SPAWNING ESCAPEMENT OF OKANOGAN RIVER BLUEBACK SALMON (*O. nerka*), 1957

SPECIAL SCIENTIFIC REPORT–FISHERIES No. 275

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

EXPLANATORY NOTE

The series embodies results of investigations, usually of restricted scope, intended to aid or direct management or utilization practices and as guides for administrative or legislative action. It is issued in limited quantities for official use of Federal, State or cooperating agencies and in processed form for economy and to avoid delay in publication.

United States Department of the Interior, Fred A. Seaton, Secretary
Fish and Wildlife Service, Arnie J. Suomela, Commissioner

SPAWNING ESCAPEMENT OF OKANOGAN RIVER BLUEBACK SALMON (*ONCORHYNCHUS NERKA*), 1957

by

Donovan R. Craddock
Fishery Research Biologist

Special Scientific Report--Fisheries No. 275

Washington, D. C.

December 1958

The Library of Congress catalogue card for this publication is as follows:

Craddock, Donovan R
Spawning escapement of Okanogan River blueback salmon (Oncorhynchus nerka) 1957. Washington, U. S. Dept. of the Interior, Fish and Wildlife Service, 1958.

8 p. diagrs., tables. 27 cm. (Special scientific report—fisheries, no. 275)

Bibliography: p. 7.

1. Salmon. I. Title. (Series: U. S. Fish and Wildlife Service. Special scientific report: fisheries, no. 275)

[SH11.A335 no. 275] Int 59-19

U. S. Dept. of the Interior. Library
for Library of Congress

The Fish and Wildlife Service series, Special Scientific Report--Fisheries, is catalogued as follows:

U. S. *Fish and Wildlife Service.*
Special scientific report: fisheries. no. 1-
[Washington] 1949-

no. illus., maps, diagrs. 27 cm.

Supersedes in part the Service's Special scientific report.

1. Fisheries—Research.

SH11.A335 639.2072 59-60217

Library of Congress

ABSTRACT

The blueback salmon spawning area of the Okanogan River has been surveyed extensively each year since the start of a Canadian flood-control project in 1951. The spawning populations have been estimated and their distribution above Rock Island Dam determined. The large number of fish unaccounted for may be partially attributed to mortalities caused by the high water temperatures existing in the Okanogan River prior to spawning.

The age, length, and sex compositions of the 1957 Okanogan River spawning escapement were determined from samples collected on the spawning grounds. Although some delay in passage occurred at the thirteen newly completed drop structures, completeness of spawning was not abnormally low.

The occurrence of large numbers of 3_2's in the spawning population seems to be peculiar to the Okanogan River.

The distribution of fish on the spawning grounds has not changed appreciably since 1952.

TABLE OF CONTENTS

SPAWNING ESCAPEMENT OF OKANOGAN RIVER BLUEBACK SALMON (ONCORHYNCHUS NERKA), 1957

The encroachment of civilization has greatly restricted the spawning migrations of the Columbia River blueback salmon. The Osoyoos, Wenatchee, and Redfish Lake systems are the only spawning and rearing areas of importance remaining available to this valuable species of Columbia River salmon.

The spawning area of the Okanogan, which is the most important of the three systems, has been channelized recently in connection with a Canadian flood-control project. This channelization necessitated construction of 13 drop structures (small dams with 3 feet of head) which the salmon must ascend on their migration from Lake Osoyoos to the spawning area. Annual surveys have been made to determine the immediate effect of the flood-control work on the salmon and to see that all steps necessary for their protection are taken. The long-range effect of this project on the Okanogan blueback runs will not be known for several years.

SURVEYS

Blueback spawning activities in the Okanogan have been surveyed extensively each year since the flood-control project started in 1951. Five surveys were made this season in much the same manner as in previous years. The 1957 surveys were of particular interest because for the first time the fish have had to ascend the new channel with its 13 drop structures. Since a partial block existed at drop structure No. 2 during the last half of September, special attention was given to the spawning success of the migrants. This delay plus the possibility of other delays could cause the fish to arrive at the spawning area too late and too weak for successful spawning.

