A REVIEW

OF

THE BABINE LAKE DEVELOPMENT PROJECT

1961 - 1976

BY

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NORTH COAST BRANCH

PACIFIC REGION

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INTRODUCTION

Babine Lake (Fig. 1), the largest lake of the Skeena River drainage system, produces one of British Columbia's major sockeye salmon (Oncorhynchus nerka) stocks. Studies by the Research and Development Branch of the Fisheries and Marine Service indicated that the main lake basin of Babine Lake had further potential as a sockeye nursery area (Department of Fisheries, 1965, McDonald 1969). The rationale for this project follows from studies by Johnson (1956, 1958, MS, 1961) which suggested that Babine's main lake basin is underutilized as a lake nursery area for sockeye because of the limited capacity of adjacent spawning streams to produce fry. As a result, artificial spawning facilities were constructed on two tributaries of Babine Lake to increase sockeye fry production to the lake by 100 million or more additional fry. The project involved extension and improvement of spawning grounds by constructing artificial spawning channels and dams to provide for water flow regulation. In 1965, the first channel was completed on the Fulton River, the second was completed on Pinkut Creek in 1968 and in 1971 a third channel was completed on the Fulton River. An expenditure approximating 10 million dollars covering the design, construction and initial operation has resulted in a significant economic contribution to the Pacific Coast commercial fishery as well as many other benefits.

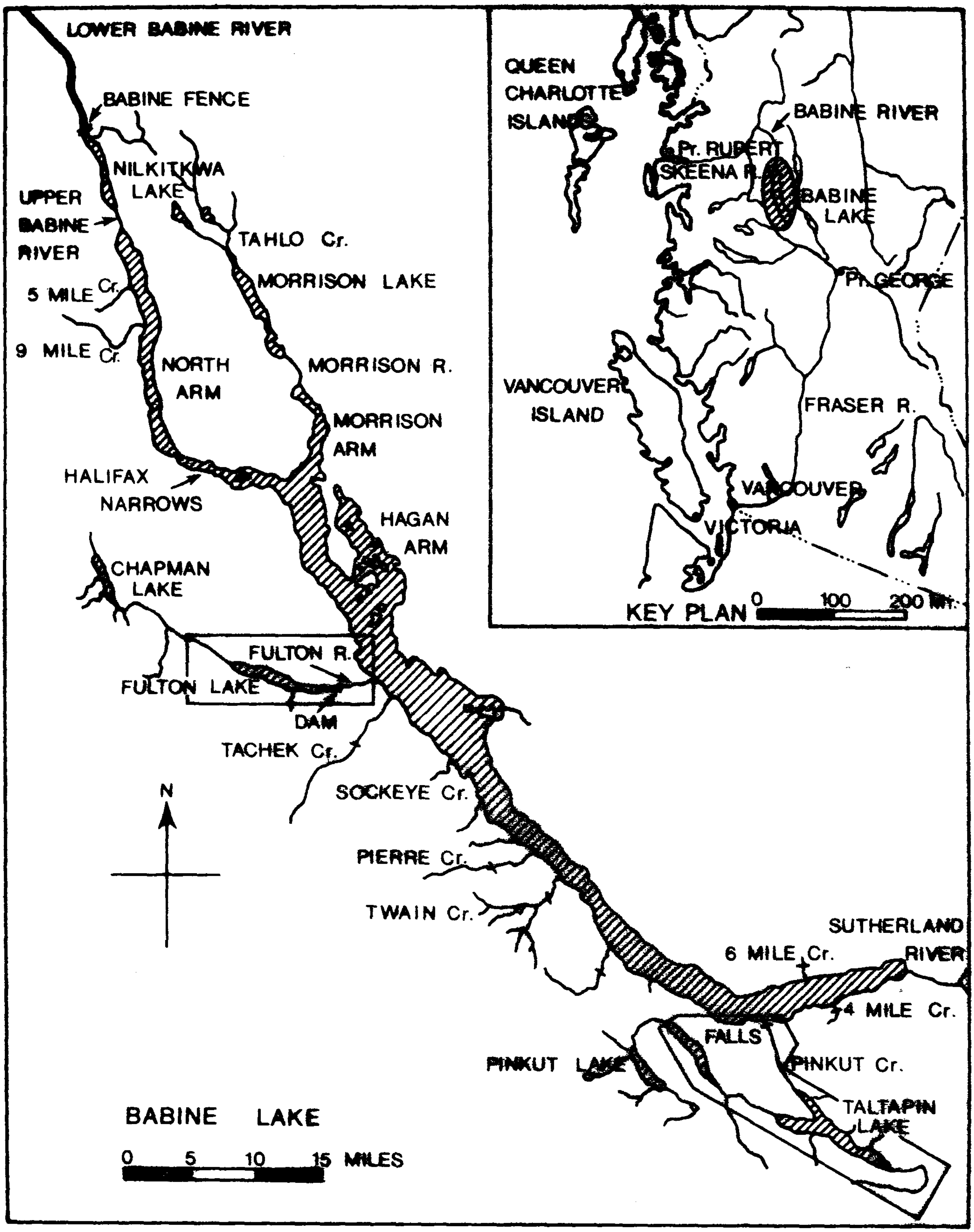


Figure 1: Geographic location of the Fulton River and Pinkut Creek enhancement projects on Babine Lake, B.C.

A biological assessment of the facilities and operational methods was conducted to evaluate the project's ability to increase sockeye production over that of the natural streams. The program emphasized the measurement of the numbers and quality of fry produces from the development projects, the number of smolts emigrating from Babine Lake, and the number of returning adults. This report describes the results of the evaluation program relative to the individual components within the Babine Development Project. For clarity, the report consists of sections which describe the individual projects from the predevelopment stage to the present.

PHYSICAL DESCRIPTION OF FULTON RIVER AND PINKUT CREEK DEVELOPMENT PROJECTS

FULTON RIVER

The Fulton River Project consists of partial flow control facilities, two artificial spawning channels and enumeration facilities (Fig. 2).

A concrete dam, 40 feet in height, was constructed at the outlet of Fulton Lake thus creating a reservoir with a capacity of 76,000 acre-feet, and providing a maximum flow regulation to Fulton River of 4200 cfs. Flow of 150 cfs during spawning and of 200 cfs during incubation to a maximum of 3500 cfs during spring runoff are the normal levels of operation. During the spring when runoff in the watershed is high, regulation is limited to the period prior to the reservoir filling and subsequent discharge over the dam. Uncontrolled flows over the dam normally occur during June or July. Maximum discharge from Fulton Lake into Spawning Channel No. 2 is 150 cfs; however, flows of 100 cfs are the normal operating flows for spawning and incubation.

The regulating works at the Fulton Lake outlet (Fig. 3) consists of a vertical gate shaft, a concrete lined tunnel (diameter = 12 feet; length = 500 feet), and a valve house at the tunnel outlet. The date shaft consists of three gates which permits the selection of water from the intake channel

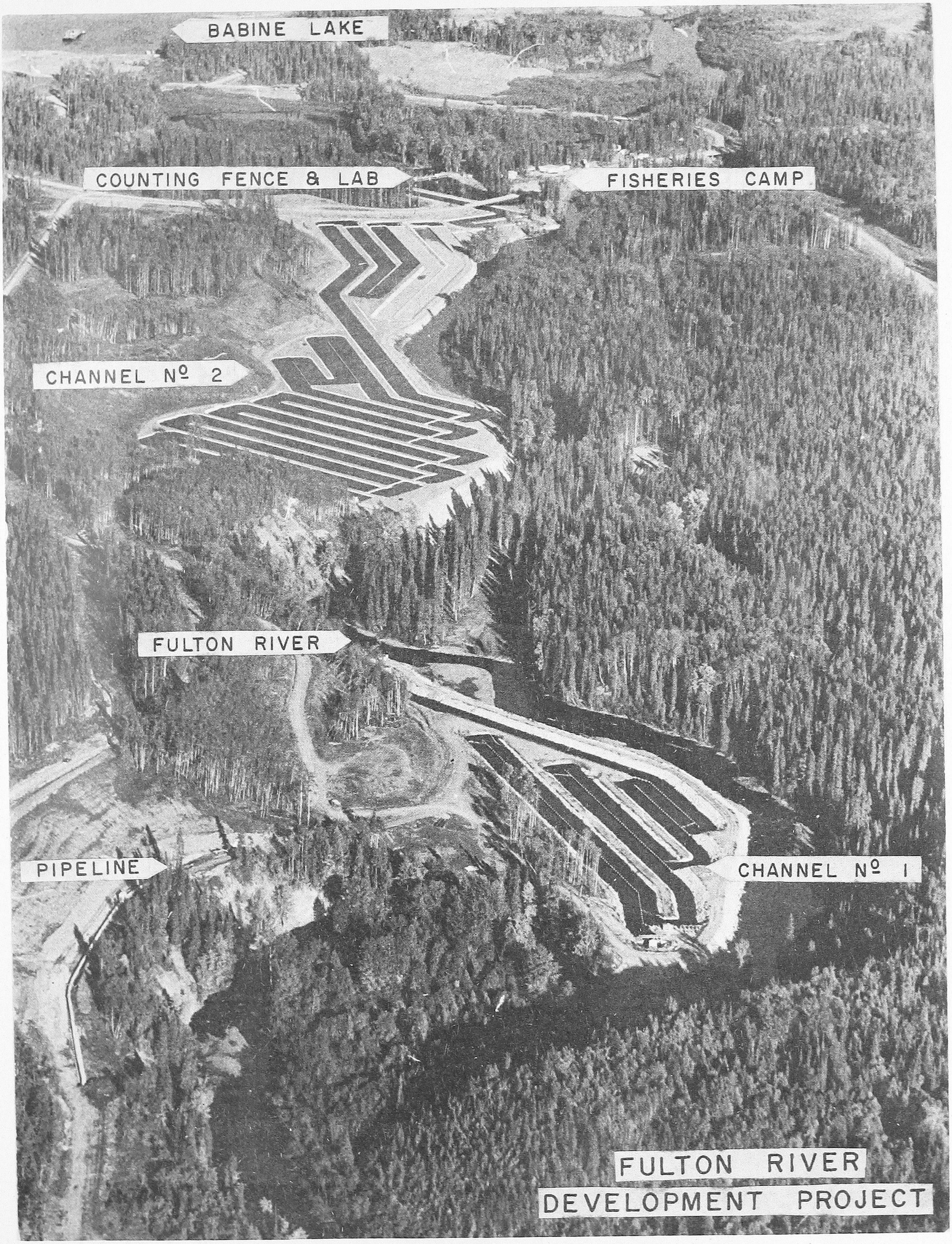


Figure 2: Aerial view of the Fulton River enhancement project.

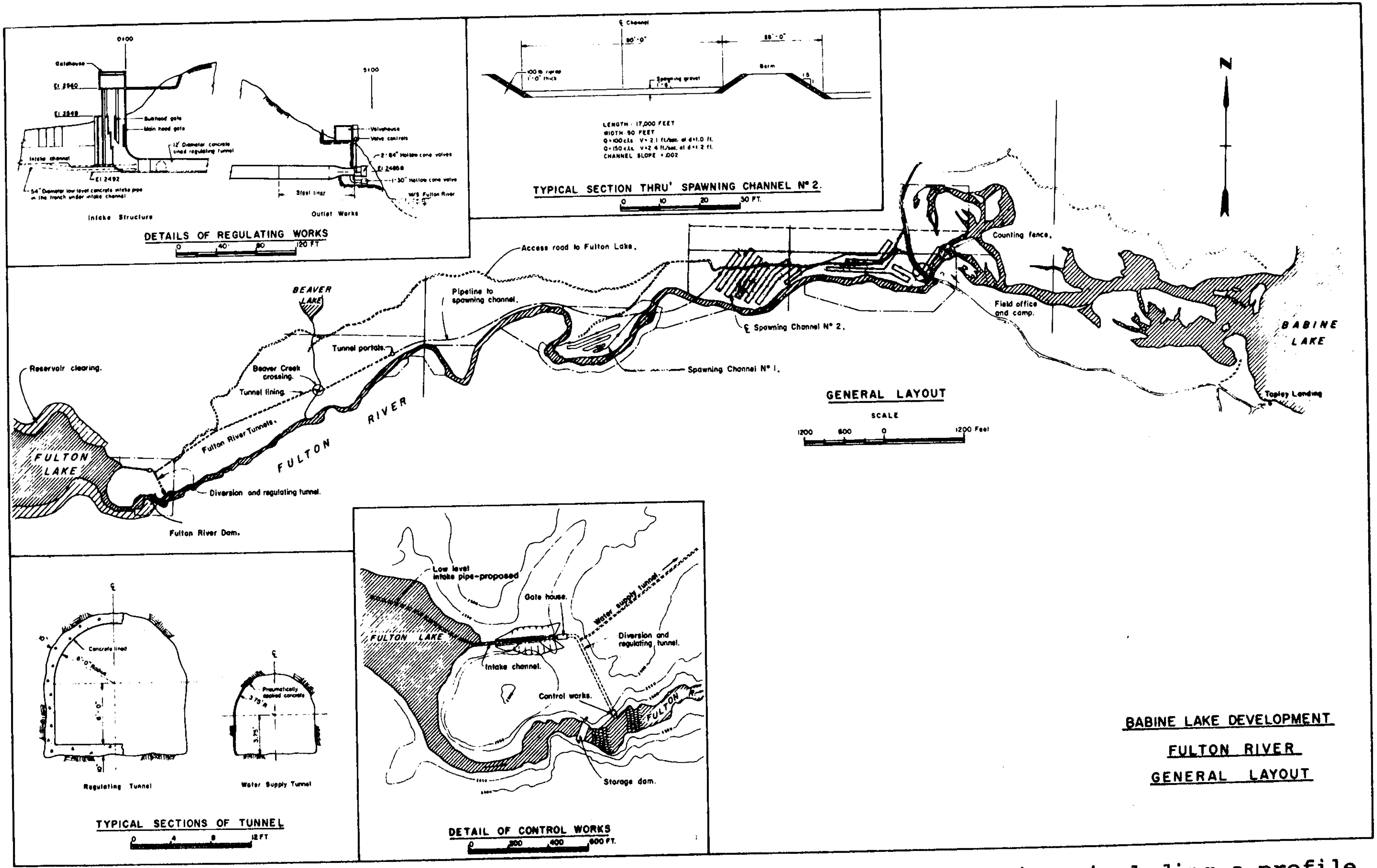


Figure 3: Schematic layout of the Fulton River enhancement project including a profile of the water regulatory works.

to a depth of 48 feet. The original intent of the gate shaft concept was to provide for water temperature control; however, the narrow intake channel creates considerable mixing of incoming water and results in little vertical stratification. Provisions do exist for an auxiliary low level intake pipe to be extended into the lake beyond the intake channel in the event cooler water is required for precise temperature control. Flows are regulated at the tunnel outlet by one 30-inch and two 84-inch diameter hollow-cone valves.

Realizing the importance of Fulton Lake as a recreation and conservation area, the specifications for reservoir clearing were developed through federal liason with British Columbia Government Agencies - Forest Services, Parks Branch, Fish and Wildlife Branch, and Water Resources (Heskin, 1967). Approximately 1800 acres of undeveloped lakeshore area was cleared of timber to create the supply reservoir. Clearing was scheduled over a three year period and the area was flooded in the spring of 1969. Final cleanup was completed in 1971.

The Fulton River project was initiated in 1965 with construction of Spawning Channel No. 1 (Fig. 4). The channel, 4900 feet in length including pools and a bottom width of 30 feet was located immediately adjacent to the Fulton River where the river has a relatively steep gradient. The steep gradient is essential for successful channel operation and maintenance of an adequate supply of water from the river. Water is conveyed

Figure 4: Fulton River Spawning Channel No. 1 shortly after completion in 1966.

to the channel through a submerged intake pipe (dia.=54") leading from a pool in the river. Gravel composition ranged from 3/4" to 4" in diameter with a large proportion being 3/4" to 2" in size. Gravel depth was 18 inches. An innovative aspect of this channel was the use of composite timber and concrete divider walls to form separate sections of the channel. This allowed for maximum use of spawning area from the available land while maintaining a suitable channel cross section and a gradient of .0009. At a discharge of 75 cfs water velocity is 1.8 feet per second and depth is 1.3 feet. The channel had an estimated capacity of 22,000 adult sockeye in 13,000 square yards of spawning gravel.

A second spawning channel was completed in 1971. Spawning Channel No. 2, 16,700 feet in length and 50 feet wide is located approximately one-half mile downstream of Channel No. 1 (Fig. 5). This facility consists of concrete lined channel berms and concrete divider walls. Gravel composition and depth was identical to that of Channel No. 1. Channel gradient was designed at .002, and at a discharge of 100 cfs, the average velocity is 2.1 feet per second and water depth is 1.0 feet. The estimated spawner capacity was set at 135,000 adults. Water is supplied directly to the channel from Fulton Lake through a combined tunnel and pipeline approximately 5,000 feet in length (Fig. 6). The supply tunnel, resembling a modified horseshoe configuration having a diameter of 7.5 feet and a length of 3800 feet (Fig. 3) originates from the main regulating works at Fulton Lake, approximately 75 feet from the gate structure (Heskin, 1967).

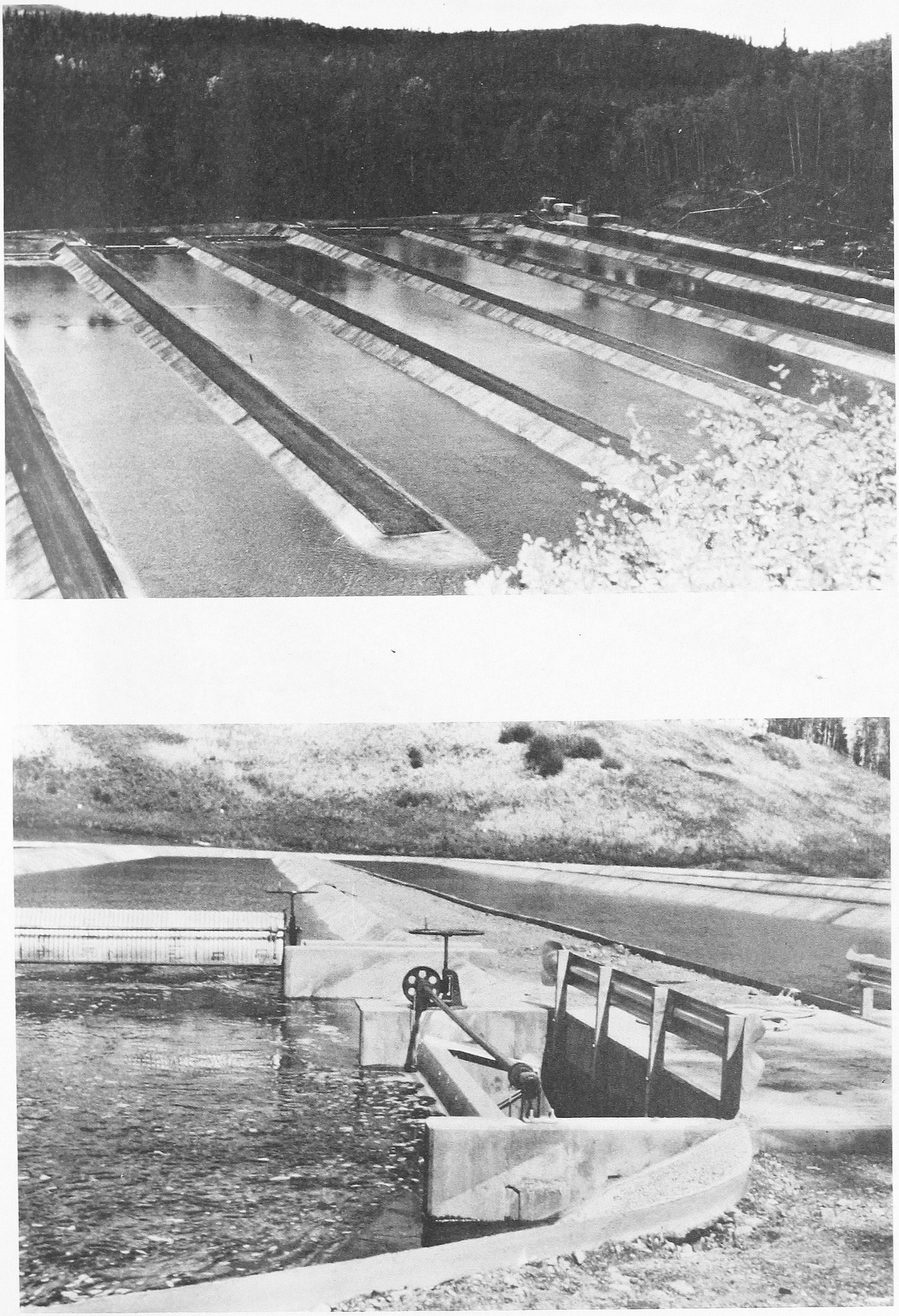


Figure 5: Fulton River Spawning Channel No. 2 shortly after completion in 1971.

Figure 6: Exposed section of water supply pipeline to Fulton River Spawning Channel No. 2.

Adult and fry enumeration facilities were constructed on Fulton River below the main spawning area and also at the downstream entrance of each spawning channel. An enumeration fence was located across both Fulton River and the downstream entrance of Channel No. 2 at a point where Channel No. 2 converges into the river (Fig. 7). Converging throat traps (Walker, C.E., Wood, J.A. and MacLean, I.A. 1969) were installed on the fence to sample fry migration.

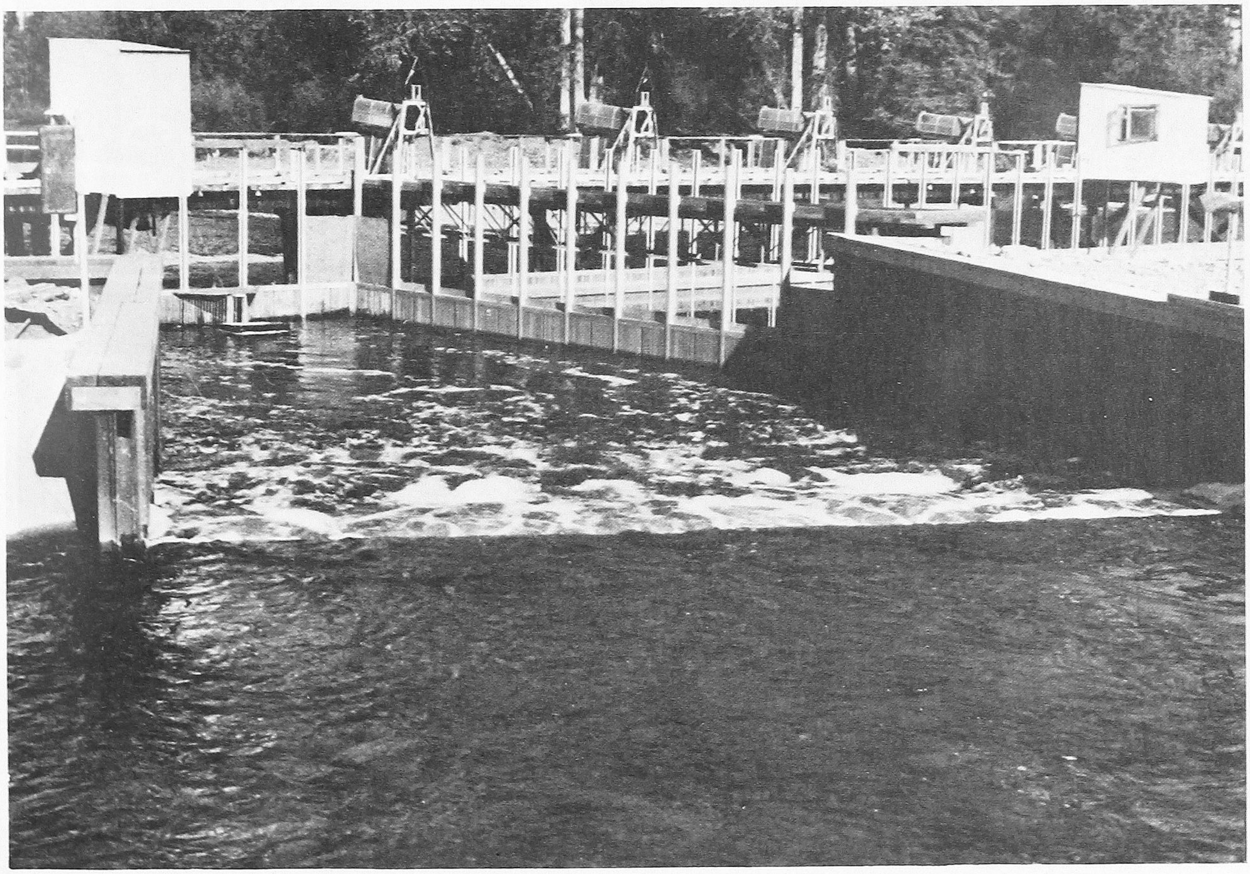


Figure 7: Adult and fry enumeration fence traversing the outlet of Channel No. 2 and Fulton River.

At the outlet of Channel No. 1, a temporary V-entrance broomstick fence is used for adult enumeration (Fig. 8). Removable aluminum fan traps are used for enumeration of fry from this channel. Different fry enumeration techniques are applied at the different locations and will be discussed later.

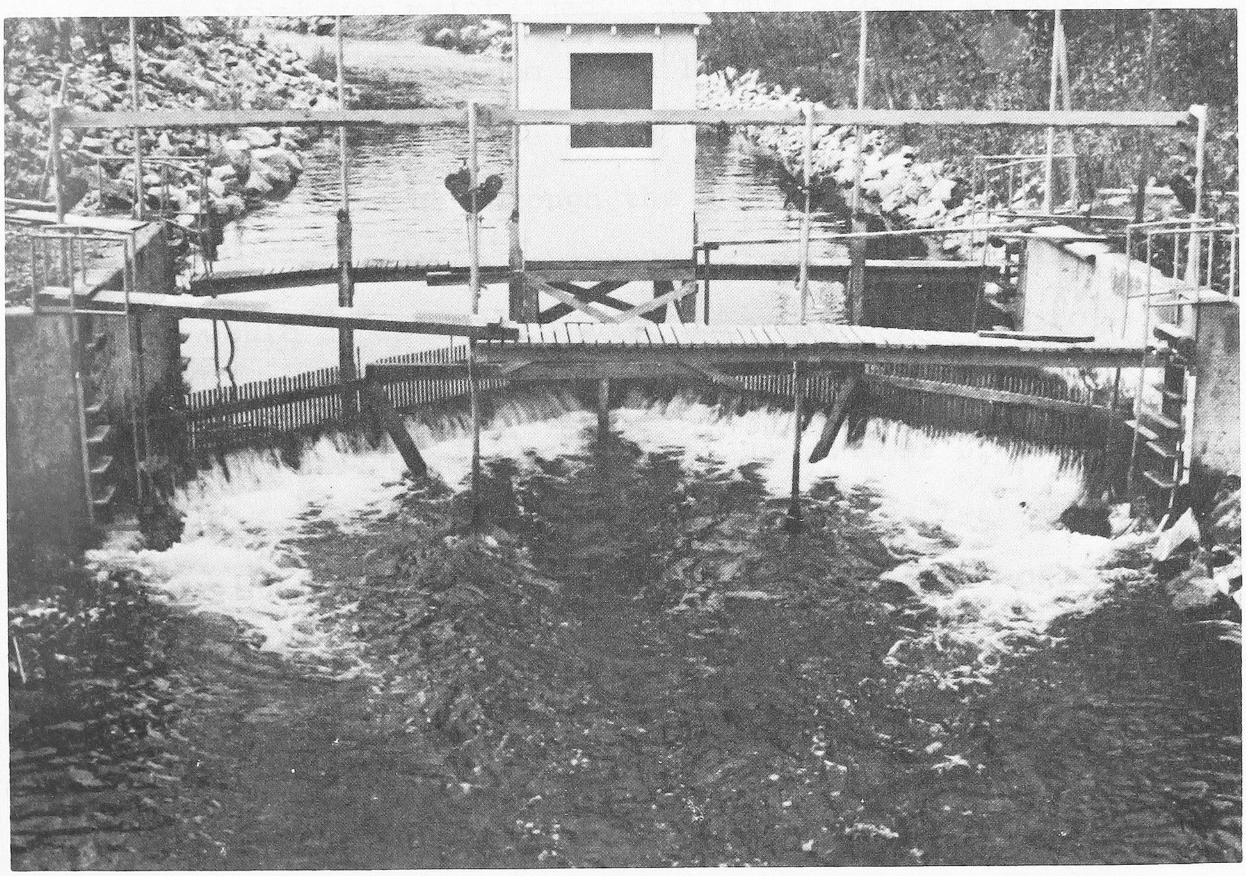


Figure 8: Temporary V-entrance broomstick fence located at the downstream entrance of Fulton River Channel No. 1.

PINKUT CREEK

The Pinkut Creek project consists of a spawning channel (Fig. 9) and partial flow control facilities.

Controlled flow to the river has been provided by installation of a weir at the outlet of Taltapin Lake (Fig. 10). Taltapin Lake was selected as the primary water source because of its storage capacity. Reservoir clearing was not required. As with the Fulton River project, the provincial government was involved in the planning to insure that recreational and conservation potential was maintained. Maximum storage capacity of Taltapin Lake below the maximum flood level was obtained by dredging a series of small lake areas downstream of the dam. Normal operating discharge through the supply tunnel from Taltapin Lake is 70 cfs. If required, about 200 cfs can be discharged, however this would deplete the winter water supply prior to fry emigration in the spring.

The water control works (Fig. 11) consist of a rock fill dam with a concrete cap six feet high and 303 feet long, and a pipeline having a diameter of 54 inches and a length of 400 feet. The control works were completed in 1966, thus providing the necessary minimum winter flows to the eggs of that brood year (Heskin, 1967).

The spawning channel, 9200 feet in length and 40 feet wide was located adjacent to the mouth of Pinkut Creek. The channel was designed to have a slope of .0009 and a water

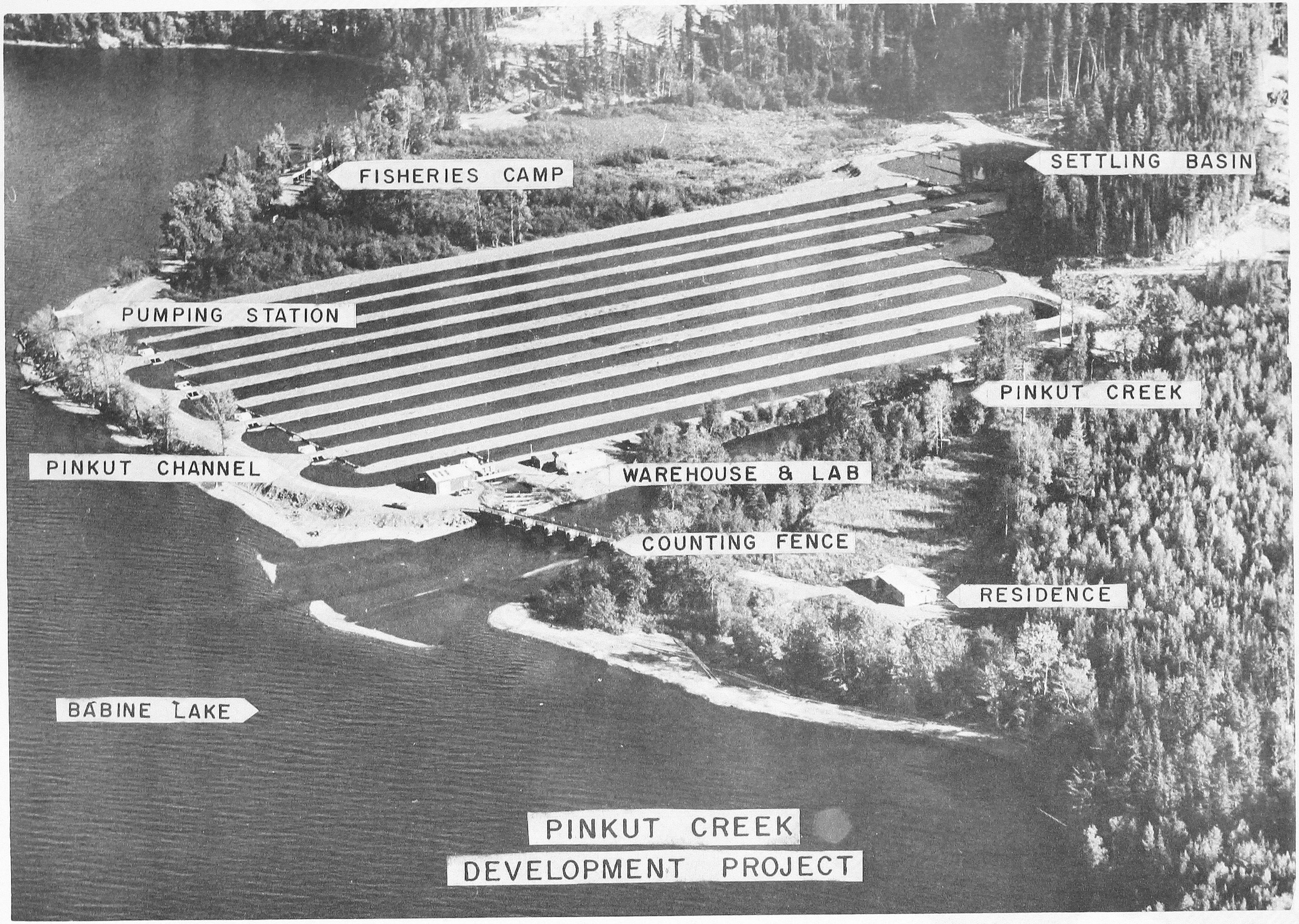


Figure 9: Aerial view of the Pinkut Creek enhancement project excluding the Taltapin Lake regulating works.

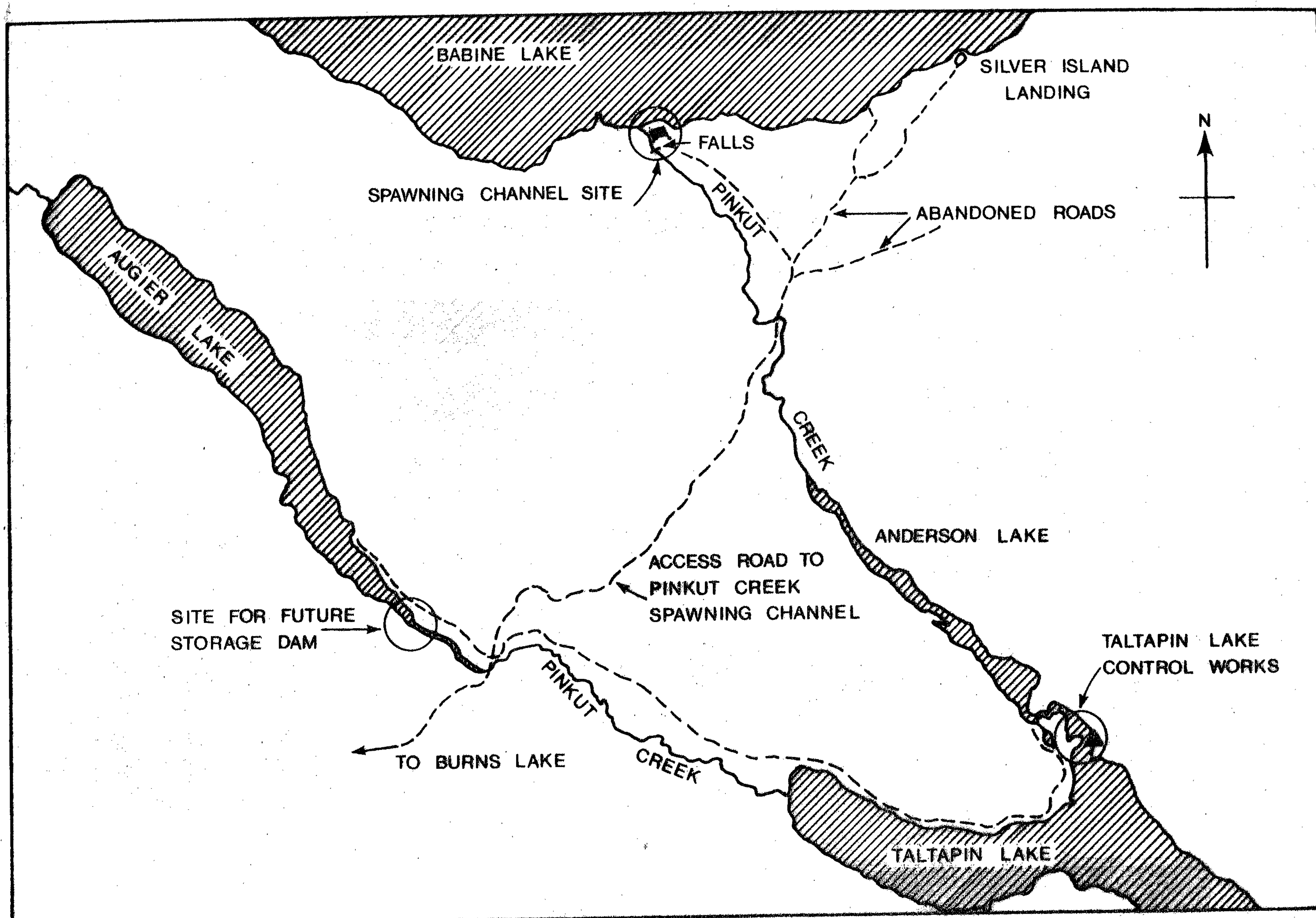


Figure 10: Location map of the Pinkut Creek enhancement project in relation to the Pinkut Creek watershed.

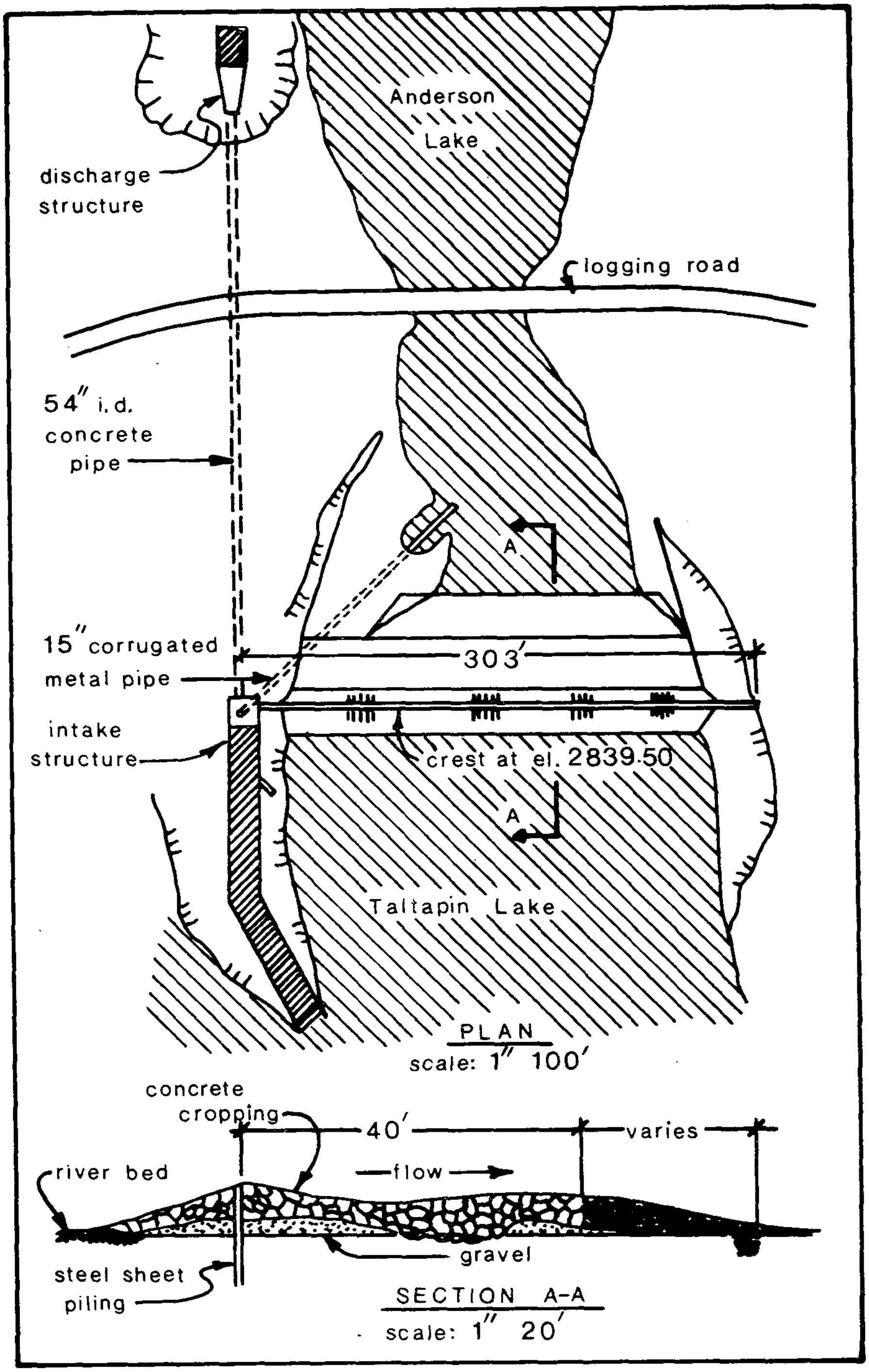


Figure 11: Schematic layout of the flow control works situated at the outlet of Taltapin Lake and leading into Anderson Lake.

velocity of 1.8 feet per second and an average water depth of 1.25 feet at a discharge of 75 cfs. The estimated spawner density was 63,000 adults in a spawning area of 39,500 square yards. Gravel composition and depth was as described for Fulton River Spawning Channel No. 1. Channel berms consist of clay core centres covered with gravel (diameter = 3/4" - 4"). The channel water is provided by partial diversion of Pinkut Creek approximately one-half mile from its mouth (Fig. 12). Water passes through a regulated supply tunnel, resembling a modified horseshoe configuration 7.5 feet in diameter and 750 feet long, into a desilting basin and then enters the channel. Maximum discharge into the spawning channel from the supply tunnel is 75 cfs, however normal operational flows are regulated between 45 and 55 cfs.

A permanent counting fence was constructed in 1968 to enumerate and control the loading of adult spawners and to assess fry production. The fence was located across the outlets of both the river and channel. Converging throat traps identical to those on the Fulton River fence were installed on the river portion of the fence for river fry enumeration and also at the top end of the main fishway leading to the channel for channel fry enumeration (Fig. 13).

Low egg to fry survivals in the channel in 1968 and 1969, as a result of scouring due to anchor ice formations in the winter, were improved in 1970 with the installation of an auxiliary warm water supply to augment the channel water supply.

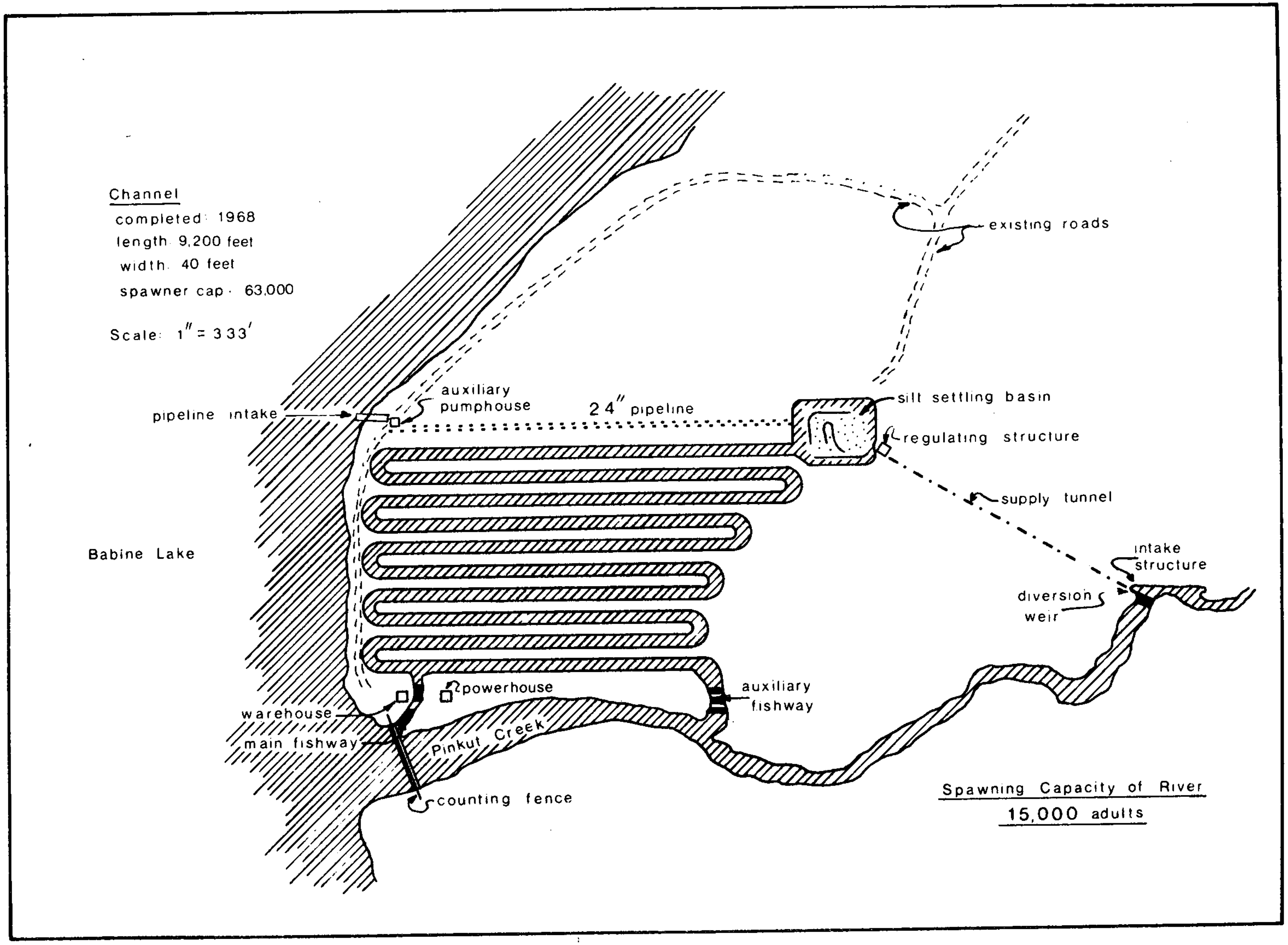


Figure 12: Schematic layout of the Pinkut Creek Spawning Channel and regulating works.

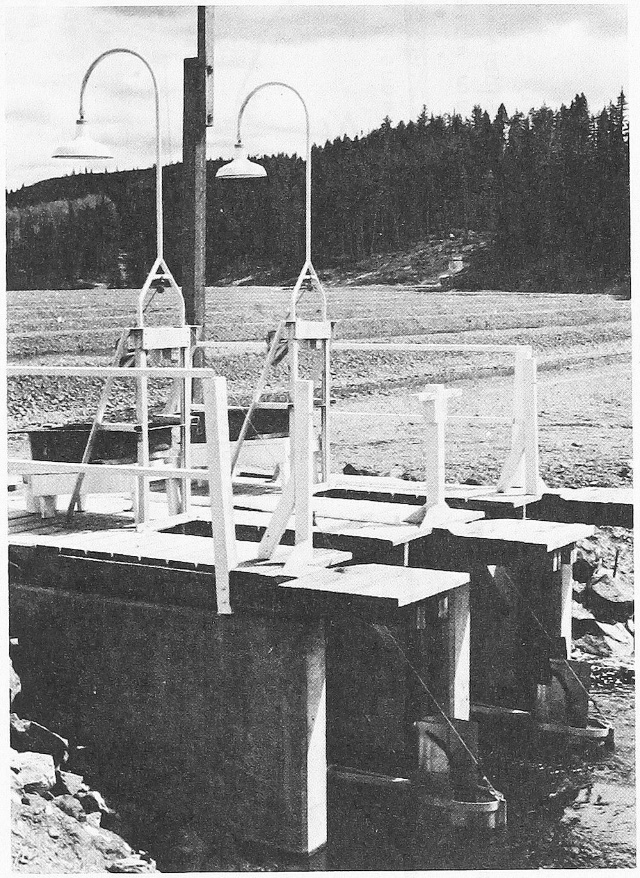


Figure 13: Converging throat traps in the fishing position used to estimate fry production from the Pinkut Creek Spawning Channel.

The system (Fig. 14) draws 22 cfs of water from 200 feet below the surface of Babine Lake and pumps it through a pipeline system to the top, middle and lower portions of the channel. The additional water, approximately 37.5°F, warmed the main channel supply from 32.0°F to 32.5°F.

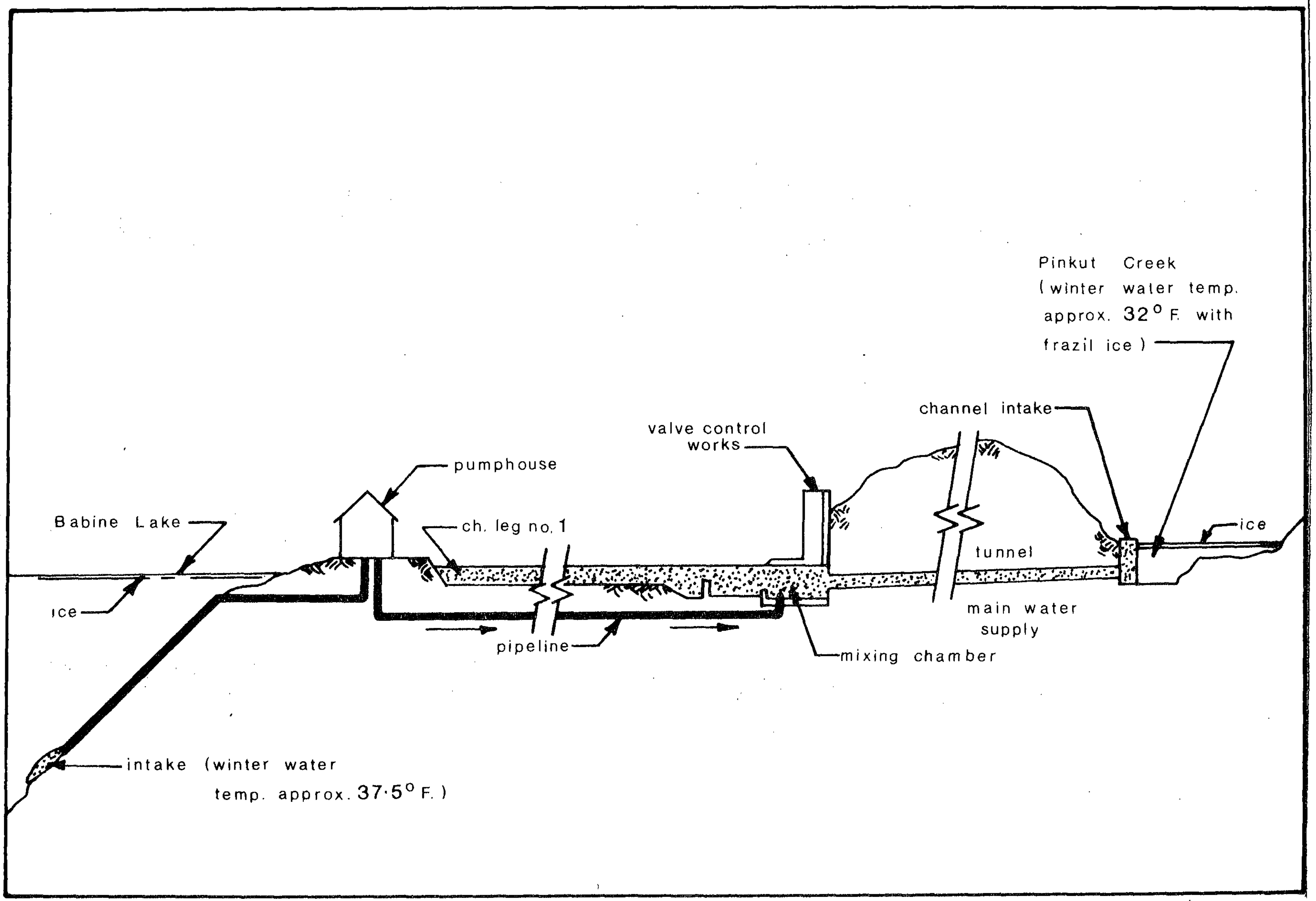


Figure 14: Schematic profile of the Pinkut Creek Spawning Channel water regulatory works including the channel intake, tunnel, valve control works and warm water supply.

EVALUATION OF FULTON RIVER FLOW CONTROL

Introduction

Studies of the Fulton River sockeye population began in 1961 in response to a proposed hydroelectric project. The power development was subsequently cancelled by the British Columbia Hydro and Power Authority; however, biological studies were continued with the new objective being fisheries development.

The Fulton River, with a drainage area of 532 square miles, rises on the northern side of the Babine mountain range and flows in an easterly direction through Chapman Lake (2.7 sq. mi.) and through Fulton Lake (3.5 sq. mi.) and empties into Babine Lake at Topley Landing, B.C. Fulton Lake is approximately 190 feet higher in elevation than Babine Lake. Prior to fisheries development, Fulton River passed over a 40-feet falls immediately downstream of Fulton Lake, then proceeded through a mile of rock canyon, and three miles of valley to enter Babine Lake. The only major change was the construction of a dam at the falls having a spillway crest approximately 25 feet above the low water level of the lake.

Fulton River is the principal spawning stream entering the main basin of Babine Lake. Salmon spawn throughout the river to the base of a falls about 100 feet below the dam. Spawning populations prior to development excluding jacks ranged from 15.2

Figure 15: Aerial view of the water control dam located at the outlet of the Fulton Lake reservoir.

to 170.1 thousand with an average of 80.5 in the period 1949 to 1966 (Table 1). The optimum spawning capacity of the river in terms of maximum fry production, based on an area allotment of 1.25 sq. yds. of area per female, was estimated to be 120,000 fish in a spawning area approximating 75,000 square yards. This area allotment per female spawner formed the basis for future channel design densities.

The main run of sockeye enters the river between August 20 and September 25 with the peak of migration occurring in the first week of September. The fish remain in pools for up to

TABLE 1: Babine sockeye escapements in thousands of fish during the period 1949 to 1966

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1949-1966 Means
Babine fence count	461	364	141	349	687	494	71	355	433	812	783	263	942	548	588	828[1]	580	389	504.9
Indian catch	29	27	19	34	27	22	10	31	20	39	17	17	32	18	20	20	19	19	23.3
North Arm - Nilkitkwa Region																			
Upper Babine River	216.0	65.0	13.3	78.2	147.0	136.7	9.7	66.5	117.8	156.8	156.7	36.9	196.0	192.0	119.3	222.0	120.4	69.0	117.7
Lower Babine River	135.0	116.0	10.8	69.0	127.4	100.0	9.0	52.3	66.5	107.8	123.5	54.0	171.5	61.0	34.5	46.0	176.0	114.0	87.5
9 Mile Cr.	0.9	1.0	0.4	0.1	2.5	1.0	0.1	0	4.0	0	2.4	1.8	2.5	0.5	1.0	1.5	0.5	0.8	1.2
5 Mile Cr.	0	0.1	0.1	0	0.3	0.3	0.1	0	0.2	0	0.6	0	0.5	0.1	0	0.1	0.2	0.2	0.2
Total spawners	351.9	182.1	24.6	147.3	277.2	238.0	18.9	118.8	188.5	264.6	283.2	92.7	370.5	253.6	154.8	269.6	297.1	184.0	206.5
Main Lake Region																			
Morrison system	1.6	5.9	4.1	1.2	24.7	24.0	1.8	27.0	28.9	18.0	35.9	9.9	23.6	12.5	41.8	27.0	8.5	8.8	17.0
Fulton River	33.9	42.0	15.2	31.5	134.4	105.6	16.7	81.0	108.0	76.0	114.0	36.0	170.1	86.4	98.6	117.0	123.3	59.2	80.5
Pinkut Creek	10.5	12.0	4.9	7.5	23.5	25.0	3.2	22.8	29.1	44.0	77.6	27.0	44.1	21.4	40.0	135.3	23.8	21.5	31.8
Pierre Creek	4.2	17.9	11.5	3.3	19.2	17.0	3.2	18.0	21.2	29.4	33.0	9.9	24.5	4.1	28.4	22.0	10.0	8.8	15.9
Grizzly Cr.	1.5	2.7	2.1	3.5	6.0	3.1	0.5	4.8	7.0	30.0	14.0	10.8	23.5	4.6	11.4	8.0	5.0	4.5	7.9
Twin Cr.	2.3	7.6	4.8	0.4	9.8	14.0	2.4	4.5	5.4	12.0	9.0	5.4	6.9	1.3	11.4	9.0	3.0	2.0	6.2
4 Mile Cr.	1.6	4.2	0.9	0.2	2.0	2.2	0.4	0.4	2.5	6.0	5.4	1.8	1.0	2.8	2.8	2.5	1.4	1.7	2.2
Tachek Cr.	2.6	2.6	2.5	0	2.4	1.9	0.3	0	6.4	1.8	6.0	1.8	0	0.6	1.6	3.0	0.7	0.3	1.9
Sockeye Cr.	0.2	0.9	0.8	0	0.6	0.9	0.5	0	2.5	1.5	4.0	1.8	0	1.0	2.4	1.5	0.1	1.4	1.1
6 Mile Cr.	0.4	1.2	0	0	2.6	1.8	0.1	0.1	0.6	2.3	3.5	0.9	0	0.9	1.4	1.5	0.1	0.3	1.0
Pendleton Cr.	1.1	1.2	0	0	1.4	1.1	0	0	0.3	0	2.5	0	0	0.2	0	1.4	0	0	0.5
Others[2]	0	0	20.0	74.4	1.0	0	0	0	0.2	72.5	3.9	0.3	51.8	6.2	6.2	9.3	1.8	0	13.7
Total spawners	59.9	98.2	66.8	122.0	227.6	196.6	29.1	158.6	212.1	293.5	308.8	105.6	345.5	142.0	246.0	337.5	177.7	108.5	179.8

[1]Estimate derived from stream counts, tag and recovery, av. "not accounted for" 1949-1963.

