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GLACIATION AND THE PHYSICAL, CHEMICAL  
AND BIOLOGICAL LIMNOLOGY OF YUKON LAKES

by

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## ABSTRACT

Lindsey, C. C., K. Patalas, R. A. Bodaly, and C. P. Archibald. 1981. Glaciation and the physical, chemical and biological limnology of Yukon lakes. Can. Tech. Rep. Fish. Aquat. Sci. 966: vi + 37 p.

A preliminary limnological characterization of 91 Yukon lakes is presented with data on lake morphometry, temperature, chemical composition, zooplankton species presence and abundance, and fish species presence. Most of the lakes sampled are situated in glaciated terrain. Summer epilimnion temperatures ranged from 8 to 18.5°C and were affected mainly by lake elevation and surface area (wind action). Total dissolved solids (TDS) ranged from about 50 to 910 mg/L. A distinct belt of lakes with TDS greater than 200 mg/L was evident in the upper Yukon River valley, centered at about Frenchman Lake, and this belt corresponds to an area over which a volcanic ash layer thicker than about 5 cm was laid down 1,400 years ago. In most lakes, major cations followed the patterns of concentration  $\text{Ca}^{+2} > \text{Mg}^{+2} > \text{Na}^+ > \text{K}^+$ .

Thirty-two species of crustacean zooplankton were recorded; *Cyclops scutifer* and *Diaptomus pribilofensis* were present in almost all lakes and were dominant in most. The most common cladocerans were *Daphnia longiremis*, *Eubosmina longispina* and *Daphnia middendorffiana*. Most zooplankton species were widely distributed throughout all the drainage basins but some of the species were restricted to a particular area only. *Acanthodiaptomus denticornis* was found in only three shallow unglaciated lakes. *Senecella calanoides* was found in only four lakes in the southwestern corner of the Yukon Territory in lakes presently or formerly part of the Alsek drainage area. *Cyclops bicuspispidatus thomasi* occurred only in southern-most part of the Yukon Territory (Upper Teslin drainage). *Limnoecanus macrurus*, a common northern species, was not found in any of the Yukon lakes.

Twenty-three fish species were found, the most common being lake whitefish *Coregonus clupeaformis*, lake trout *Salvelinus namaycush*, and northern pike *Esox lucius*. Post-glacial alterations in drainage patterns have profoundly affected the distribution of fish species in Yukon lakes. Parts of the drainage basins of the Alsek, Upper Liard and Peel Rivers all drained into the Yukon basin during deglaciation and these three areas have received much of their fish fauna directly from the Yukon River basin (Bering refugium). Lake whitefish electrophoretic patterns in Alsek, Upper Liard and Peel basin populations are very similar to Yukon basin populations. Three species of fish, the inconnu, *Stenodus leucichthys*, broad whitefish, *Coregonus nasus*, and least cisco, *Coregonus sardinella*, are present in the Yukon River basin but absent from Alsek, Upper Liard and Peel basins, apparently because they failed to disperse into the latter areas while they were tributary to the Yukon River. The rare high gill raker form of lake whitefish is found only in the absence of the least cisco in the Alsek basin, Squanga Creek drainage and South McQuesten drainage.

**Key words:** Yukon; limnology; water temperature; water chemistry; zooplankton; freshwater fish; biogeography; glaciation.

## RESUME

Lindsey, C. C., K. Patalas, R. A. Bodaly, and C. P. Archibald. 1981. Glaciation and the physical, chemical and biological limnology of Yukon lakes. Can. Tech. Rep. Fish. Aquat. Sci. 966: vi + 37 p.

L'étude présente des caractéristiques limnologiques préliminaires pour 91 lacs du Yukon, avec données sur la morphométrie, la température, la composition chimique des lacs, la présence et l'abondance des espèces de zooplancton et la présence des espèces de poisson. La plupart des lacs échantillonés sont situés en terrain moutonné. Les températures de l'épilimnion en été variaient de 8 à 18.5°C, surtout en fonction de l'altitude des lacs et de leur superficie (action du vent). Le total des solides dissous (TSD) variait de 50 à 910 mg/L. On a pu observer une ceinture distinctive de lacs dans la vallée supérieure du Yukon River, où le TSD était supérieur à 200 mg/L, centrée aux environs du Frenchman Lake, cette ceinture correspondant à une région où la couche de cendre volcanique déposée il y a 1400 ans dépasse 5 centimètres d'épaisseur. Dans la plupart des lacs, on trouvait les principaux cations dans l'ordre de concentration suivant:  $\text{Ca}^{+2} > \text{Mg}^{+2} > \text{Na}^+ > \text{K}^+$ .

On a observé 32 espèces de zooplancton crustacéen, *Cyclops scutifer* et *Diaptomus pribilofensis* étant présents dans presque tous les lacs et dominants dans la plupart. Les cladocères les plus communs étaient *Daphnia longiremis*, *Eubosmina longispina* et *Daphnia middendorffiana*. La plupart des espèces de zooplancton étaient largement distribuées dans tous les bassins de drainage, mais certaines des espèces étaient limitées à une zone particulière seulement. *Acanthodiaptomus denticornis* a été observé dans seulement trois lacs non glaciaires peu profond. *Senecella calanoides* a été observé dans seulement quatre lacs de la partie sud-ouest du Territoire du Yukon, dans des lacs qui font ou qui ont fait partie du bassin de drainage de l'Alsek. On a trouvé *Cyclops bicuspispidatus thomasi* uniquement dans la partie la plus septentrionale du Territoire du Yukon (bassin de drainage supérieur de la Teslin). *Limnoecanus macrurus*, espèce commune du nord, n'a été observé dans aucun des lacs du Yukon.

On a trouvé vingt-trois espèces de poisson, les plus communes étant le grand corégone (*Coregonus clupeaformis*), le touladi (*Salvelinus namaycush*), et le brochet (*Esox lucius*). Les modifications post-glaciaires des bassins de drainage ont grandement influé sur la distribution des espèces de poisson dans les lacs du Yukon. Certaines parties des bassins de drainage de l'Alsek, de la partie supérieure de la Liard et de la Peel se déversaient dans le bassin du Yukon au cours de la déglaciation et la plus grande partie de la faune halieutique de ces trois régions provient directement du bassin du Yukon ("refuge" de Bering). Les habitudes électrophorétiques du grand corégone dans les bassins de l'Alsek, la partie supérieure de la Liard et la Peel sont semblables à celles des populations du bassin du Yukon. Trois espèces de poisson, l'inconnu (*Stenodus leucichthys*), le corégone tschir (*Coregonus nasus*) et le cisco sardinelle (*Coregonus sardinella*) sont présentes dans le bassin du Yukon, mais absentes des bassins de l'Alsek, de la partie supérieure de la Laird et de la Peel, apparemment parce qu'elles n'ont pu se disperser dans ces cours d'eau au moment où ils

étaient tributaires du Yukon River. La forme assez rare de grand corégone à hauts branchiosténiés se trouve seulement en l'absence du cisco sardinelle dans le bassin de l'Alsek, dans la bassin de drainage du Squanga Creek et dans le bassin de drainage de la South McQuesten River.

Mots-clés: Yukon; limnologie; température de l'eau; chimie de l'eau; zooplancton; poisson d'eau douce; biogéographie; glaciation.

## INTRODUCTION

The Yukon Territory is a zoogeographically diverse but little studied region of Canada. Parts of the Yukon were covered by ice during the Pleistocene glaciations, yet much of the Territory remained ice free. This unglaciated area formed a part of the Bering refugium and served as a refuge for terrestrial and aquatic organisms. At present, river drainage from the Yukon Territory is to the Bering Sea via the Yukon River, to the Pacific Ocean via the Alsek River and to the Mackenzie River and Arctic Ocean via the Peel and Liard Rivers. The distribution of fish in the Yukon has been affected by the presence of these watershed boundaries, by changed drainage patterns during deglaciation and by the presence of the Bering refuge. Some accounts of specific aspects of fish zoogeography in the Yukon have been previously published. These include studies on the glacial history and fish distribution of the Alsek basin (Lindsey 1975) and the Peel basin (Bodaly and Lindsey 1977), the post-glacial dispersal of the lake whitefish across western Canada (Lindsey et al. 1970; Franzin and Clayton 1977) and the zoogeography of the pygmy whitefish in western Canada (Lindsey and Franzin 1972).

It is the purpose of the present report to discuss the physical and biological limnology of 91 Yukon lakes, including their chemical composition, oxygen and temperature regimes, morphometry, zooplankton species presence and abundance, and the effect of the glacial history of the Yukon on the distribution of its fishes. The biological and limnological data are presented here in the hope that they will be of value in the management of the aquatic resources of the Yukon and in prediction of the impact of future development. Other data on the fisheries and limnology of Yukon lakes and streams not covered in the present report are available in Anon. (1973), Brown et al. (1976), Cleugh (1977), Elson (1974), McPhail and Lindsey (1970), Steigenberger et al. (1975a, 1975b), Steigenberger and Elson (1977), Walker (1976), Walker et al. (1973), and a variety of consultants reports arising from the assessment of possible effects of proposed pipeline construction in the region.

## MATERIALS AND METHODS

Ninety-one lakes were sampled in Yukon Territory and adjacent areas from 1960 to 1978. Lakes are listed alphabetically in Tables 1 and 2 along with their location and present drainage. The location of lakes sampled is given in Fig. 1. The amount and type of information collected from each lake varied from lake to lake according to the particular purpose of the sampling. Data are from our own sampling and analyses unless otherwise stated.

Elevations are those given on the topographic maps or refer to the enclosing contour intervals. Maximum known depths are in most cases not based on extensive soundings over the whole lake, but rather on exploratory transects using an echo sounder. These transects were done before selecting deep-water netting sites and limnological sampling stations.

Limnological measurements were usually made in early afternoon at one station over the deepest part of the lake, generally mid-lake. Water transparency was measured with a 20 cm Secchi disc, and water temperature profiles were recorded with a YSI tele-thermometer calibrated periodically against a mercury thermometer. Water samples for oxygen determination were taken with a three litre van Dorn bottle and the oxygen content was measured with a YSI Model 54 oxygen meter. Although the meter was generally calibrated before use with air-saturated water of known temperature, altitude was not taken into account and this introduced an error of not more than 10%.

Prior to 1975, water samples for chemical analyses were taken from the surface, and in 1975 from 1 m depth. Samples were treated according to Stainton et al. (1974) for subsequent analysis of calcium, magnesium, sodium, potassium, chloride, sulphate, silicon, total dissolved solids (TDS), conductivity (prior to 1975 only) and in 1975 only chlorophyll *a* (uncorrected for phaeophytin). A Hach kit was used to measure the pH and hardness (expressed as mg/L of CaCO<sub>3</sub>) of surface waters.

Zooplankton collections were made mostly in summer 1970 and 1975 with a few samples taken in summer 1974. All the samples in 1970 and 1974 were taken with a large Wisconsin net (mouth diameter 24 cm, mesh size 73 µm). A single or several vertical hauls were taken from near the lake bottom to the surface. In very deep lakes, however, only the top 20 or 30 m of the water column was filtered through the net, representing the epilimnion, metalimnion, and a substantial part of the hypolimnion. Rotifers were not counted in the 1970 and 1974 samples and crustacean abundance was expressed as the number of individuals per liter and per cm<sup>2</sup> of lake area, assuming the efficiency of the net to be 100%. In fact, the efficiency is between 45 and 85%, on the average 63% relative to the zooplankton trap (see below) (Patalas 1975).

In 1975 more quantitative samples were taken with a 26 liter Schindler-Patalas trap (Schindler 1969) fitted with a filtering net of 73 µm mesh. Samples were taken every 2 or 3 meters in the epilimnion and every 3-10 meters in the hypolimnion, depending on the depth. Samples from within each zone were combined, but the zones were kept separate, resulting in two samples per station. Numbers of rotifers and crustaceans were expressed per liter and total zooplankton abundance (rotifers plus crustaceans) was expressed as mg wet weight per liter and per cm<sup>2</sup> of lake surface (see Archibald 1977 for details of biomass calculations). Results obtained with the vertical hauls should be multiplied by 1.6 (1/0.63) before being compared with results from the trap method. In all samples the crustacean species composition was expressed as a percentage of the total number of crustaceans. Crustacean species identification was according to Brooks (1957, 1959), Wilson (1959), and Yeatman (1959).

Almost all records of fish distribution given here are based on personal observations by one or more of the authors. A few records are included where the authors have not seen specimens but have reason to trust the report. Of the many survey reports which have been produced recently under the spur of impending pipeline construction, only those where specimens were retained for verification have been considered here.

Unless otherwise noted, fish species records presented here are based on a minimum of one overnight gill netting per lake and do not necessarily constitute exhaustive lists. Several experimental gill nets of monofilament nylon (with panels of stretched mesh ranging from 1.91 or 2.54 to 7.62 cm) were usually set in each lake, some in shallow areas and some on the surface and bottom in a deep area. Seining was not always carried out and therefore small fish species (e.g. sculpins) may have been overlooked in some lakes. Scientific and common names for all fish species sampled are listed in Table 3.

## RESULTS AND DISCUSSION

### PHYSICAL LIMNOLOGY

#### Lake area

The areas of the lakes under study ranged from 0.2 to almost 2,000 km<sup>2</sup> (Tables 4, 5 and 6), with 80% of the lakes smaller than 20 km<sup>2</sup>, 50% smaller than 5 km<sup>2</sup>, and 12% smaller than 1 km<sup>2</sup>. Most of the larger lakes are located in the southern part of the Yukon Territory, and the lakes in the northern part are small, usually less than 5 km<sup>2</sup>. The distribution of sizes of the 91 lakes under study roughly reflects the overall size distribution of lakes in the Yukon.

#### Maximum depth

The information on maximum depth (Tables 4, 5 and 6) was not always adequate and in many cases represents rather the maximum depth sounded. Depth ranged from 2-283 m with 80% of the lakes shallower than 50 m, 20% shallower than 10 m, and 10% deeper than 100 m.

#### Elevation

Lake elevation ranged from 300 to 1,500 m above sea level (Tables 4, 5 and 6). Most of the lakes (70%) were located between 600 and 900 m. Five lakes were situated above 1,000 m and three lakes at about 400 m.

#### Temperature

Temperature profiles are presented in Tables 7, 8 and 9. The temperature of the upper 4 m layer, which in most cases corresponds to the epilimnetic temperature, was used for comparison between lakes and only measurements made between 1 July and 31 August were used. The lowest epilimnetic temperatures (8-11 C) were generally recorded in lakes of higher elevation (>900 m) and in large, deep lakes between 700 and 900 m in elevation. The highest epilimnetic temperatures (16.0-18.5 C) were generally found in small lakes (<20 km<sup>2</sup>, 6.6 km<sup>2</sup> on the average) situated below 700 m.

### CHEMICAL LIMNOLOGY

#### Total dissolved solids (TDS)

TDS ranged from about 50 to 910 mg/L (Tables 10, 11 and 12); the frequency distribution is shown in Fig. 2. TDS values below 130 mg/L were found in the northern lakes in the unglaciated

area (Barlow, Chapman, Davis, Hungry, Margaret), in some of the lakes tributary to the Stewart River, in the higher lakes of the Alsek and Teslin systems, and in the central group of lakes in the south (Fig. 3). There was a distinct belt of lakes with TDS values over 200 mg/L situated in the upper Yukon River valley (Braeburn, Chadburn, Twin, Frenchman, Fox, Tatchun, Tatemain, Von Wilczek). Approximately 1,400 years ago a volcanic eruption in the mountains near the present Alaska-Yukon boundary spread ash over much of the Yukon Territory, and this deposited layer of volcanic ash is particularly thick in the region of these high-TDS lakes (see Fig. 3 and Bostock 1952). Mandanna Lake is also situated in this area of thick ash deposit and although TDS was not measured in this lake, the high calcium hardness value (256 mg/L) indicates that it also has high concentrations of dissolved solids. Of course, local climate and geology also play a role in determining the TDS content of lakes, and these factors probably account for the four lakes which have high TDS values but are outside the area of heavy ash deposit (Finlayson, Kathleen, Squanga, Wheeler).

#### Major ions, chlorophyll a, and Secchi disc transparency

The raw data for major ions, chlorophyll a and Secchi disc transparency are presented in Tables 10, 11 and 12, frequency distributions are shown in Fig. 2. The ionic composition of Yukon lakes followed the general pattern where Ca<sup>+2</sup> was the most abundant cation followed by Mg<sup>+2</sup> > Na<sup>+</sup> > K<sup>+</sup> (on a molar basis).

