Volume 18 | Study AFS 44-3

STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

RUSSIAN RIVER RED SALMON STUDY

by

David C. Nelson

ALASKA DEPARTMENT OF FISH AND GAME
James W. Brooks, Commissioner

SPORT FISH DIVISION
Rupert E. Andrews, Director
W. Michael Kaill, Chief, Sport Fish Research

TABLE OF CONTENTS (Continued)

Section N

Job No. AFS 44-3
Russian River Red Salmon Study   David C. Nelson

TABLE OF CONTENTS (Continued)

Section O

Job No. AFS 44-3 (continued) Page No.

the majority of the salmon sampled (73.3%), the left skein contained a greater number of eggs than did the right.

It is estimated that approximately 23.5 million early run red salmon eggs were potentially available for deposition in Upper Russian Creek in 1976. Hydraulic sampling conducted in this area revealed actual egg deposition to be 846,890, or an average density of 61.3 eggs/M^2. This density is the second lowest recorded since 1972 despite the exceptionally high early run escapement. Observations are presented which indicate Upper Russian Creek was subject to severe flood conditions in 1976. These observations coupled with low egg density suggest many eggs were washed from the gravel prior to sampling.

Sampling to detect the presence of infectious hematopoietic necrosis (IHN) revealed the incidence of this disease in 16.7% of the early run. This is in contrast to the 100% occurrence reported in 1975. Varying rates of infection in the 1975 and 1976 samples are not directly comparable as sampling design was modified in 1976. Effect(s) of this virus on red salmon production in Upper Russian Lake are not presently known.

Climatological data were again collected at Lower Russian Lake weir site. Rainfall recorded during a 73 day period totaled 235 mm (9.3"). Stream discharge was greatest in mid-June, averaging 303.7 cfs for a seven day period. Discharge steadily declined thereafter reaching an average six day low of 137.0 cfs from August 24-29. Observation indicated neither early nor late run red salmon experienced difficulty negotiating Russian River falls at these velocities. Average air and water temperatures closely approximated similar data collected in 1975.

BACKGROUND

Russian River is a clear stream adjacent to the Sterling Highway at Mile 55, seven miles west of the Kenai Peninsula community of Cooper Landing, and 150 miles south of Alaska's largest City, Anchorage. At this point the Russian River enters the larger glacial Kenai River (Figure 1). It is at the confluence of these two rivers that a privately operated ferry transports anglers to the south bank. Approximately 50% of all angler effort on red salmon, *Oncorhynchus nerka* (Walbaum), occurs here.

Red salmon sport fishing is presently restricted to Lower Russian River from a marker 600 yards below Russian River Falls to a marker 1,800 yards below the Kenai and Russian River confluence, a distance of approximately three river miles. Only coho or streamer flies with a gap between point and shank no greater than 3/8" are permitted as legal sport fishing gear in this area from June 1 to August 31. The area between a marker below the ferry crossing dock and a marker 700 yards upstream on Russian River is closed to all sport fishing from June 1-July 14 (Figure 2).

Russian River red salmon runs are bimodal, i.e., there are two distinct runs. Early run salmon generally enter the sport fishery from June 10-15,

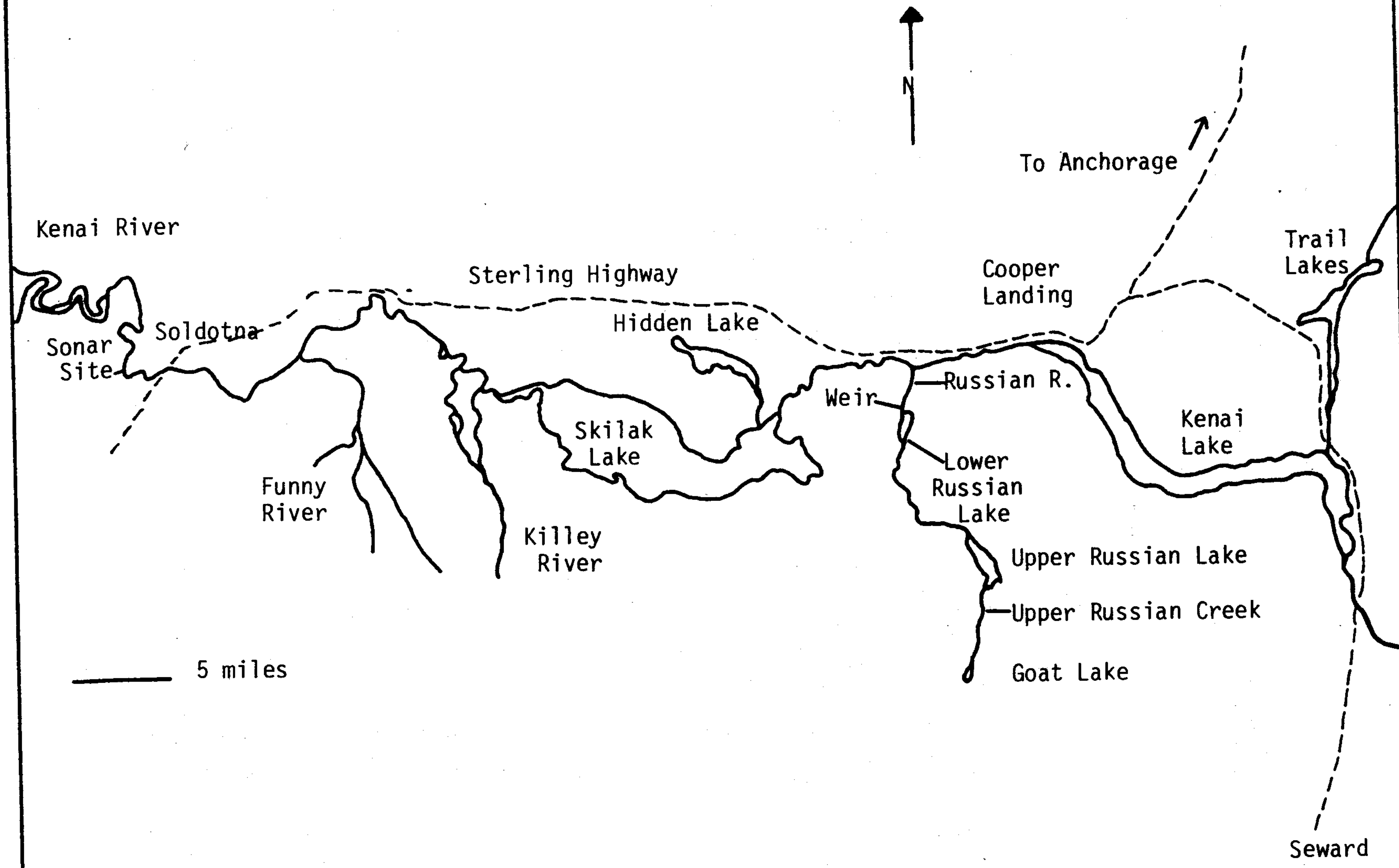

Figure 1. Schematic diagram of the Kenai River drainage. (not to scale)

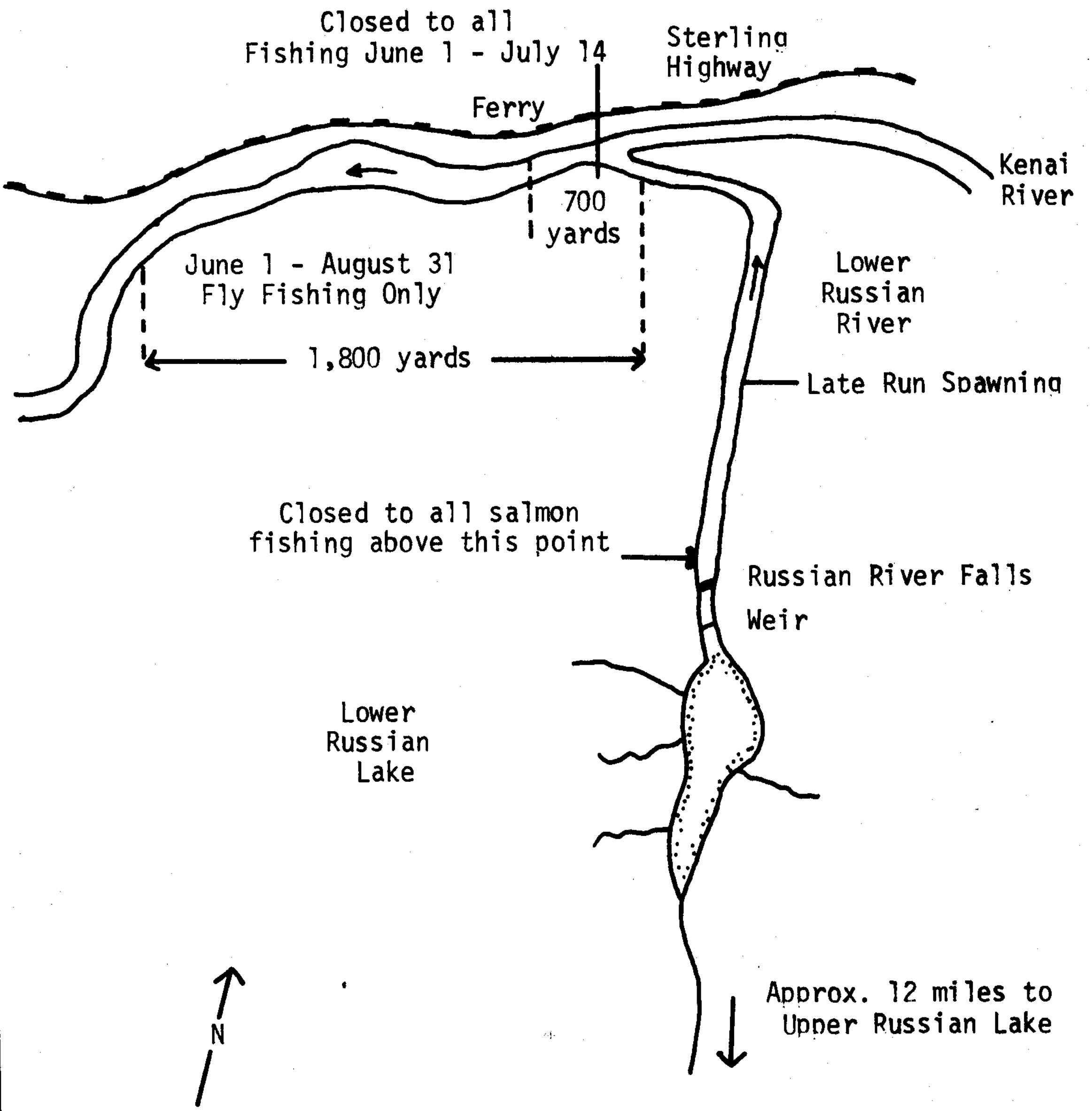

Figure 2. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not To Scale).

and by July 5 approximately 50% of the run has passed the weir at Lower Russian Lake. This is the smaller of the two runs, averaging 17,209 (14-year mean) annually. The late run enters the fishery in mid-July and averages 45,688 (14-year mean) annually. Approximately 50% of this run has passed the weir by August 5. Red salmon migration in Russian River is generally complete by September 1.

Russian River also supports chinook, coho, and a few pink salmon. Resident game species include rainbow trout and Dolly Varden.

Lower Russian River from its confluence with the Kenai River to a point approximately two miles upstream is of moderate gradient. Upstream from this point the stream flows through a canyon of considerable gradient commonly called Russian River Falls. During the past 15 years salmon have been delayed in the canyon on several occasions due to abnormally high water. The only documented mortality, however, occurred in 1971 (Engel, 1972).

Lower Russian Lake supports an active Dolly Varden and rainbow trout sport fishery. The lake's maximum depth is 25 feet and it is 215 acres in area. No known salmon spawning areas are located here, but it is utilized by rearing chinook and coho salmon.

Upper Russian River enters Lower Russian Lake from the south. This stream contains excellent spawning gravel and connects Upper and Lower Russian Lakes. Nelson (1976) has presented a detailed description of Upper Russian Lake. Figure 3 is a schematic diagram of this area depicting the known spawning grounds of both early and late runs.

Management and research activities associated with this complex system have been carried out by the Sport Fish Division of the Alaska Department of Fish and Game since 1962. Prior information relating to this fishery has been presented by Lawler (1963, 1964), Engel (1965 through 1972), and Nelson (1973, 1974). In 1974 Russian River red salmon investigations were partially financed with Anadromous Fish Act funds. Results of these studies have been presented by Nelson (1975, 1976).