The section designations used in previous years were followed closely. These sections and the location of the drop structures are depicted in figure 1 (page 2). Conditions for observing the spawners were very good except on October 22, when wind and snow made observations difficult. The area from the Southern Okanogan Lands Project Dam to drop structure No. 13 was surveyed by rubber boat, and the area from drop structure No. 13 to Lake Osoyoos was checked from the dike paralleling the river. A few spawning fish were observed near drop structures No. 6 and No. 13, but the spawning below No. 13 was of little importance.

SPAWNING ESCAPEMENT

Table 1 presents the actual counts made on the various surveys and table 2 shows the spawning population estimate derived by the "Factor 5" method. This method (Gangmark and Fulton 1952) has been used on the Okanogan for several years. Although we are convinced that it gives a consistently low estimate, we feel that it serves as a reliable index of the magnitude of the spawning population.

The 1957 count of blueback through the fishways at Rock Island dam was 71,261. Of these, 28,231 were counted at Tumwater Dam on the Wenatchee River, 811 were taken by "up river" hatcheries and miscellaneous samples, and an estimated 3,017 were taken by the Okanogan Indian fishery. The "Factor 5" estimate of 25,350 for the Okanogan spawning population leaves 13,919 fish or 19.5 percent of the Rock Island blueback count unaccounted for. Table 3 is a record of the distribution of blueback above Rock Island obtained by using "Factor 5" estimates for the Okanogan. The increasing number of fish accounted for in recent years is probably due to improved survey techniques and accurate counts obtained at Tumwater Dam.

WATER TEMPERATURE

Although it has not been proved, many of the fish unaccounted for may have succumbed to the effects of the high temperatures encountered in the Okanogan during the migration period (fig. 2). For more than 2-1/2 months during July, August, and September, the river temperature was well above the 65°F. level. These high temperatures are common since the four

