

# Informational Leaflet **134**

## 1967 BRISTOL BAY RED SALMON SMOLT STUDIES

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Anchorage, Alaska

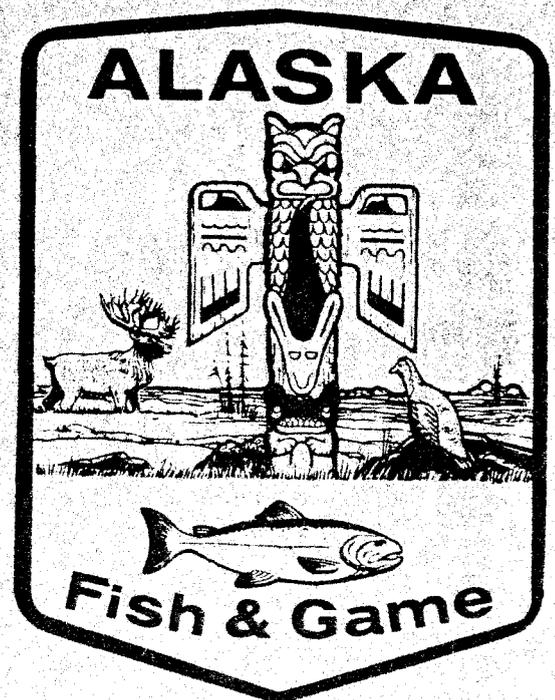
September 30, 1969

STATE OF ALASKA

 - GOVERNOR

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1967 BRISTOL BAY RED SALMON SMOLT STUDIES

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

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September 1969

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1967 KVICHAK RIVER RED SALMON (Oncorhynchus nerka) SMOLT STUDIES<sup>1/</sup>

By

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I. INTRODUCTION

During the past thirteen years, an attempt has been made to obtain an accurate annual index of relative red salmon smolt abundance on the Kvichak River. Ultimate objectives of the project were to: (1) predict adult returns from given smolt emigrations from Lake Iliamna and Lake Clark down the Kvichak River and to the Bering Sea, (2) determine production of smolts from given brood years, and (3) monitor annual age composition and size characteristics of the migrating smolt.

While much of the data collected has added new insight to the life history of Kvichak red salmon stocks, the indices of abundance have not been accurate enough to predict adult returns from abundance of smolts, however, smolt age composition is being used as one factor to forecast adult returns.

In 1965, a project was financed by the Commercial Fisheries Research and Development Act (P.L. 88-309) with the main objective of obtaining an annual total estimate of smolt outmigration. Also, the index project was to be continued during the early years of this project for comparison with past data and the new method being employed.

The objective of this report is to discuss in detail, methods, procedures, and results of the 1967 field season with a discussion of comparative data.

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<sup>1/</sup> This investigation was financed by the Commercial Fisheries Research and Development Act (P.L. 88-309) for the period commencing July 1, 1966, under sub-project 5-5-R-1, Contract No. 14-17-0007-374.

Personnel of the Alaska Department of Fish and Game's Commercial Fisheries Division collected and compiled the majority of the data. Mr. Orra E. Kerns, Jr., Fisheries Research Institute, contributed red salmon fry and fingerling data. Mr. Donald M. Stewart served as editor and assembled this material in its present form.

## II. CONTINUATION OF INDEX PROJECT

### A. Methods and Procedures

From May 17 to June 17, the standard index fyke net was fished in the same manner and location as it has been since 1955 (Figure 1). Twenty-four hour fishing was conducted from May 17 to June 14. Fishing was conducted on a sampling basis from June 14-17 due to small number of smolts. Any fishing time lost during this period is attributed to occasional ice floes and clogging of the net with algae which in both cases prompted pulling of the net.

### B. Results and Discussion

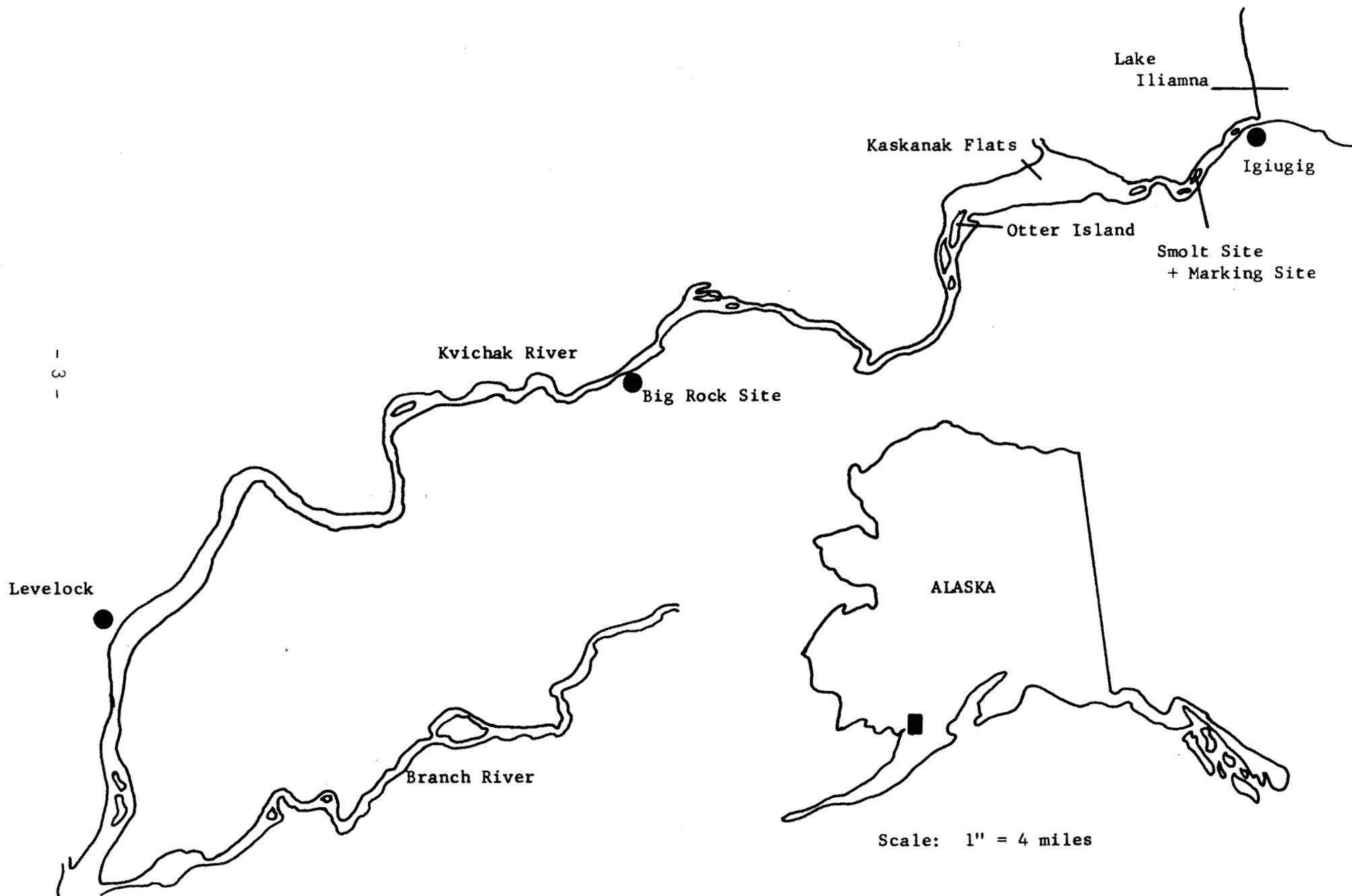
#### 1. Ice Interference, Climatological and Hydrological Data

Ice interference from Lake Iliamna break-up was minimal in 1967. In all, only 14 hours of fishing time were missed as compared to 187 hours in 1966.

Weather observations were recorded twice daily, as in the past, at a site located one mile below the outlet of Lake Iliamna (Figure 1). Water temperatures for the season ranged from a low of 34° F. to a high of 49° F., with a mean seasonal temperature of 44° F. Past data has shown that substantial outmigration of smolt does not commence unless water temperatures are above 36° F., however, water temperature does not appear to be sufficient to precipitate outmigration. This was the condition exhibited in 1967, as substantial outmigration didn't occur until May 25, when the water temperatures averaged 38° F. Possibly of even greater importance in precipitating outmigration, the largest seasonal outflow of ice occurred on the afternoon of May 25, further substantiating the relationship between ice outflow and the start of smolt migration indicated in the 1966 report (Pennoyer, 1967).

Table 1, Appendix A, shows yearly comparative data since 1955 of water temperatures at the beginning of peak smolt outmigrations. This year the water temperature was 40° F. at the start of the peak of outmigration, slightly higher than the 36° F. thirteen year average.

FIGURE 1. Kvichak River red salmon smolt study area, 1967.



Daily water temperatures, on the average, were higher in 1967 than in 1966. This characteristic is probably responsible for the heavy concentrations of algae in the Kvichak River this year, leading to frequent pulling of the fyke net for cleaning.

A depth stake was placed in the river at Igiugig on May 16. The gauge was set at 0.40 feet at 0900 hours with the water level 7 feet below the fixed bench mark. The seasonal range of river depth was 0.40 to 1.75 feet with a total seasonal increase of water depth of 1.35 feet. For annual comparative purposes, an attempt is made to fish the fyke net in 3.8 feet of water; since the fishing site is located on a sloping gravel bar, it was necessary to relocate the fyke net many times during the season due to rising water levels.

It is possible that future climatological and hydrological data, collected during a year's time, will be conducted by personnel of the Water Resources Division, U.S. Geological Survey (U.S.G.S.), Anchorage, Alaska. The Kvichak smolt project was visited in late June by Mr. Harry Hulsing and staff of U.S.G.S. to survey and evaluate the merits of installing a permanent gauging station at Igiugig. Such a station, with records made available to the Alaska Department of Fish and Game and other agencies connected with the research and management of the Bristol Bay red salmon fishery, would be a valuable asset.

General climatological and hydrological data collected during the 1967 season is given in Table 1.

## 2. Index Net Catch and Photocounter Calibration

### a. Index Catch

The expanded 24-hour index net catch for 1967 was the third largest on record (3,088,742) since 1955, (Table 2, Appendix A). Fishing on a sampling basis started May 17 going to 24-hour fishing with the aide of photo-electric equipment from May 18 until June 17. Substantial numbers of smolts did not start migrating until 2200 hours, May 26, as can be seen in Table 2 showing index catches by period. The duration of the peak periods of smolt outmigration were from May 26 to June 6; or 12 days with 80 percent of the index catch occurring during this time. Figure 2 shows four days of heavy outmigration. The largest index catch for a 24-hour period occurred on June 6, with 596,428 smolts passing through the fyke net. May 26 had the period of highest passage rate of smolts through the fyke net; i.e., 391,296 in 2 hours (2200-2400). Yearly comparative data since 1955 can be found in Table 3, Appendix A.

TABLE 1. Climatological and stream observations.

Station: Igiugig			Month: May & June						Year: 1967			
Date	Sky		Precip-24 Hr.			Wind Dir. - Vel.		Water Temp. °F.		Water Gauge 2000	0900 Turbidity	Remarks
	0900	2000	0900	2000	Amt.	0900	2000	0900	2000			
5/16										.40		
5/17	1	2	0.00	0.00	0.00	NE8	NE2	39°	39°	.42	A	Light Ice-A.M.
5/18	3	2	0.00	0.00	0.00	NE7	NE5	40°	39°	.48	A	
5/19	1	1	0.00	0.00	0.00	E11	E4	40°	41°	.46	A	
5/20	1	2	0.00	0.00	0.00	E7	N7	41°	40°	.48	A	Light Ice-A.M.
5/21	1	1	0.00	0.00	0.00	E5	W12	41°	42°	.62	A	Light Ice-A.M.
5/22	3	1	0.00	0.00	0.00	W17	W6	41°	43°	.56	A	
5/23	1	2	0.00	0.00	0.00	N5	W7	41°	-	.62	A	
5/24	1	3	0.00	0.00	0.00	E11	NE8	43°	42°	.76	A	
5/25	1	3	0.00	0.00	0.00	E15	NE15	42°	34°	1.00	A	Heavy Ice-P.M.
5/26	-	1	-	0.00	0.00	0	0	-	40°	.68	-	Moderate Ice
5/27	2	2	0.00	0.00	0.00	0	W8	42°	43°	.70	A	Light Ice-A.M.
5/28	1		0.00			W11	0	42°			A	
5/29	1	2	0.00	0.00	0.00	E8	N5	-	42°	.90	A	
5/30	4	3	0.00	0.09	0.09	E6	NE10	43°	43°	.90	B	Algae in water
5/31	4		0.01	-	0.01	NE12	0	44°			B	Algae in water
6/ 1	3	1	0.00	0.00	0.00	SW30	W4	45°	44°	.90	B	
6/ 2	3	3	0.00	0.00	0.00	W13	N5	45°	46°	1.00	A	
6/ 3	4		0.14	-	0.14	E15	0	46°			B	
6/ 4		4		0.85	0.85	0	W20		44°	1.10	B	
6/ 5	4	3	0.15	0.00	0.15	W25	W15	43°	44°	1.08	A	
6/ 6	4	4	0.00	0.01	0.01	N10	E7	44°	45°	1.10	B	
6/ 7	4	4	0.14	0.02	0.16	E8	E10	44°	45°	1.31	A	
6/ 8	4	4	0.35	0.03	0.38	N7	E8	45°	45°	1.38	B	
6/ 9	4	4	0.01	0.02	0.03	E17	0	46°	46°	1.31	B	
6/10	4	4	0.09	0.15	0.24	NNE3	W7	46°	46°	1.37	B	Light rain
6/11	2	3	0.00	0.00	0.00	NE7	E6	47°	48°	1.44	A	
6/12	3	4	0.00	0.25	0.25	ESE20	E6	48°	48°	1.50	B	
6/13	4	4	0.18	0.20	0.38	SW2	0	47°	46°	1.49	A	
6/14	3	4	0.00	0.00	0.00	0	S4	47°	47°	1.52	A	
6/15	1	3	0.00	0.00	0.00	0	SW9	47°	48°	1.59	A	
6/16	3	4	0.00	0.00	0.00	E15	E7	48°	49°	1.75	A	
6/17	4	4	1.30	1.40	2.70	E11	E15	49°	48°	1.75	B	
6/18	4	4	3.50	0.00	3.50	0	0	48°	47°	1.75	A	
6/19	4	2	0.00	0.00	0.00	E6	NE5	48°	47°	1.70	A	
6/20	1	2	0.00	0.00	0.00	0	E7	49°	48°	1.75	A	

(Continued)

TABLE 1 - (Con't). Climatological and stream observations.

