STATE OF ALASKA

William A. Egan, Governor

Annual Report of Performance for

SPORT FISH STUDIES

by

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RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska.

Project No.: F - 9 - 6

Study No.: G - II Study Title: SPORT FISH STUDIES.

Job No.: G - II - G Job Title: Studies on the Russian River Red Salmon Sport Fishery.

Period Covered: July 1, 1973 to June 30, 1974

ABSTRACT

Creel census estimates on the Russian River sport fishery revealed 15,670 red salmon, Oncorhyncus nerka, were harvested by 30,590 man-days of effort. Early and late runs contributed 6,740 and 8,930 salmon, respectively, to the harvest. Seasonal success rate was 0.102 red salmon per hour. Anglers harvested 29.1% of the red salmon to reach Russian River.

Early and late run escapements were 13,120 and 24,970 red salmon, respectively. Early run escapement is considered excellent and exceeds the 13 year mean by 6.1%, late run escapement is one of the lowest recorded.

Results of an angler poll to determine acceptance of an anti-snagging regulation are presented.

Fecundity studies revealed early and late run female red salmon averaged 4,630 and 3,190 eggs per female, respectively. Early and late run fish weighed 2.968 and 2.187 kg., respectively.

Egg deposition of early run salmon in Upper Russian Creek was estimated at 29,592,923.

Results of a tagging experiment to determine distribution of late run fish in Upper Russian Lake are presented and discussed.

Egg retention of early and late run salmon was estimated at 92.8 and 248.1 eggs per female, respectively. No early run fish sampled were unspawned, while 2.4% of the late run sampled perished without spawning.

Egg to fry survival for progeny of the 1972 early run escapement was estimated at 11.0%. Egg deposition of early run fish in 1973 was estimated at 11.0%. Egg deposition of early run fish in 1973 was estimated at 319.6 eggs/M^2. Egg survival was 93.0%. Egg density in a spring-fed tributary utilized by late run fish is estimated at 796.0 eggs/M^2. Survival was 4.6%. Factors contributing to low survival are discussed.

RECOMMENDATIONS

1. Discontinue tagging late run red salmon at Russian River weir to determine spawning areas utilized by these fish and the percent of the run spawning in each area. Results obtained in 1973 indicate variables exist which cannot be accurately compensated for.

2. Construct a temporary weir at the mouth of Bear Creek to determine numbers of late run fish spawning in this area.

3. Conduct a limited tagging program at Bear Creek weir to determine average stream life.

4. Continue fecundity investigations of early and late run salmon at Lower Russian Lake weir.

5. Continue to determine number of eggs retained by spent female red salmon in Russian River drainage.

6. Increase the number of samples collected in Upper Russian Creek to determine egg and fry density from 50 to 100. Increase area sampled from five to ten sections. Sampling should be proportionate to the number of fish spawning in 200-yard index areas.

7 Construct a weir at outlet of Lower Russian Lake capable of enumerating adult and juvenile red salmon.

8. Construct a fishway at Russian River falls to prevent delay of migrating salmon.

OBJECTIVES

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

2. To determine racial characteristics and age composition of adult and juvenile red salmon.

3. To determine the sport and commercial harvest of Russian River red salmon.

4. To determine the areas utilized by late run spawning red salmon in the Upper Russian Lake drainage and to determine the numbers of fish utilizing each area.

5. To determine the fecundity of adult female red salmon and to determine egg retention of spent female red salmon.

6. To determine the density of eggs deposited in relation to the number of spawning red salmon.

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

TECHNIQUES USED

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

Escapements were enumerated at a temporary weir. Weir location and construction have been previously described (Engel, 1970).

Approximately five percent of the late run was tagged at Russian River weir with serially numbered Petersen disc tags. Only uninjured fish were tagged. Tags were numbered 000 through 999 with oversized numerals approximately 6 mm high. Tags utilized were color coded. Application of these tags has been previously described (Nelson, 1973).

Tag recovery was effected by ground surveys and float trips of Upper Russian Lake drainage. Numbers of red salmon spawning in a given area were determined by instantaneous count and tagged to untagged ratio. Formula for calculating the spawning population was $N=n/p$ where N is the population estimate, n is number of tagged fish observed, and p is the proportion of fish tagged.

Stream life of late run salmon in Bear Creek (tributary to Upper Russian Lake) was determined by observation and tag recovery. Day One was the day the tagged fish was observed. The final day was the day the carcass was recovered.

Early and late run carcasses were opened in conjunction with spawning ground surveys to determine spawning success. Eggs retained were individually enumerated. Salmon were considered unspawned if the eggs remained firmly attached to the skein. These eggs were not enumerated but were considered to be the average number of eggs carried by early or late run females as determined by sampling at Russian River weir.

Fecundity studies were conducted at Russian River weir. Female red salmon were randomly selected throughout early and late runs. Total weight and skein weight were obtained. Skeins were then boiled until eggs could be removed. Eggs were individually enumerated.

Egg density in Bear Creek and egg and fry density in Upper Russian Creek were determined by hydraulic sampler patterned after equipment described by McNeil (1964). Sampling in both streams was identical to 1972 sampling and has been described (Nelson, 1973).

F NDINGS

Area Description

Lower Russian River is a clear Kenai Peninsula stream approximately 3.5 miles in length draining Lower Russian Lake. It is adjacent to the Sterling Highway at mile 55 where it intersects the glacial Kenai River. At this point a privately operated ferry transports anglers to the south bank. Approximately 50% of all angler effort on red salmon, Oncorhyncus nerka, occurs in this area.

Red salmon sport fishing is restricted to lower Russian River from a point 600 yards below Russian River falls to a marker 1,800 yards below the confluence of Kenai and Russian rivers. Total fishing area is approximately three river miles. The area is designated a fly-only area from June 1 through August 30. Only coho or streamer flies with a gap between point and shank of 3/8" or less are permitted. The area from the Kenai River ferry crossing to a marker 500 yards upstream on the Russian River is closed to all fishing from June 1 through June 30 and affords increased protection to early run red salmon (Nelson, 1973). The Russian River drainage, above a marker 600 yards below Russian River falls, has been closed to all salmon fishing since 1960 (Figure 1).