#### Oxygen content

Oxygen concentrations in the hypolimnion ranged from 0.3 to 12.0 mg/L, but in 65% of the lakes with thermal stratification more than 8 mg/L O<sub>2</sub> was found (Tables 7, 8 and 9). Twenty-five percent of the lakes (7 in number) had less than 5 mg/L O<sub>2</sub> in the hypolimnion. This hypolimnetic oxygen deficit was not always related to high lake productivity as only two of the seven lakes had epilimnetic chlorophyll a values over 2 µg/L.

### GLACIOLOGICAL BACKGROUND

Over half of Yukon Territory was glacier-covered three or four times during the Pleistocene period (about the last one million years). The rest of Yukon Territory and a strip west of the Mackenzie River in Northwest Territories persisted as an ice-free refugium within which organisms could survive (unlike the rest of Canada which was almost all inundated with ice) (Fig. 4). Each glacial advance and retreat disrupted drainage patterns, dammed up temporary lakes, and allowed aquatic organisms temporary passage between what are now separate drainage basins.

The most recent of the Pleistocene glacial advances is referred to as the Wisconsin (= Late Wisconsin, or Classical Wisconsin) in the rest of North America and is probably equivalent to the McConnell and Kluane advances in southern Yukon Territory. One of the earlier advances (the Reid) was somewhat more extensive than the Wisconsin so that the margins of the area unglaciated in the Wisconsin contain old and weathered moraines of pre-Wisconsin age. Only the margins of the

Wisconsin glaciation, which lasted from about 50,000 to 10,000 years ago, are shown in Fig. 4.

Ice-advance into southern Yukon Territory was generally from the south, forming at its maximum a northern extension of the Cordilleran ice sheet which had coalesced mostly from mountains in British Columbia. The general directions of advance at the margins of Cordilleran ice are shown by open arrows in Fig. 4. A northwest limit of the Laurentide ice sheet which covered most of Canada east of the Rocky Mountains intruded westward slightly into the Peel River area along lines shown by hatched arrows in Fig. 4. Between the Cordilleran and Laurentide ice sheets there persisted a strip of unglaciated land probably extending from the upper Peel River southeast at least to Nahanni Park; little is known so far about the glacial and biological history of this area.

Ice retreat probably followed the reverse directions of ice advance. Ice remnants remaining on high ground about 9,500 years ago are shown hachured in Fig. 5. During ice retreat large channels were cut by meltwater, and in some places temporary lakes deposited silt on their bottoms and cut wave-washed shorelines which are still visible. Spectacular changes were brought about in some drainage systems.

The detailed post-glacial history of Yukon Territory drainage basins will be discussed below in relation to the present distribution of zooplankton and fish species. Geological inferences are based on the following sources, which should be consulted for detailed background material: Bostock 1948, 1952, 1966, 1969; Campbell 1967; Ford 1976; Gabrielse 1963; Green 1971; Hughes 1969, 1972; Hughes et al. 1969; Kindle 1953; Mulligan 1963; Prest 1969, 1970; Prest et al. 1968; Tempelman-Kluit 1974; Vernon and Hughes 1966; Wheeler 1961.

#### ZOOPLANKTON DISTRIBUTION AND ABUNDANCE

Thirty-two crustacean zooplankton species were found in the 70 Yukon lakes where plankton collections were made (Tables 13, 14 and 15). Twenty-three of these species can be considered as pelagic and nine as littoral species (Table 16). The systematics of the genus *Daphnia* presented the most difficulty. Out of seven species of *Daphnia* listed in this paper only three have been previously recorded in the Yukon by Brooks (1957): *D. longiremis*, *D. pulex*, and *D. middendorffiana*. Of the four remaining species *D. schoedleri* was found in two, and *D. galeata mendotae* in three lakes. The other two species could not be identified using Brooks' system and are described here as *D. galeata galeata* Sars and *D. longispina microcephala* Sars. A more detailed description is given by Patalas and Archibald (in prep.).

*Cyclops scutifer* was the most common species (Table 16) and was also usually a dominant species (contributing more than 10% to the total number of crustaceans). The next most common species, *Diaptomus pribilofensis*, was a dominant in 70% of the lakes. *Heterocope septentrionalis*, although occurring in 60% of the lakes, rarely contributed more than 1% to the total number of crustaceans, but its contribution to the biomass was much higher due to its large size. None of the remaining species occurred in more than 50% of the lakes. The most

common cladocerans were *Daphnia longiremis*, *Euboammina longispina*, and *Daphnia middendorffiana*. Although they rarely were numerical dominants, cladocerans, particularly *Daphnia*, were often important in terms of biomass.

The more common zooplankton species (*C. scutifer*, *D. pribilofensis*), were distributed over the whole of the Yukon Territory. *H. septentrionalis* was spread over most of the Yukon with the exception of lakes situated between Squanga and Twin Lakes. A conspicuous absence from the zooplankton fauna of Yukon lakes is *Limnoecalanus macrurus*, a large calanoid common throughout much of central and eastern Canada. This species prefers cool, deep lakes and its absence from central and southern Yukon Territory cannot be explained by the lack of suitable habitat. *Limnoecalanus* is a "glaciomarine relict" whose distribution in Canada is largely a function of the past distribution of proglacial lakes east of the Rocky Mountains (Dadswell 1974). These proglacial lakes were not confluent with proglacial lakes in the Yukon and so *Limnoecalanus* has apparently had no opportunity to disperse into the Yukon. Also, since *Limnoecalanus* usually inhabits deeper layers, it is not as readily dispersed as other zooplankton species living closer to the surface.

*Senecella calanoides* is another large calanoid that is considered to be a glacial "relict" species, although its origin and distribution in North America are not as well understood as for *Limnoecalanus* (Carter 1969; Dadswell 1974). *Senecella* was found in four lakes in this study (Aishihik, Frederick, Pine, Kusawa), all located in the southwestern corner of Yukon Territory. The first three lakes are part of the Alsek River system, and Kusawa Lake was at one time connected with the Alsek system, through Glacial Lake Champagne (Kindle 1953; Fig. 5). These occurrences of *Senecella* greatly extend the known distribution since according to Wilson (1959) and Dadswell (1974) this species is known only from eastern Canada west to the Great Slave Lake area.

*Acanthodiaptomus denticornis* was found in only three lakes (Hungry, Von Wilczek, and Willow), all of them shallow and situated in unglaciated terrain. *A. denticornis* is one of the very few species of Diaptomidae that is found in both North America and Eurasia.

*Cyclops bicuspidatus thomasi*, probably the most widely distributed cyclopoid in North America, was found in only two lakes in the southern-most part of Yukon Territory (Little Teslin and Squanga).

The cladoceran community in Yukon lakes was correlated with the presence or absence of planktivorous fish (mainly *Coregonus sardinella* and the high gill-raker form of *C. clupeaformis*). *Daphnia longiremis* and bosminids were dominant in their presence; *Daphnia middendorffiana*, a much larger species, was dominant in their absence (Archibald 1977; Archibald and Patalas, in prép.).

The total number of crustaceans was compared separately within the group of lakes where the trap was used and within lakes where the Wisconsin net was used. The trap samples ranged from 10 to 160 ind/L (average of entire water column) with the most frequent values from 20-40 and from 60-80 ind/L. The net samples ranged from 1 to 239 ind/L with the most frequent values from 10-30 and from

40-60 ind/L. The trap and net results are similar given that the net is only 63% efficient relative to the trap.

The abundance of planktonic crustaceans in Yukon lakes compares well with the abundance found in the Canadian Great Lakes. Patalas (1975) found that the number of crustaceans was highly correlated with average epilimnetic temperature in mid-summer:  $N = 0.7e^{0.25t}$  where N = number of crustaceans per liter, assuming Wisconsin net is 100% efficient, and t = mean epilimnetic temperature ( $r = 0.96$ ). The predicted values for the temperature range 12-18 °C, the range in Yukon lakes, are from 14-63 ind/L which coincides with the most frequent values found in Yukon lakes.

#### GLACIAL HISTORY AND FISH DISTRIBUTIONS

Yukon Territory contains the following principal drainage basins (Fig. 1):

- a. the Yukon River system is the largest with an extensive southern basin (south of 65°N) draining most of southwestern Yukon Territory into the main Yukon River, and a northern basin draining via the Porcupine River;
- b. the Mackenzie River has two separate basins in Yukon Territory, the Liard River draining southeastern Yukon and the Peel River in the north;
- c. the Alsek River system is a small but zoogeographically significant basin draining the southwestern corner of Yukon Territory into the Pacific Ocean, and
- d. a small coastal strip north of the Porcupine River basin contains several short rivers draining into the Arctic Ocean (no lakes sampled from these systems).

The fish species found in lakes of the various drainage and subdrainage basins are shown in Tables 17, 18, 19 and 20.

The distribution patterns of some fish species in Yukon Territory conform to these major drainage basins, probably reflecting the direction of their postglacial entry to the region. The following is a discussion of the fish distributions in major drainage areas as related to post-glacial history.

#### Alsek and White River drainages

The Alsek basin has had a complex post-glacial drainage history, having at first been tributary to the Yukon River and later receiving, until recently, the outflow from Kluane Lake which is now tributary to White and Yukon Rivers. No parts of the Alsek basin were unglaciated (Fig. 4) but during deglaciation ice blocked the outlets to the Pacific Ocean (roughly 10,000 years ago) and a large lake, Glacial Lake Champagne, backed up to an elevation of 700-850 m (Kindle 1953). This glacial lake covered the present Kusawa (presently Takhini-Yukon system), Frederick, Kathleen, Rainbow, Pine and Dezadeash Lakes (Fig. 5). Glacial Lake Champagne drained into the Yukon River system, probably via Taye Lake (and/or Klusha Creek) to the Nordenskiold River valley (Fig. 5). With the

recession of ice in the lower Alsek basin, drainage to the Pacific Ocean was established.

Most of the fish fauna of the Alsek basin was probably established during the Glacial Lake Champagne phase, by dispersal from the Yukon River basin. The Alsek system is one of the few Pacific drainages containing northern pike, round whitefish and arctic grayling, and their presence is testimony to an earlier connection to the Yukon River system. Also, lake whitefish in the Alsek River system have electrophoretic patterns characteristic of lake whitefish from the Yukon River basin (Franzin and Clayton 1977). There are, however, a number of notable exceptions between the fish faunas of the two areas. Four species (exclusive of Pacific salmon) are absent in the Alsek system but present in the Yukon basin: the inconnu, broad whitefish, least cisco and lake chub (Table 20). These species evidently did not enter Glacial Lake Champagne while it drained northward and cannot now cross the drainage divide.

Rainbow trout are present in the Alsek basin in Kathleen, Rainbow and Klukshu lakes (Table 17) and in Aishihik River below Otter Falls. Rainbow trout are absent from the Yukon basin (Table 20). Rainbow trout reportedly were planted in Aishihik River during construction of the Alaska Highway but they probably are native to the Alsek system. Kindle (1953) reported that rainbow trout were present in the Kathleen River between 1946 and 1950 and Wynne-Edwards (1947) reported "first class rainbow trout fishing" in the Dezadeash and Alsek Rivers in 1945. It is unlikely that artificial introductions in Aishihik River in 1943 or later could be the basis for these reports. The absence of rainbow trout from Aishihik Lake is probably due to the presence of falls along the Aishihik River, including Otter Falls, which may have always prevented fish from entering Aishihik Lake from the south.

Kluane Lake basin probably was covered completely by the maximum McConnell (Kluane) ice advance (Fig. 4). During ice recession, Kluane Lake may have been confluent with Glacial Lake Champagne. When Glacial Lake Champagne receded, Kluane Lake became tributary to the Alsek River via Slims River and Kaskawulsh River, and remained so until relatively recently. About four centuries ago the Kaskawulsh Glacier advanced so as to cut across the valley containing the outlet river from Kluane Lake, reversing the river's flow (Bostock 1969). Kluane Lake then rose rapidly from 12 m below to 9 m above its present level. An overflow began to spill to the northwest into the course of the present Kluane River and a channel was quickly cut down to the bedrock level now controlling the lake level (Bostock 1969). This headwater capture of the Kluane Lake basin by the Yukon (White) River apparently has not resulted in the transfer of any fish species from the Alsek basin which were not already present in the Yukon drainage (Tables 17, 20). Rainbow trout and kokanee apparently were not present in hypothermal Lake Kluane and therefore were not introduced into the Yukon drainage. Kluane Lake does now support inconnu (reported by Wynne-Edwards 1947) (Table 17) and since this species is not present in the Alsek basin, it probably entered Kluane Lake after the reversal of its drainage.

Both Marshall and Moraine Lakes were covered by ice of the last glaciation but were above the level of Glacial Lake Champagne. Marshall Lake was close to the shore of Glacial Lake Champagne but was nearly 610 m higher. It presently contains no fish (Table 17) and its outlet has probably always been impassable to fish. An esker and ice marginal stream lie along the west side of Moraine Lake, and drainage at one time during ice retreat was evidently northward, probably along Nördenskiöld River (Kindle 1953; Hughes et al. 1969).

All five species of Pacific salmon (genus *Oncorhynchus*) are found in the Alsek drainage basin (Table 17). The upper Alsek basin sustained anadromous Pacific salmon and steelhead runs until a few centuries ago (Kindle 1953; Lindsey 1975). These runs probably were ended at the time of the creation of Recent Lake Alsek. In about 1720 A.D. and again in about 1845 A.D., Lowell Glacier advanced across the lower Alsek, backing up the river to an elevation of about 683 m, covering Pine Lake (Kindle 1953). No sea-going salmon are now known from the upper Alsek system, but landlocked *Oncorhynchus nerka* (kokanee) exist in Frederick, Kathleen and Sockeye (near Kathleen) lakes (Table 17). Only an eastern tributary of the Alsek, the Tatshenshini, supports anadromous trout and salmon, and these fish run into the headwaters of the Tatshenshini into and near Kluukshu Lake (Table 17). The headwaters of the creek now entering the north end of Kluukshu Lake are separated from those of a creek flowing north to Dezadeash, thereby preventing the re-establishment of anadromous salmon runs directly from the Tatshenshini to the Dezadeash system.

An important consequence of the failure of *Coregonus sardinella* to become established in the Alsek basin apparently has been the survival of the rare high gill raker form of lake whitefish in Dezadeash Lake; high gill raker lake whitefish are only known in the absence of *C. sardinella*. This rare and interesting lake whitefish form will be discussed in detail in the Squanga drainage section.

The pygmy whitefish, *Prosopium coulteri*, also is native to the Alsek basin, being known from Kathleen and a nearby lake, Sockeye Lake (Wickstrom 1977; Wynne-Edwards 1947). Their racial affinities to other pygmy whitefish (Lindsey and Franzin 1972) have not been investigated. Further, it is not known whether the pygmy whitefish will conquer the Yukon River drainage.

The distribution of fish species over the lakes of the Yukon River basin sampled in this study is relatively homogeneous (Tables 18 and 19). Two major exceptions to this, Diamain Lake and the Squanga Creek drainage system, will be discussed below. Part of the area of the present Yukon drainage basin was unglaciated during the Pleistocene (Fig. 4) and acted as a refugium for fish species (McPhail and Lindsey 1970; Franzin and Clayton 1977). No lakes in the Yukon system have been sampled which were completely unglaciated; lakes tend to be the creation of recent glaciation and few lakes exist outside of glacial limits. Barlow Lake was not covered by the latest glaciation (McConnell) or the earlier, more extensive Reid glacial advance, but is within the limits of pre-Reid glaciation(s) (Hughes et al. 1969). Seven other Yukon River system lakes sampled, namely, Crystal, Diamain,

Ethel, Minto, Reid, Von Wilczek and Willow, were covered by the Reid glaciation but not by the McConnell advance. The fish fauna of these lakes, unglaciated by the McConnell advance, does not contain any unusual elements which are absent from lakes in the glaciated areas of the Yukon basin (Tables 18 and 19). That is, there is no evidence of a failure of any fish species which may have survived Wisconsin (McConnell) glaciation in the unglaciated portions of the Yukon basin sampled in this study to disperse into the recently glaciated region. In fact, a total of only seven fish species were collected in these recently unglaciated lakes: *C. clupeaformis*, *P. cylindraceum*, *T. arcticus*, *S. namaycush*, *P. lucius*, *L. tuta* and *C. cognatus* (Tables 18 and 19). Other species, such as the Alaska blackfish *Bathymaster pectoralis* and the Arctic char *Salvelinus alpinus* apparently survived Wisconsin glaciation in unglaciated parts of Alaska and have not expanded their post-glacial ranges appreciably (McPhail and Lindsey 1970).

