Environment Canada — Environnement Canada
Fisheries and Marine Service — Service des pêches et des sciences de la mer

Catalogue of Aquatic Resources of the Upper Yukon River Drainage (Whitehorse Area)

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Northern Operations Branch
Pacific Region

FOREWORD

The north is presently involved in a period of rapid change. Modern transportation methods now permit exploration and development even in the most remote areas.

In order to ensure the perpetuation of fishery resources it is essential that the resource manager attempt to minimize and control the inevitable environmental damage that results from industrial development. Recommendations on environmental protection and resource harvest must be based on biologically sound facts.

This report is an information source concerning fish species and their habitat in the upper Yukon River drainage and as such is a tool for resource management. It is one of a series covering the major drainage basins in the Northern British Columbia and Yukon Division that has been assembled for the use of those people involved in fishery management and environmental protection. The report should be considered as a preliminary documentation of fisheries and related information, and as a basis from which future resource management policy may stem.

The aim of habitat protection is to balance environmental concerns with economic demands. We believe that total environmental destruction does not necessarily accompany industrial progress, and that the concept of multiple use of resources can be safely implemented. Areas of high concentration of fish and wildlife populations or of significant aesthetic value must not, however, be sacrificed to ill-considered development projects.

Historical and current exploitation of the fishery resource of the upper Yukon River drainage is discussed in this report.

G. E. Jones
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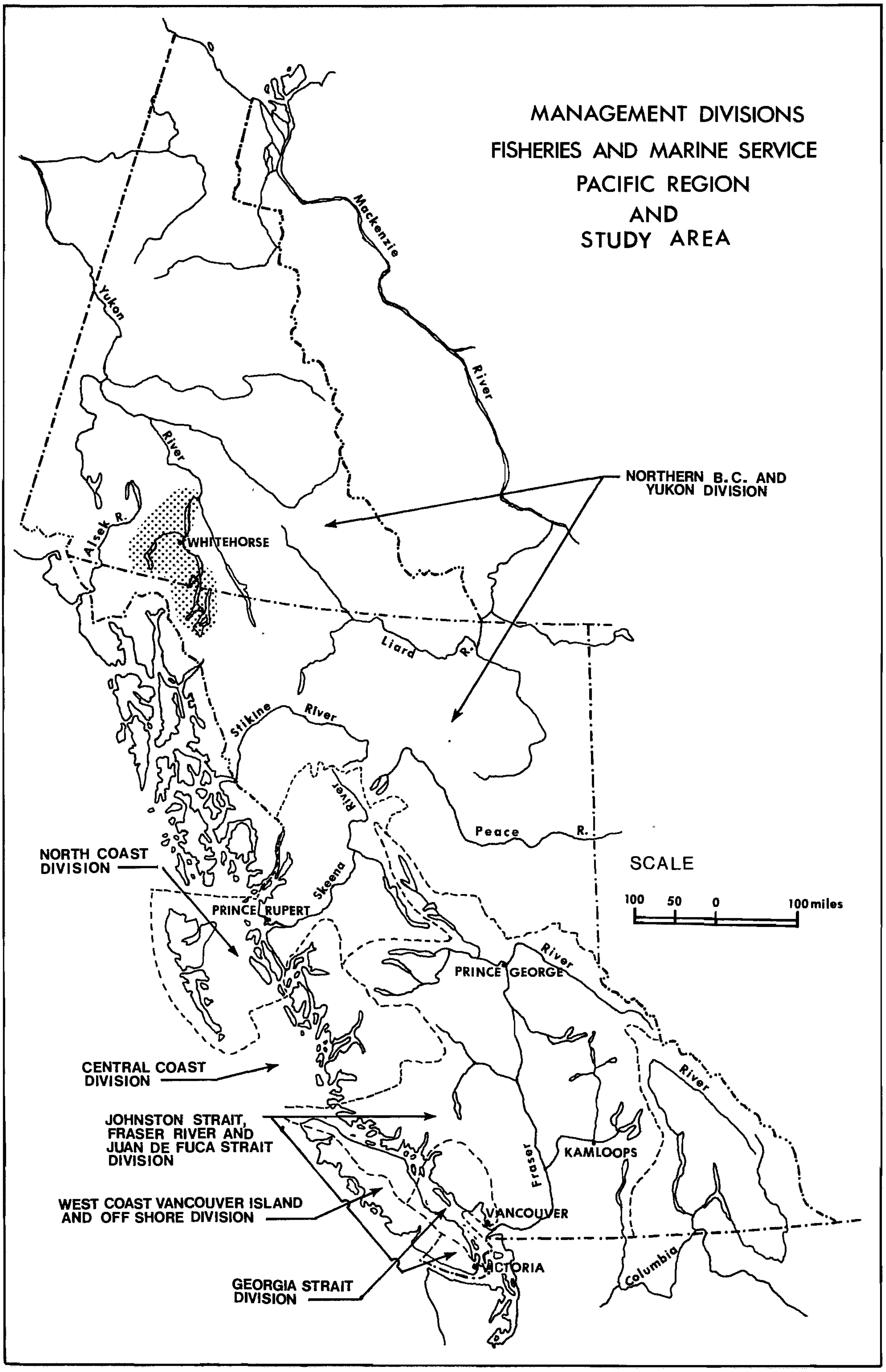
ABSTRACT

The upper Yukon River drains an area of approximately 12,000 square miles of northern British Columbia and the Yukon Territory. Eighteen species of fish have been recorded from the drainage, of which 3 species have been introduced and one species is probably no longer present. Physical, chemical and biological information is presented for each of 7 major tributary systems. Exploitation of the fish stocks is discussed. A description of dams present in the system and their effect on fishery stocks is given. A summary of fish stocking programmes in the drainage is presented.


MANAGEMENT DIVISIONS
FISHERIES AND MARINE SERVICE
PACIFIC REGION
AND
STUDY AREA
NORTHERN B.C. AND YUKON DIVISION
NORTH COAST DIVISION
CENTRAL COAST DIVISION
JOHNSTON STRAIT, FRASER RIVER AND JUAN DE FUCA STRAIT DIVISION
WEST COAST VANCOUVER ISLAND AND OFF SHORE DIVISION
GEORGIA STRAIT DIVISION
SCALE
100 50 0 100 miles
Mackenzie River
Yukon River
Alsek R.
WHITEHORSE
Liard R.
Stikine River
River
Skeena
Peace R.
PRINCE RUPERT
PRINCE GEORGE
River
River
Fraser
KAMLOOPS
VANCOUVER
VICTORIA
Columbia

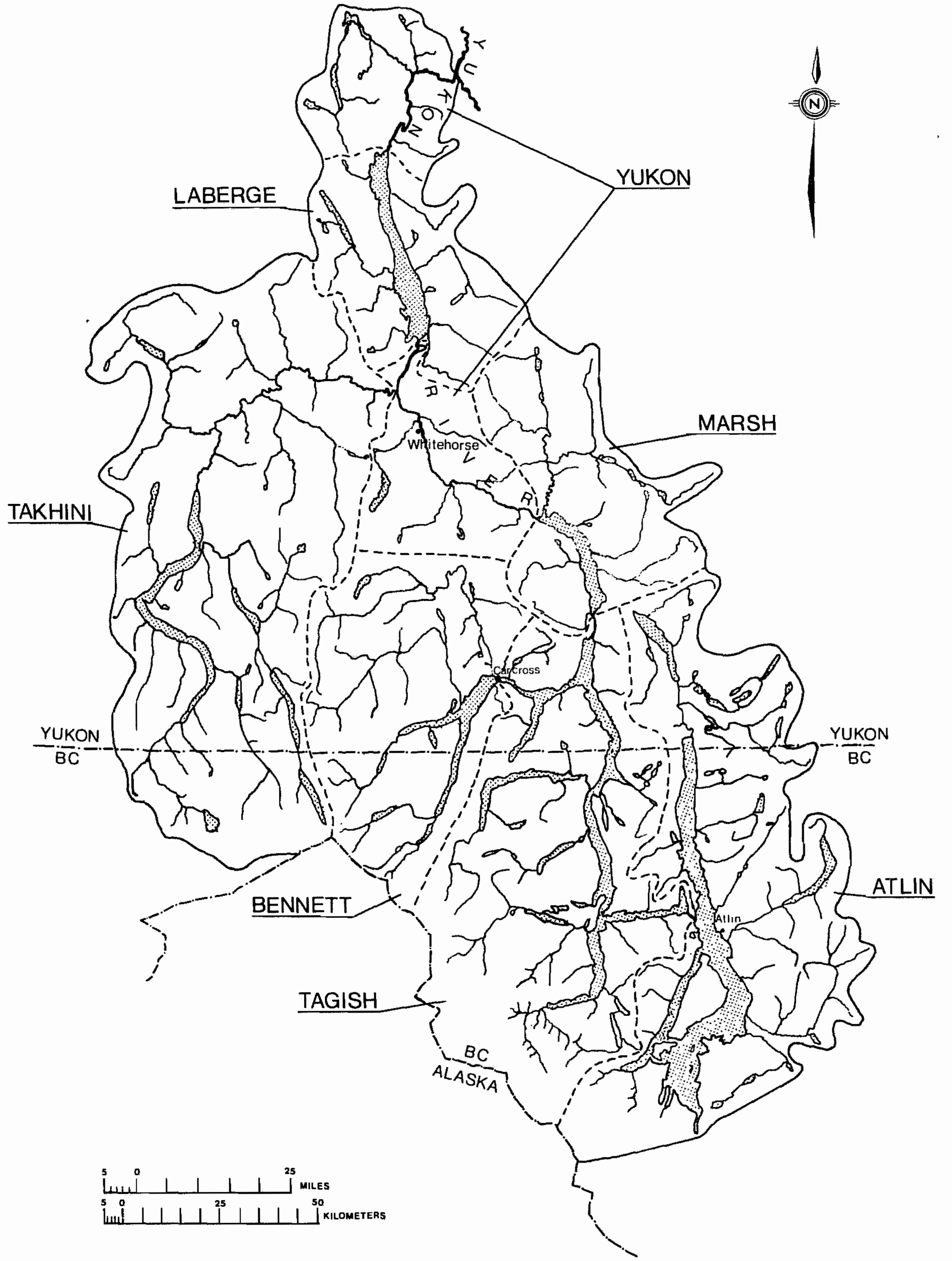


FIGURE 1. UPPER YUKON RIVER DRAINAGE.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

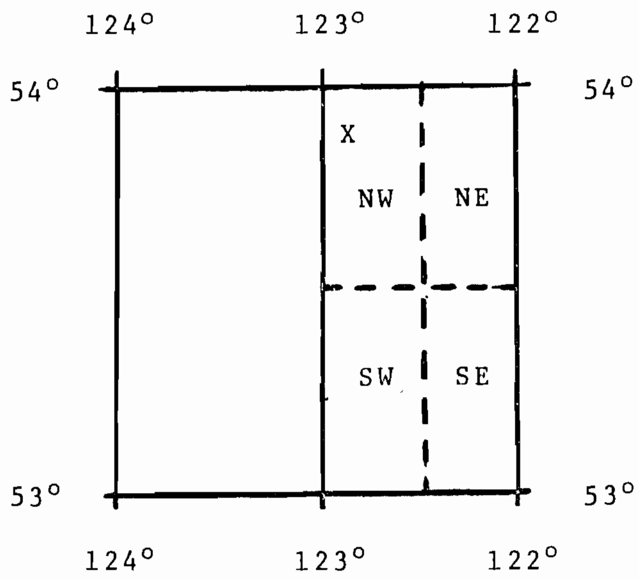
LIST OF PLATES

PLATE | Page

STANDARDS USED

NAME OF STREAM: Name given in Gazetteer of Canada for Yukon and British Columbia; other names are added in lower case type.

WATERBODIES WITHIN BRITISH COLUMBIA - LOCATION AND POSITION: Defined by quadrant indexing. Each geographical quadrilateral of the earth's surface of 1 degree in extent in latitude and longitude is divided into the SE, SW, NE and NW quarters. The southeast corner of each quadrilateral gives the initial point for the figures of reference (Gazetteer of Canada).



WATERBODIES WITHIN YUKON TERRITORY - LOCATION AND POSITION: Defined by the co-ordinates of latitude and longitude.

LENGTH: Mainstem only.

WIDTH: Average width, estimated to nearest foot.

DRAINAGE: Area in square miles of the entire drainage basin feeding the stream.

Stream bed category definitions:

Bedrock	bedrock
Boulder	>256 mm. (>10")
Coarse	50.9-256 mm. (2-10")
Fine	3.37-50.8 mm. (1/8-2")
Sand and Silt	<3.37 mm.

Distance references are from mouth of stream, unless stated otherwise.

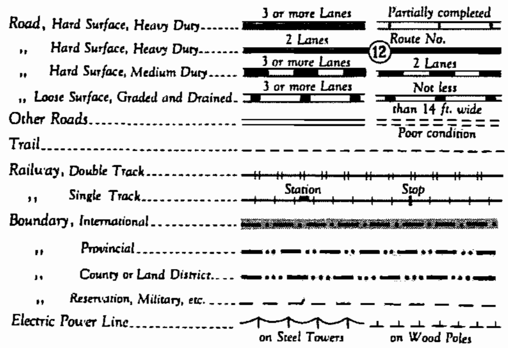
Abbreviations: MO = Methyl Organge; Phenol = Phenolphthalein; CF = Canada Fisheries personnel; ADFG = Alaska Dept. Fish and Game personnel.

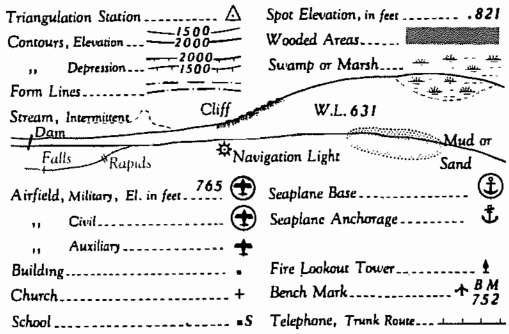
Table 1. Position of waterbodies discussed in this report.

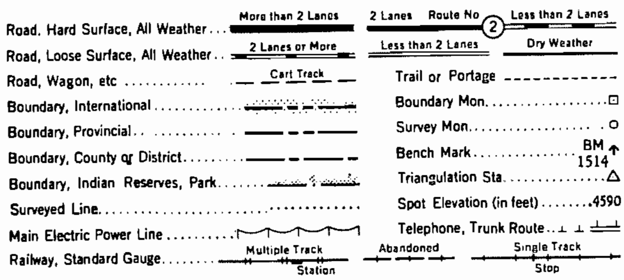
	Page	Latitude	Longitude	Position
Atlin Lake	7	60°00'	133°50'	
Atlin River	23			59°133'NW
Alligator Lake	41	60°23'	135°21'	
Annie Lake	41	60°19'	134°59'	
Bennett Lake	37	60°01'	134°56'	
Bryde Lake	11	60°04'	133°12'	
Byng Creek	60	60°41'	134°15'	
Cap Creek	59	60°44'	134°27'	
Caribou Lake	61	60°23'	130°43'	
Chadburn Lake	137	60°39'	134°57'	
Coal Lake	95	60°30'	135°10'	
Coghlan Lake	96	61°33'	135°30'	
Cowley Lake	95	60°31'	134°52'	
Crag Lake	25	60°14'	134°30'	
Croucher Creek	95	60°47'	135°04'	
Edgar Lake	24	60°18'	130°44'	
Fantail Lake	24			59°134'NE
Fantail River	24			59°134'NE
Fish Lake	96	60°37'	135°14'	
Fourth of July Creek	6			59°134'NE
Fox Lake (Michie Creek drainage)	61	60°39'	134°04'	
Fox Lake (Richtofen Creek drainage)	77	61°14'	135°28'	
Frank Lake)	95	61°42'	135°25'	
Frank Creek)		61°34'	135°06'	
Grayling Creek	61			59°133'NW
Harrison Lake	68	60°57'	136°06'	
Homan Lake	40			59°135'NE
Homan River	40			59°135'NE
Horse Creek	77			59°133'NE
Ibex Lake	65	60°31'	135°28'	
Ibex River	68	60°49'	135°50'	
Indian Creek	6			59°133'NW
Jackson Lake)	96	60°43'	135°17'	
Jackson Creek)		60°39'	135°14'	
Jo-Jo Lake	69	60°35'	136°20'	
Jo-Jo Creek		60°31'	136°25'	
Kusawa Lake	67	60°20'	136°13	
Kusawa River	65	60°05'	136°00'	
Lake Laberge	77	61°11'	135°12'	
Lindeman Lake	39			59°135'NE
Lindeman River	39			59°135'NE

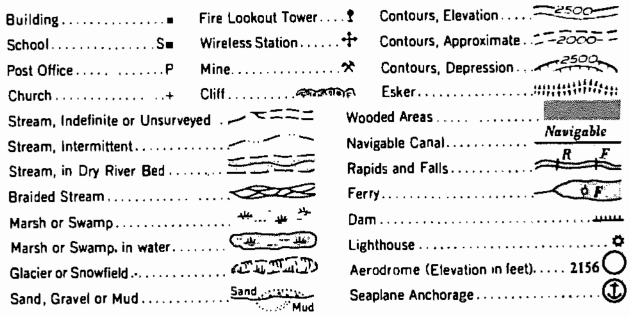
	Page	Latitude	Longitude	Position
Yukon River (outlet of Marsh Lake; formerly called Lewes River)	82	60°32'	134°31'	
Watson River	41	60°11'	134°44'	
Wheaton River	41	60°06'	134°53'	
Wolf Creek	94	60°38'	134°55'	

Map Reference









① ② ③ etc....... Photograph reference

INTRODUCTION

This catalogue describes the aquatic resources of the upper drainage of the Yukon River system. The study area extends from Atlin north to Hootalinqua at the confluence of the Yukon and Teslin Rivers, and represents a drainage area of approximately 12,000 square miles (Figure 1). The Yukon-British Columbia border bisects the study area and crosses some of the large lakes (Atlin, Tagish and Bennett) which form the headwaters of the Yukon River. Kusawa Lake in the western sector of the study area drains via the Takhini River into the Yukon River approximately 30 miles from its source at the outlet of Marsh Lake. Lake Laberge is the lowermost on-stream lake of the Yukon River within the study area.

The study area is mountainous, with summits generally in the order of 6500-7500 feet above sea level, rising steeply from lake elevations of approximately 2000 feet above sea level.

The climate is generally cold with an annual mean temperature of 30.5°F. Monthly temperatures (°F) for Whitehorse at 2289 feet above sea level are as follows:

Mean	J	F	M	A	M	J	J	A	S	O	N	D	YR
Max.	5.6	16.9	28.2	41.2	55.6	65.7	68.1	64.5	54.5	39.8	21.9	10.6	39.4
Min.	-9.5	-0.2	8.1	22.4	33.9	42.7	46.5	43.9	37.4	26.6	9.6	-3.4	21.5

Extreme temperature variations have been recorded, from 94°F to -62°F. Days of frost average 219 annually. Mean annual values of rainfall, snowfall and total precipitation are 5.6, 50.3, and 10.34 inches, respectively.

More severe weather conditions prevail at Atlin Lake, south of White-horse. The weather conditions at Atlin may be summarized as follows.

The mean winter temperature of the drainage basin is 2°F. Snow depth near the lake does not generally exceed 2 feet. Ice is present on the lake and tributary streams from late December to early June. The area averages 280 days of frost annually. Summer temperatures average between 54°F and 64°F. Annual precipitation averages 11 inches with the maximum in November and the minimum in April. The prevailing winds are from the south. The strongest winds occur almost daily during the summer (afternoon and evening). Relatively calm periods prevail through the night and early morning.

The following species of fish have been recorded within the study area:

Inconnu	*Stenodus leucichthys*	(Family Coregonidae)
Humpback whitefish	*Coregonus clupeaformis*	(" ")
Broad whitefish	*Coregonus nasus*	(" ")
Least cisco	*Coregonus sardinella*	(" ")
Round whitefish	*Prosopium cylindraceum*	(" ")
Arctic grayling	*Thymallus arcticus*	(Family Thymallidae)

Lake trout	Salvelinus namaycush	(Family Salmonidae)
Chinook salmon	Oncorhynchus tshawytscha	(" ")
Chum salmon	Oncorhynchus keta	(" ")
Coho salmon	Oncorhynchus kisutch	(" ")
Rainbow trout	Salmo gairdneri	(" ")
Cutthroat trout	Salmo clarkii	(" ")
Northern pike	Esox lucius	(Family Exocidae)
Longnose sucker	Catastomus catastomus	(Family Catastomidae)
Burbot	Lota lota	(Family Gadidae)
Slimy sculpin	Cottus cognatus	(Family Cottidae)
Arctic lamprey	Lampetra japonica	(Family Petromyzontidae)
Lake chub	Couesius plumbeus	(Family Cyprinidae)

Table 2 lists the spawning periods of fish species present in the upper Yukon River drainage.

Table 2. Spawning periods of fish species recorded from the upper Yukon River drainage.

Spawning species of fish	Spawning period
SPRING-SUMMER	
Thymallus arcticus	May - mid-June
Esox lucius	Spring
Catastomus catastomus	Spring thaw
Cottus cognatus	May
Salmo clarkii (planted)	Spring
Salmo gairdneri (planted)	Spring
Couesius plumbeus (if present)	May
Lampetra japonica	May - July
AUTUMN-WINTER	
Prosopium cylindraceum	Autumn
Coregonus clupeaformis	Late summer - early autumn
Coregonus nasus	Late summer - early autumn
Coregonus sardinella	Autumn
Lota lota	Winter (Feb.-Mar.)
Salvelinus namaycush	July - Oct.
Stenodus leucichthys (if present)	Sept. - early Oct.
Oncorhynchus tshawytscha	Aug. - early Sept.
Oncorhynchus keta (if present)	Sept. - Oct.
Oncorhynchus kisutch (planted)	Oct. - Nov.

It is believed that chum salmon no longer utilize the study area for spawning purposes although historical evidence suggests their former presence. Thus, the only naturally occurring anadromous species in the study area is the chinook salmon. All others present are strictly fresh water species. Rainbow and cutthroat trout and coho salmon are not native to the study area, but have been introduced to several small pothole lakes in the Whitehorse area. Their introduction was originally intended to enhance the recreational fishing capacity of the area, but since 1972 the introductions of these three species have led to preliminary experiments in pothole fish farming (mericulture).

For most fish species within the study area, specific life history information is very limited. Some information is available for chinook salmon. Maturing chinook salmon appear in the study area in late July and spawn in late August. Documented spawning areas have been located in Michie Creek, Takhini River and Wolf Creek. It is suspected that limited spawning occurs in the Tagish system and in the Yukon River immediately below Marsh Lake. Some mainstem spawning downstream of the Whitehorse dam has also been indicated.

Historical exploitation of the fish stocks within the study area has been more intense than elsewhere within the Yukon Territory and northern B. C. The favoured route to the Klondike gold fields at the turn of the century was by boat through Bennett, Tagish and Marsh Lakes down the Yukon River through Lake Laberge and hence to Dawson City. The tremendous influx of miners utilized the fish resources of this waterway as a supplement to their diet of mainly dried foods. In the period 1925-1935, Wynne-Edwards (1947) reports that enormous quantities of fish were taken from Bennett, Atlin and Tagish Lakes to serve as the food source for mink and fox ranches at Carcross and Tagish. The harvest sometimes amounted to several thousands of pounds per week of humpback whitefish, lake trout and least cisco (lake herring). A third period of relatively high exploitation of fishery stocks within the study area occurred during the war years as a consequence of activities connected with construction of the Alaska Highway and the Canol Road and pipeline.

Firm regulatory control of the commercial fishery on lakes in the Yukon Territory was established by passage of Order-in-Council P.C. 1961-1678 on November 23, 1961. Thirty-two lakes were designated in the regulations. In these lakes it would be permissible to conduct commercial fisheries for whitefish and lake trout. Prior to 1961, the harvest was not limited. In 1961, catch quotas were established on the basis of 1/2 pound of whitefish and lake trout per acre of lake surface. The lakes and the quotas for commercial fishing within this study area were:

LAKE	QUOTA	DESCRIPTION
Atlin	4,000	-that part of the lake within the Yukon Territory only
Bennett	9,000	-that part of the lake within the Yukon Territory only
Kusawa	15,000	-quota eliminated in 1968
Laberge	15,000	-subsequently increased to 20,000 pounds
Little Atlin	4,000	-quota eliminated in 1964

In response to recommendations by local residents in the vicinity of Tagish and Marsh Lakes, quotas were not established for these lakes. At the present time the most consistent commercial fishing effort occurs on Atlin Lake where the high quality of flesh makes the fish easily marketable. The quota is harvested every year in Atlin Lake; this is not the case in Bennett or Laberge Lakes. Modern transportation methods for foodstuffs have decreased dependence on fish as a food source within the study area.

A commercial fishery in the Yukon Territory is defined as one which entitles the holder of a twenty-five dollar ($25.00) Commerical Fishing License to sell those fish caught by means of gillnet or fishwheel. An Assistant Operator's License must be purchased for each individual assisting the commercial operator in his fishing endeavours. Regulations restrict the waters, the time, the species, and method of fishing, as well as determining the eligibility for a Commercial Fishing License. Twenty lakes have been declared open to commercial fishing and poundage quotas established for each. Portions of two rivers (Yukon and Pelly) are open for the purpose of catching salmon.

A domestic fishery in the Yukon Territory is defined as one which entitles the holder of a ten dollar ($10.00) Domestic Consumption Fishing License to fish for his personal use, but not for commercial sale. No assistant operator's license exists in the domestic fishery. Regulations restrict the waters, the time, the species, and method of fishing, as well as determining the eligibility for a Domestic Fishing License.

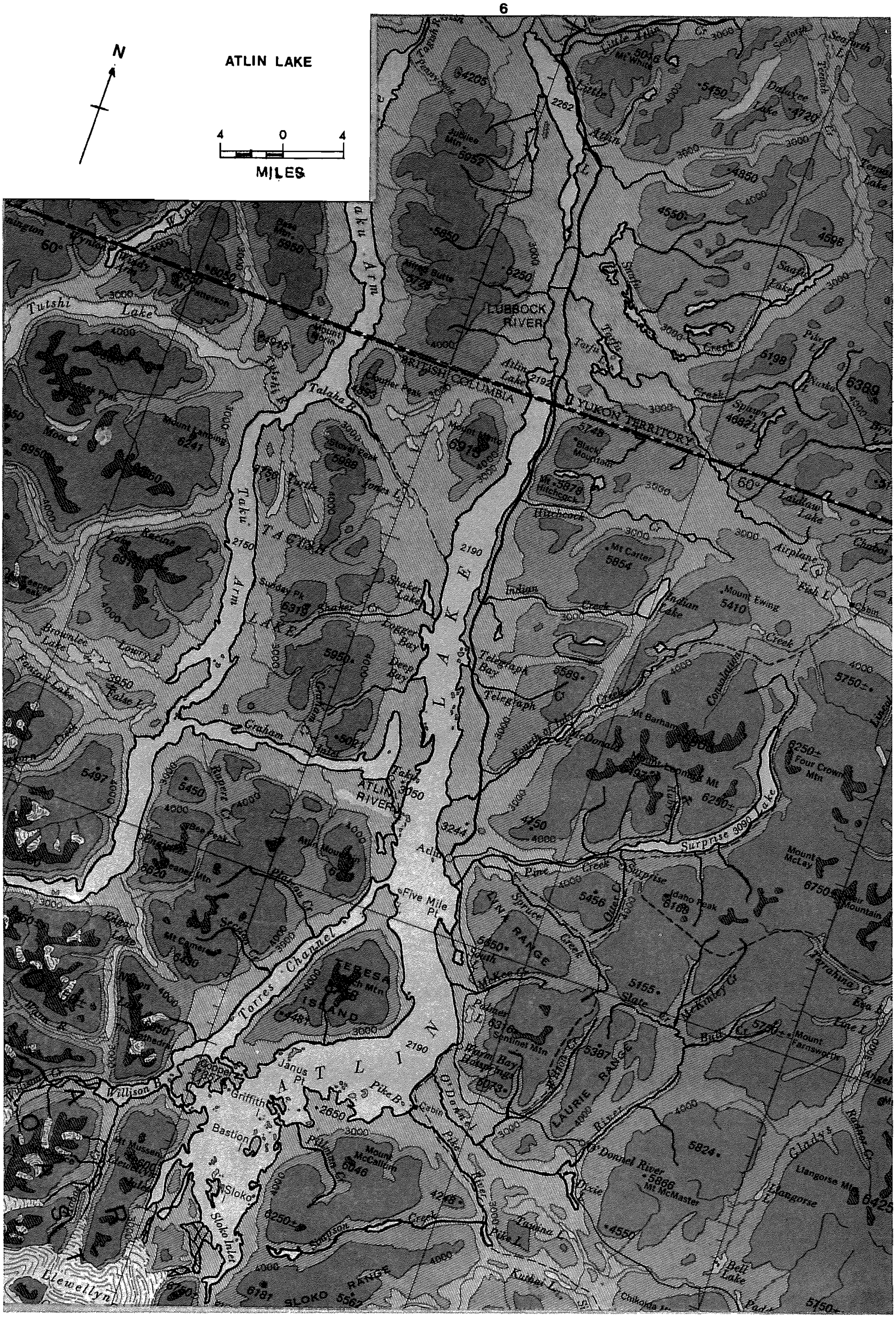
An Indian food fishery in the Yukon Territory is defined as one which grants permission to an Indian person to catch fish to be used as food for himself, his family, or his band, but for no other purpose. An Indian Food Certificate, issued free by the Regional Director or a Fishery Officer, specifies the waters, the method of fishing, and the time during which the certificate is valid.

A sports angling fishery in the Yukon Territory is defined as one which entitles the holder of a Yukon Territory Angling License to take or kill by angling, game fish from waters within the territory (excluding Kluane National Park). Three classes of angling licenses exist: Resident (Canadian) Angling - fee $3.00; Non-Resident (Alien) Angling - fee $10.00; Non-Resident (Alien) Angling 5 day - fee $3.50. Daily bag limits, possession limits and prohibitions are listed on the license. No closed seasons exist for sport fishing.

Sport fishing pressures on the fish stocks within the catalogue area are becoming more intense as population size increases. Lake trout and Arctic grayling are the native species most actively sought. Coho salmon were stocked near Whitehorse in 1974-1975 to provide additional recreational opportunities. A highly specialized and intense sport fishery for lake trout occurs at the Tagish River bridge.

Approximately one-half of the Yukon Territory population live in or in close proximity to the city of Whitehorse. Satisfactory disposal systems have not yet been implemented to adequately treat sewage and solid wastes from this population. Until such treatment facilities are constructed, a danger exists to the health and abundance of fish stocks within the study area downstream of the sewage outfall at Whitehorse.

Two dams exist on the Yukon River within the study area. These are Lewes Dam and the Whitehorse Rapids Power Development. In addition, several small dams have been constructed on tributary streams within the upper Yukon River drainage. The effect of these dams on the fishery resource within the study area is discussed in a separate section of this report.


N
ATLIN LAKE
4 0 4
MILES
LUBBOCK RIVER
BRITISH COLUMBIA
YUKON TERRITORY
Tutshi Lake
Taku Arm
TAGISH LAKE
ATLIN RIVER
ATLIN LAKE
Atlin
Five Mile Pt.
Torres Channel
TERESA ISLAND
Janus Pt
Griffith
Bastion
Sloko
Sloko Inlet
SLOKO RANGE
LAURIE RANGE
O'Donnel River
Surprise Lake
Mt Carter
Mount Ewing
Indian Lake
Telegraph Bay
Graham Inlet
Llewellyn
Mt McMaster
Mt Barham
Mount McLey
Mount Farnsworth
Four Crown Mtn
Llangorse Mtn
Pike R.
Willison B.
Bell Lake
Kuthai L.

Name of Stream	Tributary to	River System
ATLIN LAKE	ATLIN RIVER	YUKON

LOCATION N. end crosses B.C.-Yukon border E. of Tagish L., Cassiar District

POSITION 59 133 NW

LENGTH 66 miles WIDTH 2-5 miles DRAINAGE 4400 square miles

Atlin Lake lies in the extreme northwestern corner of British Columbia and extends over the provincial boundary into Yukon Territory, largely between the 59th and 60th parallels of latitude, and lies at an elevation of 2192 ft. Some physical parameters of the lake include:

Elevation: maximum 2195.48 ft., 25 & 27/08/61; minimum 2188.01 ft., 9 & 12/05/56.

Surface area: 245 sq. mi.

Depth: mean 281 ft., maximum 930 ft.

Water volume: 1.92×10^{12} cu. ft.

Most of the lake bottom drops off very sharply from shore. Of the shoal area, the largest is a shallow sandy area at the extreme north end of the lake. Exposed shoreline is composed of boulder ranging from 2-10 in. in diameter. The lake bottom is composed of gravel and boulders to a depth of 10 ft.; fine sand and mud to 40-50 ft.; mud and clay at greater depths. In some areas, rocky upthrusts rise steeply to near surface levels. Aquatic vegetation is limited. Tributary streams entering the lake from the south originate from glaciers in the coastal mountains and these streams impart a milky green coloration to waters of the southern basin of the lake. Streams entering the lake from the Yukon plateau are clear as is the north end of the lake. Total dissolved solids measurements (T.D.S.) taken in June and July of 1955 (Withler, 1956) ranged from 93-100 ppm. from south to north.

Water Temperature

	South (1)	Central (2)	North (3)
07/07/55	Surface - 42°F	44°F	48°F
	150 ft. - 40°F	37°F	45.5°F
30/07/55	Surface - 49°F	52°F	52°F
	200 ft. - 37°F	41.5°F	40°F
04/09/55	Surface - 46°F		

Bottom samples taken in 1955 with a six-inch Ekman dredge indicated increasing abundance of organisms from 5-100 ft., with the greatest abundance occurring between 30-100 ft. No organisms were present in one sample from 200 ft. Most abundant organisms were Chironomidae, Trichoptera and Gastropoda. Plankton, sampled in July and September, was sparse and the number of species restricted, with zooplanktors and diatoms comprising the bulk of the samples.

Water temperatures, invertebrate data and plankton information are extracted from Withler (1956).

Fish species recorded from Atlin Lake are lake trout, Arctic grayling, humpback whitefish, northern pike, lake chub, longnose suckers, burbot, least cisco, and slimy sculpin. There are unconfirmed reports of the presence of chinook salmon in the Atlin Lake drainage.

Lake trout sampled by 1-1/2 to 5-1/2 in. gillnets in July and September 1955 by Withler were equally distributed in the lake. A sample of 134 fish ranged in fork length from 8 to 34.1 in. with an average of 20.3 in., weight maximum 14.75 lbs. with an average of 3.7 lbs., and a range in age of 4 to 10+ yrs. Twelve-inch fish weighed approximately 1-1/4 lbs. and were five years old. A plot of length/weight/age data is available in Withler (1956, Figure 4). All classes of food forms were utilized with molluscs and fish predominating in the diet. There is ample suitable spawning area available in the lake, particularly in the northern basin.

Arctic grayling sampled in July and September of 1955 by Withler were most abundant in shallow on-shore areas and very seldom caught in depths exceeding 20 ft. Angling for this species was most successful in tributary streams and in the main lake near the mouths of streams. The largest concentration of Arctic grayling was located in the Atlin River. Gillnet-caught Arctic grayling ranged from 6.2 to 14.5 in. fork length. Anglers have reported taking fish up to 18 in. from the Atlin River. The maximum age for Arctic grayling was five years. Caddisfly larvae and surface insects composed the bulk of the diet of Arctic grayling, with terrestrial insects being most important during the summer months. Tributary streams offering spawning possibilities were sampled for bottom organisms in fine gravel areas where the velocity was approximately 2 ft/sec. The samples were mainly composed of mayfly nymphs (50%), Diptera larvae (25%), Plecoptera nymphs (17%), and Coleoptera (8%). Arctic grayling were observed spawning in Telegraph and Indian Creeks, Atlin River, O'Donnel River and Fourth of July Creek in late spring and early summer. All spawning occurred in the lower 1/2 mile of the inflow streams. It was estimated that approximately 125,000 square yards of suitable spawning gravel was available in the streams. Atlin River is the most important spawning stream for grayling and contains an additional 25,000 square yards of gravel.

Lake whitefish (22) were captured in gillnets in July and September, and were restricted to the northern portions of the lake. Fork length ranged from 12.0-23.4 in., with an average of 18.7 in. and an average weight of 4 lbs. The diet was represented by 95% Mollusca, with the remainder being Trichoptera and Chironomidae larvae. Extensive suitable spawning areas are available throughout the lake.

Netting results indicated that round whitefish were equally available throughout the lake. A total of 138 fish were captured with a maximum fork length of 16.3 in., a mean fork length of 12.1 in., and a mean weight of 0.75 lbs. The diet consisted of 65% Mollusca, 15% Chironomidae pupae, and 20% Trichoptera. Extensive suitable spawning areas exist in the lake for both round and lake whitefish, e.g., Pike Bay, Telegraph Creek, Indian Creek and Torres Channel.

Northern pike were concentrated in shallow, weedy areas in the vicinity of Copper and Teresa Islands.

Sport fishing is light at present and tends to be localized with lake trout the most sought-after species. Angling for Arctic grayling is mostly carried out in tributary streams. Commercial fishing (quota 4000 lbs. humpback whitefish and lake trout) is conducted in the 6 square mile area of the lake within the Yukon Territory. The fishery is confined to the winter months, the quota is reached in most years and the catch is sold locally in Whitehorse. Domestic fishing is permitted under licence but the catch and effort is probably small.

Samples of lake trout from the commercial fishery were taken on various dates in 1975. All fish were taken in gillnets of 4.5-4.75 in. stretched mesh. Sample 1 was collected on April 6 and consisted of 10 fish (5 male and 5 female), fork length 385-920 mm., mean fork length of 525 mm. Most scales were regenerate but the oldest readable scale was from a fish 530 mm. long and aged 10+ yrs. The stomach contents consisted primarily of fish and Cladocera.

Sample 2 was collected on April 19 and was composed of 12 fish (4 male, 8 female), with a range in fork length from 420-640 mm., and a mean fork length of 483 mm. Weights ranged from 1.8 to 6.4 lbs. with a mean of 3.01 lbs.

Sample 3 was taken on April 25 and 27 from 11 fish (7 male and 4 female). Fork lengths ranged from 447-879 mm. with a mean of 544 mm. Weight ranged from 1.8-17.0 lbs. with a mean of 4.2 lbs.

Samples of commercially gillnetted humpback whitefish from gillnets of 4.5-4.75 in. stretched mesh were sampled in 1972. A sample on April 6 of 71 fish (35 male, 32 female, and 4 immature) ranged in fork length from 425-595 mm. with a mean of 508 mm. These fish were aged from 6 to 11+ yrs. The stomachs of 40 fish were empty but Gastropoda comprised 80% of the food in the remaining stomachs. Pelecypoda, caddisfly larvae and Chironomidae were also present in varying percentages. A sample of 60 whitefish was collected on April 19, 25 and 27. The sex composition was 36 males and 24 females. Fork lengths ranged from 410-555 mm. with a mean fork length of 505 mm. Weights ranged from 1.6 to 5.8 lbs. with a mean weight of 3.7 lbs.

The recreational potential is excellent on Atlin Lake. The lake is accessible by road or boat from Tagish Lake. The area is of high scenic and historic value. Fishing, boating and camping opportunities are excellent in the area. In the following paragraphs the major tributaries to Atlin Lake are discussed.

(1) The Lubbock River flows south from Little Atlin Lake and discharges into the north end of Atlin Lake. The river is a small, pool-riffle stream with a moderate to low gradient. The upper reach of the river is meandering. The stream is 12 mi. long, with a drainage area of approximately 680 sq. mi. The maximum instantaneous discharge was 662.0 cu. ft./sec. on 7/06/64 and the minimum discharge was 19.9 cu. ft./sec. on 11/03/59. Discharge was estimated at 70 cu. ft./sec. on 15/08/74. The water temperature was 17.5°C on 15/08/74. Water chemistry measurements are included in a table for the area. Seining with a small mesh beach seine on 15/08/74 captured Arctic grayling and slimy sculpin. Longnose suckers, whitefish, northern pike and probably lake trout are present in some areas of the stream at certain times of the year. The stream is non-navigable.

(2) Little Atlin Lake is 14 mi. long and 1.5 to 2 mi. wide. The surface water temperature was 16.8°C on 15/08/74. A Secchi disc reading on this date was 15+ ft. under bright overcast conditions at 1330 hours. The lake has extensive shallow areas and is very productive. Numerous small fish and schools of fish were observed throughout the shallow areas on 15/08/74. Adult pike and whitefish were also observed. A gillnet of 100 ft. (50 ft. x 8 ft. each of 2.5 in. and 3.5 in. stretch mesh) set overnight on 15/08/74 caught 12 humpback whitefish (3 male and 9 female) ranging in fork length from 370-472 mm. Ages were 6, 7, and 8 yrs. One male round whitefish collected had a fork length of 340 mm. and was 8 yrs. old. Two northern pike were captured (1 male 585 mm. fork length, 1 female 700 mm. fork length). All fish captured were sexually mature. Local reports indicate the presence of lake trout, burbot and Arctic grayling. Commercial fishing to a quota of 4000 lbs. annually was conducted on this lake until 1964. A subsistence fishery for lake trout and whitefish exists on Little Atlin Lake but harvest records are unavailable. A recreational fishery exists with pike and lake trout being the most sought-after species. Access is possible from the Atlin highway.

(3) Pine Creek drains Surprise Lake approximately 12 miles east of Atlin Lake. A falls impassible to fish exists 3 miles upstream from Atlin Lake. The drainage area is approximately 270 sq. mi. Discharges have been recorded as (i) mean 178 cu. ft./sec., (ii) maximum 1280 cu. ft./sec. on 5/06/57, and (iii) minimum 27 cu. ft./sec. on 16-19/01/57. The discharge is affected by a storage dam at the outlet of Surprise Lake. Stream gradients are moderate to high. Hydraulic placer mining for gold is conducted on this stream and discharges from this operation are returned to the stream resulting in a very heavy silt load. Arctic grayling were observed at the lake outlet.

(4) Surprise Lake is 15 mi. long by approximately 1 mi. wide. The surface water temperature on 15/08/74 was 13.2°C. A Secchi disc reading at 1100 hours in sunny conditions measured 20 ft. The lake is silty at times near the outlet as a result of placer mining activity. A 50 ft. x 8 ft. gillnet of 3 in. stretched mesh set overnight on 15/08/74 captured 17 Arctic grayling. Fifteen of these (9 male, 6 female) ranged in fork length from 314-405 mm. and were 6, 7, and 8 yrs. old. The population of Arctic grayling is large. The only other species captured was slimy sculpin. Lake resident

populations of Arctic grayling probably overwinter in the lake and undergo seasonal upstream migrations related to feeding and spawning during spring and summer. Local reports indicate that no other fish inhabit the lake. The area is very scenic and is important as an historic attraction. The lake is accessible by road from Atlin and provides excellent recreational fishing for Arctic grayling.

(5) The O'Donnel River is 32 mi. in length. The lower section has a low stream gradient and the substrate is composed of gravel and sand. Water temperature was 9.2°C on 2/08/74. Aerial observations indicated the stream bed contains boulders throughout its length. Two small canyons are present below the settlement of O'Donnel. Hydraulic mining was in progress at the settlement of O'Donnel resulting in some silting of the stream on 19/08/74. Seining (2/08/74) with a small mesh net captured only sculpins. Grayling are reported present and unidentified fish (probably whitefish) were observed August 2, 1974 in the lower area.

(6) Snafu Lake is the headwater lake in a drainage system comprised of a series of lakes and interconnecting streams of approximately 30 mi. in total length of which 19 mi. (approximately) are lakes. The lakes are small with widths of 1/2 mi. The system drains via Snafu Creek into the Lubbock River close to its outlet from Little Atlin Lake. Snafu Lake is renowned in the area for its large pike and lake trout, and has produced fish up to 20-25 lbs. Whitefish are also caught. It is a very pretty lake with many small islands and has a high recreational value to the residents of the area. It is accessible from mile 16.5 on the Atlin highway.

(7) Tarfu Lake drains via Tarfu Creek into the Lubbock River midway between Atlin and Little Atlin Lakes. The dimensions of the lake are 3 mi. long and approximately 3/4 mi. wide. No information on fish species present is available.

(8) Bryde Lake is the headwater on Tarfu Creek. It is 2.75 mi. long with a width of 0.5 mi. Lake trout, northern pike, whitefish, and Arctic grayling are reported present. Sport fishing for pike produces excellent results. A 29 lb. pike was taken on sport gear in 1960. This pretty lake is accessible from mile 18 on the Atlin highway.

Table 3. Water chemistry measurements for tributaries to Atlin Lake.

