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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

RUSSIAN RIVER SOCKEYE SALMON STUDY

by

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STUDY NO. AFS-44 ANADROMOUS FISH STUDIES
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Job No. AFS-44-5 Russian River Sockeye Salmon Study

RESEARCH PROJECT SEGMENT

State:	ALASKA	Name:	Sport Fish Investigations of Alaska
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ABSTRACT

In 1978 the weir at the outlet of Lower Russian Lake was modified to enumerate smolts. Estimates revealed the total out-migration of sockeye salmon, *Oncorhynchus nerka* (Walbaum), smolts was 829,980, and coho salmon, *O. kisutch* (Walbaum), smolts was 16,640. Peak sockeye salmon smolt migration (75.3 percent of the total) occurred during the 10-day period May 17-26. Age 2.0 smolts comprised 90.5 percent of the sockeye salmon out-migration while age 1.0 contributed 8 percent and age 3.0, 1.5 percent. Average length of sockeye salmon smolts sampled was 89.9 millimeters (3.5 inches). Similar data are presented for coho smolts.*

A creel census was conducted during the Russian River sockeye salmon sport fishery to determine harvest and effort. The census revealed 69,860 man-days were expended to harvest 62,250 adult fish. Early and late runs contributed 37,720 and 24,530 salmon, respectively, to this harvest. Both harvest and effort estimates are the highest recorded at Russian River. Early run harvest rate was 0.183 salmon per angler hour and the late run was 0.248 salmon per angler hour. Anglers harvested 41.8 percent of the sockeye salmon which returned to Russian River in 1978.

Early run escapement was 34,150 sockeye salmon. This is the highest escapement recorded for this segment of the population and exceeds the 15-year average of 11,547 by 195.7 percent. Late run escapement enumerated at Russian River weir was 34,230. An additional 18,330 late run fish spawned below Russian River Falls. This is the highest escapement in this area. Total late run escapement was therefore 52,560.

*Smolt enumeration at Russian River weir in 1978 was funded and conducted by the Division of Fisheries Rehabilitation and Enhancement Division (FRED). Results are reported here in the interest of research continuity associated with the Russian River drainage.

Analysis of scales collected at Lower Russian Lake weir revealed both early and late runs were dominated by fish that resided 2 years in fresh water. Early run salmon were primarily three-ocean (98.3 percent) while the late run was primarily two-ocean (59.8 percent). These data are comparable to historical age structures. Average lengths of early and late run fish sampled were 602.0 (23.7 inches) and 566.9 (22.3 inches) millimeters, respectively. Male to female sex ratio for the early run was 1:1.1 and for the late run 1:1.2. Length-frequency data for both runs are presented and discussed.

Fecundity investigations revealed early and late run sockeye salmon averaged 3,815 and 2,865 eggs per female, respectively. Fecundity of the early run is comparable to historical data. However, late run fecundity in 1978 was the lowest recorded since sampling began in 1973.

The return rate per spawning fish in the early run escapement has averaged 2.6. The 1972 escapement of 9,270 fish returned a total of 98,773 sockeye salmon for a return rate of 10.6. This is the highest return rate recorded for this segment of the population and approaches maximum return rates reported in fisheries literature.

Hydraulic egg sampling conducted in Upper Russian Creek revealed actual egg deposition approximated 3.1 million or 226.1 eggs per square meter. This is the highest density recorded since 1975.

Climatological data were again collected at Lower Russian Lake weir. Data revealed air and water temperatures approximated similar historical data. Total rainfall recorded was 855 millimeters. This is more than three times the precipitation previously recorded for comparable time periods. Sockeye salmon experienced no difficulty negotiating Russian River Falls in 1978 despite increased rainfall. Information is presented which indicates that winter snowfall has a greater impact on Russian River discharge and the ability of salmon to negotiate the Russian River Falls than summer precipitation.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing and approximately 161 km (100 mi) south of Alaska's largest city, Anchorage. The stream is bordered on either side by lands of the Federal Government. Lands to the south are administered by the Kenai National Moose Range and on the north by the Chugach National Forest. A privately operated ferry at the confluence of Kenai and Russian Rivers transports anglers to the south bank. This area (approximately 1.6 km or 1 mi) received 44.6% of all angler effort in 1978. Remaining effort occurred on approximately 3.2 km (2 mi) of stream above the confluence. Public access is provided at the Forest Service Russian River Campground and at the Kenai National Moose Range Campground. Figure 1 depicts the Russian River drainage in relation to the Kenai River and other pertinent land marks.

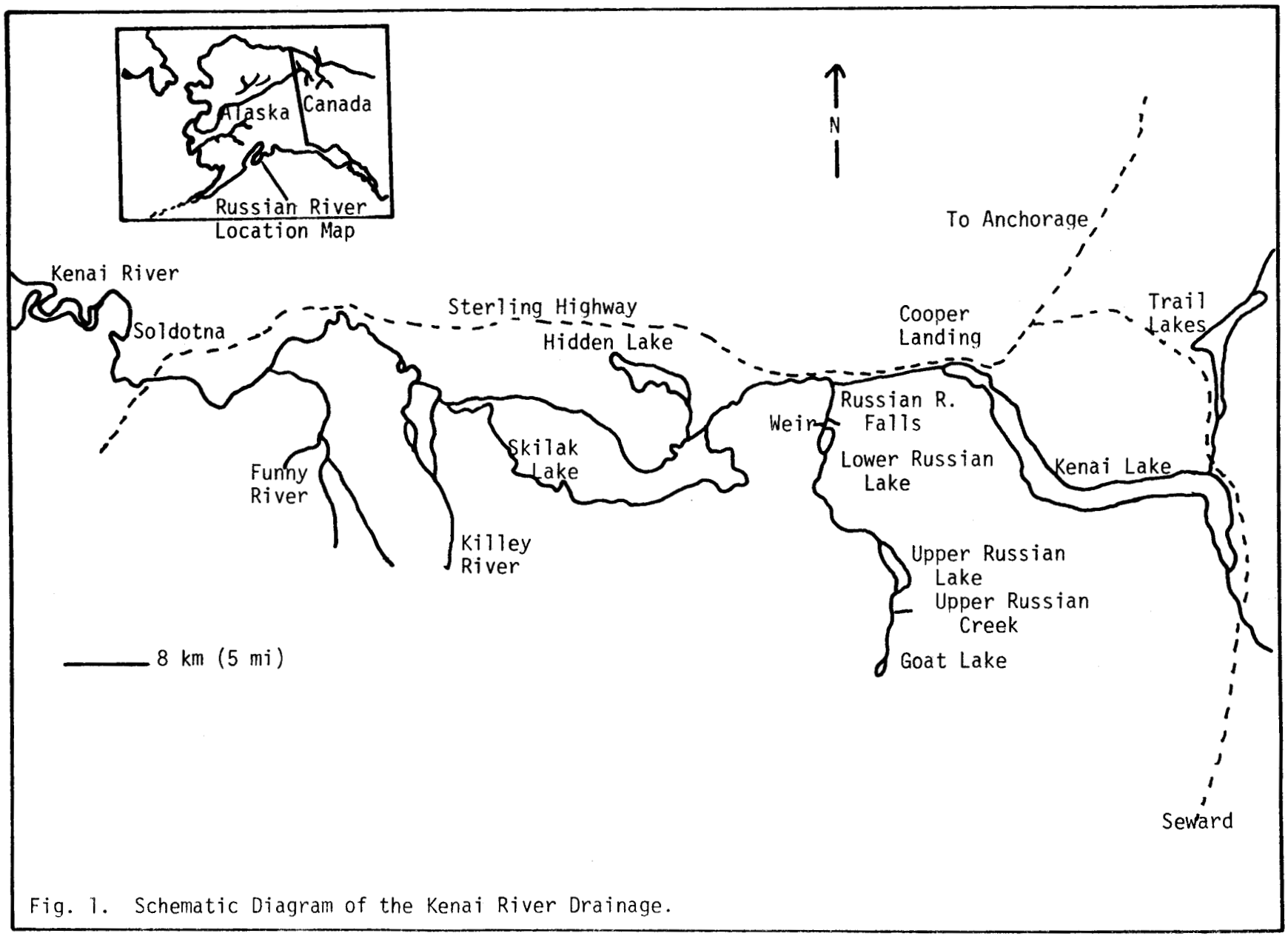

Fig. 1. Schematic Diagram of the Kenai River Drainage.

Sockeye salmon sport fishing is restricted to Lower Russian River from a marker 548 m (600 yds) below Russian River Falls to a marker 1,646 m (1,800 yds) below the Kenai and Russian River confluence, a total distance of approximately 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only-area", and from June 1 through August 20 terminal gear is restricted to streamer (coho) flies with a gap between point and shank no greater than 9.5 mm (3/8 in). The area between a marker below the ferry crossing and a marker 640 m (700 yds) upstream on the Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early run stocks which concentrate in this area for a period of time before continuing their upstream migration (Figure 2). Sockeye salmon fishing is permitted in the Kenai River below the "fly-fishing-only-area" with standard sport fishing tackle. Harvest and effort is, however, minimal due to the glacial nature of the Kenai River.

Lower Russian River from its confluence with the Kenai River to a point approximately 3.2 km (2 mi) upstream is of moderate gradient. Upstream from this point the stream flows through a canyon of considerable gradient commonly known as Russian River Falls. During the past 16 years sockeye salmon have been delayed in the canyon on several occasions due to a velocity barrier caused by abnormally high water. Documented sockeye salmon mortality associated with this barrier occurred in both 1971 and 1977 (Nelson, 1978).

Russian River sockeye salmon runs are bimodal, i.e. there are two distinct runs. Migrational timing, entry into the fishery and average run size has been previously discussed (Nelson, 1976 and 1977). Resident and anadromous species common to Russian River are presented in Table 1.

Lower Russian Lake, located 0.8 km (0.5 mi) above Russian River Falls, supports an active Dolly Varden and rainbow trout fishery. The lakes maximum depth is 7.6 m (25 ft) and it is 87 ha (215 a) in area. Observation in 1978 suggests a few (< 500) late run fish may spawn here. The lake is utilized by rearing chinook and coho salmon.

Upper Russian River enters Lower Russian Lake from the south. This stream contains excellent spawning gravel which is utilized by a segment of the late run sockeye salmon population in addition to chinook and coho salmon. This stream connects Upper and Lower Russian Lake. Nelson (1976) has presented a detailed description of Upper Russian Lake. Figure 3 is a schematic diagram of this area depicting the known spawning areas of both early and late runs.

Management and research activities associated with the Russian River drainage have been conducted by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965 through 1972) and Nelson (1973 through 1978).

To monitor angler effort and ascertain the recreational harvest of sockeye salmon, a creel census has been conducted since the inception of this project. During the 17 years the census has been active, Fish and Game personnel have contacted 68,800 anglers who reported harvesting 51,130

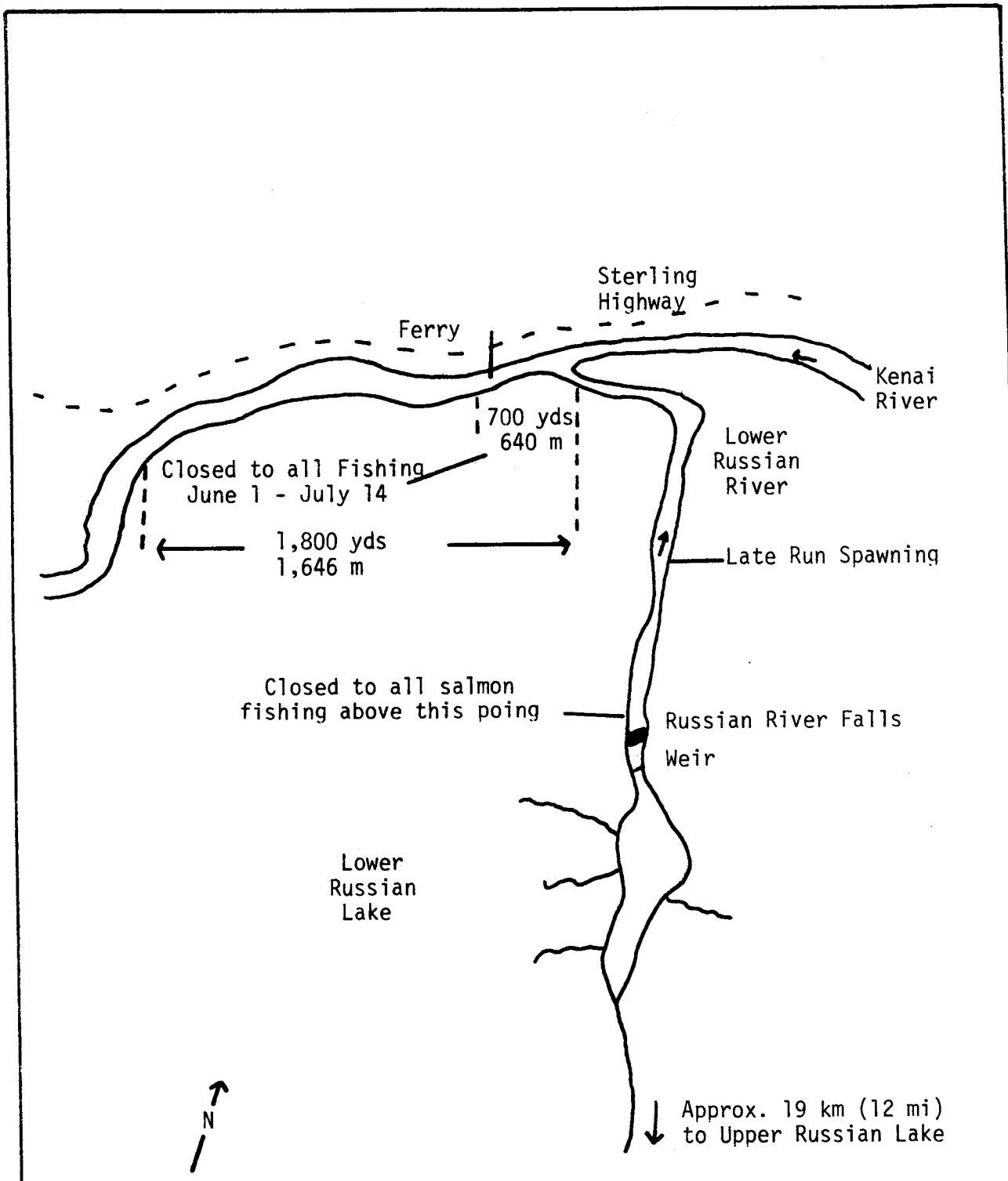

Fig. 2. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not To Scale).

