Volume 27 Study S-32

STATE OF ALASKA

Bill Sheffield, Governor

Annual Performance Report for

RUSSIAN RIVER SOCKEYE SALMON

by

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RESEARCH PROJECT SEGMENT

State: Alaska Name: Sport Fish Investigations of Alaska

Project: F-10-1

Study: S-32 Study Title: COOK INLET SOCKEYE SALMON STUDIES

Job: S-32-3 Job Title: Russian River Sockeye Salmon

Cooperators: David C. Nelson, David E. Athons and Jamie A. Carlon

Period Covered: July 1, 1985 to June 30, 1986

ABSTRACT

A creel census was conducted during the 1985 Russian River sockeye salmon, *Oncorhynchus nerka* (Walbaum), sport fishery to determine harvest and angler participation in the fishery. Census data revealed 50,770 angler-days of effort were expended to harvest 70,710 sockeye salmon. Early and late runs contributed 12,300 and 58,410 salmon to the harvest, respectively. Sport fishermen harvested 29.7 percent of the sockeye salmon return to the upper Russian River drainage in 1985. Seasonal catch per angler hour was 0.286 fish, or 3.5 hours fished, for each salmon harvested.

The incidental harvest of rainbow trout, *Salmo gairdneri* Richardson, declined for the fourth consecutive year in 1984. This decline was anticipated because of the designation of the Russian River as a hook-and-release only area for rainbow trout prior to the 1984 season. The harvest of Dolly Varden, *Salvelinus malma* (Walbaum), was 50 percent of the historical mean. A conclusion regarding the status of this species must be deferred until more definitive data are available. The harvest of coho salmon, *Oncorhynchus kisutch* (Walbaum), more than doubled, while pink salmon, *Oncorhynchus gorbuscha* (Walbaum), and Arctic grayling, *Thymallus arcticus* (Pallas), harvests approximate historical catches.

Spawning escapements of early and late run sockeye salmon that utilize the Upper Russian Lake drainage were determined by a weir at the outlet of Lower Russian Lake. Early and late run spawning escapements through the weir were 30,610 and 136,970 salmon, respectively. Early run escapement exceeded the minimal escapement goal of 9,000 fish by 240.1 percent. Late run escapement exceeded the minimal escapement goal of 30,000 by 356.6 percent and was 89,411 fish above the mean historical escapement of 56,209. An additional 8,650 late run sockeye salmon

spawned downstream from the falls in lower Russian River. Escapements in this area have ranged from 220 to 45,000 late run fish, averaging 10,194.

Management of the 1985 recreational fishery is discussed; escapement goals for early and late runs are also discussed. Late run escapements of over 80,000 fish in both 1979 and 1980 produced high returns in both 1984 and 1985. However, we have concluded that Upper Russian Lake, the only known rearing area for both early and late runs, is at or near carrying capacity. Present minimal escapement goals of 9,000 early and 30,000 late run sockeye salmon are appropriate and should be retained.

Early run Russian River sockeye salmon are harvested only by the Russian River sport fishery. Run timing in 1985 was later than the historical arrival date. Data indicated the need for an emergency closure to ensure achievement of the escapement goal. The duration of this closure, occurring during the midpoint of the run, was 4.5 days.

Late run Russian River sockeye salmon are harvested by commercial fishermen in Cook Inlet and by sport anglers in both the Kenai and Russian Rivers. Data indicate the combined exploitation rate on this stock in some years may be as high as 90 percent. The majority of the late run catch (mean of 65.8 percent) is taken by the Cook Inlet commercial fishery; in 1985 the commercial fishery harvested 76.2 percent and the sport fishery 7.1 percent: a total exploitation rate of 83.3 percent. When the exploitation rate in the commercial fishery exceeds 72 percent, the Russian River recreational fishery will probably be closed to achieve the minimal spawning-escapement goal. A higher than average percentage of the Kenai River return was comprised of Russian River fish. In addition, the Russian River stocks had a return per spawner that was higher than the Kenai River stocks, and no emergency sport fishery closure was required in 1985.

Analysis of scales collected at Lower Russian Lake weir indicated 80.9 percent of the early run was comprised of 6-year-old fish (Age 2.3); Ages 1.2, 1.3, 1.4, and 2.2 contributed 1.0, 7.2, 0.5, and 9.9 percent, respectively. Mean length of early run fish sampled was 574 millimeters (22.6 inches). The male-to-female sex ratio was 1:0.9. The late run was comprised of 64.2 percent Age 2.2, 4.2 percent Age 1.2, 14.3 percent Age 1.3, 16.3 percent Age 2.3, and 1.0 percent Age 3.2. Historically, Age 2.2 contributes 59.6 percent. Mean length of late run fish sampled was 545 millimeters (21.5 inches); male-to-female sex ratio was 1:1.0.

Fecundity of early and late run sockeye salmon averaged 3,176 and 2,836 eggs per female, respectively. Early run fish averaged 5.7 eggs per millimeter of length and 1,412 eggs per kilogram of body weight; late-run salmon averaged 5.0 eggs per millimeter and 1,283 eggs per kilogram. These data are within the ranges of fecundity data previously reported for these stocks.

Climatological data were collected at Lower Russian Lake weir. Air and water temperatures approximated historical data. Precipitation from June 6 through September 10 was 188.0 millimeters (7.4 inches). Average

weekly discharge through Russian River Falls was 257.1 cubic feet per second. Although this is above the historical mean, flows were best described as "moderate". The fish pass at Russian River Falls was used for two brief periods in 1985.

KEY WORDS

Alaska, Kenai Peninsula, Russian River, sockeye salmon, harvest, spawning escapement, production, age structure, fecundity, escapement goals, fish pass.

BACKGROUND

Russian River is a clear stream located adjacent to the Sterling Highway at 9.6 km (6 mi) west of the Kenai Peninsula community of Cooper Landing and approximately 160 km (100 mi) south of Alaska's largest city, Anchorage. The stream bisects Federally managed lands. To the south, land is administered by the Kenai National Wildlife Refuge and to the north by the Chugach National Forest. A privately owned ferry at the Kenai and Russian River confluence transports anglers to the south bank. In an average year, this area (1.6 km or 1 mi) receives about 50% of all angler effort, because anglers attempt to intercept the runs prior to their entry into Russian River. The remaining effort occurs on 3.2 km (2 mi) of Russian River, directly upstream from the confluence of the Kenai and Russian Rivers. Figure 1 depicts the general location of Russian River and other pertinent landmarks.

Sockeye salmon sport fishing occurs from a marker 548 m (600 yds) downstream from Russian River Falls to a marker 1,646 m (1,800 yds) downstream from the confluence of Kenai and Russian Rivers, a distance of 4.8 km (3 mi). This area is commonly known as the "fly-fishing-only" area and from June 1 through August 20 terminal gear is restricted to coho (streamer) flies with gap between point and shank no greater than 9.5 mm (3/8 in).

The area between a marker downstream from the ferry crossing and a marker 640 m (700 yds) upstream on Russian River is closed to all fishing from June 1 through July 14 to provide additional protection to early run sockeye salmon that concentrate in this area prior to continuing their upstream migration (Figure 2). Sockeye salmon sport fishing with conventional tackle occurs in the Kenai River downstream from the "fly-fishing-only area." Harvest and effort here is minimal because of the glacial nature of the Kenai River.

Lower Russian River, from its confluence with the Kenai River to a point 3.2 km (2 mi) upstream, has a moderate gradient; upstream from that, however, the stream flows through a canyon of considerable gradient known as Russian River Falls. Sockeye salmon have been delayed and/or totally blocked by this canyon on several occasions because of a velocity barrier caused by atypically high water. Documented mortalities of both early and late run sockeye salmon were associated with

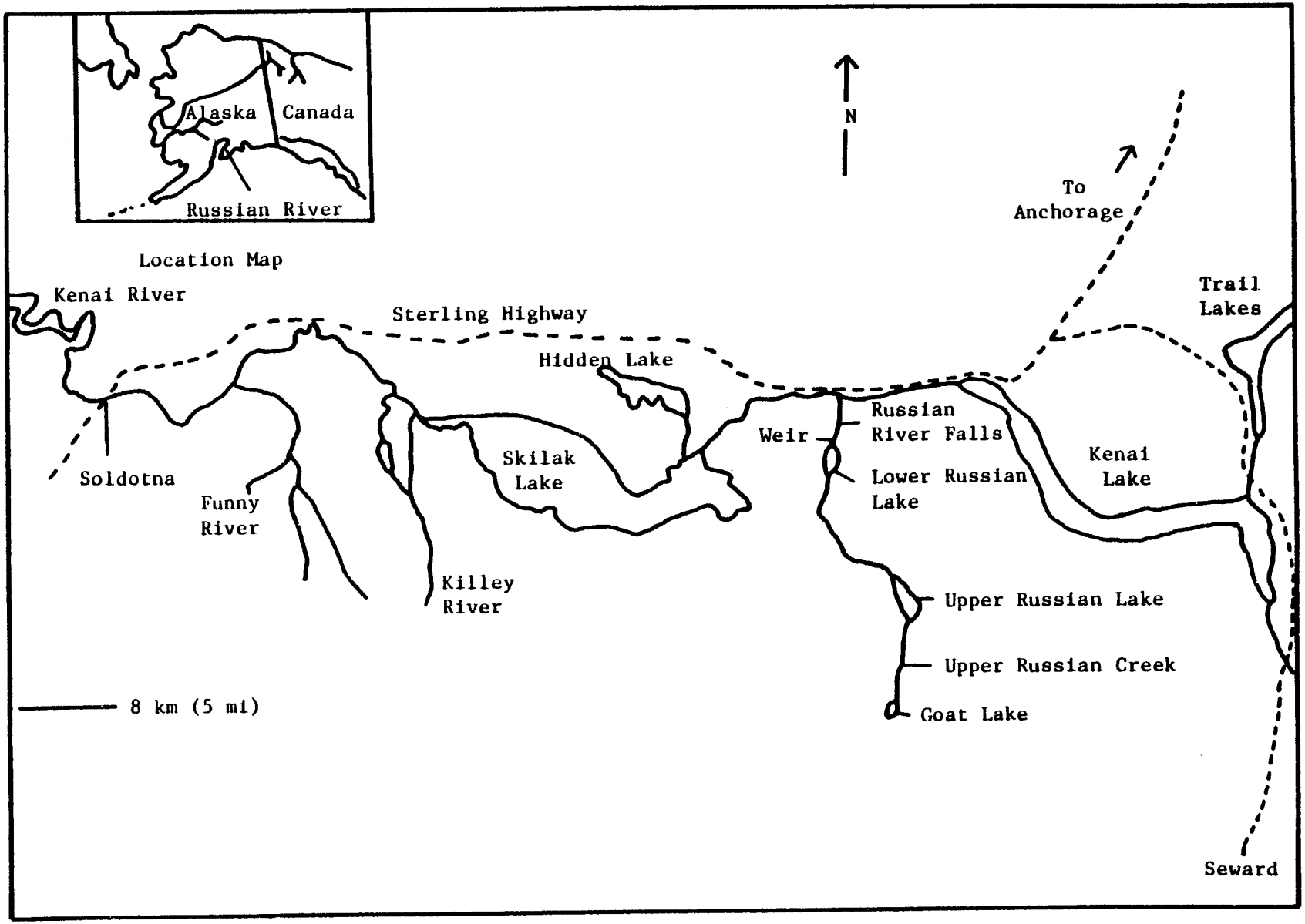

Figure 1. Schematic diagram of the Kenai River drainage.

