424	3	1,339,379	97	1,380,803	41.4
1964	173,919	22	616,623	78	790,542	23.7
1965	34,009	4	816,212	96	850,221	25.5
1966	100,199	92	8,713	8	108,912	3.3
1967	864,650	93	65,081	7	929,731	27.9
1968	252,452	11	2,042,571	89	2,295,023	68.8
1969	282,542	52	260,809	48	543,351	16.3
1970	83,201	38	135,750	62	218,951	6.6
1971	198,527	94	13,801	6	212,328	6.4
1972	-	1	-	99	-	-
Seventeen-yr. average	256,656	45	447,746	55	704,402	21.1

1/ One index point = 33,340 smolt.

Appendix Table A-4. Parent escapement and corresponding sockeye salmon smolt production, Kvichak River, 1952-1970.

Year of spawning	Escapement in thousands	24-hour index smolt produced			24-hour index smolt per spawner x 10^3		
		Age I	Age II	Total	Age I	Age II	Total
1952	5,970		241,780			40	
1953	321	18,198	47,373	65,571	57	148	205
1954	241	30,287	8,654	38,941	126	36	162
1955	250	22,253	66,679	88,932	89	267	356
1956	9,443	3,267,274	2,777,960	6,045,234	346	294	640
1957	2,964	85,916	552,603	638,519	29	186	215
1958	535	61,400	10,126	71,526	115	19	134
1959	680	26,038	72,180	98,218	38	106	144
1960	14,630	1,130,820	4,116,093	5,246,913	77	281	358
1961	3,706	113,338	1,603,464	1,716,802	30	433	463
1962	2,581	458,122	1,748,178	2,206,300	178	677	855
1963	339	64,377	24,818	89,195	190	73	263
1964	957	252,384	222,528	474,912	264	233	497
1965	24,326	2,866,214	5,475,362	8,341,576	118	225	343
1966	3,775	648,321	541,017	1,189,338	172	143	315
1967	3,216	594,327	298,882	892,609	185	93	278
1968	2,557	185,356	124,944	310,300	72	49	121
1969	8,394	1,803,040	1,409,167	3,212,207	215	168	383
1970	13,935	11,937			.9		
1971	2,387						
Averages	4,478	683,980	1,074,545	1,758,525	149	203	361

Appendix Table A-5. Dates of sampling and peak periods of sockeye salmon smolt outmigration, Kvichak River, 1955 - 1972.

Year	Date	Number of days	Date	Number of days	Percent of total catch
1955	5/28-6/27	31	6/4-9	6	94%
1956	5/24-7/4	42	6/1-9, 14-16	12	88
1957	5/28-7/24	58	5/28-6/6	10	84
1958	5/10-7/5	56	5/22-6/3	13	80
1959	5/23-6/28	36	5/26-6/2	8	98
1960	5/18-6/19	33	5/28-6/4	8	80
1961	5/23-6/20	29	5/23-6/2	11	81
1962	5/27-7/4	39	6/2-15	14	88
1963	5/16-6/16	32	5/24-29, 6/7-9	9	86
1964	5/19-6/22	35	6/4-12	9	84
1965	5/17-6/14	28	5/24-30	6	91
1966	5/18-6/17	31	6/4-11	8	97
1967	5/17-6/17	31	5/26-6/6	12	80
1968	5/17-6/14	28	5/24-27, 6/1-5	9	76
1969	5/23-6/18	26	5/27-6/5, 6/15	14	97
1970	5/1-6/15	46	5/25-29, 6/2-4	8	65
1971	5/22-6/19	28	6/9-13, 6/14-17	9	99
1972	-	-	6/9-18 1/	9 1/	83 2/
Averages		35		10	86

1/ Period estimated from 1972 outmigration results.

2/ Percentage taken from 1972 outmigration results.

Appendix Table A-6. Parent escapement and corresponding percent of Age II sockeye salmon smolt produced, 1952-1969.