With local exceptions, there are no present major barriers to fish dispersal within the Yukon River basin. Fish dispersal during the recession of McConnell ice was probably enhanced by the existence of numerous local proglacial lakes and glacial meltwater channels which crossed present subdrainage divides (Fig. 5) (Wheeler 1961; Hughes et al. 1969; Kindle 1953; Green 1971; Campbell 1967; Mulligan 1963).

Glacial Lake Champagne, while covering mostly Alsek basin lakes, also filled the Valley of the present Kusawa Lake (Kindle 1953) (Fig. 5). The least connection must have reached Kusawa Lake after its connection with the Alsek basin was broken, as this species is absent from the whole Alsek River drainage (Tables 17 and 19). It has been suggested that glacial silts in the area of Chadburn Lake may be from a lake bed at one time continuous with Glacial Lake Champagne some 65 km to the west (Wheeler 1961) and this is consistent with the occurrence of pygmy whitefish *Prosopium coulteri* in Chadburn Lake and two lakes (Kathleen and Sockeye) in the Alsek River basin (Tables 17 and 19).

Diamain Lake is a sizeable lake apparently offering all the necessities to support fish, but to which fish have been denied access by the fact that the outlet enters Pelly River in the midst of a canyon containing 7 km of rapids. Possibly, Diamain Lake has persisted this way ever since Reid glaciation since it was not covered by the most recent McConnell advance. Alternatively, the lake may not have been in existence until dammed up by debris formed by an ice tongue during the more recent McConnell glaciation. The lack of fish apparently has allowed the unique responses by those plant and animal species which have gained access there. For example zooplankters (*Daphnia middendorffiana* and *Heteropece septentrionalis*) and gammarids from Diamain Lake are of an unusually large size. Irrecoverable loss to science might result if any one were to plant any kind of fish in Diamain Lake.

A number of species of fish apparently have been denied access to the Squanga Creek drainage system, notably *C. nasus*, *C. sardinella*, and *P. cylindraceum* (Tables 19 and 20). During deglaciation, a major meltwater channel flowed across the present Teenah and Squanga Lakes, across the present drainage divide of the Squanga Creek drainage system, and continued across the present McClintock and

Michie Lakes to enter the Yukon River near the present outlet of Marsh Lake (Fig. 5) (Mulligan 1963). Squanga Creek now flows over 55 m high falls, joining Teslin River just downstream of the outlet of Teslin Lake, but these falls may have been flooded during deglaciation when the Teslin River was backed up (Mulligan 1963). Apparently, the fish species absent from the Squanga drainage area were not able to gain access before the present Squanga Creek falls were established.

The unique high gill raker form of lake whitefish (*Coregonus clupeaformis* species complex) occurs in four lakes in the Squanga Creek system; Squanga, Little Squanga, Little Teslin and Teenah lakes. Its existence in the area is probably related to the absence of the least cisco *Coregonus sardinella* which it resembles in diet (Lindsey 1963; Bodaly 1979). High gill raker lake whitefish also are known from Dezadeash Lake in the Alsek basin from which the least cisco was excluded also. Bimodal gill raker counts of lake whitefish specimens taken from Hanson Lakes before poisoning suggest that high gill raker lake whitefish were present in this lake until recently (Bodaly 1979). The least cisco is apparently absent from the South McQuesten River system, including Hanson and McQuesten lakes, although no barriers to fish movements are known. Biochemical evidence suggests that the high gill raker lake whitefish of the Squanga area lakes and Dezadeash Lake are a monophyletic group. The high gill raker lake whitefish formerly present in Hanson Lakes were probably also members of this monophyletic group. This is consistent with the known deglaciation sequence of the southern Yukon. Dispersal of fish between Glacial Lake Champagne and the Squanga area was possible during deglaciation since Glacial Lake Champagne possibly extended as far east as Chadburn Lake and the Squanga Creek area drained via meltwater channels into the Yukon River near the outlet of Marsh Lake (Fig. 5). Direct connections also existed between Hanson Lakes and Squanga Creek via extensive meltwater channels between the two areas (Fig. 5). The possibility exists that high raker lake whitefish are present in the area of extensive meltwater channels between Lake Laberge and Tatlayuk Lake. The possible occurrence of high gill raker lake whitefish, partly introgressed with the low raker form, in Tatchun Lake is suggested by recent work by K. Martin (pers. comm.).

#### *Liard River basin*

The Upper Liard River basin (above Liard Canyon) has a fish fauna with many elements in common with the Upper Yukon basin to which it is adjacent (Tables 17 and 20). Also, all the lake whitefish populations in the Upper Liard system which have been tested, namely, Frances, Watson (Franzin and Clayton 1977) and Wheeler (Bodaly, unpubl. data) Lakes, show electrophoretic patterns characteristic of lake whitefish found in the Yukon River basin and not other parts of the Mackenzie basin. Movement of fish from Yukon drainages into the Upper Liard basin was possible during deglaciation while drainage around Finlayson Lake was into the Yukon system. While Frances Lake was still blocked by ice extending south from Selwyn Mountains about 10,000 years B.P., Finlayson probably drained westward (Fig. 5). A northwesterly flowing

meltwater channel at one time discharged towards Finlayson Lake along its present outlet stream, and large channels exist along Fortin Creek to the north and down Pelly River valley to the west. All other lakes sampled in the upper Liard drained into the Liard system even during deglaciation but evidently also received their fish fauna from the Yukon basin.

A number of fish species presently found in the Upper Yukon River basin are absent in the Upper Liard basin and they evidently did not disperse into the Liard basin during deglaciation via Finlayson Lake and have been excluded since. These fish species include three species of Pacific salmon, the least cisco and the broad whitefish (Tables 17, 18, 19 and 20). Conversely, some species which invaded post-glacially from the south have penetrated the Liard basin, but are absent from the Yukon River. The farthest upstream record for about eight of these species in the Liard is in northern British Columbia below Hell Gate in the Liard Canyon, although the mountain whitefish *Prosopium williamsoni* has reached Dease Lake at the southwestern headwaters of the Liard (McPhail and Lindsey 1970).

Divide Lake, presently tributary to South Nahanni and Liard Rivers probably always has drained to the southeast towards the Mackenzie River, however, present upstream migration to Divide Lake from Liard River is impeded although not totally blocked by three canyons which cut across the unglaciated Funeral Range. The isozyme gene frequencies for lake whitefish from Divide Lake are unique (Franzin and Clayton 1977), perhaps reflecting the great elevation and headwater location of the lake. There is also an intriguing possibility of previously undetected aquatic refugia having persisted between the Cordilleran and Laurentide ice sheets (C. J. Foote, pers. comm.; Ford 1976).

#### *Peel and Porcupine River basins*

The Peel River has had a complex history of drainage reversals during Pleistocene glaciations. Extensive portions of the present Peel drainage basin remained unglaciated during the last ice advance, including Chapman, Dog, Hungry, Margaret, North Fork and Popcornfish lakes (Fig. 4). Peel River presently drains north-central Yukon emptying into the Mackenzie River at Mackenzie Delta and Porcupine River presently drains north-central Yukon, eventually joining the Yukon River inside Alaska. At least twice during the Pleistocene the Peel River has been diverted from the Mackenzie into the Yukon River system through Davis Lake (Bodaly and Lindsey 1977). Prior to the Pleistocene, the upper Porcupine River was tributary to the Mackenzie River via McDougall Pass. A pre-Reid glacial advance blocked the eastward flow of the Porcupine River, and a large lake backed up in the basins of the Eagle, Porcupine and Old Crow rivers (Fig. 5). This lake discharged into the Yukon River. Water also backed up in the Peel River basin due to the ice blockage of the lower Peel River and this lake drained through a major channel presently occupied by Davis Lake, into the glacial lake in the Porcupine basin (Fig. 5). The Porcupine River flowed to the west into the Yukon River. With Wisconsin (McConnell) glaciation, this pattern was repeated. Ice blocked the Peel River at the junction of the Peel and Snake Rivers and a proglacial lake backed up at least as far as the junction of the Blackstone and

Ogilvie Rivers. Drainage of this lake was again through Davis Lake. With the recession of Wisconsin ice, drainage of the Peel basin resumed to the Mackenzie delta, but the Porcupine River continued to flow into the Yukon River with the downcutting of the Ramparts Canyon.

The Peel River basin contains races of at least six species of fish which either dispersed into the area from the Yukon basin during periods when the Peel drainage was to the west or developed *in situ* in unglaciated areas of the Peel (Bodaly and Lindsey 1977). Margaret Lake contains the only known population of lake whitefish in the Peel basin within Yukon Territory. The isozyme characteristics of this population indicate that they are closely allied to the lake whitefish of the Yukon basin. Furthermore, the morphology of lake trout, pike and slimy sculpins from the Peel area shows that races of these species are also more similar to Yukon basin forms than other Mackenzie forms (Bodaly and Lindsey 1977). However, the Peel basin does not now have a high fish species diversity. A number of fish species present in the Yukon basin adjacent to Peel basin failed to disperse into the Peel while it was tributary to the Yukon, namely the inconnu, broad whitefish, least cisco, Dolly Varden and three *Oncorhynchus* species (Tables 17, 18, 19 and 20). Also at least 18 fish species are present in the Mackenzie delta area but have not dispersed appreciably up the Peel River into Yukon Territory (McPhail and Lindsey 1970; Bodaly and Lindsey 1977; Table 17).

Races of two other fish species, the pygmy whitefish and arctic grayling found in the Peel River also possess distinctive characteristics (Lindsey and Franzin 1972; McCart and Pepper 1971) and may have developed these distinctive characteristics in unglaciated parts of the Peel basin. Elliott Lake, presently tributary to the Hart River in the Peel basin, contains the only pygmy whitefish population in the Peel drainage area (Table 17). This lake was covered by ice of the last (McConnell) glaciation but there has been excellent opportunities for fish dispersal from unglaciated parts of the Peel basin. A glacier tongue projected northwest from the Selwyn lobe to fill the valley now occupied by Elliott Lake (Fig. 4). During ice recession this tongue retreated upslope, past the divide between the Peel and Yukon drainages and downslope into the Yukon River basin. A proglacial lake was impounded at the ice front and this lake discharged northwest into the Hart River. The proximity of Elliott Lake to the unglaciated portions of the Peel basin and the known sequence of events during ice retreat are consistent with the view that the somewhat distinctive form of the pygmy whitefish in this lake may have originated from a refugium within the Peel drainage (Lindsey and Franzin 1972). The arctic grayling of the Peel basin also may represent a stock which developed distinctive characteristics in unglaciated parts of the Peel drainage during the Pleistocene (Bodaly and Lindsey 1977).

Dog Lake is close to the Peel River canyon but is perched roughly 300 m above it. It lies about 10 km south of the maximum limit of the Wisconsin advances of Laurentide ice which moved south and west about to the junction of the Snake River and Peel River (Fig. 4). The level of the temporary lake which formed in the Peel basin was probably

about the same as that of Dog Lake. The two may not have merged (no shore lines are known to suggest this), but access by fish was probably available between the two. The lake chub *Culaeius plumbeus* evidently spread from the Mackenzie River to Yukon River but the time is unknown. The presence of lake chub in Dog Lake might suggest that they were present in the adjacent meltwater basin during maximum Wisconsin advance, and thereby gained access to the Yukon system. However, white suckers *Catostomus commersoni* are also in Dog Lake (Table 17); this species has not previously been found in the Peel River system in Yukon Territory. It is not present in the Yukon River system (Table 20) and therefore probably entered the lower Peel River and Dog Lake from the Mackenzie after the Davis Lake connection to the Yukon River was abandoned.

As noted above, Davis Lake occupies the floor of a large channel through which the lower Peel basin proglacial lakes discharged northward into the Eagle River and hence to the Yukon River (Fig. 5). The last discharge of Peel River waters through Davis Lake ceased before the Mackenzie River became ice-free, so fish in Davis Lake have either entered from Yukon River system through the northern lake outlet in recent times, or persisted there since the channel carried water from the Peel. At least three of the fish species present in Davis Lake, namely broad whitefish, least cisco and burbot, must have entered from the Yukon drainage since they are not now present in the Peel basin (Table 20). Lake whitefish in Davis Lake are Yukon-type, not Mackenzie-type, in allele frequencies of two isozymes (Bodaly and Lindsey 1977). In addition to the fish species listed for Davis Lake, four individuals were collected from the north lake which had total gill raker numbers of 27, 32, 34 and 35, higher than any *C. clupeaformis* collected. The mouths of these fish appeared intermediate between the subterminal mouth of *C. clupeaformis* and *C. nasus* and the terminal mouth of *C. sardinella* and they are suspected *C. clupeaformis* x *C. sardinella* or *C. nasus* x *C. sardinella* hybrids. Enzyme patterns for three enzyme systems examined were identical for lake whitefish, broad whitefish, least cisco and the suspected hybrids.

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Table 1. List of lakes sampled (A-K), their location, present drainage and associated comments. Names given are official names (Gazeteer of Canada 1976) unless otherwise noted (\*). All lakes in Yukon unless otherwise indicated.

Lake name	location (N Latitude x W longitude)	Present Drainage	Comments
Aishihik	61° 25'	137° 07'	Drains south through Canyon L. to Aishihik R. to Dezadeash R. to Alsek R.
Atlin	60° 00'	133° 50'	Drains west via Atlin R. into Tagish L. to Yukon R.
Barlow	63° 45'	137° 43'	Drains via Slough Cr. to Stewart R. to Yukon R.
Bennett	60° 06'	130° 52'	Outlet at east end via Lakes L. to Marsh L. to Yukon R.
Bonnet Plume	64° 18'	132° 00'	Drains northeast via 1.5 km stream to Bonnet Plume R. to Peel R.
Braburn	61° 27'	135° 48'	Expansion of Klusia Cr. tributary to Nordenstkiold R. to Yukon R.
Brace	61° 49'	132° 06'	Drains via short stream to Peel R. to Yukon R.
Caribou	60° 32'	134° 16'	Tributary to northeast side Marsh L. to Yukon R.
Chauburn	60° 39'	134° 57'	Map shows no surface drainage. Lies adjacent to Yukon R.
Chapman	64° 51'	138° 21'	No surface outlet. Close to Blackstone R. (Peel R. drainage).
Clark Lakes	64° 06'	134° 56'	Drain east via Scougine Creek to Beaver R. to Stewart R. to Yukon R.
Cryatal	63° 14'	136° 05'	Drains via Crystal Creek to Crooked Cr. to Stewart R. to Yukon R.
Daileyee	60° 20'	133° 38'	Tributary via Sealforth and Squanga Creeks to Teslin R. to Yukon R.
Daughney	60° 10'	130° 55'	Drains south into Rancheria R. to Liard R.
Davies	65° 11'	136° 25'	Drain north via Eagle R. to Porcupine R.
Dezadeash	60° 28'	136° 58'	Outlet tributary via Sixmile L. to Dezadeash R. and Alsek R.
Diana in Divide L., N.W.T.	62° 55'	136° 19'	Drains south by a 4 km stream to Peel R. (in Granite Canyon) to Yukon R.
Divide L., N.W.T.	62° 02'	128° 20'	Drains southeast via Flat R. to S. Nahanni R. to Liard R.
Dog	65° 54'	134° 13'	Drains via Solo Cr. to Peel R.
Dragon	62° 35'	131° 30'	Drains via Riddell R. to S. Macmillan R. to Peel R. to Yukon R.
Bear*	60° 14'	133° 22'	Drains through Teenah L. to Squanga Cr. to Teslin R. to Yukon R.
Elliott	64° 29'	135° 34'	Head of Elliott Cr. to Hart R. to Peel R.
Ethe	63° 22'	136° 06'	Drains east via Ethel Cr. to Rogoild Cr. to Stewart R. to Yukon R.
Fairchild	64° 58'	133° 46'	Drains by 3 km stream to Bonnet Plume R. to Peel R.
Finlayson	61° 41'	130° 38'	Drains via Finlayson R. to Frances L. to Liard R.
Fish	60° 36'	135° 14'	Drains northwest via Jacobson Cr. and Ibex R. to Takini R. to Yukon R.
Fox	61° 14'	135° 28'	Drains south via Richthofen Cr. to Lake Laberge and Yukon R.
Frances	61° 23'	129° 30'	Drains south via Frances R. to Liard R.
Frederick	65° 23'	136° 40'	Tributary via Kluthi R. to Dezadeash L. to Yukon R.
Frenchman	62° 10'	135° 50'	Drains into Tatchun R. to Yukon R.
Gillespie	64° 44'	134° 00'	Drains via Gillespie Cr. to Bonnet Plume R. and Peel R.
Halfway Lakes	63° 48'	135° 48'	Both lakes drain to Mud Cr. to Stewart R. to Yukon R.
Hanson Lakes	64° 00'	135° 22'	Outlet creek joins S. McQuesten R. to Stewart R. to Yukon R.
Hungry	63° 39'	136° 00'	Drains into Hungry Cr. to Wind R. to Peel R.
Jack Fish*	61° 56'	132° 32'	Outlet at west end apparently drains to Lapie R. to Peel R. to Yukon R.
Janet	63° 40'	135° 30'	Drains south via Janet Cr. to Stewart R. and Yukon R.
Jo-Jo	60° 34'	136° 21'	Drains south into Kusawa L. to Takini R. to Yukon R.
Kathleen Lakes	60° 33'	137° 23'	Drains via Kathleen R. through Rainbow L. to Dezadeash R. to Alsek R.
Kathleen Lakes	64° 14'	134° 11'	Drains east into Rackla R. to Beaver R. to Stewart R. to Yukon R.
Kloo	50° 58'	137° 52'	Drains south via Jarvis and Kaskawulsh Rivers to Alsek R.
Klauane	61° 15'	128° 45'	Drains northwest via Klauane R. to Boniek R. to White R. to Yukon R.
Kukshu	60° 19'	136° 59'	Head of Klukshu (or Unahini) R. to Tatschenhini R. to Alsek R.
Kokatsonon	60° 33'	134° 52'	Tributary to Cowley Cr. to Yukon R.
Kusawa	60° 20'	136° 22'	Expansion to Takini R. which drains to Yukon R.

