FUR-27

BIOLOGICAL AND HYDROLOGICAL STUDIES

KLAWOCK LAKE, RIVER AND ESTUARY

1976-77

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Klawock Lake, located on the west coast of Prince of Wales Island, was selected as the source for the water supply for a State salmon hatchery funded by a bond issue passed in the 1976 general election. The facility was designed to produce 57 million chum salmon fry and 3 million coho salmon fingerling at full production. The hatchery is located at the base of a stepped falls in the Klawock River near the outfall of Klawock Lake.

The Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, initiated biological and hydrological monitoring of Klawock Lake, Klawock River, and estuary in 1976. Dissolved oxygen, temperature, acidity/ alkalinity, and suspended solids were monitored in Klawock Lake and in the estuary. Salinity was also monitored in the estuary.

Klawock River was monitored for escapement levels, water flows, and timing of runs. Brood stock availability was determined by foot survey in 1976 and by weir in 1977. In 1976, 17,000 chum salmon were counted, and 12,759 in 1977. There were 3,964 coho, 2,899 sockeye, and 40,595 pink for a total weir count of 60,217 in 1977.

INTRODUCTION

Klawock Lake, located on the west coast of Prince of Wales Island, has been selected as a site for a State salmon hatchery. It has a design capacity for producing 57 million chum salmon fry and 3 million coho salmon fingerlings. Funding was provided by a bond issue passed by the voters in 1976.

The Klawock system was selected because of the large volume of gravity-fed quality water available. Other reasons for site selection were proximity

to a public road system which would reduce operating costs, a local labor force, a potentially high biological productivity, and historic declines in salmon returns to this system and others in the immediate vicinity. The system has never been logged or adversely affected by industry.

Klawock Lake, a 1,176.7 hectare (2,906.4 acre) muskeg lake, forms the collecting basin for a 10,891.4 hectare (26,899 acre) drainage system (Fig. 1). Numerous small streams flow into this 12 km long, 1.1 km wide lake. Klawock Lake has a volume of 20.9×10^7 cm^3 and a maximum depth of 49 m (Schmidt, 1974).

The Klawock River flows from the west end of the lake, descending 9.15 m in 1.6 km before entering the Klawock estuary (Figs. 2 and 3). The hatchery is located near the base of the stepped outfall of Klawock Lake.

Fish species utilizing the Klawock system include Oncorhynchus keta (chum salmon), Oncorhynchus kisutch (silver salmon), Oncorhynchus nerka (sockeye salmon), Salmo clarki clarki (cutthroat trout), Salmo gairdneri (steelhead trout), Gasterosteus aculeatus (three spine stickleback), and Cottidae (sculpins). Salmon are important for commercial and recreational uses and trout for recreational use.

HISTORICAL BACKGROUND

The North Pacific Trading and Packing Company operated a sockeye salmon hatchery on Klawock Lake between 1898 and 1917. This hatchery was originally built near the present hatchery site in 1897, but due to water temperature problems, it was moved the following year to the mouth of Three Mile Creek which flows into Klawock Lake (Mosar, 1898).

A heavy commercial fishery has existed for many years on the west coast of Prince of Wales Island. Records have been kept on salmon returning to Klawock River since 1886 (Rich, 1935; Orrell, et. al., 1963). The 1930 weir

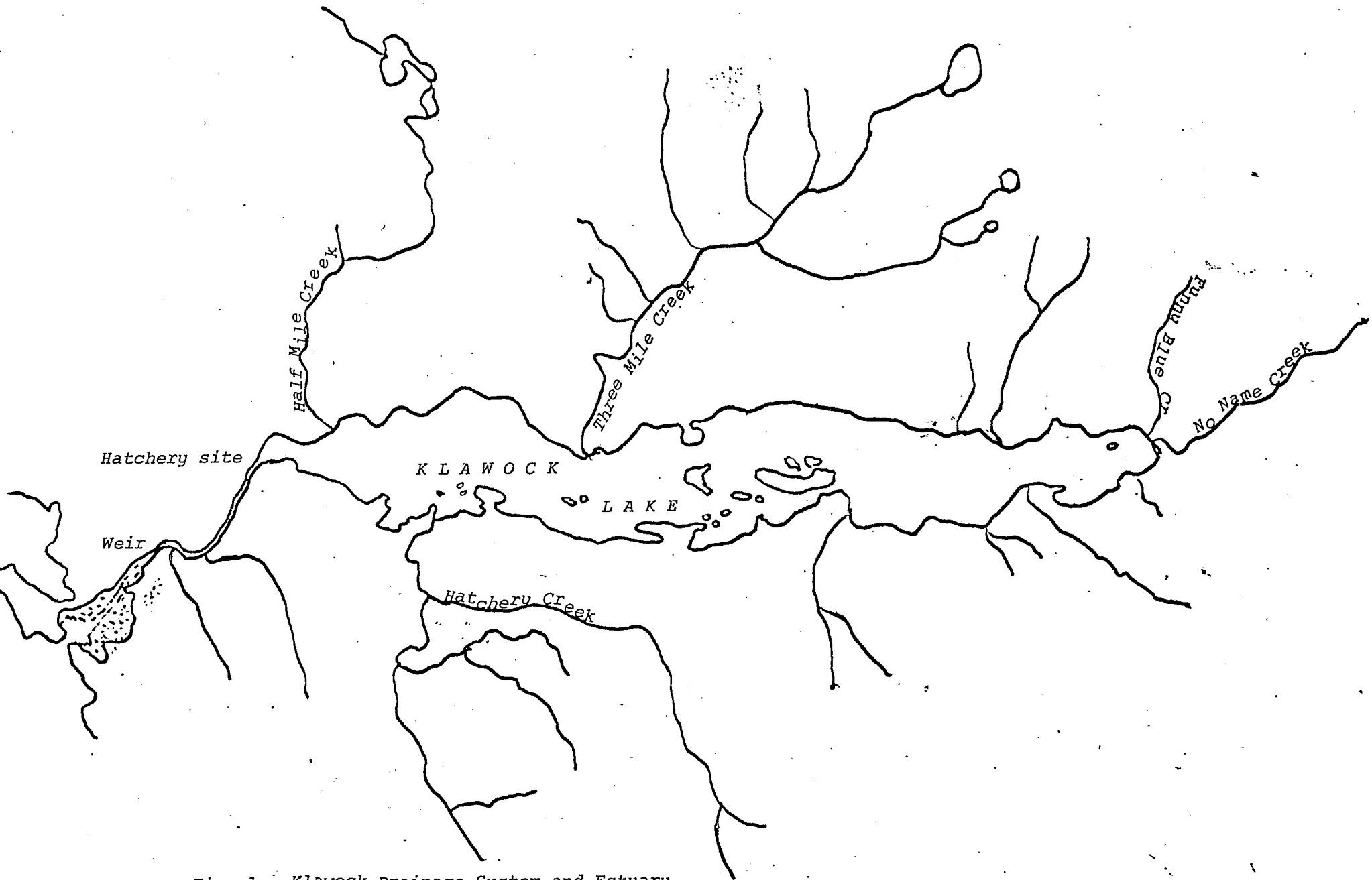

Fig. 1. Klawock Drainage System and Estuary.