Year	Escapement	Percent Age II smolt produced 1/
1952	5,970,000	10 - 15% 2/
1953	321,000	72%
1954	241,000	22%
1955	250,546	75%
1956	9,443,318	46%
1957	2,842,810	87%
1958	534,785	14%
1959	680,000	73%
1960	14,630,000	78%
1961	3,705,849	93%
1962	2,580,884	79%
1963	338,760	27%
1964	957,120	47%
1965	24,325,926	66%
1966	3,775,184	45%
1967	3,216,208	33%
1968	2,557,440	40%
1969	8,394,204	44%

1/ Based on 24-hour index catches.
2/ Estimated on basis of 2-ocean returns in 1956 and 5_2 fish in 1957 vs. 5_3 fish in 1957 and 6_3 fish in 1958.

Appendix Table A-7. Parent sockeye salmon escapement and corresponding adult return per indexed smolt, by age group, Kvichak River, 1952-1965.

Brood year	Age I smolt				Age II smolt		
	Escapement 1/	Index 1/	Adult return 1/	Ret./smolt	Index 1/	Adult return 1/	Ret./smolt
1952	5,970	--	15,906	--	242	3,587	14.82
1953	321	18	128	7.11	47	407	8.66
1954	241	30	104	3.47	9	634	70.44
1955	251	22	344	15.64	67	1,418	21.16
1956	9,443	3,267	30,108	9.22	2,778	7,469	2.69
1957	2,843	86	487	5.56	553	3,446	6.23
1958	535	61	119	1.95	10	157	15.70
1959	680	26	311	11.96	72	214	2.97
1960	14,630	1,131	1,816	1.61	4,116	51,965	12.63
1961	3,706	113	502	4.44	1,603	2,888	1.80
1962	2,581	458	238	0.52	1,748	4,986	2.85
1963	339	64	92	1.44	23	979	39.16
1964	957	252	2,348	9.32	223	2,965	13.30
1965	24,326	2,866	9,748	3.40	5,475	32,917	6.01

1/ In thousands

Appendix Table A-8. Kvichak River sockeye salmon smolt indices and corresponding adult return per indexed smolt, 1952-1965.

Brood year	Total Smolt		
	Index 1/	Adult return 1/	Ret./smolt
1952			
1953	65	535	8.23
1954	39	738	18.92
1955	89	1,762	19.80
1956	6,045	37,577	6.22
1957	639	3,933	6.16
1958	71	276	3.89
1959	98	525	5.36
1960	5,247	53,781	10.25
1961	1,717	3,390	1.97
1962	2,206	5,224	2.37
1963	87	1,071	12.31
1964	475	5,313	11.19
1965	8,341	42,665	5.12

1/ In thousands

Appendix Table A-9. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Kvichak River, 1960-1972.

Year of Outmigration	Age I Percent	Age I Mean length (mm)	Age II Percent	Age II Mean length (mm)	24-hr. Index Points	24-hr. Index Catch	Outmigration Estimate
1960	10	91	90	108	18.4	614,004	
1961	72	92	28	117	1.1	36,164	
1962	94	82	6	110	36.1	1,203,000	
1963	3	83	97	98	126.9	4,229,431	
1964	22	87	78	108	61.8	2,061,586	
1965	4	90	96	109	54.4	1,812,555	
1966	92	94	8	114	8.3	275,761	
1967	93	86	7	118	92.6	3,088,742	
1968	11	88	89	104	183.6	6,123,683	
1969	52	92	48	109	34.0	1,135,344	
1970	38	91	62	110	14.5	483,638	
1971	94	90	6	111	57.8	1,927,984	91,682,813
1972	1	80	99	106	42.6	1,421,104	67,575,075

Appendix Table A-10. Kvichak River sonar counts by day and array, 1971.