[2]Includes: a intermittent counts in small marginal streams
b counts of fish which died unspawned esp. 1951, 1952, 1958, 1961,
c for Nanika egg take from Pinkut Creek; 1961 = 2050, 1962 = 6200, 1963 = 6200, 1964 = 9300, 1965 = 1800.

three weeks and spawning peaks in late September and early October. Historically an early run population of less than a thousand fish entered the river in early August and spawned prior to the main run. In recent years, this early run has increased and now exceeds 40,000 adults.

The fry migration normally begins in late April but the peak can occur anytime during late May or early June depending on the level of discharge in the river. Migration is virtually complete by the end of the third week in June.

The distribution of spawners in the Fulton River is associated with river gradient and streambed composition. Higher spawning densities occur where the gradient is low and the streambed consists of a proportionately higher amount of small gravel (1" to 2" diameter). Low density spawning occurs where the gradient is high and the streambed consists mainly of boulders and bedrock outcroppings. Figure 16 illustrates river locations as related to degree of spawning utilization. Approximately 55 percent of all spawners are found in the high density areas and 10 percent in the low density areas. Approximately 35 percent of the population utilizes the remaining area. The development project has not altered the river's physical characteristics but the biology of the Fulton River sockeye run appears to be undergoing changes relative to age compositions, sex-rates and population numbers. The following section of the report will describe the changes that occurred during and after the development period (1965-1975).

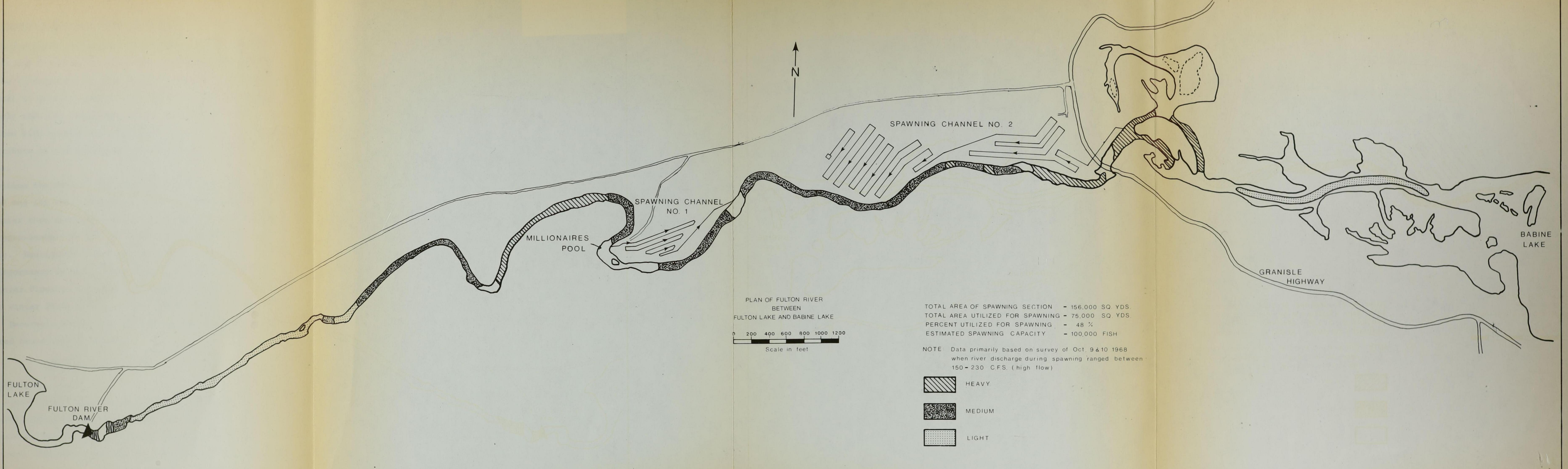


Figure 16. Schematic layout of Fulton River relative to the degree of spawning utilization.

Spawning and Incubation Water Flows

Historically, spawning and incubation flows (September to April) in the Fulton River have shown considerable variation. Prior to the introduction of flow control in August 1968, spawning flows (August to October) varied from lows of 25 cfs to highs of approximately 1800 cfs (September 1966). These conditions when combined with extreme low incubation flows (25 cfs - April 1962) contribute to a wide variation in egg to fry survivals (11% - 31%).

Since the fall of 1968 spawning flows have been regulated between 100 and 125 cfs. Incubation flows are approximately 25 cfs greater then spawning flows. The Fulton Lake reservoir provides approximately 40,000 cfs days of storage when filled to capacity. Regulation of the fall reservoir level is of critical importance in that enough water must be stored to provide winter flows to the river and spawning channels. Rule curves for winter flows have been established and are closely followed. Reservoir levels are reduced in early spring to allow for expected heavy spring runoffs.

Adult Sockeye Program

Sampling Technique

Prior to installation of the permanent enumeration fence in 1966, adult counts at Fulton River were derived from tag and recovery methods and from tower counts. A portion of the adults are sampled for sex and age composition, fecundity, length and egg retentions. During the period 1966 to 1975, upstream migrants were counted daily at the main fence. The Channel No. 2 portion of the main fence is presently operated in a manner allowing the peak of the run to be diverted into the channel. All other fish are directed into the river and as they migrate upstream, a portion are directed into Channel No. 1. The main fence may be opened for migration into the river, into Channel No. 2, or both, depending on the daily rate of upstream migration. Counts of spawners below the enumeration fence are established visually from boats and (or) aircraft.

Population Characteristics

Spawning populations to the Fulton System have ranged from 59.2 to 397.5 thousand over the period 1965-1975 (Table 2). During this period, Babine Lake sockeye escapements were purposely increased to allow for adequate seeding of the two spawning channels. According to the original design loading density of 0.8 females per sq. yd., the optimum spawner density totals 120,000 fish in the river. In all years except 1971 and 1975, the river spawning density was at or below the requirement. The large escapement in 1975 was a result of low exploitation of the Fulton River stock as it migrated through the commercial fishery. To maintain consistent channel productivity, it was decised to overseed the river and maintain normal spawner densities in the channels.

Age compositions of returning adults varies substantially from year to year but a definite trend of a cyclical nature between age 4_2 and age 5_2 adults appears to be developing on the Fulton stock (Fig. 17). At Fulton higher proportions of

TABLE 2: Sockeye escapement in thousands to the Pinkut Creek and Fulton River Systems from 1965 to 1975.

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1965-1975 Average	1949-1966 Average
Fulton River	123.3	40.4	114.2	99.2	60.6	111.3	142.6	81.4	100.0	64.3	274.4	110.2	
Channel No. 1		18.8	21.8	26.0	21.0	25.5	24.7	21.6	25.3	12.5	14.9	21.2	
Channel No. 2					23.7	58.8	115.5	106.5	112.1	62.4	108.2	83.9	
Fulton System	123.3	59.2	136.0	125.2	105.3	195.6	282.8	209.5	237.4	139.2	397.2	182.8	80.5
Pinkut Creek	23.8	21.5	31.7	8.8	8.3	9.2	8.8	16.8	36.9	44.5	57.1	24.3	
Pinkut Channel				13.5	28.8	19.8	21.7	57.1	63.3	51.7	48.1	38.0	
Pinkut System	23.8	21.5	31.7	22.3	37.1	29.0	30.5	79.9	100.2	96.2	105.2	52.5	31.8
Development Total (Pinkut & Fulton)	147.1	80.7	167.7	147.5	142.4	224.6	313.3	283.4	337.6	235.4	502.7	234.8	
Development Percent (Pinkut & Fulton)	25.4	20.7	27.8	26.8	21.6	33.9	38.4	41.7	42.3	32.4	61.2	35.4	
Babine System	580.0	389.0	603.0	552.0	660.0	662.0	816.0	680.1	797.5	727.0	820.8	662.5	504.9

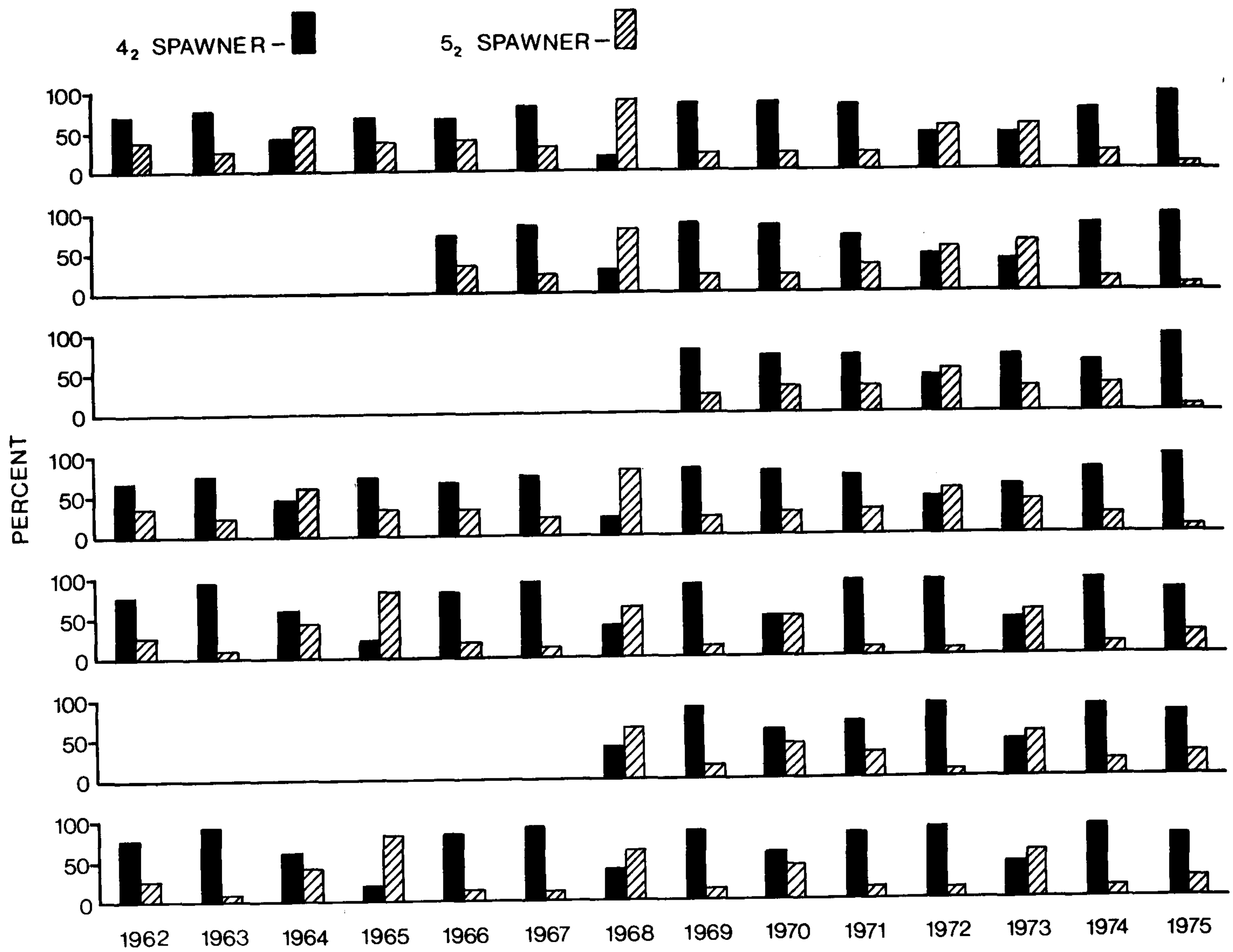


Figure 17: Annual age class of spawners in the Fulton River and Pinkut Creek Systems.

age 5_2 fish occurred in the 1959, 1964, 1968, 1972 and 1976 runs (Fig. 18). Also, the degree of dominance varies from year to year. Reasons for this unique pattern of adult return are not known. Similar observations and reasons for these trends have been discussed by Godfrey (1958) and by Larkin and MacDonald (1968). Some of the factors discussed included the commercial fishery, differential yield between Babine and non-Babine stocks, and "dominance" effects. As more information comes available, the significance of this cycle may become apparent and could be applied to overall stock composition. Accordingly, if this cycle is applied to regulation of the commercial fishery it may assist in the management of Skeena River sockeye stocks.

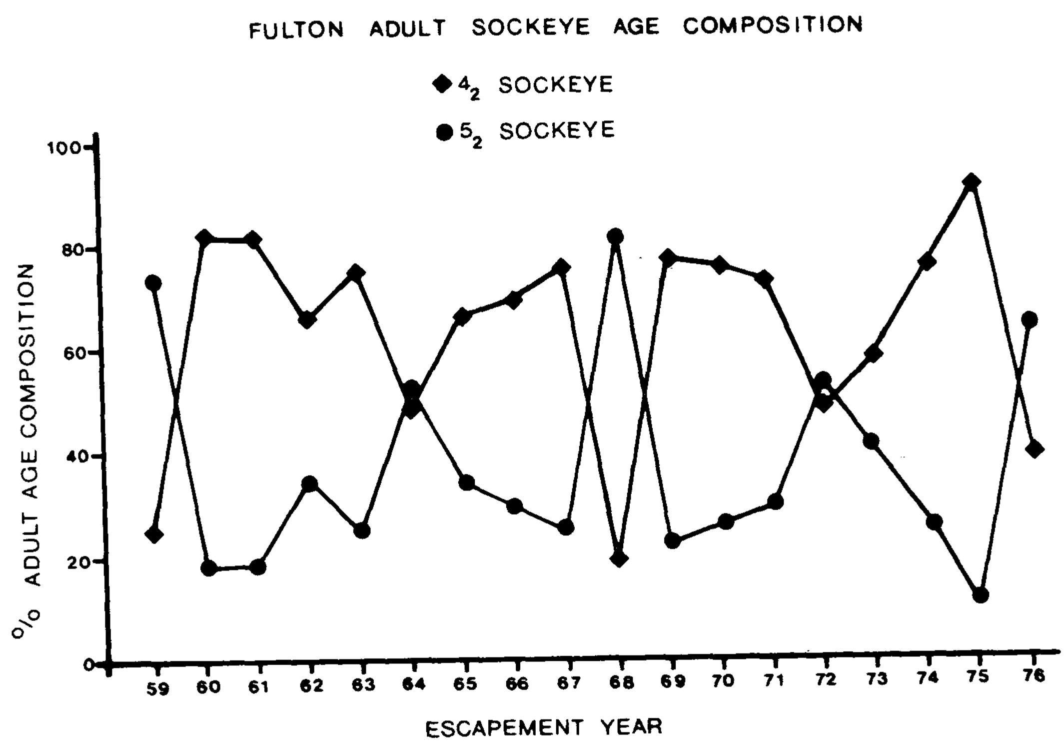


Figure 18: Pattern of cyclic dominance of 4_2 and 5_2 adult sockeye returning to the Fulton River System.

Jack or age 3_2 sockeye returns to the Fulton River System (Table 3) for the years 1961-1975 have ranged from a low of 2,754 in 1968 to a high of 139,265 in 1974. A comparison of jack returns between the pre and post development period indicates an overall average increase of 55,000 fish. This is not unusual because whenever a population increases the increase should be reflected in all age classes of that population.

TABLE 3: Escapement of adult and jack sockeye to the Fulton River System from 1961 to 1975.

Phase	Year	Jacks	Adults
	1961	19,278	170,100
	1962	-*	86,400
	1963	54,824	98,600
Pre-Development	1964	3,240	116,760
Returns	1965	15,707	123,293
	1966	30,478	59,522
	1967	4,495	135,976
	1968	2,754	99,244
	Average	(18,682)	(111,236)
	1969	43,715	105,260
	1970	56,527	195,532
	1971	16,339	282,801
Post-Development	1972	135,901	209,478
Returns	1973	81,250	237,309
	1974	139,265	139,211
	1975	46,604	399,153
	Average	(74,228)	(224,106)

*No available estimate.

The Fulton sockeye have responded accordingly and the low exploitation by the commercial gillnet fishery has further increased the jack sockeye returns. Of these returns, a major portion now return to Channel No. 2 suggesting they originated from channel brood stock. Again, a commercial gillnet fishery with low exploitation of jacks would explain the large returns to the channel. In relation to the total escapement to the Babine System (Table 4), the highest percentage return to the Fulton System occurred in 1961 before development. In recent years (1969-1975) returns have averaged 41.6 percent, which represents an increase of 25.2 percent over the previous six year average.

TABLE 4: Percentage of total Babine Lake jack sockeye escapement to the Fulton River and Pinkut Creek Systems.

Phase	Year	Babine Total	Fulton %	Pinkut %	% of Total
	1960	49,000	-	-	
	1961	28,000	68.9	-	
	1962	46,000	-	-	
Pre-Development	1963	173,000	31.7	-	
Returns	1964	60,000	5.4	2.4	7.8
	1965	64,000	24.5	15.9	40.5
	1966	182,000	16.7	3.8	20.6
	1967	29,300	15.3	5.7	21.0
	1968*	53,400	5.2	4.5	9.6
	1969	154,000	28.4	4.2	32.6
	1970	166,000	34.1	3.7	37.8
	1971	54,600	29.9	19.2	49.2
Post-Development	1972	258,582	52.5	7.9	60.4
Returns	1973	208,350	39.0	15.4	54.4
	1974	226,923	61.4	16.4	77.8
	1975	137,396	33.9	7.0	40.9

* Beginning of flow control

Egg Deposition and Retention

Potential egg deposition in Fulton River has ranged from a low of 73.9 million in 1966 to a high of 417.8 million in 1975. Over the range of depositions that have occurred in the Fulton River, egg retentions, a measure of complete spawning, have increased with increases in potential deposition (Fig. 19). The data indicates that beyond a potential deposition of 250 million in the river, there could be sharp decline in spawning efficiency.

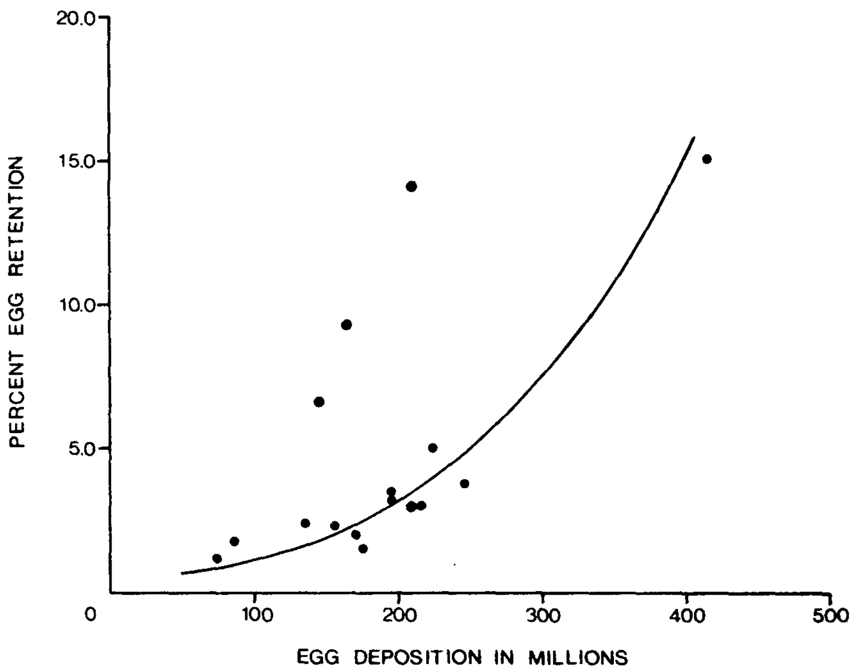


Figure 19: Relationship between potential egg deposition and percent egg retention in Fulton River.

Sockeye Fry Program

Enumeration Techniques

Enumeration of sockeye fry migrating from Fulton River began in 1962. The technique employed was a conventional mark and recapture method. From 1963 to 1966 a travelling vertical sampler was fished at different stations across the river at pre-set times. Nightly migration estimates were calculated on the basis of actual net catches and river discharge, or:

$$N = \frac{Qs\ S}{\Sigma Qn},$$

where the number of fry (N) equals the product of the total river discharge during the migration period (Qs) and the total fry catch during the sample period (S), divided by the total discharge through the nets at each station (Qn).

This technique is unreliable during flood stages when debris and velocity curtail trap fishability. This was particularly evident in 1966. Qualified estimates were obtained from 1962 to 1965 and all were subject to the limitations of the procedures. The 1966 estimate was derived from interpolation of the previous years estimates.

A more reliable method of enumeration was implemented in 1967, when a permanent fence was constructed on the lowermost spawning riffle (5,000 feet above the river mouth) for fry and adult enumeration. Permanent converging throat traps, patterned after similar units described by Tait and Kirkwood (1962), were installed on the fence to sample the fry migration. The traps, fabricated from aluminum and screening were located such that each trap fished one foot in every 20 feet across the river. The traps fished the total water column which ranged from two inches to four feet depending on river discharge.

The actual sampling procedure consisted of lowering the traps at regular time intervals, fishing for one minute, inserting a fibreglass slider between the oval retainer and rectangular tunnel and raising the trap from the water. When the traps were raised, captured fry were washed into and drained out of a fibreglass tub into a five gallon polyethylene bucket. The bucket of water, with fry, was transferred to an enumeration laboratory where the fry and water are poured onto an enumeration table to be hand counted. After counting, the fry are allowed to pass off the sloping counting table into a transport trough connected by plastic pipe to the river. Often, during peak migration, fry were volume counted rather than hand counted to prevent mortalities from prolonged handling and to minimize the time involved in the sampling process. The method involved filling a graduated 250ml volumetric container, screened to remove water, with fry, volume read and recorded. The contents of these containers would be counted three times a night to obtain a volumetric conversion factor, (4 to 6 fry per ml). This factor was then applied to the volumetric measures thus providing an estimate for the number of fry sampled that evening.

Nightly estimates of fry migration were obtained by relating the actual night's catch to the unfished area and unfished time. A standard index period of the four and a half hours of peak migration (2220 - 0250 hours) using two index traps provided the basic estimate of the nightly fry abundance (Appendix

Table I). A time check correction was applied to the 4.5 hour index period to estimate total migration over a 24 hour period. The time correction factor was obtained by fishing the index traps over a 24 hour period and adding the percent not captured in the standard index period to obtain a 24 hour estimate. (Appendix Table II). The final correction factor, that for the unfished area (Appendix Table III) or relating the catch of the two index traps against all ten traps,was applied to the time corrected standard index to arrive at the total nightly fry abundance. An example of the calculation procedure for an index catch on the night of May 25-26, 1972 provides a suitable example of estimating a nightly migration of 1,510,360 fry from an actual night's catch of 5,436 fry (Appendix Table IV).

Three standard index sampling times were adopted depending on the catch. A 20-5 fishing sequence consisted of fishing the traps for 20 minutes and then raising, emptying, cleaning and then setting the traps in the following five minute period. If the catch was excessively high, the fishing sequence was altered to 10 minutes fishing followed by 20 minutes of non fishing (10-20). Also, five minute fishing and 25 minute non fishing (5-25) sequence was employed to avoid large catches.

Fry Production and Egg to Fry Survival

The average fry production from the Fulton River prior to flow control was 30.8 million (Table 5) for an average egg to fry survival of 20.8 percent. During the period 1968 to 1976, production averaged 31.7 million fry and survival 17.2 percent. Since flow control, the average fry output has remained virtually

TABLE 5: Fulton River sockeye fry production from 1962 to 1976.

Brood Year	Egg Deposition (millions)	Fry Production (millions)	Egg-Fry Survival (%)	Fry Year
61	237.7	26.5	11.0	62
62	136.5	41.7	30.5	63
63	148.0	46.5	31.4	64
64	187.0	24.5	12.5	65
65	189.0	23.6	12.5	66
66	77.5	24.0	31.0	67
67	171.6	28.8	16.7	68
Natural Flow Average				
7 years	163.9	20.8	30.8	
68	213.6	38.7	17.6	69
69	81.7	11.2	12.6	70
70	189.9	38.9	20.5	71
71	209.3	31.0	14.8	72
72	167.4	33.4	19.9	73
73	150.0	27.5	18.3	74
74	131.5	27.7	21.0	75
75	352.9	45.5	12.9	76
Flow Control Average				
8 years	187.0	31.7	17.2	

the same; however, average egg to fry survival has declined. Expectations were that flow control would increase egg to fry survival from 20 to 30 percent. Various reasons may be given for the lack of response to flow control. For example, if post development spawning and incubation flows have remained the same as pre development flows, then flows would not be a limiting constraint to production from Fulton River. Also, flow control does not eliminate predators, or increase spawning area to any great extent, or provide better spawning gravel. However, flow control does ensure a stable flow during spawning, incubation, and spring migration. Therefore, many of the mortality factors acting on developing eggs have not been altered with the exception of emergence timing. During pre development years, spring freshet influenced emergence timing to a degree that in certain years immature fry would emerge under high discharge and migrate to the lake at a time when food was scarce. Flow control reduced the possibility of early fry emergence.

Another possible reason for the lack of increase in egg to fry survival is that pre development production estimates particularly in 1963 and 1964 were over estimates. Prior to 1966, fry production was measured with vertical samplers which are far less accurate than converging throat traps. From 1966, both hydraulic sampling (McNeil, W.J., 1964) and converging throat traps have been used to assess fry production (Table 6).

Assuming such mortality causing factors as discharge, temperature and predators remain relatively constant from year to year, egg to fry survival in the Fulton River appears to be density dependent. The negative regression of egg to fry survival on egg

TABLE 6: Comparison between annual egg to fry survival rates derived from the hydraulic sampling and enumeration fence techniques at Pinkut Creek and Fulton River.

	PINKUT				FULTON					
BROOD	RIVER		CHANNEL		RIVER		CHAN. #1		CHAN. #2	
YEAR	Hyd. Samp.	Down Stream	Hyd. Samp.	Down Stream	Hyd. Samp.	Down Stream	Hyd. Samp.	Down Stream	Hyd. Samp.	Down Stream
1963	19.1					31.4				
1964	2.0					12.5				
1965	13.5					12.5				
1966	16.9	13.8				31.0		69.1		
1967	9.9	6.6				16.7		48.9		
1968	16.4	10.0	23.4	33.8		17.6		42.7		
1969	-	19.8	59.9	40.5		12.6		21.3		67.3
1970	18.5	19.9	-	58.0		20.5		31.0		31.5
1971	20.7	-	62.6	54.2	17.0	14.8	38.6	50.7	32.9	41.7
1972	16.8	-	-	30.0	16.5	19.9	43.0	52.1	52.4	26.5
1973	12.1	10.1	16.3	24.8	14.4	18.3	42.2	43.7	42.6	45.1
1974	15.0	9.3	-	8.9	25.1	21.0	47.2	63.5	30.2	36.7
1975	12.6	-	17.0	33.1	-	12.9	55.4	54.0	36.2	40.0

deposition is significant, (Fig. 20; $P \leq .05$) and indicates that as deposition increases egg to fry survival decreases. It is thus indicated that either on above optimum density of eggs in the gravel or spawning above on optimum density reduces the efficiency of spawning. The positive regression of fry production on egg deposition is also significant (Fig. 21; $P \leq .05$). The data from these two regressions suggests that beyond an egg deposition of 200 million, only minor increases in production occur.

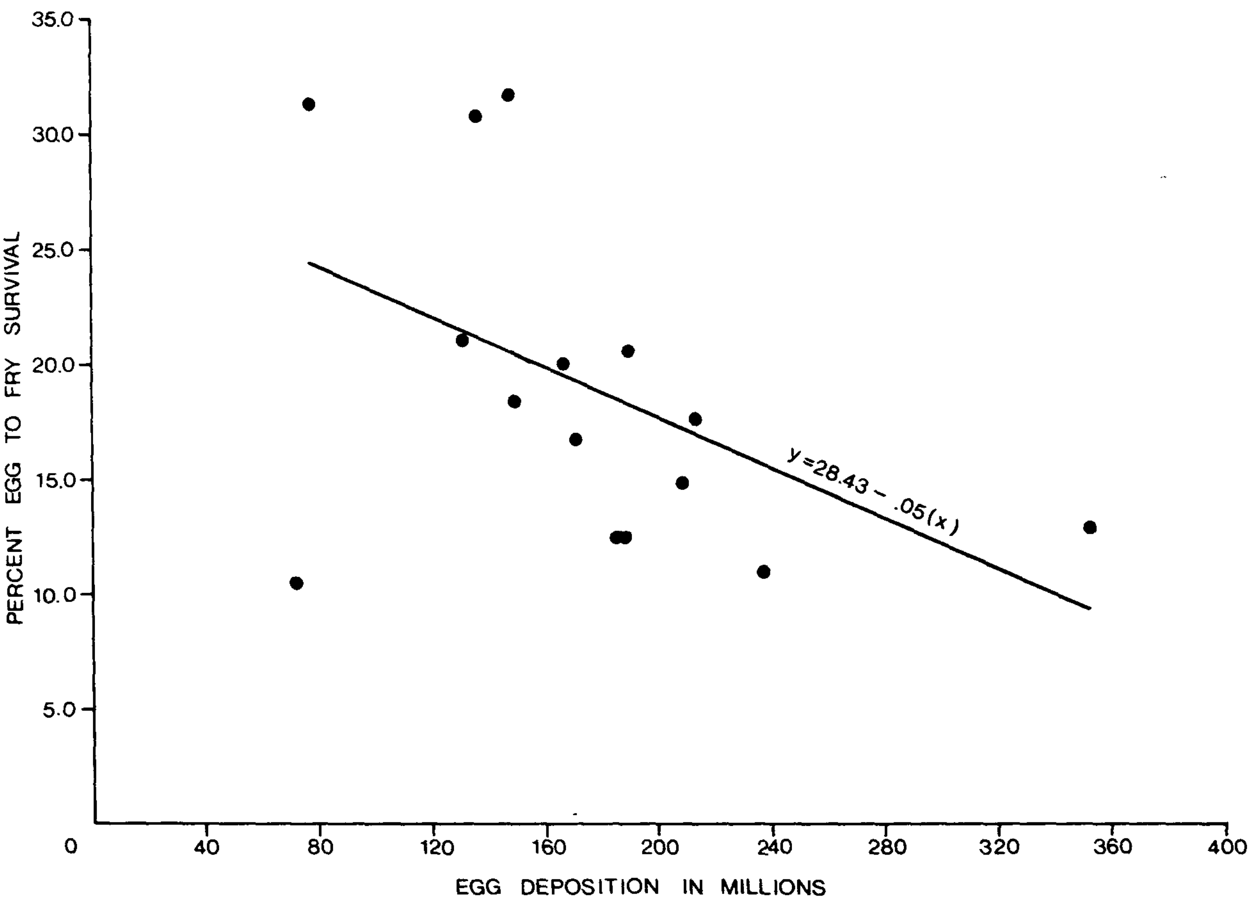


Figure 20: Regression of sockeye egg to fry survival on actual egg deposition in Fulton River.

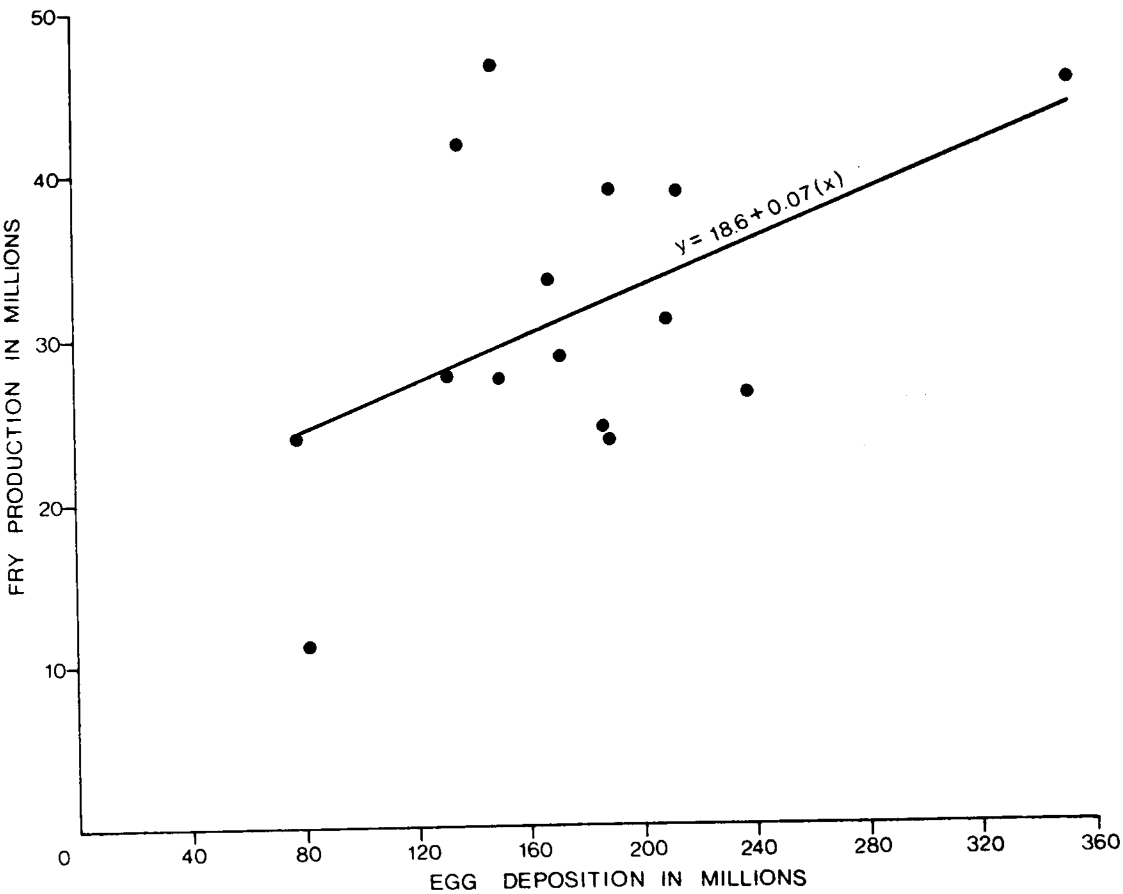


Figure 21: Regression of sockeye fry production on actual egg deposition in Fulton River.

The positive regression of egg to fry survival on the spawning area available to females is also significant, (Fig. 22; $P \leq 0.05$). These data suggest that the maximum area available for spawning in the Fulton River should approximate 1.4 sq. yds. per female spawner in order to maintain high survivals and avoid superimposition of redds. The total available spawning area of 75,000 yds. would comfortably accomodate 54,000 female spawners or 108,000 adults at a 50:50 sex ratio. This is slightly less than the original loading estimate of 120,000 fish at an equal sex ratio.

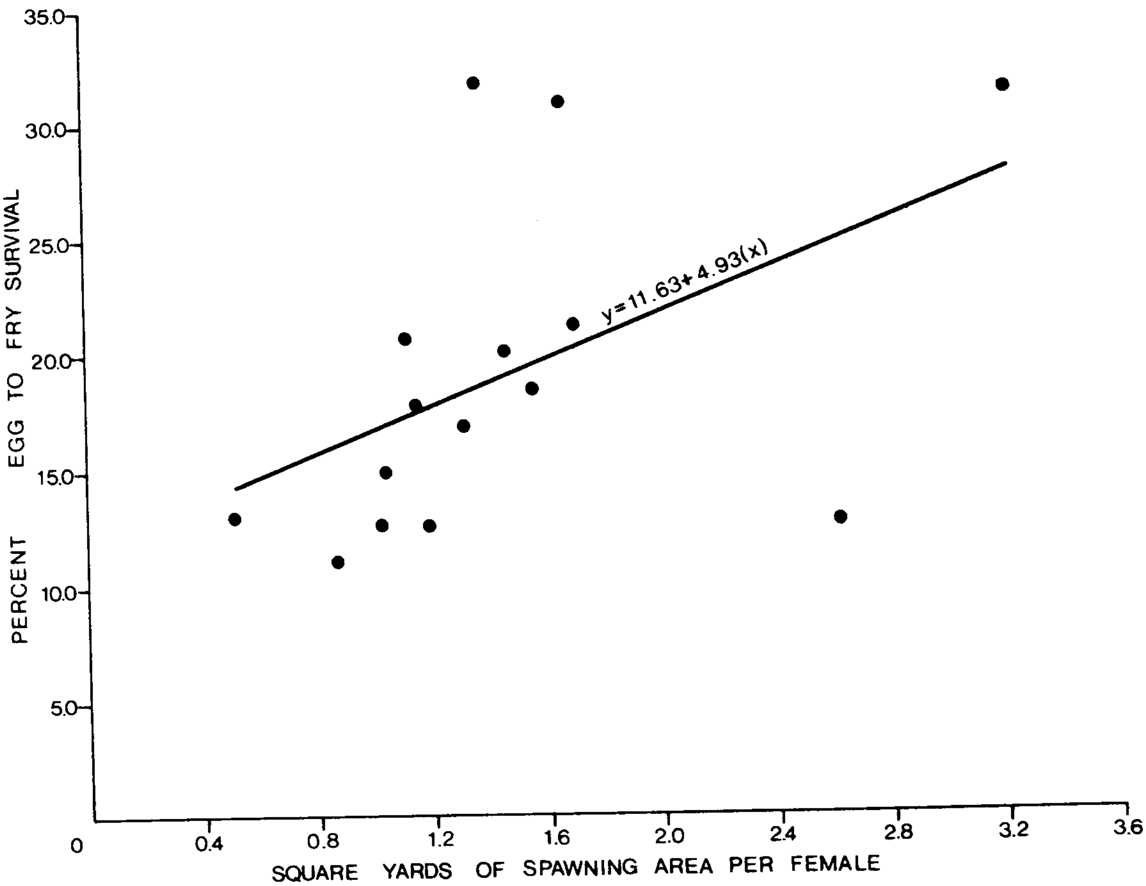


Figure 22: Regression of sockeye egg to fry survival on spawning area per female in Fulton River.

Studies conducted by Ginetz (1972) indicated that significant egg mortality occurred very early in the incubation period and that much was attributable to superimposition of redds. The present results provide further evidence of this occurrence. It appears that the most serious mortality factor during spawning and early incubation appears to be dependent upon adult density. As a result of these findings, new loading criteria have been adopted in accordance with the available information.

Fry Migration Timing

Fry migration from the Fulton River occurs during a six-week period, beginning in mid-April and ending in the first week of June. Peak migration normally occurs during the fourth or fifth week of that period. In recent years there has been a gradual shift towards an earlier peak from the last week to the third week of May (Table 7). This shift in timing in the river is probably related to river discharges and water temperatures. In virtually all years, there is a close association between river discharge and migration timing (Fig. 23). In 1975 and 1976, migrations were unusually early, and this was due to an earlier then usual spring runoff. Other factors influencing emergence timing such as timing of egg deposition in the brood years and water temperature during incubation were not abnormal.

Fry Quality

Fry produced in Fulton River vary from year to year in length, weight and development index. Average mean length during the period 1964 to 1976 is 29.51mm, with a range from 28.20 in 1965 to 30.30 in 1964 (Table 8). Since 1966, fry length has consistently averaged in the 29mm range. In terms of pre- and post-flow control comparisons, the length has not increased significantly.

TABLE 7: Peak timing of sockeye fry migrating from the Fulton River System to Babine Lake.

Fry Year	Location		
	Fulton River	Channel No. 1	Channel No. 2
1962	May 28		
1963	May 23		
1964	June 4		
1965	-		
1966	June 6		
1967	June 2	June 9	
1968*	May 21	June 3	
1969	May 25	June 1	
1970	May 17	May 27	May 18
1971	May 15	May 21	May 21
1972	May 19	May 24	May 30
1973	May 20	May 26	May 31
1974	May 19	May 29	June 1
1975	May 13	May 16	May 27
1976	May 10	May 17	May 26

* Beginning of flow control.

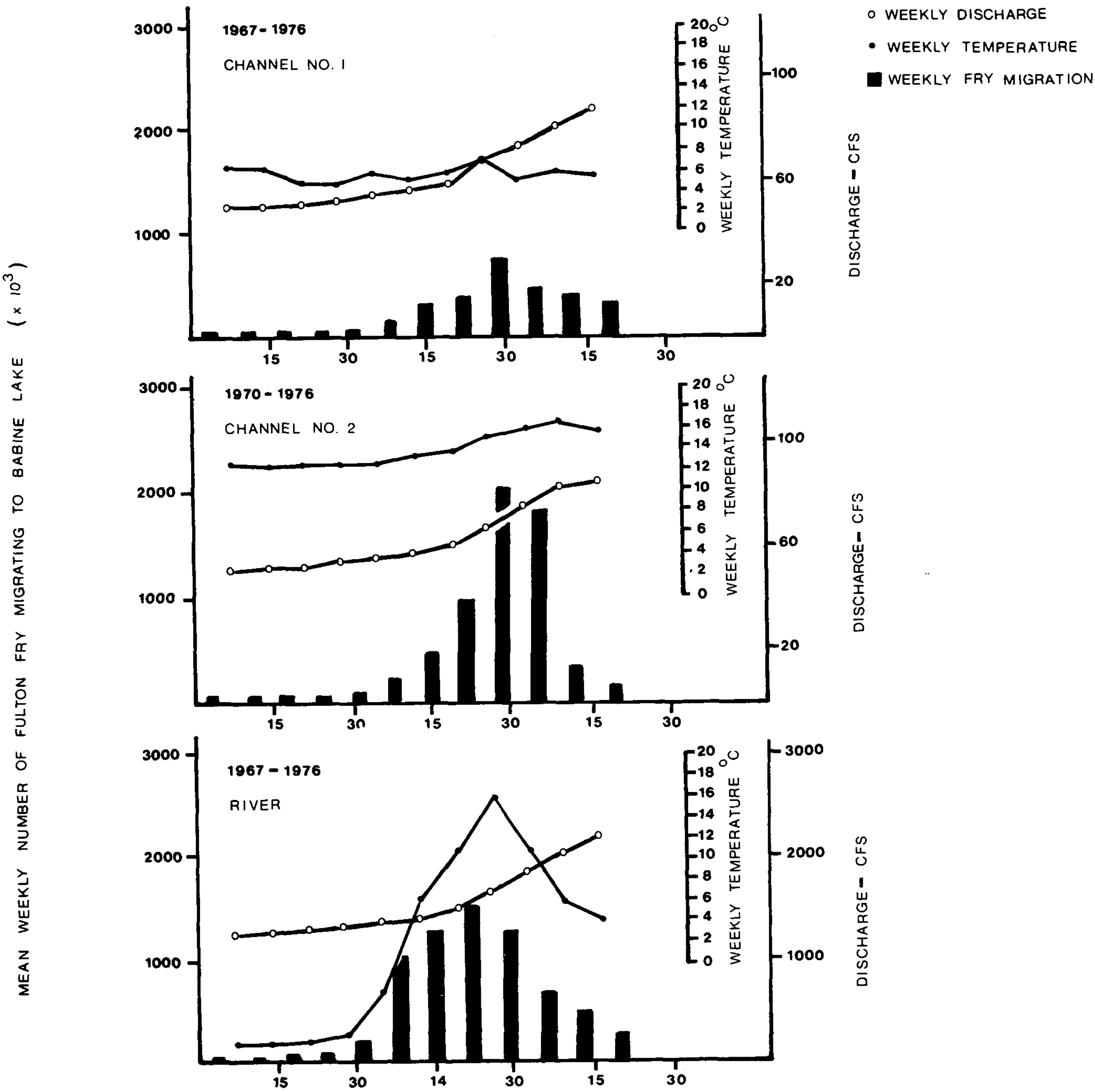


Figure 23: Mean weekly number of Fulton fry migrating to Babine Lake in relation to average weekly water temperature and discharge from 1967 to 1976.

Lengths prior to flow control averaged 29.30mm, while after control was implemented, lengths have averaged 29.60mm.

TABLE 8: Mean length in mm. of sockeye fry migrating from the Fulton River System to Babine Lake.

Fry Year	Mean Length (mm)		
	Fulton River	Channel No. 1	Channel No. 2
1964	30.30		
1965	28.20		
1966	29.33	29.05	
1967	29.40	28.97	
1968*	29.33	29.76	
1969	29.75	30.23	
1970	29.89	28.94	30.45
1971	29.84	29.27	30.15
1972	29.42	29.30	29.94
1973	29.11	29.29	29.36
1974	29.83	29.45	30.28
1975	29.99	29.18	30.05
1976	29.21	28.89	29.90
Average	29.51	29.26	30.02
1970-76 Average	29.61	29.19	30.02

* Beginning of flow control.

Average annual mean weight from 1964 to 1976 was 152.74mg (Table 9) while the average pre-development weights of 153.23mg and average post-development weights of 152.53mg are similar.

TABLE 9: Mean weight in mg. of sockeye fry migrating from the Fulton River System to Babine Lake.

Year	Mean Weight (mg)		
	Fulton River	Channel No. 1	Channel No. 2
1964	160.00		
1965	150.00		
1966	148.17	147.24	
1967	154.75	138.47	
1968*	146.90	140.05	
1969	172.24	176.68	
1970	142.67	127.89	149.45
1971	150.45	139.79	150.28
1972	149.76	148.76	146.69
1973	154.24	155.04	148.23
1974	153.02	156.16	147.09
1975	148.55	147.97	153.40
1976	154.96	139.45	143.44
Average	152.74	147.05	148.37
1970-76 Average	150.52	145.01	148.37

* Beginning of flow control.

Data for comparing stage of development at migration between pre- and post-development periods is lacking. There is an indication from high K_D values (Table 10), that in 1966 and 1967 fry migrated prematurely, and it is probable that with uncontrolled discharge, alevins were scoured from the river gravel by high water velocities. Indices below 1.80 indicate that fry were more mature at the time of migration. Controlled flow, which limits water velocities, will allow developing alevins additional time in the gravel to mature without the possibility of being washed downstream. An example of the effect of freshet timing on the fry development at the time of migration is realized when comparing K_D values in 1972, 1973 and 1976 with those in other years. When spring freshet is delayed or prolonged until early June, K_D values approximate 1.75. Values ranging above 1.80 are associated with early freshet or high discharge.

A comparison between river and channel fry indicates definite spatial and temporal differences in quality at migration. Comparing annual mean lengths and weights from 1966 to 1976 (Appendix Tables V to XIII), indicates that river fry were longer and heavier than Channel No. 1 fry with the exception of 3 years. In 1968, 1969 and 1973 Channel No. 1 fry were larger.

These data require some clarification as a result of differences in migration timing. In most years fry migration from Channel No. 1 is approximately one week later than from the river. Accordingly, where river fry appear larger than channel fry during the peak migration in the river, channel fry are just beginning their migration. For example, in 1967 (Fig. 24), the river migration was 70 percent complete while the channel migration

TABLE 10: Mean developmental indices of sockeye fry migrating from the Fulton River System to Babine Lake.

Year	Mean Development Index (K_D)		
	Fulton River	Channel No. 1	Channel No. 2
1966	1.80	1.81	-
1967	1.82	1.78	-
1968*	-	-	-
1969	-	-	-
1970	1.74	1.74	1.74
1971	1.78	1.77	1.76
1972	1.80	1.81	1.76
1973	1.84	1.83	1.80
1974	1.79	1.83	1.74
1975	1.76	1.81	1.78
1976	1.83	1.79	1.76
Average	1.80	1.80	1.76
1970-76 Average	1.79	1.79	1.76

* Beginning of flow control.

had only reached 5%. If individual lengths and weights are compared between fry of the two sources when each group exceeds 70 percent migration, it is evident that quality differences do not exist in most years, (Table 11, Appendix Tables V to XIII). However, in 1970 and 1971, significant differences existed both in length and weight between fry of the two sources

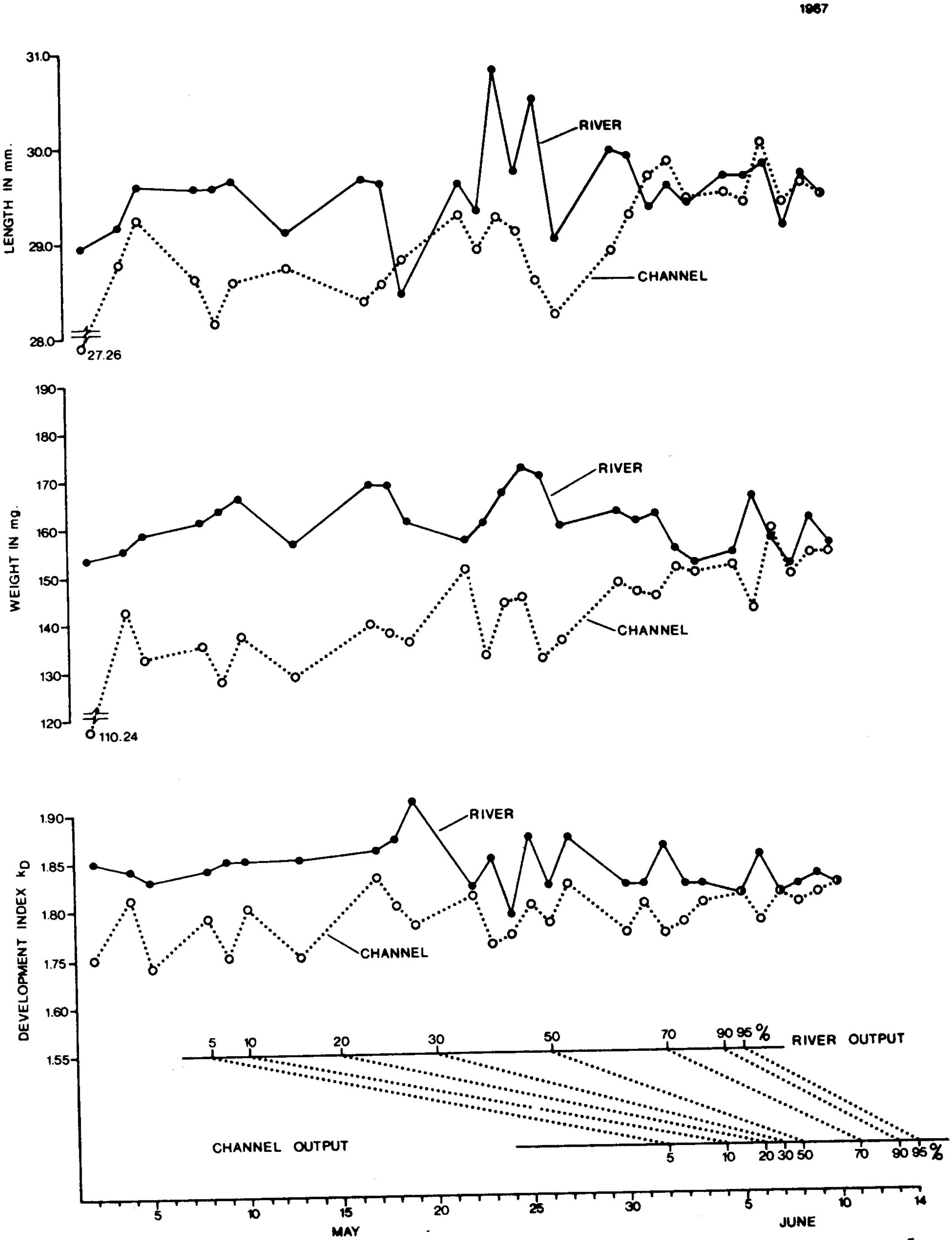


Figure 24: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, and Channel No. 1 fry at intervals during the 1967 spring migration. Also shown is the progress of the runs in time.

TABLE 11: Summary of *annual mean lengths*, weights and developmental indices, their difference and statistical significance of sockeye fry in paired samples from Fulton River and Channel No. 1.

Sample Location	Date	N	Mean Length (mm)	S^2		Δi (mm)	U	Z	P	Mean Weight (mg)	S^2		Δi (mg)	U	Z	P	Index (K_D)	S^2		Δi (K_D)	U	Z	P
River	1966	651	29.33	2.97		.28	81[b]		.05	148.17	395.42		.93	84[b]		>.05	1.80	.008		-.01	81.5[b]		>.05
Chan.1		702	29.05	4.04	1.36[c]				<.01	147.24	799.61	2.02[c]				<.01	1.81	.008	1.00[c]				>.01
River	1967	1890	29.40	1.53		.43	454.0[b]	-2.784	.0020	154.75	500.79		16.28	228.0[b]	-5.132	0	1.82	.005		.04	255.5[b]	-4.846	0
Chan.1		1890	28.97	2.07	1.35[c]				<.01	138.47	599.73	1.20[c]				<.01	1.78	.004	1.25[c]				<.01
River	1970	1449	29.89	1.50		.95	32[b]	-6.042	0	142.67	455.85		14.78	24[b]	-6.166	0	1.74	.002		0	301[b]	-1.858	.0316
Chan.1		1450	28.94	1.89	1.26[c]				<.01	127.89	413.74	1.10[c]				<.01	1.74	.005	2.50[c]				<.01
River	1971	950	29.84	1.43		.57	74[b]		<.001	150.45	383.66		10.66	41[b]		<.001	1.78	.005		.01	165.5[b]		>.05
Chan.1		950	29.27	1.65	1.15[c]				<.01	139.79	453.16	1.18[c]				<.01	1.77	.005	1.00[c]				>.01
River	1972	800	29.42	1.69		.12	119[b]		>.05	149.76	329.35		1.00	125.5[b]		>.05	1.80	.004		-.01	124[b]		>.05
Chan.1		800	29.30	2.01	1.19[c]				<.01	148.76	465.26	1.41[c]				<.01	1.81	.005	1.25[c]				<.01
River	1973	797	29.11	2.24		-.18	116[b]		>.05	154.24	385.02		-.80	126[b]		>.05	1.84	.006		.01	112.5[b]		>.05
Chan.1		800	29.29	1.69	1.33[c]				<.01	155.04	545.00	1.42[c]				<.01	1.83	.006	1.00[c]				>.01
River	1974	400	29.83	2.54		.38	25[b]		>.05	153.02	559.98		-3.14	17[b]		>.05	1.79	.008		-.04	17.5[b]		>.05
Chan.1		550	29.45	2.05	1.24[c]				<.01	156.16	419.17	1.34[c]				<.01	1.83	.006	1.33[c]				<.01
River	1975	448	29.99	1.98		.81	5.0[b]	0 p	<.001	148.55	482.98		.55	30.0[b]		>.05	1.76	.005		-.05	27.5[b]		>.05
Chan.1		500	29.18	2.72	1.37[c]				<.01	147.97	778.92	1.61[c]				<.01	1.81	.008	1.60[c]				<.01
River	1976	500	29.27	2.38		.39	20[b]		.117	154.93	399.32		4.42	4[b]		.001	1.83	.007		-.03	17[b]		.065
Chan.1		494	28.88	1.97	1.21[c]					139.11	360.54	1.11[c]				<.01	1.79	.006	1.17[c]				<.01

River, river samples; Chan.1, spawning channel no. 1 samples; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (R-1); U,Z,P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 8$.

[c] Test on homogeneity of variances.

as channel fish were definitely smaller (Fig. 25 & 26). Inferior gravel quality was the probable cause for the difference. In the summer of 1970 the gravel was removed and cleaned, but fry quality did not improve until 1972. One can only speculate as to the reasons for the lack of response in 1971.

Early entry into Babine Lake by river fry is of minor significance provided that adequate yolk reserves allow river fry time to maintain themselves until adequate food supplies are available. Apparently, Fulton fry can withstand approximately two weeks of starvation before mortalities increase significantly (Paine, 1971; Bilton and Robins, 1973). However, Bilton suggests that even though most fry would be capable of surviving a period of starvation of up to four weeks, a large mortality could occur even after food became plentiful in the lake. Thus it would appear that unusually early spring runoff and early pre-emergence in the river may seriously affect the survival of river fry.

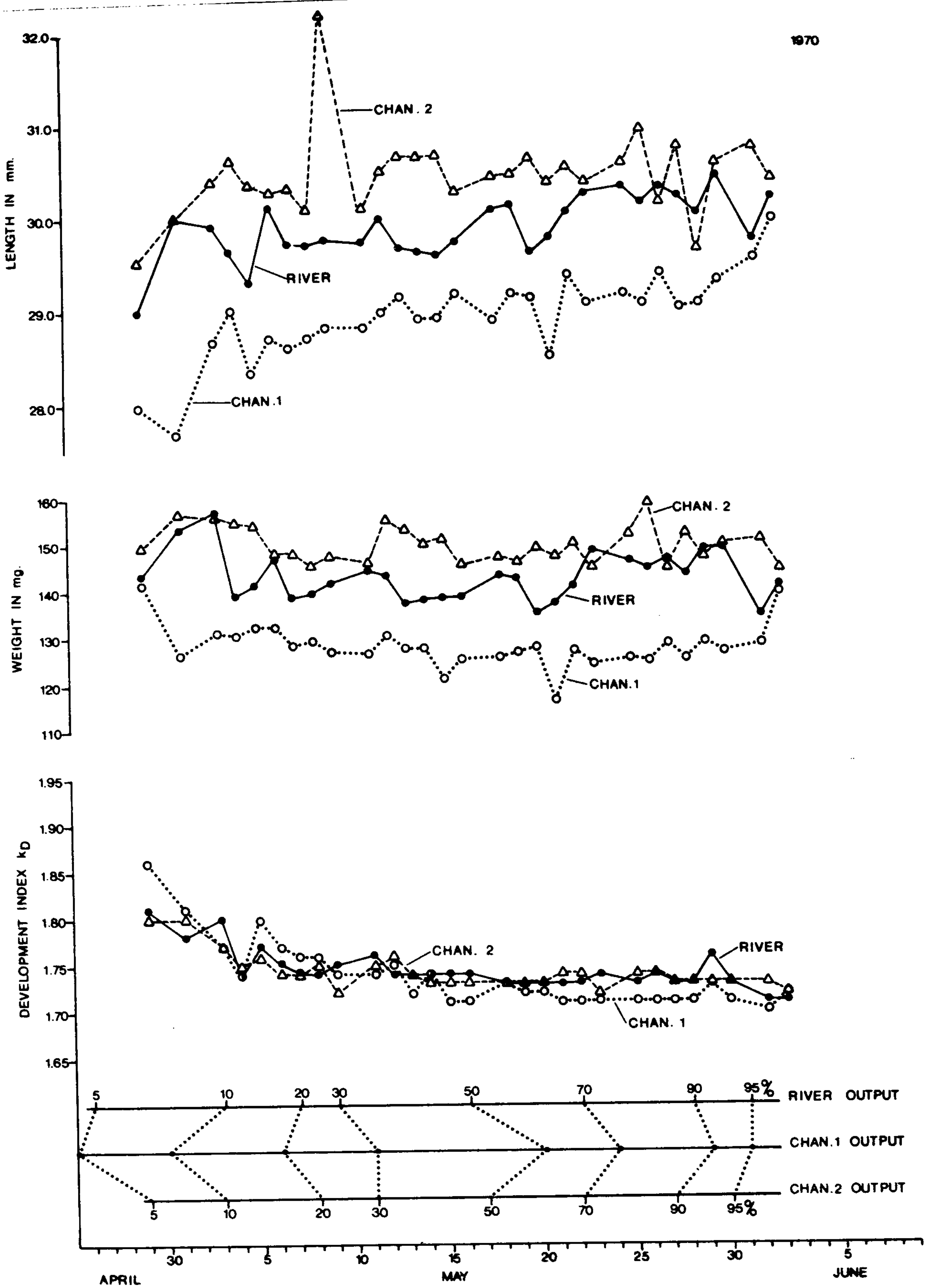


Figure 25: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1970 spring migration. Also shown is the progress of the runs in time.

