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Stream Studies in the Aishihik System with Reference to Hydroelectric Development

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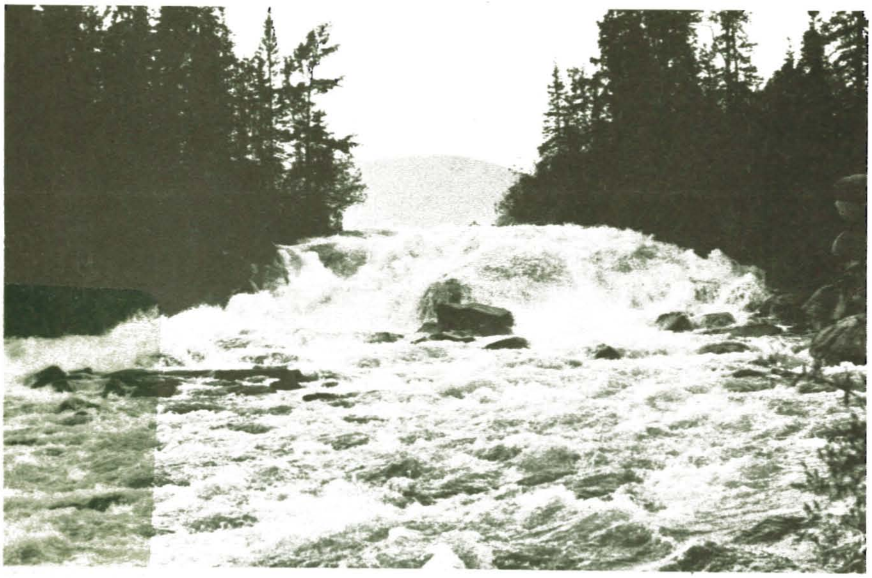
Northern Operations Branch
Pacific Region



ABSTRACT

The Aishihik River system located approximately 100 miles west of Whitehorse is under development for the production of hydro power. The Fisheries and Marine Service, Department of the Environment, carried out studies in 1972 and 1973 to assess the effects of the proposals on the productivity of the aquatic ecosystem. Responsibility was subdivided between agencies. This report discusses the program to evaluate streams and stream populations which was conducted by the Northern British Columbia and Yukon Division. The most important question is one of controlled minimum flows originating at Aishihik Lake. The effect of flow reduction on an all-purpose, all-season waterway and the fish therein is examined and discussed.

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INTRODUCTION

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In 1972 the Northern Canada Power Commission (NCPC) made application for a water licence to the Yukon Water Board for the use of the Aishihik system to generate electric power. This application was made under authority of the Inland Waters Act of 1970 and resulted in the immediate implementation of studies related to environmental and social affairs by various parties. The activities of the Fisheries and Marine Service to March 1973 in this regard are outlined by Kussat (1973).

In 1973 a second year of biological and engineering studies was undertaken in the Aishihik Lake system to determine the effects on the fish resource arising from hydro-power development. The studies were designed to provide a knowledge base from which to draw alternatives to construction, design and operation proposals and to measure losses in fish if such occur. The responsibility for study is divided between the Northern British Columbia and Yukon Division (NBCYD) and the Habitat Protection Unit of Fisheries and Marine Service, Vancouver, and Pacific Biological Station (FRBC), Nanaimo. This memorandum discusses only that for the NBCYD group and therefore outlines studies related to streams and stream populations.

The Aishihik River system is located approximately 100 air miles west of Whitehorse. It consists of three major lakes, namely Sekulmun, Aishihik and Canyon which are interconnected by short streams. A number of lateral tributary flows enter the system. Drainage is by way of the Aishihik, Dezadeash and Alsek Rivers to the Pacific Ocean (Fig. 1).

The proposed hydro-electric project will involve the storage of water in Aishihik Lake and the diversion of water from the south end of Canyon Lake to a canal which will extend to a

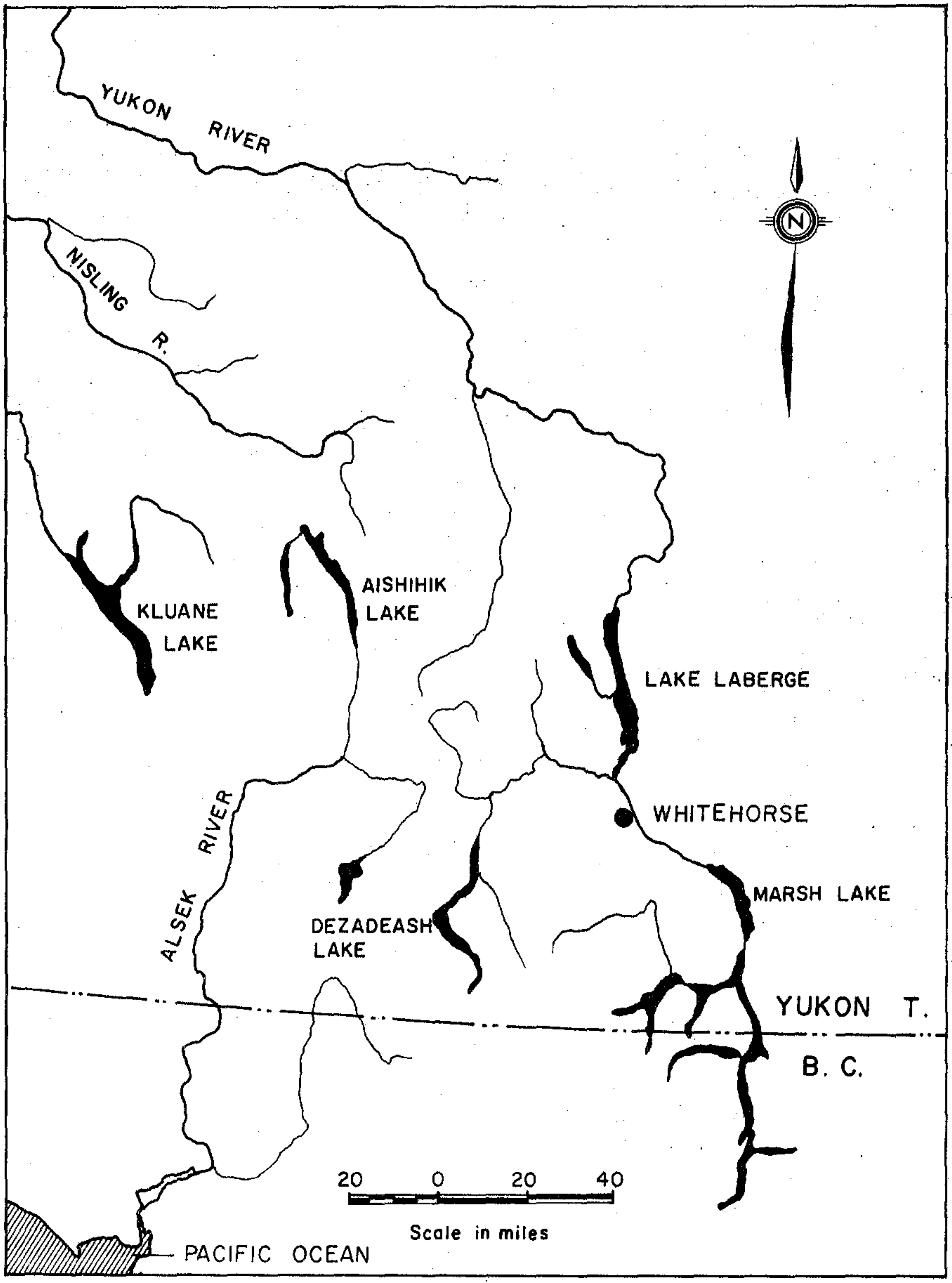


Fig. 1 Site map

powerhouse located near the confluence of the East and West Aishihik Rivers. Control structures will be erected at the outlet of Aishihik and Canyon Lakes for storage and diversion purposes respectively. A later development may transfer water from Stevens and Long Lakes, which lie within the Yukon River system, to Aishihik Lake (Fig. 2).

The Aishihik power plant will be incorporated in a grid system with Whitehorse and Mayo and tentatively will generate power during the winter months.

Storage in Aishihik Lake will take place during June, July, August, and September, and release of water for powerhouse use will occur for eight months commencing late September or early October. Currently the discharge from Aishihik Lake ranges from a monthly mean high of 760 cfs, most frequently occurring in July, to a winter low of 100 cfs, usually in April (Fig. 3). Following development discharges from Aishihik Lake will be in the order of 350 cfs from October to May inclusive and this amount exceeds the current flows in all months but one for this period. Some flows will be released during the summer to maintain the fish populations. The question of summer minimum flows is the crucial one connected with this study.

The problems raised by the proposal on streams and stream populations are as follows: One, changes in the level of Aishihik Lake will directly affect the lowermost areas of tributary streams. Drawdown will result in stream bed cutting and bank erosion; a raised lake level will inundate current riffle areas. The effect of these happenings on the fish resource depends upon the ability of the fish to adapt to the new conditions and/or to relocate.

Two, a drastically reduced outflow from Aishihik Lake during the time of storage, i.e. June, July, August and September, will directly result in lesser wetted area, lower water depths and lower velocities from Aishihik Lake to Canyon Lake. Lower stream

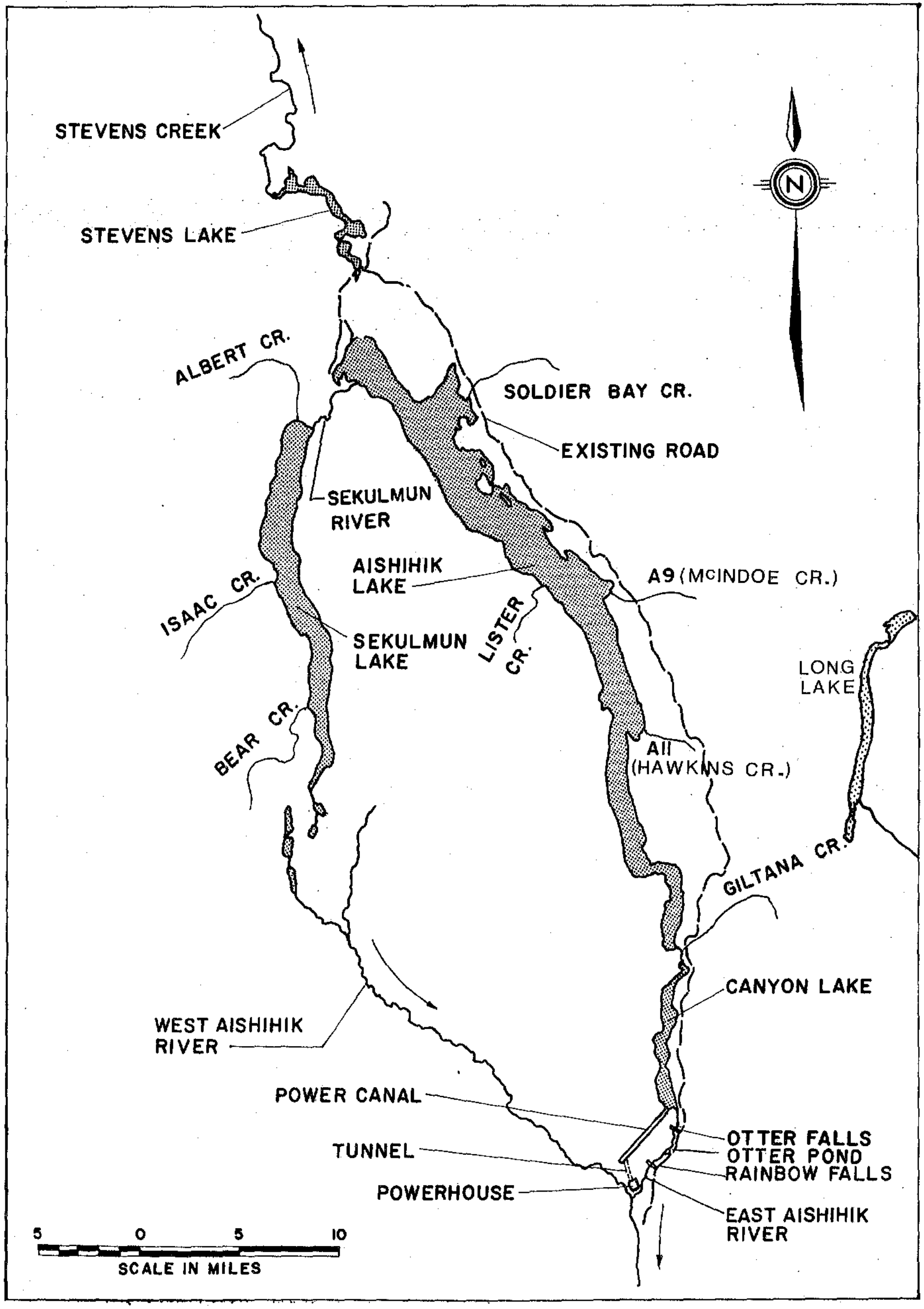


Fig. 2 Aishihik System

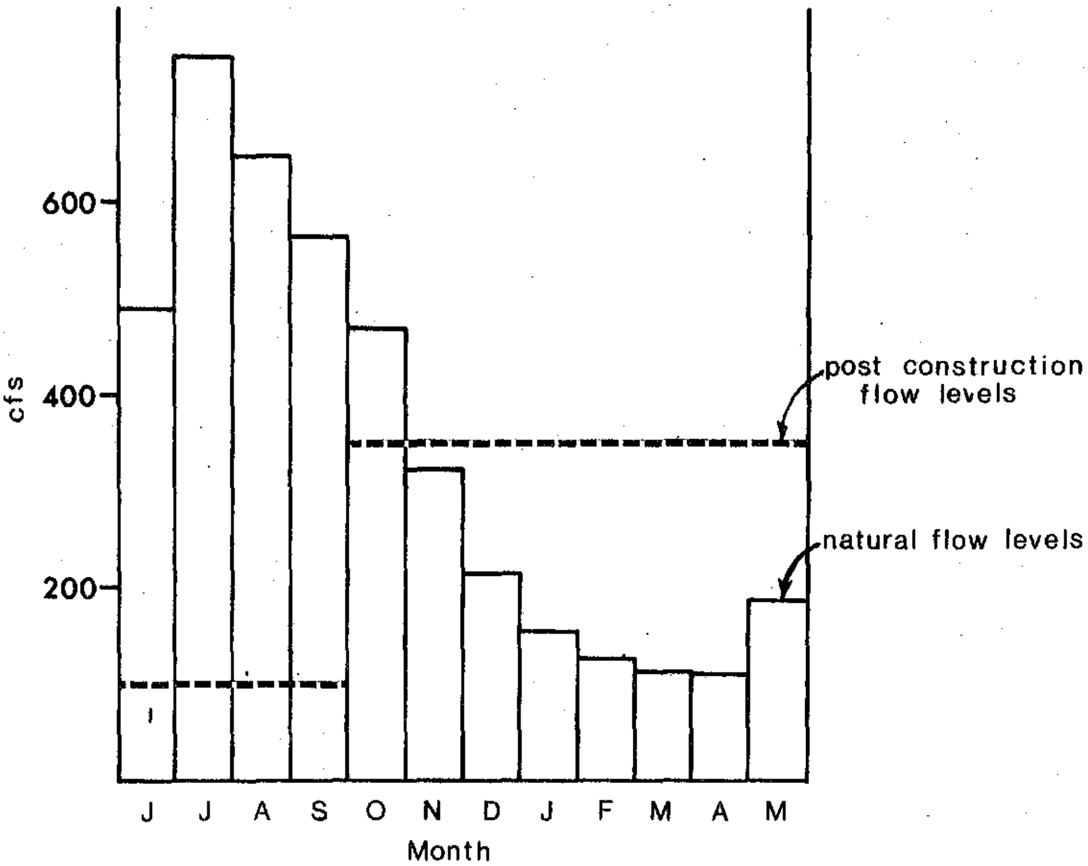


Fig. 3 Mean monthly flows from Aishihik Lake for the period 1961-1970, inclusive. The approximate flow levels following construction are shown as a dashed line.

levels and velocities may affect migration, spawning, spawn incubation, space, shelter and food requirements. A lower level in Canyon Pond will no doubt reduce the food and shelter opportunities afforded to the young by the aquatic grass lands, particularly if the water is withdrawn from the grasses. Further, the chemical and temperature properties of the flow from Canyon Pond will change in that a tributary stream, namely Giltana Creek, will contribute a higher proportion of the discharge during the summer than it did under natural conditions.

Three, flows over Otter Falls will be absent for periods of each year, thus endangering the fish inhabiting the East Aishihik River. It is highly unlikely that fish will survive in the East Aishihik River. It is proposed to rescue the rainbow trout population below Otter Falls and utilize them in an aquaculture program. However, small populations of grayling and whitefish may be lost. No study was made below Otter Falls in 1973 as these potential losses are accepted as an unfortunate part of the scheme.

The fish stocks in the Aishihik system are represented by the following nine species:

humpback whitefish	Coregonus clupeaformis
round whitefish	Prosopium cylindraceum
Arctic grayling	Thymallus arcticus
lake trout	Salvelinus namaycush
northern pike	Esox lucius
longnose sucker	Catostomus catostomus
burbot	Lota lota
slimy sculpin	Cottus cognatus
rainbow trout	Salmo gairdneri.

A commercial fishing quota of 15,000 lbs of whitefish and lake trout was established for Aishihik Lake by Canada Order in Council in 1961. However, the quota was eliminated in 1968 to resolve conflicts between commercial, subsistence and recreational interests. Subsequently, fish has been taken for subsistence purposes to supply up to 20 persons from time to time. Sport fishing activity is on the increase and the area provides good catches of rainbow trout, grayling and lake trout.

The following report has been prepared to present the results of studies conducted in 1973 by NBCYD personnel. The principal study area was the watercourse from Aishihik Lake to Canyon Lake. A select number of tributary streams were superficially examined.

The 1972 studies were previously reported in memorandum form and are presented as such in Appendix A to this report.

DESCRIPTION OF PRINCIPAL STUDY AREA

The principal study area in 1973 for the NBCYD group within the Aishihik system extended from the outlet at Aishihik Lake to entry at Canyon Lake, a distance of approximately 6,500 feet. For reporting purposes this watercourse is divided into three areas, namely Upper Aishihik River "A", Canyon Pond and Upper Aishihik River "B". Included in this area is a tributary stream named Giltana Creek which enters Canyon Pond on the south-east corner (Fig. 4).

Upper Aishihik River "A" is 1,100 feet in length with a normal wetted width ranging from 45 to 135 feet. The drop is in the order of 20 feet. Cascades are a dominant feature (Fig. 5). The stream bed is composed of bedrock and boulder with the smaller material being prevalent in the lowermost 200 feet. The stream is confined within shallow rock walls and the bottom is very irregular (Fig. 6). The water temperature ranged from 40° F in late May to 55.5° F six weeks later.

Canyon Pond (Fig. 7) measures approximately 2,000' by 1,000' with a depth generally not more than 5 feet. However, a pool, located at the point where Upper Canyon River enters the pond measures approximately 300' by 100' and has a maximum depth of 18 feet. The pond generally has a mud and sand base with some flat boulders. Aquatic plants are abundant on the east side of the pond. Water temperatures generally correspond to those of the Upper Aishihik River "A"; however, a warming of 1° F is sometimes measured near the outlet of the pond. The water level change from late May to mid-July was 1.8 feet and this has a great effect on total wetted pond area particularly in the area of aquatic plant stands.