To monitor angler effort and derive accurate harvest estimates, a creel census has been conducted since the inception of this project in 1962. During the 15 years the census has been active, Fish and Game personnel have contacted over 59,000 anglers who reported harvesting in excess of 42,000 red salmon. Fishermen have annually averaged 0.8 fish per angler day. Total harvest since 1963 is estimated at 176,700 salmon.

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

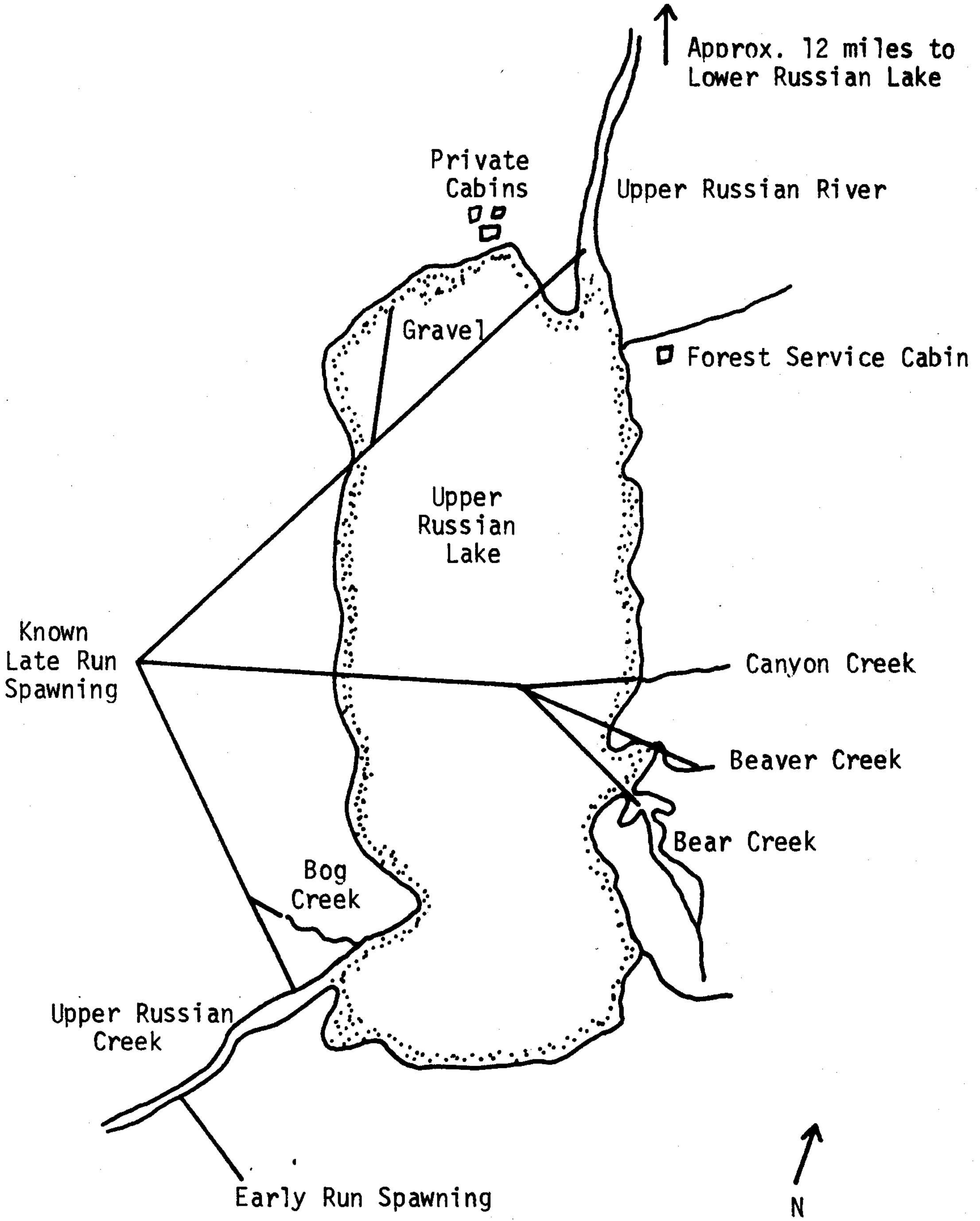

Figure 3. Schematic Diagram of Upper Russian Lake (Not To Scale).

Regulatory measures affecting this fishery from 1960-1966 have been presented by Engel (1967). Regulatory changes from 1966 through 1975 have been reviewed by Nelson (1976). Regulation of the fishery in 1976 was identical to 1975.

Despite increasing restrictions in the fishery, demands placed upon the Russian River red salmon are at times greater than the resource can provide. This is evidenced in that the Sport Fish Division has found it necessary to closed all or part of the fishery on 11 different occasions since 1969 (Table 1).

The Russian River management program is currently directed toward "in season" evaluation of stock status and analysis of fisheries statistics to determine the effectiveness of regulatory practices. Research activities presently emphasize collection and evaluation of life history data. Objectives include determination of optimum escapement goals for both runs and ultimately predictions of adult red salmon returns to Russian River. The latter objective will not be achieved until a smolt weir is constructed at the outlet of Lower Russian Lake and stock separation techniques perfected in the Cook Inlet commercial fishery.

Life history investigations of early run salmon are presently confined to Upper Russian Creek, the only spawning area utilized by this stock. Escapement counts are made to determine spawner distribution in the stream. Potential egg deposition is estimated employing fecundity/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 and, when feasible, eggs retained per female salmon are determined.

Late run investigations are directed toward determining numbers of salmon that utilize respective spawning areas of Upper Russian Lake. This is accomplished through ground counts and, from 1973 through 1975, by weir counts on the largest tributary utilized by late run stocks (Bear Creek). Escapement to this stream was minimal in 1976 and a weir was not required. Egg densities and survival are also determined and, where feasible, pertinent climatological data collected.

RECOMMENDATIONS

1. The early run Russian red sockeye salmon fishery should be closed in 1977. The parent year (1971) had an escapement of 2,650 adult red salmon, the lowest escapement on record. These fish were in poor physical condition due to a velocity barrier at Russian River Falls which delayed migration. The 1977 return is therefore expected to be exceptionally low and all fish will be required for escapement.

2. Spawning ground investigations of early and late run spawning escapements should be confined to ground surveys of various areas and determination of egg deposition. Bear Creek should be surveyed on several occasions as a greater than average return of late run red salmon is expected in this system in 1977.

Table 1. Emergency Closures Issued by the Sport Fish Division of the Alaska Department of Fish and Game Affecting the Russian River Sport Fishery, 1969-1976.*

Year	Closure Date	Total or Partial Closure	Days Closed**	Run Affected
1969	7/27-8/ 8	Total	13	Late
1970	7/ 4-7/23	Total	20	Early
	7/28 ---	Total	24	Late
1971	7/ 8-7/30	Total	24	Early
	8/14 ---	Partial***	7	Late
1972	Closure at confluence of Kenai and Russian River extended 14 days			Early
1973	Closure at confluence of Kenai and Russian River extended 14 days			Early
	7/ 5-7/14	Total	10	Late
1974	7/ 1-7/ 5	Total	5	Early
	7/31 ---	Total	21	Late
1975	7/ 1-7/14	Total	14	Early
	8/13 ---	Total	8	Late
1976	6/28-7/ 4	Total	7	Early

* No emergency closures affecting this fishery were 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, a distance of approximately 1.5 miles, to protect fish experiencing difficulty negotiating Russian River Falls.

3. Daily flow data should be collected at the outlet of Lower Russian Lake. Data should be correlated with sockeye salmon migrational timing through Russian River Falls.

4. Modify the existing weir at Lower Russian Lake to permit sockeye salmon smolt enumeration.

5. Construct a fishway at Russian River Falls.

OBJECTIVES

1. To collect and analyze biological data concerning abundance and migrational timing of adult red salmon in Russian River drainage.

2. To determine age composition of adult early and late run Russian River stocks.

3. To determine sport harvest of adult early and late run Russian River red salmon.

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

5. To determine fecundity of early and late run Russian River red salmon and to determine the relationship between body weight, skein weight, and number of eggs per skein.

6. To collect basic climatological data (rain fall, water and air temperatures, stream velocity) at Lower Russian Lake weir and to determine if a correlation exists between these parameters and migrational timing.

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

TECHNIQUES USED

The 1976 Russian River creel census was a modification of the technique described by Neuhold and Lu (1957). Sampling procedures were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Escapements were enumerated by weir at the outlet of Lower Russian Lake. The weir was constructed in June, 1975 and replaced a temporary weir (described by Engel, 1970) which has been in use since 1969. Nelson (1976) has presented a detailed description of the present structure.

Average egg content of early and late run red salmon was determined by sampling at the weir site. Both direct enumeration and volumetric estimates utilized. Methodology of egg enumeration by volumetric estimation has been previously described (Nelson, 1975).

Scale samples were randomly collected at Lower Russian Lake weir from both early and late run red salmon. 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).

Early and late run red salmon spawning in the Upper Russian Lake tributaries of Bear and Upper Russian creeks were enumerated by ground surveys.

Egg density in Upper Russian Creek was determined by hydraulic sampler patterned after equipment described by McNeil (1964). Sampling techniques in prior years sampled proportionate to numbers of salmon in a given section and has been described (Nelson, 1973, 1975). Sampling in 1976 was proportionate to section area, i.e., the greater the area of a section the more points dug, irrespective of numbers of salmon spawning in that area. This technique was introduced to increase randomness and to provide a more accurate estimate by area of average number of eggs/M^2 of spawning gravel.

Field implementation of the design consisted of randomly selected ordered pairs of numbers representing a sampling point. First number of the ordered pair was the number of yards downstream from a section boundary. The second number corresponds to the numerator of the fractional width, in eights, of the creek. For example, if the first ordered pair for section VI was 5.3, five paces would be taken downstream from the section boundary and the sample was then dug 3/8 of the distance from this point to the right hand side of the creek. Lengths were always measured downstream; fractional widths were always taken from the left side of the creek.

Total eggs deposited by early run salmon in Upper Russian Creek was determined by direct and indirect methods. Application of these methods has been described (Nelson, 1975).

Samples to determine the presence or absence of the viral disease infectious hematopoietic necrosis (IHN) were again taken from early run fish in Upper Russian Creek and late run Bear Creek salmon. Fish were captured by 50' beach seine. Sixty salmon were taken from each area. In 1975 samples were analyzed by five fish pools. In 1976 each sample was treated individually.

Water and air temperatures at Lower Russian Lake were determined by a Taylor maximum/minimum thermometer. Stream discharge was determined by Head Rod method. Fourteen stations were established at the Lower Russian Lake outlet. Stations were 10 feet apart. Average discharge in each section (the area between two stations) was found by determining the discharge at the two stations immediately adjacent to a given section, summing these two discharges and dividing by two to yield the average discharge for a given section. Discharge, expressed in cfs, for the total stream is found by summing sectional discharges.

FINDINGS

Results

A creel census to evaluate management/regulatory measures and to determine harvest and effort was in effect from June 12 through July 27 and from July 5 through August 23, 1976. Recreational fishing effort directed toward red salmon, *Oncorhynchus nerka*, salmon stocks was sampled. Data indicated anglers expended 26,310 man-days of effort, or 102,914 angler hours in 1976. Effort directed toward early and late run stocks was estimated at 8,930 and 17,380 man-days.

Based on interviews with 2,534 anglers who reported harvesting 1,683 red salmon, total catch was estimated at 17,080 fish. Early and late runs contributed 3,380 and 13,700 salmon, respectively, to this harvest. Mean hourly early and late run catch rates were higher on weekdays (0.165) than on weekend days (0.161) due to greater angler congestion during weekday periods. Seasonal average catch per hour was 0.163. Harvest, effort and catch per hour estimates since 1963 are summarized in Table 2.

Total man-days of effort increased 59.4% in 1976 compared to 1975 estimates. Effort in 1976 was the second highest recorded and is only 14.0% less than the record 1973 effort of 30,590 man-days. Increased angler participation is attributed to increased utilization of late run stocks. Effort on late run fish in 1976 was the highest recorded, i.e., 17,380 man-days. Effort on early run stocks increased by 71.4% over 1975 estimates but was below the historical average effort of 9,596 man-days. Relatively low effort directed toward early run stocks is attributed to reduction in bag and possession limit from three to one salmon (effective since 1975) and an emergency closure from June 28 through July 4. Emergency closures were not required during the late run migration.