Table 1. A List of Common Names, Scientific Names and Abbreviations of Fish Species Found in Russian River Drainage.

Common Name	Scientific Name and Author	Abbreviation
Sockeye salmon	*Oncorhynchus nerka* (Walbaum)	RS
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	PS
Dolly Varden	*Salvelinus malma* (Walbaum)	DV
Rainbow trout	*Salmo gairdneri* Richardson	RT
Slimy Sculpin	*Collus cognatus* Richardson	SSC

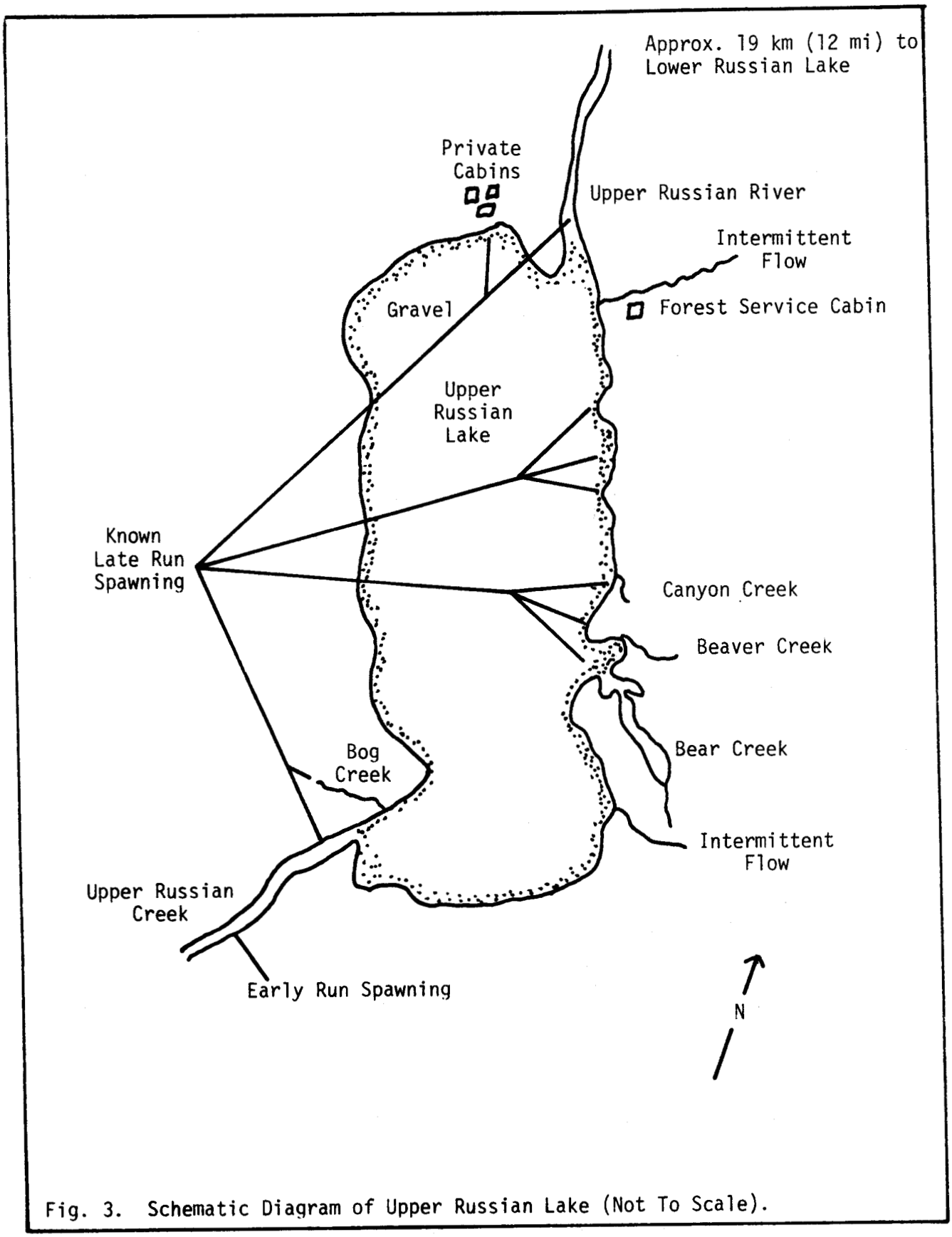

Fig. 3. Schematic Diagram of Upper Russian Lake (Not To Scale).

sockeye salmon. Fishermen have annually averaged 0.7 fish per angler day. Total sockeye salmon harvest from Russian River since 1963 is estimated at 286,760.

Prior to 1967, salmon harvested per angler-day averaged 1.1. From 1967 to 1978 this average decreased to 0.7. This decline should not be interpreted as a decline in sockeye salmon abundance or reduced angler expertise, but rather to regulatory measures designed to eliminate snagging. Nelson (1976) presented a detailed history of this practise as it pertains to Russian River as well as the management and research programs associated with it.

Regulatory measures affecting this fishery from 1960 through 1966 have been reviewed by Engel (1967). Regulatory changes from 1966 through 1975 have been presented by Nelson (1976). Regulation of the fishery has been unchanged since 1975.

Despite an increasingly restrictive fishery. Recreational demands upon the Russian River sockeye salmon resource has at times been greater than the stocks can sustain. This is evidenced in that the Sport Fish Division has closed all or part of the fishery on 16 different occasions since 1969. One emergency closure was required for management purposes in 1978 (Table 2).

The Russian River management program is currently directed towards "in season" evaluation of stock status and analysis of fisheries statistics to evaluate the effects and effectiveness of current regulatory practices. Research activities presently emphasize the collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of sockeye salmon returns to Russian River. The latter objective can not be realized until stock separation techniques are perfected in Cook Inlet to determine late run Russian River stock's contribution to the commercial fishery.

Life history investigations of early run fish are presently confined to Upper Russian Creek, the only spawning area utilized by these salmon. Escapement counts are made to determine spawner distribution in the stream. Potential egg deposition is estimated employing fecundity and mortality data. Actual egg deposition is determined by sampling various areas of the stream with an hydraulic sampler. Egg survival to the eyed stage is determined from these data.

Late run investigations are directed toward determining numbers of salmon that utilize respective spawning areas of Upper Russian Lake. When feasible, egg densities and egg survival in Bear Creek, the largest tributary utilized by late run fish, are also determined employing techniques identical to those used to sample Upper Russian Creek.

RECOMMENDATIONS

1. The feasibility of stabilizing the flow of Upper Russian Creek during the early run's egg incubation period should be explored. Data indicate that large numbers of eggs were washed from the stream in 1976 and 1977 which will adversely affect the number of returning adults.

Table 2. Emergency Closures Issued by the Sport Fish Division of the Alaska Department of Fish and Game Affecting the Russian River Sockeye Salmon Sport Fishery, 1969-1978*.

Year	Closure Dates	Total or Partial Closure	Days Closed**	Run Affected
1969	July 27 - August 8	Total	13	Late
1970	July 4 - 23	Total	20	Early
	July 28	Total	24	Late
1971	July 8 - August 30	Total	24	Early
	August 14	Partial***	7	Late
1972	Closure at confluence of Kenai and Russian River extended 14 days.			
1973	Closure at confluence of Kenai and Russian River extended 14 days.			
	July 5 - 14	Total	10	Early
1974	July 1 - 5	Total	5	Early
	July 31	Total	21	Late
1975	July 1 - 14	Total	14	Early
	August 13	Total	8	Late
1976	June 28 - July 4	Total	7	Early
1977	June 10 - 18	Total	8	Early
	June 18 - July 15	Partial***	27	Early
	August 18 - 20	Total	2	Late
1978	August 10 - 20	Total	11	Late

* No emergency closure affecting this fishery was issued prior to 1969.
** When the fishery was closed for the remainder of the season, it was assumed the season ended August 20.
*** Fishery closed upstream from the Homer Electric Power Line to protect fish experiencing difficulty negotiating Russian River Falls due to atypically high water. This reduced by approximately 1609 meters (one mile) the area open to fishing.

2. The present objectives of the Russian River Sockeye Salmon Study should be continued.

OBJECTIVES

1. To determine adult harvest of sport caught early and late run Russian River sockeye salmon.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in the Russian River drainage.

3. To determine age composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake Weir.

4. To determine egg deposition of early and late run spawning sockeye salmon in two major tributaries of Upper Russian Lake, i.e. Upper Russian and Bear Creeks.

5. To determine fecundity of early and late run Russian River female sockeye salmon and to determine the relationship (if any) between fish length and average number of eggs per sockeye salmon female.

6. To collect basic climatological data (precipitation, water and air temperature, stream discharge) at Lower Russian Lake and to determine if a relationship exists between these parameters and migrational timing.

7. To evaluate current regulations governing this sport fishery and to provide recommendations for future management and research.

TECHNIQUES USED

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present weir was constructed in June, 1975, and replaced a temporary weir (described by Engel, 1970) which had been operational since 1969. Nelson (1976) has presented a detailed description of the present structure. In May, 1978 the existing adult weir was modified by the Division of Fisheries Rehabilitation and Enhancement (FRED) to enumerate smolt.

Modification of the existing weir entailed fabrication of aluminum plates installed over the existing aluminum picket panels and construction of a smolt trap and holding pen. Dimensions of aluminum plates were 74 cm (29.25 in) in width and 148.6 cm (58.5 in) in height. Oval holes in the panels 9.6 mm (3/8 in) in diameter precluded smolt passage.

The trap was of triangular design and constructed of 12.7 mm (0.5 in) marine plywood and plexiglass. Exterior dimensions were 60.9 cm (2 ft) x 121.9 cm (4 ft) x 152 cm (5 ft). Sides were 121.9 cm (4 ft) in height. The trap was divided into two equal sized compartments. One compartment permitted smolts unrestricted passage through the trap while the other led smolts to a live box. Direction of smolt travel was achieved by a pivotal plexiglass gate. Exterior dimensions of the live box were 121.9 cm (4 ft) x 76.2 cm (2.5 ft). Height of the sides was 121.9 cm (4 ft). Figure 4 depicts the Russian River smolt weir and trap.

A stratified random sampling scheme was employed to estimate total coho chinook and sockeye salmon smolts out-migration. Each day during the out-migration was divided into two strata: (1) peak hours of 2100 - 0100 and (2) non-peak hours of 0100 - 2100. Each day was divided into 72, 20-minute periods. During peak hours the trap was opened for 2 minutes during six randomly selected 20-minute periods. During non-peak hours the trap was opened for 3 minutes during 10 randomly selected 20-minute periods. This sampling procedure represented a 2.9% sample of the total smolt out-migration. Each day's sampling data was expanded by standard statistical techniques to yield the day's total smolt out-migration. Each day's total out-migration was then summed to yield the seasonal total. The species composition of each day's out-migration was determined by sampling.

Each day 30 randomly selected sockeye salmon smolts were sampled to determine age, weight and length. Fifteen smolts were randomly selected from peak hours and 15 from non-peak. Weights were recorded for each specimen to the nearest 0.1 gram. Lengths were from mid-eye to fork of tail and recorded to the nearest millimeter. Approximately three scales per fish were taken posterior to the dorsal fin above the lateral line for age determination. A detailed sampling plant and the method employed to calculate daily and total smolt out-migration is on file at the FRED Area Office in Soldotna.

The 1978 Russian River adult creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures and calculations were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Average fecundity of early and late run sockeye salmon was determined by sampling at Lower Russian Lake weir. Sampling techniques and methodology employed have been previously described (Nelson, 1975).

Samples to determine age structure and sex ratio of early and late runs were collected at Lower Russian Lake weir. Fifteen fish were sampled daily. Lengths from mid-eye to fork of tail were recorded for each specimen. Scales were impressed on cellulose acetate and read on a Bruning 200 microfiche projector. Age designation is expressed by the European formula as discussed by Koo (1962).

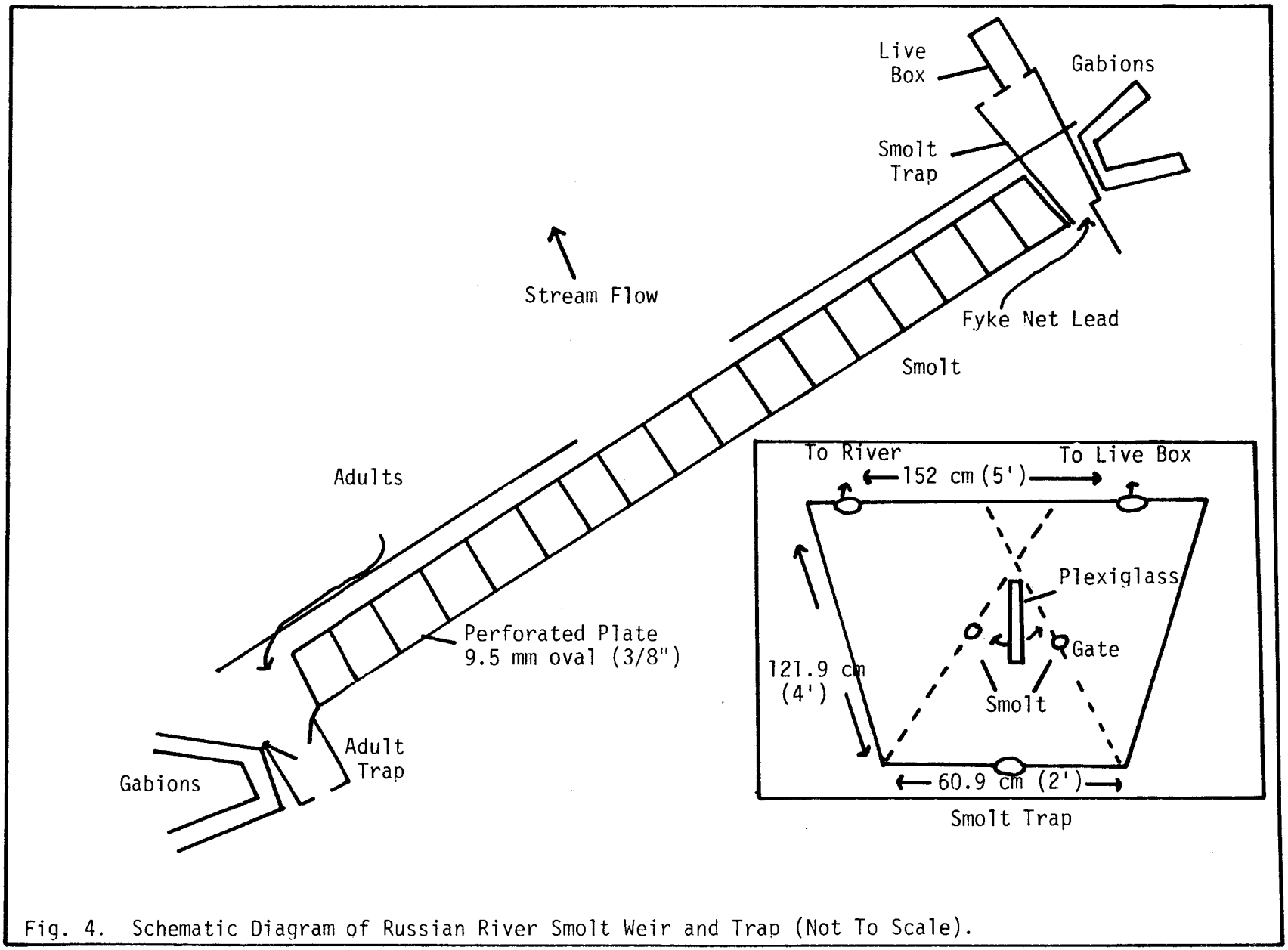

Fig. 4. Schematic Diagram of Russian River Smolt Weir and Trap (Not To Scale).