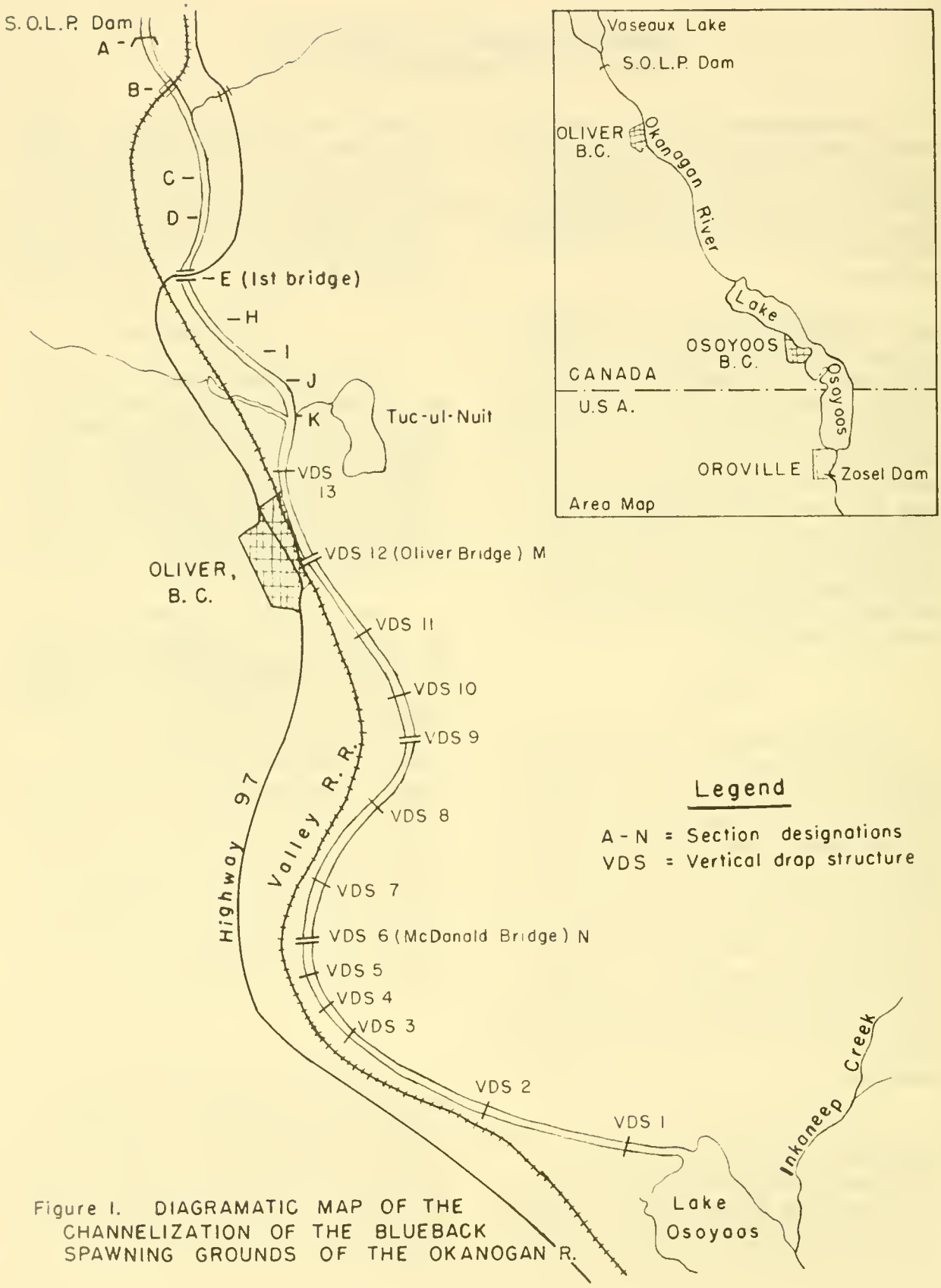


Figure 1. DIAGRAMATIC MAP OF THE CHANNELIZATION OF THE BLUEBACK SPAWNING GROUNDS OF THE OKANOGAN R.

Table 1.--Spawning ground surveys, Okanogan River, 1957

Section	Sept. 25		Oct. 1		Oct. 8		Oct. 15		Oct. 22		Total live	Total dead
	Live	Dead	Live	Dead	Live	Dead	Live	Dead	Live	Dead		
A	129		155		285		221	1	48		838	1
B	272		491		1773	2	1212	50	463	112	4211	164
C	173		923		1879	3	1343	47	320	198	4638	248
D	115		530		570		1286	44	343	283	2844	327
E-H	252		759	4	2803	12	1551	384	436	858	5863	1258
H-K	44		299		1179	17	1076	154	248	397	2784	568
K-13			50		10		30				90	
Total	985		3207	4	8499	34	6719	680	1858	1848	21,268	2,566

Table 2.--"Factor 5" estimates of Okanogan spawning population, 1957

Section	Survey date 1/	Count	Average	(X)5
A	10/1	155	177	885
	10/8	285		
	10/15	221		
	10/22	48		
B	10/1	491	985	4925
	10/8	1773		
	10/15	1212		
	10/22	463		
C	10/1	923	1116	5580
	10/8	1879		
	10/15	1343		
	10/22	320		
D	10/1	530	682	3410
	10/8	570		
	10/15	1286		
	10/22	343		
E-H	10/1	759	1387	6935
	10/8	2803		
	10/15	1551		
	10/22	436		
H-K	10/1	299	701	3505
	10/8	1179		
	10/15	1076		
	10/22	248		
K-M	10/1	50	22	110
	10/8	10		
	10/15	30		
	10/22	0		
			Estimate:	25,350

1/ The Survey of 9/25 was eliminated since spawning was not actually in progress.

large lakes in the Okanogan chain permit great surface heating.

Figure 2 also illustrates the variation in temperature, 62° to 48°F., during the period of spawning. The peak of spawning occurred at a temperature of approximately 53°F.

COMPOSITION OF ESCAPEMENT

A sample of 695 fish was measured on the Okanogan spawning grounds. The length frequency curve, figure 3, clearly indicates the occurrence of the two age classes comprising the spawning population. Examination of the otoliths from 79 of these fish disclosed that the dividing line between the 3_2's and 4_2's lies between 18 inches and 18-1/4 inches for females and between 18-1/2 inches and 18-3/4 inches for males (table 4). This table also demonstrates the divergence of the sex ratios in the two age classes as well as the age-class composition of the entire sample. The 3_2's made up 30 percent of the sample and had a sex ratio of 1 male to 0.54 females while the 4_2's made up 70 percent of the sample and had a sex ratio of 1 male to 1.62 females.

