



1973 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:
Kenneth P. Parker

1974

ADF&G TECHNICAL DATA REPORTS

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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 revisions will be made via errata sheets. Major revisions will be made in the form of revised reports.

1973 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

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

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1973 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 Department of Fish and Game, Division of Commercial Fisheries Research staff. Since the program's inception, nineteen 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. 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 with 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 total outmigration hardware and techniques. In 1969 experiments were conducted testing the feasibility of utilizing underwater sonar for counting smolt. Initial field experimentation with adult sonar counting equipment verified the feasibility of sonar application to smolt enumeration and led to its development for field tests and utilization in 1970. Improved gear was used in the field in 1971 and 1972 (Paulus and McCurdy, 1972; Parker, In Press). 1973 represents the third year of sockeye salmon smolt outmigration enumeration utilizing the Bendix biomass counters. The project results are presented in this report.

The index program was maintained in 1973 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 fyke net indices.

INDEX PROGRAM

Materials and Methods

Materials and methods used for the 1973 index program remained similar to those described for previous years (Paulus and McCurdy, 1969; McCurdy and Paulus, 1972; Paulus and McCurdy, 1972; Russell, 1972). The index fishing site remained unchanged from its standard location 2-1/2 miles downstream from the outlet of Lake Iliamna (Figure 1).

A major modification to the indexing system was introduced midway through the 1973 smolt season, as a result of chronic malfunctioning of the 14-year old Veeder-Root photo-electric counters. On June 1, it became apparent that either extensive repair or replacement of the photo-electric counting equipment was needed. Mr. Al Menin, the designer of the Bendix Smolt counter, volunteered his services and examined the malfunctioning photo-electric equipment. Mr. Menin found the photo-counting equipment in need of numerous parts that were not readily available and suggested that he could build a sonar counting system applicable to fyke net sampling. Mr. Menin was given the go ahead and in a day and a half, designed, constructed, and tested a sonar counting system that replaced the photo-electric counters for the remainder of the season.

The major features of the sonar unit include: 1) 12-volt power system with low current drain allowing an entire seasons operation on a single car battery, 2) a temperature insensitive electronic design, 3) a four transducer continuous wave counting system consisting of two sets of horizontally opposed transducers separately monitoring the upper and lower portions of the sampling aperture, 4) two mechanical digital totalizers that separately register the sonar counts from the upper and lower sets of transducers, 5) a test pushbutton to verify the proper functioning of the counting circuits, and 6) transducers that are interchangeable with the Bendix Smolt sonar system. In addition to these features, the sonar counting system is not affected by water turbidity, air bubbles in the water column, air temperatures, and humidity, all factors that often affected the operating efficiency of the photo-electric counters.

The index sonar counter works on the principal that after smolt enter the wings of the fyke net they are eventually funneled through a 4" x 18" aperture upon which the two sets of horizontally opposed transducers are mounted (Figure 2). Each pair of transducers separately monitor portions of the aperture: one pair samples the upper portions, and the other pair sample the lower portion. As a smolt passes between the transducers the sonar beam is broken causing a count to be registered on the appropriate digital totalizer. In that the transducers are restricted to a 18 degree beam width, approximately 20% of the aperture is sampled. As a result, the sonar counting system theoretically registers one count for every five fish that pass through the aperture.

Results

Climatological and Hydrological Information. Climatological and hydrological information was recorded at the Barge Island station from May 15 through

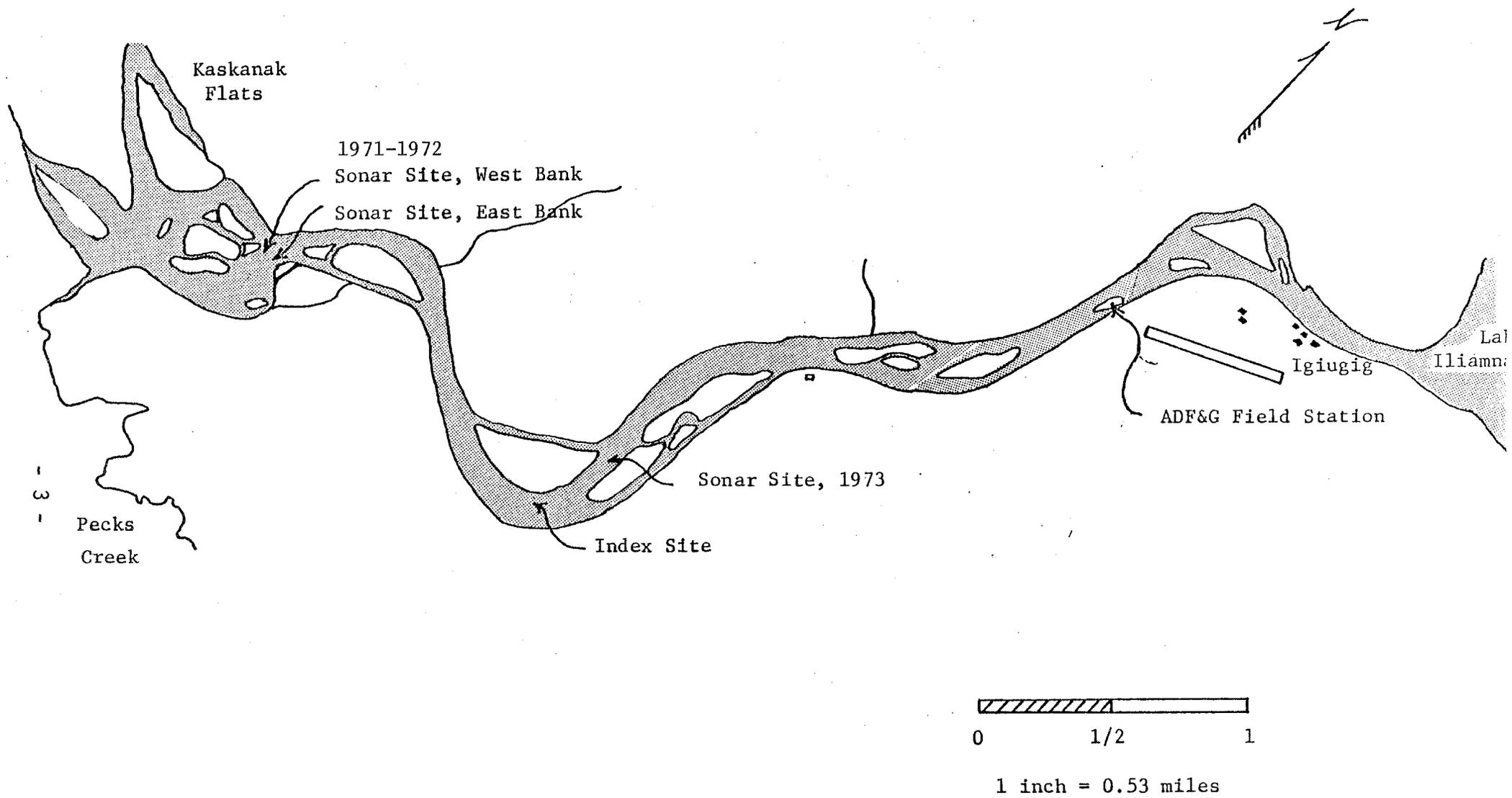


Figure 1. Upper Kvichak River sample sites, 1971 - 1972 and 1973.

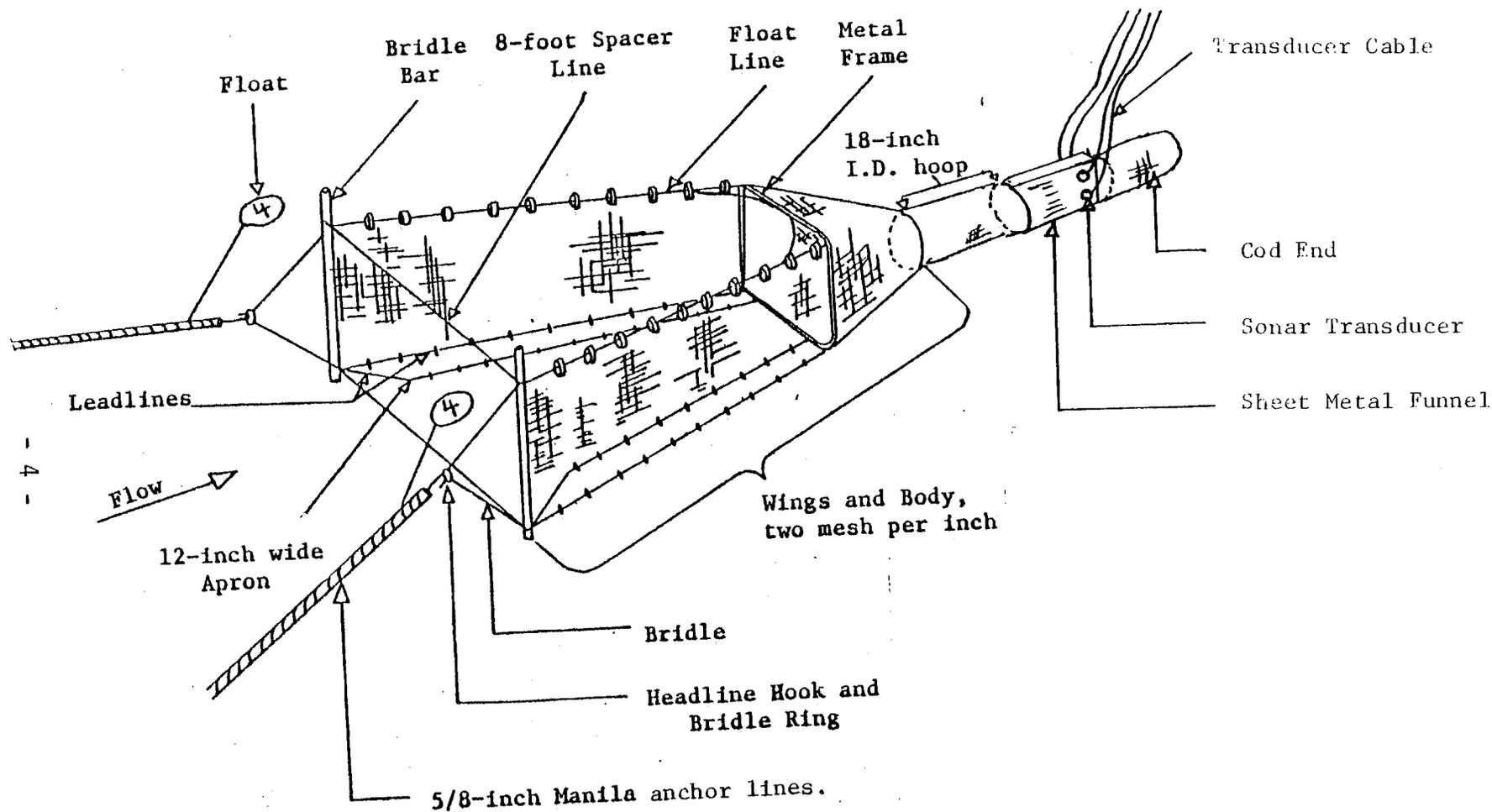


Figure 2. Alaskan style fyke net showing location of funnel and sonar transducer mounts, Kvichak River, 1973.

