Informational Leaflet 37

ABUNDANCE, SIZE AND AGE OF RED SALMON SMOLTS FROM THE WOOD RIVER SYSTEM, 1963

By

Michael L. Nelson
Division of Commercial Fisheries

MAR 11 1964

STATE OF ALASKA
WILLIAM A. EGAN - GOVERNOR

DEPARTMENT OF
FISH AND GAME
WALTER KIRKNESS - COMMISSIONER
SUBPORT BUILDING, JUNEAU

ERRATA SHEET

for

Informational Leaflet No. 37 -- March 11, 1964, Alaska Department of Fish and Game - Abundance, Size and Age of Red Salmon Smolts from the Wood River System, 1963.

The following changes in Informational Leaflet No. 37 were brought about by weighting the age composition and length of each age group by the index net catch:

1. Page 15, fourth paragraph, second sentence.

   Reads: Age I smolts comprised 81.15 percent of the total run and averaged 84.5 mm in length; Age II smolts comprised 18.85 percent of the run and averaged 102.9 mm in length.

   Change to read: Age I smolts comprised 84.27 percent of the total run and averaged 82.6 mm in length; Age II smolts comprised 15.73 percent of the run and averaged 102.1 mm in length.

2. Page 17, table 4, 11th column.

		Mean Length		Percent	
		Age I	Age II	Age I	Age II
Reads:	Season total	84.5	102.9	81.15	18.85
Change to read:	Season's Weighted Total	82.6	102.1	84.27	15.73

3. Page 18, table 5 (years of seaward migration)

   1959 Reads: 88.0 (third column)

   Change to read: 87.9; add 105.0 to fifth column

   1961 Reads: 82.0 (third column)

   Change to read: 81.7

   1963 Reads: 81.2, 84.5, 18.8 and 102.9 (second through fifth column)

   Change to read: 84.3, 82.6, 15.7 and 102.1

   Average Reads: 87.1, 84.1, 12.9 and 100.7 (second through fifth column)

   Change to read: 87.3, 83.9, 12.7 and 101.3

Footnote 1/ reads: Number winters in freshwater

Change to read: Number winters in freshwater; weighted by index catch.

4. Page 19, Smolt Production Versus Escapement Levels, second paragraph, fourth line.

   Reads: 81.2 percent

   Change to read: 84.3 percent

5. Page 21, table 7. Second column, Age I length.

   1963 reads: 84.5

   Change to read: 82.6

   Fourth column, Age II length.

   1963 reads: 102.9

   Change to read: 102.1

6. Page 21, table 8, Index Values of Smolts Produced.

   1960 reads: 16.7 (Age II) and 169.3 (total)

   Change to read: 14.0 (Age II) and 166.6 (total)

   1961 reads: 72.2 (Age I)

   Change to read: 74.9 (Age I)

7. Page 22, seventh paragraph.

   Reads: Age I smolts comprised 81.15 percent of the total run and averaged 84.5 mm in length. Age II smolts comprised 18.85 percent of the run and averaged 102.9 mm in length.

   Change to read: Age I smolts comprised 84.27 percent of the total run and averaged 82.6 mm in length. Age II smolts comprised 15.73 percent of the run and averaged 102.1 mm in length.

ABUNDANCE, SIZE, AND AGE OF RED SALMON SMOLTS FROM THE WOOD RIVER SYSTEM 1963

INTRODUCTION

In 1963 the Alaska Department of Fish and Game continued the red salmon *(Oncorhynchus nerka)* smolt program of enumeration and sampling at Mosquito Point, Lake Aleknagik.

Smolt enumeration and sampling at the outlet of Lake Aleknagik was begun by the Fisheries Research Institute in 1951 and continued by them through 1960. This is the Alaska Department of Fish and Game's third consecutive year of operating this program.

The abundance, size, age, and condition of red salmon smolts, determined over a period of years, provide one basis for predicting return runs on which management regulations can be made. The magnitude of the smolt run also provides basic data for the establishment of the highly variable freshwater survival, and consequently the optimum escapement.

This report is a summary of the data obtained in 1963. Results are comparable with past records, since methods developed and used by the Fisheries Research Institute have been continued without major modifications.

OBJECTIVES

The primary objective is to measure the relative abundance of red salmon smolts migrating seaward from the Wood River Lakes by establishing a numerical index which is comparable from year to year. Other objectives are as follows: (1) to study the index hour fluctuation and seasonal timing of the migration; (2) to study the age and size composition of the run; (3) to arrive at a condition factor; and (4) to evaluate the smolt production versus escapement levels.

DESCRIPTION OF THE AREA

The Wood River Lakes system comprises four major lakes of which Lake Nerka is the largest (Table 1).

Wood River, the outlet of the Wood River Lakes system, is about 25 miles long and empties into Nushagak Bay on the western shore of Bristol Bay. Tidal influence extends to the outlet of the first lake.

The smolt sampling site is located at Mosquito Point, on the outlet of Lake Aleknagik (Figure 1).

Escapements of red salmon into the Wood River Lakes has varied greatly during the period from 1953 to 1963. The low escapement of 288,727 occurred in 1957 and the high escapement of 2,209,266 occurred in 1959, while the average for this period has been 888,416.

Table 1. Physical data on principal lakes of the Wood River system.

Name	Length (miles)	Maximum recorded depth (ft)	Area (square miles)	Surface elevation (ft)
Aleknagik	20	360	34	34
Nerka	25*	538	78	70
Beverley	22	617	38	100
Kulik	17	525	24	140

* Longest arm only

METHODS

Fyke Net Design

A fyke net constructed of ½ inch mesh cotton webbing throughout was used to trap the smolts. The net was hung from a solid steel frame 4-foot square and was provided with two 10-foot lead-in wings (Figure 2). The two wings were held open by the force of the river current and two connecting spacer lines allowed the net to fish a consistent 9-foot wide section of the river.

The body of the net tapered from the frame to a single rectangular funnel 2" x 10" at the throat. A second funnel of the same dimenstions was located in the detachable cod-end. A heavy duty zipper facilitated in emptying the catch from the cod-end.