There are two distinct Russian River red salmon runs. Early run fish generally enter the river by June 15. Total run size averages 19,410 salmon (12-year mean). The second run enters the river by July 15 and is the largest of the two runs, averaging 46,930 fish (12-year mean). Approximately 50% of the early and late run has passed through lower Russian River by July 1 and August 1, respectively, (Engel, 1972).

Russian River also supports king, O. tshawytscha, and silver, O. kisutch, salmon. Pink salmon, O. gorbuscha, have also been observed. Resident game species include rainbow trout, Salmo gairdneri, and Dolly Varden, Salvelinus malma.

Lower Russian River flow data has been compiled by a United States Geological Survey gaging station from 1947 through 1954. The station was located 0.3 miles below outlet of Lower Russian Lake. Average annual discharge has ranged from 83.9 to 198.0 cfs. Greatest average monthly discharge during the eight year period was 262.5 cfs in June (Table 1). The river drains an estimated 61.8 square miles. 1/

1/ Drainage area and stream flow data excerpted from 1947 through 1954 gage records received from United States Geological Survey, Water Resources Division, 218 E. Street - Skyline Building, Anchorage, Ak.

TABLE 1. Mean Monthly Discharge Rates (cfs) Recorded by United States Geological Survey Gage, Russian River, 1947 through 1954.

Month	Year								
	1947	1948	1949	1950	1951	1952	1953	1954	Mean
January	*	59.9	25.4	45.6	25.4	24.0	123.0	37.5	48.7
February	*	51.2	19.8	30.2	21.1	23.0	84.7	38.6	38.4
March	*	35.6	26.1	28.7	18.0	21.8	54.7	26.0	30.1
April	*	51.2	36.2	30.8	40.3	20.5	81.9	32.9	42.0
May	191.0	223.0	116.0	135.0	I53.0	62.2	358.0	340.0	197.3
June	216.0	224.0	206.0	256.0	174.0	214.0	543.0	267.0	262.5
July	318.0	166.0	156.0	157.0	122.0	188.0	347.0	155.0	201.1
August	98.3	91.4	93.0	92.7	62.8	96.7	239.0	150.0	115.5
September	80.0	47.1	104.0	167.0	170.0	69.8	168.0	86.1	111.5
October	137.0	110.0	131.0	83.9	84.6	349.0	236.0	*	161.6
November	281.0	80.6	275.0	40.1	98.5	465.0	79.8	*	188.6
December	172.0	40.2	110.0	27.0	36.3	231.0	49.1	*	95.1

* Gaging station inoperative during these months.

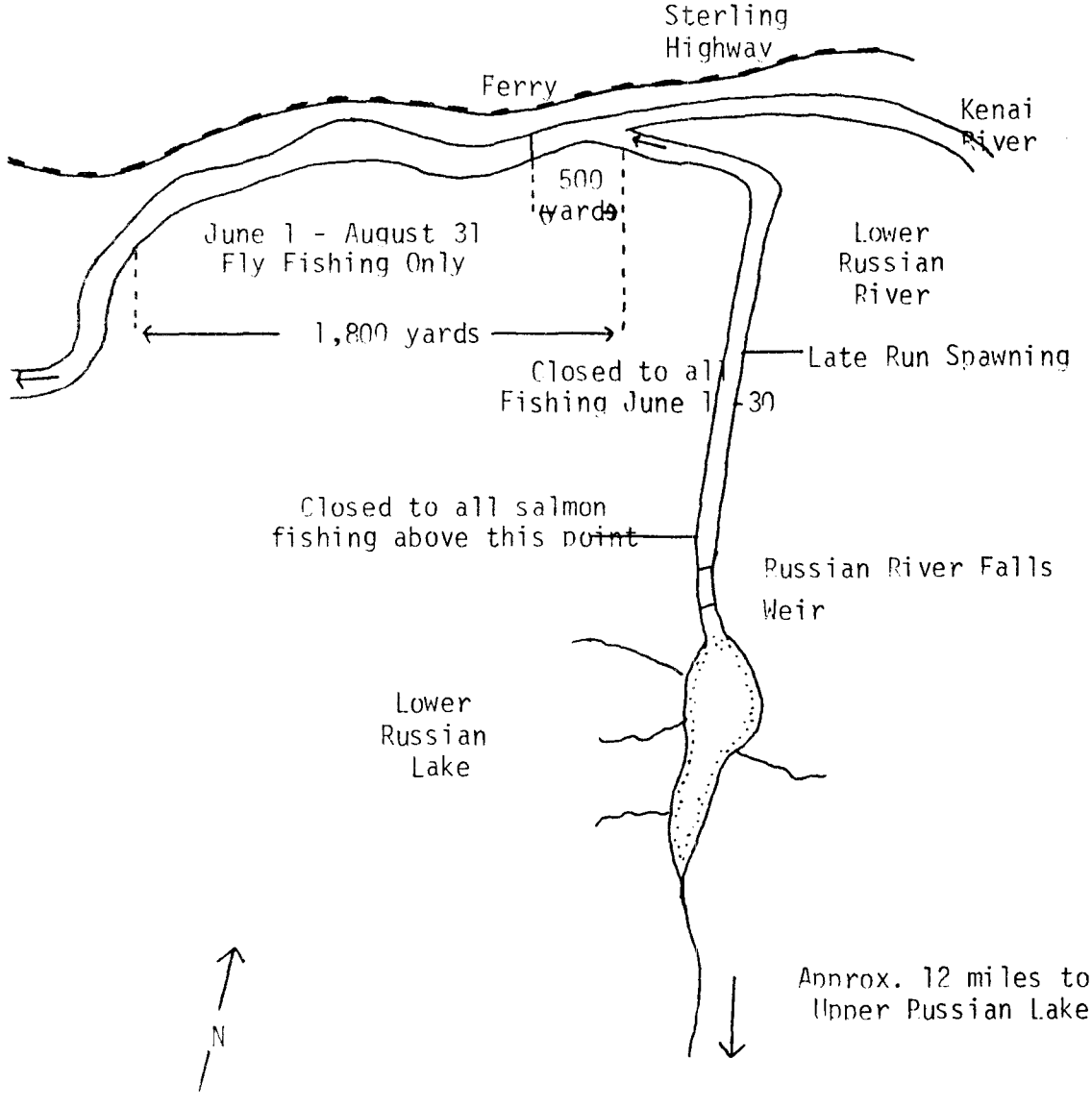

Figure 1. Schematic Diagram of Lower Russian River and Kenai and Russian River Confluence (Not To Scale).