Date (noon to noon)	West bank upper 1/	West bank lower 1/	West bank inshore total 2/	West bank offshore total 2/	East bank offshore upper	East bank offshore lower	East bank offshore total	East bank inshore upper	East bank inshore lower	East bank inshore total
5/24-25					852	80		710	5	
25-26					658	129		1,100	79	
26-27					0	1	4/	22	24	4/
27-28					24	43		352	227	
28-29					247	26		552	57	
29-30					0	183	183	75	67	142
30-31					0	9	9	4	4	8
31-1					7	15	22	34	10	44
6/1-2					8	0	8	5	0	5
2-3	51	15	31	35	23	3	26	21	0	21
3-4	368	328	324	372	3	5	8	2	0	2
4-5	361	159	242	278	3	9	12	10	8	18
5-6	139	130	125	144	26	25	51	24	17	41
6-7	254	355	283	326	137	60	197	112	64	176
7-8	87	17	48	56	48	112	160	173	324	497
8-9	8	2	5	5	5	15	20	6	44	50
9-10	586	3	274	315	-	-	3,348 3/	-	-	4,315 3/
10-11	7,335	609	3,694	4,250	3,409	3,267	6,676	5,606	2,973	8,579
11-12	8,066	20	3,760	4,326	3,154	1,639	4,793	9,372	667	10,039
12-13	6,284	202	3,016	3,470	4,057	1,140	5,197	10,946	249	11,195
13-14	740	13	350	403	1,851	5,818	7,669	2,871	2,965	5,836
14-15	1,213	24	575	662	443	300	743	1,237	483	1,720
15-16	5,946	44	2,785	3,205	373	187	560	673	78	751
16-17	751	1	752	865 3/	670	86	756	754	20	774
17-18	184	21	205	236 3/	627	53	680	307	147	454
Total			16,469	18,948			31,118			44,667

1/ Comprises counts from W-inshore & offshore deducers combined.
2/ Apportioned counts based on 1972 season total counts for corresponding arrays.
3/ Expanded counts to compensate for missed fishing time.
4/ Counts disregarded due to heavy ice, wind, and rain.

Appendix Table A-11. Kvichak River sonar counts by day and array, 1972.

Date (noon to noon)	West bank inshore upper	West bank inshore lower	West bank inshore total	West bank offshore upper	West bank offshore lower	West bank offshore total	East bank offshore upper	East bank offshore lower	East bank offshore total	East bank inshore upper	East bank inshore lower	East bank inshore total
5/29-30	21	8	28	155	28	183						
30-31	46	26	72	114	17	131	11	47	58	37	21	58
31-1	92	65	157	355	270	625	530	752	1,282	2,760	151	2,911
6/1-2	6	77	83	0	87	87	0	0	0	10	1	11
2-3	58	68	126	164	78	242	6	10	16	7	9	16
3-4	105	293	398	509	67	576	100	31	131	32	13	45
4-5	804	222	1,026	635	196	831	143	73	216	29	19	48
5-6	644	92	736	942	264	1,206	277	183	460	138	14	152
6-7	3,927	1,644	5,571	3,353	1,171	4,524	1,365	505	1,870	308	200	508
7-8	8,665	2,347	11,012	12,149	3,708	15,857	1,969	1,177	3,146	2,365	1,377	3,742
8-9	14,785	844	15,629	14,324	509	14,833	2,656	227	2,883	2,789	324	3,113
9-10	9,747	535	10,282	8,755	854	9,609	259	20	279	2,488	10	2,498
10-11	28,916	1,422	30,338	28,977	1,203	30,180	12,755	5,169	17,924	25,687	5,594	31,281
11-12	3,206	1,242	4,448	5,848	4,705	10,553	-	-	3,629 1/	-	-	6,178 1/
12-13	52,814	1,917	54,731	29,708	2,484	32,192	847	29	876	2,047	0	2,047
13-14	31,022	1,802	32,824	31,264	3,487	34,751	81	1	82	928	683	1,611
14-15	27,441	1,309	28,750	18,647	12,446	31,093	-	-	5,913 1/	-	-	9,759 1/
15-16	-	-	19,484 1/	-	-	25,146 1/	-	-	3,489 1/	-	-	5,758 1/
16-17	15,848	7,375	10,218 2/	12,264	5,973	19,199 2/	2	1	3	264	1	265
17-18	26,313	828	34,998 2/	19,450	837	24,920 2/	558	438	996	705	73	778
18-19	1,873	129	4,424 2/	755	25	17,736 2/						
19-20	229	19	1,027 2/	50	0	205 2/						
20-21	0	722	1,341 2/	0	240	520 2/						
21-22	220	41	709 2/	282	167	1,364 2/						
22-23	2	4	18 2/	23	1	62 2/						
23-24	166	304	613 2/	374	78	512 2/						
24-25	2,124	655	2,779	1,194	145	1,339						
25-26	346	49	698 2/	445	22	826 2/						
26-27	321	12	333	500	61	561						
27-28	249	76	325	699	69	768						
28-29	178	12	190	678	49	727						
Total			319,932			281,358			43,253			70,779