Codings: Sky

0. No observations made
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

Secchi dist. reading in inches or:

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

TABLE 2. Kvichak River red salmon smolt expanded twenty-four hour index catch by period, 1967.

DATE	1200-2200	2200-2300	2300-2400	0000-0100	Index Hour Total	0100-1200	Daily Total	Accumulative Total
5/17-18	100	0	0	0	0	-	100	100
18-19	0	0	183	21	204	234	438	538
19-20	0	0	2	5	7	55	62	600
20-21	1	0	6	6	6	12	19	619
21-22	29	1	2	0	3	5	37	656
22-23	58	0	0	12	12	26	96	752
23-24	6	1	1	18	20	34	60	812
24-25	12	0	1	32	33	397	442	1,254
25-26	14,130	1,513	2,214	2,214	5,941	4,059	24,130	25,384
26-27	45,937	195,648	195,648	823	392,119	6,752	444,808	470,192
27-28	1,072	33,094	33,094	33,094	99,282	364,026	464,381	934,573
28-29	3,373	21,491	17,841	1,438	40,770	4,777	48,920	983,493
29-30	41,704	9,374	17,131	3,484	29,989	28,272	99,965	1,083,458
30-31	75,098	7,988	30,891	309	39,188	119	114,405	1,197,863
31-6/1	7,885	7,114	7,114	7,114	21,342	6,322	35,549	1,233,412
1- 2	77,395	35,994	35,994	4,747	76,735	340,823	494,953	1,728,365
2- 3	39,598	8,476	4,032	12,920	25,428	33,330	98,356	1,826,721
3- 4	1,800	0	0	0	0	0	1,800	1,828,521
4- 5	78	168	10	10	188	94	360	1,828,881
5- 6	2,413	1,084	1,084	1,084	3,252	61,601	67,265	1,896,146
6- 7	196,370	24,413	65,459	16,157	106,029	294,029	596,428	2,492,574
7- 8	9,761	5,045	5,045	2,686	12,776	56,500	79,037	2,571,611
8- 9	184,517	4,939	1,451	1,451	7,841	5,988	198,346	2,769,957
9-10	5,786	155	143	48	346	6,957	13,089	2,783,046
10-11	49,371	6,515	6,515	6,515	19,545	131,889	200,805	2,983,851
11-12	6,413	15,986	8,906	8,906	33,798	27,821	68,032	3,051,883
12-13	8,780	783	1,309	700	2,792	11,516	23,088	3,074,971
13-14	33	1,994	1,693	1,211	4,898	-	4,931	3,079,902
14-15	-	677	1,377	2,280	4,334	-	4,334	3,084,236
15-16	1,557	16	0	55	71	-	1,628	3,085,864
16-17	96	1,201	876	705	2,782	-	2,878	3,088,742
TOTAL	773,373	383,670	438,016	108,045	929,731	1,385,639	3,088,742	

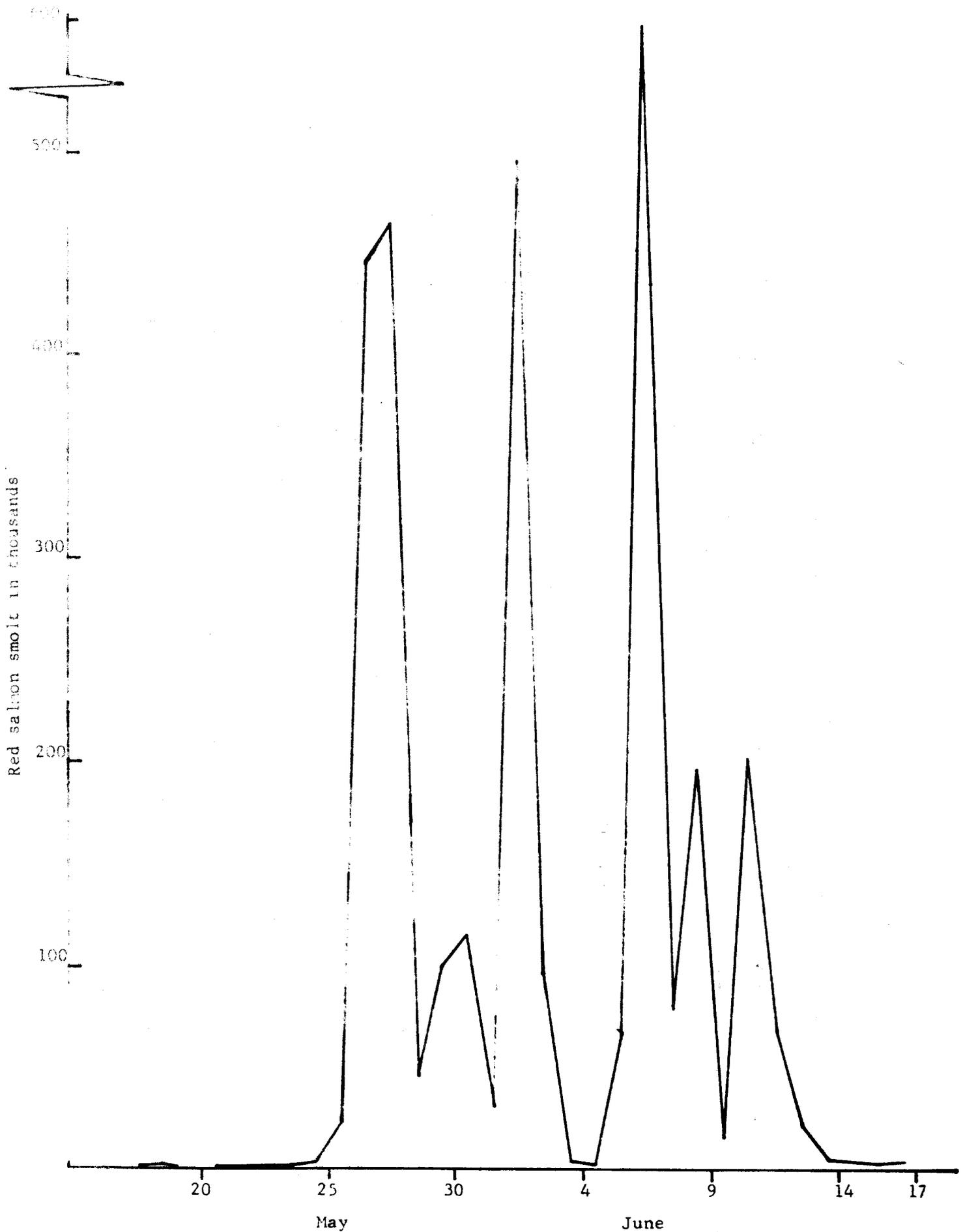


FIGURE 2 Daily fyke net catches of red salmon smolt, Kvichak River, 1967.

The total 3-hour index catch for 1967 amounted to 929,731 smolt or an index value of 27.9 (one index point being equal to 33,340 smolt). Total 3-hour index values for the years 1955 to present are presented in Table 4, Appendix A.

The 24-hour index catches from May 28 through June 11 were derived entirely by taking Veeder Root Counter tallies and using the daily average conversion of fish per count to arrive at the expanded index net catches.

A complete description of photo-electric equipment and its operation can be found in Alaska Department of Fish and Game Informational Leaflet No. 58.

#### b. Photo-Electric Counter Calibrations

Daily average conversion ratios ranged from 8.15 to 19.14 fish per count for the 1967 season, with a seasonal average of 13.10 (Table 3). This seasonal average (13.10) is the highest since 1963 (7.21 smolt/count) almost twice as large. In addition, it is the largest seasonal ratio recorded since 1962.

Kerns and Marriott (1963) point out that from examination of simultaneous counter tallies and catches during the 1962 season, it was apparent that counter efficiency changed during this time. He further points out that different average ratios from three general strata occurred. Causes for the first two strata are not known, however, the altered ratio in the last strata was associated with defective rheostats which prevented proper adjustment of light source, hence one factor for the variance in smolt per count ratios.

Calibration data from previous years has indicated that water turbidity, light intensity, battery charge and smolt passage rate all may affect the efficiency of the photo-electric counters. In addition, when passage rates are high sampling errors may be increased. An example of the latter occurrences would be smolt "spill over" from the tunnel into the cod end after counters have been stopped and counts recorded. This occasionally happens when pulling the tunnel from the water to empty heavy cod end catches. Of the factors listed above as possibly affecting counter efficiency, extensive quantitative data is available for only smolt passage rate. Thus, one is confronted with the problem of determining conversion (photo-electric counts to smolts) factors to convert index net photo-electric counts to numbers of smolts.

Realizing that factors, such as water turbidity, could affect counter efficiency and that such factors would generally be less variable during a single day than during the entire season, calibrations were made daily (with

TABLE 3. Kvichak River smolt photo-counter calibration data, 1967.

Date	Hour	Fishing Time	Weight	Fish Per Pound	Total Fish	Counts	Counts Per Minute	Fish Per Minute	Fish Per Count	Daily Totals Fish/Count
5/28-29	2200	34.75	81.6	76	6,202	562	16.17	383.5	11.04	11.24
	2200	2.92	31.6	67	2,117	190	65.07	725.0	11.14	
	2200	2.37	32.0	70	2,240	200	84.39	945.1	11.20	
	0000	30.42	6.6	79	521	45	1.48	17.1	11.58	
5/29	2200	4.58	21.6	78	1,685	210	45.85	367.9	8.02	8.15
	2200	1.25	28.2	43	1,354	200	160.00	1,083.2	6.77	
	2200	1.58	27.0	62	1,674	200	126.58	1,059.5	8.37	
	2200	2.25	28.4	72	2,045	200	88.89	908.9	10.23	
	2200	1.72	26.2	56	1,465	200	116.28	852.9	7.34	
5/30	2200	12.73	19.2	78	1,498	100	78.55	117.7	14.98	14.71
	2200	7.08	15.2	85	1,292	100	14.12	182.5	12.92	
	2200	4.75	23.4	77	1,802	111	23.36	379.4	16.23	
5/31	2200	6.08	19.6	72	1,411	100	16.45	232.1	14.11	14.27
	2300	2.50	17.2	76	1,307	100	40.00	522.8	13.07	
	2300	6.40	21.4	73	1,562	100	15.63	244.1	15.62	
6/1-2	2200	1.73	55.0	70	3,850	221	127.75	2,225.4	17.42	18.44
	2200	2.42	52.0	80	4,160	214	88.43	1,719.0	19.44	
	2200	1.87	51.2	78	3,994	200	106.95	2,135.8	19.97	
	2200	2.17	53.2	86	4,575	205	94.47	2,108.3	22.31	
	2200	3.48	48.4	86	4,162	210	60.34	1,196.0	19.82	
	2200	3.50	19.2	75	1,440	100	28.57	411.4	14.40	
	2200	2.83	26.2	72	1,886	102	36.04	666.4	18.49	
	2200	3.38	22.8	95	2,166	106	31.36	640.8	20.43	
	0000	24.00	47.2	62	2,926	214	8.97	121.9	13.67	

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TABLE 3 - (Con't). Kvichak River smolt photo-counter calibration data, 1967.