Total weekday and weekend day stream counts averaged 72.5 and 134.4 anglers, respectively, in 1976. Weekday counts approximate the historical average of 75.0 (Table 3). Weekend counts exceeded the historical average by 5.1 anglers or 3.9%. Average angler counts do not accurately reflect total angler effort, but do indicate average number of anglers on the stream during different segments of the fishery.

Early run weekday angler counts ranged from 58 to 101, averaging 70.8. Late run weekday counts approximated those of the early run averaging 73.7 anglers per count. Weekend counts during the early run ranged from 5 to 249, averaging 104.9. In contrast, late run weekend counts ranged from a low of 43 to a high of 384, averaging 151.7. It is therefore evident that greatest fishermen concentrations occurred on weekend days during the late run.

Each angler fished an average of 3.5 and 4.5 hours on weekdays and weekends, respectively. This represents a decrease in average hours fished when compared to historical data. Reason(s) for the decrease are not known. Fisheries statistics since 1964 are presented in Table 3.

Table 2. Red Salmon Estimated Harvest, Effort and Success Rates on Russian River, 1963-1976.

Year	Harvest Early Run	Harvest Late Run	Total	Total Effort (man-days)	Catch/ Hour	Census Period
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	9,730	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	17,270	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	6/11-7/27*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/20**
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,590	0.102	6/ 8-8/19***
1974	6,440	8,500	14,940	21,120	0.131	6/ 8-7/30****
1975	1,400	8,390	9,790	16,510	0.140	6/14-8/13*****
1976	3,380	13,700	17,080	26,310	0.163	6/12-8/23******
1963-1975 Average	6,185	6,090	12,276	16,163	.175	

* Census active from June 11-July 3 and from July 24-July 27.

** Census active from June 17-July 7 and from July 31-August 20.

*** Census active from June 9-July 4 and from July 15-August 19.

**** Census active from June 8-June 30 and from July 6-July 31.

***** Catch/hour computed on data collected when fishery was open and fish were present. Data collected from July 15-July 24 when fishery was open and fish were not present is not included in the calculations.

****** Census active from June 12-June 27 and from July 5-August 23.

Table 3. Differences Between Weekday and Weekend Day Fishing Pressures and Rates of Success at Russian River, 1964-1976.

Year	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
1964-1975 Average	75.0	129.3	0.203	0.140	4.6	5.1

Stream counts revealed 38.6% and 60.9% of the anglers enumerated during total stream counts fished the confluence area of the Kenai and Russian rivers during the early and late runs, respectively. This distribution pattern is similar to 1975 when 37.3% of the anglers fished this area during the early run. The 1975 late run effort in this area was slightly greater as 72.2% of the anglers were concentrated here. Weekend anglers tended to favor the confluence area while weekday anglers concentrated their efforts in the clear waters of Russian River.

The tendency for anglers to concentrate their efforts on Russian River during the early run was primarily due to the sporadic operation of the privately operated ferry. Anglers wishing to fish the confluence area had to walk approximately one mile downstream from the Forest Service camp ground or gain the south bank of the Kenai River via private boat. The closed or sanctuary area at the confluence, coupled with an eight day closure during the peak of the early run migration also affected angler distribution. The ferry was operational throughout the late run and the sanctuary areas were opened to fishing on July 15. These factors undoubtedly accounted for increased effort in this area during the late run.

During the census, 47 Dolly Varden, Salvelinus malma (Walbaum), 27 rainbow trout, Salmo gairdneri (Walbaum), three pink, O. gorbuscha (Walbaum), and 45 coho, O. kisutch (Walbaum), salmon were creel checked. These data were expanded, revealing a total harvest of 340 rainbow trout and 540 Dolly Varden. The first pink salmon was harvested on July 26 and data indicate only 55 salmon of this species were caught during the census period. The first coho salmon was reported on August 14 and by the last day of the census (August 23) 10 coho had been creel checked as opposed to two sockeye salmon. Total coho harvest was estimated at 750.

Escapement:

The first early run red salmon was harvested June 12 at the confluence of the Kenai and Russian rivers. Salmon began to pass Russian River weir on June 17, only six days after they entered the fishery. Although large numbers of early run fish were observed in the sanctuary area, escapement lagged below historical levels during the first 17 days of the fishery and the fly-only area was closed to the taking of red salmon by emergency order on June 28. Early run stocks immediately responded to the increased protection and the fishery was reopened on July 5 after minimum escapement goals had been achieved.

The weir was operational June 16, 1976. Early run salmon were passed on June 17, nine days earlier than in 1975 and three days prior to the historical average, June 20. Fifty percent of the escapement had passed the site by June 30, five days earlier than the July 5 historical date of passage during years of weir operation. Early run passage was complete by July 16. (Table 4).

Early run red salmon escapements average 10,957 (1963-1975) and have ranged from 2,650 to 21,510. Escapement in 1976 was 14,700. This is the highest escapement recorded since 1966 and is 34.2% greater than the

Table 4. Arrival Date, Date 50% of the Escapement Passed Weir/Counting Tower and Termination Dates of Early and Late Russian River Runs, 1960-1976.*

Year	Early Run			Late Run		
	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended	Arrival At Weir/ Counting Tower	Date 50% Passed	Date Run Ended
1960	6/19	6/26	7/15	7/16	8/ 1	8/12
1961	6/21	6/28	7/15	7/16	7/31	8/28
1962	6/18	7/ 4	7/15	7/16	7/30	8/31
1963	6/18	7/ 1	7/12	7/16	7/31	8/23
1964	6/20	7/ 7	7/15	7/16	7/30	8/15
1965	6/22	7/ 4	7/15	7/16	8/ 5	8/15
1966	6/20	6/29	7/15	7/16	7/30	8/17
1967	6/20	6/28	7/15	7/16	8/ 2	8/18
1968	6/25	6/29	7/13	7/19	7/31	8/14
1969					8/ 2	8/18
1970	6/17	7/ 5	7/15	7/16	8/ 7	8/23
1972	6/24	7/ 5	7/29	7/30	8/ 5	8/28
1973	6/21	7/ 6	7/15	7/16	8/ 1	8/30
1974	6/14	7/ 1	7/21	7/22	8/ 7	8/27
1975	6/25	7/ 6	7/27	7/21	8/ 6	9/ 1
1976	6/17	6/30	7/16	7/17	8/ 2	9/ 1
1960-1975 Average	6/20	7/ 2	7/17	7/18	8/ 2	8/23
1969-1975 Average**	6/20	7/ 5	7/21	7/20	8/ 5	8/26

* 1971 was deleted due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Years of weir operation.

historical average. As scale analysis indicates these are primarily six-year fish, total run (harvest plus escapement) was 6,880 or 61.4% greater than the 1970 parent year return of 11,200 salmon. Russian River early and late run escapements and harvest rates are summarized in Table 5.

Anglers harvested 18.7% of the early run stocks to reach Russian River. This is an appreciable decrease compared to the historical average of 36.7% and well below the record 1969 harvest rate of 54.0%. The late run was harvested at the rate of 30.0% (exclusive of fish spawning below the falls). This is the highest harvest rate recorded for this segment of the population and is well above the 13-year mean of 12.8%.

Late run Russian River escapements range from 21,820 to 79,000, averaging 40,369. Escapement in 1976 was 31,950. This closely approximates the 1975 escapement of 31,970. A ground survey between Russian River Falls and the confluence of the Kenai and Russian rivers revealed an additional 3,470 late run sockeye salmon spawning in this area (Table 6). Total late run escapements to Russian River is therefore estimated at 35,420.

Escapement below Russian River Falls in 1976 approached the historical average of 3,888. However, it is of interest to note that the 1971 parent year escapement was the highest recorded, i.e., 10,000. Return per spawner in this area was therefore only 0.4. A possible reason for this low return in 1971 was that high water delayed passage of late run salmon at Russian River Falls (Engel, 1972). This high water probably had no effect on the reproductive potential of fish spawning below the barrier. However, sockeye salmon delayed below the falls may have been erroneously included in the escapement count. Spawning population in this area may therefore have been less than 10,000.

Table 7 indicates that prior to 1971 over 50% of angler effort was directed toward early run stocks. In 1971 an extensive closure during the early run directed effort toward late run fish. From 1972 through 1974 effort was divided between the two segments of the population. Effort on early run stocks in 1975 and 1976 was the lowest recorded, averaging 32.7%. This trend is expected to continue and appears to be a direct result of the restrictive bag and possession limit (in effect since 1975) on early run stocks, emergency closures to increase escapement levels, and angler realization that more numerous late run fish may be more readily caught.

A total of 145 chinook, O. tshawytscha (Walbaum), and an estimated 1,791 coho salmon were enumerated at Lower Russian Lake weir in 1976. An additional 155 chinook salmon were observed spawning between Russian River weir and the confluence of the Kenai and Russian rivers. This is a marked increase over 1975 when only 32 chinook were observed in this area. Table 8 presents the annual chinook and coho escapements enumerated at Russian River weir since 1969.

Annual chinook escapements are comparable (Nelson, 1975) and indicate escapement of this species in 1976 closely approximated the historical

Table 5. Russian River Sockeye Salmon Escapement Estimates and Harvest Rates for Early and Late Runs, 1963-1976.

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	21,510	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
1963-1975 Average	10,957	40,369	51,326	36.7	12.8	19.5

* Based on escapement passed weir. Commercial harvest and fish spawning downstream from Russian River weir are not considered.

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

Table 6. Late Run Red Salmon Escapements Enumerated Between Russian River Falls and Confluence of Kenai and Russian Rivers, 1968-1976.

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	222	29,022	0.8
1971	10,000	75,160	13.3
1972	6,000	101,050	5.9
1973	6,685	40,585	16.5
1974	2,210	35,360	6.3
1975	690	41,050	1.7
1976	3,470	49,120	7.1
1968-1975 Average	3,888	51,537	6.9

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

Table 7. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1976.

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
1963-1975 Average	9,596	6,575	63.4	31.3

* Man-day is defined as one individual fishing for one day, irrespective of the number of hours fished.

Table 8. Coho and Chinook Salmon Escapements Enumerated at Russian River Weir, 1969-1975.

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
1969-1975 Average	1,177	146		

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

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

average of 146. Coho salmon escapement enumerated at the weir totaled 1,391 as of September 1. An estimated 400 coho were below the weir when it was removed on September 2. Minimum escapement is therefore estimated at 1,791. This is the second highest escapement of this species since the installation of Russian River weir in 1969 and is 52.2% greater than the 1969-1975 historical average of 1,177.

Early Run Return/Spawner and Optimum Escapement Estimates:

Table 9 reveals return per early run spawning salmon. In the brood year escapement ranged from 0.3 to 3.3, averaging 1.4. The highest return per spawner (3.3) was achieved in 1976 and resulted from a relatively low brood year escapement of 5,450. Reason(s) for a high return per spawner in 1976 which more than doubled the average return of 1.4 are not definitely known. Although favorable freshwater spawning and rearing conditions should not be discounted, virtually all sockeye salmon returns to the Cook Inlet area in 1976 were average or of greater than average strength (personal communication, David Daisy, Cook Inlet Commercial Fisheries biologist, Jan. 4, 1977). This suggests a higher than average marine survival was the primary factor resulting in an exceptionally high early run return per spawner in 1976.

Although not definitive, data in Table 9 suggest large escapements do not necessarily produce large returns. The 1965 parent year escapement of 21,510 is the highest early run escapement recorded. This escapement returned only 5,460 salmon in 1971, or 0.3 fish for each one that spawned. The largest escapement therefore produced the lowest return. Similarly, relatively high escapements in 1963 (14,380) and 1966 (16,660) failed to reproduce themselves, i.e., they returned less than 1.0 fish per spawner. Conversely, average to above average returns were obtained from parent year escapements between 5,000 and 13,710 early run salmon with the exception of 1964, when an escapement of 12,700 returned 11,200 (0.9 fish/spawning adult).

Spawning area in Upper Russian Creek (only area utilized by early run salmon) approximates 13,800 M^2. Studies by other investigators (summarized by Foerster, 1968) indicate area required per spawning sockeye salmon female ranges from 2.0-3.7 M^2.

For calculation purposes, it is assumed that 2.67 M^2 (average of other investigations) is required per female in this stream. Based on this figure, spawning area in Upper Russian Creek could therefore support 5,170 females, or assuming a male to female sex ratio of 1:1, 10,340 early run sockeye salmon.