1/ Estimated sonar counts for missing day.
2/ Includes estimated sonar counts to compensate for missed fishing time.

Appendix Table A-12. Calibrations recorded on the west side Kvichak River for the 1970 sonar electronics, 1971 (continued).

Date	Fishing Time Set	Fishing Time Pulled	Min.	Sonar Counts Upper	Sonar Counts Lower	Sonar Counts Total	Cod End Catches Wt.	Cod End Catches No./lb.	Cod End Catches Catch	Fish per count
6/16	1711	1810	59	3	0	3	13.5	56	756	252
	1906	1936	30	7	0	7	18.3	52	952	135
	1936	2003	27	5	0	5	29.8	62	1848	370
	2003	2023	20	15	0	15	19.6	67	1313	87
	2023	2100	37	2	0	2	34.8	64	2227	1114
	2100	2124	24	7	0	7	18.8	68	1278	183
	2132	2143	11	20	0	20	37.0	57	2109	105
	2138	2148	10	10	0	10	29.0	60	1740	174
	2148	2155	7	6	0	6	23.0	70	1610	268
	2155	2202	7	3	0	3	25.4	64	1626	542
	2218	2229	11	2	0	2	17.1	66	1129	564
	2238	2258	20	10	0	10	19.8	69	1366	137
	2313	2327	14	4	0	4	17.1	64	1094	274
	2350	2357	7	2	0	2	19.1	65	1242	621
	2406	2429	23	3	0	3	28.8	68	1958	653
	2459	0113	14	20	0	20	34.0	70	2380	119
6/17	0113	0120	7	41	0	41	24.7	71	1753	43
	0120	0135	15	70	0	70	57.3	59	3381	48
	0135	0200	25	59	0	59	35.8	68	2434	41
	0200	0222	22	60	0	60	63.6	70	4452	74
	0222	0238	20	31	0	31	33.2	73	2424	78
	0238	0243	5	4	0	4	37.5	69	2588	647
	0243	0256	13	2	0	2	15.0	64	960	480
	0307	0334	27	3	0	3	15.4	70	1078	359
	0334	0405	31	19	0	19	-	-	24	1

Appendix Table A-12. Calibrations recorded on the west side Kvichak River for the 1970 sonar electronics, 1971.

		Fishing Time		Sonar Counts			Cod End Catches			
Date	Set	Pulled	Min.	Upper	Lower	Total	Wt.	No./lb.	Catch	Fish per count
6/15/71	2304	2312	8	0	32	32	38.6	69	2654	829
	2312	2321	9	0	7	7	20.4	65	1326	189
	2321	2330	9	0	9	9	27.4	65	1781	198
	2338	2345	7	0	10	10	33.1	69	2284	228
	2345	2349	4	0	5	5	40.3	69	2781	556
	2349	2353	4	0	2	2	31.5	70	2205	1102
	2356	0001	5	0	6	6	39.6	69	2732	455
6/16	0001	0005	4	0	2	2	33.5	69	2312	1156
	0005	0008	3	0	13	13	51.5	66	3399	261
	0008	0011	3	0	5	5	26.7	74	1976	395
	0011	0015	4	0	1	1	13.0	73	949	949
	0015	0022	7	0	2	2	33.3	71	2364	1156
	0022	0026	4	0	1	1	39.3	72	2830	2830
	0055	0102	7	0	5	5	38.3	69	2643	529
	0102	0106	4	0	1	1	36.0	70	2520	2520
	0106	0112	6	0	2	2	13.0	75	975	488
	0117	0126	8	0	4	4	36.2	74	2679	670
	0256	0300	4	0	10	10	25.7	74	1902	190
	0936	0949	13	4	0	4	21.8	59	1286	322
	0950	1007	17	1	0	1	3.5	44	154	154
	1007	1022	15	10	0	10	16.6	64	1062	106
	1106	1128	22	5	0	5	18.7	63	1178	236
	1128	1134	6	13	0	13	7.9	62	490	38
	1134	1200	26	2	0	2	-	-	71	35
	1200	1208	8	6	0	6	22.3	54	1204	200
	1208	1216	8	2	0	2	16.2	57	923	462
	1216	1249	33	6	0	6	12.6	50	630	105
	1249	1302	13	8	0	8	3.9	58	226	28
	1302	1333	31	4	0	4	15.4	54	832	208
	1407	1434	41	10	0	10	14.8	58	858	86
	1434	1505	31	5	0	5	13.5	51	686	138
	1505	1607	82	10	0	10	5.8	66	383	38
	1617	1711	54	20	0	20	30.9	61	1885	94

