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Alaska Department of Fish and Game
Division of Commercial Fisheries
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Frazer Lake Sockeye Salmon Investigations, 1986

by

Bruce M. Barrett

State of Alaska

Steve Cowper, Governor

The Technical Fishery Report Series was established in 1987, replacing the Technical Data Report Series. The scope of this new series has been broadened to include reports that may contain data analysis, although data oriented reports lacking substantial analysis will continue to be included. The new series maintains an emphasis on timely reporting of recently gathered information, and this may sometimes require use of data subject to minor future adjustments. Reports published in this series are generally interim, annual, or iterative rather than final reports summarizing a completed study or project. They are technically oriented and intended for use primarily by fishery professionals and technically oriented fishing industry representatives. Publications in this series have received several editorial reviews and at least one *blind* peer review refereed by the division's editor and have been determined to be consistent with the division's publication policies and standards.

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TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	iv
LIST OF FIGURES	v
LIST OF APPENDICES	vi
ABSTRACT	vii
INTRODUCTION	1
METHODS	2
RESULTS AND DISCUSSION	4
LITERATURE CITED	8
APPENDICES	29

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. Age composition of sockeye salmon smolt sampled at the Frazer Lake fishpasses from 1965 through 1986	11
2. Length, weight, and condition factor of age-1.0 sockeye salmon produced from the 1963 through 1986 escapements	12
3. Length, weight, and condition factor of age-2.0 sockeye salmon produced from the 1962 through 1986 escapements	13
4. Daily and cumulative escapement counts by species, Frazer Lake fishpass, 1986	14
5. Sockeye salmon catch and escapement figures, Dog Salmon Creek (Frazer Lake drainage), 1965 through 1986	16
6. Estimated number of sockeye salmon killed by brown bears at Pinnell Creek in the Frazer Lake drainage, 1982 and 1984-1986	17
7. Peak sockeye salmon counts of the primary spawning areas in the Frazer Lake drainage and the percent of the Frazer Lake escapement represented by the combined peak counts, 1965-1986	18
8. Age composition of the Frazer Lake sockeye salmon escapement by statistical week, 1986	19
9. Age composition of the Frazer Lake sockeye salmon escapement, 1965-1986	20
10. Sex composition of the Frazer Lake sockeye salmon escapement by statistical week, 1986	21
11. Length by age and sex of sockeye salmon escapement sampled at the Frazer Lake fishpasses, 1986	22
12. Frazer Lake sockeye salmon return by age class and escapement year, 1962 through 1986	23

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1.	Map of Frazer Lake	24
2.	Schematic of the Frazer Lake fishpasses	25
3.	Daily (smoothed) sockeye salmon smolt catches in the inclined plane and concrete traps at Frazer Lake fishpasses, 1986 . .	26
4.	Daily (smoothed) escapement counts of sockeye salmon at the Frazer Lake fishpasses, 1986	27
5.	Sockeye salmon peak counts of Linda, Midway, and Stumble Creeks combined, Pinnell Creek, and Frazer Lake shoals as a percentage of the total escapement counted at the Frazer Lake fishpasses, 1965-86	28

LIST OF APPENDICES

	<u>Page</u>
APPENDIX A: STATISTICAL WEEKS	
A.1 - 1986 statistical weeks by calendar days	30
APPENDIX B: FRAZER LAKE SMOLT	
B.1 - Daily and cumulative downstream migrant fish catch by species in the inclined plane trap at Frazer Lake fishpasses, 1986	31
B.2 - Daily and cumulative downstream migrant fish catch by species in the cement weir trap at Frazer Lake fishpasses, 1986	33
B.3 - Length, weight, and condition factor of age-3.0 sockeye salmon smolt produced from the 1961 through 1986 escapements	35
B.4 - Age composition of sockeye salmon smolt sampled by statistical week, at Frazer Lake fishpasses, 1984 through 1986	36
APPENDIX C: FRAZER LAKE ESCAPEMENT	
C.1 - Daily (smoothed) escapement counts of sockeye salmon at the Dog Salmon Creek weir, 1986	37
C.2 - Cumulative percentage of the sockeye salmon escapement by date at the Dog Salmon Creek weir and Frazer Lake fishpasses, 1986	38
C.3 - Annual sockeye salmon run into Frazer Lake with the commercial catch and escapement components illustrated, 1956-1986	39
C.4 - Sockeye salmon escapement surveys of Frazer Lake and its inlet streams, 1986	40
C.5 - Monitoring data on the number of sockeye salmon entering and exiting the old (1962) and new (1979) Frazer Lake fishpasses, 1986	42

ABSTRACT

In 1986 the Alaska Department of Fish and Game, Division of Commercial Fisheries monitored the sockeye salmon (*Oncorhynchus nerka*) smolt out-migration and escapement at the Frazer Lake fishpasses, and conducted escapement surveys of the lake shoals and inlet streams.

The sockeye smolt out-migration occurred from mid-May through the end of June. Peak movements occurred in late May and early June. Nearly all (94%) the smolt were age 2.0. The age-2.0 smolt averaged 98 mm in length, 7.4 g in weight, and 0.79 in condition. The age-1.0 and age-2.0 smolt in 1986 were above average in length, weight, and condition than the smolt produced from the 1980-82 parent escapements which annually averaged about 400,000 fish. The improvement in smolt quality was attributed to the size of the parent-year escapements which were 53,524 fish for the age-1.0 fish and 158,340 fish for the age-2.0 fish.

The Frazer Lake run totaled 178,205 sockeye salmon. The catch was 41,652 fish, while the escapement through the Dog Salmon Creek weir was 136,553 fish. The escapement through the Frazer Lake fishpass was 126,529 fish. The majority (93%) of the escapement migrated through the fishpasses in the first three weeks of July. The escapement was 13.5% 4-year-olds, 5.7% 5-year-olds, and 79.6% 6-year-olds. Most of the run was produced from the 1980 parent year escapement. The male to female ratio in escapement was 0.6:1. The average sockeye length in the escapement was 541 mm.

Sockeye spawning peaked in August on the Frazer Lake shoals and in the lake inlet streams. Most of the escapement spawned in Pinnell Creek and lake shoal areas. Bear predation was heaviest on inlet stream spawners. Approximately 8% of the escapement into Frazer Lake was killed by bears at Pinnell Creek.

KEY WORDS: Frazer Lake, sockeye, introduction, smolt, escapement, fishpass, spawning surveys, Kodiak, bear

INTRODUCTION

Frazer Lake, located on the southern end of Kodiak Island, is the second largest lake on the Kodiak Archipelago (Figure 1). The lake covers 4,200 acres and is 8.6 mi long and 0.8 mi wide. It has a mean depth of 108.9 ft and a maximum depth of 193.2 ft. The principal inlet stream is Pinnell Creek which enters the lake at the west end. The outlet stream, Dog Salmon Creek, is at the east end of the lake and flows southeasterly 8.0 mi to where it enters lower Olga Bay. A natural, 30-ft high fish barrier falls occurs on Dog Salmon Creek 0.6 mi below the outlet of Frazer Lake.

Sockeye salmon (*Oncorhynchus nerka*) were first introduced into Frazer Lake in 1951 starting with an egg plant (Russell 1972, Blackett 1979). For the next 20 years (1952-1971) a combination of egg, fry, and adult transplants were used to develop the population. From 1951 through 1956 egg plants were made from the Karluk Lake early run spawners; in 1958 and from 1961 through 1969 adults from early run Red Lake escapements were introduced; in 1961, 1966 and from 1968 through 1971 fry from the Red Lake early run were introduced; and in 1968 eggs from Becharof Lake outlet spawners were transplanted to the system. Although several brood stocks were introduced into the system, it is not known which stock contributed the most to the success of the sockeye introduction.

The first Frazer Lake sockeye run occurred in 1956. That same year and through 1962 the returning fish were back-packed over the falls to the lake. The first fishpass at the falls was installed in 1962 (Ziemer 1962), and a second fishpass was added in 1979 (Blackett 1987). Initially the introduced population responded well to the combination of conservative management and the new habitat as the escapements built from fewer than 25,000 fish before 1971, to 55,000 - 83,000 fish during 1971-75, to 119,000 - 142,000 fish during 1976-79, and to 378,000 - 430,000 fish during 1980-82. However in the last 4 years the population has dramatically fluctuated with escapements ranging from fewer than 54,000 fish in 1984 to more than 485,000 fish in 1985.

Frazer Lake sockeye salmon are harvested in commercial gill net and seine fisheries in June and early July operating at the south-end of Kodiak Island. The run is managed on escapement counts obtained at the Dog Salmon Creek weir located 0.3 mi above lower Olga Bay and aerial counts of sockeye salmon staging in the closed-waters area at the mouth of Dog Salmon Creek. The escapement is re-counted at falls for a back-up against wash-out of the Dog Salmon Creek weir and for a more precise measure of the escapement reaching Frazer Lake.

Blackett (1979) estimated that Frazer Lake had sufficient rearing capacity to support the fry produced from a 400,000 fish escapement and a spawning area capacity for a 383,000 fish escapement. Kyle, Koenings, and Barrett (in press) suggest that Frazer Lake is rearing limited, and that not only are fewer spawners needed to match the rearing capacity of the lake but that the 400,000 range escapements have adversely affected the rearing capacity of Frazer Lake. Currently the Fisheries Rehabilitation, Enhancement and Development (FRED) Division is considering fertilizing

Frazer Lake to rehabilitate the rearing environment (J.P. Koenings, Alaska Department of Fish and Game, Soldotna, personal communication).

In 1986 the Frazer Lake fishpass operation was transferred from the FRED Division to the Division of Commercial Fisheries (CF). The current goal is to manage the Frazer Lake system for optimal sockeye production which includes setting an escapement objective that is in balance with the lake's rearing capacity and to accurately forecast annual returns. The basic data required to determine optimum escapement and to forecast returns includes a time series of data covering: escapements and catches; escapement age, length, and sex compositions; smolt age, length, and weight; and spawner distribution.

This report addresses the 1986 field work by the Division of Commercial Fisheries at Frazer Lake and includes a compilation of the historic catch, escapement, and smolt data available on the system.

METHODS

A downstream migrant, inclined plane trap as described by Mesiar (1986) was operated behind the lower adult salmon diversion weir from 17 May through 11 July (Figure 2). The trap was fished in two locations. From 17 May through 2 June the trap was positioned between weir unipods 5 and 6, and from 3 June through the end of the season it was positioned in relatively swifter water between unipods 6 and 8. On 3 June the trap was also outfitted with 13-ft leads to increase trap efficiency. The trap was checked several times daily for proper operation and catch. All captured fish were enumerated by species and released. A total of 220 sockeye smolt were sampled weekly for age, length, and weight. Each weekly sample was taken from a single days catch. To ensure random selection, the trap contents were stirred before any fish were removed. A small mesh dip net was used to remove the smolt from the trap to water-filled 5-gal plastic buckets. Anesthetized with MS-222, the smolt were measured to the nearest mm from tip-of-snout to fork-of-tail, weighed to the nearest 0.1 g, and age sampled by removing 5-10 scales from the preferred area (INPFC 1963). The smolt scales were mounted on glass slides and subsequently viewed for age determination with a standard microfiche reader.

A concrete smolt trap located at the south end of the lower diversion weir was operated concurrently with the inclined plane trap from 17 May through 11 July (Figure 2). To insure water flow and to channel out-migrant fish into the concrete trap, 30 ft of 5-ft wide visqueen was laid against the upstream face of the lower adult weir beginning at the offshore end of the trap mouth. An illustration of the concrete trap is in Eaton (1967). Through the season the trap was checked daily for catch and proper operation. All fish caught were enumerated by species and released.

All smolt catches were logged to the respective trap by sampling day. A sampling day encompassed a 24-h period extending from noon to noon and was identified as the calendar date corresponding to the first 12 h of the sampling day.

Smolt condition factor was calculated by the formula: $K = W(10^5)/L^3$, where W equals weight in grams and L equals length in millimeters.

All ages were reported in European notation (e.g., 2.3, where the first digit is the number of freshwater annuli, the second digit preceded by a period is the number of marine annuli, and the total age is the summation of the first and second digits plus one). Samples were summarized by statistical week. (A statistical week is a 7-day period starting at 0000 hours Sunday and ending on 2400 hours Saturday. Each statistical week is sequentially numbered beginning from the first Sunday in January.). A list of the 1986 statistical weeks and corresponding calendar dates are provided in Appendix A.

The lower adult weir associated with the fishpasses was installed on 17 May and kept fish-tight for adult salmon through 18 August (Figure 2). The fishpasses were operated from 21 June to 18 August. A description of the fishpasses facility is in Blackett (1987). Adult salmon ascending the fishpasses were counted at the top exit pool. Three observers used hand-held tally counters to record the species counts and wore polarized glasses for improved visibility. The exit pool gate was kept open while fish were being counted. At least four counts were taken daily. A total of 235 fish were sampled weekly from the escapement for age, length, and sex. The weekly sampling was conducted at the exit pool over a 1-2 day period that depended on fish and or staff availability. The taking of age, length, and sex data from these live adult salmon followed methods described by McGregor, McPherson, and Clark (1984). A standard microfiche reader was used to determine fish ages.

Fishpass evaluation data were collected from 2 July through 19 July. Periodic, 15-min counts were made of the number of fish entering, exiting, and dropping out of the respective old (1962) and new (1979) fishpasses. The counts were made by a person counting at the entrance while another person counted simultaneously at the exit tank at the top of the fishpass.