Date	Hour	Fishing Time	Weight	Fish Per Pound	Total Fish	Counts	Counts Per Minute	Fish Per Minute	Fish Per Count	Daily Totals Fish/Count
6/6-7	2200	4.80	57.2	89	5,091	205	42.71	1,060.6	24.83	
	2200	4.80	52.0	90	4,680	204	42.50	957.0	22.94	
	2200	3.25	21.4	82	1,755	105	32.31	540.0	16.71	
	2200	2.58	26.0	85	2,210	103	39.92	856.6	21.46	
	2200	1.25	52.8	70	3,696	200	160.00	2,956.8	18.48	
	0000	3.28	25.0	42	1,050	101	30.79	320.1	10.39	19.14
6/7-8	2200	18.08	19.0	81	1,539	104	5.75	85.1	14.80	
	2200	13.75	19.4	73	1,416	109	7.93	103.0	12.99	
	2300	14.43	19.4	75	1,455	104	7.21	100.8	13.99	
	2300	23.31	19.4	87	1,688	199	8.54	72.4	8.48	
	0000	34.33	17.4	86	1,496	114	3.32	43.6	13.12	
	0000	23.67	12.8	90	1,152	97	4.10	48.7	11.88	12.54
6/9	2200	6.17	21.4	97	2,076	240	38.90	336.5	8.65	
	2200	8.42	8.8	93	818	101	11.99	97.2	8.10	
	2200	23.00	20.0	88	1,760	201	8.74	76.5	8.76	8.50
6/10	2300	10.62	13.8	87	1,201	103	9.70	113.1	11.66	
	0000	25.75	11.8	93	1,097	103	4.00	42.6	10.65	
	0000	26.28	8.6	94	808	60	2.28	30.8	13.47	11.93
6/11	0000	53.00	65.6	86	5,642	467	8.81	106.4	12.08	12.08
Seasonal Avg.										13.10

the exception of June 3-5 when smolt migration was light) during the period when approximately eighty percent of the outmigration occurred. The objective was to obtain daily conversion factors which, if necessary, could be used to convert the corresponding daily photo-electric counts to numbers of smolts. The calibration data is presented in Table 3. Daily calibrations were generally completed during a two-hour period; "daily" calibrations then, in fact, refer to calibrations conducted during approximately a two-hour period in a given day.

The data in Table 3 indicates that within calibration period variation was small relative to between period variation although some of the calibration periods experienced relatively large fluctuations in smolt passage rate (e.g. as on June 1-2). Chi-square tests on counter efficiency observations within a single calibration period indicated no extreme within period variations. However, when the calibration data is grouped as shown in Figure 3 a significant (although weak) linear trend is indicated ( $r = 0.49$ , d.f. = 41) between counter efficiency and passage rate. (Theoretical considerations and field data -- in particular the 1964 field data when passage rates were observed in the range of 2,000 to 6,000 fish per minute-- indicate that counter efficiency is a non-linear function of passage rate. However, for the lower levels of passage rate a linear relationship serves as a good approximation.) It appears that combined factors, other than smolt passage rate, contributed very significantly toward determining counter efficiency. Furthermore, the factors, excluding passage rate, were relatively constant within calibration periods but fluctuated significantly between calibration periods.

The extreme scatter of points about the fitted regression line in Figure 3 and the relatively small variations in counter efficiency estimates within calibration periods would seem to preclude the exclusive use of passage rate for estimating counter efficiency and would suggest the use of daily average conversion factors.

Intuitively the authors feel that the photo-electric counts should be expanded on the basis of passage rate. As the passage rate increases, multiple fish may break the light beam simultaneously, resulting in higher fish per count ratios. Furthermore, as larger schools of fish approach the counter the probability of a single fish in the school breaking the light beam must be reduced, thus reducing the counter efficiency. However, until all various affecting counter efficiency are defined and measured, estimation of counter efficiency solely on the basis of passage rate would not seem advisable.

Therefore, since the within calibration period estimates of counter efficiency are more consistent than all estimates adjusted for passage rate and until further analysis of counter efficiency can be conducted, the daily average fish per count ratios will be used to expand the daily counts as has been done in the past.

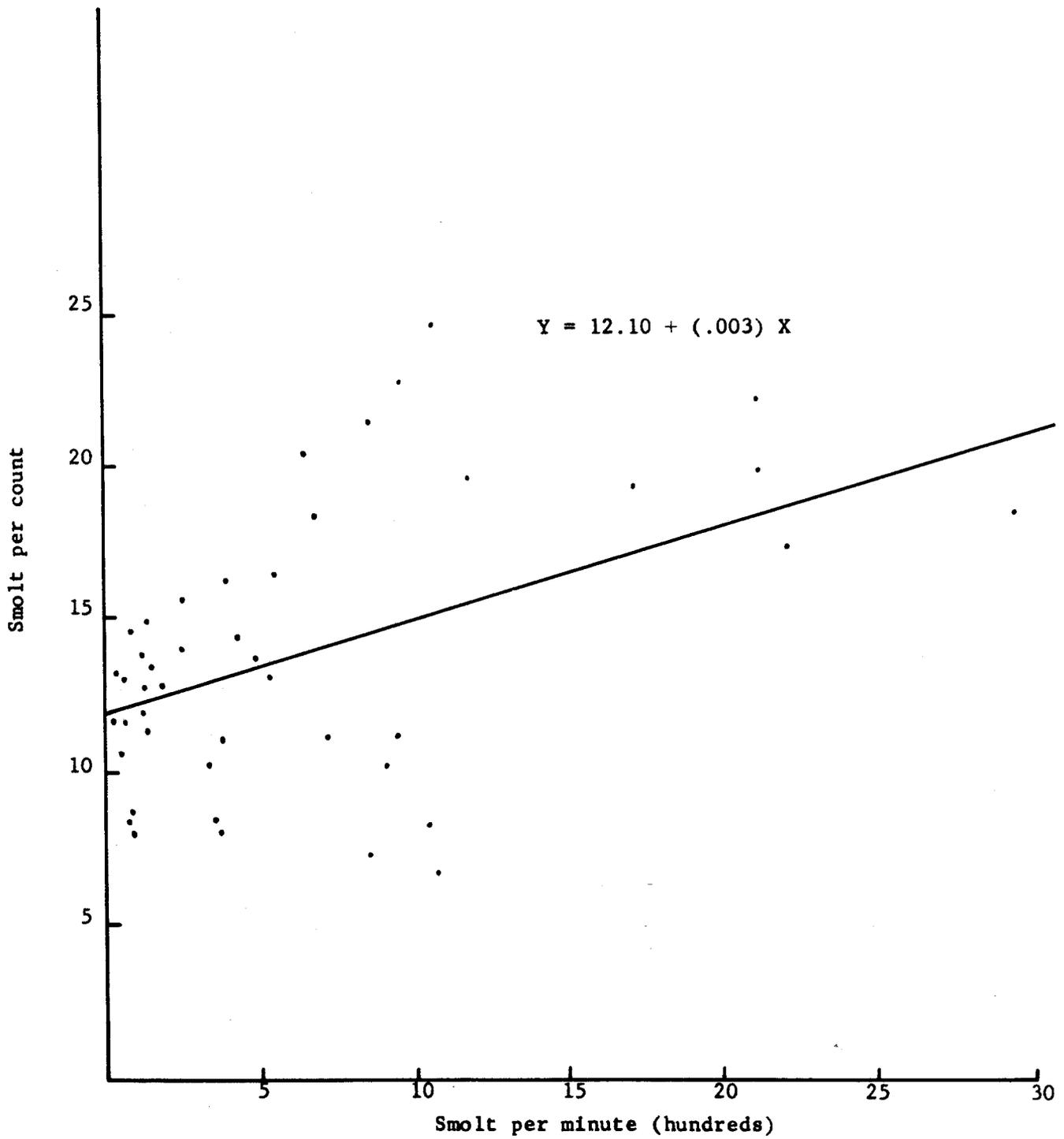


FIGURE 3. Relation between red salmon smolt per minute and red salmon smolt per photo-electric count, Kvichak River, 1967.

To investigate the high smolt per count ratios observed in 1967, several approaches were taken. First the photo-electric system was tested in the field by hooking up the system and placing the photo-tunnel in the water. The objective was to determine how long a battery with a known rating (Hydrometer reading) at the beginning of the test would last, i.e., at what rating and time interval would the count paks fail to register counts when the light beam in the counting aperture was interrupted?

The test started at 1030 hours August 29 and lasted until 2300 hours, or 13-1/2 hours. The average hydrometer reading of the six cells in the twelve volt battery at the start of the experiment was 1185. The test was repeated five times during the 13-1/2 hour interval with decreasing battery rating as indicated by successive hydrometer readings. On the fourth test hydrometer readings were 0,0,1100,1110, and 1110 for the six cells respectively. Also, the fourth test showed the counters to be registering counts with every interruption of the light beam. The fifth test had all cells reading zero. Therefore, sometime between the fourth test (2100 hours) the counters ceased to function.

In essence there was a period of 10-1/2 hours that the counters did register counts on both count paks with an average of 32 interruptions for four tests or an average total of 128 interruptions.

Considering that the above test was not repeated, that high passage rates such as experienced in the past with smolt migration (7,000 + per minute) could not be simulated and also that batteries at some plateau of rating become less efficient in power output, the above test might or might not be indicative of counter performance under field conditions.

With these factors in mind information was compiled from daily fishing logs and the following information was noted concerning batteries and changes of batteries made during the 1967 field season. First of all it was noted that batteries were not always checked with the hydrometer after periods of charging, therefore, ratings cannot be assessed at all times for batteries in service. However, for the most part batteries were checked after each charging and averaged ratings of 1185. Second, for all but two days, frequency of battery changes occurred every eight hours, and more commonly every four hours, in almost every instance a newly charged battery was put on the photo-electric system before the index hours and periods of calibration. On the two days the above did not occur, the batteries were changed every twelve hours.

It appears, therefore, that the condition of the batteries during the smolting season was similar to the condition during the testing period in August.

Considering all of the above and knowing in addition that batteries did

not take a charge as they should at the end of the season, we can only surmise that the reason for the high smolt per count ratios in 1967 could have been the use of weak batteries, i.e., batteries with ratings of 1185 do not produce the power that one at 1250 would, thus the occurrence of higher smolt per count ratios.

It has been stated in the past that to assure peak counter efficiency the counters should be tested periodically with a rod breaking the light beam such as was done in the August experiment. However, after reviewing the August test and reflecting on such things as drop in efficiency of battery output, it is our belief that the above test tells only when the counters are functioning or when the battery is completely dead.

After analysis of the above data, we have concluded that the count paks in use must be rated as to the minimum amount of power needed to operate efficiently and that once this level is known that a meter be incorporated into the photo-counter system that will indicate to personnel precisely when the battery rating has dropped to a point where peak efficiency cannot be expected from the counters.

### 3. Length and Weight of Smolts by Age Group

Table 4 and Figure 4 show the weighted length frequencies of smolts assigned to the index net catch by age class. Length frequencies were taken from 26 one-pound random samples during the index hours throughout the season. Age class composition was determined by relating 405 individual smolt scales to lengths to arrive at the dividing point between the two age classes. Age I smolts (fish having spent one winter in freshwater) comprised 92.8 percent of the index catch and averaged 86.4 mm in length. Age II smolts (fish having spent two winters in freshwater) comprised 7.2 percent and averaged 118.3 mm in length.

To arrive at average weights for the two age classes smolt were randomly sampled during the peak period of the migration and linear analysis applied. Age I smolts averaged 5.9 grams and Age II averaged 14.2 grams (Table 4).

## III. DISCUSSION AND COMPARISON WITH PAST DATA

The discussion and comparisons with past data in this section are based on 24-hour indices and should not be related or compared to 3-hour index data (Pennoyer, 1965).

TABLE 4. Weighted length frequencies of red salmon smolt, Kvichak River, index site, 1967.