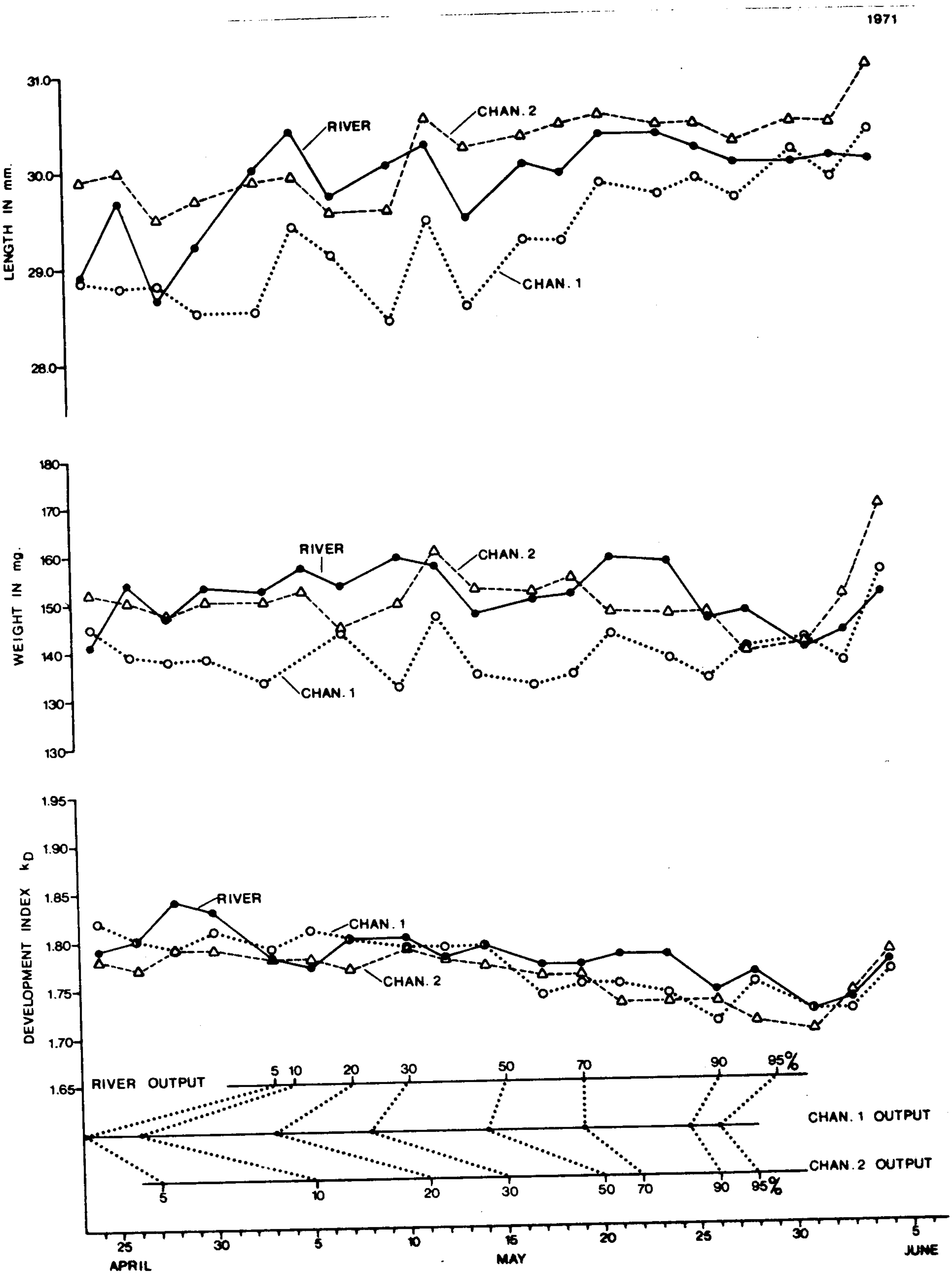


Figure 26: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1971 spring migration. Also shown is the progress of the runs in time.

EVALUATION OF SPAWNING CHANNEL NO. 1

Introduction

With approval of the development project on Babine Lake early in 1965, construction of Spawning Channel No. 1 was completed at Fulton River in October, 1965. This late completion date and the lack of a natural spawning population at the time, necessitated the requirement to collect 1.2 million sockeye eggs from natural Fulton River spawners, and incubate them to the eyed egg stage prior to placement in the channel at the end of November. An 82% survival was obtained from this artificial plant. Natural spawning has occurred in Channel No. 1 since 1966. The natural production from this facility was expected to be approximately 40 percent egg to fry survival.

This section of the report provides a descriptive evaluation of the performance of Channel No. 1 from the first year of natural adult entry (1966) to the 1975 brood year and its associated fry production. Emphasis is placed on quality of the artificially produced fry, fry production and other biological and physical characteristics related directly to the channel.

Operational History of Channel No. 1

The channel's first natural operational year was 1966 when approximately 18,800 spawners entered the channel. Adult entry in that year was prolonged due to high river flows creating a greater attraction for upstream migration into the river (Table 12). In 1969, adult entry into the channel was also prolonged, but this was due to problems encountered in loading Channel No. 2. Only small numbers of fish were allowed to migrate upstream from the river enumeration fence thus creating a lengthy loading time in Channel No. 1. Simular problems were encountered in 1970 and 1971. Since then, reduced flows in the river and easier manipulation of adult spawners through the river enumeration fence has enabled rapid loading of Channel No. 1.

Spawners returning from 1966 to 1971 entered the channel throughout the migration period which normally was more than 30 days in duration. Studies in 1971 (Ginetz), suggested that superimposition created by successive spawning waves in the channel lead to high egg mortality. Therefore in 1972, loading time was reduced to eliminate the wave spawning. This was accomplished by selecting the more mature portion of the adult run to enter the channel.

Declining egg to fry survival rates from 1965 to 1970 prompted the removal, cleaning and replacement of the gravel in 1970. Intensive gravel scarification, an annual maintenance priority, has been conducted since 1971 with moderate success.

TABLE 12: Adult loading time (in days) for the Fulton River and Pinkut Creek spawning channels.

YEAR	Channel No. 1	Channel No. 2	Pinkut Channel
1966	51	-	-
1967	24	-	-
1968	32	-	32
1969	49	30	63
1970	37	30	19
1971	36	38	53
1972	10	41	41
1973	4	36	18
1974	20	24	35
1975	3	20	12

Adult Sockeye Program

Sampling Technique

Adult counts into Channel No. 1 are presently obtained with the aid of a temporary V-shaped broomstick fence located at the outlet of the facility. Enumeration occurs daily but only during daylight hours. In 1966 and 1967 a wire mesh panel fence and counting strip was used. Counts were made as adults passed over a white counting board. However with the fence panels raised, significant downstream migration out of the channel created a loading and enumeration problem. The V-shaped fence was incorporated in 1968 to alleviate this problem. A portion of the adults are sampled for sex, age, lengths, fecundity and egg retention.

Population Characteristics

The spawning populations in Channel No. 1 have ranged from 12.5 to 26.0 thousand sockeye for the period 1966 to 1975

(Table 2). The original loading density selected was 1.25 sq. yds. per female and was employed up to and including the 1973 brood stock year. In 1974 and 1975 loading was reduced to 1.5 sq. yds. per female, after it became apparent that egg to fry mortalities were density dependent.

Age compositions of spawners in Channel No. 1 is similar to that described for the Fulton River stock in that a cycle is apparent between age 4_2 and 5_2 adults.

Jack sockeye populations in Channel No. 1 have ranged from 9,184 in 1966 to 719 in 1967. Again, the 3_2 component of the spawning population has increased but not unexpectedly. Reasons for the increase were described earlier. Escapement to Channel No. 1, although not necessarily originating from Channel No. 1 brood stock, approximated 22 percent in 1972 and 1973, and 40 percent in 1974 (expressed as a percentage of the total Fulton jack escapement).

Egg Deposition and Retention

Results (Fig. 27) support the view that egg retention is a function of potential egg deposition or spawner density. Except for two spawning populations, egg retentions have been minimal suggesting that in most years spawning populations did not reach levels where spawning efficiency was affected. In 1968, potential deposition exceeded 60 million eggs and the corresponding egg retention of 5.1 percent indicated that populations of such magnitude experience difficulties in complete spawning. High numbers of spawners per unit area not only lead to high retentions but may also result in poor fry quality as well as low egg-fry survival rates.

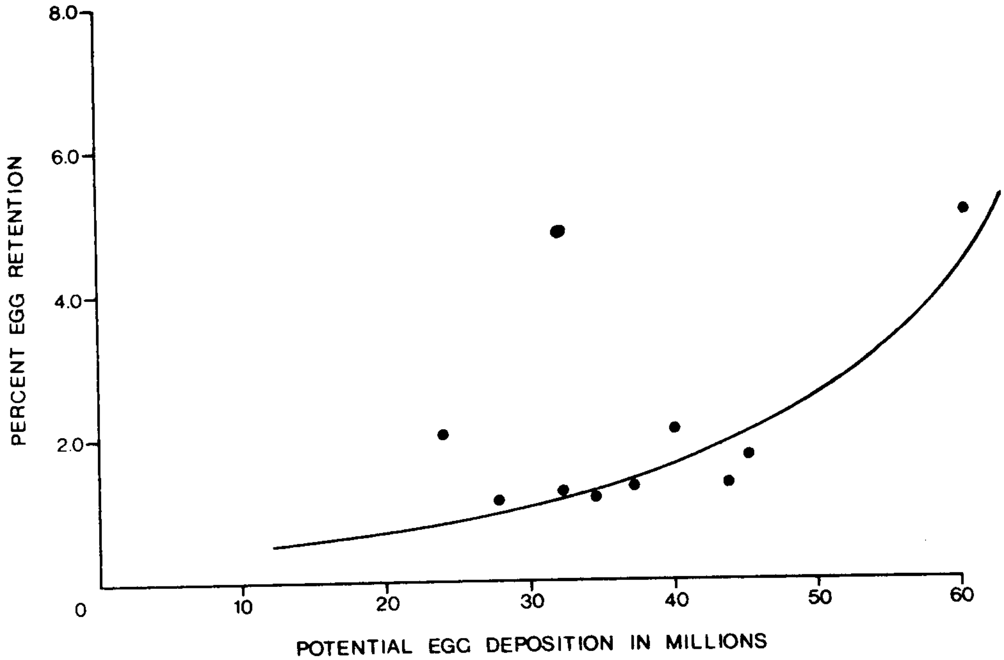


Figure 27: Relationship between potential egg deposition and percent egg retention in Spawning Channel No. 1 at Fulton River.

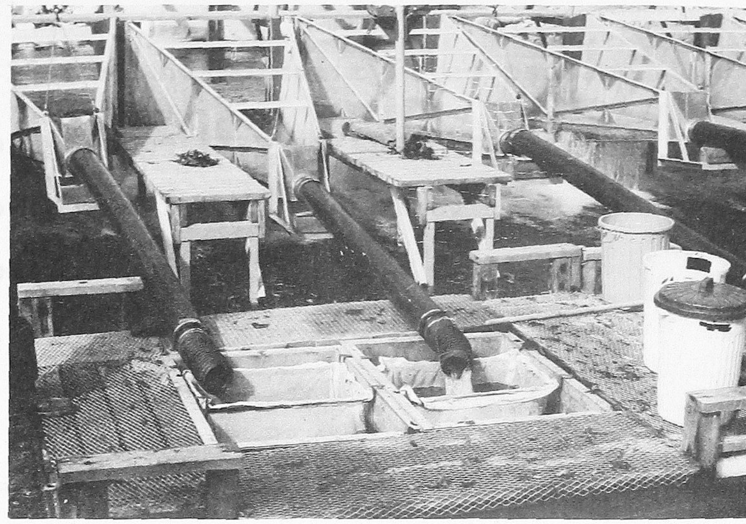
Sockeye Fry Program

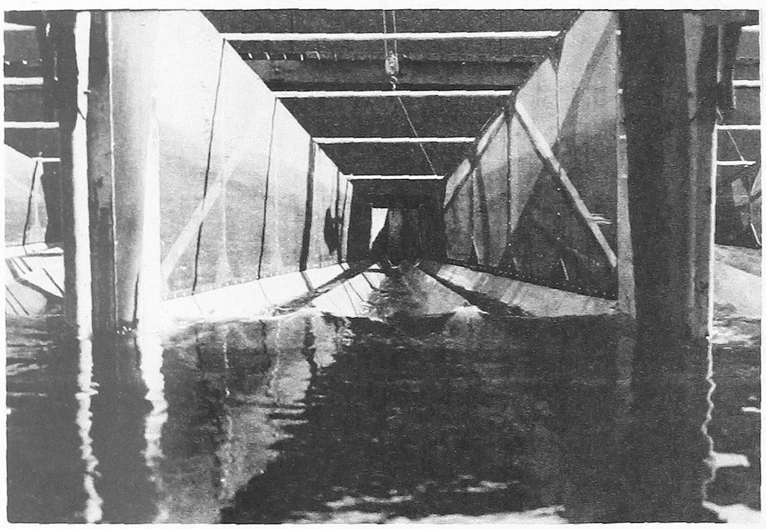
Enumeration Technique

Assessment of fry production from Channel No. 1 was conducted utilizing two series of fan traps with attached live boxes (Fig. 28). One series of six traps, located below the intake regulating structure in the channel, served to collect river fry migrating through an intake tunnel into the channel. This was necessary to evaluate the survival and quality of channel fry production. A second series of five traps, located at the channel outlet, functioned to capture total channel production.

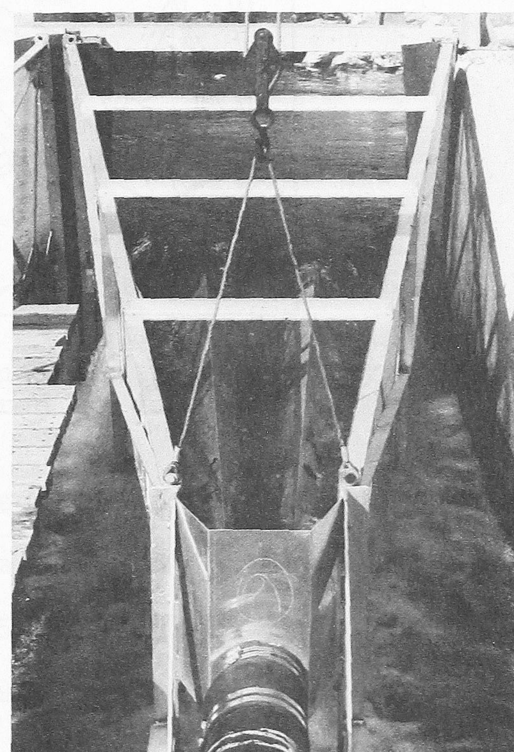
The fan traps (Fig. 29) constructed of perforated aluminum, in a tapered-folded design, provide for a maximum water

Upstream view of upper fan traps. Note transport pipes leading to live boxes.





Downstream view of fan trap throat.



Upstream view of fan trap taper.

Figure 28: Perforated aluminum fan traps used for enumerating fry production from Channel No. 1 at Fulton River.

screening surface capacity of 25 cfs and mortality free passage of migrant fry. Another feature of the trap is that the folded floor provides for minimum debris and fry impingement. Fry migrate along the solid V-shaped troughs, through a six inch pipe to an adjoining live box, from which fry are removed and enumerated.

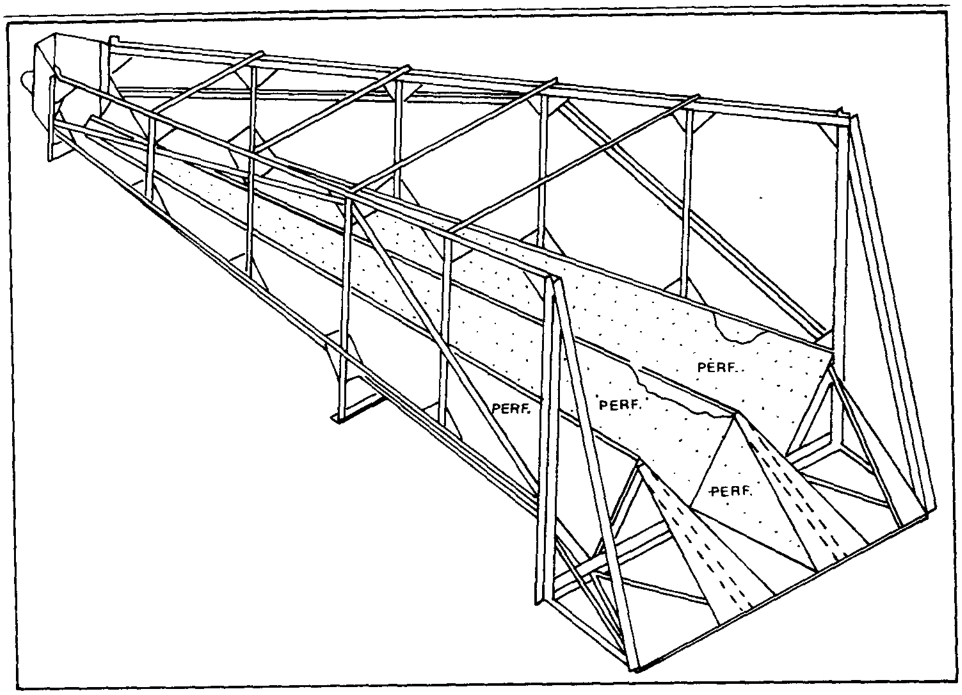


Figure 29: Schematic diagram of individual fan trap displaying perforated aluminum and tapered folded design.

Considerable effort was directed towards reducing excessive handling of migrant fry on any sampling day which in 1967 exceeded 17 million of a total of 25 million fry during a season. A subsampling technique developed in 1968 reduced handling to less than 500,000 fish. The method involved insertion of a sock, three feet in length and constructed of a marquisette bag and metal insert, into the outlet of the six inch pipe connecting the fan trap to the live box. Samples were collected for one minute out of every 10 minutes and the "sock" count was then multiplied by 10 to arrive at an estimate of fry migration for a 10 minute period. When excessive numbers of fish (200 - 300) were trapped, a volumetric procedure, incorporating a conversion factor of 5 to 6 fry per ml was used to estimate total migration.

The daily sampling period normally occurred over a four hour period, from 2300 to 0300 hours. Each trap was fished one minute out of 10 throughout the four hours. From 1969 to 1974 sampling as described above was conducted on alternate days. On other days, sampling was conducted for three consecutive catch periods, during the time when up to 30 percent of the total nightly migration passed through the fan traps. The catchability during the sampling period, determined from the previous evening when intense sampling was conducted, provided an estimate approximating 98 percent accuracy. Comparable catchability coefficients from six consecutive years of sampling data, provided the basis for a reduced sampling effort in 1975 and 1976. The procedure of sampling for three secessive 10 minute periods during peak migration once every three days provided a production estimate considered to be within 95 percent accuracy.

Details of the calculation process for determining nightly production from Channel No. 1 are presented in Appendix Tables XIV & XV. The time expansion established from the night of June 2 - 3, 1972 and applied to the night of June 4 - 5 exemplifies the estimation process.

Fry Production and Egg to Fry Survival

Average fry production from Channel No. 1 from 1966 to 1975 approximates 17.1 million while egg to fry survival averaged 47.7 percent (Table 13). The highest production from the channel was 24.7 million fry to 1969 while lowest production was 5.9 million in 1970. Survival rates have exceeded the design level (40 percent) in all but two years. Survival rates declined from 1966 to 1969 probably as a result of gravel deterioration. The quality of the gravel was improved in the summer of 1970 and since then, survival rates have exceeded 40 percent in all but one year. Although gravel quality is important in maintaining high production and egg to fry survival rates, other factors play an equally important role. For example, recent studies (Ginetz,

TABLE 13: Channel No. 1 sockeye fry production from 1966 to 1976.

Brood Year	Egg Deposition (millions)	Fry Production (millions)	Survival (%)	Fry Year
1966	36.9	25.5	69.1	1967
1967	32.8	16.0	48.9	1968
1968	57.7	24.7	42.7	1969
1969	27.8	5.9	21.3	1970
1970	43.3	13.4	31.0	1971
1971	39.4	20.0	50.7	1972
1972	44.6	23.2	52.1	1973
1973	34.3	15.0	43.7	1974
1974	23.6	15.0	63.5	1975
1975	23.5	12.7	54.0	1976
Average	36.4	17.1	47.7	

1972) indicated that as many as four individual waves of spawners constructed redds on the grounds and on many occasions redd superimposition occurred. The approach taken to eliminate superimposition was to minimize spawner loading time (Table 12) and reduce the spawning densities.

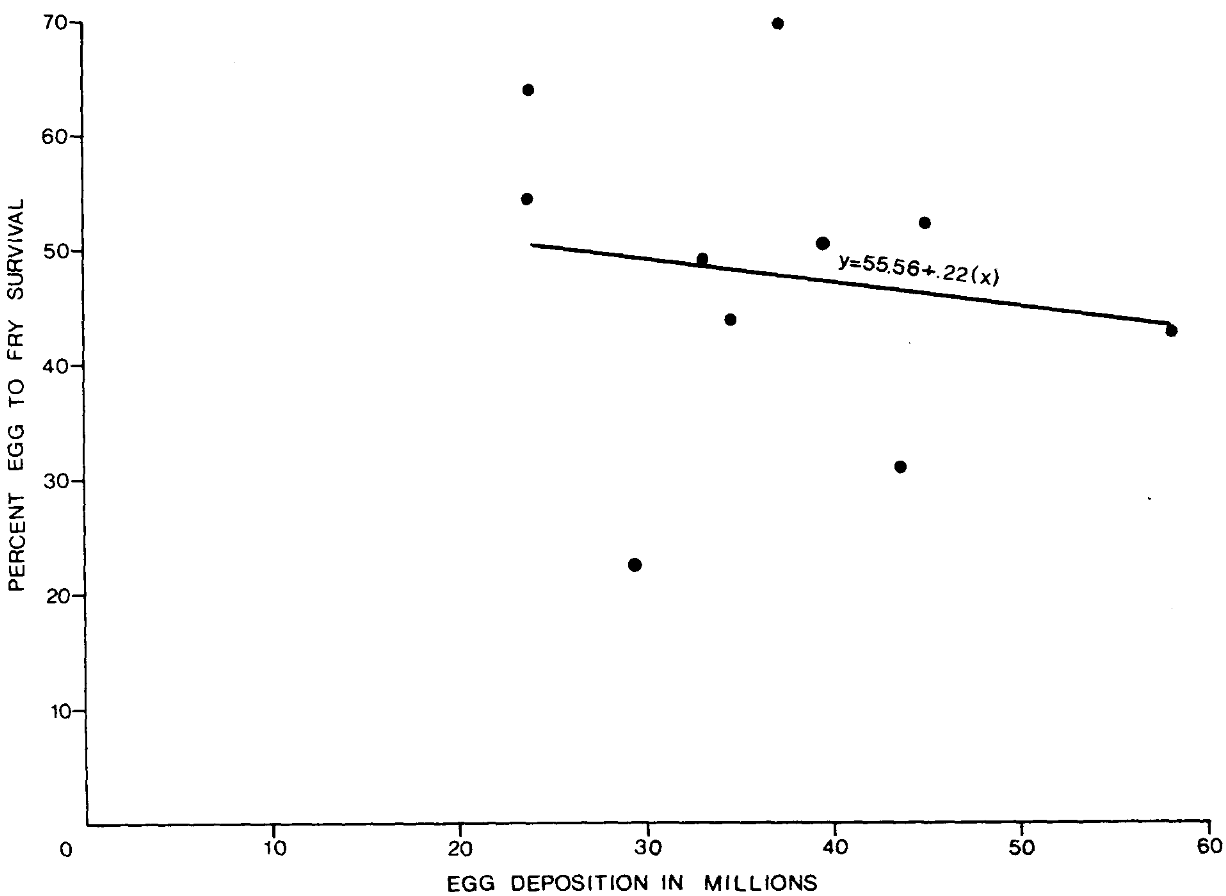


Figure 30: Regression of sockeye egg to fry survival on actual egg deposition in Channel No. 1 at Fulton River.

As in Fulton River, egg to fry survival appears to be density dependent. Although the negative regression of egg to fry survival on egg deposition is not statistically significant (Fig. 30; P $\geq$ .10), there is a trend indicating that as egg deposition increases, egg to fry survival decrease. Thus, the data suggests that an above optimum density of spawners would reduce the production efficiency. The positive regression of fry production on deposition is significant (Fig. 31; $P \leq .025$), indicating that production for Channel No. 1 increases as egg deposition increase. This data does not provide a good indication of the optimum level of egg deposition for the channel. Egg depositions approximating 24 million have resulted in egg to fry

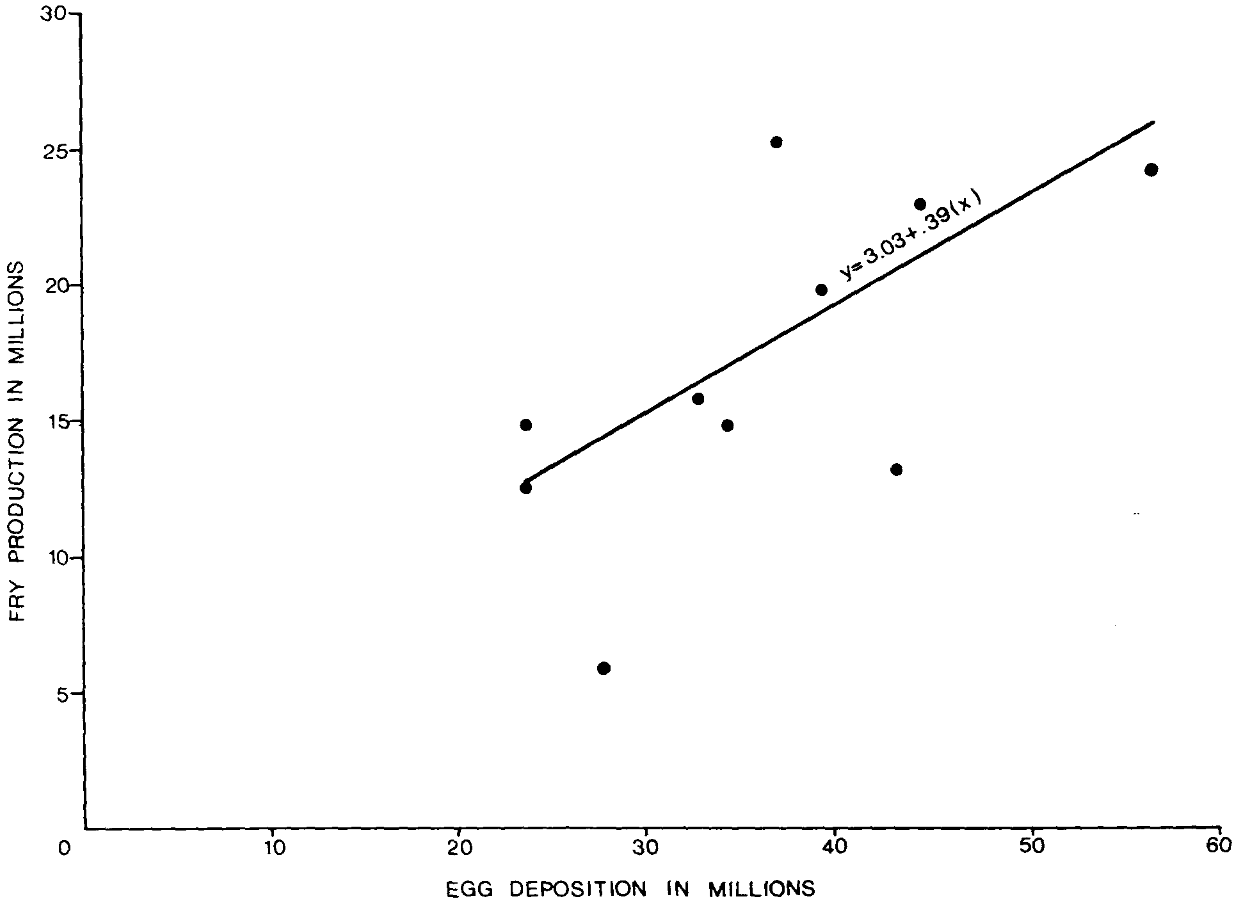


Figure 31: Regression of sockeye fry production on actual egg deposition in Channel No. 1 at Fulton River.

survivals ranging from 50 to 60 percent. The corresponding female spawning density at these survival rates approximate 1.40 sq. yds. per female. A reduction in female spawning area results in a significant decrease in egg to fry survival as indicated by the positive regression of egg to fry survival on female spawning area (Fig. 32; P $\leq$ .05). Fry production from an egg deposition of 23.5 million approximates 14.0 million or about 1,700 fry per female spawner. Higher deposition results in a higher fry production and significant decline in production per spawner. The data on egg deposition, egg to fry survival and female spawning density suggests that low survivals accompanied by small incremental increases in fry production from high egg depositions will result in inefficient production and a waste of adult spawners that could be exploited in the commercial fishery.

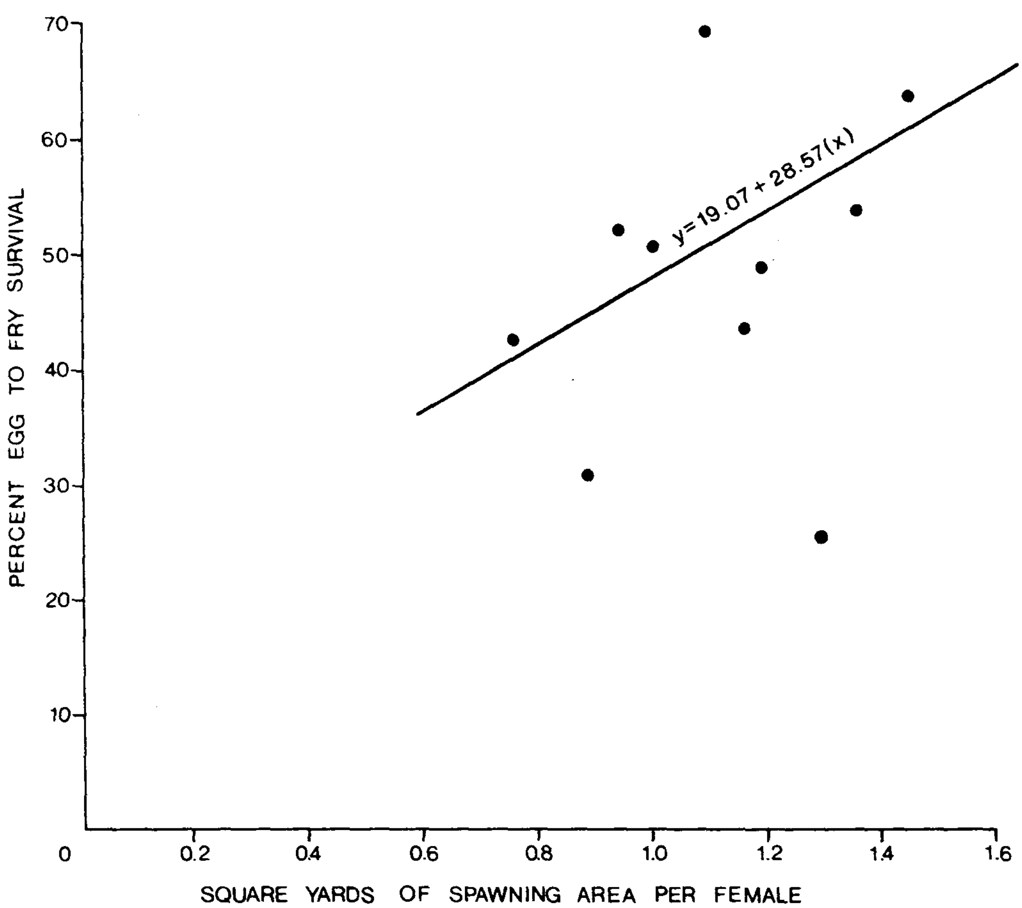


Figure 32: Regression of sockeye egg to fry survival on spawning area per female in Channel No. 1 at Fulton River.

Fry Migration Timing

Fry migration timing from Spawning Channel No. 1 varies from year to year, and as in Fulton River there has been a gradual shift in peak migration to the earlier portion of the spring season (Table 7). Due to the location of the channel, flows are influenced to a certain degree by those in Fulton River. Data collected from 1967 to 1976 (Fig. 23) indicates that migration was directly influenced by water temperature. Apparently water entering the channel increases in temperature over its length thereby initiating fry emergence. Also it appears that migration increases rather sharply when average daily or weekly water temperature exceeds 4°C. In all operational years, peak fry migration from the channel was later (1 week) than from the river. Since egg deposition occurred at approximately the same time in both the river and channel, high discharge in the river is probably the single reason for the earlier river migration.

Fry Quality

Average length of Channel No. 1 fry has ranged from 30.23 in 1969 to a low of 28.89 in 1976 (Table 8). In most years, average length falls in the 29 mm. range which is comparable to river fry. Similarly, the long-term average of 29.26 mm. is comparable to the 29.51 mm. recorded for river fry. Average mean weight of channel fry is 147.05 mg. (Table 9), slightly less than the 152.74 mg. recorded for river fry. Development of channel fry at the time of migration is also comparable to that of river fry (Table 10). As indicated earlier, channel fry migrate approximately one week later than river fry and generally arrive at Babine Lake when levels of food abundance should be increasing.

Channel No. 1 fry in 1970 and 1971 were distinctly shorter and weighed less than river fry (Fig. 25 & 26). The quality adjustment relative to migration timing indicates that the differences between the two sources were real. Reasons for these differences can not be explained. In other years, quality when adjusted to migration timing, appears similar to river fry (Appendix Tables V to XIII).

EVALUATION OF SPAWNING CHANNEL NO. 2

Introduction

Spawning Channel No. 2, designed to produce 70 million fry per year (based on 70,000 females x 2,500 eggs per female = 175 million eggs x 40 percent survival = 70 million fry) was constructed in two stages and not completed until 1971 when it was fully loaded. Fry production and egg to fry survival rates have been below expectations for several reasons. High adult loading densities, and more recently, poor gravel quality are the primary cause of low production efficiency. The immense area of spawning gravel has created problems associated with cleaning (costs) and with maintaining proper loading densities in various sections of the channel. Once these problems are overcome, production and survival rates should exceed original expectations.

This section of the report describes the performance of Channel No. 2 from its first operational year (1969) to the 1975 brood year fry production. Fry quality, fry production, egg to fry survival and other biological and operational aspects will be discussed.

Operational History of Channel No. 2

The first stage of Channel No. 2 was operational in the fall of 1969. Difficulties were encountered with adult entry and migration in the channel. Apparently, some minute, but significant water quality difference existed between river and channel water which inhibited movement into the channel. Small amounts of river water (1 cfs) introduced by gas-driven water pumps, into the channel provided the stimulus needed to elicit a migration response. Strategic placement of these pumps enabled adults to migrate into all channel legs but spawning distribution was very unequal. The result was severe overspawning in some areas and under-utilization in others. This problem, occurring from 1969 to 1972, was minimized with the installation of a large submersible electric pump (8 cfs cap.) in the river to pump river water into the channel.

In 1972, jack sockeye originating from the 1969 channel production entered the channel without hesitation. Returning adults in 1973 entered the channel without hesitation. In recent years, as the percentage of adults originating from channel brood stock increased, river water was not required to load the channel. In fact in 1975, approximately 70 percent of returning adults homed to the channel to spawn. This behavior may indicate that in time the genetic composition of the Fulton River stock may consist almost entirely of Channel No. 2 fish. By effectively proportioning the returning adult stocks such that equal numbers spawn in all locations, the genetic integrity, although greatly diversified, will still contain some natural river stock.

The length and size of Channel No. 2 created significant heat loss in the winter and resulted in icing problems. In 1970-71, anchor ice formations occurred in the lowermost sections of the channel and resulted in high alevin mortalities. Although the temperature of water entering the channel approximated +2°C., water exiting the channel some three miles downstream was 0°C. The scouring that resulted from ice dams was eliminated by increasing the normal discharge of 100 cfs to 140 cfs during the cold periods. The increase in discharge reduced the rate of heat loss and increased the temperature of water leaving the channel to 0.25°C. This procedure has been adapted and applied whenever air temperatures approach -20°C.

Large algae blooms (Ulothrix sp.) occurred in the months of May and June and posed problems both to emerging alevins and fry, and to incubating eggs. In early years, the uppermost legs of the channel became completely matted with algae growths resulting in suffocation and entrapment of juvenile fish attempting to migrate downstream. This algae eventually died leaving a highly eutrophic environment for incubating eggs. Gravel scarification programs have been implemented annually and the problem, although reduced, still results in significant mortalities to developing eggs, particularly in the upper eight legs where the algae effect is most significant.

The algae problem appears to result from a combination of factors such as water temperature, sunlight and high nutrient enrichment from lake water and decomposing algae and eggs. In addition to gravel scarification, trees were planted along all berms to reduce the sunlight and provide a cooling effect during summer months and a warming effect during winter months.

Adult Sockeye Program

Sampling Technique

Adult counts are obtained daily at the main enumeration fence which spans both the river and the downstream entrance of

Channel No. 2. In the initial years of operation, all fish migrating to the fence were diverted into the channel but more recently only the fish migrating at the peak of the run were allowed entry into the channel. Individual counts by sex are made throughout the channel at the entrance of each reversing loop (legs 1 & 2, 3& 4, etc.) to control loading densities within 10 controlled areas. Loading density will remain constant from year to year or may be varied within the channel depending on gravel quality, timing and adult maturity. For example, in 1975 channel legs one to eight were loaded at a density exceeding 1.75 sq. yds. per female due to poor gravel quality. Cleaner areas characterized by consistently high survivals were loaded to densities of 1.25 sq. yds. per female.

Adults are sampled for sex, age composition, fecundity, lengths and retention at the main fence on three occasions during the migration and die-off period. Equal sample sizes are obtained to maintain a standardized analysis.

Population Characteristics

Spawning populations in Channel No. 2 have ranged from 23,700 adult fish in 1969 to 115.5 adults in 1971 (Table 2). The low spawning populations in 1969 and 1970 were primarily due to a reluctance by the fish to enter the channel and also because only one half of the channel was completed for production purposes.

Age compositions of returning adults is similar to that for the Fulton River stock in that 4_2 adults dominate the runs in most years with a reversal occurring every fourth year.

Sex ratios vary as years of high female return are followed by a near equal 50:50 sex ratio. In Channel No. 2 and the entire Fulton system, high female returns occur on even years while equal ratios occur on the odd year. Furthermore, low adult male returns occur in years of high jack returns. In 1974 the total jack population in Channel No. 2 (82,326) exceeded the total adult spawning population (62,397). The consistent pattern in female and male sex ratios from year to year is now a useful total in managing the channel operation.

Egg Deposition and Retention

In Channel No. 2 egg retention, a measure of complete spawning, does not increase significantly with increases in potential egg deposition (Fig. 33). Since retentions have yet to exceed two percent even at the highest density, it appears that excessively high spawning densities have not occurred in this channel. By comparison, data from both Fulton spawning channels indicates that retentions in Channel No. 2 are lower than for Channel No. 1. Reasons for these peculiar results may be attributed to the sampling procedure. In Channel No. 1, samples from the entire population are obtained from the enumeration fence at the channel exit. Samples in Channel No. 2 are obtained only from fish spawning in the upper two legs of the channel and not from the entire population. As mentioned earlier, the upper section of the Channel No. 2 is loaded at a reduced density compared to lower sections. This variation in sampling procedure may account for the low egg retentions recorded for Channel No. 2. A more complete sampling program is required to fully assess egg retention in Channel No. 2 spawning populations.

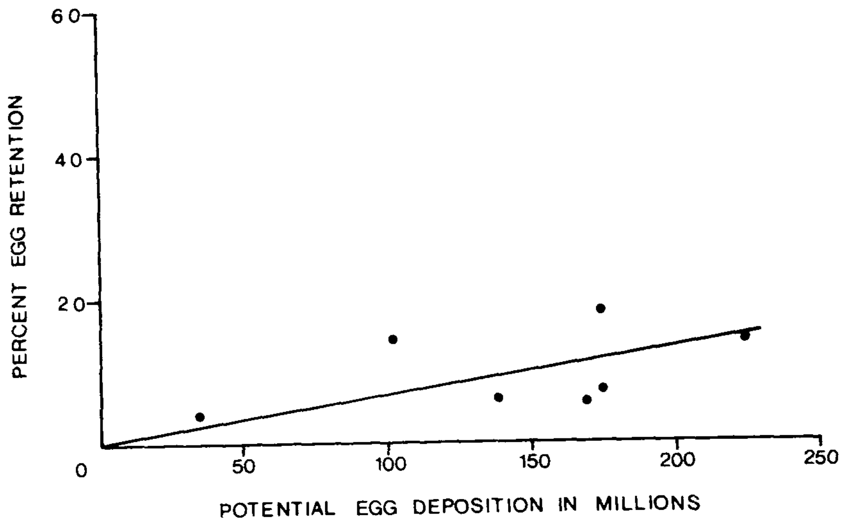


Figure 33: Relationship between potential egg deposition and percent egg retention in Spawning Channel No. 2 at Fulton River.

Sockeye Fry Program

Enumeration Technique

Fry enumeration in Channel No. 2 began in 1970 on the production from the 1969 brood stock. The converging throat trap technique was used to assess fry production. The enumeration facilities, at the bottom end of the channel consist of three converging throat traps in each of two outflow bays. The traps, each with an opening width of 9.0 in., sample 1/7th of the bay width. In each bay, the middle trap serves as the index trap. The trapping procedure is similar to that for the river in that time checks and area checks are made from one to three times a week. A standard breakdown of the catches, along with time and area calculations is provided in Appendix Tables XVI to XVIII. Fish handling has been less than one percent.

The overall technique based on the assumption of an even distribution of migrants across the width of the sampling bays was thought to provide a fairly accurate estimate of total migration through an individual bay. In recent years, sampling with horizontal and vertical ladders has indicated that fry tend to migrate along the bay walls. This error plus individual trap efficiency checks indicated that an adjustment of the nightly estimate upwards to six percent would better reflect the actual daily night fry migration. From these findings, it appeared appropriate that all production estimates be adjusted accordingly.

Fry Production and Egg to Fry Survival

Production from Channel No. 2 for the 1969 to 1975 brood years has averaged 58.1 million fry (Table 14). Largest output occurred for the 1971 brood and it totalled 82.2 million. Egg to fry survival for the same period averaged 44.2% which is slightly above design expectations. However, survivals lower than design expectations on a number of years lead to studies (Ginetz, 1972) which indicated that large egg mortalities occurred early in the incubation period. These mortalities appeared to occur during the spawning period, suggesting that mortality could be attributed to superimposition of redds from wave spawning. Compounding the spawning effect, algae growth and decay within the upper portions of the channel has created a eutrophic environment which could create a high biological oxygen demand in those areas. Low survivals in these areas may be partially due to suffocation from a lack of oxygen. A varied gravel composition in the channel could also account for the high mortalities. Because of an in-adequate supply of gravel in the size range 1 to 2.5 in., legs

1 to 8 contain gravel consisting of large proportions of small and large sizes but lacks any substantial amount in the medium size range. Perhaps egg mortality in the upper portion of the channel is due to compression resulting from high intragravel velocities.

The approach taken in recent years to increase survival rates has been to reduce loading times and distribute spawners more evenly within the channel. The cost has been the only factor preventing gravel cleaning or replacement.

TABLE 14: Channel No. 2 sockeye fry production from 1970 to 1976.

Brood Year	Egg Deposition (millions)	Fry Production (millions)	Survival (%)	Fry Year
1969	35.0*	25.4	72.5	1970
1970	101.7*	37.3	36.7	1971
1971	175.2	82.2	46.9	1972
1972	220.4	69.9	31.7	1973
1973	168.7	75.0	45.1	1974
1974	132.0*	48.5	36.7	1975
1975	171.6	68.6	40.0	1976
Average	143.5	58.1	44.2	

*Only upper half of channel utilized by spawners.

Analysis of Channel No. 2 egg depositions, fry production, and survival rates, indicate that the main mortality factor during incubation appears to be density dependent. The negative regression of egg to fry survival on deposition is significant (Fig. 34; $p \leq .05$). Also the regression of survival on spawning area per female is significant (Fig. 35; $p \leq .005$). The data from these regressions indicate that spawner density which is directly related to deposition is a dominant factor influencing fry production from Channel No. 2.

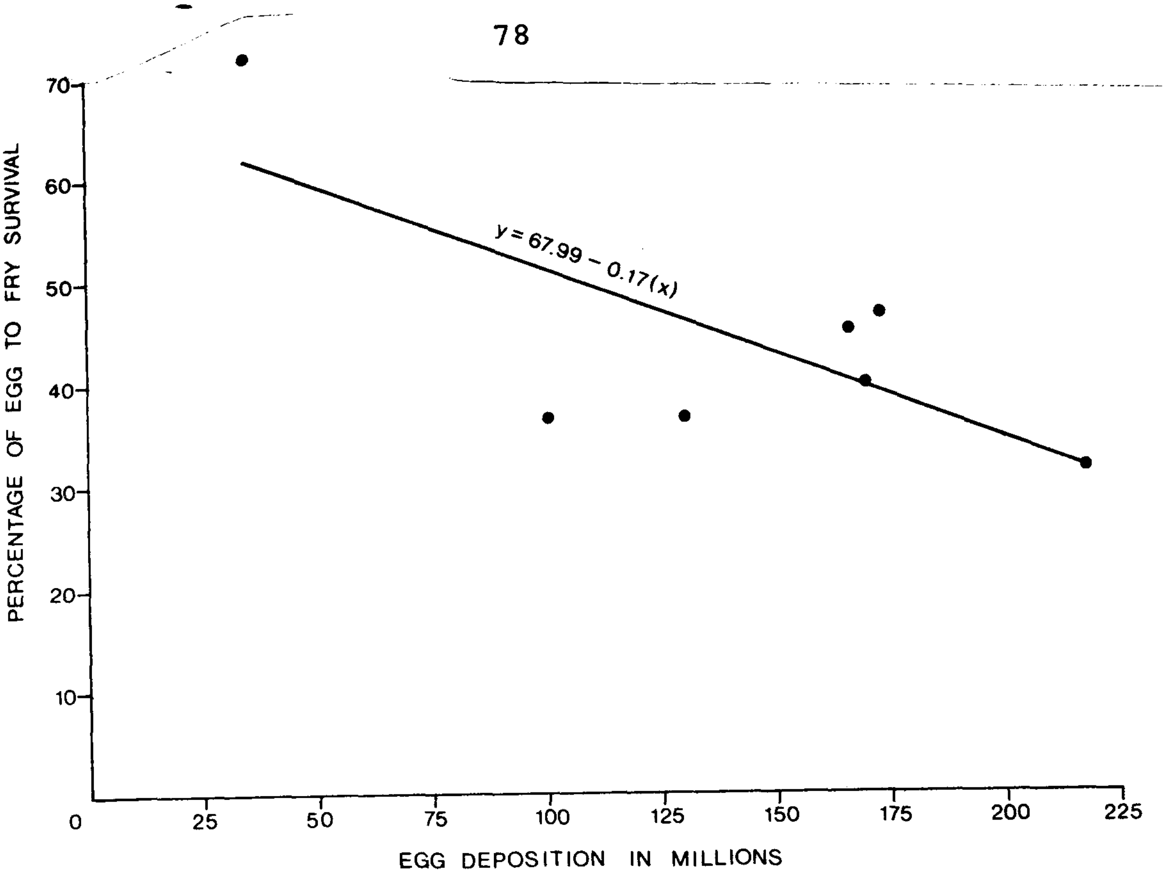


Figure 34: Regression of sockeye egg to fry survival on actual egg deposition in Channel No. 2 at Fulton River.

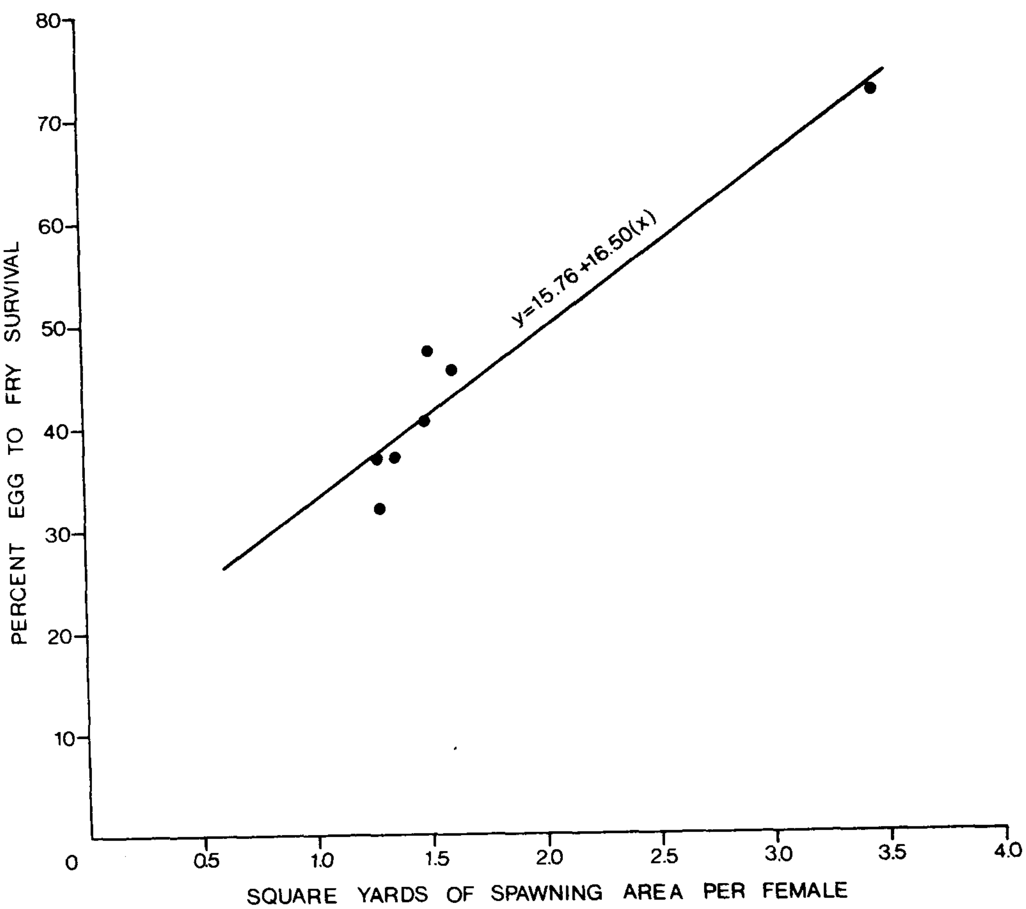


Figure 35: Regression of sockeye egg to fry survival on spawning area per female in Channel No. 2 at Fulton River.

The data indicates that at an area allotment of 1.50 sq. yds. per female or a female population density of 58,000, survivals will fluctuate around 45 percent. Higher survivals may require increasing the area allotment to over 2.0 sq. yds. per female.

The positive regression of fry production on egg deposition is also significant (Fig. 36; $p \leq .05$). The data

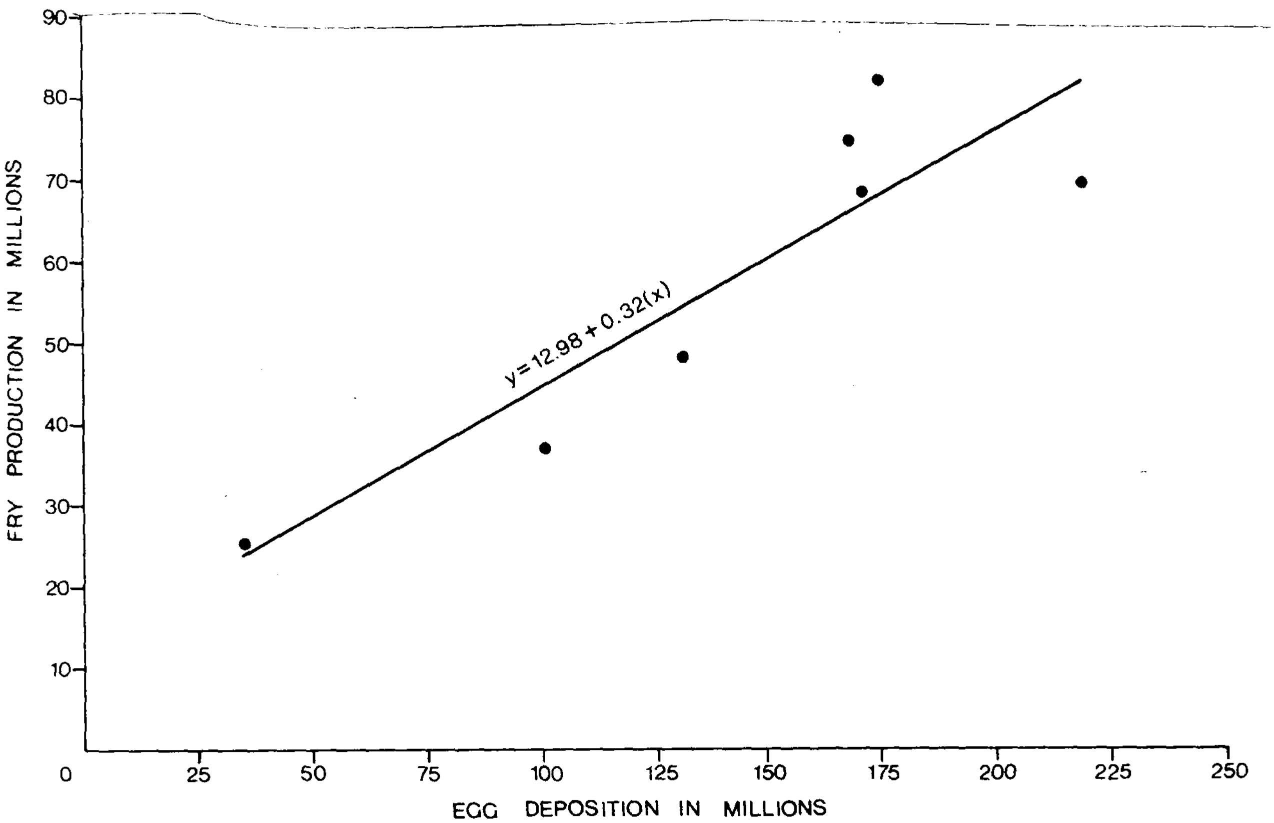


Figure 36: Regression of sockeye fry production on actual egg deposition in Channel No. 2 at Fulton River.

from the regression suggests that beyond a deposition of 200 million eggs, fry production does not increase, and that optimum production results from depositions approximating 175 to 180 million eggs. This egg density could be achieved from approximately 58,000 females at an area allotment of 1.50 per female spawner. Over the long term, larger female escapements would not result in significant gains in production.

An obvious difference exists in the optimum spawner densities between Channels No. 1 and No. 2. Channel No. 1 appears to function best when the area allotment per female spawner approximates 1.40 sq. yds. The area allotment in Channel No. 2 is 1.50 sq. yds. per female. Perhaps the difference is related to the physical differences between the channels. Perhaps larger groups of spawners in Channel No. 2 interact and effect more individual spawning acts than do the smaller populations in Channel No. 1. Also when sockeye stocks migrate to interior streams to spawn, wave spawning will occur because all spawners do not arrive on the grounds simultaneously. However, the effect of wave spawning may be tempered by lowering spawning densities and reducing the loading times.

Fry Migration Timing

Fry migration timing from Spawning Channel No. 2 varies from year to year; however, peak migration has occurred in late May or early June since 1972. In all years, migration timing correlates well with water temperature and appears to accelerate sharply when average weekly water temperatures exceed 4°C (Fig. 23).

Comparing fry migrations among the three spawning areas in the Fulton System, fry from Channel No. 2 migrate approximately two weeks later than river fry do, and about one week later than fry from Channel No. 1 (Table 7). One reason for the migration timing difference between the channels is related to egg deposition timing. Peak spawning in Channel No. 2 differs by approximately spawner. Over the long term, larger female escapements would not result in significant gains in production.

An obvious difference exists in the optimum spawner densities between Channels No. 1 and No. 2. Channel No. 1 appears to function best when the area allotment per female spawner approximates 1.40 sq. yds. The area allotment in Channel No. 2 is 1.50 sq. yds. per female. Perhaps the difference is related to the physical differences between the channels. Perhaps larger groups of spawners in Channel No. 2 interact and effect more individual spawning acts than do the smaller populations in Channel No. 1. Also when sockeye stocks migrate to interior streams to spawn, wave spawning will occur because all spawners do not arrive on the grounds simultaneously. However, the effect of wave spawning may be tempered by lowering spawning densities and reducing the loading times.

