



1970 BRISTOL BAY SOCKEYE SALMON SMOLT STUDIES

Edited by:
Philip A. Russell

1972

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.

1970 Bristol Bay Sockeye Salmon Smolt Studies

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

Edited by

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TABLE OF CONTENTS

	Page
LIST OF TABLES	i
LIST OF FIGURES	iii
LIST OF APPENDIX TABLES	iv
1970 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES	1
INTRODUCTION	1
METHODS AND PROCEDURES	2
Index Project	2
Total Outmigration Estimate	2
DATA SUMMARY	5
Index Project	5
Total Outmigration Estimate	10
1970 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES	14
ABSTRACT	14
INTRODUCTION	14
METHODS AND PROCEDURES	15
Fyke Net Design	15
Fyke Netting Procedure	15
Sampling Design	15
RESULTS	18

TABLE OF CONTENTS (Continued)

	Page
DISCUSSION	21
SUMMARY	21
LITERATURE CITED	23
1970 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES	24
INTRODUCTION	24
METHODS AND PROCEDURES	24
RESULTS	24
LITERATURE CITED	31
1970 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES	32
ABSTRACT	32
INTRODUCTION	32
RESULTS	33
APPENDIX A	36
APPENDIX B	52
APPENDIX C	56

LIST OF TABLES

	Page
 1970 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES	
Table 1. Kvichak River water velocities at sonar test areas 1970, measured June 8, with Std. Model 622 Gurley Meter . . .	4
Table 2. Weighted length frequencies of sockeye salmon smolt, Kvichak River, index site, 1970	9
Table 3. 1970 smolt sonar calibrations summary, Kvichak River	12
Table 4. Comparative index and smolt site catches for related time periods, Kvichak River, 1970	13
 1970 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES	
Table 1. Ugashik River sockeye salmon smolt sampling data, 1970	19
Table 2. Age, length and weight of sockeye salmon smolt by sampling period from the Ugashik River system, 1970 . .	19
Table 3. Ugashik River sockeye salmon smolt catches in the random sampling scheme by fishing site, 1970	20
Table 4. Ugashik River sockeye salmon catch in index net during 24-hour fishing periods, 1970	22
 1970 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES	
Table 1. Mean water and air temperatures by day, Naknek River, 1970	25
Table 2. Random sampling catches of sockeye salmon smolt by fishing site, Naknek River, 1970	26
Table 3. Naknek River index net catches of sockeye salmon smolt by 90-minute periods, May 30-July 5, 1970	29

LIST OF TABLES (Continued)

	Page
Table 4. Number, percent and apportioned catch by age of sockeye smolt samples, Naknek River, 1970	30

1970 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES

Table 1. Wood River sockeye salmon smolt catch by hour and day, 1970	34
Table 2. Age, weight and length of sockeye salmon smolt by period from the Wood River system, 1970	35
Table 3. Wood River sockeye salmon smolt sampling data, 1970	35

LIST OF FIGURES

	Page
1970 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES	
Figure 1. Upper Kvichak River sample sites and points of interest, 1970	3
Figure 2. Details of Bendix smolt sonar transducer arrangement, Kvichak River, 1970	6
Figure 3. Data print from smolt sonar, Kvichak River, 1970	7
Figure 4. Daily fyke net catches of sockeye salmon smolt, Kvichak River index site, 1970	8
Figure 5. Weighted length frequencies of sockeye salmon smolt in millimeters, Kvichak River, index site, 1970	11
1970 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES	
Figure 1. Nylon fyke net and live box used to sample sockeye salmon smolt, Ugashik River	16
Figure 2. Ugashik River sockeye salmon smolt sampling site	17
1970 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES	
Figure 1. Naknek smolt site	27

LIST OF APPENDIX TABLES

		Page
Appendix Table A-1.	Weather and stream observations, Kvichak River, May 3 - June 7, 1970	37
Appendix Table A-2.	Kvichak River sockeye salmon smolt expanded twenty-four hour index catch by period, 1970	39
Appendix Table A-3.	Dates and water temperatures at beginning of peak smolt outmigration, Kvichak River, 1955-1970	41
Appendix Table A-4.	Kvichak River 24-hour sockeye salmon smolt catches, average lengths and weights, 1955-1970	42
Appendix Table A-5.	Kvichak River sockeye salmon smolt photo-counter calibrations, 1970	43
Appendix Table A-6.	Percent of sockeye salmon smolt outmigration occurring during index hours (2200-0100), Kvichak River, 1955-1970	47
Appendix Table A-7.	Kvichak River 3-hour sockeye salmon smolt catches, 1955-1970, (3-hour index catches) .	48
Appendix Table A-8.	Dates of sampling and peak periods of sockeye salmon smolt outmigration, Kvichak River, 1955-1970	49
Appendix Table A-9.	Parent escapement and corresponding percent of Age II sockeye salmon smolt produced, 1952-1967	50
Appendix Table A-10.	Parent escapement and corresponding sockeye salmon smolt production, Kvichak River, 1952-1968	51
Appendix Table B-1.	Average length and weight of Ugashik River sockeye salmon smolts by freshwater age group, 1958-1970	53

LIST OF APPENDIX TABLES (Continued)

	Page
Appendix Table B-2. Ugashik River sockeye salmon escapements and smolt production, 1956-1967	54
Appendix Table B-3. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Ugashik River system, 1956-1969	55
Appendix Table C-1. Comparative age, length and index net catches of sockeye salmon smolt from the Wood River system, 1951-1970	57
Appendix Table C-2. Average length and weight of Wood River sockeye salmon smolts by freshwater age groups, 1961-1970	58
Appendix Table C-3. Wood River sockeye salmon escapement and smolt produced, 1951-1968	59
Appendix Table C-4. Percentage of Wood River sockeye salmon smolt parasitized by the cestode, <u>Triseno-</u> <u>phorus crassus</u> , 1961-1970	60

1970 KVICHAK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

1970 represents the seventeenth year that an index has been obtained on sockeye salmon smolt (Oncorhynchus nerka) leaving Iliamna Lake and migrating down the Kvichak River. Information obtained from these indices is used to forecast age composition and magnitude of adult returns to the Kvichak River. The data is also used to evaluate smolt production from various levels of adult escapement.

The indices, however, have proven to be unreliable as a source of information from which to predict adult sockeye returns to the Kvichak River. Factors producing this unreliability are smolt which migrate beneath the ice from the lake break-up, irregular river bottom contour, two channels at the operations site, and annual variations in water level, turbidity, and light intensity. The last two factors influence the amount of net avoidance exhibited by the smolt.

The index project has, however, provided some information on population dynamics of the Iliamna Lake system sockeye salmon and its continuation is necessitated by need of comparative annual data.

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

To the long-standing problem of achieving a total smolt outmigration sonar electronics are being applied. The first model of a sonar unit for counting smolt was designed at Bendix Electrodynamics Division in 1969-70 by the head engineer of Oceanica, Mr. Al Menin. Menin is the engineer responsible for the creation of the adult salmon sonar counter presently in use in several

Alaskan streams. Tests on the transducers were made in the Nimbus Hatchery in Sacramento, California and in the Bendix sonar testing pool.

The first field test was made in the Kern River in California on 90 mm trout fingerlings which caused a strong response on the counter. The unit was then disassembled and shipped to Bristol Bay. Figure 1 illustrates the sites of operation for the smolt sonar.

METHODS AND PROCEDURES

Index Project

To obtain the 1970 smolt index the same methods and procedures were used as in past years. The equipment consisted of a standard 4 foot x 4 foot fyke net, a cod-end, and photo-electric counters. The site of operations were at the same location (Figure 1) and at the same depth. Due to early lake break-up, fyke net fishing began May 2 in anticipation of an early outmigration and ended June 15. Use of photo-electric counters began May 21 and terminated June 5.

Total Outmigration Estimate

The first site of operations for the sonar equipment was the river channel located about a quarter mile upstream from the index site. A system of anchors and ropes were used to install the gear on the river bottom. The inshore array was installed in 5 feet of water (minimum operational depth) and the offshore array in about 7.5 feet of water. Maximum operational depth is 12 feet. Surface water velocities (0.3 feet below the surface) varied from 5.25 f.p.s. over the inshore array to 6.09 f.p.s. (Table 1) over the offshore array. The site was near the west side of the river where channel width is about 500 feet. During the latter part of the outmigration, another site of operations was located about 50 yards offshore of the index site.

The sonar ladder-like arrays were made of 8-3/4 inch I.D. plastic pipe primary rails, with 4-inch crossbars or "rungs," which are attached by steel hose clamps. The complete unit consists of two sections 11 feet long, 3 feet wide, with a maximum height of 1.7 feet. Alternately mounted on each section are vertical and lateral scanning transducers. The transducers are mounted 0.8 feet apart. The vertical mounts count smolt in the surface water while the lateral mounts count smolt downstream of the array in the bottom area thus eliminating "unscanned" areas for which corrections had to be made on the adult array. The lateral scanning transducers are at an angle of 20° to the bottom. Each section is equipped with 200 feet of cable and 50 feet of hose

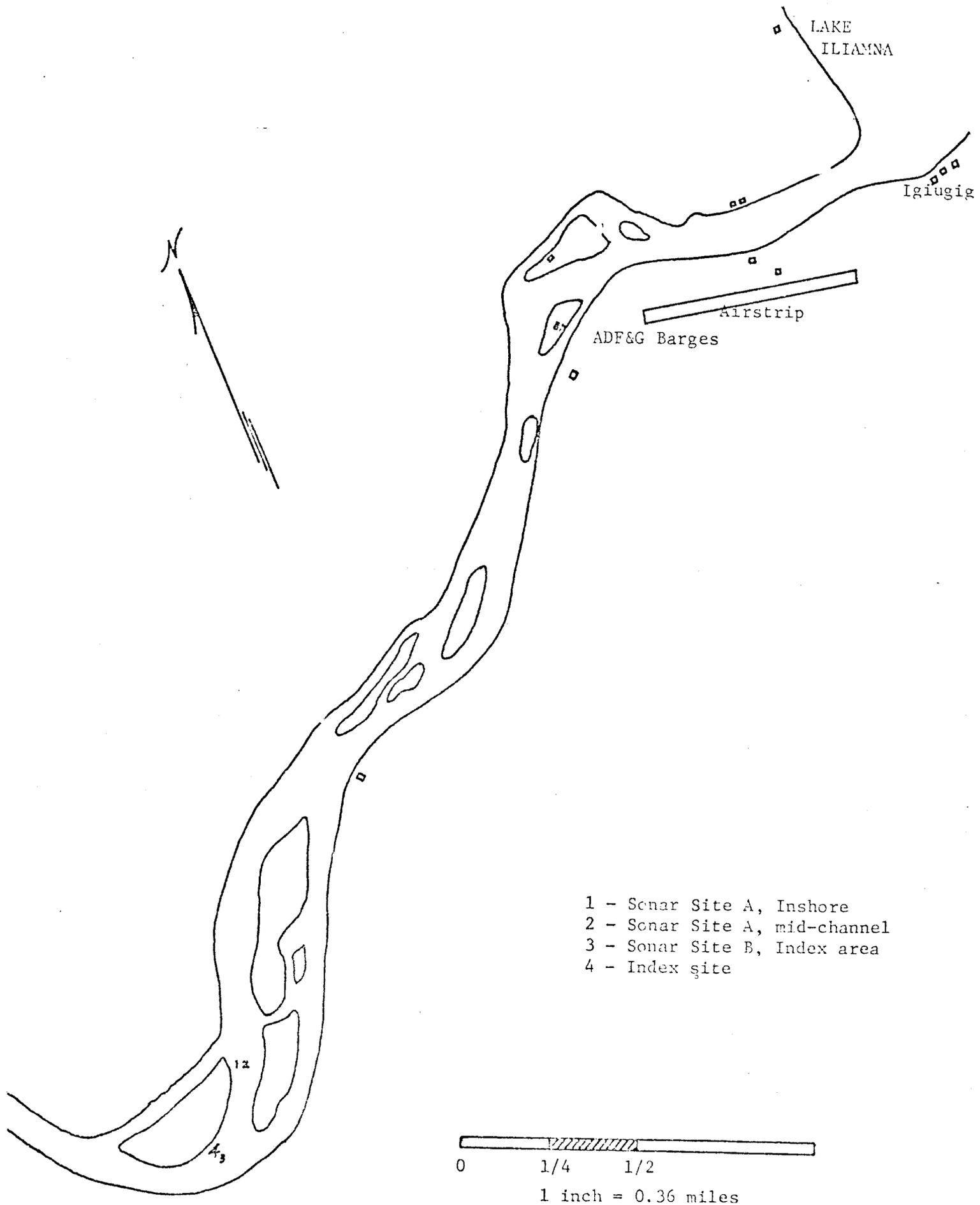


Figure 1. Upper Kvichak River sample sites and points of interest, 1970.