June 14, 1973 (Table 1). During this period water temperatures ranged from 37 degrees F. to 48 degrees F. with a seasonal average of 41 degrees F. An average water temperature of 39 degrees F. was recorded during the peak out-migration period (May 22-27). Water level increased a total of 4.8 inches during the sampling period.

Minimal ice interference was experienced during the 1973 season with only 48 hours of index sampling lost on May 19 and 20. Smolt outmigration was observed to begin after the ice had cleared the river.

Index Net Catch. Smolting operations were initiated May 17, 1973 with the installation of the index net. Index sampling was continued for a total of 28 days. Smolt outmigration began on the 21 day of May and continued through June 9, with 87 percent of the outmigration occurring between May 22 and May 29 (Figure 3).

The 24-hour index net catch for the 1973 season totaled 1,241,715 smolt (37.2 index points) of which 460,845 (37 percent of the 24-hour index) were indexed during the index hours (2200-0100). Index points and index hours are defined in Pennoyer and Seibel, 1965.

Length-Weight-Age Composition. A total of 61 one-pound samples were taken throughout the smolt season to determine the length frequency distribution of the outmigration. From the length frequency samples, 328 scale samples were collected, aged, and recorded along with their respective lengths and weights. The age class separation point was found to be between 87 mm and 88 mm length. This information was then applied back to the length frequency samples to determine the daily age class compositions. Using this technique it was estimated that the 1973 smolt index catch consisted of 3.57 percent (44,273) Age I smolt and 96.43 percent (1,197,442) Age II smolt (Table 2).

Age I and Age II smolt are defined as young sockeye salmon that have spent one and two winters respectively in lake residence prior to emigration.

The seasons weighted mean length by age class was determined by applying each days mean length by age class to its corresponding days index. The resulting mean length of the weighted daily mean lengths for Age I smolt is 85.6 mm and 97.1 mm for the Age II smolt.

Mean weights were derived from the 328 length-weight-age samples which gave a length-weight regression of $y = -18.12 + .2717x$, where $x = \text{length}$.

Photo-electric Counter Calibrations. Fishing with the photo-electric counters began May 24 and continued until June 2 when the system was replaced with a new sonar index counter. During the period of photo-counter operation, a total of 50 calibrations were recorded using the standard procedures (Pennoyer and Seibel, 1965).

Analysis of the 50 photo-counter calibrations reflect the systems highly variable performance. Calibrations ranged from 1.68 to 10.26 fish per count with a mean of 5.95, variance of 5.42 and a standard deviation of 2.33 (Table 3).

Table 1. Weather observations, Kvichak River, May 15 - June 14, 1973.

Date	Sky		Wind Direction-Velocity (MPH)		Air Temperature (°F)		Water Temp. (°F)	Water Gauge (feet)	Turbidity 0900
	0900	2000	0900	2000	Max.	Min.	0900		
5/15	3	3	NE 10-15	NE 20-30	38	-	37°	-	1
16	1	3	NE 10-15	NE 20-30	41	-	37°	-	1
17	3	4	NE 10-15	-			38°	-	1
18	3	3	0	-	52	- 35	-	-	1
19	4	4	NE 10-15	-	65	- 34	-	-	1
20	4	4	NE 10-15	NE 5-10	45	- 32	-	-	1
21	4	-	S 10-15	-			-	-	1
22	3	-	0	-	52	- 32	38	-	1
23	3	-	NE 5-10	-	66	- 30	40	.88	1
24	3	-	SW 10-15	-			37	.9	1
25	4	-	S 5-10	-	57	- 33	40	.92	1
26	3	3	NE 5-15	NE 2- 7	68	- 34	40	1.0	2
27	4	4	NE 15-20	NE 13-17	48	- 40	38.5	.9	2
28	4	-	NE 15-25	-	58	- 37	39	.4	2
29	4	-	NE 5-10	-	44	- 40	40	.74	1
30	1	4	NE 5-7	NE 6- 8	52	- 30	42	1.08	1
31	4	4	NE 10-15	0	58	- 40	42	1.20	2
6/ 1	4	-	S 0- 5	-	62	- 39	41	1.05	1
2	3	-	SW 5-10	-	48	- 38	39	.77	1
3	1	-	N 10-15	-	58	- 30	46	1.10	1
4	3	-	N 5-10	-	58	- 31	42	1.04	1
5	4	-	NE 5-10	-	63	- 33	42	1.04	1
6	2	-	N 8-12	-	58	- 33	44	1.18	1
7	4	-	N 0- 5	-	73	- 43	44	1.18	1
8	2	-	N 0- 5	-	62	- 34	45	1.18	1
9	3	-	N 0- 5	-			-	-	1
10	2	-	NW 0- 7	-	64	- 35	44	1.20	1
11	4	-	0	-	70	- 42	45	1.20	1
12	3	-	W 0- 5	-	60	- 42	48	1.20	1
13	1	-	SW 0- 5	-	64	- 36	46	1.26	1
14	4	-	N 0- 5	-	75	- 36	46	1.28	1

Sky Codes:

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 Codes:

1-Clear.
 2-Partly Cloud.
 3-Cloudy.
 4-Debris

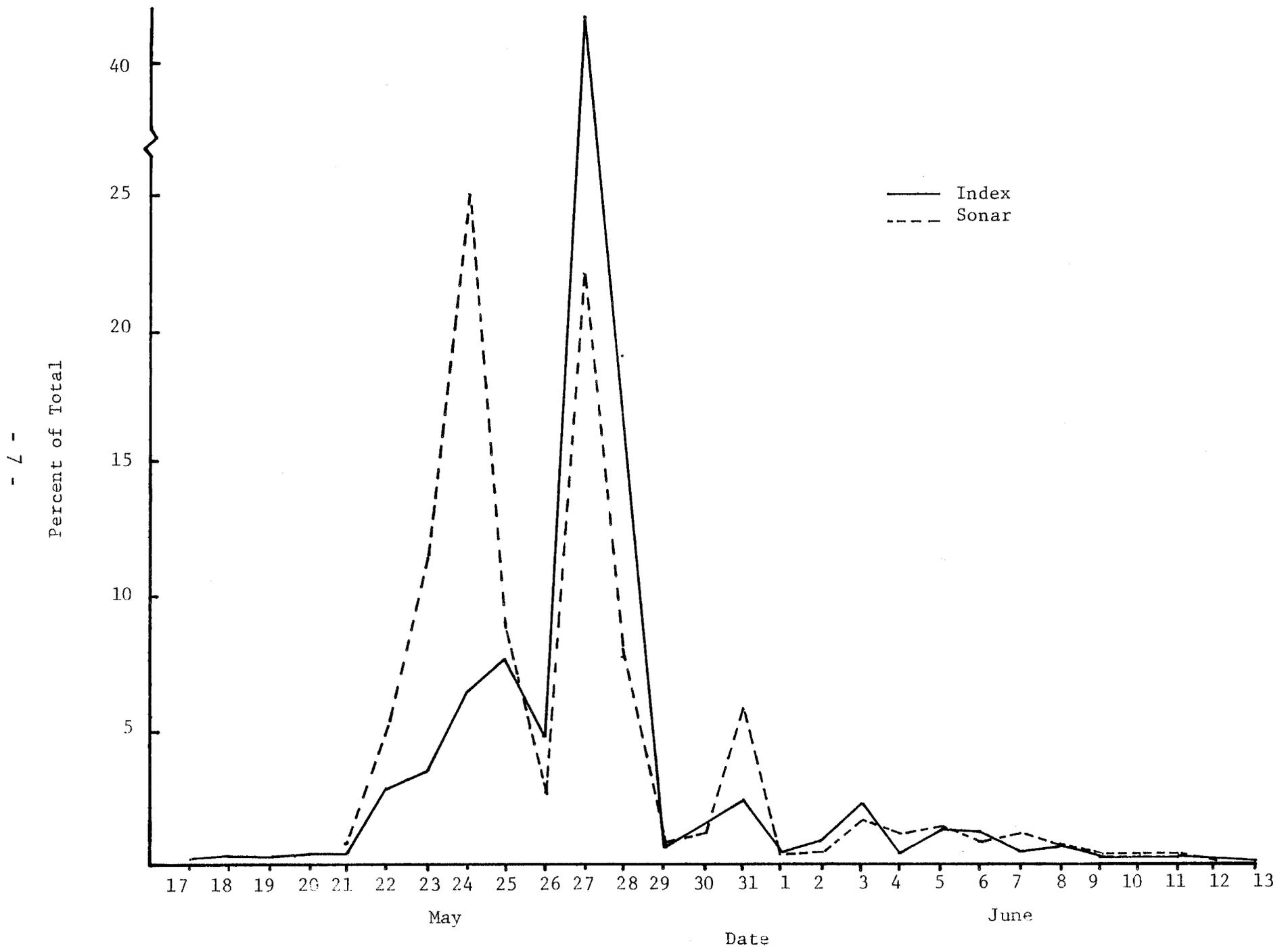


Figure 3. Percent of total outmigration by day as measured at index and by sonar, 1973.

Table 2. Kvichak River sockeye salmon smolt 24-hour index by day and age group, 1973.

Date Noon-Noon	24-Hour Index		Age I Smolt		Age II Smolt	
	Number	Percent	Number	Percent	Number	Percent
5/17 - 18	6	.00	0	0	6	100.0
18 - 19	321	.03	0	0	321	100.0
19 - 20	(1,437)	.15	(0) ^{1/}	0	(1,437)	100.0
20 - 21	(2,552)	.27	(0) ^{1/}	0	(2,552)	100.0
21 - 22	4,782	.39	0	0	4,782	100.0
22 - 23	36,337	2.80	0	0	36,337	100.0
23 - 24	44,803	3.53	224	0.5	44,579	99.5
24 - 25	78,370	6.32	1,254	1.6	77,116	98.4
25 - 26	96,116	7.78	0	0	96,116	100.0
26 - 27	61,050	4.92	549	0.9	60,501	99.1
27 - 28	519,078	41.85	14,015	2.7	505,063	97.3
28 - 29	229,915	18.54	22,072	9.6	207,843	90.4
29 - 30	11,220	.90	146	1.3	11,074	98.7
30 - 31	18,328	1.48	275	1.5	18,053	98.5
31 - 1	30,093	2.43	1,715	5.7	28,378	94.3
1 - 2	3,929	.32	220	5.6	3,709	94.4
2 - 3	13,296	1.08	0	0	13,296	100.0
3 - 4	28,676	2.31	0	0	28,676	100.0
4 - 5	6,400	.51	237	3.7	6,163	96.3
5 - 6	16,645	1.34	1,831	11.0	14,814	89.0
6 - 7	17,089	1.38	615	3.6	16,474	96.4
7 - 8	7,485	.60	0	0	7,485	100.0
8 - 9	8,650	.70	606	7.0	8,044	93.0
9 - 10	2,329	.19	168	7.2	2,161	92.8
10 - 11	1,276	.10	157	12.3	1,119	87.7
11 - 12	1,337	.11	165	12.3	1,172	87.7
12 - 13	127	.01	16	12.3	111	87.7
13 - 14	68	.00	8	12.3	60	87.7
Total	1,241,715	100.00	44,273	3.57	1,197,442	96.43

^{1/} Interpolation for missed days of fishing.

Table 3. Kvichak River sockeye salmon smolt photo-counter calibrations, index site, 1973.