Fyke Netting Procedure

The fyke net was set before 9 p.m. each night and commenced fishing on the hour. The net was tended from an 18-foot skiff by one or more men.

To check the catch, the cod-end was detached by removing a single locking pin and an empty cod-end was immediately put in place and lowered into the water to continue fishing.

If the catch was small, the smolts were counted by hand and returned immediately to the river. If the catch was over five pounds, they were placed in a large weighing basket that was immersed in a tub of water. This weighing basket was then removed from the tub of water. This weighing basket was then removed from the tub and hung on a spring balance of 60-pound capacity, suspended from

Figure 1. Wood River Lake System, Bristol Bay, Alaska

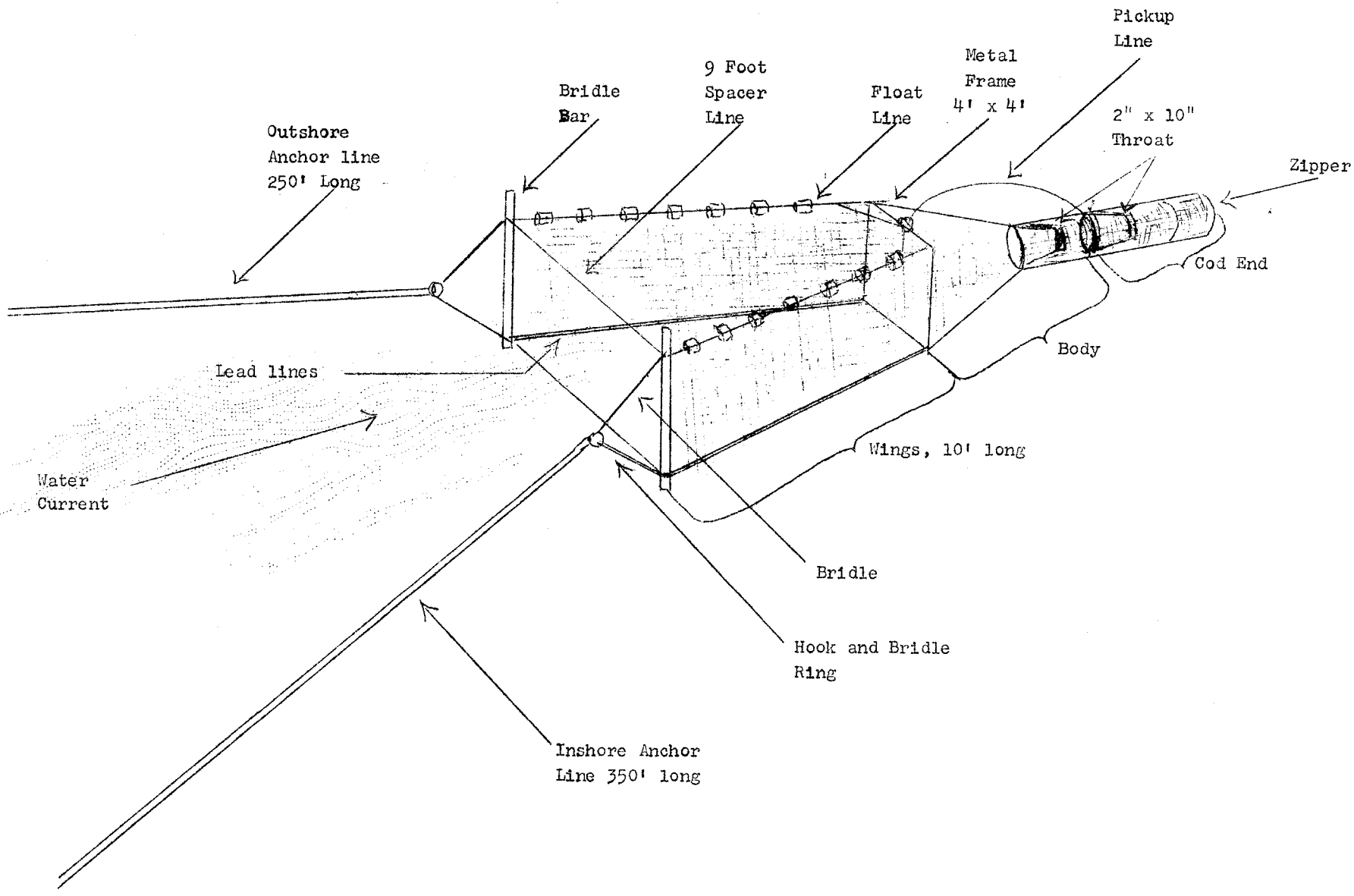

Figure 2. Cotton fyke net used to sample red salmon smolts, Wood River, 1962.

a weighing stand in the skiff. The total catch in pounds was then recorded from each cod-end check during each night's fishing. When the catches were weighed, one-pound sample counts were made in order to convert total weight into numbers of fish. Fish were released at the fyke net site except when specimens were needed for parasite or scale studies.

Collection of Biological Data

A representative sample of smolts was saved from each cod-end check and placed in containers. At the end of the fyke netting period, one pound sub-sample was taken for each hour that the net fished. These fish were anesthetized in MS-222 *(Tricaine methanesulfonate)*, measured (snout to tail-fork), and returned to the water unharmed.

A tally was also kept from each sample to determine the percentage of parasitized smolts.

Every fifth day a one-pound sample was preserved in formalin to be used in age determination of the smolt outmigration.

A condition sample was taken from the peak of the run.

RESULTS

Fishing Site and Schedule

The location of the fyke net remained at the previously established index site, the south shore of Lake Aleknagik, at Mosquito Point. The position of the net varied according to fluctuation of lake level, maintaining, in general, a depth of just less than four feet.

The fyke net was fished each night from 9 p.m. to 11 p.m., the previously established index hours. Field operations commenced on May 30 and continued through July 21.