Table 1. Kvichak River water velocities at sonar test areas 1970, measured June 8, with Std. Model 622 Gurley Meter.

Depth in feet	Water velocities ^{1/}		
	Index site B	Sonar site A (inshore)	Sonar site A (mid-channel)
0.3	5.08	5.25	6.09
1.0	4.78	5.31	6.00
2.0	4.75	4.85	5.80
3.0	4.48	4.62	5.76
4.0	3.71	3.86	5.41
5.0	Bottom (5.00')	Bottom (5.30')	4.78
6.0			4.70
7.0			
8.0			Bottom (7.50')

^{1/} Measured in feet per second.

through which air or water is pumped to float or sink the array. See Figure 2 for an array illustration. The smolt counter has: (1) a control for water velocity; (2) a control for depth; (3) a battery (power source) condition meter; and (4) digital printers for upper and lower counts and can record at 5, 10, or 15 minute intervals. See Figure 3 for an example of a data print.

Calibrations of the sonar counts (a biomass estimate) were conducted by the use of a metal 4 foot by 4 foot fyke trap mounted on pontoons or a 6 foot by 4 foot fyke net. The calibrating devices were placed far enough downstream so as not to interfere with the lateral scanning sonar pulses. Calibrations were conducted by key-setting the counters to zero, attaching a cod-end to the trap or net, accumulating 20 to 40 counts, pulling the cod-end, obtaining a total fish weight, and removing a randomly selected one pound sample for a fish per pound ratio. Fish per sonar count was thus determined for each calibration.

DATA SUMMARY

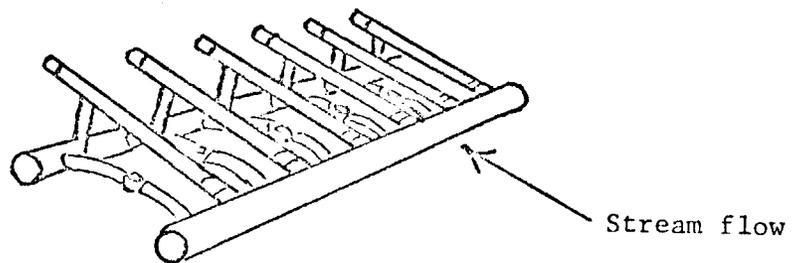
Index Project

Water temperatures ranged from 35° to 52° F., with a mean of 44.3° F. (Appendix Table A-1). Although spring breakup came in mid-April, earlier than ever recorded, the beginning of peak outmigration was not unusually early (Appendix Table A-3).

The total expanded index was 483,638 smolt (or 14.5 index points). Approximately 54 percent of the index or 259,440 smolt occurred during a three-day period beginning May 26-27 and ending May 28-29. Total index hour (2200-0100) catches totaled 218,951 (45 percent of the total index) or 6.6 index points (Appendix Table A-2 and Figure 4). Percent of index catch taken during index hours and age composition is presented in Appendix Tables A-6 and A-7.

Age I smolt comprised 38.3 percent (185,356) of the total index with Age II smolt making up the balance (61.7 percent or 298,282) of the total index. Age I smolt averaged 90.8 millimeters in length and 6.0 grams in weight. Age II smolt averaged 110.2 millimeters and 11.0 grams (Table 2). Age I smolt were above while Age II equaled the 16-year average lengths and weights for their respective age classes (Appendix Table A-4).

Forty-four 1-pound and seventeen 2-pound samples were taken to determine average lengths, weights and an age class separation range. This range was determined by aging scales from smolt, which by lengths, bracketed the



Isometric of Assembled Array

- 9 -

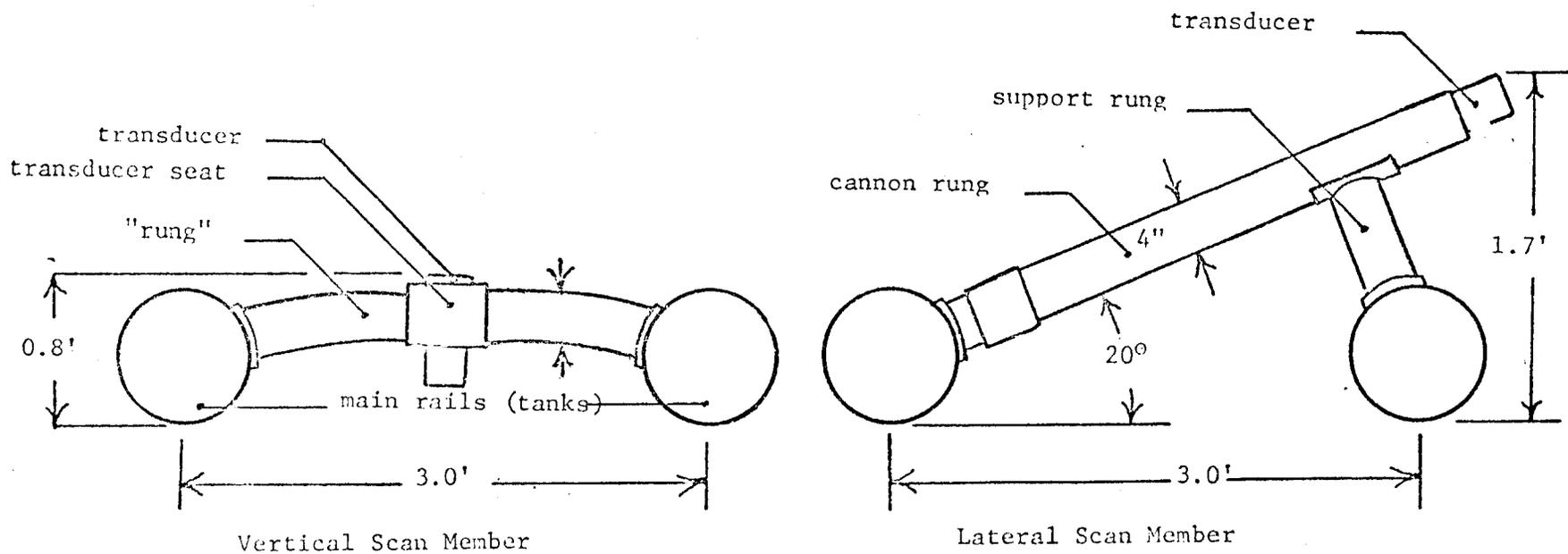


Figure 2. Details of Bendix smolt sonar transducer arrangement, Kvichak River, 1970.

Figure 3. Data print from smolt sonar, Kvichak River, 1970.

Time and date
tape terminated

10:00	0	3	1	1	
	0	5	2	1	
	0	6	2	4	
	0	2	8	2	
9	0	2	6	7	
	0	3	4	5	
	0	3	9	8	
	0	2	5	5	
8	0	0	0	0	
	0	4	8	5	
	0	4	6	7	
	0	2	1	2	
7	0	3	6	0	
	0	5	4	7	
	0	8	5	8	
	0	9	1	1	
6	1	4	9	8	
	0	6	4	3	
	1	6	1	3	
	1	3	8	0	
5	1	8	1	1	
	0	7	5	7	
	0	6	6	4	
4	0	6	5	2	
	0	7	0	3	
	0	2	2	6	
3	0	0	0	0	
	0	0	0	1	
	0	0	0	0	
	0	0	0	2	
2 AM	0	0	0	0	
	0	0	0	0	
	0	0	0	0	
	0	0	0	0	

Marginal code
denotes printer
being utilized

Counts printed
at 15 minute
intervals

Counts made by
throwing rocks
into sonar
beam

Rocks 0 1 9 0

Vertical scan
transducers
only

UPPER

1 AM 5/22

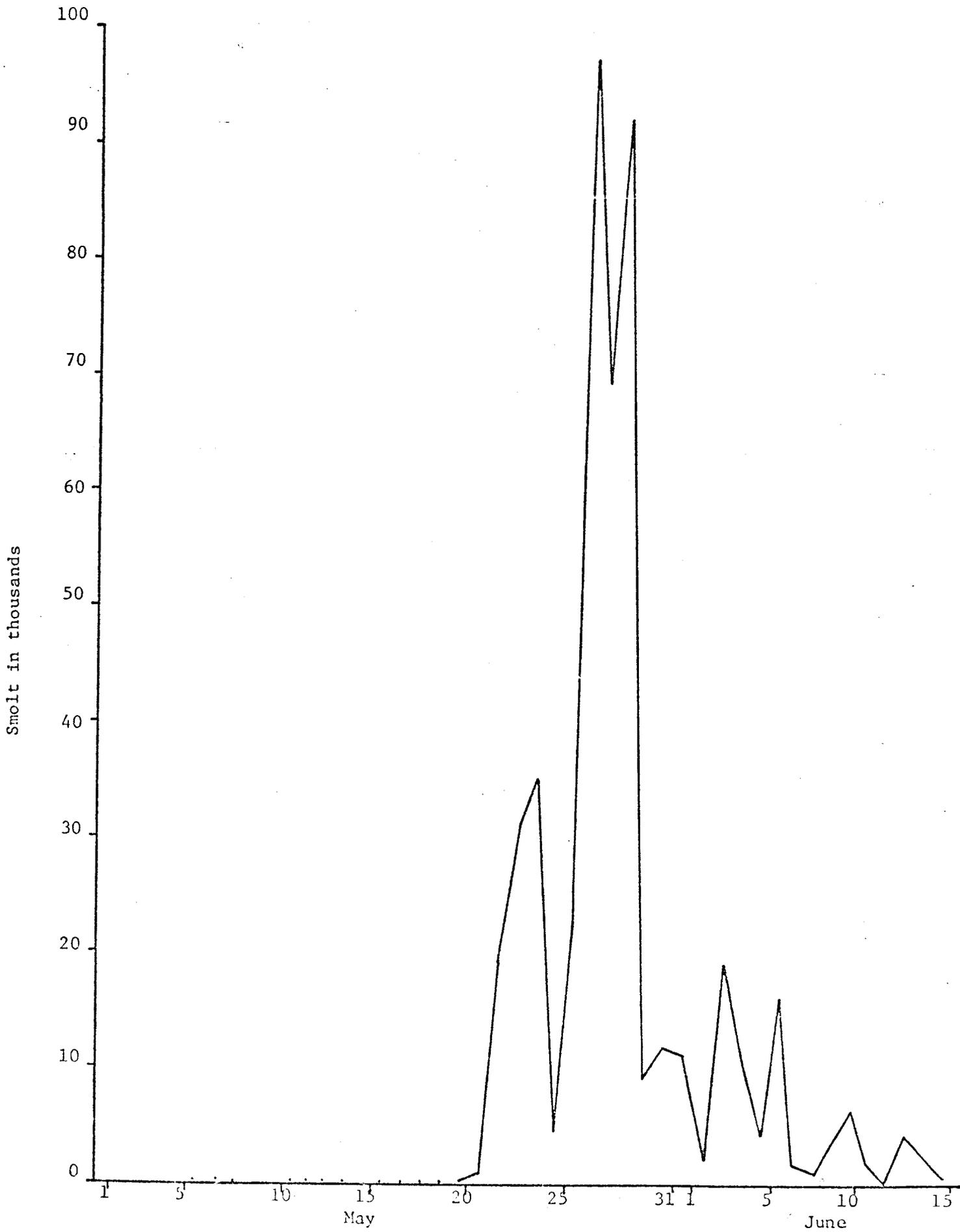


FIGURE 4. Daily fyke net catches of sockeye salmon smolt, Kvichak River index site, 1970.