Escapement surveys of Frazer Lake inlet streams, except Pinnell Creek, were conducted nearly weekly from 26 July through 19 August. The surveys were conducted on foot by observers wearing polarized glasses and using hand-held tally counters. Live and dead fish by species were counted separately. In addition to fish counts, stream visibility, and distance surveyed were recorded on a standard form for each survey. Pinnell Creek and the shore area of Frazer Lake were surveyed twice in-season from fixed wing aircraft using the enumeration procedures as above.

Escapement age composition and associated standard errors were computed by statistical week. By age escapements within a statistical week were determined by multiplying the statistical week's proportion for a particular age by the escapement of that week. Standard error of the estimate for a particular age within a statistical week was determined by taking the square root of the variance as given by Cochran (1977, equation 3.12 without the finite population correction factor). Standard error provides a measure of the relative accuracy of the estimate but is not valid for confidence intervals. No standard errors were calculated across statistical weeks. Total escapement by age across statistical weeks was obtained by simple summation.

Mean lengths of the escapement by age and sex were computed from an unweighted composite of the weekly samples. Sex composition was estimated by statistical week.

Daily smolt catches, daily escapement counts, and the peak spawning ground counts graphically presented in this report were smoothed by the von Hann linear/filter method (BMDP 1981).

Brown bear predation on sockeye salmon at Pinnell Creek was calculated using standard methodology described by Cousens et al. (1982) and Johnson and Barrett (1986) for estimating escapement from spawning ground counts. In application of the methodology, expanded bear counts from the U.S. Fish and Wildlife Service (USFWS) at Kodiak, were substituted for fish counts to geometrically generate a bear abundance curve. The expanded counts assume that only one-third of the bears present were observed during an aerial surveys (V.G. Barnes, Kodiak National Wildlife Refuge, Kodiak, personal communication). The area under the bear abundance curve provided an estimate of the number of bear days at Pinnell Creek. With total number of bear days calculated, two estimates of the number of fish killed were determined by applying minimum and maximum per-bear consumption rates of five and 10 fish per day. The consumption rates are based on USFWS studies (V.G. Barnes, Kodiak National Wildlife Refuge, Kodiak, personal communication).

RESULTS AND DISCUSSION

In 1986 sockeye smolt migrated from Frazer Lake from mid-May through the end of June (weeks 20-27) based on trap catches (Figure 3). The peak migration occurred in late May and early June (weeks 21-23).

A total of 29,081 sockeye smolt were caught in the two traps operated below the falls at the Frazer fishpass. The inclined plane trap was more efficient as it accounted for 83% of the total catch (Appendix B.2 and B.3). The daily catches in the two traps were only poorly correlated. For example from 17 May through 2 June there was no correlation ($r^2 = 0.00$), and after 2 June when the inclined plane trap was relocated and fished with leads the trap catches were only slightly correlated ($r^2 = 0.32$). The lack of correlation in the trap catches from 17 May through 2 June can be attributed to high variability associated with extremely low operational success of each trap. This became apparent in late May when the crew noticed particularly large concentrations of smolt dropping over the falls without appreciable increase in the smolt catch in either trap. To improve catch efficiency, the inclined plane trap was relocated to a site with faster velocity water and fitted with a lead. This was accomplished on 3 June and the catch went from 56 smolt on 2 June to 1,146 smolt on 3 June (Appendix B.2). The concrete trap was not altered.

Four age classes of sockeye smolt out-migrated from Frazer Lake in 1986 (Table 1 and Appendix B). Most of the smolt were either age 1.0 (5.6%) or age 2.0 (94.3%) from the respective 1984 and 1983 parent year escapements. The dominance of age-2.0 smolt over age-1.0 smolt is not unusual. Age-2.0 smolt have been dominant for 10 of the 21 years sampled. Survival of age-

2.0 smolt is usually higher than for age-1.0 smolt. The average parent escapement return (1965-1981) has been 67% age-2.0 and 32% age-1.0 fish indicating that age-2.0 smolt survival is greater in the marine environment than among the age-1.0 smolt (Appendix B.3). In 1986, the age composition of the smolt changed relatively little between adjacent statistical weeks (Appendix B). However age-1.0 smolt did become slightly more abundant as the out-migration progressed, while at the same time age-2.0 smolt became less abundant. This temporal trend was generally evident in 1984 and 1985 (Appendix B).

In 1986 the age-1.0 smolt averaged 89.8 mm in length, 5.5 g in weight, and 0.76 in condition (Table 2). The age-2.0 smolt averaged 98.0 mm in length, 7.4 g in weight, and 0.79 in condition (Table 3). The age-1.0 and age-2.0 smolt in 1986 were above average in length, weight, and condition than the smolt produced from the 1980-82 parent escapements which annually averaged 400,000 fish. The improvement in smolt quality can be attributed to the size of the parent-year escapements which were 53,524 fish for age-1.0 fish and 158,340 fish for the age-2.0 fish. The age-1.0 and age-2.0 smolt in 1986 were smaller than the smolt produced from similar size pre-1980 escapements. The reduction can be attributed to the stressed rearing conditions in Frazer Lake caused by the high escapements from 1980-82 (Kyle, Koenings, and Barrett, in press).

The 1986 sockeye salmon escapement into Frazer Lake was 126,529 fish (Table 4). The majority (92.6%) of the escapement passed through the Frazer Lake fishpasses from 2 July through 19 July (weeks 27 -29) (Figure 4). The peak escapement occurred on 8 July (week 28) with 18,558 fish or 14.7% of the total season escapement migrating on that day. The median migration point (63,265 fish) was reached on 10 July (week 28).

The 1986 Frazer Lake escapement of 126,529 sockeye salmon is 7.3% less than the 136,553 fish count at Dog Salmon Creek weir 7.5 miles below the Frazer Lake fishpasses. The discrepancy between the counts can be attributed to: (1) losses associated to bear predation; (2) fishpass induced mortalities; and (3) observer error at Dog Salmon weir. The primary factors are probably brown bear predation in the stream reach between the two counting sites and mortalities brought upon by fish striking the padded concrete abutment at the fishpass entrance.

In 1986 sockeye salmon averaged a travel time of 6.8 days between Dog Salmon weir and the Frazer Lake fishpass facility, a distance of 7.7 mi (Appendix C). This was nearly identical to the 1985 season when the average was 6.9 days (Manthey 1986).

The 1986 Frazer Lake sockeye run was 178,205 fish. Of this amount 23% (41,652) was catch, while 77% (136,553 Dog Salmon weir count) was escapement (Table 5 and Appendix C.1). The 1986 run and catch levels were below average, and the escapement at the Frazer Lake fishpass (126,529) was also lower than average (Table 5). The lower escapement should benefit the recovery of Frazer Lake as a nursery area which has been adversely impacted by the relatively high numbers of fry produced from escapements in the 400,000 fish range (Kyle, Koenings, and Barrett, in press).

The majority of the escapement spawned along the shoals of Frazer Lake and in Pinnell Creek during 1986 (Appendix C.2). The peak of spawning was in August on both the lake shoals and in the inlet streams. Bear predation was substantial on the inlet streams. Of the 575 carcasses counted on 39 foot surveys of 12 inlet streams all were bear killed. No quantifiable data was collected on the impact of bear predation on shoal spawning fish. However bears generally have much lower impact on lake shoal spawners than on stream spawners by an order of several magnitude (T.A. Chatto, Kodiak National Wildlife Refuge, Kodiak, personal communication). Approximately 8% (10,080 fish) of the 1986 escapement through the Frazer fishpass was lost to bear predation at Pinnell Creek assuming a bear kill rate of 10 fish/day and 10,080 bear/days at Pinnell Creek (Table 6). The 1982-86 bear related mortality of Pinnell Creek has averaged 5% of the escapement counted through the fishpass.

From 1965 to present a general decline has occurred in the percentage of the escapement that spawns in the inlet streams of Frazer Lake, while at the same time there has been a general increase in lake shoal spawning (Figure 5 and Table 7). This trend should continue due to lower bear predation on shoal spawners and higher egg-to-fry survival that results because shoals generally buffer adverse weather related factors (e.g., scouring, dewatering, freezing) better than streams. The use of shoal areas by early run sockeye salmon appears to be somewhat atypical at least for the Kodiak Archipelago and Alaska Peninsula where except for a segment of the Karluk Lake and Buskin Lake early run, essentially all other early run escapements spawn in streams. This divergence indicates that the Frazer stock may still be colonizing spawning habitat and could eventually split into an early and a late run population with the early run using the inlet streams and the late run occupying lake shoals for spawning. An advantage to this would be lower littoral area competition between stream and shoal area produced young-of-the-year (age 0.0) fry through differences in emergence timing. At Frazer Lake May and June are critical months for fry rearing due to low food availability (G.B. Kyle, Alaska Department of Fish and Game, Soldotna, personal communication). A late run escapement spawning on the lake shoals, if similar to the late stock of neighboring Karluk Lake, would produce emerging fry in late June and early July when rearing conditions are more optimal than earlier in the year.

Within the Frazer Lake system all sockeye salmon spawning essentially occurs in Linda Creek, Midway Creek, Stumble Creek, Pinnell Creek, and the lake shoals. The combined peak counts of these areas has represented from 10% to 74% of the escapement counted at the fishpass (Table 7). The 19-year average is 32%. The peak counts are reasonably correlated with the fishpass escapement counts ($r^2 = 0.83$). Cousens et al. (1982) reports that a peak count does not represent total escapement or even a consistent portion of total escapement and is, at best, an escapement index.

The 1986 escapement was 13.5% 4-year-olds, 5.7% 5-year-olds, and 79.6% 6-year-olds (Tables 8 and 9). Most of the 4-year-olds were age 1.2, 5-year-olds age 2.2, and 6-year-olds age 2.3. Overall, males were less abundant than females by a 0.6:1 ratio (Table 10). Only among ages 1.1 and 2.1 were males more abundant than females. The average male and female lengths were 546 mm and 538 mm, respectively (Table 11). The average sockeye length was 541 mm.

Historically, the escapements have averaged 22.4% for 4-year-olds, 55.1% for 5-year-olds, and 20.8% for 6-year-olds (Table 9). The relatively large composition of 6-year-olds (79.6%) in 1986 is attributable to the near complete failure of the 1981 brood year to produce 5-year-olds or any other age fish to date (Table 12). The return per spawner ratio for the 1981 brood-year escapement (485,835) is 0.1:1 which is the lowest on record. The 1982 parent-year escapement of 430,423 fish has produced relatively few 3- and 4-year-old fish (Tables 8 and 10). The return per spawner ratio for the 1982 brood-year will probably be less than 1.0:1 unless a relatively high number of 6-year-olds return in 1987 which is unlikely based on cohort returns to date.

In 1986, 127 chinook and 9 chum salmon passed through the Frazer Lake fishpasses (Table 4). Most (86%) of the chinook migration occurred between 1 July and 21 July. The chum salmon passed through the fishpasses between 8 July and 8 August.

The old fishpasses built in 1962 was constructed with three resting pools and the new fishpass built in 1979 was outfitted with a single resting pool. The new fishpass has consistently performed poorly compared to the old fishpass (Blackett 1987). The 1986 season was no exception. Both fishpasses received about the same level of fish use at their entrances in 1986 yet the old fishpass successfully passed four times as many fish as the new fishpass (Appendix C).

Blackett (1987) suggests that the lower efficiency of the new fishpass may be due in part to plywood chute extensions in the old fishpass entry that were not in the new fishpass and slight elevation differences between the respective fishpass exits which allows more flow to enter the old fishpass. In 1985 chute extensions were added to the new fishpass (R.F. Blackett, Alaska Department of Fish and Game, Kodiak, personal communication), and in 1986 the elevation at the new fishpass exit was lowered to match the exit elevation of the old fishpass. Together the changes made no marked improvement in salmon migration through the new fishpass. The apparent problem with the new fishpass is that it does not have a sufficient number of resting pools. Because severe muscular activity associated with swimming through rapidly flowing water can be stressful even to the point of being lethal to salmon (Black 1958), it is recommended that the new fishpass be closed except for the times when the design capacity of the old fishpass may be exceeded. The design capacity of the two fishpasses is above 40,000 fish per day or 2,500/h over a 16 h work day (Blackett 1987). If assumed for simplicity that both fishpasses are equally efficient then the old fishpass can be operated singly until a 1,250/h passage rate is exceeded.

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TABLES AND FIGURES

Table 1. Age composition of sockeye salmon smolt sampled at the Frazer Lake fishpasses from 1965 through 1986.