Methods employed to calculate adult age structure and male to female sex ratio for the respective runs have been previously discussed (Nelson, 1978). Identical methods were employed to calculate the age structure and sex ratio of the smolt out-migration.

Early run egg density in Upper Russian Creek was determined by hydraulic sampler patterned after equipment described by McNeil (1964). Techniques used and sampling scheme employed have been previously presented (Nelson, 1977). Potential eggs available for deposition in Upper Russian Creek were also determined. The method of estimation has been described by Nelson, (1975).

Water and air temperature at Lower Russian Lake were determined by a Taylor maximum-minimum thermometer. Precipitation was determined by gauge of standard manufacture and recorded daily.

Where appropriate, all numerical data have been rounded to the nearest significant figure.

FINDINGS

Smolt Investigations

In 1978 the existing adult weir at the outlet of Lower Russian Lake was modified to permit the enumeration of sockeye, coho, and chinook salmon smolts. The smolt weir was operational from May 2 through August 11, 1978. The first sockeye salmon smolts were enumerated May 17 and the first coho salmon smolts on May 25. Estimates revealed a total sockeye and coho salmon smolt out-migration of 829,980 and 16,640, respectively (Table 3). Only 28 chinook salmon smolts were enumerated. Chinook salmon smolts may have migrated prior to weir installation on May 2 or weir attendants may have failed to correctly identify this species.

Table 3 revealed 54.3% of the sockeye salmon smolt migrated during the 5-day period May 22-26 and 75.3% of the migration occurred during the 10-day period May 17-26. The remaining 24.7% of the out-migrants were enumerated during the remaining 76 days of weir operation. Hartman et. al. (1967) indicates that for a single-lake system the smolt exodus occurs over a relatively short time period and is prolonged in a multilake or multibasin system. The prolonged migrational period from this latter lake system is felt by Hartman to be "a result of variations in timing of the migrations from each lake and in magnitude of the different smolt populations." Russian river drainage is a multilake system consisting of Upper and Lower Russian Lake. Sockeye salmon, however, rear only in Upper Russian Lake. Russian River drainage is therefore a single-lake system in terms of sockeye salmon production, and the rapid smolt exodus conforms to Hartman's observations regarding single-lake systems. Figure 5 graphically depicts the timing and magnitude of the 1978 sockeye and coho salmon smolt out-migration in Russian River.

Table 3. Estimated Outmigration of Russian River Sockeye, Coho and Chinook Salmon Smolt by Five Day Period, 1978.

Five-Day Period	Water Temperature °C	Water Temperature °F	Sockeye Smolt	Coho Smolt	Chinook Smolt
May 17 - 21	6.3	43.3	174,280		1
May 22 - 26	6.6	43.9	451,080	40	
May 27 - 31	6.6	43.9	57,540	200	2
June 1 - 5	7.8	46.0	48,360	2,900	1
June 6 - 10	9.7	49.5	25,440	3,140	
June 11 - 15	10.7	51.3	7,308	2,744	14
June 16 - 20	8.6	47.5	8,553	3,026	7
June 21 - 25	10.5	50.9	5,135	2,103	3
June 26 - 30	9.6	49.3	4,024	1,274	
July 1 - 5	10.1	50.2	7,576	585	
July 6 - 10	10.8	51.4	16,961	309	
July 11 - 15	11.8	53.2	14,975	76	
July 16 - 20	12.1	53.8	4,474	55	
July 21 - 25	11.8	53.2	1,746	30	
July 26 - 30	14.0	57.2	1,134	58	
July 31 - Aug 4	16.5	61.7	981	32	
Aug. 5 - 11**	15.8	60.4	413	68	—
Total			829,980	16,640	28***

* Temperature is the average of the daily recordings for that period.
** Seven day period.
*** Inspection alone reveals an outmigration of 28 chinook smolt for the Russian River system is incorrect. Data is reported here to maintain continuity.

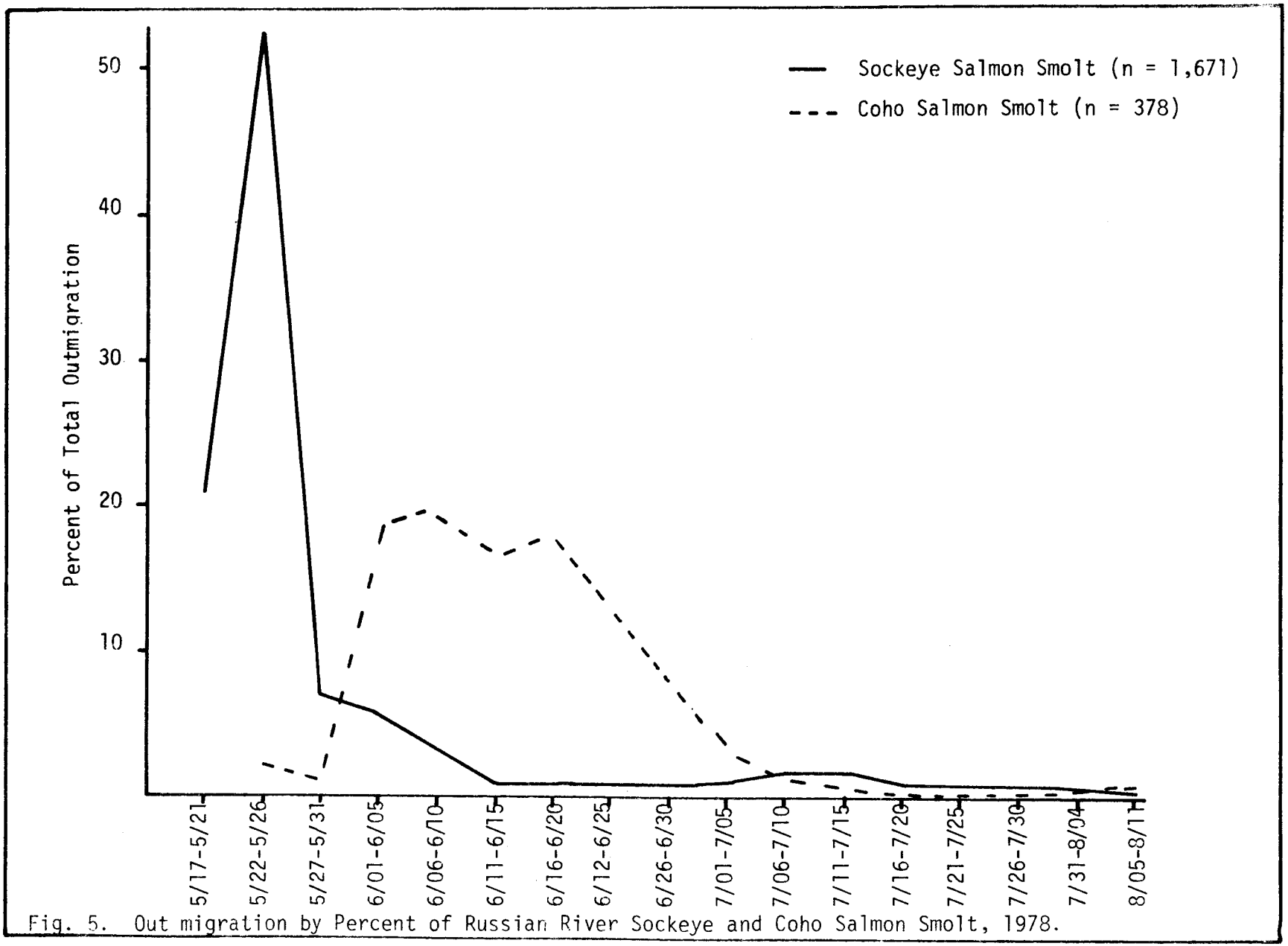

Fig. 5. Out migration by Percent of Russian River Sockeye and Coho Salmon Smolt, 1978.

Sockeye salmon smolt out-migration commenced when the water temperature at the outlet of Lower Russian Lake reached 6.3°C (43.3°F) and terminated on August 11 at a temperature of 15.8°C (60.4°F). These data are in basic agreement with data presented in the literature. Foerster (1968) indicates that sockeye salmon smolt out-migration commences when temperatures reach 4.4° to 5.0°C (40-41°F). As Lower Russian Lake is undoubtedly ice free prior to Upper Russian Lake, the water at Lower Russian Lake would be expected to be warmer. It is, therefore, not unreasonable to assume that a temperature of 6.3°C (43.3°F) at Lower Russian Lake may indicate a lower temperature at Upper Russian Lake approximating 4.4° to 5.0°C (40-41°F)--the threshold temperature suggested by Foerster which triggers smolt migration. Hartman (1967) also indicates that smolt migration is related to an increase in water temperature. In addition, he suggests that the shift in young sockeye salmon from a non-migratory to migratory stage of their life cycle is strongly related to photoperodism. The timing of migration therefore may not deviate as much from calendar dates as it would were it tied solely to climatic conditions.

Foerster (1968) indicates sockeye salmon smolt out-migration ceases when the lake temperature approximates 13°C (55.4°F). He suggests that migration ceases when the warmer epilimnial waters form a temperature "blanket" through which young sockeye salmon are unable to pass. Only 0.3% of the sockeye salmon smolt migration at Lower Russian Lake was enumerated during the last 16 days of weir operation when the temperature exceeded 13°C (55.4°F). Again, water temperature at Upper Russian Lake was probably cooler and smolt outmigration from this lake may have ceased at a temperature of 10°C (50°F) as reported by Burgner (1958) for Lake Aleknagik in Alaska's Wood River system.

Average length and weight of all sockeye salmon sampled at Lower Russian Lake in 1978 was 89.9 mm (3.5 in) and 6.0 g (0.2 oz). Age class 2.0 dominated the out-migration, contributing 90.5% to the total. These fish averaged 93.1 mm (3.7 in) in length and 6.5 g (0.2 oz) in weight. Table 4 and 5 summarizes Russian River sockeye salmon smolt data collected in 1978. Figure 6 presents the length frequency of these fish.

Table 4 indicates that lengths and weights for age 1.0, 2.0 and 3.0 sockeye smolts are 84.4 (5.1 g), 93.1 (6.5 g) and 115.1 mm (11.0 g), respectively. These average lengths and weights are within the ranges as reported by Foerster (1968) for other areas.

Figure 7 presents the length frequency of 1.0, 2.0 and 3.0 age sockeye salmon smolts. It should be noted that there is a high degree of overlap in the lengths of the respective age classes. Age class differentiation by length is therefore not possible.

Coho salmon outmigrants sampled for age, weight and length averaged 124.9 mm (4.9 in) and 19.0 g (0.7 oz), respectively. Age class 2.0 and 3.0 contributed 52.7% and 43.3%, respectively, to the out-migration. Age, length and weight data of coho salmon out-migrants are presented in Table 6.

Table 4. Summary of Russian River Sockeye Salmon Smolt Age, Length and Weight Data Collected at Russian River Weir, 1978.

Age Class	Number Sampled	Percentage Migration	Average Length (mm)	S.D.*	Average Weight (g)	S.D.*
1.0	646	8.0	84.4	4.4	5.1	0.9
2.0	1,017	90.5	93.1	8.7	6.5	1.8
3.0	8	1.5	115.1	8.3	11.0	2.1
Combined	1,671	100.0	89.9**	8.6	6.0**	1.7

* Standard Deviation
** Mean length and weight of 1,671 smolts sampled.

Table 5. Age Class Composition, Sample Size, Parent Year and Parent Year Escapement of Russian River Sockeye Salmon Smolts Sampled at Russian River Weir, 1978.

Age Class	Number Sampled	Estimated Number in the Out-migration	Parent Year	Parent Year Escapement*
1.0	646	67,575	1976	46,650
2.0	1,017	749,010	1975	37,610
3.0	8	13,395	1974	37,800
Combined	1,671	829,980		122,060

* Sum of early and late run escapements.