Upper Aishihik River "B" is approximately 2,600 feet in length with a normal wetted width ranging from 105 feet to 240 feet. Total drop is in the order of 30 feet. The stream bed is

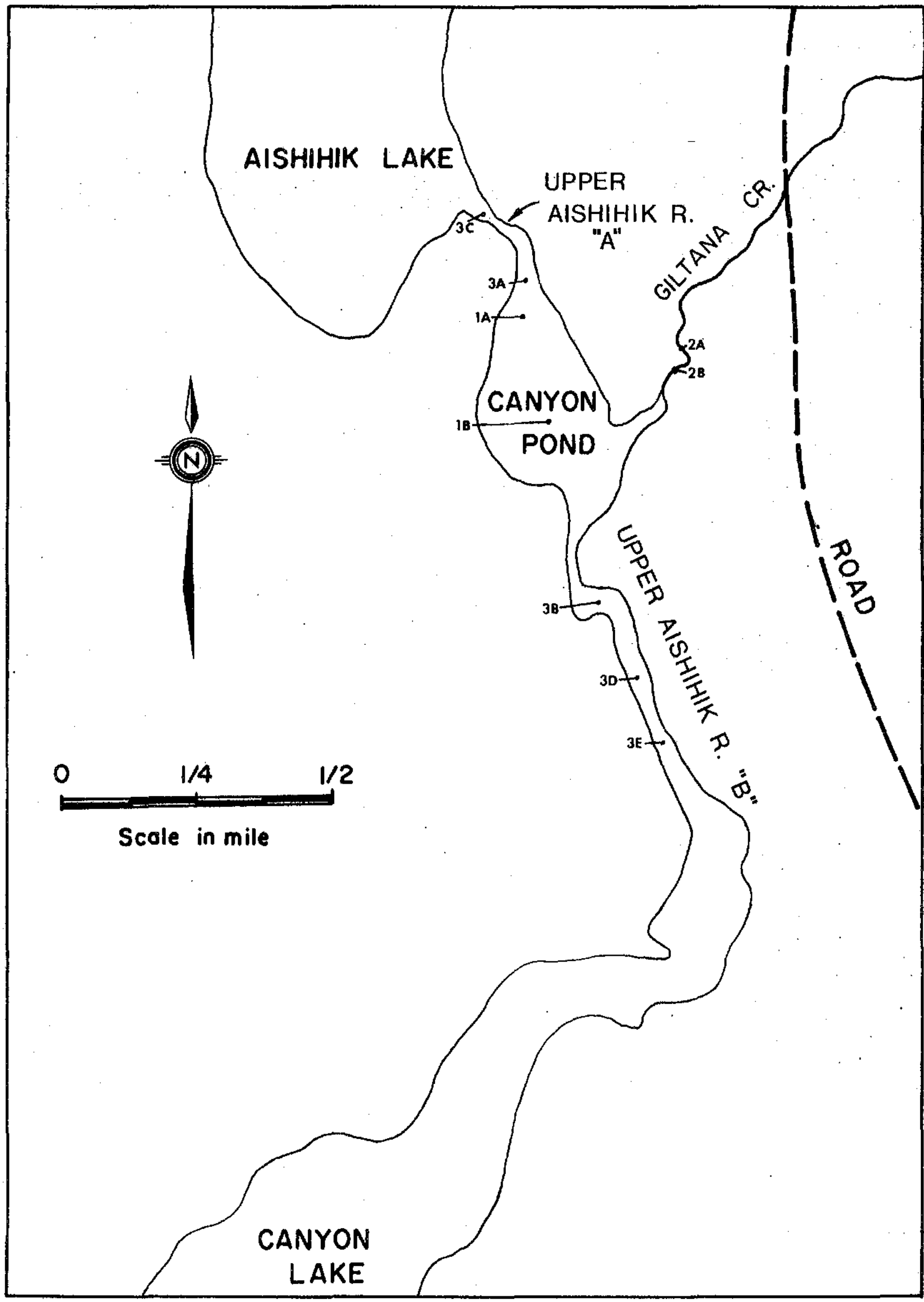


Fig. 4 Principal study area in 1973

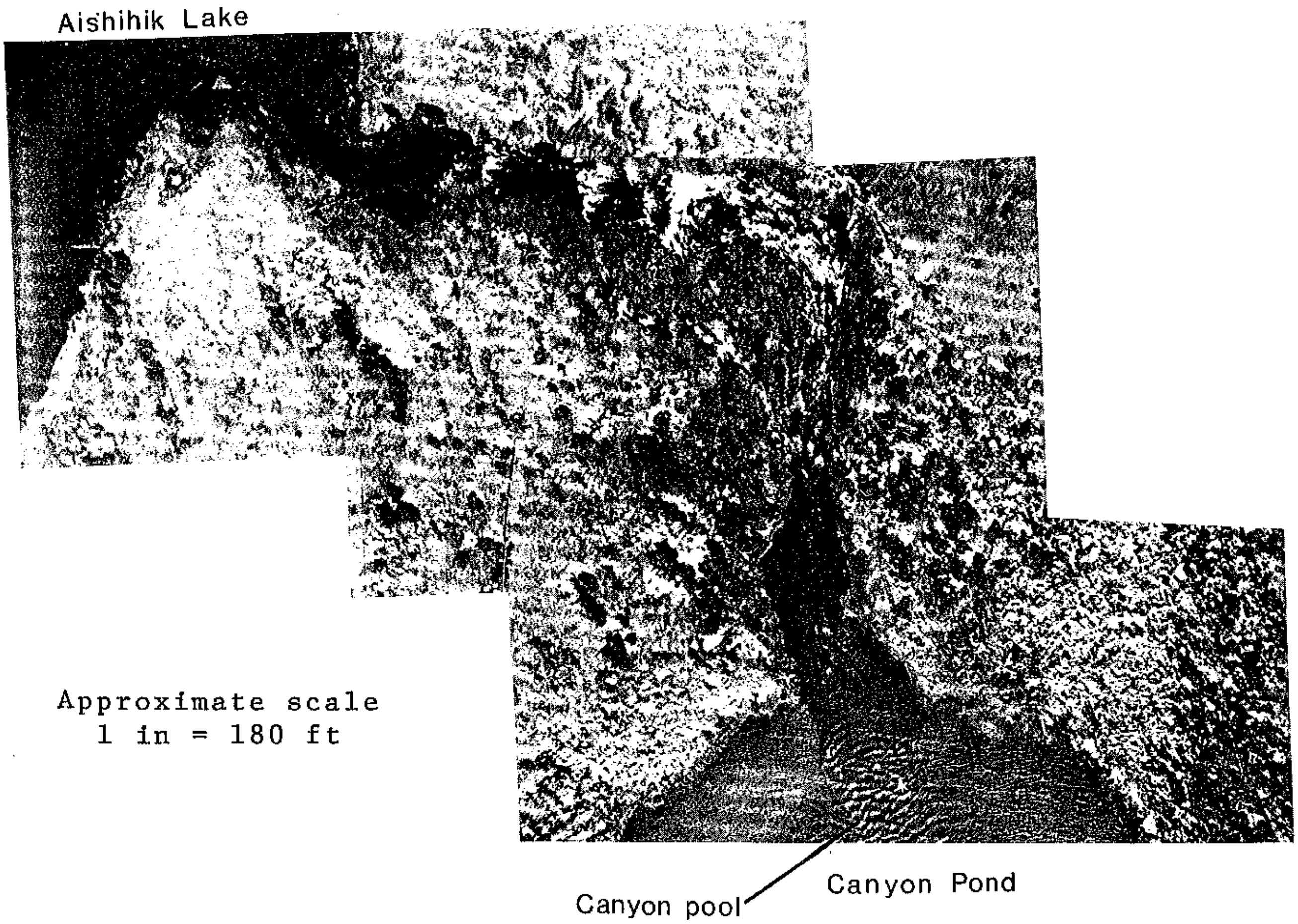


Fig. 5 Upper Aishihik River "A"

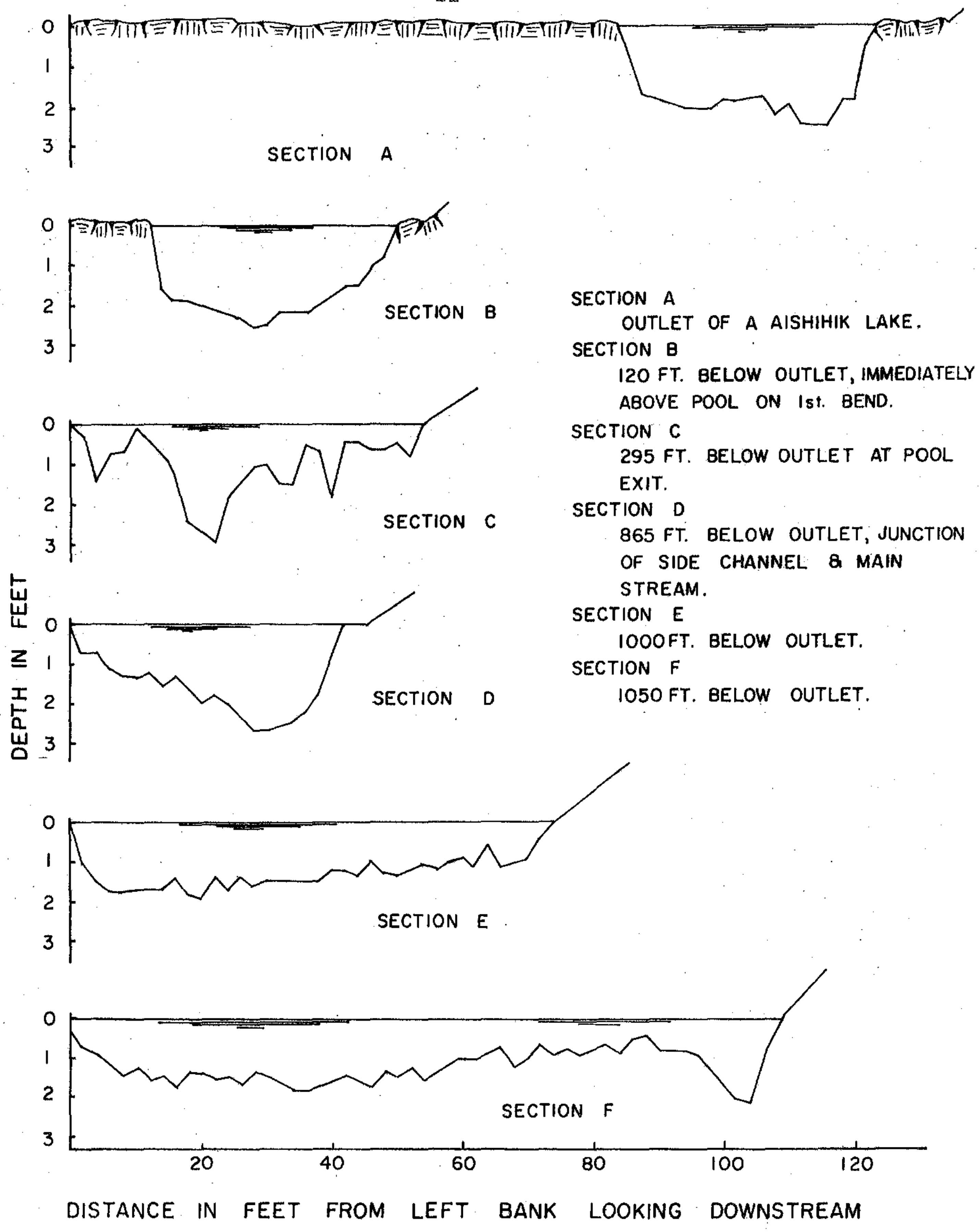


Fig. 6 Cross-sections of outlet stream from Aishihik Lake, namely Upper Aishihik River "A".

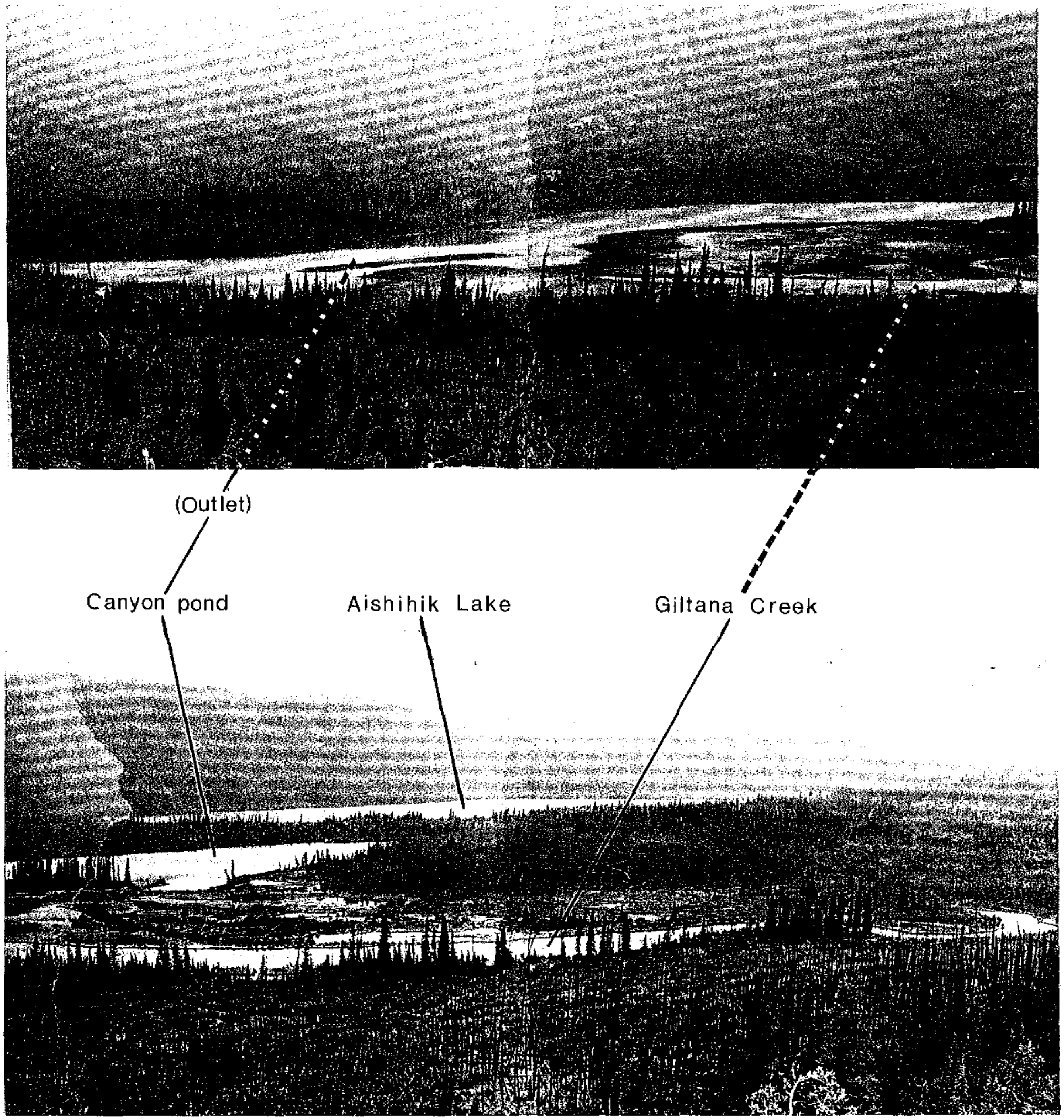


Fig. 7 Canyon pond and Giltana Creek

bedrock and flat boulders with small quantities of gravel. Characteristically the stream has a trench throughout its length with extensive shelf areas on one or both sides of the trench. The trench averages approximately 25 feet in width and 2 feet in depth (Fig. 8). Between 800 and 1,400 feet below Canyon Pond the trench enlarges and forms two pools. The upper pool measures approximately 200 by 100 feet and the lower one 250 by 150 feet (Fig. 9). Maxima depths are 10.5 and 17.0 feet respectively. From Canyon Pond to the second pool the water on the right side (looking downstream) is clear and that on the left brownish. Water temperature differences range from 3° to 9°F at a given time with the left side being the warmest. These differences are due to unmixed waters originating with Aishihik Lake and Giltana Creek respectively.

Giltana Creek drains a small lake system located east of Canyon Pond. Only that part from the Aishihik road to entry at Canyon Pond, a distance of approximately 4,000 feet was examined. The top half of the area is steep, rocky and turbulent and the bottom half (Fig. 7) is low gradient, silty, weedy and slow. A very short transitional section of approximately 300 feet contains some gravel. The water temperature ranged from 42°F in late May to 60°F in mid-July. The temperatures of Giltana Creek were consistently higher than those in Upper Aishihik River "A" the difference being from 3° to 9°F during the summer (Fig. 10).

Properties of flow from Upper Aishihik River "A" and Giltana Creek as determined by the HACH Kit method are given in Table I.

Photos of general interest appear in Appendix B.

Table I. Some properties of Giltana Creek and Upper Aishihik River "A"

	GILTANA CREEK		UPPER AISHIHIK RIVER "A"	
	May 29	June 21	May 29	June 21
Alkalinity: Ca Cl	0	0	0	0
MO	6	5	4	4.5
Hardness	7	6	5	5
Acidity: free	0	0	0	0
Total	.33	.33	.33	.33
pH	8.5	8.5	8.5	8.5
dissolved oxygen	12.0	11	12.5	11.5
CO_2	5	2	5	7.5

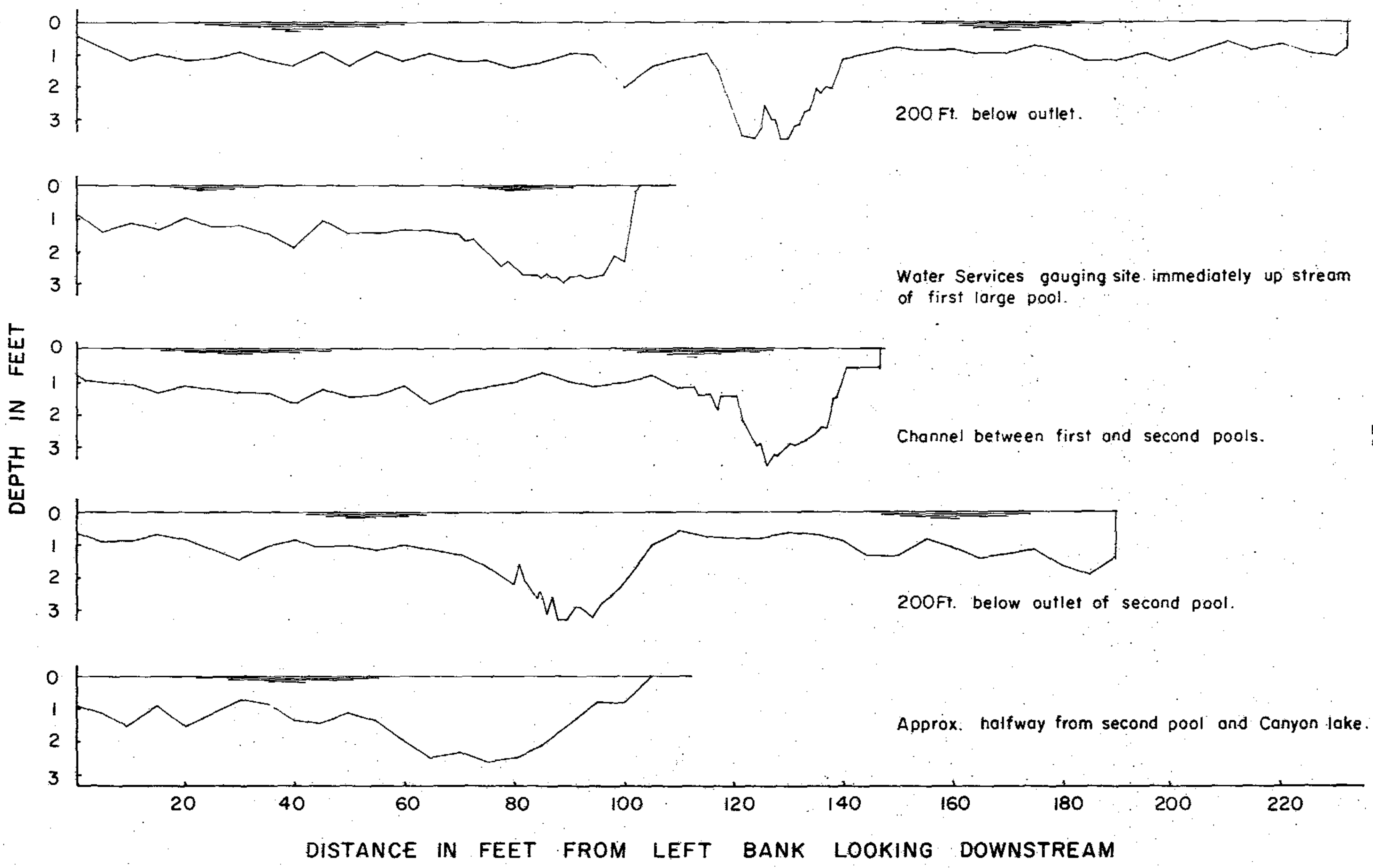


Fig. 8 Cross-sections of outlet stream from Canyon Pond, namely Upper Aishihik River "B".