Appendix Table A-13. Calibrations recorded on the east side Kvichak River for the 1971 sonar electronics, 1971.

Date	Set	Fishing Time Pulled	Min.	Sonar Counts Upper	Lower	Total	Cod End Catches Wt.	No./lb.	Catch	Fish per count
6/11/71	0238	0249	11	3	51	54	22.0	51	1122	20.7
	0251	0300	9	5	19	24	50.9	54	2748	114.5
	0321	0344	23	56	55	111	93.8	66	6191	54.9
	0353	0418	25	107	140	247	22.6	62	1401	5.7
	1010	1025	15	71	1	72	18.0	78	1404	19.5
	1106	1116	10	1	124	125	19.0	77	1463	11.7
	1150	1154	2	66	378	444	39.8	76	3025	6.8
	1154	1268	14	255	127	382	46.8	71	3323	8.7
	1226	1245	19	103	211	314	14.8	69	1021	3.3
	1400	1450	50	269	94	363	26.8	69	1849	5.1
	1450	1526	36	647	255	902	25.7	66	1696	1.9
	1537	1612	35	310	34	344	26.2	65	1703	5.0
	1612	1627	15	132	158	290	5.7	47	268	0.9
	1627	1743	73	137	197	334	26.2	65	1703	5.1
	1743	1754	11	6	1	7			15	1.9
	1754	1929	95	290	263	553	14.9	69	1028	1.8
	1929	2030	61	248	144	392	13.2	74	977	2.5
	2030	0009	39	118	0	118	5.5	73	403	3.4
6/12	0009	0014	5	47	0	47	2.5	64	160	3.4
	0014	0123	69	41	0	41	2.7	69	186	4.5
	0123	0334	131	43	2	45	4.5	78	351	7.8
	0334	0429	54	73	2	76	2.2	73	160	2.1
	0429	0446	17	49	35	84	3.0	79	237	2.8
	0446	0611	85	111	26	137	2.6	64	166	1.2
	0611	0800	109	2	34	36	2.5	68	170	4.7
	1652	1804	72	4	8	12	1.1	87	96	8.0
	1804	1820	16	0	50	50	4.5	51	230	4.6
	1820	1855	35	67	69	136	5.5	75	413	3.0
	1855	1935	40	104	158	262	47.2	69	3257	12.4
	1944	2008	24	212	163	375	32.2	73	2351	6.3
	2015	2042	27	178	22	200	7.6	79	600	3.0
	2042	2103	21	169	115	284	20.6	76	1566	5.5

Appendix Table A-13. Calibrations recorded on the east side Kvichak River for the 1971 sonar electronics, 1971 (continued).