Fry Migration Timing

Fry migration timing from Spawning Channel No. 2 varies from year to year; however, peak migration has occurred in late May or early June since 1972. In all years, migration timing correlates well with water temperature and appears to accelerate sharply when average weekly water temperatures exceed 4°C (Fig. 23).

Comparing fry migrations among the three spawning areas in the Fulton System, fry from Channel No. 2 migrate approximately two weeks later than river fry do, and about one week later than fry from Channel No. 1 (Table 7). One reason for the migration timing difference between the channels is related to egg deposition timing. Peak spawning in Channel No. 2 differs by approximately

7 to 10 days from that in Channel No. 1. For example, in 1974 and 1975, Channel No. 1 was completely loaded well in advance of Channel No. 2. Additionally, loading time in Channel No. 2 occurs over a 3-week period while in Channel No. 1 loading can be completed in less than one week.

Fry Quality

Fry from Spawning Channel No. 2 display significant quality differences when compared to Fulton River (Table 15) or Channel No. 1 fry (Table 16). Annual mean fry length of Channel No. 2 fry is consistently larger than Channel No. 1 fry (Fig. 37 to 41, Appendix Tables XIX to XXV), Channel No. 2 fry are more mature. Similar results occur when comparing Channel No. 2 with Fulton River fry (Appendix Tables XXVI to XXXII).

Comparing mean weights among the three sources indicates that Fulton River fry are normally heavier than fry from either Channel No. 1 or Channel No. 2. Channel No. 2 fry have been heavier than Channel No. 1 fry in four of seven years.

The differences in fry quality can be accounted for by the extent of yolk conversion occurring in the respective environments. If fry from all sources displayed the same migration timing, one would expect the fry to be of equal size and maturity. However, because of the timing differences, it is possible that fry from Channel No. 2 may be of superior quality to those of Channel No. 1, or the river. If so, Channel No. 2 fry should experience a better fry to adult survival rate. Adult returns to the Fulton System appear to consist almost entirely of Channel No. 2 stock, however, this is probably due to a significantly larger

TABLE 15: Summary of annual mean lengths, weights and developmental indices, their difference and statistical significance of sockeye fry, in paired samples from Fulton River and Spawning Channel No. 2.

Sample	Date	N	Mean Length (mm)	S^2	Δi (mm)	U	Z	P	Mean Weight (mg)	S^2	Δi (mg)	U	Z	P	Index (K_D)	S^2	Δi (K_D)	U	Z	P
River	1970	1449	29.89	1.50	-.56	104[a]	-4.922	0	142.67	455.85	-6.78	135[a]	-4.440	0	1.74	.002	0	3.84[a]	-.568	.2850
Chan.2		1450	30.45	7.07					149.45	437.22					1.74	.004				
				4.71[c]				<.01		1.04[c]				<.01		2.00[c]				<.01
River	1971	950	29.84	1.43	-.31	115.5[b]		>.01	150.45	383.66	.17	166[b]		>.01	1.78	.005	.02	121[b]		>.01
Chan.2		950	30.15	1.45					150.28	442.91					1.76	.004				
				1.01[c]				>.01		1.15[c]				<.01		1.25[c]				<.01
River	1972	800	29.42	1.69	-.52	38[d]		<.001	149.76	329.35	3.06	89.5[d]		>.05	1.80	.004	.04	15.5[d]		<.001
Chan.2		800	29.94	1.68					146.69	375.09					1.76	.002				
				1.01[c]				>.01		1.14[c]				<.01		2.00[c]				<.01
River	1973	797	29.11	2.24	-.25	83[d]		.05	154.24	385.02	6.01	63.5[d]		.001<p<.01	1.84	.006	.04	31		<.001
Chan.2		792	29.36	2.23					148.23	361.55					1.80	.008				
				1.00[c]				>.01		1.06[c]				<.01		1.33[c]				<.01
River	1974	400	29.83	2.54	-.45	13.5[e]		.01<p<.05	153.02	559.98	5.93	8.0[e]		.001<p<.01	1.79	.008	.05	5.0[e]		.001
Chan.2		550	30.28	1.68					147.09	411.85					1.74	.004				
				1.51[c]				<.01		1.36[c]				<.01		2.00[c]				<.01
River	1975	448	29.99	1.98	-.06	39.0[f]		>.05	148.55	482.98	-4.85	40.0		>.05	1.76	.005	-.01	36.5[f]		>.05
Chan.2		500	30.05	1.88					153.40	575.52					1.78	.005				
				1.05[c]				<.01		1.19[c]				<.01		1.00[c]				<.01
River	1976	397	29.27	2.38	-.42	9.5[e]		.0085	154.93	399.32	11.39	7.0[e]		.0030	1.83	.007	.07	4[e]		.0010
Chan.2		500	29.69	1.54					143.53	261.69					1.76	.004				
				1.55[c]				<.01		1.53[c]				<.01		1.75[c]				<.01

River, river samples; Chan.2, spawning channel no. 2 samples; N, number of fry in samples; S^2, variance of the mean; Δi, difference between the means of parameter (River-Chan.2); U,Z,P, statistics of the Mann-Whitney test.

[a] $n_1 = n_2 = 29$

[b] $n_1 = n_2 = 19$

[d] $n_1 = n_2 = 16$

[e] $n_1 = n_2 = 8$

[f] $n_1 = n_2 = 9$

[c] Test on homogeneity of variances.

TABLE 16: Summary of annual mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2.

Sample	Date	N	Mean Length (mm)	S^2		Δi (mm)	U	Z	P	Mean Weight (mg)	S^2		Δi (mg)	U	Z	P	Index (K_D)	S^2		Δi (K_D)	U	Z	P
Chan.1	1970	1,450	28.94	1.89		-1.51	3[b]	-6.493	0	127.89	413.74		-21.56	2[b]	-6.509	0	1.74	.005		0	304.5[b]	-1.804	.0356
Chan.2		1,450	30.45	7.07						149.45	437.22						1.74	.004					
					3.74[c]				<.01			1.06[c]				<.01			1.25[c]				<.01
Chan.1	1971	950	29.27	1.65		-.88	37[b]		<.001	139.79	453.16		-10.48	45[b]		<.001	1.77	.005		.01	137[b]		>.05
Chan.2		950	30.15	1.45						150.28	442.91						1.76	.004					
					1.14[c]				<.01			1.02[c]				<.01			1.25[c]				<.01
Chan.1	1972	800	29.30	2.01		-.64	51[b]		<.001	148.76	465.26		2.06	96.5[b]		>.05	1.81	.005		.05	25.5[b]		<.001
Chan.2		800	29.94	1.68						146.69	375.09						1.76	.002					
					1.20[c]				>.01			1.24[c]				<.01			2.50[c]				<.01
Chan.1	1973	800	29.29	1.69		-.07	99.5[b]		>.01	155.04	545.00		6.81	59[b]		<.01	1.83	.006		.03	65.5[b]		001<p<.01
Chan.2		792	29.36	2.23						148.23	361.55						1.80	.008					
					1.32[c]				<.01			1.51[c]				<.01			1.33[c]				<.01
Chan.1	1974	550	29.45	2.05		-.83	18[b]		.001<p<.01	156.16	419.17		9.07	14[b]		<.001	1.83	.006		.09	0		0
Chan.2		550	30.28	1.68						147.09	411.85						1.74	.004					
					1.22[c]				<.01			1.02[c]				<.01			1.50[c]				<.01
Chan.1	1975	500	29.18	2.72		-.87	17.0[b]		.025	147.97	778.92		-5.43	32[b]		>.05	1.81	.008		.03	39.5[b]		>.05
Chan.2		500	30.05	1.88						154.30	575.52						1.78	.005					
					1.45[c]				<.01			1.35[c]				<.01			1.60[c]				<.01
Chan.1	1976	494	28.88	1.97		-.82	15.5[b]		.001<p<.01	139.11	360.54		-4.42	27[b]		.05	1.79	.006		.03	29[b]		>.05
Chan.2		500	29.67	1.54						143.53	261.69						1.76	.004					
					1.28[c]				<.01			1.38[c]				<.01			1.50[c]				<.01

Chan.1, spawning channel no. 1 samples; Chan.2, spawning channel no. 2 samples; N, number of fry in sample: S^2, variance of the mean; Δi, difference between means of parameter (Chan.1 - Chan.2); U,Z,P, statistics of the Mann-Whitney test.

[b] $n_1 = n_2 = 10$.

[c] Test on homogeneity of variances.

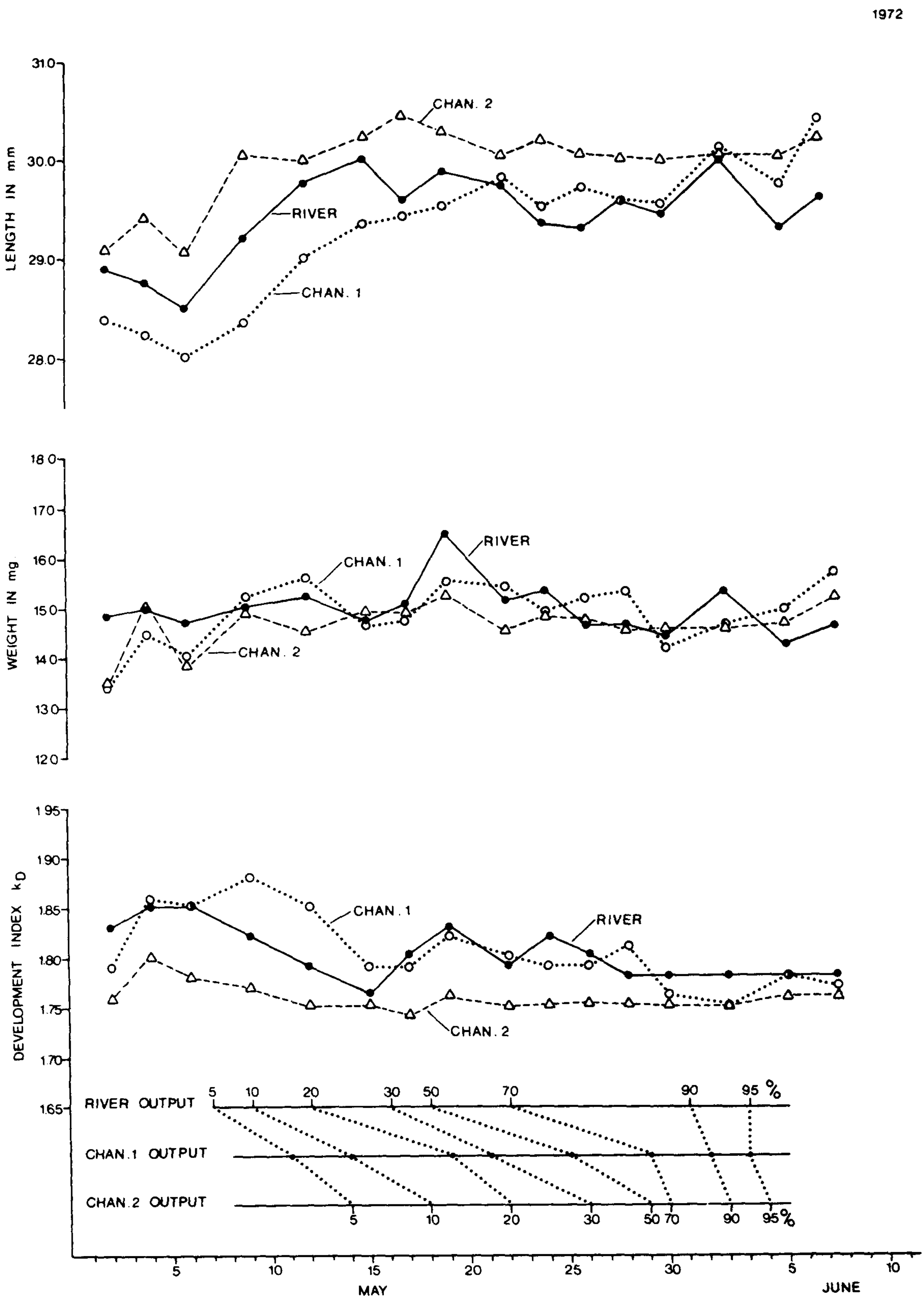


Figure 37: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1972 spring migration. Also shown is the progress of the runs in time.

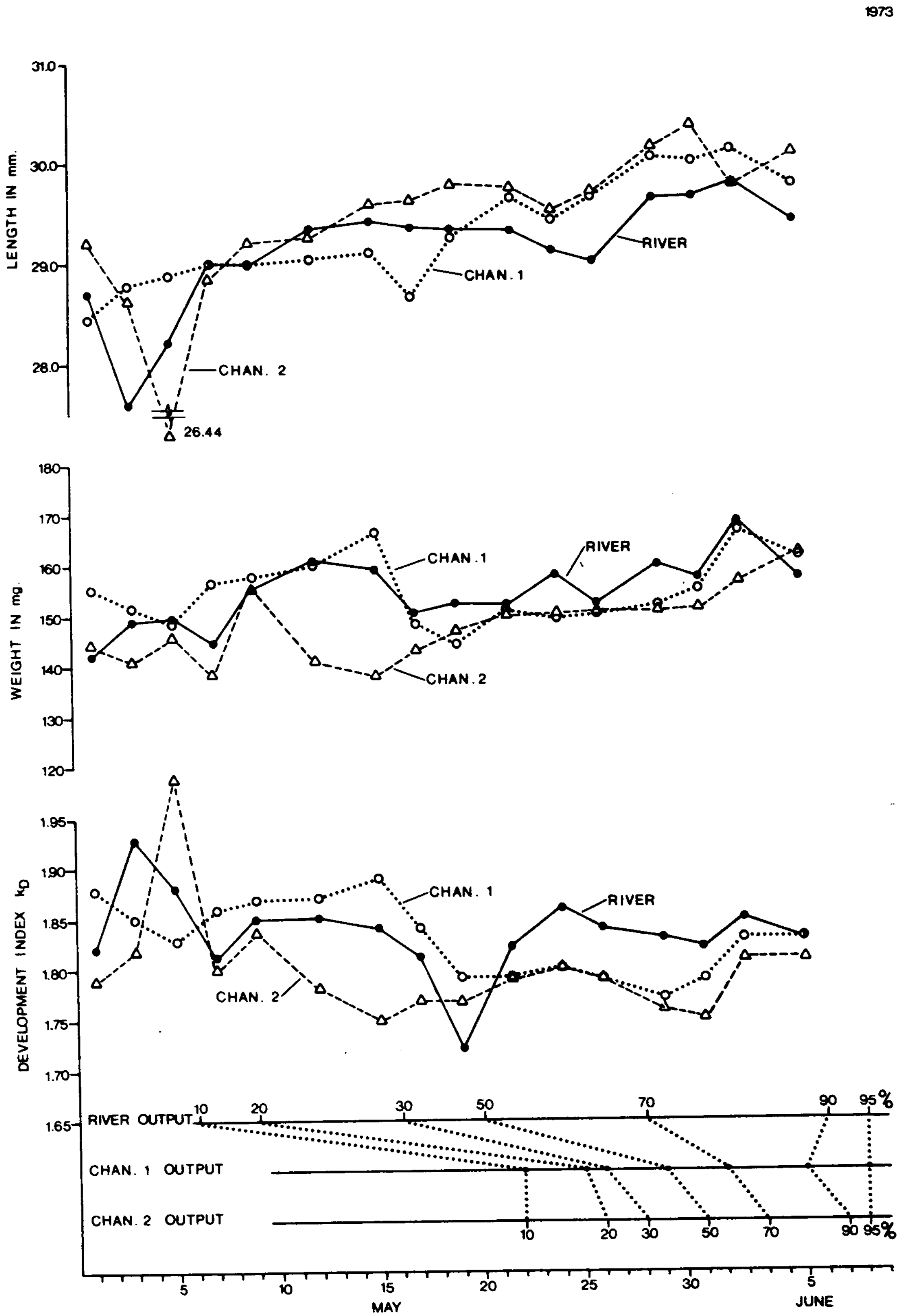


Figure 38: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1973 spring migration. Also shown is the progress of the runs in time.

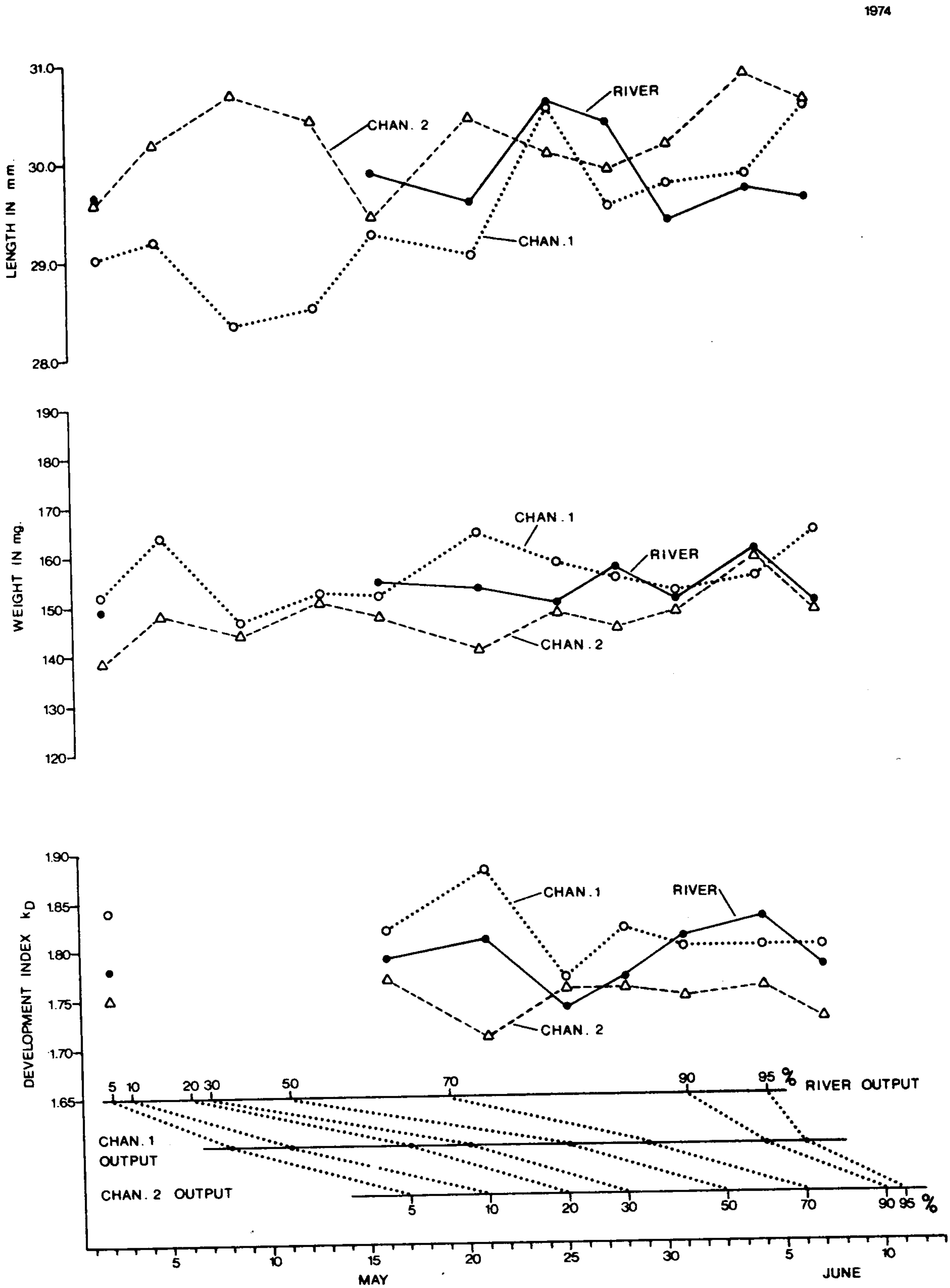


Figure 39: Average lengths in mm, average weights in mg, and average developmental indices of Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1974 spring migration. Also shown in the progress of the runs in time.

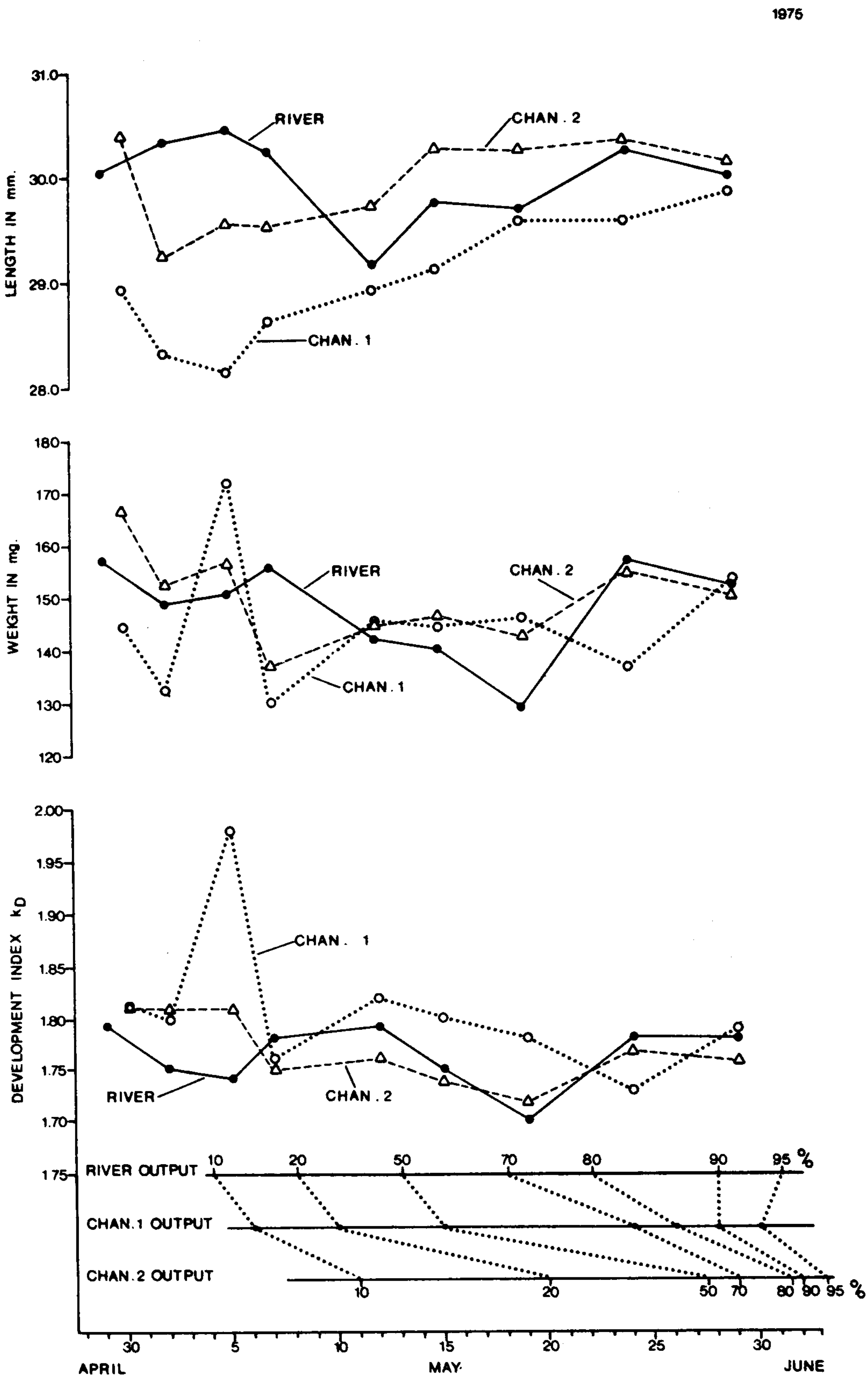


Figure 40: Average lengths in mm, average weights in mg, and average developmental indices at Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1975 spring migration. Also shown is the progress of the runs in time.

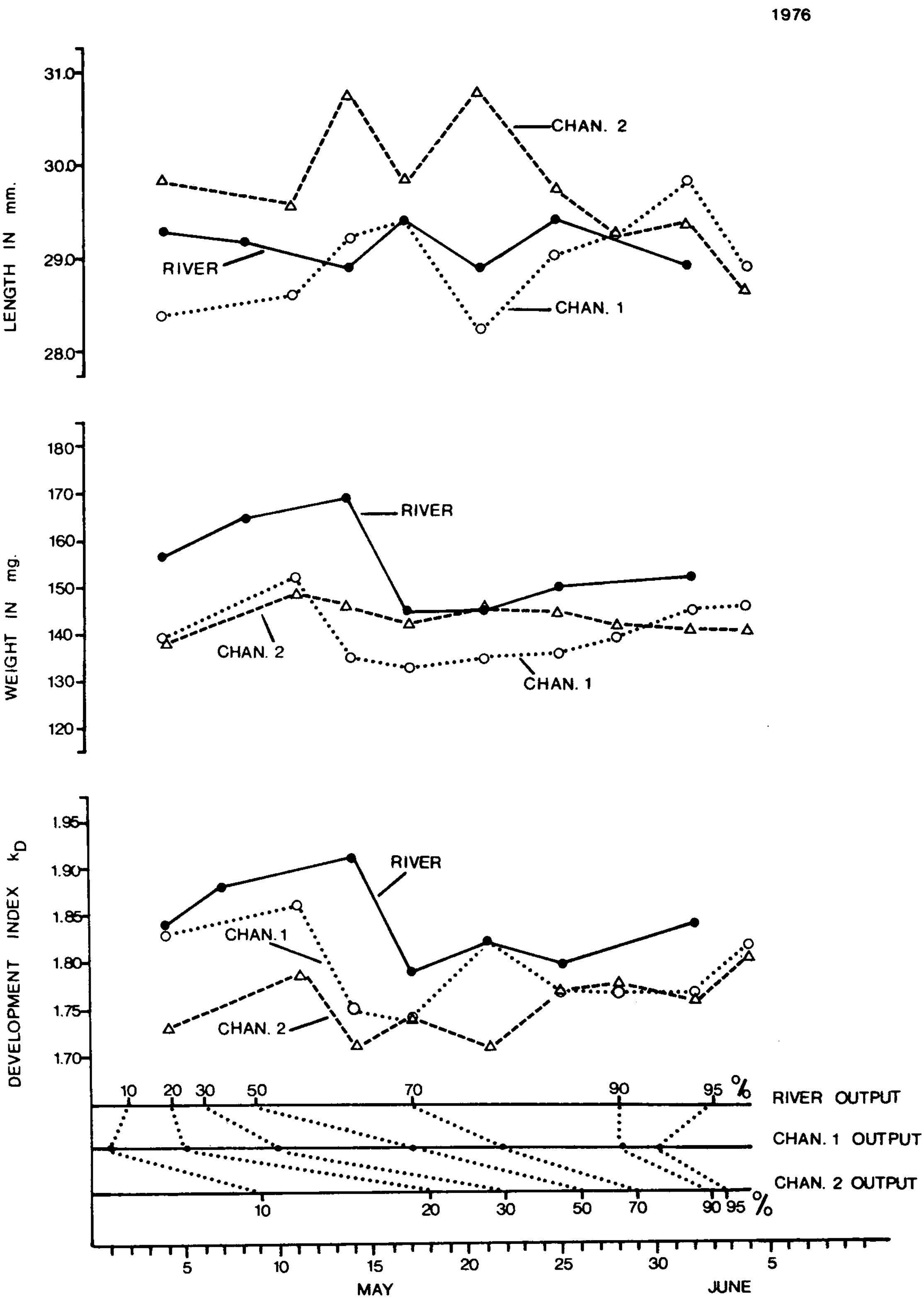


Figure 41: Average lengths in mm, average weights in mg, and average developmental indices at Fulton River, Channel No. 1 and Channel No. 2 fry at intervals during the 1976 spring migration. Also shown is the progress of the runs in time.

fry output compared to river or Channel No. 1. An adult mark recovery program has provided results which do not indicate any significant differences in fry to adult survival among the three sources (MacDonald, 1976, pers. comm.).

EVALUATION OF PINKUT CREEK FLOW CONTROL

Introduction

Biological data has been collected at Pinkut Creek since 1963 as part of the overall evaluation of the Babine Lake System. The decision to enhance Pinkut Creek stocks prompted more intensive studies on the system and the results provide a good comparison of pre and post development production from the natural river.

Pinkut Creek discharges into Babine Lake in the southeast part of the main Babine Lake basin (Figl). The creek drainage area is approximately 320 square miles and includes three lakes: Taltapin Lake (8.6 sq. miles), Augier Lake (3.7 sq. miles) and Pinkut Lake (2.1 sq. miles). Access to salmon is limited to the lower 1,200 yards of stream by an impassable falls.

The runoff characteristics of the Pinkut Creek area are similar to those of the Fulton Lake area, with low flows observed in the winter and a flood peak, resulting from snow-melt, occurring in June. The autumn floods are less prominent than those observed at Fulton.

Pinkut Creek ranks second to Fulton River as a sockeye producing stream tributary to the main lake basin. Sockeye salmon populations have ranged from 3.2 to 146 thousand and the 1949 - 1966 average approximates 33 thousand (Table 1). The optimum spawning capacity was estimated to be 15,000 fish in the 12,000 yards of spawnable area below the falls. Since 1973.

adult sockeye were airlifted by helicopter over the falls to allow utilization of an additional four miles of spawning area in upper Pinkut Creek. The airlift program was conducted to compensate for the decline in production from the Pinkut Creek spawning channel. Spawner capacity in the upper river, derived from aerial and map survey of available spawning gravel was estimated to be approximately 40,000 adults.

Spawning distribution in Pinkut Creek is fairly uniform throughout the area below the falls. Above the falls, spawner density is related to gradient and gravel composition to the extent that fish completely avoid areas of high gradient and course boulders.

Adult sockeye begin entering Pinkut Creek in the first week of August. Peak migration does not occur until at least the third week of August and peak spawning in Pinkut Creek occurs about two weeks prior to the Fulton River peak. As at Fulton a small substock spawns in Pinkut prior to larger main stock.

The fry migration begins in late April and peaks in the second week of May. Termination occurs approximately two weeks later, around June 1 to 7.

This section of the report will describe various biological and physical changes that have occurred on Pinkut Creek as a result of enhancement.

Spawning and Incubation Water Flows

Prior to 1968, minimum flows of seven cfs were recorded during the spawning and incubation periods. After construction of the spawning channel, and the associated control works on Taltapin Lake, the minimum flow in Pinkut Creek above the channel intake is 100 cfs. At the channel intake 50 cfs is directed to the spawning channel which is designed such that all water circulated through the channel is directed back into Pinkut Creek upstream of the main spawning grounds below the lowermost falls on the river. Minimum flows of 100 cfs are maintained in Pinkut Creek during the period August 15 to May 15 with the use of rule curves established from stream flow metering data.

Due to the extreme climate, Pinkut Creek undergoes extensive icing problems virtually every winter. Heavy scouring from icing occurs and results in significant mortality during incubation. Furthermore, spring freshets exceeding 300 cfs in most years have influenced premature fry emergence and appear to affect overall productivity of the system.

Adult Sockeye Program

Sampling Technique

Adult counts were obtained daily at the enumeration fence which spans both the river at its mouth and the downstream entrance to the channel. Initially, the policy was to load the lower river first and then utilize the remaining stock to load the channel. With the introduction of the airlift, the upper river was loaded first, followed by the lower river and the channel simultaneously. The reason for this was due to operational constraints involved in airlifting salmon. The channel was used as a collection site for airlifted sockeye consequently the channel could not be loaded until after the airlift was completed.

Adults were sampled for sex ratio, age composition, fecundity, lengths and retentions at the enumeration fence. Sampling was conducted at three intervals throughout the spawning and migration period, the beginning, midpoint and terminal portions of the overall time period. A total of 300 samples were obtained in each sampling series. The only data obtained from the upper area was egg retention and this was obtained from dead fish on the spawning ground. Data from the fence sampling was applied to all three areas as all populations appear homogeneous and therefore were assumed comparable.

Population Characteristics

The spawning population in Pinkut Creek from 1961 to 1967 averaged 50,289 with a high of 144,540 in 1964 and a low of 21,400 in 1963. Thereafter the population size has averaged 23,811 spawners (Table 2). The decline in escapement results from portioning the total system escapement between the spawning channel and river. Adult sockeye spawners airlifted to the upper river numbered 16,000 fish in 1973, 24,000 in 1974 and 40,100 in 1975. Jack sockeye airlifted in each year probably approximated 100 fish.

In relation to the total Babine System escapement, pre-channel returns averaged 6.8 percent while post-channel returns have averaged 12.4 percent. The increase was required to utilize additional area made available by the spawning channel.

Age composition of returning adults consists predominantly of 4_2 fish; however, 5_2 fish did dominate the runs in

1963, 1968, 1973 and 1976. Cyclic dominance of 5_2 fish does not occur every four years, as it does at Fulton. The adult male to female sex ratio reverses each year. On even years, females dominate the run which also consists of a large component of 3_2 jack sockeye. On the odd year, adult males dominate the run but to a lesser degree than when females are dominant.

Pre-channel jack returns to Pinkut Creek (1964 to 1970) averaged 5.7 percent of the total jack escapement to the Babine System (Table 4). Returns to the Pinkut System since 1971 average 14.0 percent suggesting that increased egg to fry survival from the channel has resulted in an increase in jack production. The largest return since 1964 was 37,201 jacks in 1974.

Egg Deposition and Retention

Potential deposition in lower Pinkut Creek has ranged from a high of 260 million eggs in 1964 to a low of 10 million in 1969. This data indicates that beyond an egg density of 30 million eggs, retention levels increase significantly (Fig. 42). An egg retention of 7.1 percent occurred when egg deposition exceeded 40 million eggs. Surprisingly, the high deposition in 1964 resulted in an egg retention of less than two percent. Judging from the remaining data it is very likely that this result was inaccurate, consequently it was not included in the interpretation.

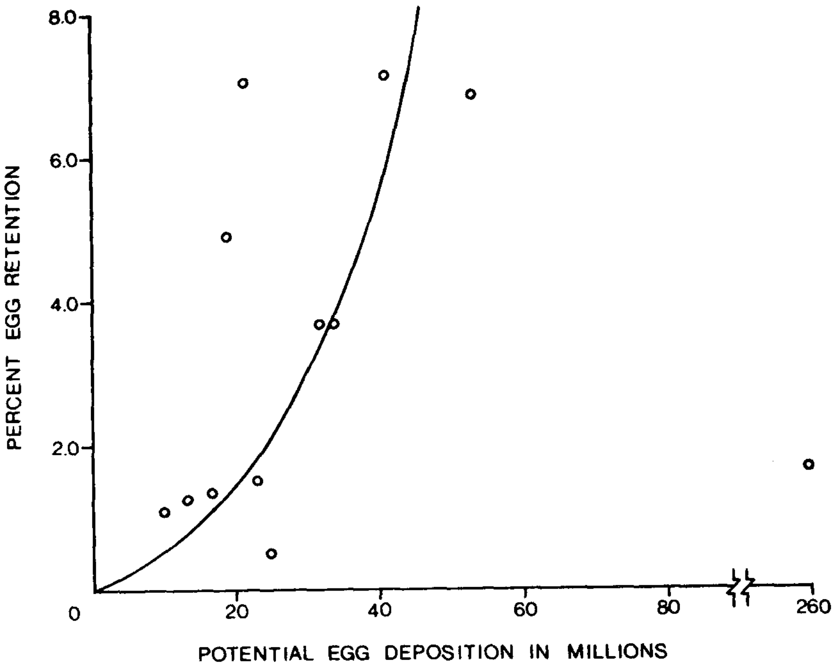


Figure 42: Relationship between percent egg retention and potential egg deposition in Pinkut Creek.

Sockeye Fry Program

Enumeration Techniques

Assessment of fry production from Pinkut Creek was initiated in 1963 with a hydraulic sampling procedure similar to that developed by McNeil (1964). The sampling procedure consisted of sampling approximately 300 sites throughout the spawning area and expanding the number of live eggs and (or) alevins collected in the sample area into a total fry output figure based on the total deposition in the river and the spawning area. The production estimates for the years 1963 to 1965 were not accurate due to the lack of precise deposition and spawning data. Consequently, interpretation of the overall data relative to production and survival was based on data collected since 1966.

Attempts at fry enumeration using a travelling vertical sampler were made in 1966 and 1967. This technique was ineffective at times of high water and debris. A downstream converging throat trap technique similar to the one at Fulton was initiated in 1968 in order to provide consistent accuracy to fry production estimates. Since then, hydraulic sampling has been conducted annually to provide a comparative estimate of production and also to provide a backup estimate in years when high water limits the effectiveness of the enumeration fence sampling. Refinement in the hydraulic sampling technique which has included randomized sampling at a much reduced effort has provided reliable fry production estimates in recent years (Table 6).

Fry Production and Egg to Fry Survival

Prior to implementation of flow control in 1968, production from Pinkut Creek averaged 5.8 million and survivals averaged 11.0 percent (Table 17). After 1967, average survival increased to 14.9 percent, but production declined to an average of 2.6 million. The decline in production is due to a reduction in egg deposition.

After completion of the channel, large segments of the sockeye run to Pinkut Creek were diverted into the channel to increase overall fry production from the Pinkut system. The reduced deposition in the river has resulted in a higher egg to fry survival. As expected, mortality of eggs and alevins appears to be density dependent. For example, the positive regression of egg to fry survival on spawning area per female is significant.

TABLE 17: Pinkut Creek sockeye fry production from 1964 to 1976.

Brood Year	Deposition (millions)	Production (millions)	Survival (%)	Fry Year
1963	57.6	11.0	19.1	1964
1964	255.7	4.5	2.0	1965
1965	53.2	6.9	13.5	1966
1966	24.8	3.7	13.8	1967
1967	40.9	2.7	6.6	1968
1968*	19.0	1.9	10.0	1969
1969	10.0	1.8	19.8	1970
1970	16.5	3.3	19.9	1971
1971	13.1	2.2	20.7	1972
1972	21.5	3.0	16.8	1973
1973	30.6	3.1	10.1	1974
1974	30.7	3.0	9.3	1975
1975	20.6	2.6	12.6	1976
Natural Flow Average				
5 year Average	86.4	11.0	5.8	
Partial Flow Control Average				
8 year Average	20.3	14.9	2.6	

*Beginning of flow control.

(Fig. 43; p $\leq$ .01) suggesting that survival is directly related to spawning area available per female sockeye. Also, the negative regression of egg survival on egg deposition is significant (Fig. 44; p $\leq$ .01) indicating that continual increases in deposition will result in a decline in egg to fry survival. Accordingly, beyond an optimum level of deposition, as measured by egg to fry survival and fry production, increases in fry production will be minimal. The positive regression

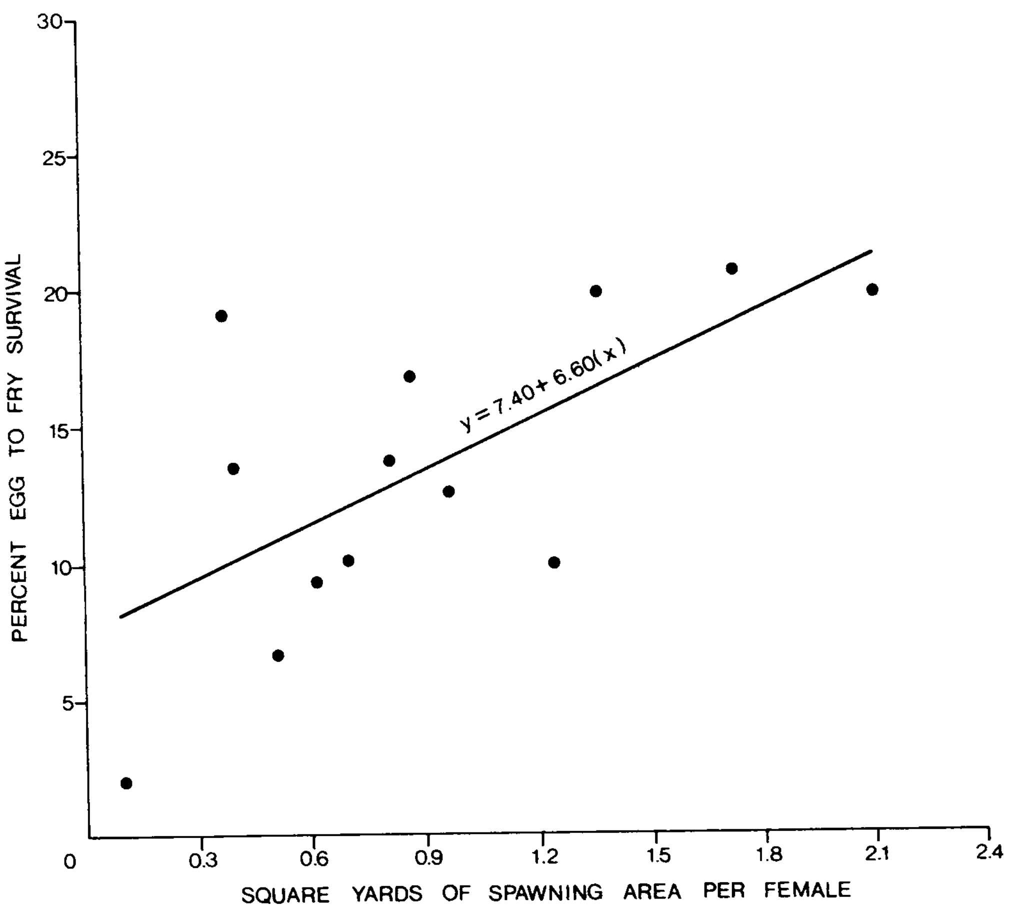


Figure 43: Regression of sockeye egg to fry survival on spawning area per female in Pinkut Creek.

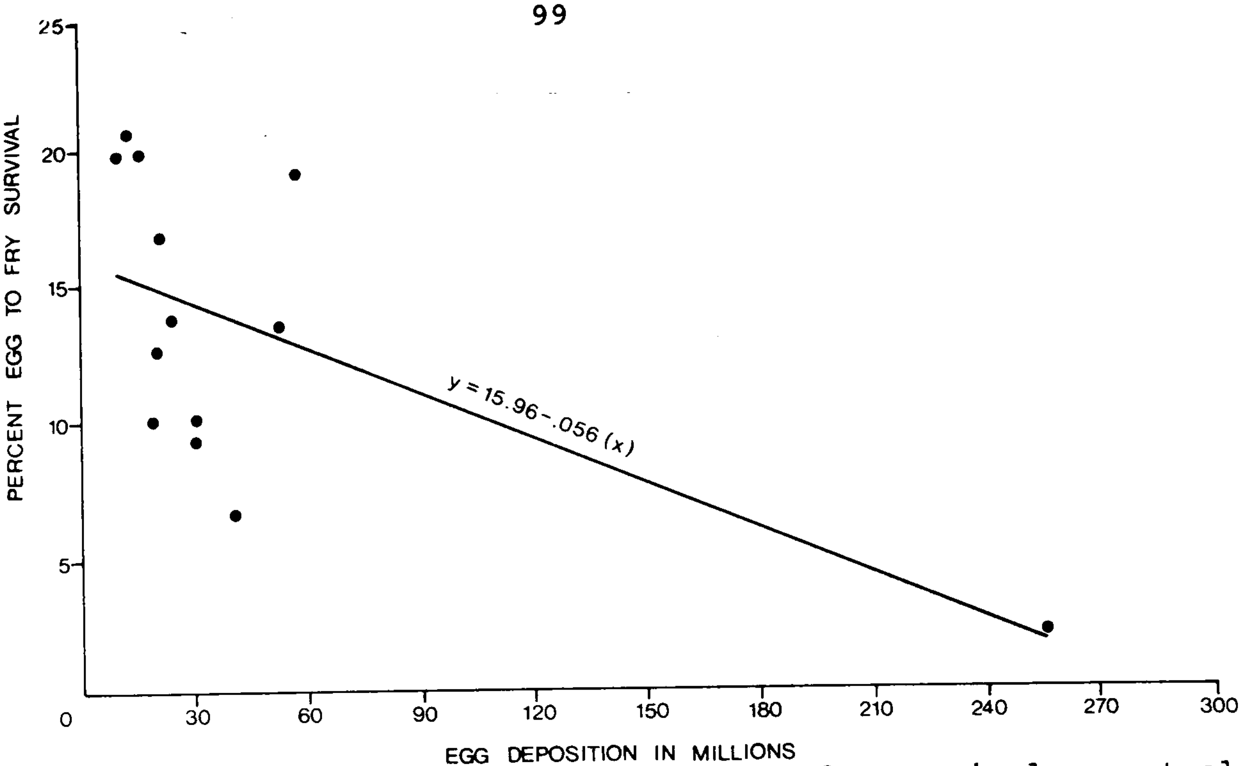


Figure 44: Regression of sockeye egg to fry survival on actual egg deposition in Pinkut Creek.

of fry production on egg deposition is not significant (Fig. 45; p $\geq$ .10) suggesting that depositions greater than 30 million eggs would result in little production gains. This egg density

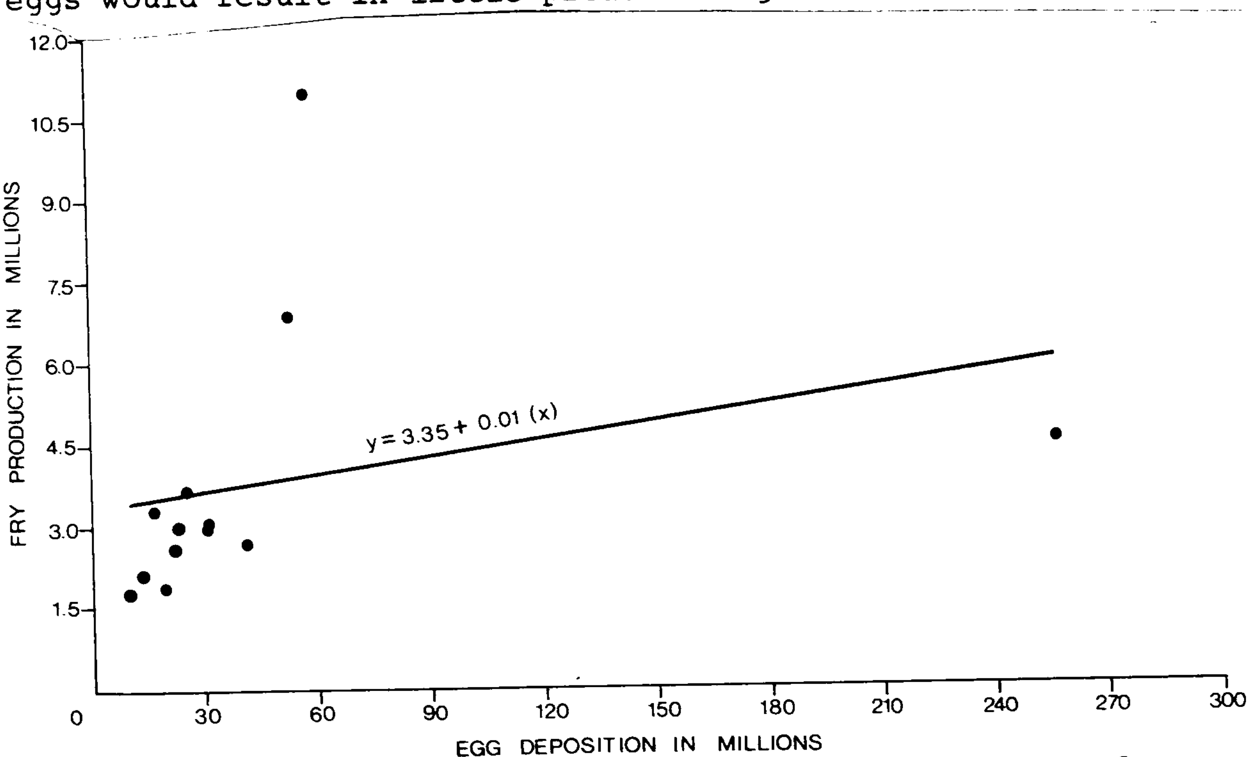


Figure 45: Regression of sockeye fry production on actual egg deposition in Pinkut Creek.

would result from a spawning population of 9000 females. The optimum spawning allotment per female spawner would approximate 1.35 sq. yds. at this population level.

Fry Migration Timing

The timing of peak river abundance fry has varied little since 1969 (Table 18). The variation appears to be related to river discharge (Fig. 46), however, in all years, a significant increase in fry migration occurred when average weekly water temperatures approximate 4°C or higher. Also when high discharge coincides with warm water, one can expect the rate of migration to be accentuated. An example of the warm water effect on migration occurred in 1975 when migration commenced and peaked prior to any large increase in river discharge.

TABLE 18: Peak timing of sockeye fry migrating from the Pinkut Creek System to Babine Lake.

Fry Year	Location	
	Pinkut Channel	Pinkut Creek
1969	May 20	May 21
1970	May 20	May 19
1971	May 28	May 27
1972	May 31	May 30
1973	May 29	May 28
1974	May 25	May 26
1975	May 20	May 27
1976	June 2	May 25

Fry Quality

The quality of fry produced from Pinkut Creek varies from year to year both in length, weight and maturity at migration.

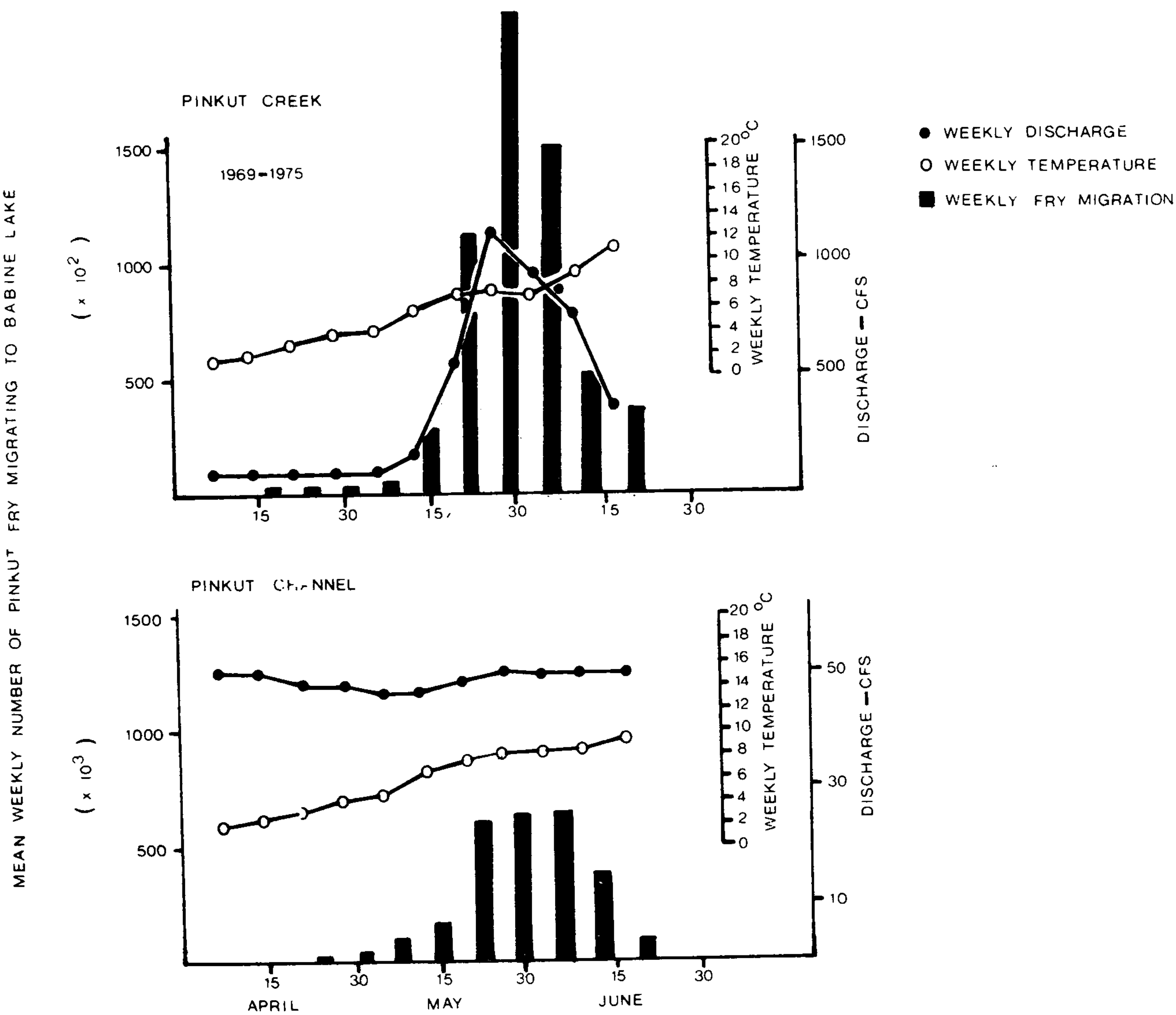


Figure 46: Mean weekly number of sockeye fry migrating in Pinkut Creek and Pinkut Spawning Channel in relation to average weekly water temperature and discharge from 1969 to 1975.

Mean length has varied from 28.59 mm. in 1973 to 29.54 in 1976 (Table 19). Average mean length for the 1969 to 1976 period is 29.02 mm. Mean weight (Table 20) has varied from 124.70 mg. in 1970 to 158.97 mg. for 1975, for an overall average of 145.78. mg. The mean development index (Table 21) has averaged 1.80 which again reflects premature emergence of fry. In most years many river fry are forcefully washed or scoured from the gravel by the high discharge created from spring freshet.

TABLE 19: Mean Length in mm. of sockeye fry migrating from the Pinkut Creek System to Babine Lake.

	Mean Length (mm)	
Year	Pinkut Creek	Pinkut Channel
1969	29.00	30.47
1970	28.87	28.22
1971	29.29	29.90
1972	28.70	29.64
1973	28.59	29.31
1974	29.12	29.83
1975	29.07	29.34
1976	29.54	29.29
Average	29.02	29.50

Fry from Pinkut Creek have, with the exception of 1970 and 1976, been smaller in length than channel fry (Fig. 47). Consistent differences in fry weights have not occurred (Table 22). From 1970 to 1972 river fry were heavier than channel fry while the reverse was true in other years. Overall, the differences appear to be quite small. In terms of maturity,

TABLE 20: Mean weight in mg. of sockeye fry migrating from the Pinkut Creek System to Babine Lake.

Year	Mean Weight (mg)	
	Pinkut Creek	Pinkut Channel
1969	142.43	148.18
1970	124.70	113.03
1971	144.20	138.65
1972	139.93	135.26
1973	151.61	153.03
1974	152.85	159.30
1975	158.97	160.27
1976	151.54	152.23
Average	145.78	144.99

TABLE 21: Mean development indices of sockeye fry migrating from the Pinkut Creek System to Babine Lake.

Year	Mean Development Index (k_D)	
	Pinkut Creek	Pinkut Channel
1969	1.80	1.73
1970	1.73	1.71
1971	1.79	1.73
1972	1.81	1.73
1973	1.87	1.82
1974	1.83	1.81
1975	1.79	1.76
1976	-	-
Average	1.80	1.75

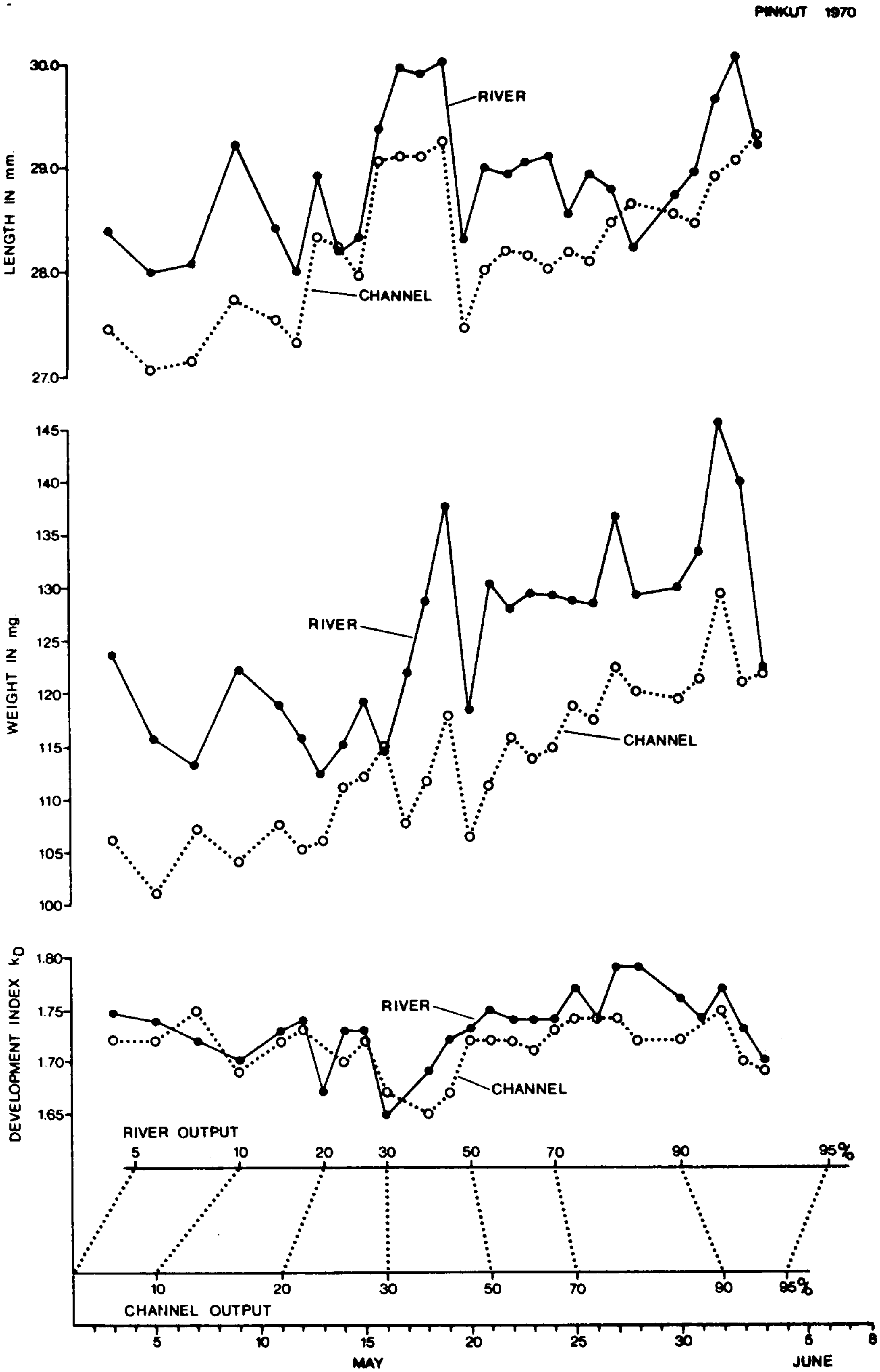


Figure 47: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1970 spring migration. Also shown is the progress of the runs in time.