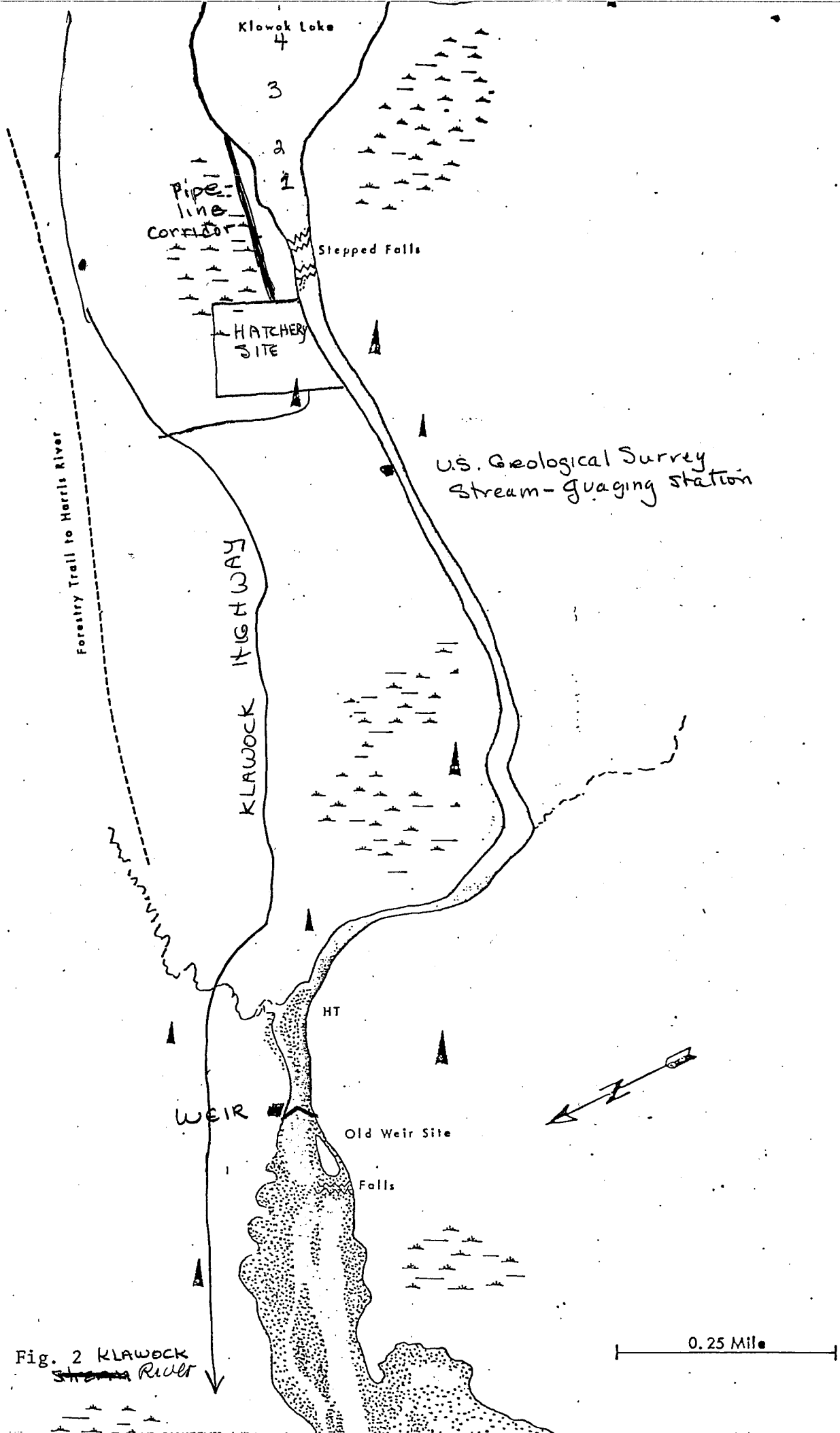

Fig. 2 KLAWOCK ~~Stream~~ River

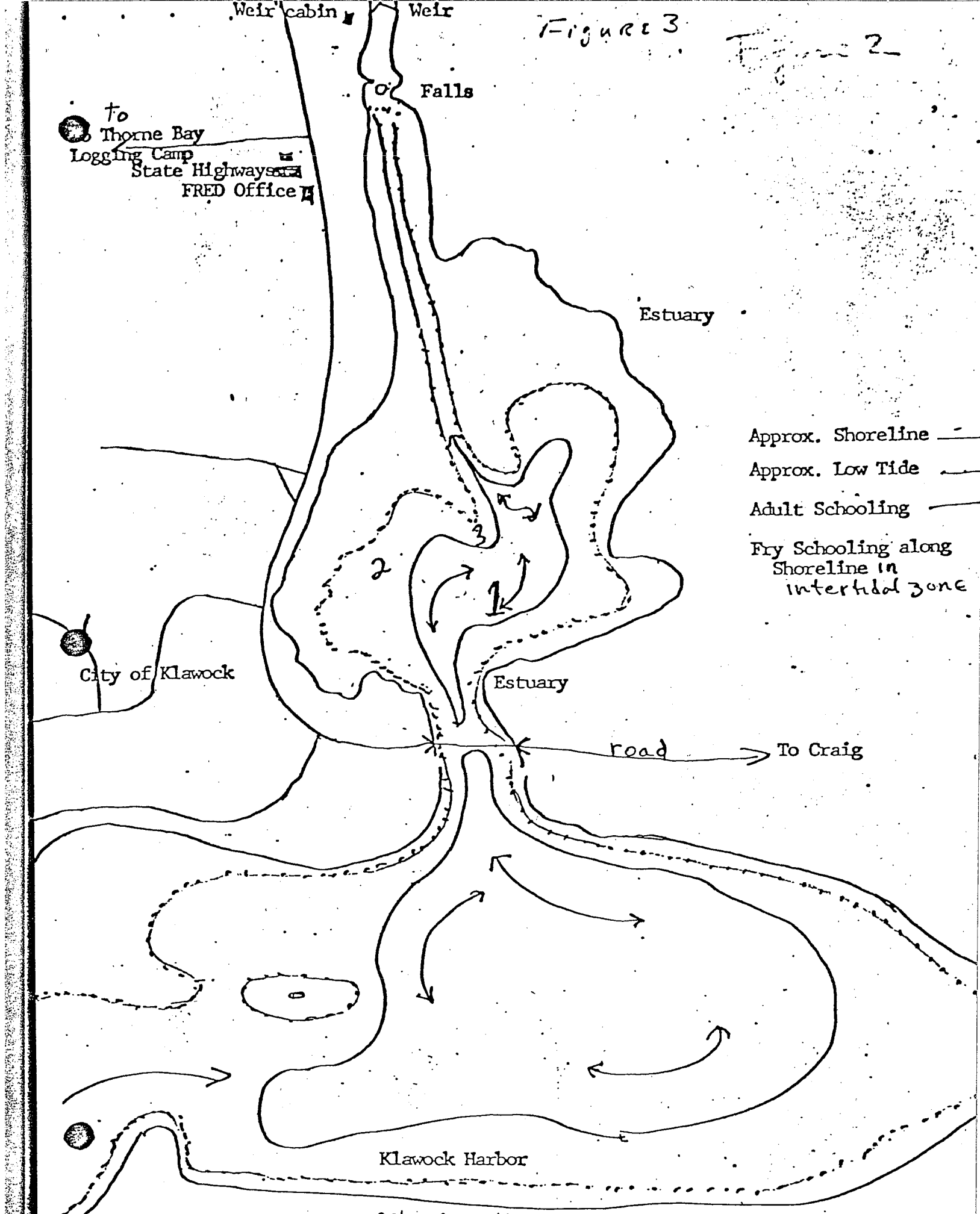

Figure 3. Klawock ~~Klawock Island~~ estuary with adult schooling areas

count showed approximately 1.5 million salmon spawned in this system. The river has been weired several times since 1930 (Table 1). The highest records for chum escapement was 350,000 in 1946 and 264,812 in 1932; the highest coho escapement was 13,240 in 1930; while the highest sockeye escapement was 65,178 in 1936 (Tables 1 and 2).