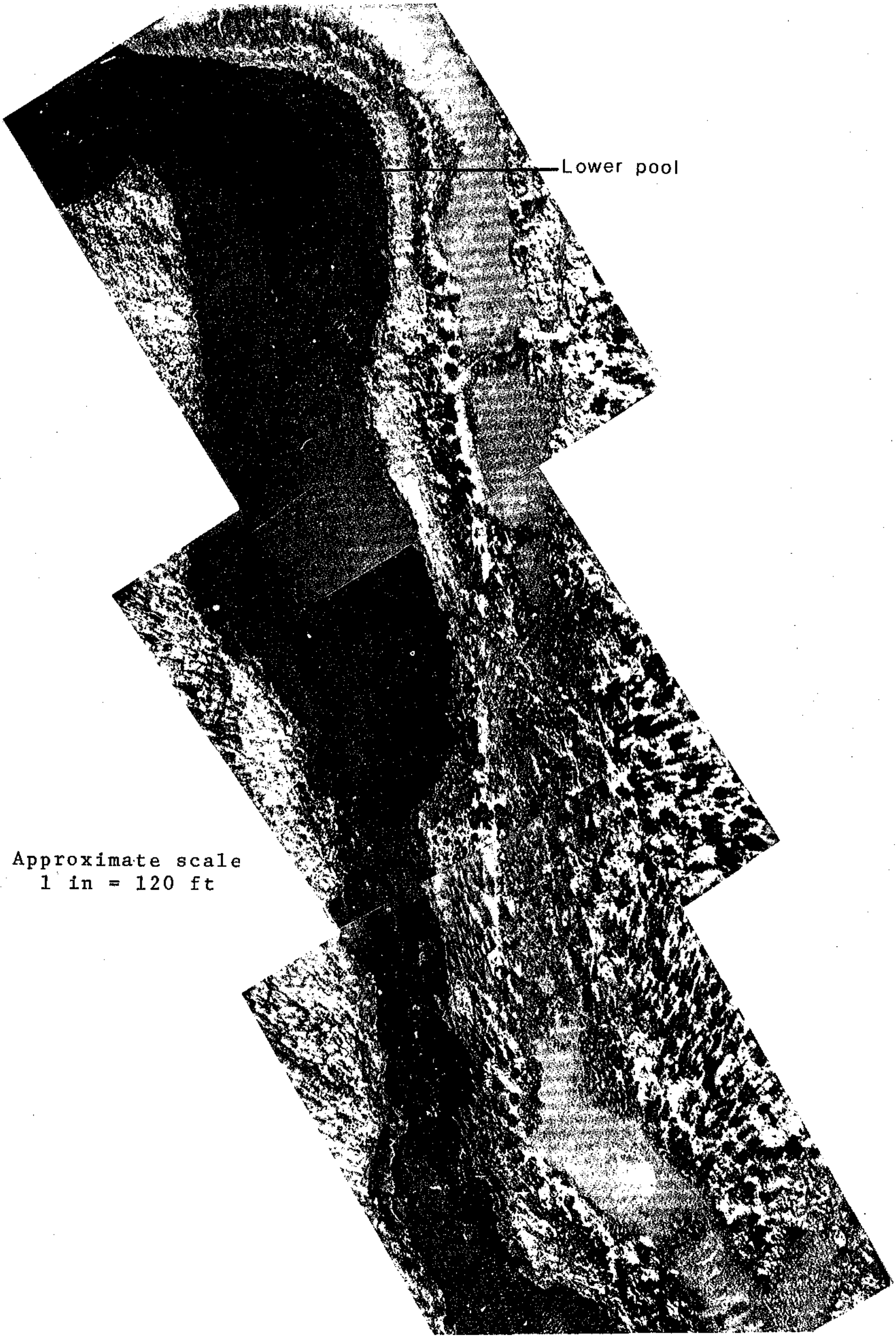


Fig. 9 Lower 1200 feet of Upper Aishihik River "B".

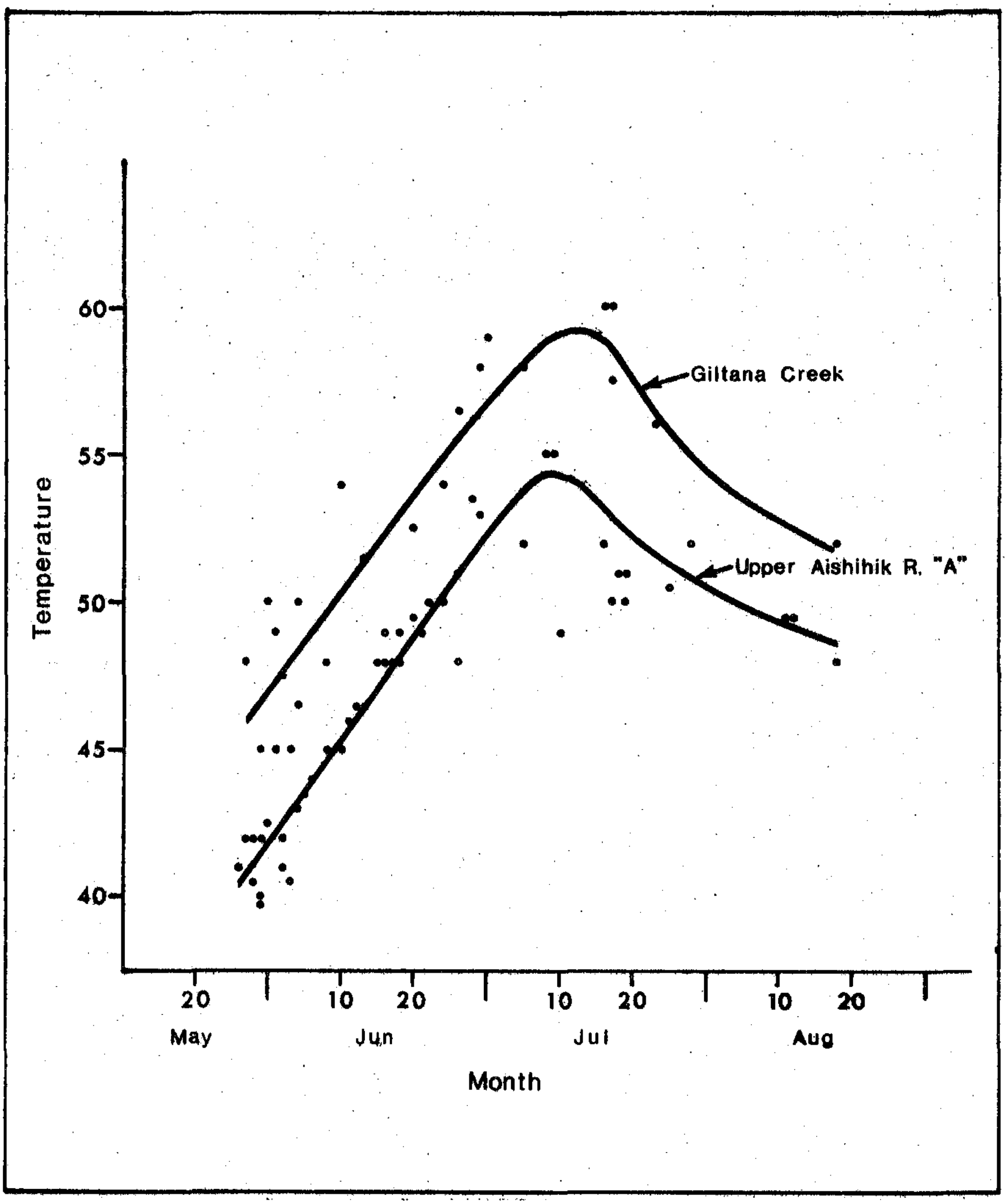


Fig. 10 Water temperatures (°F) in Giltana Creek and Upper Aishihik River "A".

METHODS

In 1973 the activities in the principal study area included the observation, capture, measurement and tagging of fish; the collection and analysis of invertebrate populations; and the examination of stomach contents in fish.

Studies were carried out in the periods May 25 - September 10, October 3-6, November 5-9, November 13-23 and December 10-13.

The capture techniques for fish were gillnet, seine, dipnet, fyke net and sport gear.

Gillnet mesh was monofilament nylon with sizes ranging from 1½" to 3½" stretched mesh. The netting was hung in panels measuring 50' x 8', both sink and float types were available. A panel contained only one mesh size. Up to three panels were tied together to form a net. The size of net and size(s) of mesh used depended upon the purpose for which the sample was taken. Gillnets were utilized more widely in both time and place than any other gear. However, the catch was restrictive to fish of adult and near-adult size.

Seines measured from 10' x 3' to 50' x 8'. Each net had a bunt with mesh in the order of 1/8". This gear was used in pond, pool and slow-riffle areas. It was most effective on fish intermediate in size between adult and infant.

The dipnets were rectangular frames (2' x 1½') covered with 20-mesh-per-inch netting. The equipment was useful to capture fry-of-the-year (infant) and was effective in pools and slow riffles.

The fyke nets were the two throat-type with a front opening of 4' x 4'. One-eighth-inch mesh was used in the cod end and ¼" on the sides, body, and wings. These nets were used to test for outmigration from Aishihik Lake. Generally two nets were installed, one within 200 feet of the lake outlet and the other within 100' of Canyon Pond. The distance between nets was in the order of 600 - 1,000 feet. The nets were fished for 5 days per week in the period May 27 - June 15. Usage at other places and times was too infrequent to warrant mention.

Spin and fly cast equipment represented the sport effort. Sport activity was carried out almost continuously during the summer and over a wide variety of places and times. Sport gear was particularly effective for sampling grayling. The risk of obtaining highly selective samples in terms of size of individual and contents of stomach was recognized. Lake trout and pike were also taken on sport gear.

Tags were applied to the body in the vicinity of the dorsal fin to provide information on migration and magnitude of stock. The tags were Petersen disc, 9 1/6" diameter. A total of 542 fish were tagged with the following composition:

133 humpback whitefish; 29 round whitefish, 201 Arctic grayling, 2 northern pike, 176 longnose sucker and 1 lake trout. A summary of the tags applied is given in Table II.

Stomach contents were examined on 50 whitefish and 50 Arctic grayling. Stomachs were removed and preserved in 10% formalin. At a later date the stomachs and contents were weighed to the nearest gram, then the stomachs were emptied and re-weighed. Stomach contents were identified and the percentage occurrence of Order and/or Family groups was estimated based on its mass relative to total content .

Length was taken as the distance from tip of snout to fork of tail. Length measurement totals: 237 humpback whitefish, 55 round whitefish, 243 Arctic grayling, 174 longnose suckers.

Table II. Numbers of fish tagged - Aishihik, 1973.

Date	Area*	Ta	Cc	Pc	Cac
			Nos. Tagged		
29/05/73	1A	1	20	4	
18/06/73		6	28	9	
23/07/73		2	6	6	
		9	54	19	
27/05/73	1B				2
01/06/73			8		8
			8		10
02/06/73	2A				23
04/06/73		1	2		4
05/06/73		3	20		136
		4	22		163
28/05/73	2B		6		3
02/06/73			4		
			10		3
28/05/73	3A		8		
29/05/73			5		
05/06/73			1		
12/06/73			12		
13/06/73			4		
27/06/73		34			
29/06/73		6	1	1	
28/07/73		24			
29/07/73		19			
		83	31	1	
01/06/73	3B	9	3	3	
03/06/73		11	3		
20/06/73		10	1	6	
21/06/73		4	1		
28/06/73		15			
		49	8	9	
30/07/73	3D	40			
		40			
29/07/73	3E	9			
30/07/73		7			
		16			
		201	133	29	176

27/03/73 - 1A - 1 Sn
01/06/73 - 1B - 1 El
28/05/73 - 2B - 1 El

Total Number Fish Tagged = 542

Ta = Arctic grayling
Cc = humpback whitefish
Sn = lake trout
Pc = round whitefish
Cac = longnose suckers
El = northern pike

* See Fig. 4.

Scales were removed for age and growth analyses in the following numbers: 20 humpback whitefish, 10 round whitefish and 30 Arctic grayling.

Interpretation for age was made by personnel of the Technical Services Group utilizing standard techniques.

Invertebrate drift was sampled in two ways. The sampler reported by Miller (1961) was used with 250-micron mesh. Depending upon the depth of water, one or two standard tubes were attached to the undersurface of the float to sample a 4" diameter flow centering at 9 and 13 inches below the surface. The second method used to sample invertebrate drift was one modified from a trap design reported by Mundie (1970). The apparatus consisted of a front-end, bagnet, and sample container. The front end was made of 10-gauge aluminum plate which flared from a rectangular opening measuring 1¼ x 12 inches (fishing area) to one 3 x 12 inches over a distance of 8 inches. The bag net was made of 250-micron nylon; its length was 34 inches. The sample container was made of ABS black plastic tubing and measured 1 5/8 inches inside diameter with windows of 250-micron mesh (Fig. 11). In instances where the depth of water was greater than 12 inches a second similar unit was stacked on top. The samples were analyzed by laboratory groups under the direction of Dr. D. N. Gallup, University of Alberta, and Mr. W. Schouwenburg, Fisheries and Marine Service. The method was designed by Dr. Gallup and is given in Appendix C.

The standing crop of stream bottom organisms in gravel and rock areas was measured by sampling an area measuring 20 x 20 in. which was marked out by a metal frame. Rocks within the enclosed area were scrubbed with a brush and the remaining substrate disturbed by shuffling and digging with the heel and toe. The resulting drift was captured by a rectangular-mouthed bag net with a mesh of 250 microns. In areas of sand, silt and mud an Ekman dredge measuring 6 x 6 in. was utilized to obtain a sample.

The second and minor part of the 1973 studies was to survey the tributary streams of Aishihik Lake. Sekulmun River was surveyed its full length on June 24 - 26, July 2 and July 14. In

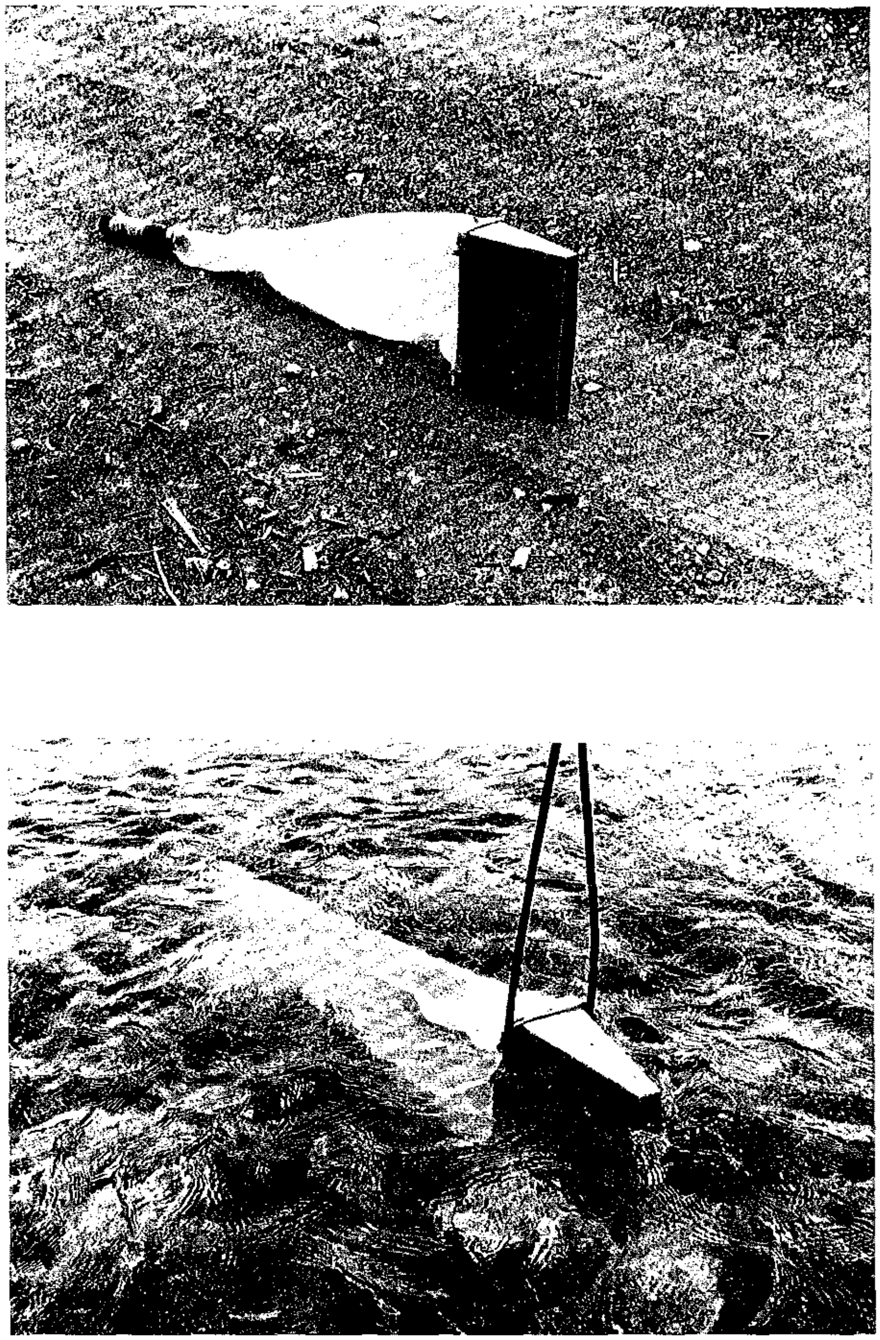


Fig. 11 Sampling apparatus for invertebrate drift

the course of the June 24-26 survey, gillnets with mesh sizes of $1\frac{1}{2}$, $2\frac{1}{2}$, 3, $3\frac{1}{2}$ and $5\frac{1}{2}$ inches were set in 6 widely separated places and lifted after 24 and 48 hours of soak. Small mesh seines were used in the uppermost 1 mile of stream, and sport gear (fly and small spinner) in the upper $2\frac{1}{2}$ miles. Observations were carried out at all times, with particular attention being given to the gravel areas with a view toward locating spawning areas for grayling. The net catches were identified to species, measured for length (TSFT) and examined for sexual maturity and stomach contents. In the course of the surveys of July 2 and 14 the activities were limited to sport fishing and observation with the exception of one "sweep" with a small mesh seine in the latter survey. Hawkins Creek was surveyed for 600 feet on June 29, Lister Creek for 3,000 feet on June 29, McIndoe Creek for 6,000 feet on June 29 and Soldier Bay for 3,000 feet on June 1. In each case general stream characteristics were noted, photographed and in some cases measured. The presence of fish was determined largely by observation because the rocky nature of the stream and/or the high flows inhibited effective use of nets.

RESULTS

Principal Study Area

Fish Stocks:

Eight species of fish were found in the principal study area, namely humpback and round whitefish, Arctic grayling, lake trout, northern pike, longnose sucker, slimy sculpin and burbot. Rainbow trout which inhabit the Aishihik River have not been observed between Aishihik and Canyon Lakes.

The whitefishes and grayling were most abundant throughout the study period; however, suckers were present in relatively good numbers in late May and early June.

Grayling:

The grayling were more widely distributed than the other fish inhabiting a wide range of velocity conditions, from "white" water to placid flows.

Sexually maturing grayling measuring 265-455 mm "appeared" at the inflow area to Canyon Pool and in the lower area of Giltana Creek at the end of May. Spawning was observed in Giltana Creek in the period of May 28 - June 10. It is likely that grayling spawned in Upper Aishihik River "A" and "B" also because newly emerged fry appeared in or close to these areas at a later date.

As June progressed, adult-size grayling extended their distribution throughout the watercourse, presumably away from spawning areas and/or overwintering sites. They were observed to occupy the swifter and deeper parts of the watercourse between Aishihik and Canyon Lakes. This extension in distribution resulted in migration through at least Upper Aishihik River "A". This was evident by the appearance of grayling progressively upstream through June eventually reaching the outlet pool on July 3 and by the capture of two tagged grayling at the outlet area of Aishihik Lake. These fish had been tagged in Canyon Pond two weeks earlier.

Intermediate size fish (200-270, mode at 230 mm) occupied shelf areas through the summer and were very apparent by their jumping activity which was associated with feeding. This was particularly noticeable in Upper Aishihik River "B" from the outlet of Canyon Pond to the second pool. This size group could not be found in October and later.

Newly emerged fry measuring 16-18 mm in length were first observed in Giltana Creek on June 24. Similar size fry showed in Upper Aishihik River "B" and Canyon Pond (north end) on June 26 and July 5 respectively. Grayling fry distributed throughout the aquatic grasses of Canyon Pond, Giltana Creek and adjacent ponds. Distribution extended into the grass areas as the water level increased; here the fish benefited from shelter, relatively high water temperatures, and abundance of planktonic food. Growth of grayling fry was rapid attaining an approximate average length of 50 mm by late August. Fry of the year were not sampled after that date.