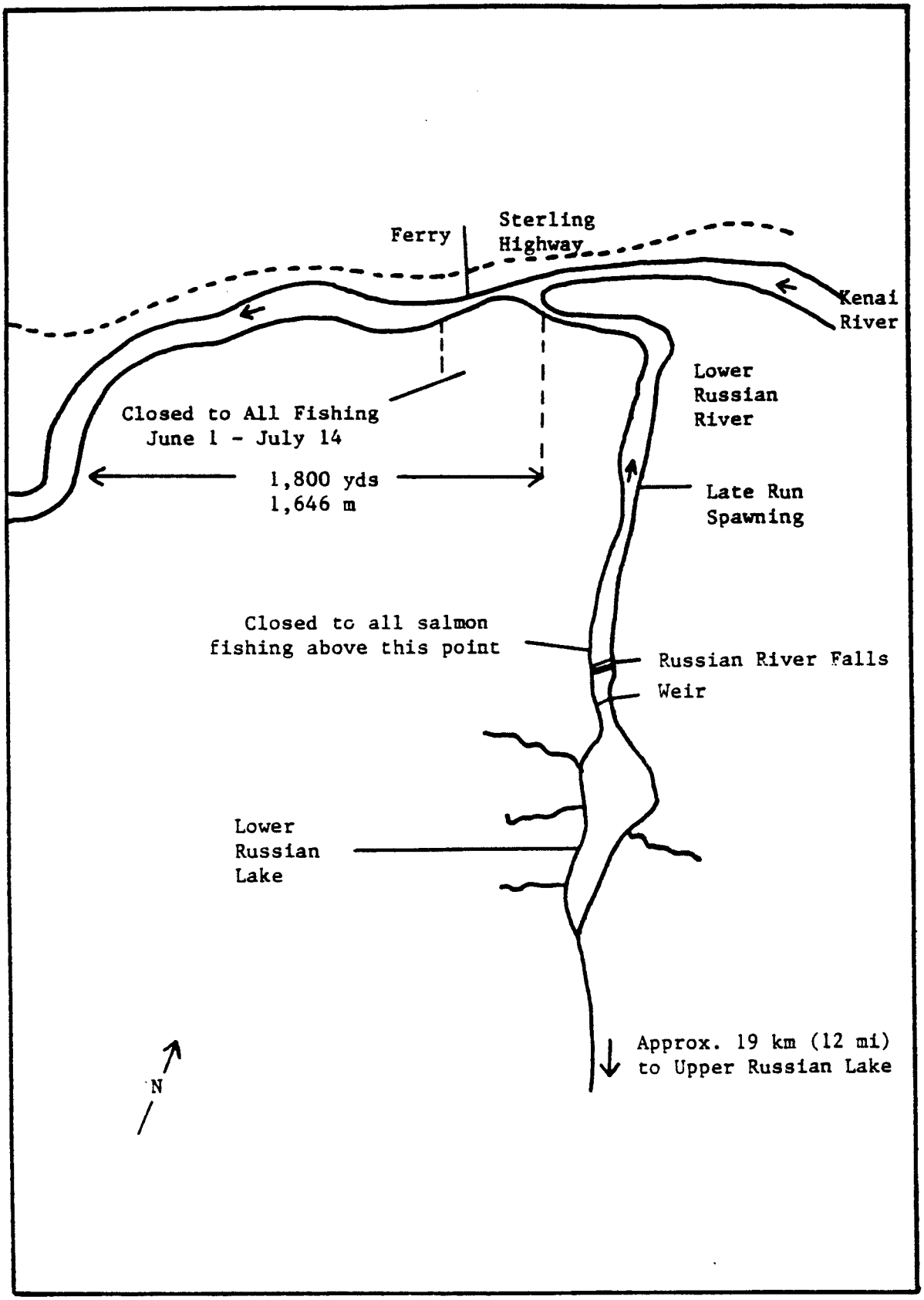

Figure 2. Schematic diagram of lower Russian River, and Kenai and Russian River confluence.

this barrier in 1971 and 1977 (Nelson 1978). In 1979 a fish pass was constructed around the falls to enable salmon to negotiate this segment of Russian River at all water levels.

Russian River sockeye salmon run is bimodal; i.e., there are two distinct runs. Early and late run total returns have averaged 29,557 and 57,422 fish, respectively, from 1963 through 1984. Migrational timing and entry into the fishery for these stocks have been previously presented (Nelson 1976, 1977). Resident and anadromous fish species present in Russian River are presented in Table 1.

Lower Russian Lake, 0.8 km (0.5 mi) above Russian River Falls, supports a Dolly Varden and rainbow trout fishery. Physical characteristics of the lake have been described by Nelson (1979). Sockeye salmon spawning in this lake is limited to less than 500 late run fish. Observations indicate Lower Russian Lake is utilized by rearing chinook and coho salmon. Chinook and coho salmon spawn in upper Russian River between Upper and Lower Russian Lakes. Coho salmon also spawn in Upper Russian Lake's tributary streams.

Upper Russian River enters Lower Russian Lake from the south and connects it with Upper Russian Lake. Nelson (1976) has presented a detailed description of this stream and the Upper Russian Lake drainage. Figure 3 depicts the Upper Russian Lake drainage and delineates the spawning areas of both early and late runs. Management and research associated with the Russian River sockeye salmon sport fishery have been conducted by the Sport Fish Division of the Alaska Department of Fish and Game (ADF&G) since 1962. Prior information pertaining to this fishery has been presented by Lawler (1963, 1964), Engel (1965-1972) and Nelson (1973-1984).

Even with a restrictive sport fishery limiting harvest methods and protecting salmon in areas where they are concentrated, recreational demands upon the Russian River sockeye salmon resource has, at times, been greater than the stocks could sustain. The Sport Fish Division has closed all or part of the fishery on 20 different occasions since 1969 to increase spawning-escapement levels. Numerous emergency openings and closings of the Russian River sockeye salmon fishery indicate it is the most intensely managed sport fishery in Alaska.

The Russian River program is currently directed toward "in season" evaluation of stock status to determine the effects and effectiveness of current regulatory practices. Research activities emphasize the collection and evaluation of life history data. Objectives include determination of optimal escapement goals for both runs and accurate predictions of sockeye salmon returns to Russian River.

RECOMMENDATIONS

1. Continue the present objectives of this study.

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

Common Name	Scientific Name and Author	Abbreviation
Sockeye salmon	*Oncorhynchus nerka* (Walbaum)	RS
Chinook salmon	*Oncorhynchus tshawytscha* (Walbaum)	KS
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Pink salmon	*Oncorhynchus gorbuscha* (Walbaum)	PS
Dolly Varden	*Salvelinus malma* (Walbaum)	DV
Rainbow trout	*Salmo gairdneri* Richardson	RT
Arctic grayling	*Thymallus arcticus* (Pallas)	GR

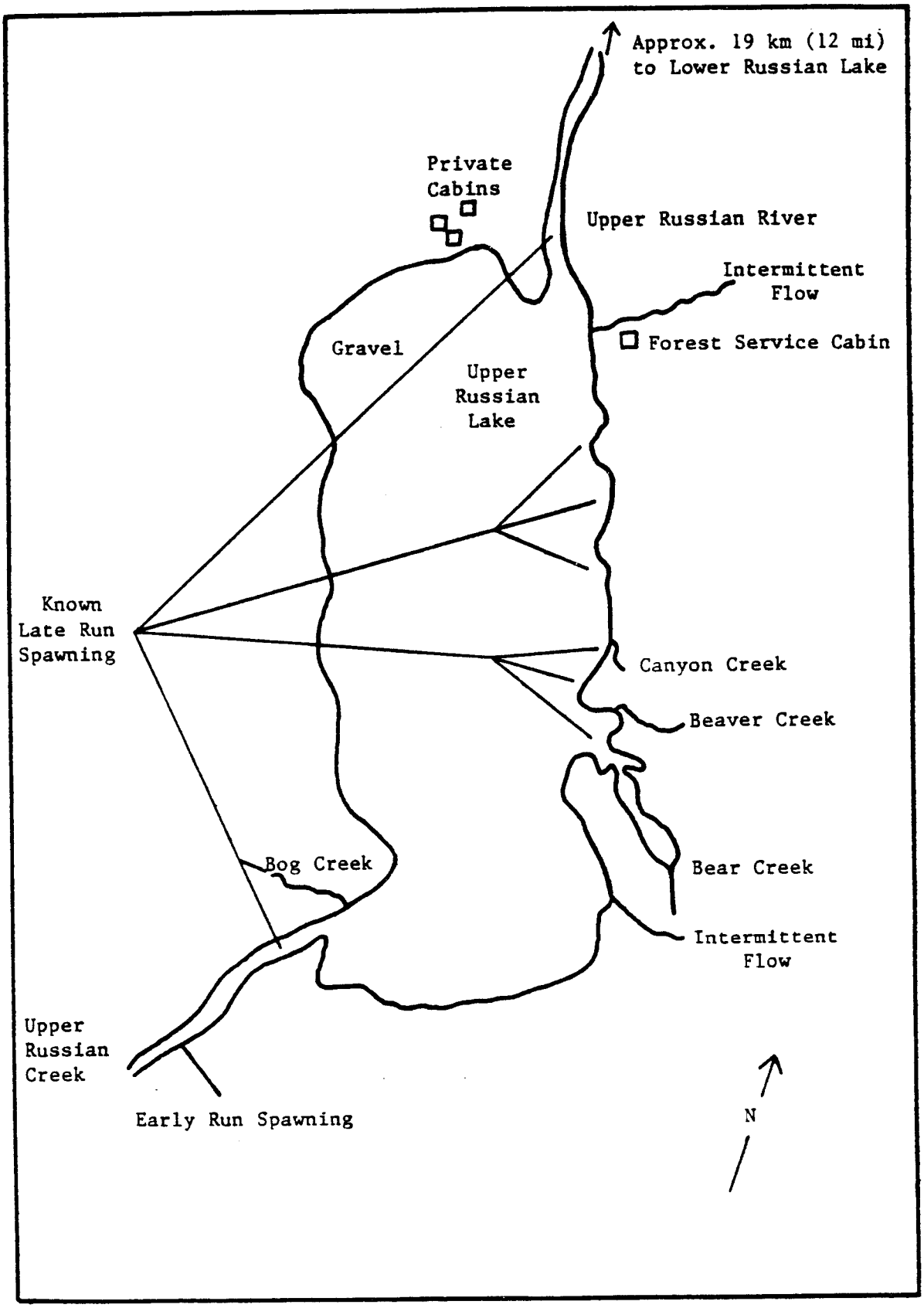

Figure 3. Schematic diagram of Upper Russian Lake.

OBJECTIVES

1. To determine adult harvest and angler-days expended to harvest sport caught early and late run Russian River sockeye salmon during June, July and August in the Russian River drainage.

2. To collect and analyze biological data concerning abundance and migrational timing of adult sockeye salmon in lower Russian River from June through early September.

3. To determine age-class composition of adult early and late run Russian River sockeye salmon escapements enumerated at Lower Russian Lake weir from June through early September.

4. To determine the fecundity of early and late run female sockeye salmon and to determine the relationship between fish length and mean number of eggs per female sockeye salmon.

TECHNIQUES USED

The 1985 Russian River creel census was a modification of the census method described by Neuhold and Lu (1957). Sampling procedures and data analyses were identical to those outlined by Engel (1965, 1970, 1972) and Nelson (1973, 1975).

Adult escapements were enumerated by weir at the outlet of Lower Russian Lake. The present structure built in June 1975 replaced an earlier temporary weir described by Engel (1970) that had been employed since 1969. Nelson (1976) has presented a detailed description of the present structure.

Fecundities of late run sockeye salmon were determined by random sampling at Lower Russian Lake weir. Sampling technique and analyses have been presented (Nelson 1981).

Scale samples were collected at Lower Russian Lake weir to determine the age structure of the respective runs. Age designation and methods to determine the adult-age structure and male-to-female sex ratio have been presented (Nelson 1978).

Potential egg deposition from the early run spawning escapement in Upper Russian Creek was determined by applying criteria previously described (Nelson 1976).

Water and air temperatures at Lower Russian Lake weir were determined by Taylor maximum-minimum thermometer. Precipitation was ascertained by a gauge of standard manufacture. Russian River velocity was determined by the head-rod method as previously described by Nelson (1977). Velocity of Rendezvous Creek, a tributary to Russian River upstream from Russian River Falls, was determined in a like manner.

FINDINGS

Creel Census

As noted, Russian River sockeye salmon runs are bimodal. In some years the sport fishery is continuous as the latter segment of the early run is present when the late run enters the fishery; however, this did not occur from 1981 to 1984 (Nelson 1984) nor in 1985. In 1985 the early run migration through the fishery had been completed by July 11. The late run did not enter Russian River until July 19; therefore, no creel census was conducted from July 11 through July 18.

The census revealed anglers expended 50,770 angler-days of effort during the 1985 sockeye salmon season (June 13-August 16). Effort directed toward early and late runs was estimated at 16,140 and 34,630 angler-days, respectively. Angler participation in 1985 was 66.4% greater than the historical mean angler participation of 30,508 angler-days. Late run effort established a new record, while early run effort was below the historical mean because of a 4.5-day fishing closure.

Based on interviews with 2,681 anglers who reported harvesting 3,449 sockeye salmon, total harvest was estimated at 70,710 fish. Early and late runs contributed 12,300 and 58,410 salmon, respectively, to this harvest. The 1985 catch exceeds the 1978 record harvest of 62,250; this is primarily due to the late run harvest that nearly doubled the previous record of 33,490 fish (1980).

Mean hourly catch rates were higher on weekdays (0.311) than on weekends (0.267) because of greater angler congestion on weekends that reduced individual angler efficiency. Seasonal catch per hour was 0.286 fish, which is the highest recorded at the Russian River since 1964. Early run anglers experienced slightly below average fishing conditions, while late run anglers experienced some of the highest daily catch rates ever recorded at the Russian River. Table 2 summarizes historical harvests, efforts, and catch-per-hour estimates since 1963.

Weekday and weekend total stream counts during the 1985 fishery averaged 226.7 and 291.1 anglers, respectively. Both counts are indicative of crowded conditions and are well above historical means. However, the mean total stream counts in more recent years (1977-1984) are 228.7 for weekdays and 346.3 for weekends. Anglers in 1985 experienced less crowding than the recent years' average. This decline is attributed to reduced numbers of early run fish.

Sockeye salmon were available to sport anglers for 54 days in 1985. Average daily angler effort exceeded 940 angler-days. Anglers harvested an average of 1,309 fish daily. These data attest to the high degree of interest in the fishery and the relatively high efficiency of Russian River sockeye salmon anglers who harvested 1.4 sockeye salmon for each angler-day of effort expended.

Anglers fished an average of 4.4 hours per day on weekdays and 4.6 hours on weekends (Table 3). The weekday figure is identical to the historical mean, while the weekend figure is slightly less. Stream counts

Table 2. Estimated Sockeye Salmon Harvests, Efforts and Success Rates on Russian River, 1963-1985.