Tributary	Date	Water colour	Alkalinity (gpg)	Hardness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Lubbock River	15/08/74	Clear	9	9	5	.33	9	10
Little Atlin Lake	15/08/74	Clear	9	9	5	.33	9	11
Surprise Lake	15/08/74	Clear	3	3	5	.33	7.5	10
O'Donnel River	2/08/74	Clear, green tinge	7	6	5	.33	8.5	10
Snafu Lake	28/09/74		10	10	5	.33	8.5	11
Tarfu Lake	28/09/74		9	10	5	.33	8.5	11
Bryde Lake	29/09/74		6	6	5	.33	8.5	9

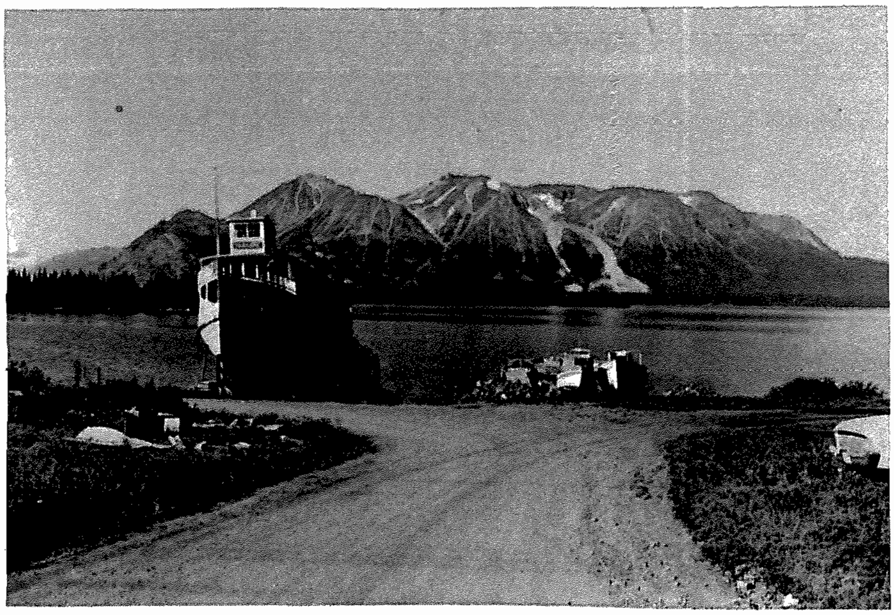


Plate 1. Atlin Lake from Atlin, B.C.

Plate 2. Atlin Lake from Atlin looking towards Llewellyn Glacier.

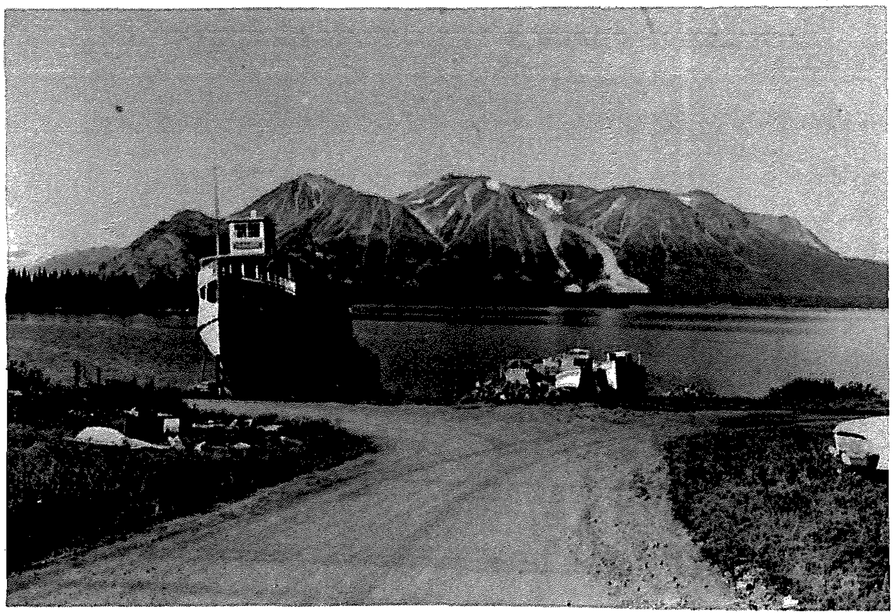


Plate 1. Atlin Lake from Atlin, B.C.

Plate 2. Atlin Lake from Atlin looking towards Llewellyn Glacier.

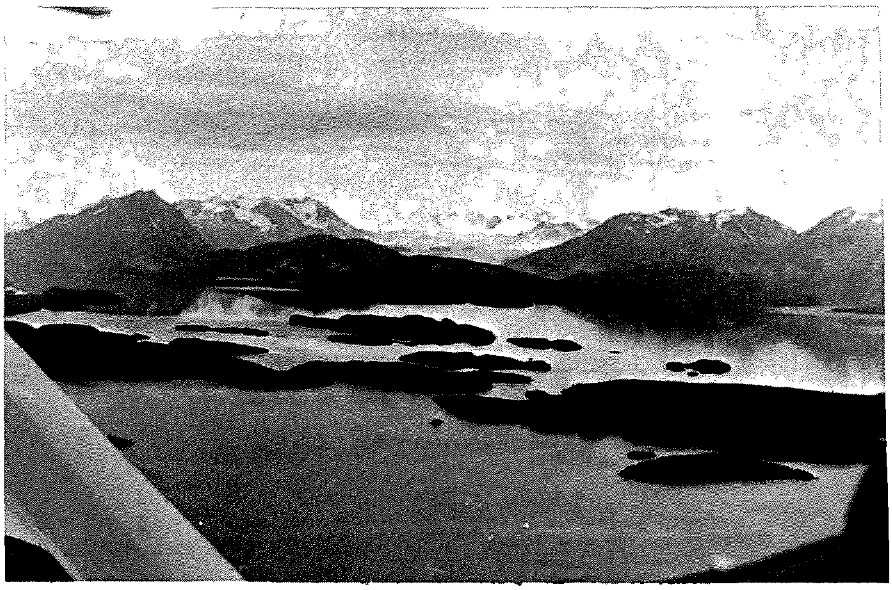


Plate 3. South end of Atlin Lake with Llewellyn Glacier in background.

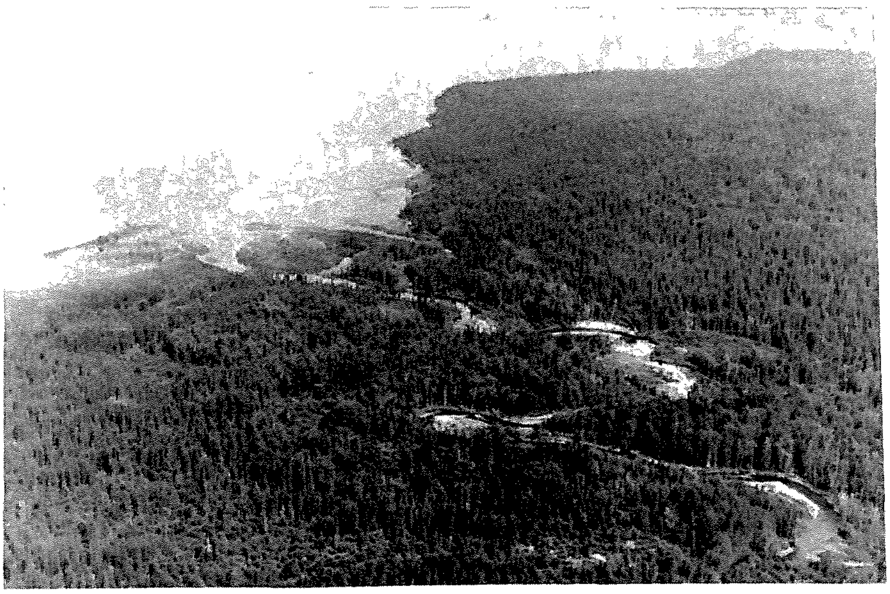


Plate 4. O'Donnel River- junction with Atlin Lake.

Plate 5. O'Donnel River- (Mile 0.5).

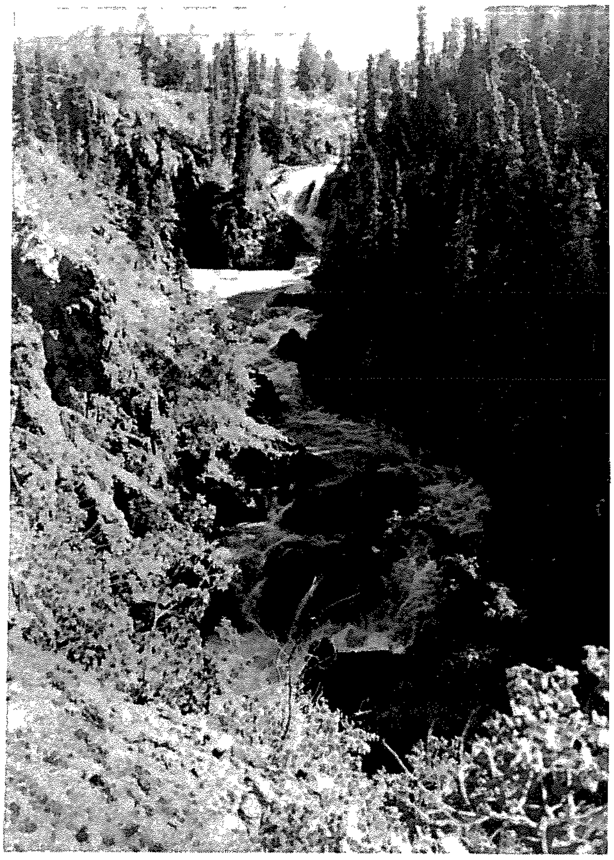


Plate 6. Pine Creek falls.

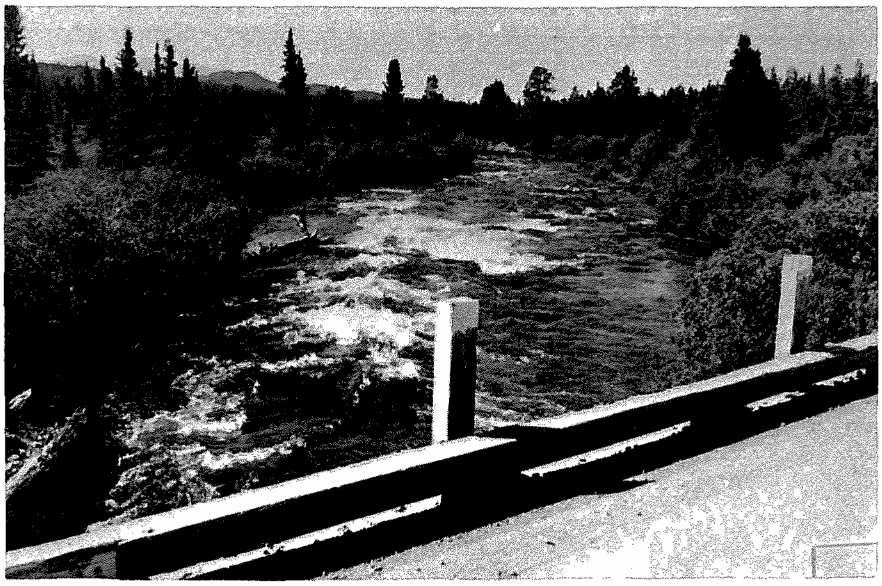


Plate 7. Pine Creek- upper area.

Plate 8. Pine Creek- hydraulic mining (gold).

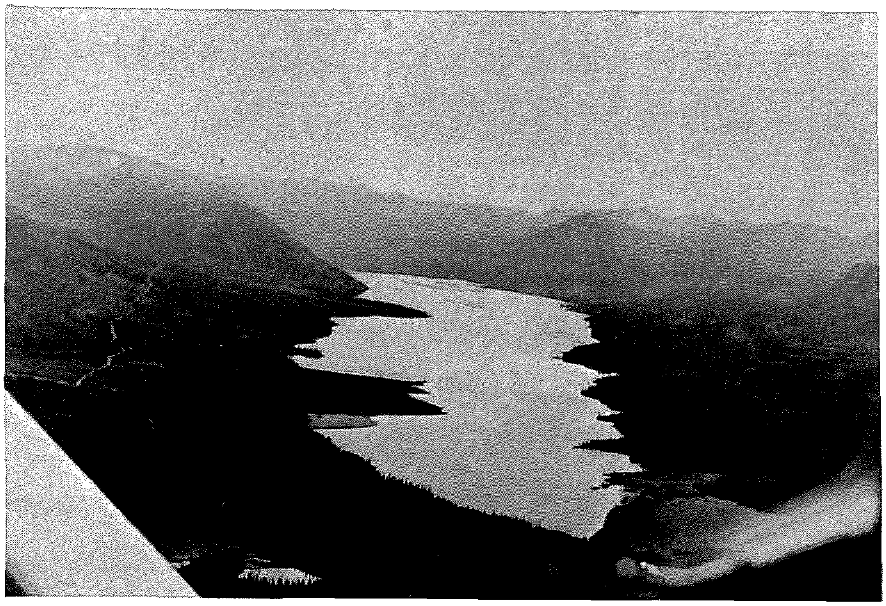


Plate 9 . Surprise Lake- outlet in foreground.

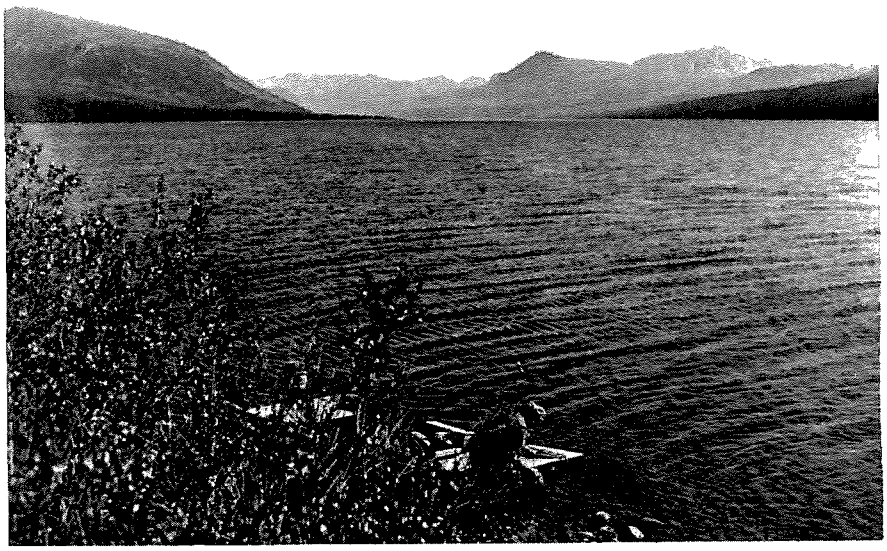


Plate 10. Surprise Lake- from near outlet.

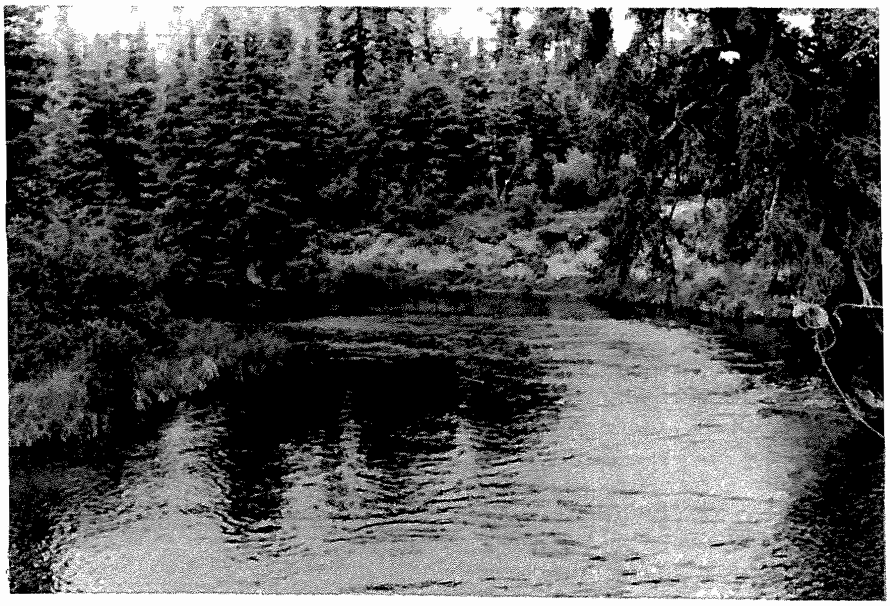


Plate 11. Lubbock River- mid section.

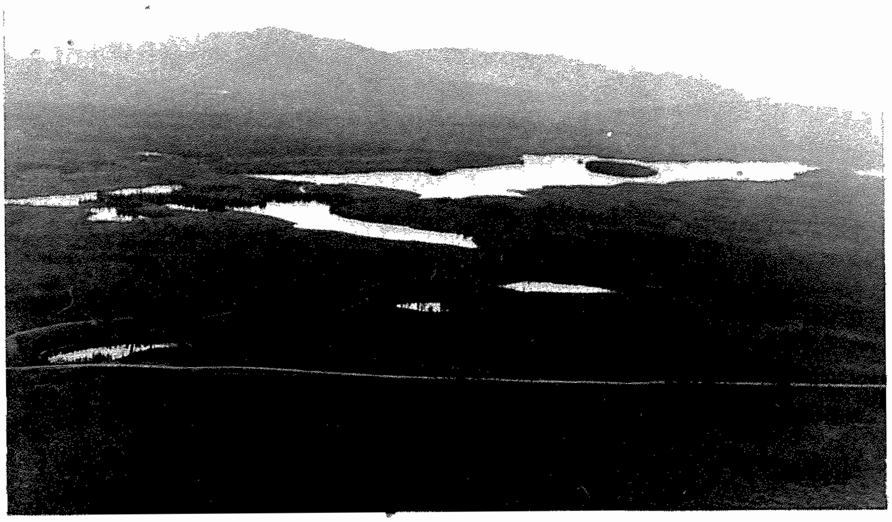


Plate 12. Tarfu Lake- with Atlin road and lake access road in foreground.

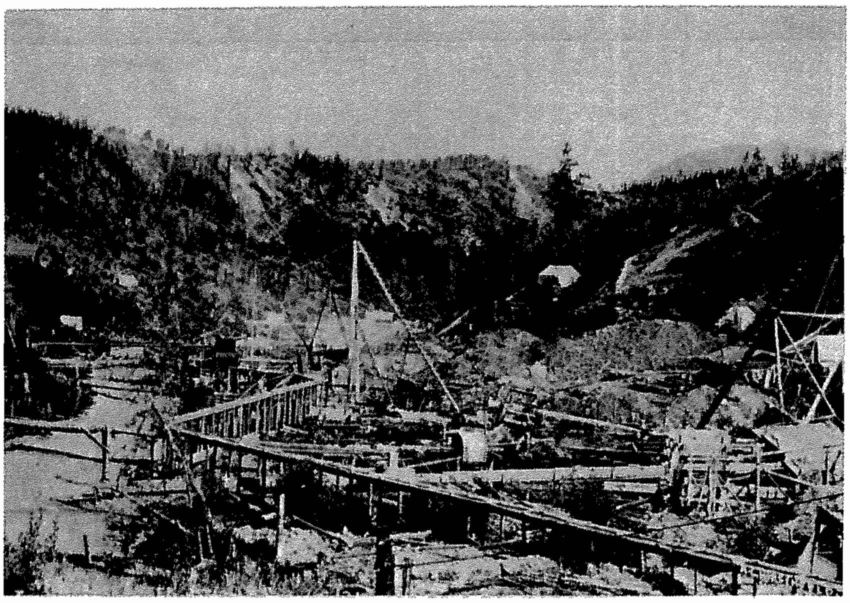


Plate 13. Spruce Creek-(from Bilsland and Ireland, 1971).

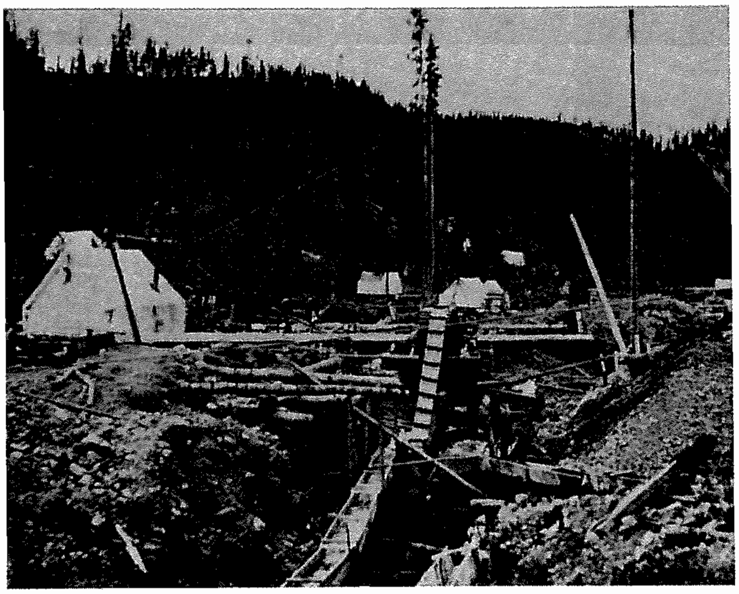
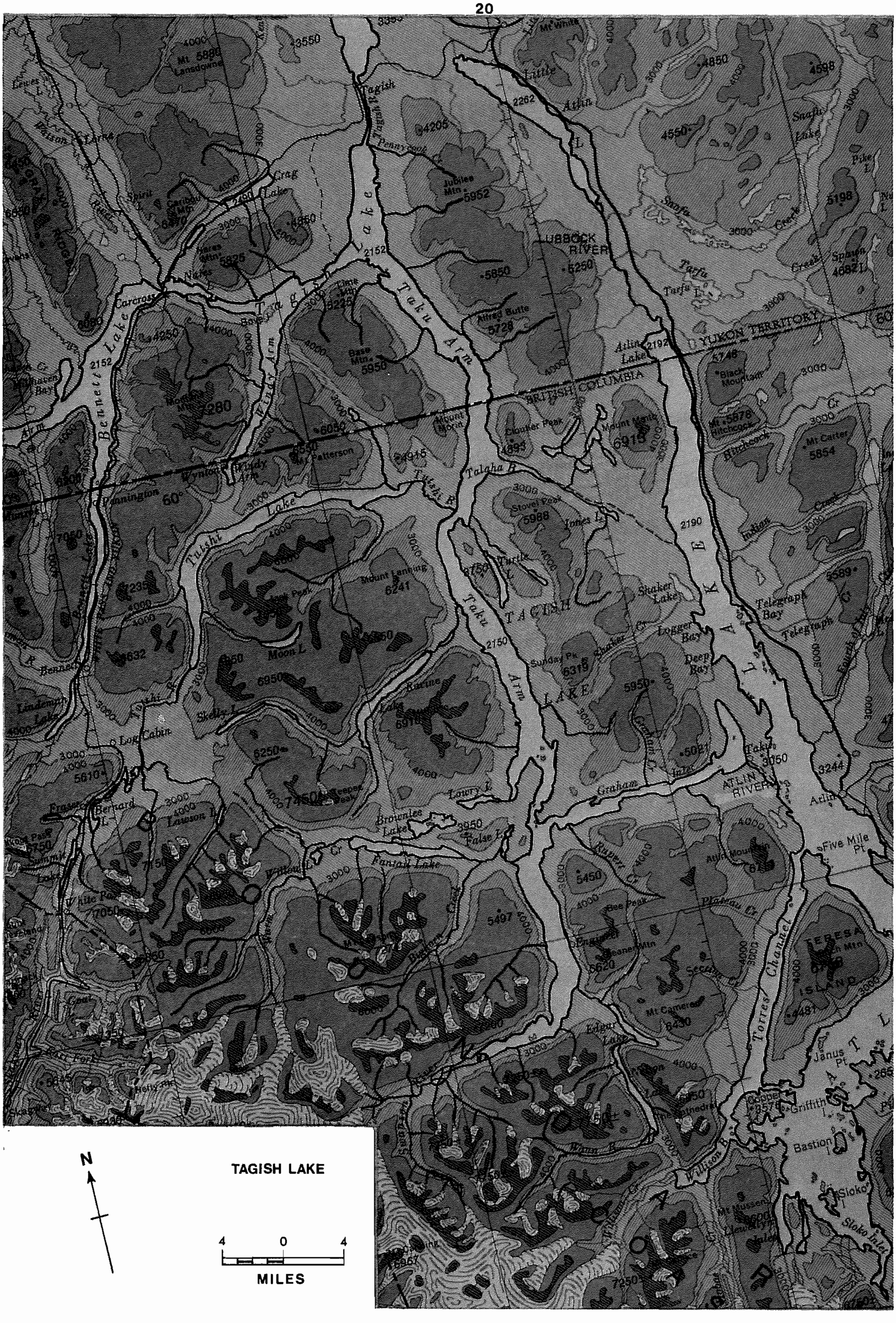


Plate 14. Spruce Creek-1900 (from Bilsland and Ireland, 1971).


TAGISH LAKE
N
4 0 4
MILES
Mt Lansdowne
Tagish
Jubilee Mtn
5952
Little Atlin L
Snafu Lake
Crag Lake
Carcross
Bennett Lake
Nares
Tagish Lake
Taku Arm
Windy Arm
LUBBOCK RIVER
Alfred Butte
5728
Base Mtn.
5950
Atlin Lake
YUKON TERRITORY
BRITISH COLUMBIA
Black Mountain
Mt Hitchcock
5878
Mt Carter
5854
Mount Minto
6915
Mt Patterson
Wynton
Pennington
60°
Tutshi Lake
Talaha B.
Stovel Peak
5988
Jones L.
Turtle L.
Mount Lanning
6241
Moon L
Skelly L
Log Cabin
Indian Cr
Telegraph Bay
Telegraph Cr
Shaker Lake
Shaker Cr
Logger Bay
Deep Bay
TAGISH LAKE
Sunday Pk
6318
Graham Inlet
ATLIN RIVER
Atlin
Five Mile Pt
Brownlee Lake
False L
Fantail Lake
Lawson L
Bernard L
Fraser
Bee Peak
5450
5497
Mt Cameron
6430
Torres Channel
TERESA ISLAND
Edgar Lake
The Cathedral
Janus Pt
Griffith I.
Bastion I.
Sloko I.
Willison B.
Mt Wellington
Lindeman Lake
White Pass
Summit Lake

Name of Stream	Tributary to	River System
TAGISH LAKE	TAGISH RIVER	YUKON

LOCATION West of Atlin Lake, Cassiar District

POSITION 60 134 SE

LENGTH 74 mi. WIDTH mean 2 mi. DRAINAGE 2062 sq. mi.(approx)

Tagish Lake lies parallel to Atlin Lake approximately 15 mi. to the west. It is drained by the Tagish River flowing north into Marsh Lake. Approximately 1/3 of the area of Tagish Lake lies in the Yukon Territory, with the remainder in British Columbia. The lake is largely surrounded by steep, glaciated mountains of the Coast Range. Local conditions of snowfall, ice-cover, light-periods, wind, and temperature closely parallel those of the Atlin district but precipitation is somewhat higher. The lake littoral zone drops off very sharply from shore, minimizing the rearing capacity of the lake. Depths to 700 ft. have been recorded. Shoal areas are present near the mouth of Atlin and Swanson Rivers in the south. In the southern basin small boulders cover the bottom to a depth of 10 ft., fine sand extends to a depth of 30 ft., and clay and mud cover the remaining lake bottom. Tributary streams from the south are typically silty (reflecting their glacial origins), have high gradients and extreme fluctuations in discharge.

The surface area is 128 sq. mi. The 10 ft. maximum seasonal water level fluctuation of Tagish Lake is similar to Atlin and Bennett Lakes. The mean lake elevation is 2150 ft. above sea level. Samples for total dissolved solids (T.D.S.) taken by Withler in 1955 were 70 ppm in the south basin of the lake and 75 ppm in the central region. Low. T.D.S. values are typical of large oligotrophic lakes of relatively low productivity. Secchi disc readings in August 1955 were shallow at the south end of the lake (3.3 ft.) and 20 ft. in the central region, again reflecting the high input of glacial material. A Secchi disc reading taken on 28/08/74 in north Tagish Lake was 30+ ft. Temperature readings are similar to those of Atlin Lake for comparable time periods and suggest higher water temperatures to the north where the influence of glacial material in streams is less.

Water temperature: surface 47°F, 200 ft. 41.5°F, 16/08/55 (S. Taku Arm); surface 51°F, 200 ft. 40.5°F, 28/08/55 (Central Taku Arm). During June 1956, the water temperature of that portion which lies within the Yukon Territory ranged between 47.5°F and 51.8°F on the surface and between 41.7°F and 47.8°F at 40 ft.; surface (N. Tagish Lake) 55°F, 28/08/74.

Samples of bottom fauna in August 1955 taken by Withler indicated that the bottom organisms are sparse but occur at a wide depth range. Chironomidae larvae represented 75% of the samples and had a distribution from the shallowest to deepest zone (200 ft.) sampled. Oligochaetes were obtained at depths of 30 and 200 ft., and represented the remaining 25% of the samples. Samples taken in the northern part of the lake in 1956 consisted of Amphipoda, Chironomidae, Gastropoda, Trichoptera and Pelecypoda. Of these organisms, 71% were chironomids and 20% molluscs. The maximum depth sampled for bottom organisms was 44 ft. Plankton samples taken in August 1955 in the south and central area were comprised mainly of zooplanktors. A few diatoms were present.

Lake trout. Withler (1956) suggests on the basis of slower growth rates for lake trout and round whitefish that productivity is lower in the southern basin of the lake. Four main factors for this lower productivity are postulated: 1) reduced water transparency due to glacial silting; 2) low total dissolved solids; 3) low temperatures; and 4) sparse bottom fauna. Samples of lake trout caught by gillnetting in the south and central basins of Tagish Lake in mid-August 1955 had a mean weight of 2.6 lbs. and 5.0 lbs. respectively. Samples collected in June 1956 in the southern basin of the lake ranged in fork length from 450-920 mm. with a mean of 654 mm. Weights ranged from 1.75 to 17.0 lbs. with a mean of 8.4 lbs. A sample of 22 sport-caught lake trout taken June 17, 1972 ranged in fork length from 419-1065 mm. with a mean of 571 mm. Weights ranged from 680-19351 gm. with a mean of 2795 gm. The sample was heavily weighted by one large fish. Sex composition was 7 male and 15 female. Stomach contents consisted of caddisfly larvae, midges, snails, ants, shrimp, fish and debris.

Results of a study conducted by T. Brock from 9-30 June, 1971 in the south (S) and central (C) basins of Tagish Lake are summarized below. The angling catch effort was 1.1 fish/hr. An angled and gillnetted sample of 34 lake trout ranged from 350-690 mm. in fork length with a mean fork length of 509 mm. The weight ranged from 825-2875 gm. with a mean of 1641 gm. The age ranged from 8-13 yrs. with a mode occurring at age 10.

Back calculations of growth rates from scales were:

	LENGTH (mm) AGE	1	2	3	4	5	6	7	8	9	10
Tagish		85	120	165	225	285	340	390	430	465	505
(S) Tagish		66	109	170	226	292	358	421	467		
(C) Tagish		84	124	193	295	371	427	472	518		
	WEIGHT (gm)	96		64	160	295	460	700	920	1075	1450

Arctic grayling. A sample of gillnet caught fish from the south and central areas of the lake taken in August 1955 had a mean weight of 1.2 lbs. in the central area and 0.8 lbs. in the south basin. The diet at both sample stations consisted largely of terrestrial insects.

<u>Humpback whitefish</u>. A gillnet-caught sample taken in June 1956 ranged in fork length from 290-650mm. with a mean of 365 mm. The largest fish weighed 10 lbs.

<u>Least cisco</u>. A gillnet-caught sample of 30 fish taken in June 1956 ranged in fork length from 175-220 mm. with a mean of 193 mm. Ages were 2 and 3 yrs.

<u>Round whitefish</u>. Gillnet-caught samples taken in August 1955 had the following measurements: mean weight 0.5 lb south end (N=6); 0.8 lb. central area (N=62). A sample taken in June 1956 within the Yukon boundary had a length range of 370-400 mm. with a mean of 384 mm.

Other species known to be present are longnose suckers and slimy sculpin.

Spawning areas for lake trout and whitefish appear to be adequate. Adequate spawning areas are available for Arctic grayling although they are restricted in the south to the larger unglaciated streams and the streams of Graham Inlet.

Commercial fishing ceased in 1961. Prior to this time, no quotas existed, and records of catch are incomplete. Intensity was at its peak during the height of the mink and fox farming era.

Some domestic and native food fishing is conducted on this lake, but catches are relatively small.

The recreational potential of the area is excellent. Sport fishing is becoming increasingly popular in this system. Opportunities for boating are excellent if one is prepared for sudden unpredicted winds. With the exception of Windy Arm, many camping areas exist along the lakeshore. The lake is accessible from the Alaska Highway and via boat from Tagish and Carcross. Food and supplies are available at both communities. Government campsites are also present in the area.

<u>Tributaries to Tagish Lake</u>

(1) Atlin River. Approximate length 2.5 mi., flows from Atlin Lake into the head of Graham Inlet. This is a large, fast-flowing stream dropping 42 ft. over its length. Average velocity is reported to be 10 mph. It is navigable by power boat but extreme caution must be taken to avoid large boulders. Standing waves of 4-5 ft. may be encountered in a few places. The discharge is recorded at a mean of 3210 cu. ft./sec., a maximum of 10800 cu. ft./sec. (25/08/61), and a minimum of 623 cu. ft./sec. (on 9/05/56). Local reports indicate that the river is a major spawning stream for Arctic grayling, and sport fishing for this species produces excellent results.

(2) Swanson River, flowing into the extreme south end of Tagish Lake, is a short (14 mi.) stream with a heavy glacial silt load. Arctic grayling have been reported in a clear tributary creek located near the mouth.

(3) Wann River has a drainage area of 104 sq. mi. This swift river flows northwest into Taku Arm of Tagish Lake. Many rapids are present, and an impassable falls is located about 1 mi. above the lake. The stream bed is composed mostly of bedrock and boulder. Some gravel exists near the mouth. Between Nelson and Edgar Lakes the stream flows through a canyon and has many rapids. Mostly bedrock and boulder make up the bottom here. The upper Wann River is a short, glacial, bouldery stream. The silt load was heavy on

19/08/74. An abandoned powerhouse at one time supplied power to the Engineer Mine. Stream discharges have been recorded at 2020 cu. ft./sec., maximum instantaneous on 11/06/64, and a minimum of 20.9 cu. ft./sec. on 29/04/67. Water temperature was 12.2°C on 26/08/74. Arctic grayling were present in the lower section on 26/08/74. Only slimy sculpin were reported above the falls.

(4) Edgar Lake is approximately 4 mi. long with a maximum width of 0.5 mi. Water temperature on 19/08/74 was 10.5°C. A Secchi disc reading of 20 ft. was obtained under bright conditions. Local reports indicate that fish are not present in this lake. An overnight gillnet failed to capture fish, and seining produced only slimy sculpins.

(5) Nelson Lake is approximately 6 mi. long with a width of approximately 0.5 mi. It drains via the Wann River 1.5 mi. into Edgar Lake. Water temperature was 10.9°C on 19/08/74. A Secchi disc reading was 5 ft. on a bright day. Nelson Lake acts as a sediment bowl for the glacial feeder streams since Edgar Lake immediately downstream is considerably clearer. Seining on 19/08/74 resulted in the capture of sculpins only. No fish were taken in an overnight gillnet set.

(6) Fantail River has a drainage area of 289 sq. mi. It flows 4 mi. easterly from Fantail Lake into the head of Taku Arm of Tagish Lake. It is a glacial stream, swift and rocky with many rapids. Water temperature was 9.8°C on 25/08/74.

(7) Fantail Lake is 7.75 mi. long by 0.5-0.75 mi. wide. It is a glacially-fed, silty lake with an elevation of 2263 ft. above sea level. Water temperature was 12.5°C on 19/08/74. A Secchi disc reading was 1.5 ft. under bright conditions. Beach seining on 19/08/74 took juvenile round whitefish. An overnight gillnet caught 5 longnose suckers ranging in fork length from 315 to 343 mm. and 4 humpback whitefish (3 male, 1 immature) ranging in fork length from 321-350 mm. Five lake trout (3 male, 2 female) ranged in fork length from 410-510 mm. One male Arctic grayling was taken with a fork length of 340 mm. The lake is very silty but supports a variety of fish species. Most fish were taken in shallow in-shore areas.

(8) Racine River flows 4 mi. from Racine Lake through a series of 3 small lakes and empties into mid-Taku Arm after a series of impassable falls. The stream is clear and swift with a bouldery streambed. Water temperature was 12°C on 25/05/74. Grayling were present at the base of the outflow falls on 25/08/74.

(9) Racine Lake is 8 mi. long by 0.5-0.75 mi. wide with an elevation of 2321 ft. above sea level. Water temperature was 11.1°C on 19/08/74. A Secchi disc reading was 30+ ft. under clear conditions. An overnight gillnet on 19/08/74 caught 2 male and 1 female round whitefish with a range in fork length from 353 to 370 mm. These fish were aged at 5 and 6 years. Eight Arctic grayling were taken (2 male, 6 female) with a range in fork length of 332-395 mm. and a range in age from 6 to 7 years. Eighteen lake trout were also captured ranging in fork length from 355-465 mm. One burbot of 475 mm. fork length was also caught. Thirty-five angled and gillnetted

lake trout taken by T. Brock (9-30 June, 1971) ranged in fork length from 330-890 mm. with a mean of 479 mm. The weights ranged from 330-8200 gm., with a mean weight of 1879 gm. Ages ranged from 7-15 yrs. with modes occurring at 8 and 10 yrs. Back calculations of growth rates were:

AGE	1	2	3	4	5	6	7	8	9	10
LENGTH (mm)	65	90	140	200	235	290	330	380	400	490
WEIGHT (gm)	2.0	5.5	23	74	120	270	350	560	660	1250

(10) Tutshi River flows southeast into lower Taku Arm from Tutshi Lake. It is a clear, swift, bouldery stream with many rapids. The bottom is composed of sand and gravel in the lower reaches. Similar stream characteristics prevail above the lake. The river drains an area of 336 sq. mi. Maximum instantaneous discharge was 3700 cu. ft./sec. on 14/06/64, with a minimum of 91.5 cu. ft./sec. from 26/03 to 10/04/67. Water temperature was 11.7°C on 25/08/74. Sculpins were observed on 25/08/74, and lake trout and Arctic grayling were taken while angling in the lower reaches on the same day.

(11) Tutshi Lake lies to the west of Tagish Lake at an elevation of 2230 ft. above sea level and drains via the Tutshi River. The lake is 23 mi. long by 3/4 to 1 mi. wide. Water temperature was 14.4°C on 19/08/74. A Secchi disc reading of 30+ ft. was taken under clear conditions. A gillnet set on 20/08/74 caught the following fish:

	No.	Range in Fork Length (mm)	Sex Composition
Arctic grayling	3	391-415	2 male, 1 female
round whitefish	12	354-468	5 male, 6 female, 1 immature
lake trout	11	415-520	4 male, 6 female, 1 immature

The lake has excellent recreational potential, and access will soon be available from the Whitehorse-Skagway Highway.

(12) Nares Lake is a small, relatively shallow lake 3 mi. in length joining Bennett and Tagish Lakes. The north shore is flat and marshy near the community of Carcross and marshy at the junction with Tagish Lake. The narrow area connecting to Bennett Lake has a weedy, sandy bottom. There is a detectable current in this section. Fish species are probably the same as those present in Bennett and Tagish Lakes. Arctic grayling were observed spawning in Nares Creek on May 29, 1972, at a water temperature of 9.5°C (R. Kendel, unpublished memorandum).

(13) Crag Lake drains southwest a distance of 6 mi. through one small lake into Nares Lake. Crag Lake is 3.5 mi. long by 0.75 mi. wide at an elevation of 2490 ft. above sea level.

Fish reported present are lake trout, whitefish, Arctic grayling and northern pike. Arctic grayling and lake trout reportedly utilized the outlet stream for spawning prior to construction of 2 dams (Nares or Crag Creeks) in 1954 to provide a water reservoir. One dam is located approximately 1/2 mi. and the other about 2 mi., both upstream from Nares Lake. Both are low-level (approximately 7 ft. and 5 ft. respectively) concrete dams with flood control gates in the centre, and both are impassable to fish for upstream migration (Plate 30).

The lake is accessible from the old section of the Alaska Highway between Carcross and Tagish.

Table 4. Water chemistry measurements for tributaries to Tagish Lake.

Tributary	Date	Water colour	Alkalinity (gpg)	Hardness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Tagish Lake	28/08/74		3	3	5	.33	7.5	10
Wann River	26/08/74	Clear, green tinge	3	3	5	.33	7.5	10
Edgar Lake	19/08/74	Clear, green tinge	3	4	5	.33	7.5	10
Nelson Lake	19/08/74	Glacial, green tinge	3	3	5	.33	8.0	10
Fantail River	25/08/74		1	1	5		7.0	10
Fantail Lake	19/08/74		2	2	5	.33	7.0	10
Racine River	25/08/74	Clear, green tinge	3	3	5	.33	8.5	10
Racine Lake	19/08/74		4	4	5	.33	8.5	10
Tutshi River	25/08/74		2	2	5	.33	7.5	10
Tutshi Lake	19/08/74	Clear	2	2	5	.33	7.5	10

Plate 15. Tagish Lake- Taku Arm mouth.

Plate 16. Tagish Lake- Taku Arm from Fantail River.

Plate 17. Tagish Lake- Graham Arm from Atlin Lake outlet.

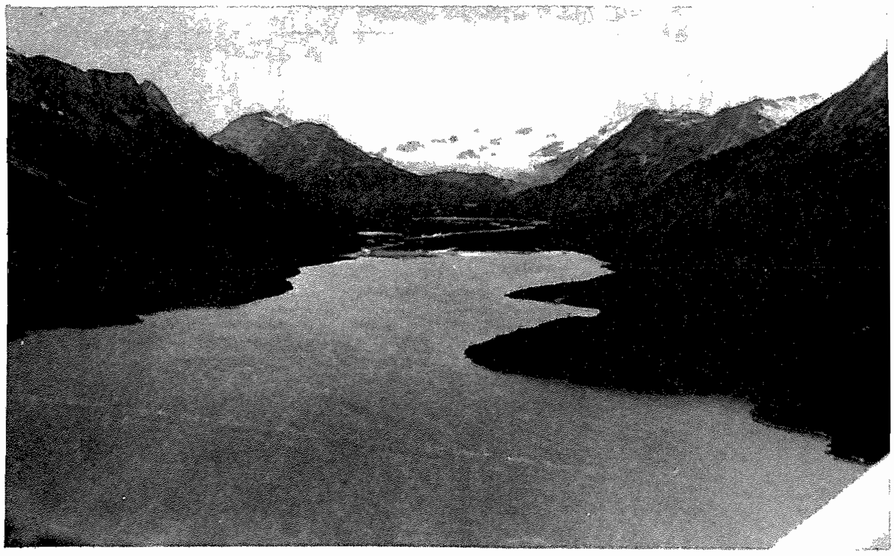


Plate 18. Tagish Lake- end of Taku Arm, (Swanson River in background).

Plate 19. Swanson River outlet.

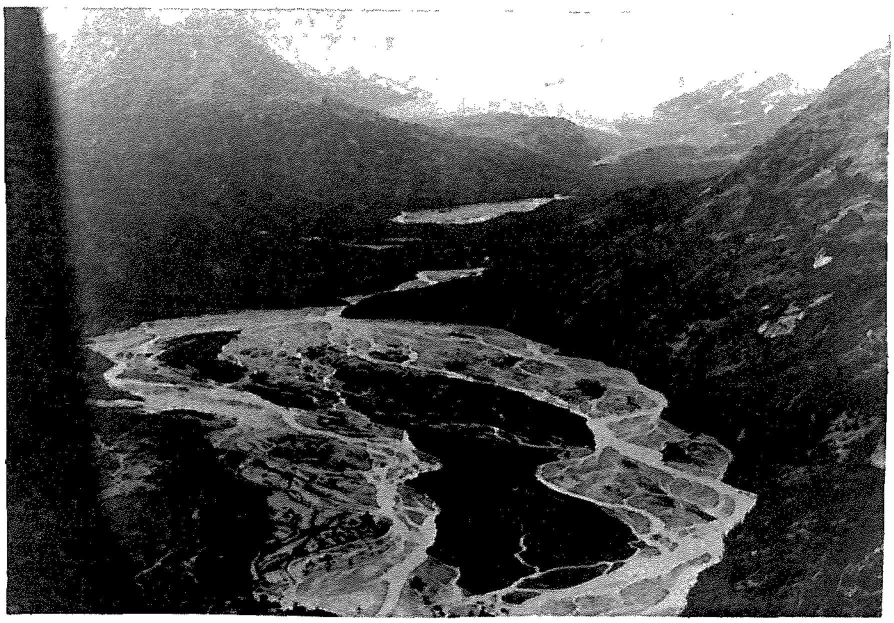


Plate 20. Swanson River headwaters.