The magnitude of the adult populations (i.e. >275 mm) is difficult to estimate because of migration into and out from the study area, loss of tagged fish, lack of reliable tagged to un-tagged ratio information from the sport fishermen and low recovery effort by scientific means.

Suckers:

A gillnet located at the extreme north end of Canyon

Lake and operated by Natives for personal use began catching maturing suckers in the third week of May. Suckers were observed in a school estimated at 100 fish in Canyon Pond on May 27 near the outlet end. Their position was evident by the presence of "dirty" water in a very small area of the pond. The "dirty" water was caused by agitation of the bottom of the pond by fish. It was not determined if the fish were involved in spawning or pre-spawning activities. Two members (490 and 500 mm in length) were caught in gillnet and found to be sexually mature. On the following day mature suckers were present in Giltana Creek. Spawning was casually observed in Giltana Creek up to June 10. With one exception, the length of mature fish ranged from 435 to 550 mm with a mode at 470 mm. (Stream temperatures were 45 to 54°F during spawning.) Spawning was observed from the lowest riffle to the vicinity of the bridge, an approximate distance of 3,000 feet. The areas for spawning had gravel and velocity conditions not unlike those utilized by salmon for this purpose. At the precise moment of egg deposition males appeared to outnumber females 6:1. Sucker spawners were not observed elsewhere in the system, however new fry appeared at the point of inflow into Canyon Pool and in Upper Aishihik River "B" at a later date suggesting suckers did spawn in both parts of the Upper Aishihik River, i.e. "A" and "B". Adult suckers were not seen or sampled within the study area after June 10.

Newly emerged fry, measuring 10-12 mm in length, were observed along the stream banks in the low velocity parts of Giltana Creek below the beaver dam and in adjacent pools from June 24 to July 23. They were particularly prevalent on June 30. The length measurements did not change over a four-week period which suggests samples were continually taken from new emergents.

The 10-12 mm fish were initially observed in Upper Aishihik River "B" on June 26 and in Canyon Pond near the water level gauge commencing July 7. It is unlikely that the fry originated from any source other than Upper Aishihik River although spawning was not observed here.

During the summer intermediate-size suckers, in the order of 100 mm in length, were caught in small numbers in Giltana Creek in the low-velocity areas. The samples were too small from which to draw conclusions but it would appear that a limited number of juvenile suckers, possibly of age 1, rear here. On October 5 juveniles of approximately 60 mm in length were sampled in the lowest section of Giltana Creek. This probably indicates winter residence in creek waters.

Round whitefish:

This species was present throughout the summer in moderate flows in Upper Aishihik Rivers "A" and "B" and in low-velocity areas of Canyon Pool; they were not observed or captured in Giltana Creek. Fyke net catches obtained above Canyon Pool during the summer suggest that round whitefish made feeding forays into Upper Aishihik River "A" from time to time. The length of fish at this time ranged from 270 to 435 mm. In October sexually mature fish measured 285 - 330 mm. Spawning occurred in November at the outlets of Aishihik and Canyon Ponds. Water temperature at this time was in the range of 33 - 37°F. The spawning activity is being reported in detail by J. E. Bryan at a later date. The abundance of round whitefish in the study area appeared to maximize in October co-inciding with spawning.

Humpback whitefish:

Generally humpback whitefish occupied Canyon Pond and the two large pools in Upper Aishihik River "B" almost exclusively. However, in late May and early June they were found in Giltana Creek up to the beaver dam and in the lower 200 feet of Upper Aishihik River. Stomachs contained fish eggs tentatively identified as sucker and grayling. Individual size ranged from 335 to 480 mm with a mode at 410 mm. Sexually mature fish were present in Canyon Pond in early October but spawning was not observed. However, eggs were found on aquatic plants at the outlet of Aishihik Lake in November.

Lake trout:

Lake trout were relatively scarce in the study area. The maximum number seen at any one time was 6 and these were located in the major flow areas of the Upper Aishihik River. Length measurements on trout are lacking but weight varied approximately 2 to 17 pounds. There is no information on sexual maturity, migration, or other matters.

Northern pike:

Pike were found in the weedy, slow-moving areas on the east side of Canyon Pond and in the lowermost 500 feet of Giltana Creek. Under good conditions up to 5 adult-size fish were observed on a single pass with a boat. Information on life history is lacking.

Slimy sculpin:

Sculpins were present in good numbers in all waters. Sexually mature fish were found in mid-May. The largest sculpin measured 128 mm in length.

Age and growth:

Reference was made to length of fish in the section titled fish stocks. This one attempts to relate length to age. Age interpretation from scales of northern fishes has proven to be controversial and the length frequency data is limited due to an apparent inability to adequately sample all size (age) groups in the population.

To date age and growth have been satisfactorily worked out for grayling only, that is, the length frequency data corroborates age interpretation made from scales. The results are given in Table III.

Table III. Age and length of stream grayling in the Aishihik system.

Age of sample	Calculated mean lengths of fish				Sample size
	Age I	Age II	Age III	Age IV	
Age II	95	176			25
Age III	89	172	243		2
Age IV	104	172	242	295	12
	Modal values in length frequency data				
		170	230	285	235

The oldest grayling found in Aishihik streams was Age V.

In the other species there was little relationship between size and age suggesting further study is required.

The age of humpback whitefish obtained by sampling was interpreted to range from Age III to Age IX. Mode values of 370 and 410 mm appear in the length data and fish of these sizes are believed to be largely Ages VII and VIII respectively.

Round whitefish ages were interpreted as ranging from Age V to Age VIII. A mode value of 310 mm was represented by Ages V and VI.

There is no age-growth information available for the other species.

Stomach contents:

The Arctic grayling in the size range of 297 - 372 mm consumed largely black flies (Simuliidae), which frequently represented 80-90% of the bulk of the stomach contents. Caddis fly (Trichoptera) and midges (Chinonomidae) were of next importance in that order. The average weight of food was 8.5 gm.

The caddis fly was the dominant organism (80-90%) found in the stomachs of round whitefish (300-383 mm). Midges and black flies and molluscs were also represented. An average of 1.4 gm of food was found in the gut.

The stomach contents of humpback whitefish were more varied. Major items were molluscs, black flies and midges. Minor components were crustacea and plants. The amount of food was extremely variable from a trace to 5.2 gm.

Most insects were in the larval stages.

Invertebrate Populations:

The results on invertebrate sampling are given in Appendix Report "D" prepared by D. N. Gallup and Alan Clements, University of Alberta; some samples are yet to be processed. A calculation for total invertebrate biomass in the stream drift is not made for reasons explained by Gallup and Clements. Also, irregularities in methodology preclude making direct quantitative comparison with results obtained elsewhere by similar types of gear. However, the data is valuable as base-line information to make comparison with samples to be obtained in 1974. The main points of the Aishihik stream invertebrate study are:

- the number of invertebrate species present are relatively scarce. Hence interdependence on each other for survival may be high and if this is true there is great risk of collapse in the "balance" of interrelationships if one or more species is adversely affected by modified flows. If an upset does occur the food supply to the fish may be drastically diminished or altered in kinds of available organisms;
- the quantity of stream drift is relatively high. This is based on in-situ observations made by Dr. D. Gallup. The drift has two components, i.e. plankton originating from Aishihik Lake and insect larvae and adults arising with the stream itself. The minimum amount of drift that is required for consumption and fertilization in the stream, pond and lake waters is not known. However, it must be expected that a "balance" of sorts has been established since creation of the present system and that a drastic change in flow pattern would upset this balance;
- invertebrate production appears to be extremely high on the stream and pond shelf areas. Desication of shelf area would have very serious adverse effects on invertebrate production and in turn on the fish stocks.

Tributary Streams

Lister Creek:

Date of survey:	June 29	Length of survey:	3,000 ft.
Temperature:	45° F	Width of stream:	40' - 60'

Within the area surveyed the stream is pool and riffle with a gravel and sand base and appears to offer the best opportunity for lateral stream spawning within the Aishihik system. The area is heavily forested with spruce (Fig. 12). No fish were sighted.

A reduction in lake level will result in stream bed cutting and bank erosion with a fall-in of spruce. An increase in lake level will inundate the forested fan.

The stream appears to have the potential to maintain a fish stock and further study is recommended.

Hawkins Creek:

Date of survey:	June 29	Length of survey:	600 feet
Width at mouth:	12'	Depth 6" - 20"	Current 3'-5'/sec.
Temperature:	55° F		

The stream has rock and boulder base with rapid drop; chutes exist at 300' upstream from mouth and cascades at 600' (Fig. 13); does not appear to have potential for spawning; no further study required.

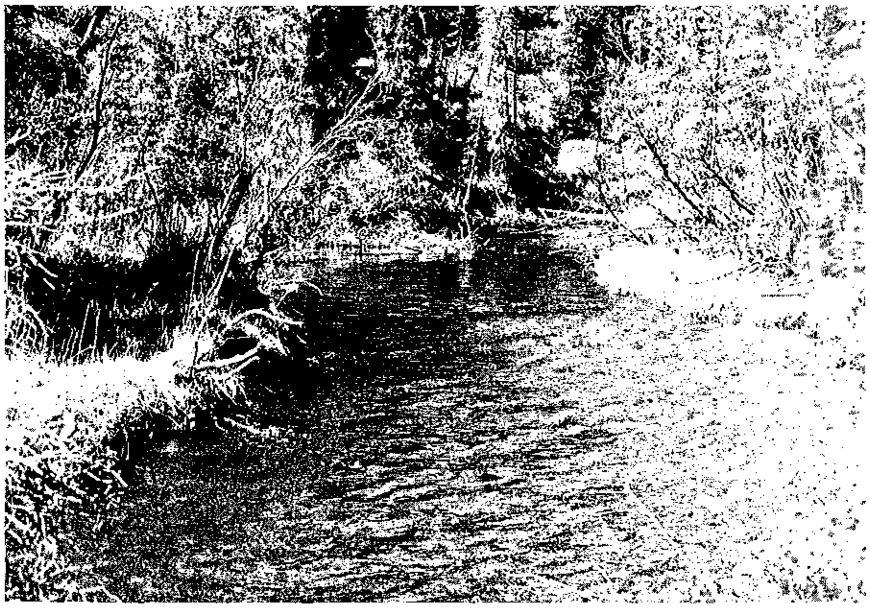
McIndoe Creek:

Date of survey:	June 29	Length of survey:	6,000 ft.
Temperature:	49° F		

Stream meanders through extensive fan; lower 1 mile has slow current, width up to 100' and sufficient depth to operate

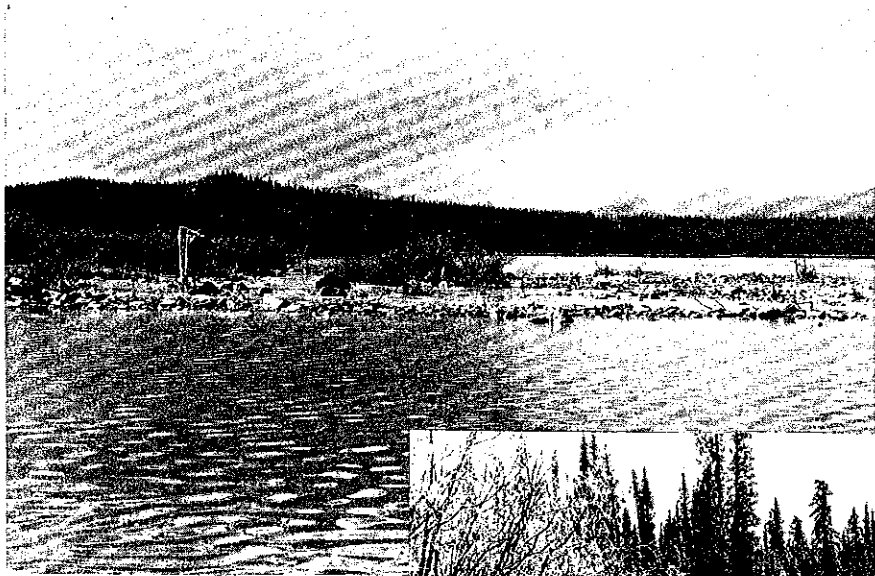
Delta area
mid-September 1972

Mouth area June 29/73



"Typical" pool and
riffle section

Fig. 12 Lister Creek



Mouth

100 ft. above mouth

Chute

Above chute

Fig. 13. Hawkins Creek

propeller-equipped outboard motor; from 1.0 to 1.5 miles stream is largely riffle with mud and sand banks and base and insignificant quantities of gravel (Fig. 14); beaver houses plentiful; bank sloughing exists; grayling and whitefish are abundant in lower 1 mile. Any change in lake level most likely will result in extensive stream bed and bank erosion and general deterioration of a relatively extensive rearing habitat; area requires more study.

Sekulmun River:

Dates of survey: June 24-26, July 2, July 14.
Length of Survey: 5.0 miles.
Temperature: 45°F 24-26/06/73, 48°F 02/07/73; 49°F 14/07/73.

Net catches were: 57 humpback whitefish, 3 round whitefish, 11 Arctic grayling and 2 lake trout for a total of 73 fish. Fish were effectively caught in the 1½", 2½", 3", 3½" mesh nets; the 5½" mesh net caught no fish. Sport caught fish were represented by 11 grayling. Seines accounted for 2 unidentified fry during the first survey, and numerous grayling fry in mid-July.

Size composition of the species was as follows:

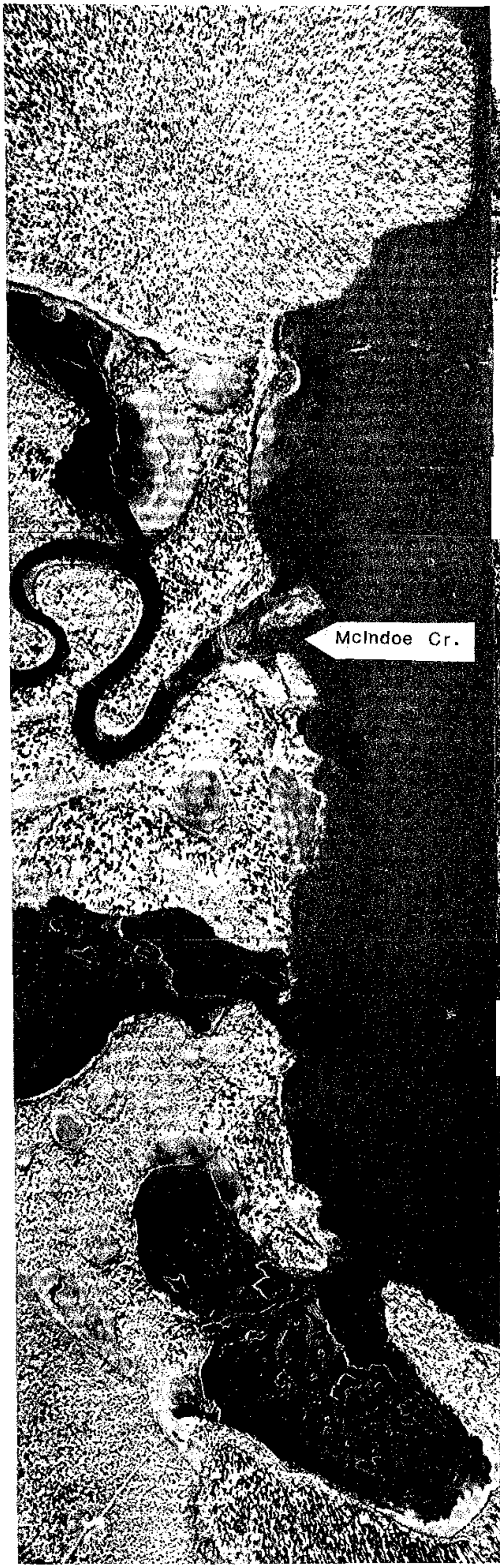
humpback whitefish:	335-445 mm; mode at 370 mm
round whitefish:	245, 285 and 310 mm
arctic grayling:	122-445 mm; modes at 165-170 and 335 mm.

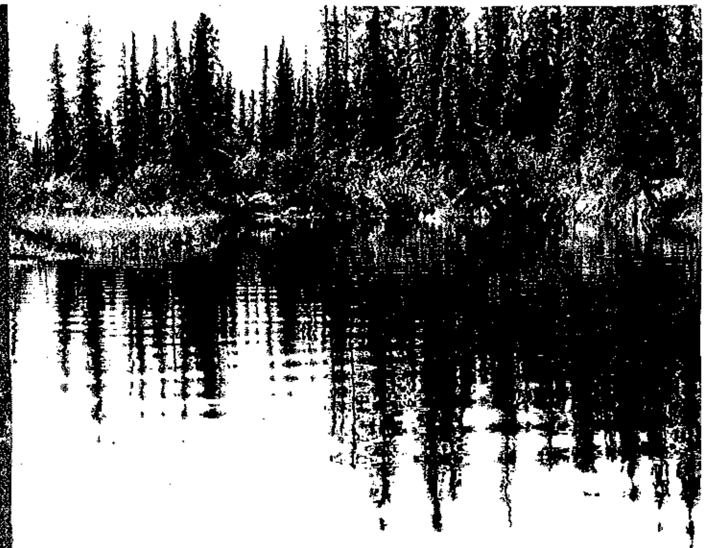
No spawning was observed for any species nor were sexually mature fish positively identified. Some grayling examined on the first survey exhibited a spawn-out condition.

Stream deserves further study.

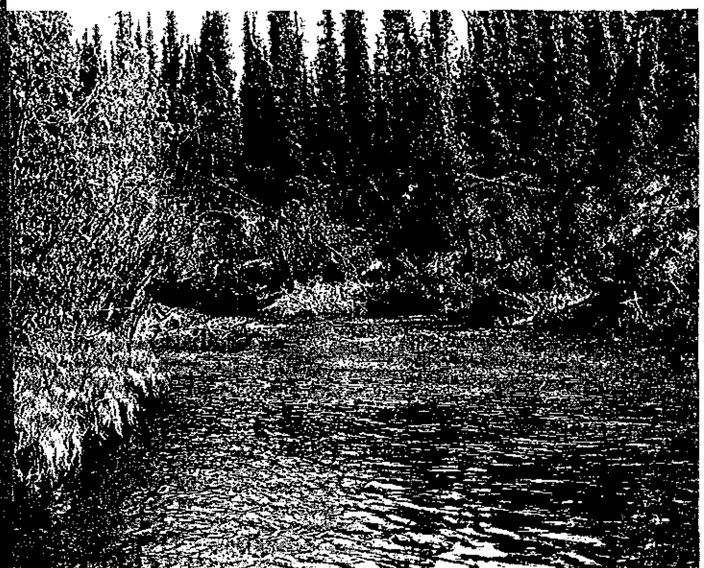
Soldier Bay Creek:

Date of survey:	July 1	Length of survey:	3,000 ft.
Temperature:	56° F	Width of stream:	20 ft.





Mouth area June 29/73



First riffle

Sluff bank area

Fig. 14 McIndoe Creek

This is a fairly rapidly dropping stream with a rock and gravel base; mouth area is slough-like (Fig. 15); juvenile and adult fish sighted in mouth section. Further study is required.

Mouth area July/73

Section of creek
near mouth

"Typical" section
of creek

Fig. 15 Soldier Bay Creek

SIGNIFICANCE OF FINDINGS TO HYDRO-POWER SCHEME

The watercourse between Aishihik and Canyon Lakes is inhabited by fish of eight species for one or more of the following functions: spawning, egg incubation, nursing, feeding, migration and shelter. Fish have been present on all surveys which collectively represent 9 months of a year. Therefore, the watercourse can be classified as an all-purpose, all-season habitat as far as some fish are concerned.

The turn-about in flow pattern that will arise with the generation of power from low to high in winter and from high to low in summer raises serious questions.

Practically nothing is known of the requirements of the fish to survive through the winter. At this time it is presumed that the fish are sedentary and that wetted area and adequate oxygen are the prime factors involved in their survival but food may be important with some species. If so, increased winter flows, if maintained on a continuing basis, may improve conditions and enhance survival. Conversely, during the summer the fish are active. Therefore, reduced discharges may have significant adverse effects on fish and in some instances go so far as to eliminate a species or a specific group within a species from the study area. The question of summer minimum flows out of Aishihik Lake becomes paramount.