The Division of Fisheries Rehabilitation, Enhancement and Development (F.R.E.D.) of the Alaska Department of Fish and Game received approval in September 1976 from the Klawock-Heenya Corporation (who selected the land under the Native Land Selection Act) to begin hydrological and biological monitoring of the Klawock system and estuary. Parameters monitored were dissolved oxygen, temperature, acidity/alkalinity, suspended solids, and salinity. These monitoring activities were conducted in cooperation with the Alaska Department of Fish and Game (ADF&G), Alaska Pathology Laboratory (F.R.E.D.), Kramer, Chin and Mayo, the hatchery engineering consultant firm, and the U.S. Geological Survey, which maintains a stream gauging station on Klawock River.

MATERIALS AND METHODS

LAKE INVESTIGATIONS

Four data collecting stations were set up at the lake (Fig. 2). Dissolved oxygen and temperature data were recorded at all four monitoring stations, and pH and suspended solids data were recorded from Station 3. Recording thermographs were anchored and buoyed at Station 3. All data were collected following standard procedures given in the instructions accompanying the equipment.

Dissolved oxygen data were collected at depths of 0.3 m, 1.8 m, and 6.1 m (or 0.61 m from the bottom when 6.1 was not obtainable). A Yellow Springs Instrument Company (YSI) Model 57 meter was used. Accessories included a Model 5739 probe and 15.25 m cable. Water temperature data were collected at

Table 1. Klawock River Weir Counts.

Year	Weir Dates	Sockeye	Coho	Pink	Chum
1930	7/12-9/27	6,892	13,240	1,407,912	15,615
1931	6/5-10/10	35,580	6,322	533,967	151,545
1932	5/30-10/7	58,286	7,113	186,090	264,812
1934	6/3-10/8	16,294	7,304	391,163	16,294
1935	5/29-10/10	19,962	6,938	442,812	32,913
1936	6/11-10/3	65,178	9,951	594,692	37,389
1937	6/3-9/29	33,491	2,578	672,271	13,625
1938	5/25-9/27	15,368	4,398	357,751	22,209
1968	7/1-9/13	12,087	5,272	66,836	1,023
1969	6/16-9/19	1,498	1,135	62,338	1,110
1970	6/7-9/10	6,376	3,467	100,740	528
1971	6/14-9/12	10,627	2,718	54,543	905
1977	8/8-11/10	2,899	3,964	40,595	12,759

Table 2. Estimated Escapement Levels, Klawock River.

Year	Date	Sockeye	Coho	Pink	Chum
1940	9/14			430,000	20,000
1945	10/5	20,000		1,000,000	100,000
1946	10/16			400,000	350,000
1947	10/5	10,000	2,000	350,000	20,000
1948	8/20		35	1,800	1,350
	9/30			830,000	150,000
1949	8/12			1,000	
	8/29			187,000	
	9/16			750,000	
	9/30			997,000	60,000
1950	8/19	160		30	15
	8/29		100	10,000	375
	9/2			27,000	125
	9/8			12,950	2,560
	9/9			15,284	10,000
	9/18			14,760	18,130
	10/3			60,000	31,200
	10/6			63,000	4,200
1951	8/12		200	100	0
	8/22			250	2,100
	9/1			550	210
	9/12			17,000	5,800
	9/22			19,000	45,000
	10/3			9,000	15,000
1952	8/9	200		0	2
	8/19			0	1,000
	9/1			1,500	300
	9/10		270	2,500	350
	9/18			3,000	0
	9/19		150	3,700	3,030
	9/29			12,000	28,000
	10/3			7,000	20,000
1953	8/9			190	2
	8/19			0	1
	9/7		100	1,800	100
	9/23			5,000	12,000
	10/1			7,300	30,000
1954	9/8			500	0
	9/18			2,600	900
	9/25			34,000	19,000
1955	8/19	3,000		0	0
	8/28			2,000	0
	9/5			>5,000	0
	9/16			30,000	5,000
	9/23			50,000	20,000
	9/28			140,000	0

Table 2. Estimated Escapement Levels, Klawock River.

Year	Date	Sockeye	Coho	Pink	Chum
1956	8/26			200	0
	9/7			2,500	0
	9/17			4,000	
	9/28			>100,000	>50,000
1957	8/25			>500	0
	9/2			>3,000	2,000
	9/4			17,850	0
	9/22			20,000	>60,000
1958	9/7			2,000	0
1960	8/17			300	200
	8/30		500	4,000	2,000
	9/6			8,000	7,000
	9/15			10,000	8,000
	9/18		400	9,000	6,000
	9/27			3,000	2,000
1961	8/15			300	0
	9/4			3,160	0
	9/12			22,000	2,500
	9/27			7,600	5,300
1962	8/2			800	0
	8/15			200	0
	9/3			24,800	0
1963	7/16	170			
	8/12				2,000
	8/26			75,000	
1964	9/10			77,000	4,000
1965	8/4				200
	8/24			48,800	
1966	9/1			102,100	
1967	8/12			1,600	
1968	8/5	2,000			
	8/27			2,800	
1970	9/9			76,020	
1971	8/31			25,000	
1972	9/5			13,000	
1973	9/17			8,100	2,800
1974	8/27			20,000	
1975	9/17			26,790	3,000
1976	9/4			91,000	

the same times and depths using a Model 57 YSI meter. Additional temperature data were collected by a Model D Ryan-Peabody thermograph placed at Stations 1 and 5, 3 m below the surface. The Model D is a 45 day, hand wound, graph recording instrument.

Acidity/alkalinity (pH) data were collected with a Model 17-N wide range pH indicatorkit from Hach Chemical Company. Suspended solids (turbidity) data were collected using a secchi disk. Water quality samples were collected by plunge method at the lake outlet and sent to the Alaska Department of Environmental Conservation Laboratory at Douglas, Alaska. Samples were analyzed at drinking water standards for trace metals, mercury, nitrates, fluoride, turbidity, coliform, color, pesticides, and herbicides.

ESTUARINE INVESTIGATIONS

Klawock estuary was surveyed, and three monitoring stations were established to collect data at two week intervals (Fig. 3). Dissolved oxygen, temperature, and salinity data were collected at all three stations. Suspended solids and pH data were collected at Station 3. Recording thermographs were buoyed and anchored at Stations 2 and 3. All data were collected by standard procedures described in the instructions accompanying the equipment.

Dissolved oxygen data were collected at the three stations at depths of 1.8 m and 6.1 m (or 0.61 m). A Model 57 YSI meter, probe and cable were used. Water temperature data were collected at the three stations at the same times and depths using a Model 57 YSI meter. Additional temperature data were collected by Model D Ryan-Peabody thermographs located at Stations 1 and 3, 3 m below the surface. Salinity data were collected at the three stations at the same times and depths. A YSI Model S-C-T 33 with a probe and cable were used. Acidity/alkalinity (pH) data were collected from Station 3 with a Hach

Chemical Company Model 17-N wide range pH indicator kit. Suspended solids (turbidity) data were collected at Station 3 with a secchi disk.

BROOD STOCK AVAILABILITY

A weir across the Klawock River was constructed and operated in 1977 to determine brood stock availability. It was an inverted "V" design, constructed 122 m upstream from mean high tide, of wood frame, angle iron steel cross bars, and pipe picket. A 3.66 m x 4.88 m cabin was constructed above the Klawock River flood plain near the weir. The weir was manned in rotating shifts 24 hours a day. Data were collected on chum timing, tidal, and weather influence on in-migrants, species separation, and species escapement levels.