Engel (1972) notes that this period of peak discharge corresponds to the migrational passage of the early run. A description of Russian River Falls and effects of unseasonably high discharge rates on migrational timing of early and late runs has been presented (Engel, 1972).

Lower Russian River from its confluence with the Kenai River to a point approximately 2.0 miles upstream is of moderate gradient. This area is the spawning grounds for a segment of the late run.

Lower Russian Lake is approximately 1.5 miles long and less than 0.5 miles wide. Surface area is estimated at 215 acres. Maximum recorded depth is 25 feet. The lake has no known salmon spawning areas. Rainbow trout and Dolly Varden are present and support a moderate sport fishery. Three small streams enter the lake from the west and one from the east. The major tributary is Upper Russian River entering from the south.

Upper Russian River is approximately 12 miles long and connects Upper and Lower Russian lakes. The stream is of moderate gradient and contains excellent spawning gravel. A series of rapids approximately three miles below Upper Russian Lake is not a barrier to adult salmonid migration. Late run red salmon spawn between the rapids and outlet of Upper Russian Lake. Observation suggests king salmon spawn below the rapids, while silver salmon utilize the entire stream.

Upper Russian Lake (Figure 2) is a clear, deep lake, approximately 3.0 miles long and 0.75 miles in width. Surface area is estimated at 1,100 acres. Maximum depth exceeds 240 feet. Shoal area is estimated at 5.0%. Late run fish are known to spawn at the northwest end of the lake. In addition, the lake is fed by five tributaries, the largest of which are Upper Russian and Bear creeks.

Upper Russian Creek is the lake's major tributary. It is clear except during periods of warm weather and high water when it may assume glacial coloration. Excellent spawning gravel is available in the lower 1.1 mile. Beyond this point a canyon of considerable gradient is a total barrier to fish passage. This stream is the only spawning area utilized by early run red salmon. A small segment of the late run also spawns here.

Bear Creek is a relatively small spring-fed tributary, characterized by stream areas between ponds, and ponds themselves are a major spawning area of late run red salmon (Nelson, 1973). Measurements obtained in 1973 indicate total area of Bear Creek approximates 5,400 M^2. Average depth is approximately one foot and salmon mortality associated with brown, Ursus arctos, and black, U. americanus, bear predation is probably high, as confined area and low water afford little opportunity of escape.

Management and Research

Prior information on the Russian River red salmon sport fishery has been presented in Alaska Department of Fish and Game, Federal Aid in Fish Restoration Annual Progress Reports by Lawler (1963, 1964), Engel (1965 through

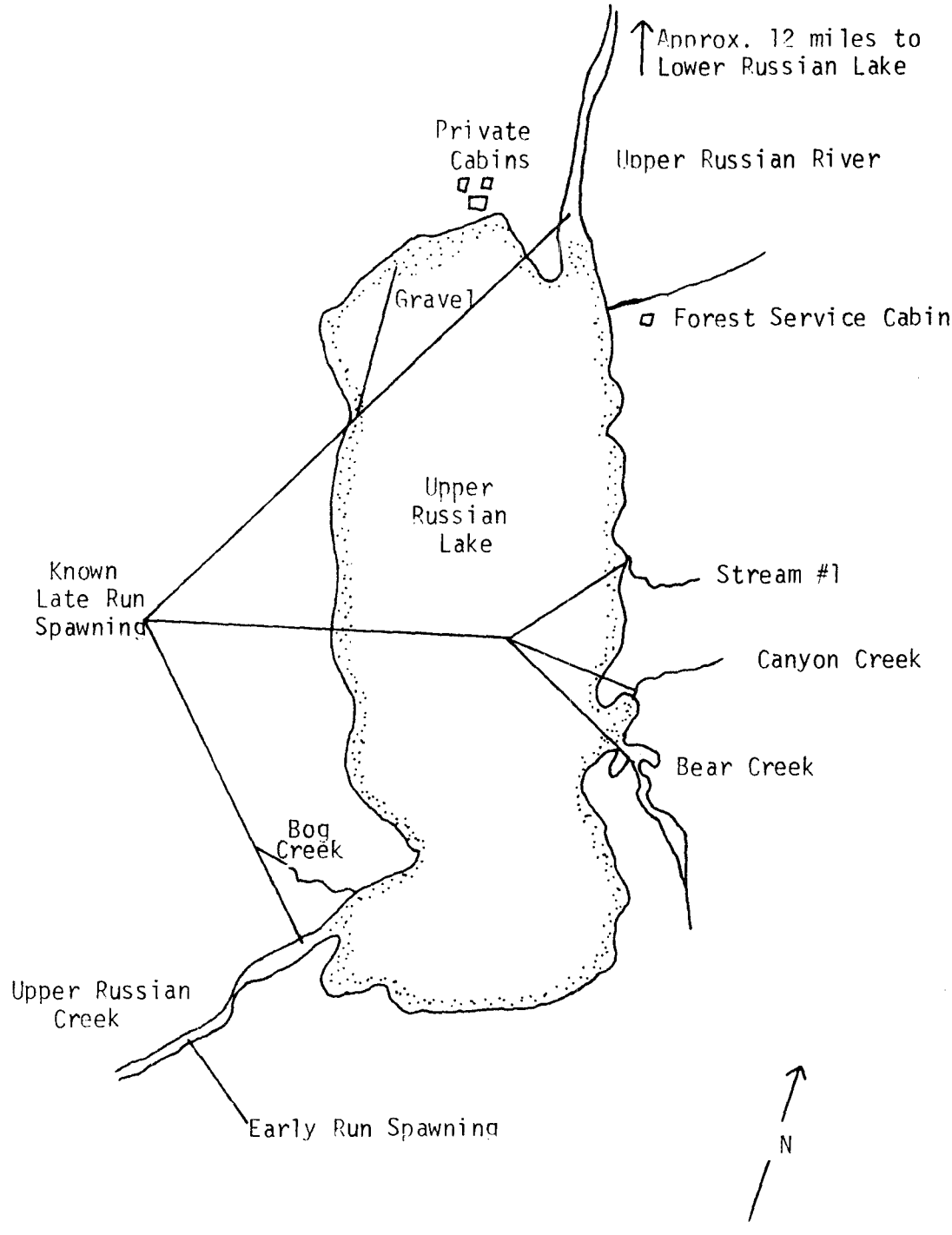

Figure 2. Schematic Diagram of Upper Russian Lake (Not To Scale).