Table 2. Weighted length frequencies of sockeye salmon smolt, Kvichak River, index site, 1970.

Length (mm)	Frequency	Length (mm)	Frequency
78	104	97	1,458
79	71	98	2,154
80	958	99	1,691
81	577	100	3,378
82	1,041	101	5,352
83	2,748	102	4,246
84	4,263	103	8,010
85	6,348	104	9,742
86	6,217	105	13,090
87	9,444	106	14,200
88	13,678	107	16,169
89	17,061	108	24,394
90	27,745	109	22,952
91	14,136	110	26,074
92	17,876	111	26,099
93	13,243	112	29,178
94	19,870	113	23,020
95	10,033	114	13,141
96	10,561	115	14,762
97	3,568	116	9,998
98	3,829	117	6,822
99	1,985	118	6,531
		119	2,696
		120	6,562
		121	2,128
		122	1,800
		123	766
		124	335
		125	1,078
		127	434
		130	22
Age I smolt =	185,356		
Percent =	38.3		
Average length =	90.8		
Average weight =	6.0		
		Age II smolt =	298,282
		Percent =	61.7
		Average length =	110.2
		Average weight =	11.0

range of separation. Verification of this range separation was continued throughout the duration of the outmigration. The separation was determined to be between the lengths of 97 to 99 millimeters (Table 2 and Figure 5).

Photo-electric counter calibrations were conducted from May 21 to June 5. The method of calibration was the same as used in past years. Daily conversion ratios of smolt per count ranged from 2.56 to 8.06. The seasonal average was 5.83. During the season 73 calibrations were taken. See Appendix Table A-5 for the season's data.

The seasonal average of 5.83 represents an arithmetic mean of all the calibrations taken.

Arrival date on timing, run duration, and age class by numbers of smolt produced from escapements is shown in Appendix Tables A-8, A-9 and A-10.

Total Outmigration Estimate

During the season a total of 52 calibrations were taken. One calibration series was made on May 30-31, giving 18 calibrations having an average smolt per count of 24.68. After adjustments, 34 additional calibrations were made with an average of 84.69 smolt per count. The range of smolt per count on May 30-31 was 7.54 to 85.87, and after adjustment 20.68 to 225.96. See Table 3 for a summary of sonar calibrations. In 1970 an increase in catch per count with increased counts per minute was apparent.

The data also indicated that there is an increase in fish per count as the number of fish per pound increases. This is expected since the biomass of small fish is less than large fish, thus requiring more small fish to trigger a count.

During the portion of the season that an array was fished offshore of the index site a difference, sometimes considerable, was noted between the two sites in passage rates (smolt per minute) and age composition (smolt per pound) (see Table 4).

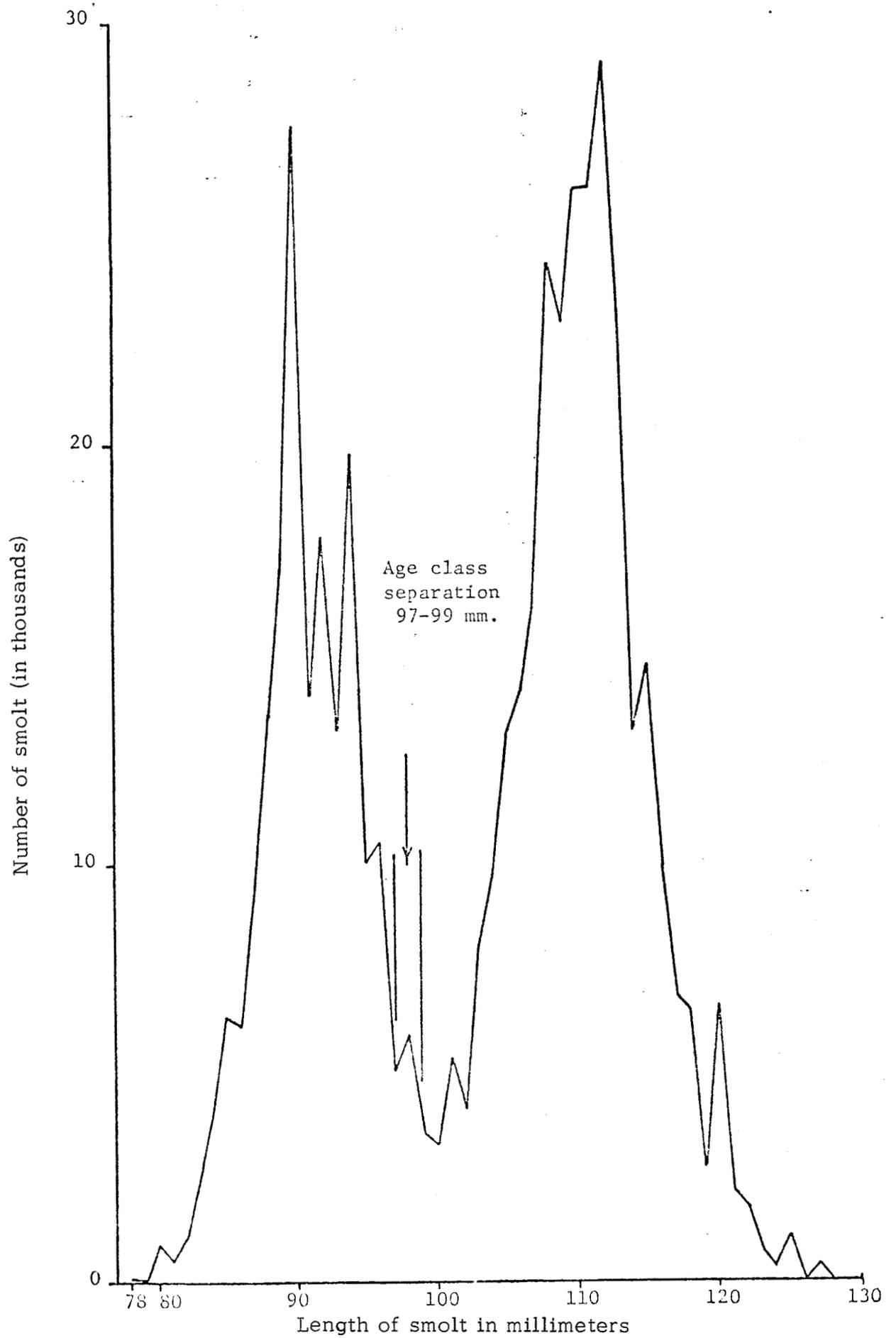


Figure 5. Weighted length frequencies of sockeye salmon smolt in millimeters, Kvichak River, index site, 1970.

Table 3. 1970 smolt sonar calibrations summary, Kvichak River.

Date	Total Minutes	Total Counts	Cts./Min.	Total Catch	Catch/Minute	Catch/Count
5/30	-	49	-	1,430	-	29.18
5/30-5/31*	231	984	4.260	12,727	55.10	12.93
6/1	71	67	0.9	2,185	30.77	32.61
6/2	62	57	0.9	3,786	61.06	66.42
6/3-4	230	332	1.4	20,838	90.60	62.76
6/4	16	14	0.9	1,947	139.07	121.68
6/5-6	171	329	1.9	23,483	137.33	71.38
6/6-6/7	221	241	1.1	15,308	69.27	63.52
Season Total	1,002	2,024		80,274	80.11	39.66

* Counter readjusted after this evening of calibrations.

Table 4. Comparative index and smolt site catches for related time periods, Kvichak River, 1970.

Date	Time	Minutes	Pounds	S ¹ /lb.	Smolt	S/min.	Lbs./min
5/30-31							
Index	2230-2400	90	110.4	47.0	5,189	57.6	1.23
Sonar	2232-2358	86	78.4	51.7	4,051	47.1	0.91
6/3-4							
Index	2200-0008	128	88.6	54.6	4,841	37.8	0.69
Sonar	2200-0004 ² / ₁	97	110.4	58.8	6,492	66.9	1.14
6/4							
Index	2300-2400	60	18.8	55.0	1,034	17.2	0.31
Sonar	2250-2306	16	31.4	62.0	1,947	121.7	1.96
6/5							
Index	2200-2252 ² / ₁	38	105.1	55.9	5,873	154.5	2.76
Sonar	2218-2255 ² / ₁	29	164.4	56.2	9,233	318.4	5.67
6/6							
Index	2200-0200	240	18.7	46.6	872	3.6	0.08
Sonar	2225-0206	221	315.0	49.3	15,536	70.3	1.43

¹/₁ S = smolt

²/₁ Discontinuous fishing

1970 UGASHIK RIVER SOCKEYE SALMON SMOLT STUDIES

By

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ABSTRACT

The sockeye salmon smolt enumeration and sampling program at the outlet of Lower Ugashik Lake was conducted from May 15 to June 11. A series of standard winged fyke nets were used to trap the smolt during their seaward migration. Five fishing sites fished on a random schedule two out of every three nights between 9:00 p.m. and 2:00 a.m., yielded a total smolt outmigration estimate of 1,306,430, consisting of 57.5 percent Age I and 42.5 percent Age II smolt.

The index fishing scheme was not conducted during the 1970 season due to a shortage of large nets required to fish the two sites located in the deep channel. The index net site (site 4) was, however, fished every third day to determine the percentage of smolt migrating to sea outside of the random fishing hours. Age, weight and length data, which were previously taken from a sample of the index net catches, were derived from a composite sample from all five fishing sites.

INTRODUCTION

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

Field work was under the supervision of the author with Wilson Potterville, Don Bill and Jay Priest participating in the program.

METHODS AND PROCEDURES

Fyke Net Design

Fyke nets constructed of 1-inch (stretched measure) nylon or vinyl webbing in the wings and body and 1-inch stretch measure webbing in the tunnel were used to trap the smolts (Figure 1). The nets were hung from steel frames, 4-feet wide and between 4 and 7 feet deep. Each of the two wings were 10 feet long and were held open by the force of the river current. Two spacer lines, each 8 feet long, were attached to the wings and allowed the net to fish an 8 foot wide section of the river. The body of the net funneled from the frame to a 4" x 10" rectangular aperture at the throat.

Fyke Netting Procedure

Fyke nets were suspended at five standard fishing sites across the river along a 1/2-inch wire cable which was secured to each bank by Dead-men (Figure 2). 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 instead of cod ends on all nets. A six-inch diameter rubber tube carried the smolt from the fyke net to the live box. The use of the live boxes facilitated handling of the smolt and reduced the mortality due to a reduction in scaling of the smolt against the sides of the cod ends.

Sampling Design

In 1958 a random sampling scheme using fyke nets on five sites were developed to derive an estimate of the total smolt outmigration. Each site was fished on a random schedule for one hour between the hours of 9:00 p.m. and 2:00 a.m. The random scheme was fished four out of five nights with the index net site being fished 24 hours on the fifth day.

The index fishing scheme, used since 1956, was not conducted in 1970. A newly formed channel running through the fishing sites 4 and 5 and the lack of enough nets of the proper depth to fish these sites, prohibited operation of the fishing scheme.

Fishing was conducted between May 15 and June 11. The random scheme was fished two out of every three nights with the index net site being fished on the third night.

