Volume 4

1962-1963

STATE OF ALASKA

William A. Egan, Governor

ANNUAL REPORT OF PROGRESS, 1962 - 1963

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-4

SPORT FISH INVESTIGATIONS OF ALASKA

Alaska Department of Fish and Game

Walter Kirkness, Commissioner

E. S. Marvich, Deputy Commissioner

Alex H. McRea, Director

Sport Fish Division

Richard Haley, Coordinator

INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-4, "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. While some studies are of a more general nature and deal with gross investigational projects, others have been developed to evaluate specific problem areas. These include studies of king salmon, silver salmon, grayling and State Access requirements. The information gathered will provide the necessary background data for a better understanding of local management problems and development of future investigational studies.

The assembled progress reports may be considered fragmentary in many respects due to the continuing nature of the respective studies. The interpretations contained therein, therefore, are subject to re-evaluation as work progresses and additional information is acquired.

Volume 4 Report No. 8-C-4

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska.

Project No: F-5-R-4 Title: Sport Fish Evaluation of Ship Creek and Campbell Creek.

Job No: 8-C-4

Period Covered: March 1, 1962 to March 1, 1963.

Abstract:

Surveys showed a total visual count of 58 adult king salmon and 35 redds in Ship Creek, and 40 kings and 41 redds in Campbell Creek near peak spawning in 1962. Pink and chum salmon were too numerous in both streams to be counted. Thirteen adult silver salmon and seven silver redds were counted immediately below the Fort Richardson Dam in early October.

Creel census data revealed that light pressure was exerted on the fishery of Ship and Campbell Creeks and that juvenile fishermen constituted the largest age group. Angling success was 0.23 fish per hour on Ship Creek and 0.46 on Campbell Creek.

A fish ladder was constructed at the Central Elmendorf Air Force Base Dam in the Spring of 1962.

A large beaver dam on the North Fork of Campbell Creek was removed.

Wells drilled in 1955 and 1956 to supplement the water taken from Ship Creek for domestic purposes has stabilized the diversion at a mean of approximately 17 cubic feet per

second. Water also continues to be taken from Ship Creek for generating and colling purposes at the three steam and power plants.

Oil from the Elmendorf distribution station occasionally entered Ship Creek from an improperly maintained skimming device during the year. No pollution was noted in Campbell Creek.

Recommendations:

It is recommended this study be continued to obtain additional data on all species of sport fish.

An intensified creel census study should be continued on both Ship Creek and Campbell Creek.

The dams and fish ladders should be further studied as to their physical characteristics.

Arrangements should be made with the Army to install a fish ladder at the Fort Richardson Dam in the spring of 1963.

Additional counting methods should be incorporated to determine the adult salmon and trout escapement in both streams.

Chemical analysis of the streams and of the steam and power plant effluents should be continued to determine the effects on trout and salmon.

Winter streamflow studies should be made to determine the effects of low flows on salmon eggs.

A partial barrier 100 feet below the Campbell Airstrip Road on the North Fork of Campbell Creek should be removed.

Improvements should be made to the existing cooling pond intake screens to keep out young salmon and trout.

Changes in the present fishing seasons is not recommended at this time.

The following modifications are recommended for the improvement of existing fish ladders:

1. Chugach Electric Association Dam - Ship Creek.

   One of the two fish ladder entrances should be blocked. This would increase both the entrance depth and attractive force of the water, allowing easier access by anadromous trout and salmon.

2. West Elmendorf Air Force Base - Ship Creek.

   Silt deposits immediately above the dam should be removed to increase the flow of water into the fish ladder.

3. Central Elmendorf Air Force Base - Ship Creek.

   The slot in the lowest pool should be raised approximately one foot to reduce the height of the second slot. The lowest pool should be widened another 4 feet to decrease the turbulence caused by the flow of water from the middle pool. Piling should be driven next to the fish ladder entrance to deflect the stream current. This would dinimish the strong eddy created there. Sand and gravel should be removed immediately above the fish ladder outlet to aid in the passage of migrating fish.

Objectives:

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

Techniques Used:

Surveys were conducted of the two streams by airplane, by rubber raft and by foot. Data collected included number

of spawning salmon, number of redds, natural and artificial barriers present, water diversions, location and type of existing pollutants, and other physical changes of the two streams.

Temperatures continued to be taken and recorded on Ship Creek to establish the effects of the power plant effluents and on Campbell Creek.

Chemical tests of the stream water and pollutants were taken at established stations on Ship and Campbell Creeks. Settleable matter was determined by volume using an Imhoff cone.

Creel census data were collected in Ship and Campbell Creeks.

Photographs were taken of natural and artificial barriers present, water diversions, existing pollutants, and other important structures pertinent to the study of Ship and Campbell Creeks.

Findings:

Description of the streams, fish ladders, dams and their location have been reported in the 1961 completion report F-5-R-3, Job 8-C-4.

SHIP CREEK:

The diversion of water at the City of Anchorage Dam for domestic purposes on the military bases and in Anchorage may be detrimental to salmon and trout eggs during low flow periods. Low flow periods are from November through April while high flows occur from May through October (Table 1). Streamflow data indicated that a minimum discharge of 21 cubic feet per second occurred on March 23, 1961. The diversion out of the creek for the same day was about 15 cfs, leaving a flow of only 6 cfs below the dam in Ship Creek. In 1955 and 1956, four wells were drilled by the City of Anchorage to supplement water from Ship Creek to the City. Two wells on Elmendorf Air Force Base and three wells on Fort Richardson were drilled for the

Table 1. The average amount of water discharge by month flowing in Ship Creek and amount of water used by the City of Anchorage and Fort Richardson for the years 1961 and 1962, as measured at Dam 5.

Year	Discharge c.f.s.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1961	Ship Creek	79.3	54.6	35.9	46.3	227.0	470.0	345.0	259.0	293.0	262.0	90.0	48.5
	Water Supply	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
1962	Ship Creek	29.8	24.9	18.6	25.1	134.0	670.0	349.0	150.0	135.0			
	Water Supply	16.9	15.9	16.8	15.6	18.4	16.9	18.0	19.0	17.1			
	Total Flow	46.7	40.8	35.4	40.7	152.4	686.9	367.0	169.0	152.1			

c.f.s. Cubic Feet Per Second.

same purpose. The well water also helps to warm water taken from the creek during the winter months. Approximately 11 cfs of water is pumped from the wells to supplement water from Ship Creek. With the use of well water, the amount of diversion from Ship Creek has leveled off to a yearly mean of approximately 17 cfs.

The temperature studies initiated in November 1961, to determine the effects of power plant heated water on the over-all stream temperature, were continued. The locations and descriptions of the temperature stations have been reported in 1961 completion report. Air temperatures were recorded simultaneously with the water temperature at every station. The effluent temperatures of the three power plants and the temperatures at the stations above and below are presented in Figure 1. Temperatures were not taken during the short period shown in Figure 1 due to the excessive work load at that time. The plant effluents increase the temperature of Ship Creek preventing formation of ice cover on most of the stream from the Fort Richardson Dam downstream to the mouth. The effects of the temperature increase on the salmon and trout eggs and the emerging fry is not yet known. Tests were made periodically for dissolved oxygen, carbon dioxide, total alkalinity, hydrogen concentration and turbidity, to determine any possible effects of the power plant effluents on the Ship Creek water (Table 2). Water temperature stations 3, 4 and 9 were selected as water sample stations (Figure 2). Station 9 was selected to sample the water before any pollutants were mixed with Ship Creek water, while stations 3 and 4 were chosen to disclose possible effects from any pollutant entering the stream. Insufficient data were collected to conclude any effects on the fish populations.