Table 2. List of lakes sampled (1-7), their location, present drainage and associated comments. Names given are official names (Gazeteer of Canada 1976) unless otherwise noted (\*). All lakes in Yukon unless otherwise indicated.

Lake name	Location (N Latitude x W longitude)	Present Drainage	Comments
La Bergerie	61° 11'	135° 12'	Expansion of Yukon R.
Ladee	64° 01'	135° 15'	Drains via Keno Ledge R. to Stewart R. to Yukon R.
Little Atlin	60° 15'	133° 57'	Drains south via Lubbock R. to Atlin L. to Liard R. to Yukon R.
Little Salmon	62° 11'	134° 40'	Drains via Little Salmon R. to Yukon R.
Little Teslin	62° 11'	133° 24'	No surface outlet. Within Squanga Cr. (Teslin-Yukon) drainage.
Long*	60° 29'	135° 02'	No surface outlet. Within upper Yukon (Levees) drainage.
Lower Snafu*	60° 06'	133° 42'	Expansion of Snafu Cr., tributary to Lubbock R., Atlin L (which see).
Mandanna	61° 55'	135° 47'	Not Snafu Lake at 60° 11' N, 133° 26' W.
Margaret	65° 21'	134° 30'	Drains north via Mandanna Cr. to Yukon R.
Marshall	60° 25'	134° 18'	No surface outlet. Lies adjacent to Bonnet Plume R. (Peel).
Marshall*	60° 57'	137° 16'	Head of upper Yukon R. (Leves).
Mayo	63° 43'	135° 04'	Drains south to Marshall Cr. to Bazadeash R. to Alsek R.
McClintock	60° 35'	133° 55'	Drains via Mayo R. to Stewart R. to Yukon R.
McQuesten	64° 07'	135° 19'	Drains northwest through short creek to Fox L., to Michie Cr. to McClintock R. to Marsh L. (upper Yukon R.)
Michie	60° 41'	134° 10'	Head of S. McQuesten R. which flows to Stewart R. to Yukon R.
Kinto	63° 41'	136° 10'	Drains via Michie Cr. and McClintock R. to Marsh L. (upper Yukon R.).
Morraine	60° 57'	136° 45'	Drains via Mindo Cr. to Mayo R. to Yukon R.
Mariay	60° 00'	132° 05'	Drains into Cracker Cr. to Dezadeash R. to Alsek R.
Nares	60° 10'	134° 39'	Enlargement of Morley R. which drains into Teslin L. to Teslin R. to Yukon R.
North Fork*	64° 38'	138° 23'	Discharges into Tagish L. to Marsh L. to Yukon R.
Palmer L., B.C.	59° 06'	133° 35'	Drains via short creek to E. Blackstone R. to Peel R.
Pine	60° 49'	137° 27'	No surface outlet. Adjacent to Atlin L. (upper Yukon system).
Pinguicula	64° 41'	133° 24'	Drains via Pine Cr. to Dezadeash R. to Alsek R.
Popcornfish	65° 28'	133° 47'	Drains west via Pinguicula Cr. to Bonnet Plume R. to Peel R.
Quiet	61° 05'	133° 05'	Drains northwest via east fork Noisy Cr. to Bonnet Plume R. to Peel R.
Rainbow	60° 39'	137° 15'	Name derived from reports of a "popcorn fish" with warts covering its head. Also called Crooked Lake.
Reid Lakes	63° 26'	137° 13'	Large lake only sampled.
Simpson	60° 44'	129° 15'	Expansion of Kathleen R. to Dezadeash R. to Alsek R.
Smart L., B.C.*	59° 57'	131° 46'	Discharge northwest to Stewart R. to Yukon R.
Snafu	60° 11'	133° 26'	Drains south via short stream to Frances R. to Liard R.
Squanga	60° 29'	133° 38'	No surface drainage. Adjacent to Smart R. (Teslin-Yukon system).
Sulphur	60° 57'	137° 58'	Drains via Snafu Creek to Atlin L. and Yukon R.
Summit	60° 25'	133° 39'	Drainage to Squanga L. to Teslin R. to Yukon R.
Swan L., B.C.	59° 53'	131° 24'	No surface outlet. Within White R. (Yukon) drainage.
Tagish	60° 10'	134° 20'	Drainage of Swift R. which flows west to Teslin R. to Yukon R.
Tarfu	60° 03'	133° 43'	Drains north to Marsh L. to upper Yukon (Levees) R.
Tatchun	62° 17'	136° 08'	Enlargement of Tatchun R. to Yukon R.
Tatimain	62° 37'	135° 59'	Drains by Tatchun R. to Yukon R.
Taye	60° 56'	136° 21'	Drains via Mica Cr. to Pelly R. to Yukon R.
Teehn	60° 18'	133° 25'	Drains via Mendenhall R. to Takhini R. to Yukon R.
Teslin	60° 15'	132° 57'	Drains via Teehn Cr. and Seaforth Cr. to Squanga Cr. to Teslin (Yukon) R.
Twin Lakes	61° 42'	135° 57'	Also known locally as Wolf Lake.
Von Wilczek Lakes	62° 42'	136° 42'	Straddles B.C./Yukon border. Formerly called Emerald Lake. Only north lake sampled.
Watson	60° 06'	128° 49'	North lake has no surface outlet. South Lake drains to Von Wilczek Cr.
Wheeler L., B.C.*	59° 41'	129° 10'	Drains to Liard R.
Willow	63° 11'	136° 47'	Head of Willow Cr. tributary to Peely R. to Yukon R.
Wolf	60° 39'	131° 40'	Local name.

Table 3. List of scientific and common names of fish species referred to in text.

Scientific Name	Common Name
<i>Stenodus leucichthys</i> (Pallas)	inconnu
<i>Coregonus clupeaformis</i> (Mitchill)	humpback whitefish complex
<i>Coregonus nasus</i> (Pallas)	broad whitefish
<i>Coregonus sardinella</i> Valenciennes	least cisco
<i>Prosopium cylindraceum</i> (Pallas)	round whitefish
<i>Prosopium coulteri</i> (Eigenmann and Eigenmann)	pygmy whitefish
<i>Prosopium williamsoni</i> (Girard)	mountain whitefish
<i>Thymallus arcticus</i> (Pallas)	arctic grayling
<i>Salvelinus namaycush</i> (Walbaum)	lake trout
<i>Salvelinus alpinus</i> (Linnaeus)	arctic char
<i>Salvelinus malma</i> (Walbaum)	Dolly Varden
<i>Salmo gairdneri</i> Richardson	rainbow trout, steelhead trout
<i>Oncorhynchus nerka</i> (Walbaum)	sockeye salmon; kokanee
<i>Oncorhynchus kisutch</i> (Walbaum)	coho salmon
<i>Oncorhynchus tshawytscha</i> (Walbaum)	chinook salmon
<i>Oncorhynchus keta</i> (Walbaum)	chum salmon
<i>Oncorhynchus gorbuscha</i> (Walbaum)	pink salmon
<i>Esox lucius</i> Linnaeus	northern pike
<i>Couesius plumbeus</i> (Agassiz)	Tale chub
<i>Catostomus commersoni</i> (Lacépède)	white sucker
<i>Catostomus catostomus</i> (Forster)	longnose sucker
<i>Lota lota</i> (Linnaeus)	burbot
<i>Cottus cognatus</i> Richardson	slimy sculpin

Table 4. Elevation, surface area, length, width, and maximum known depth for lakes of the Alsek, Liard, Peel and Porcupine River drainage systems.

Drainage	Subdrainage	Lake	Elevation (m)	Surface Area (km <sup>2</sup> )	Length (km)	Width (km)	Maximum known depth (m)	Comments
Alsek	Dezadeash	Aishihik	915	151.0	54.2	120		Mean depth 33 m. Narrow and deep except for extreme ends which are quite shallow. Contour map available (Dept. Fisheries, Whitehorse, V.T.). Shore line length approximately 140 km. Extensive soundings over whole lake. Depth 3.5 km from west end was 24.5 m; 1.5 km from west end: 13.7 m; 0.5 km from west end: 1.8 m. Upper Kathleen drains by 1.5 km river to Lower Kathleen. Contour map of both lakes is available (Walker et al. 1973: 32)
		Dezadeash Frederick	702 703-762	77.2 4.95	20. 9.	9.7 0.7	7.6 24.5	
		Kathleen (Upper) (Lower)	736 734.5	5.38 33.8	5.5 11.	1.4 8.	110	
		Kloo Marshall Moraine Pine	860 ~1430 910-1070 610-760	12.8 0.44 4.2 4.3	1.8 7 5.5	0.5 0.8	12 32 2.1	
		Rainbow	610-735	1.44			2	
		Tatshanshini	<700	1.25	5	0.5	5.5	
		Dease	Wheeler	610-760	2.8		30	
		Flat	Divide	~1040	0.2	1.4	10.4	
		Frances	Finlayson Frances Simpson	946 774 610-760	19.9 106.1 20.5	14.5 37 11	11.3 18 55	
		Rancheeria	Watson	915-1065	4.8	6	27	
Liard	Blackstone	Daughney	Chapman	680	14.3	8	2.9	19.8
		North Fork	North Fork	1067-1220	0.16	0.9	0.8	3.6
		Bonnet Plume	Bonnet Plume	1067-1121	3.7			12
		Fairchild	Fairchild	610-760	1.69	4.0	0.8	4.5
		Gillespie	Gillespie	~1370	0.63	2.8	0.5	22.3
Peel	Dog	Margaret	Margaret	490	4.5	5	1.5	26
		Pinguicula	Pinguicula	914	1.13	3.2	0.5	12.2
		Popcornfish	Popcornfish	~760	0.56	2.2	0.2	12.2
		Hart	Hart	915-1055	1.13	1.9	0.6	Lake not sounded.
Porcupine	Wind	Elliot	Elliot	305-460	0.81	1.9	0.6	22
	Eagle	Hungry	Hungry	305-460	6.6	8	4	4
		Davis (north)	Davis (north)	305-460	2.8	2.5	23.	27.
		(south)	(south)	305-460				

Table 5. Elevation, surface area, length, width, and maximum known depth for lakes of the Atlin, Lewes, Mandanna, Nordenskiold, Pelly, Big Salmon and Little Salmon subdrainages of the Yukon River drainage system.

Drainage	Subdrainage	Lake	Elevation (m)	Surface Area (km <sup>2</sup> )	Length (km)	Width (km)	Maximum known depth (m)	Comments
Yukon	Atlin	Atlin	668	588.7	102.5	3-8	283	Mean depth 85.6 m. See Withler (1956) for contour map.
		Little Atlin	686	39.8	21.	3.2	14	Extensive mud shallows over southern half of lake.
		Lower Snafu	771	3.5	5.2	1.3	37	See Archibald (1977) for sounding transects.
		Palmer	670-760	1.0	1.6	0.8	13.7	
		Snafu	878	4.7	9.	1.	29.	
		Tarfū	760	3.3	4.		33.	
Lewes	Bennett		656	80.2	40.	3.7	120.	Contour map of west arm available (Dept. Fisheries, Whitehorse, Y.T.)
	Caribou	760-910		0.44	1.5	0.5		
	Chadburn	<700		1.8	4.5	1.1	42.5	See Walker et al. (1973:18) for contour map
	Fox	760-910		15.9	17.	1.3	75.	See Brown et al. (1976) and Archibald (1977) for sounding transects.
Kootatsoon		<762		0.18	0.8			
	Laberge	628		213.6	58.1	6.4		
	Long	<700		0.39	1.3		17.	See Walker et al. (1973:34) for contour map.
	Marsh	656		94.5	29.	3.7	53.	Contour map available (Dept. Fisheries, Whitehorse, Y.T.)
McClintock		790-825		1.8	2.8	1.3	22.	Southern third of lake shallow.
Michie		742		2.75	4.3	1.6		
Nares		656		5.3	5.0	2.6	15.	Contour map available (Dept. Fisheries, Whitehorse, Y.T.)
Tagish		656		340.8	95.4	3.	214.	Contour map available (Dept. Fisheries, Whitehorse, Y.T.). See also Withler (1956).
Von Wilczek	(N)	460-610		3.2	2.4	1.6	3.7	
	(S)	460-610		2.5				
Mandanna		<610		6.0	5.	1.2	38.	
Nordenskiold	Braeburn	<760		6.0	6.2	1.9	36.5	
	Twin	610-760		1.5	2.3	1.8	51.	see Walker et al. (1973:49) for contour map.
Pelly	Bruce	760-910		2.5	4.4		35.	See Archibald (1977) for approximate bathymetric map.
	Diamond	460-610		18.8	10.	2	25.	Spot soundings at south end only.
	Dragon	760-910			16	0.6	10.	
	Jackfish	760-910			1.7		17.	
	Tatimain	558			33.2	1.2	40.	
	Willow	760-910			1.9	3.5	1.8	
Big Salmon	Quiet	802		53.0	32	3.2	>100 m	
Little Salmon	Little Salmon	608		62.6	33	1.6	96.	

Table 6. Elevation, surface area, length, width, and maximum known depth for lakes of the Stewart, Takhini, Tatchun, Teslin, and White subdrainages of the Yukon River drainage system.