Date	Hour	Sample Time ^{1/}	Weight Pounds	Fish Per Pound	Total Fish	Counts	Counts Per Minute	Fish Per Minute	Fish Per Count
5/24	2315	5.3	35.7	50	1,785	215	40.9	340.0	8.30
	2330	5.2	33.9	49	1,928	217	41.7	370.7	8.88
	2340	4.5	24.5	49	1,192	190	42.2	264.9	
5/25	2224	2.3	23.2	46	1,067	127	55.2	463.9	8.95
	2233	4.5	20.7	51	1,056	118	26.2	234.7	8.40
	2246	0.9	2.2	49	108	21	2.3	12.0	5.14
	2302	2.5	38.5	52	2,002	201	80.4	800.8	9.96
	2317	1.5	16.8	47	790	96	64.0	526.7	8.23
	2326	2.5	17.1	47	8,037	100	40.0	3,214.8	8.03
	2335	.5	35.7	45	1,607	200	400.0	3,214.0	8.04
	2341	5.0	11.5	46	529	99	19.8	105.8	5.34
	5/26	0001	14.0	11.6	46	534	97	6.9	38.1
0022		5.0	18.2	46	837	98	19.6	167.4	8.54
0040		15.0	10.2	51	520	105	7.0	34.7	5.15
2308		5.0	8.1	55	446	141	28.2	89.2	3.16
2331		12.0	6.5	55	358	110	9.2	29.8	3.18
0003		6.0	3.5	51	179	103	17.2	29.8	1.73
0030		10.0	7.1	54	383	147	14.7	38.3	2.60
5/27	2204	7.0	11.2	55	616	111	15.9	88.0	5.54
	2218	1.0	4.2	55	231	104	10.4	231.0	2.22
	2235	1.0	15.3	54	826	138	13.8	826.0	5.98
	2243	3.0	15.2	52	790	102	3.4	263.0	7.74
	2331	1.0	25.6	57	1,459	242	24.2	242.0	6.02
5/28	0015	3.0	12.2	58	708	103	34.3	236.0	6.87
	0025	6.0	11.7	58	679	119	19.8	113.2	5.70
	0043	2.0	12.5	49	613	101	50.5	306.5	6.06
	0050	4.0	13.8	55	759	101	25.3	189.8	7.51
	2253	2.0	14.4	58	835	105	52.5	417.5	7.95
	2304	2.0	14.1	59	832	115	57.5	416.0	7.23
	2313	2.0	12.6	65	819	105	52.5	409.5	7.80

^{1/} Time in minutes

Continued

Table 3. Kvichak River sockeye salmon smolt photo-counter calibrations, index site, 1973. (Continued)

Date	Hour	Sample Time <u>1/</u>	Weight Pounds	Fish Per Pound	Total Fish	Counts	Counts Per Minute	Fish Per Minute	Fish Per Count
5/28	2325	3	16.8	64	1,075	201	67.0	358.3	5.35
	2335	3	10.6	59	625	127	42.3	208.3	4.91
	2345	5	11.6	56	650	103	20.6	130.0	6.31
5/29	0039	7	15.5	58	899	218	31.1	128.0	4.12
	2206	54	41.0	58	2,378	437	8.1	44.0	5.44
	2323	15	14.1	59	832	106	7.1	55.5	7.84
	2343	21	13.5	57	770	109	5.2	36.7	7.06
5/30	2200	40	3.0	60	180	96	2.4	4.5	1.87
	2333	27	9.1	57	519	243	9.0	19.2	2.13
5/31	0004	59	27.6	56	1,546	917	15.5	26.2	1.68
	0407	23	11.6	64	742	297	12.9	32.3	2.49
	0500	61	35.2	60	2,112	1,019	16.7	34.6	2.07
	2204	10	14.4	59	1,026	100	10.0	102.6	10.26
	2222	38	26.0	64	1,664	188	5.0	44.4	8.85
	2306	10	12.1	61	738	101	10.1	73.8	7.30
	0003	5	5.3	60	318	117	23.4	63.6	2.71
	0010	3	30.3	60	1,818	307	105.9	626.9	5.92
	0203	55	25.8	63	1,625	299	4.2	29.5	5.43
	2200	60	24.9	67	1,668	238	4.0	27.8	7.01
	2304	60	16.5	61	1,007	140	2.3	16.8	7.19

1/ Time in minutes.

Sonar-counter Calibrations. The transition of the index counting equipment from photo-electric to the sonar was completed the evening of June 2. The sonar system functioned without a problem for the remaining nine days of the season. A total of 63 calibrations were recorded for the sonar unit and verified its functioning at the designed efficiency of 5.0 fish per count. Calibrations for the sonar unit ranged from 3.05 to 7.45 fish per count with a mean of 4.97 fish per count, variance of .98 and standard deviation of .99 (Table 4).

Table 4 . Kvichak River sockeye salmon smolt sonar counter calibrations
index site, 1973.

Date	Hour	Sample time 1/	Weight Pounds	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count
6/3	1400	64.0	5.0	57	285	55	0.9	4.5	5.18
	1800	60.0	9.2	55	506	137	2.3	8.4	3.69
	1900	60.0	11.2	56	627	208	3.5	10.5	3.01
	2000	60.0	52.5	62	3255	700	11.7	54.3	4.65
	2201	3.5	12.0	61	732	115	32.9	209.1	6.36
	2220	3.4	13.9	58	806	130	38.2	237.1	6.20
	2230	11.2	12.1	69	835	112	10.0	74.6	7.45
	2306	25.5	43.0	65	2795	656	25.7	109.6	4.26
6/4	0100	60.0	7.4	64	474	103	1.7	7.9	4.60
	0200	60.0	14.2	63	895	216	3.6	14.9	4.14
	1200	60.0	5.8	67	389	107	1.8	6.5	3.64
	2300	60.0	24.5	65	1568	290	4.8	26.1	5.41
6/5	0003	57.0	4.0	63	252	64	1.1	4.4	3.94
	0102	58.0	4.3	61	262	61	1.6	4.5	4.30
	0202	58.0	9.0	65	585	127	2.2	10.1	4.61
	0302	58.0	12.0	66	792	127	2.2	13.7	6.24
	0402	58.0	35.5	65	2308	670	11.6	39.8	3.45
	0600	60.0	-	-	97	20	0.3	1.6	4.85
	2300	60.0	30.9	57	1761	359	5.9	29.4	4.90
	6/6	0023	37.0	46.2	73	3373	555	15.0	91.2
0101		28.5	55.4	61	3379	742	26.0	118.6	4.55
0132		12.0	7.5	62	465	101	8.4	38.8	4.60
0202		30.0	10.6	63	668	147	4.9	22.3	4.54
0233		27.0	12.0	-	4	1	27.0	0.2	4.00
0300		60.0	37.7	66	2488	586	9.8	41.5	4.24
0403		52.0	21.7	71	1541	352	6.8	29.6	4.37
0455		65.0	12.0	70	840	195	3.0	12.9	4.30
0600		60.0	-	-	83	19	0.3	1.4	4.37
0700		60.0	-	-	78	17	0.3	1.3	4.59
0800		60.0	5.1	68	347	57	1.0	5.8	6.09
1100		60.0	-	-	77	16	0.3	1.3	4.81

continued

Table 4 . Kvichak River sockeye salmon smolt sonar counter calibrations
index site, 1973. - (continued)

Date	Hour	Sample time <u>1</u> /	Weight Pounds	Fish per pound	Total Fish	Counts	Counts per minute	Fish per minute	Fish per Count
6/6	1200	60	-	-	5	1	-	0.1	5.00
	1500	61	6.8	60	408	95	1.6	6.7	4.29
	1600	54	-	-	98	14	0.3	1.8	7.00
	1800	60	1.5	67	101	26	0.4	1.7	3.88
	1900	60	3.3	65	215	50	0.8	3.6	4.30
	2100	60	11.5	64	736	159	2.7	12.3	4.63
	2200	58	39.0	67	2613	529	9.1	45.1	4.94
	2300	40	131.6	64	8422	1440	36.0	210.6	5.85
6/7	0103	57	11.2	60	672	131	2.3	11.8	5.13
	2200	60	10.5	66	693	103	1.7	11.6	6.73
	2300	58	4.7	64	301	55	1.0	5.2	5.47
	2400	65	6.0	67	402	95	1.5	6.2	4.23
6/8	0200	60	-	-	8	2	-	0.1	4.00
	0400	60	9.3	72	670	220	3.7	11.2	3.05
	0500	60	7.3	68	496	83	1.4	8.3	5.98
	1200	65	13.1	68	890	208	3.2	14.8	4.27
	1400	60	10.0	62	620	103	1.7	10.3	6.02
	1905	55	10.9	69	752	146	2.7	13.7	5.15
	2100	60	20.4	74	1510	365	6.1	25.2	4.13
	2200	58	6.1	68	415	56	1.0	7.2	7.41
	2300	57	3.0	60	180	36	0.6	3.2	5.00
6/9	0004	60	-	-	34	8	0.1	0.6	4.25
	0005	60	3.5	68	238	42	0.7	3.9	5.67
	0006	60	3.6	68	245	49	0.8	4.1	5.00
	0700	60	-	-	88	16	0.3	1.5	5.50
	1200	65	3.2	67	214	40	0.7	3.3	5.35
	1300	54	4.0	70	280	43	0.8	5.2	6.51
	2300	60	10.4	64	666	135	2.3	11.1	4.93

continued

Table 4. Kvichak River sockeye salmon smolt sonar counter calibrations
index site, 1973. - (continued)

Date	Hour	Sample time <u>1/</u>	Weight Pounds	Fish per pound	Total Fish	Counts	Counts per minute	Fish per minute	Fish per Count
6/10	1700	60	-	-	188	37	0.6	3.1	5.08
	2100	60	-	-	89	14	0.2	1.5	6.35
	2300	60	4.0	65	260	43	0.7	4.3	6.05
6/11	1900	54	10.5	68	7.4	152	2.8	13.2	4.70

1/ Time in minutes

OUTMIGRATION PROGRAM

Materials and Methods

Site Selections. A new sonar sampling site was chosen for the 1973 smolt season, 1/3 mile upstream from the index site (Figure 1). Site relocation was undertaken in an effort to minimize the effect caused by climatological factors that reduce sonar operating efficiency. The previous site at the head of Kaskanak Flats frequently experienced high winds blowing down the channel producing white capped waves that entrained air and caused false counts. The north-south orientation of the river at the new site minimizes the exposure to the prevailing winds, hence eliminating most false "wind" counts.

In addition to meeting the channel characteristics required for sonar operations (smooth even bottom, channel depth less than 10 feet), the new site with its narrower channel (320 feet) affords greater amount of river sonification (15 percent sonification versus 8.5 percent sonification at the Kaskanak Site) utilizing the same number of transducers.

A water velocity profile of the new site was taken at the end of the season using a Gurley type AA current meter (Figure 4, Table 5). The resultant water flows were related to within channel smolt distribution as recorded by sonar.

Sonar Counting Systems and Operation. Two Bendix smolt counting systems were utilized for the smolt outmigration enumeration. The 1972 model electronics were positioned on the west bank and the 1971 model electronics on the east bank. Each unit was fished with two arrays, one fitted with transducers with 200 feet of electronic cable, and the other with transducers that had 300 feet of electronic cable. The actual positions of the four arrays are illustrated in Figure 5.

To aid in sonar array placement at 7/16 inch steel support cable was strung bank to bank with a winch attached on one bank. The individual array bridles were then attached directly to the main cable, eliminating the need to anchor each array separately. This technique greatly reduced installation time along with simplifying the servicing procedures.