Pollution studies on the three power plant effluents were initiated in early February 1963, to determine the effects of the pollutant on the fishery of Ship Creek (Table 3). Samples were collected immediately below the outlet pipes. In all three cases the pollutants flow into the outlet pipes of the cooling pond and are mixed before entering Ship Creek. Most of this pollutant apparently

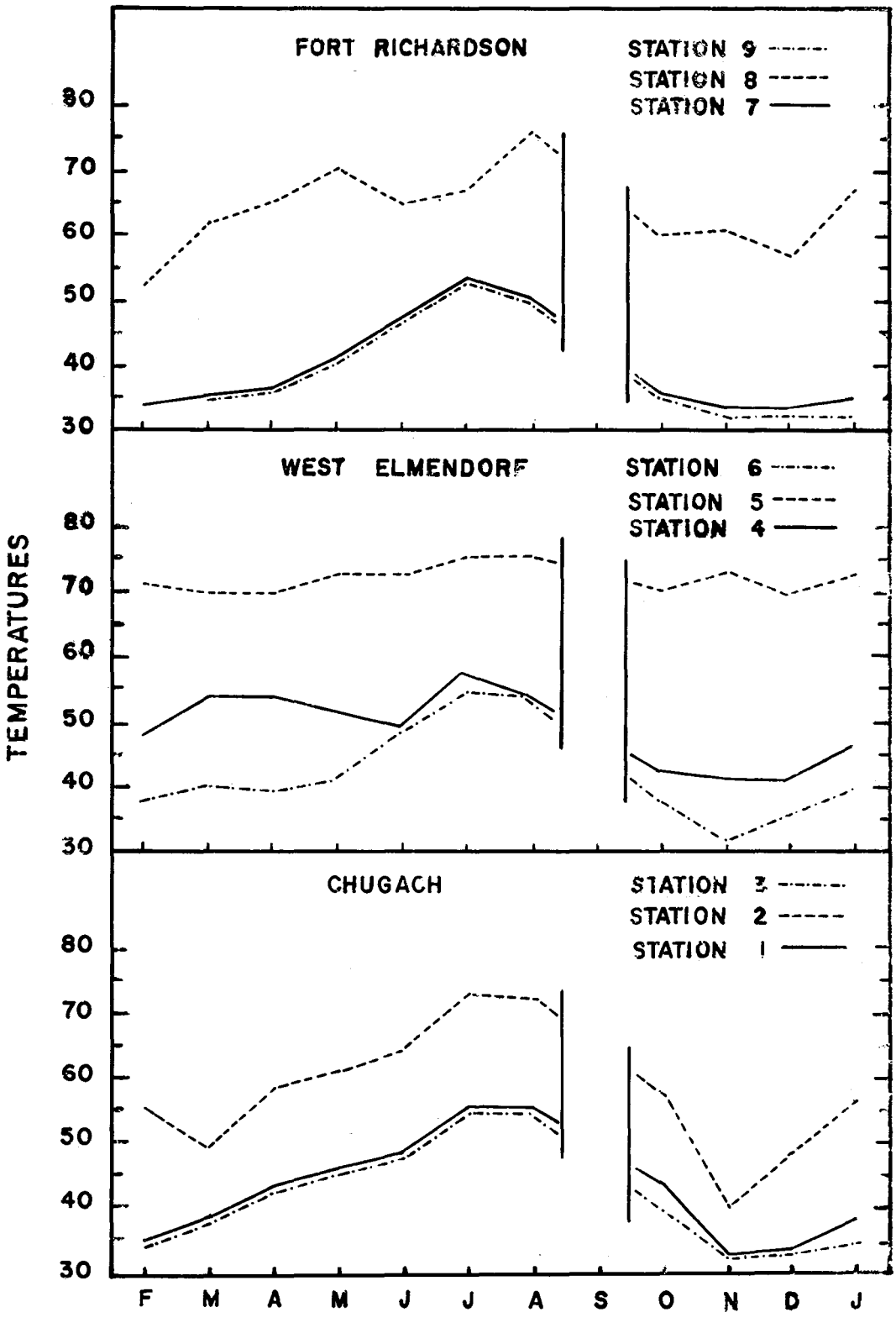

Figure 1. Monthly mean water temperatures taken at 9 stations on Ship Creek from February 1962 to January 1963.

Table 2. Dissolved oxygen, pH, carbon dioxide, total alkalinity and turbidity taken at 3 stations on Ship Creek from November 23, 1962 to February 1, 1963.

	STATION														
	3					4					9				
Date	DO*	pH	CO_2*	Tl.* Alk.	Turb.	DO	pH	CO_2	Tl. Alk.	Turb.	DO	pH	CO_2	Tl. Alk.	Turb.
11-23-62	10.0	7.6	8.0	103	0.0	9.3	7.5	8.0	90.0	0.0	11.0	7.4	7.0	58.0	0.0
12-7-62	10.0	7.6	7.0	82	10.0	11.0	7.4	8.0	80.0	0.0	12.0	7.4	10.0	47.0	0.0
12-21-62						11.4	7.2	9.0	47.0	0.0	10.0	7.3	4.0	50.0	0.0
1-11-63	8.6	7.3	8.0	98	0.0	8.6	7.3	5.0	95.0	0.0	10.4	7.2	5.0	56.0	0.0
1-18-63	9.4	7.3	4.0	95	0.0	9.0	7.3	4.0	89.0	0.0	11.0	7.3	3.0	52.0	0.0
2-1-63	9.4	7.3	5.0	103	10.0	9.1	7.3	4.0	96.0	0.0	10.4	7.3	4.0	54.0	0.0

* Parts per million.

Table 3. Dissolved oxygen, pH, carbon dioxide, total alkalinity, turbidity and settleable matter taken at 3 stations on Ship Creek from December 10, 1962 to February 16, 1963.

	STATION																	
	2						5						8					
Date	DO	pH	CO_2	Tl. Alk.	Turb.	SM*	DO	pH	CO_2	Tl. Alk.	Turb.	SM	DO	pH	CO_2	Tl. Alk.	Turb.	SM
12-10-62	8.9	7.8	0	91	15	0.0	5.0	7.3	25	123	10				0			
1-18-63														7.8	0	63	30	
2-1-63		7.4	4	107	170	0.1		7.4	4	102	0	0		7.8	0	75	20	0.05
2-16-63	8.5	7.4	3	110	10	0.0	6.5	7.4	3	105	2	0	6.8	7.8	0	72	42	0.1

* SM - Settleable Matter - ml/l.