Although data must be considered preliminary, returns from a known spawning population coupled with available spawning area suggest optimum early run escapement is between 9,000 and 13,000 salmon. The high return in 1976 (18,080) which was produced from a relatively small parent year escapement (5,450) is considered atypical and does not presently warrant lowering of escapement goals, i.e., optimum escapement levels.

Table 9. Estimated Production from Prior Escapements of Early Run Russian River Red Salmon, 1963-1970.

Brood Year	Escapement Females	Escapement Total	Return (Year)	Total Run*	Production Per Female	Production Per Spawner
1963	7,190**	14,380	1969	10,870	1.5	0.7
1964	6,350**	12,700	1970	11,200	1.8	0.9
1965	10,755**	21,510	1971	5,460	0.5	0.3
1966	8,330**	16,660	1972	14,310	1.7	0.9
1967	6,855**	13,710	1973	19,860	3.0	1.4
1968	4,600**	9,200	1974	19,590	4.3	2.1
1969	2,500**	5,000	1975	7,040	2.8	1.4
1970	2,420***	5,450	1976	18,080	7.5	3.3
Average	6,125	12,326		13,301	2.8	1.4

* Sport harvest plus escapement. Assumes negligible commercial harvest.

** Assumes a male to female sex ratio of 1:1.

*** Male to female sex ratio of 1:0.8 determined by sampling.

Although optimum escapement levels may fall between the above ranges, it is recognized that factors other than escapement influence returns from a given spawning population. Unfavorable climatic conditions (low water, high water, temperature extremes, etc.) may adversely affect developing eggs and fry. A large late run escapement spawning in Upper Russian Creek may wash early run eggs from the redds, lowering reproductive potential. An unbalanced sex ratio coupled with reduced average fecundity could reduce potential egg deposition irrespective of numbers in the spawning escapement. Predation may not be constant during years of freshwater residency. Fry density of late run sockeye in Upper Russian Lake may also affect survival rates. Predation on the spawning grounds may not be constant and ocean mortality may also show annual variation. It may therefore be concluded that despite achievement of escapement goals, returns per spawning adult will display annual fluctuation and that these fluctuations may be independent of numbers of spawning adults in the parent year population.

Relationship of Jacks to Adults:

The early run is characterized by few 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 migrations of 1969, 1971, 1972, 1973 or 1974. Jacks are more numerous during the late run, comprising between 0.2 and 8.8% of the escapement. Late run harvest, escapement, total return and number of returning jacks since 1969 is presented in Table 10.

Table 10 indicates numbers of returning jacks in a given year may reflect run magnitude the following year. Jack returns in 1969, 1972, and 1973 were less than 400 fish. Late run returns in the succeeding years (1970, 1973, and 1974) averaged only 31,950 salmon or 31.3% less than the eight year average return of 46,517. Conversely, jack escapements in 1970 and 1971 exceeded 1,000 fish. Total return (harvest plus escapement) in 1971 and 1972 were the highest recorded, averaging 80,105 sockeye salmon. Jack escapements in 1974 and 1975 also exceeded 1,000 fish. Total return in 1975 and 1976 were, however, below the eight-year average. It therefore does not necessarily follow that a large jack escapement is indicative of a large total return the following year. Data to date does however suggest that a small jack return will result in a less than average run the following year.

Table 11 presents adults per jack based on the preceding year's jack escapement. This Table indicates a range of 25.5 to 211.9 adults for every jack that returned to the system the preceding year. Range for years of low escapement (1970, 1973, 1974) are between 81.8 and 211.9, averaging 131.2 adults/jack. The range for two years of high (1971, 1972) and two years of intermediate return (1975, 1976) is 25.5 to 66.5, averaging 39.4 adults to one returning jack. In 1976, 25.5 adults returned for every jack enumerated in 1975.

It must be emphasized that although a general relationship appears to exist between numbers of jacks returning in a given year and the magnitude of the succeeding years total return, formal predictions cannot be

Table 10. Late Run Russian River Red Salmon Harvest, Escapement and Returning Jacks, 1969-1976.

Year	Escapement	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

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

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

Table 11. Late Run Red Salmon Adults Per Returning Jack as Calculated from Preceding Year's Jack Escapement, Russian River, 1969-1976.

Year	Total Return*	Preceding Year's Jack Escapement	Adults/Jack
1969	30,070	Unknown	Unknown
1970	28,800	352	81.8
1971	65,160**	2,542	25.6
1972	95,050	1,429	66.5
1973	33,900	160	211.9
1974	33,150	332	99.8
1975	40,360	1,008	40.0
1976	45,650	1,788	25.5
1969-1975 Average	46,641	971***	87.6***

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

** Excludes an estimated 10,000 late run red salmon that perished below Russian River Falls due to a velocity barrier.

*** Six-year average, 1970-1975.

made regarding future runs. Parameters exist for which adequate compensation cannot be made. These have been discussed in detail by Nelson (1975).

It is also of interest to note the migrational timing of jacks as opposed to late run adult red salmon. Historical data indicates 50% of the adults may be expected to negotiate Russian River Falls and pass the weir at Lower Russian Lake by August 5. However, 50% of the jack escapement does not pass the weir site until approximately August 11, seven days later than the adult migration. In 1976 the adult escapements migrational timing was three days earlier than the historical average while 50.0% of the jack escapement was not achieved until August 18. The disparity in 1976 between timing of adults and jacks was therefore 16 days, more than double the historical difference in passage rate of seven days (Table 12).

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 movements through the falls. Larger adults may be more readily capable of negotiating the barrier at greater velocities and therefore arrive earlier at the weir.

Migrational Timing of the Late Run in Kenai River:

An extensive summary of migrational timing of early and late run red salmon runs within Russian River drainage has been previously presented (Nelson, 1975). Data regarding migrational timing within the mainstem Kenai River drainage are limited to isolated tagging studies and a comparison of sonar counts to Russian River weir escapements.

The sonar counter, operated by the Commercial Fisheries Division of the Alaska Department of Fish and Game, is located approximately one mile below the Kenai River Bridge in Soldotna. The counter is operational only during the late run migration and has been employed in the enumeration of red salmon in the glacial Kenai River since 1968. It is approximately 58 river miles from the sonar site to Russian River weir. Sonar counts, late run Russian River escapements, dates when 50% of the run has passed the sonar site/weir, and period of travel between sonar site and weir are presented in Table 13.

Table 13 indicates elapsed time between the sonar site and the weir ranges from 11 to 34 days, averaging 17. Eliminating the 1969 extreme, migrational period of late run Russian River sockeye from 1968 through 1975 ranges from 11 to 23 days, averaging 13.5. It required 13 days for Russian River fish to traverse the estimated 58 miles in 1976, or an average of 4.5 miles per day. This is identical to 1970 and 1975 estimated travel time and closely approximates migrational times in 1968, 1972, and 1973.

In 1957 tagging experiments were conducted by Tait, et al (1962) to assess migrational timing and distribution of Kenai River stocks. Based on 106 tag recoveries at the confluence of the Kenai and Russian Rivers,

Table 12. Migrational Timing of the Late Run Russian River Red Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1976.

Year	Jack Escapement	Date 50% Passed	Adult Escapement	Date 50% Passed	Timing Differential (Days)
1970	2,542	8/10	25,658	8/ 7	4
1971	1,429	8/28	53,000	8/23	6
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
1970-1975 Average	1,210	8/11*	39,299	8/ 5*	7

* 1971 data was deleted due to atypical migrational timing resulting from a velocity barrier at Russian River Falls.

Table 13. Kenai River Sonar Counts Compared to Russian River Late Run Red Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1976.*

Year	Sonar Count**	Date 50% Passed	Russian River Escapement***	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	7/19	48,800	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	161,000	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
1968-1975 Average	173,714	7/19	38,073	8/ 3	17

Note: Sonar counts from 1968-1975 have been revised from previously reported figures to reflect refinement in data analysis.

* 1971 deleted due to sonar malfunction.

** All counts represent red salmon counts only and are exclusive of other species.

*** Escapement reflects weir counts only and are exclusive of salmon spawning in lower Russian River.

**** Preliminary data.

they concluded that the average Russian River sockeye required approximately 20 days to travel the estimated 65 miles from tagging site to point of capture in the sport fishery, or an average of 3.3 miles per day.

Similar experiments were conducted in 1970 by Davis 1970 and in 1973 by Davis, et al (1973, 1974). Data from the 1970 experiment was basically in agreement with data presented in Table 13, indicating it required an average of 14.8 days for Russian River red salmon to reach Russian River weir. Data from 1972 and 1973 experiments did not agree with data obtained from an evaluation of sonar/weir counts and indicated migrational time was between 18 and 30 days.

Reasons for these apparent disparities between travel time determined by tagging, versus a comparison of sonar/weir counts are not definitely known. Possible causes such as stress experienced by tagged fish, insufficient tag returns, sonar inaccuracies, etc., have been reviewed by Nelson (1976). Suffice it to say, that the most consistent data to date (sonar/weir) indicates an average travel time between sonar site and Russian River weir of 13.5 days, or an average of 4.3 miles per day. Appreciable variation in annual migration rates should, however, not be discounted until additional data becomes available.

Evaluation of sonar data and magnitude of total Russian River late run does provide an estimate of Russian River's contribution to Kenai River sockeye salmon escapements. Data indicate Russian River contribution ranges from 11.1% to 67.6%, averaging 37.3%. Russian River's contribution in 1976 was one of the lowest recorded, i.e., 12.9% (Table 14).

Nelson (1976) indicated percentages in Table 14 are not absolute and are dependent on: (1) accuracy of sonar counter, (2) accuracy of Russian River creel census; (3) accuracy of 1968 Russian River tower count (weir has been operational since 1969). Table 14 does, however, suggest Russian River is a major contributor to the Kenai River system in an average year.

Age Composition:

Scale analysis indicated red salmon in their sixth year of life comprised 61.9% of the early Russian River run. Five-year fish comprised 12.9% of the sample. Remaining 25.2% of the salmon examined were either four or seven-year fish. As in prior years, this run was dominated by salmon that had reared for two years in Upper Russian Lake. Majority of these sockeye (61.9%) were progeny of the 1970 escapement.

Early run salmon averaged 595.8 mm in length, 7.5 mm larger than in 1975. Average lengths of two-and three-ocean fish were 562.4 and 609.4 mm, respectively. In four of five age classes where comparisons could be made, males were larger than females. Male to female sex ratio of the early run was 1:0.9.

Late run stocks were also dominated by salmon that migrated to the marine environment after two years in freshwater (83.2%). The majority

Table 14. Kenai River Sonar Counts, Total Late Russian River Red Salmon Run and Percent of Kenai River Escapement to Enter Russian River, 1968-1976.*

Year	Red Salmon Sonar Count**	Total Late Russian River Run***	Percent Kenai Run to Russian River
1968	88,000	59,520	67.6
1969	53,000	31,160	58.8
1970	68,000	28,800	42.3
1972	335,000	102,120	30.5
1973	368,000	40,985	11.1
1974	157,000	35,357	22.5
1975	143,000	41,050	28.7
1976****	381,000	49,120	12.9
1968-1975 Average	173,143	48,427	37.3

Note: Sonar counts from 1968-1975 have been revised from previously reported figures to reflect refinements in sonar counter analysis.

* 1971 data deleted due to sonar malfunction.

** All counts represent red salmon counts only and are exclusive of other species.

*** Includes escapement passed weir, fish spawning below falls, and sport harvest.

**** Preliminary data.

of this run (71.5%) spent two years in salt water prior to returning to their natal stream. Majority of the salmon examined were progeny of the 1971 escapement. Male to female sex ratio of 322 adults (excluding jacks) was identical to the early run (1:0.9). These salmon averaged 585.0 mm in length, 10.8 mm less than the average early run fish. This difference is related to age structure in that the average early run red salmon remains at sea three years as opposed to two years for the majority of late run fish. Two-and three-ocean adults averaged 571.5 mm and 618.6 mm in length, respectively. In four of five age groups where comparisons could be made, males were larger than females.

Age class composition of early and late runs and mean lengths for respective age classes are presented in Table 15.

Mean lengths of two-and three-ocean late run salmon were 9.1 mm and 9.2 mm greater, respectively, than early run red salmon of comparable age class. Nelson (1976) indicated late run two-ocean red salmon sampled in 1975 were 10.1 mm larger than two-ocean early run fish. Three-ocean salmon in 1975 differed by only 2.5 mm with the late run stocks being larger. Nelson (1976), on the basis of 1975 data, concluded these minimal disparities indicated similar ocean growth rates and that variation in the overall average size of salmon in the respective runs was a function of age class composition. This appears to be true. However, it should also be noted that late run red salmon spend an additional one to two months in the marine environment prior to returning to their natal stream. This is also a factor when considering average size of comparable age fish within these populations.

