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Volume 5 1963-1964

STATE OF ALASKA

William A. Egan, Governor

ANNUAL REPORT OF PROGRESS, 1963 - 1964

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-5

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
Walter Kirkness, Commissioner

E. S. Marvich, Deputy Commissioner

Alex H. McRea, Director
Alaska, Sport Fish Division

Louis S. Bandirola, Coordinator

3 3755 000 85612 0

Merged with A.R.J.I.S. ANCHORAGE, ALASKA

UNIVERSITY OF ALASKA
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INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-5, "Sport Fish Investigations of Alaska."

The project is composed of 25 separate studies designed to evaluate the various aspects of the State's recreational fishery resources. Of these, eight jobs are designed to continue the cataloging and inventory of the numerous State waters in an attempt to prepare an index of the recreational waters. Four jobs are designed for specific sport fishery creel census while the remainder of the jobs are more specific in nature. These include independent studies on king salmon, silver salmon, grayling, Dolly Varden, a statewide access evaluation program, egg take program and a residual toxaphene study. The information gathered from the combined studies will provide the necessary background data for a better understanding of local management problems and assist in the development of future investigational studies.

The subject matter contained within these reports is often fragmentary in nature. The findings may not be conclusive and the interpretations contained therein are subject to re-evaluation as the work progresses.

Volume 5 Report No. 8-C-4

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No: F-5-R-5 Title: Sport Fish Evaluation of Ship Creek and Campbell Creek.

Job No: 8-C-4

Period Covered: March 1, 1963 to March 1, 1964.

Abstract:

Streamflow data on Ship and Campbell Creeks reveal that low flow periods occur from January through April and high periods of flow occur from May through October. Diversion of water at the City of Anchorage Dam exceeds the total flow of Ship Creek at times during the winter. No extensive diversion occurs on Campbell Creek. Projected Anchorage population growth indicates water diversion in March from Ship Creek for domestic purposes will exceed its total flow by 1973.

Water samples taken on Ship Creek indicate that the soot-laden effluent from the Fort Richardson power plant may be detrimental to salmonoid eggs and fish. The recorded chemical characteristics do not appear harmful to the fish in Ship and Campbell Creeks. The power plant effluents along Ship Creek raised the overall stream temperature nearly 4°F.

Visual surveys near peak spawning in 1963 revealed 119 adult king salmon and 43 redds in Ship Creek, and 159 kings and 54 redds in Campbell Creek. Pink and chum salmon escapement was less than in 1962.

Creel census data taken on Ship and Campbell Creeks indicated that heaviest fishing pressure occurred early in the season and during high tide periods. Nonlicensed

juveniles were the largest fishing group with Dolly Varden the most frequent species caught in both streams. Rate of angler success was 0.27 fish per hour in Ship Creek and o.46 fish per hour in Campbell Creek.

A fish ladder was constructed at the Fort Richardson Dam in the summer of 1963.

A beaver dam and several debris jams were removed on the North Fork of Campbell Creek.

Coho salmon hatching experiments conducted on Ship and Campbell Creeks revealed that eggs deposited in the fall overwintered and hatched in the spring. Indications from experiments with king salmon eggs show that eggs deposited in Ship and Campbell Creeks in July hatch before freeze-up.

Recommendations:

It is recommended this study be discontinued. Evaluation of the data obtained from Ship Creek and Campbell Creek should be incorporated with Job 8-B, Population Studies of King Salmon in the Upper Cook Inlet Drainage.

Objectives:

To evaluate the effect of multiple water use on the sport fish populations of Ship and Campbell Creeks and to provide recommendations for improving the runs of anadromous trout and salmon.

Techniques Used:

Streamflow data on Ship and Campbell Creeks were obtained from the U. S. Geological Survey, Fort Richardson and the City of Anchorage.

Water samples were taken and recorded to establish the effects of the power plant effluents on Ship Creek and seasonal variations on Campbell Creek. Dissolved oxygen, hydrogen-ion concentrations and turbidity tests were determined by a Hach Colorimeter. Carbon dioxide and total alkalinity concentrations were ascertained by the titrimetric method. An Imhoff cone was used to determine settleable matter.

Surveys were conducted on Ship and Campbell Creeks by snow vehicle, rubber raft and foot. Information gathered included escapement and distribution of spawning salmon, peak spawning periods, natural and artificial barriers present, location and type of existing water diversion or pollutants, tidal fluctuations and other physical changes of the two stream systems.

A creel census study was conducted on Ship Creek and Campbell Creek from May 26 to September 29.

Experiments were performed on Ship and Campbell Creeks to determine the length of incubation period, onset of hatching, mean incubation temperatures and egg and fry survival of artificially deposited coho and king salmon eggs. The studies were initiated on dates coinciding with the peak spawning periods of each species.

Findings:

Description of the streams, fish ladders, dams and their locations, cooling pond intake screens and existing pollutants have been reported in the 1961 and 1962 completion reports F-5-R-3 and F-5-R-4, Job 8-C-4.

Ship Creek

The diversion of water at the City of Anchorage Dam is utilized for domestic purposes by the military bases and Anchorage. On six occasions in 1963 and two in 1964, diversion of water exceeded the total Ship Creek flow, thereby halting the flow of water over the dam. The length of time until the flow of water over the dam is resumed depends on many factors. Some of these are time of day, time of year, weather and the extent of continued diversion. On one of those days, March 11, 1963, the reservoir was lowered 0.95 foot below the lip of the dam. The minus readings occurring in January 1964 were the result of ice jams in the stream above the reservoir. The jams blocked the creek for a short time, reducing the volume of water flowing into the reservoir. This was undoubtedly detrimental to the salmon, trout and their spawn in the stream immediately below. Although water has stopped flowing over the City of Anchorage Dam, sufficient percolation of subsurface waters occur from the streambed below to maintain a year-round water flow over the Fort Richardson Dam 3.3 miles downstream. Definite locations of

the spring areas are not known. Stream flow data indicate that periods of low flow generally occur from February through April and high flows occur from May through October (TABLE 1) (U.S. Geological Survey). The military and City of Anchorage have drilled 11 wells from 1955 to the present to supplement water needs during low flow periods. Stabilization of the diversaion of water through the use of these wells during the low flow months is shown on TABLE 2. Underground water is available to a depth of approximately 600 feet where bedrock is encountered. Additional wells and/or infiltration galleries, horizontal subsurface water collecting pipes or tanks, could possibly be used as an alternate during periods when low surface flows prevail. City Engineers, in projecting the population growth of Anchorage, predict that by 1973 the water demand during March will exceed the flow of Ship Creek (FIGURE 1). The prediction is based solely on the use of Ship Creek surface water.

