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PRECONSTRUCTION ASSESSMENT OF BIOLOGICAL QUALITY OF THE CHENA AND LITTLE CHENA RIVERS IN THE VICINITY OF CHENA LAKES FLOOD CONTROL PROJECT NEAR FAIRBANKS, ALASKA

U. S. Geological Survey

Water-Resources Investigations 29-74

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UNITED STATES DEPARTMENT OF THE INTERIOR

Rogers C. B. Morton, Secretary

GEOLOGICAL SURVEY

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Multiply English units	By	To obtain SI units
inches (in)	2.54	centimetres (cm)
feet (ft)	.3048	metres (m)
yards (yd)	.9144	metres (m)
miles (mi)	1.609	kilometres (km)
square miles (mi^2)	2.590	square kilometres (km^2)
cubic feet per second (ft^3/s)	.02832	cubic metres per second (m^3/s)

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ABSTRACT

Chemical and biological data were collected on the Chena and Little Chena Rivers from October 1972 through August 1973 to determine the water quality of these rivers prior to construction of the Moose Creek and Little Chena Dams by the U.S. Army Corps of Engineers. Chemical-quality measurements included conductivity, alkalinity, pH, dissolved oxygen, nitrogen and phosphorous species, dissolved iron, and biochemical and chemical oxygen demand. Biological measurements included a semiquantitative and qualitative assessment of benthic invertebrates, periphyton, and phytoplankton. The results indicate a typical clean-water subarctic stream with excellent water-quality characteristics. The chemical and biological water-quality constituents in the studied reach of the Chena and Little Chena Rivers are relatively uniform with the possible exception of iron and chemical oxygen demand which seems to increase downstream. The biological data show that productivity is low. The flora and fauna are diverse and characteristic of cold water streams high in dissolved oxygen and low in productivity. The construction and operation of the Moose Creek Dam probably will not appreciably alter the present water-quality conditions of the system except for possible temporary effects due to construction.

INTRODUCTION

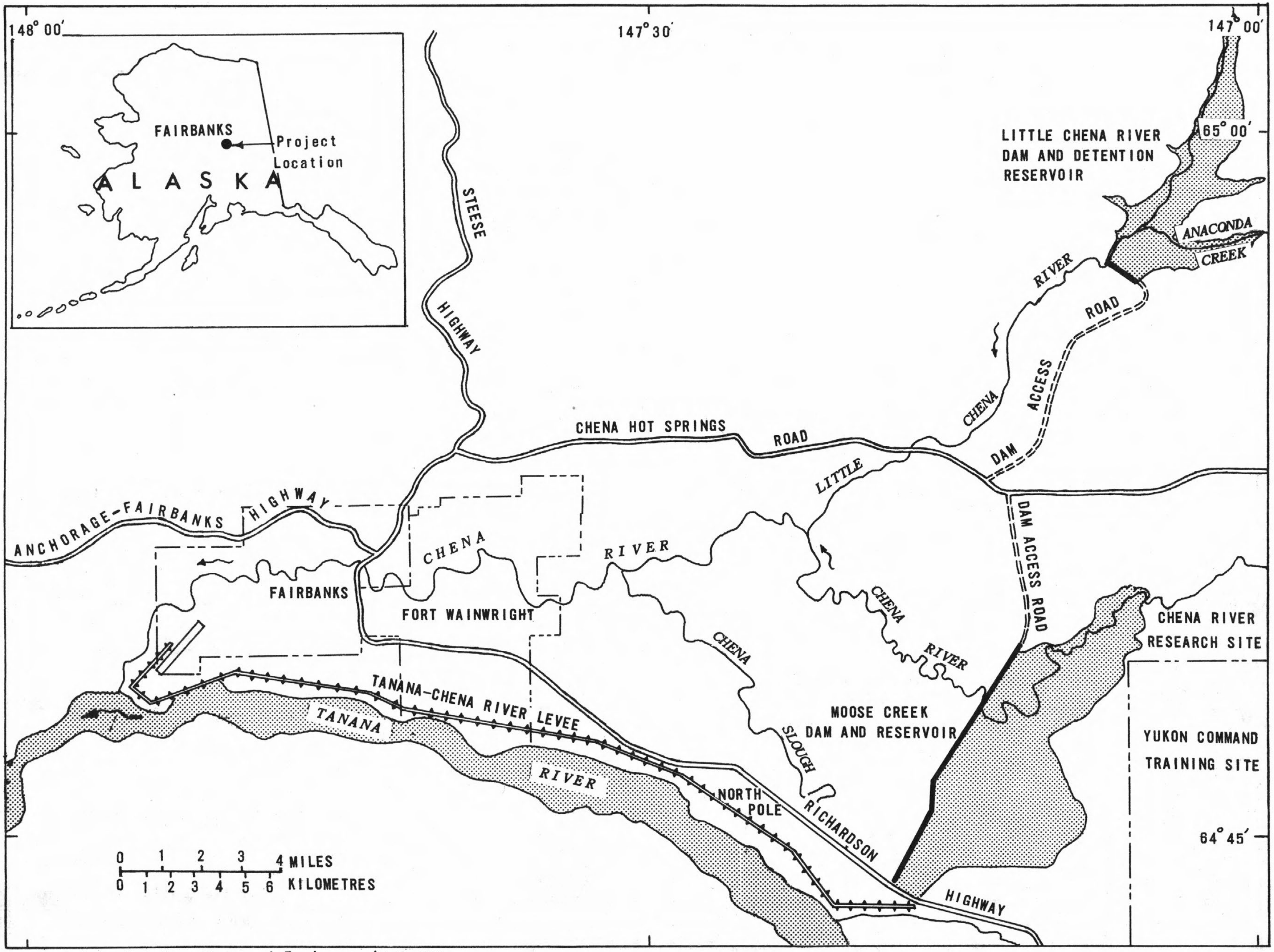
In 1972 the U.S. Army Corps of Engineers requested the U.S. Geological Survey to make a preconstruction assessment of the biological water quality of the Chena and Little Chena Rivers in the vicinity of the Chena Lakes Flood Control Project. The objectives of this study were to describe the existing water quality, to determine the probable impact of construction and operation of the project on the river system, and to establish a base line for comparison of the biological community before, during, and after construction.

The Chena River Lakes Project was authorized by the Flood Control Act of 1968. The project is designed to protect the city of Fairbanks from damaging floods originating in the Tanana, Chena, and Little Chena Rivers. Flood control is to be accomplished by regulating and restricting the Chena and Little Chena Rivers through the construction of two earthfill dams and by creating a Tanana River levee system (fig. 1) (U.S. Army Corps of Engineers, 1971). The part of that project germane to this report is the effect of construction and operation of the dams and reservoirs on the Chena and Little Chena Rivers on biological quality of the rivers.

A timetable for construction of the retention dam on the Little Chena River has not been formulated. Present plans are to provide only flood protection. High-water flows will be temporarily restricted as required to provide flood protection (1-2 week period) and a permanent pool will not be maintained behind the dam. The need for fish passage facilities will require additional study because little is known about the fisheries resource of the Little Chena River. Because design of the retention dam on the Little Chena River will not begin for several years, the emphasis of this report is on the Chena River in the vicinity of the Moose Creek Dam.

Present plans for the Moose Creek Dam on the Chena River also call for retention and diversion of water only at flood stage (greater than 8,000 ft^3/s or 227 m^3/s at the Moose Creek damsite) and the subsequent gradual release of impounded water. No permanent reservoir will be maintained. Fill for the dam will be obtained from borrow pits (fig. 2), and present plans include development of the south borrow pit as a lake for recreation. North and south access roads will be constructed to the dam site. Fish passage facilities are being designed and will be constructed if required to insure protection of the fisheries resource.

This study included the qualitative and semiquantitative assessment of benthic invertebrates, periphyton, and phytoplankton. Quantitative sampling of benthic invertebrates is difficult, time consuming, and at times impossible in the reach of the Chena River sampled in this study. Artificial substrates provided a relative or semiquantitative sample of a small defined habitat. This method is best suited for comparing the kinds and relative abundances of species at several stations or at different sampling sites. No attempt was made to determine the abundance or composition of the vertebrate populations. Biological samples were collected on seven occasions between October 3, 1972 and August 10, 1973. In June and in August of 1973, extensive reconnaissance sampling was carried out on the Chena River.



Adapted from U.S.Army Corps of Engineers base map

Figure 1.-- Location of the Chena Lakes study area.

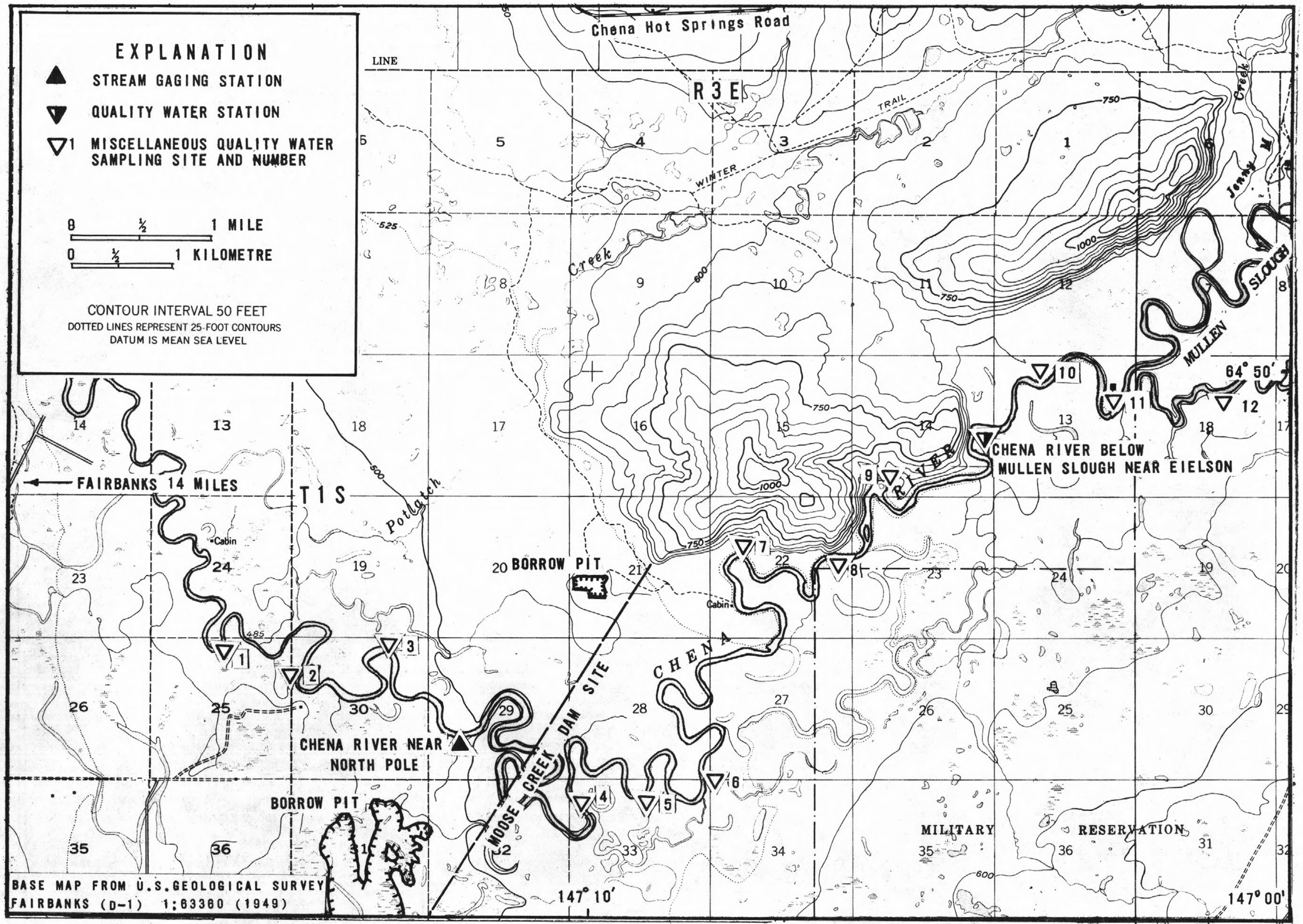


Figure 2.--Chena Lakes study area showing sampling stations, location of dam and borrow areas.

The frequency of collection of chemical-quality data was determined primarily by needs of the U.S. Army Corps of Engineers for input data for modeling and design purposes. Chemical data, discharge measurements, and suspended-sediment data were collected on 26 occasions from September 1972 through September 1973. These data were collected weekly during the summer months, twice monthly in the spring and fall, and every other month in the winter.

Three appendixes are included in this report. Some of the more important ecological requirements of the common benthic invertebrates found in this study are described in appendix I. All species of algae collected in the Chena and Little Chena Rivers during this study are listed in appendix II and notes on the ecological preferences of these species and the relative abundance of each organism are included. The biological terms used in this report are defined in appendix III.

Acknowledgments

The author wishes to acknowledge the advice and technical assistance of the Hydrologic Engineering Section of the Alaska District, U.S. Army Corps of Engineers. The author is indebted to Dr. Ole Saether of the Fisheries Research Board of Canada who examined the chironomid larvae from the Chena River and assisted with the taxonomy of this group and to Dr. C. David McIntire of Oregon State University who assisted with the identification of diatoms and conferred with the author on their taxonomy.

Description of the Study Area

The Chena and Little Chena Rivers rise in the low interior mountains of northeastern Alaska and drain 1,973 mi^2 (5,110 km^2) of timbered land, much of which has been burned over within the past 35 years (fig. 1) (Frey and others, 1970). The drainage basin is located in what is called the Yukon Plains (long 145°W, lat 65°N). The maximum length of the basin is 100 miles (161 km) and the maximum width is 40 miles (64.5 km). The Chena River originates at an altitude of 3,675 feet (1,120 m) and flows for 155 miles (250 km), where it joins the Tanana River at an altitude of 430 feet (131 m).

The upper reaches of the stream are underlain by metamorphic rocks formerly known by the abandoned name, Birch Creek Schist and by Cretaceous plutonic rocks and Tertiary volcanic rocks. The lower 93 miles (150 km) of the Chena River is in a broad alluvial valley of sedimentary rock overlain with a thick covering of loess (wind-blown silt) and a surface layer of moss about 12.2 inches (31 cm) thick (Frey and others, 1970).

The study area includes a reach of the Chena River from 40 to 57 miles (65 to 92 km) upstream from Fairbanks (fig. 2). The confluence of the Chena and Little Chena Rivers is 14 miles (23 km) upstream from Fairbanks and 31 miles (50 km) downstream from the Moose Creek Dam site. Most present human activity and cultural influence on the river is concentrated downstream from the study area and the confluence of the two rivers near Fairbanks and Fort Wainwright (fig. 1).

Use of the Chena River within the study area has been primarily recreational and limited to canoes, riverboats, and snowmobiles. There is no road access at this time. Activities on and about the river include moose hunting and fishing. The only man-made structures located in this section of the river are a U.S. Geological Survey gaging station and a small cabin located near Mullen Slough. Grayling are plentiful in this reach of the river and moose use the area as a calving ground in May and June.

The Chena River upstream from the confluence with the Little Chena River has been described as an "unpolluted stream" and the reach below the confluence as "polluted" (Frey and others, 1970). It has been relatively unaffected by human activity in the past 20 years. Prior to that time, mining operations and road construction caused intermittent heavy sediment loads.

Mining operations began on the Little Chena River and its tributaries about 1900 and have gradually diminished to one known operation in 1969 (Frey, 1969). Access to the Little Chena River is very limited except where the Chena Hot Springs road intersects the river. Consequently, human activity on the river is slight.

In high or well drained sites the predominant overstory is Picea glauca (Moench) Voss (white spruce), and Populus balsamifera L. (cottonwood). On less favorable sites Picea mariana (Mill.) Britt. (small black spruce), Betula papyrifera Marsh. (paper birch), Populus tremuloides Michx. (quaking aspen), and Larix laricina (Du Roi) Koch (tamarack) make up the overstory. Salix spp. (willow) and Alnus sp. (alder) compose the shrubby undergrowth. The ground cover includes Vibernum edule (Michx.) Raf. (high bush cranberry), Linnaea borealis L. (twinberry), Vaccinium vitis-idaea L. (low bush cranberry), Arctostaphylos uva-ursi (L.) (Spreng. (kinnikinnick), Cornus canadensis L. (bunchberry), Equisetum spp. (horsetails), and Epilobium angustifolium L. (fireweed) in the higher areas. In the lower areas including swamps and peat bogs, Ledum palustre L. (labrador tea), Salix spp. (dwarf willow), Betula nana L. (dwarf birch), Sphagnum sp. (peat moss), various lichens including species of Usnia and Cladonia Vaccinium uliginosum L. (blueberry), and Rosa spp. (wild roses) are the common herbs. In the river, rooted aquatic vegetation is lacking, but patchy growth of an aquatic moss, Fontinalis sp., occurs.

Description of Sampling Sites

Three primary sampling sites were selected to define the biological water quality of the river system. They were located on the Little Chena River near Fairbanks, on the Chena River near North Pole, and on the Chena River at a site 20 miles (32 km) upstream from the North Pole site designated Chena River below Mullen Slough near Eielson or upper site. The criteria used in selecting sites were the degree to which the station was representative of conditions in that reach of the stream and their accessibility. In addition, 12 reconnaissance sites were selected and sampled in June and August 1973 in order to assess the validity of the assumption that the primary stations were representative of the reach in which they were located. A list of all stations sampled is presented in table 1. The position of the stations relative to the proposed Moose Creek Dam construction site is indicated in figure 2.

The station on the Little Chena River near Fairbanks is located at the gage adjacent to the highway bridge on the Chena Hot Springs road. Because of thick underbrush, steep banks, and the difficulty of navigating the Little Chena River by boat, sampling was restricted to a reach 50 yards (45 m) up and downstream from the highway bridge. Two dwellings are located in the immediate vicinity, one upstream about 110 yards (100 m) from the riverbank, and one downstream about 44 yards (40 m) from the bank. The defined channel is 130 feet (40 m) wide. The bottom material is primarily silt and clay, but downstream from the bridge on the right bank is a sand and gravel bar (fig. 3). Difficulties in obtaining consistent samples from this site were caused by severe bank erosion, vandalism, and anchor ice. Furthermore, the water beneath the ice was under pressure in winter, as evidenced by water exuding from ice holes following drilling.

The Chena River near North Pole station is also located at a U.S. Geological Survey gaging station. At this site the defined channel is 200 feet (61 m) wide (fig. 3). Most of the bottom is gravel and cobble 0.2-4 inches (0.5-10 cm) in diameter. Some silt and clay accumulates along the right bank. Sampling at this site was more consistent than at the other stations primarily because of the occurrence of some open water throughout the winter months. This station is 1.2 miles (2 km) downstream from the proposed Moose Creek Dam site in a relatively straight reach of the river. Right and left banks were determined by facing downstream.