Year	Harvest			Total Effort (Man-Days)	Catch/ Hour	Census Period
	Early Run	Late Run	Total			
1963	3,670	1,390	5,060	7,880	0.190	6/08-8/15
1964	3,550	2,450	6,000	5,330	0.321	6/08-8/16
1965	10,030	2,160	12,190	9,720	0.265	6/15-8/15
1966	14,950	7,290	22,240	18,280	0.242	6/15-8/15
1967	7,240	5,720	12,960	16,960	0.141	6/10-8/15
1968	6,920	5,820	12,740	17,280	0.134	6/10-8/15
1969	5,870	1,150	7,020	14,930	0.094	6/07-8/15
1970	5,750	600	6,350	10,700	0.124	6/11-8/15*
1971	2,810	10,730	13,540	15,120	0.192	6/17-8/21*
1972	5,040	16,050	21,090	25,700	0.195	6/17-8/21
1973	6,740	8,930	15,670	30,690	0.102	6/08-8/19*
1974	6,440	8,500	14,940	21,120	0.131	6/08-7/30*
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*
1977	20,400	27,440	47,840	69,510	0.168	6/18-8/17
1978	37,720	24,530	62,250	69,860	0.203	6/07-8/09
1979	8,400	26,830	35,230	55,000	0.136	6/09-8/20*
1980	27,220	33,490	60,710	56,330	0.243	6/13-8/20
1981	10,720	23,720	34,440	51,030	0.156	6/09-8/20
1982	34,500	10,320	44,820	51,480	0.201	6/11-8/04**
1983	8,360	16,000	24,360	31,890	0.117	6/08-8/04**
1984	35,880	21,970	57,850	49,550	0.238	6/09-8/19**
Mean	12,136	12,599	24,735	30,508	0.177	
1985	12,300	58,410	70,710	50,770	0.286	6/13-8/16**

* Census period was not continuous during these years due to emergency closures required to increase spawning escapement levels.

** Census period was not continuous during these years due to negligible fishing effort after completion of the early run and prior to the arrival of the late run.

Table 3. Difference Between Weekday and Weekend Fishing Pressure and Rates of Success at Russian River, 1964-1985.

Year	Mean Angler Counts		Catch/Hour		Mean Hours Fished	
	Weekdays	Weekends	Weekdays	Weekends	Weekdays	Weekends
1964	29.6	70.6	0.444	0.209	3.3	3.9
1965	31.7	78.1	0.305	0.223	4.5	5.4
1966	53.2	143.1	0.297	0.183	4.8	5.5
1967	68.9	110.5	0.171	0.100	5.3	5.4
1968	71.5	124.9	0.153	0.107	5.3	5.8
1969	64.5	111.7	0.110	0.074	4.9	5.1
1970	83.5	127.8	0.140	0.100	4.8	4.7
1971	87.9	157.2	0.194	0.189	4.8	5.3
1972	73.3	138.5	0.203	0.187	4.0	4.4
1973	147.1	195.0	0.113	0.088	4.8	5.5
1974	123.8	144.4	0.164	0.085	4.7	5.7
1975	65.0	149.6	0.145	0.136	4.5	5.1
1976	72.5	134.4	0.165	0.161	3.5	4.5
1977	201.7	438.6	0.172	0.164	3.9	4.3
1978	264.1	425.7	0.205	0.191	3.9	4.2
1979	190.6	276.8	0.158	0.117	3.8	3.9
1980	299.1	317.8	0.270	0.210	4.2	4.7
1981	195.6	238.5	0.167	0.141	4.1	4.1
1982	256.0	423.4	0.210	0.194	4.3	4.5
1983	205.1	307.6	0.208	0.151	4.6	4.6
1984	217.1	342.3	0.261	0.211	4.8	4.7
Mean	133.4	212.2	0.203	0.153	4.4	4.8
1985	226.9	291.1	0.311	0.267	4.4	4.6

revealed effort was concentrated at the confluence of the Kenai and Russian Rivers as 61.4% and 62.9% of anglers fished that area during the early and late runs, respectively. Anglers harvested 28.7% of the early run stock that returned to Russian River and 29.9% of the late run. The fishery was closed by emergency order for 4.5 days during the midpoint of the early run. At that time anglers were experiencing high catch rates, while escapement was lagging below desired levels. Had run dynamics not dictated the closure of the early run, the exploitation rate would probably have exceeded 35%.

Nelson (1982) indicated angler effort would be directed toward the more numerous stocks rather than toward the early or late runs. This was true in 1985; total early and late run returns to Russian River were 42,910 and 195,380 salmon, respectively. The early run received 31.8% of the seasonal effort and the late run 68.2% (Table 4).

In 1977 the Sport Fish Division initiated a statewide harvest survey. It is from this survey that harvest estimates for species other than sockeye salmon are derived for Russian River (Nelson 1982). Although harvest estimates for these species are not included as an objective of the Russian River study, the results of the survey, as they relate to Russian River, are summarized in Table 5 to maintain the continuity of the Sport Fish Division's research and management efforts on this popular Alaskan stream.

The 1984 rainbow trout harvest is the lowest on record. The Dolly Varden catch of 1,072 fish is almost 50% below the mean but nearly double what it was in 1983. A record 2,432 coho salmon were caught, while the pink salmon catch (461) was below what had previously been reported during even years. Arctic grayling are not common in the Russian River, and the 1984 catch of 50 fish is above the mean.

Nelson (1983) reviewed the Russian River rainbow trout fishery from the late 1930s to present. Available information from federal records indicated that as early as 1940 the population was beginning to decline. Under state management, several restrictive regulatory actions were promulgated in an effort to restore the population to former levels. There is no information regarding this stream's rainbow trout fishery from the early 1940s until the initiation of the statewide harvest survey in 1977.

The harvest survey revealed the catch of this species increased from 1977 through 1979 and then began to decline. A harvest of only 462 fish in 1983 represents the fourth year of decreased catches. Angler preference, water levels, availability of sockeye salmon, etc., undoubtedly influence the numbers of rainbow trout harvested. However, 4 years of declining catches strongly suggest a declining population. In 1983 the Alaska Board of Fisheries recognized the possible decline exhibited by this species in Russian River. To provide additional protection to these fish, that area from the confluence of the Kenai and Russian Rivers upstream to Lower Russian Lake and the stream between Upper and Lower Russian Lakes was designated a "hook-and-release" area for rainbow trout. Beginning in 1984, retention of this species has been prohibited in these areas. The reduced 1984 catch was therefore anticipated.

Table 4. Angler Effort Directed Toward Early and Late Run Russian River Sockeye Salmon Stocks, 1963-1985.

Year	Effort (Angler-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	31.6	68.4
1976	8,930	17,380	33.9	66.1
1977	38,200	31,310	55.0	45.0
1978	51,910	17,950	74.3	25.7
1979	25,670	29,330	46.7	53.3
1980	31,430	24,900	55.8	44.2
1981	24,780	26,250	48.6	51.4
1982	39,000	12,480	75.8	24.2
1983	18,560	13,330	58.2	41.8
1984	29,230	20,320	59.0	41.0
Mean	17,839	12,669	60.5	39.5
1985	16,140	34,630	31.8	68.2

* Angler-day is one angler fishing during one day irrespective of the number of hours fished.

Table 5. Estimated Russian River Harvest of Rainbow Trout, Dolly Varden, Coho Salmon, Pink Salmon and Arctic Grayling as Determined by Alaska Statewide Harvest Survey, 1977-1984.

Year	Species				
	Rainbow Trout	Dolly Varden	Coho Salmon	Pink Salmon	Arctic Grayling
1977	769	914	1,472	37	37
1978	2,423	2,588	1,466	1,300	18
1979	3,109	3,718	1,098	0	9
1980	2,566	2,256	1,025	930	69
1981	1,437	2,905	346	0	119
1982	1,077	1,730	1,275	1,142	34
1983	462	587	1,490	52	10
Mean	1,692	2,100	1,167	494	42
1984*	324	1,072	2,432	461	50

* Only hook-and-release fishing was permitted for this species in certain areas of Russian River drainage. Data are not comparable to prior years.

Dolly Varden in Russian River are second in abundance only to sockeye salmon. The 1984 harvest of 1,072 fish is well below the mean historical catch of 2,100 fish, but it is a significant increase over the 1983 harvest. As with rainbow trout, variables other than population size undoubtedly affect the magnitude of the catch. A conclusion regarding the Russian River's Dolly Varden population must, therefore, be deferred until more definitive data become available.

Escapement

The weir at the outlet of Lower Russian Lake was operational on June 10. The first early run sockeye salmon was passed on June 14, 3 days prior to the mean historical (1960-1984) arrival of June 17. Fifty percent of the early run was enumerated by July 6; passage of this run was complete by July 18 (Table 6).

Early run spawning escapement was 30,610 fish. This is the tenth consecutive year the early run minimal spawning-escapement goal of 9,000 has been exceeded (Table 7). Total early run return (harvest plus escapement) was 42,910.

Late run fish began to pass the weir on July 19. Fifty percent of the spawning escapement had passed the structure by August 7. Late run migration was complete when the weir was removed on September 11.

Escapement of late run fish to the Upper Russian Lake drainage was 136,970. This is the highest escapement to pass the weir since escapement enumeration began in 1963. An additional 8,650 late run fish spawned below Russian River Falls. Total late run sockeye salmon spawning in Russian River drainage was 145,620 fish, representing more than 2.5 times the historical mean total escapement of 56,209 fish (Table 8).

Chinook salmon escapement through the weir was 189 fish in 1985; an additional 93 chinook salmon spawned in lower Russian River. The total spawning escapement of 282 is 43 fish greater than historical mean escapement (239) for this species. Coho salmon escapement was 2,000 fish, which is greater than the historical mean of 1,907 fish. Russian River chinook and coho salmon escapements are summarized in Table 9.

Relationship of Jacks to Adults

Jack (precocial male) sockeye salmon are generally not associated with the early run. While they have been observed in 7 of 14 years prior to 1985 (Nelson 1985), they comprised an insignificant part of those runs. Early run jacks in 1985 totaled four fish. Jacks are more numerous during the late run and have comprised from 0.2% to 8.7% of the total late run escapement. In 1985, 1,905 jacks were enumerated, comprising 1.0% of the total late run return to Upper Russian Lake drainage (Table 10).

Nelson (1977) suggested a relationship may exist between numbers of jacks in the late run and the magnitude of the late run return to Russian River the succeeding year. It is not always a definitive

Table 6. Arrival Date, Date Fifty Percent of the Escapement had Passed Russian River Weir/ Counting Tower and Termination Date of Early and Late Russian River Sockeye Salmon Runs, 1960-1985*.

Year	Early Run			Late Run		
	Arrival at Weir/Tower	Date 50% Passed	Date Run Ended	Arrival at Weir/Tower	Date 50% Passed	Date Run Ended**
1960	June 19	June 26	July 15	July 16	Aug. 1	Aug. 12
1961	June 21	June 28	July 15	July 16	July 31	Aug. 28
1962	June 18	July 4	July 15	July 16	July 30	Aug. 31
1963	June 18	July 1	July 12	July 16	July 31	Aug. 23
1964	June 20	July 7	July 15	July 16	July 30	Aug. 15
1965	June 22	July 4	July 15	July 16	Aug. 5	Aug. 15
1966	June 20	June 29	July 15	July 19	July 30	Aug. 17
1967	June 20	June 28	July 15	July 19	Aug. 2	Aug. 18
1968	June 25	June 29	July 13	July 19	July 31	Aug. 14
1969	...	...	...	July 16	Aug. 2	Aug. 18
1970	June 17	July 5	July 15	July 16	Aug. 7	Aug. 23
1972	June 24	July 5	July 29	July 30	Aug. 5	Aug. 28
1973	June 21	July 6	July 15	July 16	Aug. 1	Aug. 30
1974	June 14	July 1	July 21	July 22	Aug. 7	Aug. 27
1975	June 25	July 6	July 27	July 21	Aug. 6	Sept. 1
1976	June 17	June 30	July 16	July 17	Aug. 2	Sept. 1
1978	June 10	July 2	July 24	July 25	July 30	Sept. 1
1979	June 8	June 27	July 15	July 16	July 29	Sept. 2
1980	June 14	June 29	July 20	July 21	July 30	Sept. 6
1981	June 12	June 25	July 17	July 18	July 28	Sept. 6
1982	June 11	July 3	July 23	July 24	Aug. 4	Sept.14
1983	June 12	July 1	July 25	July 26	Aug. 6	Sept. 6
1984	June 9	June 25	July 16	July 17	Aug. 4	Sept. 9
1960-84 Mean	June 17	July 1	July 18	July 19	Aug. 2	Aug. 27
1969-84 Mean***	June 15	July 1	July 20	July 20	Aug. 3	Sept. 1
1985	June 14	July 6	July 18	July 19	Aug. 7	Sept.11

* Data from 1971 and 1977 are not included due to a velocity barrier at Russian River Falls which resulted in atypical migrational timing.

** Date run ended or escapement enumeration discontinued for the season.

*** Years of weir operation.

Table 7. Russian River Sockeye Salmon Escapement and Sport Harvest Rates for Early and Late Runs, 1963-1985.