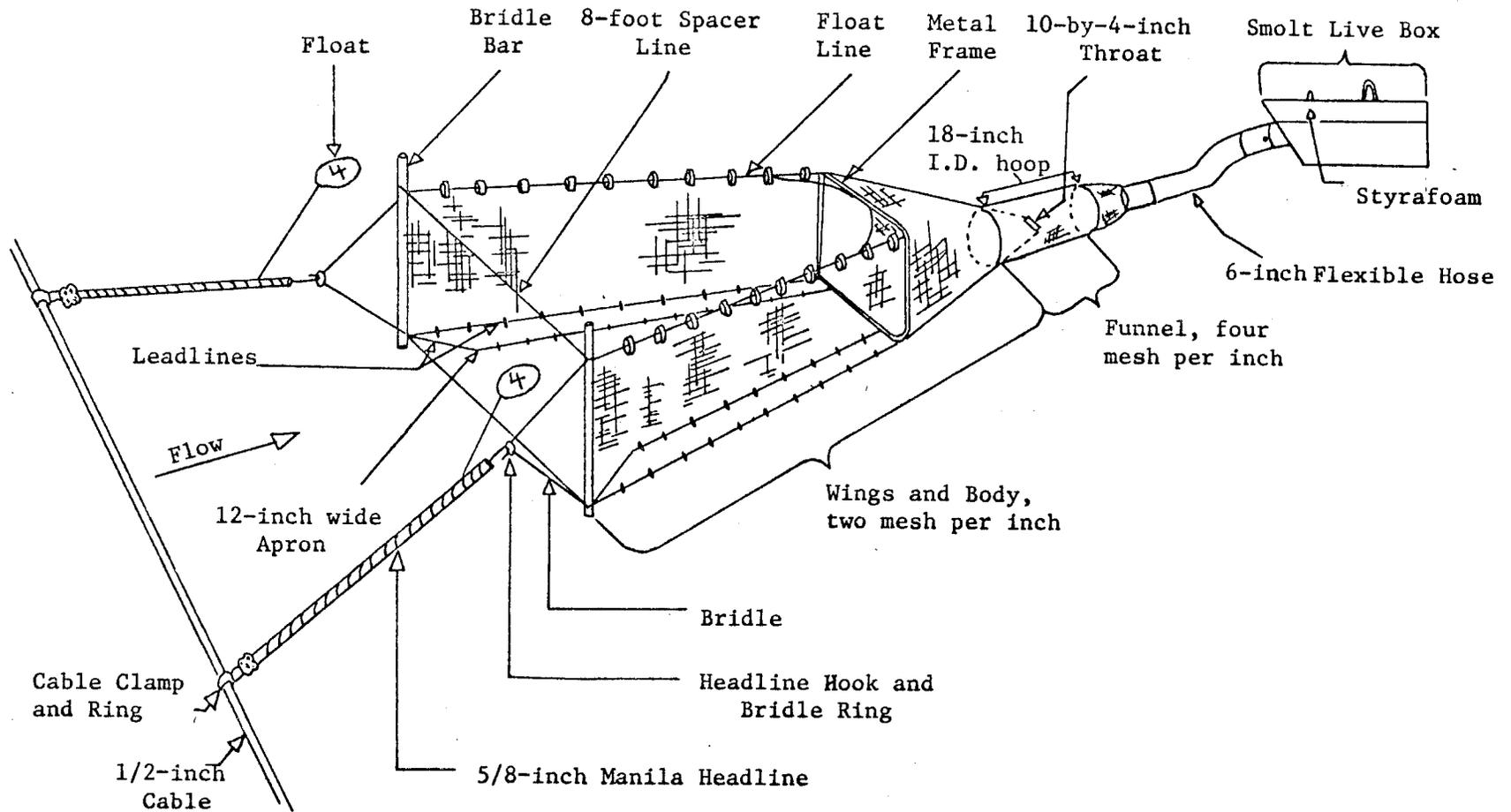


Figure 1. Nylon fyke net and live box used to sample sockeye salmon smolt, Ugashik River.

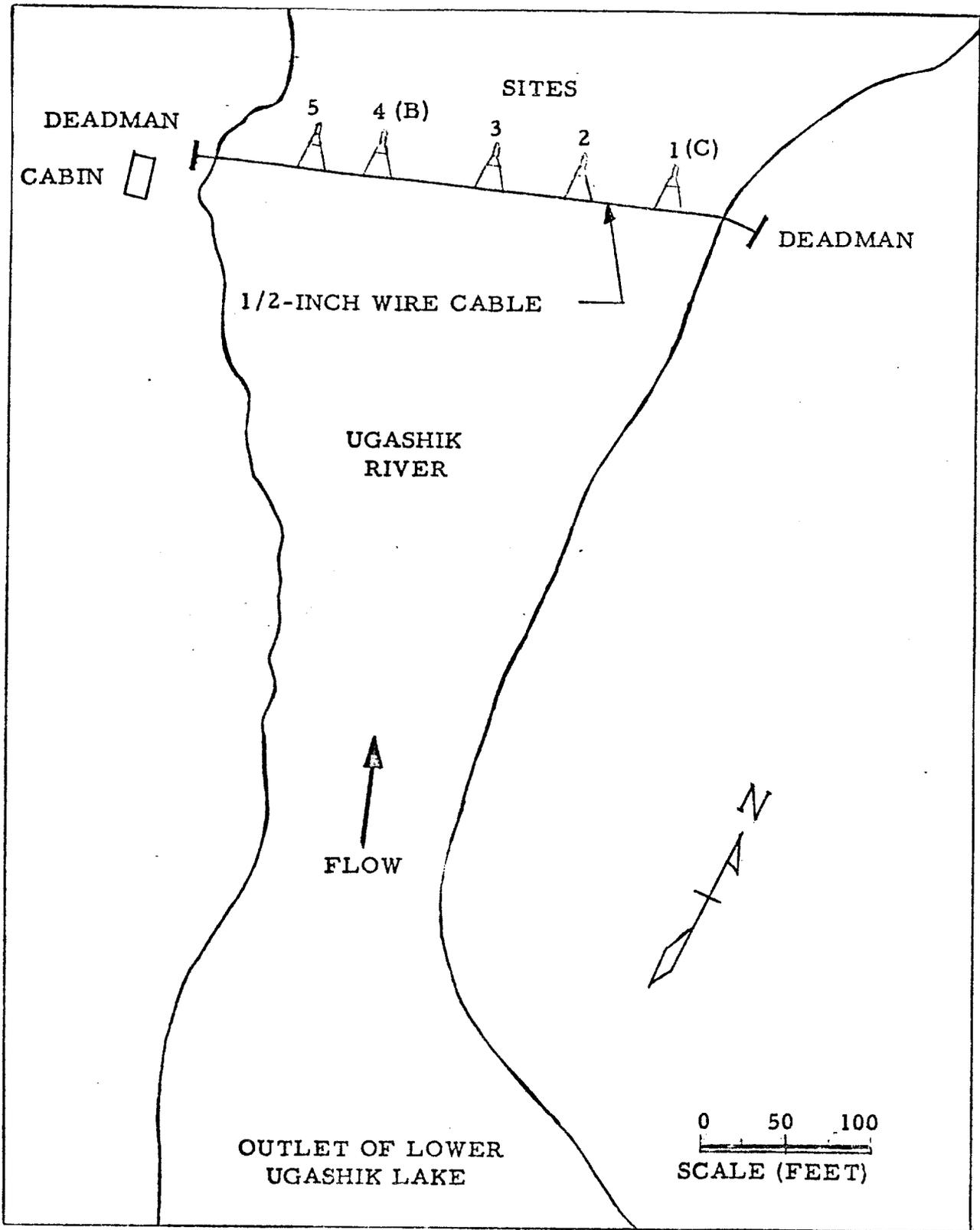


Figure 2. Ugashik River sockeye salmon smolt sampling site.

All length frequency and scale samples were acquired from a composite sample taken from catches of all five sites. A 1-pound length frequency sample and 20 weights and scales were taken each night with additional samples being taken during nights of peak outmigration.

Smolt samples were separated into three fishing periods (Tables 1 and 2). Size composition was determined from readings of 460 smolt scales (Table 1). The percentage, mean length and weight of each age group were determined by period and for the entire season by weighing the total number of samples for each period by the total catch for each period (Table 2).

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

$$x = \bar{x} abc$$

where x = estimate of total smolt outmigration

\bar{x} = average random catch between 9:00 p.m. and 2:00 a.m. per actual fishing day = $\frac{25,502 \text{ smolt}}{19 \text{ fishing periods}}$

a = number of possible fishing sites across the river
 $= \frac{\text{width of river}}{\text{opening of fyke net}} = \frac{280 \text{ ft.}}{8 \text{ ft.}}$

b = number of possible fishing days during the sample period = 27 days

c = expansion coefficient for 24-hr. estimate

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 9:00 p.m. - 2:00 a.m.

During the sample period, May 15 to June 11, 19 of 27 possible days were fished on a random schedule.

RESULTS

The random sampling scheme was fished 19 days of the 27 day season and caught a total of 25,502 smolt (Table 3). Site 4 caught the majority of smolt, 35.5 percent.

Table 1. Ugashik River sockeye salmon smolt sampling data, 1970.

Period No.	Date	Random Smolt Catch	% of season's total	# 1 lb. samples measured	# of fish measured	# of Scales read
1	May 15-23	707	2.8	5	154	120
2	May-June 24-01	18,673	73.2	8	298	160
3	June 02-10	6,122	24.0	9	455	180
Totals		25,502	100.0	22	907	460

Table 2. Age, length and weight of sockeye salmon smolt by sampling period from the Ugashik River system, 1970.

Period No.	Date	Mean length in mm of age group		Mean weight in grams of age group		Percentage of age group	
		I	II	I	II	I	II
1	May 15-23	100.0	126.8	8.2	16.3	33.1	66.9
2	May-June 24-01	97.0	124.7	7.7	15.8	50.0	50.0
3	June 02-10	96.6	125.0	7.7	16.1	83.1	16.9
Weighted Averages		97.0	124.8	7.7	15.9	57.5	42.5

Table 3. Ugashik River sockeye salmon smolt catches in the random sampling scheme by fishing site, 1970.

Date	Random Sampling Sites					Daily total	Accum. total
	1	2	3	4	5		
May 15	1	0	16	14	1	32	32
16	0	1	3	1	27	32	64
18	10	4	6	1	80	101	165
19	0	3	0	22	77	102	267
21	0	15	54	149	2	220	487
22	15	73	50	60	22	220	793
24	0	2	2	82	0	86	793
25	472	37	3	0	41	553	1,346
27	753	126	293	1,409	513	3,094	4,440
28	335	796	53	1,813	1,309	4,306	8,746
29	19	457	953	3,398	1,044	5,871	14,617
30	13	0	255	595	55	918	15,535
31	1,344	2,154	57	250	40	3,845	19,380
June 2	55	372	23	0	137	587	19,967
3	239	473	380	215	94	1,401	21,368
5	13	131	221	566	376	1,307	22,675
6	670	147	98	230	166	1,311	23,986
8	287	504	203	25	18	1,037	25,023
9	2	85	51	232	109	479	25,502
Total	4,228	5,380	2,721	9,062	4,111	25,502	25,502
Percent	16.58	21.10	10.67	35.53	16.12	100.00	100.00

Twenty-four hour sampling, conducted 9 days of the season, indicated that 97.2 percent of the smolt outmigration occurred during the random fishing hours of 9:00 p.m. and 2:00 a.m. yielding an expansion coefficient (c) of 1.03 (Table 4). The total smolt outmigration estimate for 1970 was 1,306,430.

Age I smolt comprised 57.5 percent of the total outmigration and averaged 97.0 mm in length and 7.7 grams in weight. Age II smolt comprised 42.5 percent and averaged 124.8 mm and 15.9 grams (Table 2).