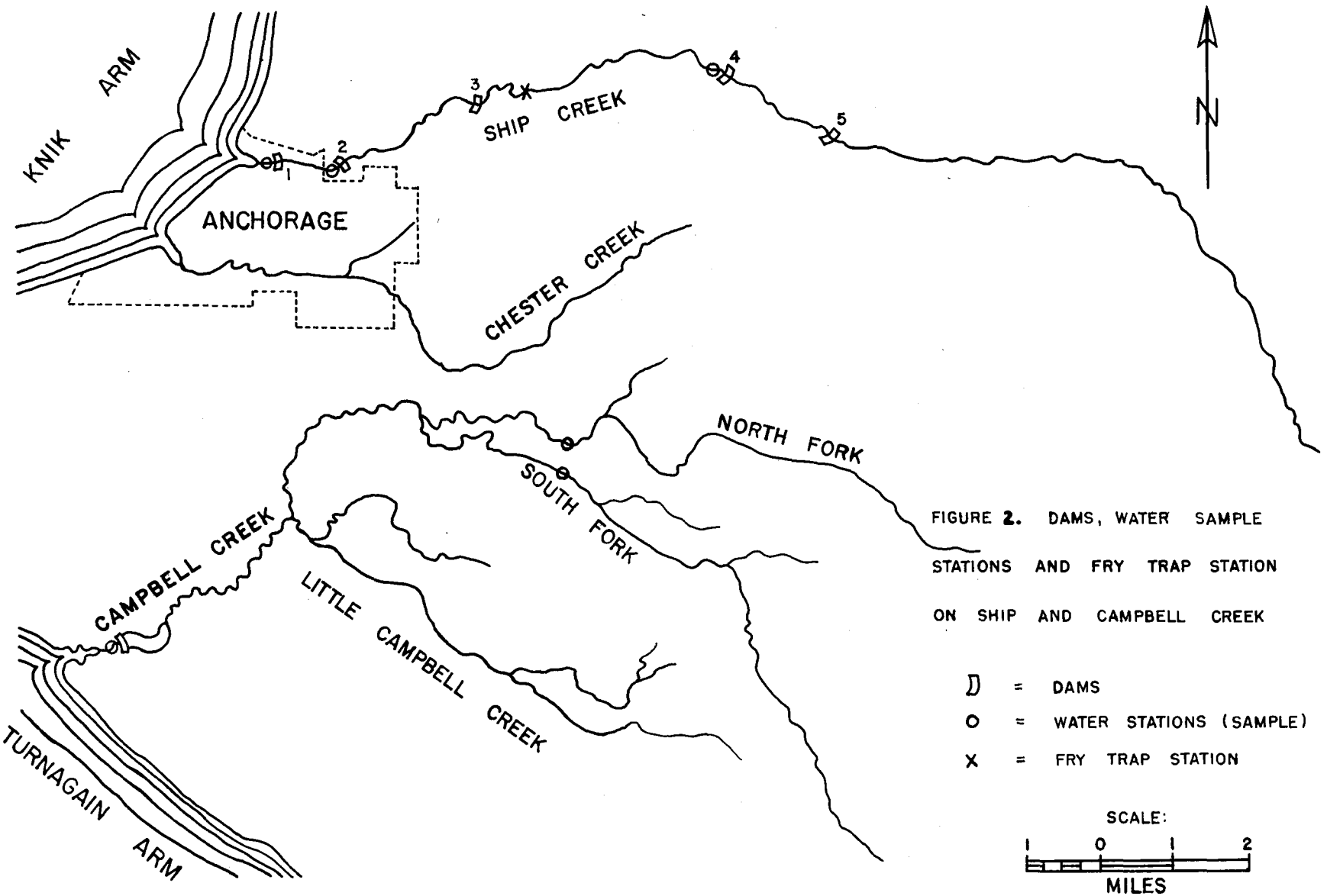

FIGURE 2. DAMS, WATER SAMPLE STATIONS AND FRY TRAP STATION ON SHIP AND CAMPBELL CREEK

comes from cleaning of the flues. The samples were tested for DO, pH, CO_2, total alkalinity, temperature, turbidity and settleable matter. The suspended matter expelled into Ship Creek from the power plants as described in the 1961 report is determined by volume with use of an Imhoff cone (American Public Health Association, 1955). What effects the plant effluents may have on the eggs or the fish are not known.

A small stream of water and oil enters Ship Creek approximately 75 yards above the West Elmendorf Dam. This effluent originates at the Elmendorf Air Force Base oil distribution station. A device (oil skimmer) to prevent oil from passing into Ship Creek was constructed across the drainage stream during the summer of 1961 by the Elmendorf Air Force Base Engineers (Figure 3). Excessive amounts of oil seepage from the distribution station have occurred occasionally during the summer. During these periods, the oil and sludge clog the oil skimmer resulting in an overflow into Ship Creek. The organization responsible for its maintenance has been advised and corrective measures have been taken.

A limited creel census study was conducted during the trout fishing season on Ship Creek which opened May 26. Lack of man power prevented a more thorough study. It was observed that the heaviest fishing pressure occurred early in the fishing season and during the peak adult migration period of king, pink and chum salmon. Observations revealed the greatest pressure on the fishery was from the juvenile non-licensed age group. Dolly Varden were caught at the rate of 0.23 fish per hour of effort and were the only species recorded. Rainbow trout are also in the stream system but none were checked in the creels. Ship Creek is closed to salmon fishing, and some salmon were caught and released.

In early August, a foot survey was conducted to determine the number of spawning salmon, number of redds, and any physical changes that might have occurred. This survey was accomplished on 4 successive days and covered a distance of 11.5 miles from the City of Anchorage Dam to the mouth of the stream. The section from the City of Anchorage Dam to the Fort Richardson Dam, a distance of

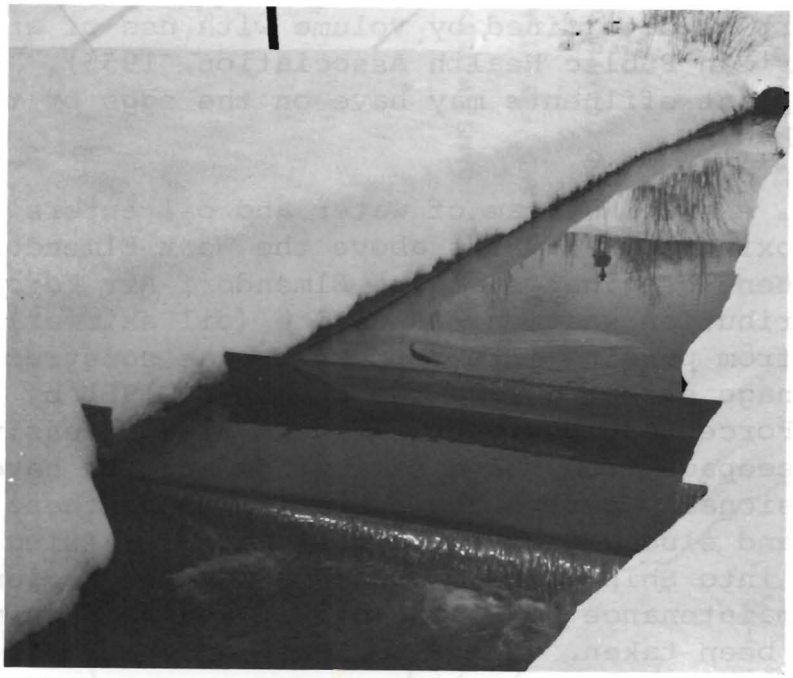

Figure 3. Oil Skimmer on Elmendorf Distribution Station Drainage. Ship Creek.