The breakup of lake ice occurred on June 3, which was consistent with past records of breakup on Lake Aleknagik. The breakup hindered operations for several days and the fishing schedule on June 3 was missed because of the large floes of ice in the river.

The index fishing hours were also missed on July 17 because of an extremely high wind.

Index of Abundance

The total catch of red salmon smolts during the index hours for the entire season was 151,206 (Table 2). Using 1952 as the base year with the assigned value of 100.0 index points, the 1963 season catch was equivalent to 88.93 index points (Tables 2 and 5).

Table 2. Wood River red salmon smolt catch by hour and day, 1963.

Date	Index Hours		Total Index Catch		Index Points	
	2100-2200	2200-2300	Daily	Cumulative	Daily	Cumulative
May 30	0	74	74	74	0.04	0.04
31	27	162	189	263	0.11	0.15
June 1	354	2,776	3,130	3,393	1.84	1.99
2	344	354	698	4,091	0.42	2.41
4	802	3,655	4,457	8,548	2.62	5.03
5	383	787	1,170	9,718	0.69	5.72
6	0	1	1	9,719	0.00	5.72
7	120	1,675	1,795	11,514	1.05	6.77
8	280	733	1,013	12,527	0.60	7.37
9	3	998	1,001	13,528	0.59	7.96
10	0	358	358	13,886	0.21	8.17
11	1,878	16,308	18,186	32,072	10.69	18,86
12	4,821	7,435	12,256	44,328	7.21	26.07
13	0	5	5	44,333	0.00	26.07
14	2	32	34	44,367	0.02	26.09
15	6,300	20,212	26,512	70,879	15.59	41.68
16	2,694	5,041	7,735	78,614	4.55	46.23
17	9,806	9,103	18,909	97,523	11.12	57.35
18	478	1,818	2,296	99,819	1.35	58.70
19	961	2,600	3,561	103,380	2.10	60.80
20	1,483	14,242	15,725	119,105	9.25	70.05
21	6	1,481	1,487	120,592	0.87	70.92
22	347	62	409	121,001	0.24	71.16
23	0	387	387	121,388	0.23	71.39
24	269	50	319	121,707	0.19	71.58
25	252	432	684	122,391	0.40	71.98
26	0	1	1	122,392	0.00	71.98
27	0	358	358	122,750	0.21	72.19
28	21	391	412	123,162	0.24	72.43
29	0	6	6	123,168	0.01	72.44
30	3,446	2,806	6,252	129,420	3.67	76.11
July 1	2,267	2,509	4,776	134,196	2.81	78.92
2	5,184	1,100	6,284	140,480	3.70	82.62
3	1,241	451	1,692	142,172	0.99	83.61
4	384	1,147	1,531	143,703	0.90	84.51

-Continued-

Table 2. Wood River red salmon smolt catch by hour and day, 1973 (continued).

Date	Index Hours 2100-2200	Index Hours 2200-2300	Total Index Catch Daily	Total Index Catch Cumulative	Index Points Daily	Index Points Cumulative
July 5	0	27	27	143,730	0.02	84.53
6	0	84	84	143,814	0.05	84.58
7	244	478	722	144,536	0.42	85.00
8	0	53	53	144,589	0.03	85.03
9	3	122	125	144,714	0.08	85.11
10	35	624	659	145,373	0.39	85.50
11	552	2,413	2,965	148,338	1.74	87.24
12	358	1,248	1,606	149,944	0.94	88.18
13	224	666	890	150,834	0.53	88.71
14	4	0	4	150,838	0.00	88.71
15	0	5	5	150,843	0.00	88.71
16	0	336	336	151,179	0.20	88.91
18	0	3	3	151,182	0.00	88.91
19	0	1	1	151,183	0.00	88.91
20	0	2	2	151,185	0.00	88.91
21	0	21	21	151,206	0.02	88.93
Total	45,573	105,633	151,206	151,206	88.93	88.93
Percent	30.14%	69.86%				

1700.34 = 1 index point

The peak of the migration occurred on June 15, when 26,512 smolts were caught during the index hours; however, heavy migration occurred throughout the season from June 11 to July 2 (Figure 3). Late season peaks in 1963 account for over 20 percent of the migration and are probably due to the later arriving smolts from the upper lakes.

The 1963 index is well below the average index value of 220.0 obtained over a 13-year period.

With the exception of 1951, this year's run at Wood River was the second lowest in 13 years of recorded smolt outmigrations. Figure 4 shows in graph form the relative magnitude of the smolt runs from the Wood River system from 1951 through 1963.

Timing of the Migration

The catches during the index hours followed the usual pattern. Migration was lowest during the first hour (30.14%), and increased during the second hour (69.86%). Catches were larger in the first hour on a few occasions, but this seldom occurred during nights of heavy migration.

Perhaps the most important factor in the overall timing of the seasonal migration pattern at Wood River is the weather. Timing of the early season migration was closely associated with breakup of lake ice, and water temperatures. The beginning of the heavy seasonal migration was delayed until the lake outlet temperatures reached 38°-39° F. following breakup of lake ice in early June.

Other influences which may have had a significant effect on timing of migration were:

1. Changes in relative numbers in the sub-population of smolts from the lakes.

2. Differences between size and age of smolts.

3. Differences in rate of growth in early summer.

Cessation of seaward migration coincided very closely with the lake surface waters warming to over 50° Fahrenheit.

Size and Age Composition

Length frequency and age data were grouped into ten periods. All were five-day periods with the exception of the last period which was six days. The number of smolts caught in each period, percentage of the season catch by period, number of samples taken, number of fish measured, and the number of scales read are shown in Table 3.

Combined length frequencies for each period are shown in Figure 5, with the dividing line between age I and II smolts as determined by scale readings, (indicated by a vertical dash). These frequencies were calculated in percentages.