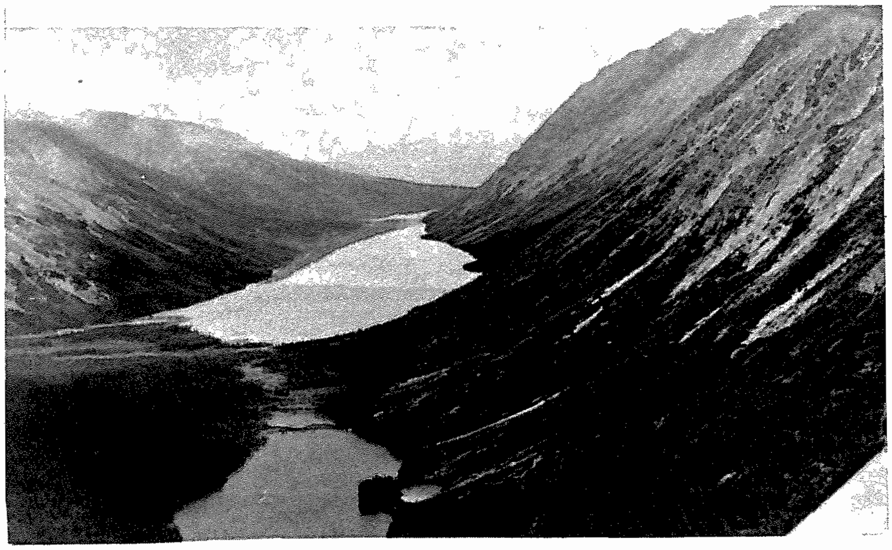


Plate 21. Nelson Lake looking north (headwaters of Wann River).

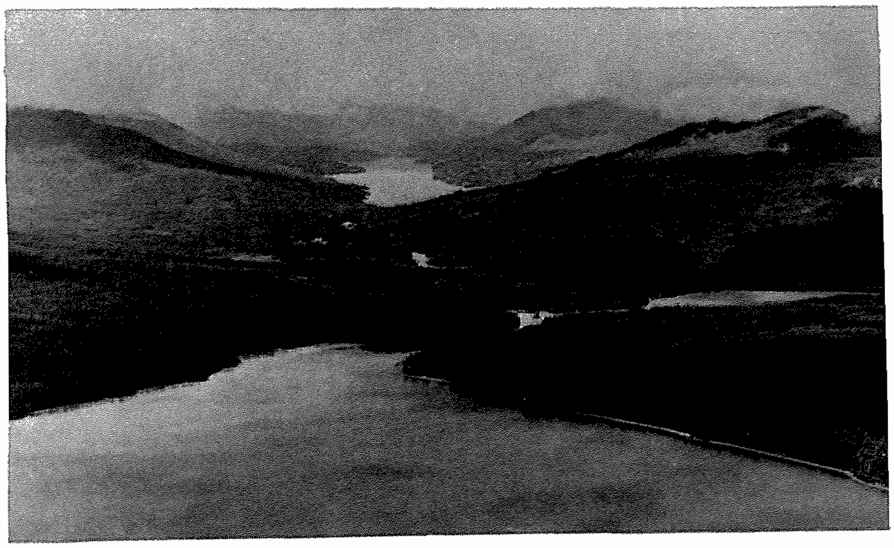


Plate 22. Fantail River and Lake from Tagish Lake.

Plate 23. Fantail Lake looking towards inlet.

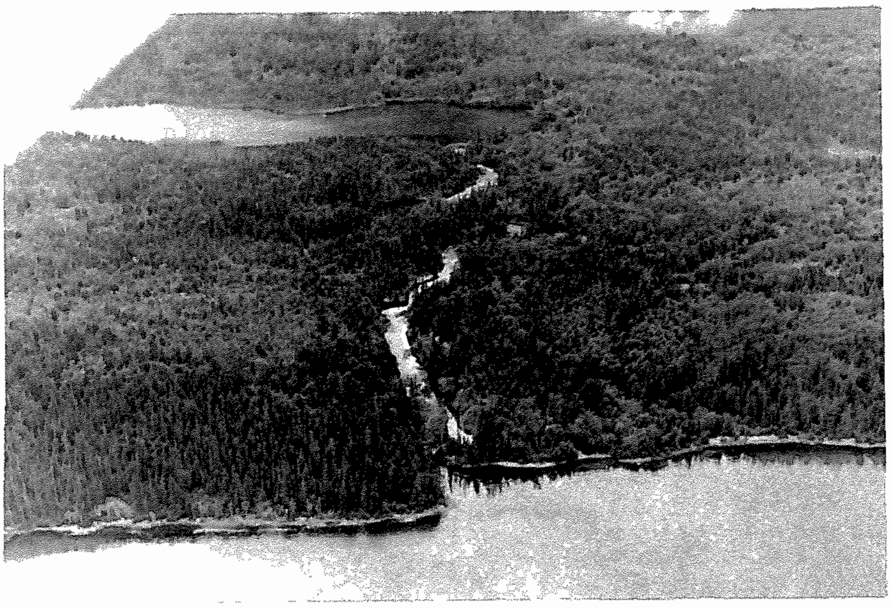


Plate 24. Racine River outlet.

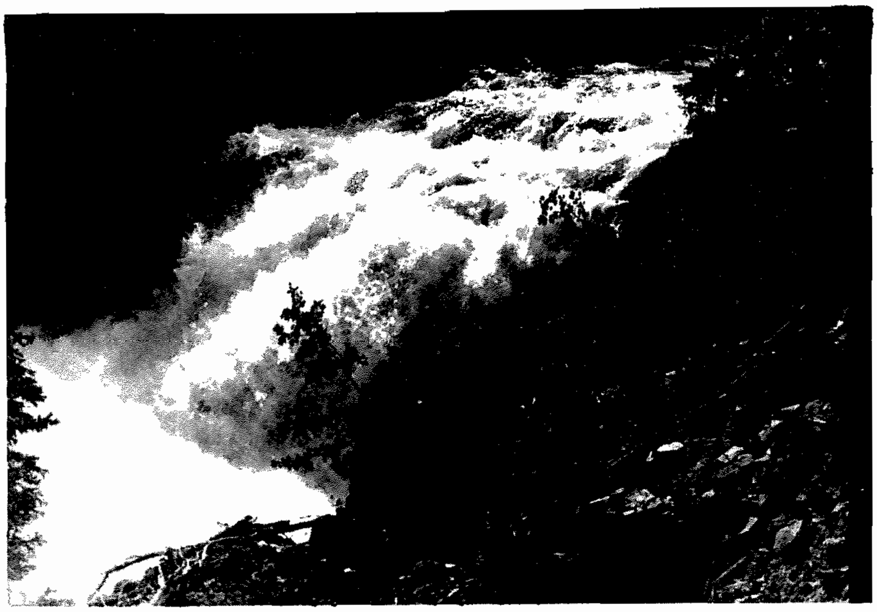


Plate 25. Racine River falls from Tagish Lake shore.

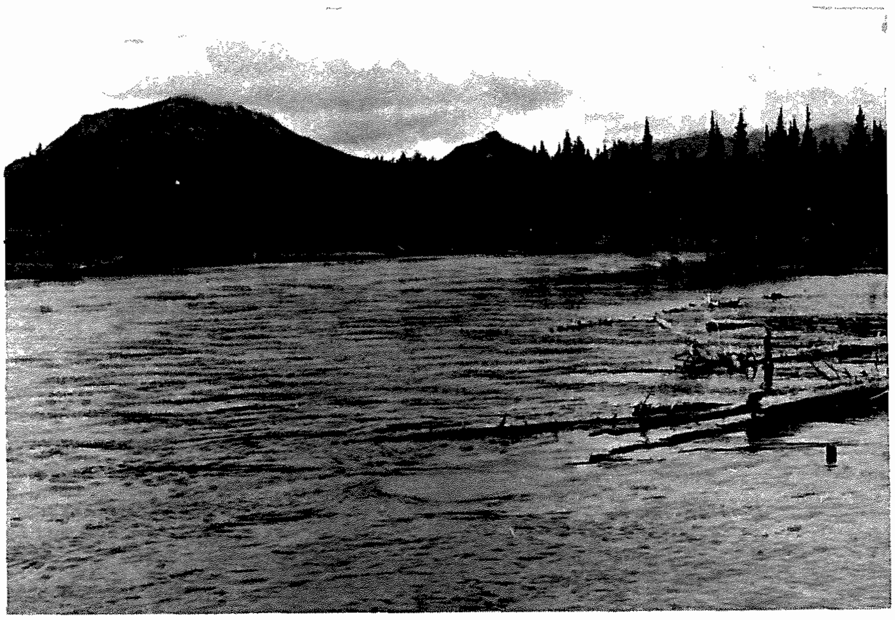


Plate 26. Tutshi River outlet.

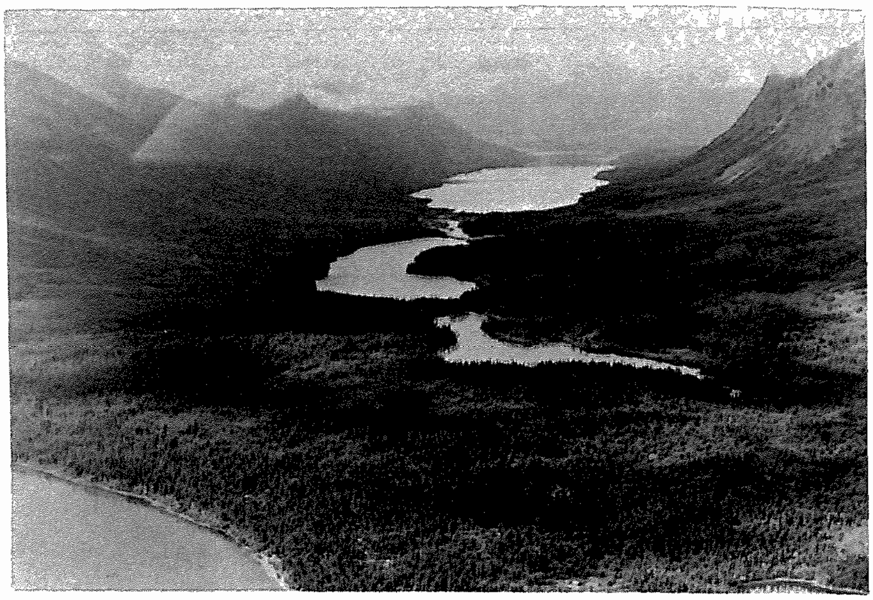


Plate 27. Tutshi Lake from Taku Arm.

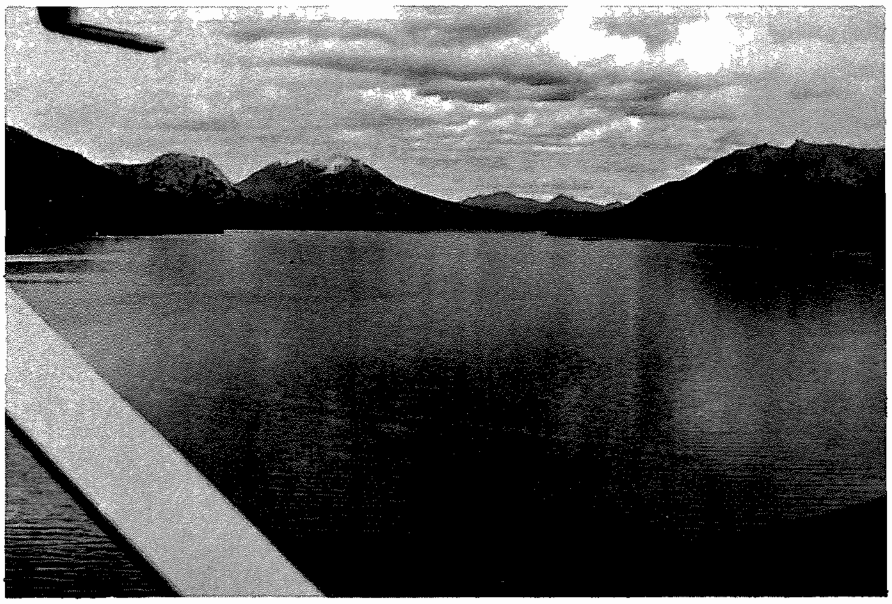


Plate 28. Tutshi Lake from mid lake looking towards outlet.

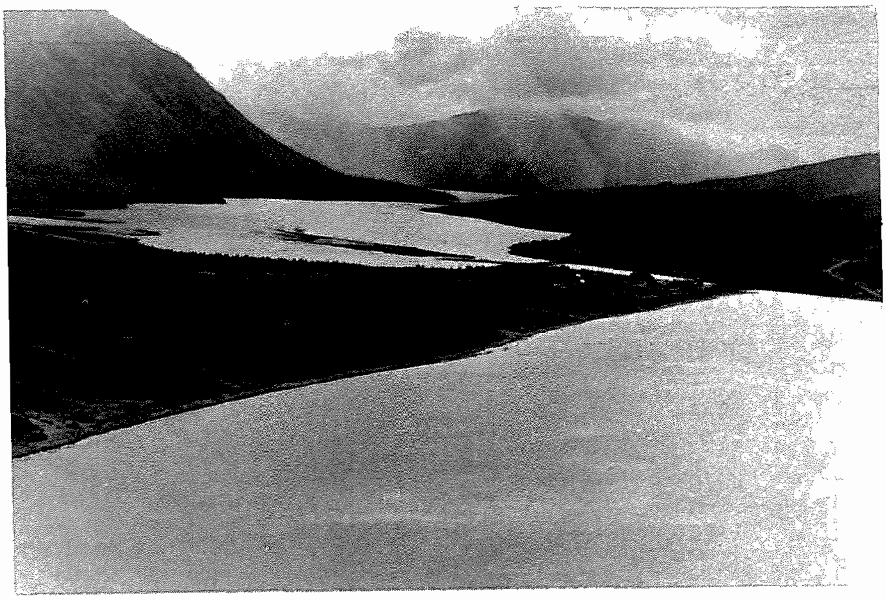


Plate 29. Nares Lake- Bennett Lake and Carcross in foreground, Tagish Lake in background.

Plate 30. Crag Creek Dam.


BENNETT LAKE
N
4 0 4
MILES
Whitehorse
Miles Canyon
Canyon Mtn
Wolf
Cowley Lakes
Cowley
Robinson
Mt Lorne
Marsh Lake
ALASKA HIGHWAY
Dam
Golden Horn Mtn
Mt Granger
Mt McIntyre
Mt Arkell
Haeckel Hill
Ibex
Fish
Coal L
Double Mtn
McConnell L
Friday Cr
Alligator Lake
Twin Mtn
Mt Lansdowne
Tagish
Lorne
Annie L
Mt Hodnett
Vesuvius Hill
Spirit L
Caribou Mtn
Crag Lake
Nares Mtn
Nares L
Carcross
Stony Mtn
Mt Stevens
Mt Skukum
Mt Ward
Watson
Wheaton R
Bove I
Lime Mtn
Base Mtn
Montana Mtn
Windy Arm
Wynton
Mt Patterson
Mount Morin
Pennington
Munroe L
Partridge Lake
Tutshi Lake
Talaha B
Mount Lansing
Moon L
Skelly L
Racine Lake
Bennett
Lindeman Lake
Mountain L
Log Cabin
Fraser
Bernard L
Lawson L
Mt Foster
Mt Van Wagenen
Crater L
Chilkoot Pass
Summit Lake
Mt Hoffman
White Pass
Teepee Peak
Brownlee Lake
Lowry L
Taku Arm
Tutshi R
Primrose
Tagish Lake
COAST MOUNTAINS
BOUNDARY RANGES
8074

Name of Stream	Tributary to	River System
BENNETT LAKE	NARES LAKE	YUKON

LOCATION W. of Tutshi L., on B.C.-Yukon boundary, Cassiar District, drains via Nares, Tagish and Marsh Lakes into Yukon River POSITION 59 134 NW

LENGTH 25 mi. WIDTH maximum 2 mi. DRAINAGE 1375 sq. mi.(approx)

Bennett Lake has a surface area of 63 sq. mi., most of it within the Yukon Territory. The upper portion and West Arm lie in a narrow mountain walled inlet with mountains rising nearly vertically in places to 3000-4000 ft. In the northern area, the mountains are more subdued and the shoreline wider with a more gradual rise and denser growth than the sparse southern part.

Sudden strong winds and high waves (to 8 ft.) are common. There is an almost constant south wind in the West Arm. The lake has a narrow,rocky shoreline with a steep drop-off and little shoal area. The deepest contour of the main lake is 400 ft. A small area of the West Arm is over 300 ft. deep. Bottom composition is of sand, gravel and boulders to a depth of 10-20 ft. Bottom samples taken in the West Arm and Millhaven Bay were:

West Arm	Millhaven Bay
0-10 ft. - sand and rock	13 ft. - clay
10-20 ft. - sand and clay	42 ft. - clay
>20 ft. - clay	

Maximum lake elevation recorded was 2155.48 ft. above sea level on 25/08/61 and the minimum was 2145.09 ft. above sea level on 09/05/68. The maximum length of the lake is 25 mi. and the maximum width is 2 mi. Most of the shoreline is rocky and is subject to severe wave action. A relatively low T.D.S. value of 65 ppm taken in the West Arm of Bennett Lake corresponds closely to concentrations in the west end of Tagish Lake. A Secchi disc reading of 26 ft. was obtained in June 1957 in the West Arm which indicates that the water of Bennett Lake is not as clear as the waters of north and central Tagish Lake. Low transparency is a result of several large glacial streams draining into Bennett Lake.

Water temperatures were taken in the West Arm of Bennett Lake on June 13, 1957 using a bathythermograph. The water temperature was 4.5°C from the surface down to a depth of 200 ft. No thermal stratification is indicated. Water temperature near Carcross on 24/08/74 was 10.5°C. A Secchi disc reading at this time was 31 ft. under clear conditions.

Plankton samples were taken in the West Arm of Bennett Lake on 13/06/57. Two hauls were taken from 163 ft. to surface and two three-minute surface hauls were made. The samples consisted primarily of copepods. The volumes of the two vertical hauls were 0.05 mm. and 0.10 mm., respectively.

Bottom samples of organisms were taken in the West Arm and in Millhaven Bay with a six-inch Edman dredge. Contents of the samples are shown in the following table, and are considered relatively sparse.

Station	Depth (ft.)	Substrate	No. Organisms /2 Dredges (72 sq. in.)	Organisms
West Arm	195	Clay	0	
	105	Clay	1	Gastropoda
	50	Clay	3	Chironomidae
	20	Clay and sand	3	Chironomidae larvae
	10	Sand and rocks	1	Chironomidae
Millhaven Bay	42	Clay	8	Chironomidae (3) Gastropoda (5)
	13	Clay	4	Gastropoda (2)

Samples of fish were taken by gillnetting on June 10-12, 1957, from Millhaven Bay on the West Arm of Bennett Lake. A gillnet gang consisting of 25-yd. lengths of floating one-inch and two-inch sunken nets was used. The net gang was set for a total of 48 hr. in water ranging in depth from zero to 30 ft. Millhaven Bay is not a typical section of Bennett Lake, but storm conditions prevented sampling on the main lake. The net catch therefore may not be representative of the lake as a whole.

The catch was as follows:

Species	No. in Sample
Lake trout	12
Round whitefish	61
Arctic grayling	39
Suckers	3
Total	115

The range in fork length for lake trout was from 405-880 mm. with a mean of 552 mm. Weight ranged from 1-20 lbs. with a mean of 5.2 lbs. The fish were aged from 6 to 14 yrs. Stomach contents were whitefish and sculpins, insect remains and Amphipods.

The range in fork length for round whitefish was from 125-440 mm. with a mean of 350 mm. Maximum weight was 1.5 lbs. and ages ranged from 3 to 10 yrs. The main food items were Trichoptera and Gastropoda.

The range in fork length for Arctic grayling was from 250-380 mm. with a mean of 310 mm. Ages ranged from 4 to 7 yrs. and the diet consisted mostly of insects (95% frequency occurrence), with Amphipods and Gastropods present in a few samples.

It is probable that slimy sculpin, burbot, northern pike and least cisco are present in the lake. There is limited spawning area for lake trout and humpback whitefish, since these species prefer shoal areas. Suitable and adequate spawning habitat exists for Arctic grayling in tributary streams to Bennett Lake.

Exploitation of the fish stocks is less intense now than in the past. A commercial quota of 9000 lbs. combined for lake trout and whitefish is now allowed. This quota is seldom reached. It is estimated that up to 100 tons of fish of all species were harvested annually from Bennett Lake to serve as food for mink and fox being raised commercially on farms in the area from 1925-1935. This heavy exploitation resulted in serious depletion of the fish populations. Subsistence fishing is carried out at the present time but effort and catch statistics are unknown. Sport fishing for lake trout produces excellent results, but the total effort is relatively light.

The area offers excellent recreational potential and provides a wealth of scenic beauty and historic interest. Access is possible by small boat from Tagish Lake, by railway or by highway to Carcross. Tourist services are available.

Tributaries to Bennett Lake

(1) The Lindeman River drains Lindeman Lake and flows into the extreme south end of Bennett Lake. It drains an area of 92 sq. mi. Discharges have been recorded as an annual mean of 361 cu. ft./sec., a maximum instantaneous discharge of 9150 cu. ft./sec on 15/09/67 and a minimum of 5.2 cu. ft./sec. on 11/02 and 22/03/57. The stream is a swift, glacial, high gradient, bouldery stream which is considered non-navigable to small boats. Beach seining on 29/08/74 captured 3 juvenile Arctic grayling.

(2) Lindeman Lake is a small glacial lake approximately 5 mi. long and 1/2 mi. wide. Maximum elevation was 2185.38 ft. above sea level on 15/09/67 and minimum elevation was 2176.17 ft. above sea level in February and March of 1957. Water temperature was 12.1^{o}C on 20/08/74 and a Secchi disc reading was 5.5 ft. under cloudy conditions.

A gillnet (2.5-3.5 in. stretch mesh) set on 20/08/74 captured 5 lake whitefish (3 male, 2 female), ranging in fork length from 340-435 mm., and from age 8 to 10 yrs.; 2 Arctic grayling (female), fork length 345 and 315 mm, age 5 and 6; and 6 lake trout (3 male, 2 female, 1 immature) fork length 287-335 mm.

The lake is accessible by railroad to the north end. The surroundings are quite barren and are not recreationally attractive.

(3) The Homan River drains 8 mi. from Homan Lake into the south end of Bennett Lake. It is a glacial, high gradient, boulder-strewn stream with many rapids. Gravel bars are heavily compacted with finer material. The system carries a heavy suspended glacial silt load. Water temperature on 24/08/74 was 10.5°C.

Seining with a small mesh net captured round whitefish, Arctic grayling and sculpins. Lake trout are also reported present in the stream.

(4) Homan Lake is approximately 4.5 mi. long with a width of 0.5 mi. A 3-in. gillnet captured 5 lake trout on 20/08/74 with a range in fork length from 390-420 mm. There were 3 female and 1 male. One female Arctic grayling 300 mm. in fork length was also captured.

(5) The Partridge River drains 4 mi. from Partridge Lake into the head of the West Arm of Bennett Lake. Above Partridge Lake the stream is glacial, boulder-strewn, and has many rapids. The outlet into Bennett Lake is braided. The stream is non-navigable. Water temperatures were 10.0°C on 24/08/74 and 6.8°C on 10/06/57. Seining with a small mesh net captured unidentified whitefish and Arctic grayling.

(6) Partridge Lake is a glacial-fed lake approximately 4 mi. long and 0.5 mi. wide. Water temperature was 11.1°C on 20/08/74 and a Secchi disc reading of 2.5 ft. was taken in shadow at 1730 hours.

Gillnetting with a 2.5- to 3.5-in. stretch mesh net caught 4 male lake trout with a fork length range from 415-517 mm., two of which were aged 7 and 8 yrs. Six Arctic grayling were captured with a range in fork length from 190-320 mm. Sex composition was 4 male, 1 female and 1 immature and unidentifiable. Four round whitefish (1 male, 3 female) were taken with a range in fork length from 322-380 mm. One male longnose sucker was taken (fork length 350 mm.).

(7) Munroe Creek drains Munroe Lake located approximately half-way down the south side of the West Arm. The streambed is composed of sand, gravel and boulders. Water temperature was 12.5°C on 24/08/74. The discharge was estimated at 25-35 cu. ft./sec. on 24/08/74. Arctic grayling were taken by angling near the outlet of Munroe Lake. Only sculpins were taken by seining on 24/08/74. The lake and stream afford good recreational potential.

(8) Munroe Lake is 4 mi. long by 0.5 mi. wide. Water temperature was 5.0°C on 10/09/74. A 2.5- to 3.5-in. stretch mesh gillnet set on 10/06/74 captured the following fish species:

Species	Range in Fork Length (mm)	Sex Composition
Arctic grayling	275-360	4 male, 6 female
Lake trout	365-492	2 male, 1 female

Seining failed to capture any fish.

(9) The Wheaton River drains an area of 337 sq. mi. and flows northeast and then south for a length of 42 mi., draining into Bennett Lake approximately 7 mi. west of Carcross. Overall, this stream is quite bouldery and swift with many rapids. For the first 8 mi. the gradient is moderately high and the bottom is composed of gravel and sand. From 8-12 mi. it is a wide flood plain type of stream with swifter velocities and coarser gravel than are present in the lower area. From 12-24 mi. the stream is very bouldery, with a swift current; from 24-30 mi. the stream gradient is moderate, streambed composed of gravel and fines; above 30 mi. the stream is small, bouldery and swift, with some small glacial feeder streams. From aerial observations, good gravel sections exist throughout but may be compacted with fines. (Distances are measured from Bennett Lake.)

Water temperature was 9.1°C on 24/08/74. Maximum discharge was 2420 cu. ft./sec. on 10/06/64 and minimum was 31.6 cu. ft./sec. on 14/03/56.

Round whitefish, Arctic grayling, and slimy sculpin were captured, utilizing a small mesh seine net on 24/08/74.

(10) Annie Lake (2 mi. long by 0.5 mi. wide) drains south into the Wheaton River via a 7-mi. long stream. The lake is reported to be very shallow and marshy. Northern pike are reported present in the lake and Arctic grayling apparently spawn in the outlet stream. The lake is accessible by road.

(11) The Watson River drains an area of 425 sq. mi., flows east and south, and discharges into Bennett Lake approximately 1.5 mi. west of Carcross. The stream meanders tortuously, the total length being approximately 100 mi. The stream was silty when observed on 20/08/74. Maximum instantaneous discharge was 1730 cu. ft./sec. on 24/05/68 and the minimum was 10 cu. ft./sec. on 1/04/56. A falls exists approximately 7 mi. above the mouth. Below this point, the current is swift. Some gravel areas exist in this region, heavily compacted with fine material. The headwater area is rocky with a steep gradient. Water temperature was 8.5°C on 20/08/74. Only Arctic grayling were captured on 20/08/74. Access is possible by boat, train and vehicle via the Annie Lake road.

(12) Alligator Lake drains 10 mi. via Two Horse Creek into the Watson River. The lake is 4 mi. long with a maximum width of 1.25 mi. Water temperature was 4.5°C on 10/09/74. Gillnetting with a 2.5- to 3.5-in. stretch mesh gillnet on 10/09/74 took the following fish:

No.	Species	Range in Fork Length (mm)	Sex Composition
10	Lake trout	360-503	8 male, 2 female
2	Arctic grayling	317, 374	2 female
1	Round whitefish	382	1 female

Two Horse Creek is a small meandering creek, the upper 8 mi. of streambed composed of mud and fines and the lower length of the streambed being gravel and boulder. An impassable falls is reported on this stream 3 mi. from its junction with Watson River.

Reports indicate excellent lake trout fishing.

Table 5. Water chemistry measurements for tributaries to Bennett Lake.

Tributary	Date	Water colour	Alkalinity (gpg)	Hardness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Bennett Lake	24/08/74		3	3	5	.33	7.5	10
Lindeman River	29/08/74		1	1	5	.33	7.5	10
Lindeman Lake	20/08/74	Milky	1	1	5	.33	7.5	10
Homan River	24/08/74	Milky	1	1	5	.33	7.0	11
Homan Lake	20/08/74		1	1	5	.33	8.0	10
Partridge River	24/08/74		1	2	5	.33	7.0	10
Partridge Lake	20/08/74	Milky	1	1	5	.33	8.0	10
Munroe Creek	24/08/74	Clear, brown tinge	1	3	5	.33	7.0	9
Munroe Lake	10/09/74	Clear	2	1	5	.33	7.0	9
Wheaton River	24/08/74		3	4	5	.33	7.5	10
Watson River	24/08/74	Silty	5	6	10	.66	7.5	10
Alligator Lake	10/09/74	Clear	2	2	5	.33	7.5	9

Plate 31. Bennett Lake from Wheaton River. West Arm in right foreground.

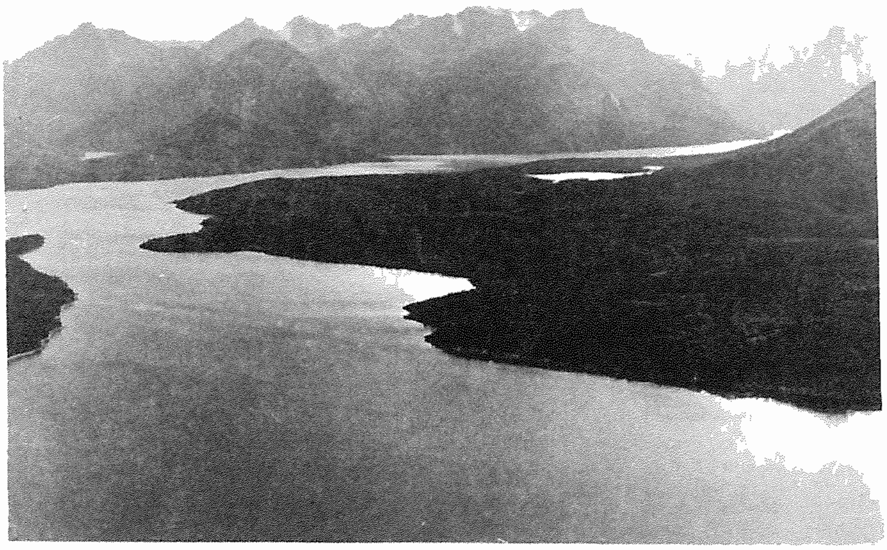


Plate 32. Bennett Lake- West Arm.

Plate 33. Bennett Lake- looking from mouth of West Arm towards Carcross.

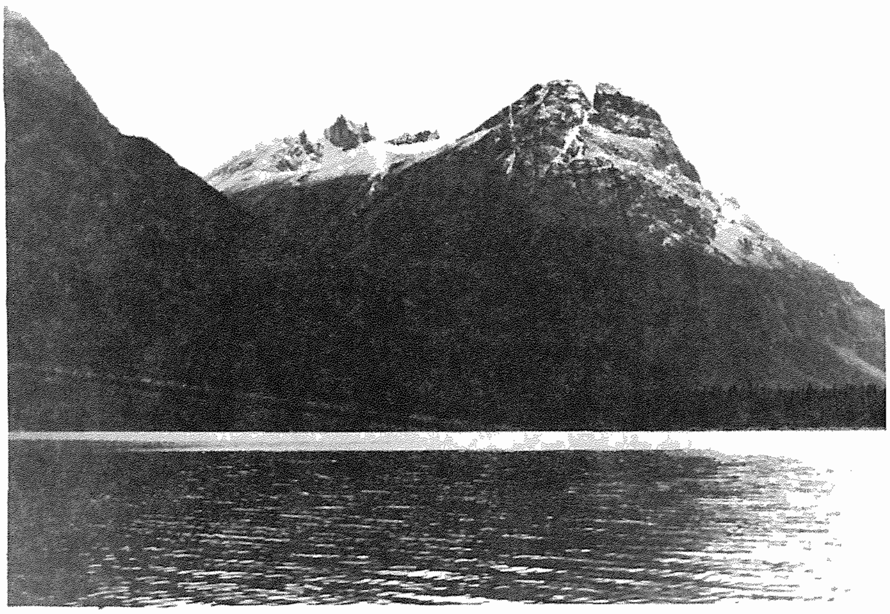


Plate 34. Bennett Lake- end of West Arm.

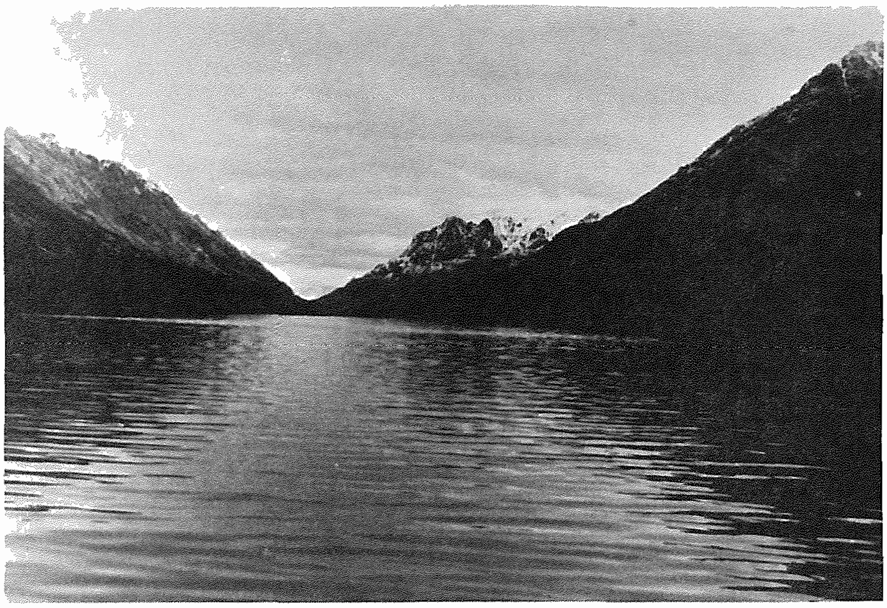


Plate 35. Bennett Lake from Bennett.

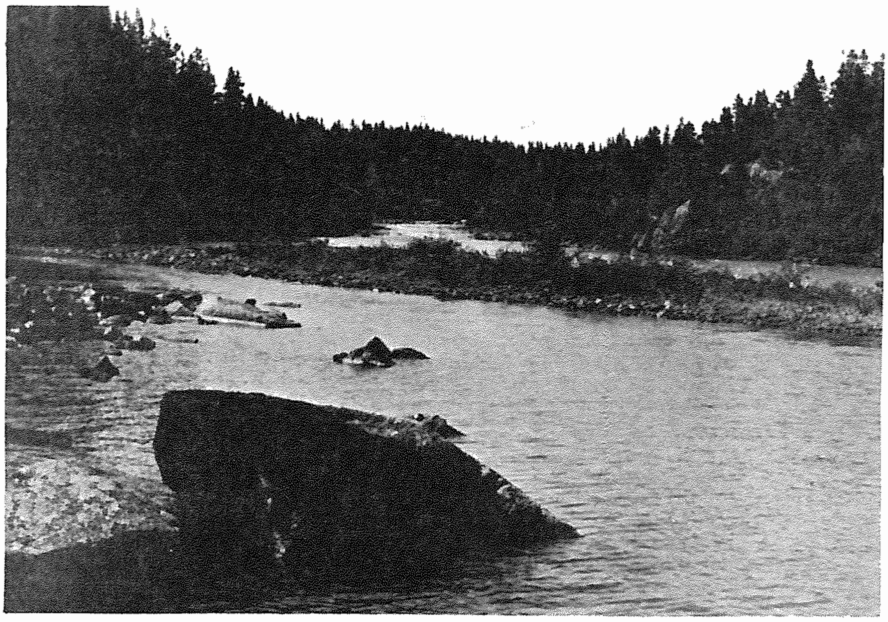


Plate 36. Lindeman River-looking upstream (Mile 0.5).

Plate 37. Lindeman Lake, Bennett and Bennett Lake.

Plate 38. Homan Lake- outlet in foreground.

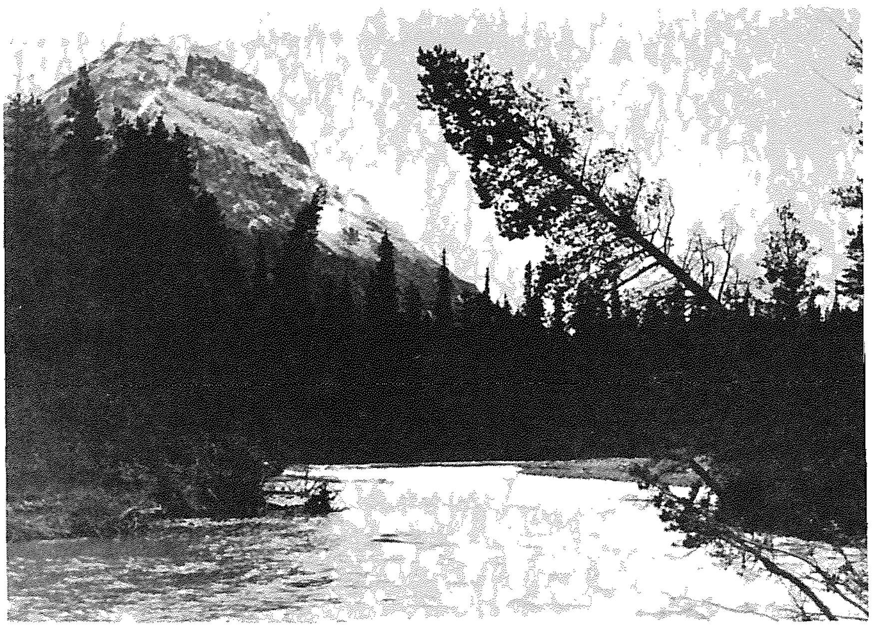


Plate 39. Partridge River- (Mile 0.25).

Plate 40. Partridge River headwaters and Lake.

Plate 41. Munroe Creek- (Mile 0.25).

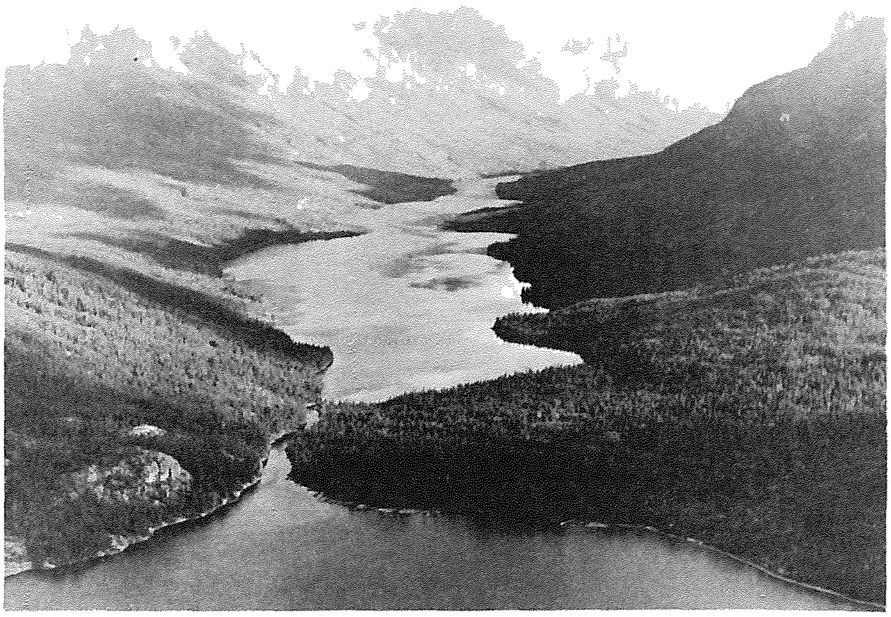


Plate 42. Munroe Lake and Creek.

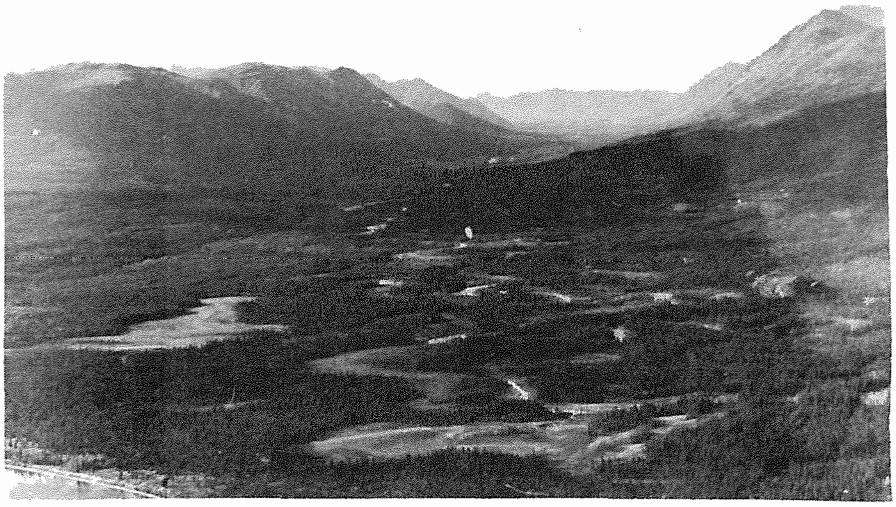


Plate 43. Wheaton River- from Bennett Lake.

Plate 44. Wheaton River- mid upper reach.

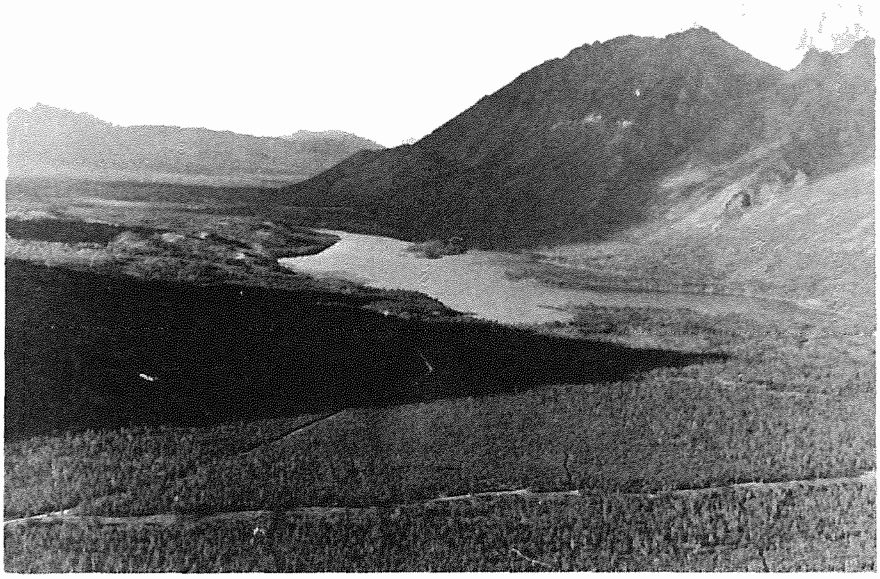


Plate 45. Annie Lake.

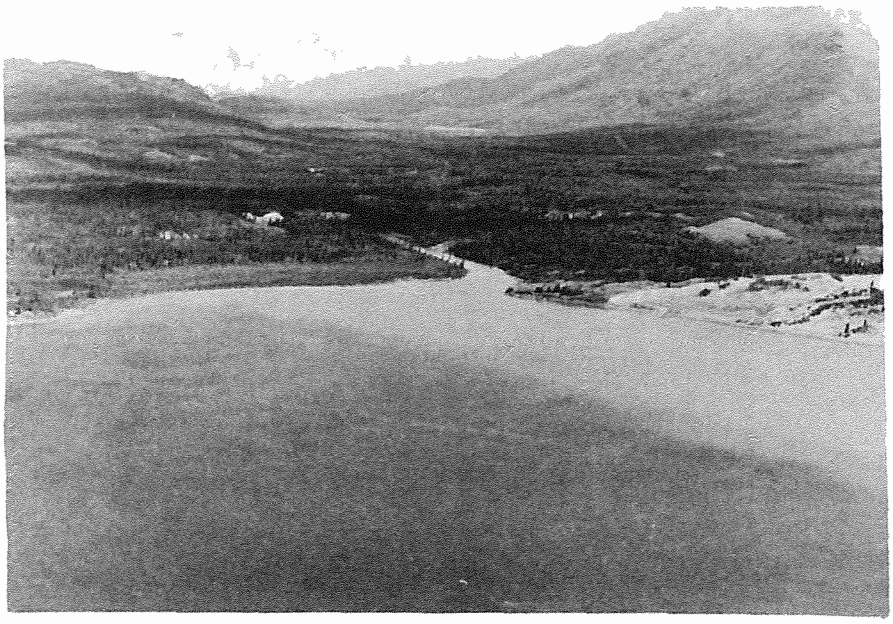


Plate 46. Watson River outlet.