1972), and Nelson (1973). Prior to 1969, effort was primarily directed toward collection and analysis of harvest, effort, and escapement data. From 1969 through 1972, emphasis was placed on evaluating regulatory measures to eliminate snagging, a common angling practice since the inception of the fishery. An historical review of Russian River fisheries regulations has been presented by Engel (1968, 1972).

In 1973, a regulation was promulgated requiring any fish not hooked in the mouth be released immediately. Opposition to this and prior anti-snagging regulations is centered on possible delayed mortality of foul-hooked and released salmon.

In 1972, an intensive tagging program was conducted at the confluence of Kenai and Russian Rivers and at the weir at Lower Russian Lake. This program was designed to determine the degree of delayed mortality resulting from foul-hook wounds with emphasis on early run salmon.

Results indicated mortality was negligible below Russian River falls. Maximum mortality associated with foul-hooked and released salmon was 5.1% of early run escapement between weir and spawning grounds. Unmarked and superficially wounded fish experienced higher survival than moderately or severely wounded salmon. It was concluded that, although limited mortality does occur when fish are snagged and released, it does not pose a biological problem in the management of this fishery (Nelson, 1973).

Angler participation has increased more than 500% since 1964. Effort from 1962 through 1972 averaged an estimated 13,500 man-days, while effort in 1973 was estimated at 30,590 man-days. An intensive creel census throughout the fishery is required to obtain harvest and effort estimates. Data is compared with escapement rates obtained from a weir at Lower Russian Lake.

Effort has become so intense in recent years that the fishery is capable of harvesting the bulk of the fish which return to Russian River. A fishery of this magnitude requires an intense management and research program to assure maximum harvest on a sustained yield basis. Definitive information regarding escapement levels, which return maximum numbers of fish to this system, will increase numbers of salmon available to the angler while assuring perpetuation of the stocks.

A program to determine desired escapement levels was initiated in 1969 and intensified in 1972. Emphasis is directed toward determining numbers of salmon which utilize respective spawning areas in Upper Russian Lake; numbers of eggs which these fish deposit, and the resultant fry produced from a known number of eggs. To determine total production from a known escapement, it will necessitate enumeration of the smolt outmigration.

A weir capable of enumerating adult and juvenile salmon is scheduled for construction in 1974 and will facilitate this phase of the investigation. Each year's data will be compared with prior years to determine escapement and smolt levels which produce highest adult returns.

Creel Census

In accordance with the Department's anti-snagging philosophy on the Kenai Peninsula, the fly-only and foul-hook regulations remained mandatory in 1973. The fly-only area was extended from 500 to 1,800 yards downstream from the confluence of Kenai and Russian rivers. The sanctuary area, established at the confluence of Kenai and Russian rivers in 1972, remained in effect. This area was closed to all fishing from June 1 through June 30. Large numbers of early run fish were observed in this area on June 30 and the closure was extended by emergency order through July 9. Escapement levels did not respond to this increased protection and the fishery was closed to the taking of red salmon by emergency order on July 4. The fishery was reopened on July 15 after the early run had passed the weir at Lower Russian Lake and late run salmon had entered the river.

A creel census to evaluate these management and regulatory measures was in effect from June 9 through July 4 and from July 15 through August 19. All fishing effort on red salmon was sampled. Projected angler counts yielded an estimated 153,100 angler hours or 30,590 man-days. Effort on early and late run was estimated at 15,220 and 15,470 man-days, respectively. Based on interviews with 4,469 anglers who reported fishing 23,060 hours and caught 2,368 red salmon, the combined catch was estimated at 15,670 fish. Early and late run harvest were 6,740 and 8,930 salmon, respectively. Mean early and late run success rates were 0.095 and 0.109 fish per hour, respectively. Table 2 summarizes harvest, effort, and catch per hour since 1962.

TABLE 2. Red Salmon Harvest, Effort, and Success Rates on Russian River, 1962-1973.

Year	Harvest			Effort (man-days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1962	3,410	1,290	4,700	6,600	0.220	6/15-8/12
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/ 9-8/19***
1962-1972 Average	6,295	4,968	11,263	13,500	0.193	

* Census active from 6/11-7/3 and from 7/24-7/27
** Census active from 6/17-7/7 and from 7/31-8/20
*** Census active from 6/9-7/4 and from 7/15-8/19

Total effort was the highest recorded despite a ten-day closure. The low harvest rate is directly related to total run size, which was one of the smallest recorded.

Weekday and weekend angler counts averaged 147.1 and 195.0 anglers, respectively. These counts are the highest recorded and exceed the 1972 average weekday and weekend counts by 100.6% and 40.8%, respectively. Although quantitative data are not available, increased angler counts on weekdays suggest greater tourist participation than in previous years.

Catch per hour was 0.113 and 0.088 for weekdays and weekends, respectively. Lower harvest rates on weekends is attributed to angler congestion on the streams. Anglers fished an average of 4.8 and 5.5 hours on weekdays and weekends, respectively. A summary of fisheries statistics since 1964 are presented in Table 3.

TABLE 3. Differences Between Weekday and Weekend Day Fishing Pressures and Rates of Success at Russian River, 1964-1973.

	Fisherman Counts		Catch/Hour		Hours Fished	
Year	Week-days	Weekend days	Week-days	Weekend days	Week-days	Weekend days
1964	29.6	70.9	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
1964-1972 Average	62.7	118.1	0.224	0.152	4.6	5.1

Stream counts revealed 57.4 and 56.8% of the anglers enumerated fished the Kenai-Russian River confluence area during the early and late runs, respectively. This approximates 1972 angler distribution when 47.6% and 48.0% of the anglers fished the confluence area during the early and late run, respectively. The tendency for anglers to distribute themselves in approximately equal proportion between confluence area and Lower Russian River is attributed to the following: (1) the sanctuary area at the confluence which is in effect during the early run; (2) exceptionally high angler participation in recent years.