Chum, coho, and sockeye salmon were randomly sampled as they passed the weir. Capture was by dipnet, and individual adults were placed in a tub with MS-222 anesthetic solution. After anesthesia, weight - length data were collected and scale samples for age determination taken. The males were revived and released, but females were killed and eggs removed for a fecundity count. Eggs were frozen and later thawed, boiled for ease in handling and mesentary separation, the ovarian tissue removed, and the eggs counted and referenced back to the donor adult. Carcasses were distributed to home-bound elder citizens of Klawock.

RESULTS

LAKE INVESTIGATIONS

Dissolved oxygen averaged 11.75 ppm with a high of 13.8 ppm and a low of 7.9 ppm (Table 3). Lake temperatures reached a low of 3.0°C and a high of 21.0°C (Table 4). The pH averaged 7.4, but varied between 7.0 and 7.5 (Table 5). The turbidity depth ranged between 2.7 m and 4.4 m (Table 6). Results of water quality analysis made by the Department of Environmental Conservation, Douglas

Table 3. Dissolved Oxygen (Parts Per Million), Klawock Lake, 1976-77.

		Station #1			Station #2			Station #3			Station #4		
Date	Time	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m
9/15/76	1030	10.1	10.2	10.3	10.3	10.2	10.2	10.2	10.4	10.2	10.3	10.3	a
9/16/76	1030	10.2	10.2	10.1	9.9	9.9	9.5	10.7	9.3	7.9	10.5	10.5	a
9/23/76	1100	10.4	9.8	8.8	10.4	10.3	9.7	10.0	10.0	9.6	10.0	10.0	9.0
9/24/76	1130	10.3	9.9	8.8	10.2	10.0	9.4	10.0	9.8	9.5	10.1	10.3	9.2
9/30/76	1200	10.8	10.6	10.2	10.7	10.6	10.8	10.8	10.5	10.4	11.8	10.8	10.0
10/14/76	1200	10.4	10.3	10.3	10.5	10.4	10.2	10.7	10.4	10.3	10.5	10.6	10.3
10/21/76	1230	9.6	10.0	9.8	10.7	10.5	10.1	10.4	10.1	9.8	10.5	10.1	10.0
11/4/76	1330	10.5	10.4	10.2	10.6	10.4	10.1	10.6	10.3	10.1	10.4	10.3	10.2
11/9/76	1130	10.6	10.5	10.5	10.6	10.4	10.4	10.6	10.5	10.4	10.3	10.2	10.1
11/17/76	1230	13.6	13.5	13.3	13.6	13.6	13.2	13.5	13.3	13.0	12.0	12.0	11.9
11/23/76	1300	12.1	12.0	12.0	12.0	12.0	11.9	12.0	11.9	11.8	12.0	12.0	12.0
12/1/76	1230	11.3	11.3	11.2	11.3	11.3	11.2	11.3	11.3	11.3	11.1	11.1	11.1
12/22/76	1319	11.7	11.7	11.6	11.7	11.7	11.6	11.6	11.6	11.6	11.6	11.5	11.5
1/5/77	1300	12.9	12.9	12.8	b	b	b	b	b	b	12.8	12.8	12.8
1/20/77	1300	12.2	12.2	12.1	12.3	12.3	12.2	12.3	12.3	12.2	12.3	12.3	12.2
2/1/77	1330	12.0	12.1	12.1	12.1	12.1	12.2	12.1	12.1	12.1	12.2	12.2	12.2
2/22/77	1100	12.4	12.3	12.3	12.4	12.3	12.3	a	a	a	12.6	12.5	12.3
4/7/77	1130	10.6	10.4	10.7	10.4	10.4	10.8	10.8	10.6	10.6	10.8	10.6	10.6
4/20/77	1230	12.2	12.4	a	11.7	12.0	12.2	11.7	12.0	12.2	11.4	11.5	11.8
5/3/77	1400	13.8	13.8	13.8	13.5	13.8	13.8	13.7	13.7	13.8	13.2	13.2	13.4
5/23/77	1500	8.7	8.7	8.7	9.0	9.0	9.0	8.7	8.6	8.6	8.9	9.7	8.7
6/10/77	1300	10.5	10.6	10.6	10.6	10.6	10.5	10.6	10.6	10.6	10.6	10.6	10.6
6/23/77	1330	9.7	9.7	9.7	9.7	9.8	9.8	9.9	9.9	9.9	9.8	9.8	9.8
7/28/77	1100	11.4	11.4	11.4	11.5	11.5	11.4	11.5	11.4	11.4	11.4	11.4	11.4
8/18/77	1500	11.0	11.6	18.6	11.0	10.7	10.0	11.0	10.8	8.6	11.0	10.6	10.7
9/2/77	1400	10.6	10.6	10.6	10.4	10.2	7.6	10.4	10.2	6.8	10.8	10.5	6.8
9/20/77	1100	9.4	9.4	9.4	9.6	9.5	9.2	9.6	9.4	9.0	9.6	9.4	9.3
10/1/77	1300	9.6	9.6	9.6	7.9	9.5	9.4	9.9	9.6	9.4	9.6	9.2	9.0
10/12/77	1200	11.6	11.6	11.6	11.6	11.6	11.6	11.4	11.6	11.6	11.6	11.6	11.6
10/22/77	1600	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.3
11/2/77	1100	12.6	12.6	12.6	12.6	12.6	12.5	12.5	12.6	12.6	12.5	12.4	12.4
11/8/77	1400	12.4	12.3	12.3	12.0	12.1	12.2	12.4	12.3	12.2	12.9	12.8	12.2

---continued---

Table 3. Dissolved Oxygen (Part Per Million), Klawock Lake, 1976-77 (continued).

Date	Time	Station #1			Station #2			Station #3			Station #4		
		0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m
11/15/77	1300	11.9	11.9	12.0	12.1	12.1	12.2	12.2	12.3	12.5	12.3	12.3	12.5
11/23/77	1030	11.6	11.7	11.7	11.7	11.7	11.7	11.7	11.8	11.8	12.0	12.0	12.0
11/30/77	1400	13.4	13.4	13.3	13.5	13.6	13.4	13.5	13.5	13.5	13.5	13.5	13.5

[a] Data not collected.
[b] Ice conditions prevented data collection.

Table 4. Temperature (Degrees Celsius), Klawock Lake, 1976-77.