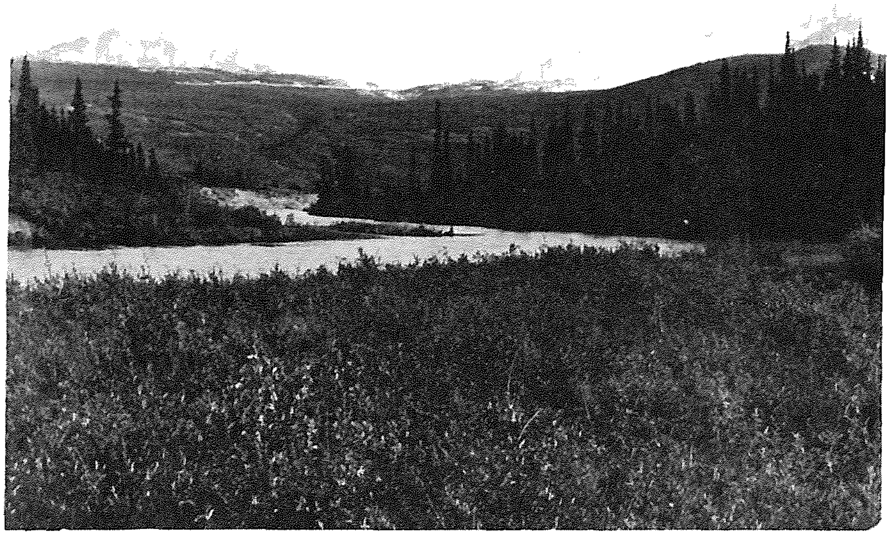
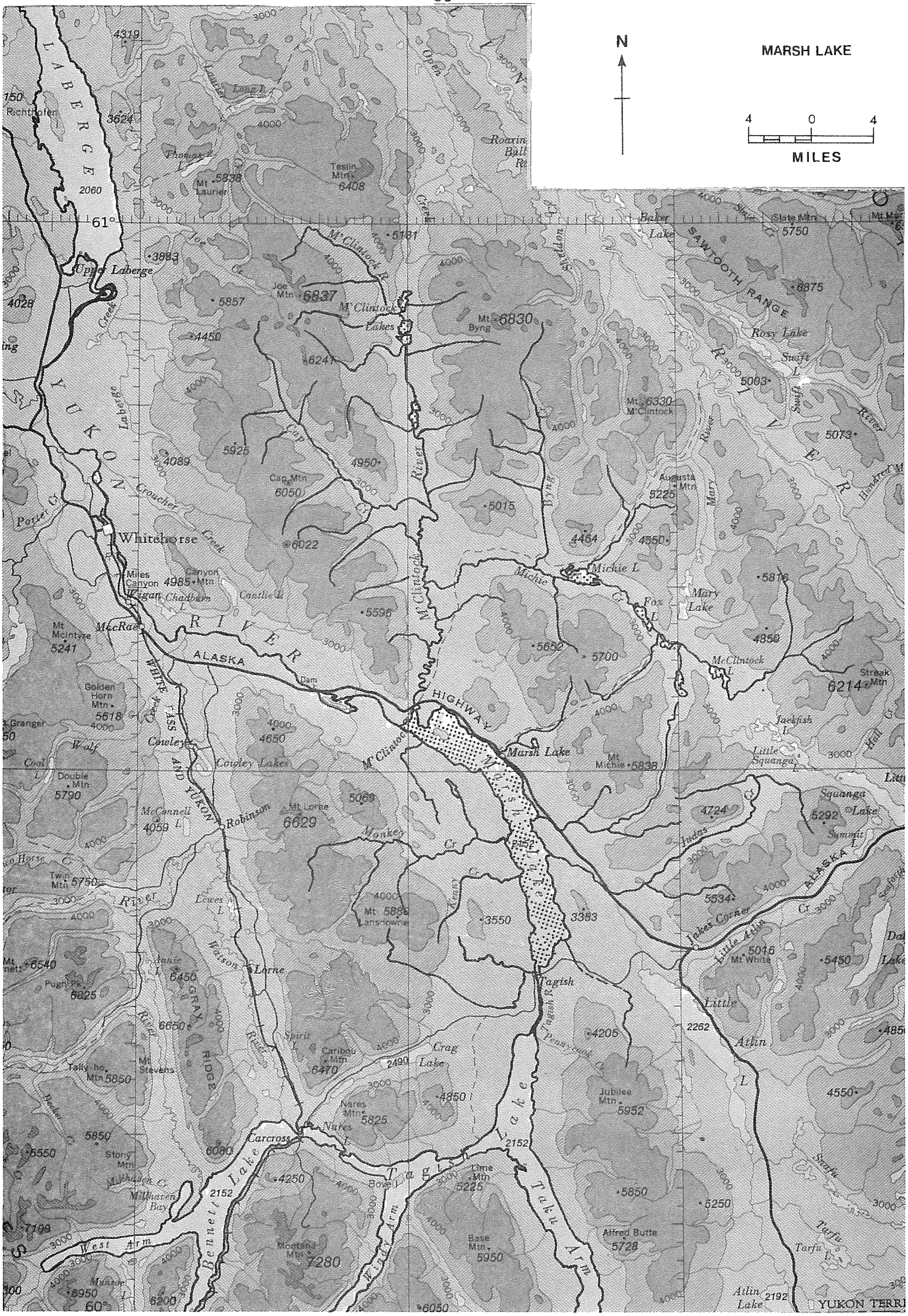


Plate 47. Watson River- (Mile 0.5) looking down-
stream.

Plate 48. Nares Lake and Indian School near Carcross.
(July, 1954).


MARSH LAKE
N
4 0 4
MILES
LABERGE
YUKON RIVER
61°
60°
Upper Laberge
Whitehorse
Miles Canyon
Canyon Mtn
Wigan
MacRae
ALASKA HIGHWAY
Dam
Marsh Lake
Marsh Lake
Tagish
Carcross
Nares L
Lorne
Robinson
Cowley
Cowley Lakes
WHITE PASS AND YUKON
GRAY RIDGE
Bennett Lake
West Arm
Windy Arm
Tagish Lake
Taku Arm
Atlin Lake
Little Atlin L
Jakes Corner
Squanga Lake
Little Squanga L
Jackfish L
SAWTOOTH RANGE
Baker Lake
Slate Mtn
Rosy Lake
Swift L
Mt McClintock
Augusta Mtn
Mary Lake
Michie L
Fox L
McClintock L
Streak Mtn
M'Clintock Lakes
M'Clintock R
Joe Mtn
Mt Byng
Cap Mtn
Canthie L
Chadburn L
Mt McIntyre
Golden Horn Mtn
Granger
Wolf Cr
Coal L
Double Mtn
McConnell L
Mt Lorne
Monkey Cr
Mt Lansdowne
Lewes L
Watson R
Annie L
Twin Mtn
Pugh Pk
Mt Stevens
Tally-ho Mtn
Caribou Mtn
Crag Lake
Nares Mtn
Spirit L
Stony Mtn
Millhaven Bay
Bove I
Lime Mtn
Montana Mtn
Base Mtn
Jubilee Mtn
Alfred Butte
Mt White
Tarfu L
Judas Cr
Summit L
Testlin Mtn
Mt Laurier
Thomas L
Long L
Richthofen
Croucher Creek
Porter Cr
Hundred Mile
YUKON TERRI

Name of Stream	Tributary to	River System
MARSH LAKE	YUKON RIVER	YUKON

LOCATION Lies N. of Tagish Lake and S.E. of Whitehorse, Y.T., drains via the Yukon River

POSITION 60 134 NE

LENGTH 24.5 mi. WIDTH 2.4 mi. DRAINAGE 875 sq. mi.(approx)

Marsh Lake has a surface area of 58.3 sq. mi., is 24.5 mi. long, and averages 2.4 mi. in width. The maximum depth measured was 177 ft. and the mean depth has been calculated to be 42 ft. The total water volume of the lake, as calculated, is 6.75×10^{10} cu. ft. Shoal areas of the lake are extensive. Thirty-six sq. mi. or 66% of the total surface area are 50 ft. deep or less. The main shoal areas are at the ends of the lake and, at the south end where the Tagish River enters, the lake is bordered by marshy flats that extend into the lake to form a large mud-bottom shallow zone. The shore at the north end is composed of boulders, gravel and sand. Maximum recorded elevation was 2155.08 ft. above sea level on 25/08/61 and the minimum elevation was 2143.94 ft. above sea level on 18/05/66.

The lake is generally shallow with a gradual drop-off from shore and the beaches are exposed to wave action. Total dissolved solids measurements were taken at three stations (south, central and north) and the resultant values were 80, 72 and 85 ppm, respectively. These relatively wide variations are probably due to the influence of the Tagish River (in the south) and the McClintock River (in the north). Secchi disc readings of 16 ft. in the north, 31.5 ft. in the central region, and 13 ft. in the south are related to the T.D.S. values.

Water temperatures ranged from 3.9°C to 7.1°C in mid-June 1957 at three lake stations. No thermal stratification was evident.

Plankton sampling was carried out on June 21, 1957 at the north, central and south stations. Vertical samples were taken from a depth of 50 ft. to the surface and three-minute surface hauls were made at approximately 1 mph.

A mean settled volume of 0.10 mm. was obtained for both the vertical and surface hauls. These volumes are very low compared to those obtained in other lakes (Northcote and Larkin, 1956). The samples consisted primarily of Copepoda and minute green and blue-green algae.

Bottom samples were taken at the north, south and central stations using a six-inch Ekman dredge. A summary of the bottom sampling is shown below.

Station	Depth(ft.)	Substrate	No./dredge (36 sq. in.)	Organism
1	6	Fine sand	9	Chironomidae larvae
	31	Clay and black mud	10	Chironomidae larvae (8) Gastropoda (1) Pelecypoda (1)
	48	Clay	0	
2	6	Clay and mud	0	
	24	Clay ooze	1	Chironomidae larvae
	48	Clay ooze	0	
3	7	Black mud and bottom plants	6	Chironomidae larvae (5)
	21	Clay	5	Gastropoda (4) Pelecypoda (1)
	48	Clay	0	-

Qualitatively, the bottom fauna of Marsh Lake must be classified as only sparse to moderate. Chironomidae larvae comprise 75% of the total with various mulluscs making up most of the remainder.

Fish were sampled at three stations with floating gillnets. The net gang consisted of five 25-yd. lengths, 6 ft. deep, with stretched mesh sizes of 1½ in., 2½ in., 3½ in., 4½ in. and 5½ in. The nets were set from shore in water varying from zero to 18 ft. in depth. At stations one (north) and two (central) the nets were set for two consecutive nights with the smallest mesh inshore one night and the largest mesh inshore the next. At station three (south) the nets were set for one night with the small mesh inshore. The catches are listed below.

Species	Station 1 North	Station 2 Central	Station 3* South	Total
Lake trout	6	4	1	11
Round whitefish	53	15	18	86
Humpback whitefish	19	37	32	88
Least cisco	5	5	19	29
Arctic grayling	0	1	0	1
Pike	1	6	10	17
Sucker	3	2	0	5
Total	87	70	80	237

*Station 3 - 1 net night. Stations 1 and 2 - 2 net nights.

The gillnet catches indicate that lake trout are distributed throughout the lake. Angling samples of two and five fish were obtained at stations one and three, respectively, during June 1955. Including these the sample totalled 18 lake trout. An additional 13 trout were sampled during June of 1956.

The gillnet sample of lake trout ranged between 47 cm. and 82 cm. in length with a mean of 58.1 cm.

The angling samples were quite similar in size. The average fork lengths for 1955 and 1956 were 60.2 cm. and 56.1 cm., respectively. The 1956 angling sample averaged 5.6 lbs. in weight.

These sizes are not representative of the total population since no younger small fish were included in the sample. The weight of the fish in the 1956 angling sample ranged from 2.75 lbs. to 28 lbs. with a mean of 5.6 lbs.

Round whitefish were found throughout the lake, with a heavier concentration at the northern station. The gillnet catch ranged in fork length from 17 cm. to 41 cm. with a mean length of 32 cm. Ages represented in the sample varied from two years to eight years.

The gillnet catches indicate that humpback whitefish are abundant at all three stations in Marsh Lake.

The gillnet catch of this species ranged in fork length between 16.2 cm. and 58 cm. with a mean of 36.1 cm. The age composition of the sample varied from two to nine years.

The sample of gillnet-caught least cisco ranged in fork length from 160 mm. to 205 mm. with a mean of 184 mm. The analysis of scales indicated that the sample consisted mainly of two-year-old fish.

Only one Arctic grayling was captured by gillnetting.

Pike were caught at all three gillnet stations although only one individual was obtained at the north station. Large numbers were observed in the marshy shallow areas at the north end and in the estuary of Mullen's Creek, a small stream near the end of the south end of the lake.

The gillnet sample ranged in fork length from 18.5 cm. to 90 cm. with a mean of 55.3 cm. The largest pike sampled weighed 11.5 lbs. During June 1956, an angling sample of 13 pike, all in spawning condition, was taken from Mullen's Creek estuary. The sample ranged from 42 cm. to 76 cm. with a mean of 52.8 cm. Weights ranged from 1 lb. to 4.75 lbs. with a mean of 2.1 lbs.

A sample of angled pike (4 male, 4 female) taken on 17/06/72 ranged in fork length from 456-875 mm. with a mean of 641 mm. Weights ranged from 794-4536 gm. with a mean weight of 2139 gm. One mature female pike, 564 mm. in length, weighing 1474 gm., contained 26500 eggs. A pike weighing 31 lbs. was taken in the domestic fishery in 1958.

Marsh Lake was eliminated from the commercial fishery in 1961. Up until that time, commercial fishing was mainly carried out to supply animal feed to fur farms. The fish are heavily infested with cysts and worms. Domestic and subsistence fishing was conducted on an irregular basis. Subsistence fishing is presently light and conducted with varying effort and catch.

Marsh Lake is an important recreational area for the residents of Whitehorse. The lake water is warmer than in most of the lakes in the area, and recreational activities such as boating, fishing and swimming are popular.

Tributaries to Marsh Lake

(1) The Tagish River connects Marsh and Tagish Lakes and drains 5 mi. from Tagish Lake through predominantly low-lying country. The river water is a deep green colour and the depth is mostly 15-20 feet. Velocities are slow (estimated at 2 mph.). Submerged vegetation is common, and the substrate is mostly of fine material. Fish species present in the river are the same as those found in Tagish and Marsh Lakes. It is believed that chinook salmon utilize the system for spawning purposes, but this has not yet been confirmed.

A sport fishery is conducted from Tagish Bridge for lake trout with excellent success. Most fish are caught on rod and reel utilizing least cisco that have been "jigged" from the bridge, for bait. Figure 2 is a sketch of Tagish River depicting fish habitat and substrate types.

The Tagish River is a very popular recreational area. The waterways are navigable, and access by road or water is possible.

(2) Tagish Creek drains an area of 31 sq. mi. and flows east for 15 mi. into the mouth of Tagish River. The maximum instantaneous discharge was 96.8 cu. ft./sec. on 24/05/69, and the minimum was 3.4 cu. ft./sec. on 12/02/61. Gradients are low to moderate in the upper reaches.

(3) The McClintock River drains an area of 597 sq. mi. and flows south into a bay at the north end of Marsh Lake. Maximum discharge was 3260 cu. ft./sec. on 22/05/57, and the minimum was 66 cu. ft./sec. on 14/03/57. The river is 53 mi. long with an average width of 50 ft. It meanders tortuously in the 12 mi. of valley above Marsh Lake. Composition of the streambed is mostly sand with some scattered gravel patches between the junction with Michie Creek and the falls. The river flows between sand and clay banks from 60-100 ft. high in this region. The water is silty from sand bank erosion just below the falls, but above this point the water is clear. The falls are about 15 ft. high and are probably impassable to fish. The river flows through marshy areas above the falls, and log jams and beaver dams are present in the upper reaches. Excellent spawning gravels are present above the falls. The river heads in a chain of lakes (McClintock Lakes). Water temperature was 10°C on 28/08/74. Fish species present are chinook salmon. longnose sucker, lake chub, slimy sculpin, northern pike and humpback whitefish. The falls referred to above are located approximately 4-1/2 mi. upstream of the McClintock-Michie Creek junction, or approximately 19-1/2 mi. from Marsh Lake.

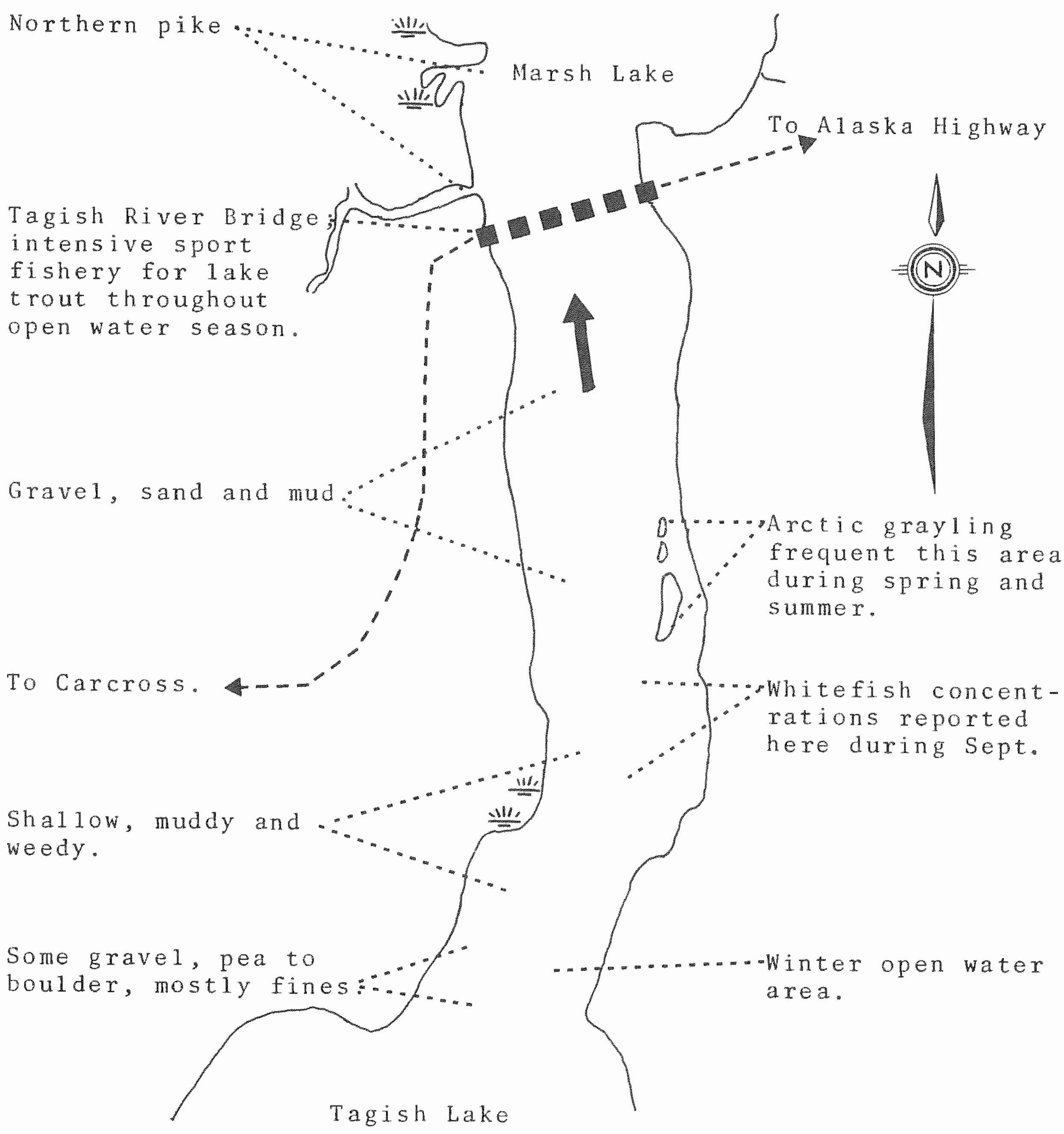


Figure 2. Sketch of Tagish River depicting fish habitat and substrate types.

A sampling programme utilizing retenone was conducted in June, 1960 in the McClintock River to determine species present. Three chinook salmon fry (38 mm. in fork length), numerous slimy sculpin, 1 lake chub (64 mm. in fork length) and 1 juvenile sucker (64 mm. in fork length) were taken in blind channels below the junction with Michie Creek. Many whitefish fry (approximately 19 mm. in fork length) were captured in McClintock River above the junction with Michie Creek. Many pike were observed in slough areas above the highway bridge.

Frequent aerial survey flights have been made on the McClintock River in attempts to enumerate spawning chinook salmon. One report of 4/09/58 indicates the presence of 15 chinook salmon but does not indicate their location. The best area for chinook salmon spawning is in the tributary stream, Michie Creek (see separate section on salmon stocks). Native reports indicate that chinook salmon do ascend the McClintock River to the falls.

The stream is accessible by road and is navigable by small boat for about 7 mi. above Marsh Lake in periods of low water, and to the junction of Michie Creek at higher water levels.

Exploitation of chinook salmon in the McClintock River by native subsistence fisheries was important for several families in the past. Catches were alleged to be 500 fish per family. The salmon were netted at the mouth of the river and trapped at a fishing site approximately 5 mi. upstream from the mouth. Catches have dropped dramatically since 1957.

(4) Cap Creek flows 17 mi. from the west into McClintock River. The stream is clear with a gravel bottom.

(5) Michie Creek is a pool-riffle stream with moderate-to-fast velocities flowing eastward for approximately 50 mi. into the McClintock River. The stream is meandering from Michie Lake to the McClintock River. Approximately 60% of this area is suitable for spawning purposes. Above Michie Lake the stream is clear and flows through some marshy sections, parts of which have sections of good spawning gravel. Log jams are common throughout the upper section. Water temperature was 10^{o}C on 30/05/60, and the discharge was estimated at 80 cu. ft./sec. on 27/08/60.

A programme of sampling with retenone conducted on 30/05/60, approximately 3/4 mi. downstream of Michie Lake, resulted in the collection of the following fish:

No.	Species	Range in Fork Length
17	Chinook salmon fry	approx. 36 mm.
18	Longnose suckers	30-75 mm.
1	Burbot	75 mm.
1	Slimy sculpin	25 mm.

Sampling with a fyke net set overnight on 30/05/60 resulted in the capture of one longnose sucker. Many longnose suckers were dipnetted from a back eddy approximately 1/4 mi. downstream from Michie Lake.

Aerial surveys were conducted in August and September of 1959 on Michie Creek in efforts to locate and enumerate spawning chinook salmon. No salmon were observed but redds were seen approximately 1 mi. downstream of Michie Lake.

In 1960, counts of spawning chinook salmon were made on August 22 and 31, and a survey of the stream was conducted on foot on August 27. The following results indicate the location of spawners:

Date	No. Live	No. Dead	Area of Location
22/08/60	12	0	1 to 2 mi. downstream of Michie Lake
27/08/60	148	5	1 to 2 mi. downstream of Michie Lake
31/08/60	0		

During the foot survey conducted on 27/08/60 several dead chinook salmon fry were observed below a beaver dam. As determined from observation of the dead adults, spawning was completed by 27/08/60. There are reports from natives that chinook salmon previously spawned between Michie Lake and Fox Lake.

(6) Byng Creek flows south joining Michie Creek approximately 3 mi. downstream of Michie Lake.

Lower reaches flow through the trees with many log jams and channel changes in this area. Mid areas have moderate velocity with good gravel beds. Upper section is swift with many riffles. The stream is shallow. It is slightly smaller than Michie Creek at the junction.

This stream is reported to have supported chinook salmon spawners at one time but aerial observations in 1959 and 1960 during the spawning period did not reveal redds or fish.

(7) Michie Lake is situated approximately 14 mi. upstream on Michie Creek. It is 2½ mi. long and approximately 1 mi. wide. The lake is surrounded by low, rolling forested hills. Some marshy areas are present at the eastern end of the lake. Water temperatures on 31/05/60 ranged from 9.25^{o}C at surface to 5.0^{o}C at 32 ft. The elevation is 2435 ft. above sea level. There is good gravel around the lake and island shores. The water is clear but has a brownish (organic) tinge. The lake is at least 100 ft. deep as determined by hand soundings.

Species reported present are lake trout and northern pike.

(8) Fox Lake lies at mile 16 on Michie Creek. It is approximately 2½ mi. long and 1/2 mi. wide. Species reported present are lake trout, whitefish and northern pike. The lake is accessible by trail from Marsh Lake.

(9) McClintock Lake is at mile 22 of Michie Creek. It is approximately 2½ mi. long and 3/4 mi. wide at the widest point. The lake lies in a broad valley with many eskers. Species reported present are lake trout and northern pike.

(10) Caribou Lake (1 mi. long by 0.5 mi. wide) drains via Grayling Creek into Marsh Lake at about mile 883 on the Alaska Highway. Water temperature was 16.1°C on 22/08/60. Species reported present are lake trout, grayling, pike and lake chub. Sport fishing produces excellent results in this lake.

Table 6. Water chemistry measurements for tributaries to Marsh Lake.

Tributary	Date	Water colour	Alka-linity (gpg)	Hard-ness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Marsh Lake	28/08/74		3	3	5	.33	7.5	10
McClintock River	28/08/74		7	6	5	.33	8.5	10

Plate 49. Spawning grounds -Michie Creek (August,1960)

Plate 50. Beaver dam on upper Michie Creek.

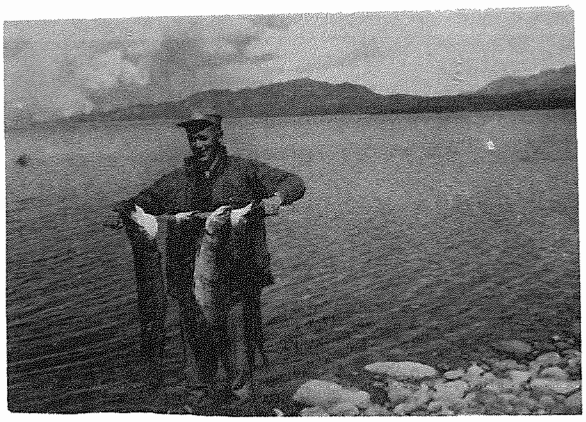


Plate 51. Catch of fish from Marsh Lake (1955)

Plate 52. M'Clintock River- Johnny Joe's Fish Camp (June, 1955).

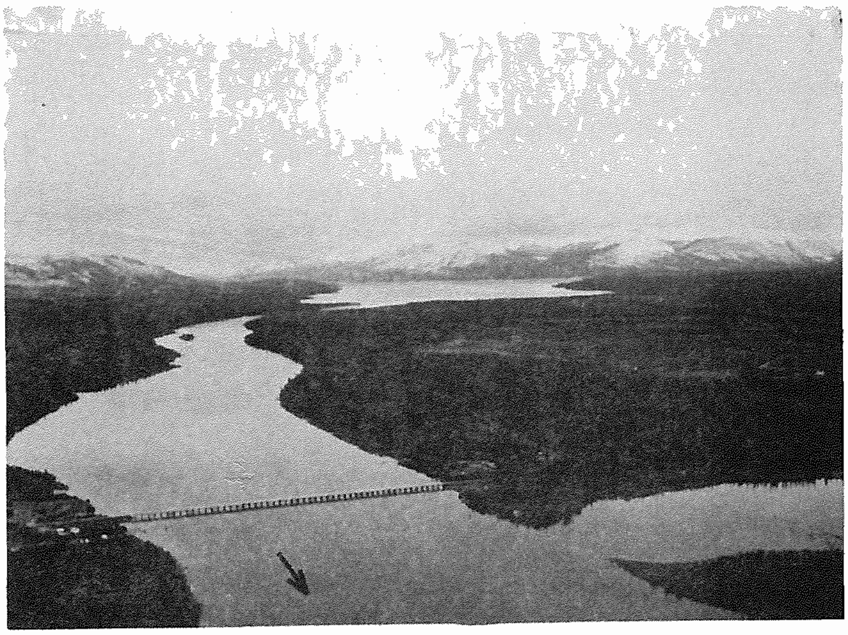
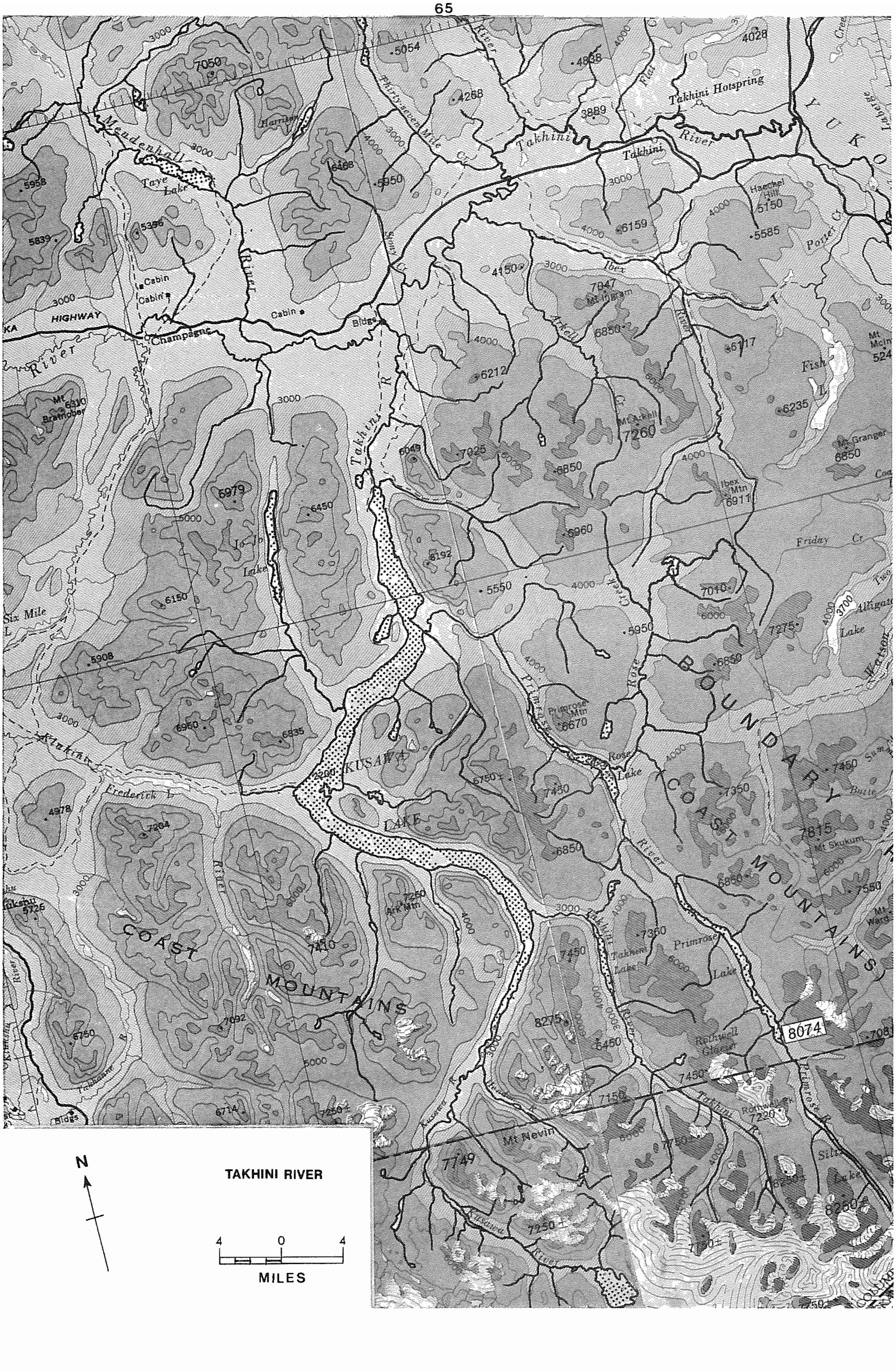


Plate 53. Tagish River Bridge with the upper limit of Marsh Lake in foreground (1972).



TAKHINI RIVER

Name of Stream	Tributary to	River System
TAKHINI RIVER	YUKON RIVER	YUKON

LOCATION Flows N.E. and E. into Yukon River, N. of Whitehorse

POSITION 60 136 NE

LENGTH 69 mi. WIDTH DRAINAGE 2640 sq. mi.

The Takhini River drains Kusawa Lake into the Yukon River. Discharges at the lake outlet were recorded as a mean of 1840 cu. ft./sec. on 21/06/64, a minimum of 191 cu. ft./sec. on 31/03/60 and a maximum instantaneous discharge of 9880 cu. ft./sec. on 21/06/64. Discharges at the Alaska Highway bridge were as follows:

Maximum 17,200 cu. ft./sec. on 2/09/49

Minimum 153 cu. ft./sec. on 19/02/51

Stream observations of the Takhini River were conducted by boat from the outlet of Kusawa Lake to a rapids area approximately 8.5 mi. downstream, on 14/08/74. In this section, the streambed was composed mainly of gravel (90+%) with some large boulders in scattered areas. The gravel quality is excellent for chinook salmon spawning. The stream is relatively deep and deceptively swift. It is difficult to stand in the stream without being swept away when the depth exceeds knee level. Only one short rapids exists on this stream but they require extreme caution when boating, as there are some large standing waves and treacherous boulders associated with them. Ground observations concurred with aerial observations which were carried out for the whole stream. From these observations, excellent spawning gravels exist to approximately 12 mi. below the lake. For the next 10 mi., the current is of moderate velocity with some good spawning gravel areas. The stream is more subject to silting in this area, especially from Mendenhall Creek and also from the large number of clay and silt banks. These banks occur throughout but particularly in the lower half where they are larger and more frequent. Below this, the stream is generally silty and meandering.

Water temperature was 13.9^{o}C on 14/08/74.

Seining with a small mesh net on 14/08/74 captured juvenile chinook salmon and suckers. Other fish observed were adult chinook salmon, suckers, Arctic grayling, and whitefish (unidentified). Twenty-six chinook salmon fingerlings ranged from 56-77 mm. and had a modal length of 70 mm.

A gillnet set near the lake outlet on 2/01/75 captured one nine-year-old humpback whitefish 308 mm. long weighing 350 gm.

Chinook salmon spawn in the Takhini River in an area from the lake outlet to approximately 12 mi. downstream. The streambed on the spawning grounds is composed of gravel riffle areas. The following table lists chinook salmon spawning information for various years in the Takhini River.

Date	No. Live	No. Dead	Location
04/09/58	5	30	throughout system
02/09/59	50	11	4-12 mi. below Kusawa Lake, numerous redds
	3	3	12-22 mi. below Kusawa Lake, numerous redds
		1	lower 28 mi.
24/08/60	Est. 200		mainly from 1-1.5 mi. below lake
30/08/60	Est. 500-1000		from Kusawa Lake to Mendenhall Creek
28/08/63	Est. 250		upper stream, silty conditions
14/08/74	15		lake outlet to 8.5 mi. downstream
26/08/75	30	1	lake outlet to 8.5 mi. downstream
29/08/75	165		lake outlet to 8.5 mi. downstream
15/09/75		18	lake outlet to 8.5 mi. downstream

It was estimated that 2000 chum salmon occupied the Takhini River spawning grounds in 1960, but the presence of chum salmon in this stream has not been confirmed to date.

Some sport fishing for chinook salmon is conducted and sport fishing for Arctic grayling produces excellent results. Limited subsistence fishing for chinook salmon is conducted during August.

Tributaries to Takhini River

(1) Kusawa Lake lies at an elevation of 2200 ft. above sea level in a general north/south direction. The lake is 46 mi. long by 0.5-1.5 mi. wide. Streams entering the lake from the south are of glacial origin, consequently the southern portion of the lake is more turbid than the north. Glacial silt accumulation at the mouth of Primrose River threatens to divide the lake. Shores of the lake are generally rocky and steep. The lake is subject to sudden treacherous winds. Water temperature on 14/08/74 at the north end of

the lake was 15.5^{o}C. A Secchi disc reading was 15+ ft. on this date.

Species present are reported to be lake trout, Arctic grayling, northern pike, whitefish, and chinook salmon. Sampling with gillnets in the north end of the lake on 14/08/74 captured 13 Arctic grayling, 2 humpback whitefish and one lake trout. Three Arctic grayling were sampled for fork length. The results were: 345 mm. male, 311 mm. female, 295 mm. female, and were aged 4 and 5 yrs. The humpback whitefish were both females 408 mm. long, and were aged 7 and 8 yrs. The lake trout, a 9-year-old female, was 465 mm. long.

Whitefish are reported to spawn in Kusawa Lake in late November and early December.

A commercial quota of 15,000 lbs. of whitefish and lake trout combined was eliminated in 1968. Previous reports from commercial fishermen indicated that the area north of Primrose River was poor but that excellent catches were made south of this area, particularly in that section that lies in a northwest and southeast trending direction.

Recreational potential is excellent in this area. The lake and surrounding area are very picturesque. Excellent angling for lake trout has been reported in the southern portion of the lake. The lake is accessible from mile 958 on the Alaska Highway.

(2) Taye Lake is drained by the Mendenhall River. The lake is approximately 4 mi. long by 3/4 mi. wide. It is a shallow lake, marshy in the north end with low relief on the adjacent shoreline. Water temperature was 13.9^{o}C on 20/08/74. An overnight gillnet set on 20/08/74 took 10 northern pike (6 male, 4 female) with a range in fork length from 464-562 mm. and a mean fork length of 518 mm. These fish were aged 5, 6, and 7 yrs.

(3) Harrison Lake drains by an eight-mile-long stream into the Mendenhall River. Lake trout and Arctic grayling are reported present.

(4) Thirty-Seven Mile Lake drains by Thirty-Seven Mile Creek into the Mendenhall River. The lake is approximately 0.3 mi. long by 0.5 mi. wide. Species present are Arctic grayling, lake trout and burbot.

(5) The Ibex River is a small, clear stream with a high gradient flowing 40 mi. from the south into the Takhini River. Discharge on 30/08/60 was estimated at 50 cu. ft./sec. The streambed is composed of gravel intermixed with boulders.

(6) Scout Lake, 1 mi. long by 0.5 mi. wide, has an intermittent drainage into the Ibex River. This lake was stocked with rainbow trout fry in 1971. A population was established and excellent growth rates were recorded. No known spawning areas are present, necessitating restocking to maintain the population. Details of the stocking experiment are found in the appropriate section of this report.

(7) The Primrose River flows north through a chain of lakes for approximately 50 mi. and drains into the east side of Kusawa Lake approximately 10 mi. from the north end. Its glacial origins are evidenced in the build-up of a glacial fan at the river mouth. It is a swift, non-navigable stream which flows through a gorge approximately 5 mi. above Kusawa Lake. The river originates from Silt Lake whose outlet is at approximately mile 42 and flows through Primrose and Rose Lakes with outlets at mile 12 and mile 27, respectively.

(8) Rose Lake is approximately 8 mi. long. It is a very shallow lake in the north end and at the mouth of Rose Creek. Water temperature was 12.9°C on 20/08/74. A Secchi disc reading was 6 ft. in milky water. A gillnet set on 20/08/74 and picked up the next day captured the following fish:

No.	Species	Range in Fork Length (mm)	Sex Composition	Age (yrs)
8	Lake trout	313-534	5 male, 3 female	10 (1 fish)
7	Arctic grayling	246-305	4 male, 3 female	5, 6, 7

(9) Primrose Lake is approximately 12 mi. long with a width of approximately 1/2 mi. It is a glacial lake draining into the Primrose River at mile 27. Water temperature was 12.0°C on 20/08/74. A Secchi disc reading was 2 ft., reflecting the high silt content. Juvenile Arctic grayling were observed from the lakeshore. An overnight gillnet set on 20/08/74 took 1 male lake trout 594 mm. long, and 1 female 182 mm. long. One male Arctic grayling, 293 mm. in fork length, was also captured.

(10) Jo-Jo Creek flows south from Jo-Jo Lake a distance of 9 mi. and enters the west side of Kusawa Lake. The upper part of this stream is slow and meandering with a bottom composition of gravel, boulders, and silt. The lower section is composed of rapids and falls, rendering it impassable to fish.

(11) Jo-Jo Lake is approximately 7 mi. long by 1 mi. wide. Water temperature on 10/09/74 was 3.9°C. A gillnet set for 24 hrs. took 18 lake trout and 16 Arctic grayling. A subsample of 10 of each species yielded the following information:

Species	Range in Fork Length (mm)	Sex Composition
Lake trout	360-673	5 male, 5 female
Arctic grayling	317-372	7 male, 3 female

(12) Takhini Lake (4 mi. long, 0.5 mi. wide) drains west for 4 mi. into the north end of Kusawa Lake. Fish species present are lake trout, humpback whitefish, Arctic grayling and longnose suckers. A sample of 9 lake trout taken by gillnetting on 20/08/74 ranged in fork length from 330-760 mm. There were 3 male and 6 female. Six humpback whitefish (5 male, 1 female) ranged in fork length from 286-370 mm. One male Arctic grayling and 1 female longnose sucker were taken with fork lengths of 255 mm. and 295 mm., respectively.

Table 7. Water chemistry measurements for tributaries to Takhini River.

Tributary	Date	Water colour	Alka- linity (gpg)	Hard- ness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Takhini River	14/08/74	Clear green tinge	2	2	5	.33		10
Kusawa Lake	14/08/74	Clear green tinge	2	1	5	.33	7.5	10
Taye Lake	20/08/74	Organic brown	6	6	5	.33	8.5	10
Primrose Lake	20/08/74	Milky	2	2	5	.33	8.0	10
Jo-Jo Lake	10/09/74	Clear	2	1	5	.33	7.0	9
Takhini Lake	20/08/74	Milky	1	1	5	.33	7.0	10

Plate 54. Takhini River- outlet of Kusawa River.

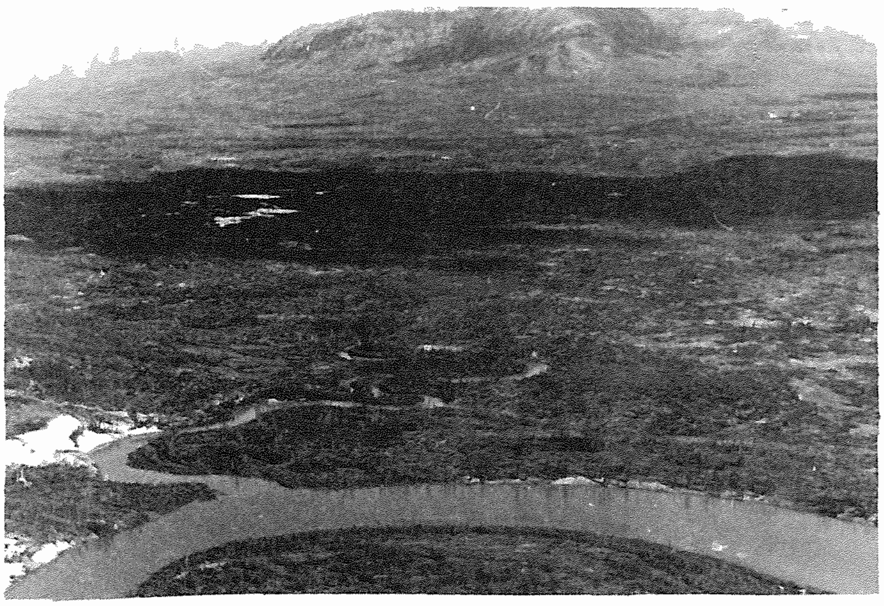


Plate 55. Little River- junction with Takhini River.

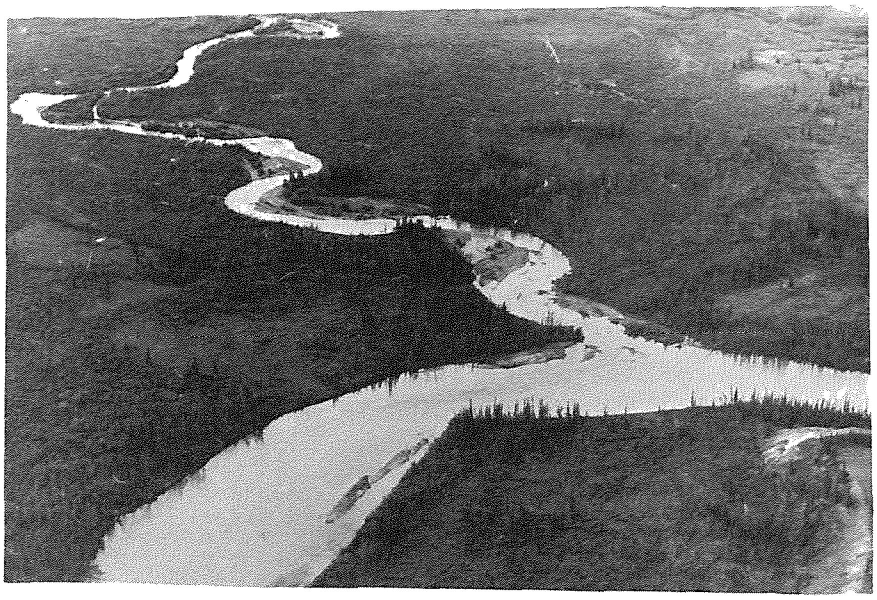


Plate 56. Ibex River- junction with Takhini River.