Year	Escapement*			Percentage of Total Return** Caught by the Sport Fishery		
	Early Run	Late Run	Total	Early Run	Late Run	Total
1963	14,380	51,120	65,500	20.3	2.0	7.2
1964	12,700	46,930	59,630	21.8	5.0	9.6
1965	21,710	21,820	43,530	31.8	9.0	21.6
1966	16,660	34,430	51,090	47.3	17.5	30.3
1967	13,710	49,480	63,190	34.6	10.3	17.0
1968	9,200	48,880	58,080	42.9	10.6	18.0
1969	5,000	28,920	33,920	54.0	3.8	17.1
1970	5,450	28,200	33,650	51.3	2.1	15.9
1971	2,650	54,430	57,080	51.5	16.4	19.2
1972	9,270	79,000	88,270	35.2	16.8	19.3
1973	13,120	24,970	38,090	33.9	26.3	29.1
1974	13,150	24,650	37,800	32.9	25.6	28.3
1975	5,640	31,970	37,610	19.9	20.8	20.7
1976	14,700	31,950	46,650	18.7	30.0	26.8
1977	16,070	21,410	37,480	55.9	56.2	56.1
1978	34,150	34,230	68,380	52.5	41.7	47.7
1979	19,700	87,920	107,620	29.9	23.4	24.7
1980	28,670	83,980	112,650	48.7	29.7	35.0
1981	21,140	44,530	65,670	33.6	34.7	34.4
1982	56,080	30,630	86,710	38.1	25.2	34.1
1983	21,200	34,000	55,200	28.3	32.0	30.6
1984	28,910	92,660	121,570	55.4	19.2	32.2
Mean	17,421	44,823	62,244	38.1	20.8	26.1
1985	30,610	136,970	167,580	28.7	29.9	29.7

* Escapement past weir. Sockeye salmon spawning below Russian River Falls are not included.

** Escapement plus sport harvest.

Table 8. Late Run Sockeye Salmon Spawning in the Russian River Drainage Upstream and Downstream From Russian River Falls, 1968-1985.

Year	Weir Count Above Falls	Stream Count Below Falls	Total Spawning Sockeye	Percent Spawning Below Falls
1968	48,800	4,200	53,000	7.9
1969	28,920	1,100	30,020	3.7
1970	28,200	220	28,420	0.8
1971	54,430	10,000	64,430	15.5
1972	79,000	6,000	85,000	7.1
1973	24,970	6,690	31,660	21.1
1974	24,650	2,210	26,860	8.2
1975	31,970	690	32,660	2.1
1976	31,950	3,470	35,420	9.8
1977	21,410	17,090	38,500	44.4
1978	34,230	18,330	52,560	34.9
1979	87,920	3,920	91,840	4.3
1980	83,980	3,220	87,200	3.7
1981	44,530	4,160	48,690	8.5
1982	30,630	45,000	75,630	59.5
1983	34,000	44,000	78,000	56.4
1984	92,660	3,000	95,660	3.1
Mean	46,015	10,194	56,209	17.1
1985	136,970	8,650	145,620	5.9

Table 9. Estimated Coho and Chinook Salmon Spawning Escapements in Russian River Drainage, 1953-1985.

Year	Weir/Counting Tower Escapements		Lower River Escapement*	Total Escapement	
	Chinook	Coho	Chinook	Chinook	Coho
1953			85**		
1954			87**		
1955			42**		
1956			40**		
1957			44**		
1958			98**		
1966			182		
1967			126		
1968	56		63	119	
1969	119	70	31	150	70
1970	240	957	125	365	957
1971	21	839	149	170	839
1972	172	666	108	280	666
1973	243	200	104	347	200
1974	124	1,508	59	183	1,508
1975	102	4,000	32	134	4,000
1976	145	1,791	155	300	1,791
1977	37	1,884	145	182	1,884
1978	253	1,570	165	418	1,570
1979	280	2,400	82	362	2,400
1980	185	3,189	65	250	3,189
1981	30	4,679	91	121	4,679
1982	68	2,291	35	103	2,291
1983	52	475	130	182	475
1984	270	4,000	120	390	4,000
Mean	141	1,907	95	239	1,907
1985	189	2,000	93	282	2,000

* Coho salmon do not spawn in lower Russian River.
** U.S. Fish and Wildlife Service data.

Table 10. Late Run Russian River Sockeye Salmon Harvest, Escapement and Returning Jacks, 1969-1985.

Year	Escapement*	Sport Harvest	Total Return**	Number of Jacks	Percent of Total Return
1969	28,920	1,150	30,070	352	1.2
1970	28,200	600	28,800	2,542	8.8
1971	54,430	10,730	65,160***	1,429	2.2
1972	79,000	16,050	95,050	160	0.2
1973	24,970	8,930	33,900	332	1.0
1974	24,650	8,500	33,150	1,008	3.0
1975	31,970	8,390	40,360	1,788	4.4
1976	31,950	13,700	45,650	1,204	2.6
1977	21,410	27,440	48,850	537	1.1
1978	34,230	24,530	58,760	2,874	4.9
1979	87,920	26,830	114,750	1,476	1.3
1980	83,980	33,490	117,470	1,533	1.3
1981	44,530	23,720	68,250	2,634	3.9
1982	30,630	10,320	40,950	1,777	4.3
1983	34,000	16,000	50,000	4,360	8.7
1984	92,660	21,970	114,630	3,450	3.0
Mean	45,841	15,772	61,613	1,716	3.2
1985	136,970	58,410	195,380	1,905	1.0

* Escapement past the weir. Sockeye salmon spawning below Russian River Falls are not considered.

** Escapement plus sport harvest.

*** Excludes an estimated 10,000 late run sockeye salmon which perished downstream from Russian River Falls due to a velocity barrier.

indication of return, however, because the percentage of the late run harvested commercially in Cook Inlet is subject to annual variation. Nelson (1985) concluded that a relationship exists between jacks and total production (commercial harvest plus total return to Russian River) the following year. Data suggests that a small return of jacks indicates of a less than average total production; the converse also applies. In support of this premise, the 1984 jack return of 3,450 fish was twice the historical mean; total Russian River production in 1985 was over 800,000 fish, which is four times the historical mean.

Table 11 compares the migrational timing of late run adults to jacks. Fifty percent of the adult escapement historically passes the weir by August 3, while 50% of the jack escapement is not enumerated until August 15, 12 days later than the adults. In 1985 the timing disparity was 11 days.

This timing differential may be a genetic trait related to environmental parameters or a combination thereof (Nelson 1976). Water velocities through Russian River Falls usually decrease during the latter part of the late run migration and may facilitate the movement of smaller jacks through the falls. Larger adults may be more readily capable of negotiating the falls at greater velocities and, therefore, arrive earlier at the weir. Russian River was atypically high in 1980 and 1981, which may account for the above average timing differential in those years. Water velocity in 1985 was above the historical mean, and timing differential at 11 days approximated the historical 12 days.

Migrational Rates in the Kenai River

Migrational rates of Russian River stocks within the Kenai River are limited to isolated tagging studies and a comparison of sonar counts to escapements enumerated at Russian River weir. Tagging studies have been reviewed by Nelson (1977).

A sonar counter is located 1.6 km (1 mi) downstream from the Kenai River Bridge in Soldotna. This enumeration device is operated by the Commercial Fish Division of ADF&G. Its primary function is to ascertain the spawning escapement of late run Kenai River sockeye salmon, but it was employed in 1978, 1979 and 1981 to determine the magnitude of the early run Kenai River sockeye salmon return. Available data indicate this stock is of Russian River origin. Comparing sonar counts to weir escapement data, Nelson (1982) concluded early run Russian River fish migrated 3.2 km (2 mi) to 5.1 km (3.2 mi) per day.

Late run sockeye salmon sonar counts in the Kenai River, Russian River late run escapements and travel time between sonar counter and Russian River weir are presented in Table 12. Elapsed time between these two points from 1969-1984 ranged from 10 to 34 days, averaging 14.9 days. Eliminating the 1969 and 1974 extremes, which appear to be atypical, decreases this range to between 10 and 18 days. The late run migrational rate would, therefore, be 5.2 km (3.2 mi) to 9.3 km (5.8 mi) per day. It required 13 days for late run fish in 1985 to traverse the 93.5 km (58 mi) between sonar site and weir, or 7.2 km (4.5 mi) per day. In most years late run fish, therefore, migrate more rapidly through the

Table 11. Migrational Timing of the Late Run Russian River Sockeye Salmon Jack Escapement Compared to the Migrational Timing of the Adult Escapement, 1970-1985*.

Year	Jack Escapement	Date 50% Passed Weir	Adult Escapement**	Date 50% Passed Weir	Timing Differential (Days)
1970	2,542	Aug. 10	25,658	Aug. 7	3
1972	160	Aug. 10	78,840	Aug. 4	6
1973	332	Aug. 6	24,638	July 31	6
1974	1,008	Aug. 12	23,642	Aug. 6	6
1975	1,788	Aug. 16	30,182	Aug. 5	11
1976	1,204	Aug. 18	30,746	Aug. 2	16
1978	2,874	Aug. 18	31,356	Aug. 2	16
1979	1,476	Aug. 15	86,444	July 29	17
1980	1,533	Aug. 19	82,447	July 30	20
1981	2,634	Aug. 22	41,896	July 28	25
1982	1,777	Aug. 19	28,853	Aug. 4	15
1983	4,360	Aug. 16	29,640	Aug. 5	11
1984	3,450	Aug. 11	89,210	Aug. 5	7
Mean	1,934	Aug. 15	46,427	Aug. 3	12
1985	1,905	Aug. 18	135,064	Aug. 7	11

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

** Escapement past the weir only. Sockeye salmon spawning below Russian River Falls are not considered.

Table 12. Kenai River Sockeye Salmon Sonar Counts Compared to Russian River Late Run Sockeye Salmon Escapements and Period of Travel Between Sonar Site and Russian River Weir, 1968-1985*.

Year	Sonar Count	Date 50% Passed	Russian River Escapement**	Date 50% Passed	Sonar to Weir (Days)
1968	88,000	July 19	48,800	July 30	11
1969	53,000	June 30	28,920	Aug. 2	34
1970	73,000	July 25	28,200	Aug. 6	13
1972	318,000	July 24	79,000	Aug. 4	12
1973	367,000	July 22	24,970	July 31	10
1974	161,000	July 17	24,650	Aug. 6	23
1975	142,000	July 24	31,970	Aug. 5	13
1976	380,000	July 20	31,950	Aug. 2	13
1978	398,900	July 18	34,230	July 30	12
1979	285,020	July 19	87,920	July 29	10
1980	464,040	July 19	83,980	July 30	11
1981	407,640	July 14	44,530	July 28	14
1982	619,830	July 2	30,630	Aug. 4	15
1983	630,340	July 19	34,000	Aug. 6	18
1984	344,570	July 21	92,660	Aug. 4	15
Mean	315,489	July 21	47,094	Aug. 2	15
1985	502,820	July 25	136,970	Aug. 7	13

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

** Escapement past the weir only. Sockeye salmon spawning downstream from Russian River Falls are not considered.

Kenai River than do early run fish. Reasons for these differing migrational rates are not known.

Russian River Falls and Fish Pass

The fish pass at Russian River Falls was constructed during the winter of 1978-1979 and employed for the first time on a limited basis during the 1979 season. At that time Nelson (1980) concluded that, given an option at normal water flows, sockeye salmon would ascend the falls rather than utilize the fish pass. During high water in 1980, migrational rate through the structure was 510 fish/hour (Nelson 1981). Nelson also indicated operation or inoperation of the facility during high water years could be used to increase or decrease the rate of migration. During these times the fish pass would be utilized as a management tool, as the migrational rate of the stocks affect the degree to which the recreational angler is capable of exploiting the resource.

Figure 4 indicates Russian River discharge was above historical flow rates during both the early and late run migration. Discharge was still considered "moderate" during most of this time period, although it reached what is considered a "high" discharge rate twice in early July. Nelson (1978) indicated that velocities of approximately 400 cfs present a barrier to or decrease in the migrational rate. On July 1 and July 6, discharge rates over Russian River Falls exceeded 400 cfs. The fish pass was operational for 16 continuous hours on July 1 through July 2. It was reopened from July 6 to July 12 for 154 hours. In August the discharge rate dropped below 200 cfs, and the fish pass was opened from August 16 to August 26 to evaluate fish-pass usage during low water conditions.

During the periods of fish pass operation, observations were made to determine salmon passage rates through the structure. During the 16-hour opening starting July 1, the mean of two similar observations showed that 193 fish/hour were utilizing the fish pass. The second opening revealed passage rates ranging from 8 to 412 fish/hour; the mean was 108 fish/hour. Passage rates declined as water velocity decreased. The fish pass was not closed until discharge had dropped below 350 cfs. The August opening revealed passage rates ranging from 4 to 132 fish/hour; the mean was 55 fish/hour.

The passage rate through the weir was greater than through the fish pass during all three openings. Although not definitive, these data, along with the observations of the weir operator, tend to support Nelson's (1978) conclusion that a discharge of 400 cfs will present a barrier to or decrease in the migrational rate. Data and observations from 1985 also tend to support Nelson's (1980) conclusion that, given an option at normal water flows, sockeye salmon will ascend the falls rather than utilize the fish pass.