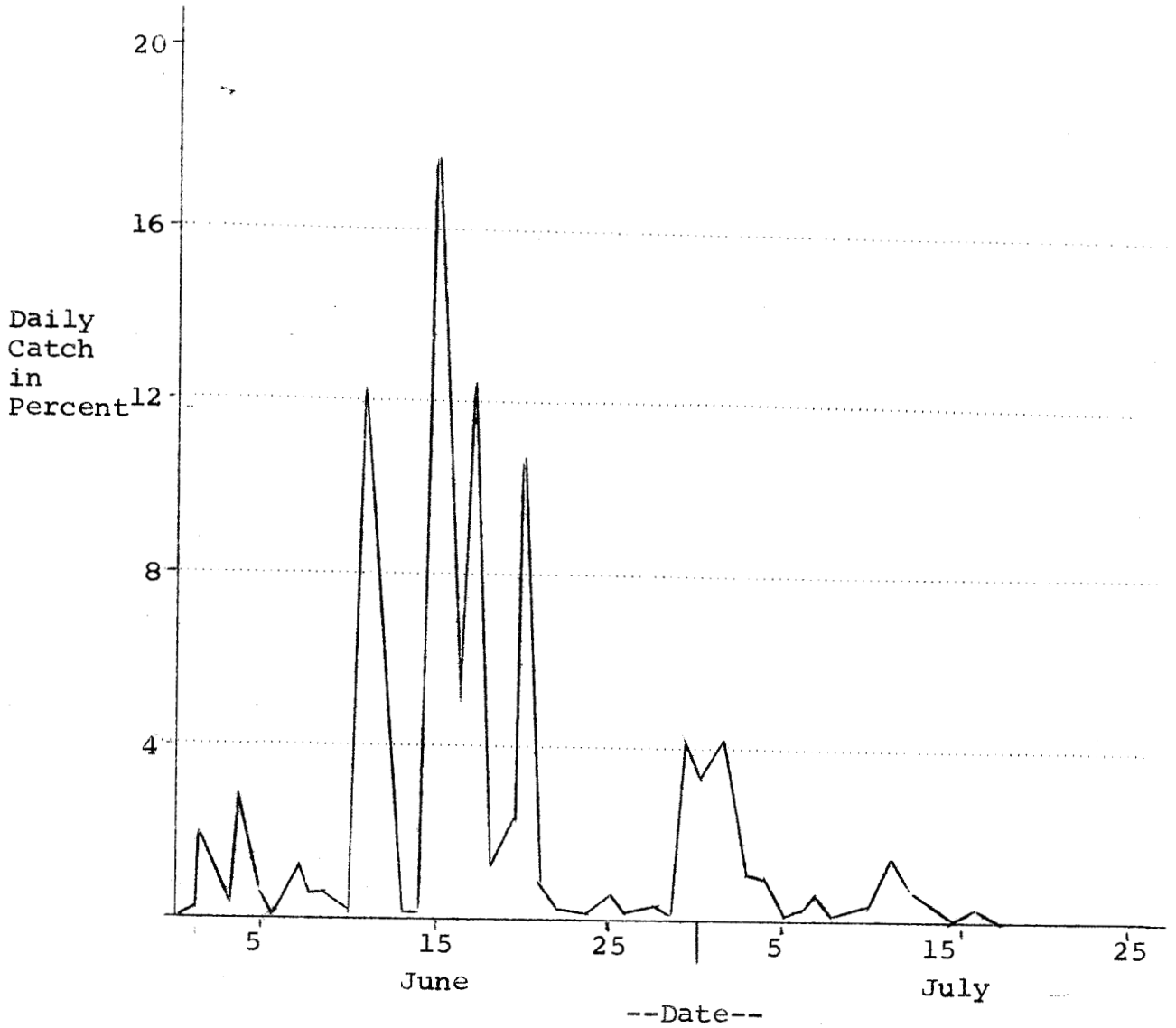

Figure 3. Daily catches of red salmon smolt in percent of total catch, from the Wood River system, 1963.