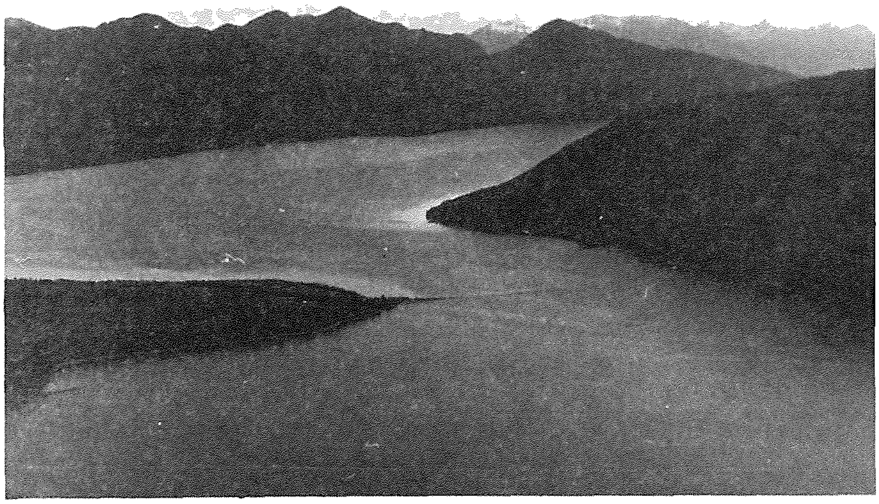


Plate 57. Kusawa Lake- looking south from Primrose Lake.

Plate 58. Kusawa River- looking toward Kusawa Lake
in background.

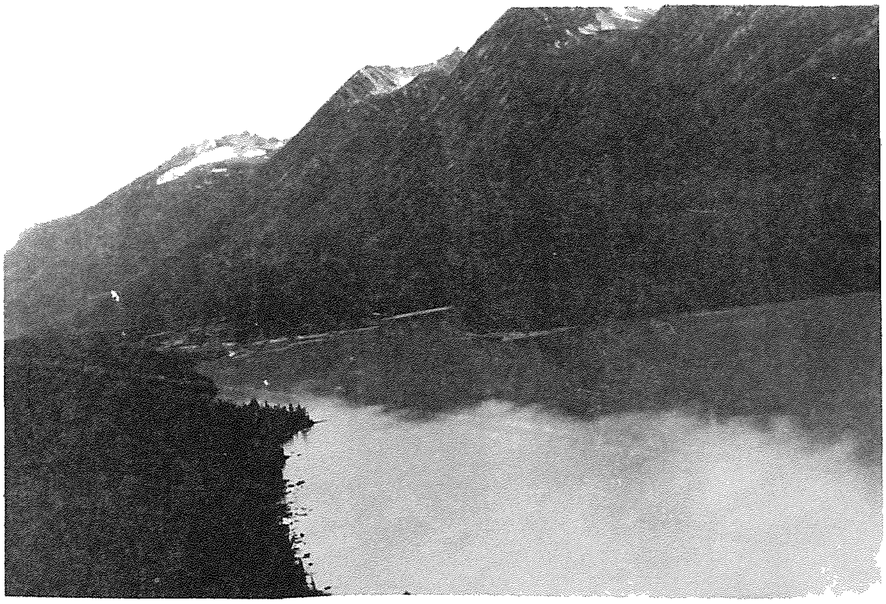


Plate 59. Takhini Lake- upper end.

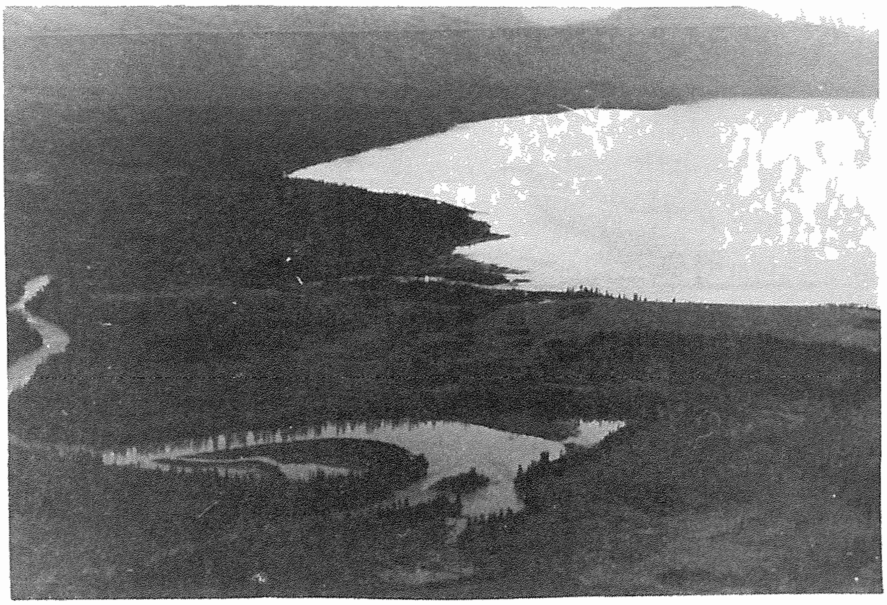


Plate 60. Primrose River- junction with Kusawa Lake.

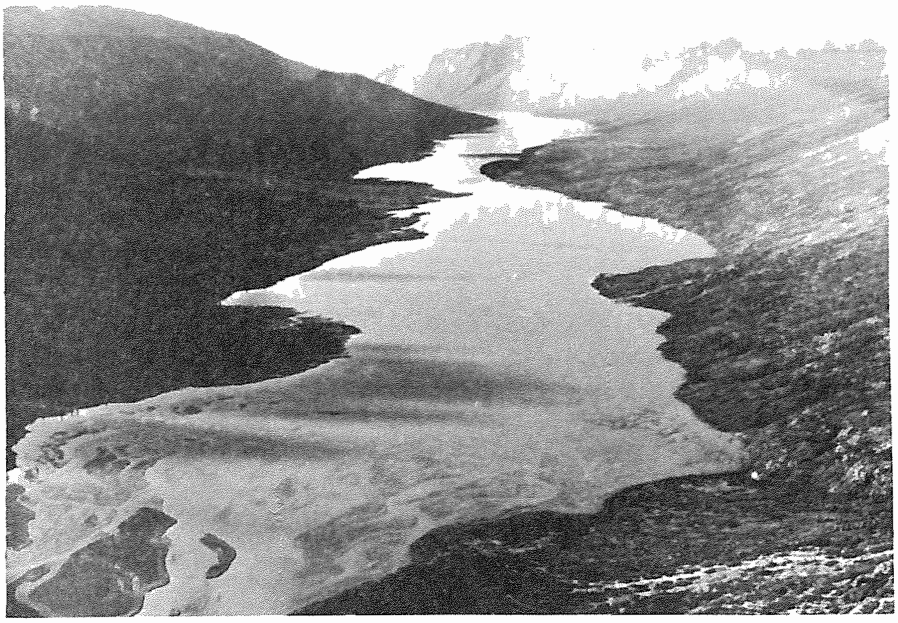


Plate 61. Primrose Lake- outlet in foreground.

Plate 62. Primrose Lake headwaters.

Plate 63. Takhini River- confluence with the Yukon River.


LAKE LABERGE
N
0 4
MILES
Lower Laberge
Goddard Pt
POVOAS MTN
Ptarmigan Pt
LAKE LABERGE
FOX LAKE
Richthofen Valley
Richthofen I
Jackfish Bay
FLAT MTN
LIME PEAK
MT LAURIER
Upper Laberge
Takhini Hotspring
JOE MTN
Miller
Laurier
Laberge

Name of Stream	Tributary to	River System
LAKE LABERGE	YUKON RIVER	YUKON

LOCATION N. of Whitehorse, Yukon, mainstream lake of the Yukon River

POSITION 61 135 SE

LENGTH 30 mi. WIDTH 1.5-4 mi. DRAINAGE 750 sq. mi.(approx)

Lake Laberge lies in a long valley surrounded by hills and mountainous country. The lake is at an elevation of 2060 ft. above sea level. Water temperature was 1.0^{o}C on 12/11/74. Fish species recorded in the lake are lake trout, round whitefish, humpback whitefish, broad whitefish, northern pike, inconnu, burbot, Arctic grayling and chinook salmon. Slimy sculpins are probably present. Chum salmon have been reported in the lake but the reports have not been confirmed. Lake trout have been observed spawning off the northeast point of Richthofen Island in late September. The bottom composition at the spawning ground is sand. Local reports indicate that Arctic grayling enter Horse Creek in May to spawn. The discharge of this stream is 30-50 cu. ft./sec.

A commercial fishery for lake trout and whitefish is conducted on Lake Laberge. A quota of 20,000 lbs. has been established of which no more than one-half may be lake trout.

Observations of the fishery were conducted for a ten-day period in December 1961. During this period, 400 yds. of 4-in. mesh net set 24 hrs. per day caught 365 whitefish (humpback and broad), 120 lake trout, and 37 inconnu. Most of the whitefish averaged 1.5 lbs. and the total catch weighed approximately 1000 lbs. (100 lbs./day or 25 lbs./100 yds. of net/day). The fish were in good condition , free from Triaenaphorous, and totally recovered from spawning. Commercial fishermen indicate that large areas of the lake are poor fishing grounds and that the best catches are made in certain traditionally fished areas.

Domestic and subsistence fisheries are also conducted on this lake. The success of sport fishermen in Lake Laberge is variable.

The lake is accessible by boat and vehicle. A government campsite with a boat ramp is situated on the lakeshore and can be reached by a short side road from Mile 21 on the Dawson highway.

Tributaries to Lake Laberge

(1) Fox Lake drains via Richthofen Creek a distance of approximately 12 mi. into the west side of Lake Laberge. The lake is 11 mi. long and 0.5-0.75 mi. wide. The lake is reported to be up to 250 ft. deep. The lake

elevation is 2580 ft. above sea level. Water temperature was 2.3°C on 12/11/74. Fish species present in the lake include lake trout, whitefish, northern pike, Arctic grayling and burbot. Arctic grayling have been observed spawning in early June immediately below the outlet of the lake.

In an experimental fishery conducted by Fisheries Service from July 10 to August 31, 1972, 64 burbot were captured and sampled. All were captured by long line with baited hooks either set on the bottom or suspended a few feet above the bottom. Suspended hooks were more effective in catching burbot. Most of the fish were caught in depths ranging from 30-100 ft. and a few were taken at depths of 150 ft. Fork lengths ranged from 365-900 mm. with a mean length of 506 mm. The weights ranged from 317-4358 gm. with a mean weight of 890 gm.

A commercial quota of 2000 lbs. of lake trout and whitefish was eliminated from Fox Lake in 1971.

The lake is accessible by road from the Dawson Highway which follows the east shore. A government campsite with boat launching facilities is located on the lakeshore. The lake offers excellent recreational attractions.

Table 8. Water chemistry measurements for tributaries to Lake Laberge.

Tributary	Date	Water colour	Alkalinity (gpg)	Hardness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Lake Laberge	12/11/74	Clear	4	4	5	.33	7.5	12
Fox Lake	12/11/74	Clear	12	12	5	.33	9	12

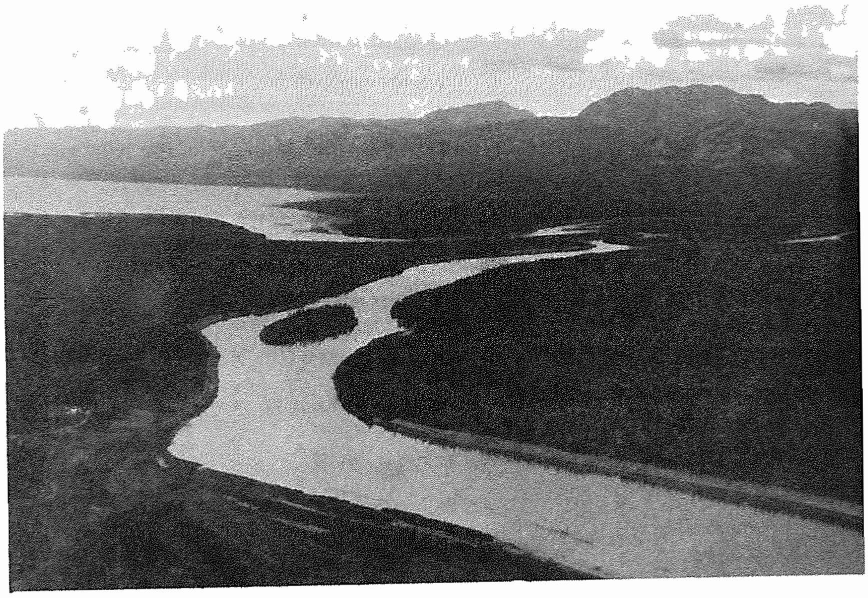
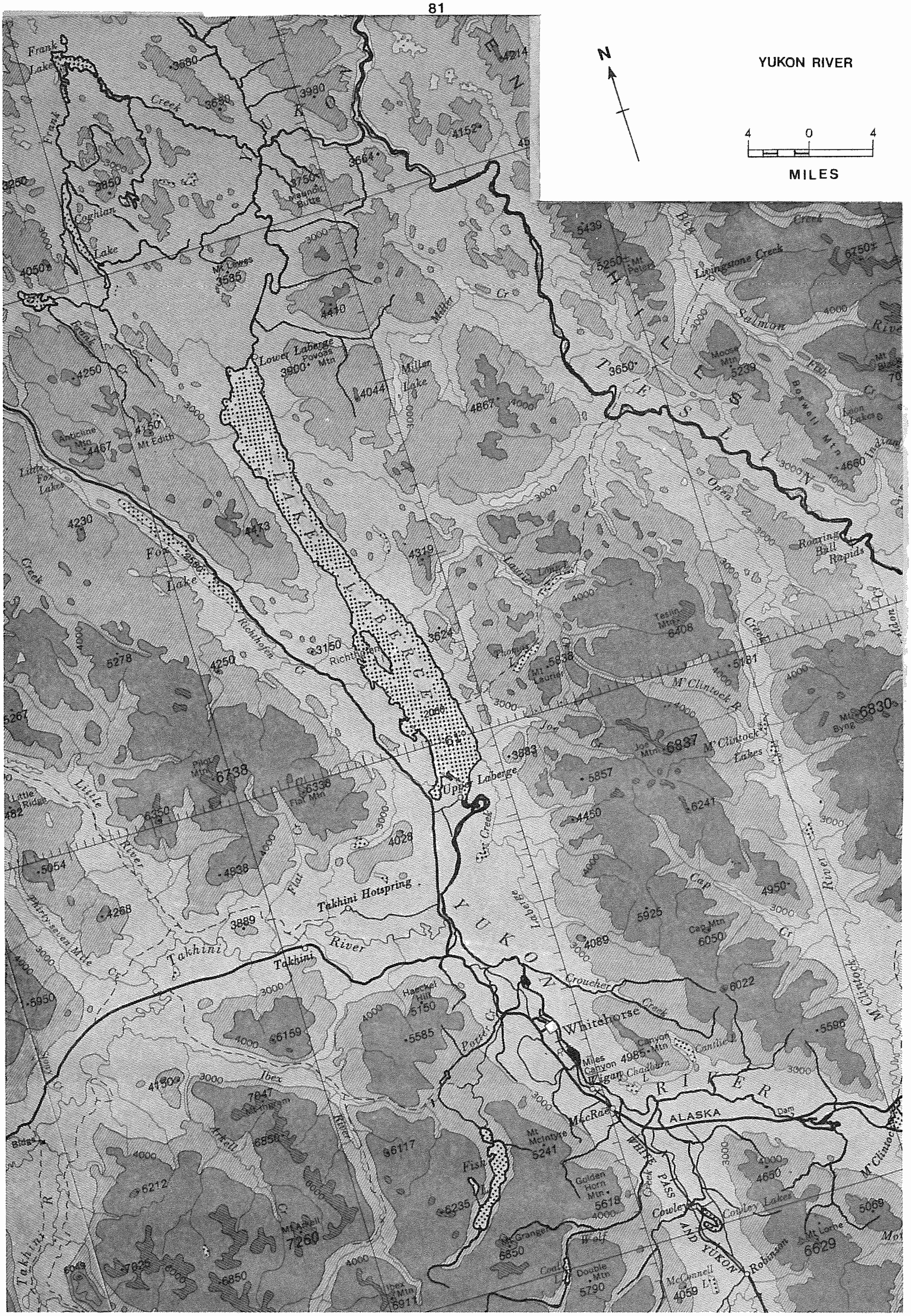


Plate 64. Inlet of Lake Laberge (1974).

Plate 65. Lake Laberge looking north (Richthofen Island mid center).


YUKON RIVER
N
4 0 4
MILES
LAKE LABERGE
Lower Laberge
Upper Laberge
Whitehorse
Takhini Hotspring
Takhini River
Miles Canyon
ALASKA
WHITE PASS AND YUKON
Teslin Mtn
Mt Laurier
Joe Mtn
Pilot Mtn
Flat Mtn
Haeckel Hill
Mt McIntyre
Golden Horn Mtn
Mt Lorne
Cap Mtn
Moose Mtn
Mt Lewes
Frank Lake
Coghlan Lake
Fox Lake
Little Fox Lakes
Anticline Mtn
Mt Edith
Richthofen
Livingstone Creek
Roaring Bull Rapids
Cowley Lakes
Robinson
McConnell L
Double Mtn
Ibex Mtn
Mt Arkell
Fish L
Canyon Mtn
Chadburn L
McRae
Croucher Creek
Thirty-seven Mile Cr
Little River
Mt Byng
M'Clintock Lakes
M'Clintock R
Joe Cr
Cap Cr
Open Cr
Salmon River
Miller Lake
Povoas Mtn

Name of Stream	Tributary to	River System
YUKON RIVER		YUKON

LOCATION that section from the outlet of Marsh Lake to Teslin River junction (Hootalinqua)

POSITION 61 134 NW

LENGTH 85 mi.*

WIDTH

DRAINAGE 12000 sq. mi.

From the outlet of Marsh Lake, the Yukon River flows 7 mi. through flat-lying, marshy country to the Alaska Highway crossing. The Lewes storage dam is located approximately 300 yds. downstream of the highway bridge. A description and history of the dam is given in the appropriate section of this catalogue. Downstream of the dam, the river flows for 6 mi. through high, clay cutbanks, periodically broken by stretches of lower bank shoreline. The river meanders for the next 6 mi. through low undercut and slumping banks with a few high cutbanks towards the downstream end of this reach. The course of the river then straightens and a constriction in width occurs in the four miles of river upstream of Miles Canyon. The river surges through Miles Canyon for one mile, constricted between vertical rock walls up to 75 ft. in height, and empties into Schwatka Lake (Plate 91). Schwatka Lake is the reservoir created by a power dam constructed in 1958 at Whitehorse Rapids approximately 1 mi. south (upstream) of the city of Whitehorse. A discussion of the hydro-electric dam is presented in a separate section of this catalogue. Schwatka Lake serves as a reservoir for domestic water supply to Whitehorse and is utilized as a float plane base. The elevation differential on either side of the Whitehorse Rapids Dam is 47 vertical ft.

Three miles downstream from Whitehorse, the river averages 600 ft. in width, flowing between 20 ft. high banks on the east and clay cutbanks up to 150 ft. on the west. Downstream of these high cutbanks the river narrows for a distance of approximately 4 mi. downstream of the confluence of the Takhini River which enters from the west. The river again widens to a width of 700 ft. in this section of the river and flows through a wide valley characterized by marshy areas. The river banks become progressively lower and the river wider until it enters Lake Laberge. Figure 3 illustrates the configuration of the river channel from Whitehorse to Lake Laberge.

The river from Lake Laberge to Teslin River junction is commonly known as The Thirty Mile River. In this section, the river flows from the low relief of Lake Laberge outlet into a relatively narrow winding channel enclosed by steep 50-300 ft. sand and gravel bluffs broken occasionally by tributary streams.

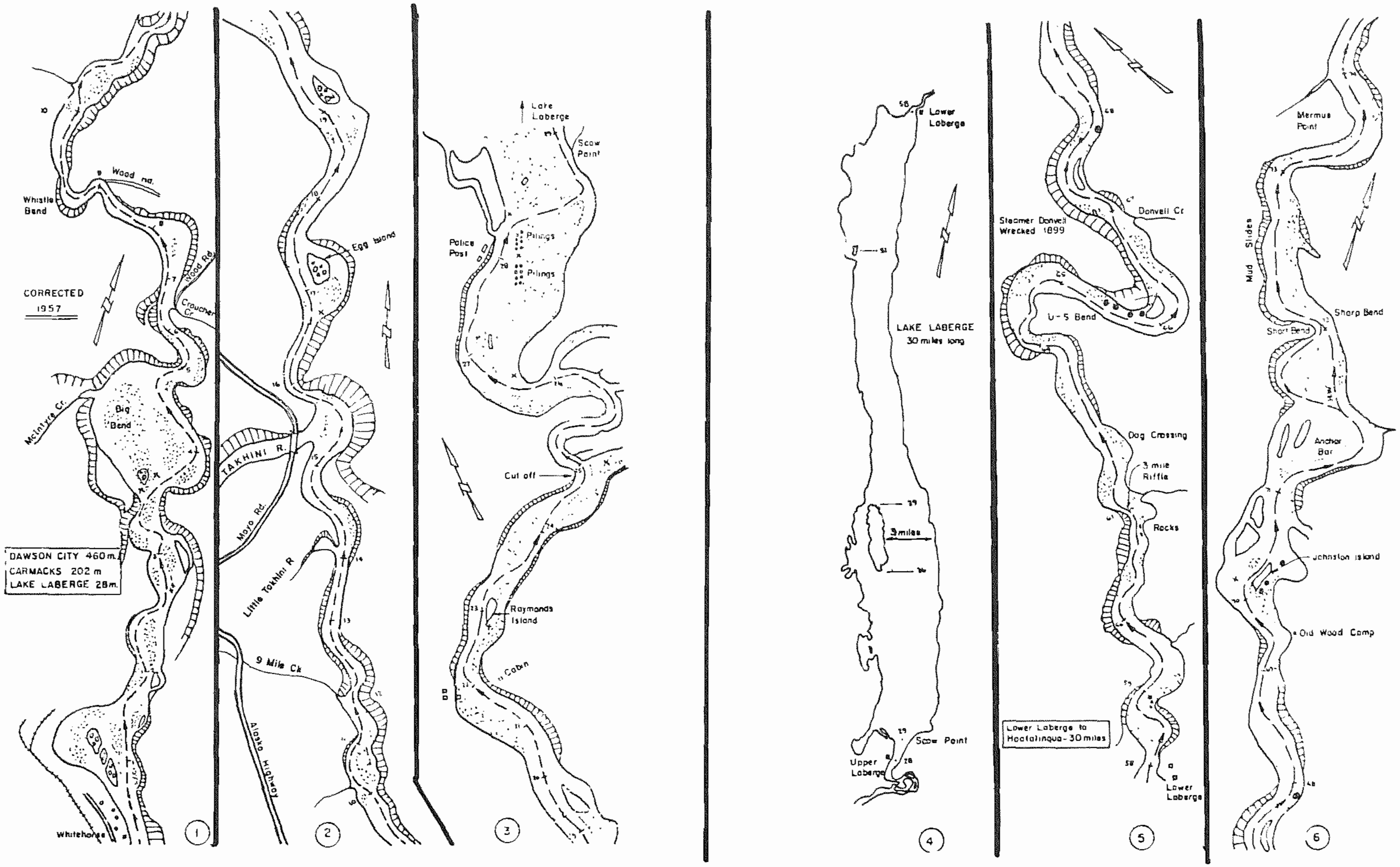


Figure 3. Channel configuration of the Yukon River from Whitehorse to Teslin River (from an old set of riverboat channel charts).

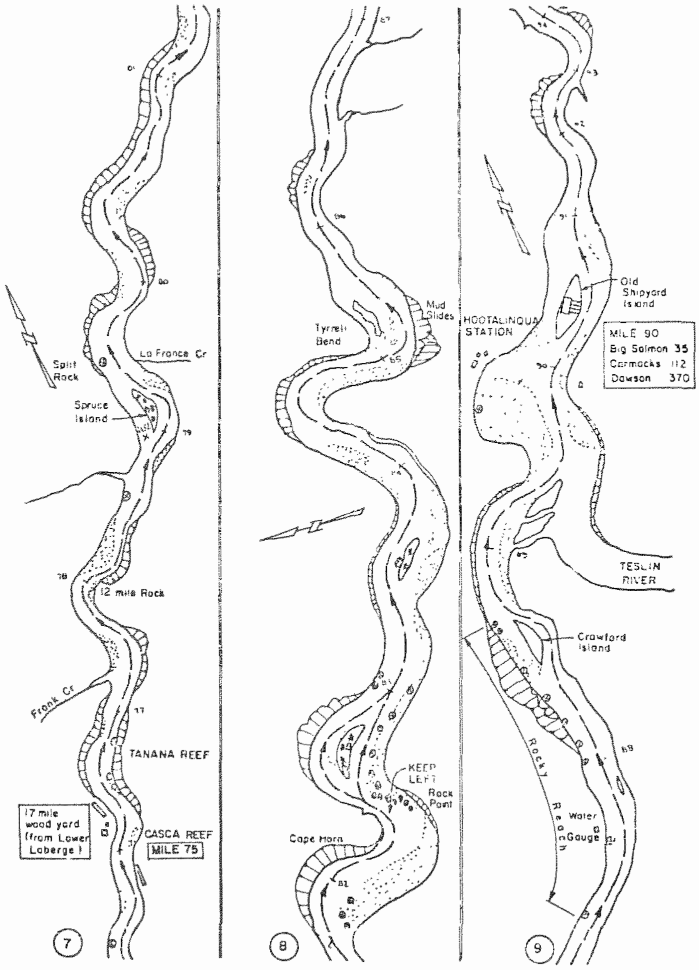


Figure 3. (continued).

In general, the Yukon River from Marsh Lake to Teslin River is deep-channelled and moderately swift with varying degrees of turbidity depending upon season and reach of the river. Generally the turbidity increases progressively with downstream distance. The streambed as far as can be determined is composed primarily of gravel heavily compacted with fines.

Discharges at a point 12 mi. above the confluence with Teslin River were:

Mean: 11600 cu. ft./sec.

Maximum instantaneous: 29200 cu. ft./sec. on 29/08/61

Minimum: 2500 cu. ft./sec. on 28/03/56

Discharges at Robert Campbell Bridge (drainage 7500 sq. mi.) were:

Mean: 8570 cu. ft./sec.

Maximum instantaneous: 22800 cu. ft./sec. on 9&10/08/53

Minimum: 1150 cu. ft/sec. on 19/05/62 and 21/05/64

Spot water temperatures at some locations were:

Temperature	Date	Location
38°F	31/10/74	Whitehorse vicinity
38°F	20/05/57	Lewes Dam
38°F	27/05/57	Lewes Dam
33.5°F	30/12/74	Immediately above confluence with Takhini River

Water temperatures at the Whitehorse Rapids Dam from April to July 1973 and for some points between May and June 1957 (X) are plotted below:

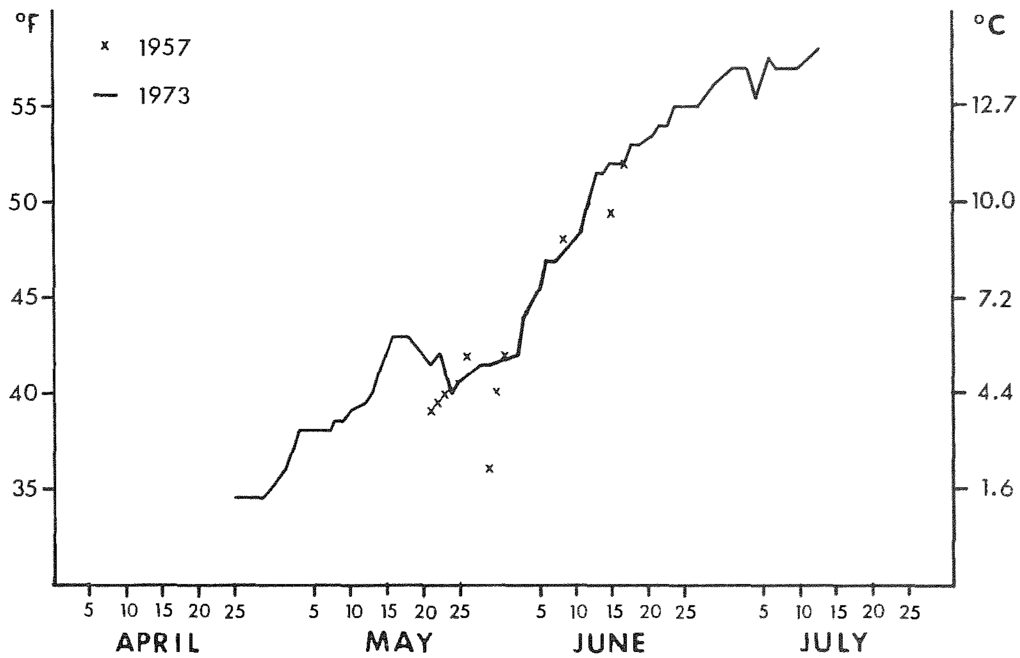


Figure 4. Water temperatures collected at the Whitehorse Rapids Dam from April-July 1973 and for days in May-June 1957.

Fish Stocks

The following species of fish have been captured in that section of the Yukon River described in this catalogue.

Species	Scientific Name	Remarks
Chinook salmon	*Onchorhynchus tshawytscha*	anadromous
Arctic grayling	*Thymallus arcticus*	
Lake trout	*Salvelinus namaycush*	
Round whitefish	*Prosopium cylindraceum*	
Humpback whitefish	*Coregonus clupeaformis*	
Broad whitefish	*Coregonus nasus*	
Least cisco	*Coregonus sardinella*	
Northern pike	*Esox lucius*	
Longnose sucker	*Catastomus catastomus*	
Burbot	*Lota lota*	
Slimy sculpin	*Cottus cognatus*	
Rainbow trout	*Salmo gairdneri*	stocked

In addition to the above recorded species, it is probable that inconnu (*Stenodus leucichthys*), Arctic lamprey (*Lampetra japonica*) and lake chub (*Couesius plumbeus*) are present in the river. Recent historical records indicate the presence of chum salmon (*Onchorhynchus keta*) above Whitehorse Rapids, but these reports have not been authenticated by Fisheries Service personnel. A discussion of salmon stocks in the upper Yukon River drainage is presented in a separate section of the catalogue.

Most of the following data were collected during a study conducted near the Whitehorse Rapids Dam in the summer of 1973 to assess fish stocks in Schwatka Lake and the stream complex upstream of the Whitehorse Dam in order to evaluate future hydro development plans and make alternate proposals and recommendations where necessary. Most of the data consist of the species and fork lengths of fish captured in the different types of sampling gear. In addition, the food habits of predatory fish species were recorded above, with a general description of the study area. The types of sampling gear included: box traps, wolf traps, inclined planes, Fyke nets, and gillnets. Figure 5 shows the location of the sampling gear. Table 9 shows fish species composition expressed as a percentage of total number of fish caught by different gear types used in the study. Table 10 shows the timing of capture of fish species composition expressed as a percentage of total number of fish caught by different gear types used in the study. The following table shows the size composition of fish species captured above and below the dam and at the fishway.

Species	Above dam Fork length (mm) Range	Modal	No.	Fishway Fork length (mm) Range	Modal	No.	Below dam Fork length (mm) Range	Modal	No.
Arctic grayling	50-90	68	3				70-95	80	20
	259-364	301	21				130-170	150	28
							260-265		3
broad whitefish	nil				90	1	115+375		2
humpback whitefish	25-45	35	*	25-45	35	*	98-178	110	30
							290+298		2
round whitefish	100-358		5	100+110		2	90-130	105	16
				30-35		*	165-195		3
							250-275		6
least cisco	nil			95-140		12	90-205	105-110	29
				27-35		*			
longnose sucker	230-390	330	46	25-115	30-50	28	40-95	65	24

where, * refers to dozens of fish not enumerated

Stomach samples of adult predatory fish species were usually collected. The only indications of predation was a 580 mm. pike which had eaten a 240 mm. Arctic grayling (June 20, 1973).

One of the most interesting results of this study is that the gillnets captured mainly longnose suckers, whereas the other sampling gear caught a larger proportion of young whitefish. This may have been a result of sampling procedures. An alternative possibility is that Schwatka Lake does have an abundance of suckers and a lack of whitefish. The higher numbers of young whitefish may have been migrating downstream from populations which are resident upstream. The interpretations could be verified by collecting more fish samples from Schwatka Lake, particularly in the deeper portions of the lake.

A discussion of the available information collected for each species follows. For some species, the information was collected in different years, but most of the data was collected in 1973.

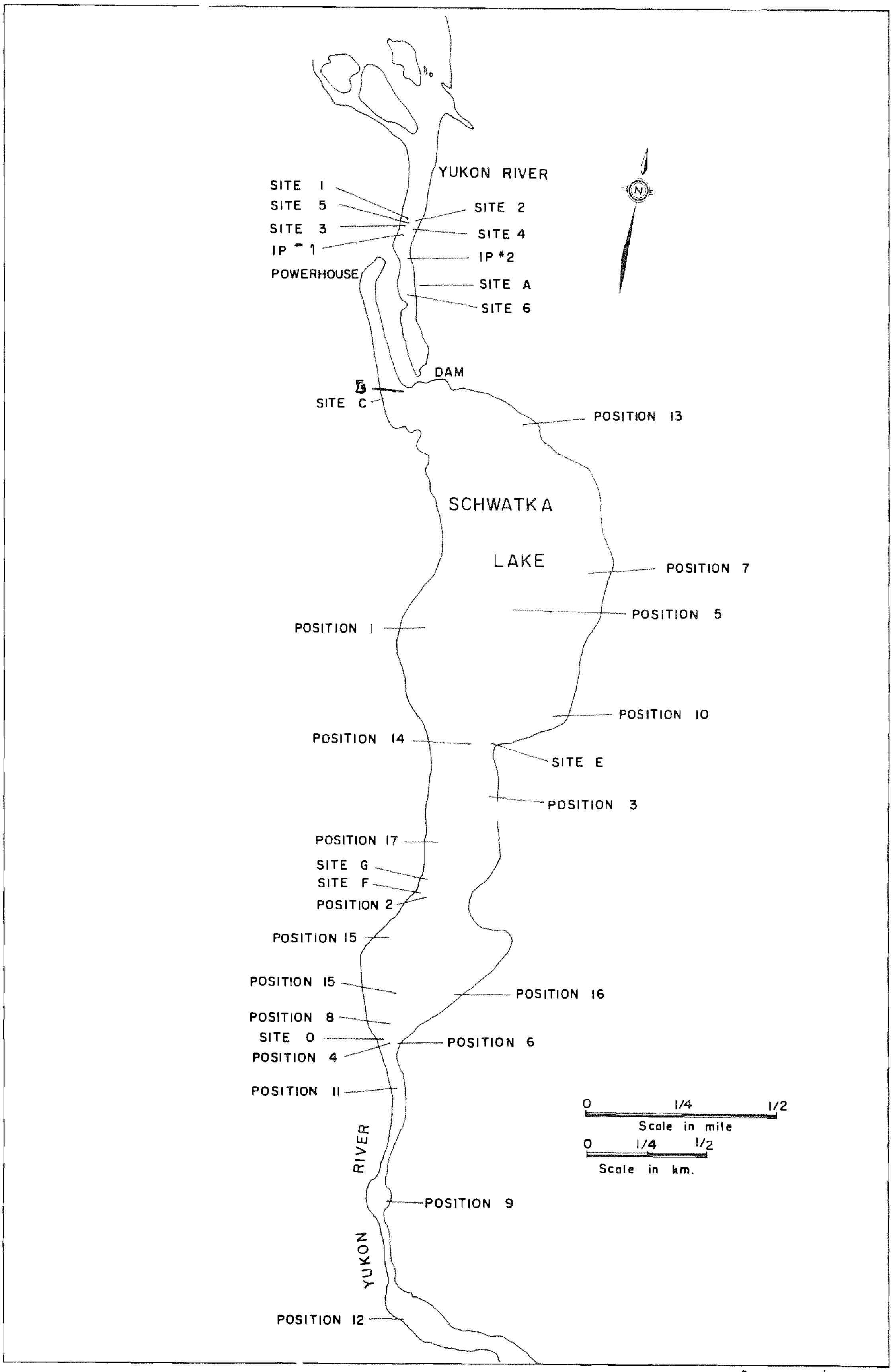


Figure 5. Locations of traps and nets used in 1973 (Whitehorse Dam and Schwatka Lake). Sites 1-5 are locations of fyke nets. Sites B-G are locations of box traps. Site A is location of Wolfe trap. Positions are locations of gillnets.

Table 9. Fish species composition (percentage of total number) of fish caught by different gear types at the Whitehorse Rapids Dam in 1973.

	Arctic grayling	Burbot	Broad whitefish	Chinook fry	Chinook smolt	Lake trout	Lake whitefish	Least cisco	Longnose sucker	Northern pike	Round whitefish	Slimy sculpin	Sample size
Box trap 1 (lake)							63.8	2.1	24.4			5.3	94
Box trap 2 (lake)							36.4		27.3			19.2	99
Gillnets (lake)	14.5	1.6				1.6	1.6		69.4	4.8	6.5		62
Wolf traps (fishway)	0.8		0.4			2.5	12.3	3.1	30.1	0.4	1.8	13.9	488
Inclined plane 1 (powerhouse)						0.2	5.3	5.8	6.6	0.2	0.8		486
Inclined plane 2 (spillway)							29.2	15.1	0.9				106
Fyke net (turbines)	36.5		1.7				4.3	4.3	10.4	0.9	17.4	5.2	115
Fyke net (downstream fishway)	68.8	6.2							12.5		6.2	6.2	16
													1466

Table 10. The timing of capture of fish species composition expressed as a percentage of total number of fish caught by different gear types at the Whitehorse Rapids Dam in 1973.

Date (1973) Day/Mon-Day/Mon	Arctic grayling	Chinook fry	Chinook smolt	Lake trout	Lake whitefish	Least cisco	Longnose sucker	Round whitefish	Slimy sculpin	Other	Sample size
					BOX TRAPS - SCHWATKA LAKE						
25/4 - 8/5											
9/5 - 22/5											
23/5 - 5/6					16.7	16.7	33.3				6
6/6 - 19/6							51.7		44.8		29
20/6 - 3/7					67.6		9.9		9.0		111
4/7 - 17/7	2.0				42.8	2.0	44.9		2.0		49
					WOLFE TRAPS - FISHWAY						
25/4 - 8/5											
9/5 - 22/5	2.7					5.5	86.3	1.4			73
23/5 - 5/6	2.3					2.3	67.4	2.3	13.9	2.3	43
6/6 - 19/6						6.6	53.3		30.0	6.6	30
20/6 - 3/7					15.8		23.7		30.3	1.3	76
4/7 - 17/7	0.5			0.5	20.9	1.6	4.3	3.2	9.1		186
18/7 - 28/7				13.6	11.1	4.9	19.8	4.9	16.0		81
					FYKE NETS AND INCLINED PLANES - SPILLWAY						
25/4 - 8/5	66.7								16.7	16.7	6
9/5 - 22/5	74.1						5.2	15.5	5.2		58
23/5 - 5/6	10.5				5.3	15.8		31.6	10.5	10.5	19
6/6 - 19/6	0.6				14.3	5.4	6.5	5.4		0.6	168
20/6 - 3/7					4.7	9.1	9.1	0.4		0.4	232
4/7 - 17/7					4.4	7.1	3.8				183
18/7 - 28/7	2.0			2.0	22.4	8.2	2.0				49

(1) Arctic grayling were captured in the Yukon River at its entry to Schwatka Lake in 1973. The species was not distributed throughout the lake proper. There was no indication of downstream movement of Arctic grayling through the fishway.

During a 1960 enumeration of chinook salmon at the Whitehorse Rapids fishway Arctic grayling were also enumerated. Figure 6 depicts the timing of this upstream migration (500 individuals) graphically.

Arctic grayling collected by gillnet and seine in 1957 from the outlet of Marsh Lake (Stn. 1), 11 mi. below Lewes Dam (Stn. 2) and one mile downstream from Whitehorse (Stn. 3) ranged in fork length from 52-390 mm. with a mean of 256 mm. and maximum age of 6 yrs. Four- and five-year-old fish made up most of the sample. Dates, catch areas, and number caught (gillnets) were:

	Station 1	Station 2		Station 3		Sample
Date	June 20	June 1,	June 22	May 26,	June 19	
No.	1	10	16	35	16	78

Most of the adult Arctic grayling sampled at Stn. 2 and 3 on June 1 and May 26 respectively were in spawning condition but none had spawned. When sampled later, June 19 and June 22, all mature grayling had spawned. From the samples, it appeared that 50% of 4th year, 90% of 5th year, and 100% of 6th year fish were mature (spawners). The main food items were the bottom insect larvae. An occasional Arctic grayling egg was present in the stomach contents. Angling on August 24 and 25, 1960 approximately 200 yds. above Robert Campbell Bridge took 11 Arctic grayling ranging from 150-323 mm. long and from 1+ to 3+ yrs. old. Long-time local residents claim that Arctic grayling migrate up and down the Yukon River for feeding and spawning purposes and that there is an accumulation below Lewes Dam following spring breakup, followed by migration into Marsh Lake as water levels decrease.

In 1958, during construction of the Whitehorse Rapids Dam, schools of Arctic grayling passed into a temporary fishway (Plate 84) from July 28-31. A total of 405 were trucked upstream of the dam during this period. In 1959, large numbers of Arctic grayling utilized the fishway from June 26 (when water was introduced) to July 18. No count was kept. Juvenile Arctic grayling temporarily established residence in the fishway during the summer.

(2) The whitefishes collected in the 1973 study are treated collectively without species differentiation because of difficulties experienced in identification of fry and juveniles. Populations of whitefish were found above and below the dam and a downstream movement of whitefish fry occurred in July. Fingerling-sized least cisco were also identified in a downstream migration in July.

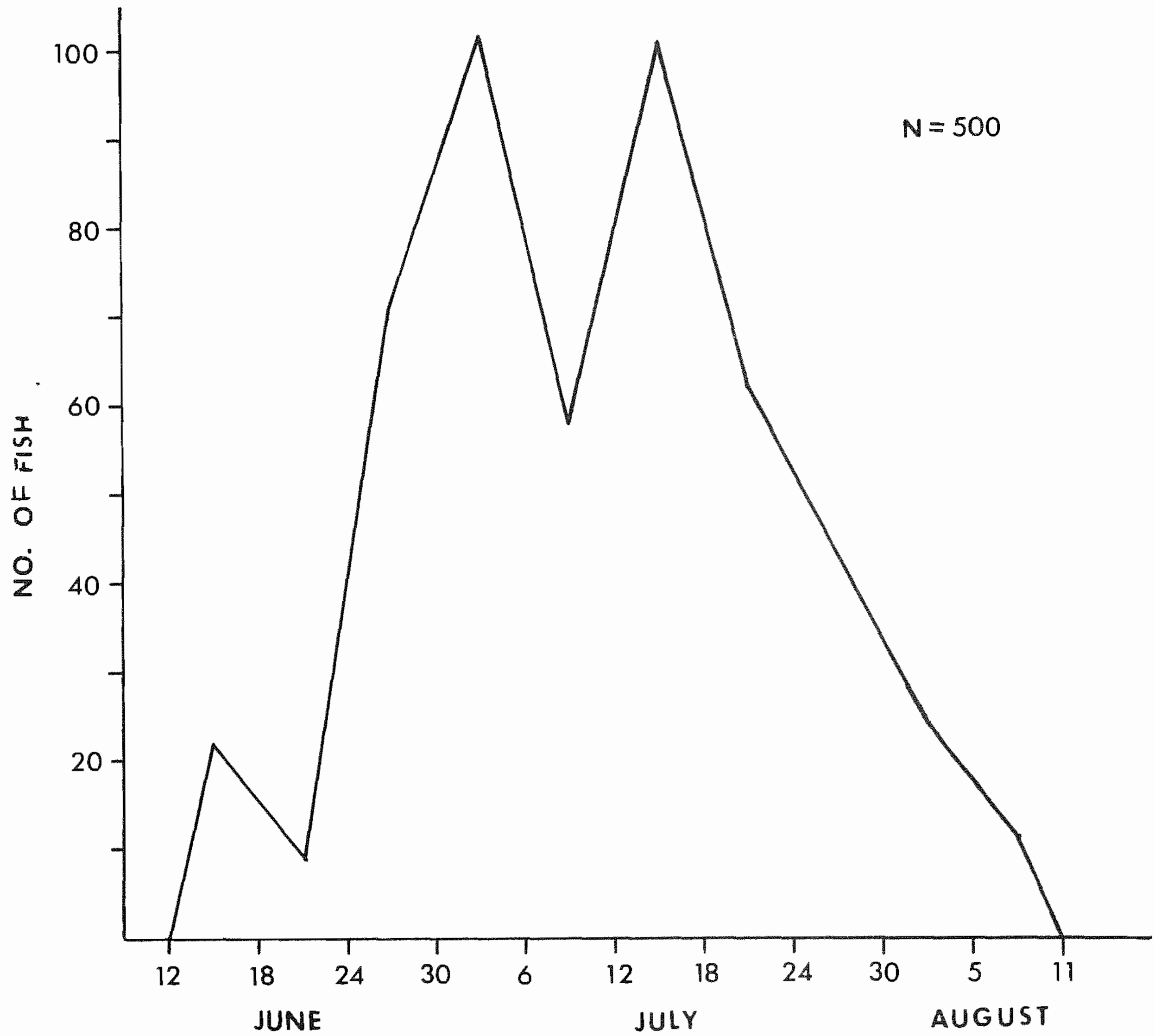


Figure 6. Seasonal upstream migration of Arctic grayling at the Whitehorse Rapids Fishway (1960).