SPAWNING SUCCESS

Table 5 is a record of a much larger sample examined for sex and for spawning success. A total of 2,046 fish were sexed, and the females were examined for completeness of spawning. The overall sex ratio of males to females in this sample was 1: 1.34, and 92 percent of the females were completely spawned. In 1955 and 1956 the percentages of completely spawned fish were 94 and 95 respectively, which indicates that the delays encountered by the 1957 spawners did not materially affect their spawning success.

Table 3.--Distribution of blueback salmon above Rock Island dam

Year	Okanogan factor 5	Wenatchee counts 1/	Entiat & Methow Hatchery	Indian catch	Total accounted for	R.I. count	% of R. I. count accounted for
1947	18,125	38,230	135	5,000	61,490	79,834	77.02
1948	35,885	38,205	90	5,000	79,180	84,627	93.56
1949	310	3,880	-	500	4,690	18,682	25.10
1950	-	-	-	2,500	-	50,059	-
1951	12,240	17,495	200	5,000	34,935	102,724	34.01
1952	25,000	19,200	1,000	3,000	48,200	113,703	42.39
1953	34,260	15,000	3,203	4,533	56,996	152,013	37.49
1954	13,206	25,000	100	3,946	42,252	91,184	46.33
1955	47,930	50,000	1,105	4,626	103,661	155,782	66.54
1956	39,256	25,518	203	3,598	68,575	92,209	74.37
1957	25,350	28,231	811	3,017	57,409	71,261	80.56

1/ Factor 5 estimates through '52 and counts at Tumwater Dam thereafter.