The sanctuary area reduced by 500 yards the area available to early run fishermen. Anglers moved upstream to the clear waters of Russian River to intercept salmon as they migrated from the closed area. Effort in 1973 increased 102.3% and 19.0% over 1971 and 1972 estimates, respectively. Area available per fishermen at the confluence decreased proportionately and anglers moved upstream to avoid congestion. Late run salmon also move rapidly through the fishery, rendering fishing attractive in Lower Russian River as well as at the confluence of Kenai and Russian rivers.

Observation indicated that anglers fished downstream on the Kenai River in larger numbers than prior years. Whether this was related to extension of the fly-only area, relative clarity of the glacial Kenai River, or angler congestion at the confluence area is unknown.

During the census, an estimated 745 Dolly Varden, 88 rainbow trout, 60 silver salmon, and 28 round whitefish, Prosopium cylindraceum, were harvested incidental to red salmon.

Angler Opinion:

Management of the Russian River sport fishery has been strongly influenced by public expression regarding the unethical aspect of snagging or foul-hooking a salmon. Regulatory measures were adopted by the Alaska Board of Fish and Game between 1965 and 1967 to discourage snagging and provide an ethically acceptable fishery for the majority of participants. In 1973, the Board promulgated a regulation in Southcentral Alaska requiring that any fish not hooked in the mouth be released immediately.

To determine public response to this regulation, all anglers interviewed during the creel census were asked their opinion of this regulatory change. A similar survey was conducted in 1967 when anglers were asked their opinion of the regulation requiring that any fish not hooked in head, mouth or gills be immediately released. Survey results are presented in Table 4.

TABLE 4. Russian River Angler Opinions on Anti-Snagging Regulations, 1967 and 1973.

	1967		1973	
Angler Opinion	Number Anglers	Percent	Number Anglers	Percent
Favor	624	50.6	3,520	78.8
Oppose	511	41.4	773	17.3
Indifferent	98	8.0	176	3.9
Total	1,233	100.0	4,469	100.0

Table 4 indicates a changing attitude among fishermen who utilize Russian River and, presumably, other freshwater fisheries in Southcentral Alaska. Prohibiting retention of a fish hooked elsewhere than head, mouth or gills did not prohibit snagging, per se. It did make snagging more difficult as the "target area" was considerably reduced. Only 50.6% of those interviewed in 1967 favored this regulation even though it did not expressly render snagging unlawful.

The regulation requiring any fish not hooked in the mouth be immediately released eliminates intentional snagging. There is no incentive to foul-hook a fish. Over 78% of the anglers interviewed favored the regulation, while only 17.3% opposed it. This is a significant change in attitude compared to the 1967 survey, when 41.4% of the anglers were against any attempts to limit a snag fishery at Russian River.

Escapement

Red salmon escapements have been enumerated by counting tower since 1960 and weir at the outlet of Lower Russian Lake since 1969. This site permits red salmon enumeration after the stocks have been harvested by Cook Inlet commercial and Russian River sport fisheries. Prior to 1973, total escapements enumerated at the counting tower/weir averaged 52,296 and ranged from 26,470 (1961) to 88,270 (1972) red salmon (Table 5).

TABLE 5. Russian River Red Salmon Escapement Estimates and Harvest Rates for Early and Late Runs, 1960-1973.

Year	Escapement			Percentage of Run Caught by Sport Fishery **		
	Early Run	Late Run	Total	Early Run	Late Run	Combined
1960	9,120	34,850	43,970	--	--	--
1961	7,790	18,680	26,470	--	--	--
1962	33,300	22,370	55,670	9.3	5.4	7.8
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
1960-1972 Average	12,363	39,932	52,296	36.4	9.0	16.6

* Escapement determined by foot survey of Upper Russian Creek.

** Based on escapement past weir; commercial harvest and fish spawning downstream from weir are not considered.

The weir was operational on June 14, 1973. Red salmon were observed above the falls on June 15 but did not pass the weir until June 21. Red salmon migration had ceased when the weir was dismantled on August 30.

Early run salmon escapements have ranged from 2,650 (1971) to 33,300 (1962) and averaged 12,365. Escapement in 1973 was 13,120 or 756 salmon above the 13-year mean. As prior data shows this run to be predominantly 6-year fish, the total run approximates the 1967 parent year return of 20,950.

Late run Russian River escapements have ranged from 18,680 (1961) to 79,000 (1972) and averaged 39,932. The 1973 escapement of 24,970 (including 332 jacks) is 14,952 less than the 13-year mean. A foot survey between Russian River falls and confluence of the Kenai and Russian rivers indicated an additional 6,885 late run salmon in this area. Total late run escapement to Russian River drainage is therefore estimated at 31,855 red salmon.

Sport fishermen harvested 33.9% of the early Russian River run (Table 5). Although this approximates the 11-year mean of 36.8%, it is considerably less than the 1969-through-1971 catch rate when over 50% of the early run to reach Russian River was caught. Decreased harvest rate in 1972 and 1973 is attributed to the sanctuary area, which afforded increased protection to early run fish, and to emergency closures, which reduced the number of days these salmon were available to the sport fishermen.

Anglers harvested 26.3% of the late run (exclusive of fish spawning below falls) to reach Russian River. This is an appreciable increase over the 11-year mean of 9.0% and reflects not only the small size of the 1973 late run, but increased angling pressure on these stocks.

TABLE 6. Russian River Angler Effort Directed Toward Early and Late Run Red Salmon, 1962-1973.

Year	Effort (man-days)		Effort (Percent)	
	Early Run	Late Run	Early Run	Late Run
1962	5,070	1,520	76.9	23.1
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
1962-1972 Average	8,936.4	4,563.7	69.8	30.2

Table 6 indicates that, prior to 1971, the majority of angler effort was directed toward early run salmon. From 1971 through 1973, over 50% of the seasonal effort was directed toward the more numerous late run fish. This trend does not indicate reduced effort on early run salmon, but rather an expanding sport fishery with intense angler usage throughout the season. Increased participation in the fishery suggests: (1) an increased interest in recreational salmon fishing by Alaska residents; (2) an expanding Alaska population; and (3) an increase in Alaska tourism.

A total of 200 silver salmon and 243 king salmon were also enumerated at Russian River weir. Annual silver salmon escapements are not comparable (Nelson, 1973). King salmon escapements may be compared as the run passes the weir during the red salmon migration. The 1973 escapement is the highest recorded. Escapements for 1969, 1970, 1971, and 1972 were 119, 240, 21. and 172 king salmon, respectively.