Year	Escap.	Number Sampled by Age Class					Age Composition			
		0.0	1.0	2.0	3.0	Total	0.0	1.0	2.0	3.0
1963	11,857									
1964	9,966									
1965	9,074	0	698	346	13	1,057	0.0%	66.0%	32.7%	1.2%
1966	16,456	0	542	1,358	16	1,916	0.0%	28.3%	70.9%	0.8%
1967	21,834	0	1,196	680	62	1,938	0.0%	61.7%	35.1%	3.2%
1968	16,738	0	1,517	264	8	1,789	0.0%	84.8%	14.8%	0.4%
1969	14,041	-	-	-	-	-	-	-	-	-
1970	24,039	0	1,878	649	10	2,537	0.0%	74.0%	25.6%	0.4%
1971	55,366	0	130	334	6	470	0.0%	27.7%	71.1%	1.3%
1972	66,419	0	452	22	0	474	0.0%	95.4%	4.6%	0.0%
1973	56,255	0	46	74	0	120	0.0%	38.3%	61.7%	0.0%
1974	82,609	0	212	564	75	851	0.0%	24.9%	66.3%	8.8%
1975	64,199	0	366	949	4	1,319	0.0%	27.7%	71.9%	0.3%
1976	119,321	0	492	418	27	937	0.0%	52.5%	44.6%	2.9%
1977	139,548	0	385	403	0	788	0.0%	48.9%	51.1%	0.0%
1978	141,981	0	107	223	0	330	0.0%	32.4%	67.6%	0.0%
1979	126,742	0	460	371	0	831	0.0%	55.4%	44.6%	0.0%
1980	405,535	0	349	90	0	439	0.0%	79.5%	20.5%	0.0%
1981	377,716	0	250	68	0	318	0.0%	78.6%	21.4%	0.0%
1982	430,423	0	64	248	15	327	0.0%	19.6%	75.8%	4.6%
1983	158,340	0	23	495	1	519	0.0%	4.4%	95.4%	0.2%
1984	53,524	19	1,189	51	2	1,261	1.5%	94.3%	4.0%	0.2%
1985	485,835	117	2,388	50	0	2,555	4.6%	93.5%	2.0%	0.0%
1986	126,529	1	85	1,438	1	1,525	0.1%	5.6%	94.3%	0.1%
						Mean	0.3%	52.1%	46.5%	1.1%

Table 2. Length, weight, and condition factor of age 1.0 sockeye salmon smolt produced from the 1963 through 1986 escapements.

Year	Escap.	Length			Weight			Condition Factor 1/		
		Sample Size	Mean (mm)	Standard Error	Sample Size	Mean (g)	Standard Error	Sample Size	Mean (g)	Standard Error
1963	11,857	698	146.0	0.4	238	27.2	0.1	238	0.91	-
1964	9,966	542	153.0	0.3	205	31.0	0.3	205	0.93	-
1965	9,074	1,196	147.0	0.2	269	28.8	0.3	269	0.90	-
1966	16,456	1,517	154.0	0.2	379	36.3	0.4	379	0.92	-
1967	21,834	-	-	-	-	-	-	-	-	-
1968	16,738	1,878	149.0	0.2	669	30.9	0.2	669	0.93	-
1969	14,041	130	129.9	0.6	62	20.5	0.5	62	0.93	-
1970	24,039	452	120.2	0.2	451	15.8	0.1	451	0.91	-
1971	55,366	46	125.5	2.0	46	18.2	0.7	46	0.91	-
1972	66,419	212	123.5	0.6	184	18.0	0.3	184	0.95	-
1973	56,255	366	132.0	0.3	362	22.4	0.1	362	0.97	-
1974	82,609	492	130.0	0.2	463	19.3	0.1	463	0.88	-
1975	64,199	385	130.0	0.3	385	20.7	0.1	385	0.95	-
1976	119,321	107	125.6	0.6	107	17.2	0.2	107	0.87	-
1977	139,548	460	112.9	0.3	460	11.9	0.1	460	0.83	-
1978	141,981	349	106.6	0.2	349	9.1	0.1	349	0.75	-
1979	126,742	250	90.3	0.3	250	5.8	0.1	250	0.78	-
1980	405,535	64	80.4	0.7	64	4.1	0.1	64	0.77	-
1981	377,716	23	84.1	1.2	23	5.0	0.2	23	0.82	-
1982	430,423	1,189	76.3	0.2	1,189	2.9	0.0	1,189	0.64	0.002
1983	158,340	2,388	70.0	0.1	2,388	2.6	0.0	2,388	0.73	0.001
1984	53,524	85	89.8	0.6	85	5.5	0.1	85	0.76	0.007
1985	485,835									
1986	126,529									

Table 3. Length, weight, and condition factor of age 2.0 sockeye salmon smolt produced from the 1962 through 1986 escapements.

Escap. Year	Escap.	Length			Weight			Condition Factor 1/		
		Sample Size	Mean (mm)	Standard Error	Sample Size	Mean (g)	Standard Error	Sample Size	Mean (g)	Standard Error
1962	3,090	346	174.0	0.9	65	48.0	0.6	65	0.89	-
1963	11,857	1,358	180.0	0.3	488	53.1	0.5	488	0.91	-
1964	9,966	680	177.0	0.5	279	53.2	0.7	279	0.97	-
1965	9,074	264	185.0	0.7	176	62.0	0.6	176	0.94	-
1966	16,456	-	-	-	-	-	-	-	-	-
1967	21,834	649	180.0	0.5	566	54.0	0.4	566	0.93	-
1968	16,738	334	173.1	0.6	97	44.5	1.1	97	0.86	-
1969	14,041	22	151.3	2.5	22	31.7	1.7	22	0.92	-
1970	24,039	74	142.3	0.8	74	25.6	0.5	74	0.88	-
1971	55,366	564	150.5	0.4	531	29.9	0.2	531	0.89	-
1972	66,419	949	149.0	0.3	931	29.5	0.1	931	0.89	-
1973	56,255	418	157.0	0.4	390	34.0	0.3	390	0.87	-
1974	82,609	403	154.0	0.4	403	32.0	0.2	403	0.88	-
1975	64,199	223	144.5	0.7	223	26.0	0.4	223	0.86	-
1976	119,321	371	143.2	0.3	371	23.4	0.2	371	0.80	-
1977	139,548	90	109.0	0.5	90	9.8	0.1	90	0.75	-
1978	141,981	68	108.2	1.2	68	10.2	0.4	68	0.79	-
1979	126,742	248	95.2	0.8	248	7.0	0.2	248	0.78	-
1980	405,535	495	94.8	0.2	495	6.9	0.0	495	0.81	-
1981	377,716	51	99.2	1.7	51	7.1	0.5	51	0.68	0.002
1982	430,423	50	83.9	1.0	50	4.7	0.2	50	0.80	0.008
1983	158,340	1,438	98.0	0.1	1,437	7.4	0.0	1,437	0.79	0.004
1984	53,524									
1985	485,835									
1986	126,529									

Table 4. Daily and cumulative escapement counts by species, Frazer Lake fishpasses, 1986.

Calendar Date	Chinook		Sockeye		Pink		Chum		Coho	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
23-Jun	4	4	0	0	0	0	0	0	0	0
24-Jun	1	5	0	0	0	0	0	0	0	0
25-Jun	1	6	0	0	0	0	0	0	0	0
26-Jun	0	6	0	0	0	0	0	0	0	0
27-Jun	0	6	0	0	0	0	0	0	0	0
28-Jun	0	6	0	0	0	0	0	0	0	0
29-Jun	0	6	0	0	0	0	0	0	0	0
30-Jun	0	6	0	0	0	0	0	0	0	0
01-Jul	3	9	0	0	0	0	0	0	0	0
02-Jul	20	29	8,400	8,400	0	0	0	0	0	0
03-Jul	1	30	2,892	11,292	0	0	0	0	0	0
04-Jul	3	33	3,010	14,302	0	0	0	0	0	0
05-Jul	9	42	10,708	25,010	0	0	0	0	0	0
06-Jul	0	42	7,168	32,178	0	0	0	0	0	0
07-Jul	3	45	1,400	33,578	0	0	0	0	0	0
08-Jul	4	49	18,558	52,136	0	0	1	1	0	0
09-Jul	0	49	1,305	53,441	0	0	0	1	0	0
10-Jul	16	65	14,247	67,688	0	0	0	1	0	0
11-Jul	5	70	13,136	80,824	0	0	0	1	0	0
12-Jul	11	81	2,334	83,158	0	0	0	1	0	0
13-Jul	3	84	4,239	87,397	0	0	0	1	0	0
14-Jul	5	89	4,315	91,712	0	0	0	1	0	0
15-Jul	0	89	931	92,643	0	0	0	1	0	0
16-Jul	1	90	1,354	93,997	0	0	0	1	0	0
17-Jul	0	90	1,848	95,845	0	0	1	2	0	0
18-Jul	13	103	16,634	112,479	0	0	1	3	0	0
19-Jul	8	111	4,720	117,199	0	0	1	4	0	0
20-Jul	2	113	518	117,717	0	0	0	4	0	0

-Continued-

Table 4. (page 2 of 2)

Calendar Date	Chinook		Sockeye		Pink		Chum		Coho	
	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
21-Jul	2	115	1,936	119,653	0	0	1	5	0	0
22-Jul	0	115	109	119,762	0	0	0	5	0	0
23-Jul	0	115	1,970	121,732	0	0	0	5	0	0
24-Jul	1	116	1,322	123,054	0	0	0	5	0	0
25-Jul	3	119	1,743	124,797	0	0	0	5	0	0
26-Jul	0	119	360	125,157	0	0	0	5	0	0
27-Jul	1	120	262	125,419	0	0	0	5	0	0
28-Jul	1	121	402	125,821	0	0	1	6	0	0
29-Jul	4	125	262	126,083	0	0	0	6	0	0
30-Jul	0	125	119	126,202	0	0	0	6	0	0
31-Jul	0	125	58	126,260	0	0	1	7	0	0
01-Aug	0	125	57	126,317	0	0	0	7	0	0
02-Aug	0	125	47	126,364	0	0	0	7	0	0
03-Aug	0	125	66	126,430	0	0	1	8	0	0
04-Aug	1	126	11	126,441	0	0	0	8	0	0
05-Aug	0	126	3	126,444	0	0	0	8	0	0
06-Aug	0	126	7	126,451	0	0	0	8	0	0
07-Aug	0	126	21	126,472	0	0	0	8	0	0
08-Aug	1	127	11	126,483	0	0	1	9	0	0
09-Aug	0	127	8	126,491	0	0	0	9	0	0
10-Aug	0	127	7	126,498	0	0	0	9	0	0
11-Aug	0	127	2	126,500	0	0	0	9	0	0
12-Aug	0	127	0	126,500	0	0	0	9	0	0
13-Aug	0	127	0	126,500	0	0	0	9	0	0
14-Aug	0	127	4	126,504	0	0	0	9	0	0
15-Aug	0	127	6	126,510	0	0	0	9	0	0
16-Aug	0	127	1	126,511	0	0	0	9	0	0
17-Aug	0	127	9	126,520	0	0	0	9	0	0
18-Aug	0	127	9	126,529	0	0	0	9	0	0

Table 5. Sockeye salmon catch and escapement figures, Dog Salmon Creek (Frazer Lake drainage), 1956 through 1986.

Year	Numbers of Fish		
	Escapement	Catch	Total
1956	6	-	6
1957	165	-	165
1958	113	-	113
1959	62	-	62
1960	440	-	440
1961	873	-	873
1962	3,090	-	3,090
1963	11,857	-	11,857
1964	9,966	-	9,966
1965	9,074	-	9,074
1966	16,456	-	16,456
1967	21,834	-	21,834
1968	16,738	-	16,738
1969	14,041	8,610	22,651
1970	24,039	3,904	27,943
1971	55,366	10,549	65,915
1972	66,419	2,761	69,180
1973	56,255	1,210	57,465
1974	82,609	2,765	85,374
1975	64,199	3,300	67,499
1976	119,321	8,770	128,091
1977	139,548	1,366	140,914
1978	141,981	30,336	172,317
1979	126,742	26,805	153,547
1980	405,535	55,173	460,708
1981	377,716	110,210	487,926
1982	430,423	76,232	506,655
1983	158,340	37,983	196,323
1984	53,524	13,853	67,377
1985	506,336	131,535	637,871
1986	136,553	41,652	178,205

Table 6. Estimated number of sockeye salmon killed by brown bears at Pinnell Creek in the Frazer Lake drainage, 1982, and 1984-1986.

Year	Frazer Escapement (fishpass)	Pinnell Creek				Percent of Frazer Escape. Killed at Pinnell Cr. (10fish/bear/day)
		Peak Bear Count	No. of Bear Days	Number Fish Kills @5fish/bear/day	Number Fish Kills @10fish/bear/day	
1982	430,423	20	2,151	10,755	21,510	5%
1983	-	-	-	-	-	-
1984	53,524	7	100	500	1,000	2%
1985	485,835	30	2,045	10,225	20,450	4%
1986	126,529	32	1,008	5,040	10,080	8%
Mean	274,078	22	1,326	6,630	13,260	5%

Table 7. Peak sockeye salmon counts of the primary spawning areas in the Frazer Lake drainage and the percent of the Frazer Lake escapement represented by the combined peak counts, 1965-1986.