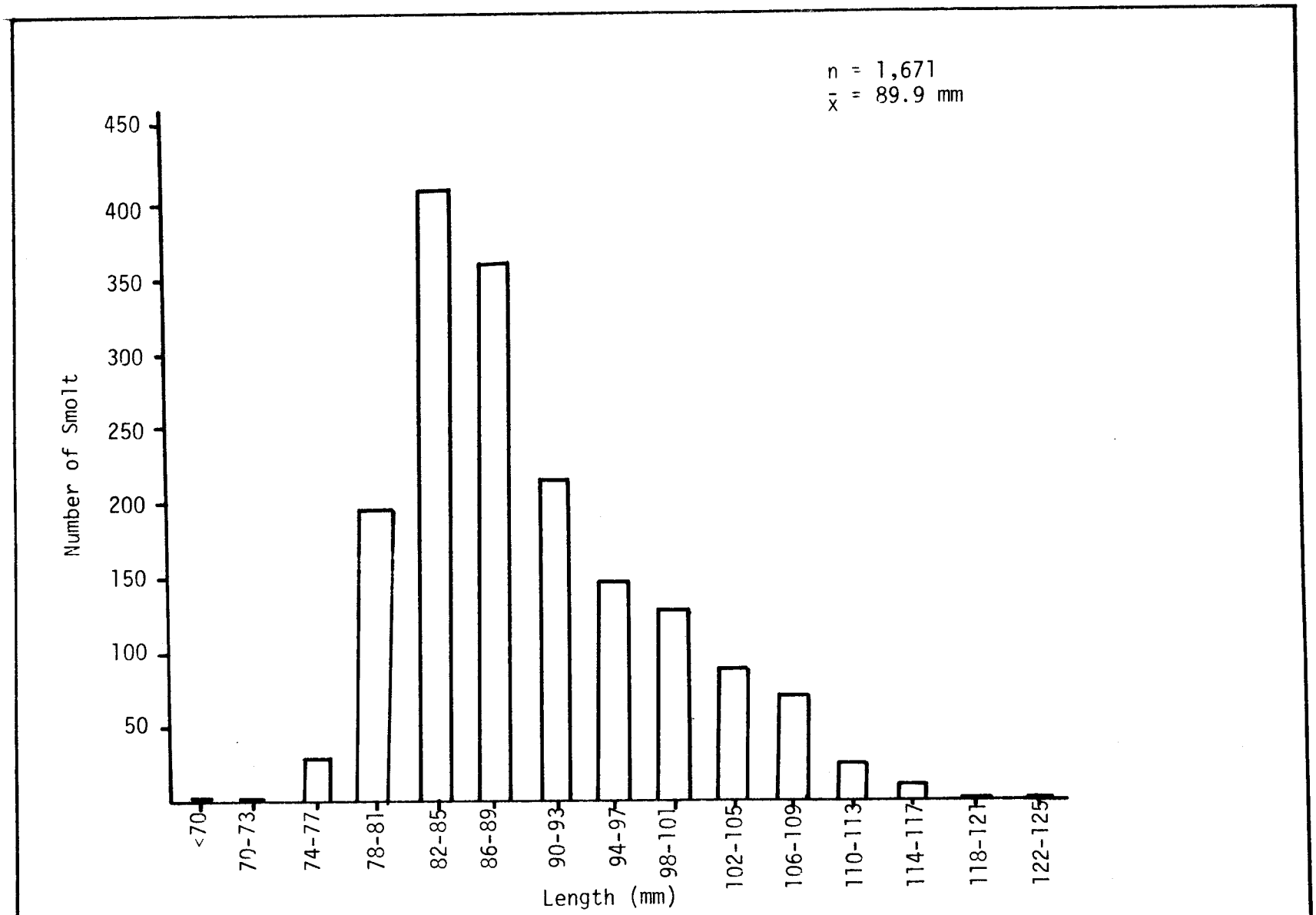

Fig. 6. Length Frequency of Sockeye Salmon Smolt Sampled at Lower Russian Lake Weir, 1978.

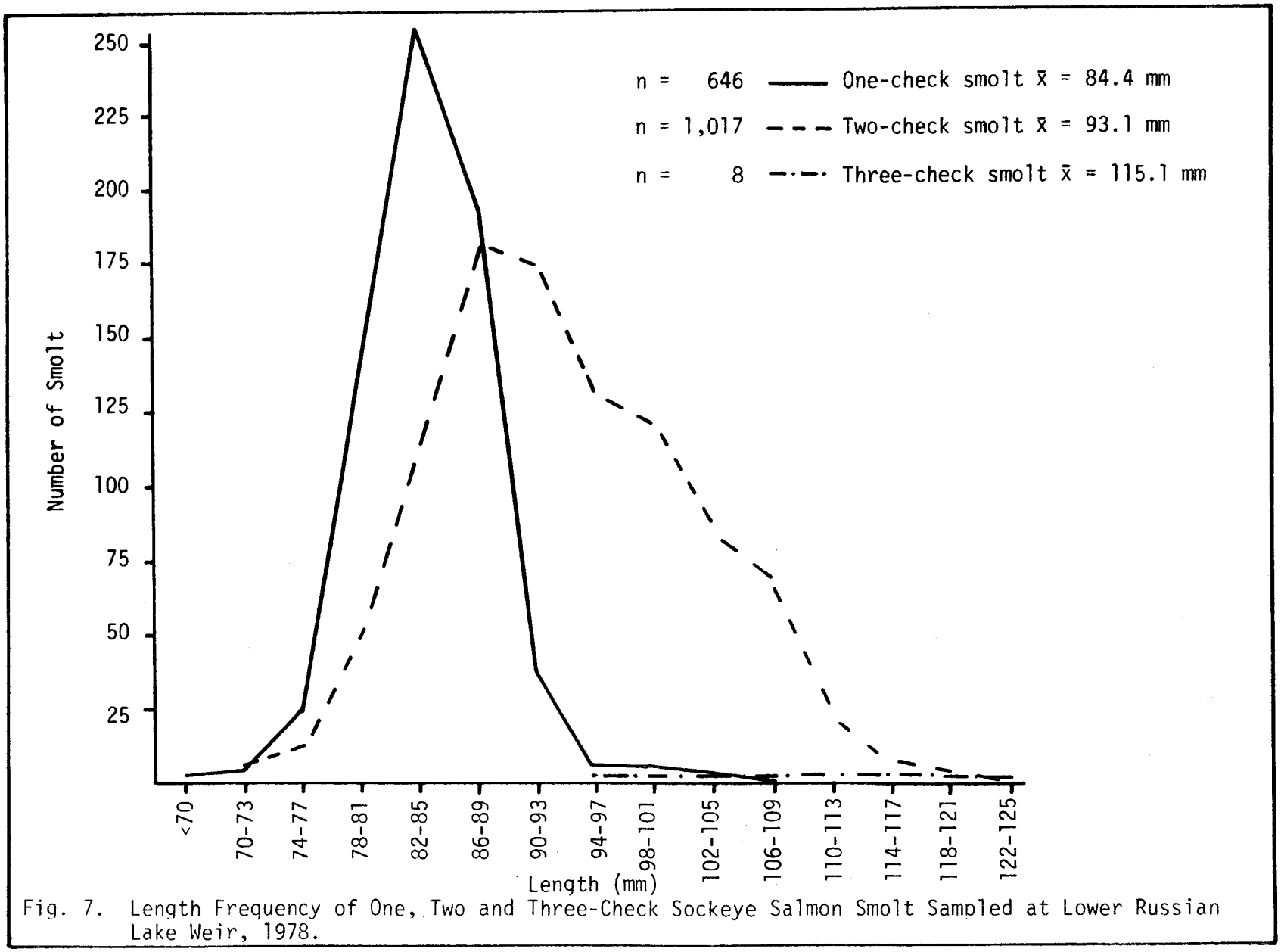

Fig. 7. Length Frequency of One, Two and Three-Check Sockeye Salmon Smolt Sampled at Lower Russian Lake Weir, 1978.

Table 6. Summary of Russian River Coho Smolt Age, Length and Weight Data Collected at Russian River Weir, 1978.

Age Class	Number Sampled	Percent of Migration	Average Length (mm)	S.D.*	Average Weight (g)	S.D.*
1.0	34	3.3	89.2	7.5	7.2	1.9
2.0	209	52.7	123.3	14.1	18.0	5.8
3.0	137	43.3	135.9	10.2	23.2	5.6
4.0	2	0.7	152.0	1.4	32.8	0.8
Combined	382	100.0	124.9**	17.7**	19.0**	7.1**

* Standard Deviation
** Mean and standard deviations of 378 fish sampled.

Creel Census

A creel census conducted from June 7 through August 9 on Russian River indicated anglers expended 69,860 man-days of effort or 295,410 angler hours in 1978. Effort directed toward early and late run stocks was estimated to be 51,910 and 17,950 man-days, respectively.

Based on interviews with 7,418 anglers who reported harvesting 6,226 sockeye salmon; total recreational catch was estimated at 62,250 salmon. Early and late runs contributed 37,720 and 24,530 fish, respectively, to this harvest. Mean hourly catch rates were higher on weekdays (0.205) than on weekend days (0.191) due to greater angler congestion during weekend periods. Seasonal catch per hour was 0.203. Harvest, effort and catch per hour estimates since 1963 are summarized in Table 7.

Total man-days of effort were the highest recorded for this fishery, approximating the previous high of 69,510 man-days in 1977. Record angler participation resulted in the largest harvest since these investigations were initiated in 1963. This record harvest may be attributed to the magnitude of the early run which was the largest recorded at Russian River.

Total weekday and weekend stream counts during the 1978 fishery averaged 264.1 and 425.7 anglers, respectively. Weekday counts are the highest recorded and are 30.9% higher than the average weekday count in 1977. The average weekend count closely approximates the 1977 average weekend count of 438.7. The increase in 1978 effort is therefore attributed to greater weekday rather than weekend participation. Although not definitive, these data suggest that due to the physical limitations of vehicular parking and stream bank area, Russian River may have reached carrying capacity in terms of weekend angler participation.

Each angler fished an average of 3.9 hours on weekdays and 4.2 hours on weekends. These data are comparable to 1977 averages but represent a decrease in average hours fished in relation to historical data (Table 8). Although the reason(s) for the decreased time the average angler spent on the stream is not definitely known, it may be related to run size. Large returns of Russian River sockeye occurred in 1972, 1977 and 1978. Average number of hours the angler fished per day during these years of high returns were less than the historical average.

Stream counts revealed 28.2% and 77.7% of the anglers enumerated during total stream counts fished the confluence area of the Kenai and Russian Rivers during the early and late run, respectively. The reason(s) why anglers favored the clear waters of the Russian River during the early run migration is not definitely known. In prior years anglers have favored the Russian River only when fishing was more productive in that area. In 1978 success rates upstream were only slightly higher than at the confluence. Due to the large size of the early run, fishing could be considered good to excellent in all areas of the "fly-fishing-only-area." Observation by this author, however, indicated exceptionally crowded conditions in the approximately 1.6 km (1 mi) area of the stream referred to as the confluence area. Anglers may therefore have chosen fishing of equal quality (in terms of angler success) on the remaining 3.2 km (2 mi) of the Russian River to avoid congestion.

Table 7. Sockeye Salmon Estimated Harvest, Effort and Success Rates on Russian River, 1963-1978.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/ 8-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/20-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/ 7-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15 1/
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/30 2/
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21 3/
1973	6,740	8,930	15,670	30,690	0.102	6/ 8-8/19 4/
1974	6,440	8,500	14,940	21,120	0.131	6/ 8-7/30 5/
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13 6/
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23 7/
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/ 7-8/ 9
1963-77 Average	6,946	8,021	14,967	20,403	0.173	

1/ Census active from June 11 to July 3 and from July 24 to July 27.
2/ Census active from June 17 to July 7 and from July 31 to August 30.
3/ Census active from June 9 to July 4 and from July 15 to August 19.
4/ Census active from June 8 to June 30 and from July 6 to July 31.
5/ Catch/hour computed on data collected when fishery was open and fish were present. Data collected from July 15 to July 24 when fishery was open but fish were not present is excluded from the calculations.
6/ Census active from June 12 to June 27 and from July 5 to August 23.
7/ Census did not commence until June 18 as fishery was closed by emergency order prior to that data. Fishery again closed by emergency order on August 18.

Table 8. Differences Between Weekday and Weekend Day Fishing Pressure and Rates of Success at Russian River, 1964-1978.

Year	Average Angler Counts		Catch/Hour		Average Hours Fished	
	Week-days	Weekend Days	Week-days	Weekend Days	Week-days	Weekend Days
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1964-77 Average	83.9	151.7	0.198	0.143	4.5	5.0

Anglers concentrated their efforts at the confluence area during the late run to intercept the fish as they entered the fishery. As the late run was of average size and these stocks move rapidly through the fishery (Nelson, 1973), anglers were more successful at the confluence and tended to remain in this area.

Anglers harvested 52.5% of the early run stocks which reached Russian River. This percentage approximates 1977 harvest rates but is an appreciable increase when compared to the historical average harvest rate of 36.8%. The late run was harvested at a rate of 41.7% (exclusive of fish spawning below the falls). This level of harvest is second only to the 1977 harvest rate of 56.2% and appreciably higher than the late run historical average harvest rate of 16.8%.

Percentages of the late run harvested by Russian River sport fishermen are useful as an index but probably do not reflect true harvest rates. Salmon migrating through the glacial Kenai River tend to school at the confluence of these two streams prior to entering the Russian River or continuing on to spawning areas in the Upper Kenai River drainage. Undoubtedly a percentage of the salmon included in the Russian River harvest rates are of Kenai River origin (Engel, 1967).

Nelson (1976) reviewed angler participation trends and concluded that angler effort would continue to shift from early to late run stocks. Table 9 indicates that these trends did not develop as anticipated. The early run in 1977 and 1978 received 55.0% and 74.3%, respectively, of all angler effort directed toward Russian River sockeye salmon. Anglers directed their efforts toward early run salmon during these years because of record early run returns. When early run stocks return to historical levels it is anticipated that the more numerous late run fish will again support a higher percentage of the total angler effort.

During the census 148 Dolly Varden, 43 rainbow trout, and 1 Arctic grayling, were creel checked. These data were expanded revealing a total incidental harvest of 1,400 Dolly Varden, 410 rainbow trout and 9 arctic grayling. No coho or pink salmon were observed during the census. These species do not generally enter the fishery until late August and the census terminated August 9.

Escapement:

Russian River weir was operational on May 2. The first early run sockeye salmon adult was passed on June 10, ten days earlier than the historical average of June 20. Fifty percent of the early run escapement had passed the weir by July 2, two days earlier than the July 4 average historical date of passage during years of weir operation. Early run passage was complete by July 24 (Table 10).

Early run sockeye salmon escapements average 11,560 and have ranged from 2,650 to 21,710 (1963-1977). Escapement in 1978 was 34,150. This is the

Table 9. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1978.

Year	Effort (Man-Days)*		(Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1963	5,710	2,170	72.5	27.5
1964	3,980	1,350	74.7	25.3
1965	7,750	1,970	79.7	20.3
1966	11,970	6,310	65.5	34.5
1967	11,460	5,500	67.6	32.4
1968	11,780	5,500	68.2	31.8
1969	12,290	2,640	82.3	17.7
1970	9,700	1,000	90.7	9.3
1971	6,250	8,870	41.3	58.7
1972	12,340	13,360	48.0	52.0
1973	15,220	15,470	49.6	50.4
1974	11,090	10,030	52.5	47.5
1975	5,210	11,300	31.5	68.5
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1963-77 Average	11,459	8,944	60.9	39.1

* Man-day is defined as one angler fishing for one day irrespective of the amount of time fished.