Length (MM)	Frequency	Length (MM)	Frequency
66	29	105	14,156
69	11	107	4,655
71	29	108	17,439
72	7,721	109	16,544
73	11,958	110	2,111
74	22,937	111	10,484
75	17,264	112	11,401
76	21,691	113	25,441
77	50,570	114	6,422
78	85,597	115	30,227
79	149,658	116	9,576
80	213,542	117	29,116
81	236,706	118	5,049
82	239,069	119	10,094
83	231,787	120	520
84	267,419	121	7,672
85	230,701	122	689
86	213,107	123	1,041
87	147,394	124	7,041
88	104,408	126	1,070
89	166,186	127	5,135
90	93,160	128	480
91	74,926	129	480
92	45,761	131	1,041
93	40,852	132	4,644
94	56,939		
95	49,397		
96	16,247		
97	10,957		
98	15,997		
99	10,356		
100	17,908		
101	6,631		
102	4,644		
103	4,644		
104	11		

Age I - 2,866,214

Age II - 22,528

Percent - 92.8

Percent - 7.2

Average Length - 86.4

Average Length - 118.3

Average Weight - 5.9

Average Weight - 14.2

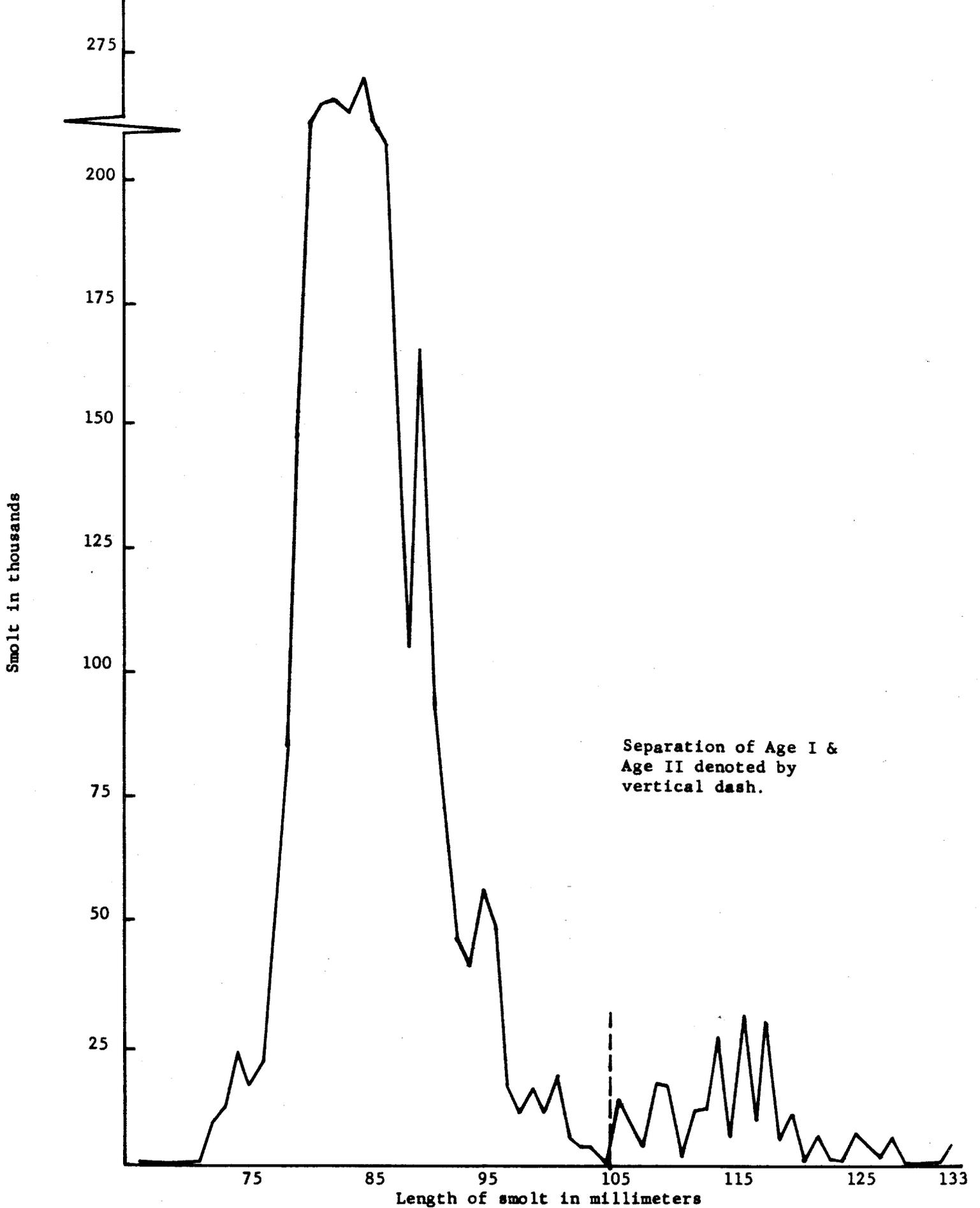


FIGURE 4. Length frequencies of smolt in mm, Kvichak River, 1967.

The 1967 smolt outmigration was the progeny of the 1964 escapement (957,000) and the 1965 escapement (24,326,000), the latter being the largest on record for the Kvichak River system. Numbers of Age I smolts were much higher than the 13 year average. This year's age group represents the second largest Age I index catch on record (2,866,214) (Table 2, Appendix A).

Considering the past production of Kvichak smolts from known brood years we find the 13 year average to be 47 and 53 percent for Age I and Age II groups, respectively. However, Pennoyer and Seibel (1965) states that "although no apparent relationship exists between the parent escapement sizes and the percent of Age II smolts produced when all of the past data is considered, the peak years, viz., 1952, 1956 and 1960, reflect a definite increase in percent of Age II smolts produced with increases in escapement size".

Assuming that with increased escapement size we do realize higher percentages of Age II smolts we would expect at least as high a proportion of Age II smolts from the 1965 brood year as the one experienced from the 1960 brood year (78 percent) (Table 4, Appendix A). On this basis the index catch in 1968 should be in the vicinity of 10,000,000 Age II smolts. This would constitute a total index catch, (Age I and Age II) from the 1965 brood year, more than two times the magnitude of any catch from any other brood year.

With this discussion of what might occur in 1968, it is worth our time to examine the Fisheries Research Institute's red salmon fry and fingerling data collected in Lake Iliamna since 1962 (Table 5). The table shows that the fingerling index of abundance in 1967 was the second largest index since 1962 (80.9). Indices are based on average catches of fry and fingerling in a predetermined number of tows each year. The 1967 fingerling also exhibit weighted mean lengths and weights well below the six-year averages of 98.4 mm and 9.4 gr., respectively. This phenomena of intra specific competition in the nursery area is expected as related to progeny of the 1956-60 peak year escapements. Further, the lower weighted mean lengths and weights of the 1967 fingerling might suggest that these fish are more vulnerable to high mortality during the winter months as opposed to more robust fingerlings. Looking at the highest abundance of fingerlings per standard tow during this six year period we find that 1962, with an index of 93.3 produced an Age II smolt outmigration of 4,229,431 and these fingerling were more robust than the 1967 fingerlings. This particular migration is the largest on record for the Kvichak River, however, it is still less than half of the expected Age II outmigration for 1968, if our assumptions are correct. At any rate, after examination of past data, we feel that the 1968 Age II index catch will be the largest migration thus far. Appendix A contains annual comparative data of Kvichak smolt <sup>1/</sup>

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<sup>1/</sup> Ed. Note: The 1968 Age II index catch was 5,475,000 smolt. This was a considerably lower number than anticipated although the combined Age I and Age II index catch from the 1965 brood year is still the largest on record.

TABLE 5.<sup>1/</sup> Mean weighted catches, lengths and weights of sockeye fry, fingerling and threespine stickleback, Iliamna Lake, Alaska, 1962-1967.

Year	Iliamna Lake			Threespine Stickleback
	Fry	Sockeye Fingerling		
Mean weighted catches of sockeye fry and fingerling and threespine stickleback per standard tow, 1962-1967				
1962	21.8	93.3		141.3
1963	27.8	12.0		24.3
1964	0.9	20.6		96.3
1965	4.4	3.6		86.7
1966	151.7	0.9		40.4
1967	67.6	80.9		38.3
Weighted mean lengths (mm) of juvenile salmon, age I threespine stickleback (adjusted to September 1)				
1962	53.6	88.0		42.8
1963	58.9	99.4		44.0
1964	54.7	95.5		45.1
1965	61.9	108.3		44.3
1966	53.7	110.9		43.8
1967	60.5	88.6		43.6
Weighted mean weights (gr) of juvenile salmon and age I threespine stickleback (adjusted to September 1)				
1962	-	-		-
1963	2.1	9.1		0.8
1964	1.4	7.8		0.8
1965	2.2	10.8		0.9
1966	1.4	13.1		0.7
1967	2.1	6.4		0.7

<sup>1/</sup> This table is through the courtesy of Mr. Orra Kerns, Jr., Research Biologist with Fisheries Research Institute.

#### IV. TOTAL SMOLT OUTMIGRATION ESTIMATE

Initially two approaches to obtaining an estimate of the total out-migration were planned. One was labeled the volumetric method and was based on estimates of smolt passage rate expressed in catch per volume of water versus total flow. The capture gear designed and used for the above method was not effective due to smolt avoidance. Thus, the first method was abandoned.

The second method was a mark-recovery method utilizing compressed air and a fluorescent pigment to mark smolt. The pigment used for marking was in granular form which is a solid solution of fluorescent dyes in a melamine-sulfonamide-formaldehyde resin. It is insoluble in water and formaldehyde.

The pigment is applied to young salmonids with the aid of a sandblast gun and delivered at 100 psi pressure. The pigment penetrates the epidermal and dermal layers of tissue and lodges next to the scale. Studies to date have shown no large mortalities directly attributable to marking in this manner. When salmonids are marked properly, excess dye will slough off, leaving no visible marks. In order to detect marked fish at the time of recapture, they were examined under a 100 watt, long-wave, ultra-violet light.

Capture of smolts for marking in 1967 was conducted at the index site by funneling smolt through a standard 4' x 4' fyke net and into a floating live box by means of a six inch flexible tube attached to the cod end and leading to the live box.

The recapture site was located at Big Rock, approximately 25 miles downstream from the index site. The recovery gear was a tow net with a nine foot square opening and no wings.

Detailed experiments have been carried out concerning short and long range mortality attributed to the marking technique. In addition, predator selectivity and other studies directly related to the mass marking technique are being worked on. However, at this writing results of the marking study will not be presented. The 1968 Kvichak smolt informational leaflet will present a comprehensive report of methods, procedures and results of the marking technique.

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# 1967 WOOD RIVER RED SALMON SMOLT STUDIES

By

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## I. INTRODUCTION

The Wood River smolt program was initiated in 1951 and was designed to measure relative abundance of smolt migrating seaward from the Wood River system by establishing a numerical index which is comparable from year to year.

In 1967 smolt sampling coincided with a marking program conducted by the U.S. Bureau of Commercial Fisheries. Consequently the method of total enumeration and collection of other data was not conducted as in the past. It is felt that the data obtained and conclusions reached are within reason and merit a report to continue the unbroken series of data.

Fishing was conducted between June 16 and June 27. Catches made between 2100 and 2300 hours resulted in the index catch. Considerable smolt had migrated before as well as after the program commenced and interpolations were necessary to represent these two periods.

## II. RESULTS

Total catch of red salmon smolt during the index hours was 136,783 (Table 1). Since only a portion of the season was actually fished, all 16 previous years' data was averaged to give an estimate of the number of smolt migrating before and after the sampling period. The expanded season index catch was 412,867 (Table 1, Appendix B). Using 1952 as the base year with assigned value of 100.00 index points, the 1967 season's catch was equivalent to 242.8 index points (Table 1). The 1967 season expanded index catch may be high, but there is no way to derive a reliable estimate for the period of the season that was not fished.

Size composition was determined from length measurements of 1,743 smolt contained in 17 one-pound samples. Age determinations were based on readings of 188 scales contained in 10 daily scale samples (Table 2).

Table 1. Wood River red salmon smolt catch by hour and day, 1967

Date	Index Hour Catch		Total Index Catch		Index Points <sup>1/</sup>	
	2100-2200	2200-2300	Daily	Cumulative	Daily	Cumulative
June 16	1,053	9,306	10,359	10,359	6.09	6.09
17	0	0	0	10,359	0.00	6.09
18	7,225	13,041	20,266	30,625	11.92	18.01
19	21,402	35,845	57,247	87,872	33.67	51.68
20	0	1,767	1,767	89,639	1.04	52.72
21	2,520	21,808	24,328	113,967	14.31	67.03
22	504		504	114,471	0.30	67.33
23	3	16	19	114,490	0.01	67.34
24	0	16	16	114,506	0.01	67.35
25	2,366	1,440	3,806	118,312	2.24	69.59
26	1,248	2,523	3,771	122,083	2.22	71.81
27	8,436	6,264	14,700	136,783	8.65	80.44
Totals	44,757	92,026	136,783	136,783	80.44	80.44
Percent	32.72	67.28	100.00			

<sup>1/</sup> One index point = 1,700.34 smolt

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

Age I smolt (fish that have spent one winter in freshwater) comprised 60.4 percent of the total run and averaged 77.7 mm in length and 5.5 grams in weight; Age II smolt (fish that have spent two winters in freshwater) comprised 39.6 percent of the run and averaged 89.9 mm in length and 6.2 grams in weight (Table 3, and Appendix B, Table 2).

TABLE 2. Wood River red salmon smolt sampling data, 1967.

Period No.	Date	Smolt Catch	Percent of Season's Total	No. of 1# Samples Measured	No. of Fish Measured	No. of Scales Read
1	June 16-20	89,639	65.53	7	615	80
2	June 21-24	24,867	18.18	4	422	60
3	June 25-27	22,277	16.29	6	706	48
Totals		136,783	100.00	17	1,743	188

TABLE 3. Age, weight and length of red salmon smolt by period from the Wood River system, 1967.