Table 1.--*Location of sampling stations and reconnaissance sites on the Chena and Little Chena Rivers*

Station name	U.S. Geological Survey station no. (when applicable)	Latitude	Longitude	Distance * from Moose Creek Dam site (km)
Little Chena R nr Fairbanks	15-5110.00	65°53'10"	147°14'50"	-
Site 1		64°48'00"	147°13'40"	-8
Site 2		64°48'16"	147°12'35"	-6
Site 3		64°47'55"	147°12'00"	-4
Chena River nr North Pole	15-4935.00	64°47'47"	147°11'56"	-2
Site 4		64°47'40"	147°11'30	+2
Site 5		64°47'10"	147°10'15"	+5
Site 6		64°47'35"	147°09'45"	+7
Site 7		64°48'35"	147°07'55"	+23
Site 8		64°48'55"	147°07'10"	+27
Site 9		64°49'25"	147°06'55"	+31
Chena R bl Mullen Slough nr Eielson	15-4937.00	64°49'35"	147°04'50"	+32
Site 10		64°49'58"	147°03'50"	+33
Site 11		64°50'05"	147°02'55"	+35
Site 12		64°49'45"	147°01'35"	+37

* (-) Indicates downstream
(+) Indicates upstream

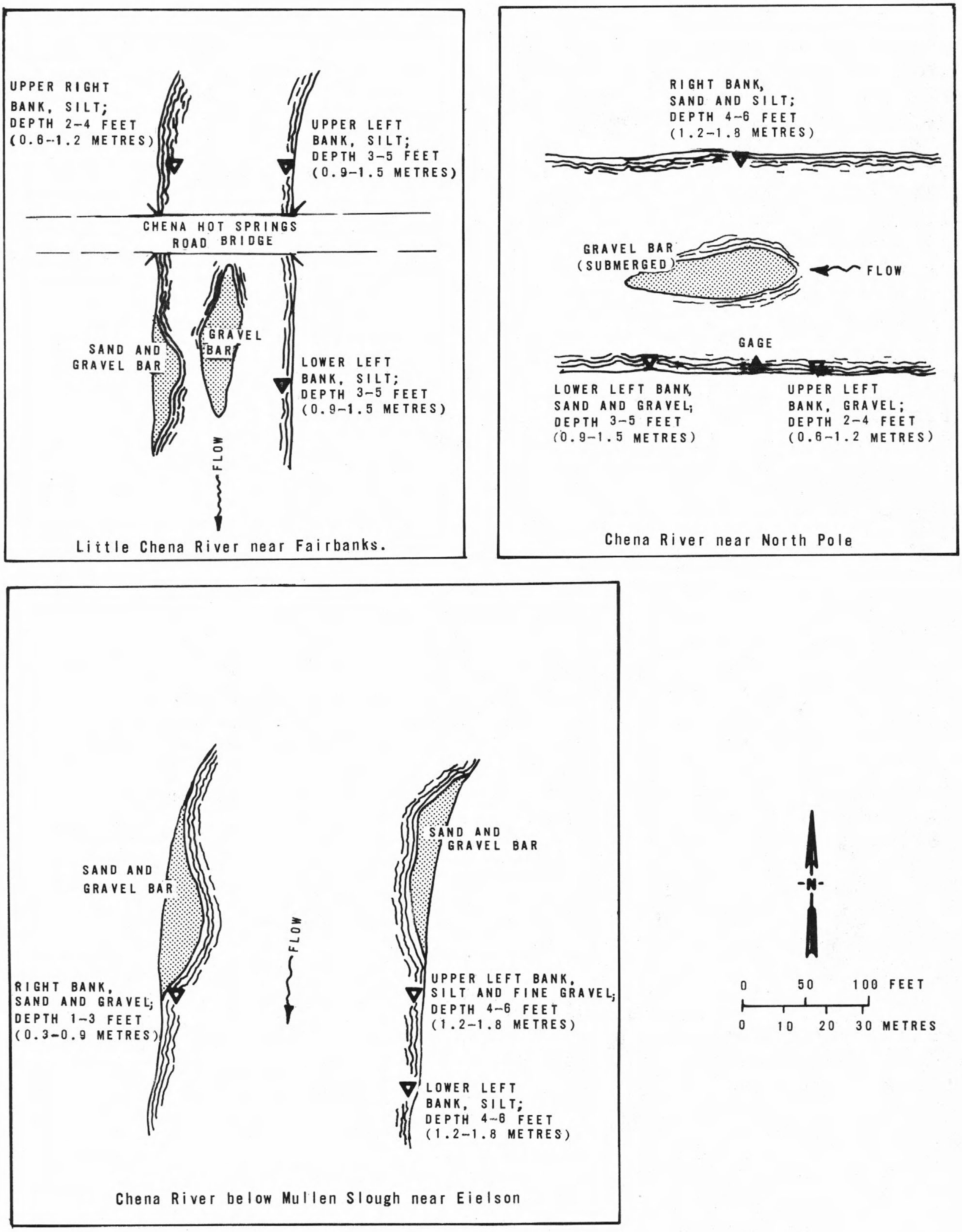


Figure 3--The positions of artificial substrates at the three primary stations.

The Chena River below Mullen Slough near Eielson (referred to as the upper site in the text) is approximately 20 miles (32 km) upstream from the North Pole site and is above the projected maximum pool level. The river here is about 250 feet (76 m) wide (fig. 3). Sand and gravel bars occur on both sides at this site and areas of silt and clay accumulation occur upstream from the sand and gravel bar on the right bank and downstream from the sand and gravel bar on the left bank. The river bends slightly in a sigmoid fashion in this reach. Regular winter sampling was not possible at this site because of thick ice, unpredicted thawing, and difficulty in gaining access to the site.

Reconnaissance stations 1-12 were relatively similar in morphology. Each station was located next to a sand and gravel bar with an adjacent riffle area and included a pool area of slowly moving water. At most sites it was also possible to do a limited amount of biological sampling in a pool. All chemical samples were collected in riffle areas. The locations of these sites are shown in figure 2.

METHODS OF INVESTIGATION

Chemical

All chemical samples were collected and analyzed in accordance with standard methods of the U.S. Geological Survey (Brown and others, 1970). Dissolved oxygen was determined in the field by the azide modification of the Winkler method or with a model 54 YSI dissolved oxygen meter.[1/] Five-day incubation at 20°C was used for the determination of biochemical oxygen demand (BOD) (American Public Health Assoc. and others, 1971).

Conductivity was measured with a Beckman RV-3-Solubridge conductivity meter and alkalinity was determined by the electrometric titration method (Brown and others, 1970). Field pH was determined with an Orion model 401 pH meter. During the August 1973 sampling trip, conductivity, dissolved oxygen, pH, and temperature were measured with a Martek Mark II model A water-quality monitoring system used in conjunction with a recorder. Chemical and physical data collected during this study are presented in tables 2 through 6.

1/ The use of named products in this report is for indentification only and does not imply endorsement by the U.S. Geological Survey.

Additional chemical-quality and sediment data from the Chena and Little Chena Rivers have been collected as part of the cooperative program with the U.S. Army Corps of Engineers and is published in the 1972 and 1973 annual series of basic-data releases of the U.S. Geological Survey. The inorganic water-quality data were used to enhance that description, but a detailed interpretation of the data is not within the scope of this report.

Biological

Sampling Procedures

Benthic invertebrates were collected with artificial substrates, by dip-net sampling, and with the Surber sampler. The artificial substrates consisted of a wire vegetable basket lined with nylon screen cloth with 210-μm (micrometre) mesh openings and filled with 40 rocks taken from the streambed (fig. 4) (Nauman and Kernodle, 1974). The basket was allowed to rest on the stream bottom for 30 to 60 days before retrieval. The substrate was placed in a bucket as quickly as possible after retrieval, and the contents were scrubbed with a stiff brush to remove attached organisms. The sample was concentrated by pouring through a 208-μm (U.S. No. 70) screen.

Dip-net samples were collected when feasible to supplement the basket samples and to provide data which would indicate the degree to which the artificial substrates were representative of that reach of the river. They were collected by wading the stream with a D-shaped dip net with a 210-μm mesh. The flat side of the net was placed on the bottom and the sediment upstream from the net was stirred with the foot. This was repeated in as many areas at the site as possible. In addition, the net was used to probe under overhanging banks and among submerged branches and stumps to sample organisms adhering to these substrates. All invertebrate samples were preserved in 40 percent isopropyl alcohol.

Only four Surber samples were collected from October 1972 to February 1973. A 210-μm mesh net was used. This sampling procedure was discontinued because of difficulty in collecting representative samples under ice cover and in water depths that occurred on the two rivers.

Periphyton was sampled by means of artificial substrates and composite samples from natural substrates. The artificial substrates were plastic strips (2x6 inches or 5x15 cm) which were suspended between a float and an anchor so that they were within 12 inches (30 cm) of the surface, or they were attached to a basket which was resting on the streambed at depths ranging

Figure 4.-- Artificial substrate for benthic invertebrates.

from 1 to 6 feet (0.3 to 1.8 m). Strips for chlorophyll a analysis were frozen with dry ice immediately after retrieval and shipped to the laboratory.

Composite samples for analysis of species composition of the periphyton were collected from all available natural substrates. An attempt was made to collect a variety of materials (deadfall, moss, rocks, and clumps of filamentous algae) in the relative proportion that they occurred in the sampling area. The substrate was scraped with a knife and the scrapings placed in 1 percent Lugols solution for storage, as were the periphyton strips (Slack and others, 1973). In some places where moss and small rocks were sampled, the entire substrate was preserved for shipment back to the laboratory.

Phytoplankton was collected with a plankton net (76-µm mesh silk bolting cloth) or with a depth integrating sediment sampler and preserved in 1 percent Lugols solution.

Laboratory Analyses

The samples of benthic invertebrates were washed using a U.S. No. 70 mesh (208 µm) screen. The organisms were separated from the debris by hand and sorted into taxonomic groups. Insects were identified to the generic level in almost all cases and to the level of species where possible. Dipteran larvae were mounted on slides using CMC 10 mounting media. All slides and preserved specimens have been retained.

A wet weight determination was made on the organisms in the basket samples by filtering the organisms onto a tared membrane filter and allowing the filter to stand exposed to the air for 9 minutes before weighing. A second filter was used as a blank by filtering an equivalent amount of 40 percent isopropyl alcohol and allowing it to stand for the same period of time. The increase in weight of this filter was substracted from the weight of the filter with the organisms to determine the wet weight of the organisms.

The rocks in the composite samples were scrubbed with a small brush, and an aliquot of the slurry was examined for algae other than diatoms. The samples were then oxidized with hot nitric acid and potassium dichromate and the specimens were mounted on slides using Carquilles mounting medium (Patrick and Reimer, 1966).

The plastic strips used for the collection of periphyton were allowed to thaw in the dark and then scraped with a glass microscope slide (Tilley, 1972). One part of the resultant slurry was used for determination of chlorophyll a concentration using a Turner Fluorometer (Strickland and Parsons, 1968), one part was used for ash weight and dry weight determinations, and a third part was examined in the same manner as the composite samples for species composition.

The phytoplankton were allowed to settle in separatory funnels. After a minimum of 24 hours, 20 ml (millilitres) were drawn off, allowed to settle in sedimentation chambers and subsequently examined with an inverted microscope. A total count in cells per litre was estimated by counting 10 fields at random under 400x magnification and multiplying by the appropriate factor. The concentrated phytoplankton was then oxidized in the same manner as the periphyton to prepare the diatoms for identification.

Diversity was computed (for all samples) using the method described by Wilhm (1970). The total number of organisms (N), number of individuals per taxon (n_i), number of taxa (s) in each sample were used to calculate diversity with the following expression:

$$\bar{d}=-\sum_{1}^{s}(n_i/N)\log_2(n_i/N)$$

This expression is relatively independent of sample size, takes into consideration relative abundance, and is dimensionless.

RESULTS AND DISCUSSION

Chemical Water Quality

The Chena River in the reach covered by this study can be characterized as a clean subarctic stream with a small amount of natural organic enrichment.

Water quality of the Chena River is excellent in this reach. The dissolved-solids concentration is low, between 48 and 104 mg/l (milligrams per litre). The dissolved ions are primarily calcium and bicarbonate. No ions are present in objectionable quantities that would impair the use of this water for most purposes. However, iron content is relatively high; a few samples exceeded the U.S. Public Health Service Standards (1962) of 300 μg/l (migrograms per litre) of iron for public water supplies.

The BOD is low, usually less than 1 mg/l but not more than 3 mg/l. A positive relation seems to exist between BOD and discharge (table 2). Chemical oxygen demand (COD) values were moderate (0 to 54 mg/l) and seem unrelated to other measurements.

Ammonia nitrogen did not exceed 1.10 mg/l. Organic nitrogen was also low but increased in the summer months (fig. 5). Total phosphorus did not exceed 0.27 mg/l. Most of the phosphorus is bound to particulate or suspended matter or is present in organic complexes, because dissolved orthophosphorus was much lower than total phosphate in all of the samples. Dissolved oxygen was uniformly high (80 to 98 percent saturation) during daylight hours except that it is markedly depressed under the ice during the winter months. The minimum value obtained, 5.8 mg/l (40 percent saturation) on February 9, 1973, approaches concentrations that could be critical for some invertebrates and species of fish.

No discernible change or trend occurred in the chemical data collected in this reach of the Chena River except for COD, which seems to decrease upstream in June and August (table 2). However, more determinations should be made before any definite conclusions are drawn. All other data indicate no significant difference in water quality as far upstream as the uppermost station (12), with the possible exception of iron. The chemical quality of the Chena River was similar to that of the Little Chena River (tables 2 and 3). Dissolved oxygen was depressed to a greater degree in the Chena River in the winter, but minimum concentrations probably were not measured. Continuous monitoring is needed in both streams to measure the magnitude and duration of the lowered oxygen concentration. The observed decrease in dissolved oxygen in the Chena River has been documented by other investigators, and values as low as 1 mg/l have been reported in the Chena River near Fairbanks (Frey, 1969; Frey and others, 1970). This was attributed to prolonged snow and ice cover, low light intensity, and slow reaeration rates. Frey suggested that low dissolved oxygen concentrations are not critical because of the adaptation of invertebrates in a subarctic stream to low oxygen concentrations in the winter. However, the limit to which dissolved oxygen may decrease in such a system without affecting the biota is not known. Dissolved oxygen may be a limiting factor and a further decrease from the values recorded by Frey could drastically affect the biota.

The most obvious difference in the two rivers is in the relative concentrations of suspended sediment. No daily records of sediment concentrations are available for either stream. However, miscellaneous measurements made during 1972 and 1973 indicate that the Little Chena River has a considerably higher concentration of suspended sediment, especially during high flows. The COD and total phosphorous measurements were comparable for the two streams except on August 8, 1972, when high values were recorded for these parameters in the Little Chena River: COD, 170 mg/l, and total PO_4, 0.85 mg/l (fig. 6; table 3).

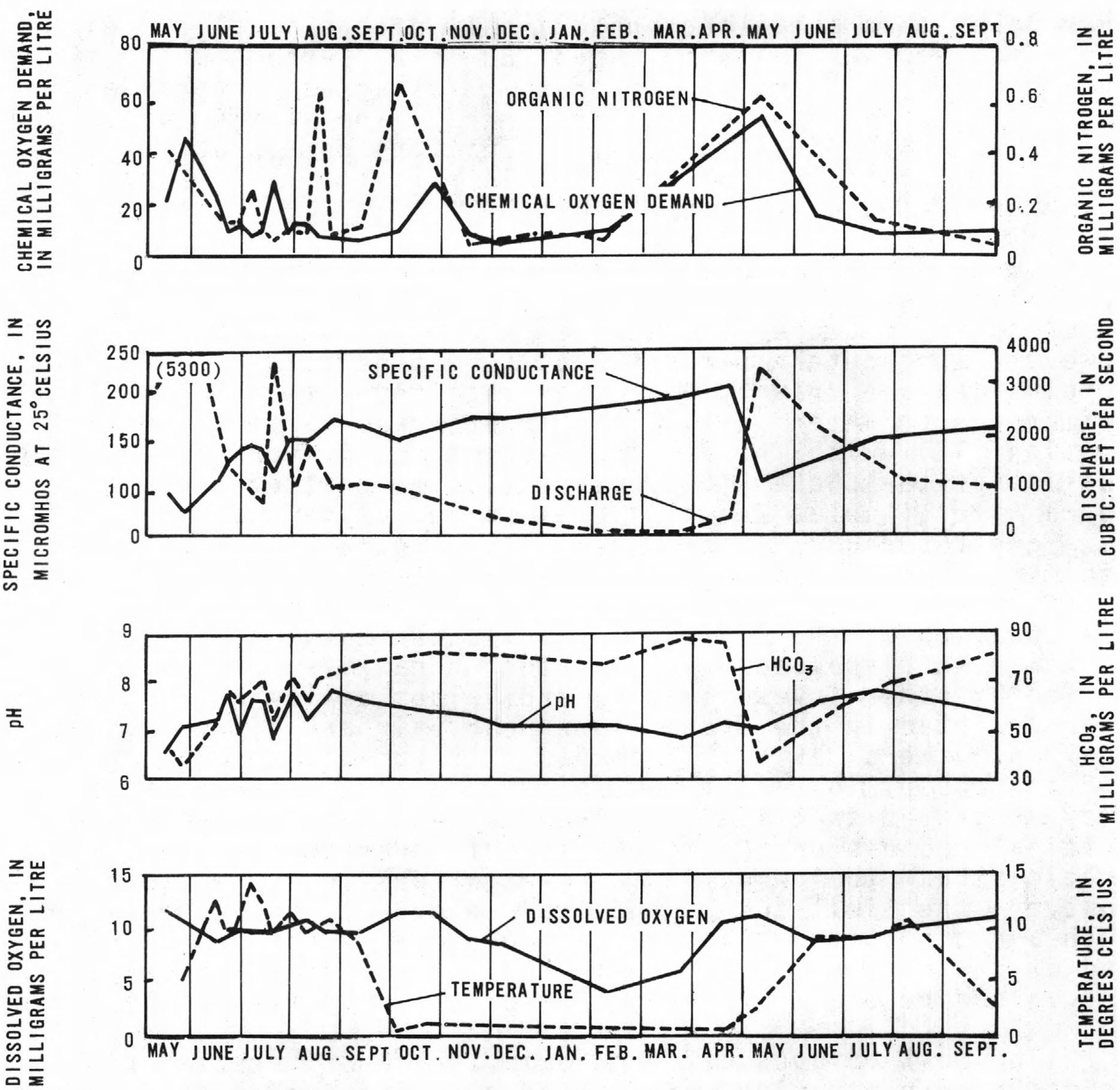


Figure 5.--Seasonal variation in water-quality constituents for the Chena River near North Pole.

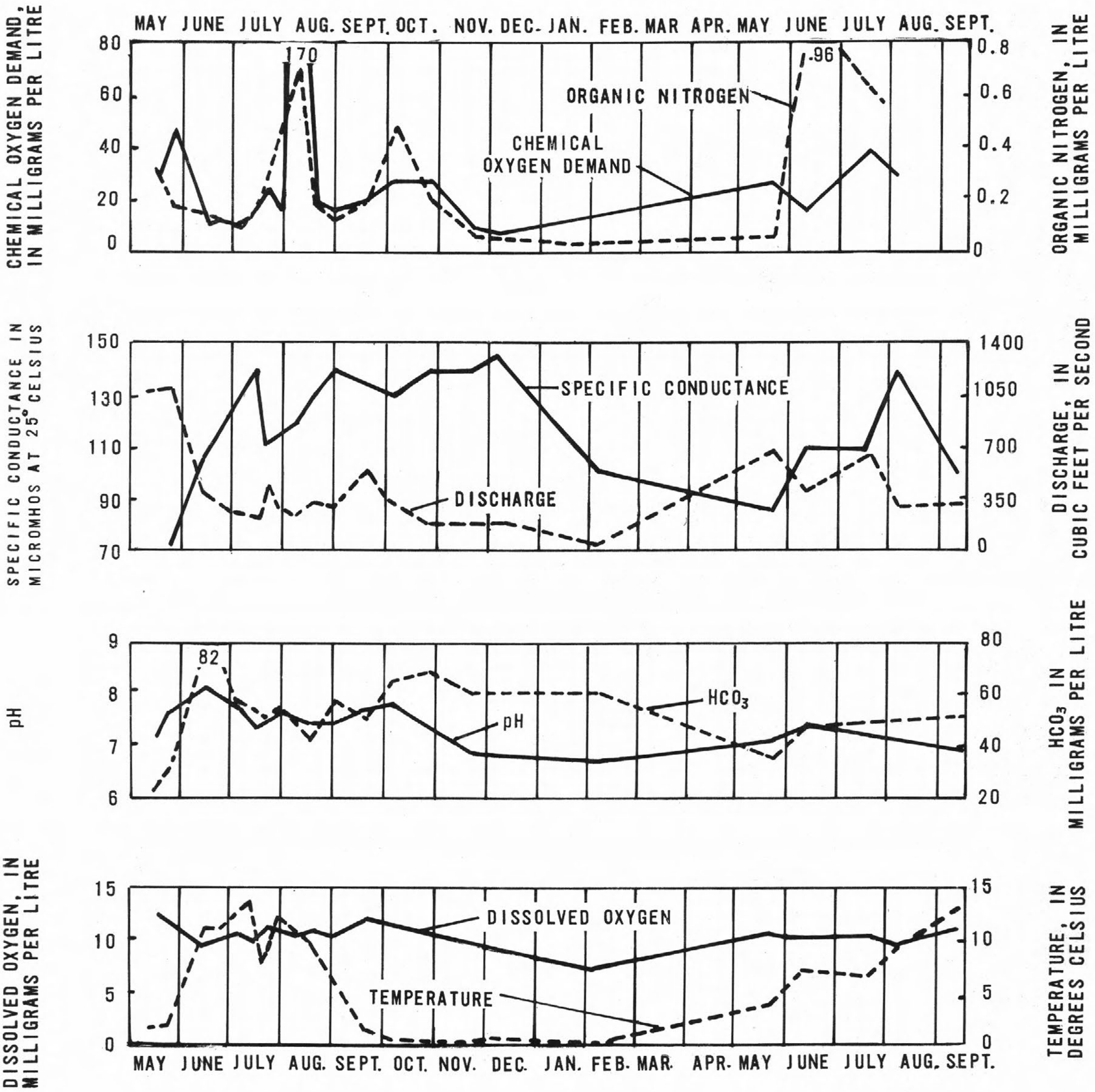


Figure 6.--Seasonal variation in water-quality constituents for the Little Chena River near Fairbanks.