The temperature studies initiated in 1961 and the pollution studies initiated in 1963 were coordinated so samples of each could be taken on the same date. Water temperatures were taken to determine the effect of power plant heated water on the overall stream temperature, and pollution samples were collected to determine the effects of three power plant effluents on the water and fishery of Ship Creek. The six sample stations utilized in these studies have been described in the 1961 completion report. Samples were collected from the three power plant effluents (Stations 2, 5 and 8) and from above or below each effluent (Stations 3, 4 and 9). Water and air temperatures were recorded simultaneously with the water samples. Water samples were tested for dissolved oxygen, carbon dioxide, total alkalinity, hydrogen-ion concentration, turbidity and settleable matter.

The annual mean water temperatures at Stations 5 and 8 were higher in 1963 than in 1962; whereas at Station 2 it was lower (TABLE 3). The 1963 annual mean water temperatures of the control stations (3, 4 and 9) were lower than in 1962. Although the effluent temperatures at Stations 5 and 8 were higher in 1963, their increase does not raise the 1963 temperatures at the control stations to the 1962 levels (TABLE 3). The Fort Richardson and Elmendorf power plant effluents raise the overall stream temperature approximately 3.7^{o}F, preventing formation of ice cover on most of

TABLE 1. The mean monthly water flow of Ship Creek and amount of water used by the City of Anchorage and military in 1961, 1962 and 1963 as measured at Dam 5.

Year	Discharge in c.f.s.*	Month											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Ship Creek	79.3	54.6	35.9	46.3	227.0	470.0	345.0	259.0	293.0	262.0	90.9	48.5
1961	Water Use	15.5	14.0	15.6	13.1	14.1	18.9	19.0	18.0	18.9	15.0	12.9	12.0
	Total Flow	94.8	68.6	51.5	59.4	241.1	488.9	364.0	277.0	311.9	277.0	103.8	60.5
	Ship Creek	29.8	24.9	18.6	25.1	134.0	670.0	349.0	150.0	135.0	84.1	66.7	47.8
1962	Water Use	16.9	15.9	16.8	15.6	18.4	16.9	18.0	19.0	17.1	17.7	16.5	17.7
	Total Flow	46.7	40.8	35.4	40.7	152.4	686.9	367.0	169.0	152.1	101.8	83.2	65.5
	Ship Creek	35.3	24.8	12.7	17.4	237.0	546.0	601.0	394.0	179.0	104.0	42.3	40.2
1963	Water Use	17.7	16.6	15.6	14.7	14.1	18.8	21.0	18.2	18.5	17.3	17.4	16.1
	Total Flow	53.0	41.4	28.3	32.1	251.1	564.8	622.0	412.2	197.5	121.3	59.7	56.3

* c.f.s. - cubic feet per second

TABLE 2. The mean water flow during February, March and April of Ship Creek, and the water used by the City of Anchorage and military in 1953 through 1963 as measured at Dam 5.

Month	Discharge in c.f.s.*	YEAR 1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Feb.	Ship Creek**	23.9	14.4	7.9	5.9	14.2	25.7	17.1	20.8	54.6	24.9	24.8
	Water Use	21.0	24.0	26.0	27.6	20.9	18.1	17.9	16.5	14.0	15.9	16.6
	Total Flow	44.9	38.4	33.9	33.5	35.1	43.8	35.0	37.3	68.6	40.8	41.4
Mar.	Ship Creek	11.0	6.0	5.6	3.6	7.5	19.9	11.8	12.1	35.9	18.6	12.7
	Water Use	21.0	28.0	26.0	27.2	20.7	18.3	18.0	14.4	15.6	16.8	15.6
	Total Flow	32.0	34.0	31.6	30.8	28.2	38.2	29.8	26.5	51.5	35.4	28.3
Apr.	Ship Creek	20.5	4.8	6.6	14.5	16.0	31.9	22.3	24.3	46.3	25.1	17.4
	Water Use	21.0	25.0	24.0	23.4	20.6	17.0	16.9	12.2	13.1	15.6	14.7
	Total Flow	41.5	29.8	30.6	37.9	36.6	48.9	39.2	36.5	59.4	40.7	32.1