DISCUSSION

The 1970 smolt outmigration estimate of 1,306,430 is the smallest on record. The extremely small outmigration was most probably the result of the small escapement of 70,896 adults in 1968, which would have produced the Age I smolts, and a minimal holdover to Age II of smolts from the 1967 escapement of 238,830. The average lengths and weights, all of which were higher than the 12-year average, is further evidence of a very small smolt population, one which is much smaller than the lake nursery area is capable of holding.

Further comparative data are continued in Appendix Tables B-1 - B-3.

SUMMARY

1. The random fishing scheme caught 25,502 smolt with site 4 catching 35.5 percent of the total random catch.
2. Twenty-four hour sampling indicated that 97.2 percent of the smolt outmigration occurred during the random fishing hours.
3. Total smolt outmigration estimate was 1,306,430.
4. Age I smolt comprised 57.5 percent of the total outmigration and averaged 97.0 mm in length and 7.7 grams in weight.
5. Age II smolt comprised 42.5 percent of the total outmigration and averaged 124.8 mm in length and 15.9 grams in weight.

Table 4. Ugashik River sockeye salmon catch in index net during 24-hour fishing periods, 1970.

Time Period	Date										Total	Percent
	May 17-18	May 20-21	May 23-24	May 27-27	May 29-30	June 1-2	June 4-5	June 7-8	June 10-11			
2200-2300	30	4	350	108	8,380	1,987	-	1,390	635	12,884	46.1	
2300-2400	312	112	812	832	3,398	125	100 ^{1/}	361	147	6,199	22.2	
2400-0100	81	19	75	233	464	0	-	94	95	1,061	3.8	
0100-0200	65	26	48	70	464	0	-	18	51	742	2.7	
0200-0330	16	17	48	0	60	0	50	4	6	201	0.7	
0330-0500	4	0	5	27	4	0	-	8	1	49	0.2	
0500-0630	0	0	6	0	0	0	-	0	0	6	0.0	
0630-0800	0	0	4	0	1	0	-	0	0	5	0.0	
0800-0930	0	0	2	0	0	0	396 ^{2/}	0	0	2	0.0	
0930-1100	0	0	0	0	0	0	-	0	0	0	0.0	
1100-1230	0	0	0	0	0	0	-	0	0	0	0.0	
1230-1400	0	0	0	0	5	0	-	0	0	5	0.0	
1400-1530	0	0	0	0	0	0	-	0	0	0	0.0	
1530-1700	0	0	0	0	0	0	-	0	31	31	0.1	
1700-1830	0	0	0	0	0	10	-	0	*	10	0.0	
1830-2000	0	1	0	0	0	0	-	0	*	397	1.4	
2000-2100	0	1	0	8	0	0	26	74	*	109	0.4	
2100-2200	0	1	0	144	2,928	0	2,162	702	318	6,255	22.4	
Totals	508	181	1,350	1,422	15,704	2,122	2,734	2,651	1,284	27,956	100.0	

* Counts Terminated

1/ Figure represents entire catch for period between 2200-0200 hours.

2/ Figure represents entire catch for period between 0330-2000 hours.

LITERATURE CITED

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1970 NAKNEK RIVER SOCKEYE SALMON SMOLT STUDIES

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INTRODUCTION

The Naknek River smolt studies continued in 1970 in the same manner as in previous years (McCurdy, 1969). The project was supervised by the author with assistance from Donald L. Siedelman. The field crew consisted of Robert Manning and Paul Brown.

METHODS AND PROCEDURES

In 1970 the complete sampling scheme began on May 28 and was completed on July 16.

The same methods were used in 1970 as were used in 1968 and 1969 as described in McCurdy (1969).

Age, weight and length samples were taken from each site fished. The scales were read and data compiled by the author.

RESULTS

Mean air and water temperatures for the 1970 season are compiled in Table 1. The largest daily outmigration occurred on June 5 (Table 2) when the mean water temperature was 52° F.

The random schedule was fished from May 29 through July 5. The total catch was 47,277 smolt (Table 2). The percentage catches by site were 1.4, 5.6, 60.5, 20.3, 9.0, and 3.2 for sites one through six respectively (Figure 1).

Table 1. Mean water and air temperatures by day, Naknek River, 1970.

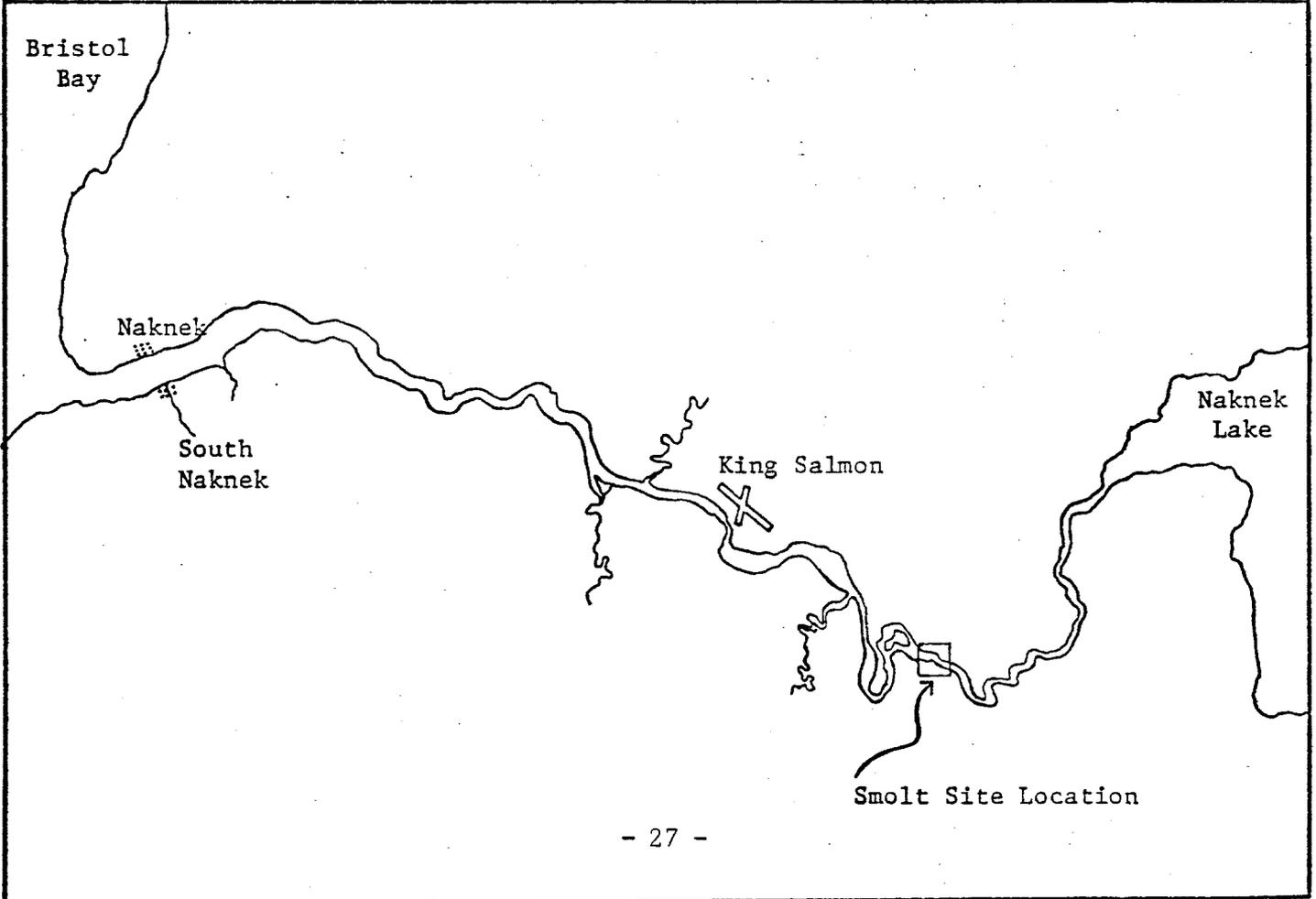
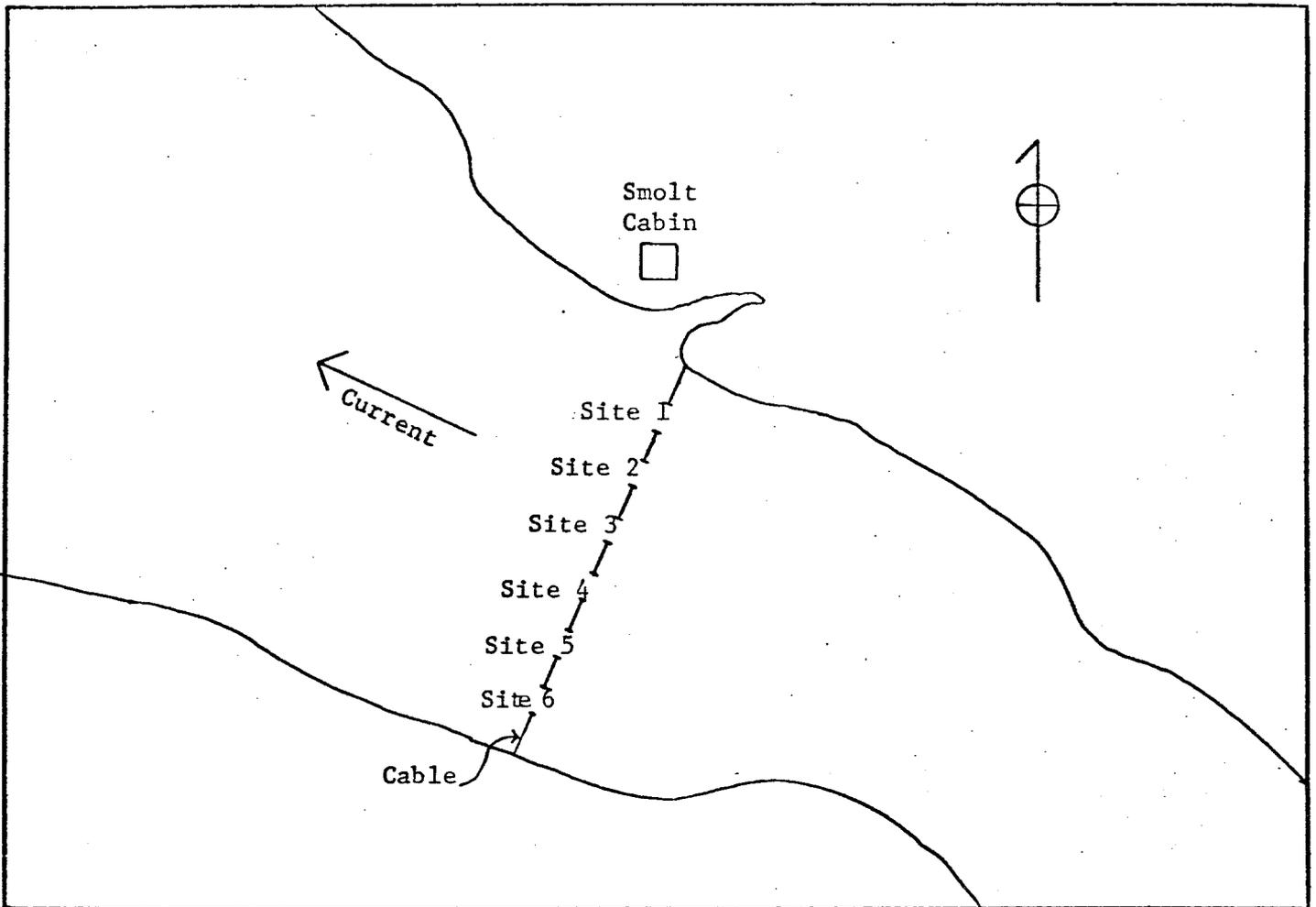
Date	Mean water temperature--°F	Mean air temperature--°F	Date	Mean water temperature--°F	Mean air temperature--°F
May 27	54	<u>1</u> /	June 17	<u>1</u> /	49
28	55	<u>1</u> /	18	<u>1</u> /	50
29	54	<u>1</u> /	19	49	47
30	52	<u>1</u> /	20	49	52
31	52	<u>1</u> /	21	49	52
June 1	55	<u>1</u> /	22	51	60
2	55	51	23	53	57
3	55	47	24	53	59
4	55	48	25	<u>1</u> /	62
5	52	46	26	54	56
6	54	55	27	54	55
7	57	55	28	55	52
8	55	55	29	56	53
9	54	54	30	56	62
10	54	55	July 1	57	61
11	52	48	2	57	59
12	52	47	3	<u>1</u> /	62
13	53	55	4	58	56
14	52	53	5	58	60
15	52	55	6	58	58
16	53	55			

1/ Not recorded

Table 2. Random sampling catches of sockeye salmon smolt by fishing site, Naknek River, 1970.