Year	Peak Counts ¹					Totals	Total Escapement (fishpass)	Total Peak Counts/Total Escapement
	Linda Creek	Midway Creek	Stumble Creek	Pinnell Creek	Frazer Lake shoals			
1965	565	46	287	876	0	1,774	9,074	20%
1966	1,135	238	9	2,603	247	4,232	16,456	26%
1967	767	387	167	4,288	286	5,895	21,834	27%
1968	694	285	225	2,196	-	-	16,738	-
1969	646	194	222	1,057	315	2,434	14,041	17%
1970	1,086	192	93	1,508	342	3,221	24,039	13%
1971	912	148	295	3,329	712	5,396	55,366	10%
1972	1,102	131	68	1,300	4,400	7,001	66,419	11%
1973	560	142	408	9,000	6,750	16,860	56,255	30%
1974	850	38	1,570	43,662	10,542	56,662	82,609	69%
1975	616	301	195	39,100	6,642	46,854	64,199	73%
1976	752	333	430	13,679	5,720	20,914	119,321	18%
1977	898	319	1,237	94,750	5,825	103,029	139,548	74%
1978	383	382	586	46,234	9,450	57,035	141,981	40%
1979	828	408	537	22,376	6,480	30,629	126,742	24%
1980	1,302	763	1,085	145,316	36,400	184,866	405,535	46%
1981	762	1,156	1,175	182,000	22,300	207,393	377,716	55%
1982	1,333	813	885	62,232	60,550	125,813	430,423	29%
1983	444	301	61	20,650	2,908	24,364	158,340	15%
1984	139	63	1	7,537	1,690	9,430	53,524	18%
1985	504	466	380	-	-	157,350	485,835	-
1986	303	131	181	-	-	21,840	126,529	-

¹Peak counts include live and dead fish.

Table 8. Age composition of the Frazer Lake sockeye salmon escapement by statistical week, 1986.

Statistical Week	Sample Size		-----Age Group-----								Total
			1.1	1.2	2.1	1.3	2.2	2.3	3.2	3.3	
27	202	Percent	0.0	13.4	0.0	0.5	3.5	79.7	0.5	2.5	100.0
		Numbers	0	3,343	0	124	867	19,934	124	619	25,010
		SE	0	600	0	124	323	710	124	274	
28	190	Percent	0.0	10.0	0.5	2.1	3.7	82.1	0.0	1.6	100.0
		Numbers	0	5,815	306	1,224	2,142	47,743	0	918	58,148
		SE	0	1,269	306	607	797	1,621	0	527	
29	192	Percent	0.0	15.6	0.0	1.0	5.2	77.1	1.0	0.0	100.0
		Numbers	0	5,319	0	355	1,773	26,240	355	0	34,041
		SE	0	894	0	250	547	1,035	250	0	
30	197	Percent	0.0	24.4	0.0	0.5	8.1	67.0	0.0	0.0	100.0
		Numbers	0	1,939	0	40	646	5,332	0	0	7,958
		SE	0	244	0	40	155	267	0	0	
31	187	Percent	0.5	27.3	0.0	0.0	5.4	66.3	0.5	0.0	100.0
		Numbers	7	374	0	0	73	910	7	0	1,372
		SE	7	45	0	0	23	48	7	0	
Total			7	16,790	306	1,743	5,501	100,159	486	1,537	126,529

Table 9. Age composition of the Frazer Lake sockeye salmon escapement, 1965-1986.

Year	Age Class (% composition)												Sample Size
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	
1965	0.0	0.9	1.7	0.0	6.5	78.0	9.0	0.0	0.2	3.5	0.2	0.0	463
1966	0.6	15.7	7.2	0.2	1.3	57.1	12.0	0.1	0.4	5.1	0.3	0.0	1,577
1967	0.3	6.5	6.6	0.7	1.6	42.0	29.6	1.9	0.5	6.5	3.6	0.2	1,380
1968	0.6	4.0	3.0	0.0	4.0	66.0	22.0	0.0	0.2	0.2	0.0	0.0	774
1969	0.0	0.0	0.0	0.0	5.7	71.4	17.7	0.0	0.9	2.6	1.7	0.0	424
1970	4.0	42.3	1.7	0.0	6.2	44.8	1.0	0.0	0.0	0.0	0.0	0.0	420
1971	0.7	58.6	11.5	0.0	0.6	24.5	3.9	0.0	0.0	0.1	0.1	0.0	1,386
1972	0.2	22.5	55.5	0.0	1.3	16.7	3.8	0.0	0.0	0.0	0.0	0.0	599
1973	3.9	25.5	26.5	0.0	9.1	26.1	8.9	0.0	0.0	0.0	0.0	0.0	517
1974	0.6	20.7	10.9	0.0	19.9	35.3	12.6	0.0	0.0	0.0	0.0	0.0	493
1975	1.1	2.1	2.5	0.0	9.4	76.0	8.9	0.0	0.0	0.0	0.0	0.0	629
1976	0.2	8.5	0.6	0.0	8.6	72.0	7.3	0.0	0.0	2.4	0.4	0.0	540
1977	7.7	1.9	5.7	0.0	4.0	65.2	14.3	0.0	0.0	0.0	1.2	0.0	401
1978	0.6	31.1	2.8	0.0	5.4	18.4	41.3	0.0	0.2	0.2	0.0	0.0	634
1979	1.4	14.7	18.7	0.0	5.8	48.9	10.4	0.0	0.1	0.0	0.0	0.0	654
1980	0.6	48.5	4.5	0.1	1.9	37.7	6.6	0.0	0.0	0.1	0.0	0.0	2,331
1981	1.6	15.0	15.1	0.0	0.6	52.8	14.9	0.0	0.0	0.0	0.0	0.0	1,775
1982	0.1	32.0	18.2	0.0	0.1	21.3	28.3	0.0	0.0	0.0	0.0	0.0	2,159
1983	0.0	0.7	12.3	0.0	0.5	11.7	74.4	0.0	0.0	0.2	0.2	0.0	820
1984	1.3	9.0	4.4	0.0	24.2	36.1	25.0	0.0	0.0	0.0	0.0	0.0	394
1985	0.2	1.9	1.2	0.0	0.0	92.4	4.2	0.0	0.0	0.0	0.1	0.0	1,829
1986	0.0	13.3	1.4	0.0	0.2	4.3	79.2	0.0	0.0	0.4	1.2	0.0	968
Mean	1.2	17.1	9.6	0.0	5.3	45.4	19.8	0.1	0.1	1.0	0.4	0.0	

Table 10. Sex composition of the Frazer Lake sockeye salmon escapement by statistical week, 1986.

Statistical Week	Sample			Escapement				
	Females	Males	Total	Percent Females	Percent Males	Females	Males	Total
27	101	139	240	42	58	10,525	14,485	25,010
28	136	104	240	57	43	32,951	25,198	58,148
29	142	91	233	61	39	20,746	13,295	34,041
30	172	68	240	72	28	5,703	2,255	7,958
31	179	56	235	76	24	1,045	327	1,372
Total	730	458	1,188	56	44	70,970	55,560	126,529

Table 11. Length by age and sex of sockeye salmon escapement sampled at the Frazer Lake fishpasses, 1986.

	-----Age Group-----								Total
	1.1	1.2	2.1	1.3	2.2	2.3	3.2	3.3	
Females									
Mean Length	0	496	0	546	500	551	486	533	538
SE	-	2.0	-	4.7	4.9	0.9	9.4	10.0	1.2
Range	0-0	448-565	0-0	531-565	453-560	443-611	468-499	497-555	443-611
Sample Size	0	114	0	6	28	451	3	5	607
Males									
Mean Length	283	498	323	548	513	562	497	577	546
SE	-	4.3	-	-	7.3	1.8	-	2.5	2.3
Range	283-283	400-571	323-323	521-575	449-596	436-648	497-497	574-582	283-648
Sample Size	1	61	1	2	22	268	1	3	359
All Fish									
Mean Length	283	497	323	547	506	555	489	550	541
SE	-	2.0	-	6.1	4.3	0.9	7.2	10.0	1.2
Range	283-283	400-571	323-323	521-575	449-596	436-648	468-499	497-582	283-648
Sample Size	1	175	1	8	50	721	4	8	968

Table 12. Frazer Lake sockeye salmon return by age class and escapement year, 1962 through 1986.

Year	Escap.	Return from Escapement by Age Class												Total Return	Return Per Spawner	Return Less Escap.
		1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4			
1962	3,090									0			385	0		
1963	11,857				0			4,009	0		589	0	0			
1964	9,966			0	0		16,173	279	0	204	0	66	0			
1965	9,074		0	475	0	1,291	12,518	2,571	0	0	66	0	0			
1966	16,456	0	11,820	7,580	0	1,732	16,149	2,629	0	0	0	0	0	39,910	2.4	23,454
1967	21,834	1,118	38,626	38,395	0	395	11,553	5,114	0	0	0	0	0	95,202	4.4	73,368
1968	16,738	461	15,565	15,228	0	899	14,998	10,757	0	0	0	0	0	57,910	3.5	41,172
1969	14,041	138	14,654	9,306	0	5,229	30,137	6,007	0	0	0	512	0	65,984	4.7	51,943
1970	24,039	2,241	17,672	1,687	0	16,989	51,299	9,351	0	0	3,074	1,691	0	104,005	4.3	79,966
1971	55,366	512	1,417	769	0	6,345	92,226	20,151	0	0	0	0	0	121,419	2.2	66,053
1972	66,419	742	10,888	8,032	0	11,016	91,876	71,167	0	0	345	0	0	194,066	2.9	127,647
1973	56,255	256	2,677	4,825	0	5,637	31,706	15,969	0	345	0	0	0	61,415	1.1	5,160
1974	82,609	10,850	53,591	28,713	461	9,305	75,084	30,407	0	154	461	0	0	209,026	2.5	126,417
1975	64,199	1,034	22,571	20,732	0	8,906	173,687	72,701	0	0	0	0	0	299,631	4.7	235,432
1976	119,321	2,150	223,444	73,677	0	8,753	257,625	143,383	0	0	0	393	0	709,424	5.9	590,103
1977	139,548	2,764	73,189	92,211	0	2,928	107,917	146,064	0	0	393	0	0	425,466	3.0	285,918
1978	141,981	7,807	162,130	24,148	0	507	22,970	16,844	0	0	0	638	0	235,043	1.7	93,062
1979	126,742	507	1,374	2,965	0	982	24,323	26,791	0	0	0	2,165		59,106	0.5	(67,636)
1980	405,535	0	6,064	7,654	0	16,305	589,393	141,065		0	684			761,166	1.9	355,631
1981	377,716	876	12,120	2,455		0	7,748			0				23,198	0.1	(354,518)
1982	430,423	1,276	23,647			431								25,354		
1983	158,340	10												10		
1984	53,524															
1985	485,835															
1986	126,529															

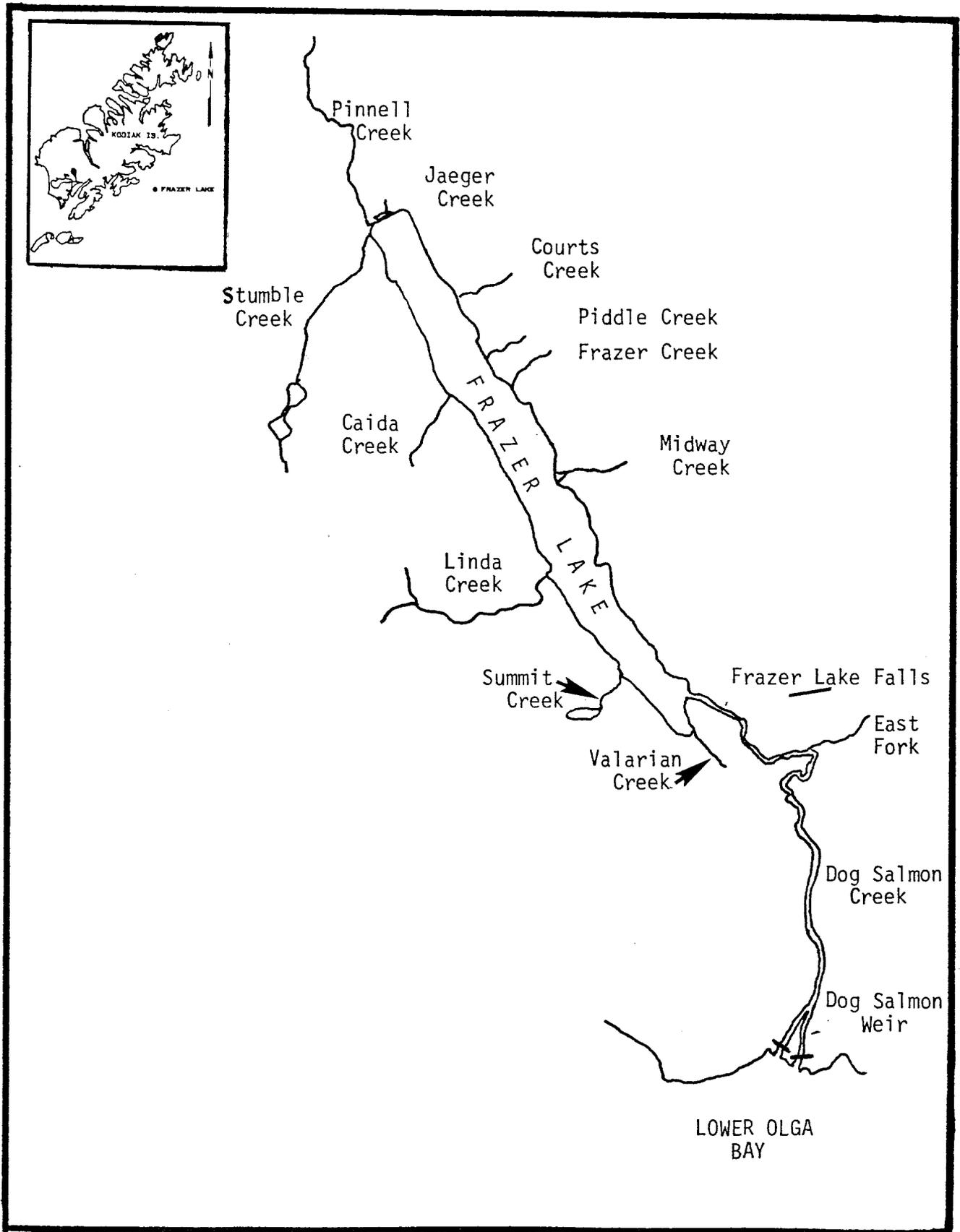


Figure 1. Map of Frazer Lake.