* c.f.s. - cubic feet per second

** streamflow below Dam 5 minus the diversion

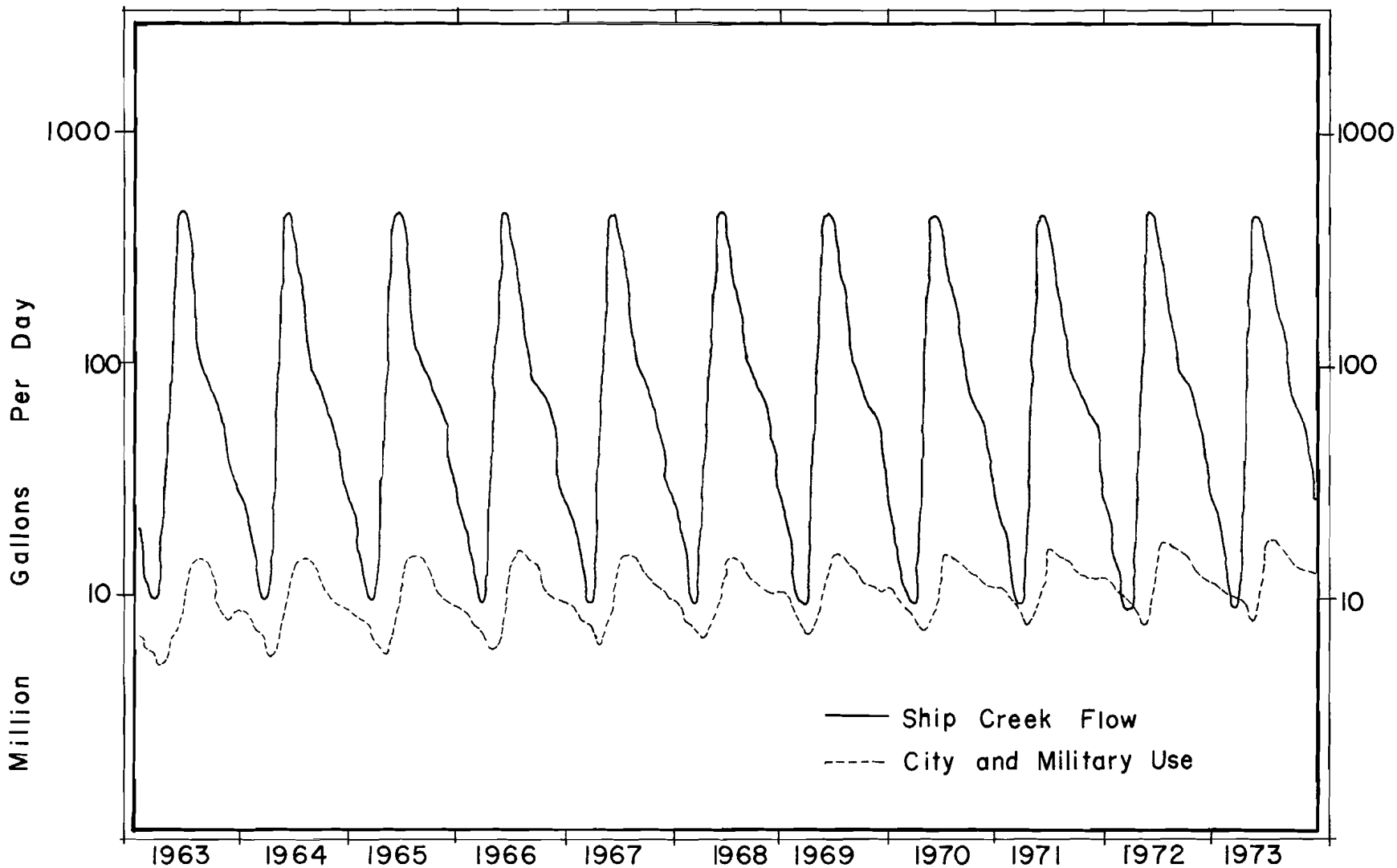

Figure 1. Average annual streamflow in Ship Creek and the projected water use of the city of Anchorage and Military for 1963 through 1973.

TABLE 3. Mean monthly and annual temperatures at 6 stations on Ship Creek from March 1962 through February 1964, expressed in degrees Fahrenheit.

Month	Station 2		Station 3		Station 4		Station 5		Station 8		Station 9	
	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963	1962	1963
March	50	46	39	38	54	49	70	68	62	71	34	35
April	59	44	44	43	54	47	70	71	65	70	35	35
May	62	46	46	45	52	59	73	79	70	68	40	40
June	65	50	49	46	50	50	73	82	65	64	47	41
July	71	63	56	48	58	57	76	83	67	73	53	47
August	70	--	56	--	55	--	76	--	76	--	50	47
September	--	59	--	49	--	52	--	89	--	77	--	46
October	58	61	40	44	43	46	71	80	60	56	36	39
November	41	60	33	34	42	44	74	90	61	64	33	32
December	49	60	35	37	42	44	70	82	57	68	32	33
January	57	54	35	39	47	47	73	87	67	66	32	33
February	55	43	41	36	47	45	71	89	60	65	--	32
Annual Mean	57.9	53.3	43.1	41.7	49.5	49.1	72.5	81.8	64.5	67.5	39.2	38.3

the stream from the Fort Richardson Dam downstream. Water samples were not obtained during August.

Chemical analysis of the water samples in 1963 did not demonstrate concentration ranges detrimental to fishes (TABLES 4, 5, 6, 7 and 8). Periodic observations below the power plant effluents have not revealed any fish mortalities. It is concluded that the chemical characteristics of the Elmendorf and Chugach power plant effluents are not harmful to the fish populations of Ship Creek. The Fort Richardson effluent (Station 8) was considerably more turbid than the other stations. Turbidity and settleable matter were the only tests consistently performed on this sample. Using a dilution factor with the Hach Colorimeter, turbidity readings fluctuated from 40 to 6,300 ppm (TABLE 8). Settleable matter measurements ranged from 0.0 to 10.0 ml/l using an Imhoff cone (American Public Health Association, 1955). The highest readings of both tests occurred on April 12. Flushing of stacks several times a day causes the heavy soot concentrations. The effects of this soot-laden effluent is apparent for 1/4 to 1/2 mile below its confluence with Ship Creek. No adult salmon were observed spawning in this area. What effects the soot may have on eggs in this area are not known.

No new pollutants other than those reported in the 1962 completion report have been observed during the past report period.

Creel census studies were initiated at the beginning of the trout season to establish trends of fishing, peak fishing pressure, species and sizes of fish caught and rate of angler success. Because of limited manpower, a modified random sample by calendar months was employed to obtain an even distribution of sampling throughout the season. A 12-hour period was sampled on the days selected for censusing and 20 days (14 weekdays and 6 weekend days) were sampled. These days were selected from a table of random numbers (Dixon and Massey, 1957). A progressive count was used in contacting fishermen on Ship Creek. Because of the distance between accessible fishing areas, a vehicle was used. All known fishing spots were checked at least twice during a sample day.