Drainage	Subdrainage	Lake	Elevation (m)	Surface Area (km <sup>2</sup> )	Length (km)	Width (km)	Maximum known depth (m)	Comments
Yukon	Stewart	Barlow	610-760	0.9	1.2	0.7	5.5	
		Clark	610-760	3.0			23	
		Crystal	760-915	1.77	2.5	0.8		
		Ethe	764	41.0	19	2.5	45	
		Ha Fway (W)	<760		1.5		4.7	
		(E)	<760		1.5		4.2	
		Hanson (N)	<760	1.0				
		Hanson (S)	<760	3.2	5.0	0.8	33	
		Janet	572	17.2	11	2	103	
		Kathieen	610-760	4.5			60	
McQuesten	Minto	Ladue	<760	2.4			24	Elevation given prior to outlet dam construction.
		Mayo	671	94.9	35.4	3.2		Spot soundings at south end of lake only.
		McQuesten	<760	13.0	13	2	8	See Archibald (1977) for approximate bathymetric map.
		Minto	610-760	4.3	3.7	1.3	33	
		Reid	460-610	14.8				
		Fish	1114	13.6	10.5	1.8	9.0	
		Jo-Jo	888	6.6	12	<1.0	52	
		Kusawa	671	142.7	57	2.5	16.8	
		Taye	610-760	8.1	7	1	3	
		Takhini						Spot soundings at north end of lake only.
Tatchun	Tatchun	Frenchman	460-610	14.1	18	1.6	39	
		Tatchun	460-610	6.6	10.5	1.0	53	
		Dalayee	970	11.1	10.3	1.6	46	
		Dwarf	760-910	0.5			18	
		Little Teslin	790	3.2	3.2	1.2	20	
		Squanga	790	11.1	8.8	1.2	40	Half of surface area <10 m deep.
		Summit	838	1.6	3.2	0.5	13	Extensive shallows, 21% of lake area less than 3 m.
		Tennah	855-885	2.5	3.9	0.8	19.2	
		Morley	760-910	13.2			34	
		Smart	760-910	1.4	1.3		6	
Teslin	(rest)	Swan	841	8.9	7	1.4	65	
		Teslin	683	355	108	3.0	214	See Archibald (1977) for approximate bathymetric map.
		Wolf	991	74.4	22	6	66	Mean depth 59 m. See Clements et al. (1968) for bathymetric map.
White	Kluane	781	409.5	74	8	82		
	Sulphur	760-910	1.5	2.8	0.6	2		

Table 7. Temperature (temp) ( $^{\circ}\text{C}$ ) and oxygen ( $\text{mg/l}$ ) profiles for lakes of the Alsek, Liard, Peel, and Porcupine River drainage systems. Depths (m) of each measurement given in brackets following measurement. Depths rounded to nearest m (0-30 m) or to nearest 2 m (>30 m). Asterisks denote measurements taken at lake bottom.

Drainage	Subdrainage	Lake	Date	Parameter
Alsek	Dezadeash	Aishihik <sup>1</sup>	1972	temp 11.5(0)
	Dezadeash	11 Aug 70	temp 11.5*(2)	
	Frederick <sup>3</sup>	12 Aug 74	temp 13.3(0)	
	Kathleen	no data	13.3(2)	
	Klao	12 Jul 75	temp 18.8(0)	
		oxygen 9.15(0)	17.3(1) 9.2(3)	
	Marshall	24 Jul 74	temp 9.0(0)	
	Moraine	16 Jul 75	temp 14.0(0)	
	Pine	12 Jun 75	temp 9.8(0)	
		oxygen 10.6(0)	9.9(6) 9.7(3)	
		oxygen 10.6(0)	10.4(10) 9.6(4)	
		oxygen 11.7(0)	11.2(20) 9.2(6)	
		oxygen 16.5(0)	10.6(15) 10.6(15)	
		temp 10.8(0)	16.2(2) 15.9(5)	
		oxygen 11.0(0)	11.0(18) 8.8*(26)	
		oxygen 10.9(6)	13.8(1) 13.6(9)	
		oxygen 9.0(0)	10.7(12) 9.0(20)	
		temp 10.8(0)	15.6(8) 13.6(8)	
		temp 14.2(0)	11.0(18) 12.8(10)	
		temp 11.0(0)	11.1(12) 9.0(26)	
		temp 25 Aug 73	10.8(0)	
		temp 19 Aug 75	17.4(0)	
		oxygen 7.6(0)	16.6(4) 8.8(11)	
	Flat	Divide	6 Aug 70	temp 13.5(0)
	Frances	Finiayson	4 Aug 70	temp 14.3(0)
		Frances <sup>5</sup>	5 Aug 70	temp 16.5(0)
		Simpson	18 Aug 75	temp 16.7(0)
		Gauthieria	17 Aug 75	oxygen 9.8(0)
		Watson	7 Aug 70	temp 14.0(0)
		Chapman	18 Jul 70	oxygen 9.7(1)
		North Fork	19 Jul 70	temp 17.4(0)
		Bonnet Plume	21 Jul 74	temp 11.9(0)
		Fairchild	no data	temp 10.5(0)
		Gillespie	18 Jul 74	temp 7.0(0)
		Margaret	3 Aug 75	temp 15.0(0)
		Pinguicula	20 Jul 74	temp 11.1(0)
		Popcornfish	no data	temp 9.9(5)
	Dog	Elliott	13 Jul 70	temp 12.7(0)
	Hart	Hungry	5 Aug 75	temp 15.3(0)
	Wind	Davis (N)	6 Aug 75	temp 13.9(0)
	Porcupine	Eagle (S)	9 Aug 75	temp 13.0(0)

<sup>1</sup> Average summer epilimnetic temperature  $10.7^{\circ}\text{C}$  in northern region and  $8.4^{\circ}\text{C}$  in southern region; oxygen concentrations above 90% saturation throughout water column (Kussat 1973).

<sup>2</sup> Surface temp reached high for the summer on August 14 ( $16.0^{\circ}\text{C}$ ); the difference between surface and bottom (4.5 m) temp never exceeded  $2.5^{\circ}\text{C}$  and was more usually 0 to  $0.5^{\circ}\text{C}$ .

<sup>3</sup> Station 1.5 km from west end.

<sup>4</sup> Station near south end.

<sup>5</sup> Station in centre of west arm.

Table 8. Temperature (temp) ( $^{\circ}\text{C}$ ) and oxygen (mg/l) profiles for lakes of the Atlin, Lewes, Mandanna, Nordenkiold, Petty, Big Salmon, and Little Salmon subdrainages of the Yukon River drainage system. Depth (m) of each measurement given in brackets following measurement. Depths rounded to nearest m (0-30 m), to nearest 2 m (32-40 m) or to nearest 5 m (>40 m). Asterisks denote measurements taken at lake bottom.

Drainage	Subdrainage	Lake	Date	Parameter	
Yukon	Atlin	Atlin	30 Jul 70	temp	
		Little Atlin	9 July 70	temp	
		Lower Snafu	10 July 70	temp	
		14 June 75	temp		
		oxygen	10.6(0)		
	Palmer	29 July 75	temp		
		3 Sep 75	temp		
		30 July 70	temp		
		20 July 75	temp		
		oxygen	10.6(0)		
Lewes	Caribou	no data	no data	Epilimnetic	
		14 Aug 70	temp		
		22 Jun 75	temp		
		oxygen	6.7(0)		
		1 Aug 75	temp		
	Kookatsoon	no data	no data	Epilimnetic of about 13 C extending to about 12 m; sharp temperature decrease between 12 and 15 m.	
		29 Jun 63	temp		
		8 July 70	temp		
		31 May 60	temp		
		16 Aug 55	temp		
Von Wlczek	Long	temp	10.1(0)	10.0(1)	
		oxygen	12.0(5)	10.0(1)	
		temp	13.5(0)	13.5(3)	
		oxygen	9.2(0)	9.0(2)	
		temp	11.4(0)	10.8(2)	
	Marsh	3 Sep 75	temp		
		26 Aug 55	temp		
		15 July 70	temp		
		8 Sep 75	temp		
		9 Aug 78	temp		
Petty	Mandanna	temp	18.3(0)	17.6(2)	
		temp	13.9(0)	8.3(1)	
		temp	16.7(0)	16.0(5)	
		temp	14.4(0)	10.0(1)	
		temp	16.4(0)	15.5(2)	
	Diamain	temp	10.6(0)	5.6(10)	
		oxygen	10.6(6)	10.5(9)	
		temp	12.2(0)	11.9(6)	
		oxygen	13.1(0)	13.0(3)	
		temp	15.3(0)	14.8(3)	
Dragon	Tatlinian	temp	11.2(0)	11.4(4)	
		temp	12.4(0)	12.4(10)	
		oxygen	13.1(0)	13.0(12)	
		temp	16.0(0)	15.9(2)	
		oxygen	11.0(0)	11.0(6)	
	Jackfish	temp	12.5(0)	12.5(12)	
		oxygen	12.7(0)	12.8(10)	
		temp	12.3(0)	12.0(5)	
		oxygen	11.9(0)	13.1(2)	
		temp	13.1(0)	13.1(2)	
Big Salmon	Willow	no data	no data	(See also Withler 1956)	
		2 Aug 70	temp		
		22 Aug 75	oxygen		
		12.2(15)	13.8(30)		
		12.2(15)	13.8(50)		
	Quiet	temp	11.9(0)	11.9(9)	
		oxygen	12.0(5)	12.3(3)	
		temp	11.6(4)	11.6(18)	
		oxygen	10.8(5)	10.5(6)	
		temp	14.0(50)	14.0(50)	
17					
(Data from Dept. Fisheries, Pacific Region) (Station 2 km E of Carcross)					
5.1(30) 5.3(24) 6.1(20) 4.0(40)					
5.4(26) 6.2(21) 5.4(26)					
5.1(30) 5.3(24) 6.1(20) 4.0(40)					

Table 9. Temperature ( $^{\circ}\text{C}$ ) and oxygen ( $\text{mg/l}$ ) profiles for lakes of the Stewart, Takhini, Tatshuina, Teslin, and White subdrainages of the Yukon River drainage system. Depth (m) of each measurement given in brackets following measurement. Depths rounded to nearest m (0-30 m), to nearest 2 m (32-40 m) and to nearest 5 m (>40 m). Asterisks denote measurements taken at lake bottom.

Table 10. Water chemistry of lakes of the Alsek, Liard, Peel, and Porcupine River drainage systems. See Sources and Methods for further information.

Station near south end. See also Kussat (1973).

1974 O<sub>2</sub> levels high throughout water column.

station 1.5 km from west end.

Station in centre of West arm

water muddy.

Table 11. Water chemistry of lakes of the Atlin, Levees, Mandanna, Nordenstkiold, Pelly, Big Salmon, and Little Salmon subdrainages of the Yukon River drainage system. See Sources and Methods for further information.

<sup>1</sup> See also Withler (1956).

Results from Dept. of Fisheries, Pacific Region.

3 Station at NW end of lake.

סבבון יוניברסיטרי מילניום ב-טכניון זכה בפרס מילניום.

Station in centre of bend in southern part of lake

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Table 12. Water chemistry of lakes of the Stewart, Takhini, Tatichun, Teslin, and White subdrainages of the Yukon River drainage system. See Sources and Methods for further information.

Drainage	Subdrainage	Lake	Date	Secchi transp. (m)	Chl a ( $\mu\text{g/l}$ )	pH	TDS (mg/l)	Conductivity ( $\mu\text{s/cm}$ )	Hardness (mg $\text{CaCO}_3$ per l)	$\text{Ca}$ (mg/l)	$\text{Mg}$ (mg/l)	$\text{Na}$ (mg/l)	$\text{K}$ (mg/l)	$\text{SO}_4$ (mg/l)	$\text{Cl}$ (mg/l)	$\text{Si}$ (mg/l)	
Yukon	Stewart	Barlow	20 Jul 70	1.0	8.0	6.0	60	51.3	5.9	1.2	1.2	1.6	16.0	2.0	0.48		
		Clark	6 Jul 75	4.0	0.26		110									1.0	1.44
		Cystal	no data														
		Ethe <sup>1</sup>	14 Jul 70	6.0													
		Halfway (E)	8 Aug 75	>4.2													
		Hanson (S)	11 Jun 60 <sup>2</sup>	6.5													
		Janet	7 Aug 75	5.8													
		Kathleen	4 Jul 75	4.0	0.7												
		Ladue	7 Jul 75	4.6	0.38												
		Mayo	24 Jul 70	5.6	0.72												
		McQuesten	13 Jul 70	3.3													
		Minto	20 Jul 70	5.0													
		17 Jun 75	3.2														
		3 Aug 75	5.4	1.32													
		5 Sep 75	4.9														
		Reid	21 Jul 70	4.0													
		Fish	9 Aug 70	8.0													
		Jo-Jo	15 Jul 75	7.0	0.36												
		Kusawa <sup>3</sup>	10 Aug 70	6.5													
		Taye	17 Jul 75	2.1	2.38												
		Frenchman	21 Aug 75	6.7	0.7												
		Tatichun <sup>4</sup>	25 Jul 70	5.0	8.0-8.5												
		Dalayee	21 Jun 75	1.8													
		Dwarf	11 Jul 70	9.8													
		Little Teslin	21 Jul 75	2.4	5.96												
		Squanga	16 Aug 70	4.0													
		26 Jun 75	4.5	1.33													
		27 Aug 75	5.5	1.90													
		Summit	8 Jun 60	4.0													
		Teenah	28 Jun 75	3.4	3.62												
		Morley	9 Jul 70	4.3	0.8												
		Smart	14 Aug 75	4.0	0.8												
		Swan	15 Aug 75	2.0	2.6												
		10 Jul 75	3.8														
		30 Jul 75	5.4	1.0													
		10 Sep 75	6.0														
		Teslin <sup>5</sup>	1944		7.5-8.1												
		Wolff	22 Jul 75	6.1	1.2												
		Kluane	11 Aug 70	>4.2													
		White	11 Jul 75	3.4	0.13												
		Sulphur	11 Jul 75	>2.0													

2

1 Station at west end of lake.

2 From Walker et al. (1973).

3 Water slightly milky.

4 Water tea-coloured.

5 See Clemens et al. (1968).

6 Station between Burwash Landing and Sandspit Point.

7 Station offshore at Alaska Hwy Mile 1066.5. Water turbid.

8 Station offshore at Alaska Hwy Mile 1066.5. Water turbid.

Table 13 (first part).

Absolute abundance of crustaceans, rotifers, and total zooplankton (crustaceans plus rotifers) for lakes of the Alsek, Liard, Peel and Porcupine River drainage systems. Zones sampled are epilimnion (e), hypolimnion (h), and entire water column (wc); wet weight per unit area ( $\text{mg}/\text{cm}^2$ ) is always expressed for the entire water column. See second part of table (below) for relative abundance of crustacean species by lake.

Drainage	Subdrainage	Lake	Date	Sampling gear	Depth (m) of total vertical haul with net	Zone sampled	Total zooplankton ( $\text{mg}/\text{cm}^2$ )			Comments
							No. crustaceans/ $\text{cm}^2$	No. rotifers/ $\text{cm}^2$	No. crusfaecans/l	
Alsek	Dezadeash	Aishihik Dezadeash	13 Aug 70 11 Aug 70 26 Jul 75 13 Aug 74 no data	net net trap net trap	12 0 22.5	wc wc wc	6.0 41.4 12.0	5.0 183	2.6 1.3	See also Kussat (1973). One minute surface tow.
	Frederick Kachleen Kloo	12 Jul 75	trap							
	Marshall	24 Jul 74	net							
Moraine		16 Jul 75	trap	e			56.9 100	42.9 31.2	1.49 1.23	
Pine		12 Jun 75	trap	e			80.8 111	165 48.0	2.21 1.67	
		27 Jul 75	trap	e			60.3 150	35.2 6.8	2.23 3.06	
		31 Aug 75	trap	e			84.4 204	153 119	2.71 3.78	
Rainbow		no data								
Tatshenshini	Kluukshu	no data								
Dease	Wheeler	19 Aug 75	trap	e			39.6 95.5	182 105	2.03 1.91	
Liard	Flat	Divide	no data	net	7	wc	8.0 20.0	11.0 13.0		
	Frances	Finlayson	4 Aug 70	net	15	wc				
		Frances	5 Aug 70	net						
Rancheria	Simpson	no data								
Watson	Daughney	no data								
Blackstone	Watson	7 Aug 70	net		15	wc				
	Chapman	18 Aug 70	net		11	wc	41	27.4		
	North Fork	19 Jul 70	net		3	wc	30.6	27.8		
Bonnet Plume	Bonnet Plume	21 Jul 74	net		12	wc	21.3	71		
	Fairchild	no data					15.4	18.5		
	Gillespie	18 Jul 74	net		21	wc	15.0	7.0		
Margaret		3 Aug 75	net							
	Pinguicula	20 Jul 74	net		20	wc				
	Popcornfish	no data			12	wc	29.4	24.5		
Dog	Dog	no data								
Hart	Elliott	13 Jul 70	net		22	wc	58.0	26.0		
Wind	Hungry	5 Aug 75	net		4	wc	106	163	2.23	0.89
Porcupine	Davis (N)	6 Aug 75	net		21	wc	26.0	25.8	0.55	1.15
	Eagle (S)	9 Aug 75	net		19.5	wc	51.2	26.3	0.82	1.63

Table 13 (second part). Relative abundance (%) by number) of crustacean plankton for lakes of the Alsek, Liard, Peel, and Porcupine River drainage systems. See first part of table (above) for sampling gear, depth of total vertical haul by net, and for absolute abundance of crustaceans, rotifers, and total zooplankton. The following zooplankton species, not recorded from these lakes but recorded from other Yukon lakes sampled (see Tables 14 and 15), are omitted from this table: *Cyclops bicuspidatus thomasi*, *C. navus*, *Eucyclops acutus*, *Macrocypris albidus*, *Daphnia 9a leata mendotae*, *D. schoedleri*, *Ceriodaphnia affinis*, *Scapholeberis kindtii*, *Sida crystallina*, *Alona affinis*, *Camptocercus rectirostris* and *Leptodora quadrangularis*.