Round whitefish, humpback whitefish and least cisco were sampled at gillnet and seine Stn. 1, 2, and 3 in 1957. Dates, catch area and number caught in gillnets were:

Species	Station 1 May 23	Station 1 June 20	Station 2 June 1	Station 2 June 22	Station 3 May 26	Station 3 June 19	Total
Round whitefish	1	-	-	3	7	2	13
Humpback whitefish	1	-	-	-	-	-	1
Least cisco	2	-	1	-	18	1	22

Round whitefish ranged in fork length from 260-420 mm. with a mean of 306 mm. and ranged in age from 5-8 yrs. with 5-year-old fish comprising 50% of the sample. Least cisco ranged from 88-145 mm. in fork length with a mean of 130 mm. and were mainly 3-year-old fish and 2-year-olds making up the remainder of the sample.

(3) Adult longnose suckers were found only upstream of the dam in the 1973 programme. An upstream migration of 230 suckers was observed from June 18 to August 5, 1960, but only downstream fry movement was apparent in 1973. The upstream migration period extended from June 17 to August 6 with 50% of the run completed by July 10. The peak counts occurred July 12 when 35 passed through the fishway. A few suckers were noted in the fishway until August 20, 1959, but no effort was made to enumerate the number of fish utilizing the fishway.

Test fishing by gillnet in December 1974 and January 1975 upstream of the confluence of the Takhini River with the Yukon River captured 13 longnose suckers (9 male, 4 female) ranging in fork length from 380-440 mm. and ranging in weight from 510-1030 gm. Egg diameter of females was 1-1.5 mm.

(4) Northern pike. One 580 mm. pike captured on June 20, 1973 had eaten a 240 mm. Arctic grayling.

(5) Lake trout. In 1960 (June 25-August 31) 17 lake trout were counted through the fishway.

(6) Burbot. Longline test fishing above the confluence of Takhini River on 31/12/74 captured the following burbot:

Sex	Fork Length (mm)	Weight (lbs)	Age (yrs)	Stomach Contents
F	770	7.6	12	empty
F	790	8.7	7	empty
M	768	7.3	9	longline bait
M	691	5.5	7	longline bait
F	650	3.2	6	empty

(7) Inconnu. In 1957 it was reported that this species was caught at Whitehorse Rapids during late summer. It was surmised that an annual upstream spawning migration occurred at this time, but this theory has not been authenticated.

Exploitation of Fish Stocks

No commercial fishing takes place on the Yukon River proper within the area of this catalogue (except within Lake Laberge). Minor subsistence fisheries are conducted by a few Indians a short distance downstream of Whitehorse and a short distance downstream of the outlet of Lake Laberge. Recreational opportunities are excellent for sport fishing and pleasure boating in the Yukon River section described in this catalogue. The only non-navigable section is at the Whitehorse Rapids Dam. Sport fishing for Arctic grayling produces excellent results, particularly at the mouths of small, clear tributary streams. Sport fishing for chinook salmon is conducted with limited success near Whitehorse in late July and early August.

Tributaries to the Yukon River

(1) Wolf Creek flows 14 mi. from Coal Lake and enters the Yukon River on the left side between Lewes dam and Miles Canyon. It is a low-discharge, pool-riffle stream with moderately high stream velocities. From the Alaska Highway to the confluence with Cowley Creek, Wolf Creek flows at a velocity of approximately 3.4 ft./sec. Many small windfalls congest sections of the stream. The substrate is composed of gravel ranging from pea-size to 6 in. in diameter, with some sand intermixed. The water is essentially silt-free and the substrate is considered good spawning gravel. Discharges were estimated at 150-250 cu. ft./sec. in May and June, 1957, and 16 cu. ft./sec. on 18/08/60. Spot water temperatures were:

$6.8^{\circ}C$ on 20/05/57

$4.5^{\circ}C$ on 21/05/57

$5.0^{\circ}C$ on 26/05/57

$7.9^{\circ}C$ on 30/05/57

Arctic grayling are reported to be abundant in August. The outlet is known as a good Arctic grayling spawning area. Presently a culvert at the Alaska Highway crossing has a vertical outfall which is probably impassable to fish. At one time, a bridge spanned this creek and a small dam was built below the bridge to prevent erosion of the highway (Plate 75). Residents of the area reported that a run of Arctic grayling in May was successful in broaching the small dam.

Chinook salmon at one time spawned in Wolf Creek (see section on chinook salmon).

(2) Coal Lake is two miles long by 0.5 mi. wide. Water temperature was 2.2°C on 10/09/74. Lake trout and Arctic grayling samples were collected by gillnetting on 10/09/74. Data collected are summarized below.

Species	Fork Length (mm) Range	Mean	Sex Composition
Lake trout	320-435	378	5 male, 5 female
Arctic grayling	250-340	304	3 male, 4 female, 2 immature

(3) Ruth Lake is a small narrow lake with an approximate surface area of 45 acres. It has a maximum depth of 18 ft. and drains via a small creek into Wolf Creek. The lake has been stocked with rainbow trout (see section on stocking of Yukon lakes) and studies prior to stocking indicated that the lake was barren of other fish species.

(4) Cowley Lake drains via Cowley Creek for 8 mi. into Wolf Creek a short distance upstream of its confluence with the Yukon River. The lake is 3 mi. long by approximately 0.25 mi. wide. Fish species present in the lake are lake trout, Arctic grayling and unidentified whitefish.

Cowley Creek is similar to Wolf Creek but has a smaller discharge (estimated 4 cu. ft./sec. on 19/08/60). Gradients are moderately steep.

(5) Croucher Creek flows 16 mi. from the east into the Yukon River approximately 4 mi. below Whitehorse. The discharge was estimated at 50 cu. ft./sec. in May, 1957. Close to its confluence with the Yukon River, Croucher Creek is a moderate gradient stream with a gravel bottom.

(6) Frank Creek flows for approximately 50 mi. through a chain of three lakes (an unnamed headwater lake, Coghlan Lake, and Frank Lake) and discharges into the west side of the Yukon River between Lower Laberge and Hootalinqua. Beaver dams are prevalent in the upper regions. The water is silty and the streambed supports aquatic vegetation excepting the lower 4 mi. which consist of a boulder and gravel substrate. The stream is non-navigable.

(7) Frank Lake is the lowermost of the chain of lakes on Frank Creek. The lake is approximately 8 mi. long and 0.5 mi. wide. Water temperature was 7.0°C on 10/09/74. Gillnetting on 10/09/74 captured lake trout, northern pike, and unidentified whitefish.

Species	Range in Fork Length (mm)	Sex Composition	Sample Size
Lake trout	460-510	2 female, 1 immature	3
Northern pike		1 sex unidentified, released	1
Whitefish	363-424	3 male	3

(8) Coghlan Lake lies approximately 6 mi. upstream on Frank Creek from Frank Lake. The lake is approximately 5 mi. long with a width of 0.5 mi. Water temperature was 5.3°C on 10/09/74. Fish species reported present are lake trout, northern pike, Arctic grayling, humpback whitefish, and burbot. Fish samples taken by gillnetting on 10/09/74 were:

Species	Range in Fork Length (mm)	Sex Composition	Sample Size
Humpback whitefish	500	female	1
Northern pike	360-424	2 male, 1 female	3(6)*

where, (6)* refers to 6 pike released.

Excellent sport fishing results for lake trout have been reported from this lake.

(9) The drainage from Jackson Lake (also known as Louise Lake) has been changed. Originally the lake drained into the Yukon River through Jackson Creek, Ibex River and Takhini River. The lake level was raised in 1949 for hydroelectric purposes and the water was diverted into McIntyre Creek. Fish species reported present in Jackson Lake are lake trout, Arctic grayling, round whitefish, slimy sculpin and rainbow trout (see section on stocking of trout in Yukon lakes). Reports indicate that sport fishing for rainbow trout is good near the lake outlet. Road access exists.

(10) McIntyre Creek is a pool-riffle stream with good gravel areas in the lower section.

(11) Fish Lake is 7 mi. long by 0.75 mi. wide. The lake drainage was similarly altered by the hydroelectric project in 1949. The lake now drains into the Yukon River through McIntyre Creek. Water temperature was 1.1°C on 31/10/74. Fish species reported present are lake trout, Arctic grayling, northern pike and whitefish. Large lake trout have been taken by sport fishing. The lake has road access and boat launching facilities.

Table 11. Water chemistry measurements for tributaries to Yukon River.

Tributary	Date	Water colour	Alka- linity (gpg)	Hard- ness (gpg)	CO_2 (mgpl)	Acidity (gpg)	pH	Dissolved oxygen (ppm)
Yukon River	31/10/74	Clear, green tinge	4	3	5	.33	8.0	12
Coal Lake	10/09/74	Clear, brown tinge	5	5	5	.33	8.5	9
Frank Lake	10/09/74	Clear	10	13	5	.33		9
Coghlan Lake	10/09/74	Clear	1	13	5	.33		10.0
Fish Lake	31/10/74	Clear, green tinge	5	5	5	.33	7.5	11.5

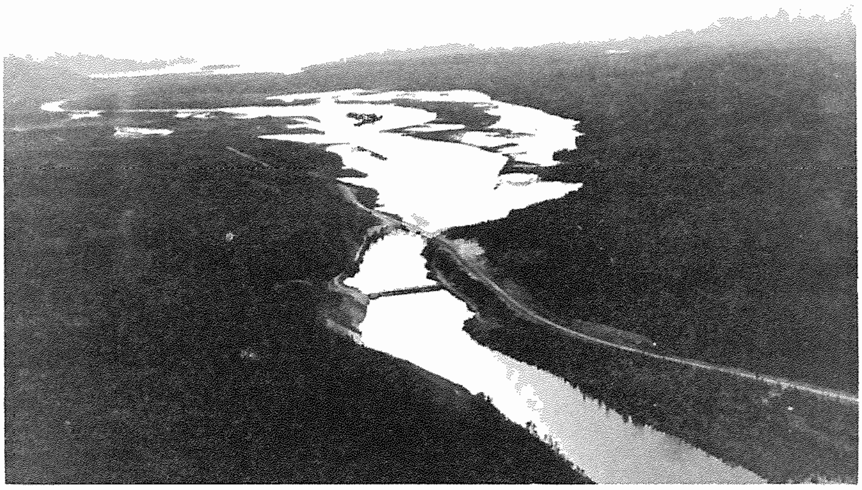


Plate 66. Yukon River, outlet of Marsh Lake, Lewes Dam and highway crossing (August, 1974).

Plate 67. Yukon River looking north from a hill near Marsh Lake.

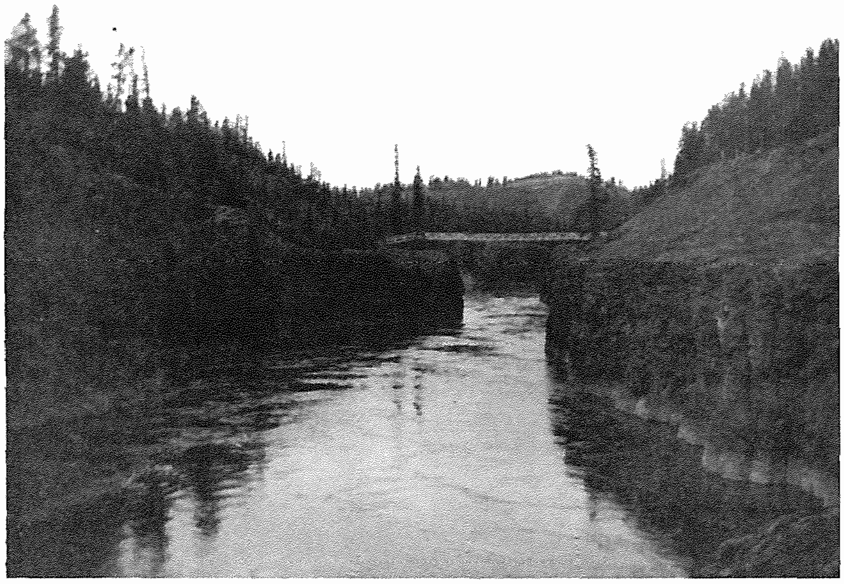


Plate 68. Miles Canyon.

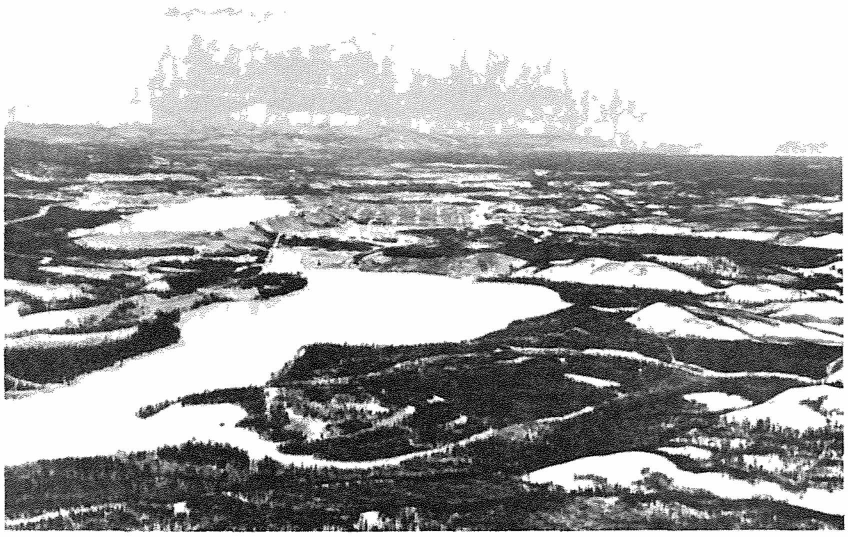


Plate 69. Schwatka Lake (created by damming the Yukon River).

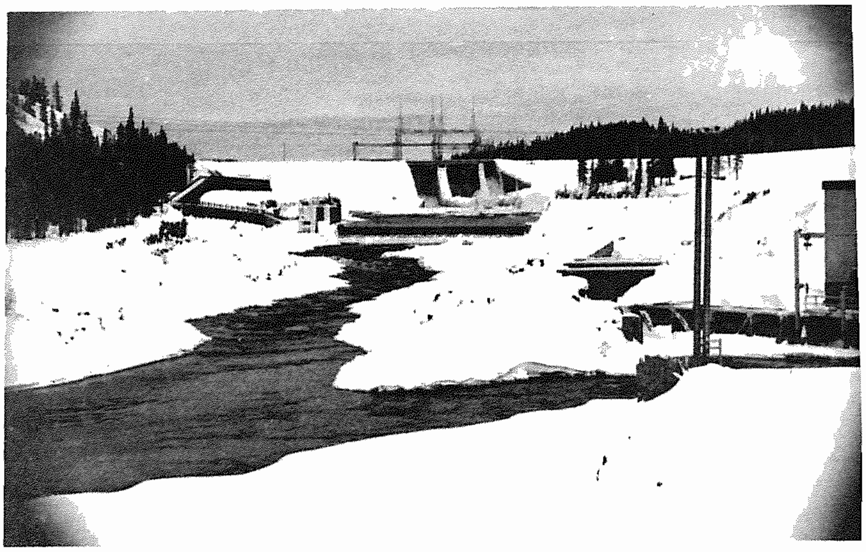


Plate 70. Yukon River downstream of the Whitehorse Rapids Dam (February, 1960).

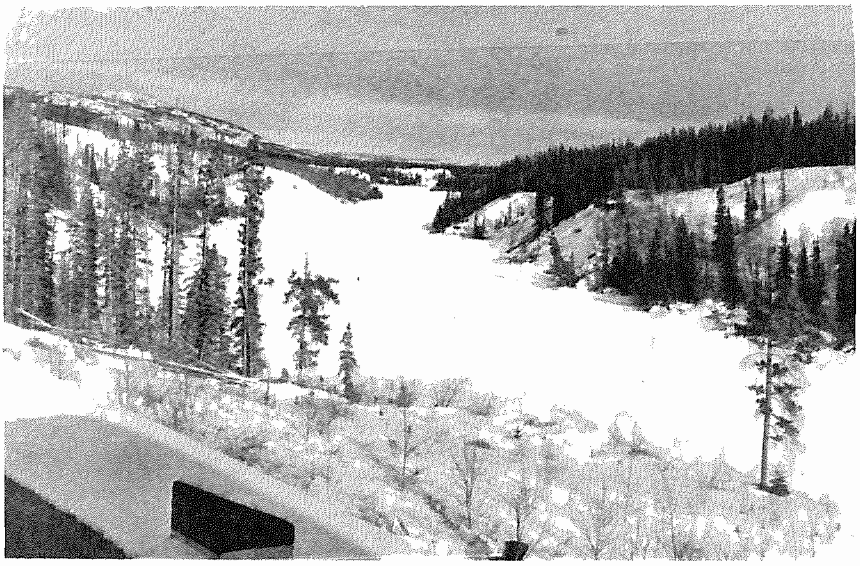


Plate 71. Yukon River looking downstream from the Takhini River outlet (February, 1960).

MAN-MADE BARRIERS TO FISH MIGRATION IN THE UPPER YUKON RIVER DRAINAGE

(1) The Lewes Dam (Figure 7) was originally constructed in 1899, approximately 7 mi. downstream of the outlet of Marsh Lake on the Yukon River, which was until recently known as the Lewes River. The original purpose of the structure was to provide water storage for a "flush" to assist boat travel downriver and to assist in removal of the ice from Lake Laberge. The original structure was replaced in 1923 by a low-level timber structure with a storage capacity of approximately 6 vertical ft. Both of these dams may have been a barrier to fish migration at some times, but the effect on fish survival is unknown. In 1951, technical staff of the Department of Fisheries recommended that a fishway be installed in the new Lewes Dam. The chain of events regarding installation of the new structure follows (Whitmore, 1957). Construction of the new dam was begun in 1952, however, the old structure washed out in 1953 and a new dam was completed in 1954 with a storage potential of 11 ft. In order to facilitate the construction schedule for the dam, and in view of the many unknown factors related to the design of a suitable fishway, the Department of Fisheries accepted a Public Works suggestion that a temporary fishway be installed first and observations of the hydraulic conditions be evaluated. This would mean a delay for the permanent fishway well into 1955. In 1954, however, the Department of Fisheries was advised of the Frobisher proposal to develop hydroelectric power from the Yukon River. Inasmuch as this project appeared imminent, and since the Lewes River Dam would be submerged in the reservoir of the power development, fishway planning was withheld until such time as the overall development plan was outlined in detail. In 1957, the Frobisher plan had been postponed for an indefinite period and negotiations for adequate fish facilities at the Whitehorse Rapids power development, a few miles downstream of the Lewes Dam, had commenced. It was during this time that the matter of a permanent fishway in the Lewes River Dam was reconsidered. At a later date, a boat lock on the right bank of the new Lewes Dam and a vertical slot fishway were incorporated into the structure.

(2) There are several smaller dams on tributary streams within the upper Yukon River drainage which have been constructed for hydroelectric and water storage purposes. These dams are located:

		Page
(a)	at the outlet of Fish Lake	137
(b)	at the outlet of Jackson Lake	137
(c)	on Crag or Nares Creek	102
(d)	at the outlet of Surprise Lake	10
(e)	on Wolf Creek	94
(f)	McIntyre Creek	96

Figure 16 shows the location of dams at Fish Lake and Jackson Lake, and the page numbers refer to a description of specific dams. Plate 77 shows a dam on Crag Creek.

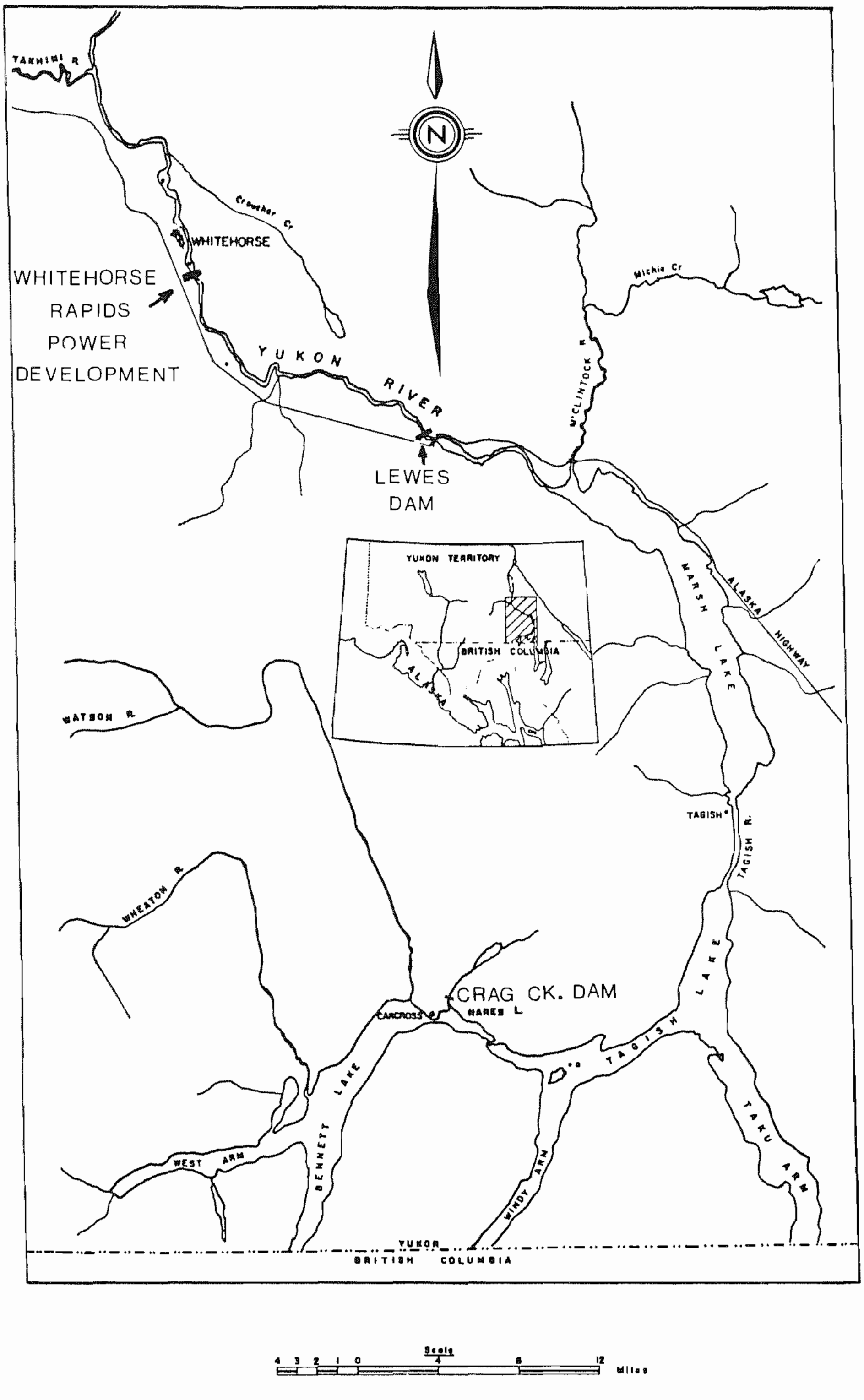


Figure 7. Dams on the Upper Yukon River (also refer to Figure 16, page 137).

The areas of streams at lake outlets are biologically critical to fish habitat because of their importance as feeding areas and spawning migration routes. The construction of dams in lake outlet areas without the incorporation in the structure of adequate fish passage facilities inevitably results in damage to fishery stocks in the pertinent stream and lake. The extent of the damage to the fish resource in waterbodies described above cannot now be measured, but the construction of similar dams in the future should ensure that the fish resources are maintained.

(3) The Whitehorse Rapids Dam (Figure 7).
(Before reference to Figure 7 and Plate 84.)

"In the spring of 1957, the Northern Canada Power Commission initiated construction of a power development on the Yukon River at Whitehorse Rapids, approximately two miles south of Whitehorse, Yukon Territory. This development, which was designed to supply hydro-electric power to the Whitehorse area, required that a dam be constructed across the river."

"The Yukon River in the vicinity of Whitehorse supports valuable stocks of lake trout, grayling and least cisco. It further serves as the migration route for a population of spring salmon which spawns in the upper watershed area, primarily in the M'Clintock River system, tributary to Marsh Lake (Figure 7)."

"Initial studies of the possible fisheries problems posed by the power development indicated that unless suitable fish facilities were provided to permit free access upstream the important populations of spring salmon and resident species would be seriously affected. Following a series of meetings attended by representatives of the Department of Fisheries and the Northern Canada Power Commission, agreement was reached to provide permanent fish facilities at the dam."

"The facilities were designed to pass upstream migrants around the obstruction, but their installation was necessarily deferred pending completion of the power dam. By 1958, construction of the dam had progressed to the point where the structure constituted a complete obstruction to all upstream migration and temporary facilities were installed for operation during the summer of that year (Plate 84)."

"The permanent fish facilities came into service on June 26, 1959, and during the succeeding months an assessment programme was conducted to determine their efficiency."

Information concerning the Whitehorse Rapids Dam has been extracted fully or in part from Gordon et al. (1960).

Description of the Whitehorse Rapids Power Development

Local conditions at the Whitehorse Rapids power site are such that the most economic damsite is situated upstream from the rapids proper, but if the powerhouse were constructed integrally with, or adjacent to the dam, as is customary at most mainstem developments, the 15-foot fall between the damsite and the base of the Rapids, representing nearly 25 percent of the contemplated gross head on the plant, would not be harnessed by the proposed development. This undesirable feature of the site was overcome by locating the powerhouse near the base of the rapids and conducting water to it from the forebay of the dam, approximately 2000 feet upstream, by means of a canal.

Thus, while the project is essentially of the main-stem type, it presents as well, certain of the characteristics of a diversionary scheme.

Construction of the Whitehorse Rapids power development, the salient features of which are described below, was initiated in the spring of 1957 and the plant came into service in November, 1958 (Figure 8 , and Plate 82).

(a) Spillway Dam

The spillway dam is situated approximately 1200 feet upstream from the head of Whitehorse Rapids on the Yukon River, two miles south of the city of Whitehorse. It consists of an impervious-core earth-fill non-overflow section with an integral concrete spillway consisting of two 40-foot wide undershot spillway gates and a 10-foot wide regulating gate on the crest of an ogee overflow section. A concrete apron and training walls extend from the toe of the ogee nearly 200 feet downstream where the apron terminates in a flip bucket which directs the spillway discharge into the atmosphere and away from the structure in order to forestall any future problems arising from erosion of the river bed in the immediate vicinity of the dam.

The spillway dam raises the normal river level at the site by approximately 47 feet, and the impoundment so created (Schwatka Lake) extends upstream for nearly 20 miles to the Lewes Dam at the outlet of Marsh Lake.

(b) Powerhouse

The Whitehorse Rapids powerhouse is situated at the toe of the Rapids on the left bank nearly 2000 feet downstream from the spillway dam. It housed two 7500-hp propeller-type turbines, each of which draws 1250 c.f.s. at full load under a normal head of 62 feet in 1958. The third turbine came on line in 1966 and the Fisheries Service received a water use application relative to the installation of the fourth turbine on July 25, 1974. At the time of publication of this catalogue the last turbine had not been installed.

(c) Power Canal

Two impervious-core earth fills, which are approximately parallel at a distance of about 100 feet, form a trapezoidal-shaped canal on the west bank extending downstream from the forebay of the spillway dam to within 200 feet of the powerhouse, where they are terminated in a concrete intake structure by means of which they are interconnected. Plant flows are conducted from the forebay to the intake via the power canal, and since there is no significant head loss in the canal, it is, in effect, simply a downstream extension of the spillway dam impoundment.

Flows in excess of plant demands are passed through the spillway gates to the river below, and since the natural river runoff is normally greater than the plant capacity, spill is expected to occur continuously; however, this may not necessarily be true if the fourth turbine is installed.

Description of the Whitehorse Rapids Fish Facilities

Studies to develop an efficient economic method for passing fish around the power project were inaugurated in December, 1956. At that time a preliminary assessment of the fisheries problems associated with the proposed development indicated that upstream migrants would be delayed at the powerhouse, where a standard-type collection system and fishway would serve effectively, but what appeared to be insurmountable problems were expected at the spillway dam. In this connection, model studies of the spillway disclosed that the flow pattern at the toe could be expected to vary considerably with varying discharge, and that erosion of the river bed would be such that the tailwater levels and flow patterns would alter unpredictably with the passage of time. There was no assurance therefore that any known type of fish-passing device could be adapted economically to operate effectively under these adverse conditions.

An investigation of several possible alternatives indicated that the most promising method would involve the construction of a fish barrier across the river some distance downstream from the spillway dam, where upstream migrants could be more easily attracted into the facilities. Subsequent detailed studies confirmed this and the design of suitable fish facilities proceeded accordingly. These facilities, as constructed, are described briefly hereunder

(a) Powerhouse Fish Facilities (Upstream)

A collection chamber (gallery) in the form of an eight-foot wide timber flume, resting on the draft tube deck, extends the entire length of the downstream face of the powerhouse, and is linked with the tailrace by three six-foot wide slidegate-controlled submerged orifices spaced uniformly along its length.

Water is supplied to the collection chamber by means of a trapezoidal-shaped rock-cut (transportation channel) which interconnects with the river near the head of the rapids, several hundred feet upstream from the tailrace (Plate 86). The channel has a minimum width of six feet and the gradient of its floor is such that it provides at least a four-foot depth of flow at all stages.

Velocities in the transportation channel and collection chamber are regulated automatically by a reinforced-concrete control structure consisting of three modified vertical slot type baffles, which provide for average velocities of 1.5-2.5 feet per second throughout the normal range of discharges. Velocity and discharge can be regulated manually as well by manipulation of the slidegates which control the discharge from the entrance ports of the collection chamber.

The facilities are so designed that the water level of the collection chamber is maintained at approximately six inches above that of the tailrace, so attraction velocities are normally in the order of 5-6 feet per second. Maximum head loss through each baffle of the control structure is restricted by design to one foot.

In operation, fish which are attracted into the tailrace locate the entrance ports, enter the collection chamber, and ascend the transportation channel back to the river where they rejoin those that had proceeded up the river directly. All migrants are therefore expected to ascend freely to the head of the rapids so it was necessary to provide only a single set of facilities to convey them from there to the forebay.

(b) Spillway Dam Fish Facilities (Upstream)

A reinforced concrete barrier dam with a crest length of 155 feet spans the Yukon River approximately 100 feet upstream from the head of the Rapids (Gordon et al., 1960, Plate 89). It creates a minimum water surface drop of 10 feet, and this, in combination with the hydraulic characteristics of the overfall, forms a total obstruction to migrating fish. Furthermore, the alignment of the barrier dam is angled upstream from the west bank to the east so that fish will lead naturally to the fishway entrance which is located in the east abutment of the barrier dam.

The fishway entrance pool is simply a 10-foot by 13-foot recess in the downstream face of the abutment, and upstream migrants gain entry by means of either a 12-inch by 18-inch submerged port or over a six-foot wide manually-operated telescopic weir which is submerged at all stages (Plate 90).

A weir-type fishway, six feet wide, six feet deep, approximately 1200 feet long, and having a vertical rise of 55 feet, conducts migrants from the entrance pool to the forebay of the spillway dam (Figure 8). Its lowermost leg, which is subject to submergence at high river discharges, is constructed of reinforced concrete, as is the culvert section which passes through the spillway dam, but the remainder is of creosoted timber. The fishway has a level centre section nearly 700 feet long and two end sections totalling more than 500 feet in length, each of which has been constructed on a 1:10 floor slope. These sloping sections are fitted with four-foot high weirs spaced at 10-foot intervals, and each has a 12-inch by 18-inch submerged orifice which is located at the bottom corner. These orifices are staggered from side to side at adjacent weirs.

Water is drawn into the fishway from the forebay of the spillway dam and regulation is effected by manipulation of stoplogs at the fishway exit. The structure is designed to operate with flow depths of from eight to eleven inches over the weirs, so total discharge, including that of the submerged ports, is normally in the order of 25 c.f.s. While this flow is considered to be adequate for transportation within the fishway there was some doubt that it would be sufficient to attract fish into the entrance pool without undue delay. An auxiliary water supply system was therefore provided at the fishway entrance (Figure 8). It consists of a six-foot square slidegate-controlled sluiceway through the east abutment of the barrier dam between the fishway entrance and the overfall. Flows are drawn directly from the pond behind the barrier dam, and the works are so designed that this auxiliary flow can be employed either as a direct jet to attract fish into the vicinity of the fishway entrance, or it can be discharged directly into the entrance pool to augment the flow passing over the telescopic weir. The motor-operated control gate is capable of supplying in excess of 600 cfs at all river stages, but its full capacity will probably not be required in practice.

(c) Downstream Fish Facilities

No provision has been made for the downstream passage of fish. Following ice melt, three exists are available to fish for downstream egress from Schwatka Lake:

The power canal is no doubt the exit route taken by the vast majority of fish. It has been the only route generally available to the fish except when water is released through the spillway, usually commencing mid-June, and when the fishway is operated to pass adult chinooks upstream, from mid-July to end of August; also, the canal flow is of high volume (3750 cfs at capacity) and from the surface of Schwatka Lake. The fish utilizing the power canal must pass through the turbines where mortality occurs.

Egress by the spillway requires the fish to sound approximately 40 feet to move under the main gates and 15 feet for the regulatory gate. It is known that chinook yearlings will sound to a depth of 65 feet for egress under certain conditions. Under spillway passage, fish may be endangered by any of the following conditions: rapid pressure changes, rapid deceleration caused by striking a baffle wall or by the shearing effects created by water under varying velocities, turbulence, or the striking force of the fish on the water in free-fall. Another factor is the abrasion of fish on the concrete floor.

The fishway appears to offer the safest downstream passage to fish, but it has been operated on a very limited basis. Additionally, the facility has practically no attraction flow and therefore, in all likelihood, has not been used to any significant degree by fish moving downstream.

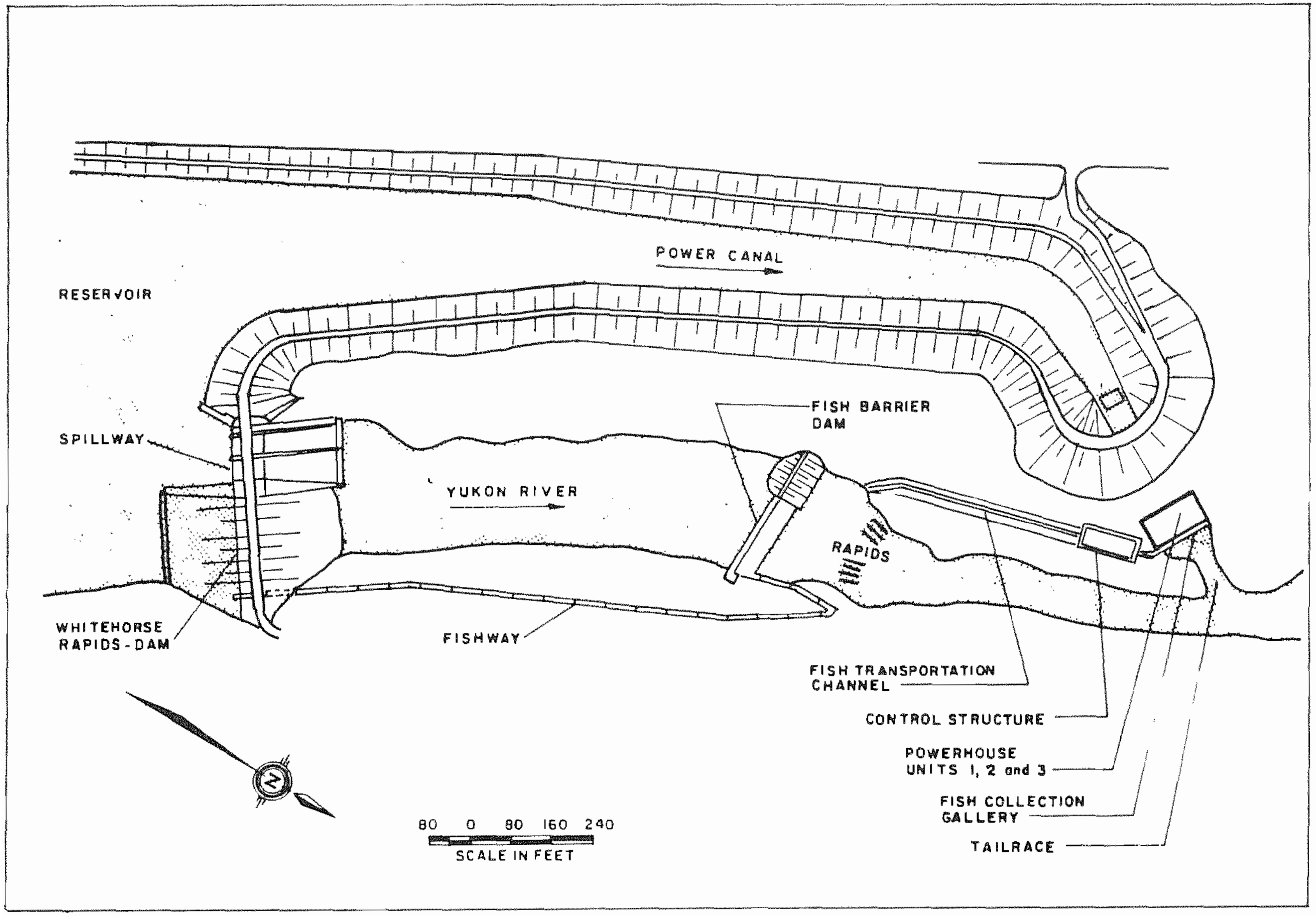


Figure 8. Fish facilities at the Whitehorse Rapids Dam.

Plate 72. Lewes Dam (newer structure constructed in 1954).

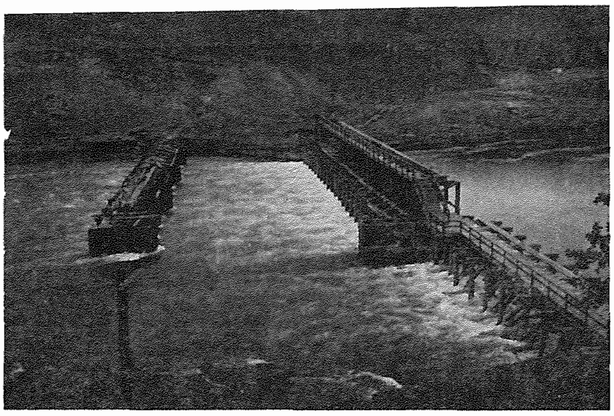


Plate 73. Lewes Dam viewed from top of left bank on the highway.

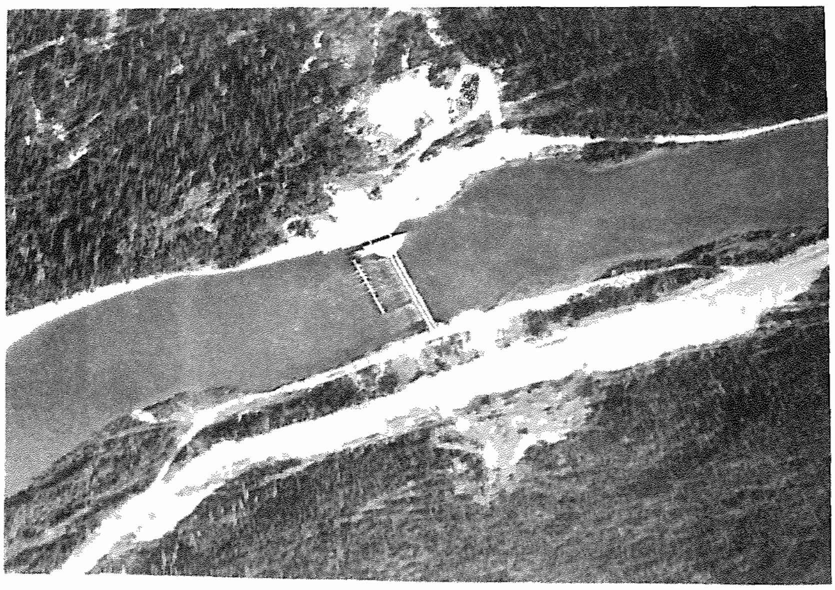


Plate 74. Aerial view of Lewes Dam.

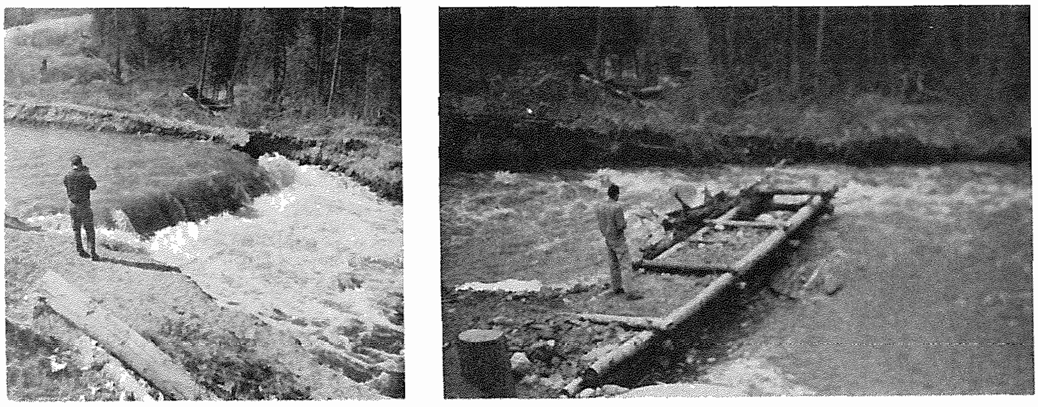


Plate 75. Wolfe Creek Dam (May 20 and 21, 1957).

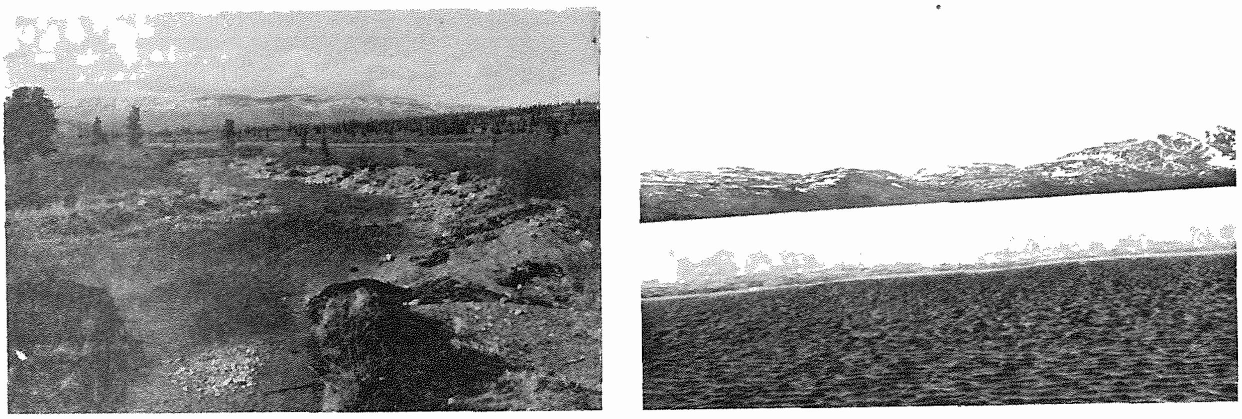


Plate 76. Looking first downstream then upstream from the Fish Lake Dam, June 1955.

Plate 77. Crag Creek Dam.

Plate 78. McIntyre Creek control structure.

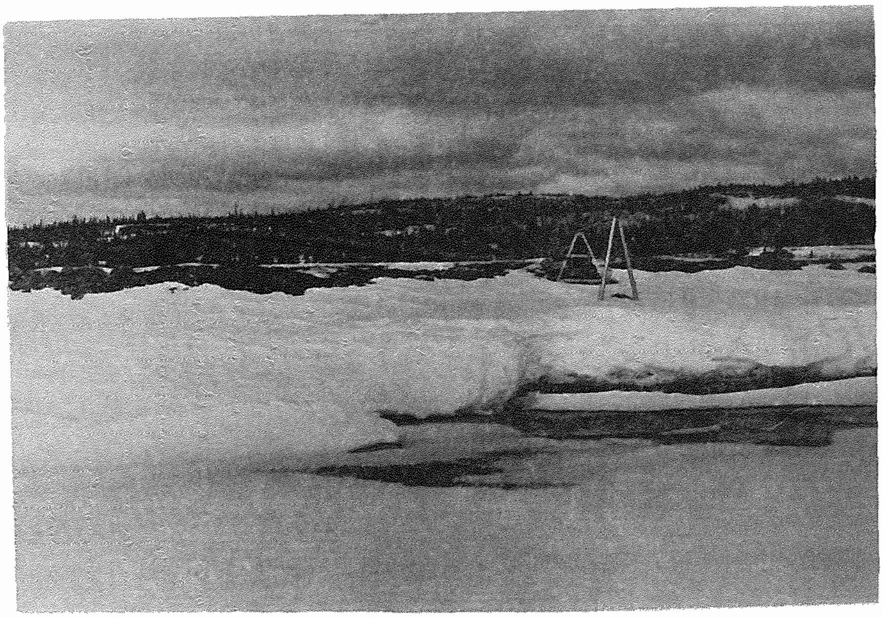


Plate 79. Fish Creek control structure.