Fraser (1972) in review of the effects of discharge on the stream environment summed it as follows:

> "Discharge effects relate to food production, stimulus for migration, success of migration, spawning, survival of eggs and juveniles, spatial requirements and shelter needs. Excessive high and low flows have caused major changes in fish populations.
>
> Discharge has different effects in stimulating migrations of anadromous fish, both with different species

and with the same species in different streams. Reduced flows cause undesirable delays in both upstream and downstream migrations. Natural freshets are important in migration patterns. Salmonids demonstrate a narrow tolerance to velocity and depth in choosing spawning areas. Velocity of flow is perhaps the most important aspect of discharge for salmonid spawning, embryo development, food production and rearing. The strong territoriality of resident salmonids in streams influences the relationship of discharge to production of salmonids. Discharge also influences water temperatures, other water quality factors, growth of terrestrial and aquatic vegetation and the transport of solids."

The direct effects of flow reduction on stream flows can be predicted. These amount to a lesser wetted area, a lesser average depth, and most significantly, a much lesser average velocity (Kraft, 1972). In Canyon Pond the direct effect will be a lower water level which will result in a reduction in wetted area, particularly in areas of aquatic grasses. This, in turn, will affect the lowermost areas of Giltana Creek.

Upstream migration has been demonstrated by adult grayling and suckers. It is possible that the movements of these fish in the study area are of greater scope than observed to date. Also lake trout and whitefish may migrate within the water body.

In Upper Aishihik River "A" migration of fish could be complicated, if not made impossible, at very low discharges because of the dispersion of flow by the irregular configuration of the stream bed. This problem may be resolved, however, by cutting a channel in the stream bed. In Upper Aishihik River "B" a flow of approximately 75 cfs or less (25 x 2 x 1.5) will accumulate in the stream trench and leave the shelves dry. No problem in transport of fish is anticipated with this. However, the stimulus for migration may be lost. Baxter (1961) in review of minimum flows suggests artificial freshets may be needed to stimulate fish into migration. He suggests that these need not be longer than 18 hours of which 12 hours should be at 30-70 per cent of the average daily flow at a given time. The onset of migration of salmon with increase in discharge has been reported by various workers (Andrew and Geen, 1960). There is a possibility, therefore, that artificial freshets may be required at Aishihik to stimulate upstream migration by fish. The degree and time of stimulus, if found necessary, has yet to be determined.

The severe channeling of flows in Upper Aishihik River "A" and "B" would concentrate the fry and remove them from the protective niches now provided by stream banks and shallow flows. Hence they would become vulnerable prey to other fishes and possibly birds. Also, the shelf rearing areas utilized by fry would be lost. Fry losses could be extremely high as a result of these consequences.

Summer spawning has not been observed in Upper Aishihik River "A" and "B" but is suspected based on the presence of eggs and "newborn" juveniles within or closely adjacent to these streams. Water depth and velocity are two very important factors connected with spawning and spawn incubation (Andrew and Geen, 1960). Obviously a flow must be maintained at all times to permit the continuation of spawning and spawn incubation. However, without knowledge of species requirements in terms of depth, velocity, substrate and spawning area it is not feasible to present a figure on minimum flow for these life stages at this time.

The most readily observed activity on the part of the fish during the summer was that of feeding. The consumption of food appeared to take place at all hours through at least late May, June, July to at least late August. This intake of vast quantities of "groceries" is necessary at least for some fishes, in order for them to store body reserves to permit the continuation of life during seven months of winter conditions. The kinds of food consumed by the fish in Upper Aishihik River "A" and "B" arise in the stream proper. However, the exit water from Aishihik Lake carries planktonic forms and nutrients that are essential to produce the stream invertebrate populations. The invertebrate mass is directly related to at least two very important factors, namely velocity and wetted area. The distribution of species of stream invertebrates is based more or less on preference for specific velocity range (Ambuehl, 1959; Curtis, 1959, Macan, 1962). A reduction in discharge from Aishihik Lake during the summer will significantly reduce stream velocity which in turn will affect species composition. As a result fast-water species will become less abundant and slow-water ones more so under control conditions.

It must be assumed that the fish will be opportunists and consume the kinds of food made available to them thus not be affected by diet changes.

The quantity of fish food produced is another question and a factor here is wetted area. In the Upper Aishihik River "A" wetted area may be little affected until the discharge approaches approximately 50 cfs. Velocities will be more affected for any reduction in discharge. What this means in terms of quantities of invertebrates is unknown. Summer flows of 1/8, 1/5 and 1/4 a.d.f. (average daily flow) are suggested for adequate food production by Baxter (1961) for fishes in British streams. On this basis the absolute minimum flow at Aishihik for July @ 1/8 a.d.f. is 100 cfs. The question of wetted area is paramount to Upper Aishihik River "B", particularly where a trench and shelf situation exists. With the trench averaging 25 feet in width and 2 feet in depth, a minimum of 75 cfs (@ 1½'/sec.) is required to fill it. A withdrawal of water to this value would expose the stream shelf and reduce the wetted area by approximately 75%. It is safe to assume that this would virtually destroy the production of invertebrates in Upper Aishihik River "B". This, in turn, would have disastrous results to the fish stocks. It is estimated that the shelf areas require 75 cfs to keep wetted and permit fry and intermediate size fish to inhabit. Therefore, the minimum requirement in terms of discharge for the Upper Aishihik River "B" is estimated at 150 cfs.

The invertebrate population in Aishihik River is eaten in part by the fish population. The unconsumed part drifts into Canyon Pond and Canyon Lake, drops to the bottom, decomposes and serves as nutrient. Since the time of glaciation a check and balance situation between invertebrate production and fish has no doubt been established (but it is unknown to the researcher). Also, the minimum invertebrate production that can satisfy food and nutrient needs exists (but is unknown). In this regard it is important that invertebrate production and fish needs be examined under various control flow conditions to determine what flows best serve the situation. This can be investigated upon completion of the Aishihik Lake control structure at which time test flows can be provided for experimental purposes.

In a very recently published work on the subject of minimum stream flows for two mid-U.S. streams Wesche (1973) discusses the matter based on hydrologic parameters, surface area and its composition relative to water depth and velocity and available cover for fish. He concludes that as a minimum flow, a discharge in the 25% ADF range will avoid the flow range for which the rate of habitat decrease is greatest. In terms of outflow from Aishihik Lake this represents the following discharges (the mean monthly averages of the natural run-off is given in parentheses): Jan (157) 39, Feb (126) 32, Mar (115) 29, Apr (113) 28, May (188) 47, Jun (491) 123, Jul (756) 189, Aug (650) 162, Sep (564) 141, Oct (468) 117, Nov (323) 81, Dec (214) 54. It is noted that the above values for the months of June to September incl. are greater than the 100 cfs minimum given earlier in the discussion.

It is impossible to evaluate the effects of lake level changes on the tributary streams and their productivity until the range of lake levels and operating rule curves become known.

ACKNOWLEDGEMENT

R. A. C. Johnston, D. Kato, D. Neave, R. Salmond, J. Stephen and R. Truelson collected data at various times. Additionally, D. Kato was particularly effective with his practical approach to various problems. G. Jones and staff of the Whitehorse office assisted in resolving many logistic problems. J. Bryan was instrumental in carrying out a study on the spawning of round whitefish. Some operational problems were handled by B. Lawley, Habitat Protection.

Dr. D. N. Gallup, University of Alberta, provided valuable in-situ advice on the sampling of invertebrate populations and processing of samples. Some equipment and literature were supplied by Dr. H. Mundie, Pacific Biological Station (FRB).

A. Gibson gave general direction and administered the funds. Miss E. Nolting kindly typed this report.

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APPENDIX "A"

Memorandum Report of 1972 Aishihik Lake Program

Environment Canada Environnement Canada

Your file Votre référence

Our file Notre référence 31-5-17-5

MEMORANDUM NOTE DE SERVICE

TO: A. Gibson, Chief,
Northern B. C. and Yukon Division

FROM: C. E. Walker, Senior Biologist,
Northern B. C. and Yukon Division

SUBJECT: RE: AISHIHIK LAKE PROGRAM

Introduction

This memorandum outlines the studies made and results obtained within the Aishihik watershed during 1972 by NBCYT personnel. The responsibility area for this group lay with stream waters and stream populations. The objectives for this program are described in a memorandum prepared by the undersigned and R. Kussat, dated January 4, 1972, file 34-6-4.

Methods

Initially the Aishihik area was entered with helicopter and vehicle on May 4 and 5 respectively for familiarization with geography and ice conditions. The lakes and streams were found to be frozen with the exception of limited areas below Aishihik and Canyon Lake. However, conditions were too hazardous for work. Also road access was limited to the Canyon Lake area.

Re-entry was made on May 17 and a camp established at Otter Falls, however, road access to the north end of Aishihik Lake was not possible until June 7. Lake travel became feasible following ice melt on the following dates: Canyon Lake - June 16, Aishihik Lake - June 18, and Sekulmun Lake - June 22. Day to day activities ceased on August 20, however, occasional observations continued to September 24.

Observing/netting/trapping activities were carried out on the following streams and at the indicated effort and times. E. Aishihik River between Rainbow Falls and Otter Pond; 20 activity days from May 4 to July 15. Otter Pond; 10 activity days from May 30 to July 25. E. Aishihik River above Otter Pond; 23 activity days from May 17 to July 23. Outlet stream from Aishihik Lake; 18 activity days from May 4 to August 13, plus Sept. 23. Giltana Creek; 3 activity days June 13, June 27, July 2. Sekulmun River; 19 activity days from June 17 to September 21 (floating ice was present in stream in June 20). Lister Creek; 4 activity days, June 17, July 21, 22, and September 23. Stream A3: 1 activity day, June 17. McIndoe Creek; 3 activity days, June 30, July 1 & 2. Albert Creek; 10 activity days from June 8 to Sept. 21. Bear Creek: 3 activity days, June 17, June 23, and August 5. Isaac Creek: 3 activity days, June 17, June 23 and August 18.

.../2

Dec. 29 19 72

F-2013 (REV. 1/72)

Stream measurements and descriptions were made as per standards developed in the stream catalogue series. Fyke nets (4 x 4 front frame, 2 throat, $\frac{1}{4}$" mesh on sides and wings and 1/8" mesh bag) were utilized in the East Aishsihik River above and below Otter Pond and in the Aishihik Lake outlet stream to sample for downstream migration. Box traps (2' x 2' x $3\frac{1}{2}$', plastic wire coated mesh of 6 mesh to inch, single throat) were used adjacent to the fyke nets to test for directional movements of small fish. The test for upstream and downstream movements was done on alternate nights. Bag nets (metal frame 2' x 1' with an attached mesh bag, 8 meshes/inch and 4' long) were set in the Aishihik River to sample for the drift of eggs, larvae and newly emerged fish. Seines (35'-50' long and 4' deep with $\frac{1}{4}$" mesh; 150 x $91\frac{1}{2}$" mesh with $\frac{1}{4}$" mesh pocket) were operated where feasible with regularity to capture fish for identification and measurements of vital statistics. Gill-nets (50' x 8', $2\frac{1}{2}$" and 3" stretched mesh, monofilament) were used in Otter and Canyon Ponds, and Sekulmun River to catch larger size fish. Sport gear (spin cast & fly) were used extensively throughout the system to supplement other sampling techniques.

A heavy algal * growth in lake fed waters precluded continuous use of nets and traps. The gear was operated during the time of minimal light, usually 2300-0100 hours. Gillnets were generally set at these hours also because they would be less visible to the fish.

Peterson disc tags were applied on fish in the Sekulmun R. and Canyon Pond as shown below.

Place	Date	Species	#Tagged	Length range in mms.	Modal Length
Sekulmun	July 9	Humpback whitefish	31	270-410	370-390
		Round whitefish	11	205-360	---
		Burbot	1	490	---
		Grayling	3	350-430	---
			46		
	August 8 & 9	Lake trout	2	418-426	---
		Grayling	54	225-405	250-300
			56		
	August 11-13	Humpback whitefish	26	250-440	390
		Round whitefish	8	290-375	---
		Grayling	162	220-415	285
			196		

Eight streams are considered to be important in the Aishihik system and are discussed in this report. These are;

E. Aishihik River - drainage stream of system outlet stream from Aishihik Lake.

Lister Creek - west side of Aishihik Lake.

* Tentatively identified as belonging to the Genus Gomphonema, coutesy of Dr. T. Northcote and U. B. C. assistants.

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McIndoe Creek - east side of Aishihik Lake.
Link (Sekulmun) River - between Sekulmun and Aishihik Lakes.
Albert Creek - north end of Sekulmun Lake.
Isaac Creek - west side of Sekulmun Lake.
Bear Creek - lower west side of Sekulmun Lake.

An undetermined number of samples were measured for length (tip of snout to fork of tail), identified to sex, and had stomach and gonals removed for further study. Unfortunately the material has not been analyzed with the exception of length composition for the tagged samples, therefore, this report is incomplete on these matters.

Results

E. Aishihik River

Length: 7.5 miles Width: 80' - 120'
Discharge: Annual mean approximately 350 cfs; est. 495 cfs. July 15.
Gradient: Approximately mean of 30'/Q00.
Temperature: Water temperature relatively similar throughout. A series of temperatures gives the following trend;
35° May 4, 40° May 17, 45° May 29, 50° June 15, 55° June 30, 60° July 3, 64° (max.) July 8, 60° July 19.

ph 8.5 June 16. D.O. 12 mg.l.
Description: The stream has three characteristically differing areas.
(1) From outlet of Canyon Lake to Otterpond (approx. 2000') mostly "white" water, bedrock and boulder, one large pool half way with fine and coarse gravel in tailrace section.
(2) Otter Pond: measures approx. 1700' x 1200'; pond depth generally 3'-4', however, pool at inlet is 10-15' deep; mud bottom throughout
(3) From Otter pond to W. Aishihik River the stream is subdivided as follows:

Otter Pond - 1000': Pool, largely boulders but some find material also present.
1000'-4000': Narrow riffle area with some side channels; coarse stream bed.
4000'-9000': Broad riffle, relatively shallow.
9000'-11000': Pool; largely fines.
11000'-18000': series of lengthy rapid and short abrupt drops; bedrock and relatively large boulders; little or no gravel; one pool area located at 15,500'; high aesthetic value.
18000': rainbow falls.
Below rainbow falls river is again a series of chutes and cascades and falls to junction with west Aishihik River.

Species Composition and Other Data

Grayling: Largely inhabit the stream area below Otter Pond: 110- 120 mm. early June; 25-30 mm. and 168-200 mm. (late June). The small size group was located at 15,000' below Otter Pond; sexually mature fish were not observed, however, the presence of newly emerged juveniles in mid June suggests spawning occurred at time of break-up.

Rainbow trout: Found only between Otter Falls and Otter Pond. Three size groups were sampled: 131-152 mm., 200-225 mm. and greater than 260 mm. (July). Neither fry nor sexually mature fish were found; the trout became readily catchable on sport gear on or about July 7 when the water temperature exceeded 60°F., the larger fish were caught in "white" water immediately below Otter Falls whereas the smaller size ones were taken from the pool area.

Round whitefish: Found only in Otter Pond, all fish were feeding adults, no juveniles seen. Long nose sucker: 100 mm., found at outlet of Otter Pond.

Burbot: Represented by one speciman only.

Remarks

The most apparent salmonid spawning area exists in the tailrace section of the pool above Otter and at 4000'-9000' and 15000' - 16000' below Otter Pond. No spawning populations of any species were observed. Likewise, migrations were not identified. A surprising feature was the complete lack of small fish in the shore water of Otter Pond.

Outlet Stream from Aishihik Lake

Length: 6500' Width: 75' - 125'.

Discharge:
Gradient: 27' from Aishihik to Canyon Lake.
Description: The stream has three characteristically distinct areas;

(1) From outlet of Aishihik Lake to Canyon Pond (1000) relatively narrow, drops 20', water fast, largely bedrock and boulder base, some coarse gravel in lower 200'. Stream temperatures show the following trend. 40° June 2, 45° June 12, 50° June 27.

(2) Canyon Pond: Measures approx. 2000' x 1000' with a depth in the order of 5'-6', however, the inlet pool is 15'-20', mud and sand base with much peripheral weed growth; Giltana Creek enters on SE corner.

(3) From Canyon Pond to Canyon Lake (3500') - relatively wide drops 7', coarse material, one pool 1/3 distance from pond to lake, area utilized for recreation fishing and has high aesthetic values, road access available. An interesting & possibly significant biologically situation is that the flow on the west side of the stream is Canyon Pond water and, therefore, relatively clear, whereas the east side water largely originates with Giltana Creek, and has a brown colouration.

Significant difference in water temperature and quality from side to side exists in some periods, eg. June 13, W. side 46°, E. side 53°. This entire area requires a high priority in future studies.

Species Composition and other Data

Grayling: Present throughout the stream; were not observed nor were fry; spawning areas are unknown as are migrations if such occur. Samples of grayling gave length as 220-415 mm. with a mode at 285 mm.

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Humpback whitefish: Occupies Canyon Pond, size range of samples was 250-440 mm. with a mode at 390 mm.; sexually mature individuals found Sept. 23.

Round whitefish: Through summer occupied Canyon Pond: sample size ranged from 290-375 m. Sexually mature fish were found in the pool b below Canyon pond on Sept. 23; spawning was not observed but was about to occur.

Suckers: Sexually mature fish were caught in the mouth area of Giltana Creek on June 13 (temp. 53.5°), eggs similar to those of suchers were found in the stomachs of small grayling and whitefish at that time; water colouration and high velocity and depth prevented sampling for fish in Giltana Creek upstream of the pond.

Note: This is a prime sport fish area for Arctic grayling.

Lister Creek

Length surveyed: 7 miles Width: 25' - 35'

Discharge: 75 (est.) July 21 ph 8.5
Gradient: 12.5' - 15.0'/000. (Average)
Temperature: 50° June 17, 48° July 21, 32.5° Sept. 23.

Within the first mile the creek flows on a delta and has low velocity, a meandering course and silt and sand bottom. Upon leaving the delta, the gradient becomes steep with the stream being confined between 500' banks. Three miles upstream the gradient lessens, and pools and riffles are present, also beaver dams. The stream eventually enters alpine meadow where the current is approximately 1/2-1½'/sec. and the pools deep (6'-8'). Ice conditions prevailed on September 23.

Species composition and other data:

Grayling: Found above three miles.

McIndoe Creek

Length surveyed: 3 miles, Width:

Discharge:
Gradient:
Temperature: 45° June 30, 51.5° July 2.
Description: In lower one mile creek, slow and meanders. Above one mile the gradient steepens with boulders and coarse bottom. Brown coloration to water.

Species composition and other Data:

Grayling: Throughout observed area but principally in lower one mile.

.../6

Lake whitefish: Adults netted close to lake.

Pike: Netted close to lake.

Sekulmun River (Link R.)

Length: 4.5 miles, Width:

Discharge: 512 cfs. (est.) July 13
Gradient: 0-2.5'/sec. (av.)
Temperature: See note below.
Description: Sekulmun Lake - 1/5 mile; broad riffle, coarse gravel, 5'/sec. velocity. 1/5 mile - 2 miles; narrow riffle, coarse, fine and silt and sand; 2.5'/sec. velocity. 2 miles - Aishihik Lake; pool, mud base, $\frac{1}{2}$'/sec. velocity. Joins with a number of adjacent ponds and lakes.

The stream was frozen over on May 4. On June 7 ice conditions precluded travel by boat and floating ice chunks, presumably from Sekulmun Lake were present to June 22. The temperature regime is complex. Un upwelling areas one mile below Sekulmun Lake, sub-surface temperatures were 45°-48° compared to 65°-67° on the surface in mid July. Also the adjoining pond waters heat rapidly resulting in significant differences between the main stream flow and the pond; eg. pond water 60°-65° F vs. main stream 45-50° in late June and 49° to 54° respectively in July 28; the lower 4/5 of the stream is contained by banks 10'-50' high.

Species Composition and other Data:

Grayling: All sizes present; sexually mature individuals (running milt or loose eggs) were netted on June 23 and spawned out females were angled on July 4; at no time was a spawning actually observed; fry tentatively identified as grayling were sampled from July 9 to August 3; one mature individual tagged on July 9 was recovered in Albert Creek one month later.

Lake trout; angled from stream on several occasions, two individuals measured 418 and 426 mm. (16"-17" approx.)

Lake whitefish: Occupied lower part of stream within and close to adjoining ponds, gillnetted fish, measured 270-410 mm.