Table 14 (first part). Absolute abundance of crustaceans, rotifers and total zooplankton (crustaceans plus rotifers) for lakes of the Atlin, Lewes, Mandanna, Nordenskjold, Pelly, Big Salmon and Little Salmon subdrainages of the Yukon River drainage system. Zones sampled are epilimnion (e), hypolimnion (h), and entire water column (wc); wet weight per unit area ( $\text{mg}/\text{cm}^2$ ) is always expressed for the entire water column. See second part of the table (below) for relative abundance of crustacean species by lake.

Drainage	Subdrainage	Lake	Date	Sampling gear	Depth (m) of total vertical haul with net	Zone sampled	No. crustaceans/cm <sup>2</sup>	No. crustaceans/l	No. rotifers/l	Total zooplankton (mg/l)	Total zooplankton ( $\text{mg}/\text{cm}^2$ )	Comments
Yukon	Atlin	Atlin	30 Jul 70	net	16.7	wc	3.6	2.4				
		Little Atlin	9 Jul 70	net	13.5	wc	75.0	55.0	206	2.30	4.94	
		Lower Shafu	14 Jun 75	trap		e	83.0	84.1	1.91			
			29 Jul 75	trap		h	57.2	60.1	2.48	4.80	9.67	
			3 Sep 75	trap		e	128	277				
						h	183					
						e	115	51.8	1.90			
						h	180	152	2.95	5.73		
		Palmer	30 Jul 70	net	7	wc	9.2	13.1				
		Shafu	20 Jul 75	trap		e						
		Tarfu	13 Aug 75	trap		h	105	189	1.89			
						e	60.9	130	1.80			
						h	78.7	66.9	1.87	5.91		
Lewes	Bennett	Bennett	13 Jun 57	net	46	wc						
		Caribou	no data									
		Chadburn	14 Aug 70	net	15	wc	0.3	0.2	81.0			
		Fox	22 Jun 75	trap		e	69.2	13.3	1.48			
			1 Aug 75	trap		h	74.8	6.8	0.84	4.68		
			4 Sep 75	trap		e	77.8	40.2	1.94			
		Kookatsoon	no data			h	104	40.9	1.84	8.58		
		Laberge	no data			e	74.9	22.5	1.97			
		Long Marsh	no data			h	99.0	28.1	1.42	7.45		
		McClintock	8 Jul 70	net	10.5	wc	3.2	2.9				
Mandanna	Nordenskjold	Von Wilczek	15 Jul 70	net	20	wc	53.0	26.5				
		Mandanna	no data									
		Braeburn	28 Jul 70	net	15	wc	18.4	12.4				
		Twin	4 Jun 57	net	35	wc						
		Pelly	Bruce	24 Aug 75	trap		e	44.7	144	2.88		
			Diamain	14 Jul 70	net	14	h	55.8	42.6	1.99	7.12	
				19 Jun 75	trap		e	51.8	14.9	0.74	1.28	
				5 Aug 75	trap		h	50.4	17.4	0.46		
				6 Sep 75	trap		e	20.3	25.2	1.06	2.06	
		Dragon	3 Aug 72	net	9	h	56.9	22.4	0.76			
Big Salmon	Little Salmon	Jackfish	23 Aug 75	trap		e	19.2	8.20	0.99	2.34		
		Tatimain	7 Sep 75	trap		h	62.0	9.40	0.81			
		Willow	14 Jul 70	net	1.8	wc	13.0	14.5				
		Quiet	2 Aug 70	net	15	wc	56.5	130	2.6	4.73		
		Little Salmon	22 Aug 75	trap		e	169	310	3.97			
				net	77	wc	71.2	28.8	2.73	10.3		
						e	85.3	33.2	2.48			
						h						
						wc						
							49.0	32.8				
						e	59.8	41.7	0.44			
						wc	23.1	7.0	0.13	1.0		

See also Withler (1956).

Two hauls yielded settled plankton volumes of 0.05 & 0.10 ml (Dept. of Fisheries, Pacific Region).

Rotifers mainly Kelliota longispina.

Five 4.6 ml vertical hauls on 21 Jun 57 yielded settled plankton volumes ranging from 0.10 to 0.12 ml (Dept. Fisheries, Pacific Region).

Station 2 km E of Carcross. Four hauls yielded settled plankton volumes of 0.05, 0.10, 0.20 & 0.25 ml (Dept. Fisheries, Pacific Region). See also Withler (1956).

Two hauls yielded settled plankton volumes of 0.12 & 0.16 ml.

Chaoborus larvae & amphipods were occasionally found in both epilimnion & hypolimnion samples.

Station in centre of bend in southern part of lake. A dense bloom of blue-green algae was observed.

Table 14 (second part). Relative abundance (% by number) of crustacean plankton for Lakes of the Atlin, Lewes, Mandanna, Nordenstkiold, Pelly, Big Salmon and Little Salmon subdrainages of the Yukon River drainage system. See first part of table (above) for sampling gear, depth of total vertical haul with net, and for absolute abundance of crustaceans, rotifers, and total zooplankton. The following zooplankton species, not recorded from these Lakes but recorded from other Yukon lakes sampled (see Tables 13 and 15), are omitted from this table: *Cyclops bicuspidatus thomasi*, *Eucyclops sphaeratus*, *E. acutifrons*, *Semenevella californica*, *Polyphemus peniculus*, *Scapholeberis kingi*, *Sidæ crystallina*, *Euryercerus longitarsis*, and *Campodeorus rectirostris*.

Table 15 (first part). Absolute abundance of crustaceans, rotifers, and total zooplankton (crustaceans plus rotifers) for lakes of the Stewart, Takhini, Teslin, and White subdrainages of the Yukon River drainage system. Zones sampled are epilimnion (e), hypolimnion (h), and entire water column (wc); wet weight per unit area ( $\text{mg}/\text{cm}^2$ ) is always expressed for the entire water column. See second part of table (below) for relative abundance of crustacean species by lake.

Drainage	Subdrainage	Lake	Date	Sampling gear	Depth (m) of total vertical haul with net	Zone sampled	No. crustaceans/ $\text{cm}^2$	No. crustaceans/l	No. rotifers/l	Total zooplankton ( $\text{mg}/\text{cm}^2$ )	Total zooplankton ( $\text{mg}/\text{cm}^2$ )	Comments
Yukon	Stewart	Barlow Clark	20 Jul 70 6 Jul 75	net trap	5.5	wc e h	132 239 37.2 22.3 24.5	52.8 0.82 0.48	1.34			
		Crystal Ethel	no date 14 Jul 70	net	22	wc	16.0	7.0				Station at west end of lake.
		Halfway (W) Hanson (S) (H)	2 Jul 75 12 Jul 70 1 Jul 75	trap net trap	12	wc wc e h e h e h e h e h e h	35.0 78.0 29.0 88.4 43.0 22.8 21.8 16.3 24.3 77.5 31.1	427 23.0 12.0 168 28.0 70.4 9.2 91.1 1.61 32.0	3.61 2.98 1.01 1.26 0.39 0.99 0.42 1.0	1.80 3.58 3.59 1.95 1.25		
		Janet	4 Jul 75	trap		h						
		Kathleen	7 Jul 75	trap		h						
		Ladue	5 Jul 75	trap		h						
		Mayo	23 Jul 70	net	15	e	16.3	10.8				Net haul from 15 m at station of 39 m depth.
		McQuesten Minto	13 Jul 70 21 Jul 70 17 Jun 75	net net trap	6 14	wc wc e h e h e h e h e h e h	27.5 56.0 46.0 40.0 137 50.6 61.4 82.2 45.8 70.7 34.7 5.3 30.5 101 45.1 30.7	46.0 56.0 10.0 28.4 32.2 17.1 0.51 0.43 2.09 0.72	1.60 0.36 2.43 1.42 2.09 0.72	2.06 4.08 3.18		
		Reid Fish Jo-Jo	22 Jul 70 9 Aug 70 15 Jul 75	net net trap	13 10	wc wc e h	53.8 10.0 41.4 10.0 28.4 36.0	41.4 10.0 32.2 17.1	0.51 2.19			
		Kusawa Taye Frenchman	10 Aug 70 17 Jul 75 21 Aug 75	net trap trap	15	wc e h e h e h e h e h e h e h	2.5 7.6 25.2 54.9 197	1.7 3.9 267 143	1.60 0.48 2.09 4.14	0.48 10.6		
		Tatchun	25 Jul 70 21 Jun 75	net trap	15	wc e h e h e h e h e h e h e h	41.0 27.3 57.0 30.7	27.3 274 52.1	0.40 0.54	1.51		
	Teslin (Squanga)	Dalayee Dwarf	10 Jul 70 21 Jul 75	net trap	23	wc e h e h e h e h e h e h e h	34.0 34.0 15.0 38.8 37.7	98.5 46.4	1.66 1.77	2.59		
		Little Teslin	16 Aug 70 26 Jun 75 27 Aug 75	net trap trap	14	wc e h e h e h e h e h e h e h	26.0 26.0 18.0 81.7 129 75.7 197	176 352 26.3 115	2.75 2.8 2.38 3.14	4.43 4.66		
		Squanga	8 Jun 60	net	27.4	wc						Single haul yielded settled plankton volume of 2.3 ml.
		Summit	16 Aug 70 28 Jun 75	net trap	12	wc e h e h e h e h e h e h e h	51.7 51.7 43.0 88.6 215	43.0 485 148	3.35 1.59	3.48		
		Teenah Morley	9 Jul 70 14 Aug 75	net trap	18	wc e h e h e h e h e h e h e h	140 140 77.7 13.7 43.0	58.8 16.5	0.17 0.67	1.37		
	Teslin (rest)	Smart Swan	15 Aug 75 25 Jun 75	trap trap		wc e h e h e h e h e h e h e h	48.1 48.1 96.2 9.6 13.2	35.7 5.0	1.53 0.3	0.92		
			30 Jul 75	trap		h e h e h e h e h e h e h e h	18.7 18.5 18.5	8.2 11.4	0.36 0.35	1.71		
			10 Sep 75	trap		h e h e h e h e h e h e h e h	31.8 60.0	51.4 33.7	0.77 0.47	2.79		
		Teslin	1944	net	30.5	wc						Hauls yielded average settled plankton volume of 0.86 ml. See Clemens et al. (1968).
		Wolf	22 Jul 75	trap		e h wc	24.5 35.5	61.6 40.2	1.13 0.87	4.75		Station slightly west of lake centre.
White	Kluane	12 Aug 70	net	5			14.3	28.0				Station midway between Burwash Landing and Sandpit Point.
		11 Jul 75	trap		e h wc		16.0 19.2	23.7 5.6	0.33 0.28	1.11		Station 38 m deep, situated off mile 1066.5, Alaska Hwy.
	Sulfur	11 Jul 75	trap				12.3	61.8	7.2	1.67	0.33	

**Table 15 (second part).** Relative abundance (# by number) of crustacean plankton from lakes of the Stewart, Takhi, Teslin, and White subdrainages of the Yukon River drainage system. See first part of table (above) for sampling year, depth of total vertical haul with net, and for absolute abundance of crustaceans, rotifers, and total zooplankton. The following species, not recorded from these lakes but recorded from other Yukon lakes sampled (see tables 13 and 14), are omitted from this table: Cyclops nevius, *Heterocyclops albidus*, *Acanthocyclops denticornis*, *Ceriodaphnia affinis*, *Sidnia crystallina*, *Aiona affinis*, *Eurytemora fimbriata*, *Leptodora quadangularis*.

Species	Date	Zone sampled	Number	Mean length	SD	CV (%)	Min	Max	Notes
<i>Argiope trifasciata</i>	20 Jul 70	wc	80.4	12.6	4.7	3.7	8.0	22.2	4.1
	6 Jul 75	e	67.5	11.1	4.0	5.9	6.7	0.3	<.1
	h	88.8	2.8	1.6	1.6	1.8	0.1	0.1	
<i>Argiope aurantia</i>	no data			24.8	<1	0.1	1.3	1.1	
<i>Argiope trifasciata</i>	14 Jul 70	wc	75.1	28.2	0.1	1.3	0.1	0.1	
	2 Jul 75	wc	77.6	13.5	0.2	4.6	0.1	0.1	
<i>Argiope trifasciata</i>	12 Jul 70	wc	69.2	13.5	0.2	4.6	0.1	0.1	
	1 Jul 75	e	81.8	5.3	0.2	2.8	0.1	0.1	
<i>Argiope trifasciata</i>	4 Jul 75	h	91.6	25.5	5.5	4.4	3.8	0.1	<.1
	7 Jul 75	e	78.4	11.5	4.2	3.6	5.1	0.3	
<i>Argiope trifasciata</i>	Kathleen	h	23.6	5.1	6.9	0.0	0.2	0.1	
	Ladue	h	86.4	0.7	12.9	<.1	0.1	0.1	
	5 Jul 75	e	70.6	29.3	0.2	2.2	0.1	0.1	
	h	60.5	39.1	0.4	<.1	0.1	0.1	0.1	
<i>Argiope trifasciata</i>	Mayo	23 Jul 70	e	50.4	49.0	0.6	0.1	0.1	<.1
	McQuarren	13 Jul 70	wc	78.9	20.0	0.6	0.1	0.1	<.1
	Minto	21 Jul 70	wc	59.9	21.1	0.1	<.1	0.1	<.1
	17 Jun 75	e	53.3	46.4	19.1	0.5	0.1	0.1	
	h	75.7	23.9	0.5	0.2	0.1	0.1	0.1	
<i>Argiope trifasciata</i>	3 Aug 75	e	34.5	49.0	16.3	0.2	0.1	0.1	
	h	87.1	49.0	0.4	0.1	0.1	0.1	0.1	
	5 Sep 75	e	39.7	48.7	3.9	0.5	0.1	0.1	
<i>Argiope trifasciata</i>	Tatihui	22 Jul 70	wc	93.5	6.4	0.6	0.2	0.1	0.1
	9 Aug 70	wc	65.9	33.2	2.5	<.1	0.1	0.1	
	15 Jul 75	e	85.9	11.2	0.5	0.2	0.1	0.1	
	h	97.2	2.5	0.1	0.1	0.1	0.1	0.1	
<i>Argiope trifasciata</i>	Kusawa	10 Aug 70	wc	42.9	38.4	0.9	0.5	0.1	0.1
	Taye	17 Jul 75	wc	1.1	95.1	2.0	1.6	18.1	0.2
	Frenchman	21 Aug 75	e	62.8	18.2	<.1	0.3	0.1	
	Tatchun	25 Jul 70	wc	95.0	3.1	<.1	0.5	0.1	
	21 Jun 75	e	84.6	14.1	0.4	0.2	0.1	0.1	
	h	98.0	1.0	0.2	0.1	0.1	0.1	0.1	
<i>Argiope trifasciata</i>	Dalysee	20 Jul 70	wc	63.2	36.1	0.7	0.8	0.1	<.1
	Dwarf	21 Jul 75	e	14.2	85.6	0.3	<.1	0.1	
	Little Testin	16 Aug 70	wc	71.6	26.5	1.5	0.1	0.1	
	Testin	26 Jun 75	e	65.8	11.9	<.1	0.3	0.1	
	h	59.0	28.6	<.1	0.3	0.2	0.1	0.1	
	h	85.7	8.4	<.1	0.1	0.4	0.1	0.1	
	27 Aug 75	e	75.3	9.0	2.2	2.3	0.1	0.1	
	h	89.7	2.1	<.1	0.1	1.3	0.1	0.1	
<i>Argiope trifasciata</i>	Souanga	8 Jun 60	wc	97.1	see Table 15 (first part)	0.5	<.1	0.1	<.1
	16 Aug 70	wc	48.5	7.0 part	8.0	14.5	17.8	4.2	<.1
	28 Jun 75	e	64.6		35.0	0.5	0.1	0.1	
<i>Argiope trifasciata</i>	Tenah	9 Jul 70	wc	96.4	3.6	<.1	0.1	0.1	0.1
	Hortley	14 Aug 75	e	63.4	16.1	3.9	2.6	9.0	
	Smart	15 Aug 75	wc	79.8	33.0	1.5	0.1	0.1	
	Swan	25 Jun 75	e	72.9	20.7	0.2	0.2	1.3	<.1
	30 Jul 75	h	87.9	15.1	7.3	0.1	0.1	0.1	
	h	64.7	15.0	<.1	0.1	1.1	0.1	0.1	
	10 Sep 75	e	88.1	16.0	6.6	0.6	0.1	0.1	
	h	60.1	5.6	<.1	0.1	1.1	0.1	0.1	
	h	90.3	13.2	0.4	0.1	2.9	0.1	0.1	
	h	36.1	2.6	0.2	0.1	1.1	0.1	0.1	
<i>Argiope trifasciata</i>	Testin	1944	wc	see Table 15 (first part)	60.8	6.8	0.4	0.5	<.1
	Wolf	22 Jul 75	e	92.6	66.0	6.8	0.2	0.1	<.1
	White	12 Aug 70	wc	35.9	57.8	34.0	0.1	0.1	<.1
	11 Jul 75	wc	12.1	57.8	63.8	0.1	0.1	0.1	

Table 16. Frequency of occurrence of the 32 species of crustacean zooplankton found in 70 Yukon lakes. Asterisks denote littoral species, all others are pelagic.