Period No.	Date	Line Dividing Age I & II	Mean Length of Age Group		Mean Weight of Age Group		Percentage of Age Group	
			I	II	I	II	I	II
1	June 16-20	83.5	78.6	90.0	5.6	6.4	47.7	52.3
2	June 21-24	84.5	76.5	88.6	5.2	5.9	77.3	22.7
3	June 25-27	85.5	75.5	90.9	5.3	5.7	92.4	7.6
Season's Weighted Totals			77.7	89.9	5.5	6.2	60.4	39.6

# 1967 UGASHIK RIVER RED SALMON SMOLT STUDIES

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## I. INTRODUCTION

The Ugashik River red salmon smolt program, which was initiated in 1955, was designed to provide an annual estimate of relative abundance of smolt migrating to sea. In 1958 a random sampling scheme was added to obtain an estimate of the total smolt outmigration from the Ugashik Lakes system. The program has been carried on annually by the Alaska Department of Fish and Game with exception of 1966.

For the Ugashik smolt study program design, fyke netting procedure, and methods for collection of field data, the reader is referred to Nelson, 1965<sup>1/</sup>.

Modification of the sampling scheme was employed in 1967 as well as termination of condition index sampling, otherwise, the program was similar to that in 1964 and 1965.

Fyke net operations began on May 15 and terminated on June 12. Random and index fishing schemes were conducted two out of every three nights, while 24-hour index sampling was conducted one out of every three nights to determine the diurnal and nocturnal fluctuations of the migration pattern throughout the season. Catches made from 2200 to 0100 hours each evening were totaled to yield the seasonal index catch. Catches made from 2100 to 0200 hours each evening were totaled to give the random sampling catch.

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<sup>1/</sup> Nelson, M.L. 1965. Abundance, Size, Age and Survival of Red Salmon Smolts from the Ugashik Lakes System, Bristol Bay, 1964. Alaska Department of Fish and Game, Informational Leaflet No. 62, 34 pgs.

## II. RESULTS

The total index catch of red salmon smolt during the index hours for the entire season was 64,185 (Table 1). Since only 20 of 29 nights were actually fished, the actual index net catch was expanded by the factor 1.45 to compensate for the 9 nights that the index did not fish. The expanded season index catch was 93,068, which is comparable to 30.9 index points (Table 1, Appendix C).

Twenty-four samples showed that 67.9 percent of the smolt were caught between the random sampling hours of 2100 and 0200 hours (Table 2). The random sampling smolt catch for the entire season was 68,721, with net sites 3 and 4 catching the majority of the smolt (Table 3).

Applying the method of determining the estimate of total outmigration, the 1967 total outmigration was calculated to be 5,137,063 (Table 1, Appendix C).

Size composition was determined from length measurements of 966 smolts contained in 18 one-pound samples, while age determination was based on readings of 360 scales contained in 18 daily scale samples (Table 4).

The percentage and mean length and weight of each age group were calculated for each period and then for the entire season by weighting the daily samples by the daily catches they represented to adjust for changes during the season in the magnitude of the catches (Table 5).

Age I smolt (fish that have spent one winter in freshwater) comprised 52.5 percent of the total run and averaged 87.5 mm in length and 6.0 grams in weight; Age II smolt (fish that have spent two winters in freshwater) comprised 47.5 percent of the run and averaged 113.1 mm in length and 12.2 grams in weight (Table 5).

Annual comparative data collected since the inception of the Ugashik smolt study may be found in Tables 1 to 3, Appendix C.

Table 1. Ugashik River red salmon smolt catch in index net by hour and day, 1967

Date	Index Hours			Total Index Catch		Index Points <sup>1/</sup>	
	2200-2300	2300-2400	2400-0100	Daily	Cumulative	Daily	Cumulative
May 15	12	9	0	21	21	0.01	0.01
16	26	16	20	62	83	0.02	0.03
18	358	63	54	475	558	0.16	0.19
19	491	310	172	973	1,531	0.32	0.51
21	21	16	43	80	1,611	0.03	0.54
22	2,281	2,781	2,403	7,465	9,076	2.48	3.02
24	16,232	2,711	928	19,871	28,947	6.60	9.62
25	190	231	189	610	29,557	0.20	9.82
27	180	148	185	513	30,070	0.17	9.99
28	757	3,796	4,275	8,828	38,898	2.93	12.92
30	5,440	2,772	1,340	9,552	48,450	3.17	16.09
31	98	245	98	441	48,891	0.15	16.24
June 2	1,457	352	616	2,425	51,316	0.81	17.05
3	(1,112) <sup>2/</sup>	(872) <sup>2/</sup>	354	2,338	53,654	0.77	17.82
5	767	1,392	1,054	3,213	56,867	1.07	18.89
6	914	680	374	1,968	58,835	0.65	19.54
8	1,600	897	578	3,075	61,910	1.02	20.56
9	333	161	280	774	62,684	0.26	20.82
11	227	616	150	993	63,677	0.33	21.15
12	142	178	188	508	64,185	0.17	21.32
Total	32,638	18,246	13,301	64,185	64,185	21.32	21.32
Percent	50.9	28.4	20.7		100.0		

<sup>1/</sup> One index point = 3,012.32 smolt

<sup>2/</sup> Interpolated estimates.

Table 2. Ugashik River red salmon smolt catch in index net over 24-hour period, 1967

Time Period	Date										Total	Percent
	May 16-17	May 19-20	May 22-23	May 25-26	May 28-29	May 31-June 1	June 3-4	June 6-7	June 9-10	June 12-13		
2200-2300	26	491	2,281	190	757	98	(1,112) <sup>1/</sup>	914	333	142	6,344	11.66
2300-2400	16	310	2,781	231	3,796	245	(872) <sup>1/</sup>	680	161	178	9,270	17.05
2400-0100	20	172	2,403	189	4,275	98	354	374	280	188	8,353	15.36
0100-0200	9	74	1,314	138	3,646	49	29	421	10	41	5,731	10.54
0200-0330	5	9	267	80	5,577	18	8	742	1	5	6,712	12.34
0330-0500	2	0	0	0	586	0	1	7	0	0	596	1.10
0500-0630	0	0	0	0	48	0	1	3	0	0	52	0.09
0630-0800	0	0	0	0	16	0	0	1	0	0	17	0.03
0800-0930	0	0	0	0	2	0	0	1	0	0	3	0.00
0930-1100	0	0	20	0	1	0	0	5	0	0	26	0.05
1100-1230	0	0	28	0	2	0	0	1	0	0	31	0.06
1230-1400	0	0	0	28	0	0	0	0	0	0	28	0.05
1400-1530	1	0	0	0	0	0	0	278	0	0	279	0.51
1530-1700	0	0	2	0	3	0	0	47	0	0	52	0.10
1700-1830	0	0	5	0	408	0	123	0	0	0	536	0.99
1830-2000	0	0	352	1,202	135	0	29	137	0	0	1,855	3.41
2000-2100	0	0	1,825	38	336	0	490	4,599	0	0	7,288	13.40
2100-2200	8	2	806	901	800	25	47	4,531	90	0	7,210	13.26
<b>TOTALS</b>	<b>87</b>	<b>1,058</b>	<b>12,084</b>	<b>2,997</b>	<b>20,388</b>	<b>533</b>	<b>3,066</b>	<b>12,741</b>	<b>875</b>	<b>554</b>	<b>54,383</b>	<b>100.00</b>

<sup>1/</sup> interpolated estimates.

Table 3. Ugashik River red salmon smolt catches in the random sampling scheme by fishing site, 1967.

Date	Random Sampling Sites					Total Catch
	1	2	3	4	5	
May 15	5	2	0	0	2	9
16	57	1	5	26	10	99
18	3	200	38	1	0	242
19	66	14	728	74	236	1,118
21	34	6	429	16	0	485
22	64	170	3,101	1,314	220	4,869
24	13	9	384	16,232	2,308	18,946
25	2	5	5	5,018	194	5,224
27	1,652	134	2,789	148	13	4,736
28	1,661	2,635	22	4,275	90	8,683
30	275	31	2,491	5,791	914	9,502
31	187	858	2,430	98	91	3,664
June 2	3	27	240	352	73	695
3	13	27	99	311	112	562
5	3	390	2,009	616	27	3,045
6	7	70	560	680	132	1,449
8	992	304	553	469	(429) <sup>1/</sup>	2,747
9	0	413	377	280	8	1,078
11	2	21	71	227	90	411
12	81	45	932	72	27	1,157
TOTALS	5,120	5,362	17,263	36,000	4,976	68,721
Percent	7.5	7.8	25.1	52.4	7.2	100.0

<sup>1/</sup> Interpolated figures.

Table 4. Ugashik River red salmon smolt sampling data, 1967

Period No.	Date	Index Smolt Catch	Percent of Season's Total	No. of 1 lb. Samples Measured	No. of Fish Measured	No. of Scales Read
1	May 15-21	1,611	2.51	3	121	60
2	May 22-28	37,287	58.09	5	260	100
3	May 30- June 5	17,969	28.00	5	234	100
4	June 6-12	7,318	11.40	5	351	100
Totals		64,185	100.00	18	966	360

Table 5. Age, length and weight of red salmon smolt  
by sampling period from the Ugashik River system, 1967

Period No.	Date	Mean Length in mm of Age Group		Mean Weight in gr. of Age Group		Percentage of Age Group	
		I	II	I	II	I	II
1	May 18-21	81.8	113.4	--	12.1	14.0	86.0
2	May 22-28	85.9	112.6	5.6	11.9	50.4	49.6
3	May 30-June 5	91.1	115.2	6.8	12.9	44.0	56.0
44	June 6-12	88.2	110.5	6.0	--	92.6	7.4
Season's Weighted Totals		87.5	113.1	6.0	12.2	52.5	47.5

Note: Age group I and II denotes number winters in freshwater. Season total weighted by index catch.

# NAKNEK RIVER RED SALMON SMOLT STUDY, 1967

By

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## I. INTRODUCTION

A program designed to enumerate the red salmon (Oncorhynchus nerka) smolt outmigration of the Naknek River was developed by the U.S. Fish and Wildlife Service during the years 1956 through 1965. The program was under the direction of Herbert W. Jaenicke, Fishery Research Biologist. In 1966 the project was transferred to the Alaska Department of Fish and Game and conducted by the Division of Commercial Fisheries. The original program design and methods have remained unchanged.

Angus D. Robertson, Fishery Biologist, Alaska Department of Fish and Game, supervised the program in 1966 under the direction of Herbert W. Jaenicke. In 1967 the project was initially supervised by Angus D. Robertson. The author assisted from June 1 until project termination. The project crew leader, Robert Nehus, was assisted by Fish and Game Aides, Michael F. McCurdy and Roger Baird.

## II. 1967 RESULTS

### A. Methods and Procedures

In 1967 the program commenced on May 27 and terminated July 9. Smolts were trapped in standard fyke nets 4 feet wide (effective fishing width increased to 8 feet by the use of wings) and varying from 4 to 7 feet in depth. The nets were suspended from a cable laid across the river bottom 8-3/4 miles below the outlet of Naknek Lake.

Six fishing sites in the main channel of the river were fished, one at a time, on a random schedule during the peak outmigration hours of 2100-0600. Catches at a single fishing site are used to estimate (direct sixfold expansion) the fishing period migration past a 48-foot section of the river, the fyke net being located in the center of the 48-foot section. In 1957-58 the entire river width was sampled. On the basis of the data obtained from these two years, it was estimated that 88.34 percent of the total migration occurred in that

portion of the river sampled by the six fishing sites presently used. The site at which the largest relative catches were made is used as an index site for the purpose of determining the proportion of outmigration occurring during the daylight hours.

A three-day schedule was employed throughout the season. On the first day the six sites were fished in a random order with each site fishing 90 minutes. The first day's schedule was repeated on the second day. However, the index site was fished for 24 hours. The third day was devoted to the repair and maintenance of equipment. The entire sequence began again the following day.

Thirty smolts were obtained from the index site on each night of the fishing schedule. Age, weight and length data was taken from each smolt. Scales were read at the end of the season by Herbert W. Jaenicke and the author.

#### B. Weather Data

Naknek River weather observations made by Herbert W. Jaenicke during the years 1956 to 1965 (Jaenicke) reveals that 90 percent of the smolt outmigrated when the mean water temperature was between 51° F. and 55° F. These temperatures are considerably higher than in other major rivers of Bristol Bay where water temperatures are between 36° F. and 41° F. during outmigration.

A very warm and early spring produced higher than normal water temperatures early in the season in 1967 (Table 1). Ninety percent of the smolts outmigrated when the mean water temperatures were between 53° F. and 56° F.