Heaviest fishing pressure occurred early in the fishing season, during the peak adult migration period of the

TABLE 4. Dissolved oxygen concentrations at 5 stations on Ship Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 2	3	4	5	9
March 1, 1963	9.0	9.0	9.2	7.8	10.6
March 15, 1963	7.0	10.9	9.8	8.8	11.2
March 29, 1963	9.9	11.0	10.2	8.2	11.8
April 12, 1963	9.1	11.4	9.8	7.8	11.6
May 15, 1963	10.3	9.8	9.4	8.1	11.4
June 11, 1963	9.3	10.0	9.2	7.3	10.7
July 3, 1963	7.9	9.0	8.0	6.5	10.6
September 5, 1963	9.2	9.4	8.5	6.5	9.3
September 26, 1963	9.5	10.6	10.4	7.0	10.5
October 14, 1963	8.5	10.0	9.6	6.7	10.0
November 28, 1963	9.0	10.2	9.8	6.3	10.4
December 20, 1963	9.2	10.1	9.7	6.0	11.4
January 17, 1964	10.4	10.8	10.6	7.0	12.0
February 18, 1964	10.9	11.8	10.9	7.1	12.5

TABLE 5. Carbon dioxide concentrations at 5 stations on Ship Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 2	3	4	5	9
March 1, 1963	4	4	4	5	4
March 15, 1963	3	4	3	7	3
March 29, 1963	4	3	3	3	2
April 12, 1963	7	2	4	5	2
April 26, 1963	3	1	5	2	2
May 15, 1963	2	3	2	3	1
June 11, 1963	3	2	1	1	1
July 3, 1963	3	2	2	2	1
September 5, 1963	2	2	2	0	1
September 26, 1963	2	1	1	1	1
October 14, 1963	3	2	2	2	2
November 28, 1963	2	2	3	2	2
December 20, 1963	3	2	3	3	2
January 17, 1964	3	3	2	2	1
February 18, 1964	3	2	3	2	2

TABLE 6. Total alkalinity concentrations at 6 stations on Ship Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 2	3	4	5	8	9
March 1, 1963	124	112	111	107	25	56
March 15, 1963	168	150	139	141	--	77
March 29, 1963	118	136	114	111	--	58
April 12, 1963	109	110	108	114	--	72
April 26, 1963	75	72	74	73	84	34
May 15, 1963	60	60	56	58	80	40
June 11, 1963	47	44	45	45	38	37
July 3, 1963	46	42	40	42	51	41
September 5, 1963	54	57	49	49	--	44
September 26, 1963	65	64	61	62	--	69
October 14, 1963	65	64	61	63	81	53
December 20, 1963	90	84	79	85	--	49
January 17, 1964	85	94	88	92	--	60
February 18, 1964	99	98	91	94	--	55

TABLE 7. Hydrogen-ion (pH) concentrations at 6 stations on Ship Creek from March 1, 1963 to February 18, 1964.

Date	Station 2	3	4	5	8*	9
March 1, 1963	7.6	7.7	7.7	7.8	---	7.6
March 15, 1963	7.6	7.6	7.5	7.6	---	7.3
March 29, 1963	7.4	7.6	7.6	7.5	---	7.3
April 12, 1963	7.6	7.8	7.6	7.3	---	7.4
April 26, 1963	7.8	7.8	7.6	7.6	7.8	7.0
May 15, 1963	7.5	7.4	7.5	7.4	---	7.5
June 11, 1963	7.3	7.4	7.4	7.4	7.4	7.4
July 3, 1963	7.3	7.2	7.2	7.3	7.8	7.4
September 5, 1963	7.5	7.6	7.5	7.8	---	7.6
September 26, 1963	7.4	7.6	7.6	7.6	---	7.6
October 14, 1963	7.4	7.6	7.5	7.5	7.8	7.5
November 28, 1963	7.6	7.5	7.4	7.6	---	7.3
December 20, 1963	7.7	7.7	7.5	7.6	---	7.4
January 17, 1964	7.4	7.4	7.2	7.4	---	7.2
February 18, 1964	7.4	7.6	7.4	7.6	---	7.3

* This station (Fort Richardson Cooling Pond effluent) often too turbid to sample.

TABLE 8. Turbidity concentrations at 6 stations on Ship Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 2	3	4	5	8	9
March 1, 1963	4	130	0	20	4,400	0
March 15, 1963	20	20	0	5	2,300	0
March 29, 1963	20	30	0	0	2,400	0
April 12, 1963	35	0	0	20	6,300	0
April 26, 1963	160	100	190	120	200	250
May 15, 1963	220	230	140	220	1,500	80
June 11, 1963	120	150	70	40	40	40
July 3, 1963	100	160	50	60	220	60
September 5, 1963	-	-	-	-	5,500	-
October 14, 1963	40	10	20	10	550	0
November 28, 1963	110	10	10	20	3,900	10
December 20, 1963	25	40	3	5	1,800	0
January 17, 1964	5	40	2	2	290	0
February 18, 1964	25	15	0	0	3,000	0

king salmon and during periods of high tide levels (Figure 2). Observations indicate that when adult salmon are migrating from salt water into Ship Creek, most of the fishing effort is extended for 1 or 2 hours at high tide or tides during any one sample day. Fishing pressure on all the weekend days sampled (73 man-days or 12.2 fishermen per day) was less than the weekdays sampled (219 man-days or 15.6 fishermen per day). Out of the 292 man-days of fishing effort, 216 or 74 per cent were from the juvenile nonlicensed age groups. A man-day constitutes one individual angler making at least one appearance on a stream to fish during one day.

A total of 292 anglers caught 109 fish for a rate of success per hour of effort of 0.27 (TABLE 9). The most popular and productive bait used was fish eggs with a 68 per cent angler frequency. Dolly Varden were the predominant species caught, followed by king salmon (TABLE 10). Although salmon fishing was prohibited in 1963, 38 "jack" kings were caught and released. Rainbow trout, pink salmon and whitefish (species undetermined) were also caught. The Dolly Varden caught averaged 8.8 inches in length (TABLE 10) with a range of 3.1 to 13.0 inches. The rainbow trout caught also averaged 8.8 inches in length with a range of 6.3 to 10.5 inches, and the whitefish averaged 12.8 inches in length ranging from 12.1 to 13.2 inches.

All the king salmon caught and released were in the "jack" size category and averaged 17.7 inches in length with a range of 13.4 to 20.5 inches (TABLE 10). The pink salmon average size was 19.7 inches in length with a range of 18.8 to 20.2 inches. The first king was caught and released on June 6, indicating that they start entering Ship Creek in early June.