Table 2.--*Seasonal variation in water-quality constituents for the Chena River*
(Results in milligrams per litre unless otherwise indicated)

Date*	Discharge (ft^3/s)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Total ammonia (N)	Total organic nitrogen (N)	Dissolved ortho phosphorus (P)	Total phosphorus (P)	Specific conductance (µmhos at 25°C)
CHENA RIVER NEAR NORTH POLE								
05-16-72	3370	46	-	0.11	0.41	0.01	0.03	100
05-25-72	5300	38	-	1.10	.33	.00	.11	80
06-15-72	2500	55	-	.00	.16	.00	.04	110
06-22-72	1540	68	-	.00	.12	.01	.03	130
06-29-72	1130	63	-	.02	.14	.00	.01	140
07-06-72	916	69	-	.03	.25	.00	.01	145
07-13-72	750	71	-	.02	.10	.05	.12	140
07-19-72	3290	54	-	.36	.05	.02	.27	120
07-28-72	1367	71	-	.05	.09	.01	.17	150
08-01-72	1070	71	-	.02	.09	.00	.12	150
08-10-72	1880	63	0.1	.01	.08	.01	.08	150
08-16-72	1360	71	.1	.02	.64	.01	.11	160
08-23-72	1100	74	.2	.03	.07	.00	.05	170
09-01-72	1130	78	.1	.04	.10	.00	.03	165
10-04-72	1010	74	.0	.00	.67	.01	.01	150
10-26-72	900	82	.1	.00	-	.01	.01	160
11-17-72	651	80	.1	.02	.04	-	-	170
12-06-72	445	81	.0	.00	.03	-	-	170
02-09-73	196	78	.0	.01	.06	-	-	171
03-22-73	142	87	.0	-	-	.03	-	190
04-18-73	453	42	-	-	-	-	-	200
05-10-73	3290	39	-	.04	.61	.00	.06	105
06-14-73	1840	56	.0	.02	.36	-	.02	125
07-19-73	1470	68	.0	.03	.13	.00	.02	150
08-09-73	1120	-	-	.00	.05	-	.02	143
09-29-73	1100	80	-	-	.08	.02	.02	160
CHENA RIVER BELOW MULLEN SLOUGH								
06-15-73	-	-	-	.01	.35	-	.02	-
08-09-73	-	-	-	.01	.16	-	.01	145
CHENA RIVER SITE 12								
06-15-73	-	-	-	.01	.33	-	.02	140
08-09-73	-	-	-	.01	.20	-	.01	-

*The time of all field measurements was between 1200 and 1600 hours

pH (units)	Temperature (°C)	Dissolved oxygen (DO)	Dissolved oxygen (percent saturation)	Chemical oxygen demand (COD)	Biochemical oxygen demand (BOD)	Carbon dioxide (CO_2)	Total organic carbon (TOC)	Dissolved organic carbon (DOC)
			CHENA RIVER NEAR NORTH POLE					
6.7	-	12.0	-	21	-	-	-	-
7.2	5.0	10.9	85	46	2.7	-	17.2	-
7.3	12.5	9.0	85	22	-	-	14.5	-
7.8	10.0	9.3	83	9	-	-	-	-
7.0	11.0	10.0	92	12	-	-	-	-
7.7	14.5	9.7	96	7	-	-	-	-
7.7	13.0	9.7	92	9	-	-	-	-
6.9	9.5	10.0	88	29	-	-	-	-
7.6	11.5	10.2	94	9	-	-	-	-
7.8	11.5	10.5	97	12	-	-	-	-
7.3	9.5	10.8	95	12	.5	5.8	-	-
7.5	-	10.2	-	7	.2	4.4	-	-
7.9	11.0	10.2	94	6	.0	1.8	-	-
7.7	8.5	9.9	85	6	.4	3.5	-	-
8.1	.0	11.7	81	9	.6	-	-	-
7.5	.5	11.7	82	28	.2	6.6	-	-
7.4	.5	9.3	65	7	.3	8.2	-	-
7.2	.5	8.8	62	4	.3	13.0	-	-
7.2	.0	5.8	40	8	.4	13.0	-	-
6.9	.0	6.0	42	-	.7	27.0	-	-
7.2	.0	10.9	76	-	.5	-	-	-
7.1	2.5	11.5	85	54	1.8	-	-	-
7.6	9.5	9.0	79	14	1.6	3.0	6.0	5.0
7.0	11.0	9.5	87	8	.7	6.5	-	-
7.5	11.0	10.4	95	9	.5	4.1	4.0	4.0
7.4	3.0	11.2	84	11	.4	-	-	-
			CHENA RIVER BELOW MULLEN SLOUGH					
-	9.4	-	-	6	.4	-	6.0	5.0
7.4	11.0	10.0	90	7	.2	-	7.5	4.0
			CHENA RIVER SITE 12					
7.5	9.2	9.5	86	0	.6	-	6.0	5.0
-	11.0	-	-	4	.4	-	5.5	5.5

Table 3.--*Seasonal variation in water-quality constituents for the Little Chena River near Fairbanks*

(Results in milligrams per litre unless otherwise indicated)

Date*	Discharge (ft^3/s)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Total ammonia (N)	Total organic nitrogen (N)	Dissolved ortho phosphorus (P)	Total phosphorus (P)	Specific conductance (µmhos at 25°C)
05-15-72	-	22	-	0.06	0.31	0.00	0.08	70
05-24-72	1070	31	-	.04	.19	.00	.16	70
06-14-72	-	82	-	.05	.15	.01	.02	107
06-28-72	262	-	-	.05	.11	.00	.04	-
07-05-72	232	56	-	.01	.11	.00	.02	130
07-14-72	189	53	-	.01	.18	.07	.08	140
07-20-72	408	49	-	.03	.27	.01	.13	110
07-27-72	279	54	-	.01	.10	.01	.13	115
08-08-72	206	-	-	.03	.66	.01	.85	120
08-17-72	313	42	0.0	.05	.18	.01	.14	130
08-30-72	262	57	.0	.05	.13	.02	.12	140
09-19-72	512	50	.1	.08	.21	.03	.04	111
10-03-72	179	65	.0	.00	.49	.01	.03	130
10-25-72	180	68	.0	.00	.20	.01	.01	140
11-22-72	122	59	-	.01	.06	-	-	140
12-05-72	140	60	.0	.00	.04	-	-	145
02-08-73	46	60	.0	.00	.02	-	-	100
05-21-73	641	34	-	.01	.50	.00	.04	85
06-11-73	396	45	.0	.02	.96	.00	.05	110
07-20-73	559	-	-	.05	.63	-	-	110
08-08-73	269	47	.0	.05	.51	-	.20	140
09-13-73	355	42	.0	.03	.29	-	.17	100

*The time of all field measurements was between 1100 and 1400 hours.

pH (units)	Temperature (°C)	Dissolved oxygen(DO)	Dissolved oxygen (percent saturation)	Chemical oxygen demand (COD)	Biochemical oxygen demand (BOD)	Carbon dioxide (CO_2)	Total organic carbon (TOC)	Dissolved organic carbon (DOC)
7.1	1.5	12.2	88	28	-	-	-	-
7.6	1.6	11.6	83	48	3.1	-	16.4	-
8.1	10.6	9.3	85	11	.8	-	12.6	-
-	11.0	-	-	14	-	-	-	-
7.7	12.5	10.5	100	11	.4	-	9.0	-
7.3	12.5	9.7	86	15	-	-	-	-
7.4	8.5	10.9	94	22	-	-	-	-
7.6	12.0	10.8	100	16	-	-	-	-
-	10.0	10.3	94	170	-	-	-	-
7.4	9.5	10.6	93	20	.4	3.5	-	-
7.4	6.5	10.1	83	16	.3	4.8	-	-
7.7	1.5	11.9	84	20	.6	2.2	-	-
7.8	.5	-	-	28	.0	2.5	-	-
7.4	.5	-	-	28	.0	7.1	-	-
6.8	.0	9.7	65	9	.3	-	-	-
6.8	.5	9.0	63	7	.7	22.0	-	-
6.7	.0	7.6	51	50	1.0	30.0	-	-
7.0	4.0	10.5	81	27	1.2	-	9.0	7.0
7.3	7.0	10.1	84	16	.7	5.0	9.0	7.0
-	6.5	10.4	86	40	-	-	-	-
7.0	9.0	9.6	83	30	.7	9.5	10.0	7.5
6.8	6.0	12.4	91	-	.9	12.0	7.5	5.5

These anomalous values did not seem to be correlated with discharge, sediment load, or other chemical parameters. The Environmental Protection Agency has also collected considerable data on the Chena River (Frey, 1969; Frey and others, 1970). The values obtained by the Environmental Protection Agency are comparable to those listed in tables 2 through 6. Frey concludes that an increase in sediment load might affect drastically the food chain, pH, and dissolved oxygen. Small fluctuations in pH, however, are probably not biologically important in the unpolluted reach.

During aerial reconnaissance, red water was observed in some of the numerous oxbow lakes, sloughs, and springs adjacent to the Chena River. This condition commonly indicates high iron concentration. The source of iron in these waters may be percolation of ground water through organic-rich sediments, weathering of bedrock, or runoff from areas containing decomposing plant material, such as the moss-muskeg-forest area near the Chena River (Frey and others, 1970 and W.W. Barnwell, oral commun., 1974). Large quantities of iron (greater than 500 μg/l) are soluble only in a reducing environment (Hem, 1970). Precipitated iron can be seen where ground water enters the Chena River at points of slow flow or backwater. Ground water, which is low in dissolved oxygen and has a high concentration of iron, may precipitate the iron as it mixes with the aerated river water. The dissolved-iron concentration, measured at several stations in this reach of the Chena River, ranged from 180 to 410 μg/l in June, but no distributional trend was discernable (fig. 7; table 4). In August less iron (90 to 220 μg/l) was measured. However, the concentration increased downstream; the greatest increase was about 245 percent of the minimum value obtained at the uppermost station.

Iron is an essential metabolite for plants and animals, but when very concentrated may limit the kinds of organisms. If a permanent pool were to be maintained, the iron concentration could become much higher than in the river and discharge of the reservoir water into the river could result in the precipitation of iron downstream from the outlet as the water is reaerated. Iron concentrations noted in the study are neither low nor high enough to have an adverse biological effect. The reservoir as planned probably will not alter the iron concentration in the river for any appreciable length of time, but short-term increases in iron may occur following retention. In order to determine the source and significance of iron in the Chena River systems, additional data needs to be obtained from ground water, springs, and runoff.

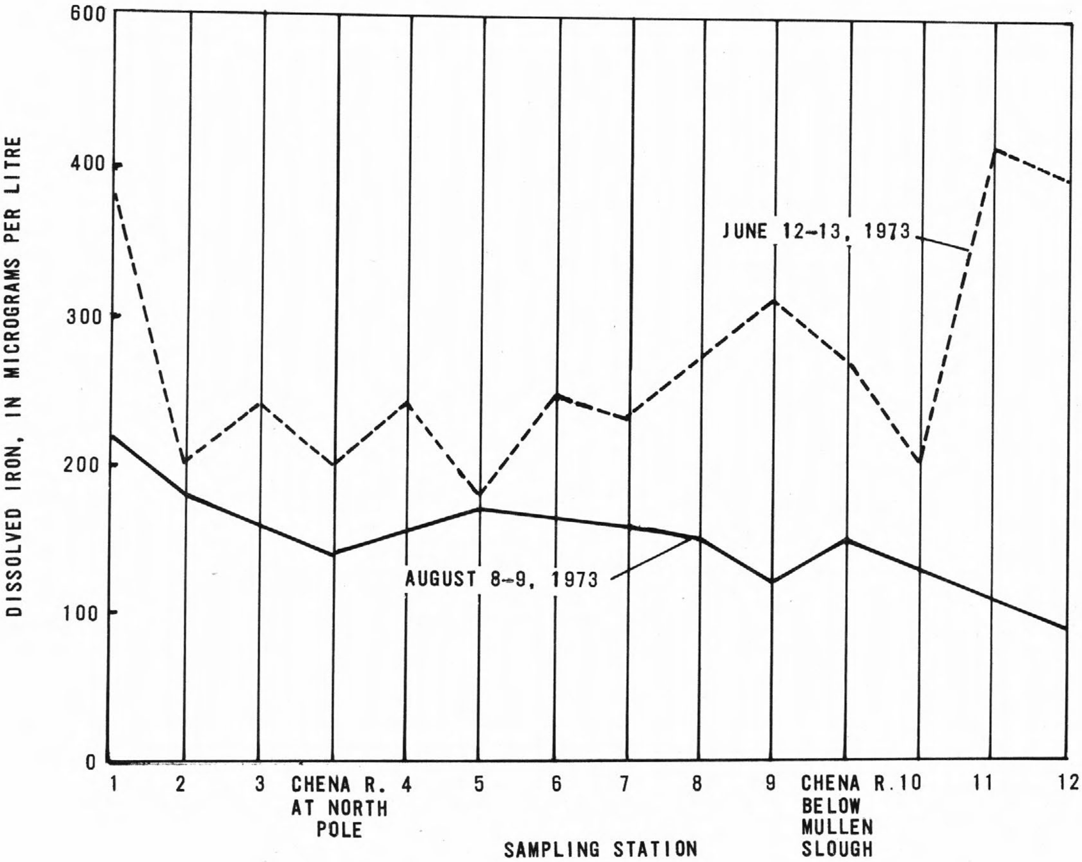


Figure 7.--Variation in dissolved iron concentration in the Chena River.

Table 4.--*Water-quality constituents for the reconnaissance sites in June and August 1973*

(Results in milligrams per litre unless otherwise indicated)

Site	Date	Time	Dissolved iron (Fe) (μ/l)	Bicarbonate (HCO_3)	Carbonate (CO_3)
1	06-14-73	1110	380	59	0.0
2	06-14-73	1140	200	58	.1
3	06-14-73	1210	240	-	-
4	06-14-73	1430	180	-	-
5	06-14-73	1410	220	-	-
6	06-14-73	1345	230	-	-
8	06-14-73	1635	270	56	.0
9	06-14-73	1705	310	-	-
Chena River blw Mullen Slough nr Eielson	06-14-73	1620	270	55	.0
10	06-15-73	1130	200	61	.1
11	06-15-73	1105	410	59	.1
12	06-15-73	1030	390	60	.1
Chena River nr North Pole	06-15-73	2000	200	56	.1
1	08-09-73	1810	220	-	-
2	08-09-73	1900	180	66	.0
Chena River nr North Pole	08-07-73	1800	140	69	.1
5	08-09-73	0945	170	66	.0
7	08-09-73	1015	160	70	.1
8	08-09-73	1130	150	70	.1
9	08-09-73	1230	120	70	.1
Chena River blw Mullen Slough nr Eielson	08-09-73	1545	150	66	.1
11	08-09-73	1445	110	69	.1
12	08-09-73	1345	90	68	.1

Specific conductance (μmhos at 25°C)	pH (units)	Temperature (°C)	Dissolved oxygen (DO)	Dissolved oxygen (percent saturation)	Carbon dioxide (CO_2)
140	7.3	9.9	9.4	84	5.7
140	7.5	10.4	9.4	85	3.8
135	7.5	10.2	9.4	84	-
135	7.6	10.7	9.4	87	-
140	7.5	10.2	9.5	85	-
140	7.1	9.7	9.3	83	-
140	7.1	10.6	9.4	85	9.9
-	7.1	10.7	9.3	85	-
-	7.1	10.6	9.3	85	9.6
140	7.4	9.7	9.5	84	4.9
150	7.4	10.2	9.3	83	4.6
140	7.5	9.2	9.5	83	3.9
125	7.6	9.5	9.0	79	3.0
145	7.5	11.5	10.6	98	-
145	7.4	11.5	10.6	98	11.2
143	7.4	11.5	10.4	96	4.1
145	7.2	11.0	10.4	95	8.0
145	7.4	11.0	10.3	94	4.2
148	7.4	10.5	10.2	92	4.2
145	7.6	11.0	10.5	96	4.8
145	7.4	10.5	10.4	94	5.7
143	7.4	11.0	10.5	96	6.7
145	7.4	11.0	10.2	94	6.6

Diel Studies

A 24-hour diel measurement of dissolved oxygen, carbon dioxide, alkalinity, specific conductance, and discharge was performed on June 12 and 13, 1973, at the North Pole site (fig. 8; table 5). On June 12 sunset occurred at 2337 hours and sunrise on June 13 at 0205 hours. Specific conductance ranged from 125 to 135 μmhos/cm (micromhos per centimetre at 25°C) during these measurements. Discharge declined slightly. Cloud cover was intermittent, and varied from clear to overcast. Very light rain showers occurred at 2015 and 0550 hours. Water temperature was lowered slightly in the late evening and early morning hours (0.6°C maximum change). The pH and alkalinity were slightly lower at night, and CO_2 increased from a minimum of 3.0 mg/l at 1800 hours to a maximum of 7.0 mg/l at 0200 hours. Dissolved oxygen ranged from 9.5 to 9.7 mg/l but exhibited no diel variation. However, percent saturation declined steadily from 86 percent at 1800 hours to a minimum of 83 percent at 0600 hours.

A second 24-hour study was performed on August 8 and 9, 1973 (fig. 9; table 6). Specific conductance, pH, dissolved oxygen, and water temperature were recorded continuously. Hourly values for all but pH are presented in figure 9. The pH during this period ranged from 7.5 to 7.6. Dissolved oxygen decreased from 2300 hours on August 8 to 1200 hours on August 9 and reached a minimum at 0600 hours. Water temperature decreased from 2100 hours to 0600 hours, then increased until measurements were discontinued at 1700 hours on August 9. Dissolved oxygen decreased from 98 to 89 percent saturation between 2000 and 0600 hours. Specific conductance decreased slightly during the night and increased the next day. Cloud cover varied from clear to overcast during this time and light rain showers occurred sporadically during the 24-hour period.