Species	No. of lakes in which species was found	%
<i>Cyclops scutifer</i> Sars	68	97
<i>Diaptomus pribilofensis</i> Juday & Muttkowski	63	90
<i>Heterocope septentrionalis</i> Juday & Muttkowski	42	60
<i>Daphnia longiremis</i> Sars	34	49
<i>Eubosmina longispina</i> (Leydig)	31	44
<i>Daphnia middendorffiana</i> Fischer	29	41
<i>Diaptomus sicilis</i> Forbes	14	20
<i>Daphnia galeata galeata</i> Sars	13	19
<i>Daphnia longispina microcephala</i> Sars	10	14
<i>Chydorus sphaericus</i> (O.F. Muller)	8	11
<i>Bosmina longirostris</i> (O.F. Muller)	6	9
<i>Holopedium gibberum</i> Zaddach	6	9
<i>Leptodora kindtii</i> Focke	5	7
<i>Cyclops capillatus</i> Sars	4	6
* <i>Polyphemus pediculus</i> (Linne)	4	6
<i>Senecella calanoides</i> Juday	4	6
<i>Daphnia galeata mendotae</i> Birge	3	4
<i>Daphnia pulex</i> Leydig	3	4
<i>Acanthodiaptomus denticornis</i> (Wierzejski)	3	4
<i>Eucyclops speratus</i> (Lilljeborg)	2	3
<i>Cyclops bicuspidatus thomasi</i> Forbes	2	3
* <i>Macro cyclops albidus</i> (Jurine)	2	3
<i>Daphnia schoedleri</i> Sars	2	3
<i>Cyclops navus</i> Herrick	1	1
* <i>Eucyclops agilis</i> (Koch)	1	1
<i>Ceriodaphnia affinis</i> Lilljeborg	1	1
* <i>Scapholeberis kingi</i> Sars	1	1
* <i>Sida crystallina</i> (O.F. Muller)	1	1
* <i>Alona affinis</i> (Leydig)	1	1
* <i>Eury cercus lamellatus</i> (O.F. Muller)	1	1
* <i>Camp tocercus rectirostris</i> Schoedler	1	1
* <i>Leydigia quadrangularis</i> (Leydig)	1	1

Table 17. Known presence of fish species in lakes of the Alsek, Liard, Peel and Porcupine River drainage systems. Confirmed species presence recorded as X and reliable report of presence as (X). See Table 3 for list of common names.

Drainage	Subdrainage	Lake	Lampetra spp.	<i>Stenodus leucichthys</i>	<i>Coregonus clupeaformis</i>	<i>C. nasus</i>	<i>C. sardinella</i>	<i>Prosopium cylindraceum</i>	<i>P. coulteri</i>	<i>P. williamsi</i>	<i>Thymallus arcticus</i>	<i>Salvelinus namaycush</i>	<i>S. alpinus</i>	<i>S. malma</i>	<i>Salmo gairdneri</i>	<i>Oncorhynchus nerka</i>	<i>O. kisutch</i>	<i>O. tshawytscha</i>	<i>Esox lucius</i>	<i>Cottus planiceps</i>	<i>Catostomus commersoni</i>	<i>C. catostomus</i>	<i>Lota lota</i>	<i>Cottus cognatus</i>
Alsek	Dezadeash	Aishihik <sup>1</sup> Dezadeash <sup>2</sup> Frederick <sup>2</sup> Kathleen <sup>3</sup> Kloo <sup>4</sup> Marshall <sup>4</sup> Moraine Pine <sup>5</sup> Rainbow	X X X X X X X X X	X X X (X) X (X) X X X	X X X X X X X X X																			
	Tatshenshini	Kluksuk <sup>6</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Dease	Wheeler <sup>7</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Flat	Divide <sup>7</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Frances	Finlayson	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Rancheria	Frances <sup>8</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Watson	Simpson <sup>9</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Blackstone	Watson	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Bonnet Plume	Chapmen	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Fairchild <sup>10</sup>	North Fork	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Peel	Gillespie <sup>11</sup>	Bonnet Plume	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Margaret	Fairchild <sup>10</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Pingutcula <sup>12</sup>	Gillespie <sup>11</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Popcornfish	Dog <sup>13</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Dog	Hart <sup>14</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Porcupine	Wind	Elliott <sup>14</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Eagle	Hungry <sup>15</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

1 Both high and low gill raker forms of *C. clupeaformis* present. *S. malma* in tributaries only.

2 *O. nerka* is landlocked form (kokanee).

3 *P. coulteri* and *S. malma* reported by Wickstrom (1977). *O. nerka* is landlocked form (kokanee).

4 No fish caught in overnight gill net sets.

5 *P. cylindraceum* and *Thymallus arcticus* reported by Wickstrom (1977).

6 *S. gairdneri*, *O. kisutch*, *O. tshawytscha* and *O. gorbuscha* in outlet only. *S. gairdneri* and *O. gorbuscha* reported by Wynne-Edwards (1947).

7 Dolly Varden also occur in nearby Glacier Lake (Royal Ontario Museum No. 26616).

8 The record of white sucker (*C. commersoni*) from Frances Lake shown in McPhail and Lindsey (1970) and Scott and Crossman (1973) is in error and is based on misidentification of *C. catostomus* (see discussion).

9 *P. coulteri* identified from lake trout stomach.

10 Daytime gill net sets and one outlet collection only.

11 No fish were caught in several gillnet sets.

12 Daytime gill net sets only.

13 Fish collection on centre east shore, in warm, weedy waters.

14 *S. alpinus* in tributaries only.

15 *C. nasus* scarce; caught in north lake only.

Table 18. Known presence of fish species in lakes of the Atlin, Lewes, Mandanna, Nordenskiold, Pelly, Big Salmon and Little Salmon subdrainages of the Yukon River drainage system. Confirmed species presence recorded as X and reliable report of presence as (X). See Table 3 for list of common names.

Drainage	Subdrainage	Lake	Lampetra spp.	<i>S. leucichthys</i>	<i>C. clupeaformis</i>	<i>C. nasus</i>	<i>C. sardinella</i>	<i>P. cylindraceum</i>	<i>P. coulteri</i>	<i>P. williamsi</i>	<i>T. arcticus</i>	<i>S. namaycush</i>	<i>S. alpinus</i>	<i>S. malma</i>	<i>S. gairdneri</i>	<i>Oncorhynchus nerka</i>	<i>O. kisutch</i>	<i>O. tshawytscha</i>	<i>O. keta</i>	<i>O. gorbuscha</i>	<i>E. lucius</i>	<i>C. plumbeus</i>	<i>C. commersoni</i>	<i>C. catostomus</i>	<i>Lota lota</i>	<i>C. cognatus</i>
Yukon	Atlin	Atlin <sup>1</sup>	X		X	(X)			X	(X)	X										X	X		X	X	X
		Little Atlin <sup>2</sup>	X	X	X				X	X											X	X		X	X	X
		Lower Snafu	X																							
		Palmer	X		X																					
		Snafu	X																							
	Lewes	Tarfu																								
		Bennett <sup>3</sup>	X																							
		Caribou <sup>4</sup>																								
		Chadburn																								
		Fox <sup>5</sup>	X						X	X																
		Kookatsoon																								
		Laberge <sup>6</sup>	(X)	X	X	X	X																			
		Long <sup>7</sup>																								
		Marsh <sup>3</sup>	X																							
		McClintock	X																							
		Michie <sup>8</sup>	X																							
		Hares <sup>3</sup>	X																							
		Tagish <sup>3,g</sup>	X		X	X							X	X												
		Von Wilczek																								
	Mandanna	Mandanna	X		X	X	(X)						X													
	Nordenskiold	Braeburn <sup>10</sup>	X	X	X	(X)							X	X												
		Twin	X		X	(X)							X	(X)												
	Pelly	Bruce																								
		Diamain <sup>11</sup>																								
		Dragon <sup>12</sup>																								
		Jackfish																								
		Tatmain	(X)	X																						
		Willow																								
	Big Salmon	Quiet <sup>13</sup>	X	X	X	X	X	X					X	X												
	Little Salmon	Little Salmon	X	X	X	X	X	X					X	X												

1 *C. plumbeus* in inlet creek.

2 *P. cylindraceum*, *T. arcticus* and *S. namaycush* reported by Brown et al. (1976).

3 Bennett, Marsh, Nares and Tagish lakes are interconnected and probably share a common fish fauna.

4 Lake not sampled by gill net. *E. lucius* reported by Brown et al. (1976).

5 *E. lucius* reported by Brown et al. (1976).

6 *D. tshawytscha* reported to spawn in Richthofen Creek.

7 No fish were present in 1958. *S. gairdneri* were later introduced but no young were found in 1966.

8 *S. namaycush* and *E. lucius* reported by Brown et al. (1976).

9 See Withler (1956) for data on fish growth rates and spawning.

10 *P. cylindraceum* and *C. cognatus* reported in this system by Brown et al. (1976).

11 Bottom and surface gill net sets in 1970 and 1975 and seining in 1970 yielded no fish.

12 *C. sardinella* is large, spotted form. *O. tshawytscha* and *L. lota* reported by Elson (1974).

13 *C. sardinella* is large, spotted form.

Table 19. Known presence of fish species in lakes of the Stewart, Takhini, Tatchun, Teslin and White subdrainages of the Yukon River drainage system. Confirmed species presence recorded as X and reliable report of presence as (X). See Table 3 for list of common names.

Drainage	Subdrainage	Lake	Lampetra spp.	Stenodus leucichthys	Coregonus clupeaformis	C. nasus	Prosopium cylindraceum	P. coulteri	P. williamsoni	Thymallus arcticus	Salvelinus namaycush	S. alpinus	S. malma	Salmo gairdneri	Oncorhynchus nerka	O. kisutch	O. tshawytscha	O. gorbuscha	Esox lucius	Coneostomus plumbbeus	Catostomus commersoni	C. catostomus	Lota lota	Cottus cognatus	
Yukon	Stewart	Barlow									X														
		Clark	X	X	X						X	X													X
		Crystal <sup>1</sup>					X				X	X													
		Ethel <sup>2</sup>																							
		Halfway																							
		Hanson <sup>3</sup>																							
		Janet																							
		Kathleen <sup>4</sup>	X								X	(X)													
		Ladue	X									X	X												
		Mayo	X			X						X													
		McQuesten <sup>5</sup>	X																						
		Minto	X																						
		Reid	X																						
	Takhini	Fish																							
		Jo-Jo																							
		Kusawa <sup>6</sup>																							
		Taye	X		X	X					X	X													
	Tatchun	Frenchman	X																						
		Tatchun <sup>7</sup>	X		X		X																		
	Teslin (Squanga)	Dalayee																							
		Dwarf																							
		Little Teslin <sup>8</sup>																							
		Squanga <sup>9</sup>																							
		Summit																							
		Teenah <sup>8</sup>																							
	Teslin (rest)	Morley	X		X	X																			
		Smart	X		X	X																			
		Swan <sup>9</sup>																							
		Teslin <sup>10</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	(X)	(X)	(X)	X	X	X	X	X	
		Wolf																							
	White	Kluane <sup>11</sup>	(X)	X																					
		Sulphur																							

1 Lake contains a dense population of stunted *I. arcticus*.

2 Lake sampled with short daytime gill net set and seining only.

3 Prior to poisoning in 1963, *C. clupeaformis* (two forms), *P. cylindraceum*, *E. lucius* and *C. cognatus* were present. Rainbow trout eggs were planted but only *E. lucius* were captured in 1970 and 1975.

4 *L. lota* reported by Elson (1974).

5 *C. sardinella* and *S. namaycush* have been reported but not captured in two years of gill netting.

6 *O. tshawytscha* reported to spawn in outlet.

7 *C. clupeaformis* from this lake are bimodal with respect to gill raker length (K. Martin, pers. comm.) (see discussion on high gill raker lake whitefish). Some *C. sardinella* captured were the rare large, spotted form.

8 Both high and low raker forms of *C. clupeaformis* are present in Little Teslin, Squanga and Teenah Lakes and in Little Squanga Lake as well.

9 *O. tshawytscha* reported to spawn in outlet.

10 *O. tshawytscha* reported as moving through lake to spawn in Nisutlin River tributaries. *O. keta* was reported by Clemens et al. (1968) but this is in doubt.

11 *S. leucichthys* reported by Wynne-Edwards (1947:17). *E. lucius* and *L. lota* reported by Wickstrom (1977).

Presence/absence data for fish species in the different drainage and subdrainage basins in Yukon Territory. Confirmed species presence is recorded as X, and a reported presence as (X). *C. autumnalis*, *P. gracilis*, *R. cataractae*, *P. omissicomavicus*, and *C. ricei* were not sampled in the present study; their presence has been recorded by McPhail and Lindsey (1970) and Bodaly and Lindsey (1977).

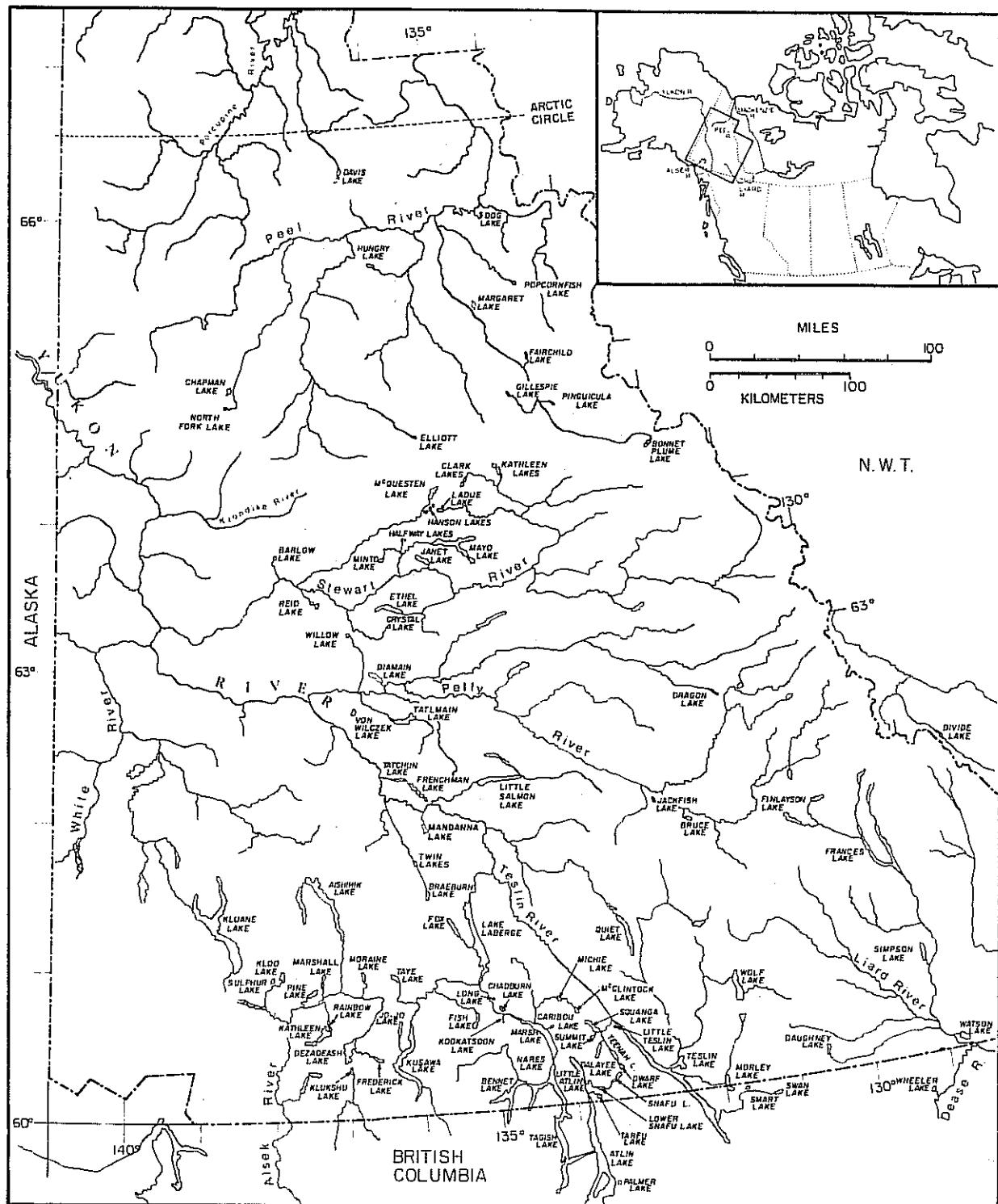


Fig. 1. Map of southern and central Yukon Territory indicating lakes sampled.