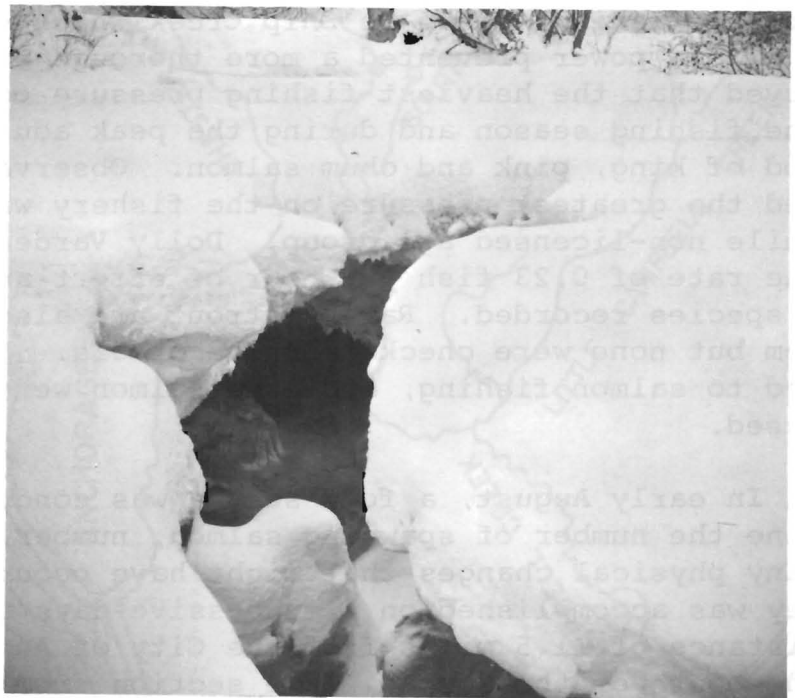

Figure 4. Ship Creek Canyon above 40 feet. City of Anchorage Dam.

3.3 miles, revealed no spawning salmon or redds. A total of 58 king salmon and 35 redds were observed in the 8.2 miles below Fort Richardson Dam. Concentration of king salmon were noted in a 3 mile area immediately below the Fort Richardson Dam and in a one-fourth mile area immediately below the West Elmendorf Air Force Base Dam. With the peak spawning period of king salmon occurring during the latter part of July, nearly one-third of the adult king salmon were dead. Approximately 75 pink salmon and 100 chum salmon were counted just below dam 3 in August. Although a fish ladder is present at this dam, few chum salmon and pink salmon passed beyond this dam. Large numbers of pink salmon and chum salmon were observed on October 6, 1962, thirteen spawning silver salmon were counted in a 200-yard area immediately below the Fort Richardson Dam. Seven silver redds were also observed in the lower reaches of Ship Creek and were too numerous to count.

The flow of Ship Creek has been changed in two locations just below the West Elmendorf Dam. The diverting of Ship Creek in these two instances amounts to about a 300 yard disturbance of spawning area. No natural obstructions were noted in the entire survey.

Two surveys, one by airplane and the other by foot, were made to the cataract just above the City of Anchorage to determine if a barrier to migrating salmon or trout exists, provided a fish ladder were to be built over the dam. On August 9, 1962, a flight was conducted over the cataract and it did not appear to be a barrier to king salmon. Passage of other salmon and trout would be questionable. On February 15, 1963, the cataract area was investigated by foot. Investigation of the rapids was made to note winter conditions and to obtain photographs of the area. At this time of the year the canyon is filled with ice (Figure 4) making it difficult to observe the cataracts.

Continued observations were made of the physical characteristics of the fish ladders to determine what effects they may have on migrating fish. For the convenience of correcting a few errors presented in the 1961 completion

report, Table 1 of that report has been reinserted with additions and corrections (Table 4). The dams, as described in the previous report are numbered in sequence starting with the one nearest salt water (Figure 2).

Table 4. Location, height and distance from mean low tide of dams on Ship Creek.

Name of Dam	Dam Number	Year Built	Distance From Mouth	Height	Fish Ladder Present
Chugach Electric Association	1	1952	1.0 Miles	5.5 Ft.	Yes
West Elmendorf	2	1954	3.6 Miles	5.0 Ft.	Yes
Central Elmendorf	3	1942	4.5 Miles	4.5 Ft.	Yes
Fort Richardson	4	1953	8.2 Miles	3.5 Ft.	No
City of Anchorage	5	1952	11.5 Miles	40.0 Ft.	No

Construction of a fish ladder at the Central Elmendorf Dam (Figure 5) was completed on July 1, 1962. The fish ladder consists of three pools. The upper pool is 4 feet wide and 8 feet long, the middle pool is 8 feet wide and 8 feet long, and the lower pool is 4 feet wide and 12 feet long. Fish passage slots 12 inches wide are present only in the lower and middle pools, while the upper pool is open the entire width and no slot is present. The depths of the lower two pools are approximately 4 feet while that of the upper pool is about 3 feet. Observations indicate that salmon have difficulty passing through this ladder. The flow of water through the ladder is low, and the strong current from the main stream causes an eddy in which adult salmon have been observed oriented downstream heading away from the fish ladder entrance. A partial velocity barrier exists between the lower and middle pools due to the difference in heights. Many pink and chum salmon were observed attempting to pass through the slot (Figure 6).

Figure 5. Upstream view looking South. Central Elmendorf dam fish ladder (3).

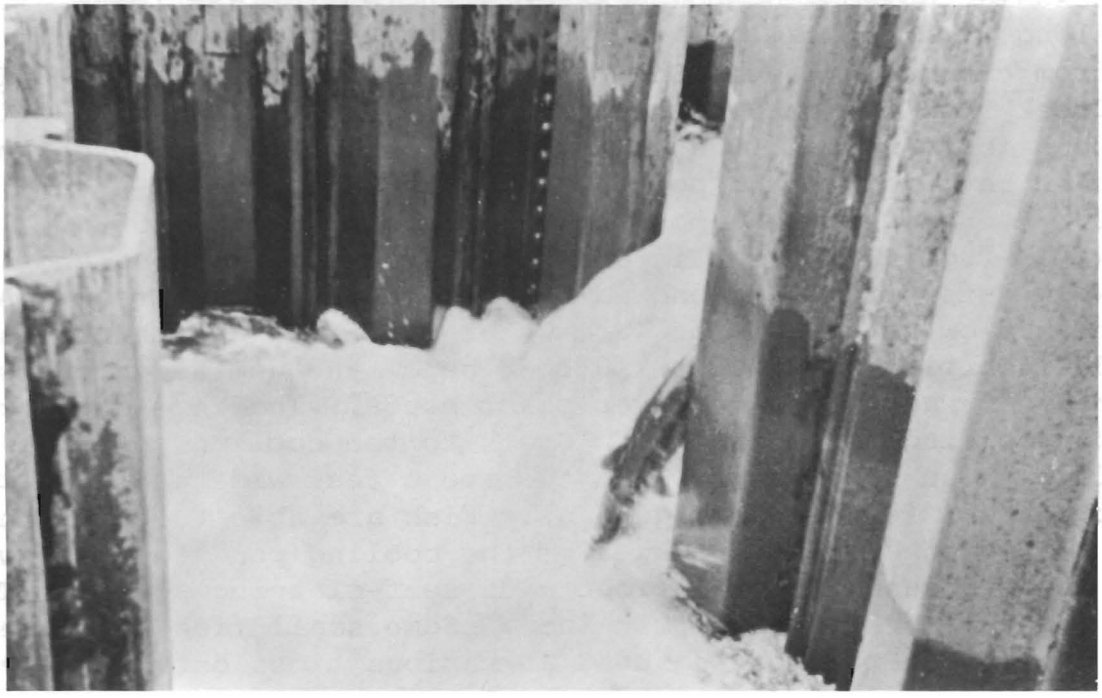

Figure 6. The slot between the lower and middle pools at the Central Elmendorf Air Force Base Dam showing a chum salmon attempting to pass upstream.