The greater decrease in the percent saturation of dissolved oxygen in August may be a result of three factors. The higher water temperature in August as opposed to June probably resulted in increased oxygen production and consumption. Therefore the dissolved-oxygen concentration during the day was relatively higher and the concentration at night relatively lower in August than in June. A second possible factor is the lower discharge in August relative to June. In August the volume of water in contact with sediment and other solids was less than in June. Because it is the solid surfaces where sources and sinks for dissolved oxygen are concentrated, the concentration of oxygen in the water may be expected to change more rapidly in August than in June. A third possible factor may be the length of the time of darkness which was greater in August than in June. The period of time during which light was sufficient for primary

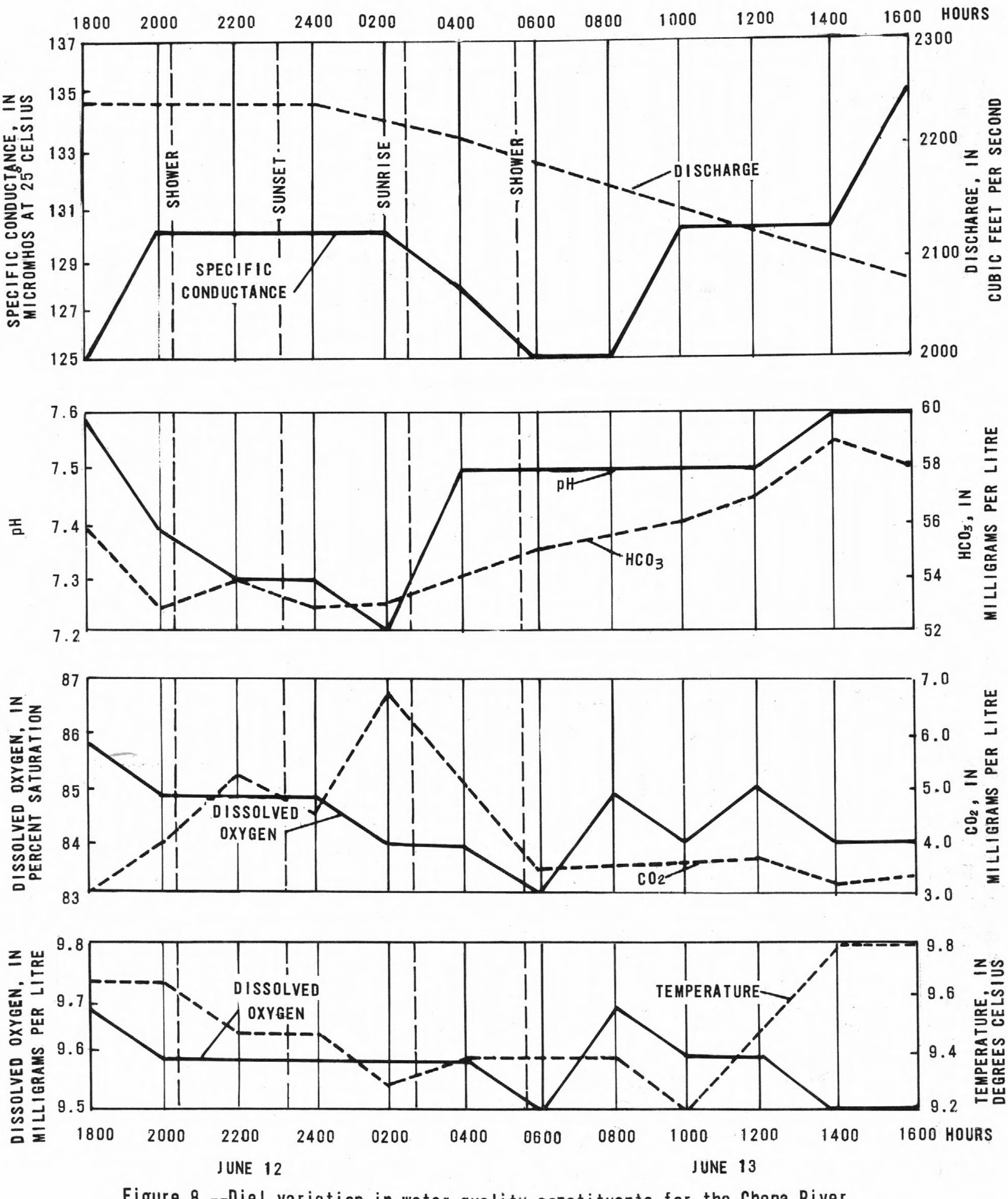


Figure 8 --Diel variation in water-quality constituents for the Chena River near North Pole, June 12-13, 1973

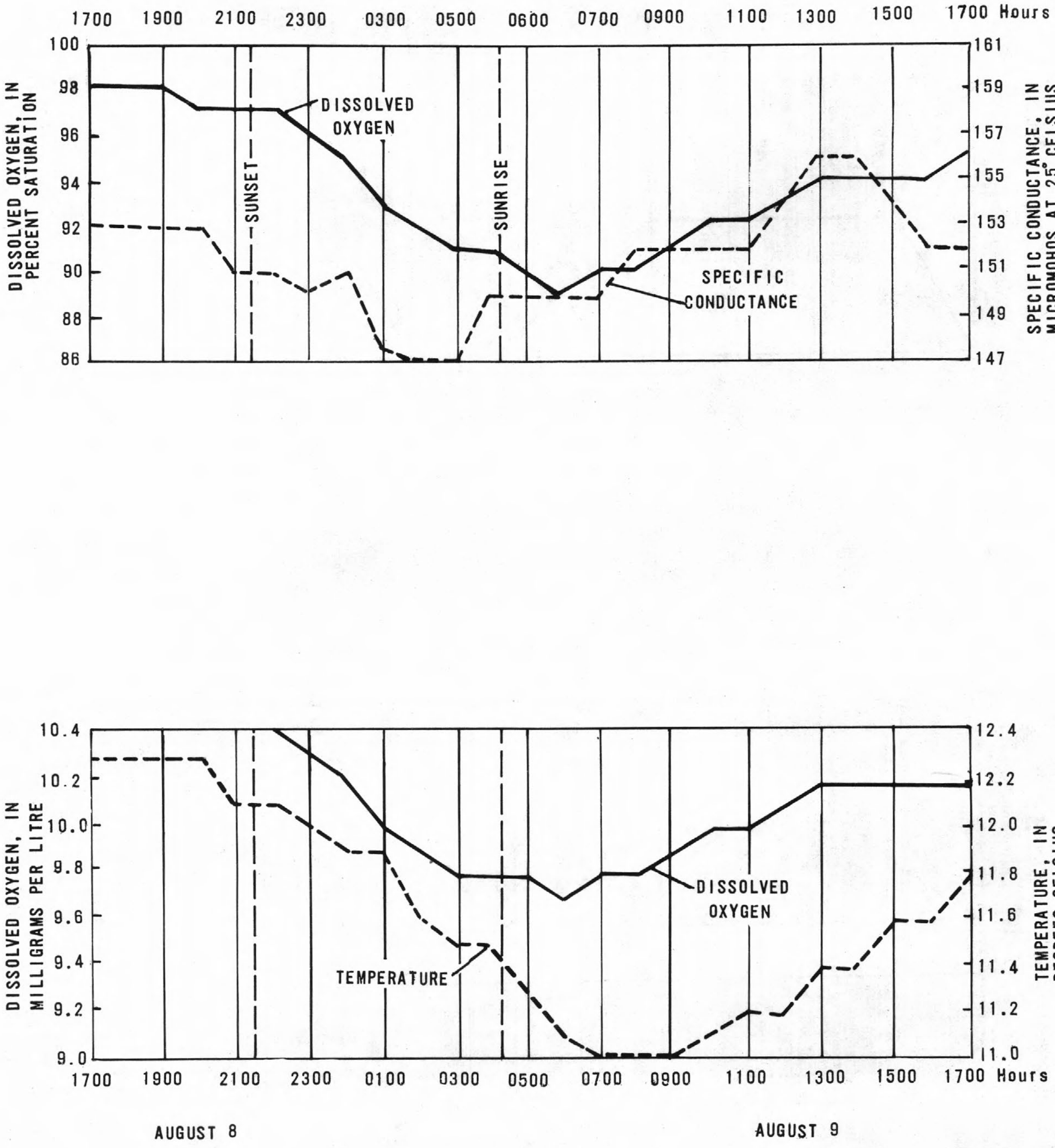


Figure 9.--Diel variation in water-quality constituents for the Chena River near North Pole, August 8-9, 1973.

Table 5.--*Diel variation in water-quality constituents for the Chena River near North Pole on June 12-13, 1973*

(Results in milligrams per litre unless otherwise indicated)

Date	Time	Discharge (ft^3/s)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Specific conductance (µmhos at 25°C)	pH (units)	Water temperature (°C)	Air temperature (°C)	Dissolved oxygen (DO)	Dissolved oxygen (percent saturation)	Carbon dioxide (CO_2)
06-12-73	1800	2240	56	0.1	125	7.6	9.7	20.8	9.7	86	3.0
06-12-73	2000	2240	53	.0	130	7.4	9.7	19.7	9.6	85	4.1
06-12-73	2200	2240	54	.0	130	7.3	9.5	14.0	9.6	85	5.3
06-12-73	2400	2240	53	.0	130	7.3	9.5	13.2	9.6	85	4.6
06-13-73	0200	2220	52	.0	130	7.2	9.3	12.8	9.6	84	7.0
06-13-73	0400	2210	-	-	128	7.5	9.4	12.7	9.6	84	-
06-13-73	0600	2190	54	.1	125	7.5	9.4	12.7	9.5	83	3.6
06-13-73	0800	2170	-	-	125	7.5	9.4	15.8	9.7	85	-
06-13-73	1000	2140	56	.1	130	7.5	9.2	16.6	9.6	84	3.7
06-13-73	1200	2130	57	.1	130	7.5	9.5	19.5	9.5	84	3.7
06-13-73	1400	2100	58	.1	130	7.6	9.8	20.7	9.5	84	3.2
06-13-73	1600	2070	57	.1	135	7.6	9.8	20.9	9.5	84	3.4

Table 6.--*Diel variation in water-quality constituents for the Chena River near North Pole on August 8-9, 1973*
(Results in milligrams per litre unless otherwise indicated)

Date	Time	Specific conductance (µmhos at 25°C)	pH (units)	Water temperature (°C)	Dissolved oxygen (DO)	Dissolved oxygen (percent saturation)
08-08-73	1700	153	7.5	12.3	10.4	98
08-08-73	1800	153	7.5	12.3	10.4	98
08-08-73	1900	153	7.5	12.3	10.4	98
08-08-73	2000	153	7.5	12.1	10.4	97
08-08-73	2100	151	7.6	12.1	10.4	97
08-08-73	2200	151	7.6	12.0	10.4	97
08-08-73	2300	150	7.6	11.9	10.3	96
08-08-73	2400	151	7.6	11.9	10.2	95
08-09-73	0100	148	7.6	11.6	10.0	93
08-09-73	0200	147	7.6	11.5	9.9	92
08-09-73	0300	147	7.5	11.5	9.8	91
08-09-73	0400	150	7.5	11.3	9.8	91
08-09-73	0500	150	7.5	11.1	9.8	90
08-09-73	0600	150	7.5	11.0	9.7	89
08-09-73	0700	150	7.5	11.0	9.8	90
08-09-73	0800	152	7.5	11.0	9.8	90
08-09-73	0900	152	7.5	11.0	9.9	91
08-09-73	1000	152	7.5	11.1	10.0	92
08-09-73	1100	152	7.6	11.2	10.0	92
08-09-73	1200	154	7.6	11.2	10.1	93
08-09-73	1300	156	7.6	11.4	10.2	94
08-09-73	1400	156	7.6	11.4	10.2	94
08-09-73	1500	154	7.6	11.6	10.2	94
08-09-73	1600	152	7.6	11.6	10.2	94
08-09-73	1700	152	7.6	11.8	10.2	95

production or photosynthesis was greater during the June measurments than during the August measurements (appendix III). This would tend to ameliorate a decrease in dissolved oxygen in June compared to August. In June it was possible to perform titrations and take notes all night without the aid of artificial light. On August 8, sunset occurred at 2137 hours and sunrise on August 9 at 0417 hours. The light intensity was considerably less than during the shorter hours of darkness in June. More work is needed to determine the relative contributions of these factors.

The diel measurements were performed to obtain a relative indication of the amount of primary production in the Chena River. The decrease in dissolved-oxygen saturation and increase in CO_2 concentration during hours of darkness is a function of the amount of respiration. The sensitivity of this method in streams such as the Chena River is limited, but it can provide a rough estimation of the amount of primary productivity. The data from these measurements indicate that productivity is moderately low. The degree to which the percent saturation of dissolved oxygen is depressed is consistent with measurements made in other subarctic streams (Nauman and Kernodle, 1973). If productivity were to increase as a result of warmer water temperature or a greater supply of nutrients, a greater nocturnal depression of dissolved-oxygen saturation and a larger increase in CO_2 would be expected.

Biological Parameters

Diversity

Wilhm (1970) presents a range of diversity ($\bar{d}$) of benthic invertebrates for clean streams of 2.60 to 4.00 and 0.42 to 1.54 for streams receiving some form of pollution. The diversity values for both rivers fall within the range given by Wilhm for clean streams except for a few anomalous values which probably are due to sample placement or collection techniques. In addition, the diversity values for benthic invertebrates obtained in this study probably are low. Aquatic Acari, Oligochaeta, and Nematoda were not identified to taxon. If these organisms had been identified to species, the number of taxa per sample ($\underline{s}$) would have increased and resulted in a higher value for $\bar{d}$ in most places (see equation on p.14). Another factor that lowers the value for $\bar{d}$ is the technique used for counting the Chironomidae and some samples of Simuliidae. Where either of these families were present in large numbers (more than 100 individuals) 10 percent or 100 individuals (whichever was smaller) were selected at random from a dish with numbered grids. This procedure yielded a reasonably accurate estimation of the species composition of the group of insects. However, many species that are very rare in occurrence (0 to 3 percent) probably were missed. Because the number and relative abundance of taxa in the subsample was used to calculate the total number and relative abundance of taxa in the sample, the diversity is lower than it would have been had the entire sample been identified. Because very rare species make a small contribution to the diversity indices obtained, the study reaches of the Chena and Little Chena Rivers should be classified as clean streams. The diversity obtained for the periphyton and phytoplankton is higher and less variable than that obtained for the benthic invertebrates. The errors discussed for the benthic invertebrates do not apply to the agal samples. The agal diversity values are based on a random count of 200 to 300 cells. Algae other than diatoms were not included in the computations, but the number of these organisms in all samples was negligible.

Wilhm (1970) suggests that samples collected from the same site be pooled for calculations of a diversity index for that site. The $\bar{d}$ of individual samples is highly variable, and in general the diversity increases progressively with the number of samples pooled, until about the fifth pooled sample. Even though five or more samples were not always available, as few as two pooled samples generally give a more accurate estimation of the diversity than a single sample. A pooled diversity was calculated for benthic invertebrate samples and periphyton strips when more than one sample was collected from a station on the same date. When samples are pooled, the number of individuals per species (s) becomes the total number of species found in all the pooled samples and the total number of organisms (N) is the sum of "N" for each sample.

Diversity is considered to be a sensitive bioassay for assessing environmental stress (Cantlon, 1969; Wilhm, 1970). In order to use a species as an indicator organism, its environmental requirements must be reasonably well defined within rather narrow limits. This has been accomplished in only a few instances. The diversity of a community, however, is a meaningful parameter which can be measured (Warren, 1971). As a rule, diversity is inversely related to productivity, and as an aquatic ecosystem undergoes the process of eutrophication, it generally becomes less diverse and less stable (Margalef, 1969).

The most important and valid use of the data collected during this study is for comparison with future data collected and analyzed using the same methodology. Comparison of these data with those collected in other streams or analyzed using different methodology would have to be qualified. Warren emphasizes the importance of diversity in defining the environmental impact of changes to a system: "One thing does seem clear: a marked environmental change without the passage of sufficient time for the evolution of a new community to occur, is likely to lead to a reduction in diversity of the community at the affected location." (Warren, 1971, p. 344).

Benthic Invertebrates

Basket Samples

Twenty-two basket samples were collected during this study. Four were from the Little Chena River near Fairbanks, 10 were from the Chena River near North Pole, and seven were from the upper site on the Chena River (tables 7, 8, and 9). Eight samples were retrieved from October 3, 1972 through April 17, 1973, when one basket per station was installed. The sample retrieved from the Little Chena River site on October 25, 1972, will not be discussed because it had been encased in anchor ice for an unknown period of time when it was recovered.

In May 1973 three baskets were installed per station. Two of these baskets were placed in water 3 to 6 feet (0.9 to 1.8 m) deep to insure that they would not be exposed by flucuating water levels which occur at this time of the year (fig. 3). The bottom material in the deeper water was a mixture of gravel and silt. One basket per station was placed in relatively shallow water (1 to 2 feet or 0.3 to 0.6 m) where the bottom material was coarser (large gravel and cobble). The basket in shallow water at the upper site was the only one recovered. A total of six baskets were recovered between June 11 and 14, 1973. Nine baskets were reinstalled in June in the same positions as those that were retrieved. Only the basket in shallow water at the Little Chena River station was not recovered on the August 6 to 8 sampling trip.

Insects comprise more than 90 percent of the benthic organisms found in all but three baskets (appendix I). The Chironomidae (midges) were the dominant group in most samples, accounting for more than 50 percent of the organisms counted. Simuliidae (black flies), Ephemeroptera (mayflies), and Plecoptera (stoneflies) were the only other insects that occurred in more than trace amounts. Aquatic Acari (water mites) were the only group of non-Insecta invertebrates that composed more than 5 percent of any basket sample. The numbers of organisms from the basket samples as well as the numbers from the dip-net and Surber samples are somewhat misleading in terms of the contribution of the various groups to the total biomass. Ephemeroptera and Plecoptera, for example, are generally much larger in size than the Simuliidae or Chironomidae. Consequently, if the biomass of the various groups had been measured, the mayflies and stoneflies would make up a significantly larger percentage of the total.

Table 7.--*Number of benthic invertebrates from baskets retrieved October 3, 1972, to April 17, 1973*

TAXON	Little Chena River near Fairbanks		Chena River near North Pole					Chena River below Mullen Slough near Eielson
Date In / Date Out	08-31-72 / 10-03-72	10-03-72 / 10-25-72	08-31-72 / 10-04-72	10-04-72 / 10-26-72	10-26-72 / 12-06-72	12-06-72 / 02-09-73	02-09-73 / 04-17-73	12-07-73 / 02-09-73
Gastropoda								
Pelecypoda								
Nematoda						1		
Oligochaeta					5		4	
Hirudinea			1				1	
Aquatic Acari	1		4	8	4	5	17	2
Insecta								
Collembola								
Isotomus sp.								
Plecoptera								
Not identified								
Brachyptera sp.	5				3	30	1	51
Alloperla sp.	4				11	2	4	1
Isoperla sp.		3	5	7	27	10	85	17
Paraperla sp.		2	17	6				
Ephemeroptera								
Ephemerella sp.	1	2	3	10	36	16	41	24
Heptagenia sp.			2	2	6	16	4	2
Baetidae (family)								3
Paraleptophlebia sp.							1	
Ironodes sp.					4			
Pseudocloeon sp.					5			
Hemiptera - Corixidae			1					
Tricoptera								
Not identified								
Athripsodes sp.	1		3	6				
Brachycentrus americanus			2	4		1	8	
Ptilostomis sp.								1
Limnephilidae (family)								
Hydropsychidae (family)			1				4	
Coleoptera								
Diptera								
Simuliidae								
Pupae								
Prosimulium pleurale	10		56	12	82	77	74	250
Prosimulium fulvum								
Simulium bicornis								
Tipulidae								
Tipula sp. 1			1	1	1	1		9
Tipula sp. 2								
Tipula sp. 3								

Rhagionidae								
Atherix sp.								
Ceratopogonidae								
Atrichopogon peregrinus Joh.								
Dolichopodidae								
Dolichopus sp.				1	1			1
Dipteran larvae - Not identified								
Chironomidae								
Podonominae								
Lasiodiamesa (Kieff.)								
Diamesinae								
Pseudodiamesa pertinax			1					
Diamesa (*Pseudokiefferiella*) Zavr.	3		5	16	14	23	55	41
Diamesinae sp. 1						6		
Tanypodinae								
Tanypodinae sp. 1								
Guttipelopia (Fiffk.)	21	5	11	58	15	11	11	
Orthocladiinae								
Orthocladiinae sp. 1								
Brillia sp. (new type)								
Cricotopus sp. (slvestris type)	3							6
Diplocladius (Kieff.)								
Eukiefferiella (Thien.) sp. 1			2	8	58	86		18
Eukiefferiella (Thien.) sp. 2								
Eukiefferiella (Thien.) sp. 3				8				
Heterotrissocladius cf. *marcidus*	18		2	8	14		33	
Metriocnemus sp. 1 (V.D. Wulp)				8				18
Metriocnemus sp. 2 (V.D. Wulp)			1					
Orthocladius thienemanni				25	44			18
Orthocladius sp. 1								
Paracricotopus (Thien. and Harn.)			5	33	73	109	241	53
Parakiefferiella sp. (new type)				50		34	11	6
Psectrocladius (Kieff.)								
Trissocladius (Kieff.)								
Chironominae								
Cryptochironomus (Kieff.)		1	1				11	
Parachironomus (Kieff.)								
Polypedilum (Kieff.)	3							
Stictochironomus (Kieff.)	3							
Cladotanytarsus sp.			1					
Micropsectra sp. 1 (Kieff.)	31	10	33	660	407	137	306	130
Micropsectra sp. 2 (Kieff.)						6		
Phaenopsectra sp.			2					6
Unknown #1								
Pupae								
Total Chironomidae	82	13	64	874	625	412	668	295
Total number of insects	103	20	155	923	801	565	890	655
Total number of organisms	104	20	160	931	810	571	912	657
Diversity (insects only)	2.874	2.123	3.060	1.797	2.606	3.121	2.714	2.938

Table 8.--*Number of benthic invertebrates from baskets retrieved June 6-14, 1973*

	Little Chena R.	Chena River near North Pole		Chena R. below Mullen Slough nr Eielson		
	Upper right bank	Right bank	Upper left bank	Right bank	Lower left bank	Upper left bank
Date In	05-11-73	05-10-73	05-10-73	05-10-73	05-10-73	05-10-73
TAXON Date Out	06-11-73	06-12-73	06-12-73	06-14-73	06-14-73	06-14-73
Gastropoda						
Pelecypoda						
Nematoda	16	9	1	6	5	5
Oligochaeta	3	14		19	3	2
Hirudinea						
Aquatic Acari	22	41	69	3		75
Insecta						
Collembola	1					
Isotomus sp.						
Plecoptera						
Not identified			1			24
Brachyptera sp.	2		1			2
Alloperla sp.	1	1	4		3	9
Isoperla sp.	1			1		9
Paraperla sp.	6	18	7	1		1
Ephemeroptera						
Ephemerella sp	5	12	11	7	3	12
Heptagenia sp.	1				1	5
Baetidae (family)						1
Paraleptophlebia sp.	2	2	3		1	1
Ironodes sp.	2					
Pseudocloeon sp.						
Hemiptera - Corixidae						
Tricoptera						
Not identified						
Athripsodes sp.	3					
Brachycentrus americanus	3		1			6
Ptilostomis sp.	2	3	2	1	1	
Limnephilidae (family)					2	
Hydropsychidae (family)						
Coleoptera						
Diptera						
Simuliidae						
Pupae			1			
Prosimulium pleurale						
Prosimulium fulvum						
Simulium bicornis					2	7
Tipulidae						
Tipula sp. 1		3	2	5	1	
Tipula sp. 2						
Tipula sp. 3						