Round whitefish: Found more in stream proper close to areas with relatively intermediate velocities, gillnetted fish measured 205-260 mm.

Pike: Occasionally caught on sprot gear and one netted on Sept. 21.

Burbot: Juveniles found on August 3 and one adult netted on Sept. 21.

.../7

The Sekulmun River is an area occupied by a variety of species over a great range in size. Unfortunately, the majority of the juvenile fish are not identified. The stream is classified as an all specie and all purpose habitat and is rated as the most important stream in the Aishihik system.

Albert Creek

Length surveyed: 15 miles. Width: 45' - 50' (generally)
Discharge: 255 cfs (est.) July 27 ph 7.5
Gradient: 7.5 - 10.0'/000.
Temperature: 35° May 4, 50° June 22, 57° (max). July 3, 51° July 28, 36.5° Sept. 20.
Description: A clear water stream having largely coarse gravel with some boulder, arises from ice fields, creek frozen on May 4.

Species Composition and other data:

Grayling: All sizes present during summer; scattered pairs and single fish which appeared to be mature were seen in the lower three miles on June 22, observers believed some pairs were mating; fry were abundant on July 28, one tagged specimen was recovered on July 28 from the tagging in Sekulmun River on July 9, majority of adult fish seen above 3 miles, sport caught fish measured 355-445 mm.

Lake trout: Single specimen seen at 2 miles on June 24.

Round whitefish: Single sexually mature female found dead and unspawned on September 21 in lower 1 mile.

Isaac Creek

Length surveyed: 10 miles Width: 35' - 40'
Discharge: 94 cfs. (est.) August 18 ph: 7.5
Gradient: 12.5 - 15.0'/000.
Temperature: 39° June 17.
Description : Largely a boulder stream, the lower ½ mile is relatively flat delta, highest gradient exists from the delta to 3 miles upstream, and a series of rapids and cascades exist here. These, however, are not considered to be impassible to grayling; the water colour is slightly brownish as a result of Gladstone Lake - one head water reservoir.

Species Composition:

Grayling: Few observed and these mostly above the 3 mile point.

Bear Creek

Length surveyed: 5 miles Width: 60-70'
Discharge: 302 cfs. (est) ph: 7.0
Gradient: 10.0 - 12.5'/000
Temperature: 42° June 17, 53.5° June 23, 49° Aug. 5.
Description: 0-1 mile delta, slow current with many meanders, sand bottom, grassy banks. 1-3 mile, steepest part of stream with rapids, cascades, shute; boulders

.../8

and bedrock prevail; appears to be passible to grayling. Above 3 mile moderate gradient in alpine meadow, mostly broad riffles and pools.

Species composition and other data:

Grayling: Found above $2\frac{1}{2}$ mile; one female on August 5 had some mature eggs in the ovary.

Round whitefish: Approximately 20 adult fish seen in lowest 1 mile on August 6.

The results can be summarized as follows:

(1) Spawning areas were not identified. However, the presence of a few sexually "ripe" fish, spawned eggs, and/or newly emerged juveniles suggest that spawning occurred at or close to:

- the lower 1 mile of Albert Creek - grayling and round whitefish
- throughout the Sekulmun River for all species
- the lower 500' of the stream between Aishihik and Canyon Lakes - round whitefish
- from Canyon Pond to $\frac{1}{4}$ mile in Giltana Creek - round whitefish
- tailrace of pool midway between Otter Falls and Otter Pond
- 2 3/4 mile below Otter Pond

(2) Spawning populations comprised of significant number of individuals were not found. In the case of grayling two dozen paired fish represents the greatest number observed at any one time and place. For round whitefish 100-200 individuals in the stream below Canyon Pond represents the greatest population for this species.

(3) The presence of ripe individual grayling from late June to early August and also the extended appearance of newly emerged juveniles suggests that grayling spawn over a period of at least one month.

(4) Migration of populations were not recognized. However, the capture of a grayling in Albert Creek, that was tagged in Sekulmun River and also reports by natives on fish movements in this stream suggests that up and down migrations occur regularly in Sekulmun River. There was no indication of migration between Aishihik and Canyon Lakes nor into or out from Otter Pond.

(5) The lateral tributary streams in Aishihik and Sekulmun Lakes are basically similar in the that the lower part flows on a delta where gradient and velocity are low, sand and fine predominate and grass banks exist. The delta areas may serve as feeding areas for immature fish and possibly as spawning areas for grayling and round whitefish. Above the delta the gradient is steep, "white" water rapids cascades and shutes prevail and the bottom is usually bedrock and boulder or coarse material at the best. The productive role of this type of habitat is unknown. The upper parts of the stream are situated in alpine meadow where gradients and velocities are low to moderate, and pools and broad riffle prevail. Grayling are more frequently observed here than elsewhere. Some spawning occurs here but feeding is a principal activity.

.../9

(6) The most important stream water in the Aishihik system is that of the Sekulmun River where the widest variety of species exist, the size composition ranges from very young to mature adult, and migration occurs. The second important stream water is that from Aishihik Lake to Canyon Lake.

Relation of Findings to the Hydro Power Proposal

The discontinuance of flow from Canyon Lake at any time will destroy populations of rainbow trout, grayling and whitefish in the East Aishihik River. If continuous flows are maintained from Canyon Lake to the outlet of Otter Pond only, it is speculated that the rainbow trout and round whitefish populations will survive; however, a complete closure at the outlet of Otter Pond will eliminate the stream below that point as a productive unit, therefore a grayling population will cease to exist. Also high aesthetic values in the form of cascades and shutes will be lost.

The cessation of flows at any time from Aishihik Lake makes Canyon Pond and the stream below dependent upon Giltana Creek. Giltana Creek lacks the discharge to compensate for the loss of Aishihik Lake flow, therefore, a decrease in water level throughout the pond and stream area will occur. Also there are considerable differences in chemical and physical properties between Aishihik and Giltana out flows, therefore, the whole ecology of the area will change. Further suspected spawning areas upstream of the canyon pool will not be available and the food and oxygen supply will be eliminated or significantly reduced to pool residents. Therefore, the cutoff of water from Aishihik could be expected to result in severe adverse effects on those populations of grayling, whitefish and suckers which are dependent upon Aishihik Lake outlet stream, Canyon Pond, and the stream below for completion of their life activities. Therefore, discharge from Aishihik Lake at all times is mandatory to the preservation of the stocks in this area. It must be remembered that the abundance of fish, road access and certain aesthetic values makes this a prime recreational area. Although migrations between Aishihik Lake and Canyon Lake have not been found, some provision for such should be considered in the storage dam.

For the discussion on the effect of changing water levels on creek productivity, Sekulmun River and lateral streams, see separate notes.

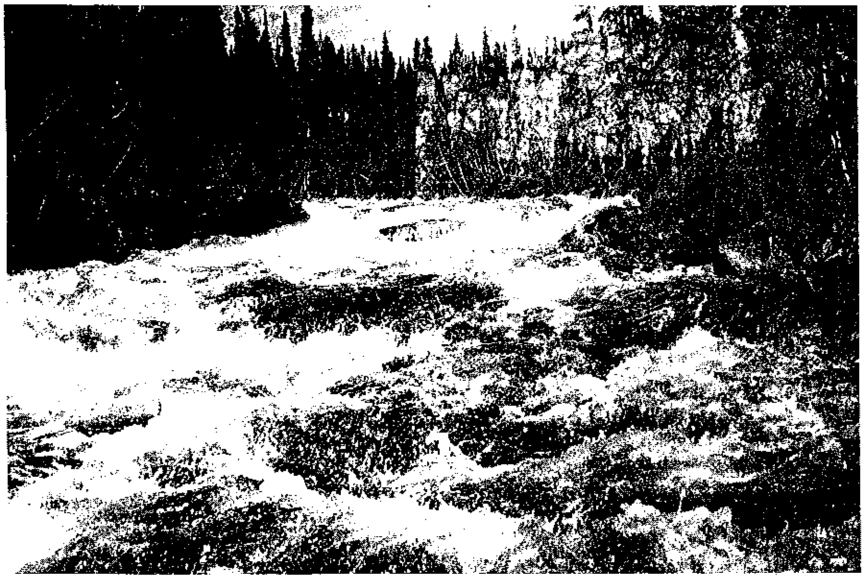
Sekulmun River: Lowering the water level will decrease pool volume and increase riffle area, therefore, favouring some species such as grayling. Whereas raising the water level will favor the production of lake and pool preferring species such as pike and lake whitefish. It is mandatory that this stream and its populations be more carefully examined in 1973 to more completely understand the requirements of each species.

Lateral streams: A lower water level will result in stream bed cutting, stream bank sloughing, and course change on the delta areas with the result the physical features will be completely changed. In this event it is highly likely the delta area will have practically no value in stock maintenance.

.../10

Raising of the water level will result in inundation of whole or part of the delta. By such action some potential spawning area will be lost but feeding opportunities may remain to some degree. Also lake spawning delta areas remain intact. In other words some flooding appears to be preperable to lowering the water level.

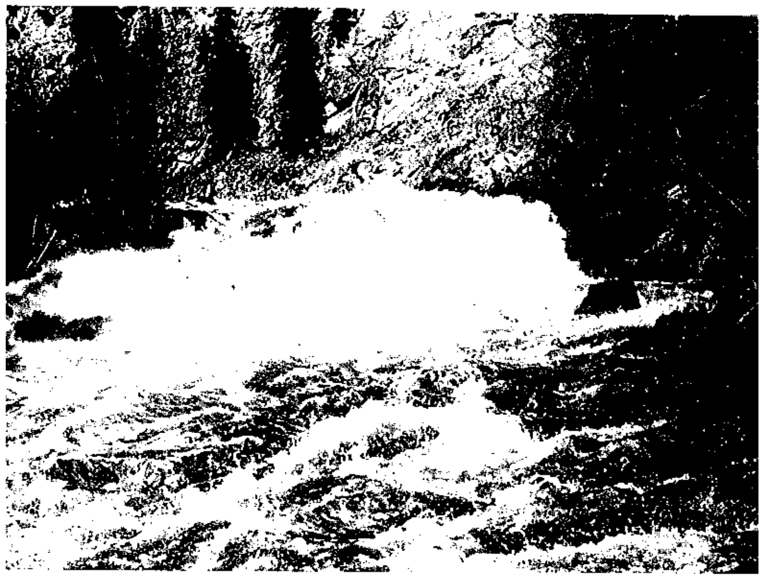
C. E. Walker,
Senior Biologist,
Northern B. C. & Yukon Div.



Start of

Rainbow Falls

Rainbow Falls



Rainbow Falls

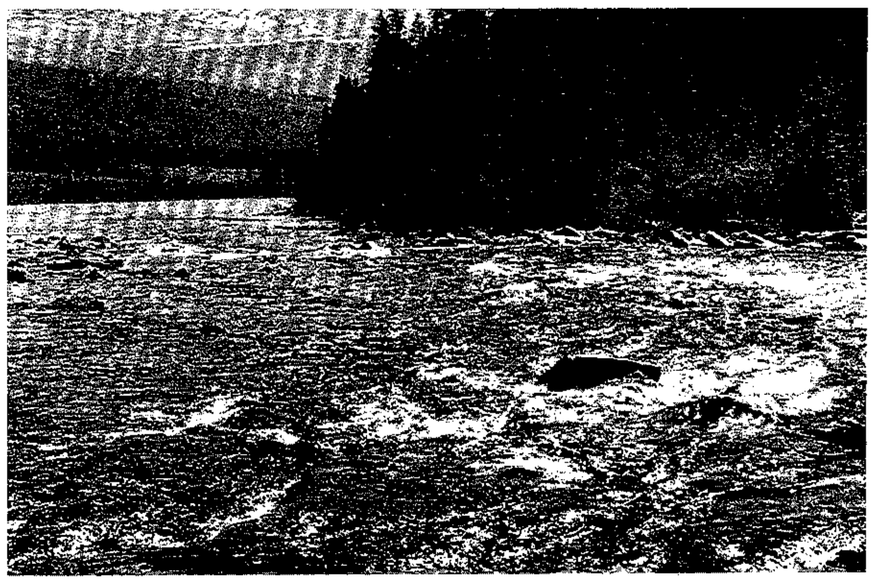
E. Aishihik River
above Rainbow
falls

Sport fish area
between Otter pond and
Rainbow falls

East Aishihik River
1 mile below outlet
of Otter pond
May 5/72

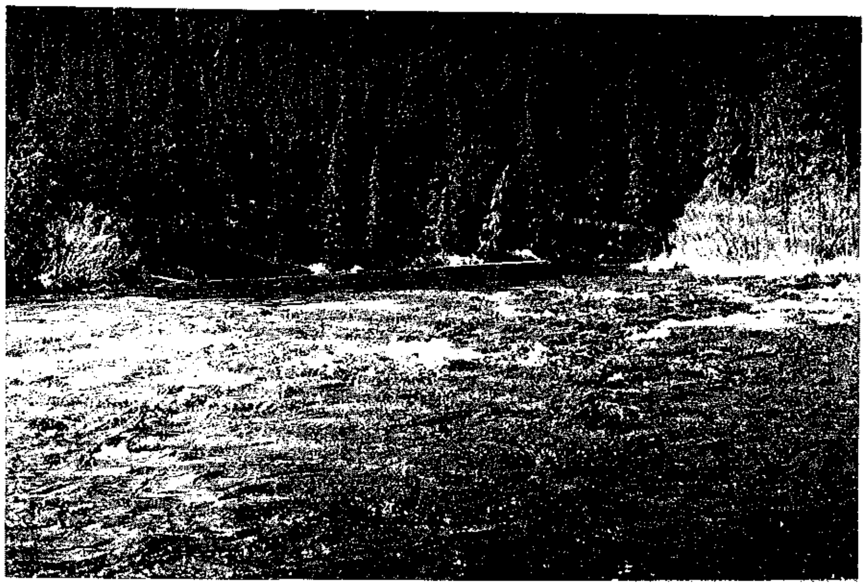
East Aishihik River
1 mile below outlet
of Otter pond
May 30/72

Otter pond May 30/72



East Aishihik River entering Otter pond, mid-summer.

E. Aishihik River
outlet of
Canyon Lake

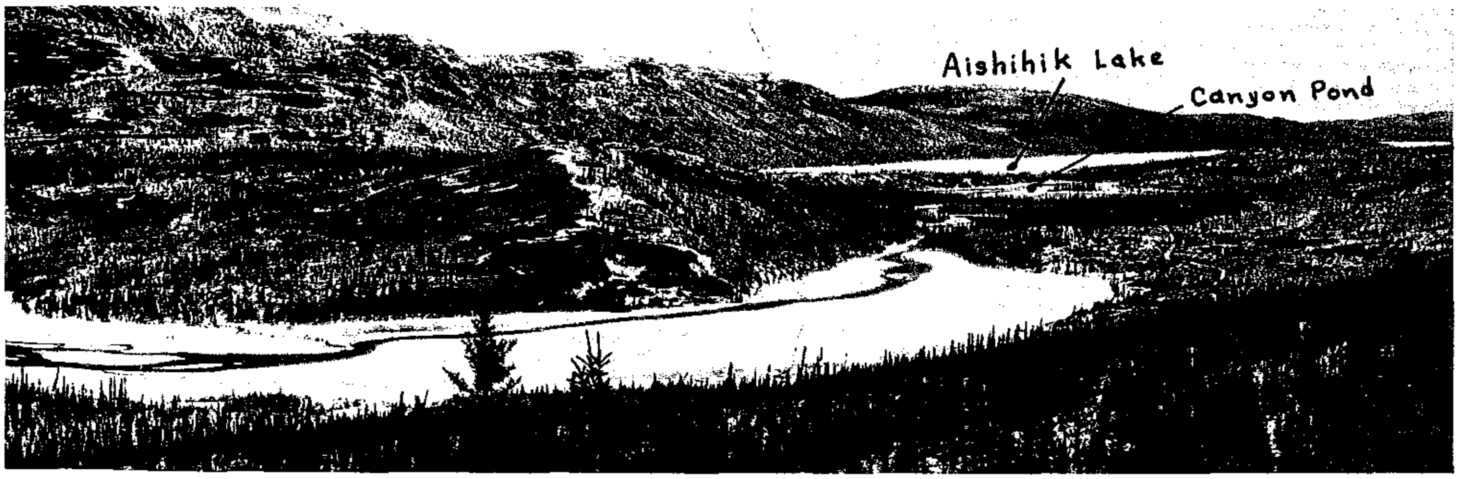


E. Aishihik River
at outlet of large
pool midway between
Canyon Lake and Otter pond.

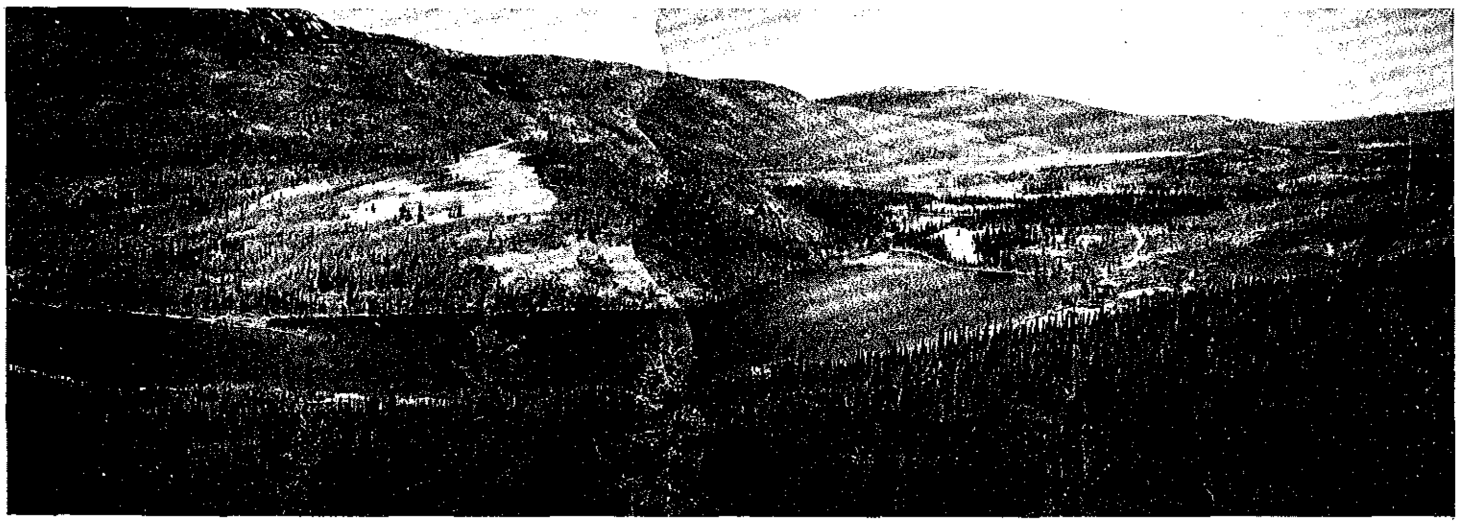
E. Aishihik River
approx. 100 yds.
upstream of Otter pond.

Ott^r Falls May 5/72

Otter Falls mid-summer



North end of Canyon Lake May 5/72



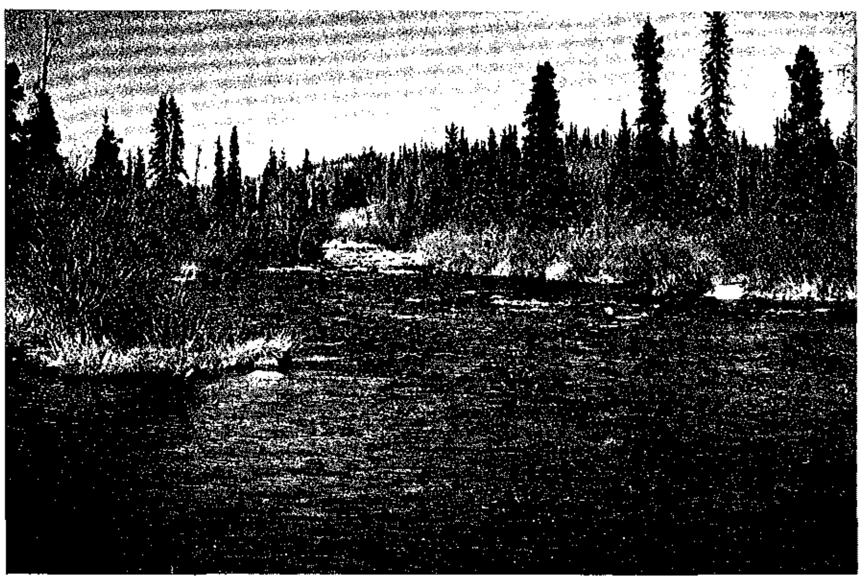
North end of Canyon Lake at mid-summer

Canyon Pond.