#### C. Total Outmigration Estimate

Indices of annual smolt abundance have been obtained since 1959 through randomized and index sampling. In 1967 the smolt migration during the daylight hours, when randomized sampling was not conducted, was estimated from the 24 hour index sampling. Since not all of the river is sampled, the outmigration in the unsampled portion of the river was estimated from data collected in 1957 and 1958 when the entire river width was sampled (Jaenicke), and from catches made at the six sampling sites in 1967.

In 1967 the peak period of outmigration was from June 5-8 (Table 2) a week earlier than in 1966. The start of outmigrations in the past 11 years have ranged from May 28 to June 9 with a midpoint varying from June 8 to June 21. The end of the main outmigration has varied from June 17 to July 20.

In 1967 21.57 percent of the total season's catch was made during the hours 0000-0130 and 77.31 percent of the total catch was made during the hours 2100-0600 (Table 3).

TABLE 1. Mean water and air temperature by day, Naknek River, 1967.<sup>1/</sup>

Date	Mean Water Temp. °F	Mean Air Temp. °F	Date	Mean Water Temp. °F	Mean Air Temp. °F
May 27	58	*	June 19	57	55
28	55	*	20	58	54
29	53	*	21	58	61
30	*	*	22	58	58
31	52	*	23	*	56
June 1	53	53	24	59	53
2	55	*	25	58	59
3	52	51	26	*	58
4	51	46	27	59	56
5	*	49	28	56	56
6	53	45	29	56	52
7	53	50	30	55	52
8	53	55	July 1	57	56
9	54	53	2	57	54
10	53	53	3	*	50
11	56	60	4	55	54
12	54	50	5	*	49
13	53	50	6	54	54
14	*	49	7	55	52
15	55	54	8	*	52
16	56	52	9	57	63
17	53	49	10	59	62
18	53	52	11	58	67

<sup>1/</sup> Water temperatures are recorded six times a day.

\* Not recorded

TABLE 2. Naknek River random sampling catches of red salmon smolt by fishing site, 1967.

Date	Sites						Total	Percent of Daily Total
	1	2	3	4	5	6		
May 27	295	415	3,894	996	1,176	280	7,056	5.80
28	229	67	349	885	1	2	1,533	1.26
30	1	409	62	900	1,524	170	3,066	2.52
31	17	2,994	2,879	2,510	773	902	10,075	8.28
June 2	645	261	1,588	206	1,282	329	4,311	3.54
3	1,541	1,889	1,377	588	2,782	217	8,394	6.90
5	1,249	1,009	1,844	4,704	184	485	9,475	7.78
6	166	455	4,756	4,218	544	195	10,334	8.49
8	27	1,183	2,416	3,608	2,927	2,287	12,448	10.26
9	279	306	335	160	227	297	1,604	1.32
11	1,011	42	1,159	1,891	1,826	2,256	8,185	6.72
12	206	506	3,528	1,441	1,400	1,290	8,371	6.88
14	608	88	200	3,286	2,514	709	7,405	6.08
15	281	205	715	1,155	304	190	2,850	2.34
17	238	946	440	345	360	340	2,669	2.19
18	332	185	751	227	24	1,764	3,283	2.70
20	214	299	1,276	350	827	1,056	4,022	3.30
21	1	19	372	869	409	291	1,961	1.61
23	45	0	99	63	0	113	320	.26
24	0	55	29	19	352	207	662	.54
26	1	0	7	840	305	284	1,437	1.18
27	130	173	648	96	696	0	1,743	1.43
29	74	0	0	447	627	242	1,390	1.14
30	6	766	303	595	3	216	1,889	1.55
July 2	317	249	266	293	972	0	2,097	1.72
3	0	395	142	194	335	363	1,429	1.17
5	0	163	583	460	490	301	1,997	1.64
6	92	1	495	202	5	63	858	.70
8	68	0	95	215	6	63	447	.37
9	28	99	1	62	217	0	407	.33
Totals	8,101	13,179	30,609	31,825	23,092	14,912	121,718	100.00
Percent	6.65	10.83	25.15	26.15	18.97	12.25	100.00	

TABLE 3. Naknek River index net catches of red salmon smolt by 90-minute periods, May 28-July 10, 1967.

	May 28-29	May 31-1	June 3-4	June 6-7	June 9-10	June 12-13	June 15-16	June 18-19	June 21-22
2100-2230	9	493	662	3,065	512	1,750	544	147	175
2230-2400	806	1,039	462	868	540	3,105	108	275	536
0000-0130	884	2,251	330	4,060	798	3,218	540	440	2,090
0130-0300	531	2,538	455	2,624	285	817	486	880	840
0300-0430	60	3,729	608	2,753	59	495	533	55	418
0430-0600	262	3,744	648	1,020	160	27	688	230	50
0600-0730	112	2,312	1,573	680	5	1	1,100	315	3
0730-0900	15	1,005	2,869	64	0	0	1,540	129	54
0900-1030	0	171	1,870	2	0	0	126	0	0
1030-1200	0	51	315	175	0	176	0	25	75
1200-1330	0	2	130	0	152	429	19	0	0
1330-1500	0	8	663	0	78	6	0	0	0
1500-1630	0	2	589	0	6	5	0	0	0
1630-1800	0	338	72	0	0	0	0	0	0
1800-1930	0	0	720	0	0	0	0	1	0
1930-2100	<u>0</u>	<u>0</u>	<u>148</u>	<u>0</u>	<u>0</u>	<u>10</u>	<u>0</u>	<u>1</u>	<u>2</u>
Totals	2,679	17,683	12,114	15,311	2,595	10,039	5,684	2,498	4,243

TABLE 3. Naknek River index net catches of red salmon smolt by 90-minute periods, May 28-July 10, 1967. (Cont'd.)

	June 24-25	June 27-28	June/July 30-1	July 3-4	July 6-7	July 9-10	Total	Percent
2100-2230	0	175	0	216	43	23	7,814	9.48
2230-2400	160	490	595	192	128	96	9,400	11.40
0000-0130	440	374	1,435	462	390	64	17,776	21.57
0130-0300	108	288	1,000	340	426	99	11,717	14.21
0300-0430	70	99	560	5	204	37	9,685	11.75
0430-0600	19	5	272	136	12	64	7,337	8.90
0600-0730	1	0	34	21	49	27	6,233	7.56
0730-0900	74	180	35	0	0	5	5,970	7.24
0900-1030	0	25	0	0	0	0	2,194	2.66
1030-1200	0	0	0	102	0	0	919	1.11
1200-1330	0	0	3	0	2	0	737	0.89
1330-1500	0	1	0	0	0	0	756	0.92
1500-1630	12	0	0	0	0	0	614	0.74
1630-1800	0	0	0	0	0	0	410	0.50
1800-1930	0	0	0	0	0	0	721	0.87
1930-2100	<u>7</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>169</u>	<u>0.20</u>
Totals	891	1,637	3,935	1,474	1,254	415	82,452	100.00

The 1967 total smolt outmigration estimate was obtained by the following procedure: ("sampling period" refers to the period 2100-0600)

- 1) Determine the seasonal average 90-minute catch per fishing site per sampling period.

Total season catch = 121,718

No. of sites fished (each site fished for 90 minutes per sampling period) = 6

No. of sampling periods fished during the season = 30

Therefore, the seasonal average 90-minute catch per fishing site per sampling period is given by

$$(121,718) / ((30) (6)) = 676 \text{ smolts.}$$

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

Average 90-minute catch per fishing site per sampling period = 676 (from Step 1)

No. of sites fished = 6

No. of subsites for which the migration is estimated from the catch at each fishing site = 6

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

$$(676)(6)(6) = 24,336 \text{ smolts.}$$

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

Estimated average migration past the sampled section of the river during a 90-minute period within a sampling period = 24,336 (from Step 2)

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

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

$$(24,336) (6) = 146,016 \text{ smolts.}$$

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

Estimated average migration past the sampled section of the river each sampling period = 146,016 (from Step 3)

Estimated  $\frac{1}{}$  proportion of migration occurring within the section of the river presently sampled = 88.34%

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

$$(146,016) / .8834 = 165,289 \text{ smolts.}$$

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

Estimated average migration past the entire width of the river at the sampling location per sampling period = 165,289 (from Step 4)

Estimated  $\frac{2}{}$  proportion of daily migration occurring during the sampling period (2100-0600) = 77.31%

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

$$(165,289) / (.7731) = 213,800 \text{ smolts.}$$

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

Estimated average daily migration past the sampling location = 213,800 (from Step 5)

No. of days fished in 1967 = 44

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

$$(213,800) (44) = 9,407,200 \text{ smolts.}$$

---

1/ Derived from 1957-1958 data when whole river width was sampled. Sites presently fished caught 88.34% of total catch.

2/ Derived from 2100-0600 hour catch during 15 nights of 24 hour index fishing, representing 77.31% of catch.

#### D. Age, Weight and Length Data

Age, weight and length of smolt migrating in 1967 was determined by examination of 855 smolt. The mean weight and length by day and for the season was calculated for each age group (Tables 4, 5 and 6, Appendix D). Table 1, Appendix D summarizes ages, weights and lengths for the years 1957 through 1967.

Both Age I and Age II smolts were the largest recorded for the eleven year period 1957-1967. The average lengths were 113 mm and 119 mm for Age I and II smolts respectively. The average weight for the Age I smolts was 13.1 grams. The average for the past eleven years is 9.6 grams. The Age II smolts averaged 14.7 grams, 2.1 grams above the eleven year average. A factor contributing to the increase in size could have been the unusually warm spring resulting in improved environmental conditions in the lake.

### III. COMPARISON OF 1967 RESULTS WITH PAST DATA

As in previous years the Age II smolt migration peaked earlier than did the Age I smolt (Table 2). By mid-June the Age I smolt began to dominate the migration. The U.S. Fish and Wildlife studies in July and August of 1956, 1958, 1959 and in September of 1962, indicated that small numbers of Age I smolt were still leaving Naknek Lake in early September. However, the 1967 Age II migration was completed by late July.

In 1967 the Age I smolts were the progeny of the 1965 adult migration of 718,000 and comprised 43.55 percent (4,096,836) of the total smolt outmigration. The Age II smolts originated from the somewhat larger 1964 escapement of 1,350,000 and comprised 56.18 percent (5,284,965) of the total outmigration. The Age III smolt were produced from the 1963 escapement of 905,358 and comprised 0.27 percent (25,399) of the 1967 outmigration (Figure 1, Table 2, Appendix D).

Relative size of smolt outmigrations and age compositions for the years 1956-1967 are given in Table 3 and Figure 2, Appendix D, respectively.

### IV. SUMMARY

1. 1967 concluded the twelfth consecutive year of smolt enumeration on the Naknek River. The project was initiated by the U.S. Fish and Wildlife Service in 1956. The Alaska Department of Fish and Game took the project over in 1966.

2. Sampling began on May 27 and terminated on July 9.
3. Six fishing sites on the main channel of the river were fished on a random schedule during the peak outmigration hours of 2100-0600. An index site was fished 24 hours on every second day of sampling.
4. The peak period of smolt outmigration was from June 5-8, a week earlier than 1966.
5. The total 1967 smolt outmigration was 9,407,200.
6. Both Age I and Age II smolts were the largest on record.
7. Age, length and weight data was determined from 855 smolts. Age I smolts comprised 43.55 percent (4,096,836) of the total outmigration and averaged 113 mm in length and 13.1 grams in weight. Age II smolts comprised 56.18 percent (5,284,965) of the total outmigration and averaged 119 mm in length and 14.7 grams in weight.
8. 1967 smolt were the progeny of the adult escapements of 1,350,000 in 1964 and 718,000 in 1965.

## LITERATURE CITED

JAENICKE, HERBERT W. 1965. Naknek smolt study report, 1956-1965, U.S. Fish and Wildlife Service, unpublished.

APPENDIX A

TABLE 1. Dates and water temperatures at beginning of peak smolt outmigration, Kvichak River, 1955-1967.

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 <sup>1/</sup>	-	-
1967	May 26	40

<sup>1/</sup> Date of peak outmigration not known for certain.

TABLE 2. Kvichak River 24-hour red salmon smolt catches average lengths and weights, 1955-1967.

Outmigration	AGE I				AGE II				Total Number	Total 24-Hour Index <sup>1/</sup>
	Number	Percent <sup>2/</sup>	Average Length	Weight	Number	Percent	Average Length	Weight		
1955	18,198	7	89 mm	-	241,780	93	109 mm	-	(259,978) <sup>3/</sup>	7.8
1956	30,287	39	92 mm	-	47,373	61	116 mm	-	(77,660) <sup>3/</sup>	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) <sup>3/</sup>	85.9
1960	61,400	10	91 mm	6.3 g	552,603	90	108 mm	10.3 g	(614,003) <sup>4/</sup>	18.4
1961	26,038	72	92 mm	6.8 g	10,126	28	117 mm	13.1 g	(36,164) <sup>3/</sup>	1.1
1962	1,130,820	94	82 mm	4.3 g	72,180	6	110 mm	9.9 g	1,203,000	36.1
1963	113,338	3	83 mm	4.8 g	4,116,093	97	98 mm	7.5 g	4,229,431	126.9
1964	458,122	22	87 mm	5.2 g	1,603,464	78	108 mm	9.8 g	2,061,586	61.8
1965	64,377	4	90 mm	6.8 g	1,748,178	97	109 mm	11.3 g	1,812,555	54.4
1966	252,384	92	94 mm	7.4 g	23,377	8	114 mm	12.6 g	275,761	8.3
1967	2,866,214	93	86 mm	5.9 g	222,528	7	118 mm	14.2 g	3,088,742	92.6
Thirteen-Year Averages	645,894	47	88 mm	5.9 g	883,923	53	111 mm	11.1 g	1,529,817	45.9

<sup>1/</sup> One index point = 33,340 smolt

<sup>2/</sup> 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.