Date	SITE						Total	Daily %	Accum. %
	1	2	3	4	5	6			
May 29	53	153	28	48	69	24	375	0.79	0.79
30	42	251	40	890	265	25	1,513	3.20	3.99
June 1	0	3	1,157	97	707	261	2,225	4.71	8.70
2	0	0	0	106	0	23	129	0.27	8.97
4	136	0	107	250	0	0	493	1.04	10.01
5	34	1	17,599	1,468	562	93	19,757	41.79	51.80
7	16	10	8	889	50	0	973	2.06	53.86
8	25	39	177	1,470	191	59	1,961	4.15	58.01
10	12	0	1,277	0	3	25	1,317	2.79	60.80
11	36	297	1,435	230	192	96	2,286	4.84	65.64
13	6	383	888	163	0	155	1,595	3.37	69.01
14	9	0	874	1,049	419	0	2,350	4.97	73.98
16	0	13	460	39	3	0	515	1.09	75.07
19	0	0	282	2,252	111	79	2,724	5.76	80.83
20	2	1,032	461	42	285	17	1,839	3.89	84.72
22	47	57	636	1	823	58	1,623	3.43	88.15
23	65	89	0	139	0	122	415	0.88	89.03
25	67	21	0	1	137	4	230	0.49	89.52
26	81	55	2,075	30	63	19	2,323	4.91	94.43
28	14	0	432	20	9	325	800	1.69	96.12
29	10	36	41	1	250	0	338	0.72	96.84
July 1	0	101	260	23	0	0	384	0.81	97.65
2	0	0	175	353	0	59	587	1.24	98.89
4	0	71	0	42	75	55	243	0.51	99.40
5	0	12	213	0	57	0	282	0.60	100.00
Total	655	2,624	28,625	9,603	4,271	1,499	47,277	100.00	
Percent	1.48	5.65	60.54	20.31	9.03	3.17	100.00		

Figure 1. NAKNEK SMOLT SITE



The largest single day's catch (19,757 smolt) was 41.79 percent of the total season's catch. The second largest catch (2,724 smolt) was 5.76 percent of the catch.

Index catches were made from May 30 through July 6. The total index catch during eleven 24-hour periods was 48,237 (Table 3). Peak catches were made between June 5 and June 15. The largest catch, taken on June 5, was 13,633 smolt.

During the random sampling hours, 2100-0600, the index net caught 77.07 percent of the total 24-hour catch.

A total of 932 smolt were sampled for age, weight and length (throughout the season). As in previous years 20 samples were collected before midnight and 20 samples after midnight.

Scale readings determined the age composition to be 55.25 percent Age I smolt and 44.75 Age II smolt (Table 4). No Age III smolt were caught in 1970. The outmigration consisted of an estimated 2,018,207 Age I and 1,634,657 Age II smolt.

Age I smolt averaged 8.98 grams in weight and 99.65 millimeters in length. Age II smolt averaged 12.05 grams and 113.65 millimeters.

Table 3. Naknek River index net catches of sockeye salmon smolt by 90-minute periods, May 30-July 5, 1970

90-minute periods	May 30-31	June 2-3	June 5-6	June 8-9	June 11-12	June 14-15	June 20-21	June 23-24	June 26-27	June 29-30	July 5-6	Total
2101-2230	28	0	1,323	0	1,136	0	50	1	0	111	0	2,649
2231-2400	248	171	675	24	1,198	909	235	268	94	255	189	4,266
0001-0130	571	106	2,151	1,470	654	1,961	859	1,647	551	959	459	11,388
0131-0300	1,610	30	1,436	801	280	216	42	26	375	598	317	5,731
0301-0430	3,730	18	2,681	212	230	281	0	0	30	18	229	7,429
0431-0600	895	22	3,183	28	626	336	116	376	129	1	0	5,712
0601-0730	123	11	1,190	0	416	6	1	38	70	0	0	1,855
0731-0900	35	0	525	0	119	0	0	15	137	0	0	831
0901-1030	28	0	212	0	66	281	0	35	0	0	0	622
1031-1200	0	0	158	4	141	67	0	0	0	0	0	370
1201-1330	0	0	54	17	11	2	0	0	2	0	0	86
1331-1500	0	0	25	118	70	1	0	0	5	0	0	219
1501-1630	0	3	7	206	85	710	0	0	0	0	0	1,011
1631-1800	0	0	2	21	739	1,971	0	0	0	0	0	2,733
1801-1930	2	0	0	224	163	451	0	0	0	0	0	840
1931-2100	0	0	11	347	240	1,897	0	0	0	0	0	2,495
Total	7,270	361	13,633	3,472	6,174	9,089	1,303	2,406	1,393	1,942	1,194	48,237

TABLE 4. Number, percent and apportioned catch by age of sockeye smolt samples, Naknek River, 1970.

Date	Sample No.	No. sampled by period			% sampled by period		Latin Sq. Catch	Apportioned catch	
		Age I	Age II	Total	Age I	Age II		Age I	Age II
5/29	1	4	11	15	26.7	73.3	375	100	275
	30	2	12	16	42.9	57.1	1,513	649	864
6/ 1	3	17	23	40	42.5	57.5	2,225	946	1,279
	2	4	25	40	62.5	37.5	129	81	48
	4	5	18	22	45.0	55.0	493	222	271
	5	6	20	20	50.0	50.0	19,757	9,878	9,879
	7	7	14	26	35.0	65.0	973	341	632
	8	8	12	28	30.0	70.0	1,961	588	1,373
	10	9	20	10	66.7	33.3	1,317	878	439
	11	10	21	19	52.5	47.5	2,286	1,200	1,086
	13	11	16	24	40.0	60.0	1,595	638	957
	14	12	23	17	57.5	42.5	2,350	1,351	999
	16	13	23	17	57.5	42.5	515	296	219
	17	14	--	--	--	--	--	--	--
	19	15	28	12	70.0	30.0	2,724	1,907	817
	20	16	24	16	60.0	40.0	1,839	1,103	736
	22	17	31	9	77.5	22.5	1,623	1,258	365
	23	18	26	14	65.0	35.0	415	270	145
	25	19	36	4	90.0	10.0	230	207	23
	26	20	34	6	85.0	15.0	2,323	1,975	348
	28	21	15	5	75.0	25.0	800	600	200
	29	22	31	9	77.5	22.5	338	262	76
7/ 1	23	34	6	40	85.0	15.0	384	326	58
	2	24	38	2	95.0	5.0	587	558	29
	4	25	36	4	90.0	10.0	243	219	24
	5	26	37	2	94.9	5.1	282	268	14
Total		595	337	932	63.84	36.16	47,277	26,121	21,156
								55.3	44.7

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McCurdy, M. L. (editor) 1969. 1968 Bristol Bay sockeye salmon smolt studies: 1968 Naknek River sockeye salmon smolt studies, Alaska Department of Fish and Game, Informational Leaflet No. 138. 95 pp.

1970 WOOD RIVER SOCKEYE SALMON SMOLT STUDIES

By

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ABSTRACT

The sockeye salmon (Oncorhynchus nerka) smolt sampling program at the outlet of Lake Aleknagik in the Wood River Lakes system coincided with a marking program conducted by the National Marine Fisheries Service.

A single standard winged fyke net was fished between June 6 and June 22 as an index to measure relative abundance of smolt migrating seaward from the system. The net was fished between 2100 and 2300 hours which resulted in a catch of 91,851 smolt composed of 78.8 percent Age I and 21.2 percent Age II smolt.

INTRODUCTION

The Wood River smolt program was initiated in 1951. The purpose was to measure relative abundance of smolt migrating from the Wood River Lakes system. The result was to be an annual index which would be comparable from year to year.

Smolt sampling has coincided with a marking program conducted by the National Marine Fisheries Service since 1967. In 1968 the sampling program was discontinued.

Fishing conducted between June 6 and June 22 was divided into three periods: June 6-10, June 11-15 and June 16-22. The index catch was made by standard winged fyke net fished each night from 2100 to 2300 hours. A large outmigration of smolt was observed before smolting operations began on June 6.

RESULTS

The total index net catch of 91,851 smolt was equivalent to 54.0 index points. The index base is the 1952 catch with an assigned value of 100.00 (Table 1). The 1970 catch was not expanded because the 5-hour index fishing period was not fished as in the past.

Size composition was determined from length measurements of 848 smolt. Nine samples of 100 fish each were taken (Tables 2 and 3). Age determinations were based on the agings of 170 scales (Table 3).

The percentage, mean length and mean weight for each age group were calculated for each period and then for the entire season. The samples for each period were weighted by the period catches they represented to adjust for changes during the season in the magnitude of the catches (Table 3).

Age I smolt comprised 78.8 percent of the total outmigration and averaged 82.7 mm in length and 4.4 grams in weight. Age II smolt comprised 21.2 percent of the run and averaged 92.9 mm in length and 6.6 grams in weight (Table 2).

TABLE 1. Wood River sockeye salmon smolt catch by hour and day, 1970

Date	Index hour catch		Total index catch		Index points ^{1/}	
	2100-2200	2200-2300	Daily	Cumulative	Daily	Cumulative
June 6	361 ^{2/}	1,702 ^{2/}	2,063	2,063	1.21	1.21
7	2,915	14,292	17,207	19,270	10.12	11.33
8	2,527	13,759	16,285	35,556	9.58	20.91
9	1,206	38	1,244	36,800	0.73	21.64
10	2,388	1,997	4,385	41,185	2.58	24.22
11	20	30	50	41,235	0.03	24.25
12	95	1,140	1,235	42,470	0.73	24.98
13	637	2,866	3,503	45,973	2.06	27.04
14	12	4,940	4,952	50,925	2.91	29.95
15	5,227	9,125	14,352	65,277	8.44	38.39
16	4	8	12	65,289	0.01	38.40
17	150	0	150	65,439	0.09	38.49
18	50	0	50	65,489	0.03	38.52
19	55	80	135	65,624	0.08	38.60
20	100	100	200	65,824	0.12	38.72
21	80	2,194	2,274	68,098	1.34	40.06
22	250	23,503	23,753	91,851	13.97	54.03
Totals	16,077	75,774	91,851	91,851	54.02	54.03
Percent	17.50	82.50	100.00	100.00	-	-

^{1/} One index point = 1,700.34 smolt.

^{2/} Percent of total catch for respective hours from June 7-22 applied to daily total of 2,063 to obtain hourly catches.

TABLE 2. Age, weight and length of sockeye salmon smolt by period from the Wood River system, 1970.

Period	Date	Cutoff	Mean length		Mean weight		Percentage of age group	
			I	II	I	II	I	II
1	June 6-10	87.5	81.3	90.9	4.4	6.0	83.0	17.0
2	June 11-15	89.5	82.7	94.0	4.8	6.6	83.8	16.2
3	June 16-23	91.5	84.7	95.1	4.1	7.5	67.6	32.4
Weighted averages			82.7	92.9	4.4	6.6	78.8	21.2

TABLE 3. Wood River sockeye salmon smolt sampling data, 1970.