TABLE 22: Summary of annual mean lengths, weights and developmental indices, their difference and statistical significance, in paired samples from Pinkut Creek and the Pinkut Spawning Channel

Sample Location	Date	N	Mean Length (mm)	S^2	Δi (mm)	U	Z	P	Mean Weight (mg)	S^2	Δi (mg)	U	Z	P	Index (K_D)	S^2	Δi (K_D)	U	Z	P
River	1969	548	29.00	1.87	-1.47	0		<.001	142.43	269.29	-5.75	22[b]	.001< p	<.01	1.80	.005	.07	6.5[b]		<.001
Chan.		550	30.47	1.25					148.18	444.43					1.73	.003				
				1.45[c]				<.01		1.65[c]				<.01		1.67[c]				<.01
River	1970	1434	28.87	2.22	.65	211[b]	-3.258	.0006	124.70	390.07	11.67	120[b]	-4.673	0	1.73	.005	.02	268.5[b]	-2.364	.0090
Chan.		1450	28.22	2.00					113.03	364.39					1.71	.005				
				1.11[c]				<.01		1.07[c]				<.01		1.00[c]				>.01
River	1971	900	29.29	2.22	-.61	109.0[b]		.05	144.20	330.57	5.55	68.0[b]		<.001[b]	1.79	.006	.06	31.5[b]		<.001
Chan.		900	29.90	1.87					138.65	344.19					1.73	.004				
				1.19[c]				<.01		1.04[c]				<.01		1.50[c]				<.01
River	1972	200	28.70	1.81	-.94	0[b]		.014	139.93	296.56	4.67	3[b]		.100	1.81	.006	.08	.5[b]		.022
Chan.		200	29.64	1.96					135.26	362.33					1.73	.005				
				1.08[c]				>.01		1.22[c]				>.01		1.20[c]				>.01
River	1973	760	28.59	3.11	-.72	96.5[b]		.01<p<.025	151.61	401.87	-1.42	150.0[b]		>.05	1.87	.010	.05	93.0[b]		.01<p<.025
Chan.		900	29.31	1.85					153.03	380.78					1.82	.004				
				1.68[c]				<.01		1.07[c]				<.01		2.50[c]				<.01
River	1974	493	29.12	2.26	-.72	22.5[b]		.01<p<.025	152.85	434.67	-6.45	27[b]		.05	1.83	.006	.02	30.5[b]		>.05
Chan.		500	29.83	1.74					159.30	453.55					1.81	.006				
				1.30[c]				<.01		1.04[c]				>.01		1.00[c]				>.01
River	1975	1000	29.18	2.77	-.14	41.5[b]		>.05	150.54[d]	386.65	-2.49	4500[d]	-1.221	.1110	1.79[d]	.004	.03	3321.5[d]	-4.102	0
		1000	29.32	1.84					153.03	1476.10					1.76	.002				
				1.51[c]				<.01		3.82[c]				<.01		2.00[c]				<.01

River, river samples; Chan., channel samples; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (R-CH); U,Z,P, statistics of the Mann-Whitney test.

[b] $n_1 = n_2 = 10$

[d] $n_1 = n_2 = 100$

[c] Test on homogeneity of variances.

river fry are less mature than channel fry at the time of migration. Therefore one might expect that since river and channel fry have the same annual migration timing, river fry would be more able to maintain themselves in Babine Lake if plankton abundance was low at the time of entry.

EVALUATION OF THE PINKUT CREEK CHANNEL

Introduction

Historically, fish production from Pinkut Creek was limited to the river, downstream from a series of falls located about one half mile from the mouth. The provision of fish passage facilities to extend distribution above the falls appeared uneconomical, therefore an artificial spawning channel was constructed, on a large muskeg area of low-lying land, adjacent to the main spawning grounds at the mouth of Pinkut Creek. Flow control works, completed in 1966 and the spawning channel, completed in 1968, make up the total enhancement development on Pinkut Creek.

During the first three years, egg to fry survival rates steadily declined as a result of icing, gravel deterioration, and high adult spawning densities. Implementation of a rehabilitation program in 1976 and operational changes should produce better results in the future.

This section of the report describes the overall performance of the channel including operational changes implemented, to alleviate some of the problems that have occurred.

Operational History of the Pinkut Creek Spawning Channel

Unforeseen icing problems occurred during the first year in the Pinkut Channel. The cold winter resulted in the formation of heavy anchor ice dams which created major short-circuits between channel legs and in some cases, partial de-watering. The overall effect was to lower egg to fry survival.

To alleviate the problem, an auxiliary water supply system was installed to draw water from 200 feet below the surface of Babine Lake and mechanically pump it into the channel at various points in the channel (Fig. 14). The lake water, approximately 4°C., would warm the channel water from 0°C. to 0.2°C., thus eliminating frazzle ice formation occurring at the lower temperature. Operational efficiency of the pumping system was based on the predictability of impending cold weather periods. In recent years, added experience has allowed the operator to minimize but not totally eliminated the icing problems.

Another problem occurring in the Pinkut Channel was siltation. Silts are deposited within the channel from the river as well as from breakdown of the berms separating the legs (loops) within the channel. The existing settling basin functions well in containing the larger particles; however, it does not settle out particles less than $.5\mu$ in diameter. The gravel-lined berms are subject to breakdown from intense spawning activity as well as anchor ice build ups. Anchor ice formations also create ice dams, which direct water flow over the berms bringing with it the fine clay sediment from the interior of the berms. Continued deterioration of the channel without the implementation of corrective meansures has led to progressively poorer survival rates and low production.

Gravel scarification, an annual maintenance requirement, appears to be ineffective as the amount of organics and inorganics entering the channel within one operational year is well above the "critical" level. Visual observations indicate that shortly after cleaning, active spawning results in silt deposition throughout the channel, thus reducing the effectiveness of the gravel scarification process.

Inadequate adult control structures within the channel has led to extensive superimposition within some legs of the channel while in others, densities have been well below optimum. Reduced loading densities, now implemented, appear successful; however, the overall poor channel environment masks out any significant increase in productivity that is expected from these lower spawning densities.

A major rehabilitation program has been implemented to rectify the operational problems. This program involves lining of the berms with concrete to stop erosion during spawning, construction of new adult control structures, replacement of the settling basin with a larger pond, replacement of the channel gravel plus the addition of more outlets for warm lake water. On completion of the rehabilitation program, production from the facility should exceed 40 million fry.

Adult Sockeye Program

Population Characteristics

Spawning populations in the Pinkut Creek channel have ranged from a first year low of 13,479 adults to a high of 63,261 in 1973 (Table 2). Only in 1972 and 1973 did the spawning population approach the original design density of 63,000 adults.

Age compositions are as described for Pinkut Creek with 4_2 adults being the dominant age class. Only in 1968 and

1973 did the 5_2 age class dominate the run. Sex-ratios of returning stocks are the same as described for the river.

Age 3_2 males in the Pinkut Channel range from a high of 18,917 fish in 1973 to a low of 1,062 in the first operational year. Returns appear to be increasing steadily but only account for a small part (10%) of the run. The high jack returns to the Fulton System are not reflected by similarly large returns to Pinkut.

Egg Deposition and Retention

Egg deposition in the Pinkut Channel has ranged from 31 to 99 million and in every year retention was less than three percent. These results (Fig. 48) indicate a direct relationship between egg retention and egg deposition, in that depositions of 100 million eggs result in retentions over two percent, while depositions of 60 million and less were less than one percent. This data does not suggest a significant egg density effect on mortality in the spawning channel at the recorded deposition levels. However, survival and production data, to be discussed later, indicate that egg depositions of 100 million exceed the level for optional production from the channel. Therefore, the retention occurring at the higher deposition level, although not appearing large, may in fact reflect crowded and spawning conditions.

Sockeye Fry Program

Enumeration Technique

Fry assessment was initiated in the Pinkut Channel in 1968 using the same converging throat trap technique described

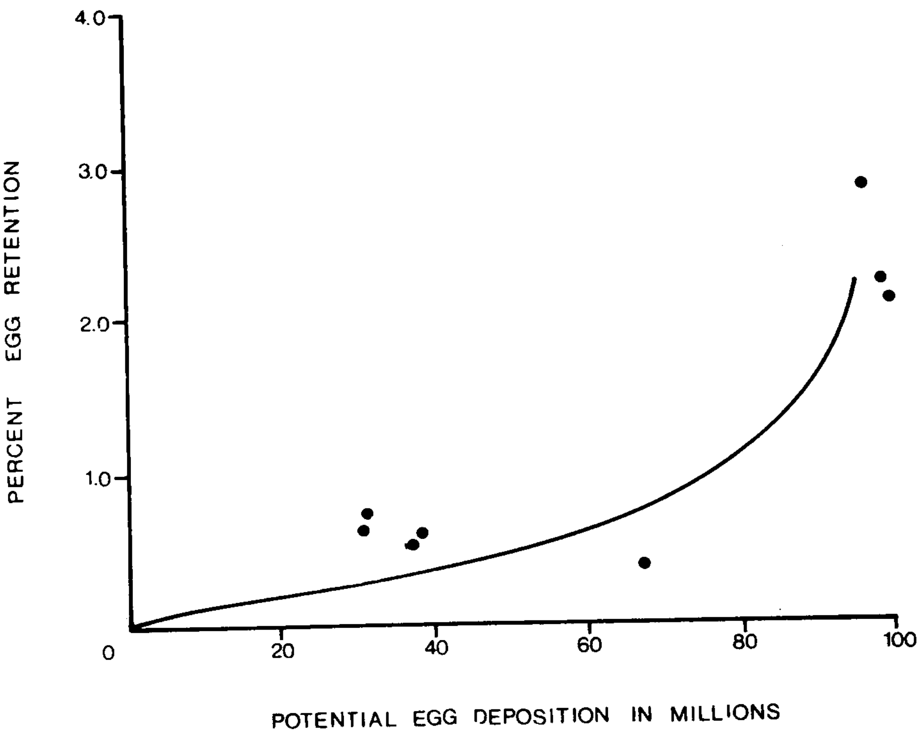


Figure 48: Relationship between percent egg retention and potential egg deposition in the Pinkut Creek Spawning Channel.

for Fulton River. Two traps installed at the bottom end of leg nine provided a production estimate for 9/10ths of the channel. The tenth leg in most years was never utilized; however, in years that it was, an interpolated estimate derived from hydraulic sampling was added to the main production estimate to give a total production figure. Each trap fished a one foot width of a culvert width of five feet, consequently a final expansion factor of five is applied in the calculation process. Details of the calculation process are outlined in Appendix Tables XXXIII and XXXIV.

Accuracy checks were conducted to verify the production estimates derived from the converging throat technique. The calculation process assumes that a trap catches a constant proportion of fry and that this constant is related to the cross-sectional width of the catching area. To determine accuracy, it was assumed that each trap would catch 20 percent of the migration in each culvert. The actual catches would then be measured against the expected catch using two techniques: dye mark releases and a horizontal ladder catch.

The procedure to measure catchability of the converging throat traps incorporated the use a a horizontal aluminum ladder, consisting of five marquesette bags each of which was 6 in. in height and 12.0 in. in width. The ladder, suspended to fish the cross-sectional width of the five foot culvert, was fished at 6 in. intervals from surface to bottom (3 feet). The ladder was located approximately 6 feet downstream of the trap mouth The results of the ladder tests (Table 23) indicate that overall production was overestimated by approximately 10 percent. The production estimates were adjusted accordingly.

Dye marked fry (neutral red, bismarck brown) releases ranging from 400 to 1,000 fry were made at the top end of each culvert and a portion recaptured in the converging throat traps. The results were similar to those obtained from the horizontal ladder tests.

Fry Production and Egg to Fry Survival

Fry production from the Pinkut Creek spawning channel has been low in recent years due to poor gravel quality during incubation, high adult spawning densities and to winter operational problems. Since its completion, the production has averaged 18.5 million fry and survival has averaged 35.5 percent (Table 24). Initially, fry output was limited by the lack of adult spawners. Compounding this was excessive loading in the uppermost legs

TABLE 23: Annual average catches by percent of the horizontal ladder trap used to assess catchability of the Pinkut Channel converging throat traps. Trap No. 3 in each bay represents position of each converging throat trap.

Year	Percent of Total Catch Per Trap										Trap No.3 Error		x̄ Error of No.3 Traps
	Bay 1 Traps					Bay 2 Traps					Bays		
	1	2	3	4	5	1	2	3	4	5	1	2	
1971	15.7	24.6	23.3	22.0	14.4	17.3	25.2	21.7	22.0	13.8	+16.5	+8.7	+12.60
1972	16.1	27.8	23.3	21.5	11.3	17.2	26.9	20.0	23.2	12.7	+16.5	0.0	+ 8.25
1973	17.8	27.3	21.6	20.9	12.4	17.7	25.6	21.1	21.1	14.5	+ 8.0	+5.5	+ 6.75
1974	18.1	28.9	22.6	20.6	9.8	14.7	30.1	22.4	20.5	12.3	+13.0	+12.0	+12.50
Average	16.9	27.2	22.7	21.2	11.9	16.7	26.9	21.3	21.7	13.3	+13.5	+6.5	+10.03*

*Correction factor applied to annual channel production estimates.

TABLE 24: Pinkut Creek Spawning Channel sockeye fry production from 1969 to 1976.

Brood Year	Egg Deposition (millions)	Fry Production (millions)	Survival (%)	Fry Year
1968	30.8	10.4	13.5	1969
1969	37.5	15.2	18.8	1970
1970	37.9	22.0	19.8	1971
1971	30.8	16.7	21.7	1972
1972	96.6	29.0	57.1	1973
1973	97.1	24.1	63.3	1974
1974	93.4	8.3	51.7	1975
1975	67.3	22.3	48.1	1976
8 Year Average	61.4	18.5	35.4	

of the channel. In all probability, production during the initial years would have been higher had the spawners been evenly distributed throughout the channel.

Local observations and studies by Ginetz (1972) indicated that high mortalities were occurring from environmental deterioration of the channel, and from density related factors. Assuming that gravel quality deteriorated rapidly during the initial years and has remained relatively stable at a sub-optimal level, annual mortality from this factor should remain constant. Therefore, following the assumption that mortality of incubating sockeye eggs in the channel is density dependent, one could then expect that changes in loading density would be reflected by changes in egg to fry survival. The positive regression of egg to fry survival on spawning area per female is highly significant (Fig. 49; P ≤ .005) indicating that the mortality in the Pinkut Creek spawning channel is density

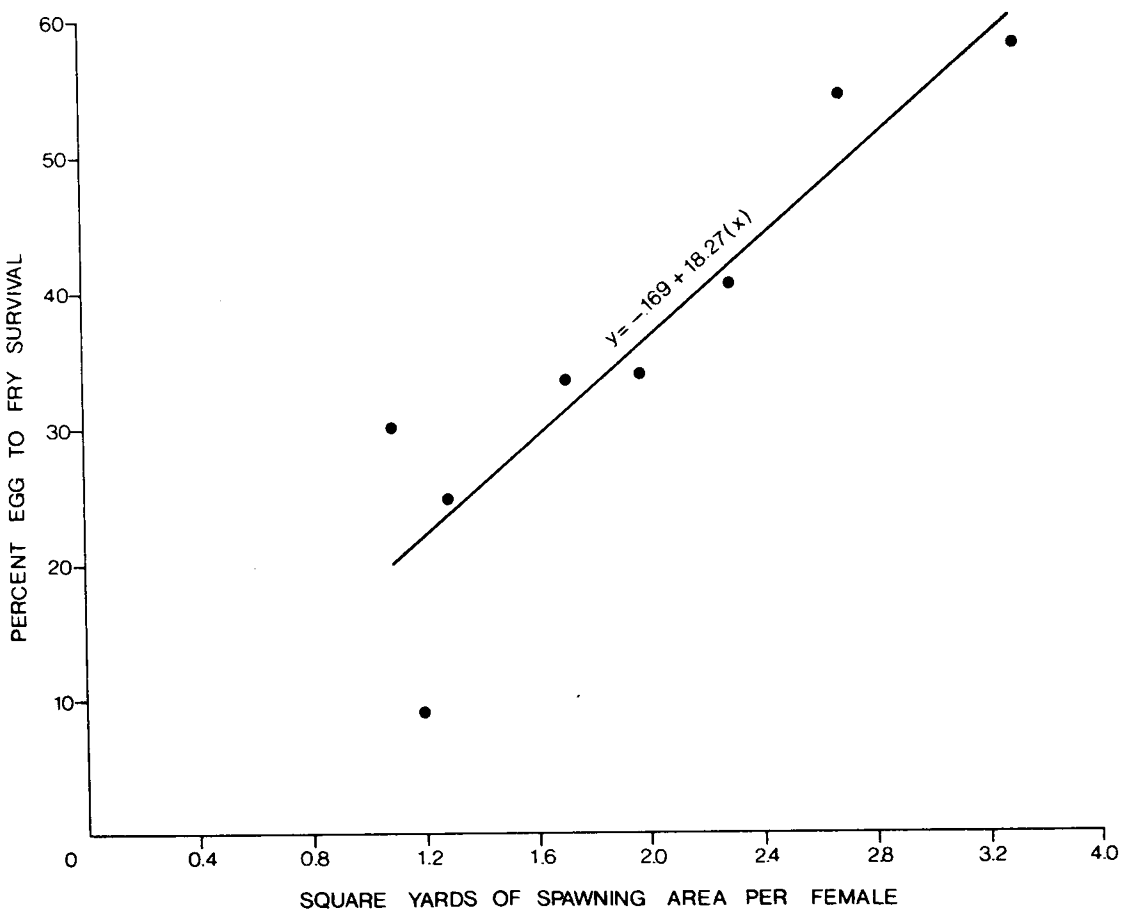


Figure 49: Regression of sockeye egg to fry survival on spawning area per female in the Pinkut Creek Spawning Channel.

dependent. Additional evidence for the density effect is shown by the significant negative regression of survival on egg deposition (Fig. 50; $p \leq .025$).

The level of optimum deposition for the Pinkut Channel is difficult to interpret from the available data due to the mortality factors in effect. The positive regression of fry production on egg deposition is not significant (Fig. 51) suggesting that fry production from egg depositions ranging from 30 million to 100 million eggs does not increase significantly. Yet it seems reasonable to expect some optimum loading level between the 30 to 100 million egg deposition range. The results obtained from the Fulton River spawning channels suggest that a spawning area allotment of 1.5 sq. yds. per female, or a female

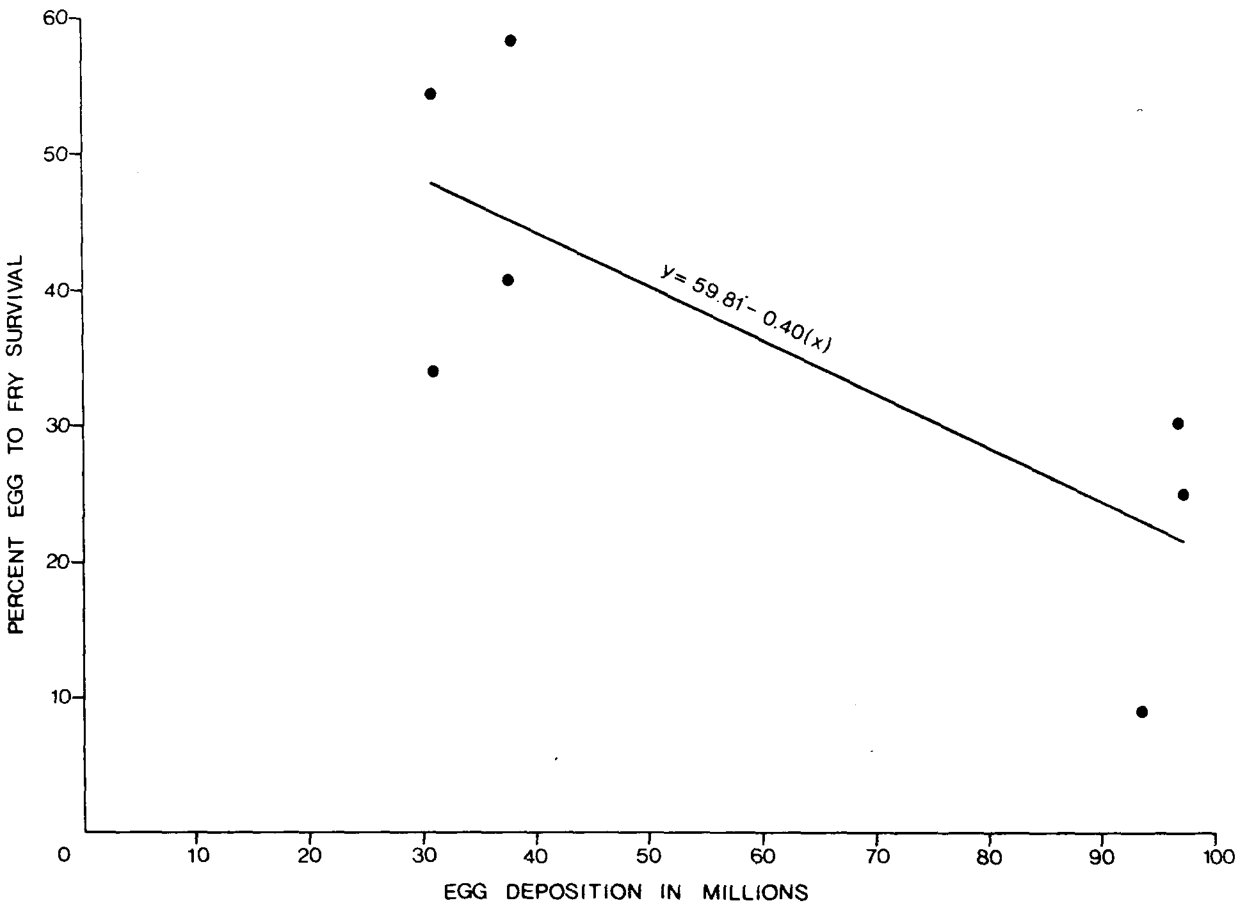


Figure 50: Regression of sockeye to fry survival on actual egg deposition in the Pinkut Spawning Channel.

spawning density approximating 25,000 fish would result in consistent survivals ranging from 40 to 50 percent. The adult density of 25,000 females would provide an egg deposition of approximately 80 million eggs.

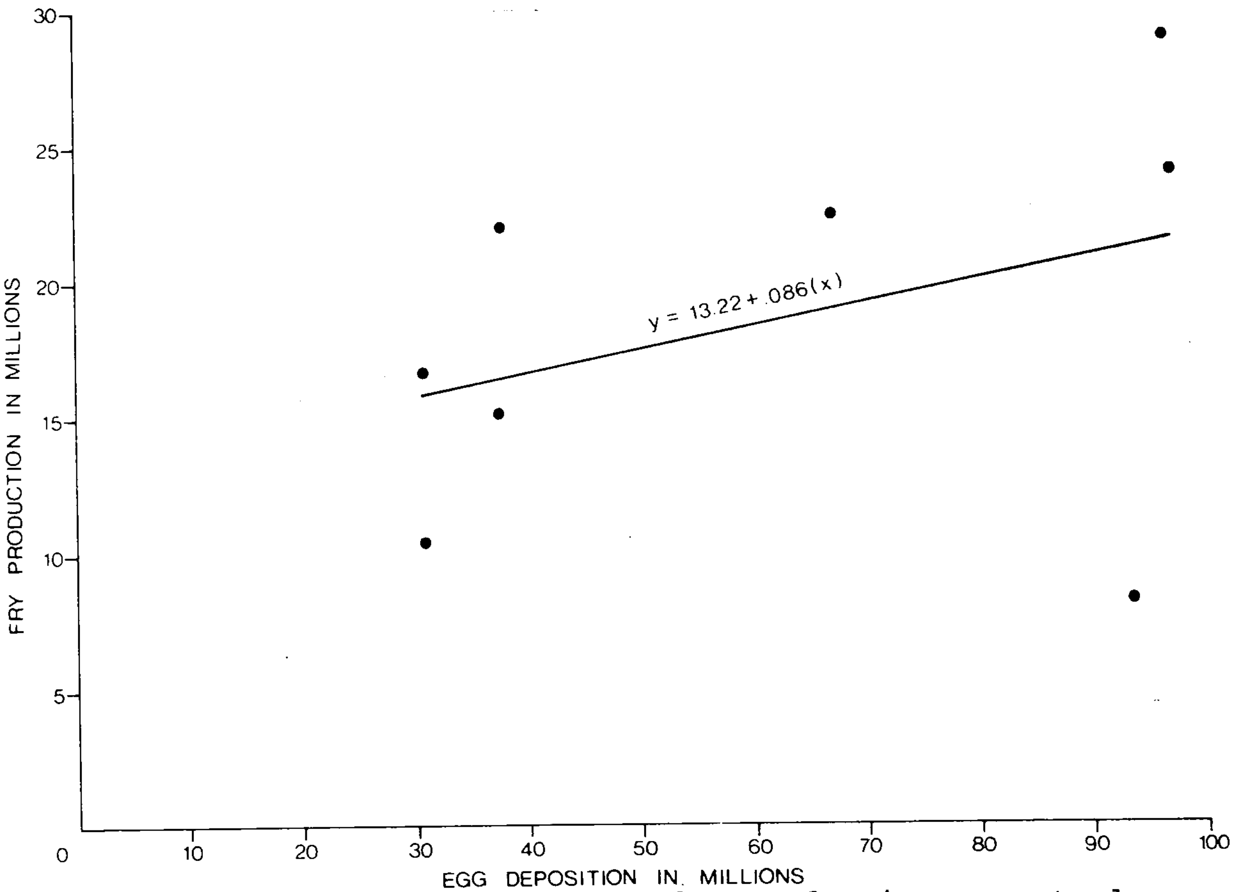


Figure 51: Regression of sockeye fry production on actual egg deposition in the Pinkut Creek Spawning Channel.

Fry Migration Timing

Fry migration timing from the Pinkut Spawning Channel, varies little from year to year (Table 18). In all years peak migration occurs during late May. The close association between water temperature and rate of migration, (Fig. 46) suggests that temperature is perhaps the key factor responsible for initiating migration. The discharge curve in 1972 corresponded very well with the migration curve; however, in 1973 and 1974

(Fig. 52) the continual rise in water temperature is reflected by the migration curves. The results also indicate that migration accelerates when the average weekly water temperature exceeds 4°C.

Fry Quality

Annual mean length of channel fry has ranged from a high of 30.47 mm. in 1969 to a low of 28.22 mm. in 1970 (Table 19). Only in the first year of operation did fry length exceed 30 mm. One possible reason for this may be poor gravel quality. The channel gravel has deteriorated continuously since its inception. Silt deposition was exceptionally high in the second year of operation (1970) and may have been the cause of a reduction in fry quality that year. One would expect environmental stress from silt to have some physiological effect on yolk to body tissue conversion. A similar trend also occurred for mean weight in that a low of 113.03 gm. was observed in 1970 (Table 20).

Development index at the time of migration has averaged 1.75 over the 8-year period from 1969 to 1976 (Table 21). Although migration timing was essentially the same for both the channel and river, channel fry were consistently more mature at migration. A possible reason for this is that channel eggs and alevins experience a significantly larger thermal heat intake as a result of the auxiliary warm water supply. The heated channel water may provide enough heat to accelerate the development of the channel fry, making them more mature at migration.

On an annual basis there are some distinct differences in quality between channel and river fry (Fig. 53 to 57, Table 22). For example, fry from the 1968 channel brood were

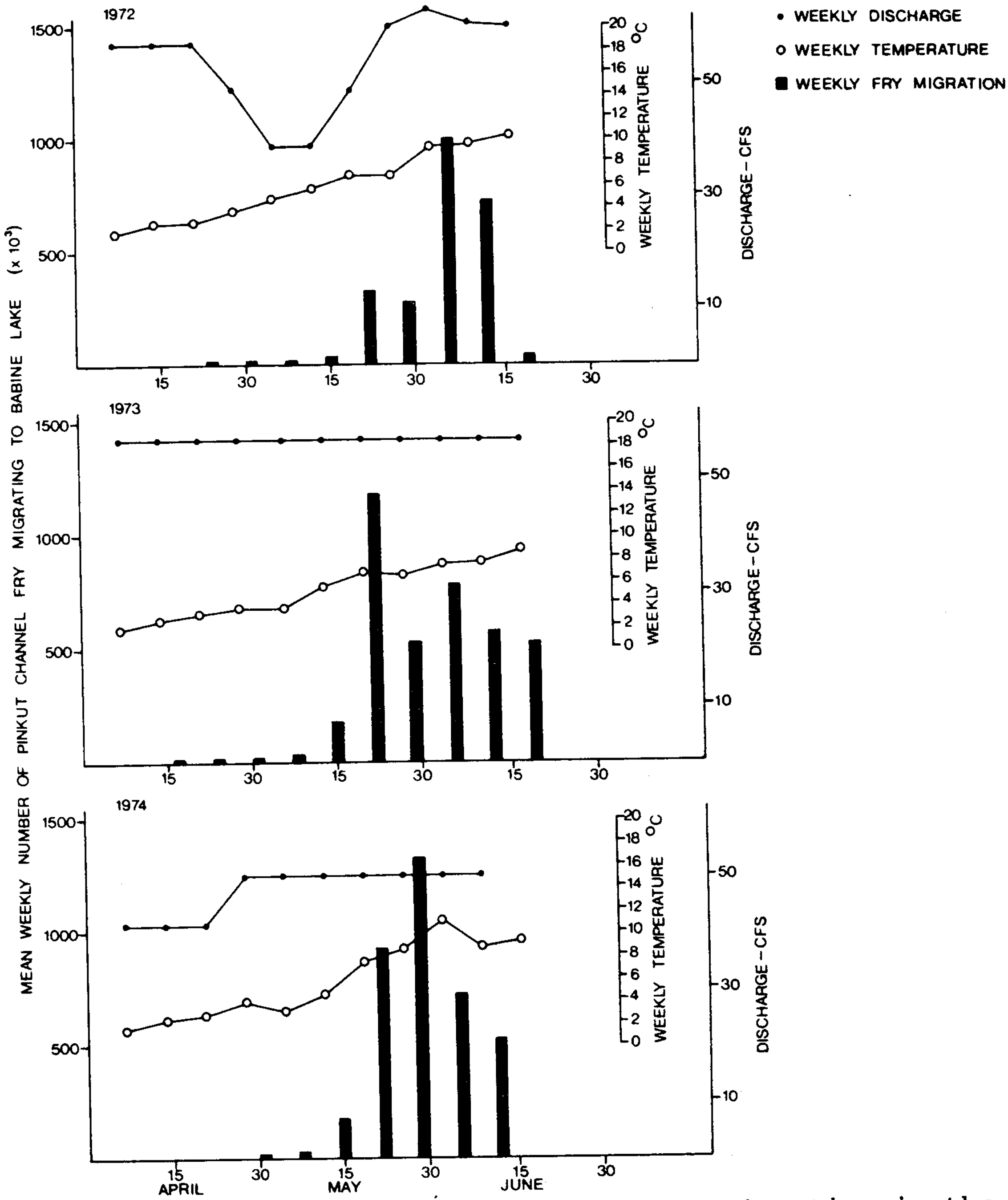


Figure 52: Mean weekly number of sockeye fry migrating in the Pinkut Creek Spawning Channel in relation to average weekly water temperature and discharge from 1972 to 1974.

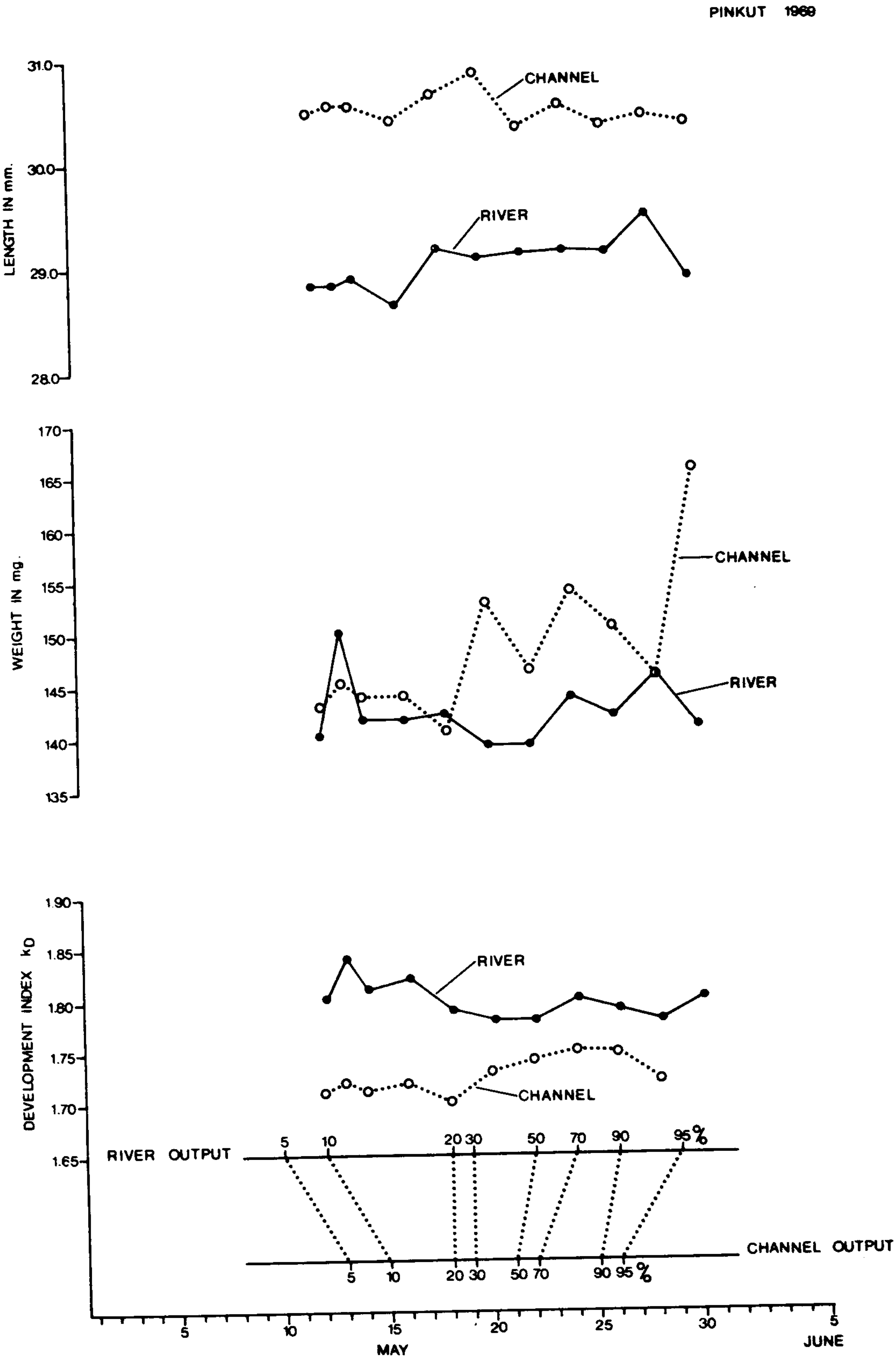


Figure 53: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1969 spring migration. Also shown is the progress of the runs in time.

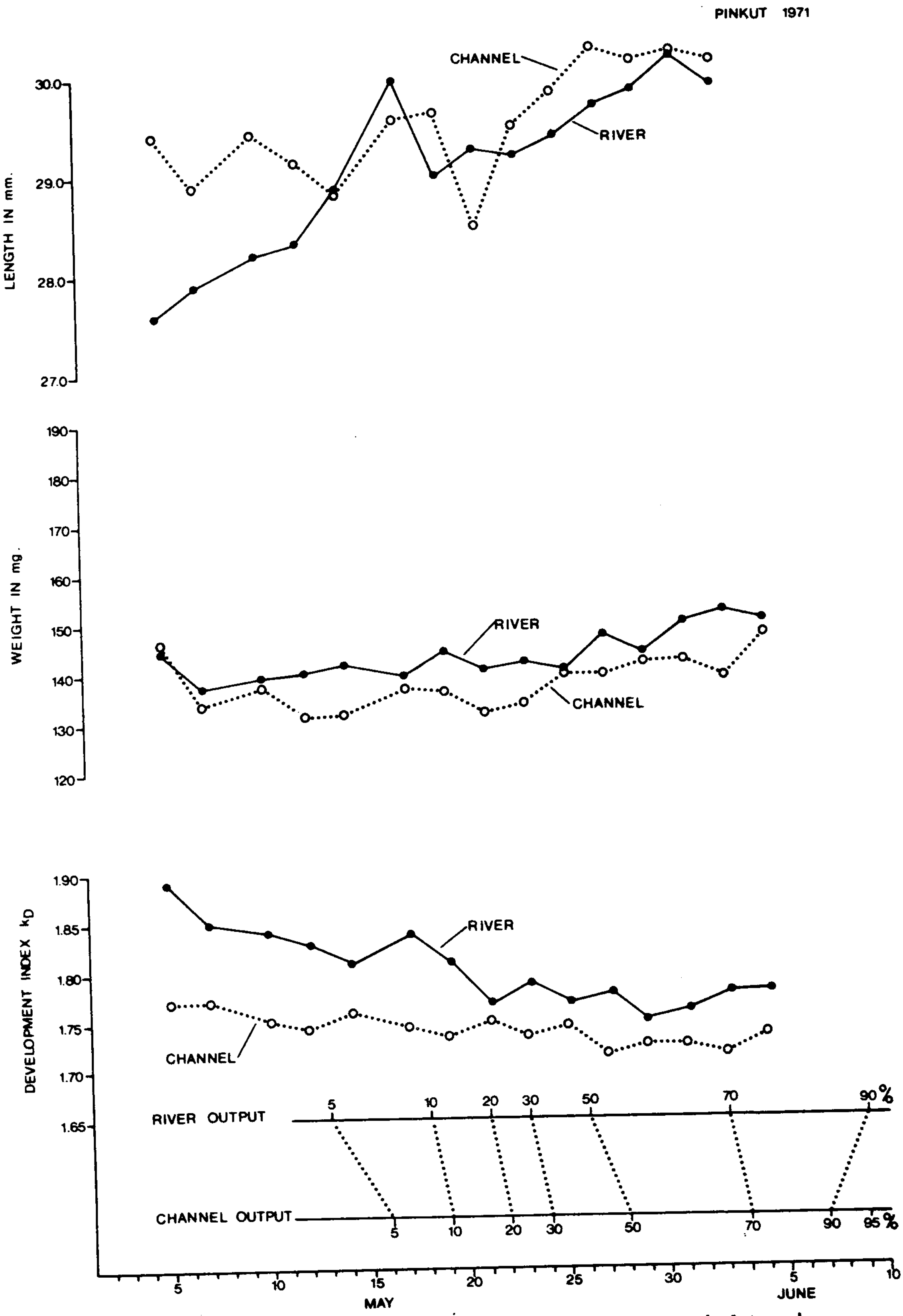


Figure 54: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1971 spring migration. Also shown is the progress of the runs in time.

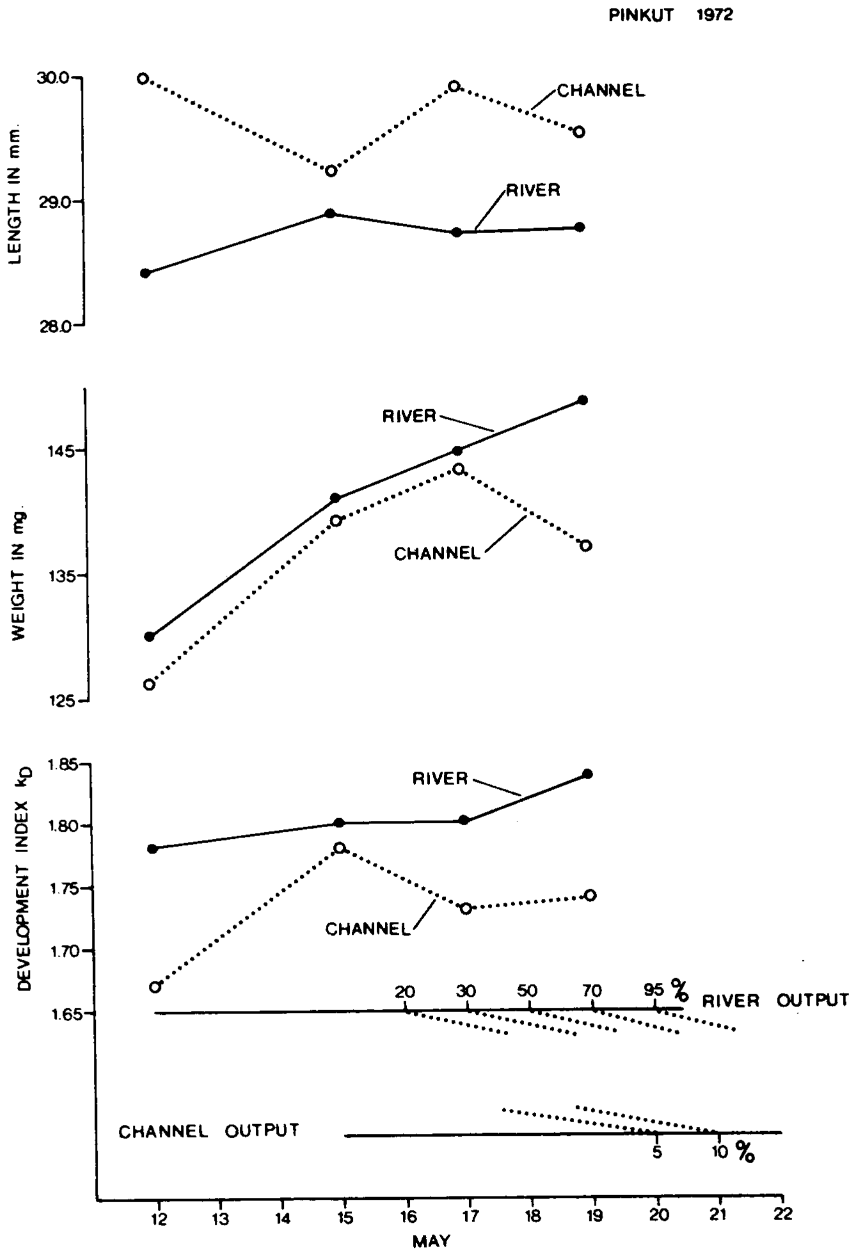


Figure 55: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1972 spring migration. Also shown is the progress of the runs in time.

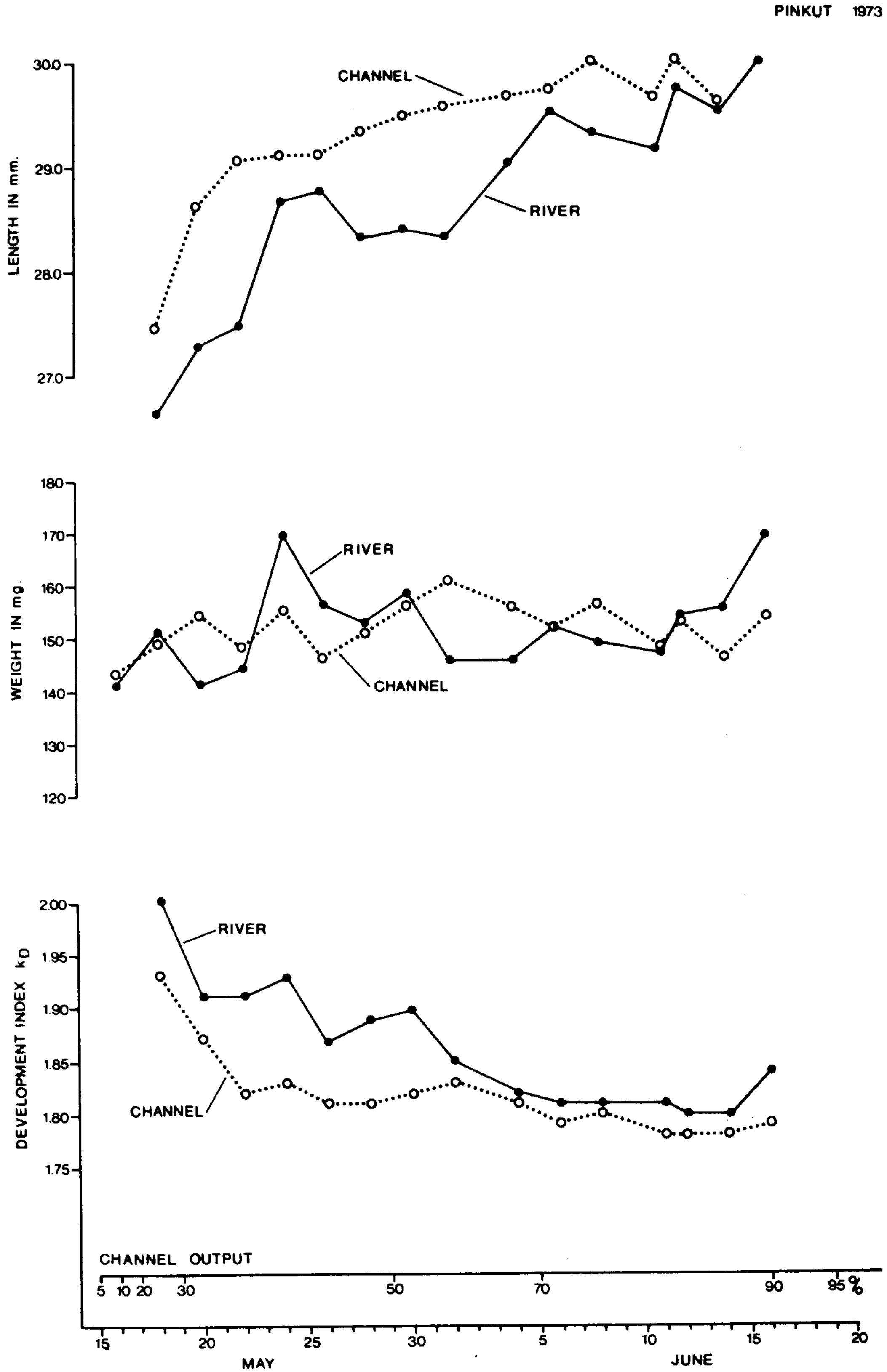


Figure 56: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1973 spring migration. Also shown is the progress of the runs in time.

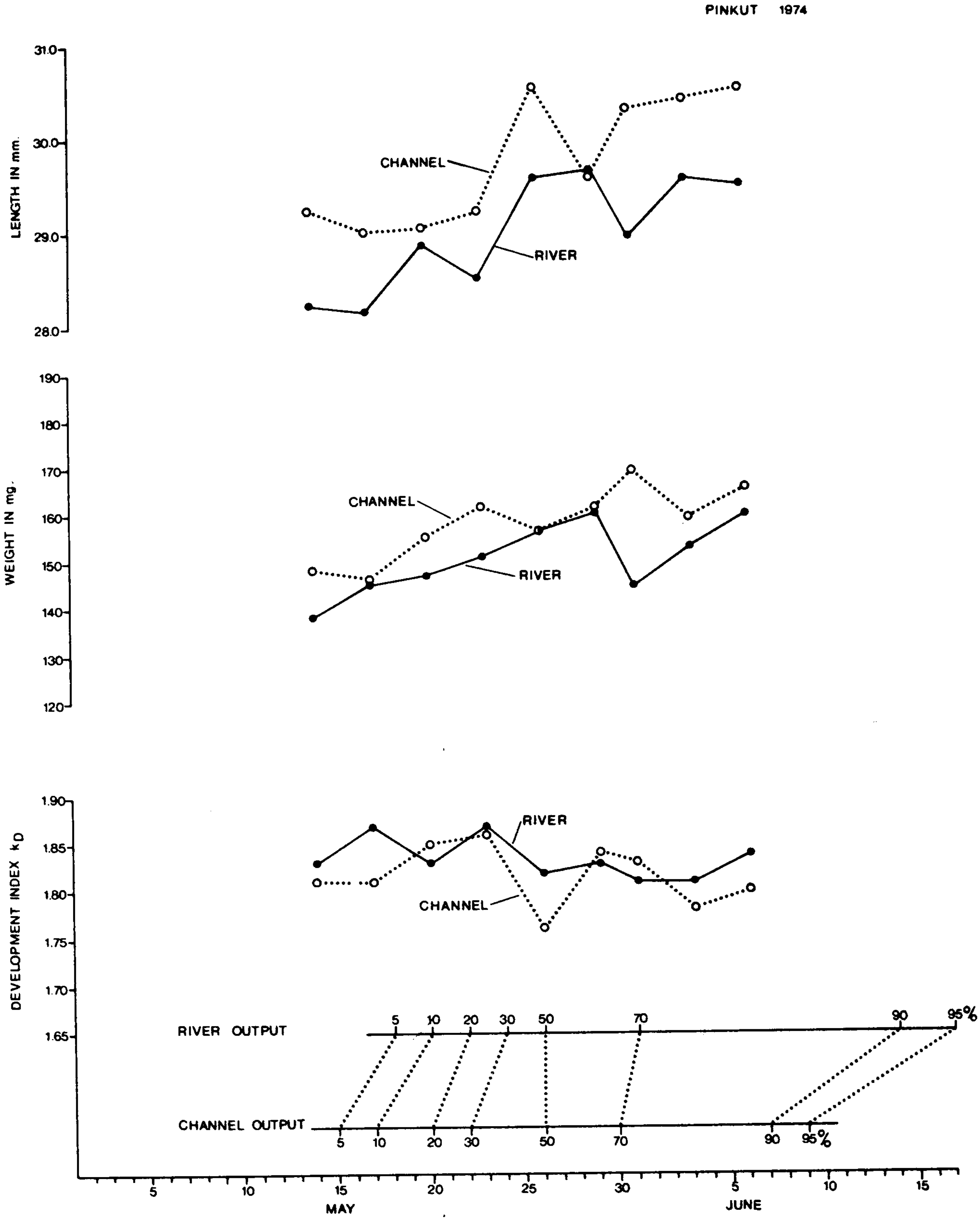


Figure 57: Average lengths in mm, average weights in mg, and average developmental indices of Pinkut Creek and Pinkut Channel fry at intervals during the 1974 spring migration. Also shown is the progress of the runs in time.

were significantly heavier, longer and more mature than river fry (Appendix Table XXXV). Perhaps this difference resulted from differences in gravel quality in that channel gravel was not contaminated with silt, and was of a uniform mixture. In 1970, the reverse situation occurred in terms of length and weight (Appendix Table XXXVI). This was probably due to extensive siltation in the channel leading to intense environmental stress on developing eggs and alevins. From 1971 to 1974 channel fry were significantly longer than river fry (Appendix Tables XXXVII to XLI) while in 1975 differences were not significant. No consistent weight difference existed between the two fry types. In terms of the development index, channel fry have been more mature at migration. The difference has been attributed to a differential heat intake between the river and channel.

GENERAL DISCUSSION

The Babine Development Project was initiated on the basis of the following premises: (1) that the main basin of Babine Lake was underutilized and could support additional sockeye fry, (2) that these additional sockeye fry could be produced in artificial spawning channels and in natural streams with regulated flow, and (3) that the channel fry so produced are comparable to naturally produced fry in their ability to survive to the adult stage. Various studies conducted by the Research and Development Branch indicated that these premises were valid; the evidence was adequate for proceeding with the development of spawning channels and controlled flow on Fulton River and Pinkut Creek.

At the onset of the enhancement program on Babine Lake, it was agreed that evaluation programs be conducted to assess the validity of the assumptions used to promote the program. The evaluation program was the only rational and objective basis for analyzing the success of the enhancement techniques and applying the information obtained to future projects. The results of the evaluation program are discussed below.

The quantity of natural fry produced from Fulton River has not changed as a result of flow control. Similarly, average egg to fry survival was not influenced. However, the results do indicate that survival appears to be density-dependent. Assuming that during incubation the various mortality causing factors such as discharge, temperature, disease and predation, did not change after flow control started, the data indicates that survival is inversely related to egg deposition and directly related to spawning area per female spawner.

The quality of fry produced from Fulton River changes annually; however, the changes are not significant. The data suggests that migration timing is largely dependent on discharge. Indications are that high river flow forces alevins from the gravel prior to the time when normal water temperatures normally activate fry emergence. River fry at migration, appear to have adequate yolk reserves to allow the fry additional time for body growth and maintenance until food becomes abundant in Babine Lake.

Fry production from Channel No. 1 has averaged about 17 million, and survivals have exceeded expectations. The data again suggests a density-dependent relationship with survival being inversely related to egg deposition and directly related to spawning area per female spawner.

Fry migration timing varies slightly in comparison to river timing. Peak migration in the channel occurs approximately one week later than in the river and this is due to the discharge and temperature differences between the two environments. Migration from the channel is largely dependent on water temperatures, which is opposite to that for the river. One would expect channel fry to migrate when river fry do if high discharge superceded increased water temperatures in the channel.

Similar results were obtained in Channel No. 2, except that production is larger than from Channel No. 1. The physical size difference between the two facilities accounts for the production output differences. Peak migration timing is about one week later than for fry from Channel No. 1, and two weeks later than Fulton River. The differences in migration timing were attributed to differences in deposition timing and duration of adult loading. The quality of migrating fry produced from Channel No. 2 appears different than those from the river or Channel No. 1. The differences in quality probably have resulted from better yolk conversion in the Channel No. 2 environment. Because emergence from the channel appears to be totally temperature dependent, the channel fry are able to remain in the gravel until yolk conversion is totally complete. Local observations have indicated that virtually all Channel No. 2 fry are fully developed when they migrate.

Fry production from Pinkut Creek has declined slightly, primarily because of a reduction in egg deposition. However, egg to fry survival has slightly increased, which is expected as a result of the dependence of egg survival on spawner density at the time of deposition. Fry quality has not changed significantly since flow control was implemented and, again, maturity at migration appears to be dependent on river emergence timing appears to have been influenced by water temperature.

Production from the Pinkut Creek channel has, in recent years, declined to lower than anticipated levels as a result of poor gravel quality and possibly high egg density. Since its inception, the quality of the gravel has deteriorated as a result of high sedimentation. Instability of channel berms, combined with icing, has created short circuits which have scoured and eroded clay material into the channel. These factors have led to a decline in production and reduced egg to fry survival rates. To counteract the problem, a major rehabilitation program was initiated in 1976 which involved gravel removal and cleaning, reconstruction of the berms, reconstruction and enlargement of the settling basins, the addition of auxiliary warm water outlets to reduce icing,and construction of adult loading faculties.

Fry migration timing in most years was identical to Pinkut Creek; however, in years where high river discharge occurred early in the spring, channel timing peaked approximately one week after the river. Here again the primary factor responsible for triggering emergence and timing in the channel is water temperature.

Channel fry are more developed than river fry at migration. Apparently, the heated channel provides more thermal heat units for development, which results in an advanced maturity state in channel fry over that for river fry.

A more reliable method of evaluating the quality of fry produced from the Babine Development Project is based on fry to smolt production and ultimately to adult production. Consistent increases in fry production have resulted in corresponding increases in smolt production (Fig. 58). For example, fry output from Pinkut and Fulton in 1969 approximated 75 million, while in 1974 it exceeded 146 million. Main basin smolt production from Babine Lake which consists largely of Fulton and Pinkut fish, has increased from approximately 34.6 and 61.1 million in the period from 1967 to 1974. This certainly suggests that channel fish are of equal quality to river fish. However, since 1973, smolt production has declined significantly, almost to the level of predevelopment years. Fry production from the development projects exceeded 150 million in 1974, yet smolt production from the main

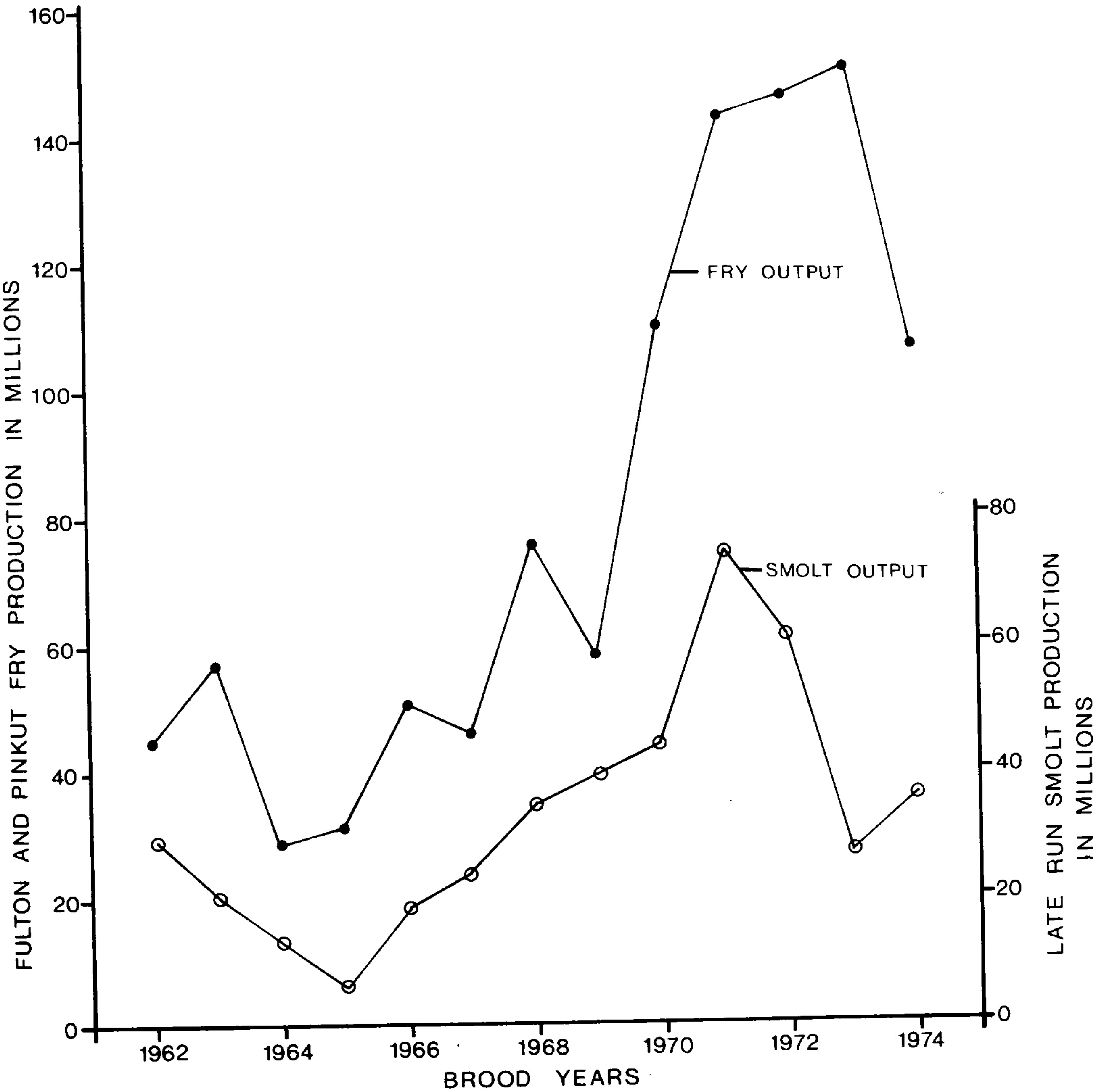


Figure 58: Fry production from the Fulton River and Pinkut Creek systems in relation to the late run Babine Lake smolt production from the 1962 to 1974 brood years.

lake only approximated 27.4 million. The following year, main lake smolt production increased to 36.1 million while fry production from Pinkut and Fulton approximated 106.9 million.