The 40-foot City of Anchorage water supply dam on Ship Creek does not possess a fish ladder (Figure 7). To construct a fish ladder that would pass migrating trout and salmon would cost approximately four thousand dollars for every foot of rise (Clay, 1961). Based on this estimate, the cost of a fish ladder would be $160,000.00. Assuming that Alaskan costs are approximately 30 per cent higher than stateside prices; the fish ladder could cost $208,000.00 to build. It has been mentioned by the Geological Survey that the dam height might be increased within the next few years to accomodate increasing water-use demands. A skip-hoist could possibly be more feasible than a ladder (Clay, 1961).

Observations were made to determine the amount of water diverted into the four cooling ponds from Ship Creek and to determine the effectiveness of the screened intake to prevent fish from entering the ponds. They are located at the lower four dams on Ship Creek (Table 4).

The cooling ponds can best be described by starting with the one nearest tide water. The Chugach Electric Association cooling pond was constructed in 1952 (USFW, 1954) along with the dam. It is located approximately one mile from the mouth of the Ship Creek. Water is taken from Ship Creek into the pond. About 17 cfs of water from the cooling pond is drawn into the power plant for cooling purposes and then returned to the pond, raising the temperature about 20° F. Whenever the pond temperatures rise above 50° F., water from Ship Creek is drawn into the cooling pond and warm water from the pond is discharged into Ship Creek. A mean flow of 6.7 cfs of warm water is discharged through a 36-inch pipe at a point 110 feet below the dam and amounts may vary according to power plant needs. The intake structure controlling flows from Ship Creek to the cooling pond has four trash screens of which two are 6 feet wide and the other two are 3 feet wide (Figure 8). Fish are able to enter the cooling pond. The intake from the cooling pond to the power plant screened with a 3 foot wide self-cleaning screen. The screen mesh is one-quarter inch. Some small fish have been observed in the cooling pond at various times during the year.

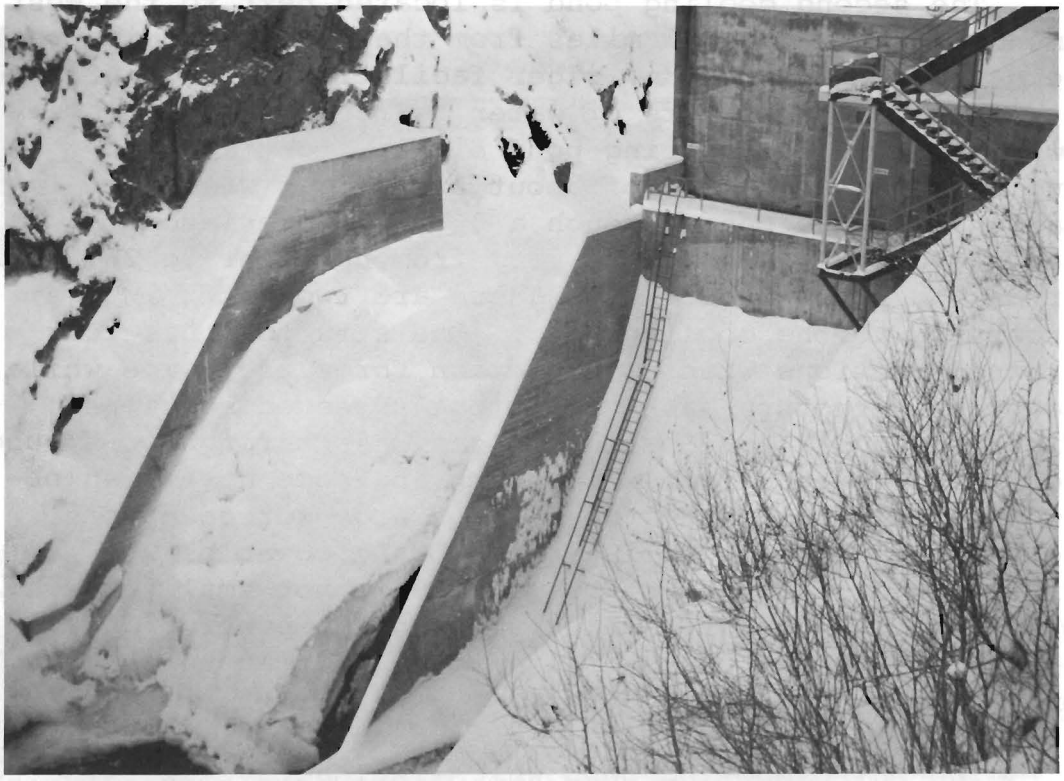

Figure 7. Upstream view of City of Anchorage Dam (40 feet).

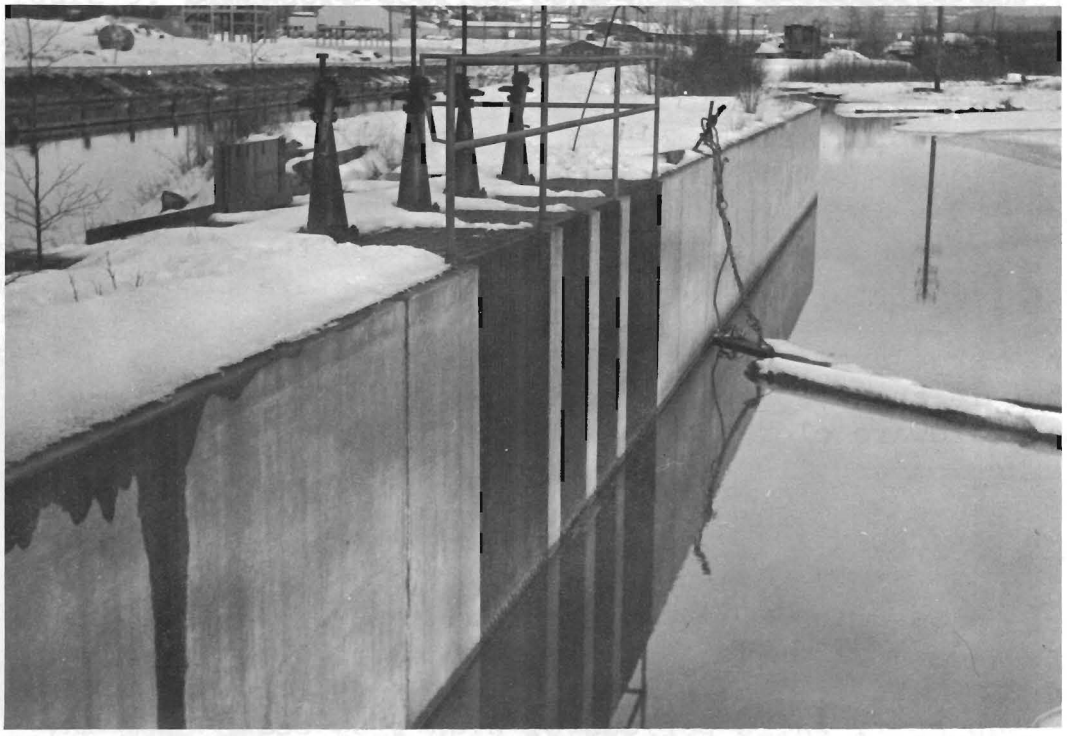

Figure 8. Trash screens at Chugach Cooling Pond Intake, Ship Creek.