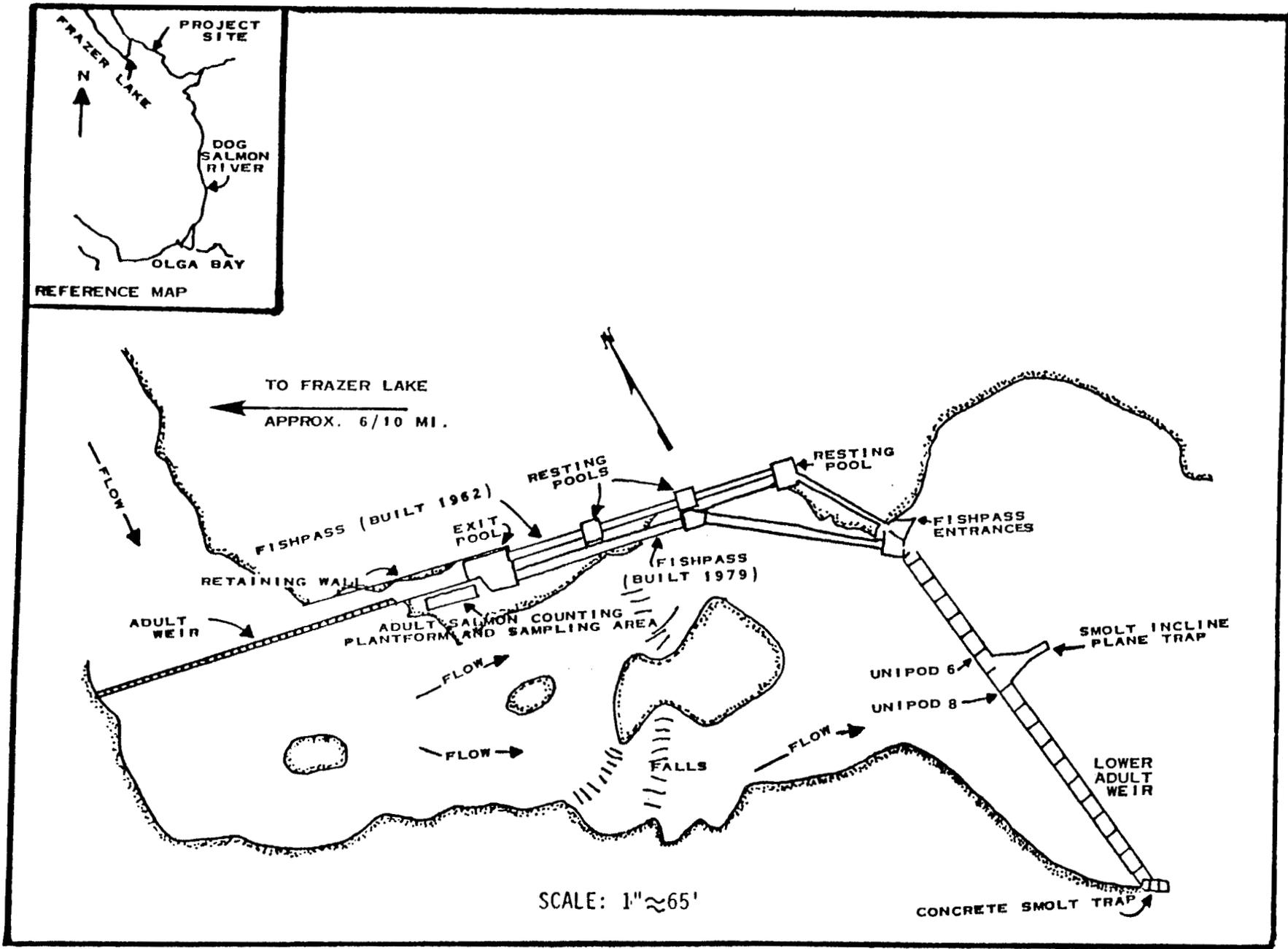


Figure 2. Schematic of the Frazer Lake fishpasses.

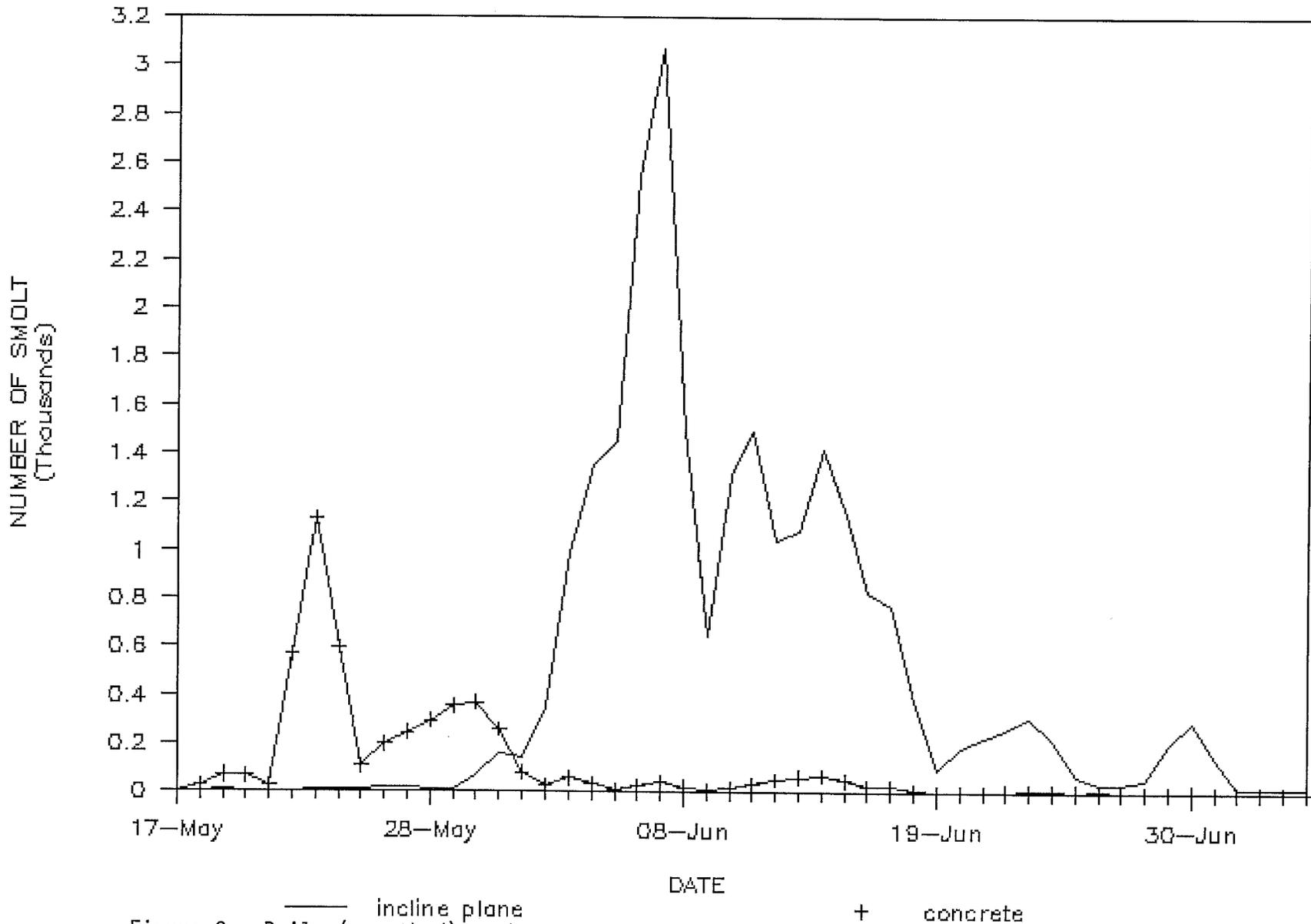


Figure 3. Daily (smoothed) sockeye salmon smolt catches in the inclined plane and concrete traps at Frazer Lake fishpasses, 1986.

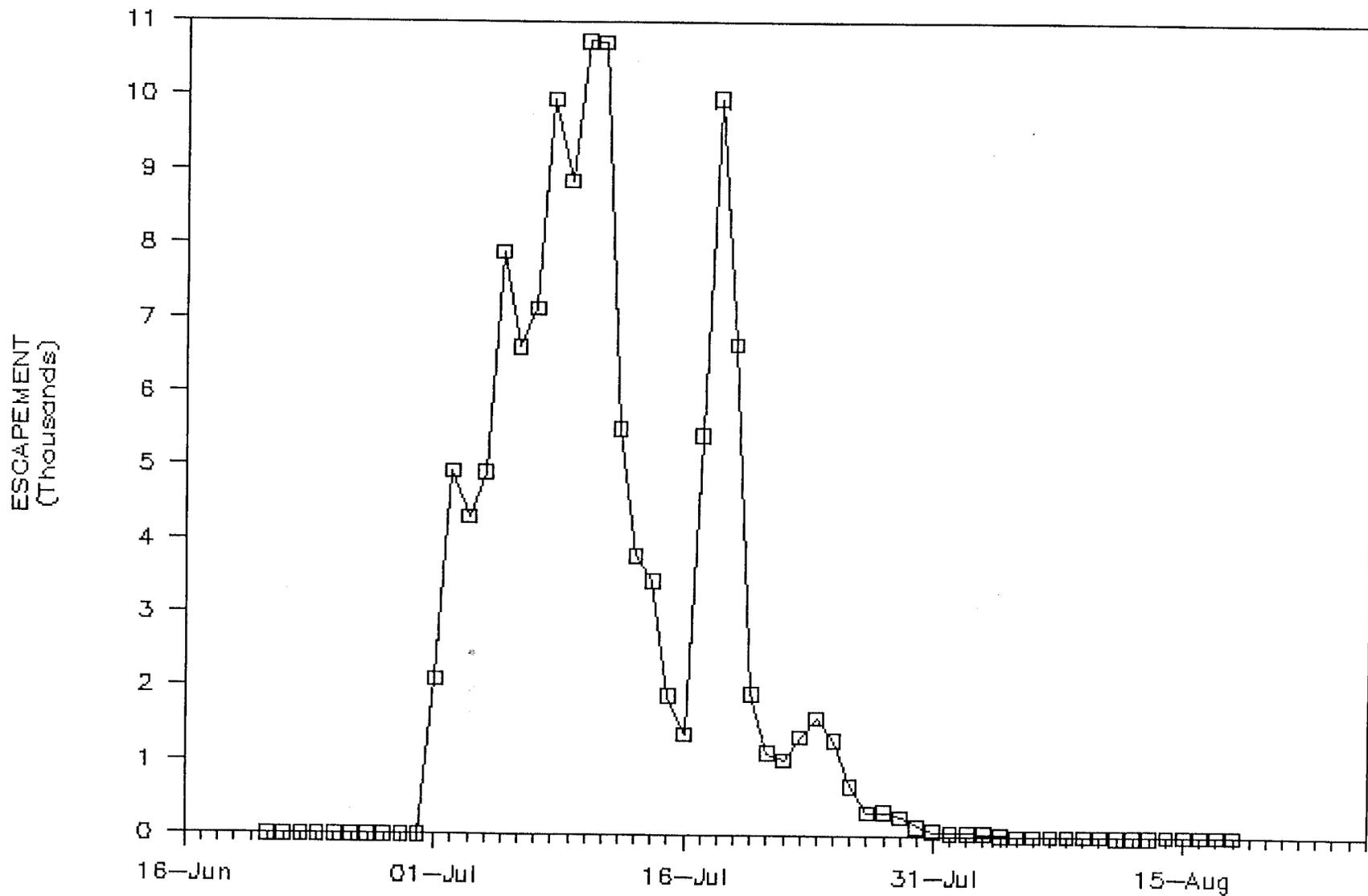


Figure 4. Daily (smoothed) escapement counts of sockeye salmon at the Frazer Lake fishpasses, 1986.