The counting expansion technique remained unchanged from that described for previous years (Parker, In Press). An extensive count recording system was developed for the 1973 season to improve the accuracy of count recording and allow daily in-season analysis of the outmigration as it developed. With this system all sonar counts are scrutinized twice daily with invalid counts being extracted as they occur and expansion factors applied at the end of every 24-hour sampling period.

Calibrations were not taken in 1973 due to difficulties encountered with fyke net anchoring. As a result, calibration factors determined in previous years were applied to the 1973 sonar counts. For the 1972 electronics the calibration was 11.81 fish per count; for the 1971 electronics it was 9.96 fish per count.

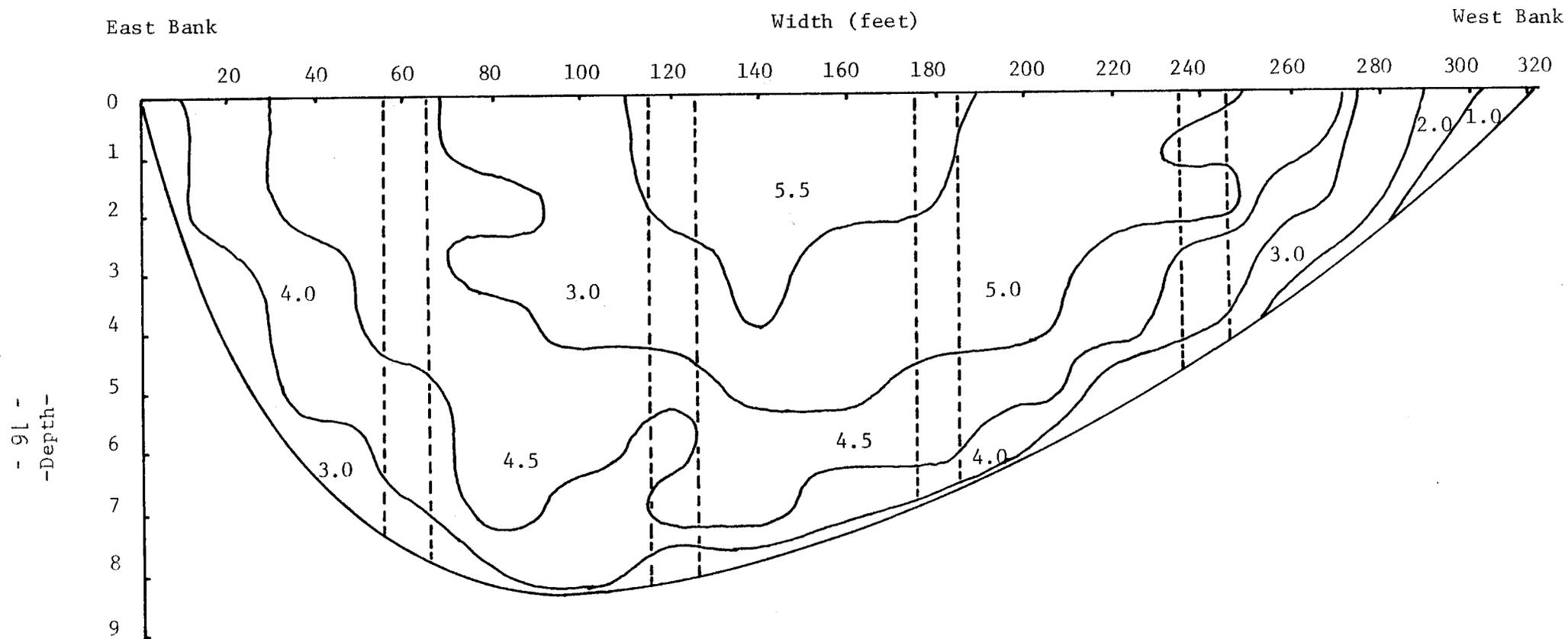


Figure 4. Velocity profile of the Kvichak River, sonar site, June 14, 1973. Depth to width ratio 1:15, velocity in feet per second. Dashed columns represent area sonified by sonar equipment.

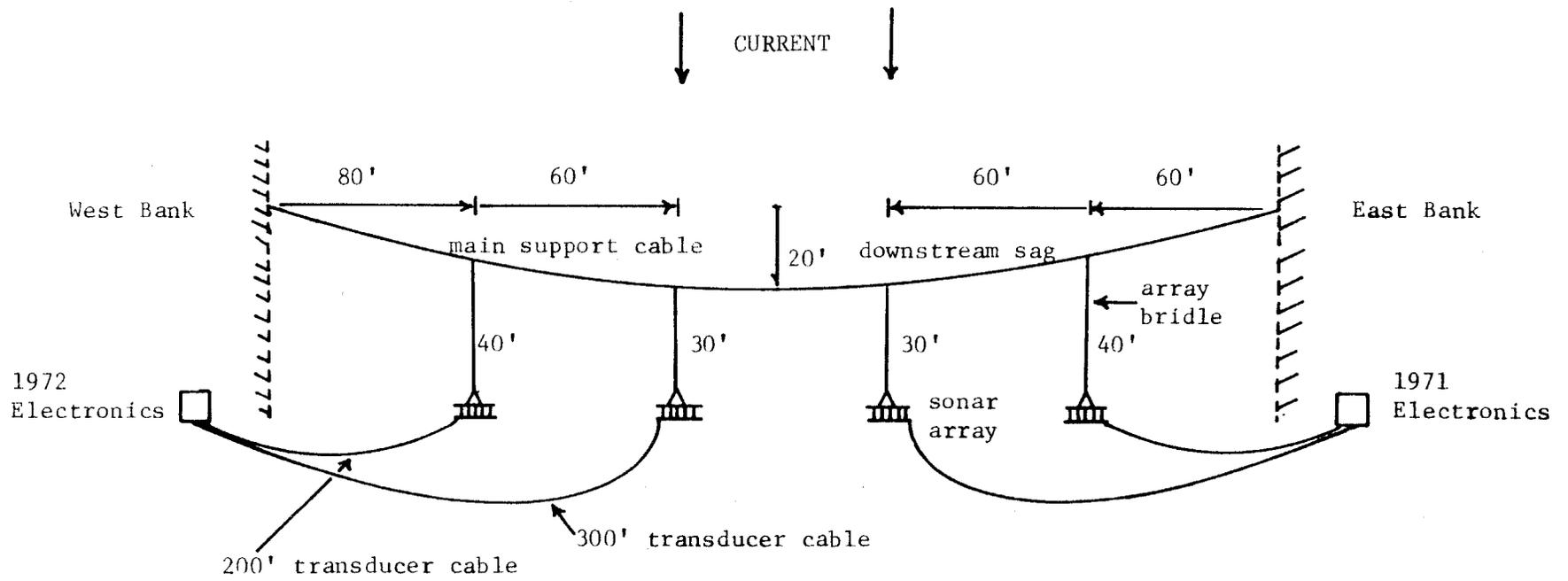


Figure 5. Sonar equipment placement in the Kvichak River, 1973.

Results

Sonar Sampling. Smolt outmigration enumeration with the Bendix biomass counters began May 22 following a three day delay caused by ice interference. After installation was completed, sonar counting continued uninterrupted until the projects termination, June 12.

Outmigration Estimate. During the 23 days of sonar operation a total of 38,315,136 smolt were counted over the four arrays with 13.20 percent over the east inshore array, 39.28 percent over the east offshore, 9.20 percent over west inshore and 38.32 percent over the west offshore.

Following expansion for the unsonified areas between arrays it is estimated that the 1973 outmigration consisted of 194,126,119 smolt (Table 6).

Age class composition of the outmigration was calculated by applying the daily index age class percentages to the corresponding days outmigration. It is estimated that the outmigration consisted of 2.57 percent (4,987,961) Age I smolt and 97.43 percent (189,138,158) Age II smolt (Table 7).

Analysis of the outmigration by day shows two major peaks occurring on May 24 and May 27 with significant outmigration between May 22 and June 9 (Figure 3). This pattern is reflected by the daily catches recorded at the index site with the exception of May 23 and 24 when the index catches fell far below the levels recorded by sonar, and May 27 when index catches greatly exceeded the sonar level. The observed differences between sonar and index estimates are thought to be related to the index programs inherent variability.

Table 6. Kvichak River daily sockeye salmon smolt counts by array, 1973. Counts include expansions for unsonified areas between arrays, water velocity differences, and non-functioning transducers.

Date Noon-Noon	East Bank		West Bank		Total
	Inshore	Offshore	Inshore	Offshore	
5/21 - 22	216,848	86,102	573,647	481,288	1,357,885
22 - 23	1,412,376	2,457,749	1,935,057	4,027,620	9,832,802
23 - 24	3,355,315	6,445,833	3,212,970	9,169,887	22,184,005
24 - 25	7,281,016	11,095,938	8,468,368	21,133,117	47,978,439
25 - 26	3,300,784	6,767,461	912,330	6,436,803	17,417,378
26 - 27	996,495	2,429,304	227,822	1,555,455	5,209,076
27 - 28	3,016,774	19,018,441	1,341,527	18,546,111	41,922,853
28 - 29	1,189,418	4,987,390	250,077	7,863,867	14,290,752
29 - 30	436,853	962,315	44,576	304,238	1,747,982
30 - 31	340,323	1,295,956	89,631	777,908	2,503,818
31 - 1	1,729,890	8,603,289	100,510	1,965,175	12,398,864
1 - 2	56,339	512,024	96,543	208,611	873,517
2 - 3	81,592	514,731	29,283	111,548	737,154
3 - 4	549,879	2,034,081	55,619	519,525	3,159,104
4 - 5	282,004	1,561,630	106,177	301,743	2,251,554
5 - 6	450,940	1,631,747	230,803	438,148	2,751,638
6 - 7	100,452	1,347,337	7,387	198,054	1,653,230
7 - 8	380,097	2,004,751	51,118	98,793	2,534,759
8 - 9	199,299	1,130,062	37,267	154,000	1,520,628
9 - 10	126,000	422,700	10,888	42,162	601,750
10 - 11	34,017	475,988	12,501	27,047	549,553
11 - 12	56,756	277,986	46,951	22,732	404,425
12 - 13	39,325	185,656	12,001	7,971	244,953
Total	25,632,792	76,248,471	17,853,053	74,391,803	194,126,119
Percent	13.20% ^{1/}	39.28% ^{1/}	9.20% ^{1/}	38.32% ^{1/}	

^{1/} Percent contribution to total outmigration by array.

Table 7. Kvichak River sockeye salmon smolt outmigration by day and age group, 1973.