The second cooling pond is located next to the West Elmendorf Dam about 3.6 miles from the mouth of Ship Creek. The dam, cooling pond and other facilities were constructed in 1954. About 15.7 cfs of water is recirculated from the power plant to the cooling pond similar to that of the Chugach system. A mean of about 8.8 cfs of water is discharged from the pond through a 36-inch pipe into Ship Creek below the dam and may vary from no water to 26.6 cfs during the year (Figure 9). There are two water intake structures to the cooling pond. One structure has four screened sections with each section three feet wide while the other structure has 3 four-foot screened sections (Figure 10 and 11). Small fish can pass through or around the intake screens from Ship Creek and some have been observed within the pond. One 5-foot wide screen covers the intake from the cooling pond to the power plant (Figure 12). The size of the screen is not small enough to prevent passage of small fish into the power plant. All screens are of one-half inch mesh and can be removed for cleaning.

The third cooling pond which is inactive is situated 4.5 miles upstream from the mouth of Ship Creek.

The Fort Richardson cooling pond was constructed in 1953 (USFWS, 1954) and is located 8.2 miles above tidewater. Approximately 20 cfs of pond water is recirculated through the power plant for cooling purposes. As the cooling pond water warms, more water from Ship Creek is added at a rate equal to that discharged below the dam, which is approximately 0.8 cfs. The intake structure at the cooling pond has two screens. One is a 2-inch mesh screen to prevent large debris from entering the pond (Figure 13). The other is an enclosure within the pond screened with 1/8th-inch hardware cloth (Figure 14). This enclosure prevents passage of any fish into the cooling pond.

CAMPBELL CREEK :

Streamflow data on the South Fork of Campbell Creek was obtained from the Geological Survey for the years 1961 and 1962 (Table 5). Periods of low flow occur from January through April while periods of high flow occur from May

Figure 9. Elmendorf Cooling Pond heated H_2O outlet pipe.

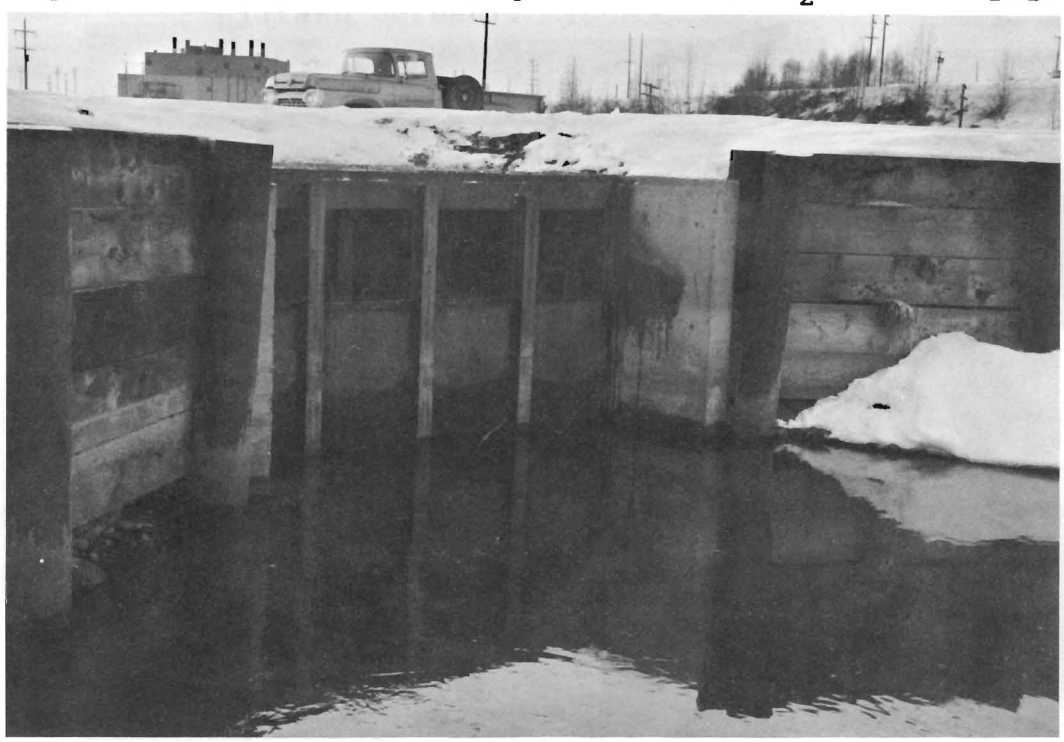

Figure 10. Elmendorf Cooling Pond Intake Screens. Original Set.

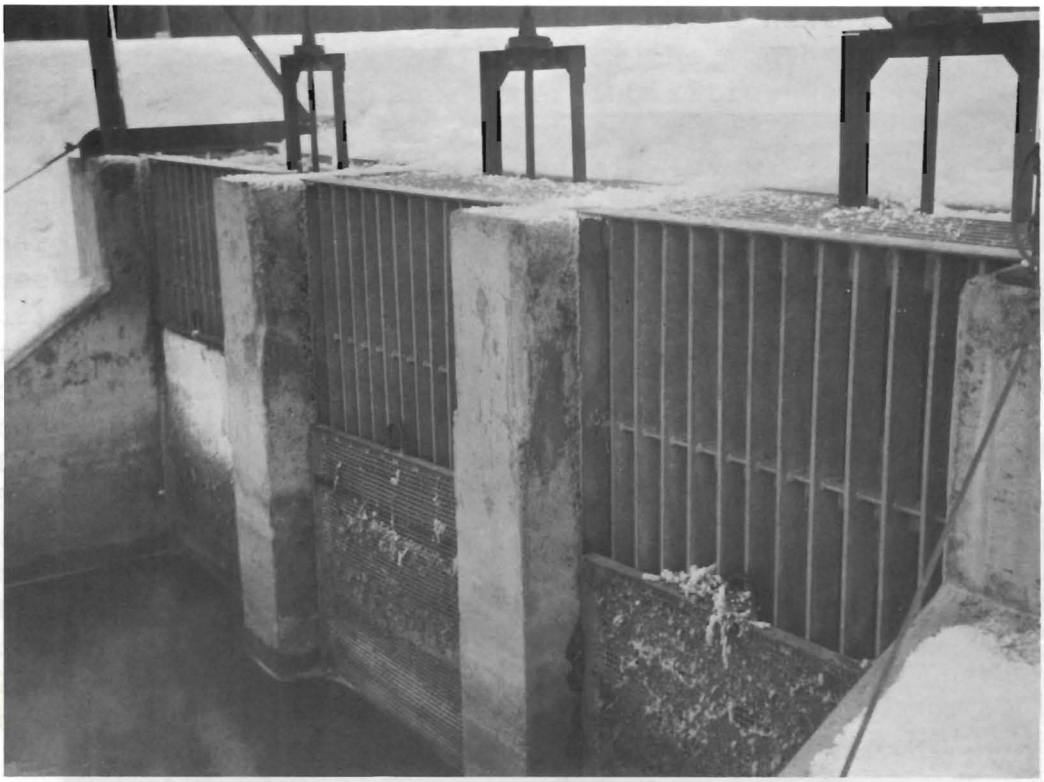

Figure 11. Elmendorf Cooling Pond Intake Screens. To Cooling Pond. New Set.