Rhagionidae						
Atherix sp.						
Ceratopogonidae	1					
Atrichopogon peregrinus Joh.						
Dolichopodidae						
Dolichopus sp.	27	2				
Dipteran larvae - Not identified						
Chironomidae						
Podonominae						
Lasiodiamesa (Kieff.)						
Diamesinae						
Monodiamesa (Kieff.)						
Diamesa (*Pseudokiefferiella*) Zavr.						
Diamesinae sp. 1						
Tanypodinae						
Tanypodinae sp. 1						
Guttipelopia (Fiffk.)	74	42	70	39	12	37
Orthocladiinae						
Orthocladiinae sp. 1						
Brillia sp. 1 (new type)						
Cricotopus sp. (slvestris type)						
Diplocladius (Kieff.)						
Eukiefferiella (Thien.) sp. 1						
Eukiefferiella (Thien.) sp. 2				4		
Eukiefferiella (Thien.) sp. 3						
Heterotrissocladius cf. *marcidus*	89			4	6	46
Metriocnemus sp. 1 (V.D.Wulp)	74			4	18	46
Metriocnemus sp. 2 (V.D.Wulp)						
Orthocladius thienemanni	15	108	317	22	107	74
Orthocladius sp. 1						
Paracricotopus(Thien. and Harn.)	7					9
Parakiefferiella sp. (new type)	45	66	440	122	124	37
Psectrocladius (Kieff.)	7					
Trissocladius (Kieff.)						
Chironominae						
Cryptochironomus (Kieff.)		8		30	12	
Parachironomus (Kieff.)						
Polypedilum (Kieff.)	22	42		70	41	19
Stictochironomus (Kieff.)				9	6	
Cladotanytarsus sp.		33	35		18	19
Micropsectra sp. 1 (Kieff.)	126	100	238	13	35	222
Micropsectra sp. 2 (Kieff.)						
Phaenopsectra sp.		17		22	12	
Unknown #1		8				
Pupae	6	9	5	11	6	5
Total Chironomidae	459	424	1100	339	391	509
Total number of insects	522	474	1138	365	411	591
Total number of organisms	563	539	1208	393	419	673
Diversity (insects only)	3.269	3.214	2.181	3.048	3.033	3.210
Diversity (pooled samples)		2.629			3.529	

Table 9.--*Number of benthic invertebrates from baskets retrieved August 6-8, 1973*

TAXON		Little Chena R		Chena River nr North Pole			Chena R below Mullen Slough nr Eielson		
		Upper left bank	Lower left bank	Lower left bank	Right bank	Upper left bank	Right bank	Lower left bank	Upper left bank
	Date In	06-11-73	06-11-73	06-12-73	06-12-73	06-12-73	06-14-73	06-14-73	06-14-73
	Date Out	08-06-73	08-06-73	08-07-73	08-07-73	08-07-73	08-08-73	08-08-73	08-08-73
Gastropoda									
Pelecypoda									1
Nemotoda		2	3	23	32	89	4	16	8
Oligochaeta		3	4		37	12	3	11	4
Hirudinea			9						
Aquatic Acari		34		15	54	122	237	343	103
Insecta									
Collembola									
Isotomus sp.			1			1			
Plecoptera									
Not identified				3	7				
Brachyptera sp.		1	1	3	6	15	2	10	
Alloperla sp.		1	2	8	2	33	30	50	2
Isoperla sp.		1		1	10	2	1	2	2
Paraperla sp.			1	6	6	2	8	5	9
Ephemeroptera									
Ephemerella sp.		2	3	25	33	42	23	11	15
Heptagenia sp.		5		12	13	1	15	4	
Baetidae (family)		2		4	11	16	7	4	
Paraleptophlebia sp.						3	2	4	1
Baetis sp.						3	10		
Pseudocloeon sp.									
Hemiptera - Corixidae									
Tricoptera									
Not identified			1		1	1			
Athripsodes sp.				1	10	3	17	2	1
Brachycentrus americanus		6				20	5	42	1
Ptilostomis sp.								2	1
Limnephilidae (family)				5	1	4	1	4	
Hydrospsychidae (family)						1			
Coleoptera									1
Diptera									
Simuliidae									
Pupae			2		4	3	1	1	10
Prosimulium pleurale									
Prosimulium fulvum									
Simulium bicornis				1		1			
Tipulidae									
Tipula sp. 1		3		1	2	7	1	4	3
Tipula sp. 2									
Tipula sp. 3									

Rhagionidae								
Atherix sp.								
Ceratopogonidae								
Atrichopogon peregrinus Joh.								1
Dolichopodidae								
Dolichopus sp.	17	10	2	5	9	1	4	1
Dipteran larvae - Not identified							1	
Chironomidae								
Podonominae								
Lasiodiamesa (Kieff.)								
Diamesinae								
Monodiamesa (Kieff.)		15	13					12
Diamesa (*Pseudokiefferiella*) Zavr.			13	16	29	23		
Diamesinae sp. 1			13					6
Tanypodinae								
Tanypodinae sp. 1								
Guttipelopia (Fiffk.)	46	91	126	123	48	76	8	95
Orthocladiinae								
Orthocladiinae sp. 1								
Brillia sp. 1 (new type)							8	
Cricotopus sp. (slvestris type)						19		6
Diplocladius (Kieff.)								
Eukiefferiella (Thien.) sp. 1								6
Eukiefferiella (Thien.) sp. 2				18				
Eukiefferiella (Thien.) sp. 3							8	
Heterotrissocladius cf. *marcidus*	23	15	89	106	16	9		48
Metriocnemus sp. 1 (V.D.Wulp)	5		25					6
Metriocnemus sp. 2 (V.D.Wulp)						19		
Orthocladius thienemanni	32	23	165	300	64	161	31	36
Orthocladius sp. 1							23	
Paracricotopus(Thien. and Harn.)	5		13		16	38	8	
Parakiefferiella sp. (new type)	5		101	370	64	388	23	30
Psectrocladius (Kieff.)	14			18		19		6
Trissocladius (Kieff.)				35	16		8	24
Chiromonimae								
Cryptochironomus (Kieff.)	5	15	13	18				6
Parachironomus (Kieff.)	14							
Polypedilum (Kieff.)		23	367	476	177	19	23	89
Stictochironomus(Kieff.)	9	159	63	18	16			36
Cladotanytarsus sp.								
Micropsectra sp. 1 (Kieff.)	27	8	253	494	1619	559	458	
Micropsectra sp. 2 (Kieff.)								
Phaenopsectra sp.	82		165	18		9		48
Unknown #1								
Pupae		2	3	3	7	5		5
Total Chironomidae	267	349	1419	1994	2052	1345	621	454
Total number of insects	305	372	1494	2108	2226	1474	772	507
Total number of organisms	344	388	1532	2231	2449	1718	1141	623
Diversity (insects only)	3.483	2.607	3.401	3.072	1.849	2.861	2.608	2.703
Diversity (pooled samples)	3.484		3.022			3.467		

The wet weight of organisms from the basket samples does not show any seasonal trend or distributional pattern (table 10). The range was from 0.0822 to 1.0126 gm (gram) and the average for all 17 baskets was 0.4850 gm. These figures give a relative estimate of secondary production in terms of standing crop; that is, the relative amount of organic carbon that has been incorporated into the biomass of invertebrates which are primarily herbivorous. These values are relative and are limited to comparison with other samples collected and analyzed by the same methods. The baskets were left in place for a minimum of 32 days. The recommended time of exposure is 4 to 6 weeks (Slack and others, 1973). Thirty-two days is assumed to be sufficient time for colonization equilibrium to occur.

No apparent differences in the taxonomic composition of the basket samples collected from the Chena River near North Pole and the ones from the upper site were observed. The baskets from the Little Chena River had a larger proportion of Chironomidae and a smaller number of Simuliidae, Plecoptera, Ephmeroptera, and Tricoptera than the samples from the Chena River. The average number of organisms collected from baskets in the Little Chena River was 350, but the baskets from the Chena River contained an average of 998 organisms. These differences probably are a result of the fine bottom material which is primarily silt and sand in the Little Chena River and the higher sediment load.

The range of diversity ($\bar{d}$) for the basket samples was 1.797 to 3.483. Only two baskets had a diversity index less than 2.0, one retrieved from the Chena River near North Pole on October 26, 1972, and one from the upper left bank at the North Pole station retrieved on August 7, 1973. The basket retrieved in June from the latter position also had a low diversity (2.181). At the point where these baskets were installed, the bottom material was very coarse gravel and cobble and some fine sediment (right bank Little Chena River; lower left bank and right bank at the North Pole station, and all baskets at the upper site) or where the bottom material was entirely fine silt and sand (left bank samples from the Little Chena River). The data suggest that the community associated with fine bottom material, or the mixture of coarse and fine material, is more diverse than the one associated with coarse substrates. The data show also that fine silt is less productive than a mixture of gravel and silt or gravel and cobble.

The diversity indices for the baskets collected in June and August from gravel and cobble substrates are relatively uniform (2.608 to 3.401). The samples collected from September 4, 1972, to April 17, 1973, from the Chena River near North Pole were collected from the upper left bank where the bottom

Table 10.--*Wet weight of organisms from baskets*

Station name	Date in	Date out	Days in	Wet weight (grams)	Average wet weight (grams)
Little Chena River					
Upper right bank	5-10-72	6-11-73	32	0.3750	0.3750
Upper left bank	6-11-73	8-6-73	56	.3796	.2309
Lower left bank	6-11-73	8-6-73	56	.0822	
Chena River nr North Pole					
Left bank	12-6-72	2-9-73	63	.4037	.4037
Left bank	2-9-73	4-17-73	67	1.0126	1.0126
Right bank	5-11-73	6-12-73	32	.8907	.8019
Upper left bank	5-11-73	6-12-73	32	.7132	
Lower left bank	6-12-73	8-7-73	56	.2513	
Right bank	6-12-73	8-7-73	56	.3105	.3543
Upper left bank	6-12-73	8-7-73	56	.5012	
Chena River (upper site)					
Left bank	12-7-72	2-9-73	63	.7882	.7882
Right bank	5-11-73	6-14-73	32	.4048	
Lower left bank	5-11-73	6-14-73	32	.3743	.4070
Upper left bank	5-11-73	6-14-73	32	.4420	
Right bank	6-14-73	8-8-73	55	.4810	
Lower left bank	6-14-73	8-8-73	55	.5944	.4347
Upper left bank	6-14-73	8-8-73	55	.2287	

material is coarse. No apparent explanation for the variation in diversity for samples obtained from this site is evident except the difficulty during the winter of obtaining consistent results because of problems of sampling through varying thicknesses of ice.

The pooled diversities for basket samples range from 2.629 to 3.592 (tables 8, 9). The pooled $\bar{d}$ for the June and August samples from the North Pole station probably is lowered by the upper left bank samples. Data from the basket samples are insufficient to conclude that any real difference exists between these three stations or between the samples collected at different times of the year (tables 7, 8, 9).

Dip-net and Surber Samples

Twenty-five dip-net and Surber samples were collected at the reconnaissance sites and primary stations from October 3, 1972, to August 9, 1973. Six samples were collected during the winter months (table 11), 12 in June (table 12), and 11 in August (table 13). The six samples collected during the winter months were obtained through the ice or with large pieces of ice drifting in the river, which made it more difficult to sample all representative environments. In June and August all areas at a station that were accessible by wading were sampled, including riffles, pools, edges of sand and gravel bars, and vertical or overhanging banks. The discharge was lower in August than in June; consequently, a larger variety of habitats was accessible and more complete samples, representative of a greater variety of habitats, were obtained.

Insects compose 50 to 90 percent of all dip-net samples. Chironomidae was the dominant group except at station 12 on June 15, 1973, when *Simulium bicornis* was the most common organism. The species composition of dip-net samples collected throughout the river system did not vary greatly. However, fewer Tricoptera and Simuliidae were collected on the Little Chena River than on the Chena River. The kinds of organisms collected in June and August are similar, except that fewer Tricoptera were noted in June than in August and a slightly larger number of Simuliidae were collected in June. Because these organisms feed by straining particles from the water, the higher concentration of sediment in the Little Chena River may account for these differences.

The dip-net samples are not quantitative and, in some instances, samples were split to facilitate the separation of invertebrates from the organic debris, sand, and silt. No significance should be attached to the total number of individuals in the sample. Rather the relative abundance of taxa within the sample should be compared.

The range of diversity for the dip-net samples was 1.845 to 4.072. The average diversity for the dip-net samples from the Chena River in June was 3.008, which is only slightly higher than the average diversity for the basket samples collected at the same time ($\bar{d}$ = 2.937). In August, however, the average diversity for the dip-net samples was 3.575 compared to 2.149 for the basket samples. The dip-net samples provide a more accurate estimation of the actual diversity of benthic invertebrates in the stream than the basket samples. The species composition of the dip-net samples collected in August is more uniform and more diverse than those collected in June. This probably is a result of better collecting conditions. The water was lower; the discharge measured 1,126 ft^3/s (31.9 m^3/s) in August compared with 2,391 ft^3/s (67.7 m^3/s) in June, which permitted access to a greater variety of habitats.

Frey (1969) compared the benthic fauna in the polluted reach at Fairbanks with the unpolluted upper reach. His data show that Diptera make up more than 99 percent of the fauna in the polluted section and 10 percent in the unpolluted reach where Plecoptera and Ephemeroptera predominate. The data from this study indicate that Diptera larvae, especially Chironomidae, and Simuliidae are the dominant organisms in this reach of the river. The most likely explanation for the gross difference in the results of Frey's study and this study is the difference in sampling methods. Frey relied heavily on Surber samples, but dip-net and basket samples are emphasized in this study. Many of the Chironomidae in the Chena River are extremely small and probably passed through the mesh of the Surber net used by Frey. The nets on the Surber samplers used in this study had a fine mesh (208 μm No. 70).

The diversity for the baskets suggests that there may be a difference between the upper site and the North Pole site. However, the diversity values of the dip-net samples indicate that the diversities of the fauna in this stretch of the river are relatively uniform if a large enough area is sampled. The data indicate that the dip-net samples provide a more representative sample of the stream than do the artificial substrate baskets. However, the baskets give a relative measure of the abundance of benthic invertebrates and can be collected in the winter through the ice.

An index of similarity was computed for all dip-net samples collected in August (table 13) (Odum, 1971). These samples were selected because they were collected under near-optimum conditions and probably are the most representative samples of benthic invertebrates. Each dip-net sample was compared with every other sample and an average was computed for all the comparisons made with one sample (table 14). If one sample was dissimilar to the other samples, then a low

Table 11.--*Number of benthic invertebrates from dip-net and Surber samples collected October 3, 1972, to April 17, 1973*

TAXON — Type of Sample / Date Collected	Little Chena R nr Fairbanks	Chena R below Mullen Slough		Chena R nr North Pole		
	Surber 10-03-73	Surber 10-27-72	Surber 12-07-72	Surber 12-06-72	Dip Net 02-09-73	Dip Net 04-17-73
Gastropoda						
Pelecypoda						
Nematoda					3	
Oligochaeta				509	268	6
Hirudinea						
Aquatic Acari	2	23	18		40	9
Insecta						
Collembola						
Isotomus sp.						
Plecoptera						
Not identified						
Brachyptera sp.	1			1	3	
Alloperla sp.	2			5	15	
Isoperla sp.		16	16	22	23	11
Paraperla sp.		8	5			5
Ephemeroptera						
Ephemerella sp.		3	25	3	12	17
Heptagenia sp.	1	10	3	4	33	3
Baetidae (family)					3	
Baetis sp.			1			
Paraleptophlebia sp.	1					2
Ironodes sp.				3		
Pseudocloeon sp.				2		
Hemiptera - Corixidae						
Tricoptera						
Not identified						
Athripsodes sp.			1	8		
Brachycentrus americanus				2	6	18
Ptilostomis sp.					1	
Limnephilidae (family)						
Hydropsychidae (family)						
Coleoptera						
Diptera						
Simuliidae						
Pupae						
Prosimulium pleurale						
Prosimulium fulvum		15	3	172	20	17
Simulium bicornis						
Tipulidae						
Tipula sp. 1			1		5	2
Tipula sp. 2						
Tipula sp. 3						

Rhagionidae						
Atherix sp.						
Ceratopogonidae						
Atrichopogon peregrinus Joh.						
Dolichopodidae						
Dolichopus sp.			6		1	9
Dipteran larvae - Not identified						
Chironomidae						
Podonominae						
Lasiodiamesa (Kieff.)						
Diamesinae						
Monodiamesa (Kieff.)						
Diamesa (*Pseudokiefferiella*) Zavr.		6		53	91	90
Diamesinae sp. 1						
Pseudodiamesa pertinax		6	9		8	
Tanypodinae						
Tanypodinae sp. 1						
Guttipelopia (Fiffk.)	40	23	18	5	8	18
Orthocladiinae						
Orthocladiinae sp. 1						
Brillia sp. 1 (new type)	1					
Cricotopus sp. (slvestris type)	10					9
Diplocladius (Kieff.)						
Eukiefferiella (Thien.) sp. 1			26	43	99	90
Eukiefferiella (Thien.) sp. 2						
Eukiefferiella (Thien.) sp. 3						
Heterotrissocladius cf. *marcidus*	10	12	26	5		18
Metriocnemus sp. 1 (V.D.Wulp)				5	8	
Metriocnemus sp. 2 (V.D.Wulp)						
Orthocladius thienemanni			9	10	49	54
Orthocladius sp. 1						
Paracricotopus (Thien. and Harn)				39		135
Parakiefferiella sp. (new type)			18	39		207
Psectrocladius (Kieff.)						
Trissocladius (Kieff.)						
Chironominae						
Cryptochironomus (Kieff.)		6	9			
Parachironomus (Kieff.)						
Polypedilum (Kieff.)						
Stictochironomus (Kieff.)			9	34	83	18
Cladotanytarsus sp.	1		9			
Micropsectra sp. 1 (Kieff.)		215	263	53	207	314
Micropsectra sp. 2 (Kieff.)						
Phaenopsectra sp.	11			10		
Unknown #1						
Pupae						
Total Chironomidae	73	268	405	296	553	953
Total number of insects	78	320	465	518	675	1037
Total number of organisms	80	343	484	1027	986	1052
Diversity (insects only)	2.191	1.934	2.648	3.303	3.158	3.088

Table 12.--*Number of benthic invertebrates from dip-net samples collected June 11-14, 1973*

TAXON	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 8	Station 9	Station 10	Station 11	Station 12	Little Chena River
Date collected	06-14-73	06-14-73	06-14 73	06-14-73	06-14-73	06-15-73	06-15-73	06-15-73	06-15-73	06-15-73	06-15-73	06-11-73
Gastropoda								1				
Pelecypoda			1		1							
Nematoda	8	2	2	2		12	70		1	5		19
Oligochaeta	10		2	2		7	83	2	2	8		6
Hirudinea												
Aquatic Acari	54	1	11	6		23	56	10	26	28	2	32
Insecta												
Collembola												
Isotomus sp.	1		3	1	3	3	2		1	1		1
Plecoptera												
Not identified	9						10		2	2		
Brachyptera sp.				1			2		1	1		4
Alloperla sp.			2	5	11	7	12	4	23	9	18	4
Isoperla sp.											1	2
Paraperla sp.	1											4
Ephemeroptera												
Ephemerella sp.	3			2	3	1	4		1	1	1	8
Heptagenia sp.	9		5	1	39	4	17		42	24	20	1
Baetidae (family)	46			5	10		46		31	5		
Baetis sp.	1											136
Paraleptophlebia sp.	2		1	1					4			
Ironodes sp.												12
Pseudocloeon sp.	1											
Hemiptera - Corixidae												
Tricoptera												
Not identified												
Athripsodes sp.												
Brachycentrus americanus												2
Ptilostomis sp.	1											
Limnephilidae (family)												
Hydropsychidae (family)												
Coleoptera												
Diptera												
Simuliidae												
Pupae		5				5		1				
Prosimulium pleurale				1		1						2
Prosimulium fulvum	6		4				19	1			7	9
Simulium bicornis	87	9	24	40	124	12	217	10	332	98	155	25
Tipulidae												
Tipula sp. 1						1						
Tipula sp.2							1					
Tipula sp. 3										2		