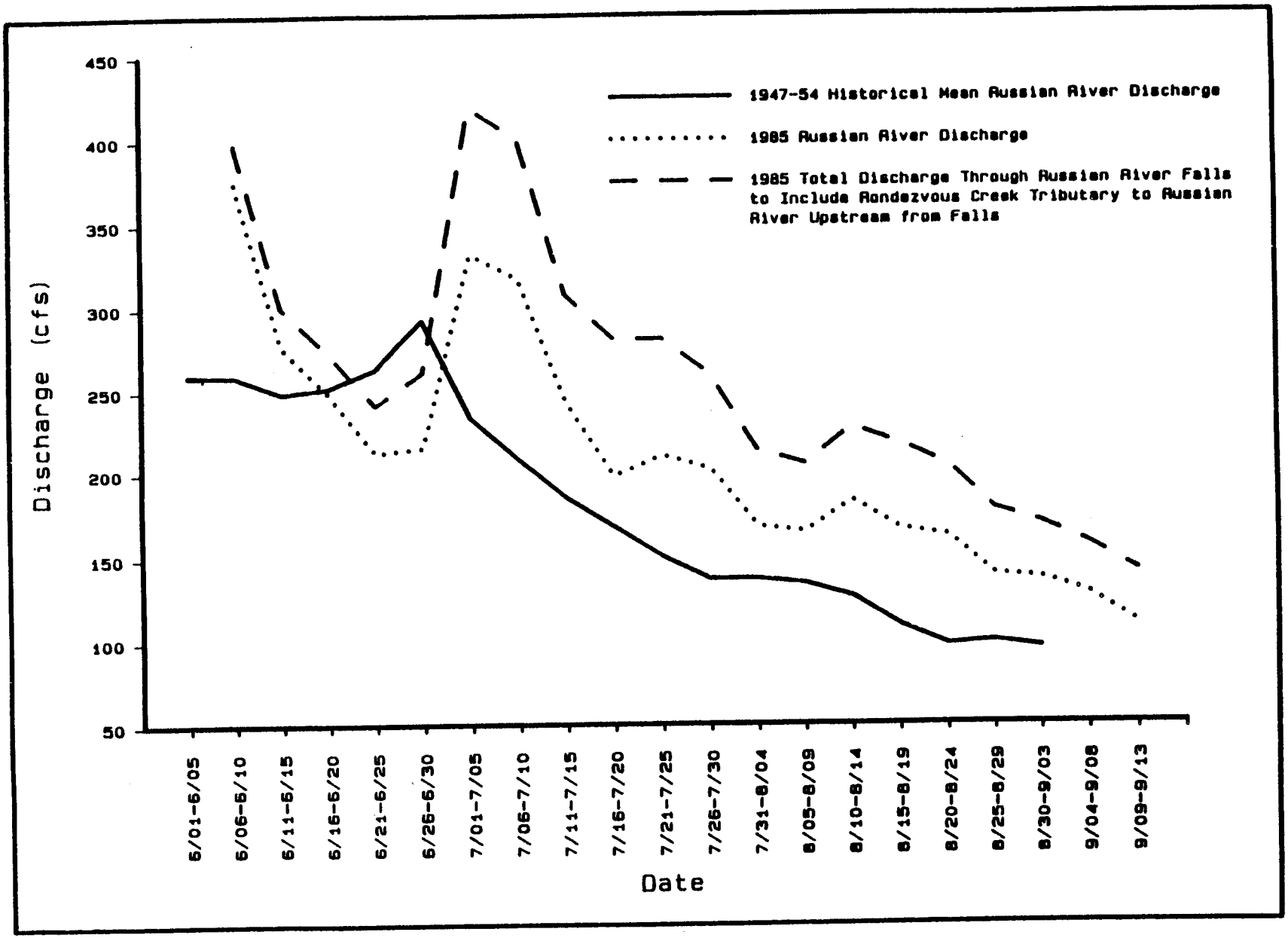

Figure 4. Mean (8 year) Russian River discharge rates by 5-day mean recorded by United States Geological Survey from 1947 through 1954 compared to 1985 discharge rates.

Management of the 1985 Fishery

Early Run:

The early run arrived at the confluence of the Kenai and Russian Rivers in harvestable numbers on June 15. Catch rates were initially low as fish gradually entered the sanctuary area. By June 24 there were an estimated 5,000 sockeye salmon holding in the sanctuary area, and anglers were enjoying high catch rates that exceeded 0.20 fish per hour. These high success rates continued through June 27, with fishing effort confined primarily to the area below the sanctuary. Virtually no fish were observed in the clear waters of the Russian River, and weir counts were below historical averages for this date; i.e., June 27.

The first fish passed Russian River weir on June 14; there was a cumulative escapement of 172 by June 23. Escapement levels were unchanged through June 27. Based on prior passage rates, the escapement on this date should have been 2,712 (30.1% of the escapement) to achieve the minimal escapement goal of 9,000. The staff concluded that run timing was later than normal because the Kenai Peninsula was experiencing a later than average summer season, with other area salmon runs displaying late migrational timing. However, a critical review of management criteria revealed:

1. There were no concentrations of fish below the weir, in the falls, or in lower Russian River.

2. Only 6,000 to 7,000 fish were estimated to be concentrated in the sanctuary.

3. An aerial survey on June 26 revealed no concentration of fish from the Moose River upstream to the powerline below Russian River.

Based on these observations the fishery was closed on Friday, June 28 at 12:01 a.m.

Observations on the evening of June 30 indicated the majority of fish had migrated from the sanctuary. Escapement had increased to 2,797 on June 30 and to 6,691 by July 1; additional concentrations of fish had been observed below the weir and throughout Russian River. This movement of sockeye salmon from the sanctuary area coincided with a doubling of flow rates and an increase in water temperature of 4°F between June 27 and July 1. With the minimal escapement assured, the Russian River was reopened to sockeye salmon fishing by emergency order at 12:00 noon on July 2. This opening included the sanctuary area.

Angler success rates were high through July 5; harvestable numbers of early run sockeye salmon were in the river through July 11. After the fishery reopened, highest success rates and greatest effort were concentrated in the clear waters of the Russian River.

Creel census data revealed 16,140 angler-days of effort were expended to harvest 12,300 early run fish. The harvest rate was 0.164 salmon per

hour (6.1 hours to harvest one fish). Spawning escapement (as enumerated by weir) was 30,610 fish. Total return (harvest plus escapement) was 42,910 fish, or 9.6% below the 1976-1984 average return. Similarly, harvest and effort were 40.7% and 45.7%, respectively, below the mean for these years. Reduced harvest and effort is attributed to the 4.5-day closure and exceptionally rapid migration of this stock through the fishery that was initiated by rising water temperatures and flow rates.

Late Run:

The late run entered the fishery on July 19. Average catch per hour was a relatively high 0.20 fish on July 24, 0.40 fish on July 29, and a peak of 0.63 on August 2. The success rate on August 2 equates to one fish every 1.6 hours or attainment of the daily bag limit of three salmon in 4.8 hours. This is the highest daily angler-catch rate recorded at Russian River. These success rates remained exceptionally high through August 10 and thereafter declined until the scheduled closure of the fishery on August 20. Seasonal catch per hour during the late run was 0.37 fish, the highest catch rate recorded for the late run fishery since 1965.

Creel census estimates indicate anglers harvested 58,410 late run sockeye salmon. Effort was 34,630 angler-days. Spawning escapement enumerated at Russian River weir totaled 136,970 late run sockeye salmon. Total return (harvest plus escapement) was 195,380 fish. Harvest, effort, spawning escapement and total return in 1985 established new records for the late run fishery.

Escapement Goals and Management Concerns

Escapement goals for Russian River stocks were not established until the early 1970s. These goals were adopted as a regulation by the Alaska Board of Fisheries: "5 AAC 21.361 RUSSIAN RIVER SOCKEYE SALMON MANAGEMENT PLAN." Early and late run minimal escapement goals established were 9,000 and 30,000 fish, respectively.

Early Run Escapement Goal:

The minimal early run escapement goal was established by analysis of the spawning area available and historical escapement levels. There was close agreement between these two methods (Nelson 1984). At the present time, the best evaluation of this escapement goal is a comparison of return per spawner from various escapement levels.

Nelson (1985) discussed the early run escapement goal by comparing return-per-spawner with parent-year escapement data and concluded that, although it was not definitive, the desired escapement level for this stock is apparently less than 20,000 fish. As the early run escapements from 1980-1985 have ranged from 21,140 to 56,080 fish, definitive conclusions must be deferred until return-per-spawner data are available from these escapements. The 1979 escapement of 19,700 has thus far returned 95,016, or a return per spawner of 4.8.

Conversely, if sufficient early run sockeye salmon are to be available for the recreational fishery, escapements of less than 5,000 early run fish would have to produce a return per spawner of at least 5:1. Although this return rate has occurred, the mean early run return per spawner is a relatively low 2.9. The minimal escapement goal of 9,000 early run fish, therefore, appears appropriate based on data currently available.

Late Run Escapement Goal:

The minimal late run spawning escapement goal was established in 1975. At this time biological data regarding this stock's early life history were limited, and the contribution of this component to the commercial fishery was unknown. These fish spawned primarily in Upper Russian Lake, and freshwater production was, therefore, assumed to be "rearing area limited." Analysis of prior escapements suggested a minimal escapement goal of 30,000 was reasonable and an escapement approximating the historical mean escapement (40,370) was desirable (Nelson 1984).

Commercial Harvest, Exploitation Rates and Production:

Because of the timing of the early Russian River run and the July opening of the commercial fishery, harvest of this stock by the commercial fishery is negligible. Late run Russian River salmon pass through Cook Inlet from July through early August and are, therefore, commercially harvested. Stock separation techniques coupled with prior tagging programs now permit an evaluation of the Kenai River stock's contribution to that mixed stock fishery (Nelson 1984). A comparison of Kenai River sonar data to total late run Russian River returns (harvest plus escapement) provides an estimate of Russian River's contribution to the Kenai River sockeye salmon escapement. This contribution historically ranges from 6.6% to 62.1%. In 1985 Russian River accounted for 38.9% of the late run Kenai River sockeye salmon escapement (Table 13). Harvests of late run Russian River sockeye salmon by both the sport and commercial fisheries are presented in Table 14.

The commercial harvest of late run Russian River fish has ranged from 43,690 (1973) to 310,930 (1983), with a 1972-1984 mean of 138,831 fish. The sport harvest at Russian River during this same period ranged from 8,390 fish in 1975 to 27,440 fish in 1977, averaging 18,452 fish. Historically, the commercial fishery harvests 86.8% of the total catch and the sport fishery 13.2%. The commercial and sport harvests in 1985 were 625,340 and 58,410 fish, respectively. The commercial catch represented 91.5% of the total harvest and the sport catch 8.5%. The commercial fishery, therefore, accounts for the majority of the late run harvested in any given year.

Historically, the commercial fishery harvests an average of 65.8% of the late run Russian River sockeye salmon total return and the sport fishery 9.8%; the combined mean annual exploitation rate is 75.5%. From 1972 through 1984 this exploitation rate has ranged from 63.6% to 90.5%. In 1985 the commercial fishery had a relatively high exploitation rate of 76.2%; while the sport fishery contributed a low rate of only 7.1%, resulting in a combined exploitation rate of 83.3% which is well above

Table 13. Kenai River Sockeye Salmon Sonar Counts, Total Late Run Russian River Sockeye Salmon Return, and Percent of the Kenai River Late Run Sockeye Salmon Escapement to Enter Russian River, 1968-1985*.

Year	Sockeye Salmon Sonar Count	Total Late Run Russian River Return**	Percent Kenai Run to Russian River
1968	88,000	54,620	62.1
1969	53,000	30,070	56.7
1970	73,000	28,800	39.5
1972	318,000	95,050	29.9
1973	367,000	33,900	9.2
1974	161,000	33,150	20.6
1975	142,000	40,360	28.4
1976	380,000	45,650	12.0
1977	708,000	48,850	6.9
1978	398,900	58,760	14.7
1979	285,020	114,750	40.3
1980	464,040	117,470	25.3
1981	407,640	68,250	16.7
1982	619,830	40,950	6.6
1983	630,340	50,000	7.9
1984	344,570	117,630	33.3
Mean	340,021	61,141	25.6
1985	502,820	195,380	38.9

* Sonar data from 1971 not available due to equipment malfunction.
** Total late run Russian River return includes escapement past weir and sport harvest.

Table 14. Harvest of Late Run Russian River Sockeye Salmon Stocks by Commercial and Recreational Fisheries, 1972-1985.

Year	Commercial Harvest	Sport Harvest	Total Harvest	Percent of Total Harvest by Commercial Fishery	Percent of Total Harvest by Sport Fishery
1972	144,130	16,050	160,180	90.0	10.0
1973	43,690	8,930	52,620	83.0	17.0
1974	55,460	8,500	63,960	86.7	13.3
1975	90,480	8,390	98,870	91.5	8.5
1976	108,280	13,700	121,980	88.8	11.2
1977	89,740	27,440	117,180	76.6	23.4
1978	274,040	24,530	298,570	91.8	8.2
1979	126,710	26,830	153,540	82.5	17.5
1980	131,410	33,490	164,900	79.7	20.3
1981	97,820	23,720	121,540	80.5	19.5
1982	113,420	10,320	123,740	91.7	8.3
1983*	310,930	16,000	326,930	95.1	4.9
1984*	218,690	21,970	240,660	90.9	9.1
Mean	138,831	18,452	157,282	86.8	13.2
1985*	625,340	58,410	683,750	91.5	8.5

* Data for these years are preliminary.

the historical mean (Table 15). While the sport fishery harvested a low percentage of the total return, it harvested a record number of fish, reflecting the magnitude of the 1985 late run return.