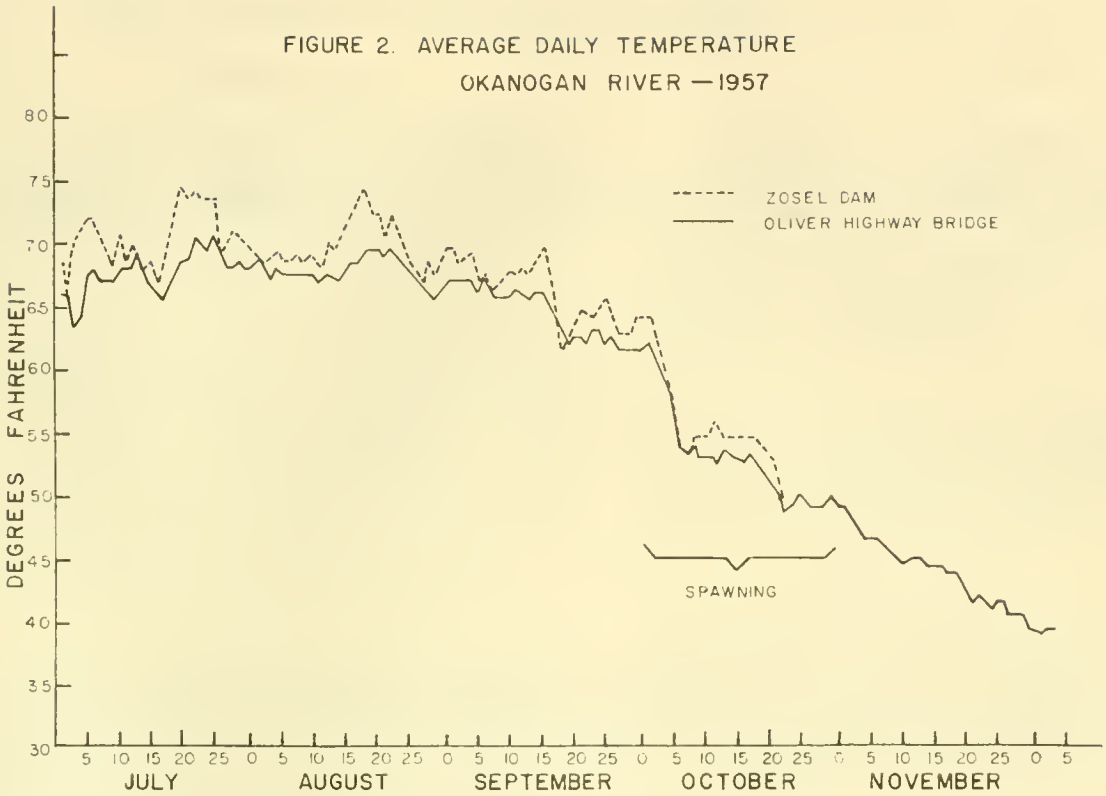


FIGURE 2. AVERAGE DAILY TEMPERATURE
OKANOGAN RIVER — 1957
ZOSEL DAM
OLIVER HIGHWAY BRIDGE
SPAWNING
DEGREES FAHRENHEIT
80
75
70
65
60
55
50
45
40
35
30
5 10 15 20 25 0 5 10 15 20 25 0 5 10 15 20 25 0 5 10 15 20 25 0 5 10 15 20 25 0 5
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER

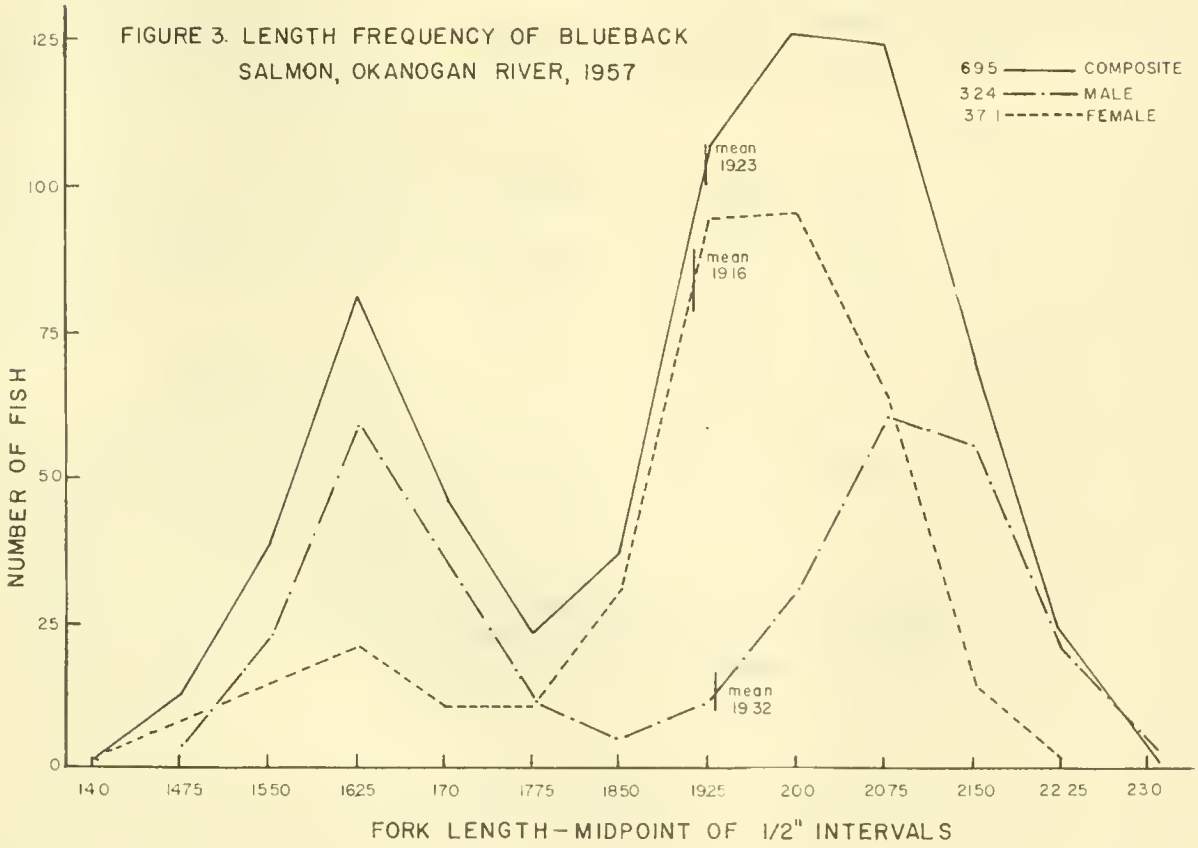


FIGURE 3. LENGTH FREQUENCY OF BLUEBACK
SALMON, OKANOGAN RIVER, 1957
695 COMPOSITE
324 MALE
371 FEMALE
mean 19.23
mean 19.16
mean 19.32
NUMBER OF FISH
125
100
75
50
25
0
14.0
14.75
15.50
16.25
17.0
17.75
18.50
19.25
20.0
20.75
21.50
22.25
23.0
FORK LENGTH — MIDPOINT OF 1/2" INTERVALS

Table 4.--Age-group breakdown as determined from otolith study, Okanogan blueback, 1957.

Age group	Males No.	Males Length	Females No.	Females Length	Total	Sex ratio M : F	Percent females	% of total sample
32	139	<18-3/4"	70	< 18-1/4"	209	1.00:0.54	35	30
42	185	18-3/4" ≥	301	18-1/4" ≥	486	1.00:1.62	62	70
Total	324		371		695	1.00:1.14	53	100

Table 5.--Sex ratio and spawning success of Okanogan blueback, 1957.

Survey date	Total dead	Dead exam.	Sex M	Sex F	Sex ratio M : F	% F	Spawning success of females 1/ SPO	USP	PSP	%SPO
Sept. 25	0									
Oct. 1	4	2	1	1	1.00:1.00	50			1	
Oct. 8	34	26	11	15	1.00:1.36	58	10	4	1	67
Oct. 15	680	360	198	162	1.00:0.82	45	140	8	14	86
Oct. 22	1848	1658	663	995	1.00:1.50	60	929	29	37	93
Total	2566	2046	873	1173	1.00:1.34	57	1079	41	53	92

1/ SPO - spawned out - over 75% Spent.
USP - unspawned - less than 25% Spent.
PSP - partially spawned - 25 to 75% Spent.

OCCURRENCE OF 3_2's

The 1957 return of blueback was of special interest since the 4_2's were the progeny of the 1953 escapement which was one of the largest in recent years. The most unusual feature of the 1953 run was that over 86 percent of the Okanogan spawners were 3-year-old fish whose sex ratio of males to females was 1:0.75. The bulk of these 3-year-old fish escape the fishery and continue to the Okanogan where in normal years they comprise about 22 percent of the spawning population. These small fish seem to be peculiar to the Okanogan and are seldom encountered in the other two systems. Table 6 demonstrates the occurrence of 3-year-old Columbia River blueback for the last 7 years.

The comparatively low return to the Okanogan this year may be partly attributed to the high proportion of 3-year-old fish in the 1953 run. Lower fecundity and possibly lower fertility linked with reduced survival of eggs, fry, and fingerlings because of their small size may be factors contributing to the low return.

DISTRIBUTION

The distribution on the spawning grounds has not changed appreciably in the last 5 years. The one exception is section M-N, which for all practical purposes supported no spawning this year (fig. 4). During the past 5 years section M-N supported an average of only 7 percent of the spawners.

EXPERIMENTAL CHANNEL

Channel improvement work in sections B to D was responsible for reducing the flow in the experimental channel to a mere fraction of normal. Consequently, only 88 fish were observed spawning in this channel compared to 2,600 for last year. This same channel work seriously reduced the flow in the west channel causing an additional loss of spawning area.

SUMMARY AND DISCUSSION

The 1957 Rock Island count of blueback salmon was the smallest recorded since 1950. This decline was more evident in the Okanogan than in the Wenatchee system. It has been speculated that lower fecundity and poor survival of the spawn of the 3_2's that made up 86 percent of the Okanogan run in 1953 was a factor in this year's low return.

The 1957 spawning escapement to the Okanogan was composed of 30 percent 3_2's and 70 percent 4_2's. The sex ratios of the two age classes were widely divergent. The 3_2's had 35 percent females and the 4_2's had 62 percent females.