<sup>3/</sup> 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.

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

TABLE 3. Percent of red salmon smolt outmigration occurring during index hours (2200-0100), Kvichak River, 1955-1967.

<u>Year</u>	<u>Outmigration</u> <sup>1/</sup>	<u>Percent Outmigration</u> <u>During Index Hours</u> <u>(2200-0100)</u>
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 <sup>2/</sup>
1967	3,088,742	30.1
Averages	1,529,817	56.2 <sup>3/</sup>

<sup>1/</sup> 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.

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

<sup>3/</sup> Note that the average 56.2% 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.

TABLE 4. Kvichak River 3-hour red salmon smolt catches, 1955-1967, (3-hour index catches).

Year of Outmigration	Age I		Age II		Total Number	Total <u>1</u> / 3-Hour Index
	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
<b>Thirteen-Year Averages</b>	272,802	47	396,827	53	669,629	18.2

1/ One Index Point = 33,340 Smolt.

TABLE 5. Parent escapement and corresponding red salmon smolt production, Kvichak River, 1952-1965.

Year of Spawning	Escapement In Thousands	24-Hour Index Smolt Produced			24-Hour Index Smolt Per Spawner x 10 <sup>3</sup>		
		Age I	Age II	Total	Age I	Age II	Total
1952	5,970		241,780			40	
1953	321	18,198	47,373	65,571	57	148	205
1954	241	30,287	8,654	38,941	126	36	162
1955	250	22,253	66,679	88,932	89	267	356
1956	9,443	3,267,274	2,777,960	6,045,234	346	294	640
1957	2,964	85,916	552,603	638,519	29	186	215
1958	535	61,400	10,126	71,526	115	19	134
1959	680	26,038	72,180	98,218	38	106	144
1960	14,630	1,130,820	4,116,093	5,246,913	77	281	358
1961	3,706	113,338	1,603,464	1,716,802	30	433	463
1962	2,581	458,122	1,748,178	2,206,300	178	677	855
1963	339	64,377	24,818	89,195	190	73	263
1964	957	252,384	222,528	474,912	264	233	497
1965	24,326	2,866,214					
<b>Averages</b>	<b>4,782</b>	<b>645,894</b>	<b>884,034</b>	<b>1,398,422</b>	<b>119</b>	<b>215</b>	<b>334</b>

TABLE 6. Dates of sampling and peak periods of red salmon smolt outmigration, Kvichak River, 1955-1967.

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
Averages		37		10	87

TABLE 7. Parent escapement and corresponding percent of Age II red salmon smolt produced, Kvichak River, 1952-1964.

Year	Escapement	Percent Age II <sup>1/</sup> Smolt Produced
1952	5,970,000	10 - 15% <sup>2/</sup>
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%

<sup>1/</sup> Based on 24-hour index catches.

<sup>2/</sup> Estimated on basis of 2-ocean returns in 1956 and 5<sub>2</sub> fish in 1957 vs. 5<sub>3</sub> fish in 1957 and 6<sub>3</sub> fish in 1958.

APPENDIX B

Table 1. Comparative age, length and index net catches of red salmon smolt from the Wood River system, 1951-67

Seaward Migration	Age I		Age II		Index Points		Two-Hour	Five-Hour
	Percent	Mean Length	Percent	Mean Length	Unadjusted	Adjusted	Index Net Catch	Index net Catch <sup>1/</sup>
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	--	745,832	
1955	98.0	85.0	2.0	102.0	221.7	--	377,032	777,665
1956	78.4	82.0	21.6	95.0	329.3	326.6	559,932	1,099,782
1957	80.7	77.0	19.3	93.0	144.0	165.5	244,831	541,521
1958	65.0	82.0	35.0	102.0	249.1	230.9	423,580	868,293
1959	93.5	87.9	6.5	105.0	59.1	60.5	100,450	174,647
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	1,318,558
1965	92.0	85.5	8.0	106.1	217.7	296.2	370,112	1,171,358
1966	94.3	77.1	5.7	101.2	147.1	133.4	250,049	527,908
1967	60.4	77.7	39.6	89.9	242.8 <sup>2/</sup>	--	412,867 <sup>2/</sup>	
Average	87.9	83.6	12.1	101.6	177.8 <sup>3/</sup>	-	403,321	

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

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

<sup>2/</sup> Based on average index net catch from June 16 thru June 27 for 1951-1966, compared with total season's catch.

<sup>3/</sup> Geometric mean

Table 2. Average length and weight of Wood River red salmon smolts by freshwater age groups, 1961-67<sup>1/</sup>

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
Mean Average	81.2	4.8	100.5	8.1

<sup>1/</sup> Weighted by index net catch.

Table 3. Wood River red salmon escapement and smolts produced, 1951-65.

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	<u>1/</u>		

1/ The Age II smolts from the 1965 escapement will not leave freshwater until 1968.

Table 4. Percentage of Wood River red salmon smolt parasitized by the cestode, Triaenophorus crassus, 1961-67

Year	Total Number of Smolt Examined	Number of 1 lb. Samples Examined	Range of 1 lb. Samp. 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
Mean Average	4,628	53	56-125	27.7	9.0-53.0

APPENDIX C

Table 1. Comparative Age, Length, Index Net Catches and Outmigration Estimates of Red Salmon Smolt from the Ugashik River system, 1956-67.

Year of Seaward Migration	Age I		Age II		Index Points	Index Net Catch	Outmigration 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 <sup>1/</sup>	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 <sup>1/</sup>	104.3	305.2	919,451	33,750,496
1964	80.1	92.2	19.8 <sup>1/</sup>	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
Average	51.7	90.5	48.3	112.6	72.3	277.349	10,340,271

Note: Age Group I and II denotes number winters in freshwater. Age and length weighted by index catch.

<sup>1/</sup> 1.0 percent Age III in 1960; 0.1 percent Age III in 1963 and 1964.

Table 2. Average length and weight of Ugashik River red salmon smolts by freshwater, age group, 1958-67<sup>1/</sup>

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
Mean Average	90.5	6.4	112.6	12.0

<sup>1/</sup> Weighted by index catch

Table 3. Ugashik River red salmon escapements and smolt produced, 1956-1965

Brood Year	Ugashik River Escapement	Millions of Smolts Produced			
		Age I	Age II	Age III	Total
1956	425,295	11.4	0.4	.01	11.9
1957	214,802	2.5	2.2	--	4.7
1958	279,546	3.3	3.0	--	6.3
1959	219,228	0.8	3.2	--	4.0
1960	2,304,200	13.5	18.1	--	31.6
1961	348,639	15.6	2.0	--	17.6
1962	255,426	8.0	2.6	--	10.6
1963	388,254	1.0	-- <sup>1/</sup>	--	1.0 <sup>1/</sup>
1964	472,770	-- <sup>1/</sup>	2.4	--	2.4 <sup>1/</sup>
1965	966,612	2.7	-- <sup>2/</sup>	--	--

Data Source: Nelson, 1965

<sup>1/</sup> No out migration estimate for 1966

<sup>2/</sup> The Age II smolt from the 1965 escapment will not leave freshwater until 1968.

APPENDIX D

TABLE 1. Average fork lengths and weights, Naknek River red salmon smolts, 1957-1967.

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
Mean Average	56.6	102	9.6	43.1	113	12.6

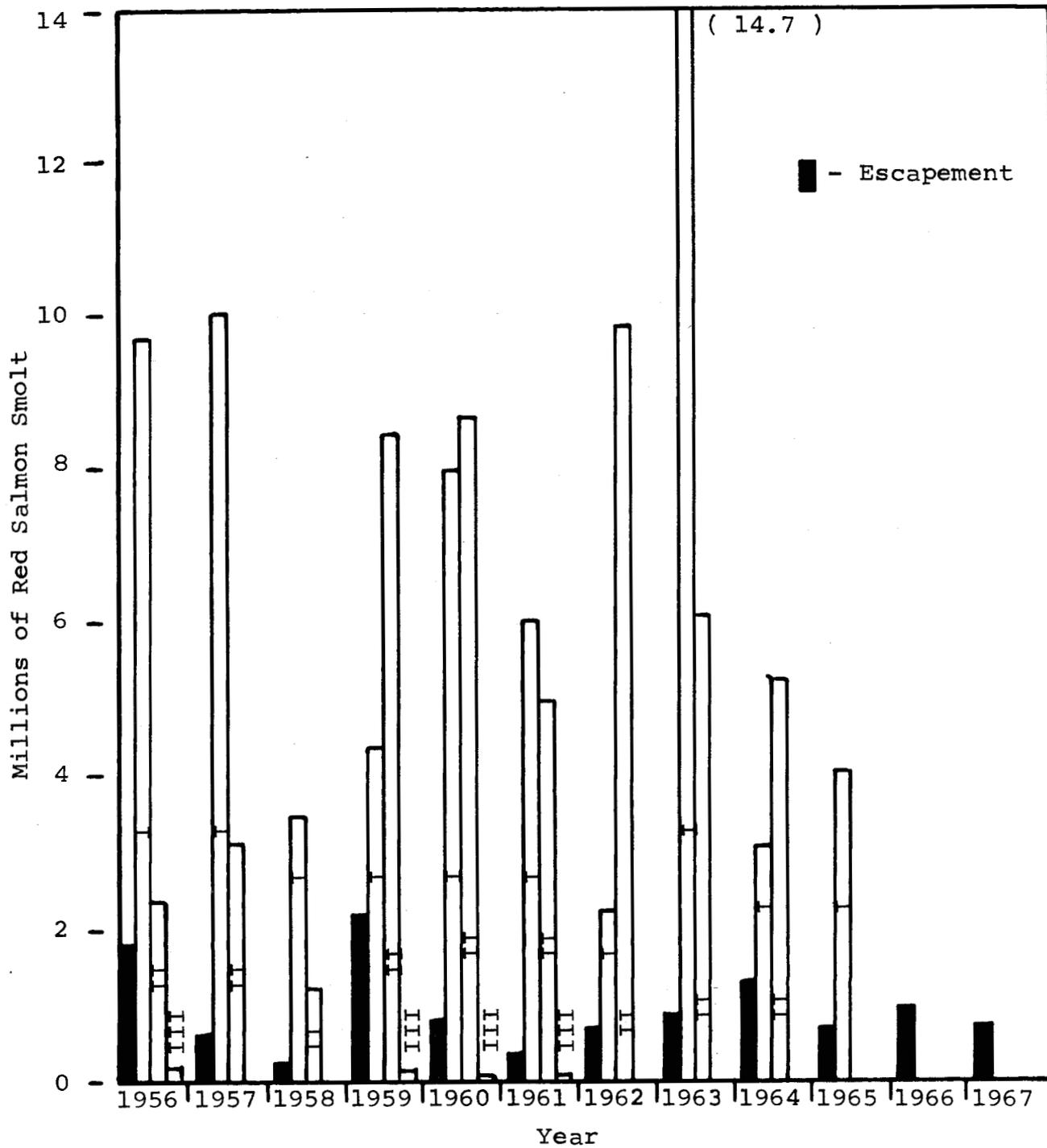


FIGURE 1. PRODUCTION OF RED SALMON SMOLT BY BROOD YEAR, NAKNEK RIVER, 1956 - 1965.

TABLE 2. Production of red salmon smolt by brood year, Naknek River, 1956-1965.<sup>1/</sup>

Brood Year	Escapement	Smolts Produced at Age			Total
		I	II	III	
1956	1,722,593	9,698,033	2,430,770	20,074	12,148,877
1957	634,655	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		8,399,850
1965	717,798	4,096,836			
1966	1,016,445				
1967	755,640				

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

TABLE 3. Red salmon smolt migrations, Naknek River, 1956-1967.