Table 10. Arrival Date, Date 50% of the Escapement Passed Russian River Weir/Counting Tower and Termination Dates of Early and Late Russian River Sockeye Runs, 1960-1978.*

	Early Run			Late Run		
Year	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended
1960	June 19	June 26	July 15	July 16	August 1	August 12
1961	June 21	June 28	July 15	July 16	July 31	August 28
1962	June 18	July 4	July 15	July 16	July 30	August 31
1963	June 18	July 1	July 12	July 16	July 31	August 23
1964	June 20	July 7	July 15	July 16	July 30	August 15
1965	June 22	July 4	July 15	July 16	August 5	August 15
1966	June 20	June 29	July 15	July 16	July 30	August 17
1967	June 20	June 28	July 15	July 16	August 2	August 18
1968	June 25	June 29	July 13	July 19	July 31	August 14
1969					August 2	August 18
1970	June 17	July 5	July 15	July 16	August 7	August 23
1972	June 24	July 5	July 29	July 30	August 5	August 28
1973	June 21	July 6	July 15	July 16	August 1	August 30
1974	June 14	July 1	July 21	July 22	August 7	August 27
1975	June 25	July 6	July 27	July 21	August 6	September 1
1976	June 17	June 30	July 16	July 17	August 2	September 1
1978	June 10	July 2	July 24	July 2	July 30	September 4
1960-76 Average	June 20	July 2	July 17	July 18	August 2	August 23
1969-76 Average**	June 20	July 4	July 21	July 20	August 5	August 27

* 1971 and 1977 data were deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Years of weir operation.

highest escapement recorded for this system and is 195.4% greater than the historical average. Russian River sockeye salmon escapements and harvest rates are summarized in Table 11.

A ground survey between Russian River Falls and the confluence of the Kenai and Russian rivers revealed 18,330 late run sockeye salmon spawning in this area. This is the greatest number of fish spawning in this area since these surveys began (1968). Total late run return (harvest plus escapement) in 1978 was therefore 77,090 (Table 12). This is the second highest return recorded for this system since 1968 and exceeds the historical average return (52,934) by 46.2%.

Table 13 presents historical late run escapements recorded at Russian River Weir (above Falls) and below the Falls in Lower Russian River. Escapement in 1978 enumerated at Lower Russian Lake weir was 3,200 fish less or 9.3% lower than the historical late run average escapement for this area. The 1978 escapement below Russian River Falls was a record 18,330--more than three times the average escapement for this segment of the population. Total 1978 escapement of late run fish to Russian River was therefore 52,560 or 23.4% greater than the historical escapement. Increased late run escapement is directly attributed to the record spawning escapement below Russian River Falls.

Nelson (1978) indicated that above average spawning escapements below Russian River Falls also occurred in 1971 and 1977. These large escapements corresponded to years of high water when Russian River Falls constituted a velocity barrier which denied a segment of the late run access to the Upper Russian Lake spawning grounds. Nelson also presented several possible explanations for above average escapements in this area. The most probable explanation appeared to be that these returns were naturally occurring phenomena which were not related to the high water of 1971 and 1977. The record 1978 escapement in this area lends credence to this theory, as discharge rates were considered normal during the 1978 migration.

Chinook salmon escapements enumerated at Russian River Weir in 1978 totaled 253. An additional 165 of these fish were observed spawning below Russian River Falls. Total chinook salmon escapement to Russian River in 1978 was therefore 418. This is the highest escapement recorded for this species (Table 14).

The minimal 1978 coho salmon escapement was 1,570 as the upstream migration of this species was still in progress when the weir was removed on September 5. This is the fifth consecutive year Russian River coho salmon escapement has exceeded the historical average (Table 15).

Relationship of Jacks to Adults

The early Russian River run is usually devoid of precocial male (jack) sockeye. Twenty-four were enumerated in 1970, one in 1975 and two in 1976. No jacks were observed during the early run migration of 1967, 1971, 1973, 1974, 1977 or 1978. Jacks are more numerous during the late run and comprise between 0.2% and 8.8% of the escapement (Table 16).

Table 11. Russian River Sockeye Salmon Escapement Estimates and Harvest Rates for Early and Late Runs, 1963-1978.

Year	Escapement			Percentage of Run Caught by the Sport Fishery*		
	Early Run	Late Run	Total	Early Run	Late run	Combined
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,330	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000**	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1963-77 Average	11,560	38,544	50,091	36.8	16.8	22.4

* Based on escapement passed weir, commercial harvest and fish sampling downstream from Russian River weir are not considered.

** Escapement determined by foot survey of Upper Russian Creek.

Table 12. Late Run Sockeye Salmon Escapements Enumerated Between Russian River Falls and Confluence of Kenai and Russian Rivers, 1968-1978.

Year	Escapement Below Falls	Total Late Run*	Percent of Total Return
1968	4,200	58,900	7.1
1969	1,100	31,170	3.5
1970	220	31,000	0.7
1971	10,000	75,160	13.3
1972	6,000	101,050	5.9
1973	6,690	40,590	16.5
1974	2,210	35,360	6.3
1975	690	41,050	1.7
1976	3,470	49,120	7.1
1977	17,090	65,940	25.9
1978	18,330	77,090	23.8
1968-77 Average	5,167	52,934	8.8

* Includes late run sport harvest, fish spawning below Russian River Falls and escapement enumerated at Lower Russian Lake weir.

Table 13. Late Run Russian River Sockeye Salmon Escapements Enumerated above Russian River Falls by Weir/Counting Tower and Below Russian River Falls by Ground Survey, 1968-1978.

Year	Escapement Above Falls	Escapement Below Falls	Total Late Run Escapement
1968	48,800	4,200	53,000
1969	28,920	1,100	30,020
1970	28,200	220	28,420
1971	54,430	10,000	64,430
1972	79,000	6,000	85,000
1973	24,970	6,690	31,660
1974	24,650	2,210	26,860
1975	31,970	690	32,660
1976	31,950	3,470	35,420
1977	21,410	17,090	38,500
1978	34,230	18,330	52,560
1968-77 Average	37,430	5,167	42,597

Table 14. Russian River Chinook Salmon Escapements, 1953-1978.

Year	Weir/Counting Tower Escapement	Lower River Escapement	Total Escapement
1953		85**	
1954		87**	
1955		42**	
1956		40**	
1957		44**	
1958		98**	
1966		182	
1967		26	
1968	56*	63	119
1969	119	31	150
1970	240	125	365
1971	21	149	170
1972	172	108	280
1973	243	104	347
1974	124	59	183
1975	102	32	134
1976	145	155	300
1977	37	145	182
1978	253	165	418
Average through 1977	126	87	223

* Estimated from tower count.
** Fish and Wildlife Service Ground surveys.

Table 15. Coho and Chinook Salmon Escapements Enumerated at Russian River Weir, 1969-1978.

Year	Coho Salmon	Chinook Salmon	Weir Opened	Weir Closed
1969	70	119	June 21	August 19
1970	957	240	June 14	August 24
1971	839	21	June 23	September 8
1972	666	172	June 15	August 28
1973	200	243	June 14	August 30
1974	1,508	124	June 14	August 28
1975	4,000*	102	June 25	September 1
1976	1,791**	145	June 16	September 2
1977	1,884	37	June 17	September 5
1978	1,570***	253	May 4	September 5
1969-77 Average	1,324	134		

* As of September 1, 1975, 1,875 coho had passed the weir. It was estimated a minimum of 2,000 coho were below the weir when it was removed. Escapement is therefore estimated at 4,000.

** As of September 1, 1976, 1,391 coho had passed the weir. It was estimated a minimum of 400 coho were below the weir when it was removed. Minimum escapement is therefore estimated at 1,791.

*** As of September 4, 1978, 1,370 coho had passed the weir. It was estimated a minimum of 200 coho were below the weir when it was removed. Minimum escapement is therefore estimated at 1,570.

Table 16. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1978.

Year	Escapements	Harvest	Total Return*	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160**	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1969-77 Average	36,167	10,610	46,777	1,039	2.7

* Excludes commercial harvest and salmon spawning below Russian River Falls.

** Excludes an estimated 10,000 salmon which perished below Russian River Falls due to a velocity barrier.

It is also interesting to note the migrational timing of jacks compared to late run adult salmon. Historical data indicate 50% of the adult escapement may be expected to negotiate Russian River Falls and pass the weir at Lower Russian Lake by August 4. Fifty percent of the jack escapement does not historically pass the weir site until August 12, nine days later than the adult migration. In 1978 the adults migrational timing was two days later than the historical average while 50% of the jack escapement was not achieved until August 18. The disparity between migrational timing of adults and jacks in 1978 was therefore 16 days (Table 17).

It is not known whether this timing differential is a racial characteristic or related to physical factors. Nelson (1976) indicated water levels decreased during the latter part of the late run migration and may facilitate the jack's movement through the Falls. Larger adults may be more readily capable of negotiating the barrier at greater water velocities and therefore arrive earlier at the weir.

Migrational Timing in Kenai River

An extensive summary of migrational timing of early and late runs within Russian River drainage has been previously presented (Nelson, 1975).

Data regarding migrational timing within the mainstem Kenai River are limited to a comparison of sonar counts to escapements enumerated at Russian River Weir and isolated tagging studies.

The sonar counter, located approximately 1.6 km (1 mi) below the Kenai River bridge in Soldotna is operated by the Commercial Fish Division of the Alaska Department of Fish and Game. The counter is usually operational only during the late run migration. In 1978, however, the counter was operational on May 20 and did enumerate the early Kenai River sockeye salmon run. Observation by ADF&G research personnel indicates the majority of these fish are of Russian River origin.

In 1978, 50% of the early run Kenai River escapement passed the sonar site by June 3. Fifty percent of the early run Russian River escapement was enumerated by July 2. It therefore required early run sockeye salmon approximately 29 days to traverse the 93.5 km (58 mi) between sonar site and weir. Rate of travel for these stocks was therefore about 3.2 km (2 mi) per day. A comparison of 1978 sonar and weir counts are the only data available regarding migrational rates of early run Russian River stocks in the mainstem Kenai River.

Sonar counts, Russian River escapements and time of travel between sonar site and Russian River weir for late run Russian River fish are presented in Table 18. This table indicates that elapsed time between sonar site and weir ranges from 11 to 34 days averaging 16. Eliminating the 1969 and 1974 extremes, migrational period of these fish ranged from 11 to 13 days, averaging 12. It required 12 days for the average late run Russian River fish to traverse this distance or an average of 7.7 km (4.8 mi) per day in 1978.

Table 17. Migrational Timing of Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1978.

Year	Jack Escapement	Date 50% Passed	Adult Escapement**	Date 50% Passed	Timing Differential (Days)
1970	2,542	8.10	25,658	8/ 7	4
1972	160	8/10	78,677	8/ 4	7
1973	332	8/ 6	24,642	7/31	7
1974	1,008	8/12	23,639	8/ 6	7
1975	1,788	8/16	30,179	8/ 5	12
1976	1,204	8/18	30,746	8/ 2	16
1978	2,874	8/18	31,356	8/ 2	16
1970-76* Average	1,172	8/12	35,590	8/ 4	9

* 1971 and 1977 data have been deleted due to atypical migrational timing resulting from a velocity barrier at Russian River Falls.

** Escapement passed weir only. Fish spawning below the Falls are not included.

Table 18. Kenai River Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1978*.

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	7/19	48,880	7/30	11
1969	53,000	6/30	28,920	8/ 2	34
1970	68,000	7/25	28,200	8/ 6	13
1972	335,000	7/24	79,000	8/ 4	12
1973	368,000	7/22	24,970	7/31	10
1974	157,000	7/17	24,650	8/ 6	23
1975	143,000	7/24	31,970	8/ 5	13
1976	381,000	7/20	31,950	8/ 2	13
1978	399,000	7/18	34,230	7/30	12
1968-76 Average	199,125	7/19	37,317	8/ 3	16

* 1971 and 1977 deleted due to high water which resulted in atypical migrational timing.
** Escapement passed weir only.

Evaluation of sonar data and magnitude of the total Russian River late run does provide an estimate of Russian River's contribution to Kenai River sockeye salmon escapement. Data indicate Russian River's contribution ranges from 8.7% to 66.9% averaging 31.7%. Russian River's contribution in 1978 was 19.3%. These data are summarized in Table 19.

Management of the 1978 Fishery

The early run entered the recreational Russian River sport fishery on June 7. Harvest rates were above average and observation indicated an exceptionally strong run was in progress. The minimum early run escapement goal of 8,500 fish was achieved on June 26.

As 50% of the early run escapement is not usually passed until July 4, it was evident that record numbers of early run fish were present. To enable maximum utilization of early run stocks by the angling public, the closed or "sanctuary" area at the confluence of the Kenai and Russian Rivers was opened to fishing on June 27. On June 29 the restrictive one fish bag and possession limit was raised to three. Due to large numbers of early run fish and the relaxation of the aforementioned regulations, anglers harvested record numbers of early run fish. The spawning escapement of this stock was the highest recorded.

Although a few late run fish were observed in the fishery prior to July 20, the bulk of the late run did not enter the fishery until this date. Catch rates for this segment of the population were above average. However, escapements passed Russian River weir began to lag behind historical passage rates by early August. Observation indicated large numbers of late run fish remained in the fishery. However, as occurred in 1977 (Nelson, 1978), it became increasingly difficult to differentiate between late run fish which spawn below the Falls and those destined for the spawning grounds at Upper Russian Lake. In view of the above considerations, the late run sockeye salmon fishery was closed by emergency order on August 10, ten days prior to its scheduled closure on August 20.

Despite the loss of ten days, anglers enjoyed exceptional fishing during the late run and harvested 24,530 fish. This harvest is second only to the record 1977 harvest of 27,440 sockeye salmon. Because of the emergency closure, the minimum late run escapement of 30,000 fish was exceeded by 4,230.

The return of record numbers of early run fish and the above management practices combined to produce the highest early run escapement and the greatest harvest recorded. Management of the late run resulted in the second highest recorded harvest and achievement of the escapement goal. Late run escapements above Russian River Falls coupled with a record spawning population below the Falls produced an above average late run escapement to Russian River drainage (52,560). Management associated with both runs was therefore most successful as these practices maximized harvest, escapement and fishing opportunity.

Table 19. Kenai River Sonar Counts, Total Late Russian River Sockeye Salmon Run and Percent of Kenai River Escapement to Enter Russian River, 1968-1978.

Year	Sockeye Salmon Sonar Count*	Total Late Russian River Run**	Percent Kenai Run to Russian River
1968	88,000	58,900	66.9
1969	53,000	31,170	58.8
1970	68,000	31,000	45.6
1972	335,000	101,050	30.2
1973	368,000	40,590	11.0
1974	157,000	35,360	22.5
1975	143,000	41,050	28.7
1976	381,000	49,120	12.9
1977	757,000	65,940	8.7
1978	399,000	77,090	19.3
1968-77 Average	261,110	50,464	31.7

* 1971 data deleted due to sonar malfunction.
** Includes escapement passed weir, fish spawning below falls and sport harvest.