Spawning success was good and apparently was not affected by the delays caused by the drop structures. However, the drop at many of the structures was considerably greater than anticipated, and some modification may be necessary to increase the ease of fish passage at these structures.

In general the escapement was adequate and spawning appeared to be successful.

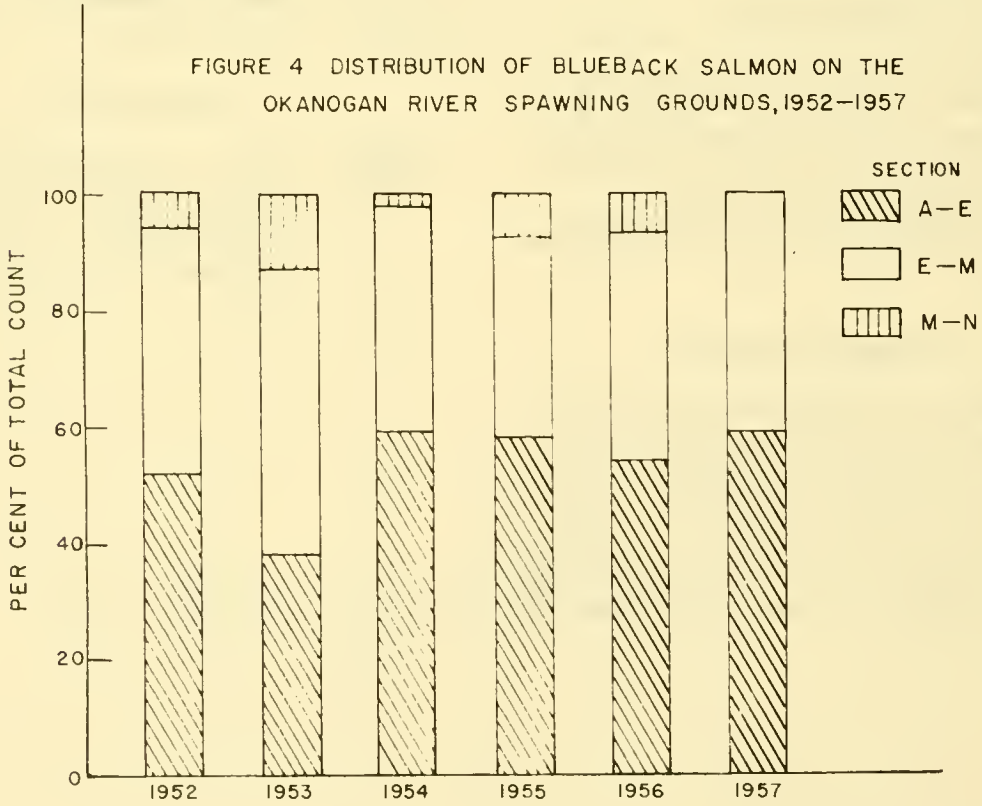
LITERATURE CITED

GANGMARK, HAROLD A., AND LEONARD A. FULTON
1952. Status of Columbia River blueback runs, 1951. U. S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 74, 29 pp.

Table 6.--Occurrence of 3-year-old Columbia River blueback salmon

Year	Total run	Rock Isl. dam counts: Large fish	Rock Isl. dam counts: Small fish	Rock Isl. dam counts: Total	Rock Isl. small fish: % of total run	Rock Isl. small fish: % of Rock Is. count	Wenatchee River system	Okanogan River 1/	% of 3₂s Okanogan
1951	204,369	89,733	12,093	101,826	5.9	11.9	17,495	12,230	-
1952	320,362	104,206	9,480	113,686	3.0	8.3	19,200 1/	25,000	-
1953	260,079	99,565	52,182	151,747	20.1	34.1	15,000 1/	72,000	86.6
1954	178,581	76,748	14,486	91,234	8.1	15.9	25,000	49,000	20.9
1955	244,879	145,461	7,601	155,062	3.9	6.2	51,820	48,000	12.7
1956	202,240	74,563	17,880	92,443	8.8	19.3	25,518	40,000	24.9
1957	156,000 1/	63,733	7,528	71,261	4.8	10.6	28,231	25,000	30.0

1/ Estimates.



INT.-DUP. SEC., WASH., D.C. 48438