		Station #1			Station #2			Station #3			Station #4		
Date	Time	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m
9/15/76	1000	12.8	12.8	12.8	12.7	12.7	12.6	12.6	12.6	12.6	12.8	12.5	12.6
9/16/76	1000	12.6	12.6	12.6	12.5	12.5	12.5	12.5	12.5	12.5	12.7	12.7	12.5
9/23/76	1100	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
9/24/76	1130	13.1	13.0	12.9	13.0	13.0	13.0	13.1	13.0	13.0	13.0	13.0	12.9
9/30/76	1130	12.5	13.3	12.2	12.0	12.2	12.2	12.1	12.2	12.2	12.2	12.2	11.9
10/14/76	1200	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.8	10.7	10.5
10/21/76	1230	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.2	10.1	10.0
11/4/76	1330	8.3	8.2	8.0	8.3	8.1	8.0	8.3	8.2	8.1	8.2	8.1	8.0
11/9/76	1100	7.6	7.4	7.3	7.6	7.3	7.2	7.5	7.4	7.2	7.5	7.3	7.2
11/17/76	1230	6.7	6.6	6.5	6.5	6.8	6.7	6.8	6.7	6.7	7.0	6.9	6.8
11/23/76	1300	6.3	6.2	6.2	6.3	6.2	6.2	6.3	6.2	6.2	6.2	6.2	6.1
12/1/76	1215	5.9	5.8	5.8	5.9	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.8
12/22/76	1215	4.1	4.1	4.0	4.1	4.0	4.0	4.1	4.0	4.0	4.1	4.1	4.0
1/5/77	1300	3.1	3.0	3.0	b	b	b	b	b	b	3.1	3.0	3.0
1/20/77	1300	3.5	3.4	3.4	3.5	3.4	3.4	3.3	3.3	3.2	3.2	3.1	3.0
2/1/77	1330	4.0	3.8	3.7	4.0	3.9	3.7	3.9	3.8	3.8	3.9	3.8	3.7
2/22/77	1100	4.1	4.1	4.1	4.1	4.1	4.1	a	a	a	4.0	4.1	4.1
3/31/77	1120	4.2	4.0	4.0	4.2	4.5	4.0	4.5	4.4	4.2	5.0	4.2	4.0
4/7/77	1130	5.8	5.6	5.8	5.8	5.8	5.8	5.6	5.6	5.8	5.8	5.5	5.8
4/20/77	1230	6.9	6.5	6.8	6.8	6.5	6.2	7.1	6.6	6.2	7.1	6.8	6.5
5/3/77	1400	7.6	7.6	7.5	7.8	7.6	7.6	7.8	7.8	7.5	7.8	7.8	7.8
5/23/77	1500	10.8	10.8	11.0	10.9	10.6	10.3	11.2	10.7	10.2	11.0	10.8	10.4
6/10/77	1300	11.8	11.5	11.5	11.8	11.5	11.2	11.8	11.5	11.4	11.8	11.8	11.8
6/23/77	1330	14.2	14.2	14.2	14.2	14.3	14.2	14.2	14.2	14.0	14.0	14.0	14.0
7/28/77	1100	14.9	14.8	14.8	14.9	14.8	14.7	15.0	14.9	14.8	15.0	14.9	14.8
8/18/77	1500	21.0	18.6	18.6	20.2	18.2	17.2	20.2	18.2	16.5	20.0	18.0	17.5
9/2/77	1400	18.0	17.8	17.8	17.8	17.5	17.0	17.8	17.5	17.0	17.8	17.2	16.2
9/20/77	1100	15.2	15.0	15.0	15.3	15.0	15.0	15.4	15.2	15.0	16.0	15.8	15.4
10/1/77	1300	14.2	14.0	14.0	14.6	14.6	14.2	14.6	14.2	14.0	15.0	14.6	14.6
10/12/77	1200	10.6	10.6	10.6	10.4	10.6	10.6	10.4	10.5	10.6	11.2	11.2	11.2
10/22/77	1600	9.9	9.9	9.9	9.9	9.9	9.9	9.8	9.9	9.9	9.9	9.9	9.9
11/2/77	1100	7.2	7.2	7.4	7.8	7.8	7.8	12.5	12.6	12.6	8.6	8.6	8.0

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Table 4. Temperature (Degrees Celsius), Klawock Lake, 1976-77 (continued).

Date	Time	Station #1			Station #2			Station #3			Station #4		
		0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m	0.3 m	1.8 m	6.1 m
11/8/77	1400	7.2	7.0	7.0	7.0	7.0	6.9	7.0	6.8	6.8	7.1	7.0	7.0
11/15/77	1300	5.3	5.3	5.4	5.4	5.4	5.7	5.7	5.8	5.8	5.8	5.7	5.7
11/23/77	1030	5.0	5.1	5.1	5.1	5.0	5.1	5.1	5.1	5.1	5.1	5.1	5.1
11/30/77	1400	3.1	3.1	3.1	3.1	3.1	3.2	3.0	3.0	3.0	3.0	3.0	3.0

[a] Data not collected.
[b] Ice conditions prevented data collection.

Table 5. Acidity/Alkalinity (pH), Klawock Lake and Klawock Estuary, 1976-77.

Klawock Lake		Klawock Estuary	
Date	pH	Date	pH
9/15/76	7.5	9/14/76	7.5
9/23/76	7.5	9/15/76	7.5
9/24/76	7.5	9/16/76	7.5
9/30/76	7.5	9/23/76	7.0
10/14/76	7.5	9/30/76	7.0
11/4/76	7.5	10/14/76	7.3
11/9/76	7.5	10/21/76	7.5
11/23/76	7.2	11/4/76	7.3
12/1/76	7.3	11/9/76	7.5
1/5/77	7.4	11/17/76	7.5
1/20/77	7.5	11/23/76	7.5
2/1/77	7.2	12/1/76	7.3
2/22/77	7.3	12/22/76	7.4
3/31/77	7.3	1/5/77	7.6
4/20/77	7.5	1/20/77	7.5
6/6/77	7.0	2/1/76	7.4
6/23/77	7.5	2/22/77	7.3
7/28/77	7.3	3/31/77	7.5
10/1/77	7.3	4/20/77	7.5
10/12/77	7.3	5/3/77	7.5
10/22/77	7.3	5/23/77	7.8
11/2/77	7.2	6/10/77	7.3
11/8/77	7.3	6/23/77	7.5
		7/28/77	9.0
		8/18/77	9.0
		9/2/77	9.0
		9/20/77	7.5
		10/1/77	7.5
		10/12/77	7.5
		10/22/77	7.5
		11/2/77	7.5
		11/8/77	7.3
		11/15/77	7.5
		11/25/77	7.0
		11/30/77	7.5

Table 6. Turbidity (Meters), Klawock Lake and Klawock Estuary, 1977.

Klawock Lake		Klawock Estuary	
Date	Depth (m)	Date	Depth (m)
4/20/77	3.2	4/20/77	5.3
6/6/77	3.2	5/3/77	4.4
7/28/77	4.1	5/23/77	4.0
9/20/77	3.2	7/28/77	6.0
11/2/77	2.7	9/20/77	5.1
11/8/77	3.4	10/12/77	6.2
11/15/77	3.4	10/22/77	3.8
11/23/77	4.4	11/2/77	5.8
11/30/77	3.6	11/8/77	6.0
		11/15/77	4.7
		11/25/77	5.3
		11/30/77	5.3

Laboratory, on heavy metal concentrations, mercury, fluoride and nitrates showed Klawock Lake to be well below the acceptable maximum long term concentrations damaging to fish rearing environment. Parameters tested were mercury, nitrates (sample 1 - 1.9 ppm, sample 2 - 1.6 ppm); fluorides (0.01 ppm); turbidity (0.35 NFU - total filterable residue 42.5 ppm, total unfilterable residue 1.7 ppm); coliform (15.2 ppm); color (30 units); trace metals (summarized in Table 7). Tests for pesticides and herbicides were not received.

ESTUARINE INVESTIGATIONS

Dissolved oxygen averaged 10.74 ppm and varied from a high of 13.3 ppm to a low of 6.6 ppm (Table 8). Temperatures peaked in August at 17.4°C and were at a low of 5.0°C in February (Table 9). Salinity above the halocline ranged from 0.5 to 3.0 °/₀₀. Below the halocline, it ranged from 15.3 to 29.8 °/₀₀ (Table 10). The halocline, which ranged between 0.46 m and 2.7 m, was influenced by tidal action and river flow. Average pH was 7.3, but fluctuated between 7.0 and 9.0 at extreme low water flow during August (Table 5). The turbidity depth in the estuary ranged between 4.4 m and 6.2 m (Table 6).