Rhagionidae												
Atherix sp.												
Ceratopogonidae												
Atrichopogon peregrinus Joh.												
Dolichopodidae												
Dolichopus sp.	2	1	2		3	2	3		3	2	1	1
Dipteran larvae - Not identified												
Chironomidae												
Podonominae												
Lasiodiamesa (Kieff.)												
Diamesinae												
Monodiamesa (Kieff.)												
Diamesa (Pseudokiefferiella) Zavr.	12	1			9		9	2	9	7	1	
Diamesinae sp. 1												
Pseudodiamesa pertinax												
Tanypodinae												
Tanypodinae sp. 1						40	9	9		14		
Guttipelopia (Fiffk.)	48	4	5	10	9	34		4	26		2	
Orthocladiinae												
Orthocladiinae sp. 1								3				
Brillia sp. 1 (new type)												
Cricotopus sp. (slvestris type)		1		5								
Diplocladius (Kieff.)												
Eukiefferiella (Thien.) sp. 1												
Eukiefferiella (Thien.) sp. 2							102	3				8
Eukiefferiella (Thien.) sp. 3												
Heterotrissocladius cf. marcidus			5		9			2	26		2	30
Metriocnemus sp. 1 (V.D.Wulp)	131	5	27		9	24	74	6	68	27	10	15
Metriocnemus sp. 2 (V.D.Wulp)						8		4		20		
Orthocladius thienemanni	249	1	27	10	68	40	84	23	282	62	6	158
Orthocladius sp. 1										7		
Paracricotopus (Thien. and Harn.)	24	4	27	10	17	8	19	3	60	14	2	30
Parakiefferiella sp. (new type)	261	9	11		34	57	93	6	239	41	1	98
Psectrocladius (Kieff.)			5									
Trissocladius (Kieff.)												
Chironominae												
Cryptochironomus (Kieff.)								6	17			8
Parachironomus (Kieff.)			5			8	9					
Polypedilum (Kieff.)		3										
Stictochironomus (Kieff.)			5					2				
Cladotanytarsus sp.	24	5	220	229	247	229	130	8	85	171	35	15
Micropsectra sp. 1 (Kieff.)	119	3	5	10	9	8		2	17		2	8
Micropsectra sp. 2 (Kieff.)												
Phaenopsectra sp.			5						9			
Unknown #1							28					8
Pupae	47	4	82	3	4	1	10		3	2		
Total Chironomidae	868	36	347	274	411	454	557	83	838	363	61	378
Total number of insects	1084	55	470	334	608	491	900	99	1281	510	264	489
Total number of organisms	1156	58	496	344	619	533	1109	112	1310	551	266	545
Diversity (insects only)	3.157	3.501	2.805	1.845	2.794	3.041	3.465	3.775	3.124	3.064	2.194	3.336

Table 13.--*Number of benthic invertebrates from dip-net samples collected August 6-9, 1973*

TAXON / Date Collected	Little Chena R. 08-06-73	North Pole 08-09-73	Upper Site 08-08-73	Station 1 08-08-73	Station 2 08-08-73	Station 5 08-09-73	Station 7 08-09-73	Station 8 08-09-73	Station 9 08-09-73	Station 11 08-09-73	Station 12 08-09-73
Gastropoda		1									
Pelecypoda									1		
Nematoda		15	2		6	2	2	2	4	3	8
Oligochaeta	12	15	1	10	13	8		2	6	2	2
Hirudinea				1							
Aquatic Acari	58	63	89	70	112	66	74	82	75	213	153
Insecta											
Collembola											
Isotomus sp.						1			3		
Plecoptera											
Not identified											
Brachyptera sp.	6	12	11	1	14	27	2	52	2	86	19
Alloperla sp.	9	26	1	2	15	70	21	6	10	24	47
Isoperla sp.	9	1									
Paraperla sp.		4	5	1	2	4	1	2	3	1	5
Ephemeroptera											
Ephemerella sp.	18	15	1	2	10	4	7	10	6	20	10
Heptagenia sp.	2	2	1	1		8		16		8	33
Baetidae (family)	10	13	1	1	8	10	10	4	1	1	5
Baetis sp.	22	3					1	2		3	3
Paraleptophlebia sp.		12			9	4	2	1	3	7	9
Ironodes sp.		26		2	1	12	1	34	1	4	39
Pseudocloeon sp.		5	7		7	2		3		51	2
Hemiptera - Corixidae											
Tricoptera											
Not identified											
Athripsodes sp.	2	5		9	19	1	7		2	10	4
Brachycentrus americanus	1	3	2	1	5	2	10	5		2	
Ptilostomis sp.		1									
Limnephilidae (family)	1	1		1			2	5	3	7	
Hydropsychidae											
Coleoptera											
Diptera											
Simuliidae											
Pupae											
Prosimulium pleurale		11	7		4	30	2	18	2	36	159
Prosimulium fulvum					1						4
Simulium bicornis		5	2	1	1	4	2	41	3	4	39
Tipulidae	4	6	1	5	2	5	3	1		6	11
Tipula sp. 1											
Tipula sp. 2					1	1			1		
Tipula sp. 3											

Rhagionidae											
Atherix sp.											
Ceratopogonidae											
Atrichopogon peregrinus Joh.											
Dolichopodidae											
Dolichopus sp.	23	7	3	29	2	9	6	6	2	7	13
Dipteran larvae - Not identified							1				
Chironomidae											
Podonominae											
Lasiodiamesa (Kieff.)											
Diamesinae											
Monodiamesa (Kieff.)											
Diamesa (*Pseudokiefferiella*) Zavr.	15	29	3	4				23	7	29	
Diamesinae sp. 1				2							
Pseudodiamesa pertinax	19	6						15			10
Tanypodiane											
Tanypodinae sp. 1											
Guttipelopia (Fiffk.)			7	2	15	16	3		15	38	10
Orthocladiinae											
Orthocladiinae sp. 1											
Brillia sp. 1 (new type)											
Cricotopus sp. (slvestris type)	5	17	7	2						19	
Diplocladius (Kieff.)											
Eukiefferiella (Thien.) sp.1		6			5						
Eukiefferiella (Thien.) sp.2				2							
Eukiefferiella (Thien.) sp.3				4			6		15		
Heterotrissocladius cf. *marcidus*		6	10	4	5	8			15	19	10
Metriocnemus sp. 1 (V.D.Wulp)	5	29	10	4	15	16	9			10	19
Metriocnemus sp. 2 (V.D.Wulp)	10	11		2		8	3		7		
Orthocladius thienemanni		115	74	53	108	173	58	123	184	347	335
Orthocladius sp. 1			3							19	29
Paracricotopus (Thien. and Harn.)	39	35	10	12	26	63	3	222	7	77	115
Parakiefferiella sp. (new type)			10	2	21	16	43	15	191	154	239
Psectrocladius (Kieff.)									7		
Trissocladius (Kieff.)		6				8				10	
Chironominae											
Cryptochironomus (Kieff.)						8	6	15			
Parachironomus (Kieff.)	151			2							
Polypedilum (Kieff.)				8	5	24	3				
Stictochironomus (Kieff.)			3	2	5	16				29	
Cladotanytarsus sp.			3			55	6				
Micropsectra sp. 1 (Kieff.)	29	69	27	12	36		3	46	51	96	38
Micropsectra sp. 2 (Kieff.)											
Phaenopsectra sp.		6	20			16	3		7	58	19
Unknown #1											
Pupae	1	4		3	6	4	1	5	8	15	5
Total Chironomidae	273	335	187	117	313	427	145	444	521	905	824
Total number of insects	381	497	229	176	421	625	225	655	571	1197	1232
Total number of organisms	451	591	321	257	557	701	301	741	657	1415	1395
Diversity (insects only)	3.244	4.072	3.633	3.747	3.313	3.639	3.792	3.243	3.073	3.073	3.468

Table 14.--*Indices of similarity for dip-net samples collected August 6-9, 1973*

	Little Chena	North Pole	Upper site	Station 1	Station 2	Station 5	Station 7	Station 8	Station 9	Station 11	Station 12
Little Chena		75	59	71	53	56	59	65	52	67	53
North Pole	75		72	70	73	74	72	68	69	86	79
Upper site	59	72		72	76	77	68	74	69	74	79
Station 1	71	70	72		73	75	66	64	69	75	70
Station 2	53	73	76	73		84	72	75	72	81	83
Station 5	56	74	77	75	84		80	70	71	77	78
Station 7	59	72	68	66	72	80		74	77	74	75
Station 8	65	68	64	64	75	70	74		70	83	79
Station 9	52	69	69	69	72	71	70	70		74	72
Station 11	67	86	74	75	81	77	83	83	74		84
Station 12	53	79	79	70	83	78	79	79	72	84	
Average	61	74	71	71	74	74	72	72	70	78	75

value for the average index of similarity would be expected. The average index of similarity for the samples from the Chena River were within a range of 70 to 78. The sample from the Little Chena River had an average index of 61. This indicates that the Little Chena River sample was unlike the Chena River samples. If the variation in the index of the samples from the Chena River was a result of a difference in this reach of the river, then it would be indicated by an inverse relationship between distance between stations and index of similarity. However, the variation in index of similarity for the samples from the Chena River does not seem to vary in any discernable pattern. This variation probably is a function of the variability in sample site and collection techniques. The conclusions from these data are that no significant difference in the fauna upstream and downstream from the dam site exists, and that in this reach of the Chena River a diverse clean-water fauna is present.

Algal Communities

Tables 15 through 20 present composition of periphyton and phytoplankton communities and an estimate of the quantity of phytoplankton in cells per litre for all sites sampled. In streams such as the Chena River little or no true phytoplankton exist. Most of the planktonic algae are periphyton organisms that have been dislodged from the substrate or true planktonic organisms that have entered the stream with runoff from bodies of standing water. The most common planktonic organisms (*Diatoma tenue*, *D. vulgare* var. *breve*, *Fragilaria capucina*, *F. virescens*, *F. vaucheriae*, and *Achnanthes affinis*) are the same as the most common periphyton organisms. This suggests that most of the phytoplankton organisms are periphyton that have broken loose from the natural substrate. The ecological requirements of many of the less common species (appendix II) suggest that they enter the river from sloughs, oxbow lakes, springs, and swamps with runoff.

The average concentration of phytoplanton was 12,000 cells per litre in March, 26,000 in June, and 67,000 in August, which indicates an increase in biomass or standing crop during the months of open water. The average diversity varies inversely with the concentration of phytoplankton. The average values for the diversity indices were 3.926 in April, 3.488 in June, and 2.836 in August. The inverse relationship of diversity and biomass is not unusual. In this instance the diversity may also be lowered when fewer planktonic organisms enter the stream because of decreased runoff.

Table 15.--*Percent composition periphyton and phytoplankton collected October 15, 1972 to April 18, 1973*

	PERIPHYTON				PHYTOPLANKTON					
	Chena River near North Pole			Upper site	Little Chena R near Fairbanks		Chena River near North Pole		Upper site	
Date installed	02-09-73	10-25-72	10-25-73	02-09-73						
Date Collected	04-17-73	12-06-72	12-06-72	04-17-73	10-25-72	12-15-72	12-06-72	04 17-73	12-07-72	04-18-73
Kind of sample	Strip	Strip 1	Strip 2	Strip	Net tow	Net tow	Net tow	2 litre sample	Net tow	2 litre sample
TAXON										
Bacillariophyta (Diatoms)										
Tabellaria fenestrata				T	T	T		T		
T. flocculosa	T*	T		2			1	T	T	
Diatoma hiemale var. mesodon				3				T		2
D. tenue (new variety)	13	14	13	26	4	3	6	14	3	27
D. vulgare var. breve	16	2	11	11	2	6	7	9	3	2
Meridion circulare	T	T	T	2		T	T	4		4
M. circulare var. constrictum								T		T
Fragilaria capucina	3	12	13	4	12	2	4	15	7	3
F. virescens		1	5	T		8	8	3	2	6
F. vaucheriae	6	13	23	12	12	11	8	11	19	8
F. constricta					T					
F. pinnata					T		T		T	
Fragilaria (new species)	T	4	3		12	8	10	4	T	3
Hannaea arcus	5	8	4		4	7	3		5	T
Synedra ulna	2	T	T	T		3	5	3	3	1
S. filiformis		1		T	T			T		
Eunotia praerupta							1			T
E. tenella	T				T					
Cocconeis placentula			T					T		
Achnanthes linearis				T		T				
A. minutissima	T	3	T	2	3		1	1	3	2
A. affinis	24	20	13	11	19	28	24	10	18	11
A. lapponica	9	1	T	1	2	3	2	1	2	1
A. flexella	2	2	T	2	T	3	5	2	2	3
A. alaskana	T	T		T			T	T		
Achnanthes sp. 1							T			
Frustulia rhomboides var. amphipleuroides		T			1	T	T		T	
Stauroneis anceps		T		T	T		T			T
S. fluminea							T			
S. Kriegeri				T						
Anomoeoneis vitrea								T		
Neidium affine										T
Neidium sp.1					T			T		
Diploneis oblongella								T		
Navicula contenta var. biceps		T			T					
N. gysingensis					T					T
N. minuscula						T				T

N. minima								T	3	
N. lanceolata		T	T	T	4		T	1		
N. tridentula										
Navicula sp. 1						T			5	
Caloneis ventricosa (new variety)			T							
C. ventricosa var. *truncatula*	T									
C. alpestris	T									
Pinnularia mesolepta								T	T	
P. borealis		T								
P. barrowiana										T
Cymbella sinuata				T		T	2	3	T	5
C. ventricosa	8	5	3	3	5	5	3	3	7	4
C. fluminea						T			1	
C. tasmaniensis var. *alaskana*	T							T		2
C. latens	T		T	T	T		T	T	5	
C. acuta				1				T		T
Nitzschia dissipata	T		T	T				T		
N. acuta	2			T					T	
Nitzschia sp. 1 (*dubia* group)	T	2	2		2		T		T	T
Nitzschia sp. 2		T	1	T	6	T	T			T
Nitzschia sp. 3 (*sigmoidae* group)				T				T	T	
Hantzschia amphioxys				T			T			T
Didymosphenia geminata					T				T	
Gomphonema angustatum	3	3	4	8	2			4		
G. intricatum				T		3	2		7	8
G. ventricosum								T		
Melosira sp. (prob. *distans*)					1					
Denticula tenuis				T						
Number of Species	24	25	22	32	28	23	28	34	27	29
Diversity	3.498	3.730	3.493	3.834	3.903	3.654	3.654	3.905	4.118	3.947
Chlorophyta (Green algae)										
Closterium sp.					T			T		
Cosmarium sp.					T					T
Ceratium hirundinella					A**	T	T		T	
Ankistrodesmus sp.					T	T				
Total number of species	24	25	22	32	32	25	29	35	28	30
Plankton cells per liter								10,000		14,000

(*) Present in trace amounts (one percent or less)
(**) Abundant

Table 16.--*Percent composition of periphyton and phytoplankton collected June 11-15, 1973*

	PHYTOPLANKTON			COMPOSITE PERIPHYTON				
	Chena R. nr North Pole	Station 1	Station 12	Little Chena R	Station 1	Station 3	Station 5	Station 12
Date collected	06-14-73	06-14-72	06-15-73	06-11-73	06-14-73	06-14-73	06-14-73	06-15-73
Bacillariophyta (Diatoms)								
Tabellaria fenestrata		3		T*			T	T
T. flocculosa	1	T	T	1		T		T
Diatoma hiemale var. mesodon	T	3	1	T		T		1
D. tenue (new variety)	2	T	3	4	4	6	5	5
D. vulgare var. breve	2	1	1	9	2	6	1	3
Meridion circulare	5	7	T	T		T		
M. circulare var. constrictum								
Fragilaria capucina	12	18	23	10	11	12	6	8
F. virescens		10	4	T	3	2	2	T
F. vaucheriae	19	11	18	22	8	26	9	20
F. construens	T							
F. constricta								
F. pinnata	T				T	T	2	
Fragilaria (new species)	1	2	1	2		T	T	2
Hannaea arcus		11		2		T	T	2
Synedra ulna	T	3		2	T	T	T	T
Synedra filiformis					1			T
Eunotia curvata		T			T		T	
E. praerupta		T		T		T		
E. tenella			2		T		2	
Cocconeis placentula				T			T	
Achnanthes linearis				T				
A. minutissima				T	1	3		
A. affinis	44	9	22	2	32	15	32	28
A. lapponica	T	T	2	1	3	2	3	T
A. flexella		2	T	1	T	T	5	1
A. lanceolata		T		2		1	T	
A. alaskana	T		T					
Achnanthes sp. 1								
Frustulia vulgaris							T	
F. rhomboides var. amphipleuroides		T		T			T	
Stauroneis anceps								
S. fluminea								
S. kriegeri				1				
Anomoeoneis vitrea	T			T				
Neidium affine								
Neidium sp. 1		T	T					
Diploneis oblongella								
Navicula crucicula var. barrowiana	T		T					
N. contenta var. biceps	T		T	T			T	T
N. gysingensis					T			T
N. minuscula						T		
N. minima				T	T			
N. mutica								

N. seminulum								
N. secura				T		T		
N. pupula				T			2	
N. radiosa						T	1	
N. lagerstedtii				T				
Navicula sp.1	T					T	2	
N. lanceolata			1	3	3	3	T	T
N. tridentula					1			
Caloneis ventricosa (new variety)						T		
C. ventricosa var. truncatula								
C. alpestris								
Pinnularia mesolepta		T	1	T				
P. borealis				T	T		T	
P. barrowiana	T							
Pinnularia sp. 1								
Pinnularia sp. 2								
Cymbella sinuata	2		2	3		T	T	T
C. ventricosa		5	4	7	8	5	5	10
C. fluminea	1			1		T		T
C. tasmaniensis var. alaskana								
C. latens		T	T	T	2	4	2	2
C. cistula	T	1	1	T	T	T	T	
Nitzschia dissipata	T	T		T	T		1	T
Nitzschia sp. 1 (dubia group)	T	T		T	T	1	1	T
Nitzschia sp. 2				2	1	T	1	T
Nitzschia sp. 3 (sigmoidae group)	T					T		T
Hantzschia amphioxys		T	T					
Didymosphenia geminata		T			T			
Gomphonema angustatum	3	3	4	5	7	T	7	10
G. intricatum	T	1	2	2	3	T	2	T
Melosira sp. (prob. distans)			1					T
Cyclotella glomerata							T	
Number of species	27	31	27	41	28	34	35	28
Diversity	2.905	4.018	3.540	4.392	3.674	3.873	3.915	3.422
Cyanophyta (Blue-green algae)								
Oscillatoria sp.				A**	T			A
Anabaena sp.					T			
Chroococcus sp.						T		
Chlorophyta (Green algae)								
Oedogonium sp.					T		T	
Mougeotia sp.								
Stigeoclonium sp.							T	T
Total number of species	27	31	27	42	31	35	34	40
Plankton cells per liter	30,000	24,000	24,000					

(*) Present in trace amounts (one percent or less)
(**) Abundant

Table 17.--*Percent composition of phytoplankton collected August 8-9, 1973*

TAXON / Date collected	Chena River nr North Pole 08-08-73	Station 5 08-08-73	Station 7 08-08-73	Station 8 08-09-73	Upper Site 08-09-73	Station 11 08-09-73
Bacillariophyta (Diatoms)						
Tabellaria flocculosa			T*			
Diatoma tenue (new variety)	7	7	3		9	5
D. vulgare var breve	T	4	T	4	3	3
Meridion circulare	T			4	T	
Fragilaria capucina	4	66	46	36	6	34
F. virescens	46	8	3	7	25	5
F. vaucheieae	10		6	2		10
Fragilaria new species			2			
Hannaea arcus	2	T	2	3	T	4
Synedra ulna	2	1	4	T	2	6
S. filiformis	T	T				
Eunotia tenella					T	T
Cocconeis placentula			T	T		
Achnanthes affinis	12	4	21	30	36	17
A. minutissima				T		T
A. lapponica	1	T	4	1	3	T
A. flexella	T		2		1	1
A. lanceolata	1				T	
A. alaskana	T	T				
Frustulia rhomboides var. amphipleuroides				T		T
Navicula crucicula var barrowiana				T		
N. gysingensis	T					
N. pupula	T					T
N. radiosa		T	T		T	
N. lanceolata	1		1	T		1
N. lagerstedtii					T	
N. tridentula	1					1
Navicula sp. 1					T	
Caloneis ventricosa (new variety)					T	
Pinnularia mesolepta			T			
Cymbella sinuata	T		T	1	T	1
C. ventricosa	3	3	T	4	7	5
C. fluminea	T		T			
C. tasmaniensis var. alaskana					T	
C. latens	T	T		T	T	1
C. cistula			T			
Nitzschia dissipata	T	T		T		T
N. acuta	1	T				
Nitzschia sp. 1 (dubia group)	2	T	T	T		T
Nitzschia sp. 2						
Nitzschia sp. 3 (sigmoidae group)	T		T			T
Didymosphenia geminata				T		T
Gomphonema angustatum	1	T	1	3	1	2