Nelson (1984) concluded the exploitation rate of late run Russian River fish will always be greater than the exploitation rate for Kenai River sockeye salmon. The Kenai River component is harvested only by the commercial fishery and a relatively minor sport fishery in the Kenai River. Russian River salmon are also subject to these fisheries, and at Russian River are exploited by the most intense sport fishery in Alaska. The 1985 exploitation rates for Kenai and Russian River salmon were 80.2% and 83.3%, respectively; the disparity may be as high as 17.5%, occurring in 1977 (Table 16).

The return per spawning fish for Kenai (Cross et al. 1983) and late run Russian River stocks is about twice the return experienced by the Russian River early run (Table 17). This is to be expected because the early run Russian River fish utilize the "spawning area limited" waters of Upper Russian Creek. This area provides a much more harsh and unstable spawning and egg-incubation environment than either Upper Russian Lake or the Kenai River spawning and incubation areas. The early run's limited reproductive capabilities are not a concern because the run is exploited only by a strictly regulated sport fishery at Russian River (Nelson 1984). Late run Russian River production from 1969 through 1972 averaged only 3.3:1, compared to Kenai River production for that same period of 6.4:1. In 1973 Russian River production began to increase. Since that date these stocks have produced at a slightly higher rate than the overall Kenai River run.

Late run Russian River production estimates may now be compared to known spawning escapements in Table 18. In this table, production figures are correlated with escapements, which are categorized as "low", "intermediate" or "high".

Fry Rearing Capacity of Upper Russian Lake:

Nelson (1984) concluded that above average late run returns per spawner resulted from low parent-year escapements and that the converse was also true. This evidence suggested Upper Russian Lake was at or near carrying capacity. The more fry in the lake, the greater the competition for food and space and the lower the production per spawner. Nelson (1984) also indicated that at some unknown high escapement level, the late Russian River run would theoretically fail to reproduce itself.

Data to generate production figures from known escapements in Table 18 were developed by compiling commercial harvest, sport harvest, escapement, and numbers of fish (by age class) produced by a given year age class. With the exception of escapement data, these figures are estimates subject to varying degrees of error. A more simplistic approach to reduce the number of variables is to compare known Russian River late run escapements to the estimated total return to Russian River 5 years hence. This comparison is shown in Table 19 and was developed by following the assumptions of Nelson (1984).

Table 15. Percentage of Late Run Russian River Sockeye Salmon Harvested by Commercial and Sport Fisheries, 1972-1985.

Year	Commercial and Sport Harvest	Escapement*	Total Production	Percent Harvested		Combined Percent Harvested
				Commercial Fishery	Sport Fishery	
1972	160,180	79,000	239,180	60.3	6.7	67.0
1973	52,620	24,970	77,590	56.3	11.5	67.8
1974	63,960	24,650	88,610	62.6	9.6	72.2
1975	98,870	31,970	130,840	69.2	6.4	75.6
1976	121,980	31,950	153,930	70.3	8.9	79.2
1977	117,180	21,410	138,590	64.8	19.8	84.6
1978	298,570	34,230	332,800	82.3	7.4	89.7
1979	153,540	87,920	241,460	52.5	11.1	63.6
1980	164,900	83,980	248,880	52.8	13.5	66.3
1981	121,540	44,530	166,070	58.9	14.3	73.2
1982	123,740	30,630	154,370	73.5	6.7	80.2
1983**	326,930	34,000	360,930	86.1	4.4	90.5
1984**	240,660	92,660	333,320	65.6	6.6	72.2
Mean	157,282	47,838	205,121	65.8	9.8	75.5
1985**	683,750	136,970	820,720	76.2	7.1	83.3

* Escapement past the weir. Sockeye salmon spawning below Russian River Falls are not considered.

** Data for these years are preliminary.

Table 16. Exploitation Rate of Late Run Kenai and Russian River Sockeye Salmon, 1972-1985.

Year	Total Production*		Commercial and Sport Harvest		Exploitation Rate	
	Kenai R.	Russian R.	Kenai R.**	Russian R.	Kenai R.	Russian R.
1972	800,070	239,180	498,100	160,180	62.3	67.0
1973	841,910	77,590	483,800	52,620	57.5	67.8
1974	433,180	88,610	288,710	63,960	66.6	72.2
1975	462,490	130,840	333,990	98,870	72.2	75.6
1976	1,287,200	153,930	934,040	121,980	72.6	79.2
1977	2,014,820	138,590	1,351,190	117,180	67.1	84.6
1978	2,272,280	332,800	1,922,350	298,570	84.6	89.7
1979	607,150	241,460	361,010	153,540	59.5	63.6
1980	993,520	248,880	581,610	164,900	58.5	66.3
1981	999,260	166,070	629,320	121,540	63.0	73.2
1982	2,350,074	154,370	1,778,960	123,740	75.7	80.2
1983***	4,589,049	360,930	4,023,099	326,930	87.7	90.6
1984***	1,005,443	333,320	694,000	240,660	69.0	72.2
Mean	1,435,111	205,121	1,067,706	157,282	68.9	75.5
1985***	2,119,495	820,720	1,698,974	683,750	80.2	83.3

* Combined commercial harvest, sport harvest and spawning escapement.
** Includes the estimated sport harvest, personal use harvest, etc., which was taken downstream from the sonar counter.
*** Data from these years are preliminary.

Table 17. A Comparison of Early Run Russian River, Late Run Russian River and Late Run Kenai River Sockeye Salmon Return Per Spawner, 1969-1980.

Brood Year	Return Per Spawner*		
	Kenai River	Early Run Russian River	Late Run Russian River
1969	7.7	2.9	3.2
1970	7.2	2.3	4.7
1971	3.4	4.1	2.3
1972	7.2	10.6	3.1
1973	6.4	1.9	9.8
1974	4.2	4.0	9.9
1975	6.3	2.8	6.2
1976	3.3	7.7	7.4
1977	4.0	1.1	5.5
1978	11.6	0.5	4.0
1969-78 Mean	6.1	3.8	5.6
1973-78 Mean	6.0	3.0	7.1
1979	4.9**	4.8**	7.0**
1980	4.3**	0.4**	8.6**

* Includes commercial harvest, sport harvest and spawning escapement. Commercial harvest on early run is negligible.

** All age classes have not yet returned. Return per spawner is minimal.

Table 18. Late Run Russian River Production Per Spawner From Years of Low, Intermediate and High Escapements, 1969-1980.

Parent-Year	Parent-Year Escapement		Total Production*	Return/ Spawner
	Low Escapement (<30,000)			
1969	28,920		92,540	3.2
1970	28,200		132,540	4.7
1973	24,970		239,710	9.8
1974	24,650		241,570	9.9
1977	21,410		143,450	5.5
		Mean	169,962	6.6
	Intermediate Escapement (30,000 - 50,000)			
1975	31,970		198,210	6.2
1976	31,950		258,800	7.4
1978	34,230		92,420	4.0
		Mean	183,143	5.9
	High Escapement (>50,000)			
1971	54,430		125,190	2.3
1972	79,000		244,900	3.1
1979	87,920		457,180	7.0**
1980	83,980		719,475	8.6**
		Mean	386,686	5.3

* Commercial harvest, sport harvest and escapement.

** All age classes for these years have not yet returned. Return per spawner is therefore minimal.

Table 19. Late Run Russian River Escapements Compared to Russian River Returns During Years of Low, Intermediate and High Escapements, 1963-1980.

Parent-Year	Parent-Year Escapement	Return Year*		Return to Russian River**	Return/ Spawner
		Low Escapement (<30,000)			
1965	21,820	1970		28,800	1.3
1969	28,920	1974		33,150	1.1
1970	28,200	1975		40,360	1.4
1973	24,970	1978		58,760	2.4
1974	24,650	1979		114,750	4.7
1977	21,410	1982		40,950	1.9
			Mean	52,795	2.1
		Intermediate Escapement (30,000 - 50,000)			
1964	46,930	1969		30,070	0.6
1966	34,430	1971		65,160	1.9
1967	49,480	1972		95,050	1.9
1968	48,880	1973		33,900	0.7
1975	31,970	1980		117,470	3.7
1976	31,950	1981		68,250	2.1
1978	34,230	1983		50,000	1.5
			Mean	65,700	1.8
		High Escapement (>50,000)			
1963	51,120	1968		54,620	1.1
1971	54,430	1976		45,650	0.8
1972	79,000	1977		48,850	0.6
1979	87,920	1984		114,630	1.3
1980	83,980	1985		195,380	2.3
			Mean	91,826	1.2

* Since 1970 over 65% of the late run Russian River sockeye salmon have returned on a 5-year cycle. The above table should therefore be considered of a general nature.

** Sport harvest plus spawning escapement.

Both Tables 18 and 19 are in basic agreement. An inverse relationship exists between numbers in the spawning escapement and production per spawner. The exception to this generalization resulted from the high escapements in 1979 and 1980, which returned large numbers of fish in 1984 and 1985. Nonetheless, it is our opinion that two exceptions in 17 years do not invalidate the general premise: as escapements increase above an optimal level, production per spawner decreases.

Further evidence that Upper Russian Lake has reached or is approaching its carrying capacity is indirectly determined by ranking selected sockeye salmon nursery lakes, based on adult escapement per km^2 of surface area. This was done by Burgner et al. (1969); when Upper Russian Lake is added to their list of 10 lakes, it ranks first in terms of escapement per km^2.

Although ranking Upper Russian Lake "Number 1" in terms of escapement per unit of surface area is not conclusive, it is one more indicator that suggests this lake is at or near its production capability. A similar conclusion was reached through analysis of available plankton, which is the primary source of food for rearing sockeye salmon.

Plankton in Hidden Lake (a low sockeye salmon producing lake on the Kenai Peninsula) was compared to plankton in Upper Russian Lake. The mean size of two species of plankton in Hidden Lake was larger than the mean size of the same two species in Upper Russian Lake. A zooplankter preferred by sockeye salmon, *Daphnia galeata mendota*, was prevalent in Hidden Lake but absent in Upper Russian Lake. Additionally, Upper Russian Lake sockeye salmon generally rear in fresh water for 2 years, as opposed to 1 year in Hidden Lake.

Rearing sockeye salmon have completely eliminated *D. galeata mendota* from Upper Russian Lake. The remaining two species are cropped to the degree that they never achieve a large mean size. Rearing is generally for 2 years in Upper Russian Lake, rather than 1 year, because of increased competition among rearing sockeye salmon for available food (Nelson 1984).

Evaluation of Escapement Goals:

Three parameters have been applied to determine early and late run Russian River escapement goals; i.e., historical escapement levels, water quality and available plankton, and analysis of the late run escapement-to-return ratio. Results from these approaches are in basic agreement. Combined early and late run escapements should approximate 62,500 fish. Maximal early run reproduction has occurred with escapements between 9,000 and 20,000 fish. To date, returns from escapements in excess of 20,000 early run fish have failed to reproduce themselves. Nelson (1984) concluded that the optimal late run escapement should range from 30,000 to 50,000 fish; an escapement of 40,000 fish is preferred.

Escapements of over 80,000 fish in both 1979 and 1980 have now produced returns per spawner of 7.0 and 8.6 fish, respectively, that are above the mean. While these 2 years alone might indicate spawning escapements

in Upper Russian Lake could be increased, an examination of all available data indicates the system may be at or near fry-carrying capacity. Any conclusion to change escapement goals should therefore be deferred until more data are available.

Management Concerns:

Management of the early run poses relatively few problems. The stock is currently at a high level and is harvested only by a restrictive sport fishery. Management of the late run is more complex; this stock is harvested by a highly efficient mixed-stock commercial fishery and an intense sport fishery. Overexploitation is an annual possibility.

Nelson (1984) reviewed total late run Russian River production and its contribution to the commercial fishery. He concluded that whenever the commercial fishery exploitation rate was 72.2% or greater, it may be necessary to close the Russian River sport fishery to achieve the minimal 30,000 fish escapement goal. The correlation between commercial exploitation rates and emergency closures during the late run Russian River sport fishery in past years is evident (Table 20). If the exploitation rate in the commercial fishery is high, there is a greater probability for an emergency closure (stock conservation) during the sport fishery.

The increasing efficiency of the Russian River angler also contributes to the probability of emergency closures for stock conservation. In 1975 the mean late run Russian River harvest was approximately 500 fish per day. Because of increased angler effort and a better general knowledge of the fishery, anglers harvested 1,333 fish per day in 1983. In 1984 this decreased to approximately 800 fish daily because of the rapid migrational rate. In 1985 the harvest averaged 2,014 fish per day, which is indicative of the harvest potential of the sport fishery. Realization of this potential increases the probability of emergency closures.

Ensuring an adequate return of late run fish to Russian River that will be sufficient for recreational and escapement needs becomes even more difficult when the magnitude of the mainstem Kenai River escapement is compared to the Russian River escapement. The Kenai River escapement, on the average, exceeds Russian River escapement by a factor of 12 (Nelson 1984).