Foot surveys in late July and early August were conducted to determine the number of spawning salmon, number of redds, peak salmon spawning period and any physical changes in the stream. The survey was accomplished during a 3-day period and covered the same area from the City of Anchorage Dam to the mouth of Ship Creek (11.5 miles) as last year's survey. In the section from the City of Anchorage Dam to the Fort Richardson Dam (3.3 miles) 32 king salmon and 15 redds were counted. In 1962 no salmon were observed in this stretch. High water conditions during the migration period kept water flowing in a small by-pass

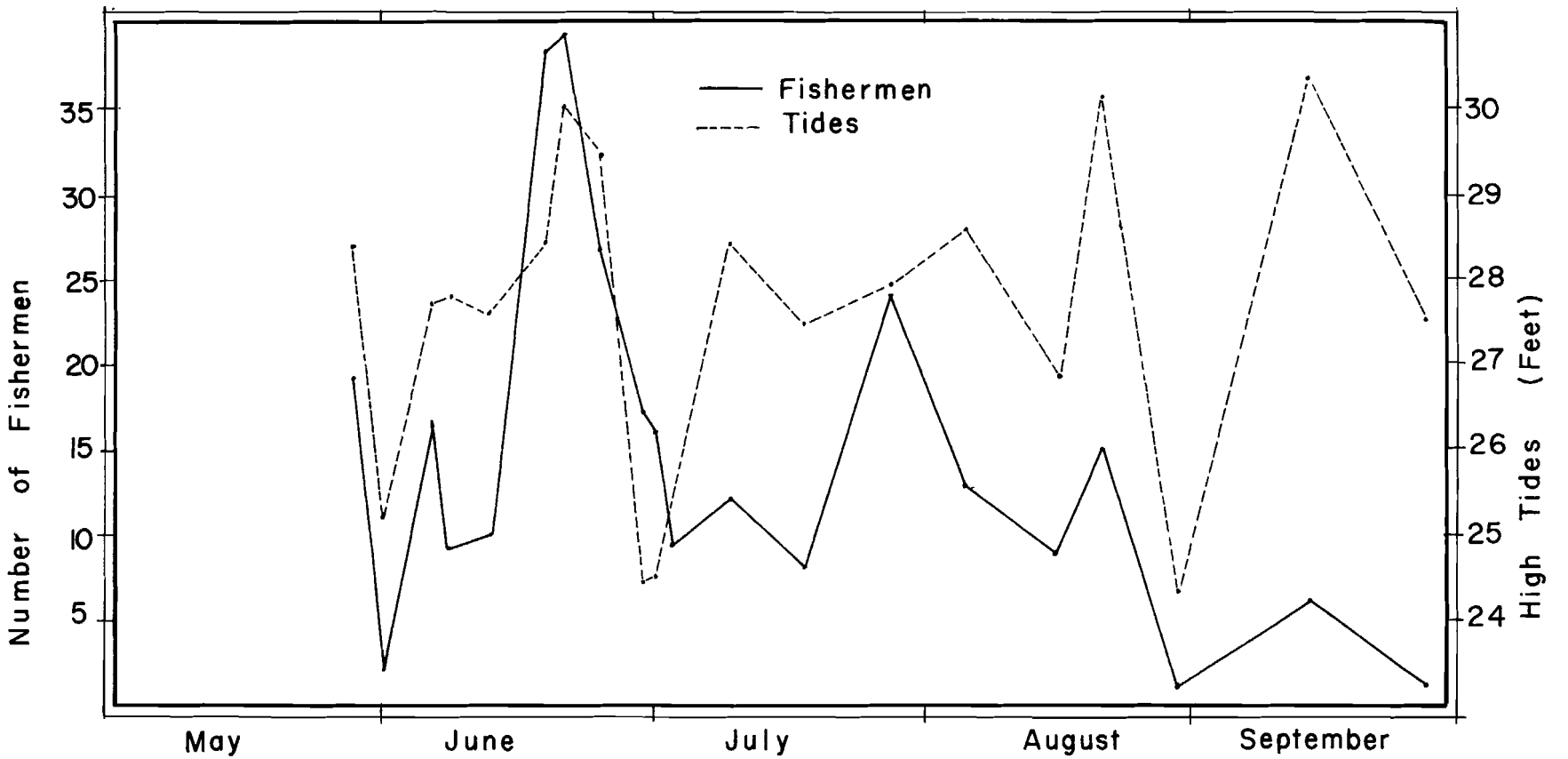

Figure 2. Fishing pressure and tidal fluctuations on Ship Creek from May 27, to September 29, 1963.

TABLE 9. Summary of angler catch by month on Ship Creek in 1963.

Item	May	June	July	Aug.	Sept.	Total Number
Number of Anglers	19	175	53	38	7	292
Hours Fished	16.0	220.0	128.5	35.8	5.0	405.3
Number of Fish:						
Dolly Varden	4	27	13	1	5	50
Rainbow Trout	-	1	11	-	-	12
Whitefish	-	2	1	-	-	3
King Salmon	-	37	1	-	-	38
Pink Salmon	-	-	6	-	-	6
Total Fish	4	67	32	1	5	109
Catch Per Hour	0.25	0.30	0.25	0.28	1.0	0.27

TABLE 10. Numbers and average fork lengths in inches of the various species of sport caught fish in Ship Creek from May 27 to September 29, 1963.

	Dolly Varden		King Salmon		Rainbow Trout		Pink Salmon		Whitefish	
Month	No.	AL*	No.	AL	No.	AL	No.	AL	No.	AL
May	4	5.0	--	--	--	--	--	--	--	--
June	27	9.8	37	17.7	1	10.5	--	--	2	12.7
July	13	8.9	1	18.0	11	8.7	6	19.7	1	13.2
Aug.	1	12.3	--	--	--	--	--	--	--	--
Sept.	5	4.0	--	--	--	--	--	--	--	--
TOTAL	50	8.8	38	17.7	12	8.8	6	19.7	3	12.8

*AL - Average Length

stream around the ladderless Fort Richardson Dam. This enabled fish to move into the spawning areas above the dam. Totals of 119 king salmon and 43 redds were counted in the entire stream compared to 58 kings and 35 redds counted in 1962. Less than 1/5 of the total salmon counted were dead, indicating that the peak spawning period was slightly later this year.

Only 20 pink salmon and 9 chum salmon were observed during surveys in July and August. Although it is known that Ship Creek produces even-year cycles of pink salmon, it is not understood why the chum salmon counts were low.

A 200 yard area immediately below the Fort Richardson Dam was surveyed by foot on October 15 when 22 spawning coho salmon and 5 redds were observed. In this same area, 13 coho salmon were counted in 1962.