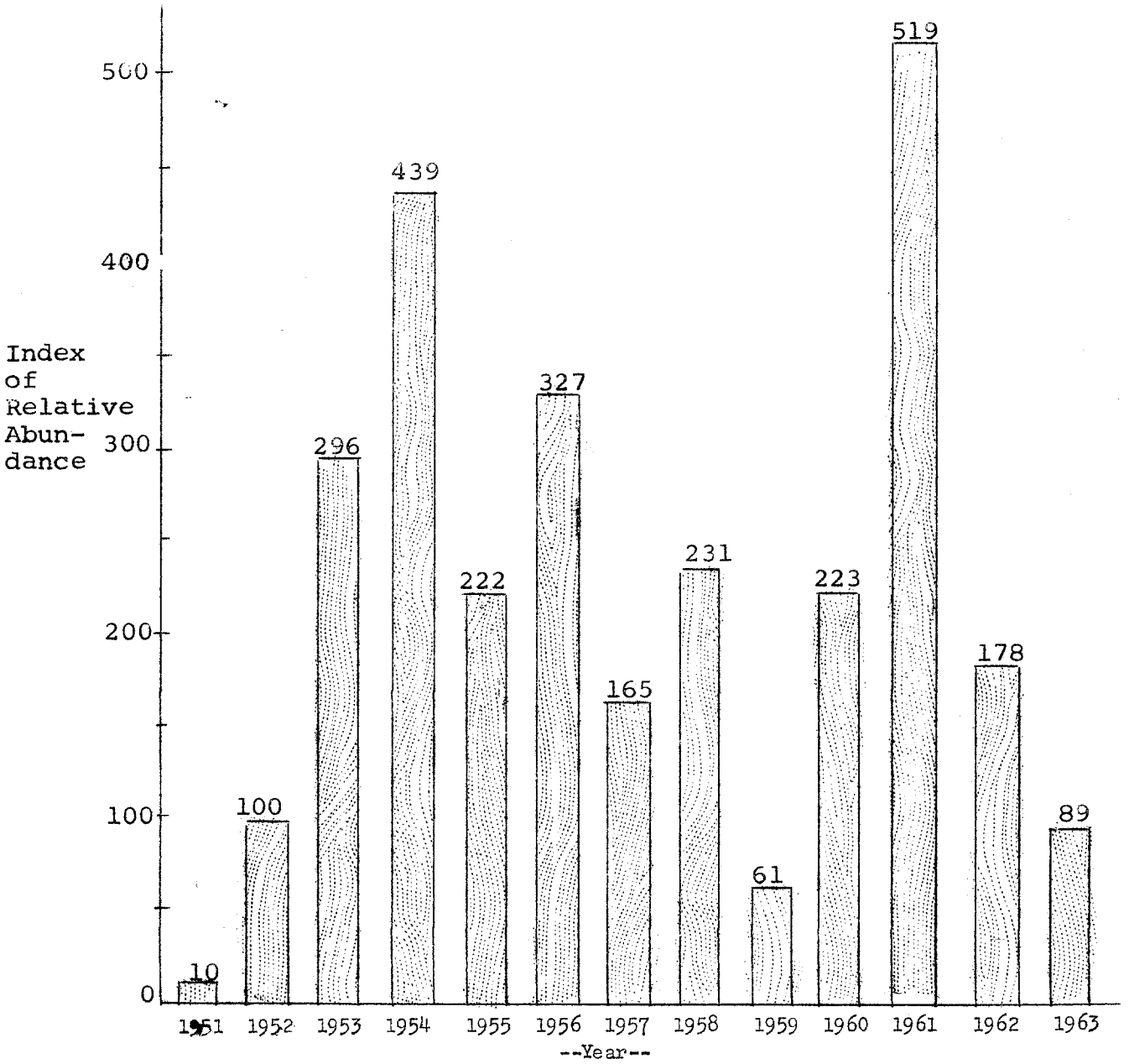

Figure 4. Relative magnitude of red salmon smolt runs from the Wood River system, 1951-1963.

Table 3. Wood River smolt sampling data, 1963.

Period No.	Date	Smolt Catch	Pct. of Seasons Total	No. of 1# Samples Measured	No. of Fish Measured	No. of Scales Read
1	May 30-June 4	8,548	5.65	5	295	21
2	June 5-9	4,980	3.29	6	464	28
3	June 10-14	30,839	20.40	5	388	30
4	June 15-19	59,013	39.03	10	827	35
5	June 20-24	18,327	12.12	6	477	28
6	June 25-29	1,461	0.97	4	330	27
7	June 30-July 4	20,535	13.58	9	721	16
8	July 5-9	1,011	0.67	2	137	27
9	July 10-14	6,124	4.05	7	392	28
10	July 15-21	368	0.24	1	60	0
Total		151,206	100.00	55	4,091	240

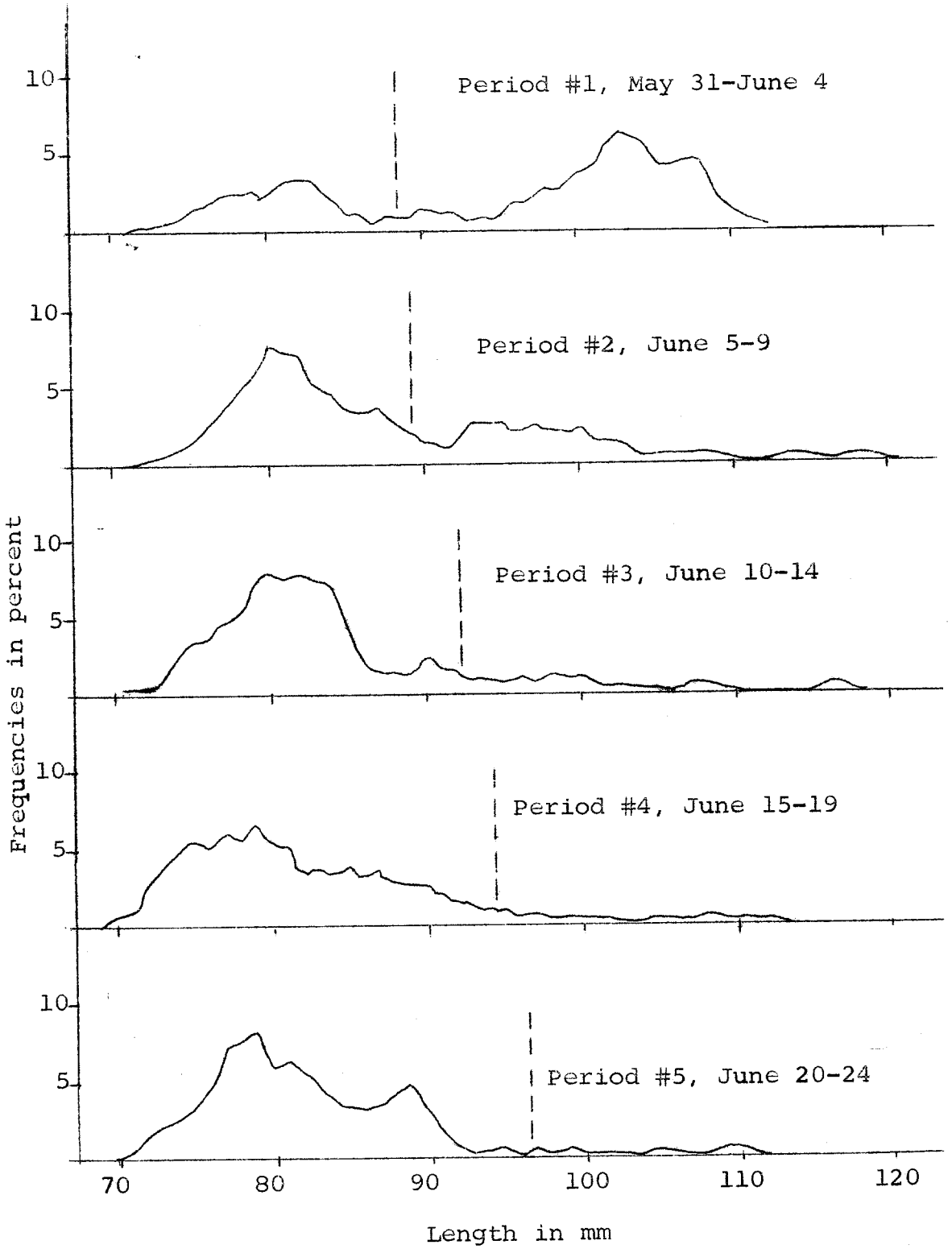

Figure 5. Weighted length frequencies of red salmon smolt from the Wood River system, 1963. (Vertical dash lines divide Age I and Age II). (Frequencies smoothed by moving averages of threes).