Several reasons may be given to explain the decline in smolt production. It has been suggested that predator populations preying on juvenile sockeye fry have increased in response to greater food abundance and are now consuming a large proportion of the fry populations. Another possible reason for low smolt production may be attributed to low plankton abundance created by an over-cropping by sockeye juveniles or by reduced primary production which, in turn, is dependent on lake chemistry. Monitoring of plankton abundance and species diversity indicate some changes have occurred in recent years (Rankin, 1976 Pers. Comm.). Increased parasitic infection in juvenile sockeye leading to high lake mortality, has also been proposed as another possible reason for the decline. Perhaps a combination of the above-mentioned factors is responsible for the decline in smolt production.

Prior to completion of the overall project, some concern was voiced as to the long term survival of channel fry compared to river fry. Tagging studies conducted by MacDonald (1971) have indicated that both fry types have equal or comparable survival rates to the smolt stage. Further evidence supporting these results is that adult stocks returning to the Skeena System appear to consist of a high proportion of channel stock. These returns are not unexpected because disproportionate fry production resulting from the spawning channels should in turn be reflected in a larger proportion of channel produced adults. Therefore, it would appear that channel fry are equal to fry produced naturally.

A significant factor which must be recognized is that each enhancement facility has its very own characteristics which affect the overall success of that facility. Also, species of fish being enhanced will behave in a unique manner from river to river, system to system and from facility to facility. For example, fish spawning in coastal streams will arrive on the spawning grounds at full maturity, spawn within a week and die. Salmon destined for inland streams will arrive on the spawning grounds over a six to eight week period in varying degrees of maturity. The latter situation occurs at Babine and definitely affects the overall success of the production from the spawning channels. The results to date have shown that mortality factors are density dependent and the current adult loading densities result in survivals ranging from 40 to 50 percent. Spawning channels on coastal streams such as the Weaver Creek Spawning Channel, operated by the International Pacific Salmon Commission, experience higher survivals. One reason for this is that the returning adults arrive on the spawning grounds and spawn in less than three weeks, thus minimizing the wave spawning effect on survival. In addition, the apparently high success of other spawning channels on the Fraser River System is greatly influenced by reduced loading rates. Spawning channels operated by the International Pacific Salmon Commission in most years have been loaded well above the level currently employed in the Babine spawning channels. For example, in eight out of 10 years, the female loading density in the Weaver Creek channel was equivalent to an area allotment of 2.0 sq. yds. per female or greater, and survivals were above 80 percent. In 1974, the area allotment was about 1.3 sq. yds. and the resultant egg to fry survival was 61.5 percent. These data support the view that loading densities definitely influence survival and production rates.

Although further study is required to fully evaluate the significance of the Babine Development Project in terms of the initial premises on which the project was approved, the current results do confirm that artificial spawning channels are a practical method for enhancing sockeye salmon. However, it is important to recognize that large scale enhancement projects and programs when implemented, can significantly alter the ecosystem(s) in which they are located. Therefore, it is imperative that proper evaluation programs be an integral part of all major enhancement projects in order that system changes can be monitored, to ensure that when changes occur, their significance is recognized and applied to the planning of future projects. In retrospect, problems, both past and present that are associated with the Babine Development Project are a clear example of some of the consequences of enhancement projects. Accordingly, the project should serve as a guide for the future.

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APPENDIX TABLE I: Calculation process for fry migration from Fulton River based on the standard index sampling.

Date - May 25-26, 1972

Fishing Time	Trap No. 1	2	3	4	5	6	7	8	9	10
22:20										
22:30-22:40			67				70			
23:00-23:10			205				163			
23:30-23:40			494				299			
00:00-00:10			669				412			
00:30-00:40			772				331			
01:00-01:10			425				241			
01:30-01:40			348				160			
02:00-02:10			252				156			
02:30-02:40			239				133			
02:50										
			3471				1965			

Step

1. Actual catch in index period by traps 3 and 7 (in a 90 minute period) = 5,436

2. Estimated catch if traps 3 and 7 fished full index period (270 minutes)
$\frac{270 \text{ min.}}{90 \text{ min.}} = 3.0 \quad 3.0 \times 5436$ = 16,308

3. Estimated catch if traps 3 and 7 fished full 24 hour period using May 22-23 time check
$\frac{100}{85.12}\ \% \times 16{,}308$ = 19,159

4. Estimated catch if all traps fished full 24 hour period using May 21-22 area check
$\frac{100}{25.37}\ \% \times 19{,}159$ = 75,518

5. Estimated catch for 20 x factor, i.e. each trap fishes 1/20 of cross section. Total nightly estimate 20 x 75,518 = 1,510,360

6. River = Fence - Channel or
R = 1,510,360 - 1,017,232 = 493,128

APPENDIX TABLE II: Calculation process for fry migration from Fulton River based on time check sampling.

Date - May 22-23, 1972 River Gauge = 3.05 ft.

Fishing Time	Trap No.									
	1	2	3	4	5	6	7	8	9	10
21:00-21:10			13				8			
21:30-21:40			41				31			
22:00-22:10			64				51			
22:30-22:40			138				154			
23:00-23:10			393				265			
23:30-23:40			634				364			
00:00-00:10			865				393			
00:30-00:40			658	T_1			375	T_2		
01:00-01:10			429	3906			228	2254		
01:30-01:40			305				192			
02:00-02:10			251				158			
02:30-02:40			233				125			
03:00-03:10			163				128			
03:30-03:40			155				112			
04:00-04:10			99				82			
04:30-04:40			37				39			
05:00-05:10			18				7			
05:30-05:40			12				9			
06:00-06:10			4				4			
			4512 T_3				2725 T_4			

$$\text{Index Trap-Time Check} = \frac{T_1 + T_2}{T_3 + T_4} \times 100\%$$

$$\text{Index Period-Time Check} = \frac{3906 + 2254}{4512 + 2725} = \frac{6160}{7237} \times 100 = 85.12\%$$

Step

1. 3 x 6160 = 18,480

2. $\frac{100}{85.12}$ x 18,480 = 21,711

3. $\frac{100}{25.37}$ x 21,711 = 85,577

4. 20 x 85,577 = nightly estimate of 1,711,540

5. River = Fence - Channel or 1,711,540 - 796,405 R = 915,135

APPENDIX TABLE III: Calculation process for fry migration from Fulton River based on area check sampling.

Date - May 21-22, 1972 River Gauge = 3.10 ft.

Fishing Time	Trap No. 1	2	3	4	5	6	7	8	9	10
22:20										
22:30-22:40			184				210			
23:00-23:10			567				390			
23:30-23:40			914				594			
00:00-00:10			1013	1372			592	805		
00:30-00:40			787				451			
01:00-01:10	190	418	613	527	614	480	346	128	177	162
01:30-01:40	146	256	401	410	452	363	251	148	169	107
02:00-02:10	130	218	358	322	385	264	208	115	118	105
02:30-02:40			275				152			
02:50										
	466	892	5112	1259	1451	1107	3194	391	464	374

Index Trap-Area Check =

$$\frac{1372 + 805}{466 + 892 + 1372 + 1259 + 1451 + 1107 + 805 + 391 + 464 + 374} = \frac{2177}{8581} \times 100\% = 25.37\%$$

Step

1. $3 \times 8306 = 24{,}918$

2. $\frac{100\ \%}{85.93\%} \times 24{,}918 = 28{,}998$

3. $\frac{100\ \%}{25.37\%} \times 28{,}998 = 114{,}300$

4. $20 \times 114{,}300$ = nightly estimate of 2,286,009

5. River = Fence - Channel or 2,286,009 - 1,137,809 R = 1,114,200

APPENDIX TABLE IV: Explanation of the standard index catch calculation method for estimating the nightly abundance of sockeye fry migrating from Fulton River.

1. The actual catch of the two index traps No. 3 and 7 was 5436 fry. These traps had fished 9-10 minute periods or 90 minutes out of a total index period of 270 minutes. The remaining 180 minutes was used for raising, emptying, cleaning and resetting the traps.

2. If these two traps had fished the full index period of 270 minutes, then their catch would be $\frac{270}{90} \times 5436 = 16{,}308$

3. If these two traps had fished a full 24 hour period their catch would have been $\frac{100\%}{85.12} \times 16{,}308 = 19{,}159$. The time check of May 23-24 (Table II) showed that the traps caught 85.12% of the total 24 hour catch in the index period of 270 minutes. The time checks were determined once to twice a week, depending on water depth and turbidity.

4. The area check for May 21-22 (Table III) showed that when all ten traps were fishing, traps 3 and 7 caught 25.37% of the total ten trap catch, then the estimate for the ten trap catch would be $\frac{100\%}{25.37} \times 19{,}159 = 75{,}518$

5. Since each trap fishes 1/20th of the cross sectional stream width, then the nightly catch is 20 x 75,518 = 1,510,360.

6. The channel 1 (C) count would have to be subtracted from the fence count (F) in order to obtain the proper fry estimate from the river (R) = F - C, or R = 1,510,360 - 1,017,232 = 493,128.

APPENDIX TABLE V: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1966.

Sample	Date	N	Mean Length (mm)	s^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight (mg)	s^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index (K_D)	s^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 13	52	28.90	4.68	-.30	1317.0	-.061	.4757	142.15	298.90	-4.56	1139.0	-1.234	.1086	1.81	.012	.01	1214.5	-.736	.2308
1_1	" "	51	29.20	1.88					146.73	408.30					1.80	.006				
2_R	May 14	51	28.88	1.75	-.81	920.5	-2.613	.0045	147.84	245.28	-1.02	1277.5	-.154	.4388	1.83	.004	.05	648.5	-4.:364	0
2_1	" "	51	29.69	1.98					148.86	533.54					1.78	.002				
3_R	May 24	47	29.87	1.25	.35	1063.5	-.490	.3121	152.64	288.26	6.06	854.5	-2.037	.0208	1.79	.003	0	911.5	-1.612	.0535
3_1	" "	48	29.52	6.09					146.58	542.05					1.79	.017				
4_R	May 28	43	27.74	3.34	-1.29	509.0	-2.803	.0026	148.77	333.77	2.18	708.0	-.845	.1991	1.91	.014	.10	381.0	-4.000	0
4_1	" "	37	29.03	4.14					146.59	587.93					1.81	.007				
5_R	June 1	52	29.38	1.38	1.03	995.5	-2.367	.0089	144.69	249.92	5.54	1088.0	-1.718	.0428	1.79	.003	-.04	1054.5	-1.934	.0266
5_1	" "	52	28.35	4.98					139.15	466.58					1.83	.010				
6_R	June 4	52	28.65	2.78	-.31	1281.0	-.470	.3192	138.85	530.62	.56	1319.5	-.211	.4164	1.80	.008	.01	1289.5	-.406	.3424
6_1	" "	52	28.96	5.14					138.29	368.73					1.79	.016				
7_R	June 8	52	30.00	2.67	.28	1157.5	-.982	.1630	154.58	468.35	-1.32	1231.0	-.462	.3221	1.79	.015	-.02	872.5	-2.862	.0021
7_1	" "	50	29.72	2.57					155.90	411.27					1.81	.004				
8_R	June 9	52	30.19	1.26	.48	1130.0	-1.496	.0673	152.50	322.88	.29	1313.0	-.254	.3997	1.77	.002	-.02	958.0	-2.562	.0052
8_1	" "	52	29.71	2.13					152.21	417.41					1.79	.003				
9_R	June 11	52	29.02	3.20	1.31	725.0	-4.032	0	149.50	279.55	7.03	981.5	-2.274	.0115	1.83	.008	-.06	698.5	-4.140	0
9_1	" "	51	27.71	2.05					142.47	199.91					1.89	.006				
10_R	June 13	52	30.46	1.23	1.77	431.5	-6.095	0	157.06	310.47	3.56	830.5	-3.392	.0003	1.77	.002	-.08	515.5	-5.439	0
10_1	" "	52	28.69	4.65					153.50	3560.02					1.85	.006				
11_R	June 14	52	29.96	1.45	1.17	737.5	-4.101	0	153.90	452.35	5.42	1136.5	-1.402	.0807	1.78	.003	-.06	719.5	-4.112	0
11_1	" "	52	28.79	2.88					148.48	384.82					1.84	.005				
12_R	June 16	46	30.07	1.75	1.99	443.5	-5.436	0	143.57	430.49	10.03	859.0	-2.400	.0082	1.74	.004	-.08	448.0	-5.325	0
12_1	" "	52	28.08	3.29					133.54	413.32					1.82	.007				
13_R	June 19	25	26.84	1.14	-3.36	160.0	-5.269	0	127.68	458.31	-39.82	276.5	-3.918	0	1.87	.007	.05	440.5	-2.074	.0190
13_1	" "	50	30.20	6.98					167.50	1695.82					1.82	.013				
14_R	June 21	23	29.09	3.90	-.10	577.5	-.242	.4044	152.30	439.68	9.90	466.5	-1.512	.0653	1.84	.012	.05	427.0	-1.965	.0247
14_1	" "	52	29.19	2.63					142.40	388.82					1.79	.005				
ϵ_R	June 21	651	29.33	2.97	.28	81^b		>.05	148.17	395.42	.93	84^b		>.05	1.80	.008	-.01	81.5^b		>.05
ϵ_1	" "	702	29.05	4.04					147.24	799.61					1.81	.008				
			$F = 1.36^c$					<.01		$F = 2.02^c$				<.01	$F = 1.00^c$					>.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 14$.

[c] Test on homogeneity of variances.

APPENDIX TABLE VI: Mean lengths, weights and developmental indices, their difference and statistical significance of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1967.

Sample	Date	N	Mean Length(mm)	S^2	Δ_1(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_1(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta_1(K_D)$	U	Z	P
1_R [a]	Apr.26	50	29.06	1.16	1.94	373.0	-6.183	0	147.28	257.49	41.24	158.0	-7.533	0	1.82	.002	.08	235.0	-6.654	0
1_1	" "	50	27.12	2.27					106.04	473.44					1.74	.003				
2_R	Apr.28	50	29.16	2.06	1.46	612.5	-4.489	0	140.86	595.03	34.60	365.0	-6.105	0	1.78	.005	.08	497.5	-5.188	0
2_1	" "	50	27.70	2.46					106.26	429.72					1.70	.003				
3_R	May 2	50	28.96	1.06	1.70	384.0	-6.138	0	153.20	278.71	42.96	151.0	-7.577	0	1.85	.003	.10	350.5	-6.201	0
3_1	" "	50	27.26	1.79					110.24	501.05					1.75	.005				
4_R	May 4	50	29.16	.79	.38	971.0	-2.013	.0220	155.42	202.27	12.48	723.0	-3.63	.0002	1.84	.001	.03	722.5	-3.637	.0002
4_1	" "	50	28.78	1.03					142.94	447.42					1.81	.003				
5_R	May 5	50	29.60	.94	.36	985.5	-1.911	.0280	158.96	294.71	25.66	392.5	-5.913	0	1.83	.003	.09	277.0	-6.708	0
5_1	" "	50	29.24	1.08					133.30	375.21					1.74	.003				
6_R	May 8	50	29.56	.78	.96	642.0	-4.374	0	160.76	239.96	25.08	380.0	-6.000	0	1.84	.002	.05	499.5	-5.174	0
6_1	" "	50	28.60	1.23					135.68	321.46					1.79	.001				
7_R	May 9	50	29.56	.86	1.42	444.0	-5.738	0	163.56	288.59	42.78	143.5	-7.632	0	1.85	.002	.10	285.5	-6.650	0
7_1	" "	50	28.14	1.43					120.78	506.35					1.75	.004				
8_R	May 10	50	29.64	.85	1.06	650.0	-4.273	0	166.00	218.24	29.46	300.5	-6.547	0	1.85	.002	.05	494.0	-5.212	0
8_1	" "	50	28.58	1.47					136.54	369.37					1.80	.002				
9_R	May 13	50	29.16	1.44	.46	1043.5	-1.473	.0704	156.82	307.08	28.26	328.0	-6.369	0	1.85	.003	.10	258.0	-6.840	0
9_1	" "	50	28.70	1.81					128.56	391.90					1.75	.004				
10_R	May 17	50	29.62	1.34	1.30	613.5	-4.512	0	168.66	396.24	29.66	391.0	-5.927	0	1.86	.004	.03	639.5	-4.210	0
10_1	" "	50	28.32	3.08					139.00	513.43					1.83	.010				
11_R	May 18	50	29.58	.66	1.08	713.5	-3.889	0	168.68	210.33	31.64	271.5	-6.748	0	1.87	.002	.07	440.0	-5.584	0
11_1	" "	50	28.50	2.09					137.04	424.58					1.80	.003				
12_R	May 19	50	28.40	2.57	-.36	1060.0	-1.347	.0890	160.76	662.98	25.40	543.5	-4.875	0	1.91	.007	.13	165.0	-7.481	0
12_1	" "	50	28.76	1.74					135.36	456.33					1.78	.004				
13_R	May 22	50	29.58	1.64	.36	1046.5	-1.457	.0725	156.98	647.59	6.60	1056.5	-1.334	.0911	1.82	.002	.01	1177.5	-.500	.3085
13_1	" "	50	29.22	1.60					150.38	565.12					1.81	.002				
14_R	May 23	50	29.28	1.80	.42	1017.0	-1.648	.0497	160.18	298.67	27.92	428.0	-5.669	0	1.85	.003	.09	221.5	-7.091	0
14_1	" "	50	28.86	1.76					132.26	562.04					1.76	.003				
15_R	May 24	50	30.76	1.00	1.56	447.5	-5.691	0	166.58	320.92	26.24	470.0	-5.379	0	1.79	.001	.02	1031.0	-1.510	.0655
15_1	" "	50	29.20	1.76					140.34	516.12					1.77	.002				
16_R	May 25	50	29.68	1.98	.62	912.0	-2.410	.0080	171.56	295.31	27.44	414.0	-5.769	0	1.87	.006	.07	426.5	-5.678	0
16_1	" "	50	29.06	1.89					144.12	454.81					1.80	.002				

Appendix Table VI (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
17_R	May 26	50	30.44	.91	1.92	310.0	-6.632	0	169.62	385.69	37.78	202.0	-7.226	0	1.82	.003	.04	700.0	-3.792	.0001
17_1	" "	50	28.52	2.50					131.84	365.54					1.78	.011				
18_R	May 27	50	28.96	2.04	.78	835.5	-2.922	.0018	159.28	459.73	24.24	510.0	-5.106	0	1.87	.003	.05	596.0	-4.510	0
18_1	" "	50	28.18	1.91					135.04	403.72					1.82	.003				
19_R	May 30	50	29.88	1.21	.16	1158.0	-.653	.2568	162.40	444.71	15.30	833.0	-2.876	.0020	1.82	.003	.05	650.0	-4.137	0
19_1	" "	50	29.72	2.21					147.10	662.45					1.77	.004				
20_R	May 31	50	29.84	1.16	.64	917.0	-2.362	.0091	160.64	362.88	15.26	730.0	-3.586	.0002	1.82	.003	.02	1038.0	-1.462	.0719
20_1	" "	50	29.20	1.96					145.38	398.39					1.80	.004				
21_R	June 1	50	29.28	1.63	-.32	1067.5	-1.296	.0975	161.08	364.67	16.68	634.0	-4.249	0	1.86	.005	.09	312.5	-6.464	0
21_1	" "	50	29.60	1.47					144.40	396.95					1.77	.002				
22_R	June 2	50	29.52	3.12	-.24	1180.5	-.497	.3158	154.88	467.96	4.78	1096.5	-1.058	.1451	1.82	.010	.04	907.0	-2.365	.0090
22_1	" "	50	29.76	1.41					150.10	320.20					1.78	.002				
23_R	June 3	50	29.34	1.37	-.14	1125.5	-.892	.1860	151.50	286.02	2.18	1217.5	-.224	.4113	1.82	.003	.02	886.5	-2.506	.0061
23_1	" "	50	29.48	2.26					149.32	455.80					1.80	.002				
24_R	June 5	50	29.64	1.21	.20	1142.5	-.780	.2177	153.94	336.53	3.42	1087.5	-1.121	.1312	1.81	.002	0	1232.5	-.121	.4518
24_1	" "	50	29.44	.99					150.52	192.04					1.81	.001				
25_R	June 6	50	29.60	2.12	.26	949.0	-2.149	.0158	165.10	395.18	23.38	456.0	-5.479	0	1.85	.005	.07	514.0	-5.075	0
25_1	" "	50	29.34	2.35					141.72	259.53					1.78	.006				
26_R	June 7	50	29.74	1.22	-.22	1136.0	-.836	.2016	156.64	310.75	-2.34	1187.5	-.431	.3332	1.81	.002	0	1163.5	-.596	.2756
26_1	" "	50	29.96	.98					158.98	319.27					1.81	.002				
27_R	June 8	50	29.08	1.18	-.24	1094.5	-1.128	.1296	150.28	452.63	1.34	1211.5	-.266	.3951	1.82	.004	.02	956.0	-2.027	.0213
27_1	" "	50	29.32	.83					148.94	326.61					1.80	.002				
28_R	June 9	50	29.62	1.83	.08	1243.5	-.046	.4817	160.48	489.43	7.42	1010.5	-1.652	.0493	1.83	.003	.02	914.0	-2.317	.0102
28_1	" "	50	29.54	1.27					153.06	259.27					1.81	.002				
29_R	June 10	50	29.40	1.10	0	1222.0	-.201	.4203	155.08	327.98	1.48	1128.0	-.842	.1999	1.82	.002	0	1107.0	-.989	.1613
29_1	" "	50	29.40	1.43					153.60	452.96					1.82	.002				
30_R	June 12	50	29.54	1.15	.12	1198.5	-.374	.3542	150.02	398.98	1.88	1227.0	-.159	.4368	1.79	.002	0	1199.5	-.348	.3639
30_1	" "	50	29.42	1.68					148.14	404.18					1.79	.002				
31_R	June 13	50	29.12	.97	-.46	959.5	-2.101	.0178	150.44	245.35	3.80	1057.5	-1.329	.0920	1.82	.003	.04	649.5	-4.141	0
31_1	" "	50	29.58	.90					146.64	217.82					1.78	.002				
32_R	June 14	50	29.22	1.20	-.10	1192.5	-.408	.3416	149.02	406.12	4.24	1153.5	-.666	.2528	1.81	.002	.02	885.0	-2.517	.0059
32_1	" "	50	29.32	2.06					144.78	366.35					1.79	.001				
33_R	June 17	50	29.20	1.88	-.46	994.5	-1.811	.0350	151.18	386.27	.98	1239.5	-.072	.4713	1.82	.005	.03	876.5	-2.575	.0050
33_1	" "	50	29.66	1.17					150.20	419.41					1.79	.004				

Appendix Table VI (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
34_R	June 19	50	29.56	.29	-.06	1185.5	-.504	.3071	144.20	250.91	-5.44	1023.5	-1.562	.0592	1.77	.003	-.02	1005.5	-1.686	.0459
34_1	" "	50	29.62	.40					149.64	315.57					1.79	.003				
35_R	June 20	40	28.72	1.08	-.30	739.5	-.604	.2729	153.38	357.68	-6.72	735.5	-.621	.2673	1.86	.006	0	743.5	-.544	.2932
35_1	" "	40	29.02	2.08					160.10	1018.32					1.86	.004				
36_R	June 24	50	28.98	1.49	.52	885.0	-2.604	.0046	126.24	328.69	-2.40	1239.0	-.076	.4697	1.73	.003	-.04	809.5	-3.037	.0012
36_1	" "	50	28.46	1.64					128.64	743.51					1.77	.006				
37_R	June 26	50	28.54	1.27	-.36	1018.0	-1.655	.0490	119.06	657.41	8.06	1101.0	-1.028	.1520	1.72	.014	.06	835.5	-2.858	.0021
37_1	" "	50	28.90	1.52					111.00	211.31					1.66	.003				
38_R	June 28	50	29.02	1.12	-.32	1026.5	-1.600	.0548	119.40	237.11	1.02	1176.5	-.507	.3060	1.69	.003	.02	911.5	-2.334	.0098
38_1	" "	50	29.34	1.62					118.38	139.88					1.67	.002				
ε_R	June 28	1890	29.40	1.53	.43	454.0[b]	-2.784	.0020	154.75	500.79	16.28	228.0[b]	-5.132	0	1.82	.005	.04	255.5[b]	-4.846	0
ε_1	" "	1890	28.97	2.07					138.47	599.73					1.78	.004				
				F=1.35[c]				<.01		F=1.20[c]				<.01		F=1.25[c]				<.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 38$.

[c] Test on homogeneity of variances.

APPENDIX TABLE VII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1970.

Sample	Date		N	Mean Length(mm)	S^2	Δi(mm)	U	Z	P	Mean Weight(mg)	S^2	Δi(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta i(K_D)$	U	Z	P
1_R [a]	Apr.	29	50	28.96	.86	.98	622.0	-4.504	0	143.68	236.85	1.86	1138.5	-.769	.2209	1.81	.002	-.05	618.5	-4.354	0
1_1	"	"	50	27.98	1.12					141.82	359.92					1.86	.005				
2_R	May	1	49	30.02	1.15	2.34	142	-7.741	0	153.31	447.75	27.23	401.0	-5.770	0	1.78	.003	-.03	829.5	-2.768	.0028
2_1	"	"	50	27.68	1.45					126.08	297.11					1.81	.003				
3_R	May	3	50	29.94	.92	1.26	439.5	-5.846	0	156.92	354.35	25.96	352.0	-6.200	0	1.80	.002	.03	757.5	-3.397	.0003
3_1	"	"	50	28.68	1.12					130.96	245.85					1.77	.002				
4_R	May	4	50	29.66	1.45	.62	843.5	-2.920	.0018	139.10	457.70	8.58	938.0	-2.153	.0157	1.74	.002	0	1244.0	-.041	.4836
4_1	"	"	50	29.04	1.47					130.52	330.84					1.74	.002				
5_R	May	5	50	29.32	2.02	.98	783.5	-3.278	.0005	141.16	383.25	8.58	948.0	-2.084	.0186	1.77	.002	-.03	976.5	-1.886	.0297
5_1	"	"	50	28.34	2.11					132.58	357.49					1.80	.004				
6_R	May	6	50	30.14	1.39	1.40	559.5	-4.871	0	146.98	424.24	14.90	691.5	-3.852	.0001	1.75	.003	-.02	973.0	-1.910	.0281
6_1	"	"	50	28.74	1.71					132.08	307.15					1.77	.003				
7_R	May	7	50	29.74	1.05	1.12	693.5	-3.999	0	138.16	291.46	9.88	869.0	-2.628	.0043	1.74	.002	-.02	906.0	-2.372	.0089
7_1	"	"	50	28.62	1.91					128.28	296.79					1.76	.003				
8_R	May	8	50	29.70	1.32	.96	769.5	-3.425	.0003	138.92	380.00	9.52	894.0	-2.455	.0070	1.74	.001	-.02	996.0	-1.751	.0400
8_1	"	"	50	28.74	1.67					129.40	270.01					1.76	.004				
9_R	May	9	50	29.76	1.33	.92	800.5	-3.176	.0007	141.44	299.33	14.18	741.5	-3.507	.0002	1.75	.001	.01	1082.0	-1.158	.1238
9_1	"	"	50	28.84	2.38					127.26	454.41					1.74	.004				
10_R	May	11	50	29.72	.98	.90	710.5	-3.845	0	144.28	339.44	17.72	605.5	-4.446	0	1.76	.002	.02	894.0	-2.455	.0070
10_1	"	"	50	28.82	1.54					126.56	267.65					1.74	.003				
11_R	May	12	50	29.98	1.16	1.02	724.0	-3.762	.0001	143.22	340.43	13.02	735.0	-3.552	.0002	1.74	.003	-.01	1194.5	-.383	.3509
11_1	"	"	50	28.96	2.08					130.20	442.42					1.75	.003				
12_R	May	13	50	29.66	1.29	.50	953.0	-2.153	.0157	137.76	310.28	10.00	838.5	-2.841	.0023	1.74	.002	.02	967.5	-1.948	.0257
12_1	"	"	50	29.16	1.16					127.76	319.63					1.72	.003				
13_R	May	14	50	29.62	2.08	.72	860.0	-2.753	.0030	137.86	511.69	10.32	879.0	-2.559	.0052	1.74	.002	0	1085.0	-1.138	.1271
13_1	"	"	50	28.90	2.05					127.54	393.49					1.74	.009				
14_R	May	15	50	29.58	1.39	.66	857.5	-2.808	.0025	138.24	483.63	17.00	664.0	-4.042	0	1.74	.002	.03	730.0	-3.585	.0002
14_1	"	"	50	28.92	1.14					121.24	240.28					1.71	.002				
15_R	May	16	50	29.74	1.38	.56	862.0	-2.755	.0030	138.56	341.61	13.78	689.5	-3.866	0	1.74	.001	.03	852.0	-2.744	.0031
15_1	"	"	50	29.18	1.74					124.78	397.66					1.71	.002				
16_R	May	18	50	30.08	1.22	1.20	644.0	-4.330	0	143.16	413.17	17.64	658.0	-4.082	0	1.73	.001	0	1158.0	-.634	.2630
16_1	"	"	50	28.88	2.15					125.52	416.35					1.73	.003				
17_R	May	19	50	30.12	1.21	.94	694.5	-3.981	0	142.54	361.29	15.94	647.0	-4.160	0	1.73	.002	.01	976.0	-1.889	.0295
17_1	"	"	50	29.18	1.29					126.60	289.56					1.72	.003				

Appendix Table VII (cont.)

Sample	Date	N	Mean Length (mm)	S^2	Δi (mm)	U	Z	P	Mean Weight (mg)	S^2	Δi (mg)	U	Z	P	Mean Index (K_D)	S^2	$\Delta_i(K_D)$	U	Z	P
18_R	May 20	50	29.60	1.51	.48	1005.5	-1.734	.0414	134.74	461.60	7.08	1023.5	-1.562	.0592	1.73	.002	.01	1099.5	-1.038	.1497
18_1	" "	50	29.12	1.86					127.66	516.53					1.72	.005				
19_R	May 21	50	29.76	1.86	1.28	601.0	-4.606	0	136.86	484.38	20.80	555.5	-4.789	0	1.73	.002	.02	988.5	-1.803	.0357
19_1	" "	50	28.48	2.66					116.06	407.74					1.71	.003				
20_R	May 22	50	30.06	1.32	.68	862.5	-2.811	.0025	140.90	430.96	14.14	740.0	-3.517	.0002	1.73	.002	.02	897.5	-2.431	.0075
20_1	" "	50	29.38	1.14					126.76	302.03					1.71	.002				
21_R	May 23	50	30.26	1.95	1.20	636.0	-4.334	0	148.62	570.84	24.68	500.5	-5.169	0	1.74	.002	.03	723.0	-3.634	.0002
21_1	" "	50	29.06	1.85					123.94	395.58					1.71	.002				
22_R	May 25	50	30.32	1.61	1.16	606.5	-4.557	0	146.00	496.94	21.24	601.5	-4.473	0	1.73	.001	.02	868.0	-2.634	.0042
22_1	" "	50	29.16	1.73					124.76	508.28					1.71	.003				
23_R	May 26	50	30.16	1.20	1.08	623.0	-4.512	0	144.42	412.22	19.70	563.5	-4.734	0	1.74	.002	.03	922.5	-2.258	.0119
23_1	" "	50	29.08	1.22					124.72	334.01					1.71	.002				
24_R	May 27	50	30.32	1.04	.94	725.5	-3.761	.0001	146.64	586.75	18.58	689.0	-3.869	0	1.73	.002	.02	950.5	-2.065	.0194
24_1	" "	50	29.38	1.51					128.06	371.21					1.71	.002				
25_R	May 28	50	30.18	1.25	1.18	684.5	-3.983	0	143.00	414.16	18.22	676.0	-3.960	0	1.73	.002	.02	1045.5	-1.410	.0793
25_1	" "	50	29.00	2.33					124.78	633.45					1.71	.003				
26_R	May 29	50	30.00	1.63	.94	701.5	-3.884	0	148.16	558.94	19.36	636.5	-4.230	0	1.76	.002	.03	769.0	-3.316	.0005
26_1	" "	50	29.06	1.53					128.80	570.34					1.73	.007				
27_R	May 30	50	30.44	2.05	1.14	763.0	-3.435	.0003	148.36	616.47	22.18	629.5	-4.279	0	1.73	.001	.02	781.0	-3.234	.0006
27_1	" "	50	29.30	2.38					126.18	504.28					1.71	.002				
28_R	June 1	50	29.74	1.63	.20	1182.0	-.486	.3135	133.90	608.59	5.46	1087.0	-1.124	.1305	1.71	.003	.01	1056.0	-1.338	.0904
28_1	" "	50	29.54	1.97					128.44	508.51					1.70	.002				
29_R	June 2	50	30.20	2.16	.26	1145.0	-.752	.2260	140.62	712.13	1.16	1183.0	-.462	.3221	1.71	.002	-.01	1129.5	-.831	.2030
29_1	" "	50	29.94	1.81					139.46	863.98					1.72	.003				
ϵ_R		1449	29.89	1.50	.95	32^b	-6.042	0	142.67	455.85	14.78	24^b	-6.166	0	1.74	.002	0	301^b	-1.858	.0316
ϵ_1		1450	28.94	1.89					127.89	413.74					1.74	.005				
				$F = 1.26^c$				<.01		$F = 1.10^c$				<.01		$F = 2.50^c$				<.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in samples; S^2, variance of the mean; Δi, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 29$.

[c] Test on homogeneity of variances.

APPENDIX TABLE VIII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1971.

Sample	Date	N	Mean Length(mm)	s^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	s^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	s^2	$\Delta_{i(K_D)}$	U	Z	P
1_R [a]	Apr. 24	50	28.92	1.59	.06	1249.5	-.004	.499	140.10	324.88	-4.82	1048.5	-1.390	.0823	1.79	.004	-.03	1022.5	-1.569	.0585
1_1	" "	50	28.86	1.55					144.92	319.69					1.82	.004				
2_R	Apr. 26	50	29.72	1.51	.94	738.0	-3.641	.002	154.02	241.43	15.00	584.5	-4.591	0	1.80	.005	0	1126.0	-.855	.1963
2_1	" "	50	28.78	1.36					139.02	292.77					1.80	.005				
3_R	Apr. 28	50	28.64	1.91	-.20	1134.0	-.826	.2044	146.72	297.20	8.54	881.5	-2.542	.0055	1.84	.005	.05	737.0	-3.537	.0002
3_1	" "	50	28.84	1.48					138.18	192.98					1.79	.004				
4_R	Apr. 30	50	29.22	2.18	.70	869.0	-2.701	.0035	153.32	310.41	14.96	617.5	-4.363	0	1.83	.003	.02	1042.0	-1.434	.0758
4_1	" "	50	28.52	1.64					138.36	266.41					1.81	.004				
5_R	May 3	50	29.98	1.16	1.44	462.0	-5.608	0	152.18	305.33	18.84	434.0	-5.627	0	1.78	.007	-.01	1244.0	-.041	.4836
5_1	" "	50	28.54	1.36					133.34	179.67					1.79	.004				
6_R	May 5	50	30.38	1.30	.96	775.5	-3.415	.0003	156.76	381.06	4.44	1138.5	-.769	.2209	1.77	.010	-.04	1170.0	-.552	.2905
6_1	" "	50	29.42	1.84					152.32	667.59					1.81	.007				
7_R	May 7	50	29.70	.91	.58	919.5	-2.389	.0084	152.76	361.71	8.90	952.0	-2.056	.0199	1.80	.003	0	1238.0	-.083	.4669
7_1	" "	50	29.12	1.29					143.86	382.42					1.80	.004				
8_R	May 10	50	30.02	.59	1.64	249.5	-7.136	0	159.10	306.24	26.16	362.5	-6.121	0	1.80	.003	.01	1165.0	-.586	.2888
8_1	" "	50	28.38	.89					132.92	306.97					1.79	.003				
9_R	May 12	50	30.24	1.08	.78	753.5	-3.602	.0002	156.88	374.00	10.30	800.5	-3.101	.0010	1.78	.002	-.01	1172.0	-.538	.2953
9_1	" "	50	29.46	.87					146.58	256.02					1.79	.005				
10_R	May 14	50	29.46	1.15	.94	696.5	-3.984	0	146.60	258.06	12.36	602.5	-4.467	0	1.79	.003	0	1241.0	-.062	.4753
10_1	" "	50	28.52	1.60					134.24	269.99					1.79	.006				
11_R	May 17	50	30.00	.78	.78	717.5	-3.953	0	149.70	242.61	17.22	525.0	-5.002	0	1.77	.002	.03	920.5	-2.272	.0115
11_1	" "	50	29.22	.87					132.48	202.51					1.74	.002				
12_R	May 19	50	29.90	1.44	.70	903.0	-2.501	.0062	150.56	533.86	16.60	732.0	-3.572	.0002	1.77	.003	.02	912.0	-2.330	.0099
12_1	" "	50	29.20	1.14					133.96	309.73					1.75	.004				
13_R	May 21	50	30.30	1.19	.50	978.0	-2.018	.0218	158.44	343.35	16.14	645.5	-4.172	0	1.78	.002	.03	674.0	-3.973	0
13_1	" "	50	29.80	1.06					142.30	311.49					1.75	.002				
14_R	May 24	50	30.30	.83	.64	843.5	-3.050	.0011	156.86	281.57	19.30	577.0	-4.642	0	1.78	.003	.04	763.5	-3.355	.0004
14_1	" "	50	29.66	1.25					137.56	401.85					1.74	.003				
15_R	May 26	50	30.16	1.16	.32	1042.0	-1.531	.0629	145.62	319.53	12.62	735.5	-3.549	.0002	1.74	.004	.03	854.0	-2.730	.0032
15_1	" "	50	29.84	.91					133.00	289.71					1.71	.003				
16_R	May 28	50	29.96	1.26	.32	1076.5	-1.285	.0984	146.88	496.24	7.40	985.5	-1.825	.0339	1.76	.003	.01	1061.0	-1.304	.0964
16_1	" "	50	29.64	1.42					139.48	381.04					1.75	.003				

Appendix Table VIII (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
17_R	May 31	50	29.98	1.29	-.16	1206.0	-.326	.3722	139.46	480.80	-1.58	1180.5	-.479	.3160	1.72	.003	0	1138.5	-.769	.2209
17_1	" "	50	30.14	2.00					141.04	1216.05					1.72	.003				
18_R	June 2	50	30.04	1.22	.20	1146.0	-.767	.2215	142.28	396.30	5.48	1067.5	-1.259	.1041	1.73	.004	.01	1186.0	-.441	.3296
18_1	" "	50	29.84	1.16					136.80	495.44					1.72	.005				
19_R	June 4	50	30.02	1.08	-.32	1089.0	-1.168	.1212	150.28	526.55	-5.42	1213.0	-.255	.3983	1.77	.004	.01	1237.5	-.086	.4657
19_1	" "	50	30.34	1.78					155.70	1244.57					1.76	.006				
ε_R		950	29.84	1.43	.57	74[b]		<.001	150.45	383.66	10.66	41[b]		<.001	1.78	.005	.01	165.5[b]		>.05
ε_R		950	29.27	1.65					139.79	453.16					1.77	.005				
			F = 1.15[c]					<.01		F = 1.18[c]				<.01	F = 1.00[c]					>.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in samples; S^2, variance of the mean; Δ_i, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 19$.

[c] Test on homogeneity of variances.

APPENDIX TABLE IX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1972.

Sample	Date	N	Mean Length(mm)	S^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i(mg)	U	Z	P	Mean index(K_D)	S^2	$\Delta_i(K_D)$	U	Z	P
1_R [a]	May 2	50	28.94	2.02	.54	1019.0	-1.632	.0515	148.28	372.47	14.18	905.0	-2.379	.0087	1.83	.004	.04	899.0	-2.420	.0078
1_1	" "	50	28.40	2.45					134.10	745.61					1.79	.005				
2_R	May 4	50	28.76	3.29	.52	902.0	-2.452	.0070	149.56	356.31	4.64	1094.0	-1.076	.1410	1.85	.011	-.01	1017.5	-1.603	.0545
2_1	" "	50	28.24	1.08					144.92	368.39					1.86	.005				
3_R	May 6	50	28.48	2.87	.44	1092.0	-1.108	.1339	147.20	328.67	7.18	1016.0	-1.614	.0533	1.85	.006	0	1216.0	-.234	.4075
3_1	" "	50	28.04	2.53					140.02	337.58					1.85	.005				
4_R	May 9	50	29.22	2.42	.86	867.0	-2.718	.0033	150.22	421.67	-2.54	1198.0	-.359	.3598	1.82	.004	-.06	677.5	-3.947	0
4_1	" "	50	28.36	1.17					152.76	559.92					1.88	.006				
5_R	May 12	50	29.76	1.66	.76	918.5	-2.350	.0094	152.30	312.45	-3.64	1126.0	-.855	.1963	1.79	.002	-.06	639.0	-4.212	0
5_1	" "	50	29.00	1.96					155.94	627.27					1.85	.007				
6_R	May 15	50	29.98	1.53	.62	875.0	-2.660	.0039	147.64	275.65	1.44	1159.0	-.628	.2650	1.76	.002	-.03	770.5	-3.306	.0005
6_1	" "	50	29.36	1.54					146.20	255.69					1.79	.002				
7_R	May 17	50	29.56	.95	.14	1139.5	-.793	.2139	150.54	225.96	3.14	1113.5	-.941	.1733	1.80	.002	0	1091.0	-1.096	.1394
7_1	" "	50	29.42	1.72					147.40	341.82					1.79	.004				
8_R	May 19	50	29.88	.97	.34	1082.0	-1.202	.1147	165.26	284.88	9.94	916.0	-2.303	.0106	1.83	.002	.01	872.5	-2.603	.0043
8_1	" "	50	29.54	1.93					155.32	394.94					1.82	.003				
9_R	May 22	50	29.74	1.05	-.06	1246.5	-.025	.4990	151.98	239.35	-1.62	1190.0	-.414	.3394	1.79	.002	-.01	1221.5	-.197	.4219
9_1	" "	50	29.80	1.59					153.60	303.00					1.80	.003				
10_R	May 24	50	29.34	.96	-.16	1128.5	-.877	.1902	153.48	181.59	4.54	1076.5	-1.197	.1156	1.82	.002	.03	769.0	-3.317	.0005
10_1	" "	50	29.50	1.19					148.94	277.88					1.79	.002				
11_R	May 26	50	29.28	.98	-.42	961.5	-2.073	.0208	146.14	261.73	-5.66	1043.0	-1.428	.0767	1.80	.003	-.01	1203.0	-.324	.3730
11_1	" "	50	29.70	1.77					151.80	313.94					1.79	.003				
12_R	May 28	50	29.56	1.35	.0	1237.5	-.091	.4637	146.32	320.49	-7.08	1059.0	-1.317	.0940	1.78	.003	-.03	947.5	-2.086	.0185
12_1	" "	50	29.56	1.31					153.40	535.78					1.81	.005				
13_R	May 30	50	29.42	1.55	-.12	1202.5	-.343	.3658	144.42	427.08	2.62	1127.5	-.845	.1991	1.78	.002	.02	948.5	-2.079	.0188
13_1	" "	50	29.54	1.23					141.80	288.14					1.76	.002				
14_R	June 2	50	29.96	.98	-.14	1089.0	-1.162	.1226	153.36	249.00	6.62	1074.5	-1.211	.1129	1.78	.002	.03	764.5	-3.348	.0004
14_1	" "	50	30.10	1.03					146.74	237.41					1.75	.003				
15_R	June 5	50	29.28	.90	-.48	959.0	-2.141	.0162	142.76	369.55	-6.80	1025.5	-1.549	.0607	1.78	.004	0	1228.0	-.152	.4396
15_1	" "	50	29.76	.84					149.56	359.57					1.78	.002				
16_R	June 7	50	29.60	1.23	-.82	841.0	-2.925	.0017	146.66	334.20	-10.96	972.5	-1.915	.0277	1.78	.002	.01	1108.0	-.979	.1637
16_1	" "	50	30.42	1.96					157.62	1019.49					1.77	.003				

Appendix Table IX (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
ε_R		800	29.42	1.69	.12	119[b]		>.05	149.76	329.35	1.00	125.5[b]		>.05	1.80	.004	-.01	124[b]		>.05
ε_1		800	29.30	2.01					148.76	465.26					1.81	.005				
				$F = 1.19$[c]				<.01		$F = 1.41$[c]				<.01		$F = 1.25$[c]				<.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in sample; S^2 variance of the mean; Δ_1, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE X: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1973.

Sample	Date	N	Mean Length(mm)	s^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	s^2	Δ_i(mg)	U	Z	P	Mean Index(K_D)	s^2	$\Delta_i(K_D)$	U	Z	P
1_R [a]	May 1	50	28.72	3.10	.26	1076.	-1.227	.1098	142.86	392.26	-13.10	868.0	-2.634	.0042	1.82	.006	-.06	583.0	-4.598	0
1_1	" "	50	28.46	1.68					155.96	807.65					1.88	.007				
2_R	May 3	50	27.58	6.74	-1.20	881.5	-2.567	.0051	148.70	364.53	-3.20	1124.0	-0.869	.1925	1.93	.019	.08	838.0	-2.840	.0023
2_1	" "	50	28.78	1.73					151.90	347.51					1.85	.005				
3_R	May 5	50	28.24	2.51	-.64	964.0	-2.021	.0216	149.50	263.08	.22	1223.5	-.183	.4274	1.88	.004	.05	841.5	-2.816	.0024
3_1	" "	50	28.88	1.25					149.28	355.90					1.83	.006				
4_R	May 7	50	29.00	1.96	0	1227.0	-.164	.4348	144.70	248.10	-13.18	780.5	-3.239	.0006	1.81	.005	-.05	853.0	-2.737	.0031
4_1	" "	50	29.00	1.80					157.88	729.96					1.86	.009				
5_R	May 9	50	28.98	.96	0	1248.0	-.011	.4956	155.66	252.57	-4.18	1099.5	-1.038	.1569	1.85	.005	-.02	1033.5	-1.493	.0677
5_1	" "	50	28.98	1.86					159.84	458.65					1.87	.005				
6_R	May 12	50	29.34	1.86	.32	1080.5	-1.202	.1147	160.64	541.29	.94	1212.5	-.259	.3978	1.85	.004	-.02	1072.0	-1.227	.1098
6_1	" "	50	29.02	1.37					159.70	596.04					1.87	.007				
7_R	May 15	50	29.40	1.39	.32	1052.0	-1.442	.0747	158.80	267.08	-7.66	1030.0	-1.518	.0645	1.84	.003	-.05	709.0	-3.730	.0001
7_1	" "	50	29.08	1.10					166.46	658.24					1.89	.004				
8_R	May 17	50	29.34	.68	.66	915.5	-2.406	.0081	150.22	170.20	2.14	1110.0	-.966	.1670	1.81	.003	-.03	1097.0	-1.055	.1457
8_1	" "	50	28.68	1.86					148.08	750.35					1.84	.007				
9_R	May 19	50	29.32	1.94	.10	1217.5	-.230	.4090	152.20	341.45	7.66	969.5	-1.934	.0266	1.82	.005	.03	866.0	-2.648	.0040
9_1	" "	50	29.22	1.69					144.54	474.89					1.79	.002				
10_R	May 22	50	29.30	1.15	-.34	1027.5	-1.615	.0532	151.64	316.27	.74	1244.5	-.038	.4848	1.82	.003	.03	998.0	-1.738	.0412
10_1	" "	50	29.64	1.09					150.90	534.04					1.79	.007				
11_R	May 24	50	29.12	1.21	-.28	1064.0	-1.329	.0920	158.22	279.43	8.94	938.0	-2.153	.0157	1.86	.004	.06	645.5	-4.168	0
11_1	" "	50	29.40	1.06					149.28	423.00					1.80	.005				
12_R	May 26	50	28.98	1.57	-.64	927.5	-2.301	.0107	152.22	384.98	1.92	1184.0	-.455	.3246	1.84	.003	.05	690.0	-3.861	0
12_1	" "	50	29.62	1.67					150.30	409.80					1.79	.005				
13_R	May 29	50	29.64	1.21	-.40	1030.0	-1.602	.0546	159.92	351.37	8.12	908.5	-2.355	.0092	1.83	.003	.06	493.0	-5.220	0
13_1	" "	50	30.04	1.47					151.80	505.82					1.77	.002				
14_R	May 31	50	29.66	.96	-.30	1041.5	-1.500	.0668	157.04	321.73	1.56	1167.5	-.569	.2846	1.82	.003	.03	875.5	-2.582	.0049
14_1	" "	50	29.96	1.39					155.48	393.18					1.79	.003				
15_R	June 2	50	29.78	1.20	-.32	1085.5	-1.178	.1194	168.04	315.73	.42	1245.0	-.034	.4864	1.85	.002	.02	844.5	-2.796	.0026
15_1	" "	50	30.10	1.52					167.62	461.37					1.83	.002				
16_R	June 5	47	29.40	3.33	-.34	1100.0	-.561	.2874	157.64	866.09	-4.02	1090.5	-.610	.2709	1.83	.002	0	1149.5	-.184	.4270
16_1	" "	50	29.74	.97					161.66	303.88					1.83	.003				

Appendix Table X (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
ϵ_R		797	29.11	2.24	-.18	116[b]		>.05	154.24	385.02	-.80	126[b]		>.05	1.84	.006	.01	112.5[b]		>.05
ϵ_1		800	29.29	1.69					155.04	545.00					1.83	.006				
				$F = 1.33$[c]				<.01		$F = 1.42$[c]				<.01		$F = 1.00$[c]				>.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1974.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 2	50	29.66	1.74	.60	909.5	-2.437	.0073	149.08	442.51	-3.28	1112.5	-.949	.1704	1.78	.004	-.06	615.0	-4.378	0
1_1	" "	50	29.06	1.20					152.36	309.86					1.84	.003				
2_R	May 17	50	29.84	1.77	.58	961.0	-2.047	.0203	154.20	437.94	2.36	1141.0	-.752	.2260	1.79	.004	-.03	933.5	-2.182	.0145
2_1	" "	50	29.26	1.63					151.84	291.10					1.82	.004				
3_R	May 21	50	29.54	1.89	.50	978.5	-1.923	.0272	153.48	378.65	-10.80	862.0	-2.677	.0037	1.81	.006	-.07	540.5	-4.892	0
3_1	" "	50	29.04	1.84					164.28	448.84					1.88	.005				
4_R	May 25	50	30.58	5.47	.06	1144.0	.757	.2245	149.56	509.45	-8.56	952.5	-2.053	.0200	1.74	.033	-.03	606.0	-4.44	0
4_1	" "	50	30.52	1.11					158.12	398.61					1.77	.003				
5_R	May 28	50	30.36	1.62	.86	838.0	-2.916	.0018	157.04	550.92	1.94	1198.0	-.359	.3598	1.77	.004	-.05	701.0	-3.785	.0001
5_1	" "	50	29.50	1.89					155.10	425.43					1.82	.005				
6_R	May 31	50	29.36	0.97	-.36	960.0	-2.065	.0196	150.68	365.18	-1.72	1229.0	-0.145	.4423	1.81	.003	.01	1018.0	-1.600	.0548
6_1	" "	50	29.72	2.70					152.40	483.45					1.80	.009				
7_R	June 4	50	29.66	2.96	-.16	1208.5	-.292	.3851	160.40	893.90	5.12	1120.0	-0.897	.1850	1.83	.004	.03	937.0	-2.158	.0156
7_1	" "	50	29.82	1.54					155.28	410.59					1.80	.002				
8_R	June 7	50	29.64	2.97	-.86	877.0	-2.621	.0044	149.76	865.27	-15.00	782.5	-3.225	.0006	1.78	.004	-.02	1166.5	-.576	.2823
8_1	" "	50	30.50	1.85					164.76	389.06					1.80	.003				
ε_R		400	29.83	2.54	.16	25[b]		>.05	153.02	559.98	-3.64	17[b]		>.05	1.79	.008	-.02	17.5[b]		>.05
ε_1		400	29.67	2.05					156.76	419.17					1.83	.006				
				F = 1.24[c]				<.01		F = 1.34[c]				<.01		F = 1.33[c]				<.01

[a] R, river samples; 1, spawning channel No. 1 samples; N, number of fry in sample; S^2 variance of the mean; Δ_1, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 8$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1975.

Sample	Date	n	Mean length(mm)	S^2	Δ_1(mm)	U	z	P	Mean weight(mg)	S^2	Δ_1(mg)	U	z	P	Mean index(K_D)	S^2	Δ_1(K_D)	U	z	P
1_R [a]	Apr 29	50	30.06	1.98	1.14	724.0	-3.705	0	157.10	497.92	12.40	843.0	-2.808	.0025	1.79	.002	-.02	1038.5	-1.458	.0724
1_1	Apr 30	50	28.92	1.95					144.70	404.84					1.81	.007				
2_R	May 2	50	30.34	3.66	2.02	450.5	-5.632	0	149.06	414.08	16.30	739.5	-3.521	.0002	1.75	.007	-.05	816.0	-2.992	.0014
2_1	"	50	28.32	1.98					132.76	416.52					1.80	.005				
3_R	May 5	50	30.46	1.60	2.32	332.5	-6.431	0	150.56	356.35	-22.08	654.0	-4.109	0	1.74	.003	-.23	59.5	-8.207	0
3_1	"	50	28.14	2.61					172.64	802.55					1.97	.010				
4_R	May 7	50	30.24	.84	1.62	445.0	-5.770	0	156.00	241.63	27.02	312.0	-6.470	0	1.78	.002	.02	1013.0	-1.634	.0512
4_1	"	50	28.62	1.91					129.98	331.01					1.76	.003				
5_R	May 12	48	29.13	1.22	.21	1126.5	- .536	.2960	142.81	312.16	- 2.83	1113.0	- .619	.2677	1.79	.003	-.03	918.5	-2.001	.0227
5_1	"	50	28.92	2.89					145.64	423.90					1.82	.004				
6_R	May 15	50	29.76	1.25	.64	844.5	-2.927	.0017	140.74	266.45	- 3.44	1117.5	- .914	.1801	1.75	.003	-.05	622.0	-4.330	0
6_1	"	50	29.12	1.25					144.18	382.41					1.80	.004				
7_R	May 19	50	29.68	1.45	.10	1187.0	- .445	.3283	129.70	403.90	-17.26	773.5	-3.286	.0005	1.70	.004	-.08	445.0	-5.549	0
7_1	"	50	29.58	2.33					146.96	515.24					1.78	.004				
8_R	May 24	50	30.26	2.52	.68	963.0	-2.010	.0222	157.82	609.61	21.34	670.5	-3.996	0	1.78	.004	.05	650.0	-4.136	0
8_1	"	50	29.58	2.49					136.48	602.67					1.73	.002				
9_R	May 29	50	29.98	2.22	.10	1185.5	- .454	.3255	152.92	616.71	- .56	1245.0	- .035	.4860	1.78	.003	-.01	1187.0	- .434	.3327
9_1	"	50	29.88	2.07					153.45	508.20					1.79	.004				
Σ_R		448	29.99	1.98	.81	5.0[b]	0<p	<.001	148.55	482.98	.55	30.0[b]		>.05	1.76	.005	-.05	27.5[b]		>.05
Σ_1		500	29.18	2.72					147.97	778.92					1.81	.008				
				F=1.37[c]				<.01		F=1.61[c]				<.01		F=1.60[c]				<.01

[a]R, river sample; 1, channel No.1 sample; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter ($R-CH_1$); U, z, P, statistics of the Mann-Whitney test.

[b]Test on sample means, $n_1 = n_2 = 9$.

[c]Test on homogeneity of variances.

APPENDIX TABLE XIII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 1 in 1976.