Table 16 presents a summary of early and late run red salmon age class data collected at Russian River weir since 1970. This Table clearly shows the dominance of age classes 2.3 and 2.2 in the early and late run, respectively. It is of interest to note that in 1976 both early and late run populations were composed of a higher percentage of age class 1.2 than is normally present. These four-year fish are the progeny of the 1972 escapement. That year's escapement of 79,000 late run sockeye is the highest recorded.

Figure 4 presents the length-frequency of 131 early run red salmon. Although not definitive, this graph suggests a possible division of two- and three-ocean salmon between 590 mm and 599 mm. If the division were made here, it would indicate 40.5% and 59.5% of the population were two- and three-ocean salmon respectively. Table 15 indicates this is incorrect and that only 29.0% of the population are two-ocean salmon while 71.0% are three-ocean. Length-frequency analysis alone could therefore not be employed in 1976 to separate early run red salmon ocean-age classes.

Figure 5 presents length-frequency of two-and three-ocean early run red salmon as determined by scale analysis. This graph illustrates the ranges for these two age classes and indicates the division between 2.2 and 2.3 salmon is more correctly between 570 mm to 579 mm rather than 590 mm to 599 mm as suggested by Figure 4.

Table 15. Age Class Composition of Early and Late Run Russian River Adult Red Salmon Escapements Sampled at Lower Russian Lake Weir, 1976.

Class	No. In Sample	Percent of Sample	Parent Year	Average Length (mm)*	SD**
EARLY RUN					
1.2	22	16.8	1972	566.6	21.6
1.3	2	1.5	1971	637.5	17.7
2.2	15	11.4	1971	556.3	19.9
2.3	80	61.1	1970	608.6	22.0
3.2	1	0.8	1970	560.0	
3.3	11	8.4	1969	610.0	29.5
Combined	131	100.0		595.8	31.0
LATE RUN					
1.2	35	10.9	1972	565.4	16.4
1.3	14	4.3	1971	615.0	19.8
2.2	192	59.6	1971	572.6	24.0
2.3	76	23.6	1970	618.5	26.7
3.2	3	1.0	1970	570.0	17.3
3.3	2	0.6	1969	645.0	35.3
Combined	322	100.0		585.0	32.0

* Length is from mid-eye to fork of tail.

** Standard deviation.

Table 16. Age Class Composition by Percent of Early and Late Run Adult Red Salmon Escapements Sampled at Russian River Weir 1970-1976.

Year	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
1970-1975 Average*	1.1	15.0	0.1	9.3	73.0	1.0	0.2	0.3
LATE RUN								
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			1.0
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
1970-1975 Average**	3.8	5.0		68.3	22.1		0.5	0.3

* 1973 deleted from computations.

** 1972 and 1973 deleted from computation.

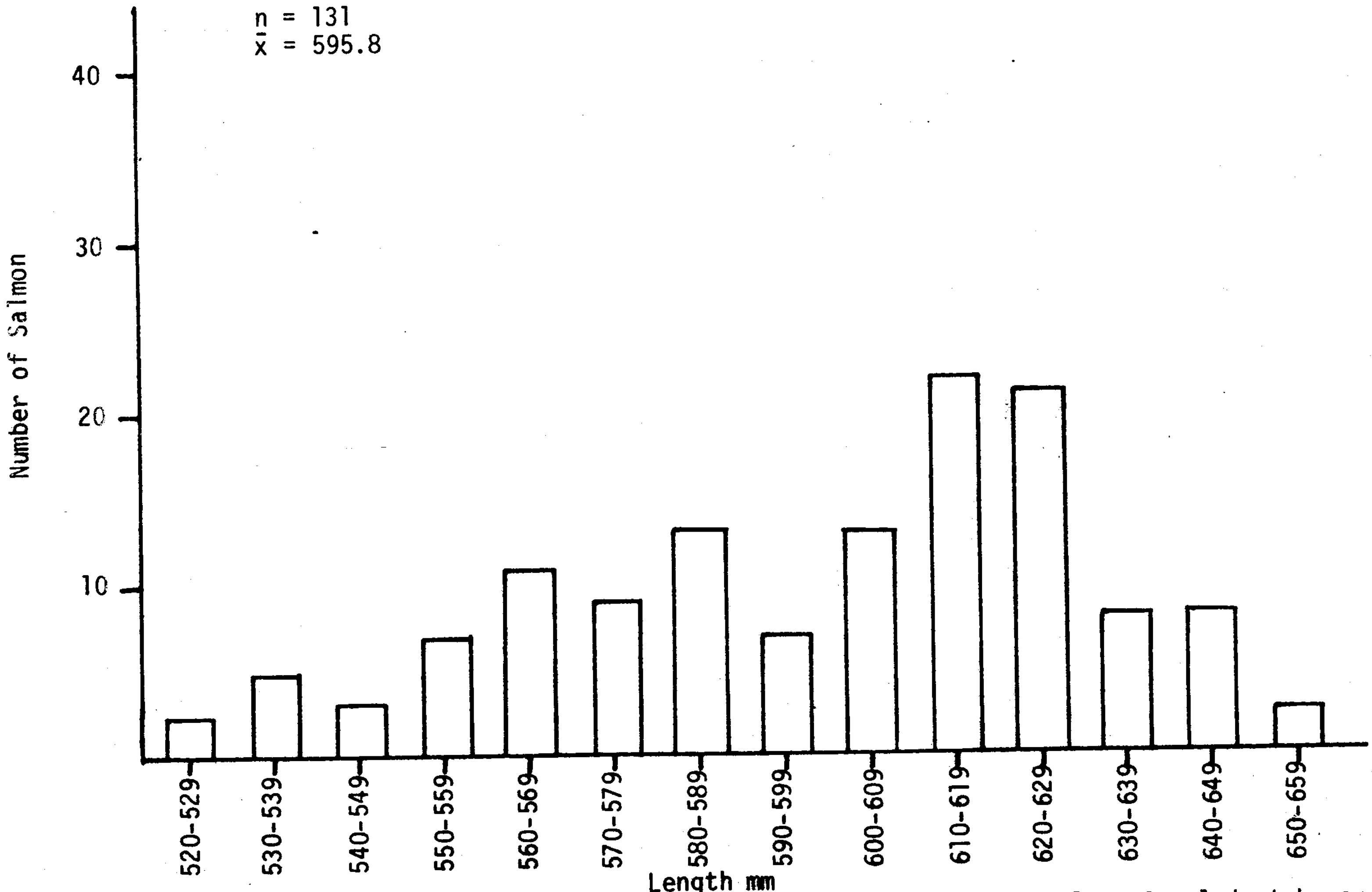

Figure 4. Length Frequency of Early Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1976.

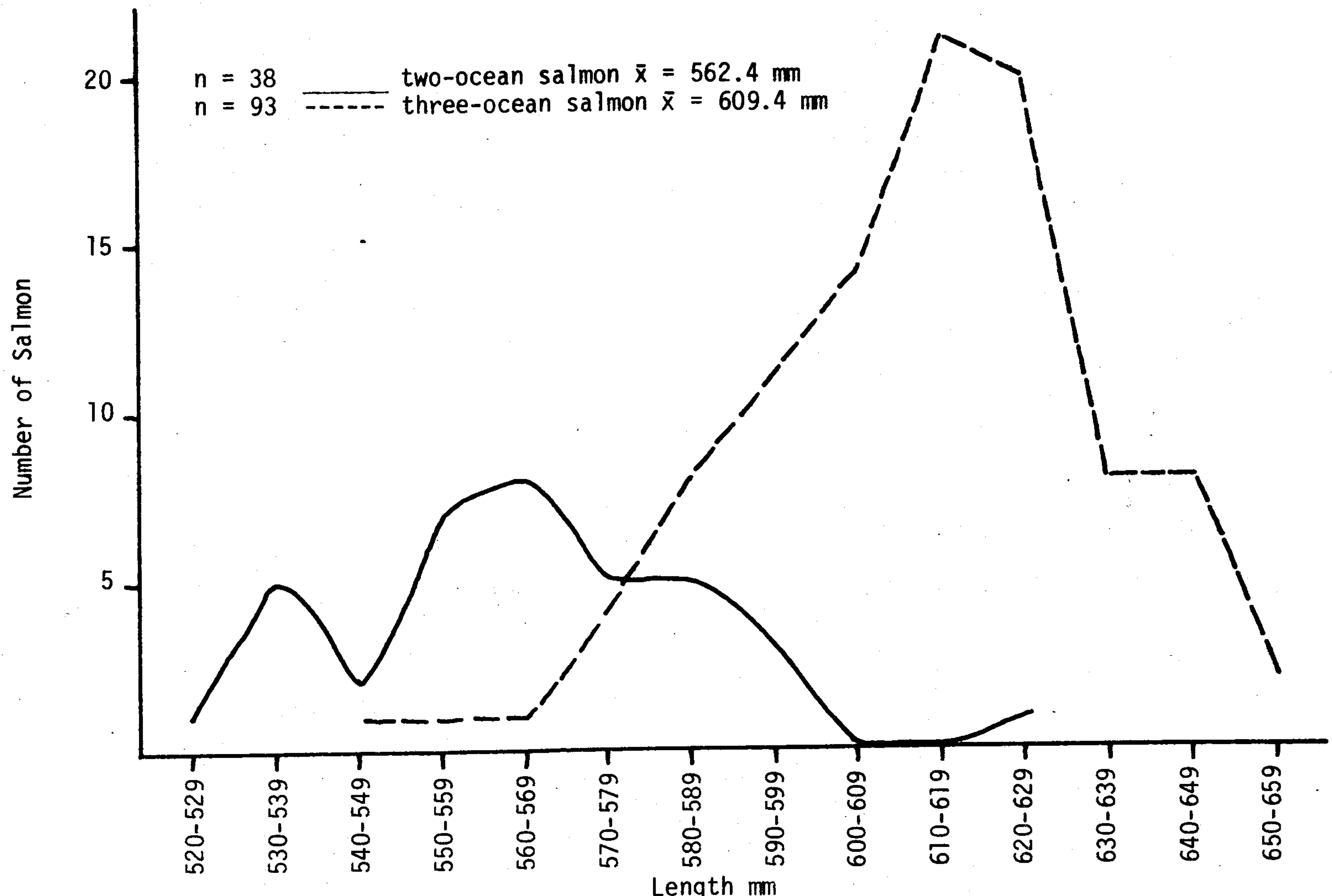

Figure 5. Length Frequency of Two and Three-Ocean Early Run Russian River Red Salmon Sampled at Lower Russian Lake Weir, 1976.

Length-frequency of 322 late run red salmon is graphically presented in Figure 6. This figure indicates appreciable variation in lengths of adult (jacks excluded) individuals within this population. Tentative divisions between ocean-age individuals are not indicated. This is contrary to data reported by Nelson (1976) indicating that in 1975 ocean-age for late run red salmon could be accurately determined by length-frequency.

Figure 7 depicts length-frequency of two- and three-ocean late run fish as determined by scale analysis. It graphically depicts ranges of the respective ocean ages as well as the degree of overlap between one- and two-ocean fish. The extreme range of three-ocean fish is especially noteworthy and emphasizes the difficulty in accurately determining ocean-age by size in the 1976 sample.

Fecundity Investigations:

Fecundity investigations initiated in 1973 were continued at Russian River weir during early and late red salmon runs. Results of the 1976 investigation are presented in Tables 17 and 18.

It should be noted that direct enumeration was used to check the volumetric estimate of every third fish sampled. Average error was +.66% during the early run and 0.03% during the late run. Average error of this magnitude justifies the exclusive use of volumetric estimation. Therefore, in the ensuing discussion dealing with fecundity, only data determined volumetrically will be presented.

Fecundity of early run salmon ranged from 3,015 to 4,565, averaging 3,668. Average weight and length of females sampled was 2.608 kg and 596.0 mm, respectively. These salmon averaged 1,407 eggs per kilogram of body weight and six eggs per millimeter of body length. Late run red salmon averaged 3,491 eggs per female with a range of 2,836 to 4,379. Average length and weight of late run red salmon used in the sample was 587.3 mm and 2.533 kg, respectively. These fish averaged 1,378 eggs per kg of body weight and six eggs per millimeter of body length. Table 19 compares these data with results from prior investigations at Russian River.