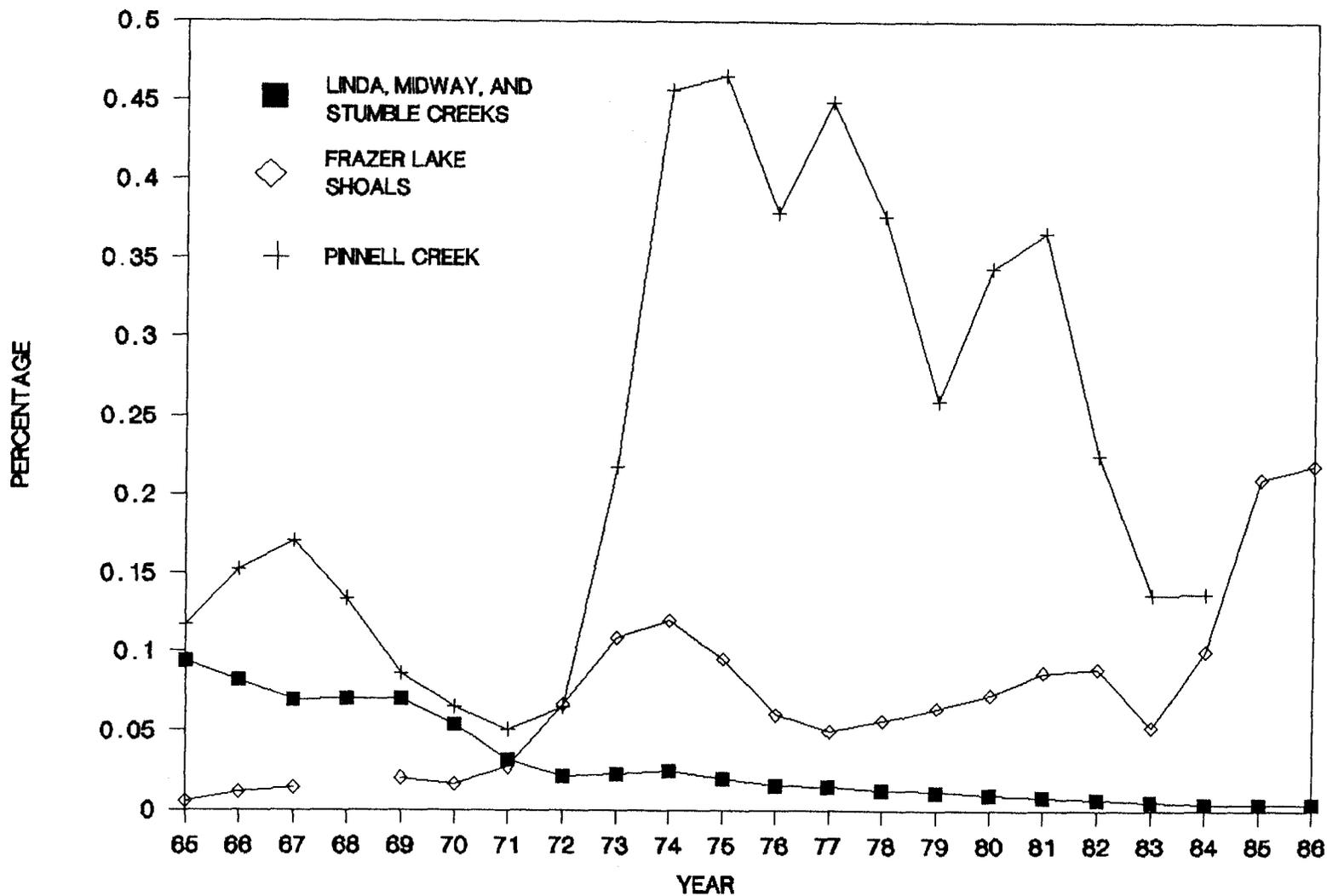


Figure 5. Sockeye salmon peak counts of Linda, Midway, and Stumble Creeks combined, Pinnell Creek, and Frazer Lake shoals as a percentage of the total escapement counted at the Frazer Lake fishpasses, 1965-86.

APPENDICES

Appendix A.1. 1986 statistical weeks by calendar days.

STATISTICAL WEEK	CALENDAR DATES	STATISTICAL WEEK	CALENDAR DATES
1	01/01 to 01/04	27	06/29 to 07/05
2	01/05 to 01/11	28	07/06 to 07/12
3	01/12 to 01/18	29	07/13 to 07/19
4	01/19 to 01/25	30	07/20 to 07/26
5	01/26 to 02/01	31	07/27 to 08/02
6	02/02 to 02/08	32	08/03 to 08/09
7	02/09 to 02/15	33	08/10 to 08/16
8	02/16 to 02/22	34	08/17 to 08/23
9	02/23 to 03/01	35	08/24 to 08/30
10	03/02 to 03/08	36	08/31 to 09/06
11	03/09 to 03/15	37	09/07 to 09/13
12	03/16 to 03/22	38	09/14 to 09/20
13	03/23 to 03/29	39	09/21 to 09/27
14	03/30 to 04/05	40	09/28 to 10/04
15	04/06 to 04/12	41	10/05 to 10/11
16	04/13 to 04/19	42	10/12 to 10/18
17	04/20 to 04/26	43	10/19 to 10/25
18	04/27 to 05/03	44	10/26 to 11/01
19	05/04 to 05/10	45	11/02 to 11/08
20	05/11 to 05/17	46	11/09 to 11/15
21	05/18 to 05/24	47	11/16 to 11/22
22	05/25 to 05/31	48	11/23 to 11/29
23	06/01 to 06/07	49	11/30 to 12/06
24	06/08 to 06/14	50	12/07 to 12/13
25	06/15 to 06/21	51	12/14 to 12/20
26	06/22 to 06/28	52	12/21 to 12/27

Appendix B.1. Daily and cumulative downstream migrant fish catch by species in the inclined plane trap at Frazer Lake fishpasses, 1986.

Julian Day	Calendar Day	Sockeye		Chinook		Coho		Dolly Varden		Stickleback	
		Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
137	17-May	0	0	0	0	0	0	0	0	0	0
138	18-May	0	0	0	0	0	0	0	0	0	0
139	19-May	23	23	0	0	0	0	0	0	0	0
140	20-May	1	24	0	0	0	0	0	0	0	0
141	21-May	0	24	0	0	0	0	0	0	0	0
142	22-May	0	24	0	0	0	0	0	0	0	0
143	23-May	21	45	0	0	0	0	0	0	0	0
144	24-May	10	55	0	0	0	0	0	0	0	0
145	25-May	11	66	0	0	0	0	0	0	0	0
146	26-May	26	92	0	0	0	0	0	0	0	0
147	27-May	26	118	0	0	0	0	0	0	0	0
148	28-May	10	128	0	0	0	0	0	0	0	0
149	29-May	8	136	0	0	0	0	0	0	0	0
150	30-May	2	138	0	0	0	0	0	0	0	0
151	31-May	252	390	0	0	0	0	0	0	0	0
152	01-Jun	132	522	0	0	0	0	0	0	0	0
153	02-Jun	56	578	0	0	0	0	0	0	0	0
154	03-Jun	1146	1724	1	1	0	0	0	0	1	1
155	04-Jun	1620	3344	6	7	0	0	0	0	3	4
156	05-Jun	1015	4359	0	7	0	0	0	0	0	4
157	06-Jun	2131	6490	0	7	0	0	0	0	0	4
158	07-Jun	4898	11388	2	9	0	0	0	0	1	5
159	08-Jun	347	11735	0	9	0	0	0	0	0	5
160	09-Jun	393	12128	0	9	0	0	0	0	0	5
161	10-Jun	1428	13556	0	9	0	0	0	0	0	5
162	11-Jun	1976	15532	0	9	0	0	0	0	2	7
163	12-Jun	584	16116	0	9	0	0	0	0	0	7
164	13-Jun	1016	17132	0	9	0	0	0	0	1	8
165	14-Jun	1709	18841	0	9	0	0	1	1	0	8
166	15-Jun	1248	20089	0	9	0	0	0	1	2	10
167	16-Jun	374	20463	0	9	0	0	0	1	0	10
168	17-Jun	1307	21770	0	9	0	0	0	1	1	11
169	18-Jun	96	21866	0	9	0	0	0	1	0	11
170	19-Jun	27	21893	0	9	0	0	0	1	0	11
171	20-Jun	237	22130	0	9	0	0	0	1	1	12
172	21-Jun	245	22375	0	9	0	0	0	1	0	12
173	22-Jun	188	22563	0	9	0	0	0	1	1	13
174	23-Jun	409	22972	3	12	0	0	0	1	1	14

- CONTINUED -

Appendix B.1. Daily and cumulative downstream migrant fish catch by species in the inclined plane trap at Frazer Lake fishpasses, 1986 (continued).

Julian Calendar		Sockeye		Chinook		Coho		Dolly Varden		Stickleback	
Day	Day	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
175	24-Jun	231	23203	0	12	0	0	0	1	0	14
176	25-Jun	2	23205	0	12	0	0	0	1	0	14
177	26-Jun	55	23260	0	12	0	0	0	1	0	14
178	27-Jun	42	23302	0	12	0	0	0	1	0	14
179	28-Jun	11	23313	0	12	0	0	0	1	0	14
180	29-Jun	155	23468	0	12	0	0	0	1	0	14
181	30-Jun	485	23953	0	12	0	0	0	1	0	14
182	01-Jul	42	23995	0	12	0	0	0	1	0	14
183	02-Jul	16	24011	0	12	0	0	0	1	2	16
184	03-Jul	12	24023	0	12	0	0	0	1	0	16
185	04-Jul	24	24047	0	12	0	0	0	1	0	16
186	05-Jul	13	24060	1	13	0	0	0	1	0	16
187	06-Jul	4	24064	0	13	1	1	0	1	0	16
188	07-Jul	2	24066	0	13	0	1	0	1	0	16
189	08-Jul	3	24069	0	13	0	1	0	1	0	16
190	09-Jul	12	24081	0	13	0	1	0	1	0	16
191	10-Jul	15	24096	0	13	0	1	0	1	0	16
192	11-Jul	0	24096	0	13	0	1	0	1	0	16

Appendix B.2. Daily and cumulative downstream migrant fish catch by species in the cement weir trap at Frazer Lake fishpasses, 1986.

Julian Calendar		Sockeye		Chinook		Coho		Dolly Varden		Stickleback		Rainbow	
Day	Day	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
137	17-May	4	4	0	0	0	0	0	0	0	0	0	0
138	18-May	0	4	0	0	0	0	0	0	0	0	0	0
139	19-May	109	113	0	0	0	0	0	0	0	0	0	0
140	20-May	67	180	0	0	0	0	0	0	0	0	0	0
141	21-May	15	195	0	0	0	0	0	0	0	0	0	0
142	22-May	18	213	0	0	0	0	0	0	0	0	0	0
143	23-May	2213	2426	0	0	0	0	0	0	0	0	0	0
144	24-May	62	2488	0	0	0	0	0	0	0	0	0	0
145	25-May	39	2527	0	0	0	0	1	1	0	0	0	0
146	26-May	285	2812	2	2	0	0	1	2	0	0	0	0
147	27-May	182	2994	0	2	0	0	1	3	0	0	0	0
148	28-May	326	3320	0	2	0	0	0	3	0	0	0	0
149	29-May	336	3656	0	2	0	0	0	3	0	0	0	0
150	30-May	414	4070	2	4	0	0	0	3	0	0	0	0
151	31-May	311	4381	1	5	0	0	0	3	0	0	0	0
152	01-Jun	2	4383	0	5	0	0	0	3	0	0	0	0
153	02-Jun	1	4384	0	5	0	0	0	3	0	0	0	0
154	03-Jun	112	4496	0	5	0	0	0	3	0	0	1	1
155	04-Jun	3	4499	0	5	0	0	0	3	0	0	0	1
156	05-Jun	11	4510	0	5	0	0	0	3	0	0	0	1
157	06-Jun	15	4525	0	5	0	0	0	3	0	0	0	1
158	07-Jun	74	4599	0	5	0	0	0	3	0	0	0	1
159	08-Jun	1	4600	0	5	0	0	0	3	0	0	0	1
160	09-Jun	20	4620	0	5	0	0	0	3	0	0	0	1
161	10-Jun	12	4632	0	5	0	0	0	3	0	0	0	1
162	11-Jun	23	4655	0	5	0	0	0	3	0	0	0	1
163	12-Jun	71	4726	0	5	0	0	0	3	0	0	0	1
164	13-Jun	44	4770	0	5	0	0	0	3	0	0	0	1
165	14-Jun	93	4863	0	5	0	0	0	3	0	0	1	2
166	15-Jun	42	4905	0	5	0	0	1	4	0	0	0	2
167	16-Jun	20	4925	0	5	0	0	0	4	0	0	1	3
168	17-Jun	36	4961	0	5	0	0	0	4	0	0	0	3
169	18-Jun	6	4967	0	5	0	0	0	4	0	0	0	3
170	19-Jun	1	4968	0	5	0	0	0	4	0	0	0	3
171	20-Jun	0	4968	0	5	0	0	0	4	0	0	0	3
172	21-Jun	4	4972	0	5	0	0	0	4	0	0	0	3

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Appendix B.2. Daily and cumulative downstream migrant fish catch by species in the cement weir trap at Frazer Lake fishpasses, 1986 (continued).