Early Run Return Spawner

Numbers of fish produced for each early run fish in the parent (brood) year spawning escapement is presented in Table 20. During the 15-year period 1963-1978 the return per spawning fish in the parent year escapement averaged only 1.7. The highest return per spawner (4.1) during these years was produced by the 1971 escapement which returned in 1975, 1976 and 1977. It should be noted that the 1971 escapement of 2,650 was the smallest early run escapement recorded at Russian River. The lowest return/spawner of 0.2 was produced by the largest early run escapement of 21,510. It is therefore evident that a large spawning escapement will not necessarily result in high production rates.

As noted, early run return/spawner through 1971 averaged only 1.7. Although this figure is relatively low, the trend seems to be toward increased production. Production from 1963 through 1966 spawning escapements which averaged 16,312 fish failed to reproduce themselves. Average return rate was only 0.6. Escapements from 1967 through 1971 averaged 7,202. The average return rate for these years was 2.5 or more than four times the production of earlier years which had larger escapements.

The majority of the early run Russian River sockeye salmon are historically age 2.3 or 6-year fish (Nelson, 1978). The return in 1977 was therefore expected to be composed primarily of the progeny of the 1971 escapement which was the lowest recorded. A less than average return was therefore expected. However, total return in 1977 of 36,470 fish was the highest early run return recorded to date. Nelson (1978) determined that the majority (27,243) of these fish had returned as age 1.3 (5-year fish) and were therefore the progeny of the 1972 rather than the 1971 escapement. Reason(s) for this departure from the historical age structure are not definitely known.

Total 1978 early run return of 71,870 salmon was the highest recorded and more than three times the historical average of 21,069. Scale analysis revealed that 68,492 (95.3%) of the return were 6-year fish and the progeny of the 1972 escapement of 9,270. The 1972 parent year therefore returned 3,038 fish in 1976, 27,243 in 1977 and 68,492 in 1978 for a total return of 98,773. Production per spawner from 1972 was 10.6, or more than four times the average return/spawner for this run.

Foerster (1968) indicates that no matter what level of escapement is compared, the variations in production, as indicated by the numbers of adult fish returning, are quite marked. For the Fraser River, which has been called "the world's best sockeye-producing river" (Foerster, 1968, p. 64) fluctuations are quite marked. Return per spawner has ranged from 2.2 to 13.0 and averaged 5.4 from 1938 to 1954. Foerster concludes that most of the variability in production occurs during the freshwater developmental stages.

Nelson (1978) suggests exceptional freshwater growth and survival may have been responsible for high return in 1977. He noted that a high percentage of fish reared for 1 year in Upper Russian Lake as opposed to the historical 2-year lake residency. This suggested exceptionally

Table 20. Estimated Production from Known Escapements of Early Run Russian River Sockeye Salmon, 1963-1974.

Brood Year	Escapement	Return* Year(s) 1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	Total	Per Female	Per Spawner
1963**	14,380	10,870										10,870	1.5	0.7
1964	12,700		11,200									11,200	1.8	0.9
1965**	21,510			4,875								4,875	0.4	0.2
1966**	16,660			525	7,241	417						8,183	1.0	0.5
1967**	13,710			60	6,640	12,830	98					19,628	2.8	1.4
1968**	9,200				429	5,938	12,459	120				18,946	4.0	2.0
1969**	5,000					675	6,935	5,378	1,520			14,508	5.8	2.9
1970**	5,450						98	1,514	11,198			12,810	5.3	2.3
1971**	2,650							28	2,334	8,534		10,896	8.7	4.1
1972**	9,270								8,038	27,243	68,492	98,773	26.6	10.6
1973	13,120									693	3,306			
1974	13,150										72			
Total	136,800	10,870	11,200	5,460	14,310	19,860	19,590	7,040	18,090	36,470	71,870	210,689		
Average	11,400											21,069	5.8	2.6

* Return equals sport harvest plus escapement. A negligible commercial harvest is assumed.
** Assumes a male to female sex ratio of 1:1.
*** Male to female sex ratio determined by sampling at the weir.

favorable rearing conditions. This author postulated these conditions may have occurred because of relatively few late run fish rearing at that time; i.e., there was limited competition for food and space from late run juvenile salmon. Additionally, egg sampling of early run eggs in Upper Russian Creek in 1972 revealed egg density to be 407.8 per M^2. This is the highest density recorded for this stream. It should also be noted that with few exceptions Alaskan salmon stocks appear to have experienced above average marine survival during the last several years. The exceptional production of the 1972 parent year may therefore be related to high freshwater survival, high marine survival or a combination of the two.

Age Composition

Scale analysis revealed sockeye salmon in their sixth year of life comprised 95.3% of the early Russian River run. Five-year fish comprised 4.6% of the sample and 4-year fish the remaining 0.1%. The run was dominated by salmon that reared for 2 years in Upper Russian Lake. The majority of these sockeye were progeny of the 1972 escapement.

Early run salmon averaged 602.0 mm (23.7 in) in length. Average lengths of two- and three-ocean fish were 551.5 mm (21.7 in) and 604.5 mm (23.8 in), respectively. Male to female sex ratio was 1:1.1.

Late run stocks were also dominated by salmon that migrated to the marine environment after 2 years in fresh water (93.8%). The majority of this run (59.7%) spent 2 years in salt water prior to returning to their natal stream. Parent years 1972 and 1973 contributed 35.0% and 63.6%, respectively, to the 1978 return. The male to female sex ratio (excluding jacks) was 1:1.2. These salmon averaged 566.9 mm (22.3 in) in length, 35.1 mm (1.4 in) less than the average early run fish. This length differential is related to age structure in that the average early run fish remains at sea 3 years as opposed to 2 years for the majority of the late run fish. Two- and three-ocean adults averaged 549.8 mm (21.6 in) and 602.7 mm (23.7 in), respectively.

Age class composition of early and late runs and average lengths for respective age classes are presented in Table 21.

Table 22 presents a summary of early and late run sockeye salmon age class data collected at Russian River since 1970. This table clearly shows the dominance of age classes 2.3 and 2.2 in the early and late runs. The exception to the dominance of age 2.3 fish in the early run occurred in 1977 when 60.7% of the run was composed of age 1.3 sockeye salmon. The significance of this departure from the historic age structure has been previously discussed (Nelson, 1978).

Figure 8 presents the length-frequency of 372 early run sockeye salmon sampled in 1978. Although not definitive, this graph does suggest a possible division of two- and three-ocean salmon between 579 and 580 mm. If the division were made here, it would indicate 9.1% and 90.9% of the early

Table 21. Age Class Composition, Sample Size, Parent Year and Average Length of Adult Sockeye Salmon in Respective Age Classes for Early and Late Run Russian River Escapements, 1978.

Class	Estimated No. In Escapement	Sample Size	Estimated Percent Of Escapement	Parent Year	Average Length (mm)*	S.D.**
			Early Run			
1.2	34	1	0.1	1974	490.0	-
1.3	1,025	10	3.0	1973	609.0	10.5
2.2	546	17	1.6	1973	555.2	27.3
2.3	32,545	344	95.3	1972	604.4	18.3
Combined	34,150	372	100.0		602.0****	22.0****
			Late Run			
1.2	275	3	0.9	1974	530.7	24.6
1.3	1,664	11	5.3	1973	596.8	24.7
2.2	18,436	163	58.8	1973	550.1	29.7
2.3	10,981	68	35.0	1972	603.6	29.5
Combined	31,356***	245	100.0		566.9****	38.3****

* Length is from mid-eye to fork of tail.
** Standard Deviation.
*** Excludes 2,874 jacks.
**** Average limit and standard deviation calculated from total sample.

Table 22. Age Class Composition by Percent of Early and Late Run Adult Sockeye Salmon Escapements Sampled at Russian River Weir, 1970-78.

Year	Age Class 1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
				Early Run				
1970	0.4			8.9	87.1	3.6		
1971	1.1	3.2		6.4	89.3			
1972	3.0	38.0		8.4	50.0	0.6		
1973			No Data Available					
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4	0.9	1.3
1976	16.8	1.5		11.4	61.1		0.8	8.4
1977	1.9	60.7		14.0	23.4			
1978	0.1	3.0		1.6	95.3			
1970-77 Average*	3.4	19.6	0.1	10.3	64.2	0.7	0.2	1.4
				Late Run				
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1972			No Data Available					
1973			No Data Available					
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1970-77 Average**	5.5	5.4		67.6	20.9		0.5	0.1

* 1973 deleted from computations. Seven year average.
** 1972 and 1973 deleted from computations. Six year average.

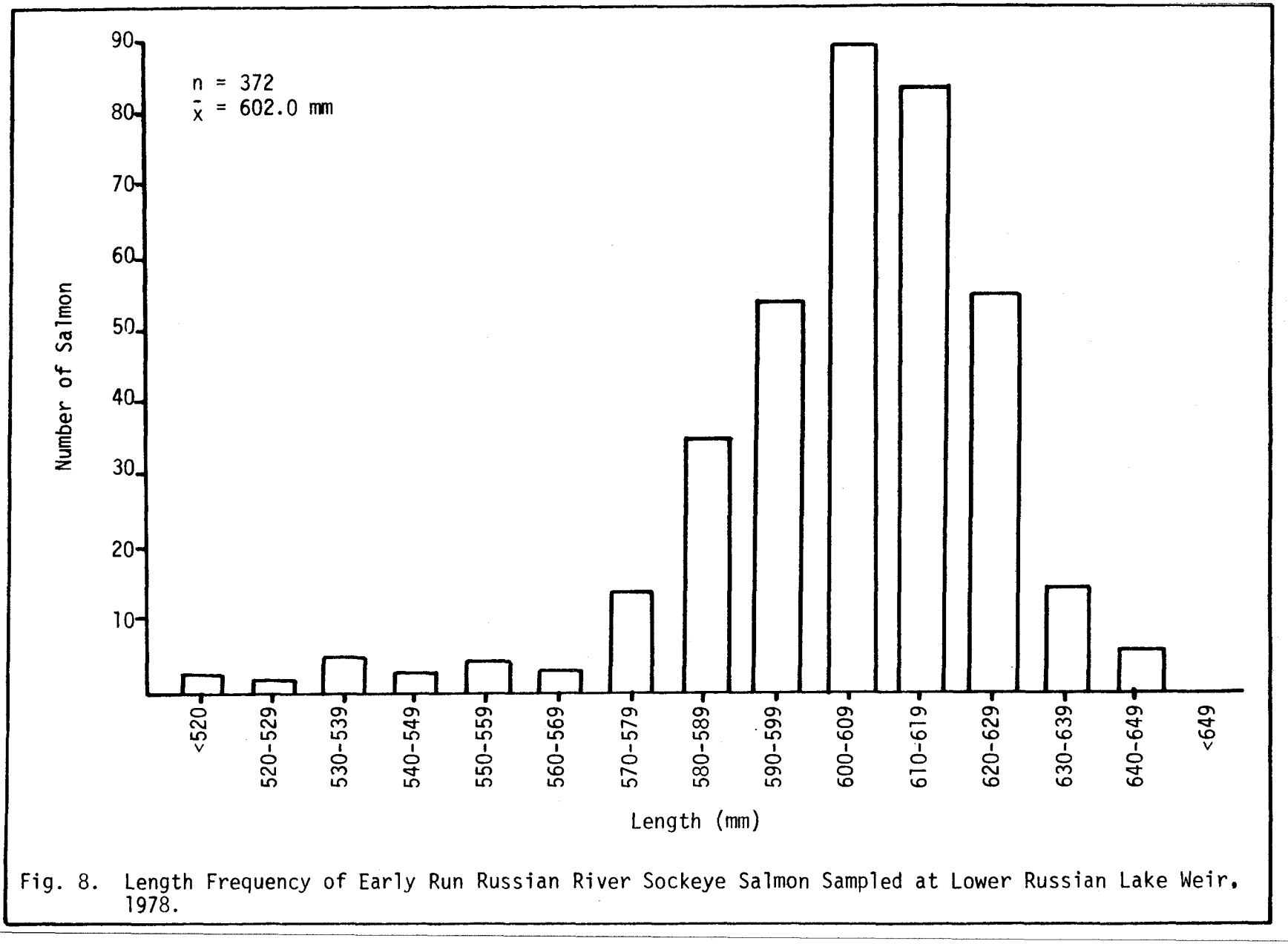

Fig. 8. Length Frequency of Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1978.

run were two- and three-ocean fish, respectively. Table 22 indicates only 1.7% of the escapement were two-ocean fish and the remaining 98.3% were three-ocean. Length-frequency analysis alone would therefore provide only an approximate division of 1978 early run ocean-age classes.

Length-frequency of two- and three-ocean early run sockeye salmon as determined by scale analysis is presented in Figure 9. This graph illustrates the ranges for these two age classes and indicates the division between age 2.2 and 2.3 salmon is more correctly between 569 mm and 570 mm rather than 579 mm and 580 mm as suggested by Figure 8.

Length-frequency of 245 adult late run fish is graphically presented in Figure 10. This figure indicates appreciable variation in lengths of adult (jacks excluded) individuals within this population. Tentative divisions between ocean-age classes are not indicated. This is contrary to data presented by Nelson (1976) indicating that in 1975 ocean-age for late run Russian River stocks could be accurately determined by length-frequency.

Figure 11 depicts length-frequency of two- and three-ocean late run fish as determined by scale analysis. This graph illustrates the length ranges of the respective ocean ages as well as the degree of overlap between two- and three-ocean fish. The extreme range of three-ocean fish is especially noteworthy and emphasized the difficulty in accurately determining ocean-age by size in the 1978 sample.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1978 migration. Results are presented in Table 23 and 24.

Direct enumeration was used to check the accuracy of volumetric estimation. Average error utilizing volumetric estimation was 1.4% during the early run and 1.1% during the late run. Direct enumeration was used to check 58.3% and 52.4% of the early and late run samples, respectively. Applying the correction factors (1.4% and 1.1%) to the respective runs indicates an estimated average fecundity of 3,815 eggs/early run female. Average fecundity of late run females is correspondingly estimated at 2,865. These figures will therefore be used in referring to average fecundity of early and late run fish.

Fecundity of early run salmon ranged from 3,004 to 4,211. Average weight of females sampled was 2.82 kg (6.21 lbs) and average length 608.1 mm (23.9 in). These fish averaged 1,352 eggs/kg of body weight and 6.3 eggs/mm of body length. Late run sockeye salmon averaged 2,865 eggs/female with a range of 2,079 - 3,995. Average length and weight of late run fish sampled was 584.0 mm (23.0 in) and 2.67 kg (5.9 lbs). These fish averaged 1,072 eggs/kg of body weight and 4.9 eggs/mm of body length. Table 25 compares these data with results from prior investigations.