In 73.3% of the fish sampled in 1976, the left ovary contained a greater number of eggs than did the right. This was also observed in 1974 and 1975. The probable explanation of this phenomenon was advanced by Brown and Kamp (1942). They indicated the posterior portion of the intestine usually bends sharply to the right, crowding the right ovary at the caudal end. The left ovary has greater room for expansion and therefore has a higher egg content.

Foerster (1968) indicates that the larger the salmon the greater the egg content. Table 19 indicates that this is generally true but exceptions do occur. The average female salmon in 1975 was somewhat smaller than the average female utilized in 1974 investigations, but egg content was 10.7% greater in 1975. Similarly, the average length of fish utilized in 1976 was seven mm less than the 1974 average, yet average fecundity

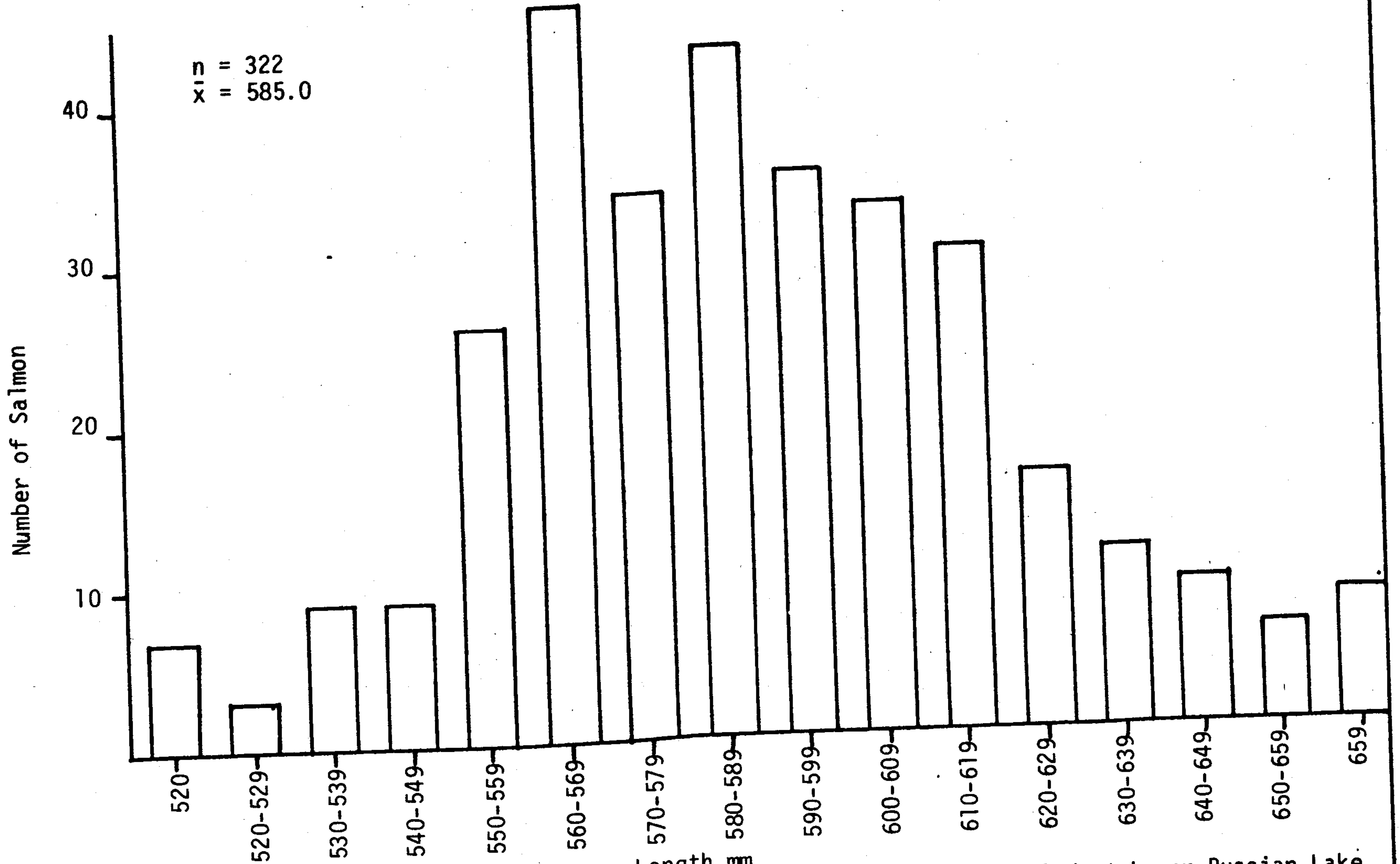

Figure 6. Length Frequency of Late Run Russian River Red Salmon Sampled at Lower Russian Lake Weir, 1976.

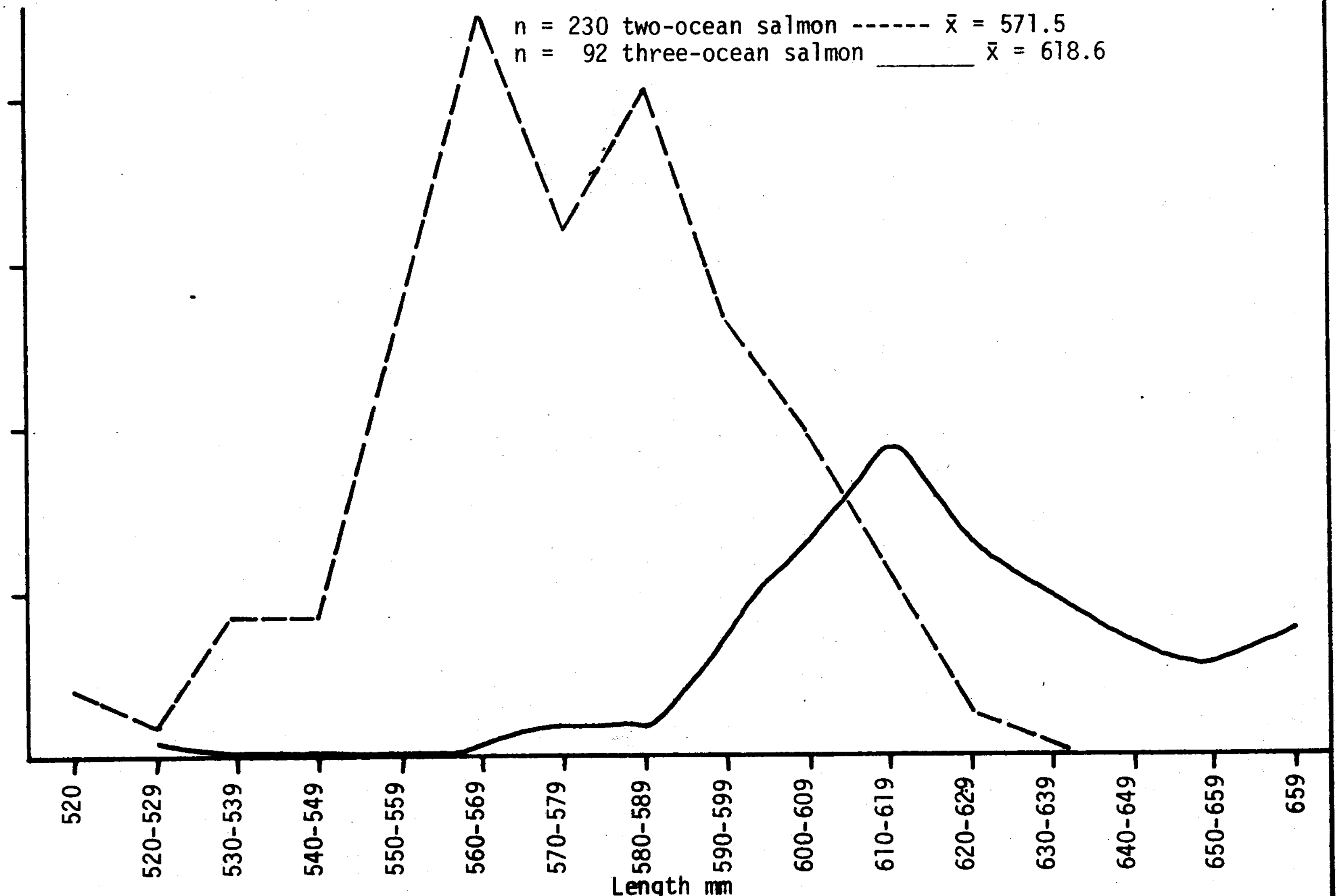

Figure 7. Length Frequency of Two and Three-Ocean Late Run Russian River Sockeye Salmon Sampled at Lower Russian Lake Weir, 1976.

Table 17. Fecundity of Early Run Russian River Red Salmon as Determined by Actual Counts and Volumetric Estimate, Lower Russian Lake Weir, 1976.

EARLY RUN

Sample Number	Weight (kg)		Number of Eggs (Actual Count)			Number of Eggs (Volumetric Estimate)			
			Right Skein	Left Skein	Combined	Right Skein	Left Skein	Combined	Percent Error
1	2.268	(5.00 lb)				1,505	1,836	3,341	
2	2.325	(5.13 lb)				1,623	1,880	3,503	
3	2.268	(5.00 lb)	1,705	1,776	3,481	1,680	1,760	3,440	1.17
4	2.722	(6.00 lb)				1,697	1,782	3,479	
5	2.041	(4.50 lb)				1,352	1,677	3,029	
6	3.175	(7.00 lb)	1,652	1,921	3,573	1,625	1,872	3,497	2.12
7	2.835	(6.25 lb)				2,117	1,932	4,049	
8	2.268	(5.00 lb)				1,915	1,751	3,666	
9	2.835	(6.25 lb)	1,924	2,346	4,270	2,016	2,218	4,234	0.01
10	2.495	(5.50 lb)				1,772	1,836	3,608	
11	3.289	(7.25 lb)				1,792	2,173	3,965	
12	3.062	(6.75 lb)	1,775	1,727	3,502	1,813	1,786	3,599	-2.76
13	2.155	(4.75 lb)				1,408	1,607	3,015	
14	2 835	(6.25 lb)				2,341	2,224	4,565	
15	2.551	(5.62 lb)	2,007	1,921	3,928	2,072	1,960	4,032	-2.64
Average	2.608	(5.75 lb)	1,813*	1,938*	3,751*	1,715	1,886	3,668	0.42*

* Averages computed using samples 3, 6, 9, 12 and 15 only.

Table 18. Fecundity of Late Run Russian River Red Salmon as Determined by Actual Count and Volumetric Estimate, Lower Russian Lake Weir, 1976.

LATE RUN

Sample Number	Weight (kg)		Number of Eggs (Actual Count) Right Skein	Left Skein	Combined	Number of Eggs (Volumetric Estimate) Right Skein	Left Skein	Combined	Percent Error
1	2.098	(4.63 lb)				1,844	1,775	3,619	
2	2.070	(4.56 lb)				1,637	1,883	3,520	
3	3.175	(7.00 lb)	1,585	1,645	3,230	1,562	1,612	3,174	1.73
4	2.410	(5.31 lb)				1,389	1,447	2,836	
5	2.693	(5.94 lb)				1,661	2,014	3,675	
6	2.977	(6.56 lb)	2,079	2,218	4,297	2,074	2,261	4,335	-0.41
7	2.637	(5.81 lb)				1,368	1,746	3,114	
8	1.928	(4.25 lb)				1,680	1,654	3,334	
9	3.033	(6.67 lb)	1,873	1,968	3,841	1,901	1,983	3,884	-1.11
10	1.928	(4.25 lb)				1,442	1,647	3,089	
11	1.928	(4.25 lb)				1,406	1,649	3,055	
12	3.289	(7.25 lb)	2,059	2,257	4,316	2,111	2,268	4,379	-1.46
13	2.268	(5.00 lb)				1,214	1,785	2,999	
14	2.155	(4.75 lb)				1,739	1,644	3,383	
15	3.402	(7.50 lb)	1,810	2,196	4,006	1,754	2,208	3,962	1.10
Average	2.533	(5.58 lb)	1,881*	2,057*	3,938*	1,652	1,838	3,491	-0.03*

* Averages computed using samples 3, 6, 9, 12 and 15 only.

Table 19. A Comparison of Fecundity Data Collected at Lower Russian Lake Weir During Early and Late Run Russian River Red Salmon Migrations, 1973-1976.