	Fishing Time			Sonar Counts			Cod End Catches			
Date	Set	Pulled	Min.	Upper	Lower	Total	Wt.	No./lb.	Catch	Fish per count
6/12	2103	2119	16	272	7	279	22.9	75	1718	6.2
	2119	2151	32	330	154	484	45.7	75	3428	7.1
	2151	2336	106	247	0	247	17.8	80	1424	5.8
	2336	2351	15	410	0	410	18.0	76	1368	3.3
	2351	2355	4	573	6	579	31.5	78	2457	4.2
	2355	0007	13	284	0	284	20.7	80	1656	5.8
	0007	0037	24	56	0	56	5.0	77	385	6.9
	0134	0148	14	32	0	32	2.0	80	160	5.0
	0425	0456	31	364	50	414	12.6	83	1046	2.5
	0456	0520	24	310	47	357	4.5	81	365	1.0
	0520	0640	80	173	6	179	8.5	80	680	3.8
6/13	1528	1545	17	242	240	482	56.4	70	3948	8.2
	1545	1600	15	148	201	349	16.3	62	1011	2.9
	1621	1626	5	60	399	459	37.5	72	2700	5.9
	1626	1638	12	13	142	155	11.5	73	840	5.4
	1638	1648	10	254	618	872	138.8	70	9716	11.1
	1648	1708	20	57	115	172	17.2	80	1376	8.0
	1708	1738	30	15	32	47	1.7	52	80	1.8
	1738	1752	14	3	112	115	3.5	55	193	1.7
	1752	1830	38	0	209	209	29.0	76	2204	10.5
	1830	1841	11	0	170	170	13.0	66	858	5.0
	1841	1858	3	31	329	360	22.3	66	1472	4.9
	1857	1918	21	0	170	170	13.8	82	1132	6.7
	1918	1944	26	24	14	38	13.5	72	972	25.6
	1944	2317	143	8	62	70	5.7	82	467	6.7
6/14	1420	1510	30	8	27	35	3.0	60	180	5.1
	1558	1705	67	7	21	28	3.8	68	258	9.2
	1705	1753	47	123	35	158	26.5	68	1802	11.4
6/15	0945	1047	72	60	50	110	5.8	59	342	3.1

Appendix Table A-14. Calibrations recorded on the east side Kvichak River for the 1972 sonar electronics, 1972.

	Fishing Time			Sonar Counts			Cod End Catches			
Date	Set	Pulled	Min.	Upper	Lower	Total	Wt.	No./lb.	Catch	Fish per count
6/6/72	0500	0600	60	10	0	10	15.2	45	684	68.4
	1927	2018		89	64	153	5.1	45	229.5	1.5
6/7	0100	0200	60	42	0	42	8.3	40	332	7.9
	0200	0300	60	108	1	109	7.5	35	262.5	2.4
	0300	0400	60	14	1	15	4.5	39	175.5	11.7
	0400	0435	35	703	224	927	200.0	39	7800	8.4
	0435	0500	25	265	161	426	44.0	40	1760	4.1
	0500	0600	60	112	3	115	21.3	35	745.5	6.5
	0800	0827	27	323	303	626	67.8	37	2508.6	4.0
	1305	1335	30	329	181	510	83.0	39	3237	6.3
	1340	1405	25	36	38	74	23.0	39	879	11.8
	2100	2110	10	136	67	203	47.0	42	1974	9.7
	2120	2234	74	266	158	424	98.0	42	4116	9.7
6/8	0100	0145	45	88	19	107	4.5	39	175.5	1.64
	0145	0203	28	205	65	270	54.5	38	2071	7.6
	0203	0216	13	96	23	119	18.5	44	814.0	6.8
	0216	0235	29	82	66	148	37.3	45	1678.5	11.3
	0235	0241	6	75	55	130	22.3	40	892.0	6.8
	0241	0316	35	84	72	156	42.5	47	1997.5	12.8
	0316	0337	41	95	87	182	25.7	38	976.6	5.3
	0337	0347	10	133	95	228	42.0	42	1764.0	7.7
	1700	1733	33	45	93	138	9.4	38	357.2	2.58
	1733	1742	9	25	12	37	11.0	40	440	11.8
	1742	1755	13	27	46	73	5.0	37	185	2.53

Appendix Table B-1. Average fork lengths and weights, Naknek River sockeye salmon smolts, 1957-1972 1/.