Age composition of 1973 adult red salmon was not available at the time of report preparation. Male-to-female sex ratio of 146 early and 1,350 late run salmon was 1:1.1 and 1:1.0, respectively.

The Cook Inlet commercial salmon fishery did not open until June 25, 1973, in the Central District. Early Russian River red salmon generally reach the Kenai-Russian River confluence between June 10 and June 15. It is therefore assumed early run red salmon did not contribute to the commercial harvest. Data are not available regarding the late run's contribution to the Cook Inlet commercial fishery.

Fecundity Studies

Limited fecundity studies were conducted at Russian River weir throughout early and late run migrations. Sampling results are presented in Table 7.

TABLE 7. Fecundity of Early and Late Run Russian River Red Salmon Sampled at Lower Russian Lake Weir, 1973.

EARLY RUN

Number	Total Weight (kg)		Length (cm)*	Egg Weight (g)	Number of Eggs
1	3.052	(7.00 lb)	62.0	238	4,900
2	3.052	(7.00 lb)	63.5	159	4,967
3	2.834	(6.50 lb)	62.5	170	4,638
4	2.834	(6.50 lb)	61.0	172	4,308
5	3.488	(8.00 lb)	66.5	240	4,394
6	2.616	(6.00 lb)	63.0	134	4,340
7	2.725	(6.25 lb)	61.5	170	4,000
8	3.052	(7.00 lb)	63.0	167	4,964
9	2.834	(6.50 lb)	60.0	270	4,682
10	2.725	(6.25 lb)	62.0	232	4,277
11	2.943	(6.75 lb)	62.0	282	4,122
12	2.943	(6.75 lb)	62.0	224	5,350
13	3.488	(8.00 lb)	66.0	330	5,250
Average	2.968	(6.81 lb)	62.7	214	4,630

LATE RUN

Number	Total Weight (kg)		Length (cm)*	Egg Weight (g)	Number of Eggs
1	2.507	(5.75 lb)	60.5	226	3,944
2	2.943	(6.75 lb)	62.5	184	4,132
3	2.071	(4.75 lb)	56.0	66	2,354
4	2.507	(5.75 lb)	60.0	Not Weighed	3,102
5	2.289	(5.25 lb)	58.0	Not Weighed	3,389
6	2.136	(4.90 lb)	57.0	Not Weighed	2,980
7	1.962	(4.50 lb)	54.0	Not Weighed	2,779
8	1.962	(4.50 lb)	54.5	Not Weighed	3,107
9	1.526	(3.50 lb)	51.0	Not Weighed	3,158
10	1.962	(4.50 lb)	55.5	Not Weighed	2,953
Average	2.187	(5.01 lb)	56.9	--	3,190

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

Fecundity of early run salmon ranged from 4,000 to 5,350 and averaged 4,630 eggs per female. Average weight and length of females sampled was 2.968 kg. and 62.7 cm., respectively. These fish averaged 1,560.0 eggs per kilogram and 73.8 eggs per centimeter. Late run salmon averaged 3,190 eggs per female with a range of 2,354 to 4,132. Average weight and length of late run females was 2.187 kg. and 56.9 cm., respectively.

Table 7 corroborates conclusions of other fecundity investigations (Foerster, 1968) in that positive correlation is established between fish size and egg number. Early run salmon weighed 35.7% (0.781 kg.) more and were 10.2% (5.8 cm.) longer than late run salmon. Early run fish also averaged 45.2% (1,440 eggs) more eggs per female than late run fish.

Rounsefell (1957) and Foerster (1968) consolidated 15 fecundity studies from various red salmon producing areas. Fecundity ranged from 2,157 (Port John, B.C., 1950) to 5,165 eggs per female (Bolshava River, 1947). Foerster concluded red salmon from the latter area appeared to be the greatest known egg producers. Comparing egg content of 1973 early Russian River stocks to the 15 examples cited by Foerster and Rounsefell revealed fecundity of these fish was second only to red salmon of the Bolshaya area.

Although 1973 investigations revealed egg content of early run fish to be exceptionally high, other factors must be considered before definitive conclusions may be drawn regarding fecundity of this population: (1) sample size was small in relation to total number of females and may not be representative; (2) fecundity of a given stock displays annual variation dependent on age structure and average size of mature fish (Rounsefell, 1957).

Egg Deposition:

Assuming average fecundity of the sample is representative of 1973 early run stocks, early run egg deposition on the spawning grounds of Upper Russian Creek may be estimated. This estimation must consider the following: (1) Male-female sex ratio is 1:1.1. Escapement passed the weir is therefore estimated at 6,872 female red salmon; (2) annual mortality between weir and spawning ground is constant and assumed to be 5.1% of the escapement (Nelson, 1973); (3) mortality between weir and spawning ground is non-selective for males and females; (4) number of females reaching the spawning grounds and perishing without spawning must be ascertained, as well as number of eggs retained per spent female. Examination of 46 early run female carcasses randomly sampled on the spawning grounds revealed average egg retention to be 92.8 eggs per female. No females were observed which had not spawned (Table 8).

TABLE 8. Egg Retention of Early Run Russian River Red Salmon in Upper Russian Creek, 1973.

Eggs Retained (Range)	Average Eggs Retained	Number of Red Salmon	Percent of Total Sample
0	0.0	1	2.2
1-50	13.2	32	69.6
51-100	88.5	2	4.3
101-150	145.5	2	4.3
151-200	--	0	-
201-250	236.0	2	4.3
Over 250	415.6	7	15.3
Unspawned	--	0	-
* Average/Total	92.8	46	100.0

* Weighted Average

The following estimate may then be derived applying the above parameters:

Early run escapement	13,120
Early run female escapement	6,872
Mortality between weir and spawning grounds	5.1%
Female red salmon to reach spawning grounds	6,522
Female red salmon which perished without spawning	0.0
Average eggs per female	4,630
Total possible eggs deposited	30,196,860
Percent eggs deposited per female	98.0%
Estimated egg deposition	29,592,923

Similar calculations concerning late run fish can not be made as mortality between weir and spawning grounds is not known. Late run salmon also spawn in five areas of Upper Russian Lake drainage as opposed to early run salmon which spawn only in Upper Russian Creek (Nelson, 1973). Observation indicates late run fish spawn over a 2.5 month period rendering them more vulnerable to predation than early run fish. It is also probable that prespawning mortality varies between the five areas, as does the number of eggs retained per female.