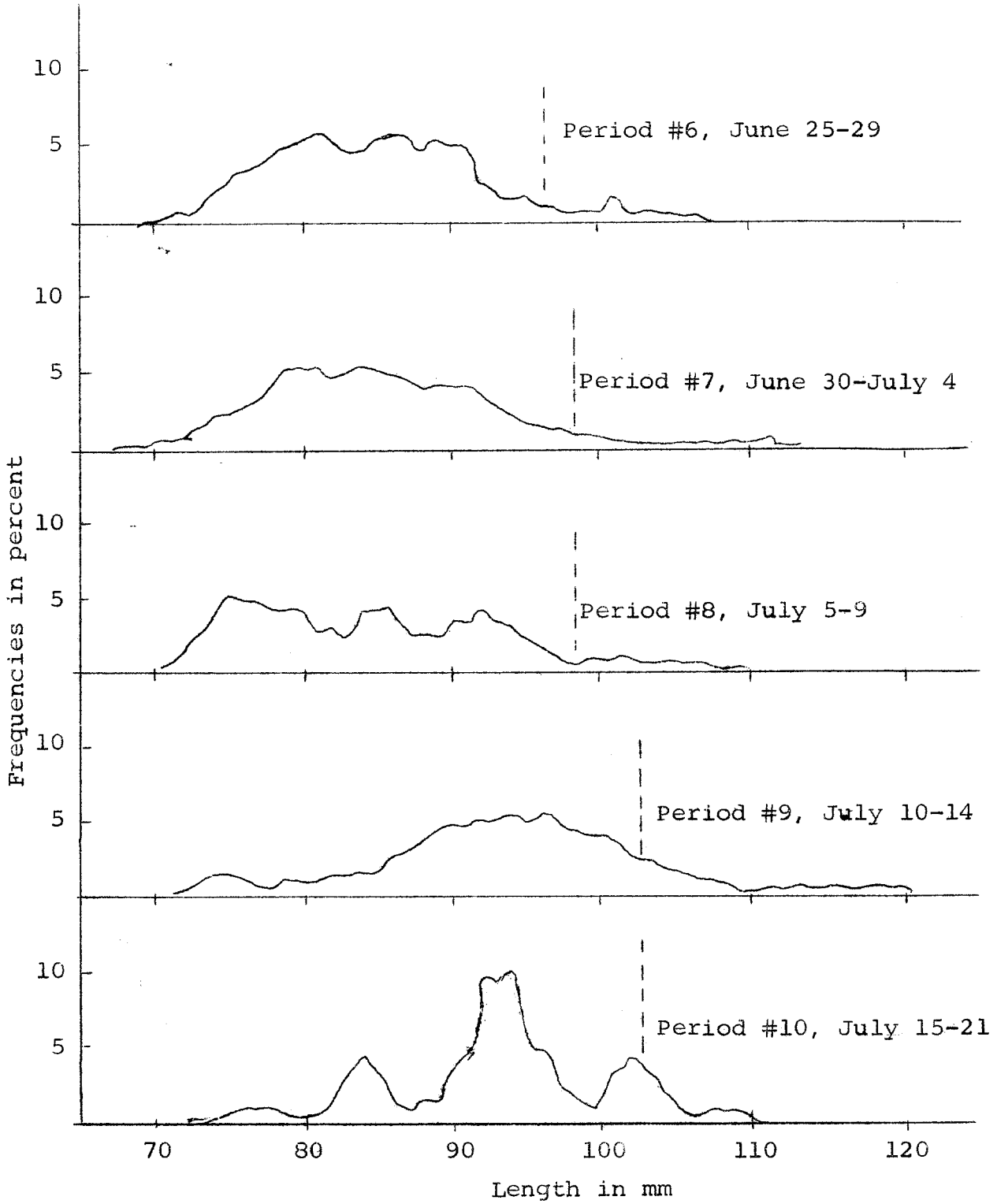

Figure 5. Weighted length frequencies of red salmon smolt from the Wood River system, 1963. (Vertical dash lines divide Age I and Age II). (Frequencies smoothed by moving averages of threes) - continued.

Progression in size during the season is evident in both age groups. Evident also is the dominance of age I fish throughout the season, with the exception of the first period when age II smolts were in greater numbers.

The season's weighted length frequency distribution is shown in Figure 6.

Size composition was determined from length measurements of 4,091 smolts contained in 55 one-pound samples. Age determination was based on readings of 240 scales contained in 10 scale samples, one taken each five-day period.

The percentage and mean length of each age group were calculated for each period and for the entire season (Table 4). Age I smolts comprised 81.15 percent of the total run and averaged 84.5 mm in length; age II smolts comprised 18.85 percent of the run and averaged 102.9 mm in length.

The lack of increase in size during the season and fluctuation of mean lengths of both age groups in the mid-periods is probably due to the presence of different populations of smolts.

The pattern of seasonal changes in smolt length frequency is cause for speculation of possible migration trends within this multi-lake system. Smolt work conducted by the Fisheries Research Institute in 1961 showed that the Kulik and Little Togiak Lake, age I smolts migrated during the same period of time (or even slightly later) than did the same age fish as Mosquito Point. If it is assumed that smolts from each lake are approximately the same size at beginning of migration, the gradual increase in size of age I smolts during the season could be interpreted as plus-growth. Thus the first age I fish caught at Mosquito Point would be from Lake Aleknagik and the last fish from the upper lakes. As the age II smolts are the first to migrate at Mosquito Point, they are likely to be fish from the extreme upper lakes which encountered a late season temperature block at Mosquito Point and have wintered in Lake Aleknagik until suitable temperatures the following spring.