Date Noon-Noon	Total Outmigration		Age I Smolt		Age II Smolt	
	Number	Percent	Number	Percent	Number	Percent
5/21 - 22	1,357,885	0.70	0	0	1,357,885	100.0
22 - 23	9,832,802	5.10	0	0	9,832,802	100.0
23 - 24	22,184,005	11.43	110,920	0.5	22,073,085	99.5
24 - 25	47,978,439	24.72	767,655	1.6	47,210,784	98.4
25 - 26	17,417,378	8.97	0	0	17,417,378	100.0
26 - 27	5,209,076	2.68	46,882	0.9	5,162,194	99.1
27 - 28	41,922,853	21.59	1,131,917	2.7	40,790,936	97.3
28 - 29	14,290,752	7.36	1,371,912	9.6	12,918,840	90.4
29 - 30	1,747,982	0.90	22,724	1.3	1,725,258	98.7
30 - 31	2,503,818	1.29	37,557	1.5	2,466,261	98.5
31 - 1	12,398,864	6.39	706,735	5.7	11,692,129	94.3
6/ 1 - 2	873,517	0.45	48,917	5.6	824,600	94.4
2 - 3	737,154	0.38	0	0	737,154	100.0
3 - 4	3,159,104	1.63	0	0	3,159,104	100.0
4 - 5	2,251,554	1.16	83,308	3.7	2,168,246	96.3
5 - 6	2,751,638	1.42	302,680	11.0	2,448,958	89.0
6 - 7	1,653,230	0.85	59,516	3.6	1,593,714	96.4
7 - 8	2,534,759	1.31	0	0	2,534,759	100.0
8 - 9	1,520,628	0.78	106,444	7.0	1,414,184	93.0
9 - 10	601,750	0.31	43,326	7.2	558,424	92.8
10 - 11	549,553	0.24	67,595	12.3	481,958	87.7
11 - 12	404,425	0.21	49,744	12.3	354,681	87.7
12 - 13	244,953	0.13	30,129	12.3	214,824	87.7
Total	194,126,119	100.00	4,987,961	2.6	189,138,158	97.4

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1973 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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INTRODUCTION

This was the eighteenth 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 estimate of outmigration and age composition of emigrating sockeye salmon smolt.

MATERIALS AND METHODS

The project was conducted in the same manner as in previous years (McCurdy, 1972).

Standard fyke nets four feet in width and four to seven feet in depth were used during the 1973 season. The nets were fished by suspending them from a cable stretched across the river bottom. The fishing site is located approximately 8-3/4 miles downriver of the Naknek Lake outlet. To lower smolt mortality live boxes attached to the nets were used throughout the season on both the random and index schedules.

In 1957 and 1958, the entire river width was fished to determine the most productive sites. Six sites in the main channel are now fished. Data obtained from 1957 and 1958 indicated that 88.34 percent of the entire outmigration passed within these sites. The most productive of the six sites is used as an index site (Van Valin, 1969).

The basic fishing schedule used for the Latin Square scheme is three days in length. The first day all six sites are fished in a random order from 2100 hours to 0600 hours. Each site is fished for a 90-minute period. Day two is fished in the same manner, with the addition of the index site, which is fished for 24 hours or from 2100 hours to 2100 hours. During the next 24 hours, day 3, no fishing is conducted. Random fishing schedules are set up previous to the season. In this manner, a random sample of numbers of smolt is collected. This data is then expanded to obtain a total outmigration estimate, using the Latin Square method.

Sampling for age-weight-length data was conducted as in previous years. The procedure is to collect twenty samples previous to 2400 hours and twenty samples after 2400 hours. In order to insure that all fishing sites are sampled throughout the season, ten samples are collected from the site fished from 2100-2230 hours, and then samples are collected from the site fished from 2230-2400 hours. The following samples are collected in the same manner, with the sampling times being 0000-0130 hours and 0130-0300 hours.

RESULTS

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

The random schedule was initiated on May 28 and terminated on June 26. The total random catch was 39,114 (Table 2). Forty-six percent of the catch occurred from May 28 to June 2. A minor peak also occurred on June 10-11. A total of 38,705 smolt were caught during the index portion of the program (Table 3). During the random sampling hours, 2100-0600, the index net caught 88.17 percent of the total 24-hour catch.

The outmigration estimate for 1972 was 2,712,150 smolt. The estimate was obtained as follows:

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

$$\begin{aligned} \text{Total season catch} &= 39,114 \\ \text{No. of sites fished} &= 6 \end{aligned}$$

$$\text{No. of sampling days fished during the season} = 20$$

Therefore the seasonal average catch per 90-minute set is derived by

$$39,114 / (6) (20) = 326$$

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

$$\begin{aligned} \text{Average catch per 90-minute period} &= 326 \\ \text{No. of sites fished} &= 6 \\ \text{No. of subsites for which the migration is estimated from the} \\ \text{catch at each fishing site} &= 6 \end{aligned}$$

Therefore the estimated average migration past the sampled section of the river during a 90-minute period within a sampling period is derived by

$$(326) (6) (6) = 11,736$$

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

$$\text{No. of 90-minute periods within a sampling period} = 6.$$

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

$$(11,736) (6) = 70,416$$

TABLE 1. Mean water and air temperatures by day, Naknek River, 1973.^{1/}

Date	Mean water temperatures °F	Mean air temperatures °F
May 28-29	44.5	40.2
29-30	48.0	41.6
May 31 - June 1	47.4	40.4
1-2	45.5	37.3
3-4	46.6	40.3
4-5	47.6	40.0
6-7	50.3	44.3
7-8	49.5	41.3
9-10	49.4	40.7
10-11	50.6	44.0
12-13	51.0	41.5
13-14	53.2	44.4
15-16	53.6	43.4
16-17	53.4	47.0
18-19	55.6	43.1
19-20	57.4	51.4
21-22	59.3	47.3
22-23	56.7	47.4
24-25	60.7	49.0
25-26	59.3	46.9

^{1/} Both water and air temperatures were recorded for each 90-minute fishing period.

TABLE 2. Naknek River random sampling catches of sockeye salmon smolt by fishing site, 1973.

Date	Sites						Total	Percentage of total catch
	1	2	3	4	5	6		
May 28-29	14	40	606	4,110	109	2	4881	12.48
29-30	1	59	97	107	10	35	309	0.79
31-June 1	3	0	1,378	8,067	3,333	0	12,781	32.68
1-2	2	1	51	11	114	35	214	0.55
3-4	0	57	165	618	1,134	5	1,979	5.06
4-5	0	2	0	794	277	119	1,192	3.05
6-7	20	0	135	1,738	715	144	2,752	7.03
7-8	0	14	9	147	931	8	1,109	2.84
9-10	122	281	0	577	1,534	76	2,590	6.62
10-11	0	1	2,299	888	300	498	3,986	10.19
12-13	83	32	26	2,869	93	4	3,107	7.94
13-14	0	3	1,351	0	7	449	1,810	4.63
15-16	158	0	9	7	288	29	491	1.26
16-17	26	0	0	374	0	67	467	1.19
18-19	16	0	16	908	0	0	940	2.40
19-20	0	59	1	9	26	0	95	0.24
21-22	0	24	0	18	0	0	42	0.11
22-23	0	0	0	53	150	0	203	0.52
24-25	0	0	0	4	1	4	9	0.02
25-26	0	0	147	0	3	7	157	0.40
Total	445	573	6,290	21,299	9,025	1,482	39,114	100.00
Percent	1.14	1.46	16.08	54.46	23.07	3.79	100.00	

TABLE 3. Naknek River index net catches of sockeye salmon smolt by 90-minute periods, May 29-June 26, 1973.

Time	May 29-30	June 1-2	June 4-5	June 7-8	June 10-11	June 13-14	June 16-17	June 19-20	June 22-23	June 25-26	Total	Percent of Total Catch
2100-2230	968	7	150	352	153	0	0	3	0	0	1,633	4.22
2230-2400	559	49	545	147	661	133	445	112	53	68	2,772	7.16
0000-0130	263	320	794	907	7,965	2,049	706	692	212	463	14,371	37.13
0130-0300	107	261	538	1,925	1,920	3,497	374	752	252	140	9,766	25.23
0300-0430	53	48	11	77	185	3,000	269	103	56	6	3,808	9.84
0430-0600	170	10	4	6	888	470	16	9	204	0	1,777	4.59
0600-0730	154	151	0	3	387	383	16	0	77	10	1,181	3.05
0730-0900	42	104	1	13	78	8	6	0	1	1	254	0.66
0900-1030	87	21	0	5	45	0	2	0	43	0	203	0.53
1030-1200	212	50	0	15	365	0	2	0	0	0	644	1.66
1200-1330	70	0	0	0	17	0	0	0	0	0	87	0.22
1330-1500	1	1	0	7	22	0	0	0	0	0	31	0.08
1500-1630	8	1	0	103	2	0	2	0	0	0	116	0.30
1630-1800	186	0	0	54	0	0	24	0	0	0	264	0.68
1800-1930	714	2	0	47	0	8	4	0	28	0	803	2.08
1930-2100	884	18	54	14	0	14	11	0	0	0	995	2.57
Totals	4,478	1,043	2,097	3,675	12,688	9,562	1,877	1,671	926	688	38,705	100.00

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 percent

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

$$70,416 / .8834 = 79,710$$

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 = 88.17 percent

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

$$79,710 / .8817 = 90,405$$

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

No. of days fished = 30

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

$$(90,405) (30) = 2,712,150$$

The age composition of the outmigration estimate was 26.77 percent Age I's (726,042), 72.22 percent Age II's (1,958,714) and 1.01 percent Age III's (27,393). This is next to the lowest estimate for Age I fish since the initiation of the program while the numbers of Age II fish is among the lowest since the program's initiation. This year is the first since 1968 that Age III smolt have been part of the outmigration estimate. Table 4 gives the age composition by date.

The 1973 outmigration estimate is the lowest in the program's history. This might be attributed to the following conditions that existed for brood years 1970 and 1971. They were: 1) high water in the spawning streams allowing fish to spawn on gravel banks away from the main channel of the stream, 2) this was followed by extreme low temperatures in early winter causing the stream water levels to drastically drop, thus exposing many redds to freezing conditions resulting in a high loss of eggs, 3) following this the winters of 1970-71 and 1971-72 were extremely cold and were followed by late breakups and late, mild springs. This no doubt resulted in higher than usual fry and fingerling mortality. If this last supposition is true then the 1971 brood year production of Age II smolt will probably be far lower than average due to high mortality levels imposed upon the 1971 Age I fingerlings in the lakes.

TABLE 4. Age composition of the random sampling catches of sockeye salmon smolt, by date, Naknek River, 1973.

Date	Random Catch	Percent			Number		
		Age I	Age II	Age III	Age I	Age II	Age III
May 28-29	4,881	22.6	74.2	3.2	1,103	3,622	156
29-30	309	22.5	75.0	2.5	69	232	8
31-June 1	12,781	17.5	82.5	0.0	2,237	10,544	0
1-2	214	22.5	75.0	2.5	48	161	5
3-4	1,979	28.6	68.6	2.8	566	1,358	55
4-5	1,192	2.5	92.5	5.0	30	1,102	60
6-7	2,752	22.5	77.5	0.0	619	2,133	0
7-8	1,109	22.5	77.5	0.0	250	859	0
9-10	2,590	32.5	67.5	0.0	842	1,748	0
10-11	3,986	32.5	65.0	2.5	1,295	2,591	100
12-13	3,107	42.5	57.5	0.0	1,321	1,786	0
13-14	1,810	45.0	55.0	0.0	815	995	0
15-16	491	55.0	45.0	0.0	270	221	0
16-17	467	40.0	57.5	2.5	187	268	12
18-19	940	44.4	55.6	0.0	417	523	0
19-20	95	60.0	40.0	0.0	57	38	0
21-22	42	79.0	21.0	0.0	33	9	0
22-23	203	82.5	17.5	0.0	167	36	0
24-25	9	60.0	40.0	0.0	5	4	0
25-26	157	90.0	10.0	0.0	141	16	0
Total	39,114				10,472	28,246	396
Percent					26.77	72.22	1.01

A total of 745 smolt were sampled to determine average lengths and weights by age class (Tables 5 and 6). Age I smolt averaged 106 millimeters in length and 10.7 grams in weight. Age II smolt average 114 millimeters and 12.9 grams, while Age III's averaged 122 millimeters and 15.2 grams.