This table indicates that fecundity data from 1978 is not in total agreement with data collected since 1973. The number of eggs/kg of body weight is the lowest recorded for the early run. This is also true when comparing late run data. The number of eggs/kg is the lowest recorded.

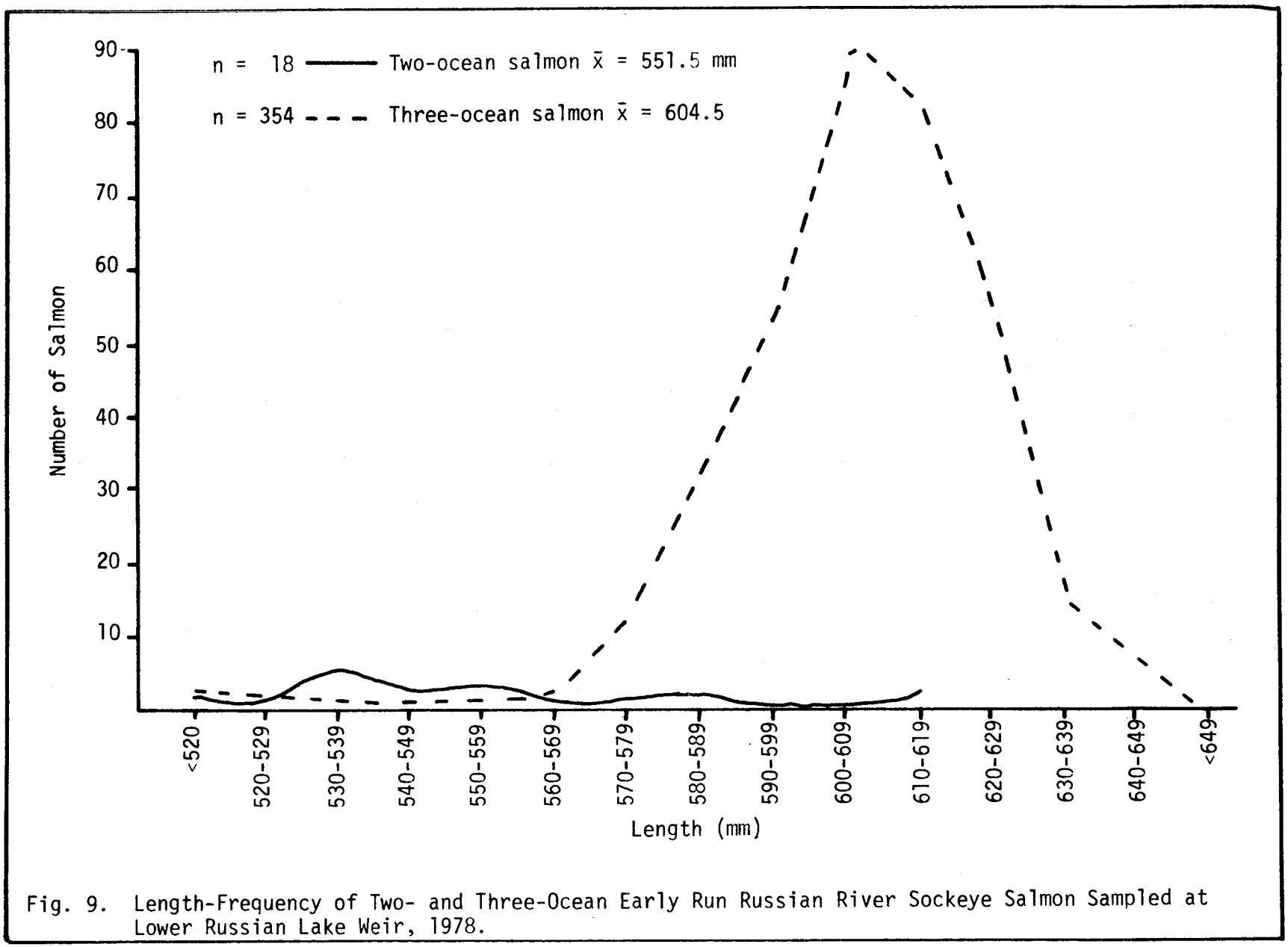

Fig. 9. Length-Frequency of Two- and Three-Ocean Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1978.

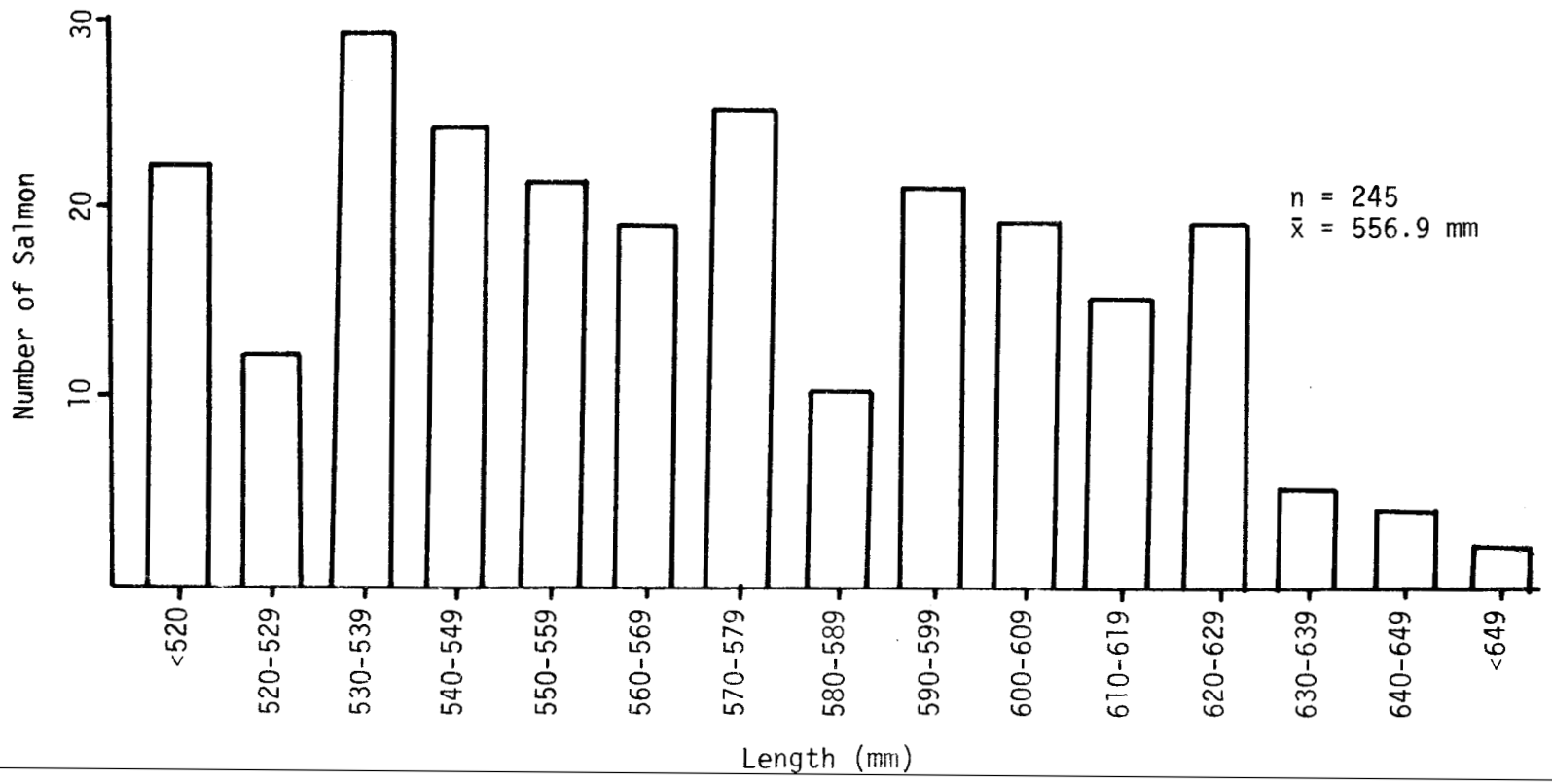

Fig. 10. Length Frequency of Late Run Russian River Adult Sockeye Salmon Sampled at Lower Russian Lake Weir, 1978.

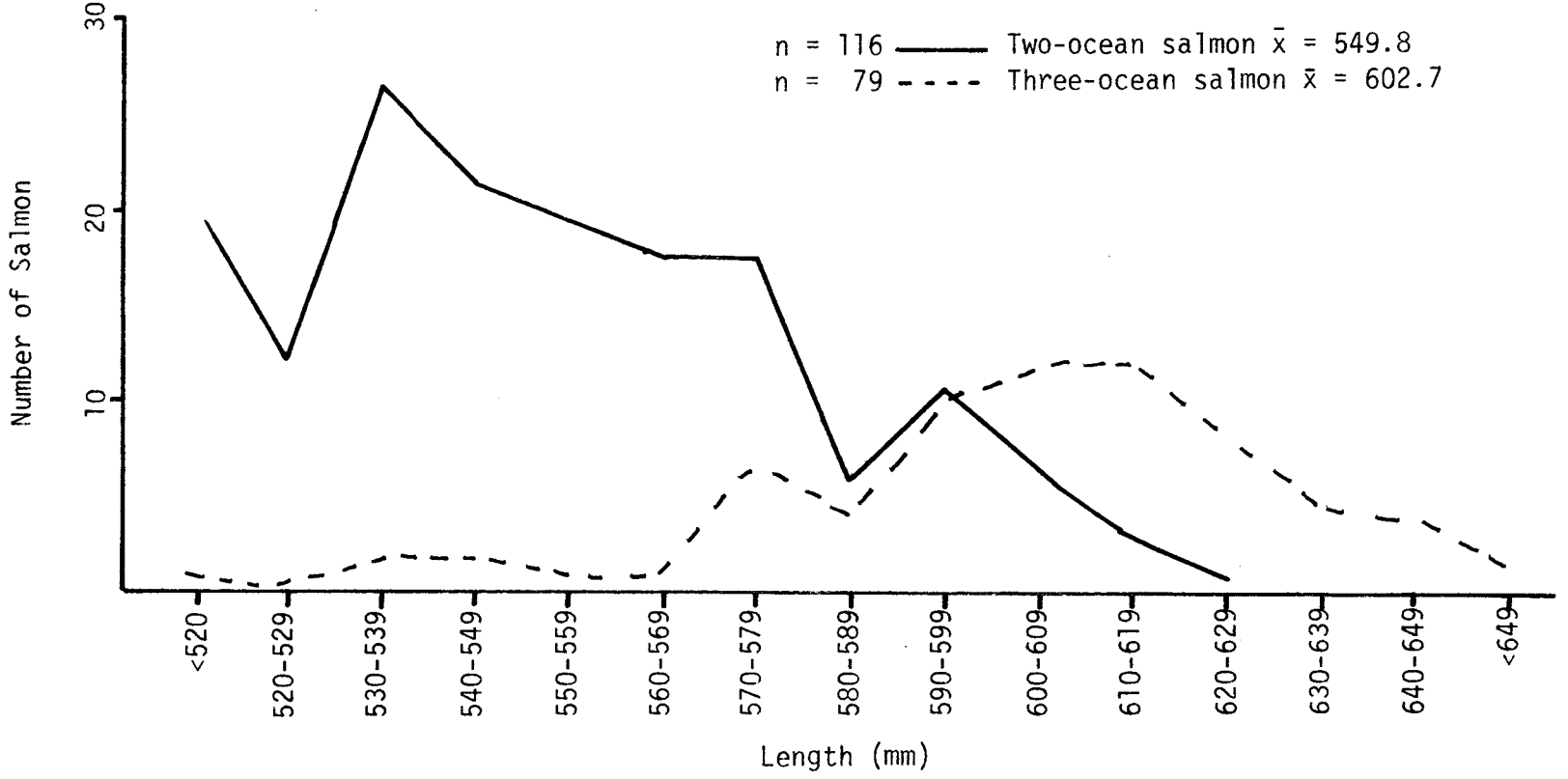

Fig. 11. Length Frequency of Two- and Three-Ocean Late Run Adult Sockeye Salmon Sampled at Lower Russian Lake Weir, 1978.

Table 23. Estimated Fecundity of Early Run Russian River Sockeye Salmon as Determined by Actual Count and Volumetric Estimate, Lower Russian Lake Weir, 1978.

Number	Weight kg (lb)	Length (mm)	Number of Eggs (Actual Count) Right Skein	Left Skein	Combined	Number of Eggs (Volumetric Estimate) Right Skein	Left Skein	Combined	Percent Error
1	2.75 (6.06)	600	1,855	2,155	4,010	1,736	2,070	3,806	+5.1
2	3.06 (6.75)	607	2,002	2,246	4,248	2,002	2,163	4,165	+1.9
3	2.58 (5.69)	600				1,447	1,597	3,044	
4	2.95 (6.50)	610				1,800	2,192	3,992	
5	3.06 (6.75)	639	1,677	2,292	3,969	1,655	2,030	3,685	+0.7
6	2.86 (6.31)	616	1,495	1,789	3,284	1,455	1,762	3,217	+2.0
7	2.43 (5.37)	585	1,556	1,796	3,352	1,599	1,812	3,411	-1.8
8	2.75 (6.06)	600				1,872	2,150	4,022	
9	3.03 (6.69)	630				1,890	2,070	3,960	
10	2.43 (5.37)	600	1,597	2,003	3,600	1,554	1,952	3,506	+2.6
11	3.20 (7.06)	615				1,742	2,469	4,211	
12	2.72 (6.00)	595	1,989	2,102	4,091	2,059	2,070	4,129	-0.9
Average	2.82 (6.22)	608.1	1,738.7*	2,054.7*	3,793.4*	1,734.3	2,028.1	3,762.3**	+1.4

* Averages computed utilizing samples 1, 2, 5, 6, 7, 10 and 12 only.

** Average early run fecundity was volumetrically estimated at 3,762.3 eggs per female. Assuming volumetric analysis under estimated by 1.4%, the average fecundity of early run Russian River sockeye salmon is assumed to be 3,815.1.

Table 24. Estimated Fecundity of Late Run Russian River Sockeye Salmon as Determined by Actual Count and Volumetric Estimate, Lower Russian Lake, Weir, 1978.