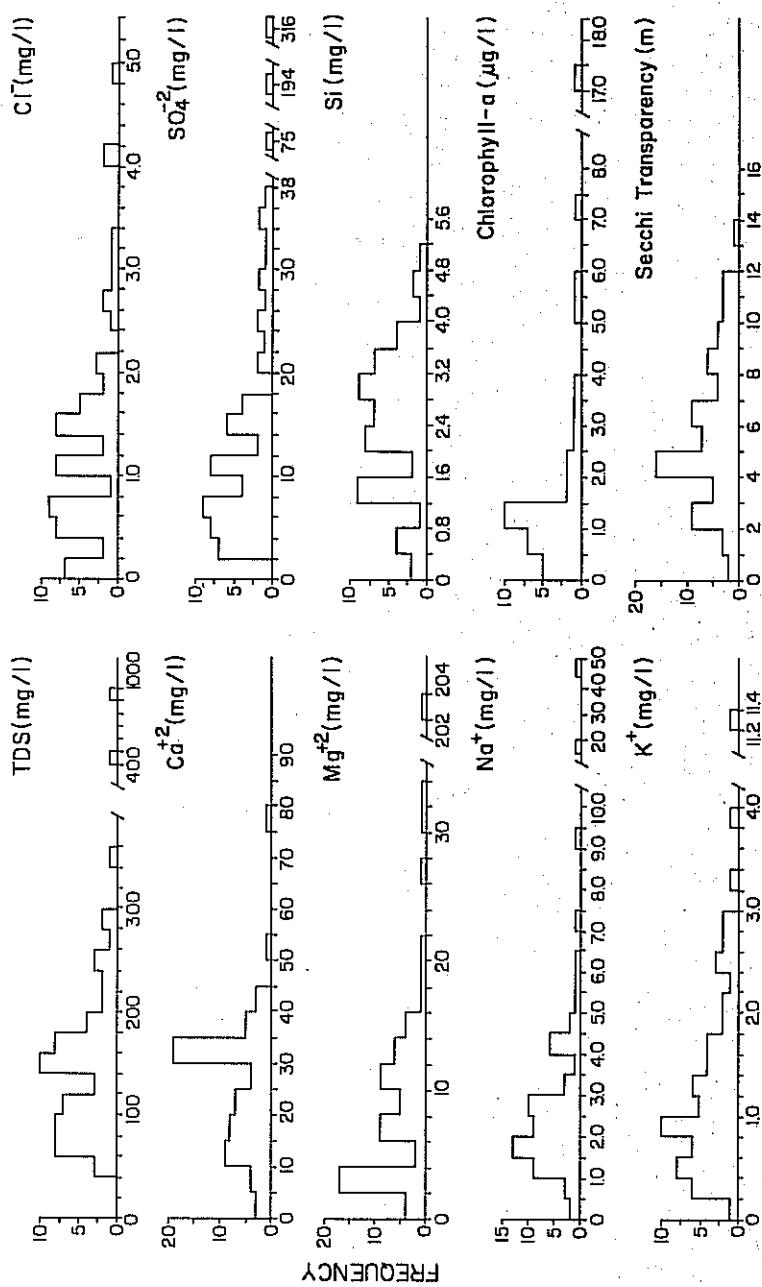


Fig. 2. Frequency distributions of total dissolved solids (TDS), major ions, chlorophyll  $\alpha$  values, and Secchi disc transparencies in Yukon lakes.

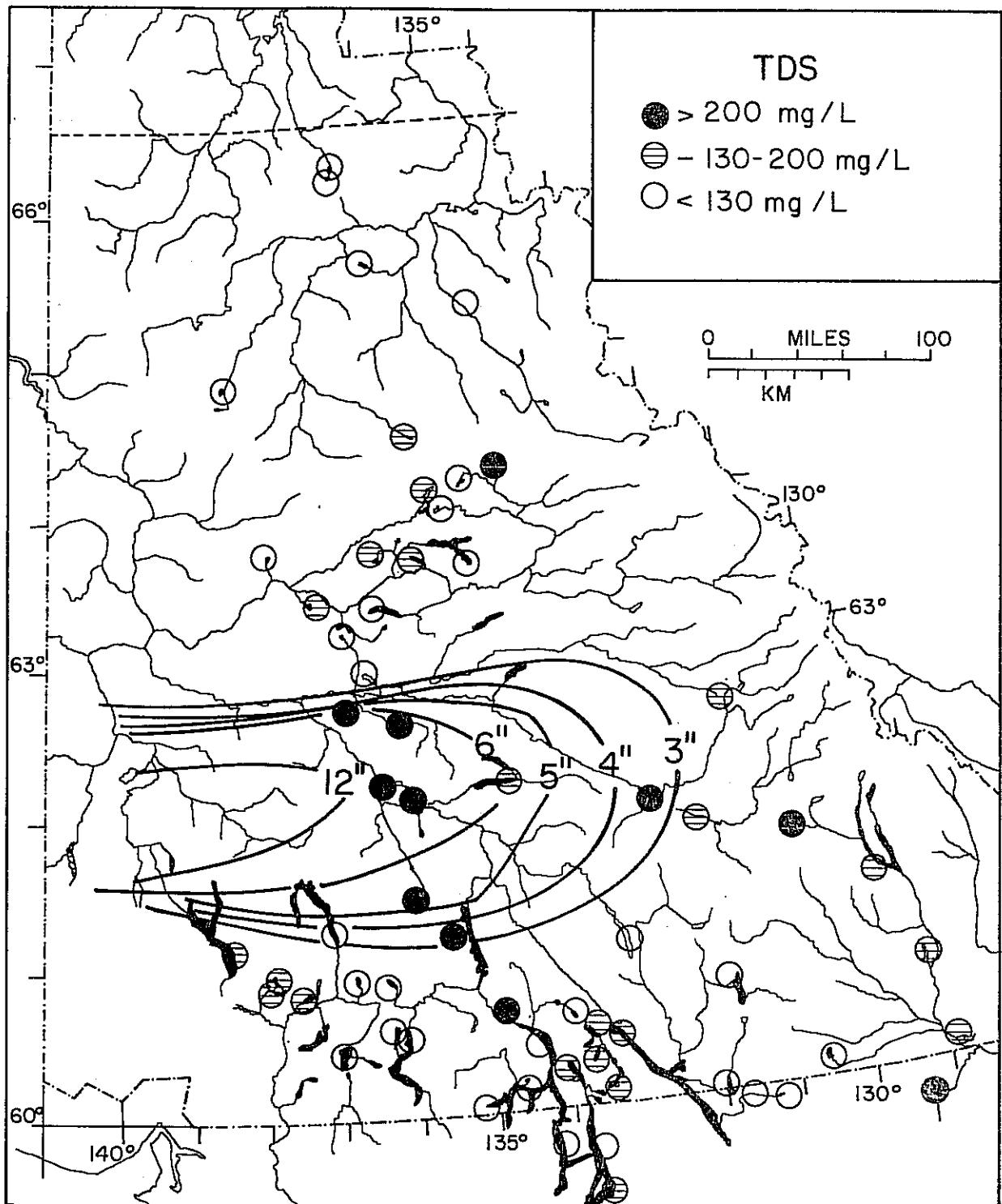


Fig. 3. The geographic distribution of total dissolved solid (TDS) values in Yukon lakes and isopleths of volcanic ash thickness.

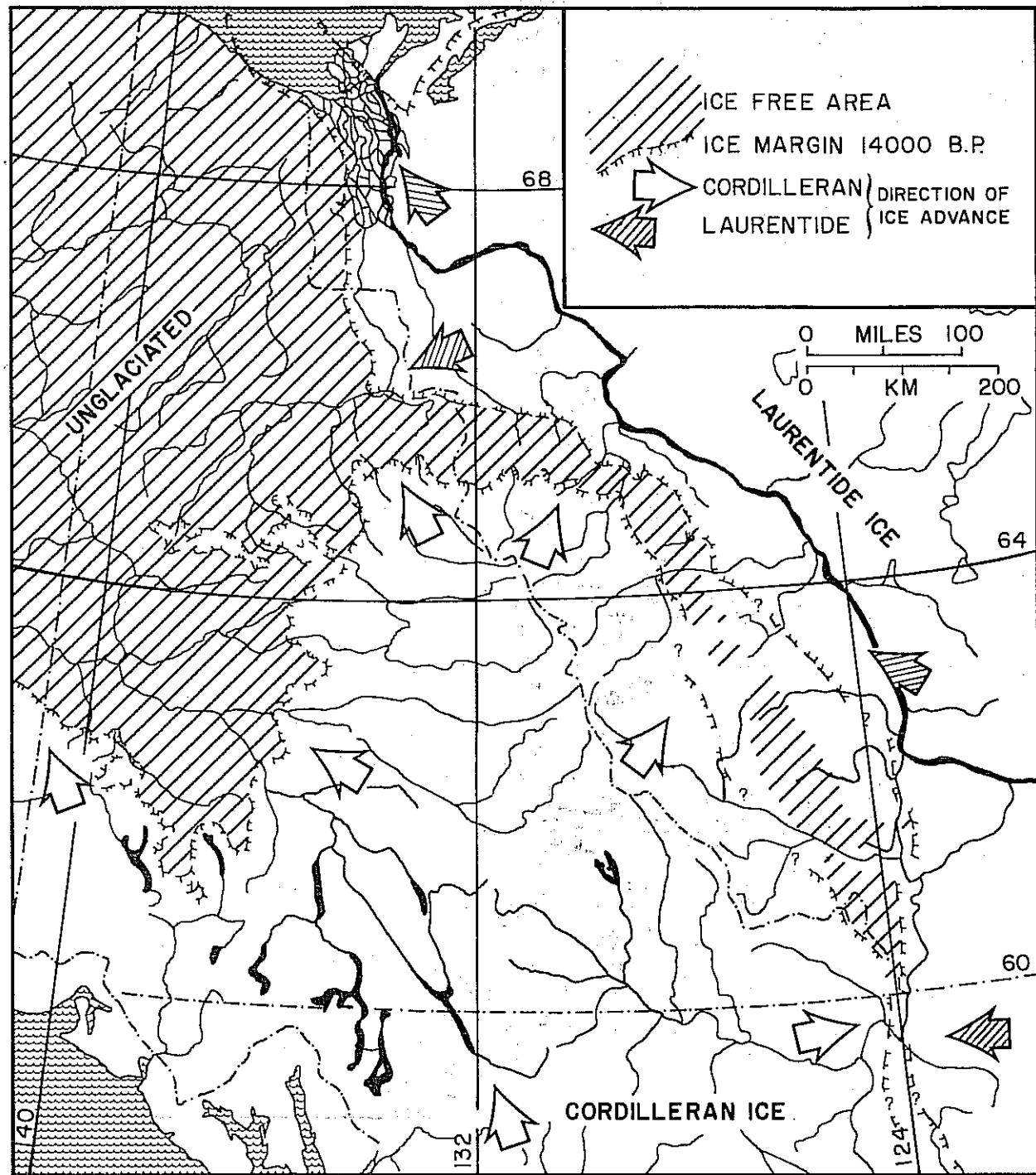


Fig. 4. Glacial map of Yukon Territory showing maximum extent of advance of last (Wisconsin) ice sheet (about 14,000 years ago).

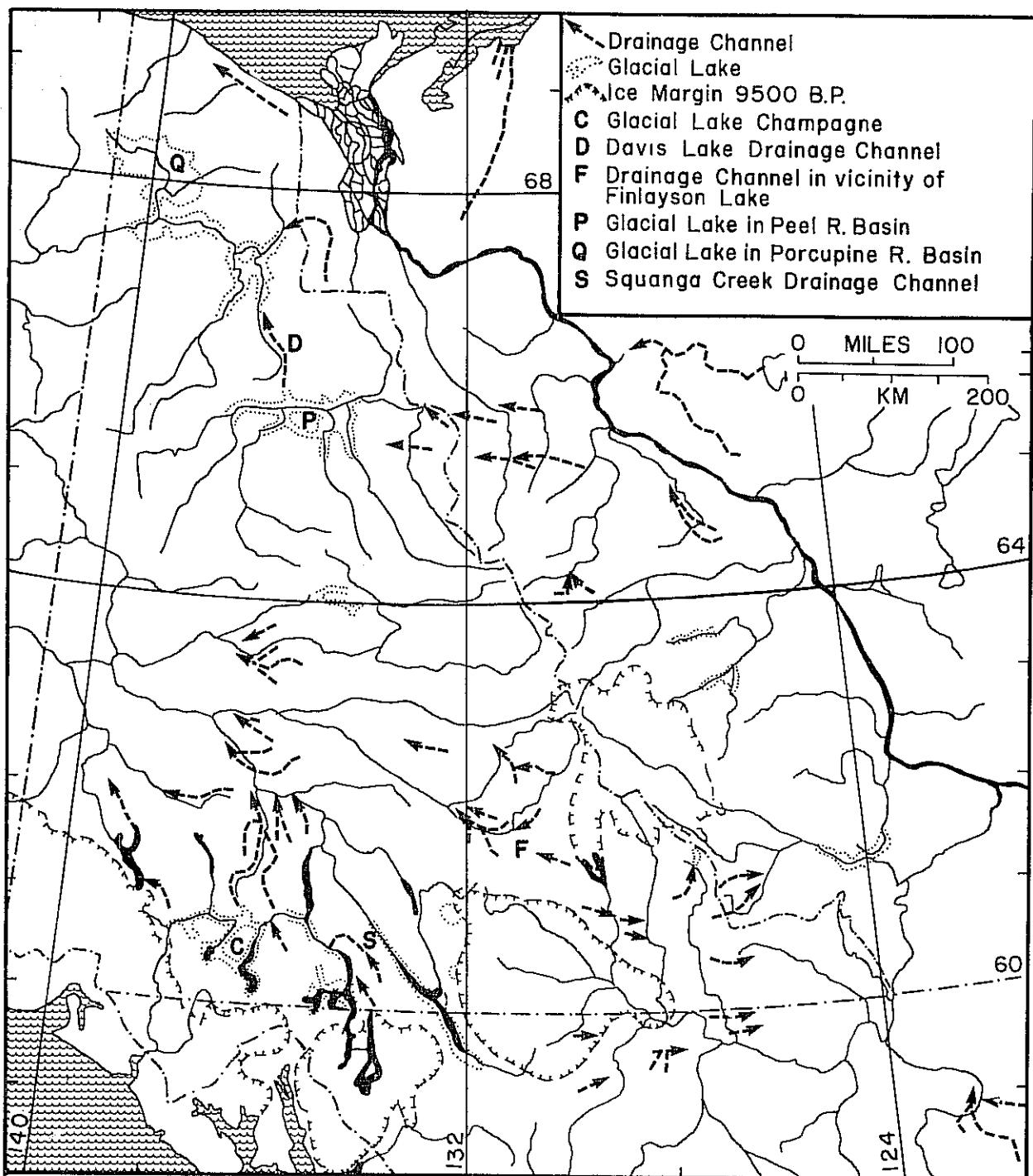


Fig. 5. Glacial map of Yukon Territory showing position of ice margin 9,500 years ago, and major glacial lakes and meltwater drainage channels.