Giltana Creek immediately upstream of Canyon Pond

Outlet Stream from Aighihik Lake within 100 yds. of lake.

Outlet Stream from Aishihik Lake approx. 200 yd. below outlet



Outlet stream from Aishihik Lake entering Canyon pond.

Albert Creek

1 mi.

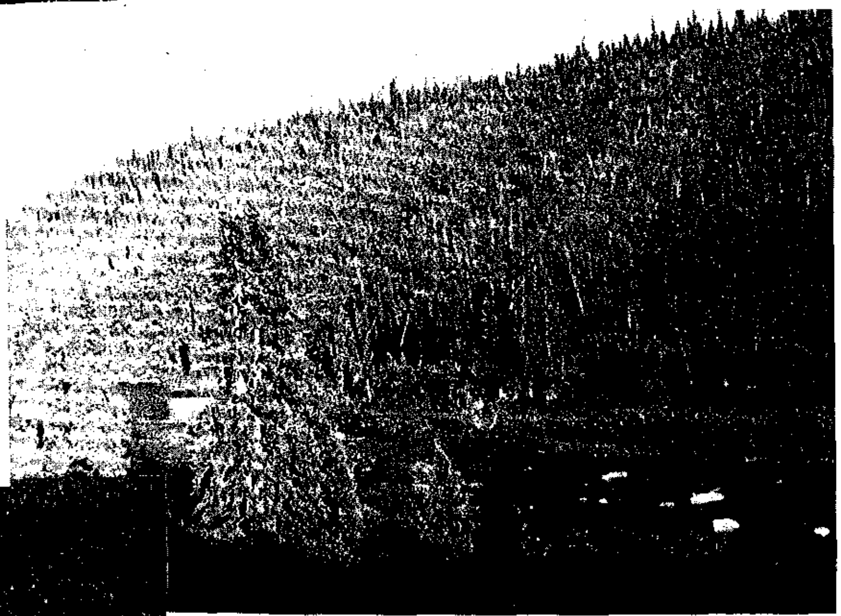
Albert Creek 2 mi.

Albert Creek 3 mi.

Albert Creek 5 mi.

Albert Creek

9.5 mi.

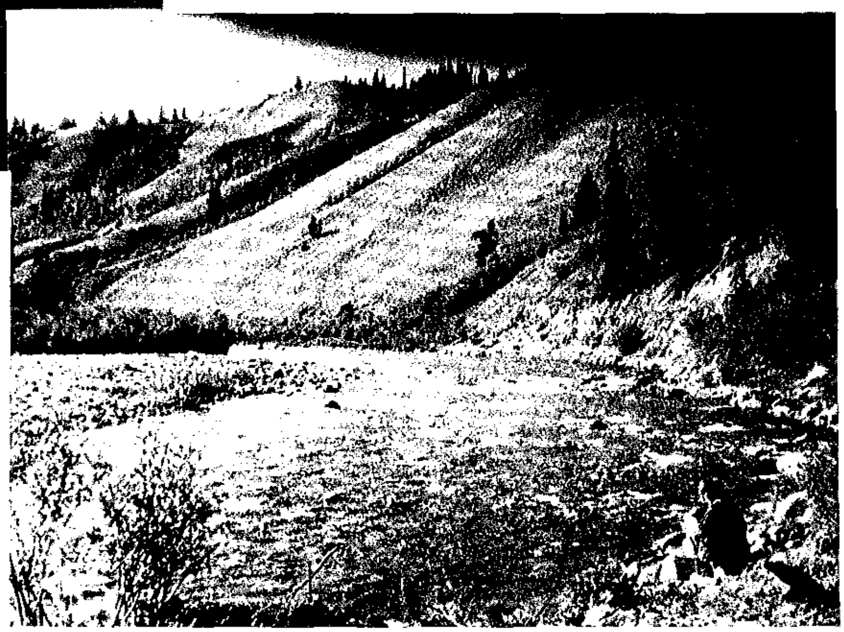


Albert Creek

12 mi.

Albert Creek

13 mi.

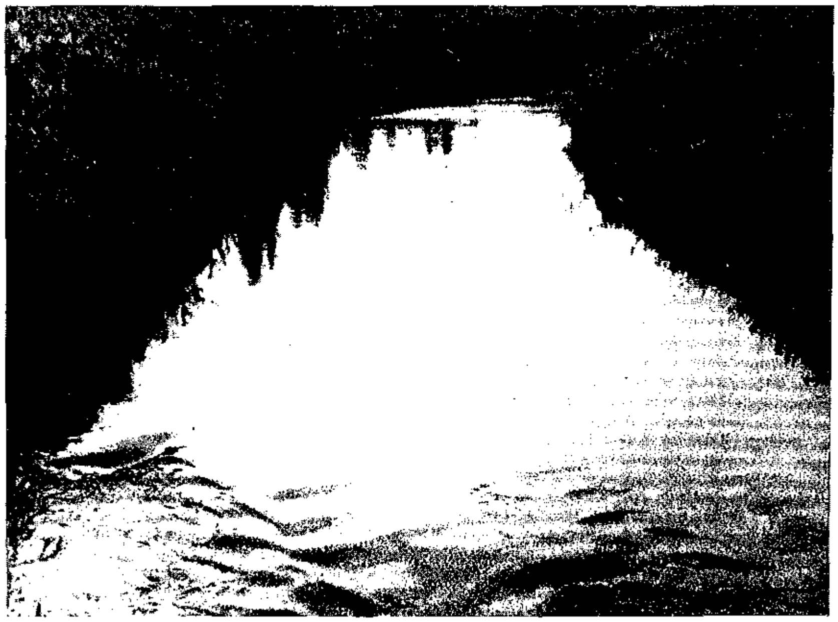


Albert Creek

15 mi.

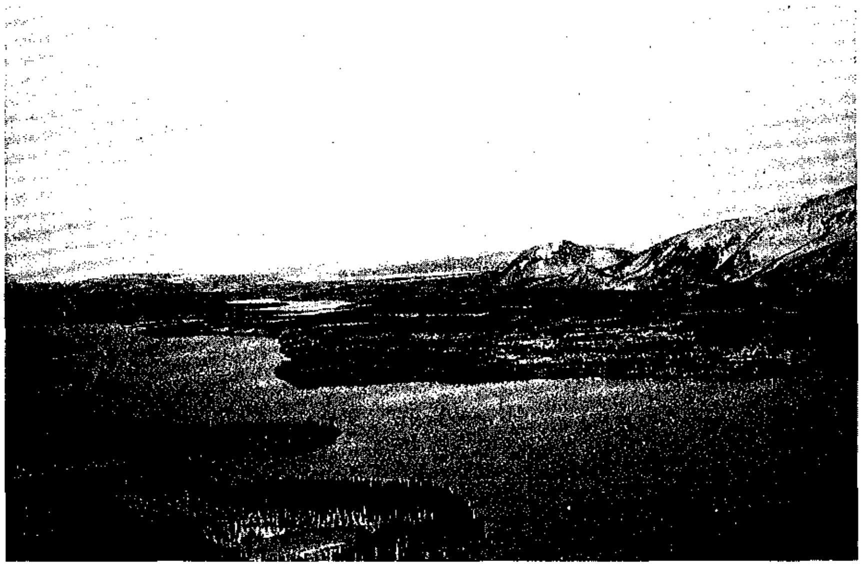
Lister Creek
8.5 mi.

Lister Creek 10 mi.



Lister Creek
11 mi.

Aishihik Lake looking south
from north end of lake.



Aishihik Lake

Sekulmun Lake
looking South on west side

Delta of Isaac Creek
Sekulmun Lake, west
side.

Delta of Bear Creek,
Sekulmun Lake, west
side.

Mouth of McIndoe Creek
Aishihik Lake east side.

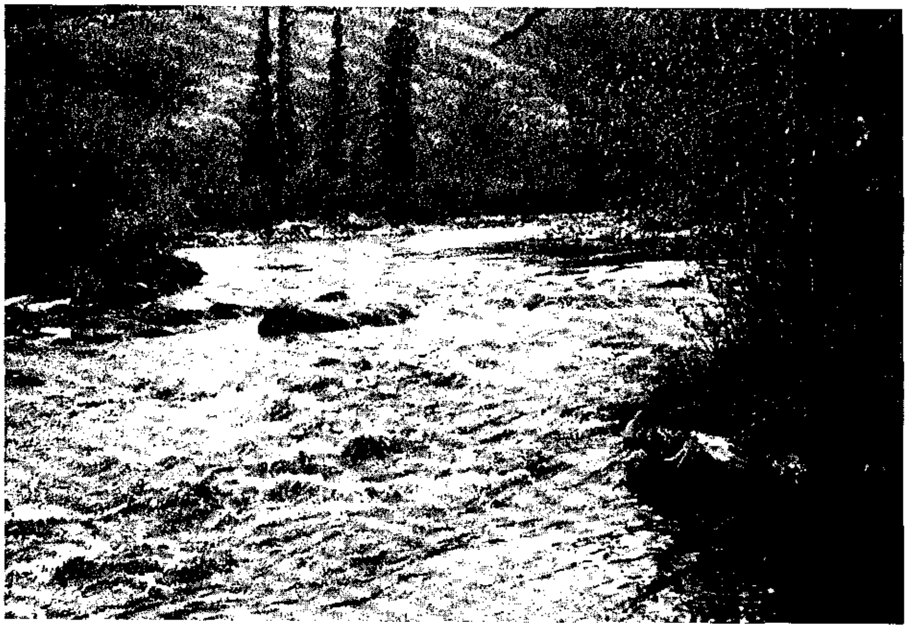
APPENDIX "B"

Photographs of (a) Upper Aishihik River "A"
June 15, 1973.
Discharge approx. 200 cfs.

(b) Upper Aishihik River "B"
June 21, 1973.
Discharge approx. 313 cfs.

Outlet of
Aishihik Lake.

250 ft below
outlet of
Aishihik Lake.



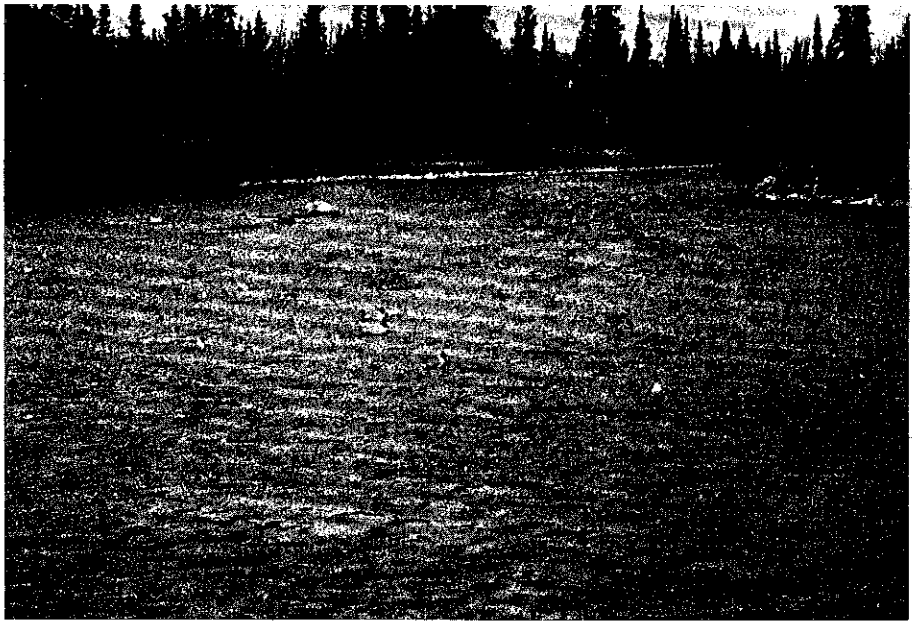
475 ft below
outlet of
Aishihik Lake
(falls area).

575 ft below
outlet of
Aishihik Lake

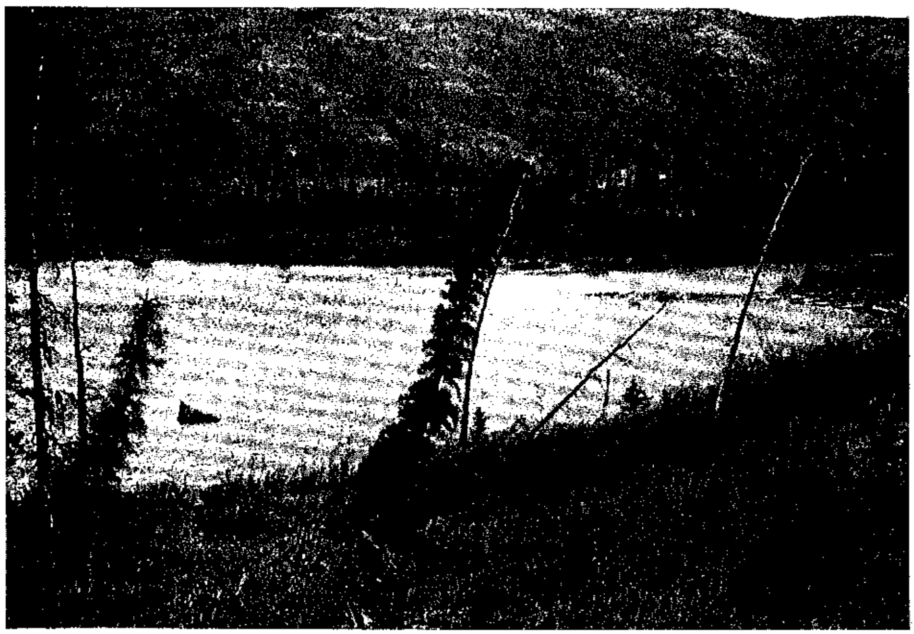
800 ft below
outlet of
Aishihik Lake

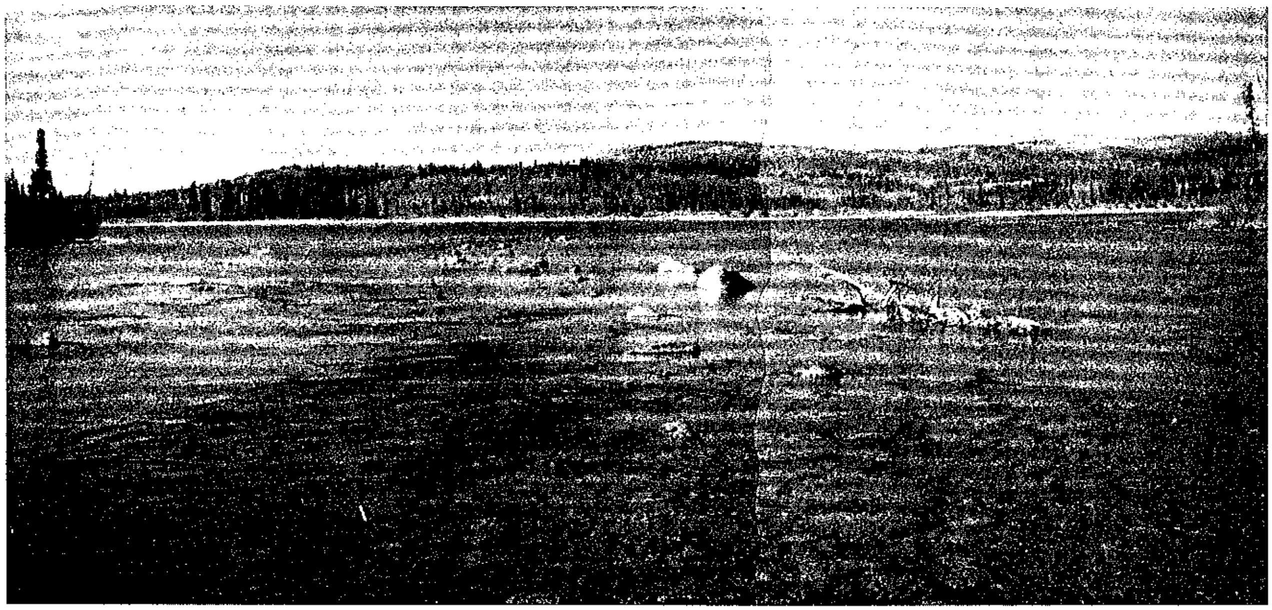
990 ft below
outlet of
Aishihik Lake

1100 ft below outlet of Aishihik Lake (inlet to Canyon Pond; fish and bird feeding area).



Entry of stream to Canyon Pond.



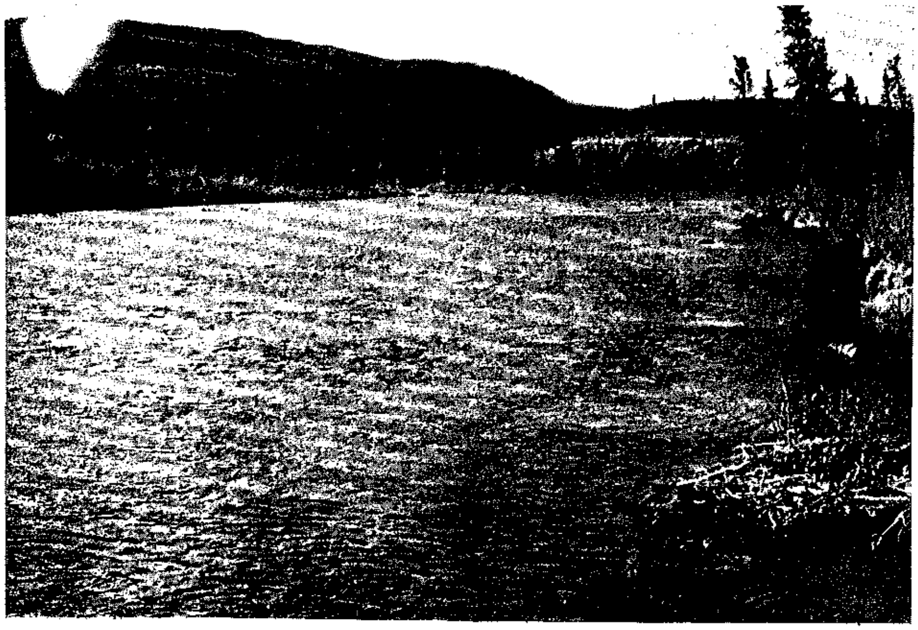


Outlet of Canyon Pond.

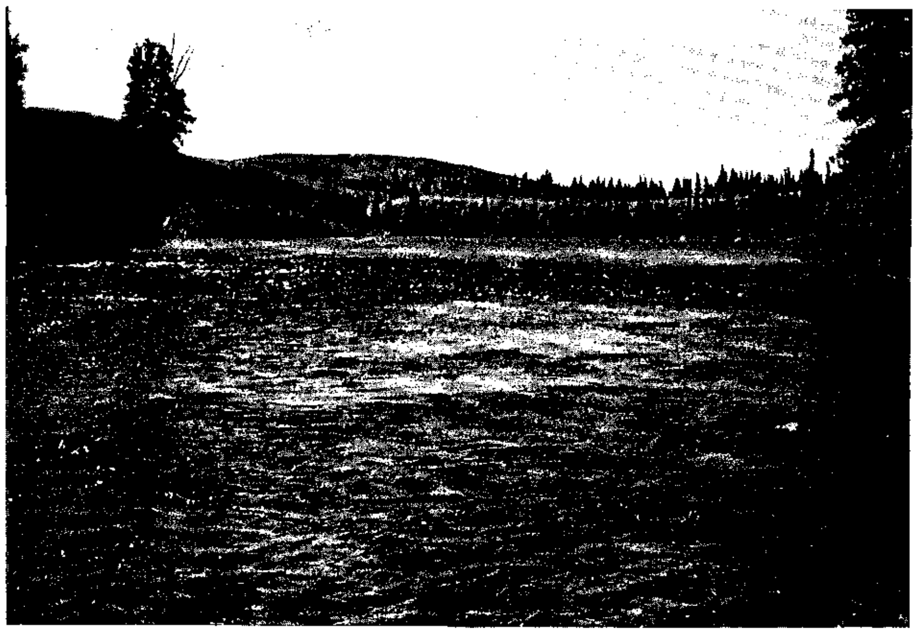
640 ft below outlet of Canyon Pond (metering site).

1200 ft below outlet of Canyon Pond (pool area).

1600 ft below outlet of Canyon Pond.