Sample Number	Weight kg (lb)	Length (mm)	Number of Eggs (Actual Count) Right Skein	Left Skein	Combined	Number of Eggs (Volumetric Estimate) Right Skein	Left Skein	Combined	Percent Error
1	2.46 (5.44)	565	1,518	1,709	3,227	1,512	1,730	3,242	-0.5
2	3.17 (7.00)	595	1,464	2,152	3,616	1,444	2,106	3,550	+1.8
3	3.29 (7.25)	620				1,544	1,848	3,392	
4	3.31 (7.31)	620				2,215	1,780	3,995	
5	2.86 (6.31)	610				1,038	1,140	2,178	
6	2.95 (6.50)	610				1,332	1,452	2,784	
7	2.52 (5.56)	585	1,167	1,000	2,167	1,119	960	2,079	+4.1
8	3.06 (6.75)	630	1,424	1,850	3,274	1,365	1,683	3,048	+6.9
9	3.23 (7.13)	600	1,766	2,022	3,788	2,029	2,075	4,104	-8.3
10	2.72 (6.00)	590	1,278	1,206	2,484	1,244	1,155	2,399	+3.4
11	2.04 (4.50)	550	1,048	1,931	2,979	1,141	1,620	2,761	+7.3
12	2.41 (5.31)	570	1,428	1,725	3,153	1,550	1,870	3,420	-8.5
13	2.55 (5.63)	590				1,045	1,215	2,260	
14	2.61 (5.75)	590	1,724	1,765	3,489	1,699	1,702	3,401	+2.5
15	2.38 (5.25)	570				1,176	1,591	2,767	
16	2.55 (5.63)	550				1,106	1,140	2,246	
17	2.83 (6.25)	570				1,084	1,026	2,110	
18	2.33 (5.13)	560	1,291	1,467	2,758	1,236	1,409	2,645	+4.1
19	2.04 (4.50)	560				1,101	1,152	2,253	
20	2.27 (5.00)	565	1,400	1,861	3,261	1,480	1,800	3,280	-0.6
21	2.41 (5.31)	565				1,352	1,278	2,630	
Average	2.67 (5.89)	584.0	1,409.8*	1,698.9*	3,108.7*	1,372.0	1,511.0	2,883.0**	+1.1

* Averages computed utilizing samples 1, 2, 7-12, 14, 18 and 20 only.

** Average late run fecundity was volumetrically estimated at 2,883.0 eggs per female. Assuming volmetric analysis under estimated by an average of 1.1%, the average fecundity of late run Russian River sockeye salmon is assumed to be 2,864.7.

Table 25. A Comparison of Fecundity Data Collected at Lower Russian Lake Weir During Early and Late Run Russian River Sockeye Salmon Migrations, 1973-1978.

Year	Average Fecundity	Average Length (mm)	Average Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
		EARLY RUN			
1973	4,630	627.0	2.968	1,560	7.4
1974	3,569	603.0	2.603	1,371	5.9
1975	3,952	600.0	2.540	1,556	6.6
1976	3,668	596.0	2.608	1,406	6.1
1977	4,313	602.7	2.852	1,512	7.1
1978	3,815	608.1	2.821	1,352	6.3
		LATE RUN			
1973	3,190	569.0	2.187	1,459	5.6
1974	3,261	558.0	2.301	1,417	5.8
1975	3,555	555.0	2.257	1,575	6.4
1976	3,491	587.3	2.533	1,378	5.9
1977	3,302	567.1	2.438	1,354	5.8
1978	2,865	584.0	2.672	1,072	4.9

Foerster (1968) indicates that the larger the fish the greater the egg content. Table 25 indicates this is generally true but exceptions do occur. This apparent disparity was also noted by Foerster (1968) while investigating the fecundity of Cultus Lake sockeye salmon. He concluded that differences in egg content in relation to size were not statistically significant but were the result of inherent variability of the samples. This is the probable explanation for the variation in Russian River early and late run samples.

Foerster (1968, P. 126) provides an excellent summary of sockeye salmon fecundity investigations. Early run Russian River fish have averaged 3,999.2 eggs/female since 1973. Comparing this average to data presented by Foerster indicates fecundity of the early run is quite high. The Bolshaya River and Cultus Lake stocks are the only populations with consistently higher average fecundities than early run Russian River stocks. Late run Russian River fish are smaller than early run salmon. Fecundity of this stock since 1973 has averaged 3,277 eggs/female. Although it is difficult to rank various populations when dealing with fecundity, a comparison of late run Russian River sockeye salmon fecundity with those reviewed by Foerster suggests these stocks are "intermediate" in relation to other populations.

Egg Deposition

Assuming that average fecundity of early run samples is representative of early run stocks, the potential number of eggs available for deposition in Upper Russian Creek may be calculated. It is recognized that losses between weir and spawning grounds, females that perish without spawning, and average number of eggs retained per female must be considered. These criteria have been presented in detail by Nelson (1976).

Applying the parameters as outlined by Nelson (1976) potential early run egg deposition is calculated as follows:

Early run escapement	34,150
Early run female escapement	17,888
Mortality between weir and spawning grounds	5.1%
Female salmon to reach spawning grounds	16,976
Female salmon that perished without spawning	1.1%
Remaining spawning females	16,789
Average fecundity per female	3,815
Total possible eggs deposited	64,050,036
Percent eggs deposited per female	98.0%
Estimated potential egg deposition	62,769,034

Potential early run deposition in 1978 of approximately 62.8 million eggs is the highest recorded for Russian River. The 1978 escapement was also the highest recorded. Estimated potential deposition in 1973, 1974, 1975, 1976 and 1977 was 29.6, 17.7, 12.7, 23.5 and 18.2 million, respectively. Egg deposition in 1978 was therefore 111.8% greater than the previous high deposition in 1973 of 29.6 million.

Egg sampling to determine actual egg deposition and survival of early run eggs in Upper Russian Creek was conducted October 4-5 in all 11 sections of the creek and was proportionate to section area; i.e., the larger the area of a section the more samples dug. Points to be dug were randomly selected. Only 92 of 108 points scheduled to be dug were sampled due to the sampling point falling on a rock or in a pool.

Number of eggs dug per point ranged from zero to 2,035. Average egg density in all areas of the stream was subsequently estimated at 226.1. Egg survival at time of sampling was 87.6% which compares favorably with prior years data. Egg density and survival estimates determined by hydraulic sampler in Upper Russian Creek are presented in Table 26.

Egg density estimates obtained by hydraulic sampler may also be used to estimate total egg deposition in Upper Russian Creek. Multiplying the estimated spawning area available to early run fish by the estimated eggs/m^2 yielded a total deposition of 3,123,687 eggs. Thus the estimated deposition in Upper Russian Creek as determined by hydraulic sampler is many times lower than the number of eggs potentially available (62.7 million). This disparity between actual and potential deposition has been previously noted (Nelson, 1976, 1977).

Nelson (1976) indicated that is does not necessarily follow that because major differences exist between actual and potential deposition estimates that one or the other method is incorrect. Indirect estimation employing fecundity and mortality data yields the maximum potential eggs available for deposition and does not necessarily reflect numbers of eggs in the stream. Direct estimation (provided sampling design is correct) should indicate the numbers of eggs in Upper Russian Creek at the time of sampling.

Nelson (1978) indicated that observation in 1976 and 1977 suggested Upper Russian Creek may have been subject to extreme high water during those years. Hydraulic sampling in 1976 and 1977 indicated exceptionally low egg densities (Table 26). Observation by this author indicated moderate water flows in 1978. Egg density in 1978 was the highest recorded since 1974. This high density is related to stable water conditions and the record number of eggs potentially available for deposition.

Considerable variability in reproductive potential exists independent of actual number of spawners (Hartman and Conkle, 1960). Nevertheless, the numbers of eggs available for deposition is closely related to the magnitude of the spawning escapement. As has been indicated previously in this report, large numbers of early run spawners do not necessarily produce large returns. It is therefore suggested that numbers of eggs in

Table 26. Early Run Russian River Sockeye Salmon Egg Densities Determined by Hydraulic Sampler in Upper Russian Creek, 1972-1978.

Year	No. Points Dug	Total Eggs Dug	Average Eggs Per Point	Percent Survival	Density (Eggs/M^2)
1972	50	3,790	75.8	81.1	407.8
1973	50	2,967	59.3	93.0	319.6
1974	98	8,229	84.0	64.2	455.6
1975	98	605	6.2	84.3	33.3
1976*	71	901	12.7	91.6	61.3
1977*	78	981	12.6	55.0	67.7
1978*	92	4,415	48.0	87.6	226.1

* These data are comparable. These three years may not be comparable to prior years due to revised methods of estimating egg density.

Upper Russian Creek as determined by hydraulic egg sampling may provide more meaningful data than a knowledge of the potential numbers of eggs available for deposition.

The record early run return in 1978 was primarily the progeny of the 1972 spawning escapement. Egg sampling at Upper Russian Creek was first conducted in 1972. Density was 407.8 eggs/m^2. This is the highest density recorded for this stream. Sampling in 1973 indicated a higher than average early run egg density of 319.6 eggs/m^2. Progeny from the 1973 escapement are expected to return in 1979. It will be of interest to determine, as additional data becomes available, whether or not a correlation exists between egg density in Upper Russian Creek and the number of returning adults 6 years later.

Bear Creek is a small (approximately 5,400m^2) spring fed tributary on the east side of Upper Russian Lake. The system has been described in detail by Nelson (1976). In 1978 a beaver dam denied late run salmon access to the majority of the stream. Observation by this author indicated less than 300 fish were attempting to utilize this creek and that sufficient spawning area was available below the barrier. The obstruction was therefore left in place and hydraulic egg sampling not conducted.

Climatological Observations

Air and water temperatures recorded at Lower Russian Lake were grouped by 6-day periods to facilitate analysis (Table 27). No correlation was found between air or water temperature and adult sockeye salmon migration. The relationship between smolt out-migration and water temperature has been discussed earlier in this report. Total precipitation recorded from May 8 to September 4 was 1,079 mm (42.5 in).

Table 28 compares climatological data recorded since 1975. Data presented in this table are for the period June 29 through August 29. Average maximum water temperature in 1978 was 12.7°C (54.9°F) which is 0.9°C (1.6°F) cooler than the 1975-1977 average. Similarly, the average maximum air temperature was 17.0°C (62.6°F) or 1.6°C (2.9°F) cooler than the 1975-1977 average. Total precipitation during this period was 855 mm (33.7 in). This is more than 3.5 times greater than previous rainfall recorded for comparable periods. However, precipitation recorded in this area has little affect on the volume of water in Russian River. Rainfall and runoff at Upper Russian Lake are of much greater significance (Nelson, 1976). It is probable that lower than average air and water temperatures reduced runoff and decreased Russian River discharge rates in 1978.

Stream velocities at Russian River Weir were not determined in 1978. Additional time required of weir attendants to conduct the smolt enumeration portion of the program precluded this activity.

Table 27. Climatological and Hydrological Observations by Six-Day Periods Recorded at Lower Russian Lake Weir, May 8 - September 14, 1978.

Period	Water Temperature*		Air Temperature		Rainfall**
	Max. °C	Min. °C	Max. °C	Min. °C	(mm)
May 8 - 13	4.0	2.1	15.4	-0.7	
May 14 - 19	6.6	2.0	16.1	-2.8	6.0
May 20 - 25	6.4	5.4	13.9	-0.7	64.0
May 26 - 31	6.6	5.3	11.9	-0.3	10.0
June 1 - 6	8.0	6.9	13.6	2.9	12.0
June 7 - 12	10.5	8.3	17.9	3.9	
June 13 - 18	9.4	7.8	12.2	4.2	62.0
June 19 - 24	10.1	8.6	16.5	4.3	138.0
June 25 - 30	9.6	8.7	13.7	3.8	180.0
July 1 - 6	10.1	9.3	14.4	7.5	77.0
July 7 - 12	11.3	10.3	16.5	6.5	52.0
July 13 - 18	11.9	10.3	14.8	7.2	114.0
July 19 - 24	11.8	10.4	14.3	7.4	133.0
July 25 - 30	13.7	11.3	18.2	6.9	46.0
July 31 - August 5	16.3	13.4	21.4	7.7	
August 6 - 11	15.8	13.4	19.6	9.0	5.0
August 12 - 17	14.1	12.3	16.3	6.1	74.0
August 18 - 23	13.8	11.8	19.3	3.2	12.0
August 24 - 29	14.4	11.8	19.0	2.6	24.0
August 30 - September 4	12.5	10.7	15.3	3.6	70.0

* Air and water temperature for the respective periods are the average of the daily recordings.
** Rainfall for each period is the cumulative total of the daily readings.

Table 28. A Comparison of Climatological Data Collected at Russian River Weir by Six-Day Period, June 19 - August 29, 1975-1978.

Period	Average Max. Water Temperature °C				Average Max. Air Temperature °C				Precipitation (mm)			
	1975	1976	1977	1978	1975	1976	1977	1978	1975	1976	1977	1978
June 19 - 24	...	...	10.7	10.1	...	15.7	17.8	16.5	...	3.5	8.4	138.0
June 25 - 30	...	13.3	12.1	9.6	...	23.8	19.9	13.7	...	2.5	19.9	180.0
July 1 - 6	11.5	12.5	12.8	10.1	19.5	17.1	20.2	14.4	1.2	0.0	2.7	77.0
July 7 - 12	14.3	13.7	14.3	11.3	23.7	23.3	23.1	16.5	17.5	0.0	0.8	52.0
July 13 - 18	13.4	13.8	13.2	11.9	16.7	19.3	18.9	14.8	11.4	19.5	1.7	114.0
July 19 - 24	13.6	13.7	14.6	11.8	15.6	17.3	20.1	14.3	5.7	129.0	0.5	133.0
July 25 - 30	13.6	15.0	13.7	13.7	17.9	18.0	21.7	18.2	5.2	0.0	1.6	46.0
July 31 - Aug. 5	14.1	...	13.3	16.3	17.9	21.3	19.2	21.4	6.2	0.0	18.4	0.0
Aug. 6 - 11	15.0	...	12.7	15.8	17.0	16.4	17.3	19.6	8.0	1.5	24.4	5.0
Aug. 12 - 17	14.8	...	12.9	14.1	16.7	15.0	17.7	16.3	4.1	0.0	14.7	74.0
Aug. 18 - 23	14.3	...	14.1	13.8	16.0	16.7	23.1	19.3	2.2	76.0	0.0	12.0
Aug. 24 - 29	14.1	...	13.1	14.4	15.8	15.6	19.1	19.0	1.3	3.0	0.0	24.0
Total									62.8	23.5	93.1	85.5
Average*	13.9	13.7	13.1	12.7	17.7	18.3	19.8	17.0	6.3	19.5	7.7	71.3

* Averages computed using only available data.

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