Assuming a Kenai River parent-year escapement of 500,000, a corresponding Russian River minimal escapement of 30,000 fish, and an identical return rate for both systems of 6:1, the returns to the Kenai and Russian Rivers would be 3 million and 180,000 fish, respectively. From the Kenai River return, the commercial fishery could harvest 2.5 million fish; the remaining 500,000 fish would represent the escapement, resulting in an exploitation rate of 83.3%. At this rate, only 30,000 of the original 180,000 Russian River fish would remain to return to Russian River. This would not permit a recreational fishery.

The above scenario has infinite combinations. The conclusion, however, is the same when any reasonable combination is applied. As long as

Table 20. The Commercial Exploitation Rate of Kenai River Stocks and its Relationship to Emergency Closures for Stock Conservation During the Late Run Russian River Sport Fishery, 1975-1985.

Year	Total Russian River Production	Late Run Russian River Escapement	Kenai River Commercial Exploitation Rate	Emergency Closure Required for Stock Conservation
1975	130,840	31,970	68.9	Yes
1976	153,930	31,950	70.1	No
1977	138,590	21,410	64.5	Yes
1978	332,800	34,230	82.0	Yes
1979	241,460	87,920	51.8	No
1980	248,880	83,980	52.3	No
1981	166,070	44,530	58.6	No
1982	154,370	30,630	73.1	Yes
1983	360,930	34,000	85.8*	Yes
1984	333,320	92,660	65.3*	No
1985	820,720	136,970	75.8*	No

* Preliminary data.

production rates of the Kenai and Russian Rivers are similar and Kenai River escapements remain disproportionately high in relation to Russian River, a high commercial fishery exploitation rate of the late run Russian River stock will eventuate. This high exploitation rate will not permit sufficient numbers of fish to return to Russian River to satisfy the needs of the recreational fishery and spawning escapement. If the Kenai River produces at a greater rate than the Russian River, the problem becomes more acute.

The 1985 return of Kenai River sockeye salmon was above average. Commercial fishing in Cook Inlet was, therefore, not restrictive, and the seasonal exploitation rate in this fishery was 75.8%, which is above average. The return to Russian River of 195,350 fish was a record, and no closure of the sport fishery was required. The Russian River contributed an above average 38.9% escapement to the Kenai River, and although all age classes have not yet returned from the 1980 brood year, the return-per-spawner ratio for late run Russian River salmon is double that for late run Kenai River salmon. As production per spawner in the Russian River was higher than the Kenai River and a higher than average percentage of the Kenai River return was composed of Russian River fish, this year's commercial exploitation rate did not adversely impact the Russian River late run stock. High production rates allow higher commercial exploitation rates and decrease the possibility of emergency sport closures. However, if Kenai River production per spawning fish exceeds that in Russian River, an emergency closure for stock conservation will probably occur during the late run Russian River sport fishery.

Age Class Composition

Scale samples were collected at Lower Russian Lake weir to determine age and length composition of early and late run sockeye salmon escapements. The results of sampling are presented in Table 21.

The age structure of the 1985 early run escapement was consistent with the historical mean-age structure in that the dominant component was comprised of salmon in their sixth year of life. These 6-year-old fish were predominately of age class 2.3 (Table 22).

Historically, 5-year-old fish of age class 2.2 dominate the late run escapement; this also occurred in 1985 (Table 23). The only exception to the historical dominance of age class 2.2 fish occurred in 1983. The possible reason for the shift in age composition from predominately age class 2.3 to predominately age class 1.3 in that year has been discussed (Nelson 1984).

Mean lengths of 2-ocean and 3-ocean early run salmon were the lowest recorded (Table 24). Mean length of 3-ocean late run salmon was also the lowest on record, while mean length of 2-ocean late run salmon was the second lowest on record (Table 25). Because the late run experiences a historical commercial exploitation rate of 65.8%, size- specific gear selectivity for larger fish could decrease the mean length of returning salmon. There is some preliminary evidence that drift catches of Age 1.2 sockeye salmon are consistently larger than Age 1.2 fish

Table 21. Age-Class Composition, Sample Size, Parent-Year and Mean Lengths of Adult Sockeye Salmon Sampled From Early and Late-Run Russian River Escapements, 1985.

Age Class	Estimated Number in Escapement	Sample Size	Estimated Percent of Escapement	Parent-Year	Mean Length (mm)*	SD**
			Early Run			
2.3	24,756	157	80.9	1979	581	21.08
2.2	3,030	19	9.9	1980	520	18.67
1.3	2,203	14	7.2	1980	576	20.93
1.2	306	2	1.0	1981	490	28.28
1.4	153	1	0.5	1979	565	...
3.2	153	1	0.5	1979	520	...
Combined	30,601***	194	100.0		573****	28.98****
			Late Run			
2.2	86,711	197	64.2	1980	530	22.83
2.3	22,015	50	16.3	1979	577	17.80
1.3	19,314	44	14.3	1980	581	26.51
1.2	5,673	13	4.2	1981	529	18.73
3.2	1,351	3	1.0	1979	550	26.46
Combined	135,064***	307	100.0		545****	31.96****

* Mean lengths are from mid-eye to fork-of-tail.
** Sample standard deviation.
*** Excludes 4 and 1,905 jacks from the early and late runs, respectively.
**** Mean lengths and standard deviation computed from total adult sample.

Table 22. Age-Class Composition in Percent of Early Run Adult Russian River Sockeye Salmon Escapements, 1970-1985*.

	Age Class							
Year	1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
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		
1974	0.5	32.0		3.4	63.6	0.5		
1975	0.4	1.8	0.4	19.7	75.1	0.4		
1976	16.8	1.5		11.4	61.1		0.9	1.3
1977	1.9	60.7		14.0	23.4		0.8	8.4
1978	0.3	2.7		4.5	92.5			
1979		4.5		20.9	74.6			
1980	6.2	8.1	0.4	4.3	81.0			
1981	6.3	46.5		18.9	28.3			
1982		1.2		0.4	98.4			
1983	11.2	37.4		2.8	48.1			0.5
1984	4.8	86.7		0.6	7.9			
Mean	3.8	23.2	0.1	8.9	62.9	0.3	0.1	0.7
1985	1.0	7.2	0.5	9.9	80.9		0.5	

* No samples were collected during the early run in 1973.

Table 23. Age-Class Composition in Percent of Late Run Adult Russian River Sockeye Salmon Escapements, 1970-1985*.

Year	Age Class							
	1.2	1.3	1.4	2.2	2.3	2.4	3.2	3.3
1970	2.5	2.9		87.3	7.3			
1971	1.9	5.3		61.5	30.3			
1974	5.5	9.0		58.6	26.9			
1975	5.4	2.9		65.9	23.9		1.9	
1976	10.9	4.3		59.6	23.6		1.0	0.6
1977	6.6	7.7		72.6	13.1			
1978	0.9	5.3		58.8	35.0			
1979	2.1	0.4		88.2	8.2		0.9	0.2
1980	25.2	7.4		56.6	10.8			
1981	13.8	6.6		60.2	18.9		0.5	
1982	8.8	2.8		46.0	39.2		2.0	1.2
1983	73.7	8.0		12.6	5.7			
1984	22.7	15.6		47.1	14.2		0.4	
Mean	13.8	6.0		59.6	19.8		0.6	0.2
1985	4.2	14.3		64.2	16.3		1.0	

* No samples were collected during the late run in 1972 and 1973.

Table 24. Early Run Russian River Sockeye Salmon Total Returns and Mean Lengths by Ocean-Age of Fish Sampled, 1975-1985.

Year	Total Return**	Mean Length (mm)*		
		Two-Ocean Salmon	Three-Ocean Salmon	Combined
1975	7,040	542	601	589
1976	18,090	562	609	592
1977	36,470	560	611	598
1978	71,870	552	605	602
1979	28,100	550	611	605
1980	55,890	544	597	596
1981	31,860	550	602	588
1982	90,580	540	590	590
1983	29,560	532	594	586
1984	64,790	544	591	588
Mean	43,425	548	601	593
1985	42,910	518	581	574

* Lengths are from mid-eye to fork-of-tail.
** Sport harvest plus spawning escapement.

Table 25. Late Run Russian River Sockeye Salmon Total Returns and Mean Lengths by Ocean-Age of Fish Sampled, 1975-1985.

Year	Total Return**	Mean Length (mm)*		
		Two-Ocean Salmon	Three-Ocean Salmon	Combined
1975	40,360	552	603	561
1976	45,650	572	619	585
1977	48,850	554	615	571
1978	58,760	550	603	567
1979	114,750	542	610	548
1980	117,480	544	601	563
1981	68,250	545	609	561
1982	40,950	531	597	560
1983	50,000	532	606	542
1984	114,630	526	585	546
Mean	69,968	545	605	560
1985	195,380	530	579	545

* Lengths are from mid-eye to fork-of-tail.
** Sport harvest plus spawning escapement.

sampled from the Kenai River escapement (McBride and Cross 1985). However, the less than average length of early run fish suggests that other factors may also be influencing length because the early run experiences negligible commercial exploitation. Comparison of length and age data from the commercial harvest and the Kenai and Russian River escapements in subsequent years is recommended to permit detection of any trend toward smaller fish.

Length-frequency distributions of sockeye salmon sampled from the early and late runs are presented in Figure 5. Late run jacks (ocean-age one) form a discreet group, based on the length distribution of late run fish.

The separation of ocean-age ones from ocean-age twos and threes occurs at 465 mm. However, length frequency could not be used to separate ocean-age twos from threes in either the early or the late run samples. The distribution does illustrate a similarity in length range of early and late run adults. With the exception of two small 2-ocean late run fish, late run lengths ranged from 475 to 635 mm, while early run lengths ranged from 465 to 635 mm. The male:female sex ratios of early and late run fish sampled at Lower Russian Lake weir were 1:0.9 and 1:1.0, respectively.

Early Run Return Per Spawner

Table 26 presents fish numbers produced for each early run fish in the parent-year spawning escapement. From 1963-1978, the return per spawning fish in the parent-year escapement averaged 2.7 fish, ranging from 0.2 to 10.6 fish. The significance of a return of 10.6 fish for each salmon in the escapement has been discussed (Nelson 1979). As previously noted in this report, large spawning escapements have not yielded high production rates. The two highest parent-year escapements failed to reproduce themselves. Conversely, the return rate of 10.6 fish/spawner originated with a relatively low spawning escapement of 9,270 fish.

Foerster (1968) indicates that, irrespective of the escapement level, fluctuations in the numbers of returning adult fish are quite marked. As an example, he cites the Fraser River return per spawner from 1938 to 1954, which ranged from 2.2 to 13.0, averaging 5.4 fish. He concluded that most of the variability is attributable to environmental conditions during the freshwater developmental stages. This conclusion applies to the early Russian River sockeye salmon stock, as the spawning area of upper Russian Creek is not a stable environment. Observation indicates it is subject to flooding, low water, etc., during the spawning and incubation period.

Fecundity Investigations

Fecundity investigations initiated in 1973 were continued during the 1985 season. Data from the 1985 early and late run investigations are presented in Tables 27 and 28, respectively.

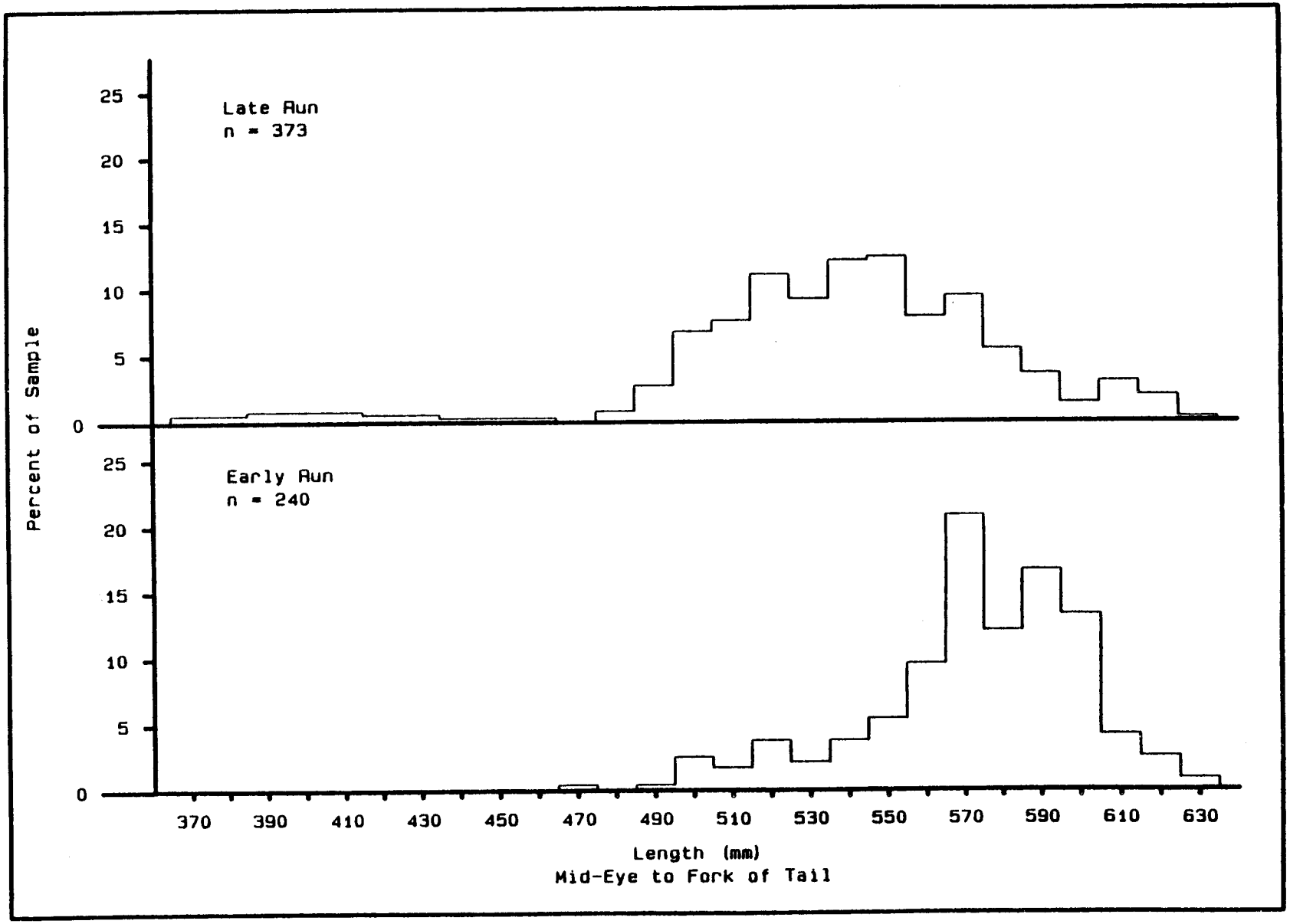

Figure 5. Length frequency distributions of early and late-run Russian River sockeye salmon sampled at Lower Russian Lake weir, 1985.