1800 ft below outlet of Canyon Pond.



2300 ft below outlet of Canyon Pond (entry to Canyon Lake).

APPENDIX "C"

Report on the techniques used on samples from Aishihik Lake area.

DEPARTMENT OF ZOOLOGY

QUAECUMQUE VERA

THE UNIVERSITY OF ALBERTA
EDMONTON 7, CANADA

Report on the techniques used on samples from Aishihik Lake area.

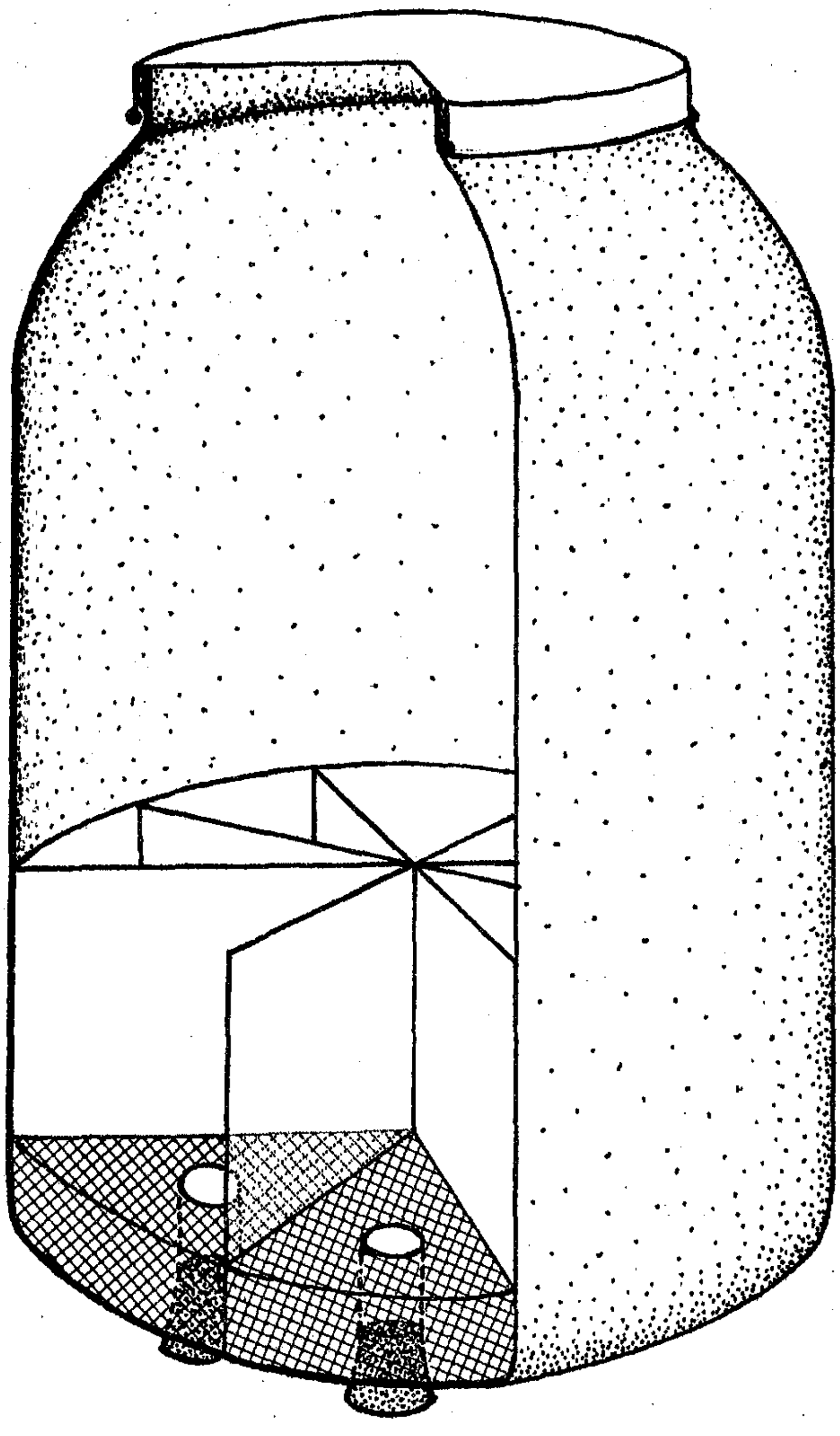
Several physical difficulties were encountered during the initial stages of the survey; due to the conditinn of the samples. The majority of the collections were extremely large, necessitating sub-sampling. This process was hampered by the presence of large amounts of fibrous fungal and algal material which tended to bind up a large number of specimens, not allowing them to distribute evenly within any liquid medium.

In the hope that both methods will prove useful in the correct circumstances, this report will include the normal method of sub-sampling (which could not be used in this study) as well as the alternative method employed.

Initially all the samples were washed in a fine sieve (# I00) and all the large, solid clumps of algal material were extracted and carefully washed and picked to ensure that no animals were left entangled.The algal material can be retained, dried and weighed; or an estimate of abundance can be made visually before the collection is cleaned. The samples were then replaced in the jars taking care to wash all the zooplankton from the sieve to the jar.

The form of the sub-sampler is shown in the accompanying diagram. A large plastic storage jar has its lower section divided into eight equal cells with the aid of strips of plexiglass (3" by I/8"). These

Diagram of eight-celled sub-sampler.



are fixed in position by setting them in 3/4" of paraffin wax. The dividers are of course forty five degrees to each neighbour. The vertical joints were also sealed with wax making each cell water-tight. To facilitate extraction of the required fraction a hole is bored in the base of each cell and plugged with the correct size rubber bung. It is more accurate to be able to drain any of the eight cells so that you can pick a cell at random; if only one cell is used all the time there may be a mechanical bias in the sub-sampling.

To use this sampler, the collection is added along with a regular amount of water, enough to three quarters fill the jar. The lid is screwed on tightly and the whole thing is inverted and righted several times until the collection is evenly distributed throughout the water. It is then allowed to stand on a flat surface until all the specimens settle into the cells. One cell (I/8th. of the whole) is then drained through a sieve; or if further division is necessary (I/I6th. to I/64th.) then the cell can be drained into a second sub-sampler. If more than one eighth is required, two or more cells can be drained.

This sub-sampler was unsuccessful with these particular collections for two reasons:

I. The algal material left in the collections was sufficient to bind and clump the specimens, not allowing even distribution.

2. As the collections had been preserved in formalin their body weight had been altered such that they floated in water; and a large percentage floated in alcohol.

Another method of sub-sampling was necessary. This involved the use of a large flat tray (I8" by I2" by I/2") and a plexiglass quadrat whose internal area was a known fraction of the area of the tray (say I/50th. or I/I00th.). It is more accurate to use a smaller quadrat since then a larger number of fractions will be required to make up the sub-sample.

The collection is placed in the tray along with 750mls. of water. The large specimens, which are unlikely to be accurately represented in the sub-sample, are removed at once. The remainder is spread over the whole area as evenly as possible and the quadrat placed firmly in a random position. Everything within the quadrat is sucked out with a wide-mouthed pipette and placed in a large petri-dish. This process is repeated until the required sub-sample has been collected. The fraction which makes up a countable sub-sample will vary with the size of the collection; if the latter is sufficiently small the whole sample can be picked.

The specimens in the sub-samples are separated into organisms belonging to the following groups:

Annelida; Amphipoda; Trichoptera; Ephemeroptera; Odonata; Plecoptera; Hemiptera; Coleoptera; Diptera and Gastropoda.

For the purpose of speciation a selection of the individuals from each sample was placed in a series of nine vials retaining spacial and time separation in the hope of noting variations in such. The vials, therefore, pertain to:

Morning - Bottom; Morning - Middle; Morning - Top;

Afternoon - Bottom; Afternoon - etc.

Examples of the larger species, all of which have been removed for weighing, must be placed in the vials after their weight has been noted.

Methods of estimating biomass of small, aquatic species are either of limited accuracy or extremely time consuming. Wet weight estimation is extremely variable due to the retention of external water in varying amounts. Dry weight estimation consumes more time than can be allowed in this particular survey. The method used produces comparative results while remaining within the realms of simplicity.

Filter papers were used as collecting trays; these were soaked with tap water, layed out to dry, and weighed in the morning, after overnight drying. This was done as the papers would soak up water from the specimens and they may retain variable amounts of water after overnight drying. The specimens were collected on these papers, the whole left to dry over night and reweighed in the morning. The difference in weight between the second and the first reading is an approximate figure for the dry weight of the specimens. With such a long drying time, differential water loss between animals will not be significant. Alternatively the animals could be collected on the papers and allowed to dry overnight. The whole weighed, then the animals removed and the filter papers weighed on their own. The dry weight produced is not classical dry weight as body fluids will still be retained. The weights produced are compareble and can later be related to constant dry weight by calculating a correction factor. The results are noted down on a data sheet and the total weight within a collection can be calculated.

Due to the vast numbers in some of the collections, the zooplankton numbers and distribution were estimated separately. Each collection was shaken vigorously with 250mls. of water to distribute the fauna equally throughout. Using an hyperdermic syringe with the nozzle removed, a known fraction is extracted (5ccs., 10ccs., etc.). This fraction is placed in a counting dish, divided into eight numbered compartments of equal area,- the compartments facilitate the counting process. Numbers of the following groups are then counted:

<u>Copepods</u>

- Cyclopoid
- Calanoid

<u>Cladocera</u>

- *Daphnia* sp.
- *Bosmina* sp.
- *Diaphanosoma* sp.

A mean length for each group is then estimated by measuring a number of individuals, and their approximate weight calculated using the formula: $w = ql^b$ where q and b are constants for a known species. The necessary constants are:

Daphnia	q = 0.052	b = 3.0I2
Bosmina	q = 0.I24	b = 2.I8I
Diaphanosoma	q = 0.092	b = 2.449
Copepods	q = 0.055	b = 2.730

It is often easier to see copepods, etc., when the sub-samples are added to a solution of 75% alcohol and 25% glycerin plus a drop of lignin pink.

Possible improvements in collection technique:

I. Samples could be preserved in 70% alcohol plus I0% formalin to prevent bacterial breakdown. Formalin makes the specimens extremely brittle and also affects the body weight.

2. Collection time for drifts could be cut to one or two hours, being repeated at maybe six hour intervals.

3. If practical the animals in each sample could be separated immediately after collectlon by a flotation technique using either salt or sugar.

APPENDIX "D"

Report of drift and Ekman dredge samples from Aishihik River.

REPORT

DRIFT AND EKMAN DREDGE SAMPLES — AISHIHIK RIVER

All the samples were treated in the two phase way outlined in the methods report previously submitted; the biomass of the macroscopic material was estimated by direct weighing methods; the microscopic zooplankton was estimated by derivation through a formula equating length and weight. The two weights are not directly comparable as they were derived by different methods. They do, however, give an indication of the amount and flux of organisms passing down the river.

Unfortunately, the information on the labels within the sample jars was not sufficient to make it possible to calculate biomass to standard conditions. There were no flow rate recordings, cross-sectional map of the river at the sampling transect, and in many cases it was not known how long the drift net was set. The situation was further complicated by only having the results for a fraction of the samples, and having to make deductions on some rather ambiguous labelling.

However, a few tentative comments can be made concerning zonation, although we did not have enough results, or continuity of samples, to make concrete statements. It appears that while the plankton drift increased during the day the drift of the other invertebrates tended to decrease; the latter probably reaching a maximum during midnight and the early morning hours. As far as special zonation is concerned, it was difficult to interpret; the top and the bottom samples were similarly stocked (though a detailed species and life-stage examination would probably produce noticeable differences); the middle zone, however, was peculiarly lacking in life. This was noticeable upon initial perusal of the sample jars; it was evident that the middle net trapped little or nothing. This may be either a result of zoning, or a mechanical effect or defect in the sampling system.

A species list has been compiled and enclosed; the list is not complete since funds did not allow for detailed consideration. However, many of these organisms could not be identified to species due to a lack of adult specimens. By far the most abundant family is Tendipedidae; and within this the sub-families of Orthocladinae and Diamesinae. The literature concerning taxonomy of these two families is somewhat confusing and constantly changing. This confusion is compounded by the fact that most studies have been carried out in more southern locations and accurate descriptions of northern species are infrequent. With only larvae and pupae to work with, it is not possible, in most cases, to key further than genus.

There appeared to be no general difference between species or groups caught in top or bottom drift nets. However, it was noted that the top or bottom nets caught more total organisms than the middle net. Ranking of importance for all organisms sampled on a weight basis is as follows: Tendipedidae - extremely abundant; Simulidae - abundant; all other groups - not very abundant. This also applies to numbers of organisms. However, the zooplankton numbers were very high at times in the top and bottom drift samples, thereby contributing considerably to the biomass. The ranking of zooplankton species as to numbers sampled is as follows:

Copepoda	
Heterocope septentrionalis	+ + + +
Cyclops (*strenuus*?)	+ +
Diaptomus sicilis	+
Harpacticoid	present
Cladocera	
Eubosmina longispina	+ + +
Daphnia galeata mendotae	+
Chydorus sp.	present

This is only a relative abundance scale for the Copepoda and Cladocera separately, but hold true for all the samples analyzed. It should be noted that *Heterocope septentrionalis* was by far the most important organism in the plankton group both by numbers and weight (since this is a large copepod).

Apart from the chironomids it appears that although there is an abundance of organisms present in the river system, the variety of species is somewhat limited, indicating that only a few varieties can adjust to the more severe conditions of this northern river system. It is possible, therefore, that the ecosystem is in a delicate state of balance and small changes in conditions could cause drastic detrimental changes in the system as a whole.

Conspicuous by their absence from the samples were the distinctive stonefly nymphs. It is difficult to believe that there are no such nymphs in this section of the river. It is possible that these powerful aquatic insects crawled back out of the net before the sample was collected. This, of course, is one possibility, making one hesitant to rely too heavily on the other results; i.e., the results may under-estimate the amount of drift due to the long periods for drift collection.

A great deal of information can be extracted from this survey if the remaining samples fill the spaces in the present results. The size and condition of the samples, however, will necessitate the allocation of considerable time and effort to this task.

It is suggested that modification be made concerning length of time for drift collections. Other modifications would include a more complete determination of stream velocity, methods of handling drift samples in the field, as well as positioning of samplers in the stream. This can all be reviewed in detail before continuing the study during 1974.

It should be noted that the results given in the following table are only some of those analyzed from samples taken in the Aishihik River and do not include any of the Ekman dredge samples. Complete analyses of all samples are recorded on the enclosed data sheets.

A complete list of references used to identify organisms will follow at a later date.

Results of biomass estimations on samples from Aishihik Lake area.
(in grams)

Date	Time	Time set	Bottom Plankton	Bottom Other invertebrates	Middle Plankton	Middle Other invertebrates	Top Plankton	Top Other invertebrates
Morning								
8/7/73	02:00	?	0.0274	0.4232	0.0004	0.0045	0.0206	0.6606
9/7/73	08:45	?	0.0510	0.6423	0.0022	0.0160	0.0042	0.4553
11/7/73	03:00	13 hrs	0.0157	0.5440	0.0006	0.0043	0.0008	0.2620
12/7/73	03:00	6 hrs	0.7509	0.8542	0.0024	0.0066	0.5744	0.2915
12/7/73	09:00	6 hrs	0.9152	0.0540	0.1907	0.0018	1.4809	0.1085
13/7/73	03:00	?	0.5179	0.7780	0.0339	0.0098	0.3689	0.8369
13/7/73	09:00	?			0.0339	0.0058		
24/7/73	09:00	13 hrs	0.0077	0.0069	1.8104	0.7266	0.2234	1.0432
25/7/73	10:45	12 hrs	0.0081	0.0464	0.0244	0.0041	0.0044	0.0141
26/7/73	11:30	25 hrs	0.5754	0.1137	0.0494	0.0009	0.0057	0.0020
Afternoon								
9/7/73	14:00	?			0.0162	0.1513	0.0232	0.6830
10/7/73	14:00	12 hrs	0.0168	0.8040	0.0002	0.0059	0.0093	0.4586
11/7/73	15:00	6 hrs	0.0680	0.2570	0.0002	0.0116	0.0336	0.7483
12/7/73	15:00	6 hrs	0.6369	0.1774	0.1354	0.0198	0.3290	0.5311
Evening								
10/7/73	20:00	?	0.0031	0.0209	0.0035	0.0091	0.0139	1.1936
11/7/73	21:00	?	0.1063	0.1209	0.0044	0.0151	0.0056	0.0395
9/7/73	20:00	?	0.0300	0.0359	0.0604	0.2102	0.0466	1.8663
10/7/73	20:00	12 hrs	0.0095	0.2020				
11/7/73	21:00	?	1.6368	0.1640			0.0714	0.8877
12/7/73	21:00	?	2.2067	0.1367	0.0056	0.0074	0.1750	0.1324
13/7/73	21:00	?					0.8071	0.0797
23/7/73	20:00	24 hrs	0.0036	0.0050	0.7371	0.4326	1.1316	0.5083
24/7/73	21:30	12 hrs			0.6032	0.0836	0.5933	1.2178

Note: Plankton refers only to zooplankton caught in the drift.

Results of biomass estimations on samples from Aishihik Lake area.
(in grams)

			Bottom right		Top right		Left		Centre	
Date	Time	Time set	Plankton	Other invertebrates	Plankton	Other invertebrates	Plankton	Other invertebrates	Plankton	Other invertebrates
<u>Morning</u>										
12/7/73	03:00	6 hrs	0.2615	0.4790	0.5982	0.4569	0.6780	0.3645		
12/7/73	09:00	6 hrs	2.9358	0.0282	0.7464	0.0891	0.1098	0.0694	2.2765	0.1950
13/7/73	03:00	?	0.7267	0.4710	1.6261	0.5979	0.1223	0.4353	1.7324	0.9612
13/7/73	09:00	?	0.2457	0.0423	1.1454	0.1070			0.8872	0.2000
24/7/73	09:00	13 hrs	0.0171	0.0771	0.0220	0.0698	1.7452	0.1496	0.2049	0.4140
12/8/73	06:00	6 hrs	0.5571	0.0273	1.5809	0.0311	4.1072	0.0633		
<u>Afternoon</u>										
12/7/73	15:00	6 hrs	0.8058	0.0713	0.6304	0.1009	0.7984	0.0598	0.4906	0.3552
<u>Evening</u>										
12/7/73	21:00	?	0.3838	0.0717	0.6592	0.0861	0.6223	0.0228	1.2204	0.2123
13/7/73	21:00	?					0.2275	0.0277		
23/7/73	20:00	24 hrs					1.3291	0.2624		
24/7/73	21:30	12 hrs	0.2086	0.0597	0.0734	0.0239	0.2048	0.0421	0.3688	0.0755
11/8/73	24:00	6 hrs	0.2981	0.0544	0.1598	0.0211	2.5612	0.0845	2.2272	0.2580

LIST OF SPECIES FOUND IN SAMPLES FROM AISHIHIK LAKE AREA

AMPHIPODA

Gammarus lacustris

EPHEMEROPTERA

Baetidae

Ephemerellinae

Ephemerella grandis ingens
Ephemerella aurivillii

Baetinae

Baetis sp.

TRICHOPTERA

Rhyacophilidae

Rhyacophila hyalinata

Hydroptilidae

Hydroptila sp.

Limnophilidae

Discomoecus sp.

COLEOPTERA

Elmidae

Stenelmis sp.

GASTROPODA

Lymnaeidae

Lymnaea (Bulimnaea) sp.

Valvatidae

Valvata heliciodes

DIPTERA

Tendipedidae

Pelopiinae
(Tanypodinae)

Pentaneura spp. (melanops group)
(two species)

Diamesinae

Syndiamesa branickii
Diamesa
Prodiamesa spp. (two species)

Orthocladinae
(Hydrobaeninae)

Cardiocladius sp.
Cricotopus slossonae
Eukiefferiella bavarica
Trichocladius fuscipes

Tendipedinae
Tendipedini

Tanytarsus tendens
Tendipes (tendipes) tentans

Calopsectrini

Calopsectra sp. (micropsectra group)

Simuliidae

Simulium vittatum
Simulium arcticum
Cnephia sp.

Tipulidae

Tipula sp.
Antocha sp.

COPEPODA

Heterocope septentrionalis
Diaptomus sicilis
Cyclops (*strenuus*?)
Harpacticoid

CLADOCERA

Eubosmina longispina
Daphnia galeata mendotae
Chydorus sp.

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December 13, 1973.

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