Although the pink and chum salmon escapement decreased in 1963, the escapement of king and coho salmon increased.

The flow of Ship Creek was changed below the West Elmendorf Dam to prevent erosion of a sewage line. A stream area 150 yards long was straightened and the spawning gravel disturbed. No natural obstructions or diversions were noted in the entire survey.

Continued observations were made of the physical characteristics of the fish ladders to determine what effects they may have on migrating fish. In two instances, minor modifications were made to correct the deficiencies. At the Chugach Power Plant Dam, adult salmon were having difficulty swimming into the fish ladder entrance due to shallow water. This was quickly remedied by placing large rocks across 1/2 of the entrance. A partial velocity barrier existed in the ladder at the Central Elmendorf Dam. During construction, the lowermost baffle was placed approximately 12 inches lower than plan specifications. A drop of almost 2 feet between the first and second pools prevented many of the salmon from passing through the pool slots (FIGURE 6, ADFG, 1963). In the summer of 1963, the baffle was raised and the slots enlarged, making the water flow equal throughout the ladder.

Construction of a fish ladder at the Fort Richardson Dam (FIGURE 3) was completed on August 27, 1963. The fish ladder is 20 feet in length and consists of 5 pools; each pool is 4 feet wide by 4 feet long. The ladder parallels the face of the dam from its center to the northern edge. The steps are 9 inches high between each successive pool, and the pools are approximately 4 feet deep. Water flows into the ladder through a 4-foot opening in the face of the dam. Because the fish ladder was completed after the adult king salmon runs, its efficiency in passing adult salmon is not yet known.

Studies were initiated on Ship Creek on November 1, 1962 to determine the emergence time of coho salmon. Sixteen envelopes were placed in individual artificial redds at Station 9 (200 feet below the Fort Richardson Dam) on Ship Creek. The envelopes were constructed of fine hardware cloth and 50 fertilized eggs were placed in each envelope. Two rows of eight envelopes each were set perpendicular to the flow of the stream in the streambed. Water and air temperatures were recorded periodically during incubation of the eggs. Soon after placing the eggs in the stream, water temperatures dropped and an ice cover formed over the area.

When the ice melted on March 29, 1963, the first envelope was uncovered and examined for development. Egg development indicated about early-eye stage. One envelope was uncovered each week thereafter and on May 3 the first hatched egg was observed. After this date, one envelope was uncovered every 3 days until May 20 when high water made it impossible to retrieve the envelopes. All envelopes checked had hatched eggs. Of the 8 envelopes checked, a 36 per cent survival was recorded. Incubation period was 184 days at a mean water temperature of approximately 34°F.

Studies similar to the coho egg hatching studies were conducted with king salmon eggs. On July 25, during the spawning period, 50 fertilized king salmon eggs were placed in each of 5 envelopes in Ship Creek at Station 9. The envelopes were checked about every 5 days. On August 13 Ship Creek was diverted around this area in preparation for the construction of a fish ladder over the Fort Richardson Dam. At this time nearly all of the eggs were killed. On

FORT RICHARDSON WILDLIFE
CONSERVATION OFFICE PHOTO

Figure 3. View from the north shore of the nearly completed fish ladder over the Fort Richardson Dam on Ship Creek.

August 20 the remaining live eggs were eyed. The average water temperature of Ship Creek from July 25 to November 1 (100 days) was approximately 45°F. This indicates that king salmon eggs may hatch before winter.

Campbell Creek

There is no extensive diversion of water from Campbell Creek other than incidental irrigational uses by property owners along the stream. Streamflow data on the South Fork of Campbell Creek from 1961 through 1963 indicate that low flow periods occur from January through April and periods of high flow occur from May through October (TABLE 11) (U.S. Geological Survey). The minimum flow recorded in 1963 was 5 cubic feet per second which occurred during a 27-day period in late March and early April. A maximum flow of 292 cfs occurred on July 17, 1963. It is not known if the low streamflows during the winter are detrimental to the eggs and/or young fish.

Water samples were collected at three stations (Stations 1, 4 and 5) established along Campbell Creek in 1961 to determine tributary temperature influence on the overall stream temperature, chemical characteristics and seasonal temperature and chemical changes. Water and air temperatures were taken simultaneously with each water sample. There is no significant difference between 1962 and 1963 annual mean water temperatures (TABLE 12). The water samples were analyzed for DO, CO_2, total alkalinity, pH and turbidity. Chemical analysis of the water indicated that no unusual concentration pattern other than normal seasonal variations occurred during 1963 (TABLES 13, 14, 15, 16 and 17).

An intensified creel census study was conducted on Campbell Creek from May 26 to September 29 when 14 weekdays and 7 weekend days were sampled. During the sample period there were more man-days of effort during week days (14.5 anglers) than during weekend days (11.3 anglers). The creel census method used is described in Ship Creek findings of this report.

Fishing pressure was greatest during the first part of the trout season, adult migration periods and high tide levels (FIGURE 4). The study revealed that high tides affect fishermen numbers during the course of a sample day.

TABLE 11. The mean monthly water flow of the South Fork of Campbell Creek in 1961, 1962 and 1963.

Year	Discharge in cfs*	Month											
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1961	South Fork Campbell Creek	33.3	17.1	12.0	15.5	52.5	99.6	79.1	70.8	92.7	83.7	38.7	20.6
1962	South Fork Campbell Creek	14.0	12.0	8.0	19.2	32.6	166.0	92.4	47.0	41.4	28.2	24.0	20.1
1963	South Fork Campbell Creek	13.6	9.8	6.5	6.5	58.4	106.0	151.0	89.2	48.0	31.4	21.5	18.2

* cfs - cubic feet per second

TABLE 12. Mean monthly and annual temperatures at 3 stations on Campbell Creek from March 1962 through February 1963, expressed in degrees Fahrenheit.