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

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- McCurdy, Michael L. 1972. 1971 Naknek River Sockeye Salmon Smolt Studies. In 1971 Bristol Bay Sockeye Salmon Smolt Studies (Ed. Phillip Russell and Michael McCurdy). Alaska Department of Fish and Game Technical Data Report No. 2, pp. 29-34.
- Van Valin, Glenn R. 1969. 1968 Naknek River Sockeye Salmon Smolt Study. In 1968 Bristol Bay Sockeye Salmon Smolt Studies (Ed. Michael McCurdy). Alaska Department of Fish and Game Informational Leaflet 138, pp. 62-77.

TABLE 5. Naknek River sockeye salmon smolt mean weight in grams, 1973.

Date	Age I		Age II		Age III	
	Percent of total season's catch	Mean weight	Percent of total season's catch	Mean weight	Percent of total season's catch	Mean weight
May 28-29	10.53	12.1	12.83	15.1	39.40	14.5
29-30	0.66	12.3	0.82	13.8	2.02	21.0
31-June 1	21.36	12.4	37.33	13.4	0.00	----
1-2	0.46	11.4	0.57	15.2	1.26	14.9
3-4	5.40	11.8	4.81	14.2	13.89	18.4
4-5	0.29	11.6	3.90	12.3	15.15	14.9
6-7	5.91	10.1	7.55	11.4	0.00	----
7-8	2.39	11.9	3.04	11.6	0.00	----
9-10	8.04	10.6	6.19	12.0	0.00	----
10-11	12.37	9.4	9.17	11.7	25.25	11.5
12-13	12.61	9.8	6.33	10.6	0.00	----
13-14	7.78	10.7	3.52	12.2	0.00	----
15-16	2.58	8.4	0.78	9.8	0.00	----
16-17	1.79	9.1	0.95	13.9	3.03	38.0
18-19	3.98	8.5	1.85	12.7	0.00	----
19-20	0.54	9.0	0.13	12.7	0.00	----
21-22	0.32	8.0	0.03	9.1	0.00	----
22-23	1.59	8.2	0.13	9.0	0.00	----
24-25	0.05	7.6	0.01	24.1	0.00	----
25-26	1.35	9.6	0.06	10.2	0.00	----

Age I mean weight = 10.7

Age II mean weight = 12.9

Age III mean weight = 15.2

TABLE 6. Naknek River sockeye salmon smolt mean length in millimeters, 1973.

Date	Age I		Age II		Age III	
	Percent of total season's catch	Mean length	Percent of total season's catch	Mean length	Percent of total season's catch	Mean length
May 28-29	10.53	112.6	12.83	120.7	39.40	125.0
29-30	0.66	112.7	0.82	118.0	2.02	134.0
31-June 1	21.36	112.0	37.33	116.2	0.00	---
1-2	0.46	109.6	0.57	120.9	1.26	119.0
3-4	5.40	107.0	4.81	117.5	13.89	130.0
4-5	0.29	109.0	3.90	115.5	15.15	119.0
6-7	5.91	105.3	7.55	110.2	0.00	---
7-8	2.39	110.9	3.04	110.0	0.00	---
9-10	8.04	105.3	6.19	112.0	0.00	---
10-11	12.37	101.5	9.17	109.2	25.25	109.0
12-13	12.61	103.2	6.33	106.1	0.00	---
13-14	7.78	105.5	3.52	111.2	0.00	---
15-16	2.58	98.8	0.78	103.7	0.00	---
16-17	1.79	101.3	0.95	116.1	3.03	160.0
18-19	3.98	101.4	1.85	114.5	0.00	---
19-20	0.54	99.9	0.13	113.1	0.00	---
21-22	0.32	96.4	0.03	101.0	0.00	---
22-23	1.59	97.2	0.13	101.1	0.00	---
24-25	0.05	93.5	0.01	138.0	0.00	---
25-26	1.35	100.5	0.06	102.3	0.00	---

Age I mean length = 106.4

Age II mean length = 114.3

Age III mean length = 121.9

1973 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 annually since then except for 1966 and 1971. Data obtained from this program have been used to estimate total abundance by age class, with average lengths and weights of sockeye salmon smolt migrating to sea. These data are used to estimate optimum escapement ranges and to forecast numbers and age composition of returning adults.

In addition to continuing the standard sampling program an effort was made to examine the feasibility of sonar application to the Ugashik outmigration program.

MATERIALS AND METHODS

The sample site remained unchanged from previous years; 150 yards below the outlet of lower Ugashik Lake.

Fyke nets were suspended at five standard fishing sites across the river on a 280 foot, 1/2 inch diameter wire cable secured to each bank by deadmen (Figure 1). A pair of manila headlines were attached to the cable at each fishing site while numbered floats, tied to each headline, served to identify each site.

Divided live boxes, as described in Siedelman, 1969, were used on all nets. A six-inch diameter rubber tube connecting the fyke net to the live box facilitated the transfer of the captured smolt into the holding chambers of the live box. The application of live boxes to sampling procedures has greatly reduced smolt mortality from that experienced with cod ends.

In 1973 the random sampling scheme was fished daily with each site being fished on a random schedule for one hour between 2100-0200. The index net site (site 4) was fished every fourth day for 24-hours to determine the percentage of the outmigration occurring outside the random fishing hours. During the sampling period of May 17 through June 12, the random scheme was fished 21 of a possible 27 days.

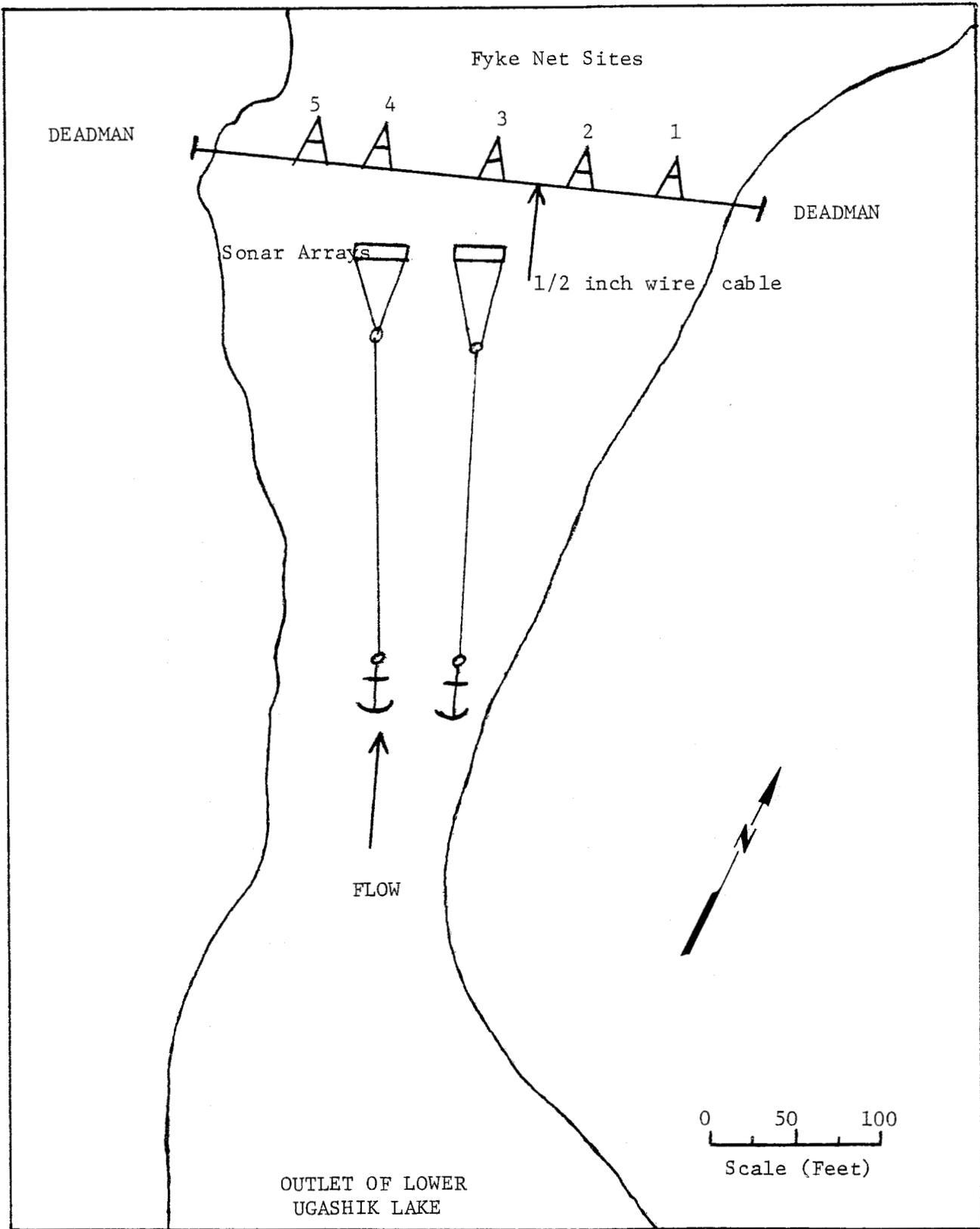


Figure 1. Ugashik River sockeye salmon smolt sampling site.

To insure the acquisition of representative length frequency samples from the smolt outmigration, individual one pound length frequency samples were collected each night at the five random sites and combined to produce a composite sample. From the composite sample collected each night, a one-pound subsample was extracted with lengths and weights recorded. Additional samples were taken during nights of peak migration.

Smolt samples were separated into four fishing periods. Age composition was determined from readings of 452 smolt scales (Table 3). The percentage and mean length and weight of each age group were determined by period and for the entire season by weighting the total number of samples for each period by the total catch for each period.

An estimate of the total outmigration of smolts was derived by the following formula:

$$x = (x_r ab)c$$

where x = estimate of total smolt outmigration

x_r = average random catch between 2100 hours to 0200 hours

per actual fishing day $\frac{\text{Total Random Catch}}{\text{Number of Fishing Days}}$

a = number of fishing sites across the river

$$\frac{\text{Width of River}}{\text{Opening of Set}} = \frac{280 \text{ Feet}}{8 \text{ Feet}} = 35$$

b = number of possible fishing days during sample period

The expansion coefficient (c) for a 24-hour estimate was derived from the 24-hour index net catches as follows:

$$c = y/z$$

where y = total 24-hour index net catches

z = 24-hour index net catches during the random fishing hours of 2100 hours - 0200 hours

The resulting coefficient gives the ratio of smolt catches made within the 24-hour period to the catches made during the random fishing period.

RESULTS

The random scheme was fished 21 of a possible 27 days and resulted in a catch of 103,242, most of which occurred on two days (Figure 2 and Table 1). Site 4 caught the majority of smolt with 39.42 percent of the catch.