Figure 12. Elmendorf Cooling Pond Outlet Screens to Power Plant.

Figure 13. Fort Richardson Cooling Pond Intake Screen (Trash Screen).

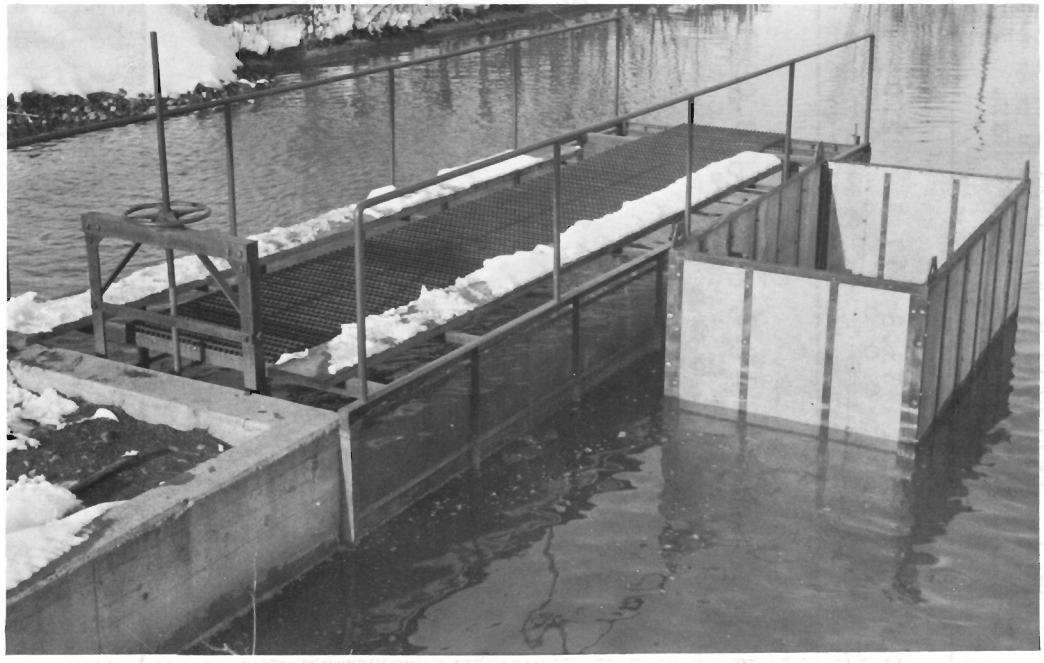

Figure 14. Intake Screens into Cooling Pond from Ship Creek (Fort Richardson).

Table 5. The average amount of water discharge by month flowing in the South Fork of Campbell Creek for the years 1961 and 1962.

Year	Discharge	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1961	S.F. Campbell Creek, c.f.s.	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	S.F. Campbell Creek, c.f.s.	14.0	12.0	8.0	19.2	32.6	166.0	92.4	47.0	41.4			

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

through December. Streamflow data indicates a minimum flow of 9 cfs occurred on April 8, 1961, while maximum flow of 347 cfs occurred on June 13, 1962. The low flows that occur during the winter may be detrimental to the eggs and young fish.

Temperatures of the stream water were taken at five stations established along Campbell Creek in 1961 (Table 6). Station 1 is located at the rapids just below Campbell Reservoir Dam, and station 2 is at the head of the reservoir below the Sand Lake Road bridge. Station 3 is situated at the Lake Otis Road bridge, while stations 4 and 5 are located at the Campbell Airstrip Road crossing on the North Fork and South Fork of Campbell Creek. Locations were selected because of the accessibility to the stream.

Table 6. Water temperatures of Campbell Creek at five stations from April 6, 1962 to February 1, 1963.

Date	STATIONS 1	2	3	4	5	Air Temp
4-6-62	33°	32°	32°	34°	34°	45°
4-13-62	32°	32°	32°	34°	34°	39°
4-20-62	33°	32°	32°	35°	35°	50°
4-27-62	34°	32°	36°	37°	36°	43°
5-4-62	38°	36°	35°	36°	36°	45°
5-11-62	38°	39°	38°	38°	36°	45°
5-18-62	46°	40°	39°	39°	38°	48°
6-1-62	50°	44°	43°	46°	40°	55°
6-8-62	50°	44°	44°	45°	41°	61°
6-15-62	44°	44°	44°	44°	42°	66°
6-22-62	53°	52°	51°	51°	50°	69°
6-29-62	51°	51°	51°	51°	51°	65°
7-6-62	58°	51°	56°	55°	55°	74°
7-13-62	54°	52°	50°	48°	50°	60°
7-27-62	62°	57°	54°	53°	54°	69°
8-10-62	57°	53°	53°	51°	52°	67°
10-6-62	40°	35°	36°	35°	36°	41°
11-23-62 to 2-1-63	32°	32°	32°	32°	32°	56° *

* Mean temperature.

Water samples were also collected on Campbell Creek. The studies were initiated on November 23, 1962, at temperature stations 1, 4 and 5 (Figure 2). The water samples were analyzed for DO, pH, CO_2, total alkalinity and turbidity to determine the chemical and characteristics and the seasonal changes of Campbell Creek (Table 7).

The lack of man power prevented an intensive creel census of the catch of trout and salmon in Campbell Creek. Heaviest fishing pressure occurred during the first part of the trout season. Non-licensed juvenile fishermen exerted the most pressure on Campbell Creek. The number of fish caught per hour of effort was 0.46 with Dolly Varden trout and silver salmon being the only fish caught. Fishing pressure was light during the silver salmon run in the fall. Fishing for salmon is allowed from August 22 to September 23.

On August 9, 1962, a survey to count the number of spawning salmon and redds, to note any new barriers, to observe any pollutants and to note other physical changes was made by floating Campbell Creek in a rubber raft. The float survey, starting on the South Fork at the Campbell Airstrip Road and ending at the Sand Lake Road, covered a distance of 11 miles. Twenty-one king salmon (14 dead) and 21 king salmon redds were counted. At approximately 10 miles above tidewater on the South Fork of Campbell Creek, pink salmon and chum salmon were in such large numbers that individual counts were not feasible. About one-half of the chum salmon and pink salmon were in the process of spawning. No salmon were in the main stream below the mouth of Little Campbell Creek.

On July 5, 1962, approximately 50 king salmon were counted in Campbell Reservoir just above the dam. The following day only 10 king salmon were observed in the same area. Two foot surveys on the North Fork from the Campbell Airstrip Road upstream to the impassable beaver dam were made during the month of July (Figure 15). Nineteen adult king salmon were observed from the Commercial Fisheries Division removed the beaver dam to allow passage of trout and salmon (Figure 16). After the removal of the beaver dam, another foot survey was made. Of the seven

Table 7. Dissolved oxygen, pH, carbon dioxide, total alkalinity and turbidity taken at 3 stations on Campbell Creek from November 23, 1962 to February 1, 1963.