BROOD STOCK INVENTORY

Operation of the weir began August 8 after a few chum salmon were observed in the Klawock River, but no significant in-migration occurred until the first week in September. The river level decreased from 50 cm during weir construction in early July to about 16.5 cm in mid-August and held this level through early September. River temperatures reached a high of 15°C on September 6 and lake temperatures reach a high of 20.2°C on August 18. Dissolved oxygen dropped to 9.5 ppm on September 2. Species which entered the Klawock River returned to saltwater without passing the weir despite overcast days and morning drizzles which lowered river temperatures in the morning. Significant

Table 7. Trace Metal Concentrations[a], Klawock Lake, 1977

	Sample 1		Sample 2	
	Test 1	Test 2[b]	Test 1	Test 2[b]
Ag	ND[c]	[d]	[d]	[d]
Cd	2		0.2	0.3
Cr	[d]	ND	[d]	[d]
Cu	[d]	ND	0.7	3.0
Fe	0.5	0.1	[d]	0.1
Hg	2.0	[d]	[d]	[d]
Mn	0.01		[d]	2.5
Na	[d]	2.5		
Pb	0.1	ND[c]	0.3	2.0
Zn	22.0	[d]	36.0	25.0

[a]Values in ppb (ug/L) unless otherwise noted.
[b]ND indicates concentration is at or below the detection limit for the analytical techniques used.
[c]Tested by absorption analysis.
[d]Data not supplied by Dept. of Environmental Conservation Laboratory.

Table 8. Dissolved Oxygen (parts per million), Klawock Estuary, 1976-77.

Date	Time	Tide	Station #1		Station #2		Station #3	
			1.8 m	6.1 m	1.8 m	6.1 m	1.8 m	6.1 m
9/14/76	1530	High	8.0	7.4	7.8	7.2	6.9	7.0
9/15/76	1210	Low	9.6	7.3	8.4	6.6	[a]	[a]
9/16/76	1235	Low	10.0	7.4	10.0	7.0	10.0	7.0
9/23/76	0700	Low	7.6	7.6	8.7	8.2	8.1	8.3
9/30/76	1015	High	[a]	[a]	7.3	7.4	9.4	8.8
10/14/76	1500	Flood	7.6	7.4	7.6	7.2	7.3	7.2
10/21/76	0930	Flood	7.6	7.6	7.4	7.4	7.5	7.5
11/4/76	1015		8.5	7.7	8.4	7.8	8.8	8.0
11/9/76	0930	Low	9.2	9.0	7.8	7.9	9.0	8.9
11/17/76	1100	High	10.0	9.8	9.9	9.8	10.0	9.9
11/23/76	1100	Flood	10.9	10.4	10.7	10.5	10.7	10.4
12/1/76	1100	Flood	10.4	10.3	10.4	10.2	10.2	10.1
12/22/76	1130	High	10.6	10.5	10.5	10.4	10.6	10.5
1/5/77	1130	Flood	11.0	11.0	[a]	[a]	11.1	11.1
1/20/77	1130	Flood	11.5	11.6	11.4	11.4	11.5	11.6
2/1/77	1430	Flood	11.1	11.1	11.1	11.2	11.1	11.1
2/22/77	0930	Low	[a]	[a]	11.0	10.8	10.0	10.7
3/31/77	1030	Flood	[a]	[a]	[a]	[a]	[a]	[a]
4/7/77	0930	Flood	12.4	12.8	12.3	12.3	11.8	12.6
4/20/77	1200	Flood	12.3	12.5	11.8	12.3	12.2	12.4
5/3/77	1045	Flood	12.5	12.6	12.2	12.5	12.8	13.2
5/23/77	1400	Flood	9.9	9.6	9.0	10.2	9.9	9.8
6/10/77	1400	Flood	12.3	11.8	12.4	12.6	12.4	12.2
6/23/77	1430	Flood	12.1	12.2	12.2	12.2	12.4	12.4
7/28/77	1100	Flood	10.7	10.6	9.8	10.3	10.9	10.4
8/18/77	0900	Ebb	9.9	9.6	10.2	9.8	10.0	9.9
9/2/77	1200	Flood	10.7	10.4	10.7	10.0	10.6	10.6
9/20/77	1100	Ebb	8.6	8.2	9.0	8.4	8.2	7.8
10/1/77	1000	Ebb	9.4	9.2	9.8	10.2	7.6	10.0
10/12/77	1445	Ebb	10.3	8.2	11.0	9.2	10.0	8.8
10/22/77	1500	Ebb	11.6	9.2	11.1	8.3	11.6	9.0
11/2/77	0905	Ebb	8.8	8.2	8.0	7.6	8.2	8.5
11/8/77	1015	Ebb	9.5	9.5	9.3	9.3	9.0	9.8
11/15/77	1100	Ebb	13.0	11.5	11.0	12.9	13.0	11.5
11/25/77	1230	Flood	12.8	12.0	12.1	12.2	12.7	12.7
11/30/77	1000	Ebb	9.6	10.0	10.2	10.5	11.4	11.6

[a] Data not collected.

Table 9. Temperature (Degrees Celsius), Klawock Estuary, 1976-77.

Date	Time	Tide	River Flow	Station #1 1.8 m	Station #1 6.1 m	Station #2 1.8 m	Station #2 6.1 m	Station #3 1.8 m	Station #3 6.1 m
9/14/76	1530	Flood	High	13.5	13.2	13.0	13.0	13.4	13.2
9/15/76	1207	Low	High	12.5	13.0	12.5	13.0	12.6	13.0
9/16/76	1230	Low	High	13.0	12.9	12.8	12.8	12.8	12.9
9/23/76	0830	Low	Med.	13.0	13.0	13.0	13.0	13.0	13.0
9/30/76	1000	Flood	Med-Hi	12.0	12.0	12.5	12.0	12.0	12.0
10/14/76	1500	Flood	Med.	11.8	11.8	11.5	11.5	11.6	11.6
10/21/76	0930	Flood	Low	11.3	11.3	11.0	11.3	11.3	11.3
11/4/76	1015	Flood	High	7.3	9.5	7.8	9.6	7.9	9.5
11/9/76	0930	Low	Med.	9.5	9.9	9.5	9.7	9.3	9.9
11/17/76	1100	Flood	Med.	8.8	9.0	8.7	8.9	8.8	9.0
11/23/76	1100	Flood	Med.	8.0	8.2	8.0	8.5	8.0	8.2
12/1/76	1100	Flood	Low	8.2	8.6	8.2	8.6	8.2	8.6
12/22/76	1130	Flood	High	6.9	7.0	6.9	7.0	6.9	7.0
1/5/77	1130	Flood	Low	6.5	6.6	a	a	6.5	6.6
1/20/77	1100	Flood	Med.	6.2	6.3	6.2	6.2	6.2	6.3
2/1/77	1430	Flood	Low	5.5	5.6	5.5	5.5	5.5	5.6
2/22/77	0730	Low	Low	6.0	6.3	5.0	5.0	5.0	6.2
3/31/77	1000	Flood	High	6.2	6.2	6.0	6.0	6.0	6.0
4/7/77	0930	Flood	Low	6.8	6.8	6.0	6.0	6.6	6.6
4/20/77	1200	Flood	Low	7.3	7.3	7.3	7.3	7.0	6.9
5/3/77	1045	Flood	Med.	7.9	8.0	7.9	7.9	8.0	8.0
5/23/77	1400	Flood	Med.	10.5	9.7	11.0	10.0	10.0	10.0
6/10/77	1400	Flood	Med.	11.8	12.4	13.5	13.0	13.8	13.0
6/23/77	1430	Flood	Med.	13.0	13.0	12.8	12.8	12.5	13.0
7/28/77	1330	Flood	Low	15.0	14.0	15.7	14.5	15.2	14.0
8/18/77	0900	Ebb	Low	16.8	15.5	17.0	16.2	17.4	16.0
9/2/77	1200	Flood	Low	15.5	15.4	16.2	15.0	15.8	15.5
9/20/77	1100	Ebb	Low	14.0	13.5	14.0	13.8	14.0	13.5
10/1/77	1000	Ebb	Low	13.8	13.5	13.6	13.4	13.6	13.7
10/12/77	1445	Ebb	High	11.5	13.0	11.4	14.5	12.0	13.0
10/22/77	1500	Ebb	High	9.5	12.0	9.9	12.0	9.9	13.0
11/2/77	0900	Ebb	Med.	12.5	8.5	9.5	12.0	12.0	12.8
11/8/77	1015	Ebb	Med.	10.1	10.2	7.9	11.9	12.0	12.9
11/15/77	1100	Ebb	High	9.5	9.6	8.9	9.0	7.1	8.5
11/25/77	1240	Flood	Low	8.4	8.5	8.7	8.7	6.9	7.4
11/30/77	1030	Ebb	Med.	8.2	8.0	8.0	8.2	8.2	8.4