Period	Date	Smolt catch	Percentage of season's total	No. of 100 fish samples	No. fish measured	No. of scales aged
1	June 6-10	41,185	44.84	4	364	70
2	June 11-15	24,092	26.23	3	302	60
3	June 16-23	26,574	28.93	2	182	40
Totals		91,851	100.00	9	848	170

APPENDIX A

Appendix Table A-1. Weather and stream observations, Kvichak River, May 3 - June 7, 1970^{1/}.

Date	Sky		Wind Dir.-Vel.		Air temp. °F	Water temp. °F		Water gauge ^{3/}	Turbidity 0900
	0900 ^{2/}	2000	0900	2000	Max.-Min.	0900	2000		
5/3	-	-	-	-	-	37	-	-	-
4	2	-	3 NE	-	-	38	-	-	A
5	4	-	15 NE	-	-	37.5	-	-	A
6	4	3	15 NE	8 NE	66-36	37	35	-	A
7	1	3	8 NE	7 SE	72-32	39	37.5	-	A
8	3	2	7 N	6 N	56-30	38	37	-	A
9	1	1	9 NE	1 NE	59-32	39	37	-	A
10	1	1	11 N	5 N	59-30	39	39	-	A
11	1	1	13 NE	14 NE	61-30	39	42	-	A
12	3	3	15 NE	6 NE	62-41	42	40	-	A
13	1	1	19 NE	3 N	66-39	42	43	-	B
14	2	-	6 NE	-	72-	43	-	-	B
15	4	4	4 N	4 NE	53-	41	41	-	A
16	4	3	12 NE	0	56-40	43	44	-	A
17	4	-	17 NE	-	-	44	-	-	B
18	3	-	20 NE	-	-	44	-	-	B
19	2	2	25 NE	20 NE	62-42	45	44	-	A
20	3	2	15 NE	0	64-40	44	43	-	A
21	4	3	9 N	4 E	67-38	42	44	-	A
22	1	3	7 W	0	72-42	46	44	-	A
23	2	-	20 N	-	-	46	-	-	B
24	4	4	7 S	5 S	68-35	44	46	-	A
25	4	1	15 S	0	62-48	45	46	-	A
26	1	1	5 S	10 N	70-32	45	46	-	A
27	2	1	7 NE	13 NE	70-32	46	46	19.1	A
28	2	2	8 N	5 N	70-36	48	47	19.1	A
29	2	1	10 N	0	70-36	49	50	19.1	A
30	2	1	24 N	0	64-40	49	48	19.1	B

(continued)

Appendix Table A-1. Weather and stream observations, Kvichak River, May 3 - June 7, 1970^{1/}(continued).

Date	Sky		Wind Dir.-Vel.		Air temp. °F Max.-Min.	Water temp. °F		Water gauge ^{3/}	Turbidity 0900
	0900 ^{2/}	2000	0900	2000	0900	2000			
5/31	1	4	0	0	78-44	49	48	19.2	A
6/ 1	4	3	4 S	7 N	64-38	48	49	19.2	B
2	3	3	15 NE	0	70-43	48	50	19.2	B
3	3	3	0	10 N	68-44	49	50	19.2	A
4	2	3	14 N	20 N	65-44	50	50	19.3	A
5	3	3	30 E	10 N	68-44	47	50	19.2	C
6	1	1	12 N	0	82-40	48	52	19.2	B
7	1	3	0	25 S	78-42	52	51	19.2	A

^{1/} Data for June 8-15 lost during field operations.

^{2/} All readings from May 3-May 15 taken at 1200 hrs.

^{3/} Data from U.S.G.S., Water Resources Division, data provisional and subject to revision. Bench mark elevation 25.15 ft. G.D., established October 9, 1969.

Depth readings to the nearest one-tenth foot.

Codings:

- 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.

Appendix Table A-2. Kvichak River sockeye salmon smolt expanded twenty-four hour index catch by period, 1970.

Date	Index hours				Index total	0100-1200	Daily total	Accum. total
	1200-2200	2200-2300	2300-2400	0000-0100				
5/2-3	-	0	0	0	0	-	0	0
3-4	-	0	0	0	0	-	0	0
4-5	-	0	0	0	0	-	0	0
5-6	-	0	3	0	3	-	3	3
6-7	-	0	2	0	2	-	2	5
7-8	-	0	1	0	1	-	1	6
8-9	-	0	0	0	0	-	0	6
9-10	-	0	0	0	0	-	0	6
10-11	-	0	1	0	1	-	1	7
11-12	-	5	2	2	9	-	9	16
12-13	-	2	4	6	12	-	12	28
13-14	-	29	8	2	39	-	39	67
14-15	-	0	0	0	0	-	0	67
15-16	-	2	6	4	12	-	12	79
16-17	-	2	35	3	40	-	40	119
17-18	-	14	4	7	25	-	25	144
18-19	-	0	2	4	6	6	12	156
19-20	-	3	2	51	56	1	57	213
20-21	83	8	284	146	438	432	953	1,166
21-22	737	3,705	715	245	4,665	13,721	19,123	20,289
22-23	9,866	8,450	5,384	2,000	15,834	5,619	31,319	51,608
23-24	1,768	1,724	11,603	8,817	22,144	11,182	35,094	86,702
24-25	1,681	273	0	229	502	2,309	4,492	91,194
25-26	246	354	2,174	8,249	10,777	14,780	25,803	116,997
26-27	24,963	31,661	28,149	1,739	61,549	11,066	97,578	214,575
27-28	32,060	12,562	5,862	1,661	20,085	17,332	69,477	284,052
28-29	17,573	6,053	11,684	13,684	31,421	43,391	92,385	376,437
29-30	2,492	1,226	3,097	1,467	5,790	767	9,049	385,486
30-31	1,340	2,175	3,564	3,735	9,474	1,955	12,769	398,255

(continued)

Appendix Table A-2. Kvichak River sockeye salmon smolt expanded twenty-four hour index catch by period, 1970.

Date	Index hours				Index total	0100-1200	Daily total	Accum. total
	1200-2200	2200-2300	2300-2400	0000-0100				
5/31-6/1	350	251	1,927	3,016	5,194	5,614	11,158	409,413
6/1-2	1,094	239	310	8	557	376	2,027	411,440
2-3	288	414	484	1,332	2,230	16,971	19,489	430,929
3-4	897	1,627	2,632	3,407	7,666	2,505	11,068	441,997
4-5	1,024	1,052	1,034	1,070	3,156	52	4,232	446,229
5-6	1,915	8,571	3,220	748	12,539	1,688	16,142	462,371
6-7	236	88	312	248	648	509	1,393	463,764
7-8	463	232	60	1	293	233	989	464,753
8-9	35	0	133	1	134	3,524	3,693	468,446
9-10	1,001	365	194	730	1,289	4,149	6,439	474,885
10-11	642	41	0	0	41	1,087	1,770	476,655
11-12	0	22	67	7	96	47	143	476,798
12-13	2,316	273	192	651	1,116	840	4,272	481,070
13-14	1,347	338	243	159	740	113	2,200	483,270
14-15	1	230	137	0	367	0	368	483,638
Total	104,418	81,991	83,531	53,429	218,951	160,269	483,638	
Percent	21.59	37.45	38.15	24.40	45.27	33.14	100.00	

Appendix Table A-3. Dates and water temperatures at beginning of peak smolt outmigration, Kvichak River, 1955-1970.

Year	Beginning date of peak outmigration	Water temperatures in degrees fahrenheit
1955	June 4	38°
1956	June 1	36°
1957	May 28	42°
1958	May 22	45°
1959	May 26	42°
1960	May 26	41°
1961	May 23	36°
1962	June 1	37°
1963	May 24	36°
1964	June 1	38°
1965	May 24	41°
1966 ^{1/}	-	-
1967	May 26	40°
1968	May 25	40°
1969	May 30	34°
1970	May 26	45°

^{1/} Date of peak outmigration not known.

Appendix Table A-4. Kvichak River 24-hour sockeye salmon smolt catches, average lengths and weights, 1955-1970.

Outmigration	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	22,253	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	2,061,585	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	298,282	62	110 mm	11.0 g	483,638	14.5
Sixteen-year averages	614,039	44	88 mm	5.9 g	1,112,855	56	110 mm	10.9 g	1,726,892	51.8

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 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.

Appendix Table A-5. Kvichak River sockeye salmon smolt photo-counter calibrations, 1970.

Date	Hour	Fishing time	Weight	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily avg. fish/count
5/21-22	2200	18.58	19.4	41	795	106	5.71	42.8	7.50	
	2200	3.10	18.6	36	670	105	33.87	216.1	6.38	
	2200	14.73	17.3	33	571	159	10.79	38.8	3.59	
	2300	15.07	9.3	34	316	107	7.10	21.0	2.95	5.10
5/22-23	2200	4.00	27.6	35	966	200	50.00	241.5	4.83	
	2200	3.57	16.0	49	784	103	28.85	219.6	7.61	
	2200	4.03	16.6	35	581	102	25.31	144.2	5.70	
	2200	10.45	41.4	37	1,532	268	25.64	146.6	5.72	
	2300	2.77	16.0	36	576	115	41.52	207.9	5.01	
	2300	2.85	19.1	40	764	113	39.65	268.1	6.76	
	2300	2.03	12.5	38	475	100	49.26	234.0	4.75	
	2300	16.68	9.4	39	367	121	7.25	22.0	3.03	
	2300	5.68	10.1	39	394	100	17.60	69.4	3.94	
	0000	6.80	7.1	36	256	100	14.70	37.6	2.56	
	0000	9.73	7.6	43	327	100	10.28	33.6	3.27	4.83
5/23-24	2300	8.48	15.4	38	585	101	11.91	69.0	5.79	
	2300	2.97	17.0	39	663	108	36.36	223.2	6.14	
	2300	1.30	13.6	34	462	103	79.23	355.4	4.48	
	2300	2.45	15.5	35	542	103	42.04	221.2	5.26	
	2300	1.12	15.8	38	600	100	89.28	535.7	6.00	
	2300	3.32	17.4	39	679	102	30.72	204.5	6.66	
	0000	1.95	13.6	39	530	102	52.31	271.8	5.20	
	0000	4.45	14.5	39	566	100	22.47	127.2	5.66	
	0000	5.97	9.7	37	359	103	17.25	60.1	3.48	5.41

(continued)

Appendix Table A-5. Kvichak River sockeye salmon smolt photo-counter calibrations, 1970 (continued).

Date	Hour	Fishing time	Weight	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily avg. fish/count
5/25-26	2200	20.83	5.5	37	204	30	1.44	9.8	6.80	
	2300	9.47	18.6	34	632	102	10.77	66.7	6.20	
	2300	14.95	16.5	36	594	100	6.69	39.7	5.94	
	2300	23.85	6.6	35	231	31	1.30	9.7	7.45	
	0100	4.60	17.0	36	612	101	21.96	133.0	6.06	
	0100	5.32	16.3	37	603	106	19.92	113.3	5.69	6.36
5/26-27	2200	3.70	24.6	42	1,033	216	58.38	279.2	4.78	
	2200	4.32	25.2	41	1,033	203	46.99	239.1	5.09	
	2200	0.98	31.6	37	1,169	203	207.14	1,192.8	5.76	
	2200	3.15	27.3	36	983	201	63.81	312.1	4.89	
	2200	1.65	23.7	40	948	200	121.21	574.5	4.74	
	2200	1.70	30.5	44	1,342	200	117.65	789.4	6.71	
	2200	2.22	28.6	44	1,258	210	94.59	566.7	5.99	
	2200	1.15	36.4	42	1,529	206	179.13	1,329.6	7.42	
	2300	2.53	28.1	43	1,208	211	83.40	477.5	5.72	
	2300	0.62	40.0	39	1,560	200	322.58	2,516.1	7.80	
	2300	2.23	28.6	37	1,058	200	89.69	474.4	5.29	
	2300	1.83	29.5	42	1,239	200	109.29	677.0	6.20	
	2300	1.80	32.5	40	1,300	200	111.11	722.2	6.50	
	2300	0.70	29.0	37	1,073	200	285.71	1,532.8	5.36	
	2300	3.68	27.3	42	1,147	220	59.78	311.7	5.21	
	2300	6.82	14.2	39	554	185	27.13	81.2	2.99	
	0000	8.78	-	-	-	34	7	0.80	3.9	4.86

(continued)

Appendix Table A-5. Kvichak River sockeye salmon smolt photo-counter calibrations, 1970 (continued).