Sample	Date	N	Mean Length (mm)	S^2	Δi (mm)	U	Z	P	Mean Weight (mg)	S^2	Δi (mg)	U	Z	P	Index(K_D)	S^2	Δi (K_D)	U	Z	P
1_R[a]	April 30	50	30.20	9.34	2.22	312.0	-6.630	0	155.24	356.08	26.06	365.0	-6.104	0	1.79	.010	-.01	1102.5	-1.017	.1523
1_1	" 23	50	27.98	1.12					129.18	254.00					1.80	.004				
2_R	May 4	50	29.26	1.42	.86	822.5	-3.013	.0012	157.44	384.04	17.98	572.5	-4.672	0	1.84	.005	.01	1075.5	-1.203	.1145
2_1	" "	50	28.40	3.02					139.46	181.16					1.83	.010				
3_R	May 7	50	29.18	1.38	.56	922.0	-2.326	.0100	164.92	369.69	13.04	821.0	-2.961	.0015	1.86	.006	-.02	1121.5	- .886	.1878
3_1	" 11	50	28.62	2.20					151.88	339.18					1.88	.006				
4_R	May 14	48	28.90	1.33	-.32	998.5	-1.480	.0694	169.25	365.21	34.67	202.5	-7.092	0	1.91	.007	.16	131.5	-7.594	0
4_1	" "	50	29.22	1.60					134.58	289.85					1.75	.003				
5_R	May 17	49	29.37	1.07	-.01	1141.0	-.621	.2673	145.39	329.51	11.99	721.0	-3.529	.0002	1.79	.003	.05	701.0	-3.668	.0001
5_1	" "	50	29.38	.81					133.40	185.68					1.74	.004				
6_R	May 21	50	28.88	.97	.65	751.0	-2.750	.0030	145.00	246.73	9.86	783.0	-2.405	.0081	1.82	.004	0	1053.0	-.356	.3609
6_1	" "	44	28.23	2.27					135.14	333.30					1.82	.007				
7_R	May 25	50	29.42	1.02	.40	995.0	-1.835	.0332	150.40	300.92	14.32	680.0	-3.934	.0001	1.80	.002	.03	726.5	-3.610	.0002
7_1	" "	50	29.02	.96					136.08	238.21					1.77	.002				
8_R	June 1	50	28.94	1.49	-.82	855.5	-2.829	.0023	152.16	367.02	6.96	954.0	-2.044	.0205	1.84	.005	.07	456.0	-5.475	0
8_1	" "	50	29.76	2.35					145.20	318.39					1.77	.005				
Σ_R		397	29.27	2.38	.45	20[b]		.1170	154.93	399.32	16.86	4[b]		.0010	1.83	.007	-.04	17[b]		.0650
Σ_1		394	28.8	1.97					139.11	360.54					1.79	.006				
			F = 1.21[c]					<.01	F = 1.11[c]					<.01	F = 1.17[c]					<.01

[a] R, river samples; 1, spawning channel no. 1 samples; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (R-1); U, Z, P, statistics of the Mann-Whitney test.

[b] $n_1 = n_2 = 8$.

[c] Test on homogeneity of variance.

APPENDIX TABLE XIV: Calculation process for enumeration of nightly fry production from Spawning Channel No. 1

Date - June 2-3, 1972
Start - 22:20 hours

	Hour Period		Trap No. 1	2	3	4	5
	00:00						
	00:10						
	22:20		0	0	2	5	1
	22:30		5	5	3	3	4
	22:40		10	7	5	9	4
	22:50		21	21	13	11	18
	23:00		48	40	61	41	36
	23:10		156	185	202	123	106
	23:20		80	80	90	50	122
	23:30		140	160	130	80	235
	23:40		165	205	185	105	65
	23:50		185	290	255	150	90
TIME CHECK PERIOD	24:00	Volume Sampling	195	380	300	185	100
	00:10		220	310	300	145	90
	00:20		180	295	240	130	65
	00:30		155	235	200	100	60
	00:40		140	210	175	75	50
	00:50		125	175	140	60	209
	01:00		100	140	115	50	169
	01:10		90	130	105	50	129
	01:20		85	110	80	147	115
	01:30		208	90	70	133	86
	01:40		181	75	60	153	79
	01:50		186	65	50	91	66
	02:00		130	50	164	87	73
	02:10		125	161	179	82	75
	02:20		81	132	148	82	52
	02:30		88	143	114	65	55
	02:40		69	108	92	56	45
	02:50		58	83	76	52	46
	03:00		68	96	74	62	37
	03:10		51	61	63	38	25
	03:20		39	57	53	35	36
	03:30		28	36	31	34	30
	03:40		23	19	20	13	17
	03:50		12	9	16	12	6
	03:60		8	1	2	0	7
	Volume Totals		1,860	3,000	2,495	1,180	520
	Actual Totals		1,595	1,164	1,318	1,334	1,883

	1	2	3	4	5
Volume x 5.11 (mean fry/ml) x 10 min.	95,046	153,300	127,495	60,298	26,572
Actual x 10 min.	15,950	11,640	13,180	13,340	18,830
Grand Totals	110,996	164,940	140,675	73,638	45,402

Nightly Migration = 535,651

Time Check Calculations for 01:20-01:40 Period

$$3135 \text{ ml} \times 51.1 = \frac{160,199}{535,651} \times 100 = 29.9\%$$

APPENDIX TABLE XV: Calculation process for estimating a total nights fry production on reduced sampling nights (time check) from Spawning Channel No. 1

Date - June 4-5, 1972
Start - 23:50 hours

Hour Period	Trap No.				
	1	2	3	4	5
22:20					
23:50					
24:00	100	120	105	60	121
00:10	125	140	120	55	127
00:20	110	125	100	50	97
03:40					
Volume Totals	335	385	325	165	
Actual Totals					345

Volume Count	= 5.11 fry/ml x 10 min x 1210 ml/min	=	61,831
Actual Count	= 345 fry/min x 10 min	=	3,450
	GRAND TOTAL		65,281

Estimated Catch in Index Period x
Time Check Calculations (01:20-01:40)
or

$$65,281 \times \frac{100}{29.9} =$$

Estimated Migration for Whole Night 218,331 fry

APPENDIX TABLE XVI: Calculation process for fry migration from Spawning Channel No. 2 based on standard index sampling.

Date - June 8-9, 1972 Channel Gauge = 4.20 ft.

Fishing Time	Bay No. 1			Bay No. 2		
	1	2	3	4	5	6
22:30-22:35		0			0	
23:00-23:05		34			0	
23:30-23:35		298			44	
00:00-00:05		473			104	
00:30-00:35		877			71	
01:00-01:05		522			62	
01:30-01:35		173			26	
02:00-02:05		84			21	
02:30-02:35		57			5	
		2518			333	

Step

1. Estimated catch if trap 2 fished full index period
   6 x 2518 = 15,108

2. Estimated catch if trap 2 fished full 24 hour period using June 5-6 time check $\frac{100}{98.90}$ x 15,108
   = 15,276

3. Estimated catch if all traps fished full 24 hour period using June 6-7 area check $\frac{100}{30.85}$ x 15,276
   = 49,517

4. Estimated catch for entire width of Bay No. 1:
   7.74 x 49,517 = 383,261

Step

1. Estimated catch if trap 5 fished full index period
   6 x 2518 = 1998

2. Estimated catch if trap 5 fished full 24 hour period using June 5-6 time check $\frac{100}{98.61}$ x 1,998
   = 2,025

3. Estimated catch if all traps fished full 24 hour period using June 6-7 area check $\frac{100}{30.77}$ x 2,025
   = 6,581

4. Estimated catch for entire width of Bay No. 2:
   7.22 x 6581 = 47,515

Total nightly estimate $A^4 + B^4$ = 430,776

APPENDIX TABLE XVII: Calculation process for fry migration from Spawning Channel No. 2 based on time check sampling.

Date - June 5-6, 1972 Channel Gauge = 4.04 ft.

Fishing Time	Bay No. 1			Bay No. 2		
	1	2	3	4	5	6
22:00-22:05		0			0	
22:30-22:35		0			0	
23:00-23:05		19			14	
23:30-23:35		290			113	
00:00-00:05		795			397	
00:30-00:35		1118			522	
01:00-01:05		1390			967	
01:30-01:35		845			497	
02:00-02:05		447			249	
02:30-02:35		149			149	
03:00-03:05		49			28	
03:30-03:35		6			10	
04:00-04:05		1			3	
04:30-04:35		0			0	
		5109			2949	

Bay No. 1

Index Trap-Area Check =

= x 100 = %

Index Period-Time Check =

$$= \frac{5053}{5109} \times 100 = 98.90\%$$

Bay No. 2

Index Trap-Area Check =

= x 100 = %

Index Period-Time Check =

$$= \frac{2908}{2949} \times 100 = 98.61\%$$

Step

1. $6 \times 5053 = 30,318$
2. $\frac{100}{98.90} \times 30,318 = 30,655$
3. $\frac{100}{28.33} \times 30,655 = 108,207$
4. $7.74 \times 108,207 =$ nightly estimate of 837,522

Step

1. $6 \times 2908 = 17,448$
2. $\frac{100}{98.61} \times 17,448 = 17,694$
3. $\frac{100}{32.17} \times 17,694 = 55,002$
4. $7.22 \times 55,002 =$ nightly estimate of 397,114

Total nightly estimate $A^4 + B^4 = 1,234,636$

APPENDIX TABLE XVIII: Calculation process for fry migration from Spawning Channel No. 2 based on area check sampling.

Date - June 6-7, 1972 Channel Gauge = 4.02 ft.

Fishing Time	Bay No. 1			Bay No. 2		
	1	2	3	4	5	6
22:30-22:35		1			1	
23:00-23:05		35			8	
23:30-23:35		319			133	
00:00-00:05		1105			448	
00:30-00:35		1080			495	
01:00-01:05	1080	810	737	835	540	344
01:30-01:35	540	393	344	393	246	172
02:00-02:05	193	151	141	162	101	90
02:30-02:35		98			50	
	1813	3992	1222	1390	2023	606

Bay No. 1

Index Trap-Area Check =

$A_1 = \frac{1354}{4389} \times 100 = 30.85\%$

Bay No. 2

Index Trap-Area Check =

$A_2 = \frac{887}{2883} \times 100 = 30.77\%$

Step

1. $6 \times 3{,}992 = 23{,}952$
2. $\frac{100}{98.90} \times 23{,}952 = 24{,}218$
3. $\frac{100}{30.85} \times 24{,}218 = 78{,}502$
4. $7.74 \times 78{,}502$ = nightly estimate of 607,605

Step

1. $6 \times 2{,}023 = 12{,}138$
2. $\frac{100}{98.61} \times 12{,}138 = 12{,}309$
3. $\frac{100}{30.77} \times 12{,}309 = 40{,}003$
4. $7.22 \times 40{,}003$ = nightly estimate of 288,821

Total nightly estimate $A^4 + B^4 = 896{,}426$

APPENDIX TABLE XIX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1970.

Sample	Date	N	Mean Length (mm)	S^2	Δ_1(mm)	U	Z	P	Mean Weight (mg)	S^2	Δ_1(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta_1(K_D)$	U	Z	P
1_1[a]	Apr. 29	50	27.98	1.12	-1.54	369.0	-6.245	0	141.82	359.92	-7.44	906.5	-2.370	.0089	1.86	.005	.06	596.5	-4.506	0
1_2	" "	50	29.52	.83					149.26	223.94					1.80	.004				
2_1	May 1	50	27.68	1.45	-2.32	99.0	-8.112	0	126.08	297.11	-31.66	232.0	-7.021	0	1.81	.003	.01	1109.0	-.972	.1655
2_2	" "	50	30.00	.86					157.74	302.10					1.80	.002				
3_1	May 3	50	28.68	1.12	-1.72	207.5	-7.472	0	130.96	245.85	-25.48	298.5	-6.574	0	1.77	.002	0	1142.5	-.742	.2290
3_2	" "	50	30.40	.61					156.44	218.90					1.77	.001				
4_1	May 4	50	29.04	1.47	-1.60	361.0	-6.360	0	130.52	330.84	-24.10	398.5	-5.879	0	1.74	.002	-.01	1062.0	-1.297	.0973
4_2	" "	50	30.64	.89					154.62	278.02					1.75	.001				
5_1	May 5	50	28.34	2.11	-2.02	350.0	-6.318	0	132.58	357.49	-21.48	559.0	-4.767	0	1.80	.004	.04	827.0	-2.917	.0008
5_2	" "	50	30.36	1.46					154.06	505.51					1.76	.001				
6_1	May 6	50	28.74	1.71	-1.54	551.0	-4.942	0	132.08	307.15	-15.76	754.5	-3.418	.0003	1.77	.003	.03	875.0	-2.586	.0051
6_2	" "	50	30.28	1.92					147.84	511.14					1.74	.002				
7_1	May 7	50	28.62	1.91	-1.70	464.0	-5.574	0	128.28	296.79	-19.52	544.0	-4.869	0	1.76	.003	.02	1019.0	-1.593	.0556
7_2	" "	50	30.32	1.28					147.80	314.35					1.74	.002				
8_1	May 8	50	28.74	1.67	-1.34	530.0	-5.111	0	129.40	270.01	-16.28	622.5	-4.328	0	1.76	.004	.01	1068.5	-1.251	.1054
8_2	" "	50	30.08	.97					145.68	314.90					1.75	.001				
9_1	May 9	50	28.84	2.38	-3.38	512.0	-5.190	0	127.26	454.41	-20.62	555.0	-4.794	0	1.74	.004	.02	1172.0	-.538	.2953
9_2	" "	50	32.22	165.36					147.88	656.00					1.72	.046				
10_1	May 11	50	28.82	1.54	-1.26	611.0	-4.517	0	126.56	267.65	-19.40	551.0	-4.821	0	1.74	.003	-.01	1067.0	-1.262	.1034
10_2	" "	50	30.08	1.63					145.96	361.16					1.75	.001				
11_1	May 12	50	28.96	2.08	-1.54	496.0	-5.341	0	130.20	442.42	-25.06	469.0	-5.386	0	1.75	.003	-.01	961.5	-1.989	.0234
11_2	" "	50	30.50	1.15					155.26	393.08					1.76	.002				
12_1	May 13	50	29.16	1.16	-1.50	488.5	-5.442	0	127.76	319.63	-25.48	413.0	-5.773	0	1.72	.003	-.02	845.5	-2.789	.0026
12_2	" "	50	30.66	1.58					153.24	362.00					1.74	.001				
13_1	May 14	50	28.90	2.05	-1.76	441.0	-5.698	0	127.54	393.49	-22.22	506.0	-5.131	0	1.74	.009	.01	1210.0	-.276	.3890
13_2	" "	50	30.66	1.37					149.76	404.16					1.73	.001				
14_1	May 15	50	28.92	1.14	-1.76	296.0	-6.746	0	121.24	240.28	-29.52	232.0	-7.021	0	1.71	.002	-.02	833.5	-2.872	.0020
14_2	" "	50	30.68	.96					150.76	296.41					1.73	.002				
15_1	May 16	50	29.18	1.74	-1.08	658.5	-4.208	0	124.78	397.66	-20.82	543.5	-4.873	0	1.71	.002	-.02	831.5	-2.886	.0019
15_2	" "	50	30.26	1.46					145.60	440.75					1.73	.001				
16_1	May 18	50	28.88	2.15	-1.54	507.5	-5.249	0	125.52	416.35	-21.48	551.5	-4.817	0	1.73	.003	0	1196.5	-.369	.3561
16_2	" "	50	30.42	1.27					147.00	376.45					1.73	.001				
17_1	May 19	50	29.18	1.29	-1.26	484.5	-5.529	0	126.60	289.56	-19.24	527.0	-4.987	0	1.72	.003	-.01	1039.5	-1.451	.0734
17_2	" "	50	30.44	.91					145.84	313.63					1.73	.001				

Appendix XIX (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
18_1	May 20	50	29.12	1.86	-1.54	486.0	-5.387	0	127.66	516.53	-21.90	589.5	-4.555	0	1.72	.005	-.01	1144.5	-.727	.2338
18_2	" "	50	30.66	1.09					149.56	431.04					1.73	.002				
19_1	May 21	50	28.48	2.66	-1.88	468.0	-5.493	0	116.06	407.74	-31.60	343.0	-6.254	0	1.71	.003	-.03	776.5	-3.265	.0005
19_2	" "	50	30.36	1.87					147.66	472.49					1.74	.001				
20_1	May 22	50	29.38	1.14	-1.14	621.5	-4.503	0	126.76	302.03	-22.92	481.0	-5.304	0	1.71	.002	-.03	759.5	-3.382	.0004
20_2	" "	50	30.52	1.32					149.68	412.37					1.74	.002				
21_1	May 23	50	29.06	1.85	-1.30	545.5	-4.992	0	123.94	395.58	-20.26	575.5	-4.652	0	1.71	.002	-.01	1017.0	-1.607	.0541
21_2	" "	50	30.36	1.38					144.20	436.71					1.72	.001				
22_1	May 25	50	29.16	1.73	-1.42	512.5	-5.204	0	124.76	508.28	-26.74	442.0	-5.572	0	1.71	.003	-.03	754.0	-3.420	.0003
22_2	" "	50	30.58	1.35					151.50	364.71					1.74	.002				
23_1	May 26	50	29.08	1.22	-1.84	372.0	-6.233	0	124.72	334.01	-33.48	321.5	-6.404	0	1.71	.002	-.03	728.0	-3.599	.0002
23_2	" "	50	30.92	1.99					158.20	795.00					1.74	.002				
24_1	May 27	50	29.38	1.51	-.78	790.5	-3.280	.0005	128.06	371.21	-16.40	723.5	-3.631	.0002	1.71	.002	-.02	935.0	-2.172	.0149
24_2	" "	50	30.16	1.69					144.46	626.88					1.73	.002				
25_1	May 28	50	29.00	2.33	-1.76	468.5	-5.479	0	124.78	633.45	-27.58	472.5	-5.362	0	1.71	.003	-.02	954.5	-2.037	.0208
25_2	" "	50	30.76	1.66					152.36	443.49					1.73	.002				
26_1	May 29	50	29.06	1.53	-.58	854.5	-2.835	.0013	128.80	570.34	-8.42	903.0	-2.394	.0083	1.73	.007	0	1080.5	-1.169	.1212
26_2	" "	50	29.64	1.75					137.22	544.92					1.73	.003				
27_1	May 30	50	29.30	2.38	-1.24	672.5	-4.085	0	126.18	504.28	-23.22	604.5	-4.451	0	1.71	.002	-.02	851.0	-2.751	.0030
27_2	" "	50	30.54	1.72					149.40	677.90					1.73	.002				
28_1	June 1	50	29.54	1.97	-1.18	659.0	-4.178	0	128.44	508.51	-22.28	579.5	-4.625	0	1.70	.002	-.03	830.0	-2.896	.0019
28_2	" "	50	30.72	1.64					150.72	491.24					1.73	.002				
29_1	June 2	50	29.94	1.81	-.46	915.0	-2.425	.0076	139.46	863.98	-4.80	978.5	-1.873	.0305	1.72	.003	0	1238.0	-.083	.4669
29_2	" "	50	30.40	1.10					144.26	392.29					1.72	.002				
ε_1		1450	28.94	1.89	-1.51	3[b]	-6.493	0	127.89	413.74	-21.56	2[b]	-6.509	0	1.74	.005	0	304.5[b]	-1.804	.0356
ε_2		1450	30.45	7.07					149.45	437.22					1.74	.004				
				F = 3.74[c]				<.01		F = 1.06[c]				<.01		F = 1.25[c]				<.01

[a] 1, spawning channel no. 1 sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (1-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 29$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1971.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{l(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{l(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{l(K_D)}$	U	Z	P
1_1 [a]	Apr. 24	50	28.86	1.55	-1.06	699.5	-3.898	0	144.92	319.69	-7.04	983.5	-1.838	.0330	1.82	.004	.04	874.5	-2.589	.0048
1_2	" "	50	29.92	1.34					151.96	250.14					1.78	.003				
2_1	Apr. 26	50	28.78	1.36	-1.22	574.0	-4.816	0	139.02	292.77	-11.32	783.5	-3.218	.0006	1.80	.005	.03	999.0	-1.731	.0417
2_2	" "	50	30.00	1.10					150.34	327.14					1.77	.003				
3_1	Apr. 28	50	28.84	1.48	-.66	933.0	-2.245	.0123	138.18	192.98	-9.30	876.5	-2.576	.0050	1.79	.004	0	1216.5	-.231	.4086
3_2	" "	50	29.50	2.21					147.48	384.61					1.79	.004				
4_1	Apr. 30	50	28.52	1.68	-1.16	677.5	-4.079	0	138.36	266.41	-12.38	750.0	-3.448	.0003	1.81	.004	.02	1005.0	-1.689	.0456
4_2	" "	50	29.68	1.73					150.74	332.43					1.79	.003				
5_1	May 3	50	28.54	1.36	-1.34	553.0	-4.963	0	133.34	179.67	-16.90	655.0	-4.104	0	1.79	.004	.01	1145.0	-.724	.2654
5_2	" "	50	29.88	1.54					150.24	437.14					1.78	.007				
6_1	May 5	50	29.42	1.84	-.52	966.5	-2.044	.0205	152.32	667.59	.22	1216.5	-.231	.4086	1.81	.007	.03	960.5	-1.996	.0230
6_2	" "	50	29.94	1.28					152.10	360.90					1.78	.003				
7_1	May 7	50	29.12	1.29	-.44	1030.5	-1.571	.0581	143.86	382.42	-1.08	1190.0	-.414	.3394	1.80	.004	.03	1000.5	-1.720	.0427
7_2	" "	50	29.56	2.37					144.94	439.43					1.77	.005				
8_1	May 10	50	28.38	.89	-1.18	516.5	-5.250	0	132.92	306.97	-16.66	636.0	-4.235	0	1.79	.003	0	1184.0	-.455	.3246
8_2	" "	50	29.56	1.03					149.60	375.90					1.79	.002				
9_1	May 12	50	29.46	.87	-1.04	577.5	4.857	0	146.58	256.02	-13.40	694.5	-3.832	.0001	1.79	.005	.01	1132.5	-.810	.2090
9_2	" "	50	30.50	.87					159.98	282.08					1.78	.002				
10_1	May 14	50	28.52	1.60	-1.68	354.0	-6.423	0	134.24	269.99	-18.52	514.5	-5.074	0	1.79	.006	.02	1001.5	-1.713.	.0433
10_2	" "	50	30.20	.90					152.76	305.22					1.77	.003				
11_1	May 17	50	29.22	.87	-1.08	537.0	-5.166	0	132.48	202.51	-18.66	471.0	-5.373	0	1.74	.002	-.02	1089.0	-1.110	.1335
11_2	" "	50	30.30	.79					151.14	238.80					1.76	.002				
12_1	May 19	50	29.20	1.14	-1.26	498.5	-5.421	0	133.96	309.73	-20.66	572.0	-4.676	0	1.75	.004	-.01	1082.5	-1.155	.1237
12_2	" "	50	30.46	1.11					154.62	419.86					1.76	.002				
13_1	May 21	50	29.80	1.06	-.70	838.5	-3.031	.0012	142.30	311.49	-5.06	1059.5	-1.315	.0942	1.75	.002	.02	906.0	-2.373	.0088
13_2	" "	50	30.50	1.40					147.36	353.16					1.73	.001				
14_1	May 24	50	29.66	1.25	-.74	822.0	-3.105	.0009	137.56	401.85	-9.04	891.0	-2.476	.0068	1.74	.003	.01	1187.5	-.431	.3332
14_2	" "	50	30.40	1.31					146.60	275.04					1.73	.002				
15_1	May 26	50	29.84	.91	-.58	876.0	-2.720	.0034	133.00	289.71	-13.64	725.0	-3.621	.0002	1.71	.003	-.02	957.5	-2.017	.0218
15_2	" "	50	30.42	1.07					146.64	328.14					1.73	.002				
16_1	May 28	50	29.64	1.42	-.58	943.0	-2.243	.0124	139.48	381.04	.60	1225.0	-.173	.4313	1.75	.003	.04	744.5	-3.486	.0002
16_2	" "	50	30.22	.95					138.88	342.08					1.71	.003				

Appendix XX (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δi(mm)	U	Z	P	Mean Weight(mg)	S^2	Δi(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta i(K_D)$	U	Z	P
19_1	May 31	50	30.14	2.00	-.30	952.5	-2.239	.0125	141.04	1216.05	1.00	1147.5	-.707	.2398	1.72	.003	.02	1159.5	-.624	.2673
19_2	" "	50	30.44	.70					140.04	316.42					1.70	.002				
17_1	June 2	50	29.84	1.16	-.58	873.0	-2.850	.0023	136.80	495.44	-13.38	816.0	-2.987	.0014	1.72	.005	-.02	1048.0	-1.393	.0818
17_2	" "	50	30.42	.70					150.18	362.88					1.74	.003				
18_1	June 4	50	30.34	1.78	-.66	975.0	-2.000	.0228	155.70	1244.57	-13.96	919.5	-2.280	.0113	1.76	.006	-.02	1163.5	-.596	.2756
18_2	" "	50	31.00	2.78					169.66	1636.16					1.78	.005				
Σ1		950	29.27	1.65	-.88	37[b]		<.001	139.79	453.16	-10.48	45[b]		<.001	1.77	.005	.01	137[b]		>.05
Σ2		950	30.15	1.45					150.28	442.91					1.76	.004				
			F = 1.14[c]					<.01		F = 1.02[c]				<.01		F = 1.25[c]				<.01

[a] 1, spawning channel no. 1 sample; 2, spawning channel no. 2 sample; N, number of fry in samples; S^2, variance of the mean; Δi, difference between means of parameter (1-2); U, Z, P, statistics of the Mann-Whitney Test.

[b] Test on sample means, $n_1 = n_2 = 20$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1972.

Sample	Date	N	Mean Length (mm)	S^2	Δ_1(mm)	U	Z	P	Mean Weight (mg)	S^2	Δ_1(mg)	U	Z	P	Mean Index (K_D)	S^2	$\Delta_1(K_D)$	U	Z	P
1_1 [a]	May 2	50	28.40	2.45	-.70	988.0	-1.865	.0310	134.10	745.61	-.82	1181.0	-.476	.3170	1.79	.005	.03	848.5	-2.768	.0028
1_2	" "	50	29.10	1.36					134.92	280.90					1.76	.003				
2_1	May 4	50	28.24	1.08	-1.20	489.0	-5.450	0	144.92	368.39	-5.18	1068.0	-1.255	.1047	1.86	.005	.06	641.0	-4.199	0
2_2	" "	50	29.44	.70					150.10	330.08					1.80	.003				
3_1	May 6	50	28.04	2.53	-1.04	777.0	-3.334	.0006	140.02	337.58	1.34	1182.0	-.469	.3196	1.85	.005	.07	454.5	-5.484	0
3_2	" "	50	29.08	1.59					138.68	342.64					1.78	.002				
4_1	May 9	50	28.36	1.17	-1.66	407.0	-5.946	0	152.76	559.92	2.98	1209.5	-.279	.3901	1.88	.006	.11	238.0	-6.977	0
4_2	" "	50	30.02	1.57					149.78	366.08					1.77	.002				
5_1	May 12	50	29.00	1.96	-1.00	821.5	-3.025	.0012	155.94	627.27	10.30	890.5	-2.479	.0066	1.85	.007	.10	315.5	-6.443	0
5_2	" "	50	30.00	1.80					145.64	278.18					1.75	.002				
6_1	May 15	50	29.36	1.54	-.88	731.5	-3.667	.0001	146.20	255.69	-3.72	1069.0	-1.248	.1060	1.79	.002	.04	660.5	-4.064	0
6_2	" "	50	30.24	2.23					149.92	487.73					1.75	.002				
7_1	May 17	50	29.42	1.72	-1.04	697.5	-3.897	0	147.40	341.82	-1.54	1181.5	-.472	.3185	1.79	.004	.05	553.5	-4.802	0
7_2	" "	50	30.46	1.48					148.94	283.02					1.74	.002				
8_1	May 19	50	29.54	1.93	-.74	886.5	-2.572	.0051	155.32	394.94	3.02	1084.0	-1.145	.1261	1.82	.003	.06	496.0	-5.198	0
8_2	" "	50	30.28	1.59					152.30	345.18					1.76	.002				
9_1	May 22	50	29.80	1.59	-.24	1114.5	-.962	.1680	153.60	303.00	8.66	943.5	-2.114	.0172	1.80	.003	.05	525.0	-4.999	0
9_2	" "	50	30.04	1.51					144.94	304.53					1.75	.002				
10_1	May 24	50	29.50	1.19	-.70	828.0	-3.008	.0013	148.94	277.88	.90	1210.5	-.272	.3928	1.79	.002	.04	551.5	-4.816	0
10_2	" "	50	30.20	1.55					148.04	314.75					1.75	.002				
11_1	May 26	50	29.70	1.77	-.36	1102.0	-1.057	.1454	151.80	313.94	4.96	1035.0	-1.483	.0690	1.79	.003	.04	618.0	-4.358	0
11_2	" "	50	30.06	1.61					146.84	413.88					1.75	.001				
12_1	May 28	50	29.56	1.31	-.38	999.0	-1.797	.0361	153.40	535.78	7.56	1074.5	-1.210	.1131	1.81	.005	.06	652.0	-4.123	0
12_2	" "	50	29.94	1.98					145.84	479.88					1.75	.002				
13_1	May 30	50	29.54	1.23	-.40	1024.5	-1.622	.0524	141.80	288.14	-3.82	1084.5	-1.141	.1269	1.76	.002	.01	1176.0	-.510	.3050
13_2	" "	50	29.94	1.16					145.62	344.71					1.75	.002				
14_1	June 2	50	30.10	1.03	.08	1225.5	-.176	.4302	146.74	237.41	1.42	1171.0	-.545	.2929	1.75	.003	0	1199.0	-.352	.3624
14_2	" "	50	30.02	1.98					145.32	373.71					1.75	.002				
15_1	June 5	50	29.76	.84	-.28	1009.0	-1.742	.0407	149.56	359.57	1.88	1212.5	-.259	.3978	1.78	.002	.02	923.5	-2.251	.0122
15_2	" "	50	30.04	1.31					147.68	337.02					1.76	.003				
16_1	June 7	50	30.42	1.96	.20	1146.0	-.738	.2301	157.62	1019.49	5.08	1134.5	-.797	.2128	1.77	.003	.01	1205.5	-.307	.3794
16_2	" "	50	30.22	1.52					152.54	513.96					1.76	.002				

Appendix XXI (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i(mg)	U	Z	P	Mean Index(K_D)	S^2	Δ_i(K_D)	U	Z	P
ε_1		800	29.30	2.01	-.64	51		<.001	148.76	465.26	2.06	96.5[b]		>.05	1.81	.005	.05	25.5[b]		<.001
ε_2		800	29.94	1.68					146.69	375.09					1.76	.002				
				F = 1.20[c]				>.01		F = 1.24[c]				<.01		F = 2.50[c]				<.01

[a] 1, spawning channel no. 1 sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (1-2); U, Z, P, parameters of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1973.

Sample	Date	N	Mean Length(mm)	s^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	s^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	s^2	$\Delta_{i(K_D)}$	U	Z	P
1_1 [a]	May 1	50	28.46	1.68	-.76	748.5	-3.578	.0002	155.96	807.65	11.84	891.5	-2.472	.0068	1.88	.007	.09	452.0	-5.502	0
1_2	" "	50	29.22	1.85					144.12	369.18					1.79	.004				
2_1	May 3	50	28.78	1.73	.10	1247.0	-.021	.4916	151.90	347.51	10.02	890.5	-2.479	.0066	1.85	.005	.03	911.5	-2.334	.0098
2_2	" "	50	28.68	2.39					141.88	329.79					1.82	.007				
3_1	May 5	50	28.88	1.25	2.44	192.0	-7.408	0	149.28	355.90	2.44	1150.0	-.690	.2451	1.83	.006	-.16	159.0	-7.522	0
3_2	" "	50	26.44	1.52					146.84	295.71					1.99	.005				
4_1	May 7	50	29.00	1.80	.14	1196.0	-.381	.3516	157.88	729.96	17.94	699.0	-3.801	0	1.86	.009	.06	738.0	-3.530	.0002
4_2	" "	50	28.86	3.18					139.94	400.77					1.80	.009				
5_1	May 9	50	28.98	1.86	-.24	1118.0	-.932	.1757	158.84	458.65	3.98	1156.5	-.645	.2594	1.87	.005	.03	929.0	-2.213	.0135
5_2	" "	50	29.22	1.60					155.86	257.41					1.84	.007				
6_1	May 12	50	29.02	1.37	-.26	1087.5	-1.156	.1232	159.70	596.04	18.44	705.0	-3.759	0	1.87	.007	.09	520.0	-5.033	0
6_2	" "	50	29.28	1.80					141.26	386.66					1.78	.009				
7_1	May 15	50	29.08	1.10	-.48	893.5	-2.585	.0047	166.46	658.24	27.90	430.00	-5.657	0	1.89	.004	.14	158.5	-7.526	0
7_2	" "	50	29.56	.91					138.56	198.22					1.75	.004				
8_1	May 17	50	28.68	1.86	-.92	774.0	-3.395	.0003	148.08	750.35	4.34	1201.5	-.335	.3688	1.84	.007	.07	628.5	-4.285	0
8_2	" "	50	29.60	1.31					143.74	301.80					1.77	.003				
9_1	May 19	50	29.22	1.69	-.54	931.0	-2.267	.0118	144.54	474.89	-3.02	1104.0	-1.007	.1573	1.79	.002	.02	1037.5	-1.465	.0714
9_2	" "	50	29.76	1.74					147.56	485.08					1.77	.004				
10_1	May 22	50	29.64	1.09	-.08	1175.5	-.559	.2880	150.90	534.04	.68	1241.0	-.062	.4753	1.79	.007	0	1185.5	-.445	.3282
10_2	" "	50	29.72	.66					150.22	189.18					1.79	.002				
11_1	May 24	50	29.40	1.06	-.10	1165.5	-.606	.2723	149.28	423.00	-.72	1235.0	-.104	.4586	1.80	.005	0	1227.0	-.157	.4376
11_2	" "	50	29.50	1.60					150.00	371.84					1.80	.003				
12_1	May 26	50	29.62	1.67	-.05	992.0	-.473	.3181	150.30	409.80	.06	1047.5	-.020	.4920	1.79	.005	.0	1013.0	-.290	.3859
12_2	" "	42	29.67	.96					150.24	277.37					1.79	.005				
13_1	May 29	50	30.04	1.47	-.12	1169.5	-.594	.2763	151.80	505.82	.78	1187.0	-.435	.3318	1.77	.002	.01	1190.0	-.414	.3394
13_2	" "	50	30.16	1.08					151.02	289.96					1.76	.003				
14_1	May 31	50	29.96	1.39	-.42	964.5	-2.055	.0199	155.48	393.18	3.74	1142.0	-.745	.3174	1.79	.003	.04	758.5	-3.389	.0003
14_2	" "	50	30.38	.85					151.74	339.86					1.75	.003				
15_1	June 2	50	30.10	1.52	.42	1039.5	-1.496	.0673	167.62	461.37	10.80	883.0	-2.531	.0057	1.83	.002	.02	1112.5	-.948	.1716
15_2	" "	50	29.68	1.20					156.82	419.37					1.81	.003				
16_1	June 5	50	29.74	.97	-.34	1042.5	-1.497	.0672	161.66	303.88	-.62	1237.5	-.086	.4657	1.83	.003	.02	1060.5	-1.307	.0956
16_2	" "	50	30.08	1.22					162.28	308.22					1.81	.002				

Appendix XXII (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
ε_1		800	29.29	1.69	-.07	99.5[b]		>.01	155.04	545.00	6.81	59[b]		<.01	1.83	.006	.03	65.5[b]	.001<p	<.01
ε_2		792	29.36	2.23					148.23	361.55					1.80	.008				
				F = 1.32[c]				<.01		F = 1.51[c]				<.01		F = 1.33[c]				< .01

[a] 1, spawning channel no. 1 sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (1-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXIII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1974.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
1_1[a]	May 2	50	29.06	1.20	-.58	917.5	-2.367	.0089	152.36	309.86	13.36	740.0	-3.519	.0002	1.84	.003	.09	259.5	-6.829	0
1_2	" "	50	29.64	1.91					139.00	343.71					1.75	.004				
2_1	May 6	50	29.20	1.39	-1.00	708.5	-3.848	.0001	164.40	491.29	16.12	720.5	-3.652	.0001	1.87	.006	.12	186.0	-7.336	0
2_2	" "	50	30.20	1.43					148.28	403.45					1.75	.002				
3_1	May 10	50	28.82	1.09	-1.48	504.0	-5.266	0	146.92	328.06	5.88	1000.5	-1.721	.0426	1.83	.003	.12	150.0	-7.584	0
3_2	" "	50	30.30	1.85					141.04	410.50					1.71	.003				
4_1	May 14	50	28.52	2.46	-1.90	415.0	-5.850	0	152.32	351.92	1.92	1179.0	-.490	.3121	1.87	.006	.12	193.5	-7.285	0
4_2	" "	50	30.42	1.64					150.40	418.14					1.75	.004				
5_1	May 17	50	29.26	1.63	-1.38	574.0	-4.766	0	151.84	291.10	4.24	1067.5	-1.259	.1040	1.82	.004	.10	248.5	-6.905	0
5_2	" "	50	30.64	1.83					147.60	478.06					1.72	.002				
6_1	May 21	50	29.04	1.84	-1.42	539.0	-5.021	0	164.28	448.84	23.32	503.5	-5.151	0	1.88	.005	.17	12.0	-8.535	0
6_2	" "	50	30.46	1.32					140.96	337.20					1.71	.002				
7_1	May 25	50	30.52	1.11	.50	937.0	-2.252	.0121	158.12	398.61	10.04	941.5	-2.129	.0166	1.77	.003	.01	1139.5	-.762	.2230
7_2	" "	50	30.02	1.65					148.08	451.61					1.76	.002				
8_1	May 28	50	29.50	1.89	-.36	1063.0	-1.334	.0911	155.10	425.43	9.48	883.5	-2.529	.0057	1.82	.005	.06	533.5	-4.940	0
8_2	" "	50	29.86	1.92					145.62	473.45					1.76	.002				
9_1	May 31	50	29.72	2.70	-.42	1070.0	-1.278	.1006	152.40	483.45	4.04	1169.5	-.555	.2898	1.80	.009	.05	934.0	-2.179	.0146
9_2	" "	50	30.14	1.63					148.36	396.22					1.75	.005				
10_1	June 4	50	29.82	1.54	-1.04	634.0	-4.370	0	155.28	410.59	-4.00	1022.0	-1.573	.0579	1.80	.002	.04	550.0	-4.827	0
10_2	" "	50	30.86	1.89					159.28	219.73					1.76	.005				
11_1	June 7	50	30.50	1.85	-.04	1209.5	-.289	.3863	164.76	389.06	15.36	745.0	-3.484	.0003	1.80	.003	.07	448.0	-5.530	0
11_2	" "	50	30.54	1.19					149.40	364.96					1.73	.002				
ε_1		550	29.45	2.05	-.83	18[b]	.001<p	<.01	156.16	419.17	9.07	14[b]		<.001	1.83	.006	.09	0		0
ε_2		550	30.28	1.68					147.09	411.85					1.74	.004				
				F = 1.22[c]				<.01		F = 1.02[c]				<.01		F = 1.50[c]				<.01

[a] 1, spawning channel no. 1 sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2 variance of the mean; Δ_i, difference between means of parameter (1-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 11$

[c] Test on homogeneity of variances.

APPENDIX TABLE XXIV: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1975.

Sample	Date	n	Mean length(mm)	S^2	Δ_1(mm)	U	z	P	Mean weight(mg)	S^2	Δ_1(mg)	U	z	P	Mean index(K_D)	S^2	Δ_1(K_D)	U	z	P
1_1 [a]	Apr 30	50	28.92	1.95	-1.48	495.0	-5.370	0	144.70	404.84	-22.24	478.0	-5.323	0	1.81	.007	0	1205.0	- .310	.3783
1_2	"	50	30.40	.94					167.24	321.92					1.81	.004				
2_1	May 2	50	28.32	1.98	- .94	823.0	-2.998	.0013	132.76	416.52	-18.80	666.0	-4.028	0	1.80	.005	-.02	1003.0	-1.702	.0444
2_2	"	50	29.26	2.93					151.56	470.96					1.82	.005				
3_1	May 5	50	28.14	2.61	-1.42	657.0	-4.153	0	172.64	802.55	16.22	822.5	-2.958	.0015	1.97	.010	.15	278.0	-6.701	0
3_2	"	50	29.56	2.50					156.42	509.57					1.82	.010				
4_1	May 7	50	28.62	1.91	- .92	746.5	-3.598	.0002	128.98	331.01	- 8.62	928.5	-2.218	.0132	1.76	.003	.01	1080.0	-1.172	.1206
4_2	"	50	29.54	.99					137.60	261.16					1.75	.003				
5_1	May 12	50	28.92	2.89	- .80	893.5	-2.514	.0060	145.64	423.90	- 8.56	1245.0	- .034	.4870	1.82	.004	.06	601.0	-4.475	0
5_2	"	50	29.72	1.51					154.20	372.55					1.76	.001				
6_1	May 15	50	29.12	1.25	-1.16	611.5	-4.539	0	144.18	382.41	- 2.68	1177.0	- .504	.3075	1.80	.004	.06	604.5	-4.451	0
6_2	"	50	30.28	1.35					146.86	407.53					1.74	.002				
7_1	May 19	50	29.58	2.33	- .68	900.5	-2.465	.0068	146.96	515.25	3.56	1182.5	- .466	.3206	1.78	.004	.06	611.5	-4.402	0
7_2	"	50	30.26	1.67					143.40	530.75					1.72	.003				
8_1	May 24	50	29.50	2.49	- .76	881.0	-2.633	.0042	136.48	602.27	-18.78	714.5	-3.698	0	1.73	.002	-.04	774.5	-3.278	.0005
8_2	"	50	30.34	1.25					155.26	518.10					1.77	.003				
9_1	May 29	50	29.88	2.07	- .24	1132.0	- .834	.2026	153.48	508.20	3.44	1194.0	- .386	.3498	1.79	.004	.03	916.5	-2.299	.0107
9_2	"	50	30.12	1.70					150.04	475.53					1.76	.002				
10_1	June 3	50	30.72	2.61	- .32	1003.0	-1.744	.0406	173.88	1437.37	- 6.54	970.0	-1.931	.0267	1.81	.003	-.01	1100.5	-1.031	.1513
10_2	"	50	31.04	1.71					180.42	555.39					1.82	.002				
Σ_1		500	29.18	2.72	- .87	17.0[b]		=.025	147.97	778.92	- 5.43	32.0[b]	-	>.05	1.81	.008	.03	39.5[b]	-	>.05
Σ_2		500	30.05	1.88				<.01	154.30	575.52				<.01	1.78	.005				<.01
				F=1.45[c]						F=1.35[c]						F=1.60[c]				

[a] 1, channel no.1 sample; 2, channel no.2 sample; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (Ch_1-Ch_2); U, z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 10$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXV: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton Spawning Channels No. 1 and No. 2 in 1976.

Sample	Date	N	Mean Length(mm)	S^2	Δi (mm)	U	Z	P	Mean Weight(mg)	S^2	Δi (mg)	U	Z	P	Mean Index(K_D)	S^2	Δi (K_D)	U	Z	P
1_1[a]	Apr. 23	50	27.98	1.12	-1.20	442.5	-5.428	0	129.18	254.00	-17.78	521.5	-5.025	0	1.80	.004	-.01	1217.5	-.224	.4113
1_2	" "	50	29.18	.72					146.96	190.92					1.81	.002				
2_1	May 4	50	28.40	3.02	-1.46	543.5	-4.996	0	139.46	181.16	1.06	1211.0	-.269	.3940	1.83	.010	.10	414.5	-5.761	0
2_2	" "	50	29.86	.86					138.40	288.01					1.73	.002				
3_1	May 11	50	28.62	2.20	-.94	790.0	-3.244	.0006	151.88	339.18	3.00	1158.0	-.635	.2627	1.86	.006	.07	568.5	-4.699	0
3_2	" "	50	29.56	2.17					148.88	288.69					1.79	.004				
4_1	May 14	50	29.22	1.60	-1.54	545.0	-4.983	0	134.58	289.85	-11.18	789.5	-3.177	.0007	1.75	.003	.04	826.0	-2.923	.0018
4_2	" "	50	30.76	2.02					145.76	296.86					1.71	.005				
5_1	May 17	50	29.38	.81	-.42	952.5	-2.193	.0142	133.40	185.68	-8.14	815.0	-3.001	.0010	1.74	.003	-.01	1156.0	-.648	.2585
5_2	" "	50	29.80	1.10					141.54	196.02					1.75	.002				
6_1	May 21	44	28.23	2.27	-2.51	198.5	-6.951	0	135.14	333.30	-9.82	783.0	-2.404	.0081	1.82	.007	.11	294.0	-6.108	0
6_2	" "	50	30.74	1.26					144.96	217.86					1.71	.004				
7_1	May 25	50	29.02	.96	-.70	764.5	-3.516	.0002	136.08	238.21	-9.04	811.0	-3.034	.0012	1.77	.002	0	1216.5	-.231	.4086
7_2	" "	50	29.72	.78					145.12	179.47					1.77	.002				
8_1	May 28	50	29.22	1.11	-.02	1221.0	-.209	.4172	139.44	290.47	-3.00	1074.0	-1.214	.1123	1.77	.002	-.01	1052.5	-1.362	.0866
8_2	" "	50	29.24	1.13					142.44	294.11					1.78	.002				
9_1	June 1	50	29.76	2.35	.32	1121.0	-.937	.1744	145.20	318.39	4.60	1104.5	-1.004	.1577	1.77	.005	.01	1100.0	-1.035	.1503
9_2	" "	50	29.44	.74					140.60	304.05					1.76	.002				
10_1	June 4	50	28.86	1.84	.24	1137.5	-.812	.2067	146.28	802.63	5.60	1188.5	-.812	.2084	1.82	.004	.01	1215.5	-.238	.4071
10_2	" "	50	28.62	.85					140.68	308.85					1.81	.003				
Σ_1		494	28.88	1.97	-.82	15.5[b]		.001<p <.01	139.11	360.54	-4.42	27[b]		.05	1.79	.006	.03	29[b]		>.05
Σ_2		500	29.67	1.54					143.53	261.69					1.76	.004				
				F = 1.28[c]				<.01		F = 1.38[c]				<.01		F = 1.50[c]				<.01

[a] 1, spawning channel no. 1 samples; 2, spawning channel no. 2 samples; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (1-2); U, Z, P, statistics of the Mann-Whitney test.

[b] $n_1 = n_2 = 10$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXVI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1970.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
1_R [a]	Apr.29	50	28.96	.86	-.56	830.0	-3.075	.0011	143.68	236.85	-5.58	862.5	-2.674	.0038	1.81	.002	.01	1029.0	-1.524	.0638
1_2	" "	50	29.52	.83					149.26	223.94					1.80	.004				
2_R	May 1	49	30.02	1.15	.02	1195.5	-.218	.4137	153.31	447.75	-4.43	1069.5	-1.089	.1390	1.78	.003	-.02	901.5	-2.264	.0117
2_2	" "	50	30.00	.86					157.74	302.10					1.80	.002				
3_R	May 3	50	29.94	.92	-.46	941.0	-2.353	.0093	156.92	354.35	.48	1246.5	-.024	.4904	1.80	.002	.03	791.5	-3.166	.0008
3_2	" "	50	30.40	.61					156.44	218.90					1.77	.001				
4_R	May 4	50	29.66	1.45	-.98	698.5	-4.030	0	139.10	457.70	-15.52	708.0	-3.738	.0001	1.74	.002	-.01	1071.5	-1.231	.1090
4_2	" "	50	30.64	.89					154.62	278.02					1.75	.001				
5_R	May 5	50	29.32	2.02	-1.04	771.0	-3.407	.0003	141.16	383.25	-12.90	894.0	-2.456	.0069	1.77	.002	.01	997.0	-1.745	.0405
5_2	" "	50	30.36	1.46					154.06	505.51					1.76	.001				
6_R	May 6	50	30.14	1.39	-.14	1238.5	-.083	.4669	146.98	424.24	-.86	1182.0	-.469	.3192	1.75	.003	.01	1172.5	-.534	.2967
6_2	" "	50	30.28	1.92					147.84	511.14					1.74	.002				
7_R	May 7	50	29.74	1.05	-.58	912.0	-2.461	.0069	138.16	291.46	-9.64	875.5	-2.583	.0049	1.74	.002	0	1096.5	-1.058	.1451
7_2	" "	50	30.32	1.28					147.80	314.35					1.74	.002				
8_R	May 8	50	29.70	1.32	-.38	970.0	-2.004	.0225	138.92	380.00	-6.76	945.5	-2.100	.0179	1.74	.001	-.01	1136.0	-.786	.2160
8_2	" "	50	30.08	.97					145.68	314.90					1.75	.001				
9_R	May 9	50	29.76	1.33	-2.46	863.5	-2.747	.0030	141.44	299.33	-6.44	962.0	-1.986	.0235	1.75	.001	.03	1151.5	-.679	.2486
9_2	" "	50	32.22	165.36					147.88	656.00					1.72	.046				
10_R	May 11	50	29.72	.98	-.36	1004.0	-1.782	.0373	144.28	339.44	-1.68	1178.5	-.493	.3110	1.76	.002	.01	1000.0	-1.724	.0423
10_2	" "	50	30.08	1.63					145.96	361.16					1.75	.001				
11_R	May 12	50	29.98	1.16	-.52	926.0	-2.336	.0097	143.22	340.43	-12.04	839.0	-2.835	.0023	1.74	.003	-.02	1036.0	-1.476	.0713
11_2	" "	50	30.50	1.15					155.26	393.08					1.76	.002				
12_R	May 13	50	29.66	1.29	-1.00	746.5	-3.599	.0002	137.76	310.28	-15.48	699.0	-3.802	.0001	1.74	.002	0	1178.0	-.497	.3096
12_2	" "	50	30.66	1.58					153.24	362.00					1.74	.001				
13_R	May 14	50	29.62	2.08	-1.04	791.0	-3.270	.0005	137.86	511.69	-11.90	871.0	-2.614	.0045	1.74	.002	.01	1108.0	-.979	.1638
13_2	" "	50	30.66	1.37					149.76	404.16					1.73	.001				
14_R	May 15	50	29.58	1.39	-1.10	599.0	-4.676	0	138.24	483.63	-12.52	753.5	-3.425	.0003	1.74	.002	.01	1096.5	-1.058	.1451
14_2	" "	50	30.68	.96					150.76	296.41					1.73	.002				
15_R	May 16	50	29.74	1.38	-.52	1025.0	-1.609	.0538	138.56	341.61	-7.04	1058.5	-1.321	.0916	1.74	.001	0	1234.0	-.110	.4562
15_2	" "	50	30.26	1.46					145.60	440.75					1.73	.001				
16_R	May 18	50	30.08	1.22	-.34	999.5	-1.826	.0339	143.16	413.17	-3.84	1065.0	-1.276	.1010	1.73	.001	0	1244.0	-.041	.4836
16_2	" "	50	30.42	1.27					147.00	376.45					1.73	.001				
17_R	May 19	50	30.12	1.21	-.32	1056.5	-1.413	.0790	142.54	361.29	-3.30	1133.5	-.804	.2107	1.73	.002	0	1147.0	-.710	.2389
17_2	" "	50	30.44	.91					145.84	313.63					1.73	.001				

Appendix XXVI (cont.)

Sample	Date	N	Mean Length (mm)	S^2	Δ_i (mm)	U	Z	P	Mean Weight (mm)	S^2	Δ_i (mm)	U	Z	P	Mean Index (K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
18_R	May 20	50	29.60	1.51	-1.06	655.5	-4.218	0	134.74	461.60	-14.82	768.0	-3.325	.0004	1.73	.002	0	1206.5	-.300	.3821
18_2	" "	50	30.66	1.09					149.56	431.04					1.73	.002				
19_R	May 21	50	29.76	1.86	-.60	1002.5	-1.786	.0370	136.86	484.38	-10.80	902.0	-2.400	.0082	1.73	.002	-.01	1039.5	-1.451	.0734
19_2	" "	50	30.36	1.87					147.66	472.49					1.74	.001				
20_R	May 22	50	30.06	1.32	-.46	990.5	-1.855	.0318	140.90	430.96	-8.78	967.5	-1.948	.0257	1.73	.002	-.01	1053.5	-1.355	.0869
20_2	" "	50	30.52	1.32					149.68	412.37					1.74	.002				
21_R	May 23	50	30.26	1.95	-.10	1209.5	-.288	.3867	148.62	570.84	4.42	1082.0	-1.159	.1232	1.74	.002	.02	900.5	-2.410	.0080
21_2	" "	50	30.36	1.38					144.20	436.71					1.72	.001				
22_R	May 25	50	30.32	1.61	-.26	1102.5	-1.059	.1448	146.00	496.94	-5.50	1029.5	-1.521	.0642	1.73	.001	-.01	1110.0	-.965	.1672
22_2	" "	50	30.58	1.35					151.50	364.71					1.74	.002				
23_R	May 26	50	30.16	1.20	-.76	878.0	-2.694	.0036	144.42	412.22	-13.78	983.5	-1.838	.0330	1.74	.002	0	1166.0	-.579	.2813
23_2	" "	50	30.92	1.99					158.20	795.00					1.74	.002				
24_R	May 27	50	30.32	1.04	.16	1206.5	-.315	.3764	146.64	586.75	2.18	1238.5	-.079	.4685	1.73	.002	0	1231.5	-.128	.4491
24_2	" "	50	30.16	1.69					144.46	626.88					1.73	.002				
25_R	May 28	50	30.18	1.25	-.58	864.0	-2.749	.0030	143.00	414.16	-9.36	858.5	-2.700	.0035	1.73	.002	0	1138.5	-.769	.2209
25_2	" "	50	30.76	1.66					152.36	443.49					1.73	.002				
26_R	May 29	50	30.00	1.63	.36	1027.0	-1.588	.0561	148.16	558.94	10.94	913.0	-2.324	.0101	1.76	.002	.03	863.0	-2.668	.0038
26_2	" "	50	29.64	1.75					137.22	544.92					1.73	.003				
27_R	May 30	50	30.44	2.05	-.10	1185.0	-.460	.3228	148.36	616.47	-1.04	1205.5	-.307	.3794	1.73	.001	0	1187.5	-.431	.3332
27_2	" "	50	30.54	1.72					149.40	677.90					1.73	.002				
28_R	June 1	50	29.74	1.63	-.98	724.5	-3.711	.0001	133.90	608.59	-16.82	728.5	-3.596	.0002	1.71	.003	-.02	1048.5	-1.389	.0824
28_2	" "	50	30.72	1.64					150.72	491.24					1.73	.002				
29_R	June 2	50	30.20	2.16	-.20	1106.5	-1.017	.1546	140.62	712.13	-3.64	1106.5	-.990	.1611	1.71	.002	-.01	1102.0	-1.020	.1539
29_2	" "	50	30.40	1.10					144.26	392.29					1.72	.002				
ε_R		1449	29.89	1.50	-.56	104[b]	-4.922	0	142.67	455.85	-6.78	135[b]	-4.440	0	1.74	.002	0	384[b]	-.568	.2850
ε_2		1450	30.45	7.07					149.45	437.22					1.74	.004				
				F=4.71[c]				<.01		F=1.04[c]				<.01		F=2.00[c]				<.01

[a] R, river samples; 2, spawning channel no. 2 samples; N, number of fry in samples; S^2, variance of the mean; Δ_i, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 29$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXVII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1971.