Month	Station 1		Station 4		Station 5	
	1962	1963	1962	1963	1962	1963
March	32	33	32	33	32	32
April	33	32	35	33	35	33
May	41	40	38	41	37	41
June	50	50	47	44	45	42
July	58	52	52	47	53	47
August	57	--	49	48	49	--
September	--	51	--	44	--	45
October	40	38	35	38	36	39
November	32	33	33	33	32	33
December	32	33	32	32	32	33
January	32	32	32	34	32	33
February	32	33	32	32	32	32
Annual Mean	39.9	38.8	37.9	38.3	37.7	37.3

TABLE 13. Dissolved oxygen concentrations at 3 stations on Campbell Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station		
	1	4	5
Mar. 1, 1963	9.9	11.5	11.3
Mar. 15, 1963	8.6	11.1	11.4
Mar. 29, 1963	10.0	11.3	10.9
Apr. 11, 1963	9.0	11.0	11.2
Apr. 26, 1963	--	--	11.2
May 15, 1963	10.1	10.7	10.6
June 11, 1963	10.4	10.3	10.5
July 3, 1963	10.0	9.9	10.0
Sept. 5, 1963	10.1	9.5	9.1
Sept. 26, 1963	10.5	10.4	10.7
Oct. 14, 1963	10.5	10.2	10.3
Nov. 28. 1963	9.6	9.7	--
Dec. 20, 1963	9.2	10.5	10.7
Jan. 17, 1964	10.8	11.8	12.0
Feb. 18, 1964	11.3	12.2	12.3

TABLE 14. Carbon dioxide concentrations at 3 stations on Campbell Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 1	Station 4	Station 5
March 1, 1963	11	7	3
March 15, 1963	7	3	2
March 29, 1963	6	3	2
April 12, 1963	4	4	2
April 26, 1963	6	5	2
May 15, 1963	2	3	1
June 11, 1963	1	1	1
July 3, 1963	2	2	1
September 5, 1963	1	1	1
September 26, 1963	1	1	1
October 14, 1963	2	1	1
November 28, 1963	7	2	-
December 20, 1963	8	2	1
January 17, 1964	6	2	1
February 18, 1964	3	1	1

TABLE 15. Total alkalinity concentrations at 3 stations on Campbell Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 1	Station 4	Station 5
March 1, 1963	55	70	42
March 15, 1963	55	72	54
March 29, 1963	64	59	40
April 12, 1963	61	52	47
April 26, 1963	46	37	40
May 15, 1963	44	48	50
June 11, 1963	36	37	23
July 3, 1963	31	36	22
September 5, 1963	40	38	28
September 26, 1963	48	47	32
October 14, 1963	43	44	38
December 20, 1963	46	48	35
January 17, 1964	63	52	36
February 18, 1964	50	52	36

TABLE 16. Hydrogen-ion (pH) concentrations at 3 stations on Campbell Creek from March 1, 1963 to February 18, 1964.

Date	Station 1	Station 4	Station 5
March 1, 1963	7.0	7.3	7.4
March 15, 1963	6.8	7.2	7.3
March 29, 1963	6.9	7.2	7.3
April 12, 1963	6.9	7.3	7.3
April 26, 1963	7.0	7.2	7.6
May 15, 1963	7.2	7.4	7.3
June 11, 1963	7.3	7.2	7.2
July 3, 1963	7.2	7.2	7.2
September 5, 1963	7.7	7.4	7.4
September 26, 1963	7.7	7.3	7.3
October 14, 1963	7.4	7.3	7.3
November 28, 1963	6.9	7.1	-
December 20, 1963	6.9	7.3	7.3
January 17, 1964	6.6	7.0	7.0
February 18, 1964	6.5	7.1	6.9

TABLE 17. Turbidity concentrations at 3 stations on Campbell Creek from March 1, 1963 to February 18, 1964, expressed in parts per million.

Date	Station 1	Station 4	Station 5
March 1, 1963	0	0	0
March 15, 1963	50	0	0
March 29, 1963	0	0	0
April 12, 1963	0	0	0
April 26, 1963	180	80	0
May 15, 1963	70	60	40
June 11, 1963	0	0	0
July 3, 1963	25	25	10
October 14, 1963	30	10	10
November 28, 1963	0	30	-
December 20, 1963	2	5	0
January 17, 1964	0	0	0
February 18, 1964	0	0	0