Table 26. Estimated Production From Known Escapements of Early Run Russian River Sockeye Salmon, 1963-1979.

Parent-Year	Parent-Year Escapement	Total Return* (Production)	Return Per Female	Return Per Spawner
1963	14,580	10,870	1.5**	0.7**
1964	12,700	11,200	1.8**	0.9**
1965	21,510	4,875	0.4**	0.2**
1966	16,660	8,183	1.0	0.5
1967	13,710	19,628	2.8	1.4
1968	9,200	18,946	4.0	2.0
1969	5,000	14,508	5.8	2.9
1970	5,450	12,810	5.3	2.3
1971	2,650	10,896	8.7	4.1
1972	9,270	98,775	26.6	10.6
1973	13,120	24,962	3.8	1.9
1974	13,150	52,704	9.7	4.0
1975	5,640	15,947	4.6	2.8
1976	14,700	113,580	15.5	7.7
1977	16,070	17,674	3.8	1.1
1978	34,150	17,001	1.1	0.5
Mean	12,973	28,285	6.0	2.7
1979***	19,700	95,016	10.2	4.8

* Total return equals sport harvest plus escapement. A negligible commercial harvest is assumed.

** Assumes a male-to-female sex ratio of 1:1.0 in the parent-year escapement. Sex ratios for succeeding years were determined by sampling.

*** Excludes 7-year fish which historically account for less than 1% of the return.

Table 27. Fecundity of Early Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1985.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	1.8	3.9	510	1,082	1,349	2,431
2	2.0	4.4	545	1,355	1,776	3,131
3	1.7	3.8	525	1,518	1,227	2,745
4	1.9	4.2	525	1,184	1,454	2,638
5	2.5	5.5	565	1,983	2,309	4,292
6	2.7	5.9	595	1,579	2,053	3,632
7	3.0	6.6	630	1,853	2,320	4,173
8	2.0	4.3	535	1,160	1,539	2,699
9	3.1	6.9	600	1,169	2,039	3,208
10	2.1	4.6	540	1,567	1,509	3,076
11	1.9	4.2	540	1,169	1,790	2,959
12	2.3	5.0	590	1,456	1,670	3,126
Mean	2.3	4.9	558	1,423	1,753	3,176

Table 28. Fecundity of Late Run Russian River Sockeye Salmon as Determined by Sampling at Lower Russian Lake Weir, 1985.

Sample Number	Weight kg	Weight lb	Length (mm)	Number of Eggs Right Skein	Number of Eggs Left Skein	Number of Eggs Combined
1	2.8	6.2	600	1,509	1,514	3,023
2	1.8	4.0	515	1,083	1,097	2,180
3	2.2	4.8	565	1,190	1,196	2,386
4	2.0	4.4	535	877	1,208	2,085
5	2.6	5.7	585	1,274	1,149	2,423
6	2.3	5.0	575	1,315	1,582	2,897
7	2.7	6.0	595	1,859	2,559	4,418
8	1.8	3.9	540	1,211	1,387	2,598
9	2.3	5.0	580	1,948	1,699	3,647
10	2.1	4.6	555	1,466	1,616	3,082
11	2.0	4.4	565	1,366	1,479	2,845
12	1.9	4.2	540	1,175	1,271	2,446
Mean	2.2	4.9	563	1,356	1,480	2,836

Mean fecundities of early and late run fish were lower than average but within historical ranges. Average weight and length of early and late run females were within historical means, although weight and length averages for early run females were at the lower end of the historical range (Tables 29 and 30).

Egg Deposition

Assuming the mean fecundity of early run fish sampled at Lower Russian Lake weir is representative of early run stocks, the potential number of eggs available for deposition in Upper Russian Creek may be calculated. Losses between weir and spawning grounds, females that perish without spawning, and numbers of eggs retained per spent female must also be considered. Nelson (1976) has presented a detailed discussion of these criteria and the methodology employed to calculate potential early run egg deposition. Deposition in 1985 was estimated at 42.3 million eggs (Table 31).

As would be expected, Table 31 reveals that the greater the spawning escapement, the greater the potential egg deposition. However, some variability in reproductive potential will occur annually, irrespective of the number of salmon in the spawning escapement, because mean fecundity and the male-to-female sex ratio are not constant (Hartman and Conkle 1960). It should also be noted that neither a definitive nor direct relationship is evident between numbers in the spawning escapement, potential eggs available for deposition, and adult return. Factors other than eggs available for deposition, therefore, exert a significant influence on the adult return of early run sockeye salmon. These variables are believed to be present primarily during freshwater residency and are environmentally related (Foerster 1968).

It was previously believed that hydraulic egg sampling would permit an evaluation of spawning success (number of eggs deposited) as this success was related to environmental parameters present during spawning and the early portion of the egg-incubation period. It was further assumed a direct relationship existed between egg density and the return of adult early run fish 6 years hence. Analysis revealed this assumption was not valid; there was no discernible relationship between eggs in the gravel at time of sampling and subsequent adult return (Nelson 1983).

Returns of early run Russian River sockeye salmon are apparently influenced by factors other than or in addition to egg density; e.g., carrying capacity of Upper Russian Lake, predation during freshwater residency, relationship of early run rearing fish to late run rearing fish, annual variation in marine survival. Until these parameters are identified and quantified, there is no predictive value in determining actual early run egg deposition in Upper Russian Creek.

Climatological Observations

Climatological data collected at Lower Russian Lake weir are presented in Table 32. Total precipitation from June 6 through September 10 was 188 mm. Although 71% of the seasonal precipitation occurred after the

Table 29. Historical Fecundity Data Collected at Lower Russian Lake Weir During the Early Run Russian River Sockeye Salmon Migration, 1973-1985.

Year	Mean Fecundity	Mean Length (mm)	Mean Weight (kg)	Eggs/kg	Eggs/mm
1973	4,630	627	2.97	1,559	7.4
1974	3,569	603	2.60	1,373	5.9
1975	3,952	600	2.54	1,556	6.6
1976	3,668	596	2.61	1,405	6.2
1977	4,313	603	2.85	1,513	7.2
1978	3,815	608	2.82	1,353	6.3
1979	3,842	577	2.49	1,543	6.7
1980	3,534	573	2.42	1,460	6.2
1981	3,412	570	2.32	1,471	6.0
1982	3,479*	588	2.64	1,318	5.9
1983	3,063	548	2.22	1,380	5.6
1984	3,505	580	2.54	1,380	6.0
Mean	3,732	589	2.59	1,443	6.3
1985	3,176	558	2.25	1,412	5.7

* Fecundity calculated by linear regression. Correlation coefficient between length (x) and fecundity (y) equals 0.75.

Table 30. Historical Fecundity Data Collected at Lower Russian Lake Weir During the Late Run Russian River Sockeye Salmon Migration, 1973-1985.

Year	Mean Fecundity	Mean Length (mm)	Mean Weight (kg)	Eggs/kg	Eggs/mm
1973	3,190	569	2.19	1,457	5.6
1974	3,261	558	2.30	1,418	5.8
1975	3,555	555	2.26	1,573	6.4
1976	3,491	587	2.53	1,380	5.9
1977	3,302	567	2.44	1,353	5.8
1978	2,865	584	2.67	1,073	4.9
1979	3,314	542	2.20	1,506	6.1
1980	2,740	544	1.98	1,384	5.0
1981	3,268	552	2.15	1,520	5.9
1982	3,702	593	2.72	1,361	6.2
1983	2,593	548	2.22	1,168	4.7
1984	2,747	543	2.10	1,308	5.1
Mean	3,169	562	2.31	1,375	5.6
1985	2,836	563	2.21	1,283	5.0

Table 31. Potential Egg Deposition From the Early Run Sockeye Salmon Escapement in Upper Russian Creek and Known Adult Returns Produced From a Given Potential Egg Deposition, 1972-1985.

Year	Escapement	Potential Egg Deposition (millions)	Adult Return
1972	9,270	15.0	98,773
1973	13,120	29.6	24,962
1974	13,150	17.7	52,704
1975	5,640	12.7	15,947
1976	14,700	23.5	113,580
1977	16,070	18.2	17,674
1978	34,150	62.8	17,001
1979	19,700	30.9	95,016*
1980	28,670	44.2	
1981	21,140	32.0	
1982	56,080	89.7	
1983	21,200	28.3	
1984	28,910	41.7	
1985	30,605	42.3	

* Excludes 7-year fish (Age 3.3) which historically account for about 1% of the adult return.

Table 32. Climatological and Hydrological Observations by 5-day Periods Recorded at Lower Russian Lake Weir, June 6 through September 13, 1985.

Period	Water Temp.* (C) Max	Water Temp.* (C) Min	Air Temp.* (C) Max	Air Temp.* (C) Min	Rainfall (mm)**	Russian R. Discharge* (cfs)	Rendezvous Ck. Discharge* (cfs)	Total Discharge* (cfs)
Jun 06-10	...	...	...	...	...	374.3	23.5	397.8
Jun 11-15	10.0	8.9	18.3	3.3	3.0	276.6	23.4	300.0
Jun 16-20	11.7	9.4	20.0	0.6	7.6	248.2	24.9	273.1
Jun 21-25	10.6	8.9	20.6	1.1	5.7	211.9	29.1	241.0
Jun 26-30	13.9	10.6	26.1	5.0	0.0	215.1	46.0	261.1
Jul 01-05	13.3	11.1	21.1	8.3	10.6	331.8	87.1	418.9
Jul 06-10	14.4	11.7	25.6	5.0	6.3	317.3	83.5	400.8
Jul 11-15	13.3	12.2	20.6	5.6	18.9	242.9	64.5	307.4
Jul 16-20	15.0	13.3	22.8	9.4	2.4	197.7	83.2	280.9
Jul 21-25	15.0	12.2	23.3	5.6	5.2	210.0	70.9	280.9
Jul 26-30	15.0	13.9	25.6	6.7	9.0	201.8	57.6	259.4
Jul 31-Aug 04	15.0	13.3	20.6	5.6	0.0	168.0	44.8	212.8
Aug 04-09	14.4	11.1	20.0	3.3	12.8	164.8	39.8	204.6
Aug 10-14	12.8	11.7	18.3	3.9	56.9	182.7	44.5	227.2
Aug 15-19	13.3	11.7	19.4	2.8	7.1	166.4	50.4	216.8
Aug 20-24	11.7	11.1	16.7	2.8	16.8	162.1	41.5	203.6
Aug 25-29	12.2	11.1	19.4	2.8	3.8	139.1	38.2	177.3
Aug 30-Sep 03	12.2	11.1	17.2	2.2	15.7	136.8	32.7	169.5
Sep 04-08	12.2	11.1	18.9	1.1	2.6	128.2	29.3	157.5
Sep 09-13	11.7	10.6	18.3	1.7	3.6	110.2	30.9	141.1

* Air temperature, water temperature and discharge for the respective periods are the means of the daily recordings.

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

early run had passed the weir, late run fish faced lesser river velocities than the early run. The velocities are considered "moderate" to "low" and did not impede late run movement in the river. The greater river velocities experienced by early run fish necessitated use of the Russian River fish pass to prevent slowing of the in-river migration, as velocities exceeded 400 cfs on July 1 and July 6. Velocities greater than 400 cfs present a partial barrier to salmon migration at Russian River Falls (Nelson 1978).

Prior to entry into the Russian River, early run fish congregated in the sanctuary area. Movement into the river occurred later than normal and coincided with both a 4°F increase in Russian River water temperature and a doubling of discharge rate. It is likely that these factors influenced early run timing in 1985.

Dates at which 50% of the run had passed the weir were 5 and 4 days later than the 1969-1984 historical mean date for the early and late runs, respectively. Air and water temperatures were comparable to temperatures experienced in prior years; no extremes were encountered. However, southcentral Alaska experienced a prolonged winter season, which was not reflected in the summer season's climatological data and may have been a factor in the delayed run timing in 1985.

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