Plate 80. Jackson Lake control structure (south).

Plate 81. Jackson Lake control structure (north).

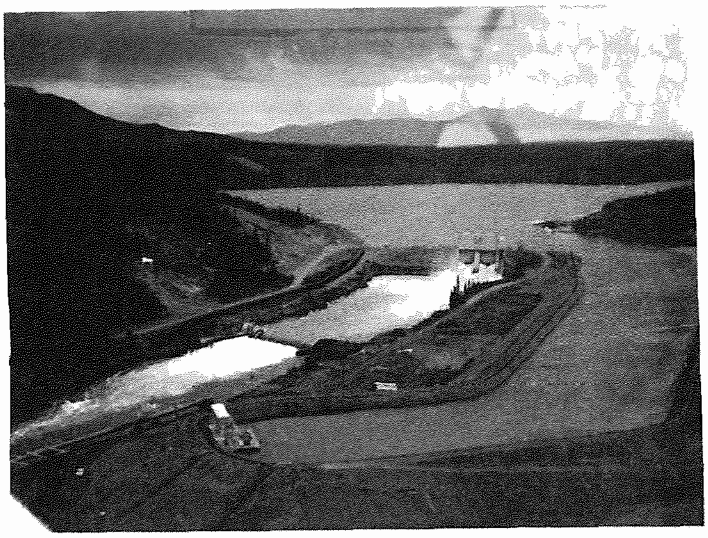


Plate 82. Whitehorse Rapids Power Development.

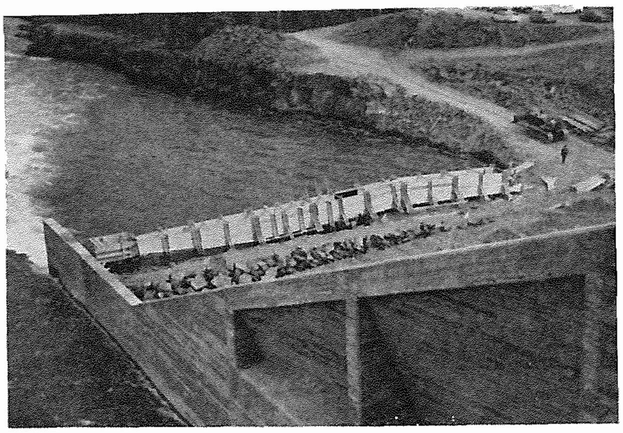


Plate 83. Temporary fishway nearing completion as viewed from bridge over sluiceway (1958).

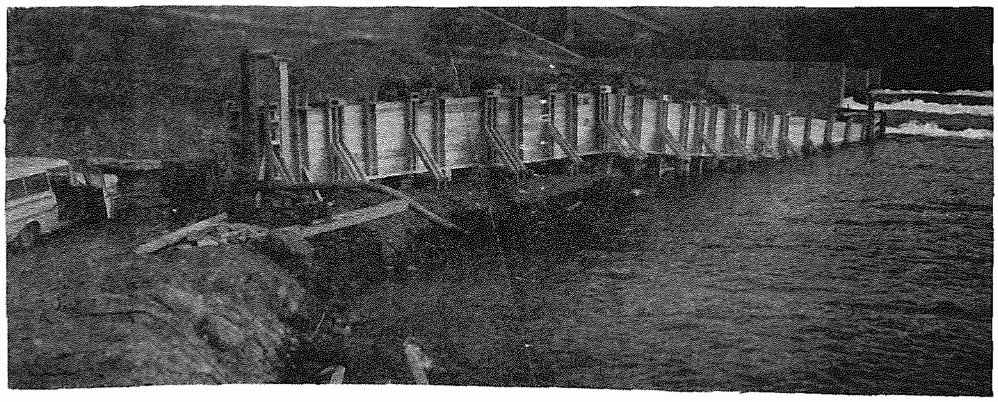


Plate 84. Temporary fishway completed. Pump (upper left) was used to prevent shrinkage prior to installation of 10 cfs pump. Stilling, brail, and holding pools are located at the head of the structure.

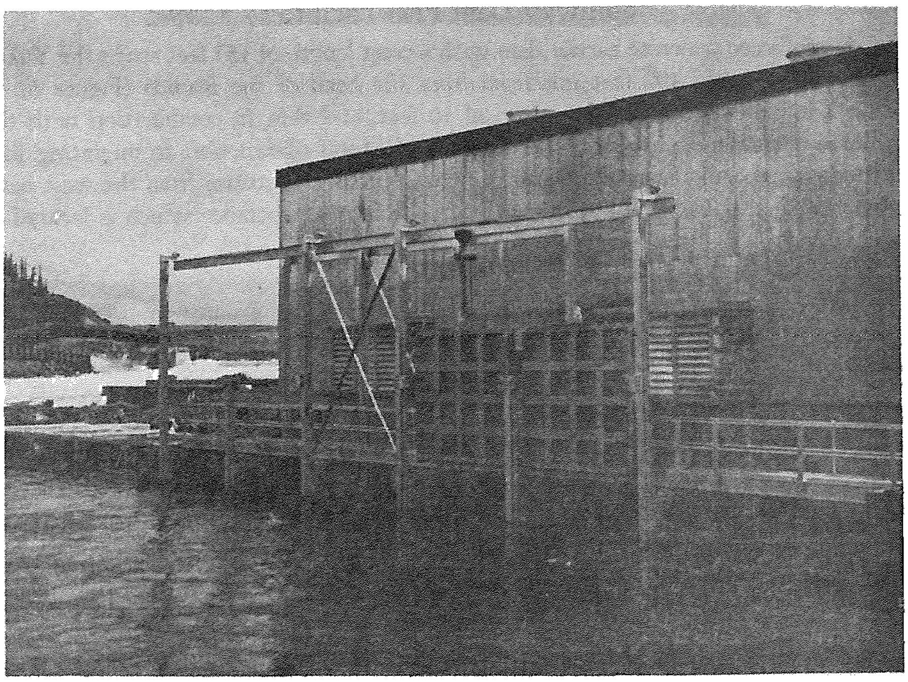


Plate 85. Powerhouse and tailrace (from Gordon <u>et al</u>, 1960).

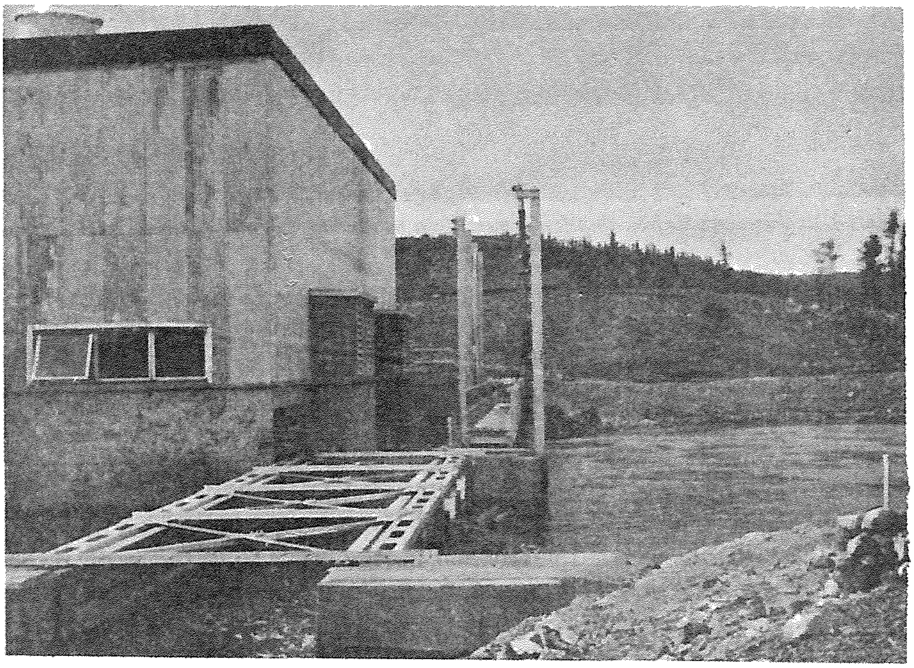


Plate 86. Lower end of transportation channel showing aqueduct leading to powerhouse collection system and tailrace (from Gordon <u>et al</u>, 1960).

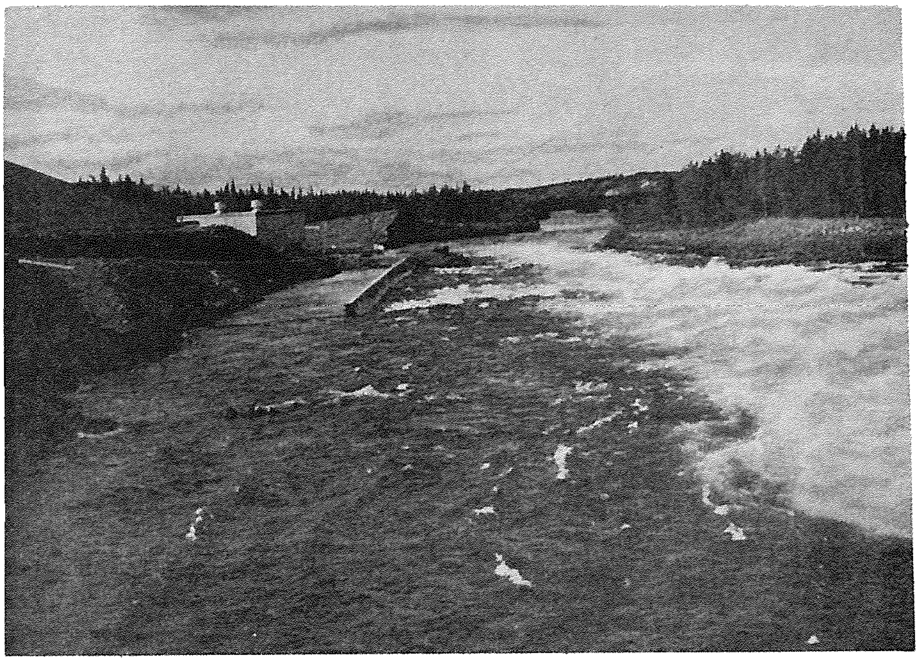


Plate 87. Downstream view from the abutment of the barrier dam showing Whitehorse Rapids and the upper leg of the transportation channel (from Gordon et al, 1960).

Plate 88. Downstream view of the transportation channel at low water levels (1973).

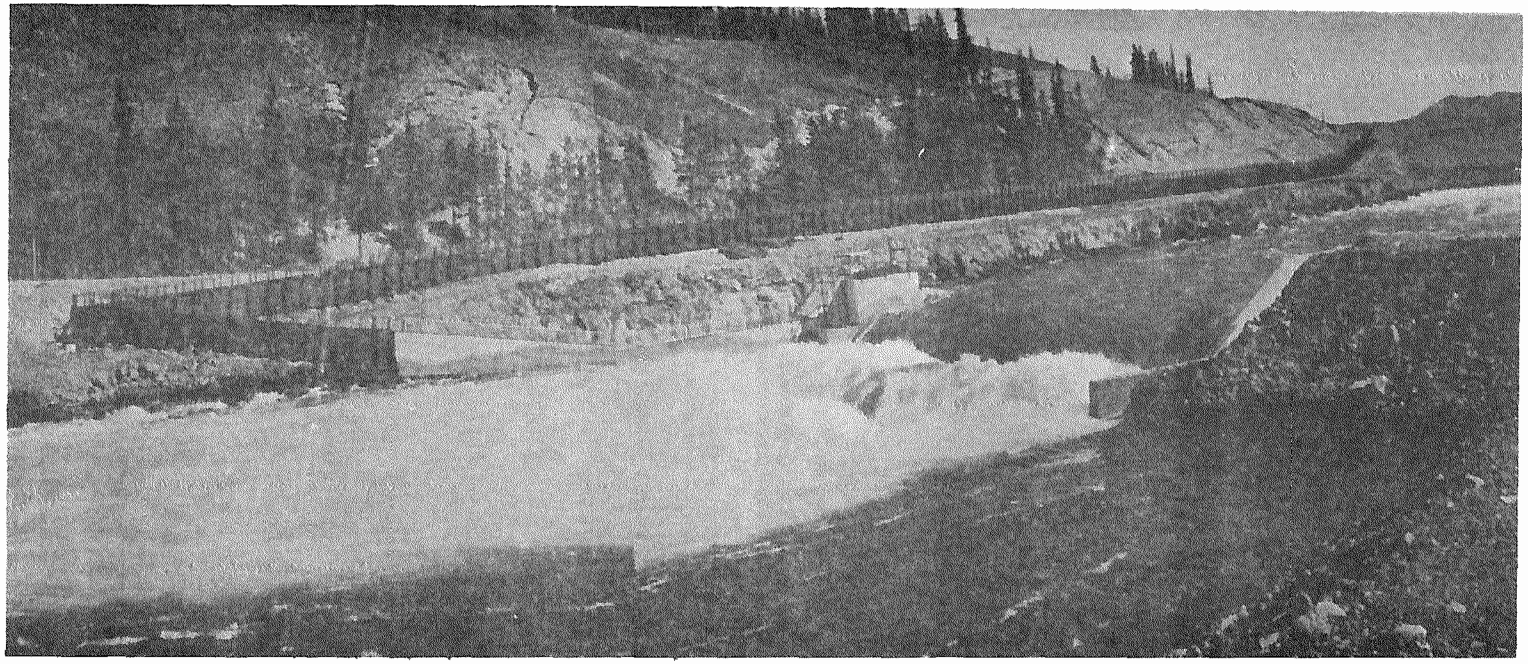


Plate 89. Barrier dam and fishway (from Gordon et al, 1960).

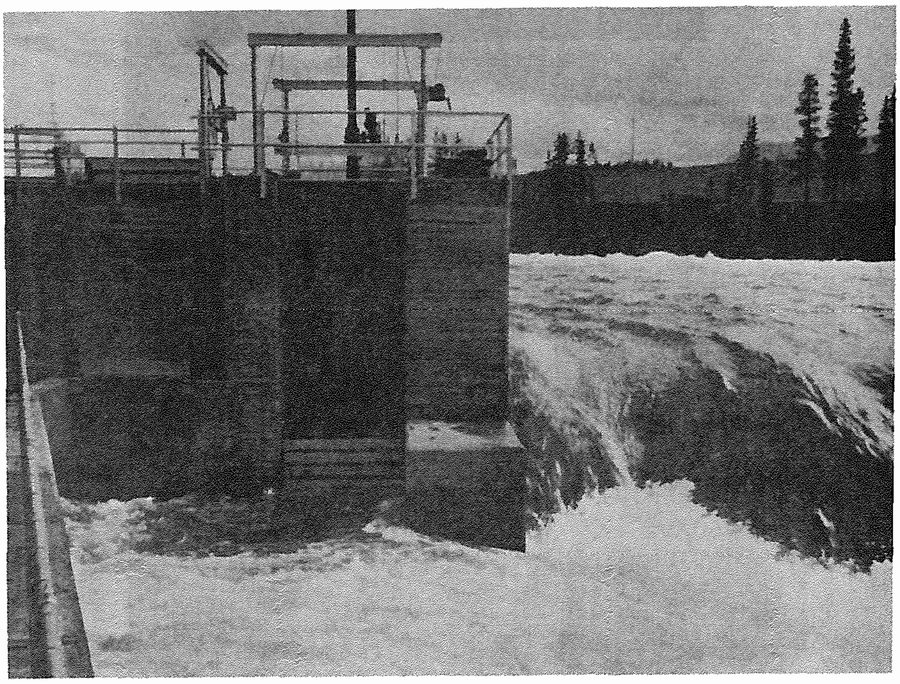


Plate 90. Fishway entrance as seen from fishway showing telescopic weir entrance at left and stoplogged auxiliary water supply sluiceway at right.

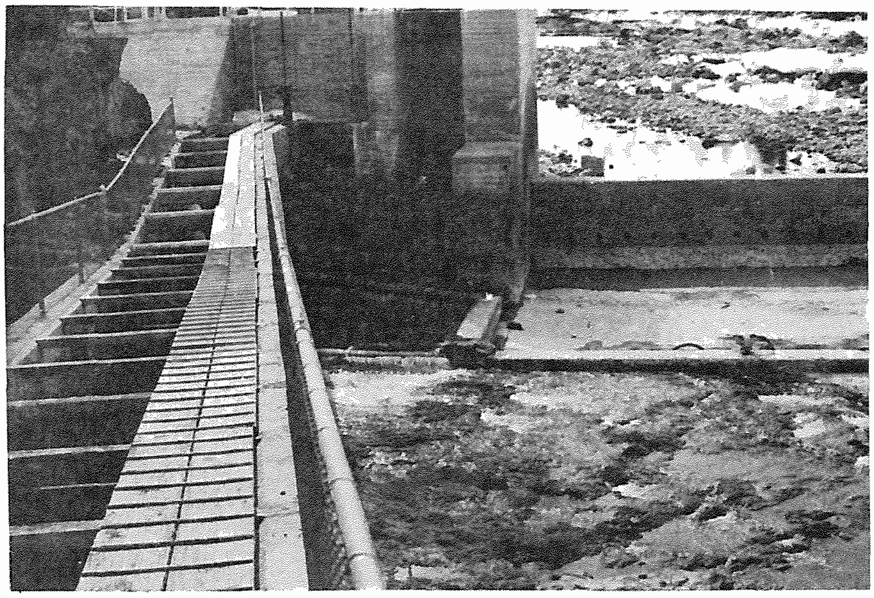


Plate 91. Entrance to the fishway at low water (note barrier dam to right).

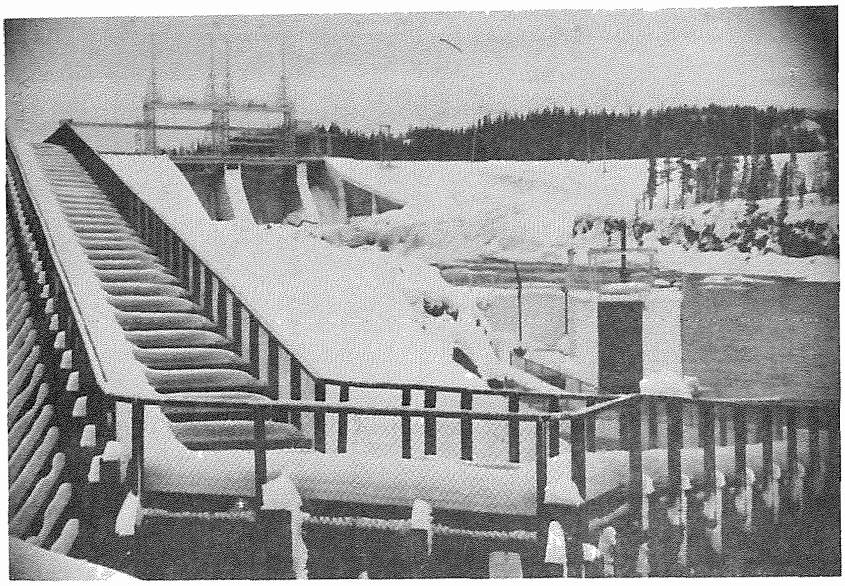


Plate 92. Lower section of fishway above entrance (Spring, 1973).

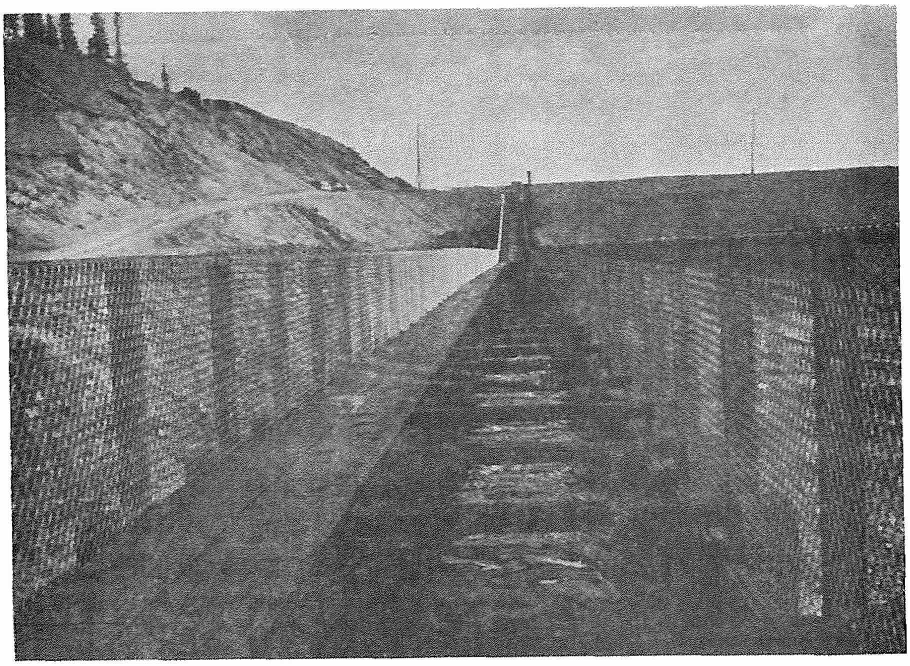


Plate 93. Level center section of fishway with counting trap and culvert through dam in distance (from Gordon _et al_, 1960).

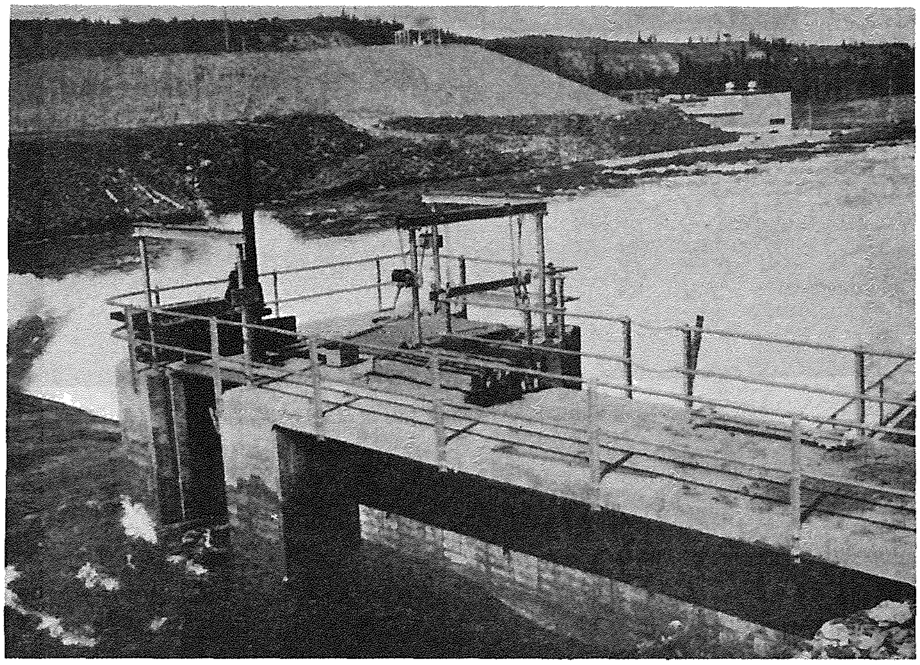


Plate 94. Upstream face of barrier dam east abutment showing auxiliary water supply intake (from Gordon et al, 1960).

Plate 95. The impoundment (Schwatka Lake) created by the Whitehorse Rapids Dam.

SALMON STOCKS IN THE UPPER YUKON RIVER DRAINAGE

Adult chinook salmon migrate up the Yukon River from the Bering Sea in Alaska to spawning grounds in the upper Yukon River drainage, arriving at tributary spawning streams within the area of this catalogue in late July or August. Recent historical evidence suggests that chum salmon utilized spawning grounds within the upper Yukon River drainage in this century, however the presence of chum salmon in the study area has never been confirmed by Fisheries Service personnel. Coho salmon are not native to the Yukon River in that section covered by this catalogue, but coho have been stocked in some small lakes near Whitehorse and Atlin attempts to provide an additional species to the sport fishing resource.[1] Chinook and chum salmon contribute to an important commercial and domestic-use fishery conducted in the Yukon River in Alaska and part of the Yukon Territory. Commercial fishing for salmon is not permitted within the upper Yukon River drainage. Alaskan and Canadian commercial and subsistence catch data respectively for chinook and chum salmon from 1963 to 1975 are shown in Tables 12 and 13 (from Brock, 1976).

Chinook salmon spawn in late August (and sometimes into early September) in tributary streams of the Yukon River within the area of this catalogue. Figure 9 shows the location of documented and indicated spawning grounds for chinook salmon. Juvenile chinook salmon remain up to two years in fresh waters close to the spawning grounds and then undertake a downstream migration to the sea. Evidence shows clearly that the total annual chinook salmon population in the upper Yukon River drainage is declining progressively.

There are no natural barriers to the passage of salmon on that section of the Yukon River discussed in this catalogue. Two man-made structures have imposed potential barriers to salmon migration on the upper Yukon River. These are the Lewes Dam (7 mi. below the outlet of Marsh Lake) and the Whitehorse Rapids power development (approximately 1 mi. upstream from the town of Whitehorse). Fishways have been incorporated into both structures to facilitate the upstream passage of adult chinook salmon. Facilities to protect the downstream migration of fry and juvenile chinook salmon from injury or mortality have not been installed (see appropriate section of this catalogue for a description of the two dams).

Effects of the Whitehorse Rapids Dam on Chinook Salmon Stocks

Construction of the Whitehorse Rapids hydroelectric development began in 1958 and early in that year it became apparent that the permanent fish collection and passage facilities could not be completed in time for the 1958 upstream migration of chinook salmon. By mid-August an estimated 1,000 chinook salmon had accumulated immediately downstream of the dam site and further upstream migration was impossible. A salvage netting programme was conducted and 224 chinook salmon were captured and transported by tank truck above the dam site. Those fish not transported either died unspawned or attempted to spawn on the rocks near the dam site where their eggs could not survive. The barrier

1 The lakes utilized for planting coho juveniles have no outlet, and hence, the fish are isolated from the main Yukon River drainage.

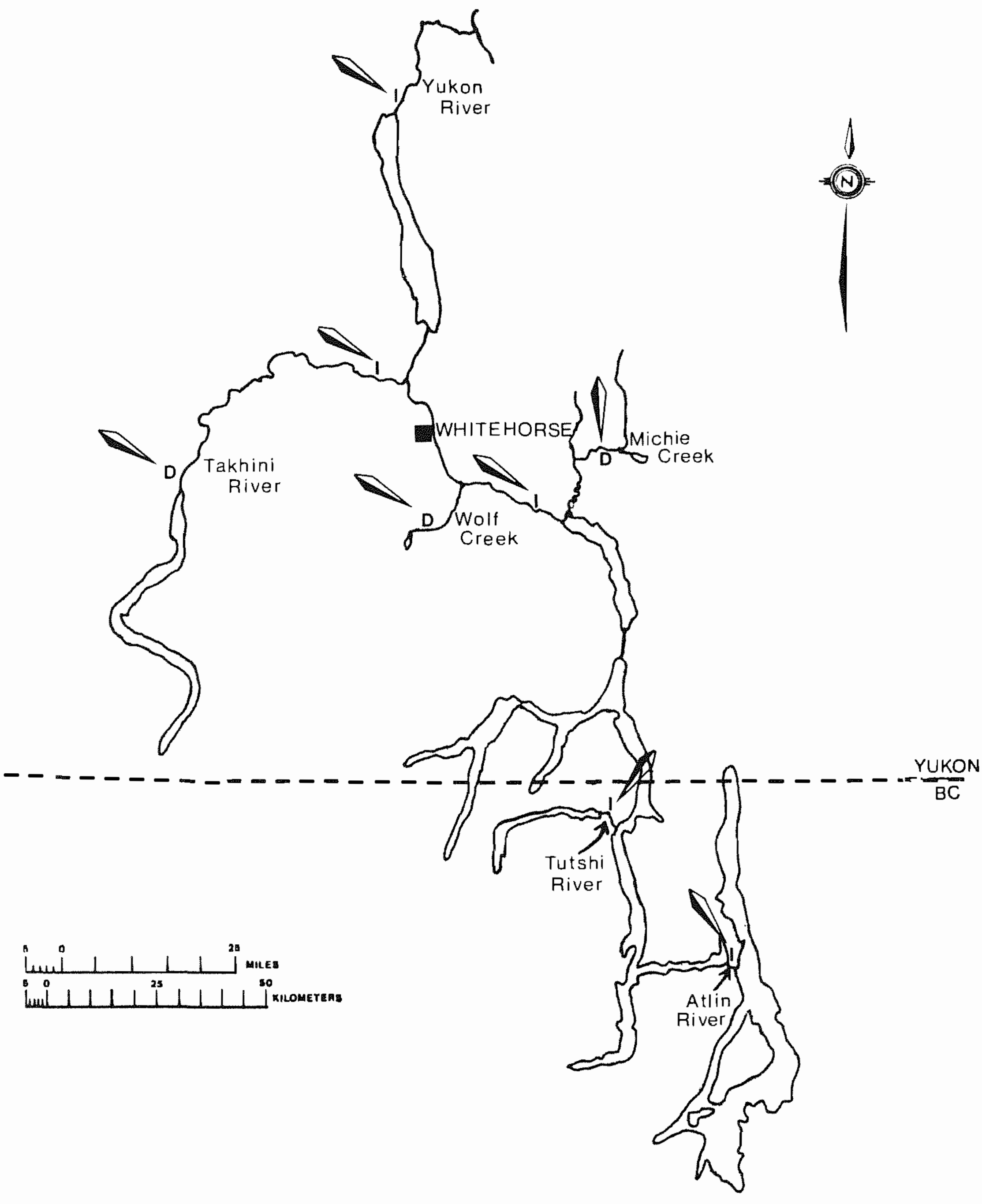


FIGURE 9 CHINOOK SALMON SPAWNING GROUNDS IN THE UPPER YUKON RIVER DRAINAGE

D – DOCUMENTED
I – INDICATED

Table 12. Alaskan and Canadian commercial salmon catch data from 1963 - 1974 (from Brock,1976).

	Alaska				Yukon Territory			Total			
Year	King	Coho	Chum	Total	King	Chum	Total	King	Coho	Chum	Total
1963	117,048	5,575		122,632	2,283	2,192	4,475	119,331	5,575	2,192	127,098
1964	93,587	2,430	8,347	104,364	3,208	1,929	5,137	96,331	2,430	10,276	109,501
1965	118,014	661	23,211	141,886	2,265	2,071	4,336	120,279	661	25,282	146,222
1966	93,254	19,254	71,058	183,627	1,942	3,157	5,099	95,257	19,254	74,215	188,726
1967	129,430	11,047	49,412	189,889	2,187	3,343	5,530	131,617	11,047	52,755	195,419
1968	106,526	13,303	67,375	187,204	2,212	435	2,647	108,738	13,303	67,810	189,851
1969	90,720	15,076	192,582	298,378	1,640	2,279	3,919	92,360	15,076	194,861	302,297
1970	79,301	13,188	347,348	439,837	2,611	2,479	5,090	81,912	13,188	349,827	444,927
1971	110,507	12,203	289,685	412,395	3,178	1,761	4,939	113,685	12,203	291,446	417,334
1972	92,840	22,233	287,844	402,917	1,769	2,532	4,301	94,609	22,233	290,376	407,218
1973	75,353	36,641	517,434	629,928	1,871	2,228	4,099	77,224	36,641	519,662	634,027
1974	96,902	16,825	877,368	991,095	2,214	3,010	5,224	99,116	16,825	880,378	996,319

Table 13. Alaskan and Canadian subsistence salmon catch data 1963 - 1974 (from Brock,1976).

	Alaska			Yukon Territory			Total		
Year	King	Other Salmon	Total	King	Other Salmon	Total	King	Other Salmon	Total
1963	24,862	396,075	420,937	8,108	25,500	33,608	32,970	421,575	454,545
1964	16,171	481,449	497,620				16,171	481,449	497,620
1965	16,608	448,861	465,469	3,000	9,800	12,800	19,608	485,661	478,269
1966	11,572	213,186	224,758	2,700	8,600	11,300	14,272	221,786	236,058
1967	16,448	274,977	291,425	3,000	13,600	16,600	19,448	288,577	308,025
1968	12,106	181,024	193,130	2,900	11,100	14,000	15,006	192,124	207,130
1969	14,000	210,772	224,772	1,000	5,500	6,500	15,000	216,272	231,272
1970	14,310	225,528	239,838	2,100	1,200	3,300	16,410	226,728	243,138
1971	22,451	201,772	223,984	2,800	14,000	16,800	25,251	215,533	240,784
1972	17,931	133,102	151,033	1,657	8,000	9,657	19,588	141,102	160,690
1973	20,099	179,241	199,340	2,116	6,938	9,054	22,215	186,179	208,394
1974	17,186	282,466	299,652	3,379	8,636	12,015	20,565	291,102	311,667

dam and fishway as it now exists were completed in 1959 and have functioned well to the present time, but losses suffered by the 1958 spawning population have probably contributed toward depletion of the stock.

Since the facilities were completed, the chinook salmon stocks have declined steadily. Table 14 lists counts of chinook salmon through the fishway from 1959 to 1975, and the enumeration and timing of upstream migration is represented graphically in Figures 10 and 11. Table 15 shows total counts of chinook salmon by year and percentage of total present by date at the fishway. Figure 12 shows the declining trend of chinook salmon counts at the Whitehorse Rapids Dam fishway (1958-1975). The effects of the 1958 losses are reflected in the 1963, 1964 and 1965 returns. (Most fish are six years old with smaller numbers of five and seven-year-olds.) There are two other possible causes for the decline which can be related to the present development at Whitehorse Rapids. Some losses may have resulted from reservoir flooding of chinook salmon spawning grounds immediately upstream of the dam. The second possible cause for the decline relates to effects of the power turbines at the dam on downstream migrant juvenile chinook salmon. The turbine mortality problem was investigated in 1960 and 1973. The 1960 study (undertaken in response to an application to increase the generating capacity of the facility) showed fry mortalities of approximately 2 percent. Fry mortalities in the range of 2 to 5% were not considered serious enough to warrant installation of downstream screening facilities; however, the 1973 programme indicated mortalities to chinook salmon smolts (1- or 2-year-old juveniles) of up to 16%. The seriousness of smolt mortality becomes more apparent when it is considered that 15 to 50 fry are required to produce 1 smolt under natural conditions. Losses of chinook salmon smolts suffered in downstream migration through the Whitehorse Rapids power turbines likely contribute substantially to the decline of chinook salmon stocks in the upper Yukon River drainage.

It is emphasized that the indicated mortality of 16% to smolts represents an immediate mortality, usually through decapitation. There is no measurement of delayed mortality arising from injury. Also, it is unknown what mortality may be from predation on dazed and disorientated fish following passage through the hydro facility.

Results of Biological Sampling of Chinook Salmon at the Whitehorse Rapids Dam

Adults

The following table shows the length frequency of a sample of adult chinook salmon at the Whitehorse fishway in 1972 and 1973.

(See page 130)

Table 14. Counts of chinook salmon through the Whitehorse Rapids fishway from 1959 to 1975.

	1959		1960		1961		1962	
Date	Daily	Cum.	Daily	Cum.	Daily	Cum.	Daily	Cum.
July 27								
28								
29	2	2	1	1				
30	5	7	0	1				
31	9	16	0	1				
Aug. 1	26	42	0	1	2	2		
2	35	77	0	1	16	18		
3	52	129	0	1	32	50		
4	45	174	3	4	36	86		
5	81	255	5	9	58	144		
6	102	357	9	18	63	207	Started 6th.	
7	62	419	8	26	47	254	No count	
8	61	480	22	48	41	295	made.	
9	94	574	28	76	50	345		
10	44	618	32	108	44	389		
11	63	681	50	158	106	495		
12	40	721	57	215	44	539		
13	84	805	84	299	84	623		
14	64	869	83	382	30	653		
15	31	900	43	425	41	694		
16	49	949	50	475	58	752		
17	30	979	48	523	44	796		
18	23	1002	16	539	52	848		
19	24	1026	19	558	42	890		
20	3	1029	33	591	49	939		
21	7	1036	13	604	9	948		
22	3	1039	4	608	16	964		
23	6	1045	17	625	22	986		
24	0	1045	3	628	3	989		
25	2	1047	6	634	12	1001		
26	0	1047	8	642	6	1007		
27	0	1047	10	652	3	1010		
28	3	1050	4	656	40	1050		
29	0	1050	0	656	3	1053		
30	0	1050	2	658	4	1057		
31	3	1053	0	658	2	1059		
Sept. 1	0	1053	0	658	1	1060		
2	0	1053	0	658	1	1061		
3	0	1053	0	658	1	1062		
4	1	1054	0	658	2	1064		
5	0	1054	0	658	2	1066		
6			2	660	2	1068		
7			0	660	0	1068		
8								
9								
TOTAL		1054		660		1068		1500 (est.)

Table 14. (Continued)

Date	1963 Daily	1963 Cum.	1964	1965 Daily	1965 Cum.	1966 Daily	1966 Cum.	1967 Daily	1967 Cum.
July 25								1	1
26								0	1
27								0	1
28								7	8
29								5	13
30								8	21
31						2	2	6	27
Aug. 1				5	5	2	4	11	38
2				4	9	6	10	15	53
3				7	16	14	24	14	67
4				14	30	16	40	20	87
5				19	49	14	54	19	106
6	10	10		9	58	20	74	15	121
7	8	18		35	93	23	97	15	136
8	34	52		31	124	23	120	36	172
9	24	76		26	150	19	139	24	196
10	10	86		47	197	49	188	37	233
11	32	118		85	282	26	214	30	263
12	38	156		100	382	34	248	43	306
13	15	171		128	510	56	304	38	344
14	64	235	NO COUNTS MADE	32	542	53	357	53	397
15	18	253		41	583	31	388	20	417
16	38	291		47	630	39	427	12	429
17	24	315		40	670	51	478	25	454
18	29	344		18	688	22	500	24	478
19	25	369		50	738	18	518	16	494
20	32	401		47	785	14	532	12	506
21	21	422		32	817	4	536	10	516
22	26	448		26	843	12	548	4	520
23	19	467		21	864	6	554	6	526
24	8	475		19	883	3	557	4	530
25	6	481		10	893	3	560	2	532
26	2	483		5	898	2	562	0	532
27				4	902	0	562	1	533
28				1	903	0	562		
29						1	563		
30									
31									
Sept. 1									
2									
3									
4									
5									
6									
TOTAL		483			903		563		533

Table 14. (Continued)

Date	1968 Daily	1968 Cum.	1969 Daily	1969 Cum.	1970 Daily	1970 Cum.	1971 Daily	1971 Cum.
July 25			5	5				
26							1	1
27								
28								
29								
30								
31	1	1						
Aug. 1	3	4						
2	1	5	3	8	1	1		
3	6	11	8	16	3	4		
4	7	18	12	28	1	5		
5	25	43	15	43	1	6		
6	27	70	56	99	6	12		
7	37	107	19	118	6	18	3	4
8	52	159	31	149	6	24	2	6
9	21	180	32	181	23	47	2	8
10	0	180	6	187	30	77	3	11
11	1	181	23	210	31	108	17	28
12	6	187	29	239	28	136	9	37
13	25	212	21	260	66	202	24	61
14	34	246	13	273	82	284	27	88
15	28	274	24	297	29	313	40	128
16	23	297	19	316	33	346	68	196
17	49	346	6	322	69	415	92	288
18	20	366	2	324	21	436	71	359
19	4	370	0	324	75	511	89	448
20	6	376	0	324	49	560	46	494
21	7	383	4	328	16	576	41	535
22	13	396	0	328	19	595	73	608
23	3	399	0	328	15	610	36	644
24	13	412	0	328	7	617	40	684
25	0	412	3	331	5	622	44	728
26	0	412	3	334	2	624	35	763
27	0	412			1	625	25	788
28	0	412					24	812
29	0	412					23	835
30	1	413					6	841
31	0	413					1	842
Sept. 1	0	413					7	849
2	0	413					6	855
3	1	414					1	856
4								
5								
6								
TOTAL		414		334		625		856

Table 14. (Continued)

Date	1972 Daily	1972 Cum.	1973 Daily	1973 Cum.	1974 Daily	1974 Cum.	1975 Daily	1975 Cum.
July 25								
26					1	1		
27					5	6		
28					1	7		
29					2	9		
30					4	13		
31					2	15		
Aug. 1					3	18		
2			1	1	13	31		
3			1	2	5	36		
4	1	1	1	3	7	43		
5	2	3	0	3	14	57		
6	6	9	5	8	13	70		
7	11	20	12	20	9	79		
8	4	24	4	24	15	94		
9	7	31	5	29	9	103	15	15
10	2	33	12	41	12	115	11	26
11	13	46	9	50	8	123	21	47
12	14	60	6	56	26	149	8	55
13	44	104	8	64	40	189	11	66
14	34	138	20	84	10	199	12	78
15	45	183	13	97	12	211	22	100
16	49	232	13	110	20	231	22	122
17	36	268	10	120	12	243	16	138
18	24	292	10	130	15	258	31	169
19	7	299	20	150	2	260	15	184
20	16	315	17	167	5	265	13	197
21	31	346	20	187	2	267	17	214
22	7	353	16	203	3	270	25	239
23	14	367	8	211	0	270	15	254
24	13	380	3	214	1	271	26	280
25	4	384	6	220	0	271	18	298
26	0	384	0	220	2	273	9	307
27	2	386	4	224			4	311
28	5	391	0	224			0	311
29							2	313
30							0	313
31								
Sept. 1								
2								
3								
4								
5								
6								
TOTAL		391		224		273		313

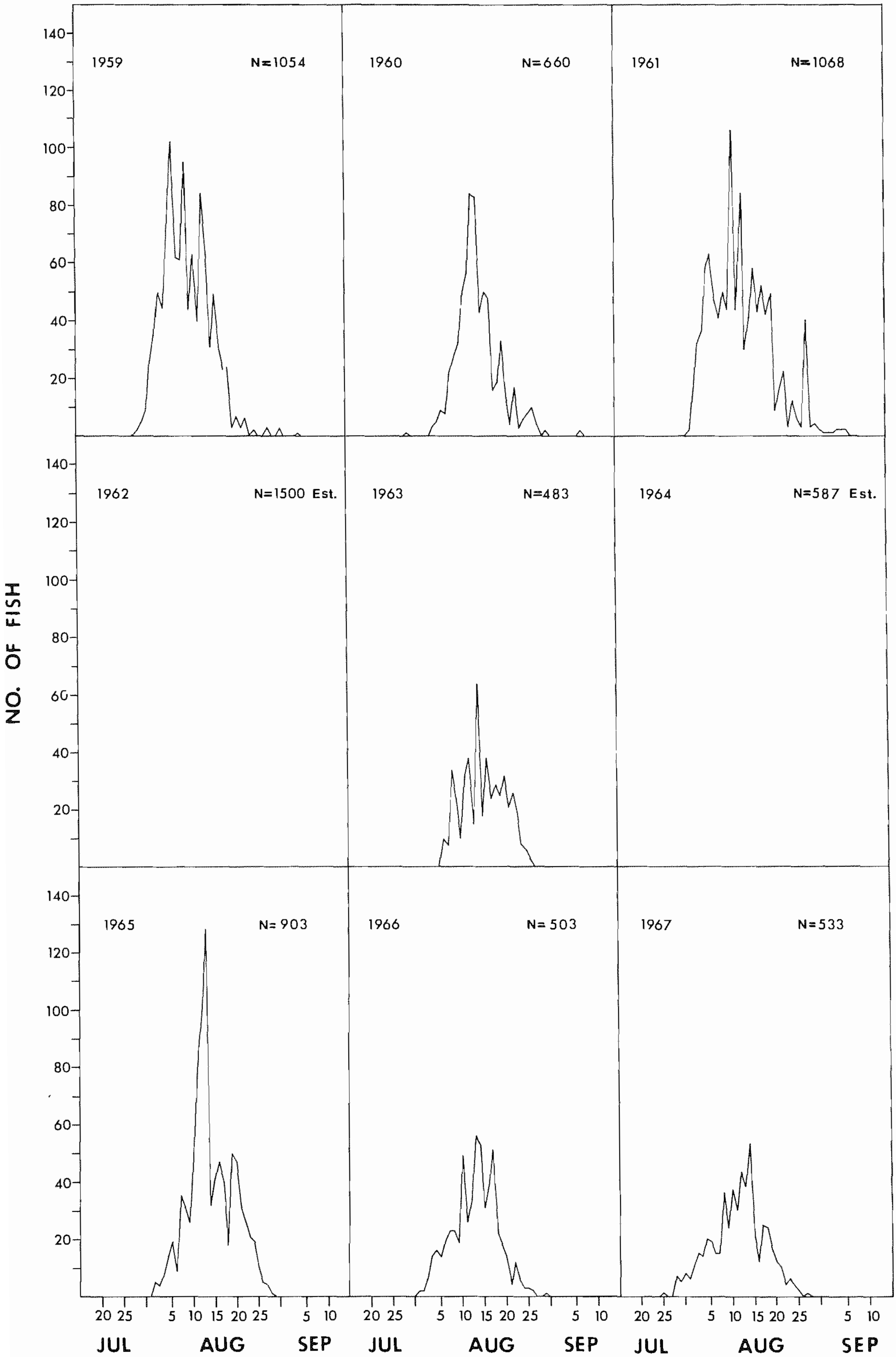


Figure 10. Enumeration and timing of upstream migration of chinook salmon at Whitehorse Rapids Dam (1959-1967).