[a] Data not collected.

Table 10. Salinity (parts per thousand), Klawock Estuary, 1976-77.

Date	Time	Tide	Station #1		Station #2		Station #3		Halocline
			1.8 m	6.1 m	1.8 m	6.1 m	1.8 m	6.1 m	(m)
9/14/76	1530	High	23.5	22.0	23.5	25.0	23.0	25.0	2.4
9/15/76	1207	Low	0.5	25.0	24.7	24.5	0.6	24.0	2.1
9/16/76	1230	Low	0.8	24.0	0.5	22.8	0.8	25.0	0.6
9/23/76	0900	Low	24.0	24.5	23.0	25.0	24.0	24.5	0.6
9/30/76	1000	High	20.5	26.2	23.8	27.0	24.0	26.0	1.2
10/14/76	1500	High	23.5	25.0	23.5	25.0	24.0	24.0	0.9
10/21/76	0930	Flood	25.5	26.1	25.0	26.0	25.5	26.0	0.3
11/4/76	1015	Flood	1.0	27.5	1.0	27.8	1.3	26.0	2.1
11/9/76	0930	Low	24.5	26.0	23.0	25.0	25.0	26.0	0.9
11/17/76	1100	High	25.5	27.0	25.2	27.5	25.5	26.0	0.8
11/23/76	1100	Flood	24.0	26.0	24.0	26.0	24.0	26.0	1.2
12/1/76	1100	Flood	25.8	27.0	25.5	27.2	26.5	28.0	0.5
12/22/76	1130	High	25.0	26.5	25.0	26.5	25.5	27.0	0.6
1/5/77	1130	Flood	23.0	25.0	[a]	[a]	23.0	25.0	0.3
1/20/77	1100	Flood	24.0	26.5	25.0	27.0	25.0	27.0	0.9
2/1/77	1430	Flood	25.0	26.0	25.5	27.0	25.0	26.0	0.5
2/22/77	0930	Low	21.0	26.0	10.0	27.0	10.0	25.0	2.4
3/31/77	1000	Flood	[a]	[a]	[a]	[a]	[a]	[a]	2.7
5/3/77	1035	Flood	23.4	28.0	23.0	25.5	24.5	26.0	
5/23/77	1400	Flood	25.4	26.2	26.4	27.0	25.4	26.2	0.8
6/10/77	1400	Flood	26.8	27.0	26.2	27.0	26.2	26.8	0.8
6/23/77	1430	Flood	26.2	27.0	26.2	26.2	26.5	26.8	0.8
7/28/77	1330	Flood	28.2	28.5	29.0	27.0	27.2	27.5	0.2
8/18/77	0900	Ebb	25.0	25.0	26.3	27.0	26.8	26.8	0.3
9/1/77	1200	Flood	22.5	19.5	26.2	29.8	25.0	25.0	0.5
9/20/77	1100	Ebb	28.0	28.8	28.0	28.8	[b]	[b]	0.5
10/1/77	1000	Ebb	26.8	27.2	26.6	26.6	27.2	27.4	0.8
10/17/77	1445	Ebb	21.5	21.5	1.5	20.5	3.0	19.8	1.5
10/22/77	1500	Ebb	1.5	21.2	1.0	25.5	1.2	28.5	2.7
11/2/77	0900	Ebb	[b]	[b]	[b]	[b]	[b]	[b]	0.9
11/8/77	1015	Ebb	3.5	4.3	[b]	[b]	[b]	[b]	0.9
11/15/77	1115	Ebb	15.0	[b]	15.3	[b]	15.9	[b]	3.1
11/25/77	1240	Flood	14.5	[b]	[b]	14.5	[b]	[b]	1.2
11/30/77	1030	Ebb	29.3	29.3	29.2	[b]	[b]	[b]	0.6

[a] No data collected.
[b] Unreliable data.

in-migration began when substantial rain dropped river temperatures to 5°C and water levels rose to 28 cm.

Prior to September 19, 1977, 4,733 summer chums were counted through the weir. By high water on October 11, 8,026 fall chums were counted through the weir for a total chum run of 12,759 for 1977 as compared to 17,000 in 1976. Fall chum in-migration averaged 400 per day and on three separate days, over 1,000 chum passed the weir (Table 12).

Pink salmon intermingled with fall and summer chum runs, but escapement peaked on September 9. Coho stock in-migration started in late August and continued at a steady rate until high water closed the weir operations in October.

The sockeye run had already began when the weir was built and was over by September 15. Low water flows from Klawock Lake prevented 2,000 sockeye from entering the lake, so they held below the falls and in the pools at the hatchery site. Egg samples were taken to determine ripeness, and results indicated these sockeye would hold for two to three weeks, but a few days later sufficient rain fell to allow their entry into the lake. Low water flows into Klawock Lake prevented adults from reaching spawning beds in the creeks above the lake until early September.

Weight, length, scale, and fecundity samples for all species were taken at intervals during weir operation (Table 13). Seventy-eight scale samples were taken: 32 chum, 35 coho, and 11 sockeye. Of the 32 chum, 14 were female with an average fecundity of 2,713 (compared to an average fecundity of 2,313 in 1976). The five females taken before September 21 were ripe, but of those taken after September 21, six were green (7-10 days to maturity), one would have been ripe in three to four days, one was ripe and one was spent. All coho and sockeye were green.

Table 1b. Daily Klawock Weir Count, 1977.

Date	Chum	Coho	Sockeye	Pink
8/8	18	0	36	23
8/9	24	0	41	22
8/10	6	0	115	25
8/11	16	0	62	18
8/12	3	2	105	30
8/13	15	1	143	80
8/14	14	0	49	76
8/15	34	0	93	92
8/16	18	0	48	33
8/17	12	0	48	23
8/18	12	0	74	51
8/19	5	0	49	1
8/20	1	0	18	2
8/21	2	0	5	1
8/22	11	0	13	9
8/23	5	0	48	9
8/24	13	0	87	37
8/25	8	0	76	87
8/26	17	1	90	288
8/27	9	4	38	112
8/28	6	37	342	1,223
8/29	10	49	277	1,209
8/30	16	29	161	1,055
8/31	3	3	47	183
9/1	4	11	155	744
9/2	3	4	184	978
9/3	7	1	85	451
9/4	23	15	39	1,263
9/5	76	24	27	2,196
9/6	110	170	138	1,750
9/7	145	112	132	3,744
9/8	347	455	107	9,371
9/9	226	71	3	2,229
9/10	99	40	6	566
9/11	181	143	1	1,200
9/12	350	230	4	3,994
9/13	464	233	2	690
9/14	537	319	1	285
9/15	374	131	4	211
9/16	555	58	0	150
9/17	449	19	0	107
9/18	467	37	0	156
9/19	1,043	91	0	424
9/20	485	32	0	99
9/21	327	44	0	56
9/22	1,427	323	0	491
9/23	1,271	330	0	268
9/24	626	87	0	100
9/25	375	75	0	250

Table 14. Daily Klawock Weir Count, 1977.