Year of Seaward Migration	Age I			Age II		
	% Age class	Length mm.	Weight grams	% Age class	Length mm.	Weight grams
1957	57.9	111	13.1	42.1	112	13.1
1958	96.4	91	6.9	3.6	114	11.3
1959	80.5	97	8.2	19.5	106	10.1
1960	53.1	99	8.8	46.6	109	11.9
1961	77.8	103	10.8	22.2	113	13.8
1962	48.6	105	10.4	51.4	112	12.5
1963	40.6	98	8.1	58.5	114	12.8
1964	31.1	97	7.7	68.8	110	11.0
1965	59.6	99	8.4	40.0	114	13.0
1966	33.8	106	10.6	66.2	118	14.2
1967	43.5	113	13.1	56.2	119	14.7
1968	41.2	99	8.4	56.7	108	11.1
1969	59.8	100	7.5	40.2	112	12.1
1970	55.3	100	9.0	44.8	114	12.1
1971	74.0	102	8.8	26.0	120	13.5
1972	6.5	98	9.1	93.5	110	11.9
Totals	859.7	1,618	148.9	736.3	1,805	199.1
Average	53.7	101	9.3	46.0	113	12.4

1/ Age III smolt not included

Appendix Table B-2. Production of sockeye salmon smolt by brood year, Naknek River, 1956-1970 1/.

Brood Year	Escapement	Smolts Produced at Age I	II	III	Total
1956	1,772,595	9,698,033	2,430,770	20,074	12,148,877
1957	634,645	10,034,717	3,118,182	0	13,152,899
1958	278,118	3,553,121	1,246,008	0	4,799,129
1959	2,231,807	4,366,639	8,461,579	134,108	12,962,326
1960	828,381	8,000,637	8,717,000	7,228	16,724,865
1961	351,078	6,049,747	4,973,098	88,951	11,111,796
1962	723,066	2,248,013	9,878,527	0	12,126,540
1963	905,358	14,741,194	6,098,025	25,399	20,864,618
1964	1,349,604	3,114,885	5,284,965	390,517	8,790,367
1965	717,798	4,096,836	10,543,954	0	14,640,790
1966	1,016,445	7,661,568	4,638,035	0	12,299,603
1967	755,640	6,907,982	1,634,657	0	8,542,639
1968	1,023,222	2,018,207	2,827,916	0	4,846,122
1969	1,331,202	8,036,148	10,274,143		
1970	732,502	716,596			
Total	14,601,461	91,214,323	80,126,858	666,277	153,010,571
Average	973,431	6,080,955	5,723,347	51,252	11,771,429

1/ Production from 1954 and 1955 brood years were only partially sampled in 1956 and 1957.

Appendix Table B-3. Sockeye salmon smolt outmigrations, Naknek River, 1956-1972.

Year of Seaward Migration	Number at Age			Total
	I	II	III	
1956	5,064,000	936,000	-	6,000,000
1957	1,760,401	1,280,015	-	3,040,416
1958	9,698,033	362,167	-	10,060,200
1959	10,034,717	2,430,770	-	12,465,487
1960	3,553,121	3,118,182	20,074	6,691,377
1961	4,366,639	1,246,008	-	5,612,647
1962	8,000,637	8,461,579	-	16,462,216
1963	6,049,747	8,717,000	134,108	14,900,855
1964	2,248,013	4,973,098	7,228	7,228,339
1965	14,741,194	9,878,527	88,951	24,708,672
1966	3,114,885	6,098,025	-	9,212,910
1967	4,096,836	5,284,965	25,399	9,407,200
1968	7,661,568	10,543,954	390,517	18,596,039
1969	6,907,982	4,638,035	-	11,546,017
1970	2,018,207	1,634,657	-	3,652,864
1971	8,036,148	2,827,916	-	10,864,064
1972	716,596	10,274,143	-	10,990,739
Total	98,068,724	82,705,041	666,277	181,440,042
Average	5,768,749	4,865,002	39,193	10,672,944

Appendix Table C-1. Average length and weight of Ugashik River red salmon smolt by freshwater age group, 1958-1972[1/].