G. intricatum	T	T				T
G. ventricosum		T				
Number of species	28	19	23	21	21	25
Diversity	3.049	2.106	2.781	2.839	2.897	3.344
Cyanophyta (Blue-green algae)						
Oscillatoria sp.				T		
Chlorophyta (Green algae)						
Closterium sp.					T	
Chrysophyta (Golden algae)	T		T			
Plankton cells per liter	72,000	58,000	64,000	68,000	48,000	72,000
Number of species	28	19	23	22	22	25

(*) Present in trace amounts (one percent or less)

Table 18.--*Percent composition of periphyton strips retrieved June 11-14, 1973*

	Little Chena	Chena River nr North Pole				Chena R below Mullen Slough nr Eielson			
	Upper right bank surface	Right bank bottom	Right bank surface	Left bank surface	Left bank bottom	Right bank surface	Lower Left bank bottom	Lower left bank surface	Upper left bank bottom
TAXON Date installed	05-11-73	05-10-73	05-10-73	05-10-73	05-10-73	05-10-73	05-10-73	05-10-73	05-10-73
Date retrieved	06-11-73	06-12-73	06-12-73	06-12-73	06-12-73	06-14-73	06-14-73	06-14-73	06-14-73
Bacillariophyta (Diatoms)									
Tabellaria fenestrata	T*		T		T		T		
T. flocculosa	T		1	T	3	1	T	T	T
Diatoma hiemale var. mesodon	T		T		T	2	T	T	
D. tenue (new variety)	3	4	3	4	7	16	3	10	
D. vulgare var. breve	2	3	6	2	6	6	5	3	
Meridion circulare	3	T	T	T	3	1			T
Fragilaria capucina	16	36	18	28	15	11	33	17	9
F. virescens	1	T			5	5	T	5	7
F. vaucheriae	25	27	16	25	20	15	14	24	11
F. pinnata		T			T			T	T
Fragilaria (new species)	2		3	1	11	1	10	3	2
Hannaea arcus	1	1	3	2			5	5	1
Synedra ulna	T		1	T	T		2		
Synedra filiformis		T			T				
Eunotia curvata			1						
E. praerupta				T				T	
E. tenella	T				T			T	1
Cocconeis placentula			T		T				
Achnanthes linearis			T			T			T
A. minutissima	T						T	T	T
A. affinis	27	8	17	9	14	9	2	11	23
A. lapponica		T	4	3	1	T	T	1	4
A. flexella		1	2		T	T	T	T	1
A. alaskana				T	T				
Frustulia rhomboides var. amphipleuroides							T		
Stauroneis anceps	T								T
Anomoeoneis vitrea			T		T	T			
Neidium sp. 1									T
Navicula crucicula var. borrowiana									T
N. contenta var. biceps	T								T
N. gysingensis	T		T						
N. minima			T						
N. pupula					T				
N. lanceolata	1	T	T	T	T		T	T	2
Navicula sp. 1									T
Caloneis ventricosa var truncatula	T								
C. alpestris			T		T				T
Pinnularia mesolepta						T	T		T
P. borealis	1			T		T			

Cymbella sinuata			2		T		T	2	T
C. ventricosa	2	8	8	9	5	9	8	8	12
C. fluminea									T
C. tasmaniensis var. *alaskana*						1		T	
C. latens	2	T	T	T	T	T		T	1
C. cistula		1				T			
Nitzschia dissipata		2	2	T		T		T	2
N. acuta									1
Nitzschia sp.1 (*dubia* group)	2						1	1	T
Nitzschia sp. 2	T	T							T
Nitzschia sp. 3 (*sigmiodae* group)		T				1	T		3
Hantzschia amphioxys				T			T		
Didymosphenia geminata								3	T
Gomphonema angustatum	2	2	3	9		8	7		4
G. intricatum	2		3	2		6	2		1
Melosira sp. (prob. *distans*)									1
Surriella ovata	T								
Number of species	28	20	28	21	26	24	25	24	35
Diversity	3.313	2.851	3.793	3.158	3.651	3.814	3.393	3.535	4.061
Pooled diversity			3.643				4.079		
Cyanophyta (Blue-green algae)									
Oscillatoria sp.			T				T		
Chlorophyta (Green algae)									
Ulothrix zonata									T
Oedogonium sp.						T			
Euastropsis richteri			T						
Total number of species	28	20	30	21	26	25	26	25	36

(*) Present in trace amounts (one percent or less)

Table 19.--*Percent composition of periphyton strips retrieved August 6-8, 1973*

TAXON	Chena R. below Mullen Slough nr Eielson			Little Chena River nr Fairbanks		
	Upper Left bank Bottom	Upper Left bank Surface	Lower Left bank Bottom	Upper Left bank Surface	Lower Left bank Bottom	Upper Right bank Surface
Date installed	06-14-73	06-14-73	06-14-73	06-11-73	06-11-73	06-11-73
Date retrieved	08-08-73	08-08-73	08-08-73	08-06-73	08-06-73	08-06-73
Bacillariophyta (Diatoms)						
Tabellaria fenestrata				T*		
T. flocculosa	T			2	T	
Diatoma hiemale var. mesodon	T			T	T	T
D. tenue (new variety)	4	1	8	T	4	4
D. vulgare var. breve	T	2	4	5	2	1
Meridion circulare	T	1		1	T	T
M. circulare var. constrictum						1
Fragilaria capucina	4	1	4	7	6	15
F. virescens	T	T	T			3
F. vaucheriae	8	1	3	13	14	9
F. construens						
F. pinnata						
Fragilaria (new species)	T	2	8	1	3	
Hannaea arcus	T			1	2	1
Synedra ulna	T	T	T	T	3	T
Eunotia praerupta					9	T
E. tenella	T				6	
Cocconeis placentula	2			T	T	
Achnanthes linearis					T	
A. minutissima	T				T	
A. affinis	40	80	61	22	14	35
A. lapponica	2	3	2	T		
A. flexella	1			T		T
A. alaskana	T				T	T
Achnanthes sp. 1						
Frustulia rhomboides var amphipleuroides				T		
F. vulgaris	T					
Stauroneis anceps						T
S. fluminea	T					
Anomoeoneis vitrea						
Neidium affine						
Navicula crucicula var barrowiana				T		
N. contenta var biceps					T	
N. gysingensis						T
N. pupula	T				T	
N. radiosa				T		
N. lanceolata	2	T	T	3	1	2
N. tridentula						

Navicula sp. 1	T			4	3	T
Achnanthes lanceolata	1				2	T
Caloneis alpestris					T	
Pinnularia mesolepta	T					
P. borealis	1			T		
Pinnularia sp. 1	2					
Cymbella sinuata	2	T		T	T	T
C. ventricosa	7	3	5	3	3	5
C. fluminea				T		T
C. tasmaniensis var. *alaskana*	2					
C. latens		T		3	2	
C. cistula	T	T		T		1
Nitzschia dissipata				1	3	
N. acuta	T					
Nitzschia sp. 1 (*dubia* group)	2			T	T	
Nitzschia sp. 2		1			T	
Nitzschia sp. 3 (*sigmiodae* group)	T					
Didymosphenia geminata	T	T				
Gomphonema angustatum	2	T	T	21	12	11
G. intricatum	3	T	1	3	5	2
Melosira sp. (prob. *distans*)				2	1	
Number of species	37	19	13	31	32	25
Diversity	3.675	1.465	2.159	3.722	4.513	3.270
Pooled diversity		2.650			4.016	
Cyanophyta (Blue-green algae)						
Oscillatoria sp.		T				
Chlorophyta (Green algae)						
Oedogonium sp.		T			T	
Ulothrix zonata	A**	A	A			
U. tenuissima			T			
Stigeoclonium sp.			T			
Closterium sp.		T				
Cosmarium sp.		T				
Oocystis sp.		T				
Spirogyra sp.			T			
Total number of species	38	25	18	31	33	25

(*) Present in trace amounts (one percent or less)
(**) Abundant

Table 19.--*Percent composition of periphyton strips retrieved August 6-8, 1973*--Cont.

TAXON	Date installed / Date retrieved	Chena River near North Pole					
		Lower Left bank Surface	Lower Left bank Bottom	Upper Left bank Surface	Upper Left bank Bottom	Right bank Surface	Right bank Bottom
	Date installed	06-12-73	06-12-73	06-12-73	06-12-73	06-12-73	06-12-73
	Date retrieved	08-07-73	08-07-73	08-07-73	08-07-73	08-07-73	08-07-73
Bacillariophyta (Diatoms)							
Tabellaria fenestrata				T*	T		
T. flocculosa				T			
Diatoma hiemale var. mesodon		T					
D. tenue (new variety)		5	3	4	5	5	4
D. vulgare var. breve		5	T	4	3	T	3
Meridion circulare		T	T		1		T
Fragilaria capucina		8	2	7	5	3	3
F. virescens		T	T	1	T	2	
F. vaucheriae		4	19	8	3	13	T
F. construens			T				
F. pinnata		T		T	T		T
Fragilaria new species		5		16	11	14	3
Hannaea arcus		T		T	2		2
Synedra ulna				1	T	T	
S. filiformis		T		T			
Eunotia praerupta			1				
Achnanthes affinis		37	50	32	43	45	74
A. minutissima		T	2	2	T		T
A. lapponica			1	1	T	T	T
A. flexella		1		1	T	T	2
A. lanceolata		T			1		
A. alaskana				2	T		
Achnanthes sp. 1					T		
Frustulia rhomboides var. amphipleuroides							
F. rhomboides			T				
Stauroneis fluminea					T		
Amomoeoneis vitrea					T		T
Neidium affine							T
N. minima							T
N. secura		T					
N. radiosa							T
N. lanceolata		T			1	T	
Pinnularia mesolepta							T
P. borealis			T				
Cymbella sinuata					T		
C. ventricosa		9	3	6	5	8	1
C. fluminea		T					
C. tasmaniensis var. alaskana			T				
C. latens		T	1	T	4	T	T
C. cistula		T					
Nitzschia dissipata			T	1	T		

N. acuta	T					
Nitzschia sp. 1 (dubia group)	T					
Nitzschia sp. 2	1					
Nitzschia sp. 3 (sigmoidae group)		T	T			
Didymosphenia geminata						T
Gomphonema angustatum	7	4	3	2	1	1
G. intricatum	4	2	5	2	4	1
Melosira sp. (prob. distans)		T	T			
Number of species	27	22	24	27	15	22
Diversity	3.462	2.690	3.478	3.289	2.644	2.645
Pooled diversity			3.170			
Cyanophyta (Blue-green algae)						
Oscillatoria sp.						
Chlorophyta (Green algae)						
Oedogonium sp.						
Gongrosira sp.				T		
Debarya sp.				T		
Ulothrix zonata		T		T	T	A**
U. tenuissima						T
Ankistrodesmus sp.		T				
Stigeoclonium sp.	T					T
Closterium sp.					T	
Total number of species	28	24	24	30	17	25

(*) Present in trace amounts (one percent or less)
(**) Abundant

Table 20.--*Percent composition of composite periphyton samples collected August 8-9, 1973*

TAXON / Date Collected	Little Chena nr Fairbanks 08-08-73	Station 5 08-08-73	Station 7 08-08-73	Station 9 08-09-73	Upper Site 08-09-73	Station 11 08-09-73	Station 12 08-09-73
Bacillariophyta (Diatoms)							
Tabellaria fenestrata	1	T*			T	T	
T. flocculosa	T		T				T
Diatoma hiemale var. mesodon			T				
D. tenue (new variety)	4	5	6	5	5	3	7
D. vulgare var. breve	1	1	T	T	1	2	4
Meridion circulare	T	T		T			
Frigilaria capucina	6	7	2	7	2	9	T
F. virescens	4	2	8	13	6	2	9
F. vaucheriae	20	5	2	2	2	6	5
F. pinnata					T		
Fragilaria (new species)	T	8	1	4	T	2	2
Hannaea arcus	2	1	T	1	T	2	1
Synedra ulna	T	4	T	4	2	2	T
S. filiformis					T	T	T
Eunotia praerupta	2						
E. curvata	T		T				
E. tenella	T					T	T
Achnanthes affinis	9	38	44	38	50	44	46
A. minutissima		3	6	3	3	4	
A. lapponica	4	2	4	3	6	5	7
A. flexella	1	2	5	1	3	2	3
A. lanceolata	1						
A. alaskana							T
Achnanthes sp. 1					1		
Frustulia rhomboides	T	T					
F. rhombiodes var. amphipleuroides				T	T		
F. vulgaris		T					
Anomoeoneis vitrea							T
Navicula crucicula var. barrowiana							
N. contenta var biceps.	T				T		
N. gysingensis	T				T	T	T
N. minima			3		1		
N. mutica	2	T					
N. seminulum	T						
N. pupula			T			T	
N. radiosa		T				T	
N. lanceolata	2	2		2		T	T
N. tridentula							T
Navicula sp. 1	4	T		1	T		T
Cymbella tasmaniensis var. alaskana			T	T		T	T
Caloneis ventricosa (new variety)	T	T		T			
C. ventricosa var. truncatula							

Pinnularia mesolepta	T						
P. borealis	T						
P. barrowiana	T						
Pinnularia sp. 1		T					
Pinnularia sp. 2						T	
Cymbella sinuata	2	T	T	T		T	
C. ventricosa	8	8	7	3	10	2	2
C. fluminea		T		2	T		T
C. cistula				T			
C. latens	3	T	2	2	T	3	2
Nitzschia dissipata	2	T		1	T	T	
N. acuta	T	1	T	T		2	
Nitzschia sp. 2	2			T		T	
Nitzschia sp. 3 (*sigmoidae* group)		T	1	T	T	T	
Hantzschia amphoixys	T						
Didymosphenia geminata			T				T
Gomphonema angustatum	5	T	2	T		3	3
G. intricatum	1	T	T	T	1	1	1
G. ventricosum							
Surriella ovata	T						
Denticula tenuis	1		T	T			
Number of species	40	31	27	30	27	30	27
Diversity	4.513	3.585	3.202	3.515	2.878	3.391	3.150
Cyanophyta (Blue-green algae)							
Oscillatoria sp.	T	T	T			T	T
Chlorophyta (Green algae)							
Ulothrix zonata	A**		T		T		T
U. tenuissima	T		T	T	T	T	T
Closterium sp.			T				T
Chrysophyta (Golden algae)							
Vaucheriae sp.				A			
Number of species	43	32	31	32	29	32	31

(*) Present in trace amounts (one percent or less)
(**) Abundant

The periphyton strips collected in December 1972 and April 1973 were dominated by the same species as the phytoplankton samples (table 15). The diversity was relatively uniform from site to site (3.493 to 3.834). Species found on the strips collected in June were not significantly different from the species on the strips collected in the winter. They were also dominated by *Fragilaria* spp., *Diatoma* spp., and *Achnanthes affinis*. The average diversity of periphyton for the samples collected in June at the Chena River near North Pole was 3.363. The pooled diversity was slightly higher (3.643). The average diversity at the upper site was 3.701 and the pooled diversity was 4.079. The variability between samples from one station is greater than the differences between stations. The samples from the North Pole station have one very low value (2.851), whereas the samples from the upper site have one very high value (4.061). The data are insufficient to indicate a difference in diversity between these stations.

Achnanthes affinis was the dominant organism on all strips collected in August, but was slightly less abundant in the Little Chena River (table 19). The average diversity was 3.835 for those samples collected from the Little Chena River and the pooled diversity was 4.016. At the North Pole station the average diversity was 3.035 and the pooled diversity was 3.170. The values for chlorophyll *a* and organic weight were higher at the North Pole station, indicating an inverse correlation between diversity and net productivity, as with the phytoplankton samples (table 21). The strips collected at the upper site in August were inadvertently destroyed.

The diversities for the periphyton composite samples from the Little Chena River near Fairbanks in June and August were 4.392 and 4.513, respectively (tables 16, 20). The difference between these values probably is not significant, but they are considerably higher than the values obtained from the Chena River. The composite samples from the Chena River in June ranged from 3.422 to 3.915 and had an average diversity of 3.855. In August the range of diversity was 2.878 to 3.515 and the average was 3.287 (table 19). The range of diversities within the August and June samples is relatively consistent and overlap only slightly, indicating a distinct difference between the diversities in June and August. The consistency of the samples collected during one sampling period supports the conclusion that no difference in biological water quality along this reach of the river exists.

The data in table 21 indicate a sharp increase in chlorophyll *a* on the strips collected in August compared to the strips collected in June. The organic weight increased slightly but the chlorophyll *a* increased considerably. This

Table 21.--*Concentration of chlorophyll a and organic weight for periphyton strips*

Station name	Date in	Date out	Days in	Chlorophyll a (mg/m^2)	Organic weight (g/m^2)	Autotrophic index *
Little Chena R nr Fairbanks near surface	5-11-73	6-11-73	31	0.0873	0.721	8287
Chena R nr North Pole						
Bottom left bank	5-10-73	6-14-73	35	.1240	.488	3935
Surface right bank	5-10-73	6-14-73	35	.0927	.479	5167
Surface left bank	5-10-73	6-14-73	35	.0961	.771	8022
Bottom right bank	5-10-73	6-14-73	35	.0873	.431	4937
Chena R bl Mullen Slough nr Eielson						
Surface right bank	5-10-73	6-15-73	36	.0532	.366	6880
Bottom lower left bank	5-10-73	6-15-73	36	.0675	.541	8015
Surface lower left bank	5-10-73	6-15-73	36	.1643	.560	3414
Bottom upper left bank	5-10-73	6-15-73	36	.1695	.444	2619
Little Chena R nr Fairbanks						
Bottom lower left bank	6-11-73	8-6-73	56	.3910	.308	788
Surface upper left bank	6-11-73	8-6-73	56	.5162	.444	860
Surface right bank	6-11-73	8-6-73	56	.4547	.476	1046
Chena R nr North Pole						
Bottom right bank	6-14-73	8-9-73	56	5.6662	.984	174
Surface right bank	6-14-73	8-9-73	56	3.7987	.754	198
Surface lower left bank	6-14-73	8-9-73	56	1.8262	.433	237
Bottom lower left bank	6-14-73	8-9-73	56	1.4565	1.149	789
Surface upper left bank	6-14-73	8-9-73	56	3.3082	.655	198
Bottom upper left bank	6-14-73	8-9-73	56	2.5428	.571	224

* Autotrophic index = $\frac{\text{biomass (g/m}^2\text{)}}{\text{chlorophyll } \underline{a} \text{ (g/m}^2\text{)}}$

may be due in part to the fact that a very small percentage of each cell is organic biomass (most of the mass of the diatom cells is in the silica frustule). The significant change in chlorophyll with a small change in organic matter may be due to changes in the colonized substrate from non-chlorophyll-bearing organisms to chlorophyll-bearing organisms.

The autotrophic index was calculated for the periphyton strips (table 19) (C.I. Weber and B.H. McFarland, written commun., 1969). A high value for the autotrophic index indicates a heterotrophic community and a large number of heterotrophic organisms (bacteria and fungi) on the strips or are an accumulation of organic sediments on the strips. The index values indicate that the strips retrieved in June were more heterotrophic than those retrieved in August. The strips from the Little Chena River near Fairbanks are more heterotrophic than those from the Chena River. The relatively stable values for organic weight and the large difference in chlorophyll a indicates that the autotrophic index is a function of the amount of autotrophic growth on the strip. The amount of organic sediment and (or) the heterotrophic growth on the strips from the Chena and the Little Chena Rivers remained relatively constant from June to August.

The chlorophyll a data, species composition, and diversities for the strips indicate that the results are more variable than those from samples obtained from natural substrates. In any detailed study of a stream, artificial substrates should be supplemented by collections from natural substrates.

The periphyton of the Chena River system can be characterized as a diverse flora consisting primarily of diatoms. A moderate but patchy growth of filamentous algae occurred in July and August but did not reach levels which would affect the chemical or esthetic quality of the river.

Possible Effects of the Moose Creek Dam on the Chena River

The objective of the Moose Creek Dam is to provide regulation of the Chena River to bankfull discharge which is considered to be 12,000 ft^3/s (340 m^3/s) at Fairbanks. The flow of the Chena River at Moose Creek Dam probably will not be restricted to less than 8,000 ft^3/s (227 m^3/s), except when uncontrolled flow below the project results in discharge greater than bankfull discharge at Fairbanks. This will occur infrequently after the Little Chena retention dam becomes operational. The recurrence interval for a 10,500 ft^3/s (297 m^3/s) flood at Fairbanks is 2 years and for a 18,100 ft^3/s (513 m^3/s) flood is 5 years (Childers, 1970). No water will be retained behind the dam except during flood regulation.