Sample	Date	N	Mean Length(mm)	s^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	s^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	s^2	$\Delta_{i(K_D)}$	U	Z	P
1_R [a]	Apr. 24	50	28.92	1.59	-1.00	703.0	-3.867	0	140.10	324.88	-11.86	747.5	-3.465	.0003	1.79	.004	.01	1097.0	-1.055	.1467
1_2	" "	50	29.92	1.34					151.96	250.14					1.78	.003				
2_R	Apr. 26	50	29.72	1.51	-.28	1092.0	-1.146	.1263	154.02	241.43	3.68	1105.5	-.997	.1594	1.80	.005	.03	860.5	-2.685	.0036
2_2	" "	50	30.00	1.10					150.34	327.14					1.77	.003				
3_R	Apr. 28	50	28.64	1.91	-.86	854.5	-2.787	.0026	146.72	297.20	-.76	1217.5	-.224	.4114	1.84	.005	.05	681.0	-3.923	0
3_2	" "	50	29.50	2.21					147.48	384.61					1.79	.004				
4_R	Apr. 30	50	29.22	2.18	-.46	1049.0	-1.422	.0775	153.32	310.41	2.58	1155.5	-.652	.2572	1.83	.003	.04	793.0	-3.151	.0008
4_2	" "	50	29.68	1.73					150.74	332.43					1.79	.003				
5_R	May 3	50	29.98	1.16	.10	1186.5	-.454	.3262	152.18	305.33	1.94	1101.5	-1.024	.1529	1.78	.007	0	1158.0	-.634	.2630
5_2	" "	50	29.88	1.54					150.24	437.14					1.78	.007				
6_R	May 5	50	30.38	1.30	.44	1018.5	-1.707	.0439	156.76	381.06	4.66	1025.0	-1.552	.0604	1.77	.010	-.01	1064.5	-1.279	.1005
6_2	" "	50	29.94	1.28					152.10	360.90					1.78	.003				
7_R	May 7	50	29.70	.91	.14	1162.0	-.637	.2621	152.76	361.71	7.82	1028.0	-1.531	.0629	1.80	.003	.03	1006.5	-1.679	.0466
7_2	" "	50	29.56	2.37					144.94	439.43					1.77	.005				
8_R	May 10	50	30.02	.59	.46	905.0	-2.560	.0052	159.10	306.24	9.50	897.5	-2.432	.0075	1.80	.003	.01	1147.0	-.710	.2389
8_2	" "	50	29.56	1.03					149.60	375.90					1.79	.002				
9_R	May 12	50	30.24	1.08	-.26	1068.0	-1.329	.0920	156.88	374.00	-3.10	1197.5	-.366	.3572	1.78	.002	0	1209.5	-.279	.3901
9_2	" "	50	30.50	.87					159.98	282.08					1.78	.002				
10_R	May 14	50	29.46	1.15	-.74	781.0	-3.486	.0002	146.60	258.06	-6.16	1098.5	-1.045	.1480	1.79	.003	.02	987.5	-1.810	.0351
10_2	" "	50	30.20	.90					152.76	305.22					1.77	.003				
11_R	May 17	50	30.00	.78	-.30	994.5	-1.911	.0280	149.70	242.61	-1.44	1138.0	-.773	.2197	1.77	.002	.01	1059.0	-1.317	.0938
11_2	" "	50	30.30	.79					151.14	238.80					1.76	.002				
12_R	May 19	50	29.90	1.44	-.56	868.5	-2.740	.0031	150.56	533.86	-4.06	1082.5	-1.155	.1237	1.77	.003	.02	1019.0	-1.593	.0556
12_2	" "	50	30.46	1.11					154.62	419.86					1.76	.002				
13_R	May 21	50	30.30	1.19	-.20	1107.5	-1.042	.1496	158.44	343.35	11.08	822.0	-2.954	.0016	1.78	.002	.05	377.0	-6.020	0
13_2	" "	50	30.50	1.40					147.36	353.16					1.73	.001				
14_R	May 24	50	30.30	.83	-.10	1193.0	-.423	.3361	156.86	281.57	10.26	868.50	-2.632	.0043	1.78	.003	.05	626.5	-4.306	0
14_2	" "	50	30.40	1.31					146.60	275.04					1.73	.002				
15_R	May 26	50	30.16	1.15	-.26	1073.0	-1.301	.0966	145.62	319.53	-1.02	1204.5	-.314	.3768	1.74	.004	.01	1094.0	-1.076	.1410
15_2	" "	50	30.42	1.07					146.64	328.14					1.73	.002				
16_R	May 28	50	29.96	1.26	-.26	1112.0	-1.017	.1546	146.88	496.24	8.00	969.5	-1.935	.0265	1.76	.003	.05	589.0	-4.559	0
16_2	" "	50	30.22	.95					138.88	342.08					1.71	.003				

Appendix XXVII (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
17_R	May 31	50	29.98	1.29	-.46	927.0	-2.406	.0081	139.46	480.80	-.58	1232.5	-.121	.4518	1.72	.003	.02	1011.5	-1.645	.0500
17_2	" "	50	30.44	.70					140.04	316.42					1.70	.002				
18_R	June 2	50	30.04	1.22	-.38	983.5	-2.025	.0214	142.28	396.30	-7.90	964.0	-1.973	.0242	1.73	.004	-.01	1087.0	-1.124	.1305
18_2	" "	50	30.42	.70					150.18	362.88					1.74	.003				
19_R	June 4	50	30.02	1.08	-.98	827.0	-3.045	.0011	150.28	526.55	-19.38	884.0	-2.525	.0054	1.77	.004	-.01	1123.5	-.872	.1916
19_2	" "	50	31.00	2.78					169.66	1636.16					1.78	.005				
ε_R		950	29.84	1.43	-.31	115.5[b]		>.01	150.45	383.66	.17	166[b]		>.01	1.78	.005	.02	121[b]		>.01
ε_2		950	30.15	1.45					150.28	442.91					1.76	.004				
			F = 1.01[c]					>.01	F = 1.15[c]					<.01	F = 1.25[c]					<.01

[a] R, river samples; 2, spawning channel no. 2 samples; N, number of fry in samples; S^2 variance of the mean; Δ_1, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 19$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXVIII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1972.

Sample	Date		N	Mean Length(mm)	s^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	s^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	s^2	$\Delta_{i(K_D)}$	U	Z	P
1_R [a]	May	2	50	28.94	2.02	-.16	1222.0	-.199	.4211	148.28	372.47	13.36	740.5	-3.514	.0002	1.83	.004	.07	474.5	-5.347	0
1_2	"	"	50	29.10	1.36					134.92	280.90					1.76	.003				
2_R	May	4	50	28.76	3.29	-.68	1049.5	-1.449	.0736	149.56	356.31	-.54	1244.5	-.038	.4846	1.85	.011	.05	970.5	-1.927	.0270
2_2	"	"	50	29.44	.70					150.10	330.08					1.80	.003				
3_R	May	6	50	28.48	2.87	-.60	996.5	-1.784	.0372	147.20	328.67	8.52	966.0	-1.959	.0250	1.85	.006	.07	494.5	-5.209	0
3_2	"	"	50	29.08	1.59					138.68	342.64					1.78	.002				
4_R	May	9	50	29.22	2.42	-.80	847.5	-2.829	.0023	150.22	421.67	.44	1159.0	-.628	.2650	1.82	.004	.05	599.0	-4.488	0
4_2	"	"	50	30.02	1.57					149.78	366.08					1.77	.002				
5_R	May	12	50	29.76	1.66	-.24	1150.5	-.709	.2482	152.30	312.45	6.66	1000.0	-1.724	.0423	1.79	.002	.04	656.5	-4.092	0
5_2	"	"	50	30.00	1.80					145.64	278.18					1.75	.002				
6_R	May	15	50	29.98	1.53	-.26	1067.0	-1.297	.0978	147.64	275.65	-2.28	1150.0	-.690	.2451	1.76	.002	.01	1112.0	-.951	.1708
6_2	"	"	50	30.24	2.23					149.92	487.73					1.75	.002				
7_R	May	17	50	29.56	.95	-.90	689.0	-4.001	0	150.54	225.96	1.60	1186.5	-.438	.3307	1.80	.002	.06	381.5	-5.988	0
7_2	"	"	50	30.46	1.48					148.94	283.02					1.74	.002				
8_R	May	19	50	29.88	.97	-.40	1006.5	-1.738	.0410	165.26	284.88	12.96	758.5	-3.389	.0003	1.83	.002	.07	286.5	-6.643	0
8_2	"	"	50	30.28	1.59					152.30	345.18					1.76	.002				
9_R	May	22	50	29.74	1.05	-.30	1095.0	-1.113	.1328	151.98	239.35	7.04	960.5	-1.996	.0230	1.79	.002	.04	508.5	-5.112	0
9_2	"	"	50	30.04	1.51					144.94	304.53					1.75	.002				
10_R	May	24	50	29.34	.96	-.86	711.0	-3.850	.0001	153.48	181.59	5.44	1035.5	-1.479	.0695	1.82	.002	.07	259.0	-6.832	0
10_2	"	"	50	30.20	1.55					148.04	314.75					1.75	.002				
11_R	May	26	50	29.28	.98	-.78	803.0	-3.227	.0006	146.14	261.73	-.70	1247.5	-.017	.4932	1.80	.003	.05	597.5	-4.499	0
11_2	"	"	50	30.06	1.61					146.84	413.88					1.75	.001				
12_R	May	28	50	29.56	1.35	-.38	996.5	-1.806	.0354	146.32	320.49	.48	1237.5	-.086	.4658	1.78	.003	.03	919.5	-2.279	.0113
12_2	"	"	50	29.94	1.98					145.84	479.88					1.75	.002				
13_R	May	30	50	29.42	1.55	-.52	972.0	-2.012	.0221	144.42	427.08	-1.20	1223.0	-.186	.4263	1.78	.002	.03	859.0	-2.696	.0035
13_2	"	"	50	29.94	1.16					145.62	344.71					1.75	.002				
14_R	June	2	50	29.96	.98	-.06	1148.0	-.730	.2327	153.36	249.00	8.04	1016.0	-1.614	.0533	1.78	.002	.03	655.0	-4.103	0
14_2	"	"	50	30.02	1.98					145.32	373.71					1.75	.002				
15_R	June	5	50	29.28	.90	-.76	740.0	-3.688	.0001	142.76	369.55	-4.92	1065.5	-1.272	.1017	1.78	.004	.02	965.0	-1.965	.0247
15_2	"	"	50	30.04	1.31					147.68	337.02					1.76	.003				
16_R	June	7	50	29.60	1.23	-.62	937.0	-2.251	.0122	146.66	334.20	-5.88	1069.0	-1.249	.1058	1.78	.002	.02	1000.0	-1.724	.0423
16_2	"	"	50	30.22	1.52					152.54	513.96					1.76	.002				

Appendix XXVIII (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i(mg)	U	Z	P	Mean Index(K_D)	S^2	Δ_i(K_D)	U	Z	P
R		800	29.42	1.69	-.52	38[b]		<.001	149.76	329.35	3.06	89.5[b]		>.05	1.80	.004	.04	15.5[b]		<.001
2		800	29.94	1.68					146.69	375.09					1.76	.002				
			F = 1.01[c]					>.01		F = 1.14[c]				<.01	F = 2.00[c]					<.01

[a] R, river sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2 variance of the mean; Δ_i, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXIX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1973.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 1	50	28.72	3.10	-.50	1049.5	-1.419	.0779	142.86	392.26	-1.26	1231.5	-.128	.4491	1.82	.006	.03	973.5	-1.906	.0286
1_2	" "	50	29.22	1.85					144.12	369.18					1.79	.004				
2_R	May 3	50	27.58	6.74	-1.10	908.0	-2.384	.0086	148.70	364.53	6.82	1024.0	-1.559	.0549	1.93	.019	.11	649.0	-4.143	0
2_2	" "	50	28.68	2.39					141.88	329.79					1.82	.007				
3_R	May 5	50	28.24	2.51	1.80	496.0	-5.284	0	149.50	263.08	2.66	1149.0	-.697	.2429	1.88	.004	-.11	269.5	-6.760	0
3_2	" "	50	26.44	1.52					146.84	295.71					1.99	.005				
4_R	May 7	50	29.00	1.96	.14	1168.5	-.578	.2817	144.70	248.10	4.76	1064.0	-1.283	.1000	1.81	.005	.01	1063.5	-1.286	.0994
4_2	" "	50	28.86	3.18					139.94	400.77					1.80	.009				
5_R	May 9	50	28.98	.96	-.24	1086.5	-1.164	.1225	155.66	252.57	-.20	1192.0	-.400	.3446	1.85	.005	.01	1108.5	-.976	.1620
5_2	" "	50	29.22	1.60					155.86	257.41					1.84	.007				
6_R	May 12	50	29.34	1.86	.06	1235.0	-.106	.4578	160.64	541.29	19.38	660.0	-4.071	0	1.85	.004	.07	570.5	-4.685	0
6_2	" "	50	29.28	1.80					141.26	386.66					1.78	.009				
7_R	May 15	50	29.40	1.39	-.16	1100.5	-1.084	.1392	158.80	267.08	20.24	400.0	-5.864	0	1.84	.003	.09	235.5	-6.995	0
7_2	" "	50	29.56	.91					138.56	198.22					1.75	.004				
8_R	May 17	50	29.34	.68	-.26	1034.5	-1.571	.0581	150.22	170.20	6.48	1009.0	-1.663	.0482	1.81	.003	.04	602.5	-4.465	0
8_2	" "	50	29.60	1.31					143.74	301.80					1.77	.003				
9_R	May 19	50	29.32	1.94	-.44	964.0	-2.029	.0212	152.20	341.45	4.64	1124.0	-.869	.1925	1.82	.005	.05	704.5	-3.761	.0001
9_2	" "	50	29.76	1.74					147.56	485.08					1.77	.004				
10_R	May 22	50	29.30	1.15	-.42	949.5	-2.205	.0137	151.64	316.27	1.42	1242.5	-.052	.4793	1.82	.003	.03	851.0	-2.751	.0030
10_2	" "	50	29.72	.66					150.22	189.18					1.79	.002				
11_R	May 24	50	29.12	1.21	-.38	1003.0	-1.760	.0392	158.22	279.43	8.22	919.5	-2.281	.0113	1.86	.004	.06	623.0	-4.323	0
11_2	" "	50	29.50	1.60					150.00	371.84					1.80	.003				
12_R	May 26	50	28.98	1.57	-.69	691.0	-2.943	.0015	152.22	384.98	1.98	969.5	-.631	.2640	1.84	.003	.05	611	-3.442	.0003
12_2	" "	42	29.67	.96					150.24	277.37					1.79	.005				
13_R	May 29	50	29.64	1.21	-.52	938.5	-2.277	.0113	159.92	351.37	8.90	840.0	-2.829	.0023	1.83	.003	.07	463.5	-5.423	0
13_2	" "	50	30.16	1.08					151.02	289.96					1.76	.003				
14_R	May 31	50	29.66	.96	-.72	743.0	-3.642	.0002	157.04	321.73	5.30	1035.0	-1.484	.0691	1.82	.003	.07	443.0	-5.564	0
14_2	" "	50	30.38	.85					151.74	339.86					1.75	.003				
15_R	June 2	50	29.78	1.20	.10	1210.5	-.283	.3886	168.04	315.73	11.22	890.5	-2.479	.0066	1.85	.002	.04	761.5	-3.368	.0004
15_2	" "	50	29.68	1.20					156.82	419.37					1.81	.003				
16_R	June 5	47	29.40	3.33	-.68	940.0	-1.753	.0398	157.64	866.09	-4.64	1081.0	-.679	.2486	1.83	.002	.02	946.0	-1.653	.0492
16_2	" "	50	30.08	1.22					162.28	308.22					1.81	.002				

Appendix XXIX (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Lambda_i(K_D)$	U	Z	P
ε_R		797	29.11	2.24	-.25	83[b]		.05	154.24	385.02	6.01	63.5[b]		$.001<p<.01$	1.84	.006	.04	31		$<.001$
ε_2		792	29.36	2.23					148.23	361.55					1.80	.008				
			F = 1.00[c]					$>.01$		F = 1.06[c]				$<.01$		F = 1.33[c]				$<.01$

[a] R, river samples; 2, spawning channel no. 2 samples; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 16$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1974.

Sample	Date	N	Mean Length (mm)	S^2	Δ_1(mm)	U	Z	P	Mean Weight (mg)	S^2	Δ_1(mg)	U	Z	P	Mean Index (K_D)	S^2	$\Delta_1(K_D)$	U	Z	P
1_R [a]	May 2	50	29.66	1.74	.02	1246.0	-0.028	.4888	149.08	442.51	10.08	883.5	-2.528	.0057	1.78	.004	.03	719.5	-3.658	.0001
1_2	" "	50	29.64	1.91					139.00	343.71					1.75	.004				
2_R	May 17	50	29.84	1.77	-.80	838.0	-2.924	.0018	154.20	437.94	6.60	1014.0	-1.628	.0518	1.79	.004	.07	440.0	-5.585	0
2_2	" "	50	30.64	1.83					147.60	478.06					1.72	.002				
3_R	May 21	50	29.54	1.89	-.92	777.5	-3.366	.0004	153.48	376.65	12.52	811.0	-3.029	.0013	1.81	.006	.10	229.5	-7.036	0
3_2	" "	50	30.46	1.32					140.96	337.20					1.71	.002				
4_R	May 25	50	30.58	5.47	.56	912.0	-2.393	.0083	149.56	509.45	1.48	1246.0	-.028	.4888	1.74	.003	-.02	636.5	-4.230	0
4_2	" "	50	29.86	1.92					145.62	473.45					1.76	.002				
5_R	May 28	50	30.36	1.62	.50	1012.5	-1.687	.0458	157.04	550.92	11.42	869.0	-2.628	.0043	1.77	.004	.01	1111.0	- .958	.1690
5_2	" "	50	30.02	1.65					148.08	451.61					1.76	.002				
6_R	May 31	50	29.36	0.97	-.78	758.0	-3.505	.0002	150.68	365.18	2.32	1189.5	-0.417	.3383	1.81	.003	.06	478.5	-5.320	0
6_2	" "	50	30.14	1.63					148.36	396.22					1.75	.005				
7_R	June 4	50	29.66	2.96	-1.20	717.0	-3.767	.0001	160.40	893.90	1.12	1228.0	-0.152	.4396	1.83	.004	.07	401.0	-5.853	0
7_2	" "	50	30.86	1.19					159.28	219.73					1.76	.005				
8_R	June 7	50	29.64	2.97	-.90	833.0	-2.946	.0016	149.76	865.27	.36	1202.0	-.331	.3695	1.78	.004	.05	599.5	-4.485	0
8_2	" "	50	30.54	1.19					149.40	364.96					1.73	.002				
ε_R		400	29.83	2.54	-.45	13.5[b]	.01<p	<.05	153.02	559.98	5.93	8[b]	.001<p	<.01	1.79	.008	.05	5[b]		.001
ε_2		400	30.28	1.68					147.29	411.85					1.74	.004				
			F = 1.51[c]					<.01		F = 1.36[c]				<.01	F = 2.00[c]					<.01

[a] R, river sample; 2, spawning channel no. 2 sample; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 8$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXXI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1975.

Sample	Date	N	Mean length (mm)	S^2	Δ_1(mm)	U	Z	P	Mean weight (mg)	S^2	Δ_1(mg)	U	z	P	Mean index (K_D)	S^2	Δ_1(K_D)	U	z	P
1_R[a]	Apr 29	50	30.06	1.98	- .34	1071.5	-1.281	.1002	157.10	497.92	-10.14	863.0	-2.670	.0038	1.79	.002	-.02	1035.5	-1.479	.0695
1_2	Apr 30	50	30.40	.94					167.24	321.92					1.81	.004				
2_R	May 2	50	30.34	3.66	1.08	915.0	-2.362	.0091	149.06	414.08	- 2.50	1128.0	- .841	.2002	1.75	.007	-.07	647.0	-4.157	0
2_2	"	50	29.26	2.93					151.56	470.96					1.82	.005				
3_R	May 5	50	30.46	1.60	.90	860.0	-2.762	.0029	150.56	356.35	- 5.86	1039.5	-1.451	.0734	1.74	.003	-.08	630.0	-4.274	0
3_2	"	50	29.56	2.50					156.42	509.57					1.82	.010				
4_R	May 7	50	30.24	.84	.70	795.0	-3.391	.0003	156.00	241.63	18.40	517.0	-5.055	0	1.78	.002	.03	808.5	-3.044	.0012
4_2	"	50	29.54	.99					137.60	261.16					1.75	.003				
5_R	May 12	48	29.13	1.22	- .59	844.5	-2.635	.0042	141.81	312.16	- 2.39	1120.0	- .568	.2849	1.79	.003	.03	828.5	-2.640	.0041
5_2	"	50	29.72	1.51					145.20	372.55					1.76	.001				
6_R	May 15	50	29.76	1.25	- .52	962.5	-2.062	.0196	140.74	266.45	- 6.12	1035.0	-1.483	.0690	1.75	.003	.01	1208.0	- .290	.3859
6_2	"	50	30.28	1.35					146.86	407.53					1.74	.002				
7_R	May 19	50	29.68	1.45	- .58	935.0	-2.239	.0125	129.70	403.90	-13.70	821.0	-2.959	.0015	1.70	.004	-.02	931.0	-2.200	.0139
7_2	"	50	30.26	1.67					143.40	530.75					1.72	.003				
8_R	May 24	50	30.26	2.52	- .08	1242.0	- .057	.4766	157.82	609.61	2.56	1201.0	- .338	.3677	1.78	.004	.0	1082.0	-1.158	.1234
8_2	"	50	30.34	1.25					155.26	518.10					1.77	.003				
9_R	May 29	50	29.98	2.22	- .14	1199.5	- .358	.3602	152.92	616.71	2.88	1166.5	- .576	.2823	1.78	.003	.02	980.0	-1.861	.0313
9_2	"	50	30.12	1.70					150.04	475.53					1.76	.002				
Σ_R		448	29.99	1.98	- .06	39.0[b]	-	>.05	148.55	432.98	- 4.85	40.0	-	>.05	1.76	.005	-.01	36.5[b]	-	>.05
Σ_2		500	30.05	1.88					153.40	575.52					1.78	.005				>.01
				F=1.05[c]				<.01		F=1.19[c]				<.01		F=1.00[c]				

[a]R, river sample; 2, channel no.2 sample; N, number of fry in sample; S^2, variance of the mean; $\Delta 1$, difference between means of parameter ($R-Ch_2$); U, z, P, statistics of the Mann-Whitney test.

[b]Test on sample means, $n_1 = n_2 = 9$.

[c]Test on homogeneity of variances.

APPENDIX TABLE XXXII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Fulton River and Spawning Channel No. 2 in 1976.

Sample	Date	N	Mean Length(mm)	S^2	Δ_i (mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i (mg)	U	Z	P	Mean Index(K_D)	S^2	Δ_i (K_D)	U	Z	P
1_R[a]	Apr. 30	50	30.20	9.35	1.02	847.0	-2.890	.0019	155.24	356.08	8.28	921.5	-2.267	.0117	1.79	.010	-.02	1051.0	-1.372	.0850
1_2	" "	50	29.18	.72					146.96	190.92					1.81	.002				
2_R	May 4	50	29.26	1.42	-.60	906.5	-2.484	.0065	157.44	384.04	19.04	588.0	-4.565	0	1.84	.005	.11	214.0	-7.143	0
2_2	" "	50	29.86	.86					138.40	288.01					1.73	.002				
3_R	May 7	50	29.18	1.38	-.38	1091.0	-1.128	.1296	164.92	369.69	16.04	641.0	-4.204	0	1.88	.006	.09	448.0	-5.530	0
3_2	May 11	50	29.56	2.17					148.88	288.69					1.79	.004				
4_R	May 14	48	28.90	1.33	-1.86	372.0	-6.006	0	169.25	365.21	23.49	450.0	-5.332	0	1.91	.007	.20	67.5	-8.049	0
4_2	" "	50	30.76	2.02					145.76	296.86					1.71	.005				
5_R	May 17	49	29.37	1.07	.43	1020.0	-1.506	.0645	145.39	329.51	3.85	1095.0	-.910	.1814	1.79	.004	.04	730.5	-3.462	.0003
5_2	" "	50	29.80	1.10					141.54	196.02					1.75	.002				
6_R	May 21	50	28.88	.97	-1.86	247.5	-7.088	0	145.00	246.73	-.04	1223.0	-.186	.4263	1.82	.003	.11	256.0	-6.854	0
6_2	" "	50	30.74	1.26					144.96	217.86					1.71	.004				
7_R	May 25	50	29.42	1.02	-.30	1028.5	-1.606	.0542	150.40	300.92	5.28	1027.0	-1.541	.0617	1.80	.002	.03	689.0	-3.870	.0001
7_2	" "	50	29.72	.78					145.12	179.47					1.77	.002				
8_R	June 1	50	28.94	.74	-.50	952.5	-2.148	.0159	152.16	367.02	11.56	823.5	-2.944	.0016	1.84	.002	.08	384.5	-5.968	0
8_2	" "	50	29.44	1.49					140.60	304.05					1.76	.005				
Σ_R		397	29.27	2.38	-.61	9.5[b]		.0085	154.93	399.32	10.91	7[b]		.0030	1.83	.007	.07	4[b]		.0010
Σ_2		400	29.88	1.54					144.02	261.69					1.76	.004				
			F = 1.55[c]					<.01	F = 1.53[c]					<.01	F = 1.75[c]					<.01

[a]R, river samples; 2, spawning channel no. 2 samples; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (R-2); U, Z, P, statistics of the Mann-Whitney test.

[b]$n_1 = n_2 = 8$.

[c]Test on homogeneity of variances.

APPENDIX TABLE XXXIII: Calculation process for fry migration from Pinkut Creek based on standard index sampling.

	Trap No.	
Date - May 22-23, 1972	7	8
Fishing Time		
00:30-00:35	698	1031
01:00-01:05	727	1309
01:30-01:35	727	1309
02:00-02:05	582	814
02:30-02:35	419	846
03:00-03:05	193	672
03:30-03:35	99	569
04:00-04:05	235	292
Total	3680	6842

Actual Catch in Index Period by Traps 7 and 8 = 10,522

Step No. 1. Estimated Catch if Traps 7 and 8 Fished Full Index Period
10,522 x 6 = 63,132

No. 2. Estimated Catch if Traps 7 and 8 Fished Full 24 Hr. Period Using May 21 - 22 Time Check

$$\frac{100}{94.77} \times 63,132 = 66,616$$

No. 3. Estimated Catch for 5 x Factor
5 x 66,616 = 333,080

i.e. Each Trap Fishes 1/5th of Cross Section Width

APPENDIX TABLE XXXIV: Calculation process for fry migration from the Pinkut Creek Spawning Channel based on time check sampling.

Date - May 21-22, 1972 River Gauge = 2.7 ft.

Time		Trap No. 7	Trap No. 8	
13:00-13:05		0	0	
13:30-13:35		1	0	
18:00-18:05		0	0	
20:00-20:05		0	0	
22:30-22:35		18	25	
23:00-23:05		91	140	
23:30-23:35		188	343	
24:00-00:05		391	545	
00:30-00:35		1998	2255	
01:00-01:05		3850	4262	
01:30-01:35		3630	5912	
02:00-02:05	15,754	2750	5087	30,252
02:30-02:35		1650	2750	
03:00-03:05		880	5612	
03:30-03:35		412	2310	
04:00-04:05		584	2064	
04:30-04:35		229	520	
05:00-05:05		15	29	
05:30-05:35		2	1	
06:00-06:05		0	0	
09:00-09:05		0	0	
		16,689	31,855	

Index Period Time Check $= \frac{15754 + 30,252}{16689 + 37,855} = \frac{46,006}{48,544} \times 100 = 94.77\%$

Step No. 1. $\frac{240}{40} \times 46,006 = 276,036$

2. $\frac{100}{94.77} \times 276,036 = 291,269$

3. $\frac{100}{20} \times 291,269 = 1,456,345$ = Nightly Estimate

APPENDIX TABLE XXXV: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1969.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
1_R [a]	May 12	50	28.82	3.33	-1.64	560.0	-4.874	0	140.18	399.10	-2.68	1139.5	-.762	.2230	1.80	.008	.09	467.0	-5.399	0
1_{CH}	" "	50	30.46	1.32					142.86	285.44					1.71	.001				
2_R	May 13	50	28.82	2.72	-1.70	538.5	-5.039	0	149.92	373.33	4.76	1083.0	-1.152	.1247	1.84	.008	.12	212.5	-7.153	0
2_{CH}	" "	50	30.52	.99					145.16	265.71					1.72	.002				
3_R	May 14	50	28.88	2.11	-1.64	496.5	-5.363	0	141.74	187.15	-1.96	1124.0	-.869	.1925	1.81	.005	.10	294.5	-6.588	0
3_{CH}	" "	50	30.52	1.11					143.70	265.13					1.71	.002				
4_R	May 16	50	28.62	1.87	-1.76	414.5	-5.872	0	141.58	236.30	-2.30	1128.5	-.838	.2011	1.82	.005	.10	324.5	-6.381	0
4_{CH}	" "	50	30.38	1.14					143.88	353.96					1.72	.002				
5_R	May 18	50	29.16	1.44	-1.46	394.0	-6.144	0	142.04	181.11	1.44	1123.5	-.873	.1914	1.79	.005	.09	328.5	-6.353	0
5_{CH}	" "	50	30.62	.65					140.60	209.69					1.70	.004				
6_R	May 20	50	29.06	1.77	-1.76	356.5	-6.301	0	139.44	257.69	-13.28	731.5	-3.576	.0002	1.78	.003	.05	595.5	-4.512	0
6_{CH}	" "	50	30.82	.80					152.72	390.92					1.73	.003				
7_R	May 22	50	29.10	1.60	-1.20	549.0	-5.313	0	139.48	315.41	-6.82	955.5	-2.031	.0212	1.78	.003	.04	748.0	-3.462	.0003
7_{CH}	" "	50	30.30	.34					146.30	206.65					1.74	.003				
8_R	May 24	50	29.14	1.63	-1.38	501.5	-5.328	0	143.96	318.05	-9.78	868.0	-2.635	.0042	1.80	.003	.05	684.0	-3.902	.0001
8_{CH}	" "	50	30.52	1.03					153.74	325.45					1.75	.003				
9_R	May 26	48	29.10	1.03	-1.22	437.5	-5.688	0	141.83	200.75	-8.59	785.5	-2.949	.0016	1.79	.002	.04	688.0	-3.639	.0001
9_{CH}	" "	50	30.32	.71					150.42	192.71					1.75	.002				
10_R	May 28	50	29.46	.87	-.94	688.5	-4.179	0	145.54	155.39	.32	1219.0	-.214	.4152	1.78	.002	.06	499.0	-5.178	0
10_{CH}	" "	50	30.40	1.43					145.22	485.31					1.72	.003				
11_R	May 30	50	28.88	1.29	-1.46	639.0	-4.309	0	140.98	293.50	-24.40	703.5	-3.769	.0001	1.80	.003	0	1209.5	-.279	.3901
11_{CH}	" "	50	30.34	4.19					165.38	1490.18					1.80	.004				
ϵ_R	May 30	548	29.00	1.81	-1.47	0^b		<.001	142.43	269.29	-5.75	22^b	.001<p	<.01	1.80	.005	.07	6.5^b		<.001
ϵ_{CH}	" "	550	30.47	1.25					148.18	444.43					1.73	.003				
				$F = 1.45^c$				<.01		$F = 1.65^c$				<.01		$F = 1.67^c$				<.01

[a] R, river samples; CH, spawning channel samples; N, number of fry in samples; S^2, variance of the mean; Δ_i, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 11$.

[c] Test on homogeneity of variance.

APPENDIX TABLE XXXVI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1970.

Sample	Date		N	Mean Length(mm)	s^2	Δi(mm)	U	Z	P	Mean Weight(mg)	s^2	Δi(mg)	U	Z	P	Mean Index(K_D)	s^2	Δi(K_D)	U	Z	P
1_R [a]	Apr.	29	50	28.86	3.31	.58	1043.5	-1.457	.0725	121.04	443.97	13.40	759.0	-3.388	.0003	1.71	.003	.03	890.0	-2.482	.0063
1_{CH}	"	"	50	28.28	2.49					107.64	257.84					1.68	.002				
2_R	May	1	50	28.56	2.41	.72	912.0	-2.420	.0078	115.32	328.36	8.66	840.5	-2.825	.0023	1.70	.006	0	1223.0	-.186	.4263
2_{CH}	"	"	50	27.84	.99					106.66	189.10					1.70	.004				
3_R	May	3	50	28.40	2.08	.94	779.5	-3.359	.0004	123.96	335.32	17.94	533.0	-4.944	0	1.75	.004	.03	791.0	-3.165	.0008
3_{CH}	"	"	50	27.46	1.19					106.02	293.25					1.72	.007				
4_R	May	5	50	28.00	1.55	.94	722.5	-3.754	.0001	115.72	243.32	14.70	530.5	-4.963	0	1.74	.003	.02	993.5	-1.769	.0385
4_{CH}	"	"	50	27.06	1.61					101.02	366.44					1.72	.003				
5_R	May	7	50	28.06	2.06	.92	764.5	-3.463	.0003	113.44	359.61	6.32	1029.5	-1.521	.0642	1.72	.003	-.03	891.0	-2.475	.0067
5_{CH}	"	"	50	27.14	.69					107.12	170.44					1.75	.003				
6_R	May	9	50	29.20	3.22	1.48	655.5	-4.167	0	122.26	308.98	18.22	596.5	-4.507	0	1.70	.004	.01	1097.0	-1.055	.1458
6_{CH}	"	"	50	27.72	1.96					104.04	427.89					1.69	.009				
7_R	May	11	50	28.38	1.67	.86	762.0	-3.492	.0003	118.82	226.33	11.16	721.5	-3.647	.0002	1.73	.003	.01	1132.5	-.810	.2090
7_{CH}	"	"	50	27.52	1.11					107.66	247.02					1.72	.003				
8_R	May	12	50	27.98	1.45	.68	854.0	-2.809	.0026	115.84	197.54	10.64	749.0	-3.456	.0003	1.74	.004	.01	1033.0	-1.496	.0673
8_{CH}	"	"	50	27.30	1.44					105.20	255.85					1.73	.004				
9_R	May	13	50	28.90	1.77	.60	981.5	-1.906	.0283	112.40	310.38	6.40	1012.5	-1.640	.0505	1.67	.003	0	1239.5	-.072	.4713
9_{CH}	"	"	50	28.30	1.89					106.00	291.18					1.67	.004				
10_R	May	14	50	28.16	1.40	-.04	1218.0	-.230	.4090	115.04	167.36	3.96	1089.5	-1.107	.1342	1.73	.003	.03	883.5	-2.527	.0058
10_{CH}	"	"	50	28.20	1.43					111.08	254.37					1.70	.003				
11_R	May	15	50	28.34	1.09	.40	1019.0	-1.672	.0473	119.24	190.52	7.00	982.0	-1.849	.0323	1.73	.003	.01	1094.5	-1.072	.1419
11_{CH}	"	"	50	27.94	1.65					112.24	263.09					1.72	.003				
12_R	May	16	50	29.34	1.49	.30	1091.5	-1.122	.1310	114.10	155.16	-.88	1229.5	-.142	.4435	1.65	.002	-.02	1179.0	-.490	.3121
12_{CH}	"	"	50	29.04	1.88					114.98	515.70					1.67	.008				
13_R	May	17	50	29.94	1.57	.86	816.0	-3.081	.0010	121.74	303.72	13.86	697.0	-3.816	.0001	1.65	.001	.02	902.0	-2.400	.0082
13_{CH}	"	"	50	29.08	1.79					107.88	297.10					1.63	.003				
14_R	May	18	50	29.86	1.55	.80	828.5	-2.990	.0014	128.74	268.00	17.14	532.0	-4.953	0	1.69	.002	.04	607.0	-4.433	.0000
14_{CH}	"	"	50	29.06	1.32					111.60	212.46					1.65	.003				
15_R	May	19	50	29.98	1.20	.76	826.0	-3.039	.0012	137.80	400.87	20.28	534.5	-4.936	0	1.72	.003	.05	700.0	-3.792	.0001
15_{CH}	"	"	50	29.22	1.52					117.52	285.86					1.67	.004				
16_R	May	20	50	28.26	1.58	.82	834.5	-2.953	.0016	118.04	226.91	11.76	836.5	-2.852	.0022	1.73	.004	.01	1053.5	-1.355	.0877
16_{CH}	"	"	50	27.44	2.09					106.28	418.01					1.72	.005				
17_R	May	21	50	28.96	2.28	.98	749.0	-3.532	.0002	130.20	335.89	19.00	522.0	-5.020	0	1.75	.006	.03	983.0	-1.841	.0328
17_{CH}	"	"	50	27.98	1.49					111.20	169.56					1.72	.004				

Appendix Table XXXVI (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δi(mm)	U	Z	P	Mean Weight(mg)	S^2	Δi(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta i(K_D)$	U	Z	P
18_R	May 22	50	28.90	1.24	.72	855.0	-2.810	.0025	127.66	226.73	11.92	771.0	-3.303	.0005	1.74	.002	.02	1070.0	-1.241	.1073
18_{CH}	" "	50	28.18	2.40					115.74	391.84					1.72	.005				
19_R	May 23	50	29.00	1.80	.88	792.0	-3.239	.0006	129.48	346.27	15.84	687.0	-3.883	.0001	1.74	.002	.03	1005.0	-1.689	.0456
19_{CH}	" "	50	28.12	1.41					113.64	428.24					1.71	.011				
20_R	May 24	50	29.06	2.43	1.08	739.0	-3.597	.0002	129.02	386.07	14.18	801.0	-3.097	.0010	1.74	.004	.01	1223.5	-.183	.4274
20_{CH}	" "	50	27.98	1.90					114.84	435.17					1.73	.003				
21_R	May 25	50	28.52	2.62	.36	1038.5	-1.492	.0678	128.48	417.12	9.94	872.0	-2.607	.0046	1.77	.008	.03	1120.5	-.893	.1859
21_{CH}	" "	50	28.16	1.81					118.54	283.45					1.74	.004				
22_R	May 26	46	28.91	1.59	.83	769.0	-2.860	.0021	128.35	285.22	10.91	789.5	-2.645	.0040	1.74	.003	0	1058.0	-.675	.2499
22_{CH}	" "	50	28.08	2.04					117.44	462.63					1.74	.004				
23_R	May 27	50	28.76	1.94	.32	1037.0	-1.520	.0643	136.48	376.92	14.44	732.5	-3.569	.0002	1.79	.007	.05	796.0	-3.130	.0009
23_{CH}	" "	50	28.44	1.60					122.04	312.79					1.74	.004				
24_R	May 28	41	28.20	1.71	-.42	805.0	-1.837	.0331	129.02	441.44	9.08	766.5	-2.063	.0196	1.79	.013	.07	675.5	-2.788	.0026
24_{CH}	" "	50	28.62	1.26					119.94	410.60					1.72	.004				
25_R	May 30	47	28.70	2.34	.18	1047.0	-.946	.1721	129.87	598.17	10.69	855.0	-2.311	.0104	1.76	.006	.04	856.0	-2.303	.0106
25_{CH}	" "	50	28.52	1.56					119.18	310.41					1.72	.003				
26_R	May 31	50	28.90	2.13	.48	965.0	-2.029	.0212	128.04	391.77	7.06	946.5	-2.094	.0181	1.74	.003	0	1223.0	-.186	.4263
26_{CH}	" "	50	28.42	1.43					120.98	249.21					1.74	.006				
27_R	June 1	50	29.62	1.55	.74	856.0	-2.802	.0026	145.28	455.69	16.18	696.5	-3.817	.0001	1.77	.003	.02	948.0	-2.082	.0187
27_{CH}	" "	50	28.88	1.70					129.10	396.72					1.75	.003				
28_R	June 2	50	30.04	1.88	1.00	752.5	-3.518	.0002	139.88	378.98	19.14	566.0	-4.718	0	1.73	.005	.03	962.0	-1.986	.0235
28_{CH}	" "	50	29.04	1.79					120.74	312.78					1.70	.004				
29_R	June 3	50	29.18	2.07	-.08	1195.0	-.389	.3487	122.36	411.96	.84	1162.5	-.604	.2729	1.70	.006	.01	1135.5	-.789	.2151
29_{CH}	" "	50	29.26	2.07					121.52	544.67					1.69	.003				
ε_R		1434	28.87	2.22	.65	211[b]	-3.258	.0006	124.70	390.07	11.67	120[b]	-4.673	0	1.73	.005	.02	268.5[b]	-2.364	.0090
ε_{CH}		1450	28.22	2.00					113.03	364.39					1.71	.005				
				F = 1.11[c]				<.01		F = 1.07[c]				<.01		F = 1.00[c]				>.01

[a] R, river sample; CH, spawning channel samples; N, number of fry in samples; S^2, variance of the mean; Δi, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 29$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXXVII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1971.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 5	50	27.58	2.54	-1.82	401.0	-5.984	0	140.44	164.39	-.16	1245.5	-.031	.4876	1.89	.010	.12	157.0	-7.535	0
1_{CH}	" "	50	29.40	.90					140.60	307.16					1.77	.002				
2_R	May 7	50	27.88	1.74	-1.00	704.0	-3.886	.0001	137.08	294.29	3.56	1105.5	-.997	.1594	1.85	.004	.08	422.0	-5.708	0
2_{CH}	" "	50	28.88	1.01					133.52	224.68					1.77	.003				
3_R	May 10	50	28.22	2.67	-1.20	705.5	-3.845	.0001	139.44	372.31	2.38	1158.5	-.631	.2640	1.84	.008	.09	400.0	-5.860	0
3_{CH}	" "	50	29.42	1.55					137.06	303.58					1.75	.002				
4_R	May 12	50	28.30	1.93	-.84	829.0	-2.978	.0014	140.06	353.29	8.62	938.0	-2.152	.0157	1.83	.003	.09	294.0	-6.591	0
4_{CH}	" "	50	29.14	1.39					131.44	328.96					1.74	.003				
5_R	May 14	50	28.86	1.14	.06	1239.5	-.075	.4701	142.24	241.10	10.60	806.5	-3.059	.0011	1.81	.003	.05	701.0	-3.785	.0001
5_{CH}	" "	50	28.80	1.72					131.64	301.63					1.76	.003				
6_R	May 17	50	28.96	1.26	-.60	875.0	-2.697	.0035	139.34	205.22	2.44	1087.0	-1.125	.1303	1.79	.003	.05	584.0	-4.592	0
6_{CH}	" "	50	29.56	1.23					136.90	330.10					1.74	.002				
7_R	May 19	50	28.96	2.12	-.66	925.0	-2.308	.0105	144.74	372.86	8.78	973.5	-1.907	.0283	1.81	.003	.08	355.5	-6.167	0
7_{CH}	" "	50	29.62	1.38					135.96	530.91					1.73	.002				
8_R	May 21	50	29.26	1.83	.30	1060.5	-1.356	.0875	140.70	339.86	9.00	921.5	-2.266	.0117	1.77	.003	.02	1057.5	-1.327	.0923
8_{CH}	" "	50	28.96	2.28					131.70	366.27					1.75	.005				
9_R	May 23	50	29.16	1.00	-.32	1060.0	-1.373	.0849	142.08	236.62	8.34	870.0	-2.621	.0044	1.79	.004	.06	562.0	-4.745	0
9_{CH}	" "	50	29.48	1.32					133.74	320.13					1.73	.002				
10_R	May 25	50	29.36	1.22	-.46	963.5	-2.065	.0195	140.36	318.17	1.08	1239.0	-.076	.4697	1.77	.003	.03	754.0	-3.420	.0003
10_{CH}	" "	50	29.82	1.01					139.28	293.85					1.74	.003				
11_R	May 27	50	29.68	1.08	-.60	847.5	-2.929	.0017	147.46	219.18	8.34	832.0	-2.884	.0020	1.78	.002	.07	323.5	-6.388	0
11_{CH}	" "	50	30.28	1.10					139.12	202.90					1.71	.001				
12_R	May 29	50	29.84	1.08	-.28	1046.0	-1.463	.0717	143.80	321.36	2.40	1192.0	-.400	.3446	1.75	.003	.02	918.5	-2.236	.0126
12_{CH}	" "	50	30.12	1.54					141.40	300.67					1.73	.002				
13_R	May 31	50	30.18	.72	-.04	1181.0	-.508	.3057	149.30	228.33	7.28	975.5	-1.894	.0291	1.76	.002	.04	731.0	-3.579	.0002
13_{CH}	" "	50	30.22	.87					142.02	337.99					1.72	.002				
14_R	June 2	50	29.88	.64	-.26	1076.0	-1.330	.0918	152.42	324.51	13.68	755.0	-3.414	.0003	1.78	.002	.07	358.5	-6.147	0
14_{CH}	" "	50	30.14	.78					138.74	272.09					1.71	.002				
15_R	June 4	50	29.84	.87	-.62	827.5	-3.055	.0011	150.28	412.67	2.88	1149.0	-.697	.2429	1.78	.003	.05	577.0	-4.640	0
15_{CH}	" "	50	30.46	1.07					147.40	323.98					1.73	.002				
16_R	June 6	50	30.52	.99	-.40	963.5	-2.062	.0196	156.64	402.55	13.04	814.5	-3.004	.0013	1.76	.004	.07	400.0	-5.860	0
16_{CH}	" "	50	30.92	1.54					143.60	439.24					1.69	.002				

Appendix Table XXXVII (cont.)

Sample	Date	N	Mean Length(mm)	S^2	Δ_i(mm)	U	Z	P	Mean Weight(mg)	S^2	Δ_i(mg)	U	Z	P	Mean Index(K_D)	S^2	$\Delta_i(K_D)$	U	Z	P
17_R	June 8	50	30.80	2.16	-1.02	526.0	-5.178	0	145.42	292.71	-4.02	1049.0	-1.386	.0829	1.71	.006	.05	602.5	-4.464	0
17_{CH}	" "	50	31.82	.60					149.44	289.29					1.66	.002				
18_R	June 10	50	29.98	1.90	-1.14	683.5	-4.009	0	143.84	501.01	1.72	1145.5	-.721	.2355	1.74	.002	.07	335.0	-6.309	0
18_{CH}	" "	50	31.12	1.41					142.12	369.14					1.67	.003				
ϵ_R		900	29.29	2.22	-.61	109.0[b]		.05	144.20	330.57	5.55	68.0[b]		<.001[b]	1.79	.006	.06	31.5[b]		<.001
ϵ_{CH}		900	29.90	1.87					138.65	344.19					1.73	.004				
				F = 1.19[c]				<.01		F = 1.04[c]				<.01		F = 1.50[c]				<.01

[a] R, river samples; CH, spawning channel samples; N, number of fry in sample; S^2, variance of the mean; Δ_i, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 18$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXXVIII: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1972.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 12	50	28.42	1.96	-1.56	494.5	-5.345	0	130.00	263.51	3.62	1117.5	-.914	.1804	1.78	.005	.11	210.5	-7.167	0
1_{CH}	" "	50	29.98	1.24					126.38	297.19					1.67	.001				
2_R	May 15	50	28.90	2.05	-.32	1123.0	-.907	.1822	141.08	211.80	1.72	1152.0	-.676	.2495	1.80	.008	.02	948.5	-2.079	.0188
2_{CH}	" "	50	29.22	2.63					139.36	243.31					1.78	.009				
3_R	May 17	50	28.74	1.58	-1.14	667.0	-4.116	0	139.78	344.51	1.44	1231.5	-.128	.4490	1.80	.005	.07	441.0	-5.578	0
3_{CH}	" "	50	29.88	1.74					138.34	322.98					1.73	.002				
4_R	May 19	50	28.76	1.62	-.74	931.0	-2.267	.0117	148.88	200.86	11.92	707.5	-3.741	.0001	1.84	.005	.10	253.0	-6.874	0
4_{CH}	" "	50	29.50	1.97					136.96	497.81					1.74	.003				
ϵ_R		200	28.70	1.81	-.94	0^b		.014	139.93	296.56	4.67	3^b		.100	1.81	.006	.08	$.5^b$		.022
ϵ_{CH}		200	29.64	1.96					135.26	362.33					1.73	.005				
			$F = 1.08^c$					>.01		$F = 1.22^c$				>.01	$F = 1.20^c$					>.01

[a] R, river samples; CH, spawning channel samples; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 4$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XXXIX: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1973.

Sample	Date	N	Mean Length(mm)	s^2	Δ_1(mm)	U	Z	P	Mean Weight(mg)	s^2	Δ_1(mg)	U	Z	P	Mean Index(K_D)	s^2	$\Delta_1(K_D)$	U	Z	P
1_R [a]	May 16	50	25.62	1.63	-1.34	632.5	-4.345	0	141.48	506.51	-1.88	1201.5	-.335	.3688	2.03	.008	.09	553.5	-4.802	0
1_{CH}	" "	50	26.96	2.24					143.36	453.27					1.94	.007				
2_R	May 18	50	26.62	4.89	-.84	932.5	-2.226	.0130	151.44	981.47	3.16	1189.0	-.421	.3368	2.00	.012	.07	743.5	-3.492	.0002
2_{CH}	" "	50	27.46	1.89					148.28	278.10					1.93	.004				
3_R	May 20	45	27.27	3.56	-1.35	562.0	-4.264	0	141.44	606.36	-13.30	692.0	-3.230	.0006	1.91	.012	.04	773.5	-2.620	.0044
3_{CH}	" "	50	28.62	1.91					154.74	420.27					1.87	.003				
4_R	May 22	24	27.46	2.78	-1.60	265.0	-3.952	0	144.83	289.54	-3.77	517.0	-.960	.1685	1.91	.004	.09	147.5	-5.226	0
4_{CH}	" "	50	29.06	1.32					148.60	329.12					1.82	.002				
5_R	May 24	26	28.69	1.66	-.41	514.0	-1.541	.0617	169.15	286.72	18.57	265.0	-4.218	0	1.93	.004	.10	129.5	-5.700	0
5_{CH}	" "	50	29.10	1.52					150.58	244.06					1.83	.002				
6_R	May 26	12	28.75	2.93	-.35	257.0	-.797	.2128	156.58	421.55	9.76	218.5	-1.454	.0729	1.87	.006	.06	140.0	-2.852	.0022
6_{CH}	" "	50	29.10	1.40					146.82	303.00					1.81	.002				
7_R	May 28	46	28.30	1.73	-1.02	643.5	-3.831	.0001	153.17	258.76	1.85	1088.5	-.451	.3260	1.89	.003	.08	293.5	-6.282	0
7_{CH}	" "	50	29.32	1.20					151.32	408.24					1.81	.002				
8_R	May 30	50	28.40	2.12	-1.08	719.5	-3.774	.0001	158.10	318.61	1.98	1168.5	-.562	.2870	1.90	.004	.08	409.0	-5.798	0
8_{CH}	" "	50	29.48	1.15					156.12	392.53					1.82	.003				
9_R	June 1	50	28.34	1.37	-1.22	541.5	-5.042	0	145.62	270.80	-14.48	729.5	-3.590	.0002	1.85	.003	.02	950.5	-2.065	.0195
9_{CH}	" "	50	29.56	.78					160.10	401.35					1.83	.002				
10_R	June 4	50	29.02	1.94	-.64	737.5	-3.695	.0001	146.44	213.04	-9.64	836.5	-2.854	.0022	1.82	.005	.01	1105.0	-1.000	.1587
10_{CH}	" "	50	29.66	.88					156.08	337.73					1.81	.001				
11_R	June 6	50	29.52	1.15	-.20	1188.5	-.464	.3214	152.22	267.96	.14	1205.0	-.310	.3783	1.81	.002	.02	1023.5	-1.562	.0592
11_{CH}	" "	50	29.72	.61					152.08	321.94					1.79	.002				
12_R	June 8	44	29.32	.78	-.66	665.0	-3.646	.0002	149.86	174.93	-7.08	833.5	-2.022	.0216	1.81	.002	.01	930.5	-1.285	.0994
12_{CH}	" "	50	29.98	.47					156.94	237.14					1.80	.001				
13_R	June 11	50	29.16	1.24	-.50	921.5	-2.411	.0080	147.64	454.31	-.98	1245.0	-.035	.4860	1.81	.002	.03	815.5	-2.997	.0013
13_{CH}	" "	50	29.66	.88					148.62	336.27					1.78	.001				
14_R	June 12	50	29.72	.61	-.28	1037.0	-1.668	.0477	154.98	313.27	1.94	1143.0	-.738	.2302	1.80	.003	.02	911.0	-2.338	.0097
14_{CH}	" "	50	30.00	.61					153.04	387.69					1.78	.002				
15_R	June 14	50	29.50	.95	-.10	1158.0	-.692	.2445	150.60	371.82	3.84	1090.5	-1.100	.1335	1.80	.002	.02	876.0	-2.579	.0049
15_{CH}	" "	50	29.60	1.18					146.76	446.45					1.78	.002				
16_R	June 16	19	29.95	.94	-.03	452.0	-.350	.3632	169.26	402.99	15.12	288.5	-2.508	.0060	1.84	.002	.05	116.0	-4.826	0
16_{CH}	" "	50	29.98	.88					154.14	314.18					1.79	.001				

Appendix Table XXXIX (cont.)

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{i(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{i(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{i(K_D)}$	U	Z	P
17_R	June 18	50	29.70	.83	-.64	800.0	-3.422	.0003	159.56	315.69	-6.58	1035.5	-1.480	.0694	1.82	.001	.01	999.0	-1.731	.0417
17_{CH}	" "	50	30.34	.76					166.14	417.61					1.81	.002				
18_R	June 20	44	29.75	.28	-.31	855.5	-2.076	.0190	155.64	165.51	-5.12	912.5	-1.422	.0775	1.81	.002	0	1062.0	-.288	.3867
18_{CH}	" "	50	30.06	.87					16C.76	395.27					1.81	.002				
ϵ_R		760	28.59	3.11	-.72	96.5[b]	.01<p	<.025	151.61	401.87	-1.42	150.0[b]		>.05	1.87	.010	.05	93.0[b]	.01<p	<.025
ϵ_{CH}		900	29.31	1.85					153.03	380.78					1.82	.004				
			F = 1.68[c]					<.01		F = 1.07[c]				>.01		F = 2.50[c]				<.01

[a] R, river samples; CH, spawning channel samples; N, number of fry in samples; S^2, variance of the mean; Δ_i, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 18$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XL: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1974.

Sample	Date	N	Mean Length(mm)	S^2	$\Delta_{1(mm)}$	U	Z	P	Mean Weight(mg)	S^2	$\Delta_{1(mg)}$	U	Z	P	Mean Index(K_D)	S^2	$\Delta_{1(K_D)}$	U	Z	P
1_R [a]	May 14	50	28.24	3.17	-1.00	845.0	-2.877	.0020	138.38	276.21	-9.76	844.0	-2.800	.0026	1.83	.008	.02	1144.5	-.727	.2336
1_{CH}	" "	50	29.24	1.21					148.14	378.06					1.81	.005				
2_R	May 17	50	28.18	2.72	-.82	714.0	-3.814	0	145.06	254.65	-1.38	1165.5	-.583	.2800	1.87	.010	.06	705.5	-3.754	.0001
2_{CH}	" "	50	29.00	1.02					146.44	439.78					1.81	.005				
3_R	May 20	50	28.88	2.23	-.18	1157.0	-.660	.2546	147.42	549.29	-8.02	931.5	-2.196	.0141	1.83	.009	-.02	1106.0	-.993	.1604
3_{CH}	" "	50	29.06	1.85					155.44	476.37					1.85	.005				
4_R	May 23	50	28.50	2.38	-.72	931.0	-2.260	.0119	151.38	383.65	-10.16	881.5	-2.541	.0055	1.87	.007	.01	1193.0	-.393	.3472
4_{CH}	" "	50	29.22	1.60					161.54	451.92					1.86	.005				
5_R	May 26	50	29.58	1.80	-.96	718.0	-3.766	.0010	156.72	336.47	-.18	1234.5	-.107	.4594	1.82	.005	.06	626.5	-4.299	0
5_{CH}	" "	50	30.54	1.32					156.90	358.98					1.76	.004				
6_R	May 29	50	29.66	1.25	.08	1178.0	-.515	.3034	160.66	404.94	-.66	1215.5	-.238	.4060	1.83	.005	-.01	1189.5	-.417	.3383
6_{CH}	" "	50	29.58	2.66					161.32	536.69					1.84	.016				
7_R	May 31	43	28.98	1.26	-1.32	445.5	-4.986	0	144.93	326.56	-24.75	364.5	-5.477	0	1.81	.004	-.02	951.0	-.956	.1695
7_{CH}	" "	50	30.30	1.07					169.68	365.51					1.83	.004				
8_R	June 3	50	29.56	1.72	-.84	801.5	-3.198	.0007	153.40	493.69	-5.72	1048.5	-1.390	.0823	1.81	.003	.03	867.5	-2.637	.0042
8_{CH}	" "	50	30.40	1.18					159.12	325.71					1.78	.002				
9_R	June 6	50	29.50	1.40	-1.02	642.5	-4.321	0	160.16	310.12	-5.72	1064.0	-1.284	.0996	1.84	.003	.04	691.0	-3.854	0
9_{CH}	" "	50	30.52	.91					165.88	390.67					1.80	.003				
10_R	June 9	50	30.08	.97	-.40	972.0	-2.011	.0222	169.30	304.12	.76	1227.0	-.159	.4360	1.84	.004	.03	889.5	-2.486	.0065
10_{CH}	" "	50	30.48	.83					168.54	327.67					1.81	.002				
ε_R	June 9	493	29.12	2.26	-.72	22.5[b]	.01<p	<.025	152.85	434.67	-6.45	27[b]		.05	1.83	.006	.02	30.5[b]		>.05
ε_{CH}	" "	500	29.83	1.74					159.30	453.55					1.81	.006				
			F = 1.30[c]					<.01		F = 1.04[c]				>.01	F = 1.00[c]					>.01

[a] R, river samples; CH, spawning channel samples; N, number of fry in sample; S^2, variance of the mean; Δ_1, difference between means of parameter (R-CH); U, Z, P, statistics of the Mann-Whitney test.

[b] Test on sample means, $n_1 = n_2 = 10$.

[c] Test on homogeneity of variances.

APPENDIX TABLE XLI: Mean lengths, weights and developmental indices, their difference and statistical significance, of sockeye fry in paired samples from Pinkut Creek and the Spawning Channel in 1975.

Sample	Date	N	Mean Length(mm)	S^2	Δi (mm)	U	Z	P	Mean Weight(mg)	S^2	Δi (mg)	U	Z	P	Mean Index(K_D)	S^2	Δi (K_D)	U	Z	P
1_R[a]	May 13	50	28.58	2.25	.20	1069.0	-1.286	.0992												
1_{CH}	" "	50	28.38	1.51																
2_R	May 15	50	28.66	2.03	.08	1170.0	-.570	.2843												
2_{CH}	" "	50	28.58	1.64																
3_R	May 18	50	29.00	2.00	.06	1194.5	-.398	.3453												
3_{CH}	" "	50	28.94	1.41																
4_R	May 20	50	28.90	2.26	-.42	1026.0	-1.580	.0571												
4_{CH}	" "	50	29.32	2.02																
5_R	May 22	50	28.96	2.24	-.12	1221.5	.203	.4195												
5_{CH}	" "	50	29.08	1.42																
6_R	May 26	50	29.12	2.31	-.94	830.5	-2.998	.0013												
6_{CH}	" "	50	30.06	1.94																
7_R	May 28	50	28.78	2.54	-1.04	824.5	-2.993	.0014												
7_{CH}	" "	50	29.82	1.91																
8_R	June 1	50	29.26	2.07	-.36	1119.0	-.944	.1730												
8_{CH}	" "	50	29.62	1.34																
9_R	June 4	50	30.12	1.98	.28	1143.5	-.786	.1872	153.66	711.43	-.44	1115.0	-.932	.1759	1.77	.003	-.02	938.5	-2.148	.0159
9_{CH}	" "	50	29.84	.67					153.22	334.08					1.79	.002				
10_R	June 6	50	30.40	5.10	.86	1022.5	-1.627	.0519	152.40	2270.10	-4.54	1133.0	-.807	.2099	1.74	.006	-.05	700.5	-3.788	.0001
10_{CH}	" "	50	29.54	2.01					147.86	432.47					1.79	.003				
Σ_R		500	29.18	2.77	-.14	41.5[b]		>.05	150.54[c]	386.65	-2.49	4500.5[c]	-1.221	.1110	1.79[c]	.004	.03	3321.5[c]	-4.102	0
Σ_{CH}		500	29.32	1.84					153.03	1476.10					1.76	.002				
				F = 1.51[d]				<.01		F = 3.82[d]				<.01		F = 2.00[d]				<.01

[a] R, river samples; CH, channel samples; N, number of fry in sample; S^2, variance of the mean; Δi, difference between means of parameter (R–CH); U, Z, P, statistics of the Mann-Whitney test.

[b] $n_1 = n_2 = 10$.

[c] $n_1 = n_2 = 100$.

[d] Test on homogeneity of variances.

Date Due