Date	Hour	Fishing time	Weight	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily avg. fish/count
5/27-28	1500	10.50	14.6	45	657	102	9.71	62.6	6.44	
	2200	7.57	17.8	46	819	105	13.87	108.2	7.80	
	2200	3.57	16.6	48	797	101	28.29	223.2	7.89	
	2200	3.32	14.7	38	559	100	30.12	168.4	5.59	
	2200	3.25	34.6	38	1,315	211	64.92	404.6	6.23	
	2200	2.90	16.7	44	735	103	35.52	253.4	7.14	
	2200	2.58	14.0	40	560	100	38.76	217.0	5.60	
	2300	2.27	37.9	43	1,630	213	93.83	718.1	7.65	
	2300	0.80	11.0	41	451	100	125.00	563.8	4.51	
	2300	16.30	9.3	43	400	100	6.13	24.5	4.00	
	0000	13.83	8.6	43	370	95	6.87	26.8	3.89	6.07
5/28-29	2200	6.85	15.3	46	704	102	14.89	102.8	6.90	
	2200	7.23	12.7	55	698	102	14.11	96.5	6.84	
	2200	7.05	14.1	51	719	100	14.18	102.0	7.19	
	2200	5.58	15.8	49	774	100	17.92	138.7	7.74	
	2300	5.33	12.1	49	593	110	20.64	111.2	5.39	
	2300	3.22	15.3	49	750	103	31.99	232.9	7.28	
	2300	3.17	12.5	50	625	111	35.02	197.2	5.63	
	2300	3.42	14.9	43	641	100	29.24	187.4	6.41	
	0000	1.93	15.4	39	601	116	60.10	311.4	5.18	
	0000	2.50	25.5	40	1,020	205	82.00	408.0	4.98	
	0000	9.75	12.2	42	512	100	10.26	52.5	5.12	6.24
5/29-30	2200	10.90	4.4	45	198	33	3.03	18.2	6.00	
	2300	6.20	7.6	53	403	50	8.06	65.0	8.06	
	2300	11.97	15.1	52	785	100	8.35	65.6	7.85	7.30
5/30-31	0000	0.72	14.3	46	658	61	84.72	913.9	10.79	
	0000	14.77	15.9	53	843	96	6.50	57.1	8.78	9.78

(continued)

Appendix Table A-5. Kvichak River sockeye salmon smolt photo-counter calibrations, 1970 (continued)

Date	Hour	Fishing time	Weight	Fish per pound	Total fish	Counts	Counts per minute	Fish per minute	Fish per count	Daily avg. fish/count
6/3-4	0000	16.00	7.7	54	416	50	3.12	26.0	8.32	
	0000	8.40	15.6	54	842	100	11.90	100.2	8.42	
	0000	14.83	10.8	41	443	85	5.73	29.9	5.21	7.32
6/4-5	2200	8.08	11.8	47	555	100	12.38	68.7	5.55	
	2300	15.45	10.2	45	459	100	6.47	29.7	4.59	
	2300	8.32	12.7	52	660	104	12.50	79.3	6.35	
	2300	6.67	10.5	46	483	100	14.99	72.4	4.83	
	2300	8.93	8.2	45	369	100	11.20	41.3	3.69	
	0000	18.77	7.4	51	377	81	4.32	20.1	4.65	4.94
Seasonal Average										5.83

Appendix Table A-6. Percent of sockeye salmon smolt outmigration occurring during index hours (2200-0100), Kvichak River, 1955-1970.

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
Averages	1,515,066	53.8 ^{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 53.8% 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-7. Kvichak River 3-hour sockeye salmon smolt catches, 1955-1970, (3-hour index catches).

Year of outmigration	Age I		Age II		Total number	Total 3-hr. index ^{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
Sixteen-year averages	260,289	44	474,868	56	735,156	22.0

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

Appendix Table A-8. Dates of sampling and peak periods of sockeye salmon smolt outmigration, Kvichak River, 1955-1970.

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, 6/10-15	14	97
1970	5/1-6/15	46	5/25-5/29, 6/2-4	8	65
Averages		36		10	86

Appendix Table A-9. Parent escapement and corresponding percent of Age II sockeye salmon smolt produced, 1952-1967.

Year	Escapement	Percent Age II smolt produced ^{1/}
1952	5,970,000	10-15% ^{2/}
1953	321,000	72%
1954	241,000	22%
1955	250,000	75%
1956	9,443,000	46%
1957	2,964,755	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	24,360,000	66%
1966	3,775,184	45%
1967	2,557,440	33%

^{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-10. Parent escapement and corresponding sockeye salmon smolt production, Kvichak River, 1952-1968.

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	365
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	17	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	23,377	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	298,282	892,609	185	93	278
1968	2,557	185,356			72		

APPENDIX B

Appendix Table B-1. Average length and weight of Ugashik River sockeye salmon smolts by freshwater age group, 1958-1970.

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
12 year Total	1,101.4	79.5	1,372.4	148.8
12 year Average	91.8	6.6	114.4	12.4

^{1/} Weighted by index catch

^{2/} Weighted by random catch

Appendix Table B-2. Ugashik River sockeye salmon escapements and smolt production, 1956-1967.

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
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	<u>1</u> / ₁	-	1.0 ^{1/}	-
1964	472,770	<u>1</u> / 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	<u>2</u> / ₁	-	0.6 ^{2/}	8 ^{2/}

^{1/} No outmigration estimate for 1966.

^{2/} The Age II smolt from the 1968 escapement will not leave freshwater until 1971.

Appendix Table B-3. Comparative age, length, index net catches and outmigration estimates of sockeye salmon smolt from the Ugashik River system, 1956-1969.

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

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

^{1/} 1.0 percent Age III in 1960; 0.1 percent Age III in 1963 and 1964.

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

APPENDIX C

Appendix Table C-1. Comparative age, length and index net catches of sockeye salmon smolt from the Wood River system, 1951-1970.

Seaward migration	Age I		Age II		Index points		Two hour index net catch	Two hour index net catch
	Percent	Mean length	Percent	Mean length	Unadjusted	Adjusted		
1951	80.0	91.0	20.0	--	9.9	--	16,809	
1952	99.0	87.0	1.0	--	100.0	--	170,034	
1953	95.3	86.0	4.7	103.0	296.1	--	503,444	
1954	95.8	87.0	4.2	107.0	438.6	--	746,832	
1955	98.0	85.0	2.0	102.0	221.7	--	377,032	777,66
1956	78.4	82.0	21.6	95.0	329.3	326.6	559,932	1,099,78
1957	80.7	77.0	19.3	93.0	144.0	165.5	244,831	541,52
1958	65.0	82.0	35.0	102.0	249.1	230.9	423,580	868,29
1959	93.5	87.9	6.5	105.0	59.1	60.5	100,450	174,64
1960	99.4	88.0	0.6	114.0	223.3	--	379,668	
1961	93.0	81.7	7.0	102.1	518.7	--	881,911	
1962	86.0	80.1	14.0	97.6	177.6	--	301,892	
1963	84.3	82.6	15.7	102.1	88.9	--	151,206	
1964	98.8	83.7	1.2	104.2	568.6	332.2	966,807	1,318,59
1965	92.0	85.5	8.0	106.1	217.7	296.2	370,112	1,171,39
1966	94.3	77.1	5.7	101.2	147.1	133.4	250,049	527,90
1967	60.4	77.7	39.6	89.9	242.8 ^{2/}	--	412,867 ^{2/}	
1969	89.3	87.9	10.7	99.8	54.6	--	92,813	
1970	78.8	82.7	21.2	92.9	54.0	--	91,851	
19 year total	1,662.0	1,591.9	238.0	1,716.9 ^{4/}	4,141.1	1,545.3 ^{5/}	7,041,120	6,479,79
19 year average	87.5	83.8	12.5	101.0 ^{4/}	218.0 ^{3/}	220.8	370,585	925,67

1/ Five hour index net catch obtained from following proportions:

$$\frac{\text{Two-hour index catch in 5-hour sampling}}{\text{Five-hour index catch in 5-hour sampling}} = \frac{\text{Seasonal total 2-hour index catch}}{\text{Seasonal total 5-hour index catch}}$$

2/ Based on average index net catch from June 16 through June 27 for 1951-1966 compared with total season's catch.

3/ Arithmetic mean.

4/ 17-year total and average.

5/ 7-year total and average.

Appendix Table G-2. Average length and weight of Wood River sockeye salmon smolts by freshwater age groups, 1961-1970.^{1/}

Year of seaward migration	Age I		Age II	
	Length	Weight	Length	Weight
1961	81.7	4.3	102.1	7.7
1962	80.1	4.2	97.6	7.9
1963	82.6	5.1	102.1	9.3
1964	83.7	4.8	104.2	8.5
1965	85.5	5.6	106.1	9.9
1966	77.1	4.3	101.2	7.5
1967	77.7	5.5	89.9	6.2
1969	87.9	5.6	99.8	7.5
1970	82.7	4.4	92.9	6.6
9 year total	739.0	43.8	895.9	71.1
9 year average	81.9	4.9	99.5	7.9

^{1/} Weighted by index net catch.

Appendix Table C-3. Wood River sockeye salmon escapement and smolt produced, 1951-1968.

Year	Wood River escapement	Index values of smolts produced		Total	Index units per 1,000 spawners
		Age I	Age II		
1951	458,000	282.2	18.4	300.6	.66
1952	227,000	420.2	4.4	424.6	1.87
1953	516,000	217.3	71.1	288.4	.56
1954	571,000	258.2	27.8	286.0	.50
1955	1,383,000	116.2	87.2	203.4	.15
1956	773,000	161.9	3.8	165.7	.21
1957	289,000	55.3	1.3	56.6	.20
1958	960,000	222.0	36.3	258.3	.27
1959	2,209,000	482.4	24.9	507.3	.23
1960	1,016,000	152.7	13.9	166.6	.16
1961	461,000	74.9	6.8	81.7	.18
1962	874,000	561.8	17.4	579.2	.66
1963	721,000	200.3	8.4	208.7	.29
1964	1,076,000	138.7	96.1	234.8	.22
1965	675,000	146.7	--	146.7	.22
1966	1,209,000		5.9	5.9	.005
1967	516,000	48.7	11.4	60.1	.12
1968	649,000	42.6	<u>1</u>	--	.07
<hr/>					
18 year total	14,583,000	3,582.1 ^{2/}	435.1 ^{3/}	3,969.1 ^{2/}	6.565
18 year average	810,000	210.7 ^{2/}	27.2 ^{3/}	233.5 ^{2/}	0.36

^{1/} The Age II smolts from the 1968 escapement will not leave freshwater until 1971.

^{2/} 17 year total and average.

^{3/} 16 year total and average.

Appendix Table C-4. Percentage of Wood River sockeye salmon smolt parasitized by the cestode, Trisenophorus crassus, 1961-1970

Year	Total number of smolt examined	Number of 1 lb. samples examined	Range of 1 lb. samples size	Percent smolt parasitized all samples	Range between samples in % parasitized
1961	5,467	60	59-129	11.9	0-27.3
1962	4,789	58	47-125	22.8	2.4-46.2
1963	4,091	55	44- 99	26.9	0-61.7
1964	5,984	68	64-118	54.4	29.7-84.1
1965	4,809	60	50-109	29.2	12.8-50.8
1966	5,516	53	54-166	22.5	4.4-57.5
1967	1,743	17	75-127	26.2	13.8-43.6
1970	464	5	63-101	58.0	52.0-70.3

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