Date	STATION 1* DO	pH	CO_2	Tl. Alk.	4* DO	pH	CO_2	Tl. Alk.	5* DO	pH	CO_2	Tl. Alk.
11-23-62	10.8	7.2	14.0	45.0	9.7	7.1	20.0	52.0	10.8	7.2	6.0	33.0
12-7-62	10.5	6.9	23.0	42.0	10.7	7.1	16.0	48.0	12.0	7.2	8.0	32.0
12-21-62	9.0	6.9	7.0	49.0	10.9	7.3	10.0	82.0	10.7	7.0	4.0	45.0
1-11-63	8.0	6.7	8.0	60.0					10.2	7.1	6.0	58.0
1-18-63	8.2	6.7	10.0	43.0					10.5	7.2	3.0	31.0
2- 1-63	9.6	6.7	8.0	46.0					10.9	7.0	3.0	35.0

* - Turbidity 0.0
Water samples chemically analyzed in p.p.m.

Figure 15. Beaver Dam, North Fork Campbell Creek.

Figure 16. Upstream view of removed beaver dam site on North Fork Campbell Creek - 4.5 foot dam was where stick is protruding from water looking East.

king salmon counted on this trip, two were seen above the removed beaver dam site. Twenty king salmon redds, all below the beaver dam, were also observed on this date.

No artificial barriers, other than the earth dam, exist in the stream system, although many partial obstructions caused by floating debris were noted. A few of the partial obstructions could develop into a barrier if debris continues to pile in front of them. There are no pollutants entering Campbell Creek from the Campbell Creek Airstrip Road on the South Fork downstream to the mouth. Physical observations of the streambed indicate a stable system.

A partial barrier exists on the North Fork of Campbell Creek just below the Campbell Airstrip Road. A collapsed foot bridge accumulated debris, causing a partial barrier across the creek.

During the middle part of the king salmon run, a heavy rainfall occurred resulting in a heavy run-off in Campbell Creek. It was of such magnitude that the 8-foot culvert at the dam forming Campbell Reservoir could not carry all of the water, thereby washing the fill from around the culvert. The large rocks that formed pools below the culvert were dislodged and washed downstream. The owner of the property was contacted, and it was decided that complete removal of the culvert was the only solution to the problem. The culvert was removed and a gradual slope was then made from the lip of the earth fill dam downstream to the tidewater channel, a distance of approximately 75 yards (Figure 17). Large rocks were then placed in the new streambed covered with rocks of a smaller size. Mean high tide covers approximately one-half of the artificial rapids. In the past, few pink salmon were able to negotiate the 8-foot culvert; however, after the removal of the culvert, many pink salmon were seen above the site. Several pink salmon were noted spawning in the artificial rapids area only 40 yards above the mean low tide mark.

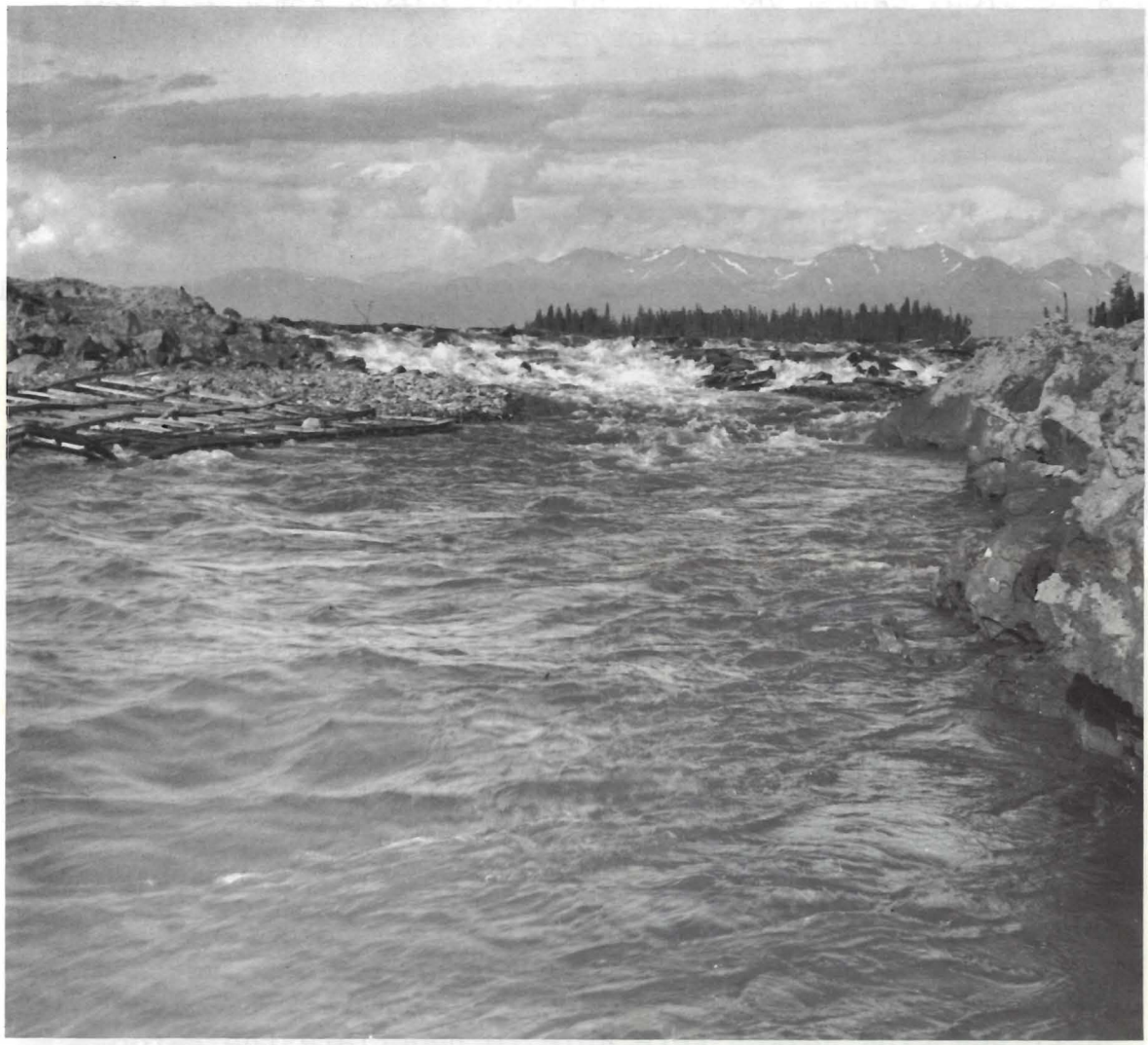

Figure 17. Upstream view of removed Campbell Lake culvert looking East. Partially completed rapids.

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Prepared by:

Gordon Gretz
Fishery Biologist

Job Leader:

Frank A. Stefanich
Fishery Biologist

Date: March 1, 1963

Approved by:

Richard Haley
D-J Coordinator

Alex H. McRea, Director
Sport Fish Division