Year	Average Fecundity	Average Length (mm)	Average Weight (kg)	Eggs/ Kilogram	Eggs/ Millimeter
			EARLY RUN		
1973	4,630	627.0	2.968	1,560	7.0
1974	3,569	603.0	2.603	1,371	6.0
1975	3,952	600.0	2.540	1,556	7.0
1976	3,668	596.0	2.608	1,407	6.0
			LATE RUN		
1973	3,190	569.0	2.187	1,459	6.0
1974	3,261	558.0	2.301	1,417	5.0
1975	3,555	555.0	2.257	1,575	6.0
1976	3,491	587.3	2.533	1,378	6.0

increased by 9.9 eggs in 1976. This apparent disparity was also noted by Foerster (1968) while investigating the fecundity of Cultus Lake red salmon. He, however, concluded that these differences were not statistically significant but were the result of inherent variability of the samples. This is also the probable explanation for variability in the Russian River samples.

Foerster (1968, p. 126) provides an excellent summary of red salmon fecundity investigations. This summation indicates average fecundity for various areas were: Babine Lake, 3,273.7 (1946-1949); Lakelse Lake, 3,815.7 (1939, 1948, 1949); Pick Creek, 3,990.0 (1948, 1950-1952); Kurile Lake, 3,967.5 (1929-1932); Port John, B.C., 2,656.6 (1949-1958); Karluk Lake, 3,132.5 (1938-1941); and Cultus Lake, 4,094.2 (1932-1935), (1937-1938). Average fecundity reported by Hartman and Conkel (1960) for Karluk Lake indicates average fecundity in 1958 was 2,762 eggs per female. Foerster (1968) also suggested red salmon from the Bolshaya River, Siberia appear to be the greatest egg producers. Between 1943 and 1950 these fish averaged 4,789.6 eggs per female. Although these investigations indicate annual fluctuation in average egg content due to size and age class variation, they do provide an index of relative sockeye salmon fecundity for different geographical areas.

Early run Russian River salmon have averaged 3,955 eggs per female since 1973. Although further investigation is required to definitely establish mean annual fecundity of this run, it does suggest egg content is quite high, ranking below the Bolshaya River, Cultus Lake and Kurile Lake. Fecundity of late run Russian River fish has averaged 3,374 eggs from 1973-1976. This is a greater fecundity than that reported for Babine Lake, Port John, or Karluk Lake, but below fecundities reported for Lakelse Lake, Pick Creek, Kurile and Cultus lakes. It is well below that reported for the Bolshaya River. Although it is difficult to rank various populations when dealing with fecundity, it is suggested that fecundity of late run Russian River sockeye salmon is "intermediate" when compared 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 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 may be calculated as follows:

Early run escapement	14,700
Early run female escapement	6,963
Mortality between weir and spawning grounds	5.1%

Female salmon to reach spawning grounds	6,608
Female salmon which perished without spawning (1.1%)	73
Remaining female red salmon	6,535
Average fecundity per female	3,668
Total possible eggs deposited	23,970,380
Percent eggs deposited per female	98%
Estimated potential egg deposition	23,490,972

Potential egg deposition in 1976 of approximately 23.5 million compares favorably with estimates in prior years. Depositions in 1973, 1974 and 1975 were estimated at 29.6, 17.7 and 12.7 million eggs, respectively. The 1976 early run potential egg deposition is therefore the second highest recorded. Early run escapement in 1976 was the highest recorded since 1966. Considerable variability in reproductive potential exists independent of actual numbers of spawners (Hartmen and Conkle, 1960).

Annual differences in sex ratios can cause substantial differences in eggs available for deposition. In 1973 (year of highest potential deposition) females dominated the escapement with a male:female sex ratio of 1.1. In 1976 the escapement favored males with a sex ratio of 1:0.9. Experiments conducted by Mathisen (1955) indicated mortality of eggs was only slightly higher with a sex ratio as high as 15 females per male. Thus, even a highly unbalanced spawning stock favoring females may result in only minor decreases in the ultimate egg survival from each female. Such a stock might yield a considerable increase in potential production over stocks of the same size, but with more evenly balanced sex ratios (Hartman and Conkle, 1960).

Average fecundity is also a primary factor in determining potential egg deposition. In 1973 average fecundity was 4,630 eggs/female. In 1976 fecundity decreased 20.7% to 3,668 eggs per female. Decreased fecundity coupled with a sex ratio in which males dominated therefore accounts for a less than record potential egg deposition from the largest early run escapement in ten years.

Egg sampling to determine actual egg deposition and survival of early run eggs in Upper Russian Creek was conducted October 4-6. Sampling was conducted in 10 of 11 stream sections and was proportionate to section areas rather than to numbers of fish spawning in a given section. Points to be dug were randomly selected. A total of 101 points were scheduled to be dug. However, due to high water and/or the sampling point falling on a rock or in a pool, only 71 points were actually dug.

Initial sampling indicated few eggs were present and deposition was subsequently estimated at 61.3 eggs/M^2. This is the second lowest density recorded since this sampling program was initiated in 1972. Egg survival was 91.6% at time of sampling. Techniques employed to calculate egg density and survival have been previously described (Nelson, 1975). Density estimates for 1972-1976 are presented in Table 20.

Egg deposition 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 salmon by the average egg deposition per M^2 yielded a total deposition of only 846,890 eggs. Thus, the estimated deposition in Upper Russian Creek as determined by hydraulic sampler is many times lower than the theoretical number of eggs potentially available (23.5 million). This disparity between potential and actual deposition estimates was also noted by Nelson (1976).

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

Water levels were exceptionally high at time of sampling. The high water mark on vegetation adjacent to the stream indicated the water was receding and that peak flows may have been much greater. In several areas the stream had left its banks. Several large trees which had been across the stream since this author first observed them in 1972 were no longer in evidence and it is assumed they were washed into Upper Russian Lake. It therefore appears that Upper Russian Creek was subject to severe flood conditions in 1976 which washed many early run sockeye salmon eggs from the redds. Although the impact of this phenomenon cannot be fully assessed until the adult return in 1982, available data suggests the return from the 1976 parent year will be somewhat smaller than could normally be expected from an escapement of 14,700 early run fish.

Bear Creek is a small (approximately 5,400 M^2) spring fed tributary on the east side of Upper Russian Lake. The system has been described in detail by Nelson (1976). Nelson (1976) also predicted that returns of late run red salmon to this system would be minimal. Reasons for this supposition were: (1) In 1972 a large beaver dam was found approximately 100 yards upstream from the mouth of the creek. It was believed this barrier existed in 1971 (year of 1976 parent year escapement) and that it effectively denied late run red salmon access to this spawning area; (2) in 1971 a velocity barrier at Russian River Falls delayed both early and late run migration. Many salmon that eventually negotiate the barrier sustained injury which cast doubt on their ability to spawn. Carcass examination conducted at Upper Russian Lake confirmed this hypothesis as 64.4% of the females examined had failed to spawn (Nelson, 1976). This reduced 1976 late run returns to all areas of the Upper Russian Lake drainage.

Table 20. Early Run Russian River Red Salmon Egg Densities Determined by Hydraulic Sampler in Upper Russian Creek, 1972-1976.

Year	No. Points Dug	Total Eggs Dug	Average Eggs Per Point	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	84.7	64.2	455.6
1975	98	605	6.2	84.3	33.3
1976*	71	901	12.7	91.6	61.3

* 1976 data may not be directly comparable to prior years as sampling was proportionate to area. In all prior years sampling was proportionate to numbers of salmon which spawned within a given section.

Bear Creek was ground surveyed on September 11. An estimated 1,300 salmon were observed off the mouth of the stream with an additional 122 enumerated in the stream proper. Observation indicated the majority of the fish that schooled off the mouth were lake spawners and were not of Bear Creek origin. An additional survey on October 6 revealed few fish off the mouth, and approximately 400 late run red salmon spawning in the stream.

Nelson (1976) concluded that stream life of late run red salmon in this system was of appreciable duration, ranging from 15.0 to 24.2 days. If this was true in 1976, a maximum of two spawning waves could have entered the stream between surveys. These spawning waves would have accounted for few fish as only 1,300 were noted in the area on September 11. It is therefore estimated that less than 1,000 late run red salmon utilized this system in 1976. Due to the small numbers of red salmon in this system, hydraulic egg sampling was not conducted.

IHN Investigations:

In 1975 samples were collected from early and late run sockeye in Upper Russian and Bear Creeks to determine the presence or absence of infectious hematopoietic necrosis (IHN). IHN is a viral disease which initially attacks blood forming tissue of the kidney. The first recorded outbreak occurred at Oregon's Willamette Hatchery in 1954. Losses have also been reported from hatcheries in California, Washington and British Columbia (Wood, 1974). In 1975 it was reported in artificially propagated Alaskan red salmon (Grischkowsky, 1975, ADF&G Pathology Laboratory, unpublished). In 1975, 135 early run salmon were sampled. Female pools (five fish/pool) were 100% positive for the disease. Male early run pools were 45.5% positive. In order to better define the distribution of IHN in wild populations and to confirm its presence in Russian River stocks, sampling was continued in 1976.

Sampling at Upper Russian Lake was conducted by Dr. Roger S. Grischkowsky, fisheries pathologist for the Fisheries Rehabilitation and Enhancement Division (FRED) of the Alaska Department of Fish and Game, with the assistance of Sport Fish personnel. Sixty fish (30 males and 30 females) were seined from both Upper Russian and Bear creeks. Contrary to procedures in 1975, samples were not pooled. Analysis indicated 16.7% of the early run samples were positive. Although this suggests a significant decrease in the occurrence of this disease from 1975 results, data are not comparable. In 1975 samples were composed of five fish pools. Therefore, if any one of the five fish were infected, the entire pool would be positive. In 1976 each fish was treated individually.

Results from late run red salmon sampled at Bear Creek were not available at the time this report was prepared.

Climatological Observations:

Air and water temperatures recorded at Lower Russian Lake weir were grouped by six-day periods to facilitate analysis (Table 21). No correlation was found between air and/or water temperature and red salmon

Table 21. Climatological and Hydrological Observations by Six-Day Period Recorded at Lower Russian Lake Weir, June 18-August 29, 1976.

Period	Air Temperature Max. C	Air Temperature Min. C	Water Temperature* Max. C	Water Temperature* Min. C	Rainfall (mm)**	Velocity* (cfs)
6/18-6/24***	15.7	4.9			3.5	307.4
6/25-6/30	23.8	6.0	13.3	12.2	2.5	298.4
7/ 1-7/ 6	17.1	7.3	12.5	12.0	0.0	295.8
7/ 7-7/12	23.3	7.5	13.7	13.6	0.0	186.0
7/13-7/18	19.3	8.2	13.8	13.5	19.5	
7/19-7/24	17.3	8.5	13.7	13.0	129.0	166.3
7/25-7/30	18.0	7.5	15.0	11.4	0.0	124.5
7/31-8/ 5	21.3	6.6			0.0	
8/ 6-8/11	16.4	9.9			1.5	108.5
8/12-8/17	15.0	7.3			0.0	94.8
8/18-8/23	16.7	5.7			76.0	100.5
8/24-8/29	15.6	6.5			3.0	137.0

* Air temperature, water temperature and stream velocity for the respective periods are the average of the daily recordings.

** Rainfall for each period is the cumulative total of the daily readings.

*** Seven day period.

migration. Total rainfall recorded during the 73-day period was 235 mm (9.3"). This is approximately 3.7 times more precipitation than was recorded in 1975, i.e., 2.5 inches. However, rainfall recorded in this area has little effect on volume of water in Russian River. Precipitation and runoff at Upper Russian Lake are of much greater significance (Nelson, 1976).

Stream velocity exhibited appreciable fluctuation during early and late run migrational periods. Maximum average flow of 307.9 cfs occurred during the first part of the early run migration. Flow steadily decreased thereafter, reaching an average six-day low of 137.0 cfs from August 24-29. Observation indicated neither early nor late run red salmon experienced difficulty negotiating Russian River at these flows.

Average low and high air temperatures in 1975 were 7.5 C and 17.6 C, respectively. Average high and low air temperatures for a similar period in 1976 were 7.5 C and 18 C, respectively. Water temperatures for 1975 and 1976 are also quite similar. It therefore appears that with the exception of rainfall, environmental parameters of air and water temperature were similar in both 1975 and 1976.

DISCUSSION

Creel census statistics collected during the Russian River red salmon sport fishery revealed a harvest of 17,080 salmon. Early and late runs contributed 3,380 and 13,700 salmon, respectively, to this harvest. Angler effort directed toward early and late run populations was estimated at 8,930 and 17,380 man-days, respectively. Total effort (26,310 man-days) was the second highest recorded and was surpassed only in 1973 when 30,590 man-days were recorded. Harvest is the third highest recorded and was previously exceeded only by catches in 1966 and 1972.