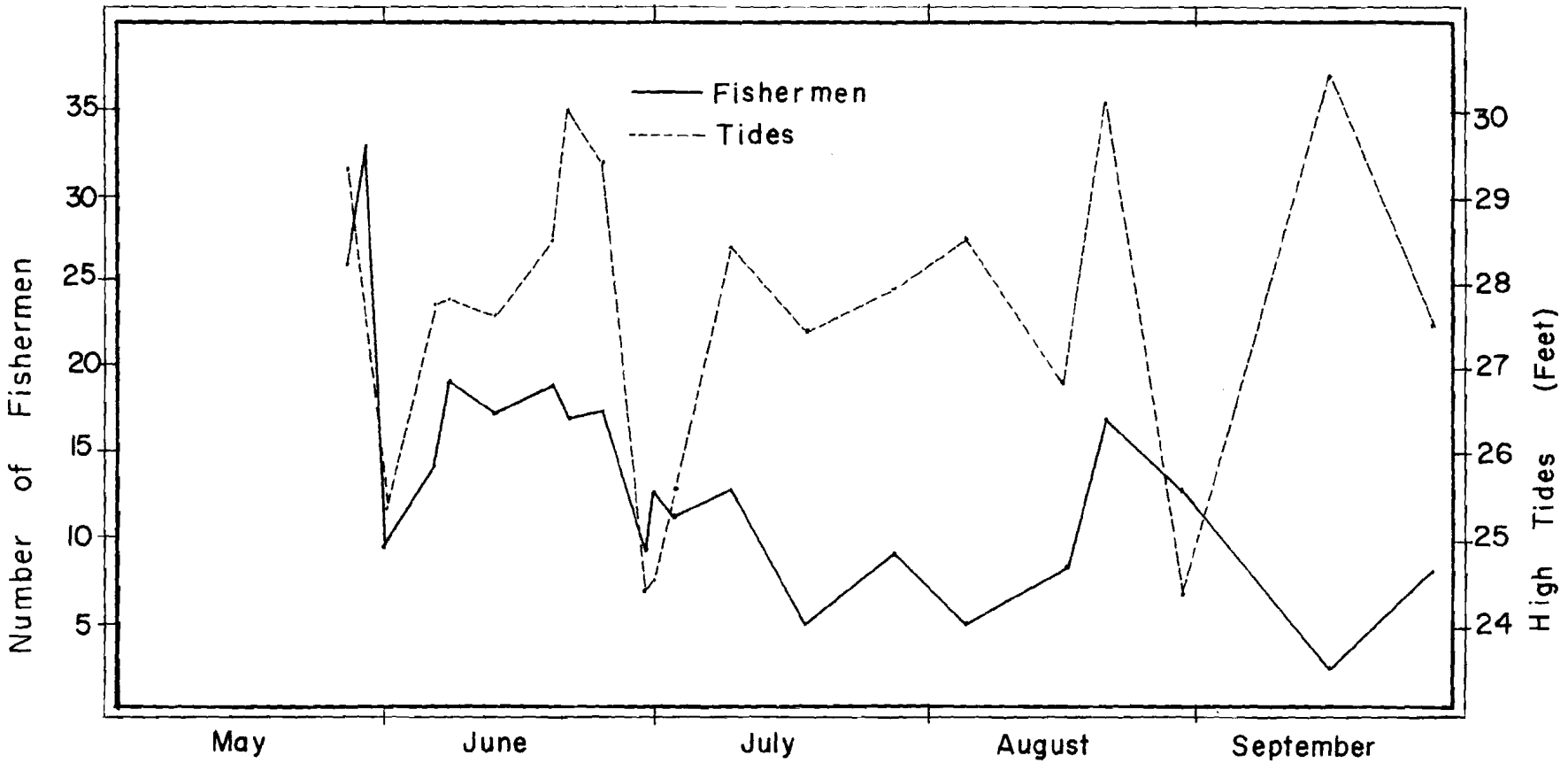

Figure 4. Fishing pressure and tidal fluctuations on Campbell Creek from May 26, to September 29, 1963.

Nonlicensed juvenile fishermen (77 per cent) exerted the most pressure on Campbell Creek. A total of 214 Dolly Varden, coho salmon and king salmon (released) was caught by 281 anglers at the rate of 0.46 fish per hour of effort (TABLE 18). Eggs were used for bait by 79 per cent of the anglers.

Dolly Varden were the most frequent species caught. Fishing pressure was light during the coho salmon season from August 22 to September 23. This is undoubtedly due to the opening of the hunting season. Only one adult coho salmon was checked in the bag. The average lengths of the Dolly Varden, coho salmon and king salmon caught are shown on TABLE 19.

Surveys during the latter part of July and early August were made to note the number of spawning salmon and redds, any new barriers, existing pollutants and other stream changes. The North Fork of Campbell Creek was surveyed by foot from the removed beaver dam (ADFG, 1963) to its confluence with the South Fork of Campbell Creek, a distance of 4 miles. A float survey covering the same area (11 miles) as in 1962 was made in a rubber raft. A total of 159 adult king salmon (83 North Fork, 33 South Fork and 73 main creek) and 54 redds were counted. Over half of the salmon counted were dead.

On September 29, 22 adult coho salmon were observed immediately above the Upper Campbell Station Road. No pink or chum salmon were observed during the year.

A reconnaissance by snow traveler on March 22 revealed a 4-foot beaver dam on the North Fork 1.5 miles above the Campbell Airstrip Road. This barrier was removed by hand on July 27. A large debris jam creating a partial barrier just below the Campbell Airstrip Road on the North Fork was removed on June 9. Removal of several smaller jams below it was also accomplished.

Physical observations throughout the year did not reveal any pollutants entering into the North and South Forks of Campbell Creek from the Airstrip Road downstream to the mouth.

On September 26, observations in the upper Campbell Creek area revealed that military vehicles driven in the

TABLE 18. Summary of angler catch by month on Campbell Creek in 1963.

Item	Month May	June	July	Aug.	Sept.	Total Number
No. of Anglers	59	130	38	43	11	281
Hours Fished	97.0	236.0	56.0	57.8	13.5	460.3
Number of Fish:						
Dolly Varden	50	71	42	11	1	175
Coho Salmon	1	24	6	-	2	33
King Salmon	-	6	-	-	-	6
Total Fish	51	101	48	11	3	214
Catch Per Hour	0.53	0.43	0.86	0.19	0.22	0.46

TABLE 19. Numbers and average fork lengths in inches of various sport caught fish in Campbell Creek from May 26 to September 29, 1963.

Month	Dolly Varden No.	Dolly Varden AL*	Coho Salmon No.	Coho Salmon AL	King Salmon No.	King Salmon AL
May	50	5.7	1	5.4	-	-
June	71	5.5	24	4.8	6	20.7
July	42	5.9	6	3.5	-	-
August	11	7.4	-	-	-	-
September	1	5.0	2	15.2**	-	-
Total	175	6.0	33	5.1	6	20.7

* AL - Average Length

** 1 Adult

creek were disturbing the streambed. The proper authorities were advised and corrective measures taken to eliminate unnecessary stream crossings.

On November 2, 1962, studies were initiated to determine the time of emergence of coho salmon fry. The studies were conducted similarly to those on Ship Creek. The eggs were placed in the North Fork of Campbell Creek 100 feet above the Campbell Airstrip Road on November 2. The first eggs hatched on May 24, giving a total incubation period of 205 days. The mean water temperature during the incubation period was 33.5°F. Egg survival was 38 per cent from 15 envelopes checked.

King salmon egg hatching studies on Campbell Creek closely followed those performed on Ship Creek. Five envelopes were placed in the North Fork on July 25. Although initial egg mortalities were high, sufficient numbers survived to carry out the experiments. Eggs first started hatching on October 4 and continued through November 6 when all surviving eggs had hatched. Incubation period was 72 to 104 days. Egg survival was 5 per cent. Periodic water temperature readings throughout the incubation period averaged 45.7°F. From October 4 until November 28 when water temperature readings were stopped, the average temperature was 37°F. Time and temperature requirements of king salmon egg incubation indicate that eggs and fry may hatch and emerge prior to winter.

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Prepared by:

Gordon H. Gretz
Fishery Biologist

Approved by:

Louis S. Bandirola
D-J Coordinator

Job Leader:

Frank A. Stefanich
Fishery Biologist

Date: March 23, 1964

Alex H. McRea, Director
Sport Fish Division

Public access and camping facility development is needed in Alaska.