Weir Tagging and Tag Recovery

Prior to 1972, it was assumed the majority of late run salmon which passed Lower Russian Lake weir spawned in Upper Russian Lake. It was known that small numbers of late run fish also spawned in Upper Russian Creek and in the stream between Upper and Lower Russian lakes. In 1972, large numbers of late run fish were observed along north and east sides of Upper Russian Lake.

Removal of a beaver dam from a small tributary (Bear Creek) facilitated fish passage and thousands of salmon entered the stream with successive waves of spawners noted at the stream mouth (Nelson, 1973). These observations tentatively suggested Bear Creek was the primary spawning area of late run salmon.

In 1973, late run red salmon were tagged at Lower Russian Lake weir. Program objectives were to determine spawning areas utilized by late run fish and numbers of salmon in each area. Tagged fish totaled 1,343 or 5.4% of the late run escapement. Numbers of red salmon in a spawning area (emphasis on Bear Creek) were to be determined by tagged-to-untagged ratio.

Table 9 presents results of 17 ground surveys conducted at Bear Creek in which tagged and untagged fish were enumerated. Table 10 presents similar information from three remaining tributaries to Upper Russian Lake.

TABLE 9. Instantaneous and Calculated Late Run Réd Salmon Stream Counts, Bear Creek, Upper Russian Lake, 1973.

Date	Count	Tags Observed	Calculated Count*
9/19	623	12	226
9/20	481	18	340
9/21	1,076	23	434
9/23	1,445	24	453
9/24	1,413	20	377
9/25	1,226	23	434
9/26	1,234	18	340
9/27	1,392	22	415
9/28	1,763	23	434
9/29	1,648	27	409
10/ 5	1,068	10	189
10/ 8	1,084	17	321
10/ 9	1,099	10	189
10/12	1,091	3	57
10/13	1,037	12	226
10/14	903	6	113
10/16	905	7	132

* Spawning red salmon estimated by the formula N=n/p where N is the population estimate, n is number of tagged fish observed and p is the proportion of fish tagged.

TABLE 10. Instantaneous and Calculated Late Run Red Salmon Stream Counts, Upper Russian Lake, 1973.

Date	Area	Count	Tags Observed	Calculated Count*
9/19	Upper Russian Creek	681	14	264
9/23	Upper Russian Creek	754	3	57
9/27	Upper Russian Creek	542	11	208
9/29	Upper Russian Creek	561	8	151
10/ 5	Upper Russian Creek	422	9	170
10/12	Upper Russian Creek	258	3	57
9/20	Stream #1	0	0	--
9/28	Stream #1	151	1	19
10/13	Stream #1	53	0	--
10/15	Stream #1	45	0	--
9/24	Bog Creek	1	0	--
9/25	Canyon Creek	1	0	--
10/13	Canyon Creek	1	0	--

* Spawning red salmon estimated by the formula N-n/p where N is the population estimate, n is number of tagged fish observed and p is the proportion of fish tagged.

Tables 9 and 10 indicate that calculated counts computed from tagged to untagged ratio did not approximate instantaneous counts. Discrepancies are of a magnitude which invalidate counts computed by this method. Disparity of similar proportions was obtained during a float trip to enumerate salmon between Upper and Lower Russian lakes. Thirty-five tags were observed during the trip yielding a calculated spawning population of 700 fish. Instantaneous count indicated the presence of 2,730 spawning salmon.

Factors contributing to disparity between observed and calculated spawning populations are not definitely known, but may be related to the following: (1) Disproportionate tagging at weir. Over 5% of the daily escapement was tagged. However, every 20th fish to pass the weir was not tagged. (2) Failure to observe all tagged fish on the spawning grounds would increase percent error. (3) In all cases, calculated counts were less than observed. This suggests tagged fish experienced greater mortality rates than untagged. Quantitative data are not available, but observation indicates late run fish are subject to intense bear predation which may be selective toward tagged fish. Handling mortality is assumed to be negligible. No tagged fish which perished without spawning were observed at the weir or between Upper and Lower Russian lakes. (4) A combination of any or all of the above may have interacted to produce inaccurate estimates.

Bear Creek Investigations:

Table 11 presents observations and subsequent recovery of tagged late run salmon in Bear Creek. Limited recoveries suggest stream life ranged from 4 to 21 days, averaging 10.7. It is concluded that observations and recoveries are insufficient and do not justify definitive conclusions regarding stream life of late run red salmon in this system. Conclusions regarding numbers of salmon utilizing this area must also be deferred until future investigations provide an accurate estimate of average stream life.

TABLE 11. Stream Life of Late Run Russian River Red Salmon in Bear Creek, Upper Russian Lake, 1973.

Date Observed	Date Recovered	Stream Life (Days)
9/20/73	9/27/73	8
9/21/73	9/24/73	4
9/20/73	9/29/73	10
10/ 8/73	10/11/73	4
9/27/73	10/14/73	18
9/27/73	10/ 9/73	13
9/24/73	10/ 5/73	12
9/25/73	10/ 5/73	11
9/19/73	10/ 9/73	21
9/19/73	9/24/73	6
	Average	10.7

Spawning red salmon were observed in Bear Creek on September 14. Observation on October 31 revealed several hundred fish were still present. The majority of these fish were males, and it is concluded spawning activity had ceased by November 1.

Nine tagged female carcasses were recovered in Bear Creek from which egg retention could be determined. Retention ranged from 0-84 and averaged 37.6 eggs per female. All fish examined spawned successfully. Untagged carcasses were also examined. Three fish (2.4%) had perished without spawning. The weighted average indicates egg retention was 248.1 eggs per untagged late run female in Bear Creek (Table 12).

TABLE 12. Egg Retention of Untagged Late Run Russian River Red Salmon in Bear Creek, Upper Russian Lake, 1973.

Eggs Retained (Range)	Average Eggs Retained	Number of Red Salmon	Percent of Total Sample
0	0.0	23	18.4
1-50	9.8	89	71.2
51-100	63.7	4	3.2
101-150	130.0	2	1.6
151-200	171.7	3	2.4
201-250	242.0	1	0.8
Unspawned	3,190.0*	3	2.4
Total/Average	248.1**	125	100.0

* Eggs retained calculated as average fecundity of late run female.
** Weighted average.