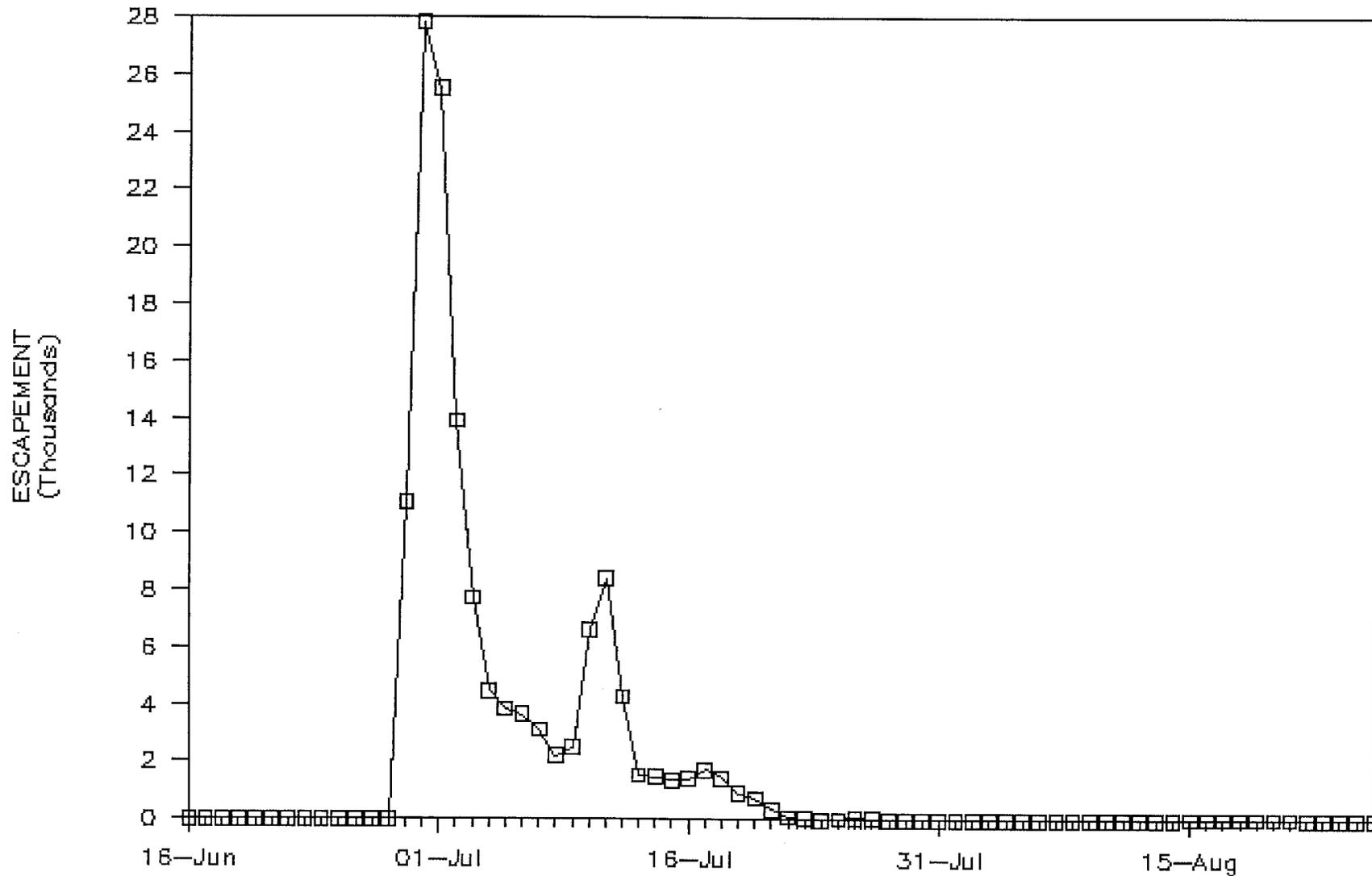
Julian Calendar		Sockeye		Chinook		Coho		Dolly Varden		Stickleback		Rainbow	
Day	Day	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
173	22-Jun	0	4972	0	5	0	0	0	4	0	0	0	3
174	23-Jun	21	4993	0	5	0	0	0	4	0	0	0	3
175	24-Jun	7	5000	0	5	0	0	0	4	0	0	0	3
176	25-Jun	2	5002	0	5	0	0	0	4	0	0	0	3
177	26-Jun	14	5016	0	5	0	0	0	4	0	0	0	3
178	27-Jun	0	5016	0	5	0	0	0	4	0	0	0	3
179	28-Jun	0	5016	0	5	0	0	0	4	0	0	0	3
180	29-Jun	1	5017	0	5	0	0	0	4	0	0	0	3
181	30-Jun	6	5023	0	5	0	0	0	4	0	0	0	3
182	01-Jul	5	5028	0	5	0	0	0	4	0	0	0	3
183	02-Jul	0	5028	0	5	5	5	0	4	0	0	0	3
184	03-Jul	1	5029	0	5	0	5	0	4	0	0	0	3
185	04-Jul	0	5029	0	5	0	5	0	4	0	0	0	3
186	05-Jul	0	5029	0	5	1	6	0	4	0	0	0	3
187	06-Jul	2	5031	0	5	1	7	0	4	0	0	0	3
188	07-Jul	0	5031	0	5	1	8	0	4	1	1	0	3
189	08-Jul	0	5031	0	5	1	9	0	4	1	2	0	3
190	09-Jul	0	5031	0	5	0	9	0	4	0	2	0	3
191	10-Jul	0	5031	0	5	0	9	0	4	0	2	0	3
192	11-Jul	0	5031	0	5	0	9	0	4	0	2	0	3

Appendix B.3. Length, weight, and condition factor of age 3.0 sockeye salmon smolt produced from the 1961 through 1986 escapements.

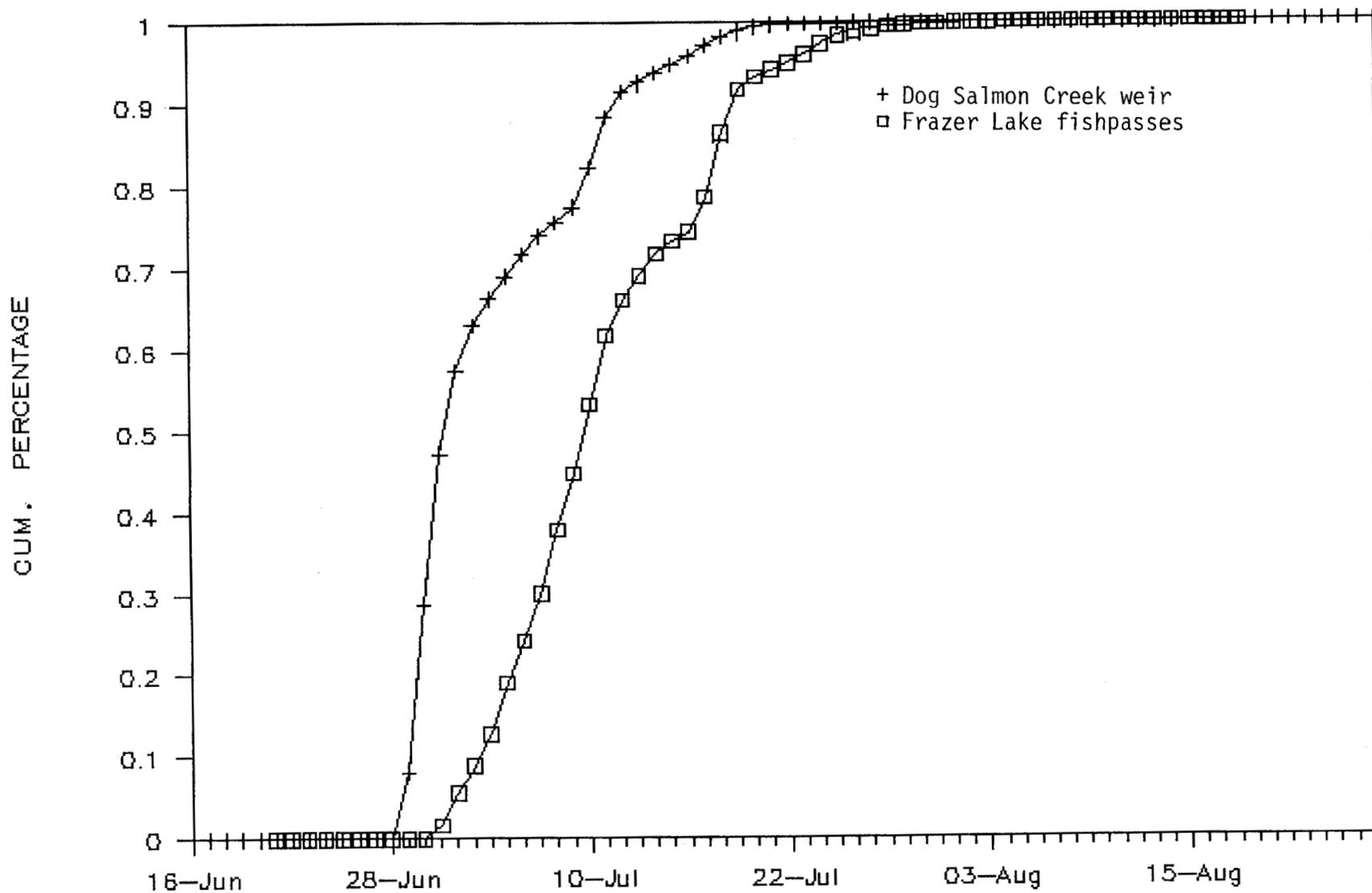
Escap. Year	Escap.	Length			Weight			Condition Factor		
		Sample Size	Mean (mm)	Standard Error	Sample Size	Mean (g)	Standard Error	Sample Size	Mean (g)	Standard Error
1961	873	13	193.0	-	-	-	-	-	-	-
1962	3,090	16	193.0	-	-	-	-	-	-	-
1963	11,857	62	201.0	1.7	48	76.4	1.6	48	0.94	-
1964	9,966	0	200.0	-	-	-	-	-	-	-
1965	9,074	-	-	-	-	-	-	-	-	-
1966	16,456	10	193.0	-	-	-	-	-	-	-
1967	21,834	6	191.3	8.2	3	72.9	12.0	3	1.04	-
1968	16,738	0	-	-	0	-	-	0	-	-
1969	14,041	0	-	-	0	-	-	0	-	-
1970	24,039	75	172.3	0.9	74	43.5	0.7	74	0.85	-
1971	55,366	4	150.5	9.3	4	30.1	5.8	4	0.88	-
1972	66,419	27	166.2	1.3	26	33.9	0.8	26	0.74	-
1973	56,255	0	-	-	0	-	-	0	-	-
1974	82,609	0	-	-	0	-	-	0	-	-
1975	64,199	0	-	-	0	-	-	0	-	-
1976	119,321	0	-	-	0	-	-	0	-	-
1977	139,548	0	-	-	0	-	-	0	-	-
1978	141,981	15	122.7	2.7	15	14.8	0.8	15	0.81	-
1979	126,742	1	250.0	-	1	15.4	-	1	-	-
1980	405,535	2	125.0	3.5	2	17.0	1.4	2	0.87	0.002
1981	377,716	0	-	-	0	-	-	0	-	-
1982	430,423	1	101.0	-	1	8.1	-	1	0.79	-
1983	158,340	-	-	-	-	-	-	-	-	-
1984	53,524	-	-	-	-	-	-	-	-	-
1985	485,835	-	-	-	-	-	-	-	-	-
1986	126,529	-	-	-	-	-	-	-	-	-

Appendix B.4. Age composition of sockeye salmon smolt sampled by statistical week, Frazer Lake fishpasses, 1984 through 1986.