Recreational fishermen harvested 18.7% of the early run to reach Russian River. This is a reduction of 18% compared to the historical mean early run harvest rate of 36.7% and is appreciably less than the 1969-1971 catch rate when over 50% of the adult return was harvested. Factors that contributed to this low harvest rate are: (1) reduction in the early run bag and possession limit from three to one salmon, (2) extension of the sanctuary area from 500 to 700 yards, and (3) emergency closure during the peak of the early run which limited exploitation of these stocks by sport anglers.

Anglers harvested 30.0% of the late run stocks to reach Russian River. This represents an appreciable increase over the historical average harvest rate of 12.8%. In 1976 this increase was due to greater angler participation during the late run migration as well as the absence of emergency closures.

Red salmon escapements were enumerated by weir at the outlet of Lower Russian Lake. Early run escapements began to pass the structure on June 17, nine days earlier than in 1975 and three days prior to the historical arrival date of June 20. Early run passage was complete by July 16 and totaled 14,700. This is the greatest early run escapement recorded since 1966 and exceeded the 1963-1975 average by 34.2%.

Return per spawner for early run red salmon has ranged from 0.3 to 2.1, averaging 1.4. Return per spawner in 1976 was 3.3 or more than double the historical average. Although it is possible that favorable fresh-water spawning and/or rearing conditions may have accounted for higher than average survival, virtually all red salmon returns to the Cook Inlet area were of average or greater than average strength in 1976. This suggests a higher than average marine survival was the primary factor resulting in an exceptionally high early run return per spawning adult.

Late run Russian River red salmon escapements have ranged from 21,820 (1965) to 79,000 (1972), averaging 40,369 (1963-1975 average). Escapement in 1976 was 31,950 or only 20 salmon less than the 1975 escapement. Ground surveys between Russian River Falls and confluence of Kenai and Russian Rivers revealed an additional 3,470 salmon spawning in this area. Total late run escapement is therefore estimated at 35,420. Although escapement passed the weir is somewhat less than the historical average, it is considered adequate for this system.

Two precocial males (jacks) were observed during the early run migration. In excess of 1,200 jacks were enumerated during the late run which accounted for 2.6% of the escapement past the weir. Although not definitive, a jack escapement of this magnitude coupled with other indicators, such as parent year escapement, suggests an above average late run return in 1977.

The majority of the jack return passes the weir at Lower Russian Lake seven days later than the majority (50%) of the adult return. In 1976 this timing differential was 16 days, which is the greatest recorded. It is not presently known whether this timing differential is racial or dependent on physical factors. Data to date indicate water levels are lower later in the migrational period which may facilitate passage of these smaller fish. Large adults may more readily negotiate Russian River Falls at greater velocities and arrive earlier at the weir.

Comparison of Kenai River sonar counts with Russian River weir data indicate that the approximately 58 miles from Kenai River bridge in Soldotna to Russian River is negotiated by the average late run salmon in 13 days, or an estimated 4.5 miles per day. Data from sonar counts and the weir also indicate Russian River late run stocks contribute an average of 37.3% to the total Kenai River escapement. In 1976 this contribution was 12.9%.

Scale analysis indicated both early and late runs were dominated by salmon that resided two years in Upper Russian Lake. Early run salmon were primarily three-ocean (71.0%) while the majority of the late run spent two years in the marine environment. Escapements in 1970 and 1971 were the primary contributors to 1976 early and late runs, respectively. Early run salmon averaged 595.8 mm in length. The adult late run escapement averaged 585.0 mm. Mean lengths of two-and three-ocean late run salmon were 9.1 and 9.2 mm greater, respectively, than early run sockeye salmon of comparable age class. Late run red salmon spend an additional one to two months in the marine environment and therefore have a longer growth period than early run fish. It is therefore suggested that size difference in respective early and late run salmon of similar age classes is related to length of ocean residency rather than to differential growth rates between runs.

Nelson (1976) indicated ocean age of early and late run salmon in 1975 could be ascertained employing length-frequency data. Data has been presented which indicates this was not true in dealing with early and late run stocks in 1976.

Fecundity investigations revealed early and late run salmon averaged 3,668 and 3,491 eggs per female, respectively. Early run salmon averaged 1,407 eggs per kilogram of body weight and six eggs per millimeter of body length. Late run fish averaged 1,378 eggs per kilogram of body weight and six eggs per millimeter of body length. These data are basically in agreement with fecundity estimates obtained from 1973-1975. In the majority of the sockeye salmon examined, the left ovary contained a greater number of eggs than did the right. This is also in agreement with prior years' data.

Average annual fecundity (1973-1976) of early run Russian River sockey salmon is estimated at 3,955 and has ranged from 3,569 (1974) to 4,630 (1973). Fecundity of late run stocks averaged 3,374 from 1973 through 1976. Although it is difficult to rank the fecundity of various red salmon populations, data suggest that the early run is somewhat "above average" while late run fecundity is "intermediate" when ranked with other geographic areas.

Numbers of eggs available from the early run escapement which were potentially available for deposition in Upper Russian Creek were calculated employing parameters outlined by Nelson (1974). Potential egg deposition was estimated at 23,490,972. Although the 1976 early run escapement was the greatest in 10 years, potential deposition is only the second highest recorded. The 1973 potential deposition was estimated at approximately 29.6 million and was derived from an escapement of 13,120. This apparent inconsistency emphasizes the importance of average fecundity and the sex ratio in a given escapement in that: (1) females dominated the 1973 escapement with a male:female sex ratio of 1:1.1 while males dominated the 1976 escapement (sex ratio of 1:0.9), and (2) fecundity of the average female in 1973 exceeded average fecundity of 1976 females by 961.9 eggs, or 26.2%.

Egg sampling to determine egg survival and actual deposition was conducted in Upper Russian Creek following the cessation of early run spawning. Egg deposition was estimated at 61.3 eggs/M^2. This is the second lowest density recorded (despite the exceptionally high escapement) since sampling was initiated in 1972. Egg survival at time of sampling was 91.6% and total deposition is estimated at only 846,890.

The disparity between potential and actual egg deposition may be related to adverse environmental factors. Observation at time of sampling revealed exceptionally high water conditions. The high water mark on adjacent vegetation indicated the waters were receding and that peak flows may have been much greater. Several large trees which had been across the stream since this author first observed them in 1972 were no longer in evidence and it is assumed they were washed into Upper Russian Lake. It therefore appears Upper Russian Creek was subjected to atypical flood conditions which washed many early run sockeye salmon eggs from the redds. Although the impact of this phenomenon can not be fully assessed until the adult return in 1982, available data suggest the return from the 1976 parent year will be somewhat less than would normally be expected from an escapement of 14,700 early run fish.

Bear Creek was ground surveyed on September 11 to determine numbers of late run red salmon utilizing this spring fed system. Approximately 122 salmon were enumerated in the stream proper with an additional 1,300 observed off the stream mouth. A second survey on October 6 revealed few fish off the mouth and only 400 in the stream. Based on stream life estimates as determined by Nelson (1976), a maximum of two spawning waves could have entered the creek between surveys. It is therefore concluded that less than 1,000 late run red salmon utilized this system in 1976 and that its value as a late run spawning area was minimal. Due to small numbers of fish in the system, hydraulic egg sampling was not conducted.

Sampling in 1975 revealed the presence of infectious hematopoietic necrosis (IHN) in both early and late Russian River runs. One hundred percent of the female samples collected during both runs were positive. Male pools from early and late runs were 45.5 and 20.0% positive, respectively. Sampling in 1976 revealed 16.7% of the early run was positive. Although this tentatively suggests a significant decrease in the occurrence of this disease, data are not comparable. The 1975 samples were composed of five fish pools. Therefore, if any one fish were positive the entire pool would be positive.

Climatological data were recorded at lower Russian Lake. Total rainfall during the 73-day period was 235 mm (9.3"). This is approximately 3.7 times more precipitation than was recorded in 1975, i.e., 2.5 inches. Stream velocity exhibited appreciable fluctuation. Maximum average velocity of 307.4 cfs occurred during the first part of the early run. Volume steadily decreased thereafter, reaching an average six-day low of 137.0 cfs during the latter period of the late run migration. Water and air temperature for 1976 were in close agreement with 1975 temperatures.

LITERATURE CITED

Brown, C. J. D. and Gertrude C. Kamp. 1942. Gonad measurements and egg counts of brown trout (*Salmo trutta*) from the Madison River, Montana. Trans. Am. Fish. Soc., 71:195-200.

Davis, A.S., T. Namtvedt, and B.M. Barrett. 1973. Cook Inlet sockeye forecast and optimum escapement studies. Technical Report. Project AFC-41-2. 94 pp.

Davis, A. S., B. M. Barrett, and L. H. Barton. 1974. Cook Inlet red forecast and optimum escapement studies. Technical Report. Project AFS 41-3.

Engel, L.J. 1965. Inventory and cataloging of the sport fish and sport fish waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6. P: 111-127.

________. 1966. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1965-1966, Project F-5-R-7. 7:59-78.

__________1967. Inventory and cataloging of the sport fish and its waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1966-1967. Project F-5-R-8. 8:73-81.

__________1968. Inventory and cataloging of the sport fish and waters of the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1967-1968. Project F-5-R-9. 9:95-116.

__________1969. Inventory and cataloging of Kenai Peninsula, Cook Inlet and Prince William Sound drainages and fish stocks. Alaska Dept. of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969. Project F-9-1. 10: 111-130.

__________1970. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1969-1970. Project F-9-2. 11:129-134.

__________1971. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1970-71. Project F-9-3. 12: 78-89.

__________1972. Studies on the Russian River red salmon sport fishery, Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1971-1972. Project F-9-4. 13:19 pp.

Foerster, R.E. 1968. The sockeye salmon, Oncorhynchus nerka. Fish. Res. Bd. of Canada, Bull. 162. 422 pp.

Hartman, Wilber L. and Charles Y. Conkle. 1960. Fecundity of sockeye salmon at Brooks and Karluk Lakes, Alaska. U.S. Fish & Wildlife Serv. Fish Bull., 180(61): 53-60.

Koo, Ted S.Y., ed. 1962. Studies of Alaska sockeye salmon. Univ. of Washington Press. Pp. 37-48.

Lawler, R.R. 1963. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula and Prince William Sound. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1962-1963. Project F-5-R-4. 4: 145-160.

____________ 1964. Inventory and cataloging of the sport fish and sport fish waters on the Kenai Peninsula, Cook Inlet-Prince William Sound areas. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1963-1964. Project F-5-R-5. 5: 113-122.

Mathisen, O.A. MS. 1955. Studies on the spawning biology of the sockeye salmon, Oncorhynchus nerka (Walbaum), in Bristol Bay, Alaska, with special reference to the effect of altered sex ratios, in R.E. Foerster,

McNeil, W. J. 1964. A method of measuring mortality of pink salmon eggs and larvae. U.S. Fish and Wildlife Service, Fish Bull., 63(3):575-588.

Nelson, D.C. 1973. Studies on Russian River red salmon sport fishery, Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1972-1973. Project F-9-R-5. 13 pp.

____________ 1974. Studies on the Russian River red salmon sport fishery. Alaska Dept. of Fish and Game. Fed. Aid in Fish Restoration, Annual Report of Progress, 1973-1974. Project F-9-6. 15:21-48.

____________ 1975. Russian River red salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress, AFS 44-1, 1974-1975, F-9-7. 16: 1-41.

____________ 1976. Russian River red salmon study. Alaska Dept. of Fish and Game. Anadromous Fish Studies, Annual Report of Progress,

Neuhold, J.M. and K.H. Lu. 1957. Creel census method; Utah Dept. of Fish and Game, Publication No. 8. 36 pp.

Tait, Howard D., Jerry L. Hout, and Frederick V. Thorsteinson. 1962. An evaluation of fyke trapping as a means of indexing salmon escapements in turbid streams. USFWS, Special Scientific Report-Fisheries No. 428. 18 pp.

Wood, James W. 1974. Diseases of Pacific salmon, their prevention and treatment. State of Washington, Dept. of Fisheries, Hatchery Div. 82 pp.

Prepared by:

David C. Nelson
Fishery Biologist

Approved by:

s/W. Michael Kaill, Chief
Sport Fish Research

s/Rupert E. Andrews, Director
Sport Fish Division