Date	Chum	Coho	Sockeye	Pink
9/26	276	70	0	155
9/27	179	79	0	97
9/28	104	33	0	110
9/29	193	32	0	204
9/30	211	35	0	283
10/1	97	8	0	127
10/2	126	7	0	239
10/3	207	6	0	310
10/4	96	3	0	231
10/5	120	7	0	264
10/6	169	5	0	353
10/7	407	81	0	581
10/8	53	100	0	103
10/9	30	65	0	27
10/10	89	83	0	99
10/11	58	109	0	55
TOTALS	12,759	3,964	2,899	40,595

Table 12. Fecundity for All Salmon Species, Klawock Weir, 1977

Length HPME*	Weight (kg)	Age	Fecundity	Remarks
		CHUM		
63.0	5.3	3	2,566	ripe
58.5	4.5	3	2,739	ripe
63.0	5.7	3	2,580	green
61.0	5.0	3	2,377	green
62.0	5.0	3	2,383	green
63.5	5.3	4	2,787	ripe
68.0	6.8	4	3,566	green
63.0	5.4	4	2,022	green
65.0	5.8	4	3,437	green
53.0	5.5	4	2,677	ripe
		COHO		
57.0	4.1	1-1	2,944	
60.0	5.4	1-1	3,704	
63.0	5.6	1-1	2,483	
65.5	6.0	1-1	3,398	
60.0	4.4	1-2	3,542	
62.5	5.0	1-2	3,678	
51.0	2.5	2-1	3,746	
62.0	4.2	2-1	3,154	
66.0	6.3	2-1	2,214	
63.0	6.6	2-1	4,110	
63.0	5.8	2-1	3,772	
64.0	5.0	2-1	2,698	
53.0	2.6	2-1	3,222	
62.0	5.6	2-2	2,405	
49.5	2.3	2-2	4,268	
			3,308	no scale sample
			2,297	no scale sample
		SOCKEYE		
51.0	2.3	1-2	2,116	
50.5	2.2	2-1	2,713	
54.5	3.0	2-2	4,364	
49.5	2.0	2-2	2,764	
57.0	3.0	2-3	3,205	
53.5	2.8	2-3	4,236	
53.0	2.6	3	4,415	

*Mideye to hypural plate in cm.

The average weight of chum females was 5.4 kg and 5.0 kg for males. Average mideye to hypural plate measurement (HPME) was 61.9 cm for females and 58.8 cm for males. The largest of the 32 chum was a females which weighed 6.8 kg and was 68 cm in length. The smallest chum, a male, weighed 3.75 kg with a 57 cm length.

All of the chum scales were badly reabsorbed. Twenty-three (74%) of the readable chum scale samples were three year fish, and eight (26%) were four year fish. Of the fall run chum, 12 (63%) were three year fish, and seven (37%) were four year fish. There were no five year chums.

Average weight of coho females was 5.2 kg and 4.8 kg for males. Length (HPME) was 56.5 cm for females and 54.7 cm for males. The largest (a male) was 8.0 kg and 69 cm in length, and the smallest (a male) weighed 1.75 kg and was 44.5 cm in length. There were 33 readable coho scales. Seventeen (52%) spent one year in freshwater and 16 (48%) spent two years in freshwater. Fifteen (45.5%) returned in two years; 15 (45.5%) returned in three years, and three (9%) returned in four years (Table 13). All coho had a bright silver color, and the majority had sea lice. Sea lice were evident on several adults caught on sport gear in Klawock Lake. Several jack coho were also caught by recreation fishermen in the lake. Ovulation had not occurred in any coho or sockeye collected for fecundity at the weir.

Eleven sockeye samples were taken and the average weight was 2.25 kg and the length was 49.9 cm; the smallest was 1.0 kg and 36 cm length. Fifty percent of the sockeye through the weir were of the 1.0 kg size; the largest was a female at 3.0 kg and 57 cm and had an abdominal cavity full of worms. Average fecundity for seven females was 3,401. Of the readable sockeye scale samples, three spent three years in salt water, seven spent two years and one spent one year (the 1.0 kg size fish which spent only one year in freshwater).

A spent male, possibly a chum-pink cross, weighing 7.5 kg and a length of 69 cm washed against the weir on September 24. Several dead pre-spawned pinks were observed each week washed against the weir. Seven dead pre-spawn sockeye and four dead pre-spawn coho were recorded during the period the weir was in operation. Organisms observed at low frequencies were Saproleguia on skin lesions of sockeye and the Salincola copepod which completely filled the mouth and gills of a 25.4 cm rainbow trout.

Redds of chum and pink were evenly distributed throughout the length of the river downstream from the U.S. Geological stream gauging station. As of January 15, 1978, no coho redds were observed in Klawock River or in the streams above Klawock Lake. Klawock residents report most coho spawning occurs in February or later.

The numbers of pink and sockeye spawners in the creek systems draining into the lake were monitored (Table 13). Counts were discontinued after September when high water flows precluded accurate counts.

On October 11, weir operations were shut down due to high water. By 11 p.m. Klawock River had reached a depth of 1.5 m or 20.3 cm over the walkway, and 20% of the pickets were removed to relieve pressure on the weir which was clogged with leaves and small debris. Over the next two weeks the river fluctuated between 0.6 m and 1.2 m in depth, and then peaked in late October near the predicted 20 year flood. At that time actual depth of the river was 1.8 m, and there was 50 cm of water over the walkway.

Klawock River dropped sufficiently to winterize the weir on November 1. Each 3 m section of pipe pickets was pulled and tied with wire into three bundles. These bundles were laid on 5 x 10 cm crossmembers in the streambed parallel to the stream flow.

Table 13. Pink and Sockeye Spawners Observed in Creek Systems Draining into Klawock Lake, September 9 - September 29, 1977[a]

Creek	Date	Pink	Sockeye
Funny Blue Creek	9/8	0	7[b]
No Name Creek[c]	9/8	0	553[b]
	9/15	0	1,171[d]
	9/28	3	98[b]
Half Mile Creek	9/27	1	37
Three Mile Creek	9/22	7	247
	9/27	3	180

[a]After September no accurate counts could be obtained due to high water flow.
[b]50% were 1 kg size.
[c]Portions of two beaver dams were removed, but the one upstream was rebuilt by October.
[d]An additional 26 dead sockeye observed.

Total count through the weir of all four species was 60,217. Chum salmon numbered 12,759 with 400 to 500 more in redds between the weir and lower falls. There were 3,964 coho and 2,899 sockeye. Pink salmon numbered 40,595 while another 500 to 600 were in redds between the weir and falls. There were 350 pinks in redds below the falls, but most of these abandoned their redds when water temperatures cooled off.

DISCUSSION

Monitoring activities in the Klawock system and estuary proved satisfactory and will be continued next year. Weir operation for brood stock determination also proved satisfactory. In addition, the weir withstood water levels in Klawock River approaching the 20 year flood stage.

The weather in 1977 was considered abnormal. Near drought conditions throughout the summer prevented accurate determination of run timing and species separation. Run timing and species separation studies will continue.

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