The length of retention would be 25 to 30 days after the summer probable maximum flood which could result only from a combination of antecedent storms and the probable maximum rainfall. The 1967 flood would have required a retention time of approximately 15 days (as determined by Corps of Engineers regulation studies). Some of the possible effects of construction and operation of a dam are increased suspended-sediment transport, lowered dissolved-oxygen concentration, increased nutrient concentration, high-water temperatures, and an altered flow regime. Because water will only be retained for a few days following flood stages that have a recurrence interval longer than 2 years, all of the above effects probably will be minimal or nonexistent.

The composition of bed material in the channel may be changed both upstream and downstream from the dam. Much of the sediment in transport will be deposited in the impoundment area and may result in an increase in fine material and organic detritus in the bed. Immediately downstream from the dam some channel erosion may be expected and could result in at least a temporary decrease in fine material in the streambed.

Sediment deposition probably would affect the species composition of the insects, especially Ephemeroptera, Plecoptera, Tricoptera, Simuliidae, and those Chironomidae that are associated with gravel and cobble substrate types. Although sediment transport characteristics of the Little Chena River are different than those of the Chena River, the diversity indices of invertebrates are not significantly different. However, deposition changes the species composition of the communities and alters the habitat for some desirable fishes by interfering with spawning and production of food. The organisms that would disappear as a result of deposition are those that are preferred fish food.

A lowering of dissolved-oxygen concentration in the summer would not be critical unless a concomitant increase in BOD or COD occurred or unless the dissolved-oxygen concentrations were reduced to less than about 4 mg/l. If oxygen reaches this critically low concentration in the Chena and Little Chena Rivers, it is during the winter under heavy ice cover. During the winter the oxygen regime should not change unless the oxygen demand of the water or sediment increases. Additional organic input during the summer may cause this increased oxygen uptake during the winter.

In the unlikely event of an unexpectedly large amount of leaching of nutrients and organic material into the water from the suspended sediment or an increase in organic matter from deposition of sediments, primary productivity would increase. This would alter species composition and probably lower diversity of all biological communities. An increase in primary productivity would alter the esthetic value of the stream and affect the fisheries resource.

Any increase in water temperature would have a profound effect on the Ephemeroptera and Plecoptera, altering species composition. If the temperatures were increased as much as 5°C, some species of every insect group would be affected. Documented cases of changes in thermal regime being a cause for reduction in benthic fauna downstream from an impoundment are known (Lehmkuhl, 1972; Hynes, 1963). Increased temperatures would also increase primary productivity with the same result as that of increased nutrients.

Changes in flow regime also affect the benthic fauna, drastically shifting species composition and lowering diversity (Fisher and Lavoy, 1972). The proposed facility will eliminate very high flows and increase the flow for a time after high water has receded. Low flows will not be affected. Unless the present fauna has been affected by periodic flushing in the past, the fauna downstream from the dam should not be affected by the changes in flow regime.

SUMMARY AND CONCLUSIONS

1. The Chena and Little Chena Rivers within the reach sampled can be characterized as clean-water subarctic streams which have been relatively unaffected by human activity during the past 20 years.

2. The chemical and biological water-quality parameters in this reach are relatively uniform with the possible exception of iron content and chemical oxygen demand which seem to increase downstream.

3. Given the present plans for the construction and operation of the Moose Creek Dam, the effect of this project on the water quality of the Chena River probably will be minimal. Possible detrimental effects of this project are increased suspended-sediment transport and deposition, lowered dissolved-oxygen concentration, increased temperature, and higher levels of nutrients.

4. Analysis of biological data collected in the section of the Chena River studied suggests that primary and secondary production are low. This is reflected by the presence of a large and diverse number of groups of aquatic insects and other benthic invertebrates that are typical of streams high in dissolved oxygen and low in productivity.

5. The most abundant benthic invertebrates are Chironomidae (midges). Plecoptera (stoneflies), Ephemeroptera (mayflies), Tricoptera (caddis flies), Simuliidae (black flies), and Aquatic Acari (water mites) were common but less abundant components of the benthic fauna.

6. Rooted aquatic vegetation is lacking in the main river channels, but there is patchy growth of an aquatic moss, Fontinalis sp.

7. Periphyton consists predominately of diatoms, but a moderate growth of filamentous algae of patchy distribution occurs in July and August. However, it did not reach levels which would affect the esthetic quality of the river.

8. Data presented in this report indicate that the diversity of benthic invertebrates, periphyton, and phytoplankton varies inversely with standing crop. Standing crop increases during the summer months. Areas with some silt accumulation in gravel and cobbles are more diverse than bare gravel and cobble substrates.

9. The biochemical oxygen demand is low, indicating the absence of large amounts of oxidizable organic material.

10. Artificial substrates were utilized to quantify the abundance and diversity of benthic invertebrates and periphyton at the three primary stations. However, data from composite periphyton samples and dip-net samples of benthic invertebrates yielded a more reliable qualitative estimation of species composition and diversity.

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APPENDIX I

NOTES ON THE MORE COMMON BENTHIC INVERTEBRATES FOUND IN THE CHENA AND LITTLE CHENA RIVERS

NEMATODA (round worms)

This freshwater group is ubiquitous, most genera and many species are cosmopolitan, found on all types of substrates. They are unaffected by very low concentrations of dissolved oxygen. They can survive indefinitely in water from 2 to 10 percent DO saturation. Active nematodes have been known to survive anerobic conditions for 1 to several weeks at a time. Eggs can survive desiccation and extreme temperatures for 10 to 20 years (Pennak, 1953).

OLIGOCHAETA (aquatic earthworms)

Most Oligochaeta feed by ingesting substrate material and digesting the organic matter. Temperature generally is not a limiting factor, and they can survive in low dissolved-oxygen concentrations or anerobic conditions for extended periods of time (Pennak, 1953). They are most commonly abundant in sand and silt (Reid, 1964).

AQUATIC ACARI (water mites)

Aquatic mites are found in all types of freshwater habitats but are most abundant in ponds and littoral regions of lakes. They are commonly associated with thick growths of rooted aquatic vegetation. In the Chena River they were most abundant where the substrate was covered with aquatic moss (*Fontinalis* sp.). Although abundant in places, the water mites probably are not important in the food chain. Many of the species collected in the Chena River are highly colored. Elton (1922) found that fish avoid eating the brightly colored mites.

INSECTA

With the exception of a few Coleoptera (beetles) and Hemiptera (true bugs), all of the insects collected in the Chena River were larval or pupal forms of insects that are terrestrial in the adult stage. The major part of the life history usually occurs in the aquatic environment. Often the adult emerges and lives as a terrestrial insect for only a few days. In some instances (for example, Ephemoroptera) the adult has no mouth parts. It emerges, carries out the reproductive functions of the species, and dies in 2 or 3 days. The juvenile stages of an aquatic insect may last from several months to 2 or 3 years, as with Plecoptera. It is during this time that all growth or increase in biomass occurs.

Plecoptera (stoneflies)

Stonefly nymphs are sluggish and are found in debris, masses of leaves and algae, and under stones in every kind of lotic environment where there is an abundance of dissolved oxygen. They are generally considered to be an important source of fish food, especially for members of the trout family, and are commonly found in clear, cool, streams where little organic enrichment occurs (Reid, 1961; Pennak, 1953).

Ephemeroptera (mayflies)

This order of insects is found in all types of fresh water where an abundance of dissolved oxygen occurs. The nature of the substrate and the rate of water movement largely determines the species composition. They are all herbivores, very sensitive to temperature changes, and one of the most important sources of fish food (Pennak, 1953). They will not survive even a short-term oxygen depletion (Beeton, 1961).

Tricoptera (caddis flies)

Most species of this order build a case of rocks or organic debris. These cases may or may not be attached to a substrate. The larvae and pupae are an important source of fish food and require an adequate supply of dissolved oxygen. The species composition is affected by rate of flow and the nature of the substrate (Pennak, 1953). In swift flowing streams most large concentrations of caddis fly larvae are associated with gravel or cobble bottoms (Hickin, 1968).

Diptera

Siluliidae (black flies)

Black fly larvae are generally abundant in shallow swift streams where there is an abundance of oxygen. They are always attached and feed on plankton and detritus (Pennak, 1953).

Chironomidae (midges)

This large and complex family is comprised of 3,000 described species. Midge larvae can be found in almost all aquatic environments. Members of the subfamilies Diamesineae and Tanypodinae are restricted to cold, clean water with high dissolved oxygen (Pennak, 1953). Orthocladiinae are ubiquitous. Larvae of the subfamily Chironominae inhabit very clean to very polluted water, and those larvae that are tolerant of low dissolved oxygen sometimes possess red respiratory pigments (Pennak, 1953). Midges with these pigments were not observed in the specimens collected from the Chena River. Optimum pH for chironomid larvae is between 6 and 7 (Roback, 1957). Curry (1954) concludes that important factors in determining the kinds of midge larvae present are bottom type and current velocity.

APPENDIX II

SPECIES OF ALGAE FOUND IN THE CHENA AND LITTLE CHENA RIVERS

Following is a list of all species of algae noted during this study with an indication of those which were abundant (A), those which were present but not in large numbers (P), and those which occur rarely (R). Some information on the ecological preferences of these organisms is also included. The references are indicated by number: (1) Patrick and Reimer, 1966; (2) Patrick and Freese, 1960; (3) Hustedt, 1930; (4) Palmer, 1962; and (5) Rawson, 1956.

Bacillariophyta (Diatoms)

(P) *Tabellaria fenestrata* (Lyngb.) Kütz.
Circumneutral water, usually shallow areas of lakes and ponds which are mesotrophic to eutrophic (1), oligotrophic lakes (5).

(P) *T. flocculosa* (Roth) Kütz.
Wide tolerance for different types of water (1), tolerates acid conditions (4), oligotrophic lakes (5).

(P) *Diatoma hiemale* var. *mesodon* (Ehr.) Grun.
Preference for flowing mesotrophic water (1).

(A) *D. tenue* Ag. (new variety).

(A) *D. vulgare* var. *breve* Grun.

(P) *Meridion circulare* (Grev.) Ag.
Preference for cool flowing water (1), clean water species (4).

(P) *M. circulare* var. *constrictum* (Ralfs) V.H.

(A) *Fragilaria capucina* Desm.
Preference for slightly alkaline water (1) oligotrophic lakes (5).

(A) *F. virescens* Ralfs.
Widely distributed in fresh water (1).

(A) *F. vaucheriae* (Kütz.) Peters.
Prefers cool water (1).

(R) *F. construens* (Ehr.) Grun.
Slightly alkaline water, seems to be indifferent to chlorides (1).

(R) *F. constricta* Ehr.
Acid water of low mineral content (1).

(R) *F. pinnata* Ehr.
Widely distributed in fresh water (1).

(A) *Fragilaria* (new species).

(A) *Hannaea arcus* (Ehr.) Patr.
Cool flowing water, particularly in mountainous regions (1).

(P) Synedra ulna (Nitz.) Ehr.
Widely distributed in fresh water (1).
(R) S. filiformis var. exilis Cl.-Eul.
(P) Eunotia curvata (Kütz.) Lagerst.
Widely distributed in waters of low mineral content. Commonly found in acid water, but may also be in slightly alkaline water. Most often in shallow ponds and swamps but also found in flowing water (1).
(P) E. praerupta Ehr.
Usually in northern or mountainous localities in acid to circumneutral waters (1).
(P) E. tenella (Grun.) Cl.
Prefers somewhat acid, soft waters (1).
(R) Cocconeis placentula Ehr.
Circumneutral to alkaline water (1), clean water species (4).
(R) Achnanthes linearis (W. Sm.) Grun.
Cold, mountain streams (3).
(A) A. affinis Grun.
Circumneutral to alkaline water (1).
(P) A. minutissima Kütz.
Small streams and springs (3).
(P) A. lapponica (Guerm. and Mang.) Reim.
(P) A. flexella (Kütz.) Grun.
Most common in lakes, ponds, or bogs, or in water draining such areas (1).
(P) A. lanceolata (Breb.) Grun.
Well aerated flowing water of neutral to alkaline pH; does not appear in large numbers under conditions of organic enrichment (1).
(P) A. alaskana Patr. and Freese.
Previously collected from the Utukak River, Ak., only (2)
(R) Achnanthes sp. 1
(R) Frustulia rhomboides A-V.H.
Slightly acid water (1).
(R) F. rhomboides var. amphipleuroides (Grun.) Cl.
Slightly acid water of low mineral content (1).
(R) F. vulgaris A-V.H.
Circumneutral water of low mineral content (1).
(R) Stauroneis anceps Ehr.
Littoral form usually associated with standing water (1). Tolerant of acid waters (4).
(R) S. fluminea Patr. and Freese.
Soft, slightly acid to neutral waters only (3).
(R) S. kriegeri Patr.
Found in swifter headwater areas (1).
(R) Anomoeneis vitrea (Grun.) Ross.
Slight preference for alkaline waters (1).
(R) Neidium affine (Ehr.) Pfitz.
(R) Neidium sp. 1.
(R) Diploneis oblongella (Naeg. ex. Kütz.) Ross.

(R) Navicula crucicula var. barrowiana Patr. and Freese.
(R) N. contenta var. biceps (Arn.) V.H.
Often associated with moss, acid to circumneutral water (1).
(R) N. gysingensis Foged
In acid soft water (2).
(R) N. minuscula Grun.
Circumneutral fresh water (1).
(P) N. minima Grun.
Widely distributed in fresh water (3).
(R) N. mutica Kütz.
Widely distributed in fresh water (3).
(R) N. seminulum Grun.
(R) N. secura Patr.
Water of low mineral content, mesotrophic to eutrophic (1).
(R) N. pupula Kütz.
Circumneutral water of fairly high mineral content (1).
(P) N. radiosa Kütz.
Circumneutral fresh water (1).
(R) N. lagerstedtii Cl.
Freese and Patrick found this species in gravel bottom streams and lakes, pH 7.4-8.4, total hardness 22-26 mg/l, and Fe 0.06-0.14 mg/l (2).
(P) N. lanceolata (Ag.) Kütz.
Seems to prefer water of high mineral content (1).
(R) N. tridentula Krasske
In lakes and streams draining swampy areas (3).
(R) Navicula sp. 1.
(R) Calonesis ventricosa (Ehr.) Meist. (new variety)
(R) C. ventricosa var. truncatula (Grun.) Meist.
(R) C. alpestris (Grun.) Cl.
Likes calcium and cool climates, mesotrophic (1).
(P) Pinnularia mesolepta (Ehr.) W. Sm.
Prefers water of low mineral content, usually circumneutral to slightly acid (1); Palmer (4) indicates that all species of Pinnalaria are tolerant of acid conditions.
(R) P. borealis Ehr.
Prefers cool water of low mineral content (1).
(R) P. barrowiana Freese and Patr.
Slightly alkaline pH (2).
(R) Pinnularia sp. 1.
(R) Pinnularia sp. 2.
(P) Cymbella sinuata Greg.
Moderately hard slightly alkaline water (1).
(A) C. ventricosa Ag.
(P) C. fluminea Freese and Patr.
Circumneutral, low alkalinity (2).
(P) C. tasmanensis var. alaskana Freese and Patr.

(P) C. latens Krasske
(P) C. cistula (Ehr.) Kirchn.
Circumneutral slightly alkaline water (pH 7-8), hardness 69-110 mg/l (2).
(P) Nitzchia dissipata (Kütz.) Grun.
(P) N. acuta Hantzch.
(P) Nitzschia sp. 1 (dubia group).
(P) Nitzschia sp. 2.
(P) Nitzschia sp. 3 (sigmoidae group).
(P) Hantzschia amphioxys (Ehr.) Grun.
Widely distributed in the arctic, perhaps a preference for slightly acid water (2).
(P) Didymosphenia geminata (Lyngbye) M. Schmidt.
(P) Gomphonema angustatum (Kütz.) Rabh.
(P) G. ventricosum Gregory (new variety?).
(P) G. intricatum Kütz.
(R) Surriella ovata Kütz.
(R) Cyclotella glomerata Bachmann.
(P) Melosira distans? (Ehr.) Kütz.
Cool water species, slightly alkaline water (2).
(P) Denticula tenus Kütz.

Chlorophyta (Green Algae)

Distribution of the following filamentous algae was irregular and discontinuous. No estimate of abundance was made.

Oedogonium sp.
Spirogyra sp.
Stigeoclonium sp.
Ulothrix tenuissma Kuetzing
Ulothrix zenata Weber and Mohr Kuetzing
  Tolerates acid conditions (4).
Mougeotia sp.

The following planktonic forms occurred rarely.

Cosmarium sp.
Closterium sp.
Ankistrodesmus sp.
  Clean water algae (4).
Gongrosira sp.
Debarya sp.
Euastropsis richteri (Schmidle) Lagerheim
Oocystis sp.

Cyanophyta (Blue-Green Algae)

Oscillatoria sp.
Anabaena sp.
  Mesotrophic and Eutrophic lakes (5).
Chroococcus sp.

Chrysophyta (Golden Algae)

Vaucheria sp.

Pyrrophyta (Dinoflagellates)

Ceratium hirundinella (O.F. Muell.) Dujardin.
  Mesotrophic lakes (5).

APPENDIX III

DEFINITIONS

Algae (sing. alga) - members of the plant kingdom containing chlorophyll, unicelluar reproductive structures, and consisting of a single cell, filament, or colony of cells of various organizations but never organized into tissues.

Anaerobic - adjective denoting the absence of free oxygen.

Autotroph (adj. autotrophic) - an organism in which organic matter is synthesized from inorganic substances.

Benthos (adj. benthic) - refers to organisms living or attached to the substrate or bottom material in an aquatic habitat; also refers to deep water life.

Biomass - see standing crop.

Chlorophyll a - the primary photosynthetic pigment in most algae and higher plants.

Community - the assemblage of organisms at a particular location or habitat. This term implies interrelationship between the species in the community and the chemical and physical aspects of the environment.

Diatom - a type of alga encased in a silica shell, often the most abundant organism in fresh water; a member of the phylum Bacillariophyta.

Diel - relating to a 24-hour period that usually includes a day and the adjoining night.

Diversity index ($\bar{d}$) - a numerical value for diversity. It is calculated with a variety of equations and is usually a function of the number of species present (s), number of individuals per species (n_i), and total number of individuals in the sample (N).

Eutrophication (n), (adj. eutrophic) - enrichment of water, a natural process that may be accelerated by the activities of man; pertaining to waters in which primary production is high as a consequence of a large supply of available nutrients.

Fauna - the animal life in a particular habitat or area.

Filament - in the algae a linear arrangement of cells joined together end to end; thread of cells.

Herbivore - an organism that obtains its nourishment by consuming plants.

Heterotroph (adj. heterotrophic) - an organism that requires organic material as a source of nutrition.

Invertebrate - an animal without a backbone.

Larvae - juvenile insect which hatches from the egg in an early stage of metamorphological development and differs fundamentally in form from the adult.

Lenthic - an adjective referring to standing waters.

Littoral - refers to the shallow water near the shore, usually of a lake.

Lotic - an adjective referring to flowing water.

Mesotrophic - a lake or stream intermediate in age between an oligotrophic and eutrophic condition; productivity is moderate.

Oligotrophic - pertaining to waters in which primary production is low as a consequence of a small supply of available nutrients.

Organic carbon - carbon incorporated into organic molecules from CO_2, through the process of photosynthesis.

Periphyton - the assemblage of organisms attached to the substrate; in this paper the term refers only to the algae.

Phytoplankton - suspended or drifting algae unable to swim against the current.

Pooled sample - combining the data from two or more samples of the same type for the purpose of computing diversity for a larger total number of organisms, usually resulting in a more accurate estimate of diversity. The number of individuals per species (n_i) is combined. The total number of species (s) increased and the total number of organisms (N) is the sum of "N" for each sample.

Primary productivity - the rate at which radiant energy is stored by photosynthetic and chemosynthetic organisms in the form of organic substances.

Productivity - the total amount of living matter produced in an area per unit time.

Pupae - in insects, the resting or inactive stage between larvae and adult.

Secondary productivity - the rate of increase of organic matter in the heterotrophs of the community.

Standing crop - the amount of living matter present at any given time, expressed as the number or weight per unit area or volume of habitat.

Substrate - the physical surface upon which something lives.

Taxon (pl. taxa) - a category in which a group of organisms are placed which denotes that they have similar genetic and morphological characteristics.

Vertebrate - an animal with a backbone enclosing a nerve cord.

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