The further observed pattern of decrease in size of yearling smolts during each evening migration may be due to difference in swimming speed or migration stimulus.

Table 5 summarizes the comparative age, length, and index catches of the years 1951 through 1963.

Condition of Smolts

The condition index of the smolt run was calculated on the basis of weight per fish of a given length. Fish were measured in millimeters and collected in 5 mm groupings. Each group of 10 fish (or fewer in extreme size groups where 10 fish were not available) was weighed in grams and weight per fish was calculated and compared with the previous nine year mean (Table 6).

The condition sample was taken from the smolt catch of June 17, one of the peak nights.

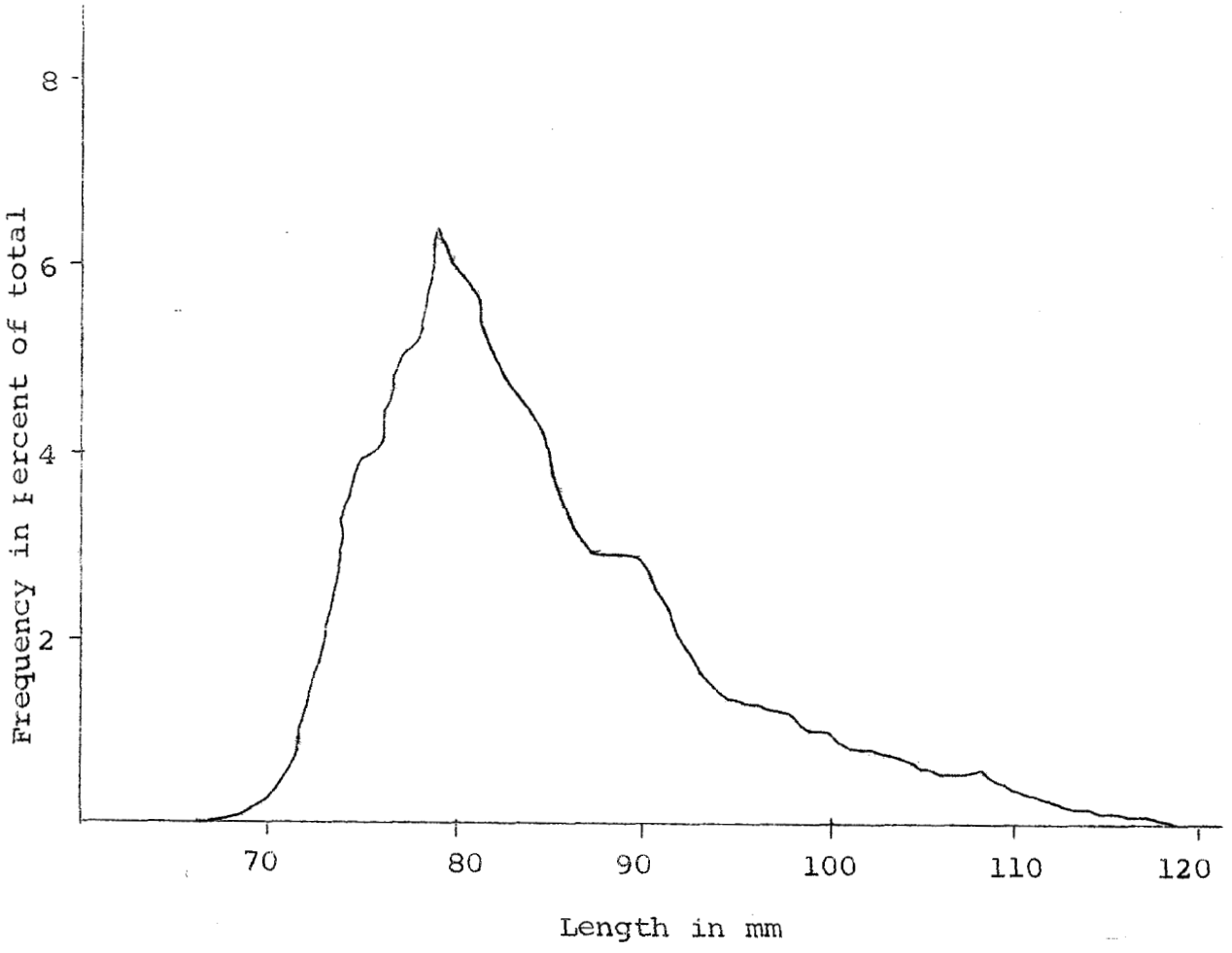

Figure 6. Season's weighted length frequency of red salmon smolts from the Wood River system, 1963. (Frequencies smoothed by moving averages of threes).

Table 4. Length and age of red salmon smolts from Wood River system, 1963.

Period No.	Date	Line Dividing Age I & Age II	Mean Length of Age Group I	Mean Length of Age Group II	Percentage of Age Group I	Percentage of Age Group II
1	May 30-June 4	88.5	79.6	102.4	30.51	69.49
2	June 5-9	89.5	81.4	98.0	69.18	30.82
3	June 10-14	92.5	81.6	100.3	76.29	23.71
4	June 15-19	94.5	82.2	101.6	90.81	9.19
5	June 20-24	96.5	83.4	102.5	90.78	9.22
6	June 25-29	96.5	84.3	102.4	94.85	5.15
7	June 30-July 4	98.5	83.2	104.7	96.26	3.74
8	July 5-9	98.5	85.2	102.8	89.05	10.95
9	July 10-14	102.5	91.9	108.9	85.46	14.54
10	July 15-21	102.5	91.7	105.4	88.33	11.67
Season Total			84.5	102.9	81.15	18.85

Table 5. Comparative age, length, and index catches of red salmon smolt from Wood River, 1951-1963.