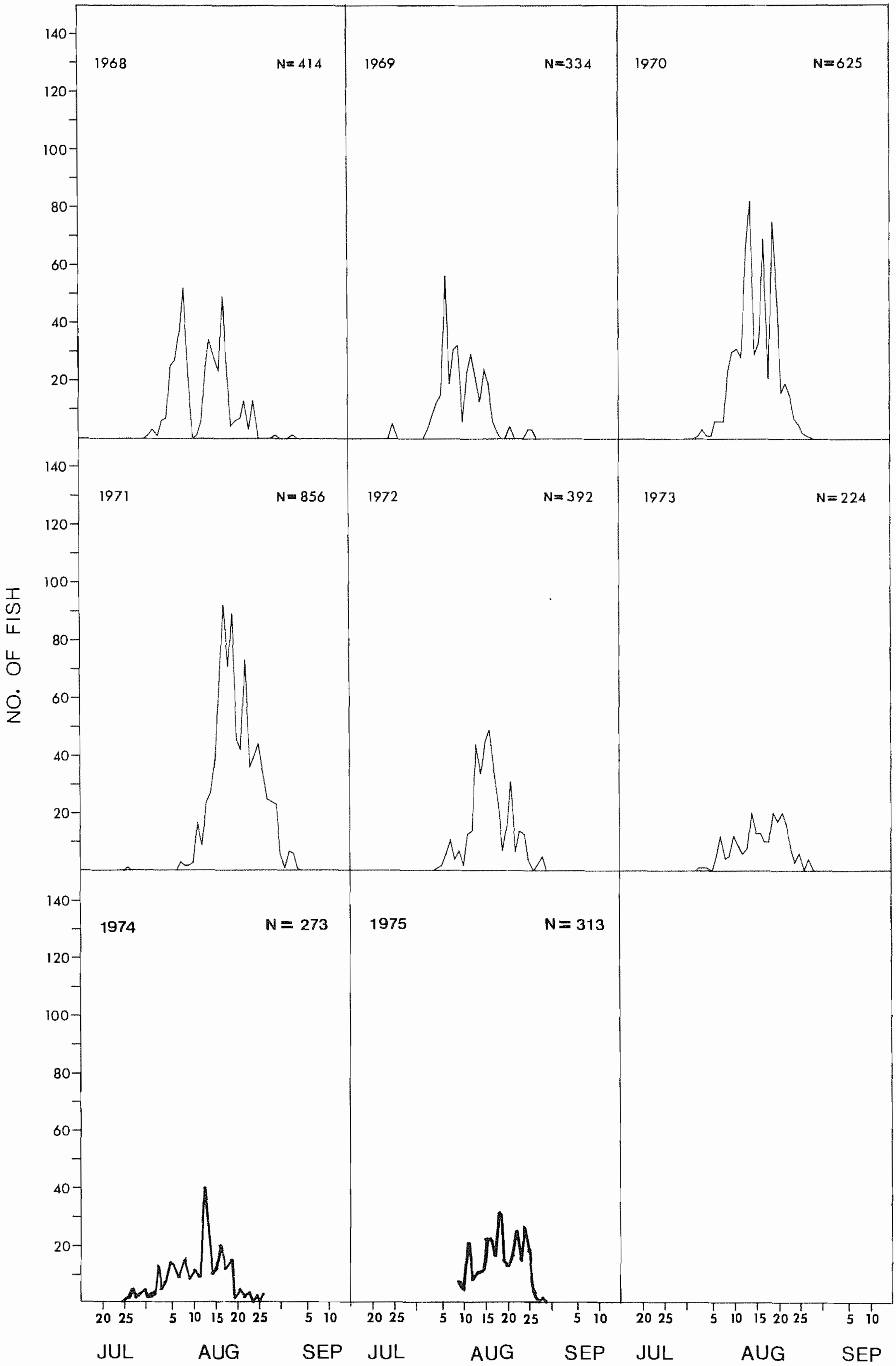


Figure 11. Enumeration and timing of upstream migration of chinook salmon at Whitehorse Rapids Dam (1968-1975).

Table 15. Total counts of chinook salmon by year and percentage of total present by date at the Whitehorse Rapids fishway.

Year	10%	50%	90%	Total
1959	August 3	August 9	August 16	1054
1960	August 9	August 14	August 21	660
1961	August 5	August 12	August 22	1068
1962	-	-	-	1500 (estimate)
1963	August 8	August 15	August 22	483
1964	-	-	-	587 (estimate)
1965	August 7	August 13	August 21	903
1966	August 6	August 13	August 21	563
1967	August 3	August 12	August 19	533
1968	August 5	August 13	August 20	414
1969	August 5	August 9	August 15	334
1970	August 10	August 15	August 21	625
1971	August 14	August 19	August 27	856
1972	August 11	August 16	August 22	392
1973	August 8	August 17	August 22	224
1974	August 2	August 12	August 18	273
1975	August 11	August 18	August 24	313

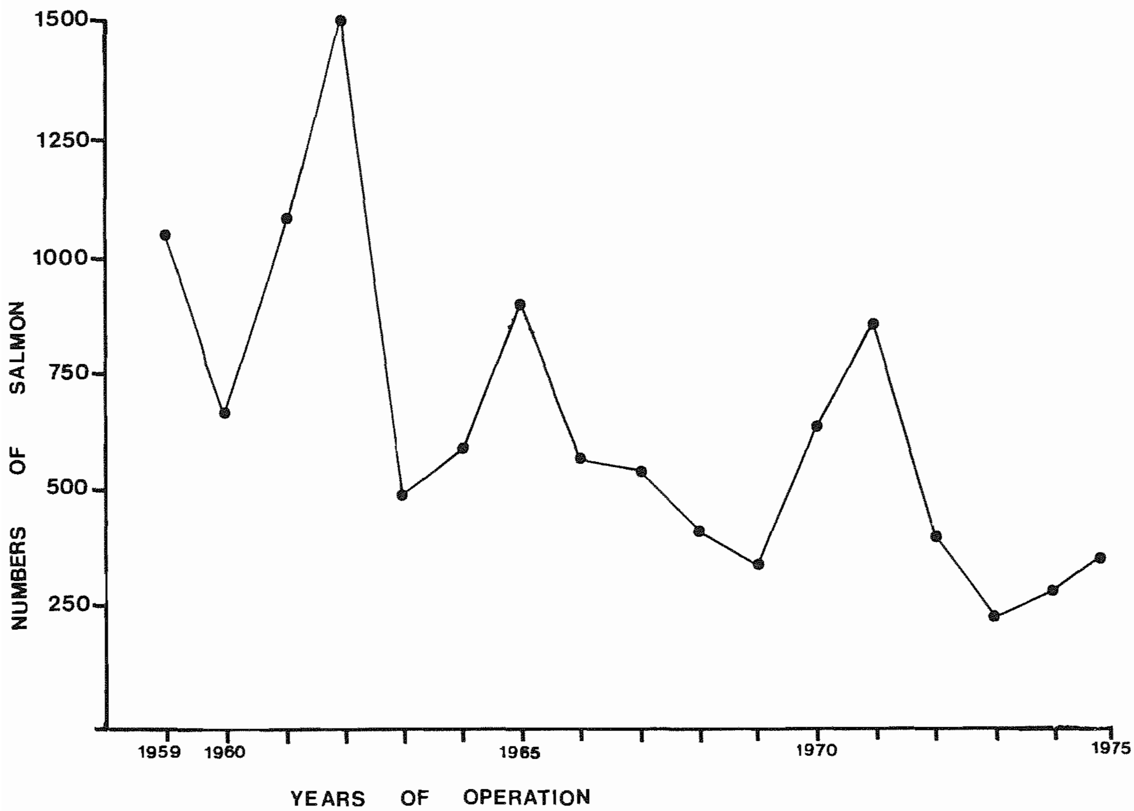


Figure 12. Chinook salmon counts at the Whitehorse Rapids Dam Fishway (1958-1975).

Fork Length (cm)	1972 Male	1972 Female	1973 Male	1973 Female
50				
55				
60				
65	1			
70	2	1	10	
75	2	1	15	
80	3	4	3	4
85	6	18	4	12
90	6	11	7	11
95	1	8	3	
100	1	1	2	2
105	3	2		
110	1			
115				
TOTAL	26	46	45	29
Range in Fork Length (mm)	667-1106	715-1052	675-1140	780-1005

A sample of the 1974 chinook salmon population showed the following length frequency:

1974 Fork Length Range (cm)	Male	Female
51-60	2	
61-70	13	
71-80	11	7
81-90	18	21
91-100	7	7
101-110	3	1
	54	36

In 1964, 90 adult chinook salmon were sampled for length at the fishway. Males yielded a mean fork length of 77.68 cm. and females yielded a mean fork length of 87.66 cm. Of the total escapement of 273 chinook salmon in 1964, 61.5% were male and 38.5% were female. In 1975, the sex ratio of 313 chinook salmon was 1:0.9 (male to female). In 1973, scale samples (30 male, 19 female) taken at the fishway showed that 76% and 24% of the males were age 5 and 6, respectively. 10.5%, 84.2% and 5.3% of the females were ages 5, 6, and 7, respectively.

Fry and Smolts

Chinook salmon fry are found in the upper Yukon River from break-up to at least August but are most abundant at the Whitehorse Rapids Dam for a one-month period commencing in the third week of June when they undertake a downstream migration. The downstream migration of chinook salmon smolts peaks earlier (June 15-20). Figure 13 shows the timing of migration of chinook salmon fry and smolts as determined in 1973 at the Whitehorse Rapids Dam.

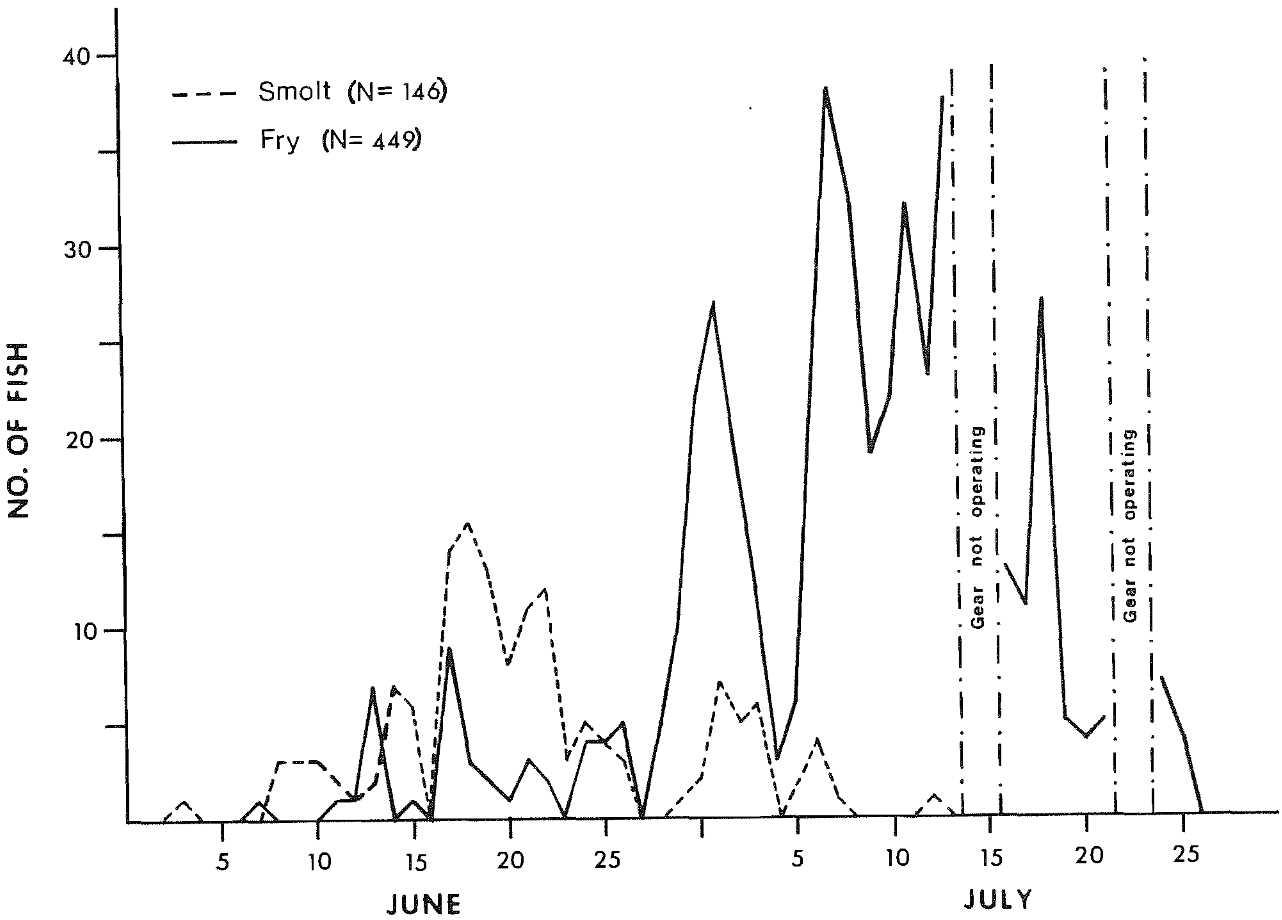


Fig. 13. Whitehorse Rapids chinook salmon smolt and fry migration in 1973 as depicted by gear catch.

Figure 14 shows the migration of chinook salmon fry as depicted by gear catches in 1960 at the Whitehorse Rapids Dam.

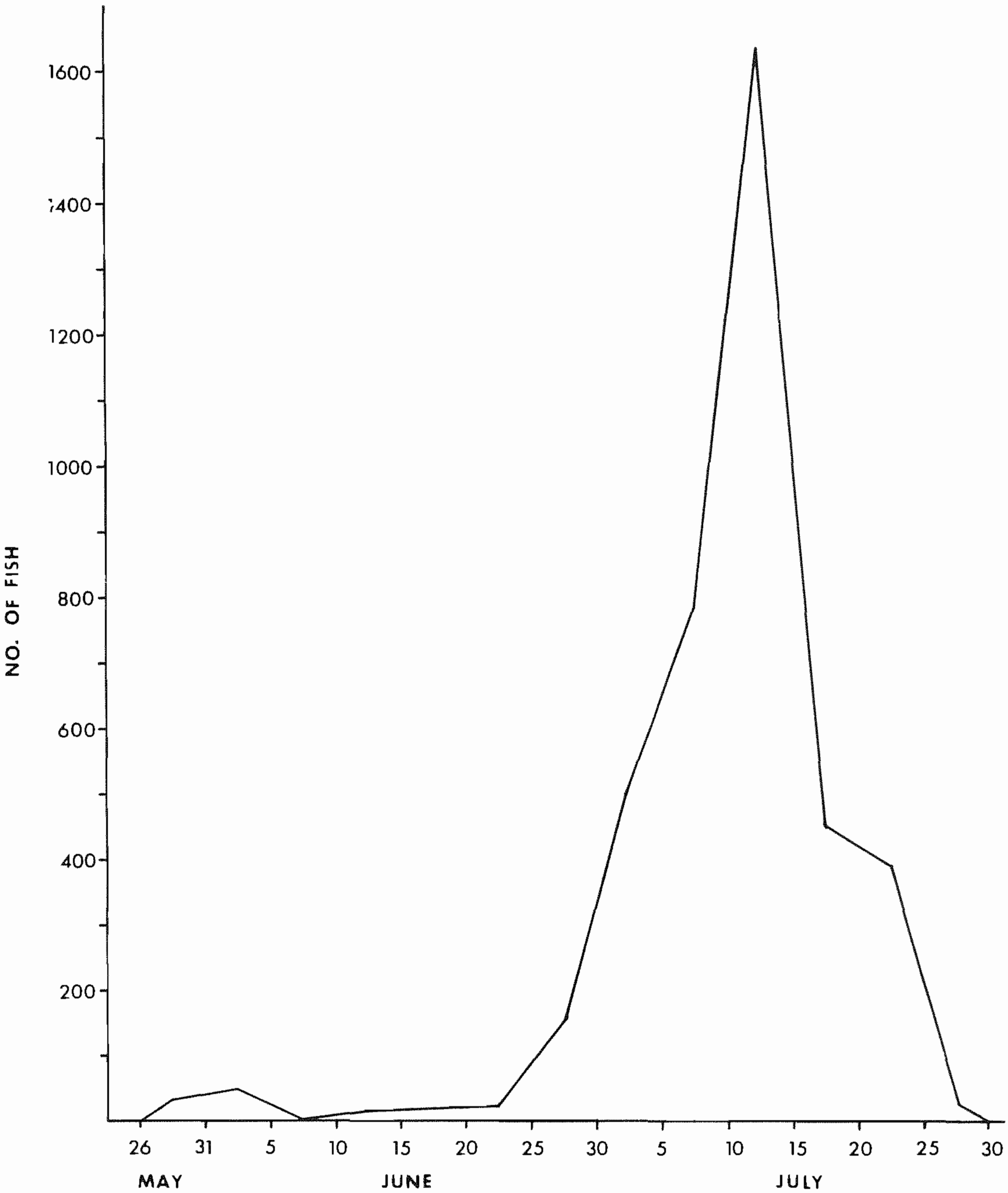


Figure 14. Daily migration of chinook salmon fry in 1960 as depicted by gear catch in 5 day intervals.

Measurement of chinook salmon smolts taken during the mortality studies ranged from 72-120 mm. with daily averages ranging from 72-97 mm. and an overall average of 93 mm. No apparent change in average size was noticed over the migration period. A definite daily average size change was noted in the fry during the 1973 migration, shown in Figure 15.

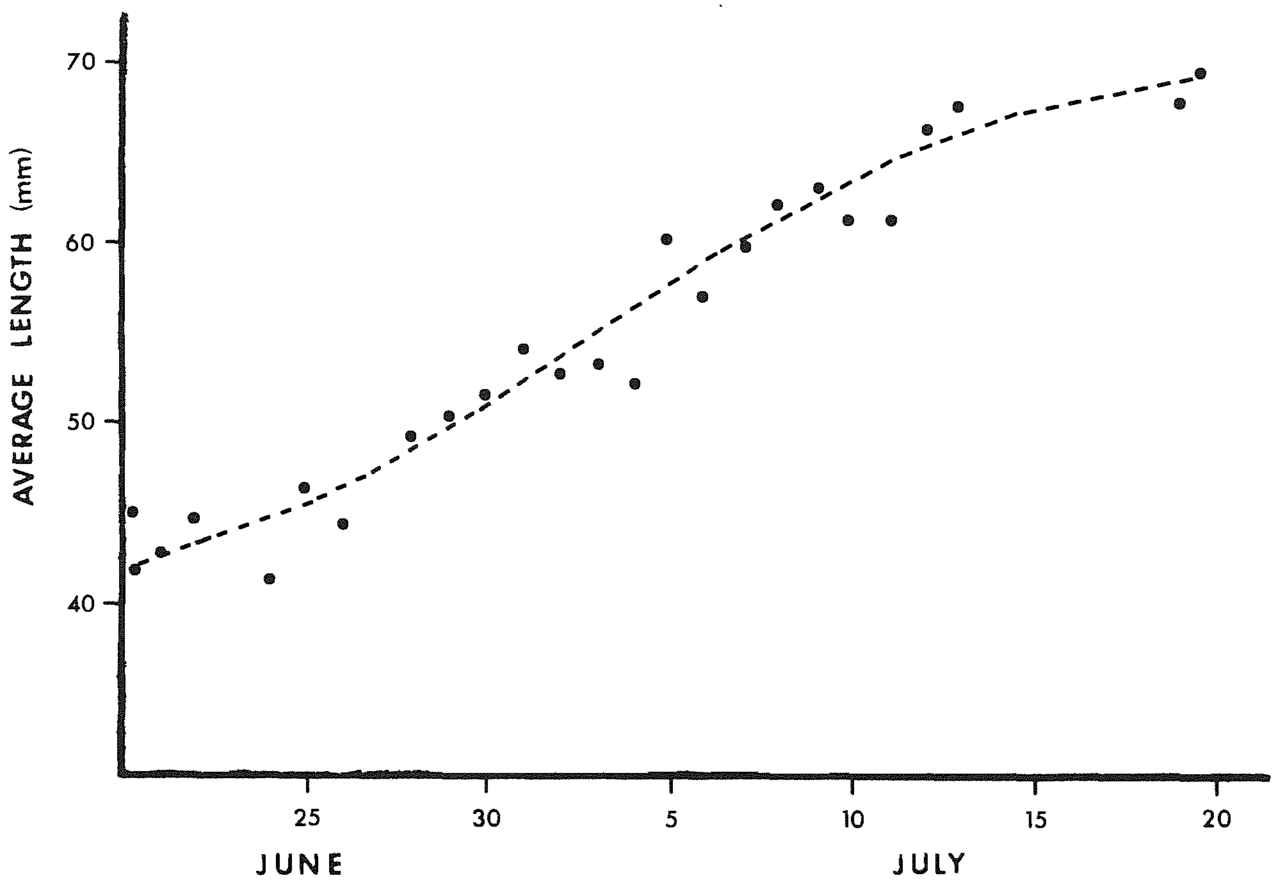


Figure 15. Daily average size (fork length) of chinook fry migrating downstream past the Whitehorse Rapids Dam in 1973.

Chinook Salmon Spawning Grounds

In the upper Yukon River drainage, chinook salmon spawning grounds (Figure 9) have been positively identified at:

(1) Takhini River
(2) Michie Creek
(3) Wolf Creek

(For details of spawning populations in the Takhini River and Michie Creek, see appropriate sections of this catalogue.)

In Wolf Creek, chinook salmon fry were observed on 16/08/60 from the Alaska Highway crossing for a distance of 3 mi. to the confluence of Wolf Creek with the Yukon River. One chinook salmon smolt (fork length 127 mm.) was captured in Ruth Lake (drains into the Yukon River via Wolf Creek) in 1961. It has been reported that Indians conducted a domestic fishing operation for chinook salmon at the outlet of Coal Lake in Wolf Creek in recent times. It is believed that chinook salmon now utilize Wolf Creek for spawning purposes in very limited numbers, if at all.

Fisheries Service personnel have conducted repeated aerial and boat surveys on the Yukon River from its junction with the Teslin River to Marsh Lake in attempts to delineate chinook salmon spawning grounds. No spawning grounds have been identified to date, but spawning is indicated in several areas. Dead chinook salmon were observed immediately downstream of the outlet of Lake Laberge in the Yukon River. Chinook salmon are reported to spawn below Lewes Dam. Good spawning gravels for chinook salmon exist close to Whitehorse. Dead chinook salmon were observed in the Takhini River 3 mi. upstream of its confluence with the Yukon River on 2/09/59. Michie Creek is the only documented chinook salmon spawning ground upstream of the Whitehorse Rapids power development, but reports exist of chinook salmon being angled in Tagish River.

In 1975, a programme utilizing sonic tags, portable monitors and a streamside monitor was utilized in attempts to locate suspected spawning grounds for chinook salmon upstream of the Whitehorse Rapids Dam. Positive confirmation of spawning grounds could not be determined by the tagging operation, but electrical impulses actuated the streamside monitor suggesting that a few chinook salmon migrated upstream of Tagish River. Possible spawning areas for salmon upstream of Tagish River are Tutshi and Atlin Rivers.

The population of chinook salmon in Michie Creek was estimated at 105 fish in 1975, and a maximum count of 165 chinook salmon was observed in the Takhini River on 29/08/75.

EXPERIMENTAL FISH STOCKING PROGRAMMES IN THE UPPER YUKON RIVER DRAINAGE

In the Yukon Territory native rainbow trout are present only in the Alsek-Tatshenshini drainage located in the extreme southwest corner of the territory, and no endemic populations of rainbow trout, cutthroat trout, or coho salmon are present within the upper Yukon River drainage. From 1946 to 1958 the Yukon Fish and Game Association planted trout in various lakes within the study area but written reports concerning these activities do not exist. It is documented that a hatchery was located at McLean Lake and that rainbow and cutthroat trout were released into some lakes in the Whitehorse area. In 1958 the Federal Department of Fisheries assumed the responsibility of stocking trout in the Yukon Territory. The purpose of the programme was to provide recreational fishing for desirable species close to major population centres within the territory. The original concept of providing a readily accessible sport fish resource has been altered by increased transportation facilities within the Yukon, and a wide range of indigenous sport fish populations are now available to the sportsman. The sporting attributes of native fish species are now recognized and the original purpose of the stocking programme has been given reduced emphasis. Available information on stocking programmes is summarized in this report.

The programme was altered in 1972 to include stocking programmes to test the feasibility of utilizing small pothole lakes without inflow or surface drainage for raising rainbow trout and coho salmon with a view to providing a commercially marketable product in one growing season. Fisheries Service experiments to investigate the viability of this concept are summarized in this section of the catalogue. As a result of encouraging growth rates of rainbow trout in one growing season in some lakes as determined by Fisheries Service, experimental programmes have been conducted by private entrepreneurs to test the viability of commercial trout farming within the study area. Results obtained from these programmes are limited, and the locations of privately stocked lakes are not given in this report.

(1) Stocking programmes from 1956-1975 to establish populations of sport fish

Figure 16 shows the locations of 7 small lakes within 20 km. of Whitehorse in which eyed eggs and fry of rainbow and cutthroat trout and fry of coho salmon have been planted in attempts to enhance recreational fishing opportunities in the vicinity of the major populations centre. The location and some physical parameters of these lakes are given in the following table.

Lake	Location	Size	Depth
Chadburn Lake	13 km. SE of Whitehorse	178 hectares	43 m. maximum
Jackson (Louise)	13 km. W. of Whitehorse	96 "	11 m. "
Long Lake	3 km. NE of Whitehorse	39 "	17 m. "
McLean Lake	8 km. SW of Whitehorse	2.6 "	7 m. "
Ruth Lake	16 km. SE of Whitehorse	18 "	6 m. "
Scout Lake	20 km. NW of Whitehorse	50 "(approx)	unknown
Hidden Lake	12 km. SE of Whitehorse	60 "(approx)	unknown

Table 16 lists species of fish collected from these lakes before the planting operation and during post-planting sampling programmes. Table 17 records the numbers by year of eggs and fry of rainbow trout and fry of coho salmon in the seven lakes. The results are presented as a brief summary in the text.

Most of the trout were transplanted and introduced as eyed eggs obtained from the B. C. Fish and Wildlife Branch which used stocks of trout resident in the interior of B. C. In 1961, eggs were donated by a federal hatchery in St. John, New Brunswick, and in 1967 they were obtained from Lindloff Fish Culture Station, Nova Scotia. In 1968, the trout eggs were domestic stock purchased from a private hatchery (Troutlodge Springs, Soap Lake, Washington, U. S. A.).

In 1971, trout fry were purchased from Steelhead Creek Hatchery Company, Mission, B. C., and stocked in several lakes. The fry were transported in insulated tanks ($3^{\circ}C$) to which pure oxygen was added (Sweitzer, M.S. 1971). Before fry were released the temperature of the water in the tanks was increased to within a few degress of the temperature in the receiving body of water.

In two instances fry and fingerlings were removed from trout populations in McLean Lake for transfer elsewhere. In these cases, the fish were placed in plastic bags partially filled with oxygen and transported to other lakes where they were released.

In 1974 coho salmon fry were obtained from Robertson Creek Hatchery on Vancouver Island and in 1975 coho salmon fry were obtained from Qualicum River hatchery on Vancouver Island. The fry were approximately 3.75 cm. in fork length. Plants in 1974 were made on May 23 and in 1975 on May 14.

Chadburn Lake was first stocked with fingerlings in 1970, and one small trout was caught in an overnight set of a gillnet in 1971. It might be difficult to establish a permanent trout population in Chadburn Lake because of predation and competition with existing populations of lake trout and whitefish.

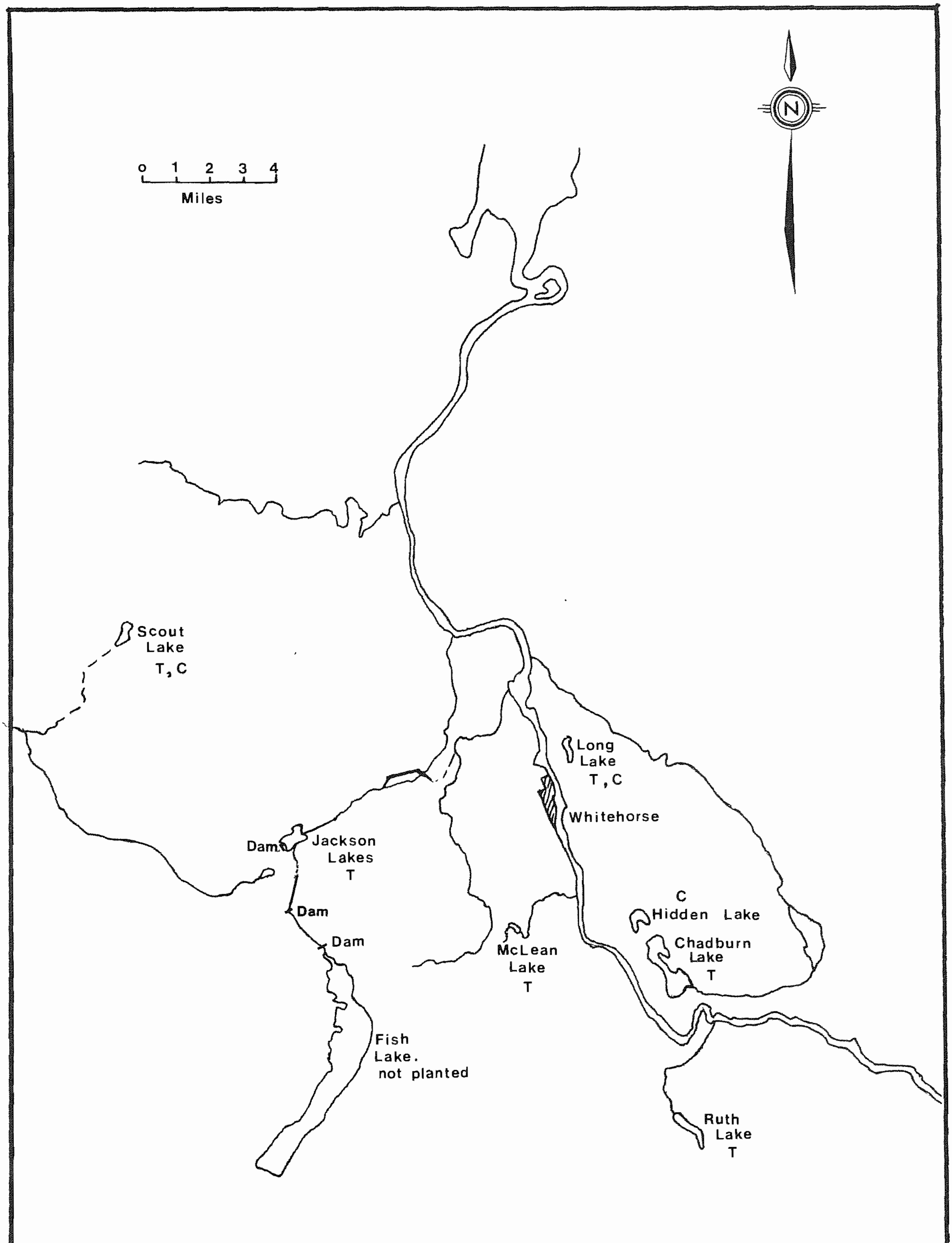


Figure 16. Lakes near Whitehorse in which trout and coho salmon have been planted (1957-1975). "T"=trout, "C"=coho salmon.

Table 16. Fish species collected from lakes near Whitehorse in which trout or coho salmon have been planted.

Water body	Year	Arctic grayling	Chinook salmon	Cutthroat trout	Kokanee	Lake chub	Lake trout	Lake whitefish	Longnose sucker	Northern pike	Pygmy whitefish	Rainbow trout	Round whitefish	Sculpin
Chadburn Lake	1961						x	x						
	1963						x	x			x		x	
Jackson Lake	1956	x					x						x	
	1957	x					x					x		x
	1958	x					x						x	
	1959	x					x					x		
	1960	x					x					x		
	1961	x					x					x	x	
Long Lake	1963											x		
	1964											x		
	1965											x		
	1966											x		
	1967					x						x		
	1970					x						x		
McLean Lake	1956			x								x		
	1962											x		
	1963			x								x		
Ruth Lake	1961		x											
	1963											x		
	1964											x		
	1965											x		

Table. 17. Record of rainbow trout and coho salmon plants in lakes near Whitehorse from 1957-1975.

Water body	Year	Number of rainbow trout eggs Planted	Number of rainbow trout eggs Survived	Number of rainbow trout fry released	Number of coho salmon fry released
Chadburn Lake	1970	0		5,000	
Jackson Lake	1957	108,000		0	
(Louise Lake)	1959	100,000		0	
Long Lake	1961	100,000	70	0	
	1963	13,000	10,618	0	
	1964	10,900		0	
	1967	25,000	20,000	0	
	1968	30,000	83	0	
	1970	0		650	
	1971	0		8,000	
	1974				30,000
	1975				18,000
McLean Lake	1961	75,000		0	
	1961	23,000	10,000	0	
	1962	25,000		0	
	1963	13,000		0	
Ruth Lake	1962	62,000		0	
	1963	25,000	24,000	0	
	1964	17,700		0	
Scout Lake	1971	0		3,750	
	1975				19,000
Hidden Lake	1974				30,000

In 1956, Jackson (Louise) Lake contained lake trout, Arctic grayling, round whitefish and sculpins. Rainbow trout eggs were planted in the inlet of the lake each year from 1956 to 1959. Some of the resulting fry survived to adulthood and had begun spawning by 1960. The introduced rainbow trout apparently had little effect on the previously established fish populations as the catches were similar during the period of 1956 to 1961.

In Long Lake, rainbow trout grew and survived well. Indeed, the 1960 brood year was so well represented in gillnet and angler catches that it is likely that more than the 70 recorded fish were released into the lake in that year. Unfortunately, lake chub were introduced into Long Lake in 1967. By 1970, lake chub had become very numerous. The chub presumably competed with trout for food and possibly preyed upon young trout. Coho salmon established a population in Long Lake but growth rates are slow.

McLean Lake had established populations of rainbow and cutthroat trout when Fisheries Service began management in 1958. A creel census conducted each year showed that angling success was good between 1959 and 1960. In the fall of 1960, McLean Lake was poisoned to remove the cutthroat trout, so that a pure stock of rainbow trout could be established. The fish kill was not complete as cutthroat trout were still present in the lake in 1963. McLean Lake was restocked with rainbow trout (Table 16), and a good population had developed by 1963. The inlet and outlet provided good spawning area. Consequently, the number of trout increased, but their average size decreased, presumably because of competition for food. By 1970, the trout in McLean Lake were numerous but small.

In Ruth Lake, rainbow trout grew and survived well from 1962 to 1965. Many dead trout were found in the lake in the spring of 1966. The fish kill was probably complete as no trout were captured in gillnets. Ruth Lake is fairly shallow (6 m.), and the trout probably died because of oxygen depletion during the winter. Trout were not re-introduced into the lake.

Scout Lake provided good growing conditions for trout. In just 20 months, the trout grew from 50-60 mm. to 394-488 mm. It is interesting that trout growth was good in both Scout and Long Lakes and that both lakes initially supported dense populations of freshwater shrimp. Coho salmon were captured by gillnetting in Scout Lake on July 10, 1975. A sample of 16 averaged 7.6 cm. in fork length and weighed an average of 6.9 gm. Growth rates appear to be slow.

In Hidden Lake, coho salmon have firmly established themselves. In August, 1975 a gillnet-caught sample of 129 coho salmon ranged from 15.8 cm. to 24.5 cm in fork length, and from 40.8 gm. to 185 gm. in weight. Two coho salmon caught by angling on the same date weighed approximately 1 lb. One male coho salmon was taken in February, 1976 approximately 22.8 cm. in fork length. This fish was in spawning condition. The coho salmon population in Hidden Lake provides an excellent recreational fishery for residents of Whitehorse. Ice-fishing is very popular and coho salmon up to 3 lbs. have been taken. A wide range in sizes is present in the population; the legal angling length limit is 8 in. (20 cm.). Results from other areas indicate that stocked coho salmon will survive for only two years if restricted to fresh water and it is probable that the coho salmon in Hidden Lake will die before the end of 1976.

Trout plants were most successful in small lakes, which probably had good food supplies. Examples are: Long Lake, McLean Lake, and Scout Lake. Small lakes have several advantages. One advantage is that they require fewer trout in order to establish a population size adequate to provide good angling. The small size allows anglers to fish the whole lake. Lower sampling effort is required to determine the status of the fish population. When necessary, a small lake can more readily be netted to reduce population size or poisoned to eradicate undesirable fish populations. There was good evidence of winter-kill in Ruth Lake.

Trout introduction was not very successful where there were established populations of other species. Jackson (Louise) Lake provides a good example of such a situation. Chadburn Lake may provide another example, although there is insufficient information about Chadburn Lake at present.

(2) Experimental mericulture programmes

Rainbow trout and coho salmon have been planted in several lakes within the area of this catalogue since 1972 to test growth and survival rates of these species.

Winter-kill of fish in lakes is a condition which results from the depletion of oxygen and usually occurs in February and/or March. Although lake conditions resulting in winter-kill are obviously disastrous for the production of stocked fish for recreational purposes, the same conditions are advantageous to a successful fish-farming venture provided that growth of the fish to market size is possible in one growing season. Winter-kill of unharvested fish prevents predation by the survivors on fry introduced the following season.

In 1972 four winter-kill pothole lakes were selected on the basis of possession of four priorities:

(1) small size to facilitate harvesting
(2) a good supply of natural food
(3) barren of other fish species
(4) accessible by road.

Of the four lakes, two were close to mile 21 on the Atlin road (named Colleen* and Marcella*) and two located close to mile 845 on the Alaska Highway (named Muriel* and Bishop*). The four lakes had large quantities of invertebrate lifeforms suitable as food organisms for fish. Table 18 lists water chemistry of the selected lakes and Table 19 lists lake dimensions and stocking densities. Totals of 4760 coho salmon (5 in. in fork length) and 2435 rainbow trout (7 in. in fork length) were planted on June 8, 1972.

Harvesting was conducted with monofilament gillnets of 2-, 2½- and 3-in. stretched mesh commencing on September 26, 1972. Table 20 is a summary indicating growth and survival of rainbow trout and coho salmon in the four lakes. The data show that trout in Marcella Lake had rapid growth rates and a high rate of survival. The high growth rate may be associated with high concentrations of total dissolved solids in this lake. There is a positive correlation between T.D.S. and biomass of fish production in lakes (Northcote and Larkin, 1956). Growth rates were low and mortality was high for coho salmon. Low growth rates in Muriel Lake suggested that the food supply was low relative to the stocking density. Further studies were recommended to determine:

(1) the effect on productivity arising from annual restocking
(2) the minimum size of rainbow trout that will grow to marketable size in one growing season
(3) optimum stocking densities
(4) the suitability of other capture methods, e.g. trap nets
(5) the potential for other species in aquaculture, e.g. Arctic grayling, inconnu, Dolly Varden.

In 1973, the programme was continued. The following lakes were stocked by Fisheries Service to further investigate growth and survival of rainbow trout.

Lake	Latitude	Longitude	No. of Fry	Stocking Date
Salmo*	60°26'	133°46'	2500	June 13
Marcella*	60°39'	133°50	2000	June 13
Haircut*	60°32'	133°17'	2000	June 13
Scout	60°47'	135°25'	1000	June 13
Little Scout*	60°47'	135°24'	2500	June 13
Gammarus*	60°25'	134°08'	12000	June 13

*Name coined by Fisheries Service personnel for purposes of identification.

Complete winter-kill occurred only in Gammarus and Little Scout Lakes. Growth rates were good in some lakes, poor in others. Trout in some lakes developed a musty flavour (rendering these fish unmarketable). The results are inconclusive regarding the potential viability of fish-farming operations in pothole lakes in the Yukon Territory.

Table 18. Water chemistry of four pothole lakes (1972) (from Kendel, 1973).

Lake	pH	Total alkalinity as $CaCO_3$ mg/l	Phosphate Ortho mg/l	Nitrate-N mg/l	Conductance micromhos/cm	Total dissolved solids mg/l	Hardness total as $CaCO_3$ mg/l	Sulfate mg/l	Calcium mg/l	Chloride mg/l
Colleen	8.71	113.45	0.05	0.04	238	117.9	136	13	27.3	0.96
Marcella	8.93	323.10	0.05	0.04	620	365.6	352	30	32.9	6.35
Bishop	8.21	80.80	0.05	0.05	170	111.9	88	6	17.6	2.41
Muriel	7.96	85.70	0.05	0.04	165	102.0	96	5	21.6	0

Table 19. Physical dimensions and stocking parameters of four pothole lakes (1972) (from Kendel, 1973).

Lake	Surface area in acres	Maximum depth in feet	Species planted	Density in fish per acre
Colleen	5	28	rainbow trout and coho salmon	516 (combined)
Marcella	10	38	rainbow trout	143
Muriel	2½	5	rainbow trout	320
Bishop	2½	22	coho salmon	952

Table 20. Growth and survival of coho salmon and rainbow trout in four pothole lakes (1972) (from Kendel, 1973).

Lake	Species	Average weight at planting in oz.	Number planted	Total weight planted in lbs.	Average weight at harvesting in oz.	Number recovered	Total weight recovered in lbs.	Percent survival
Colleen	coho salmon	0.57	2,380	89	4.21	76	20	3
	rainbow trout	2.39	200	29	12.37	188	146	94
Marcella	rainbow trout	2.39	1,435	219	9.19	1,261	725	88
Bishop	coho salmon	0.57	2,380	89	5.60	21	8	1
Muriel	rainbow trout	2.39	800	115	4.13	72	184	9

METRIC EQUIVALENTS

Length

Cm.	=	0.3937	In.
Meter	=	3.28	Ft.
Meter	=	1.094	Yd.
Kilom.	=	0.621	Mile
In.	=	2.54	Cm.
Ft.	=	0.3048	Meter
Yd.	=	0.9144	Meter
Mile	=	1.61	Kilom.

Area

Sq. Cm.	=	0.1550	Sq. In.
Sq. M.	=	10.76	Sq. Ft.
Sq. M.	=	1.196	Sq. Yd.
Sq. Kilom.	=	.386	Sq. Mi.
Sq. In.	=	6.45	Sq. Cm.
Sq. Ft.	=	.0929	Sq. M.
Sq. Yd.	=	.836	Sq. M.
Sq. Mi.	=	2.59	Sq. Kilom.
Acre	=	0.405	Hectare
Hectare	=	2.47	Acres
Acre	=	43560	Sq. Ft.

Volume

Cu. Cm.	=	.061	Cu. In.
Cu. M.	=	35.315	Cu. Ft.
Cu. M.	=	1.308	Cu. Yd.
Cu. In.	=	16.38	Cu. Cm.
Cu. Ft.	=	.028	Cu. M.
Cu. Yd.	=	.7645	Cu. M.

Capacity

Liter	=	.0353	Cu. Ft.
Liter	=	.21998	Gal. (Br.)
Liter	=	61.023	Cu. In.
Cu. In.	=	.0164	Liter
Cu. Ft.	=	28.32	Liter
Gal.	=	4.5459	Liter (Br.)

Degrees Centigrade = 5/9 (Degrees Fahr. - 32)
Degrees Fahrenheit = 9/5 (Degrees Cent.)+ 32.

WATER QUANTITIES AND FLOW MEASUREMENTS

1 cubic foot per second (cfs) or second foot	= 373.2 gallons per min. (gpm)
1 cubic foot per second (cfs) or second foot	= .537408 million gallons
1 second foot	= approximately 2 acre-feet per day
1 second foot	= 86,400 cubic feet per day
1 million gallons per day	= 1.86 cfs.
1 acre-foot	= 43,560 cubic feet or 271,379 ga.
1 cubic foot of water	= 6.23 ga. and weighs 62.4 pounds.

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