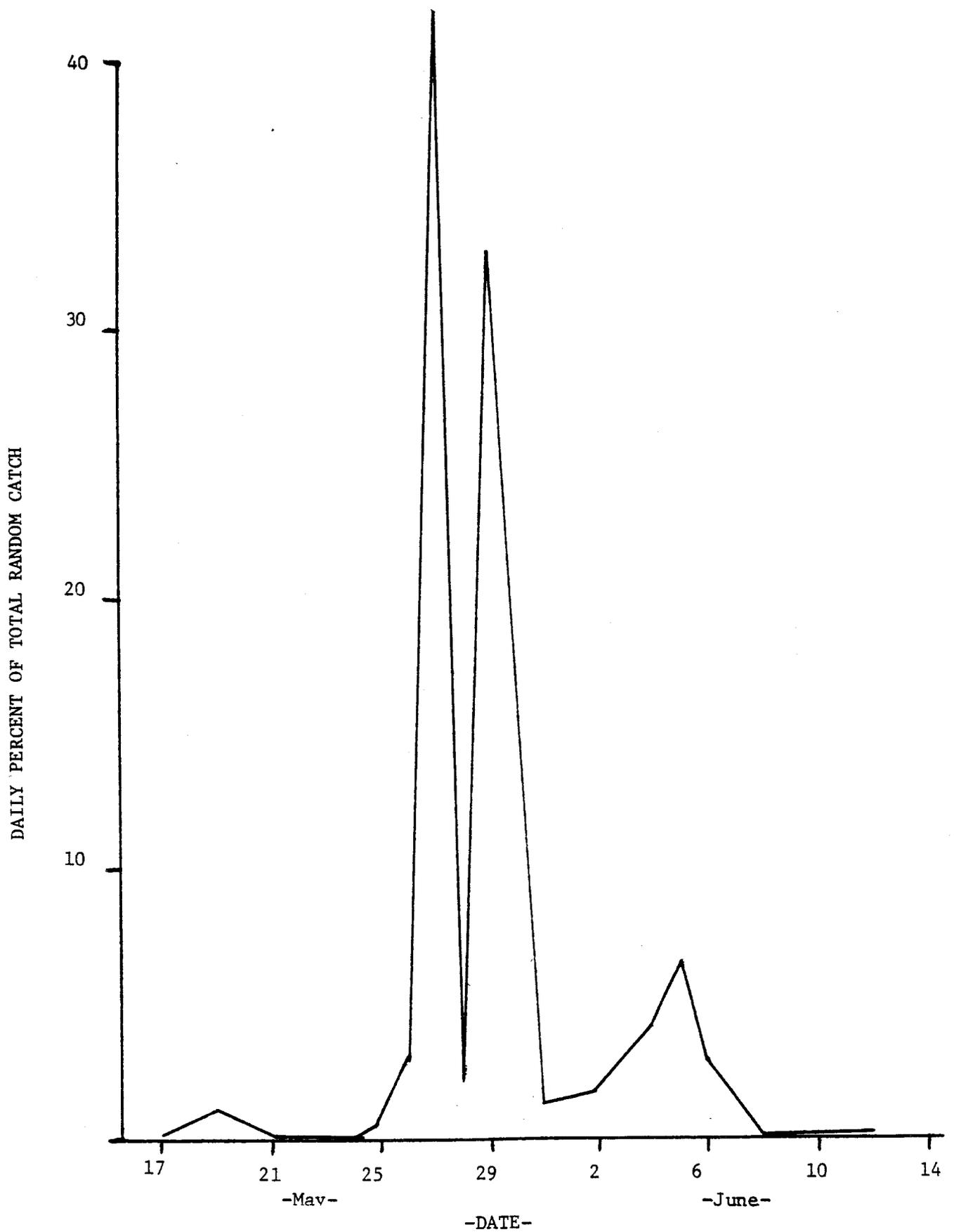


Figure 2. Daily random net catches of sockeye salmon smolt in percent of total random net catches, Ugashik River, 1973.

TABLE 1. Ugashik River sockeye salmon smolt catches in the random sampling scheme by fishing site, 1973.

Date	1	2	3	4	5	Daily Total	Accum. Total	Daily of Total
May 17	-	-	-	13	83	96	96	0.09
19	-	5	36	1,114	13	1,168	1,264	1.13
20	7	4	0	141	6	158	1,422	0.15
21	0	0	6	56	3	65	1,487	0.06
23	0	11	43	15	1	70	1,557	0.07
24	17	12	30	0	18	77	1,634	0.07
25	72	0	42	539	45	698	2,332	0.68
26	1,150	312	535	559	424	2,980	5,312	2.89
27	61	19,282	18,190	3,299	2,401	43,233	48,545	41.88
28	834	5	470	980	0	2,289	50,834	2.22
29	1,058	4,143	346	25,016	3,597	34,160	84,994	33.09
31	1	3	52	23	1,320	1,399	86,393	1.35
June 1	4	1	0	12	0	17	86,410	0.02
2	2	293	188	207	1,359	2,049	88,459	1.98
4	268	11	1,703	2,375	1	4,358	92,817	4.22
5	2	1,295	655	3,731	1,110	6,793	99,610	6.58
6	1	335	56	2,554	122	3,068	102,678	2.97
8	17	6	77	0	0	100	102,778	0.10
9	1	6	42	32	8	89	102,867	0.09
10	3	0	177	18	14	212	103,079	0.20
12	6	124	7	17	9	163	103,242	0.16
Total	3,504	25,848	22,655	40,701	10,534	103,242	103,242	100.00
Percent	3.40	25.04	21.94	39.42	10.20	100.00	100.00	100.00

The 24-hour sampling program, conducted on seven days during the season, indicated that 95.89 percent of the smolt outmigration occurred during the random fishing hours of 2100 and 0200 and yielded an expansion coefficient of 1.043 (Table 2). The total smolt outmigration estimate for 1973 was 4,845,677.

Age I smolt comprised 66.6 percent of the outmigration and averaged 93 millimeters in length and 7.2 grams in weight. Age II smolt comprised 32.9 percent of the outmigration and averaged 112.9 millimeters length and 11.9 grams weight. Age III smolt, which are rarely caught, comprised 0.5 percent of the outmigration and averaged 131.5 millimeters length and 20.1 grams weight (Table 4).

Weather data is contained in Table 5.

SONAR ANALYSIS

The 1970 model Bendix sonar smolt counter was transferred to the Ugashik River smolt project this year for evaluation as to the feasibility of using this more sophisticated equipment in future outmigration work. Several problems encountered made it impossible to use the data gathered this year to derive an outmigration estimate. However, the basic unexpanded sonar counts were recorded with false counts caused by wind and rain being extracted.

The resulting sonar counts with adjustments to correspond to random fishing hours are contained in Table 6. The daily percentages of the random catch and sonar counts during the random fishing hours compared very closely during the season with a correlation coefficient of .95 (Table 7).

The most significant difference between the fyke net and sonar gear was the estimate of the percentage of smolt outmigration occurring outside of the random fishing hours. The sonar counts contained in Table 6 would give an expansion coefficient (c) of 1.451 and would have increased the outmigration estimate of 6,741,206. It was evident at times, based on calm weather, bird activity and pattern of sonar counts, that the smolt were showing nearly 100 percent avoidance of the index net during the daylight hours.

Despite problems encountered with sonar operation in the Ugashik River the preliminary results from the 1973 season has verified the potential application of sonar sampling to this system.

LITERATURE CITED

Siedelman, Donald L. 1969. Abundance, Size and Age of Sockeye Salmon Smolt from the Ugashik River Lakes System, 1968. In 1968 Bristol Bay Sockeye Salmon Smolt Studies (Ed. Michael McCurdy). Alaska Department of Fish and Game Informational Leaflet No. 138, pp. 46-61.

TABLE 2. Ugashik River sockeye salmon smolt catches in the index net during 24-hour fishing periods, 1973.

Time	May 17-18	May 21-22	May 25-26	May 29-30	June 2-3	June 6-7	June 10-11	Total	%
2200-2300	38	56	539	17,495	4,196	2,554	95	24,973	21.94
2300-2400	44	19	626	9,434	8,640	484	46	19,293	16.95
0000-0100	13	15	189	27,961	7,579	117	15	35,889	31.53
0100-0200	21	21	80	25,433	2,922	24	18	28,519	25.05
0200-0330	31	12	61	4,153	29	9	2	4,297	3.77
0330-0500	0	0	4	4	0	0	0	8	0.01
0500-0630	0	2	2	0	3	0	0	7	0.01
0630-0800	0	0	0	0	0	0	1	1	0.00
0800-0930	1	0	0	0	1	0	1	3	0.00
0930-1100	0	0	1	0	0	0	0	1	0.00
1100-1230	0	0	0	0	0	0	0	0	0.00
1230-1400	0	0	0	0	2	0	0	2	0.00
1400-1530	0	0	0	0	16	1	1	18	0.02
1530-1700	0	0	0	2	0	0	0	2	0.00
1700-1830	0	0	2	7	0	0	0	9	0.01
1830-2000	189	0	0	11	40	0	0	240	0.21
2000-2100	58	0	0	29	2	0	0	89	0.08
2100-2200	36	0	414	17	7	0	0	474	0.42
Total	431	125	1,918	84,546	23,437	3,189	179	113,825	100.00

TABLE 3. Ugashik River sockeye salmon smolt sampling data, 1973.

Period	Date	Random Smolt Catch	% of Seasons Total	# 1 lb. Samples Measured	# of Fish Measured	# of Scales Read
1	May 17 - 23	1,557	1.5	3	212	60
2	May 24 - 27	46,988	45.5	6	267	120
3	May 28 - June 1	37,865	36.7	4	220	96
4	June 2 - 12	16,832	16.3	8	490	176
Totals		103,242	100.0	21	1,189	452

TABLE 4. Age, length and weight of sockeye salmon smolt by sampling period from the Ugashik River, 1973.

Period	Date	Mean Length in mm of Age Group			Mean Weight in grams of Age Group			Percent Age Composition		
		I	II	III	I	II	III	I	II	III
1	May 17-23	82.2	114.2	-	6.7	13.3		88.7	11.3	-
2	May 24-27	96.5	113.5	132	7.8	12.3	21.1	56.9	42.0	1.1
3	May 28-June 1	91.1	111.8	-	6.9	11.4	-	71.4	28.6	-
4	June 2-12	89.3	113.7	130	6.3	11.5	17.2	80.8	19.0	0.2
Weighted Averages		93.1	112.9	131.5	7.2	11.9	20.1	66.6	32.9	0.5

NOTE: Age groups I, II and III denote the number of winters spent in freshwater. Season averages weighted by random catches.

TABLE 5. Weather observations, Ugashik River, 1973.^{1/}

Date	Wind ^{1/} Direction-Velocity (MPH)		Mean Water Temperature (°F) ^{2/}
	AM	PM	
May 16	15-20 E.	10-15 E.	41.0
17	20-30 E.	12-16 E.	39.0
18	0	5-6 W.	38.5
19	20 E.	25-35 E.	38.5
20	5 S. W.	5-8 W.	40.0
21	3-5 S. W.	0-3 S. W.	37.0
22	5-8 S. W.	6-10 W.	37.0
23	5-10 S. W.	5-10 S. W.	37.5
24	8-10 W.	3-5 W.	37.5
25	0-3 W.	0	38.5
26	0-5 E.	0-8 E.	37.8
27	0	10-15 S. E.	39.5
28	10-15 S. E.	5-8 S. E.	39.3
29	-	10-12 E.	40.5
30	25-35 S. E.	40-50 S. E.	40.5
31	15-20 S. E.	2-3 S. W.	40.5
June 1	15-20 W.	0	39.5
2	4-5 E.	0	39.5
3	6-8 S. E.	8-12 S. E.	40.3
4	4-6 S. E.	7-9 S. E.	41.0
5	10-12 S. E.	5-8 S. E.	40.5
6	7-9 S. E.	2-4 W.	41.0
7	8-10 W.	10-12 W.	42.0
8	10-12 W.	10 S. W.	39.8
9	6-12 W.	2-4 W.	38.5
10	2-4 W.	6-8 N.	39.3
11	2-4 W.	12-15 W.	40.8
12	10-12 W.	4-6 W.	40.5
13	2-4 E.	10-12 E.	