Year of Seaward Migration	Age I[1] Percent	Age I[1] Mean[2] Length	Age II[1] Percent	Age II[1] Mean[2] Length	Index[4] Points	Index Net Catch
1951	80.0		20.0		9.9	16,809
1952	99.0	87.0	1.0	103.0	100.0[3]	170,034
1953	95.3	86.0	4.7	107.0	296.1	503,444
1954	95.8	87.0	4.2	102.0	438.6	745,769
1955	98.0	85.0	2.0	95.0	221.7	376,965
1956	78.4	82.0	21.6	93.0	329.4	555,331
1957	80.7	77.0	19.3	102.0	165.5	281,406
1958	65.0	82.0	35.0	105.0	230.9	392,609
1959	93.5	88.0	6.5		60.5	102,020
1960	86.0	88.0	14.0	102.0	223.0	379,176
1961	93.0	82.0	7.0	102.1	518.7	881,911
1962	85.9	80.1	14.1	97.6	177.6	301,892
1963	81.2	84.5	18.8	102.9	88.9	151,206
Average	87.1	84.1	12.9	100.7	220.0	373,736

[1] Number winters in freshwater.

[2] Mean length in mm.

[3] Base year; assigned value of 100.00.

[4] One index point = 1,700.34 smolt.

Table 6. Condition index of red salmon smolts from Wood River system, 1963.

Mid-Point of 5 mm Grouping.	Gms. Per Fish 1954-62 Mean	Gms. Per Fish 1963	Deviation of 1963 Sample from 1954-62 Mean
75	3.36	3.74	+.38
80	4.01	4.44	+.43
85	4.87	5.17	+.30
90	5.68	6.07	+.39
95	6.75	7.07	+.32
100	8.02	8.56	+.54
105	9.11	9.70	+.59
110	10.44	11.15	+.71
115	11.76	13.75	+1.99
120	13.33		

The 1963 smolt were larger and in better condition than either the 1961 or 1962 smolt runs (Table 7). This would be expected, as increased growth is usually associated with smaller populations within the lake.

The parasitic cestode, *Triaenophorus crassus*, was found to be a common parasite among the smolts in 1963. All of the smolts anesthesized and measured (4,091) were examined for this parasite. It was found that 26.9 percent were infested. The 1963 percentage of infestation compares closely with the value of 22.8 percent found in 1962.

Smolt Production versus Escapement Levels

The 1963 smolt run originated from the adult escapements of 1,016,000 in 1960 and 461,000 in 1961.

As the Wood River smolt are predominately one-check fish when they leave fresh water, it was anticipated that the low escapement in 1961 would provide the bulk of the run. This proved to be the case when 81.2 percent of the total outmigration was determined to be from the 1961 spawning.

As shown in Table 8, there is no close relationship between the size of escapement and the smolt indices. There is, however, an indication that the years of large escapements produce more smolts. It can be concluded that seasonally fluctuating conditions other than escapement size may greatly effect survival to smolt stage and must be considered in an evaluation of optimum escapement for this system.

SUMMARY

Nineteen hundred and sixty-three was the 13th consecutive year for smolt enumeration and sampling at the outlet of Lake Aleknagik, and the third year that the studies have been conducted by the Alaska Department of Fish and Game.

The index of abundance was obtained by use of the standard-type fyke net and other equipment comparable with previous years.

The net was fished during the previously established index hours of 9 p.m. to 11 p.m. each night from May 30 through July 21.

Breakup occurred on June 3 at Lake Aleknagik and hindered operations for several days.

The total catch of 151,206 smolts or 88.93 index points was the second lowest recorded for the Wood River system in 13 years of smolt indexing.

Weather played an integral part in the timing of the migration. Migration began as the lake water warmed to 38° - 39° Fahrenheit. Cessation of the seaward migration coincided with the lake waters warming to over 50° Fahrenheit.

Table 7. Average length[1/] and weight[2/] of Wood River red salmon smolt, 1961-1963.

Year	Age Group			
	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	84.5	5.1	102.9	9.3

1/ Length in mm.

2/ Weight in grams.

Table 8. Wood River escapements and smolts produced.

Year	Wood River escapement	Index values of smolts produced			Index units per 1,000 spawners
		Age I	Age II	Total	
1961	458,000	282.2	18.4	300.6	.66
1952	227,000	420.4	4.4	424.8	1.87
1953	516,000	217.3	71.2	288.5	.56
1954	571,000	258.2	31.9	290.1	.51
1955	1,383,000	133.6	80.8	214.4	.16
1956	773,000	150.1	3.9	154.0	.20
1957	289,000	56.6	31.2	87.8	.30
1958	960,000	191.8	36.3	228.1	.24
1959	2,209,000	482.4	25.0	507.4	.23
1960	1,016,000	152.6	16.7	169.3	.16
1961	461,000	72.2	1/		

1/ The Age II smolts from the 1961 escapement will not leave freshwater until 1964.

Size composition was determined from length measurements of 4,091 smolts contained in 55 one-pound samples. Age determinations were based on readings of 240 scales contained in 10 samples.

Age I smolts comprised 81.15 percent of the total run and averaged 84.5 mm in length. Age II smolts comprised 18.85 percent of the run and averaged 102.9 mm in length.

From the condition sample on June 17 it was concluded that smolts from the 1963 outmigration were larger and in better condition that from the two previous years.

The parasitic cestode, *Triaenophorus crassus*, was found in 26.9 percent of the smolts examined.

The 1963 smolt run originated from the adult escapement of 1,016,000 in 1960 and 461,000 in 1961.

It was concluded that in this system there is no close relationship between the size of parent escapement and the smolt index produced.

The Alaska Department of Fish and Game administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information please write to ADF&G, P.O. Box 25526, Juneau, AK 99802-5526; U.S. Fish and Wildlife Service, 4040 N. Fairfax Drive, Suite 300 Webb, Arlington, VA 22203 or O.E.O., U.S. Department of the Interior, Washington DC 20240.

For information on alternative formats for this and other department publications, please contact the department ADA Coordinator at (voice) 907-465-6077, (TDD) 907-465-3646, or (FAX) 907-465-6078.