Year of Seaward Migration	Number at Age			Total
	I	II	III	
1956	5,064,000	936,000	-	6,000,000
1957	1,760,401	1,280,015	-	3,040,416
1958	9,698,033	362,167	-	10,060,200
1959	10,034,717	2,430,770	-	12,465,487
1960	3,553,121	3,118,182	20,074	6,691,377
1961	4,366,639	1,246,008	-	5,612,647
1962	8,000,637	8,461,579	-	16,462,216
1963	6,049,747	8,717,000	134,108	14,900,855
1964	2,248,013	4,973,098	7,228	7,228,339
1965	14,741,194	9,878,527	88,951	24,708,672
1966	3,114,885	6,098,025	-	9,212,910
1967	4,096,836	5,284,965	25,399	9,407,200

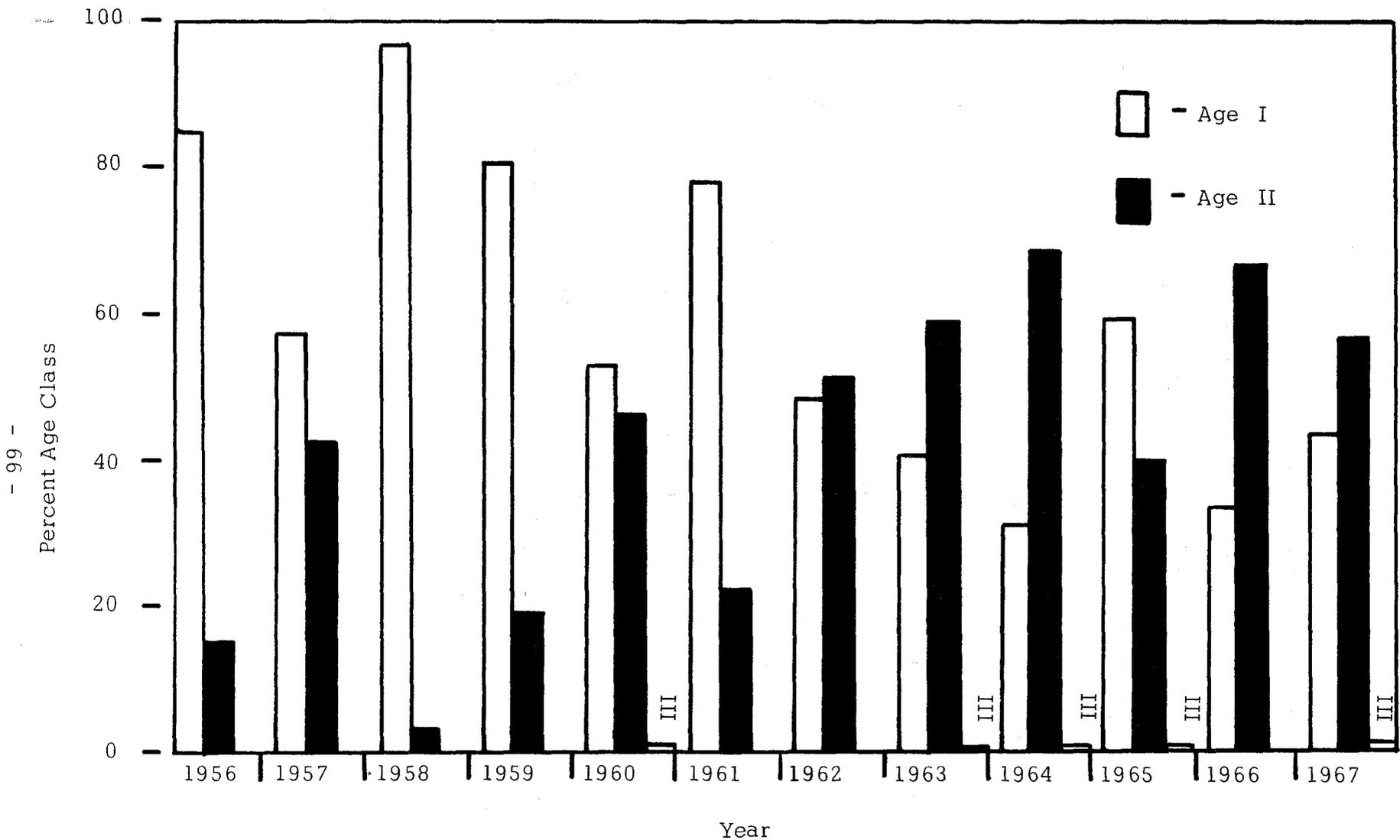


Figure 2. Age composition - Naknek River red salmon smolt - 1956-1967.

TABLE 4. Naknek River red salmon smolts, mean weight in grams, 1967.

Date	Age I			Age II			Age III		
	% of Total Season's Catch	Mean Weight	% of Mean Weight	% of Total Season's Catch	Mean Weight	% of Mean Weight	% of Total Season's Catch	Mean Weight	% of Mean Weight
May 27	0.45	17.5	.08	9.63	16.4	1.58	72.04	19.2	13.83
28	0.38	13.3	.05	1.95	18.3	.36	0.00	0.0	0.00
30	1.04	18.3	.19	3.68	17.0	.63	0.00	0.0	0.00
31	4.45	17.3	.77	11.29	16.7	1.89	0.00	0.0	0.00
June 2	1.36	15.7	.21	5.25	14.9	.78	0.00	0.0	0.00
3	3.45	13.3	.46	9.60	14.1	1.35	0.00	0.0	0.00
5	3.57	13.7	.49	11.08	14.9	1.65	0.00	0.0	0.00
6	9.75	13.2	1.29	7.56	13.7	1.04	0.00	0.0	0.00
8	10.96	11.3	1.24	9.70	13.8	1.34	0.00	0.0	0.00
9	1.21	11.9	.14	1.41	13.3	.19	0.00	0.0	0.00
11	6.70	11.5	.77	6.78	13.2	.89	0.00	0.0	0.00
12	6.85	12.0	.82	6.93	12.3	.85	0.00	0.0	0.00
14	6.75	12.9	.87	5.60	14.5	.81	0.00	0.0	0.00
15	3.58	12.9	.46	1.39	14.6	.20	0.00	0.0	0.00
17	3.30	12.7	.42	1.35	13.6	.18	0.00	0.0	0.00
18	4.46	12.4	.55	1.34	15.3	.21	0.00	0.0	0.00
20	4.04	12.3	.50	2.75	14.7	.40	0.00	0.0	0.00
21	3.33	12.5	.42	0.29	11.2	.03	0.00	0.0	0.00
23	0.30	10.5	.03	0.23	11.2	.03	0.00	0.0	0.00
24	0.91	12.2	.11	0.26	15.4	.04	0.00	0.0	0.00
26	2.19	13.4	.29	0.40	13.3	.05	0.00	0.0	0.00
27	3.04	13.0	.40	0.19	14.6	.03	0.00	0.0	0.00
29	2.31	13.6	.31	0.24	14.5	.03	0.00	0.0	0.00
30	3.09	14.7	.45	0.37	16.3	.06	0.00	0.0	0.00
July 2	3.54	13.1	.46	0.22	11.4	.03	22.19	13.6	3.01
3	2.43	13.9	.34	0.21	16.1	.03	0.00	0.0	0.00
5	3.51	14.6	.51	0.19	16.2	.03	0.00	0.0	0.00
6	1.62	14.8	.24	0.00	0.0	0.00	0.00	0.0	0.00
8	.70	13.0	.09	0.11	12.9	.01	0.00	0.0	0.00
9	.73	13.6	.10	0.00	0.0	0.00	5.77	18.7	1.08
	100.00		13.06	100.00		14.72	100.00		17.92

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TABLE 5. Naknek River red salmon smolt, mean length in millimeters, 1967.

Date	Age I			Age II			Age III		
	% of Total Season's Catch	Mean Length	% of Mean Length	% of Total Season's Catch	Mean Length	% of Mean Length	% of Total Season's Catch	Mean Length	% of Mean Length
May 27	0.45	123	.6	9.63	124	11.9	72.04	132	95.1
28	0.38	116	.4	1.95	129	2.5	0.00	000	00.0
30	1.04	126	1.3	3.68	125	4.6	0.00	000	00.0
31	4.45	123	5.5	11.29	125	14.1	0.00	000	00.0
June 2	1.36	121	1.6	5.25	119	6.3	0.00	000	00.0
3	3.45	113	3.9	9.60	118	11.3	0.00	000	00.0
5	3.57	118	4.2	11.08	120	13.3	0.00	000	00.0
6	9.75	116	11.3	7.56	120	9.1	0.00	000	00.0
8	10.96	113	12.4	9.70	116	11.3	0.00	000	00.0
9	1.21	111	1.3	1.41	115	1.6	0.00	000	00.0
11	6.70	109	7.3	6.78	113	7.7	0.00	000	00.0
12	6.85	111	7.6	6.93	111	7.7	0.00	000	00.0
14	6.75	112	7.6	5.60	118	6.6	0.00	000	00.0
15	3.58	112	4.0	1.39	117	1.6	0.00	000	00.0
17	3.30	112	3.7	1.35	118	1.6	0.00	000	00.0
18	4.46	110	4.9	1.34	119	1.6	0.00	000	00.0
20	4.04	110	4.4	2.75	117	3.2	0.00	000	00.0
21	3.33	110	3.7	0.29	107	.3	0.00	000	00.0
23	0.30	104	.3	0.23	109	.3	0.00	000	00.0
24	0.91	109	1.0	0.26	109	.3	0.00	000	00.0
26	2.19	105	2.3	0.40	112	.4	0.00	000	00.0
27	3.04	112	3.4	0.19	116	.2	0.00	000	00.0
29	2.31	113	2.6	0.24	117	.3	0.00	000	00.0
30	3.09	111	3.4	0.37	118	.4	0.00	000	00.0
July 2	3.54	112	4.0	0.22	108	.2	22.19	142	31.5
3	2.43	115	2.8	0.21	124	.3	0.00	000	00.0
5	3.51	115	4.0	0.19	124	.2	0.00	000	00.0
6	1.62	115	1.9	0.00	000	.0	0.00	000	00.0
8	.70	112	.8	0.11	112	.1	0.00	000	00.0
9	.73	113	.8	0.00	000	.0	5.77	127	7.3
	100.00		113.0	100.00		119.01	100.00		133.9

TABLE 6. Length-weight by age class of Naknek River red salmon smolt, 1967.

Date	Age I				Age II				Age III			
	No. Smolts	Mean Length	Mean Weight	Daily Sample %	No. Smolts	Mean Length	Mean Weight	Daily Sample %	No. Smolts	Mean Length	Mean Weight	Daily Sample %
May 27	1	123	17.5	3.3	28	124	16.4	93.4	1	132	19.2	3.3
28	2	116	13.3	13.3	13	129	18.3	86.7	0	0	0	0
30	5	126	18.3	17.9	23	125	17.0	82.1	0	0	0	0
31	7	123	17.3	23.3	23	125	16.7	96.7	0	0	0	0
June 2	5	121	15.7	16.7	25	119	14.9	83.3	0	0	0	0
3	5	113	13.3	21.7	18	118	14.1	78.3	0	0	0	0
5	6	118	13.7	20.0	24	120	14.9	80.0	0	0	0	0
6	15	116	13.2	50.0	15	120	13.7	50.0	0	0	0	0
8	14	113	11.3	46.7	16	116	13.8	53.3	0	0	0	0
9	12	111	11.9	40.0	18	115	13.3	60.0	0	0	0	0
11	13	109	11.5	43.3	17	113	13.2	56.7	0	0	0	0
12	13	111	12.0	43.3	17	111	12.3	56.7	0	0	0	0
14	14	112	12.9	48.3	15	118	14.5	51.7	0	0	0	0
15	20	112	12.9	66.7	10	117	14.6	33.3	0	0	0	0
17	19	112	12.7	65.5	10	118	13.6	34.5	0	0	0	0
18	18	110	12.4	72.0	7	119	15.3	28.0	0	0	0	0
20	16	110	12.3	53.3	14	117	14.7	46.7	0	0	0	0
21	27	110	12.5	90.0	3	107	11.2	10.0	0	0	0	0
23	1	104	10.5	50.0	1	109	11.2	50.0	0	0	0	0
24	11	109	12.2	73.3	4	109	15.4	26.7	0	0	0	0
26	17	105	13.4	81.0	4	112	13.3	19.0	0	0	0	0
27	24	112	13.0	92.3	2	116	14.6	7.7	0	0	0	0
29	15	113	13.6	82.2	2	117	14.5	11.8	0	0	0	0
30	26	111	14.7	86.7	4	118	16.3	13.3	0	0	0	0
July 2	25	112	13.1	89.3	2	108	11.4	7.1	1	142	13.6	3.6
3	18	115	13.9	90.0	2	124	16.1	10.0	0	0	0	0
5	28	115	14.6	93.3	2	124	16.2	6.7	0	0	0	0
6	30	115	14.8	100.0	0	0	0	0	0	0	0	0
8	5	112	13.0	82.3	1	112	12.9	16.7	0	0	0	0
9	<u>21</u>	<u>113</u>	<u>13.6</u>	<u>95.5</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>127</u>	<u>18.7</u>	<u>4.5</u>
	433				320				3			
		113	13.1	43.5		119	14.7	56.2		133.9	17.9	.3

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