^{1/} Wind velocities were measured with a Dwyer wind gauge which is inaccurate over 10 mph.

^{2/} Water temperatures were recorded six times daily.

TABLE 6. Sonar counts by day adjusted to coincide with the random fishing schedule, Ugashik River, 1973.1/

Date	Time Period	Counts	Accumulative Counts
5/27	0215-2100	20,735	20,735
	2100-2400	60,718	81,453
5/28	0000-0200	54,090	135,543
	0200-2100	50,635	186,178
	2100-2400	1,092	187,270
5/29	0000-0200	2,503	189,773
	0200-2100	14,094	203,867
	2100-2400	32,419	236,286
5/30	0000-0200	35,114	271,400
	0200-0607	1,241	272,641
5/31	1846-2100	548	273,189
	2100-2400	392	273,581
6/1	0000-0200	49	273,630
	0200-2100	135	273,765
	2100-2400	128	273,893
6/2	0000-0200	63	273,956
	0200-2100	494	274,450
	2100-2400	12,669	287,119
6/3	0000-0200	7,755	294,874
	0200-2100	4,293	299,167
	2100-2400	20,693	319,860
6/4	0000-0200	1,840	321,700
	0200-2100	15,830	337,530
	2100-2400	4,727	342,257
6/5	0000-0200	3,503	345,760
	0200-2100	694	346,454
	2100-2400	4,933	351,387
6/6	0000-0200	1,763	353,150
	0200-2100	569	353,719
	2100-2400	1,442	355,161
6/7	0000-0200	121	355,282
	0200-1245	508	355,790

(Continued)

TABLE 6. Sonar counts by day adjusted to coincide with the random fishing schedule, Ugashik River, 1973.^{1/} (Continued)

Date	Time Period	Counts	Accumulative Counts
6/9	1845-2100	40	355,830
	2100-2400	165	355,995
6/10	0000-0200	87	356,082
	0200-2100	760	356,842
	2100-2400	2,506	359,348
6/11	0000-0200	354	359,702
	0200-1540	1,259	360,961
6/12	2200-2400	439	361,400
6/13	0000-0200	227	361,627
	0200-2100	464	362,091
	2100-2400	206	362,297
6/14	0000-0200	154	362,451
	0200-1000	617	363,068
Total	13.77 days	363,068	363,068

^{1/} Counts contain interpolations for some missed fishing times. False counts have been eliminated as best possible.

TABLE 7. Comparison of the daily percentages of the total random catch and total sonar counts for Ugashik River, 1973.

Date	Sonar Count	Daily % of Total	Random Catch ^{1/}	Daily % of Total ^{1/}
5/27	114,808	45.89	43,233	41.88
28	3,595	1.44	2,289	2.22
29	67,533	27.00	34,160	33.09
31	441	0.18	1,399	1.35
6/ 1	191	0.08	17	0.02
6/ 2	20,424	8.16	2,049	1.98
3	22,533	9.01	-	-
4	8,230	3.29	4,358	4.22
5	6,696	2.68	6,793	6.58
6	1,563	0.62	3,068	2.97
6/ 9	252	0.10	89	0.09
10	2,860	1.14	212	0.20
12	666	0.27	163	0.16
13	360	0.14	-	-
	250,152	100.00	97,830	100.00

^{1/} Taken from Table 1.

APPENDIX

Appendix Table A-1. Kvichak River 24-hour sockeye salmon smolt index catches, average lengths and weights, 1955-1973

Out migration	Age I				Age II				Total number	Total 24-hr. index ^{1/}
	Number	Percent ^{2/}	Average length	Weight	Number	Percent ^{2/}	Average length	Weight		
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	1.8 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
1973	44,273	4	86 mm	5.1 g	1,197,442	96	97 mm	8.3 g	1,241,715	37.2
Nineteen yr. avg.	614,943	36	88 mm	5.8 g	1,080,937	64	109 mm	10.7 g	1,695,880	50.9

^{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, 1955-1973.

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	-	-
1973	460,845	37.2
Average	1,312,117	50.5 ^{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 50.0 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, 1955-1973.

Year of Outmigration	Age I		Age II		Total number	Total 3-hr. index Points ^{1/}
	Number	Percent	Number	Percent		
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	-	-
1973	16,452	4	444,393	96	460,845	13.8
Eighteen yr. average	243,311	35	447,560	65	690,871	20.7

^{1/} One index point = 33,340 smolt.

Appendix Table A-4. Parent escapement and corresponding sockeye salmon smolt production, Kvichak River, 1952-1972.

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	251	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	2,842	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	1,197,442	1,209,379	.9	86	87
1971	2,387	44,273			19		
1972	1,010						
Average	4,664	614,940	1,081,013	1,695,953	122	187	309

Appendix Table A-5. Dates of sampling and peak periods of sockeye salmon smolt outmigration, Kvichak River, 1955-1973.

Year	Sampling Period Date	Number of days	Peak Out-migration Period Date	Number of days	% 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	5/9-13, 6/14-17	9	99
1972	-	-	6/9-18 ^{1/}	9 ^{1/}	83 ^{2/}
1973	5/17-6/13	28	5/22-29	7	87
Average		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, 1952-1970.

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%
1970	13,935,306	99%

^{1/} Based on 24-hour index catches.

^{2/} Estimated on basis of 2-ocean returns in 1956 and 52 fish in 1957 vs. 53 fish in 1957 and 63 fish in 1958.

Appendix Table A-7. Parent sockeye salmon escapement and corresponding adult return per indexed smolt, by age group, Kvichak River, 1952-1966.

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
1966	3,775	648	1,411	2.18	541	4,599	8.61

^{1/} In Thousands

Appendix Table A-8. Kvichak River sockeye salmon smolt indices and corresponding adult return per indexed smolt, 1952-1966.

Brood Year	Total Smolt		Ret./smolt
	Index ^{1/}	Adult Return ^{1/}	
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
1966	1,189	6,010	5.06

^{1/} In thousands.

Appendix Table A-9. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Kvichak River, 1960-1973.

Year of Outmigration	Age I ^{1/}		Age II ^{1/}		24-hr. Index Points	24-hr. Index Catch	Outmigration Estimate ^{1/}
	Percent	Mean length (mm)	Percent	Mean Length (mm)			
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
1973	4	86	96	97	37.2	1,241,715	194,126,119

^{1/} Age class composition and mean length data collected from index.

APPENDIX TABLE B-1. Average fork lengths and weights, Naknek River sockeye salmon smolts, 1957-1973.^{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
1973	26.8	106	10.7	72.2	114	12.9
Totals	886.5	1,724	159.6	808.5	1,919	212.0
Average	52.1	101	9.4	47.6	113	12.5

^{1/} Age III smolt not included.

APPENDIX TABLE B-2. Production of sockeye salmon smolt by brood year, Naknek River, 1956-1971.^{1/}

Brood Year	Escapement	Smolts Produced at Age			Total
		I	II	III	
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	27,393	18,337,684
1970	732,502	716,596	1,958,715		
1971	935,754	726,042			
Total	15,537,215	91,940,365	82,085,573	693,670	171,348,255
Average	971,076	5,746,273	5,472,372	49,548	12,239,161
Average %		51.0	48.6	0.4	

^{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, 1956-1973.

Year of Seward 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
1973	726,042	1,958,715	27,393	2,712,150
Total	98,794,766	84,663,756	693,670	184,152,192
Average	5,488,598	4,703,542	38,537	10,230,677
Average %	53.6	46.0	0.4	100.00

APPENDIX TABLE C-1. Average length and weight of Ugashik River sockeye salmon smolts by freshwater age group, 1958-1973.^{1/}

Year Sea-ward 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	97.4	7.5	121.2	14.5
1970	97.0	7.7	124.8	15.9
1972 ^{2/}	80.8	5.0	111.5	11.2
1973 ^{3/}	93.1	7.2	112.9	11.9
14-Year Total	1,275.3	91.7	1,596.8	171.9
14-Year Average	91.1	6.6	114.1	12.3

^{1/} 1958-1968 Weighted by index catch; 1969-1973 weighted by random catch.

^{2/} Age III smolt averaged 129.0 mm and 14.3 grams.

^{3/} Age III smolt averaged 131.5 mm and 20.1 grams.

APPENDIX TABLE C-2. Ugashik River sockeye salmon escapements and smolt production, 1956-1971.

Brood Year	Ugashik River Escapements	Millions of Smolt Produced				Smolt Per Spawner
		Age I	Age II	Age III	Total	
1956	425,295	11.4	0.4	0.01	11.9	28.0
1957	214,802	2.5	2.2	-	4.7	21.9
1958	279,546	3.3	3.0	-	6.3	22.5
1959	219,228	0.8	3.2	-	4.0	18.0
1960	2,304,200	13.5	18.1	-	31.6	13.7
1961	348,639	15.6	2.0	-	17.6	50.5
1962	255,426	8.0	2.6	-	10.6	41.5
1963	388,254	1.0	<u>1</u> /	-	1.0 ¹ /	-
1964	472,770	<u>1</u> /	2.4	-	2.4 ¹ /	-
1965	996,612	2.7	2.9	-	5.6	5.6
1966	704,436	39.3	2.0	-	41.3	58.6
1967	238,830	3.0	0.8	-	3.8	15.9
1968	70,896	0.6	-	0.01	0.6	8.6
1969	160,380	<u>1</u> /	0.6	0.02	0.6	3.9
1970	735,024	0.1	1.6	-	1.7	2.3
1971	529,752	3.2	<u>2</u> /	-	3.2	6.0
<hr/>						
16-Year Total	8,344,090	105.0 ³ /	41.8 ⁴ /	0.04	146.9 ³ /	297.2 ³ /
16-Year Average	521,506	7.5 ³ /	3.2 ⁴ /	0.01	10.5 ³ /	21.2 ³ /

¹/ No outmigration estimates for 1966 or 1971.

²/ Age II smolt from 1971 escapement will not leave freshwater until 1974.

³/ 14-year total and average.

⁴/ 13-year total and average.

APPENDIX TABLE C-3. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Ugashik River system, 1956-1973.

Year of Seaward Migration	Age I		Age II		Index Points	Index Net Catch	Out-Migration Estimate
	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	439,587	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	-	-	1,306,430
1972 ^{2/}	14.1	80.8	83.9	111.5	-	-	662,718
1973 ^{2/}	66.6	93.1	32.9	112.9	-	-	4,845,677

^{1/} 1.0 percent Age III in 1960; 0.1 percent Age III in 1963 and 1964; 2.0% Age III in 1972; and 0.5% Age III in 1973.

^{2/} Age and length were weighted by the random catches.

NOTE: Age Group I and II denotes the number of winters spent in freshwater. Age length are weighted by the index catch.

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