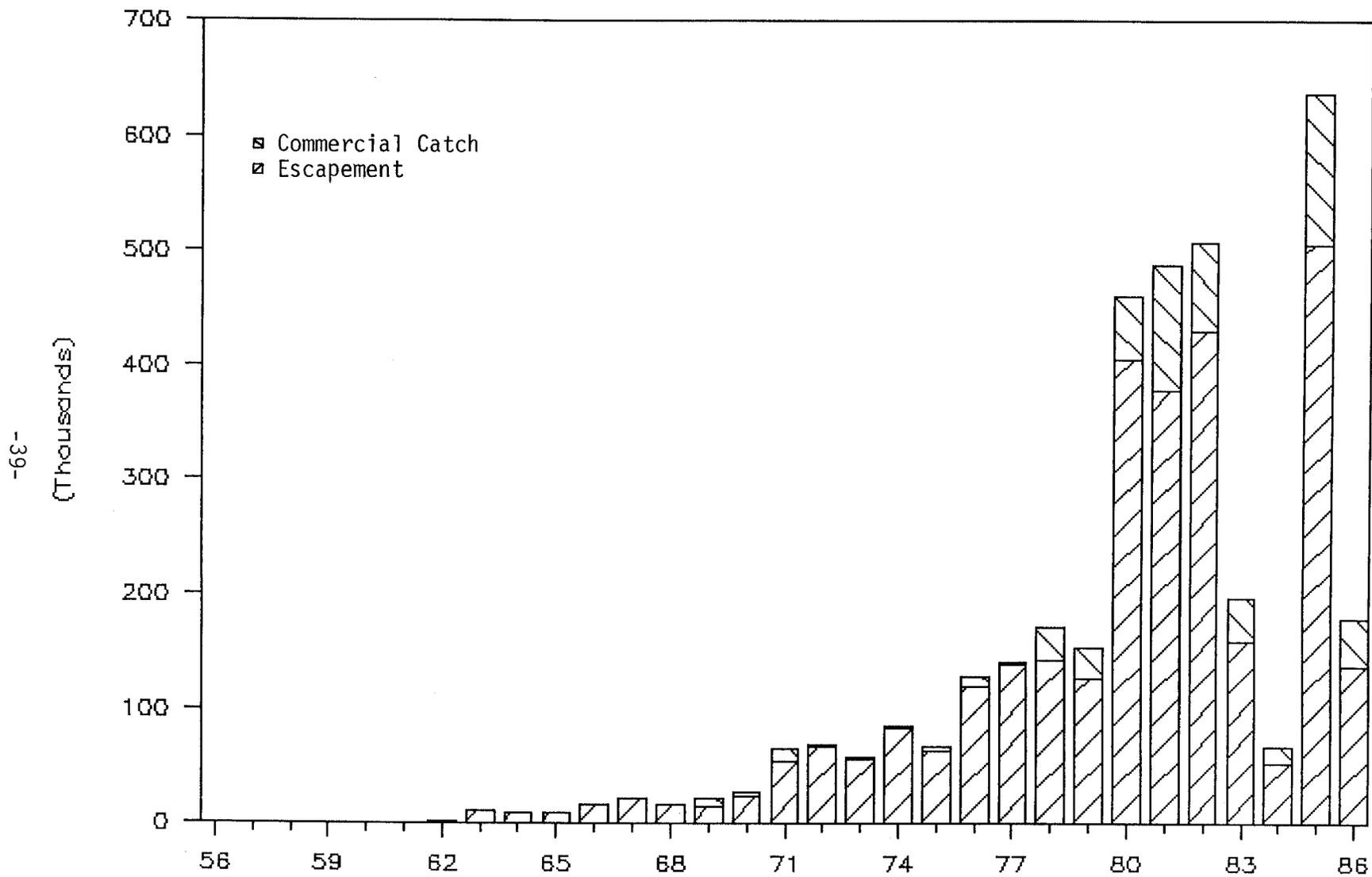
Year	Stat. Week	Sample Size	Age Composition (%)				Total
			0	1	2	3	
1984	21	294	2.4	91.5	6.1	0.0	100.0
	22	178	2.8	87.1	10.1	0.0	100.0
	23	245	0.8	95.5	2.9	0.8	100.0
	24	349	0.6	98.3	1.1	0.0	100.0
	25	155	1.9	96.1	1.9	0.0	100.0
	26	-	-	-	-	-	-
	27	40	0.0	97.5	2.5	0.0	100.0
	Totals	1,261	1.5	94.3	4.0	0.2	100.0
1985	21	109	4.6	94.5	0.9	0.0	100.0
	22	438	4.3	88.8	6.8	0.0	100.0
	23	603	5.3	92.9	1.8	0.0	100.0
	24	607	2.8	96.9	0.3	0.0	100.0
	25	244	5.7	93.4	0.8	0.0	100.0
	26	433	2.8	96.8	0.5	0.0	100.0
	27	103	9.7	89.3	1.0	0.0	100.0
	28	9	44.4	55.6	0.0	0.0	100.0
	29	5	20.0	60.0	20.0	0.0	100.0
	30	4	75.0	25.0	0.0	0.0	100.0
	Totals	2,555	4.6	93.5	2.0	0.0	100.0
1986	20	4	0.0	0.0	100.0	0.0	100.0
	21	198	0.0	0.5	99.5	0.0	100.0
	22	219	0.0	0.0	100.0	0.0	100.0
	23	220	0.0	0.5	99.1	0.5	100.0
	24	220	0.0	3.2	96.8	0.0	100.0
	25	220	0.0	8.6	91.4	0.0	100.0
	26	219	0.0	8.7	91.3	0.0	100.0
	27	219	0.0	17.4	82.6	0.0	100.0
	28	5	0.0	0.0	100.0	0.0	100.0
Totals	1,524	0.0	5.6	94.4	0.1	100.0	



Appendix C.1. Daily (smoothed) escapement counts of sockeye salmon at the Dog Salmon Creek weir, 1986.



Appendix C.2. Cumulative percentage of the sockeye salmon escapement by date at the Dog Salmon Creek weir and Frazer Lake fishpasses, 1986.



Appendix C.3. Annual sockeye salmon run into Frazer Lake with the commercial catch and escapement components illustrated, 1956-86.

Appendix C.4. Sockeye salmon escapement surveys of Frazer Lake and its inlet streams, 1986.

Stream Name	Stream Number	Julian Day	Calendar Date	Observer	MOUTH			STREAM			Stream Temp. (C)	REMARKS			
					Survey Cond.	Method	Count Live Dead Total	Survey Cond.	Method	Distance			Count Live Dead Total		
Frazer L.	0020	228	16-Aug	Malloy				Good	Aerial	Entire lake	21,225	-	21,225		15% of escap. on west side & 85% on east side of lake
Frazer L.	0020	230	18-Aug	Barrett				Poor	Aerial	Entire lake	17,200	-	17,200		Rain & foggy; escap. was split 51% east & 49% west shore
Cadia	2023	207	26-Jul	Hastings	Fair	Boat	20 - 20	Fair	Foot	1/10 mile	0	0	0	6.5	High water
Cadia	2023	216	04-Aug	Hastings	Fair	Boat	15 - 15	Fair	Foot	1/10 mile	0	3	3	6.5	High flow conditions; all mortalities bear kills
Cadia	2023	222	10-Aug	Hastings	Fair	Boat	0 - 0	Good	Foot	1/10 mile	0	2	2	7.0	No spawn outs; all carcasses were bear kills
Courts	2026	207	26-Jul	Hastings	Fair	Boat	100 - 15	Fair	Foot	1/4 mile	2	36	38	5.5	High water; all mortalities bear kills
Courts	2026	216	04-Aug	Hastings	Fair	Boat	90 - 15	Good	Foot	1/4 mile	16	49	65	6.0	High flow conditions; all mortalities bear kills
Courts	2026	222	10-Aug	Hastings	Fair	Boat	15 - 15	Fair	Foot	1/4 mile	3	52	55	7.0	No spawn outs; all carcasses were bear kills
Frazle	-	207	26-Jul	Hastings	Fair	Boat	50 - 50	Fair	Foot	1/8 mile	0	8	8	5.0	High water; all mortalities bear kills
Frazle	-	216	04-Aug	Hastings	Poor	Boat	- - 0	Good	Foot	1/8 mile	6	7	13	6.0	High flow conditions; all mortalities bear kills
Frazle	-	222	10-Aug	Hastings	Fair	Boat	10 - 10	Good	Foot	1/8 mile	1	6	7	7.0	No spawn outs; all carcasses were bear kills
Hollow Fox	-	207	26-Jul	Hastings	Fair	Boat	15 - 15	Fair	Foot	1/8 mile	0	0	0	5.0	High water
Hollow Fox	-	216	04-Aug	Hastings	Fair	Boat	10 - 10	Good	Foot	1/8 mile	3	1	4	6.0	High flow conditions; all mortalities bear kills
Hollow Fox	-	222	10-Aug	Hastings	Fair	Boat	10 - 10	Good	Foot	1/8 mile	0	3	3	6.5	No spawn outs; all carcasses were bear kills
Jaeger	-	207	26-Jul	Hastings	Fair	Boat	25 - 25	Fair	Foot	1/4 mile	1	8	9	4.0	High water; all mortalities bear kills
Jaeger	-	216	04-Aug	Hastings	Fair	Boat	10 - 10	Fair	Foot	1/4 mile	2	7	9	4.0	High flow conditions; all mortalities bear kills
Jaeger	-	222	10-Aug	Hastings	Fair	Boat	6 - 6	Good	Foot	1/4 mile	0	4	4	4.0	No spawn outs; all carcasses were bear kills
Linda	2017	207	26-Jul	Hastings	Fair	Boat	25 - 25	Poor	Foot	1 mile	150	11	161	10.0	High water; all mortalities bear kills
Linda	2017	216	04-Aug	Hastings	Fair	Boat	150 - 150	Fair	Foot	1 mile	212	91	303	8.5	High flow conditions; all mortalities bear kills
Linda	2017	222	10-Aug	Hastings	Fair	Boat	75 - 75	Good	Foot	1 mile	110	31	141	8.0	No spawn outs; all carcasses were bear kills
Linda	2017	231	19-Aug	Hastings	Fair	Boat	250 - 250	Good	Foot	1 mile	156	6	162	-	No spawn outs; all carcasses were bear kills
Midway	2020	207	26-Jul	Hastings	Fair	Boat	200 - 200	Poor	Foot	1/4 mile	44	6	50	6.0	High water; all mortalities bear kills
Midway	2020	216	04-Aug	Hastings	Fair	Boat	300 - 300	Fair	Foot	1/4 mile	71	60	131	6.5	High flow conditions; all mortalities bear kills
Midway	2020	222	10-Aug	Hastings	Fair	Boat	50 - 50	Good	Foot	1/4 mile	38	19	57	7.0	No spawn outs; all carcasses were bear kills
Midway	2020	231	19-Aug	Hastings	Fair	Boat	250 - 250	Good	Foot	1/4 mile	0	4	4	-	No spawn outs; all carcasses were bear kills
Piddle	-	207	26-Jul	Hastings	Fair	Boat	60 - 60	Fair	Foot	1/8 mile	0	5	5	5.0	High water; all mortalities bear kills
Piddle	-	216	04-Aug	Hastings	Fair	Boat	20 - 20	Good	Foot	1/8 mile	13	11	24	5.5	High flow conditions; all mortalities bear kills
Piddle	-	222	10-Aug	Hastings	Fair	Boat	10 - 10	Good	Foot	1/8 mile	0	3	3	8.0	No spawn outs; all carcasses were bear kills
Pinnell	2035	222	10-Aug	Malloy	Good	Aerial	30000 - 30000	Poor	Aerial	3 miles	200	-	200	-	Stream turbid
Pinnell	2035	230	18-Aug	Barrett	Poor	Aerial	4000 - 4000	Poor	Aerial	3 miles	100	-	100	-	High water conditions; stream muddy; count not accurate

- CONTINUED -

Appendix C.4. Sockeye salmon escapement surveys of Frazer Lake and its inlet streams, 1986 (continued).

Stream Name	Stream Number	Julian Day	Calendar Date	Observer	MOUTH			STREAM			Stream Temp. (C)	REMARKS					
					Survey	Count		Survey	Count								
					Cond.	Method	Live	Dead	Total	Cond.	Method	Distance	Live	Dead	Total		
Stumble	2029	207	26-Jul	Hastings	Fair	Boat	250	-	250	Fair	Foot	1/2 mile	60	1	61	12.0	High water; all mortalities bear kills
Stumble	2029	216	04-Aug	Hastings	Fair	Boat	90	-	90	Fair	Foot	1/2 mile	140	41	181	12.5	High flow conditions; all mortalities bear kills
Stumble	2029	222	10-Aug	Hastings	Fair	Boat	50	-	50	Good	Foot	1/2 mile	35	62	98	12.0	No spawn outs; all carcasses were bear kills
Summit	2013	207	26-Jul	Hastings	Fair	Boat	0	-	0	Fair	Foot	1/16 mile	0	0	0	13.0	High water
Summit	2013	216	04-Aug	Hastings	Fair	Boat	0	-	0	Fair	Foot	1/16 mile	0	2	2	11.0	High flow conditions; all mortalities bear kills
Summit	2013	222	10-Aug	Hastings	Fair	Boat	0	-	0	Good	Foot	1/16 mile	0	0	0	10.0	
Valarian	-	207	26-Jul	Hastings	Fair	Boat	20	-	20	Fair	Foot	1/4 mile	11	0	11	8.0	High water; all mortalities bear kills
Valarian	-	216	04-Aug	Hastings	Fair	Boat	20	-	20	Poor	Foot	1/4 mile	97	11	108	8.0	High flow conditions; all mortalities bear kills
Valarian	-	222	10-Aug	Hastings	Fair	Boat	15	-	15	Fair	Foot	1/4 mile	85	21	106	9.0	No spawn outs; all carcasses were bear kills
Valarian	-	228	16-Aug	Malloy	Fair	Aerial	50	-	50	Fair	Aerial	1 mile	125	-	125	-	
Valarian	-	231	19-Aug	Hastings	Fair	Boat	100	-	100	Good	Foot	1/2 mile	160	2	162	-	No spawn outs; all carcasses were bear kills
White Crow	-	207	26-Jul	Hastings	Fair	Boat	25	-	25	Fair	Foot	1/8 mile	0	0	0	5.0	High water
White Crow	-	216	04-Aug	Hastings	Poor	Boat	-	-	0	Good	Foot	1/8 mile	0	1	1	6.5	High flow conditions; all mortalities bear kills
White Crow	-	222	10-Aug	Hastings	Fair	Boat	10	-	10	Good	Foot	1/8 mile	0	1	1	7.0	Carcass was bear killed

Appendix C.5. Monitoring data on the number of sockeye salmon entering and exiting the old (1962) and new (1979) Frazer Lake fishpasses, 1986.

FISHPASS	DATE	TIME 1/	WATER TEMP. C	ENTRANCE (# of fish)			EXIT (# of fish)
				IN	OUT	TOTAL IN	
OLD	7/2	01600	9	174	11	163	252
OLD	7/4	02100	9.5	92	10	82	36
OLD	7/4	02130	9.5	76	11	65	66
OLD	7/5	02100	8.5	2/			242
OLD	7/8	0900	8.5	2/			262
OLD	7/8	01330	8.5	2/			293
OLD	7/19	01600	11.5	2/			282
NEW	7/2	01630	9	150	8	142	18
NEW	7/4	02130	9.5	110	55	55	20
NEW	7/4	02200	9.5	96	37	59	54
NEW	7/5	02100	8.5	2/			30
NEW	7/8	0930	8.5	2/			81
NEW	7/8	01400	8.5	2/			66
NEW	7/19	01630	11.5	2/			57

1/ Military time.

2/ Too many fish jumping to get a count at entrance.

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