Year of Seaward Migration	Age I		Age II	
	Length	Weight	Length	Weight
1958	93.0	6.4	112.0	11.7
1959	90.0	6.1	120.0	13.5
1960	90.0	6.6	108.0	11.0
1961	90.0	6.7	112.0	12.2
1962	88.0	6.1	112.0	12.3
1963	89.8	6.1	104.3	9.6
1964	92.2	6.9	118.3	12.7
1965	93.7	6.9	114.1	12.5
1967	87.5	6.0	113.1	12.2
1968	92.8	6.5	112.6	10.7
1969[2/]	97.4	7.5	121.2	14.5
1970[2/]	97.0	7.7	124.8	15.9
1972[2/]	80.8	5.0	111.5	11.2
13 year Total	1,182.2	84.5	1,483.9	160.0
13 year Average	90.9	6.5	114.1	12.3

1/ Weighted by index catches.

2/ Weighted by randon catches.

Appendix Table C-2. Ugashik River red salmon escapements and smolt production, 1956-1970.

Brood Year	Ugashik River Escapement	Millions of Smolt Produced				Smolt Per Spawner
		Age I	Age II	Age III	Total	
1956	424,295	11.4	0.4	0.01	11.9	28
1957	214,802	2.5	2.2	-	4.7	22
1958	279,546	3.3	3.0	-	6.3	23
1959	219,228	0.8	3.2	-	4.0	18
1960	2,304,200	13.5	18.1	-	31.6	14
1961	348,639	15.6	2.0	-	17.6	50
1962	255,426	8.0	2.6	-	10.6	42
1963	388,254	1.0	-1/	-	1.0 1/	-
1964	472,770	-1/	2.4	-	2.4 1/	-
1965	996,612	2.7	2.9	-	5.6	6
1966	704,436	39.3	2.0	-	41.3	59
1967	238,830	3.0	0.8	-	3.8	16
1968	70,896	0.6	-1/	0.01	0.6	9
1969	160,380	-1/	0.6	-	0.6 1/	4 1/
1970	735,024	0.1	-2/	-	0.1 2/	-

1/ No outmigration estimate made in 1966 or 1971.

2/ The Age II smolt from the 1970 escapement will not leave freshwater until 1973.

Appendix Table C-3. Comparative age, length, index net catches and outmigration estimates of red salmon smolt from the Ugashik River system, 1956-1972.

Year of Seaward Migration	Age I		Age II		Index Points	Index Net Catch	Out-Migration Estimates
	Percent	Mean Length in mm.	Percent	Mean Length in mm.			
1956	11.0	--	89.0	--	--	--	---
1957	4.0	--	96.0	--	--	--	---
1958	98.1	93.0	1.9	112.0	100.0	301,232	11,659,905
1959	87.3	90.0	12.7	120.0	36.5	109,982	2,887,002
1960	59.7	90.0	39.3 1/	108.0	75.1	226,317	5,503,646
1961	20.4	90.0	79.6	112.0	52.3	157,441	3,802,079
1962	80.7	88.0	19.3	112.0	103.1	310,616	16,692,089
1963	46.3	89.8	53.7 1/	104.3	305.2	919,451	33,750,496
1964	80.1	92.2	19.8 1/	118.3	68.1	205,145	9,990,048
1965	28.8	93.7	71.2	114.1	57.4	172,893	3,640,115
1967	52.5	87.5	47.5	113.1	30.9	93,068	5,137,063
1968	93.1	92.8	6.9	112.6	145.9	493,587	42,205,912
1969 2/	59.7	97.4	40.3	121.2	21.3	63,999	5,048,673
1970 2/	57.5	97.0	42.5	124.8	--	--	1,304,722
1972 2/	14.1	80.8	83.9 1/	111.5	--	--	662,718

Note: Age I and II denotes the number of winters spent in freshwater. Age and length are weighted by the index catches.

1/ 2.0 percent Age III in 1972; 1.0 percent Age III in 1960; 0.1 Age III in 1963 and 1964

2/ Age and length weighted by randon catches.

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