These data concur with the conclusions of Eicher (1951) in that tagging red salmon with Petersen disc tags does not alter spawning behavior or success. Nelson (1973) reported 94.5% of the females in this area were spent or partially spent in 1972, while 5.5% were unspawned. Increased spawning success in 1973 is probably due to a reduced number of spawners which utilized this area.

Egg and Fry Sampling

Fry Sampling:

Fry sampling was conducted at Upper Russian Creek on April 24, 1973. Sampling procedures were identical to that described for egg sampling by Nelson (1973) with the exception of sections sampled. Five of ten sections were sampled to determine egg density on October 27, 1972. Four of these five sections were sampled to determine fry survival as one section remained ice covered at time of sampling. Only comparative data was used to calculate egg to fry survival.

Egg sampling in 1972 revealed densities of 408 eggs/M^2. Sampling in the spring of 1973 indicated 45.0 fry/M^2. Egg-to-fry survival is estimated at 9.0%. All fry were viable at time of sampling.

Sampling by the Commercial Fisheries Division in Glacier Flat Creek (Tustumena Lake tributary, Kenai Peninsula, Alaska) in 1972 and 1973 indicated egg-to-fry survival of 7.4% and 1.5%, respectively. Sampling in Moose Creek (tributary to Upper Trail Lake, Kenai Peninsula, Alaska) in 1973 revealed a survival rate of 18.1%. Mean of these three values (9.0%) is identical to survival estimates at Upper Russian Creek.

TABLE 13. Estimates of Egg to Fry Survival in Various Red Salmon Spawning Areas (After Foerster, 1968).

Area	No. Years	Range (Percent)	Mean (Percent)
Scully Creek, Lakelse L., Skeena R.	6	9.3-13.8	12.1
Six Mile Creek, Babine L., Skeena R.	2	12.0-19.0	15.5
Tally Creek, Port John	11	1.8-19.3	8.4
Chilko L., Upper Frazer R.	7	5.0-11.9	7.9
Williams Creek, Lakelse L., Skeena R.	3	7.8-17.2	13.8
Karymai Spring, Bolshaya R., Kamchatka	8	4.2-18.4	12.2
Total/Average	37		10.55

Table 13 indicates wide variation occurs between systems. Annual fluctuation in egg-to-fry survival also occurs within a given system. Based on 37 tests this variation ranges from 1.8 to 19.3% with a weighted average of 10.5. Variation in annual survival may be related to: (1) physical character of spawning area, i.e., change due to erosion, ice, etc., (2) water level prevailing at time of spawning and incubation, (3) size of spawning population, i.e., greater or less than the capacity of the spawning grounds and (4) severity of winter conditions during incubation period.

Based on above observations by various investigators and summarized by Foerster (1968), it is concluded egg-to-fry survival of early run red salmon in 1972-1973 approximates "average" survival. It is anticipated annual egg-to-fry survival will fluctuate in this stream as escapements and environmental factors vary.

Efforts to determine egg-to-fry survival of late run fish in Bear Creek were initially attempted April 9, 1973. Sampling revealed egg development was at the "eyed" stage and no alevins were found. Logistical considerations precluded returning to Bear Creek until May 30. Sampling and observation indicated fry had migrated to the rearing area in Upper Russian Lake by this date.

Egg Sampling:

Sampling to determine egg deposition of 1973 early run red salmon in Upper Russian Creek was completed October 10. Egg deposition was estimated at 319.6 eggs/M^2. Ninety-three percent of the eggs were viable at time of sampling. Sampling estimates for 1972 and 1973 are compared in Table 14.

TABLE 14. Upper Russian Creek Early Run Red Salmon Egg Densities, Percent Viable Eggs and Total Number of Eggs by Section, 1972-1973.

Section	1972 Total Eggs	1973 Total Eggs	1972 % Viable	1973 % Viable	1972 Density (M^2)	1973 Density (M^2)
IV	857	883	97.7	92.3	462.7	474.0
V	81	121	91.4	95.0	43.0	69.9
VI	726	692	95.5	94.2	398.1	372.3
Total Stream	3,790	2,967	81.1	93.0	407.8	319.6

It is of interest to note that, although escapement increased 41.5% in 1973, estimated egg deposition decreased by 21.6%. Egg survival increased 11.5%. Samples in all sections were similar to 1972 results, with the exception of section VIII. Had the number of eggs sampled in this section equaled 1972 sampling, total egg deposition would have approximated 1972 estimates.

Bear Creek, a small tributary to Upper Russian Lake utilized exclusively by late run salmon, was sampled October 31 to determine egg densities and relative egg survival. Table 14 compares these results to data obtained in 1972. Sampling techniques, time of sampling, and areas sampled were similar in both years.

TABLE 15. Bear Creek (Upper Russian Lake) Late Run Red Salmon Egg Densities, Percent Viable Eggs, and Total Number of Eggs by Area, 1972-1973.

Section	1972 Total Eggs	1973 Total Eggs	1972 % Viable	1973 % Viable	1972 Density (M^2)	1973 Density (M^2)
Pond I	3,541	993	94.6	0.0	1,905	534
Pond III	5,069	1,625	97.9	11.1	2,668	874
Pond V	6,016	1,820	92.2	1.2	3,239	979
Total Stream	14,626	4,438	94.8	4.6	2,623	796

Density was estimated at 796 eggs/M^2. Survival in 1973 was 4.6%, as opposed to 94.8% in 1972. Factors contributing to this low survival are not definitely known, but may be due to oxygen deficiency. This deficiency could

theoretically be related to record 1972 escapement. Large numbers of decomposing carcasses were observed in this system during spring of 1973.

Sampling on October 31 revealed decomposing eggs, which are believed to have been deposited in 1972. Decomposing carcasses and eggs may have reduced the available oxygen to a critical level, killing ova deposited by the 1973 escapement.

Egg deposition in 1973 (796 eggs/$M^{2)}$ is 30.3% of 1972 density (2,623 eggs/M^2). Escapement passed lower Russian River weir in 1973 was 31.6% of the 1972 escapement. Assuming average fecundity in 1972 approximated average 1973 fecundity, these percentages tentatively suggest that in these years numbers of late run fish spawning in Bear Creek were directly proportional to total escapement. Further investigation is required to confirm or deny this hypothesis.

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