WORKING PAPER

NO. 30
May 1976

CLIMATOLOGICAL AND WATER QUALITY DATA --
CARIBOU-POKER CREEKS RESEARCH WATERSHED

U. S. ENVIRONMENTAL PROTECTION AGENCY
CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY
ARCTIC ENVIRONMENTAL RESEARCH STATION
COLLEGE, ALASKA 99701
CERL-014

CLIMATOLOGICAL AND WATER QUALITY DATA

CARIBOU-POKER CREEKS RESEARCH WATERSHED

by

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INTRODUCTION

The Caribou-Poker Creeks watershed was selected in 1969 as a site where agencies and individuals with interests in water and related research could conduct studies within a coordinated framework. Research watersheds are important areas for obtaining basic information on relationships between land, water and climate. This particular research watershed is rather unique because one of the two basins has been set aside for "planned disturbances," while the other basin will be preserved in its natural state as a control. Slaughter (1973) describes these basins in detail and presents the rationale and history of their selection. Figure 1 shows the topography and distribution of the various sub-basins comprising the entire watershed, and lists the stations and their respective numbers. "Planned disturbances" such as oil spills, road construction, forest fires, etc., under controlled and carefully monitored conditions will provide resource managers and regulatory officials with sufficient information to minimize the environmental impact of large-scale disturbances. A recent paper (Slaughter and Helmers, 1974) presents a broader overview and stresses the need for hydrological research in subarctic regions.

The Arctic Environmental Research Station (AERS) has been involved in water quality research in these basins since the basins were established. In 1971, Laboratory personnel sampled all tributaries monthly throughout the summer. Field chemistry and stream discharge measurements (11 in all) were accomplished at the sampling site. Chemical and biological samples were collected for laboratory analyses. Three similar sampling runs were completed in the summer of 1972. Jinkinson et al. (1973) report on the biological findings and present water quality data for the mainstreams of Poker and Caribou Creeks. More complete data for all stations are included in this report.

All data collected before fall 1972, represent summer conditions. To collect the necessary year-round data in 1972, a permanent field site was established as a cooperative venture with the U.S. Forest Service, Institute of Northern Forestry, Fairbanks, Alaska, and the U.S. Army Cold Regions Research and Engineering Laboratory, Ft. Wainwright, Alaska. This field station provides the capability for continuous water quality monitoring of Poker and Caribou Creeks and the collection of some climatological data. This report describes the establishment of the field station; presents some climatological data; discusses the water chemistry data from 1971 and 1972; includes the monitoring data for 1973, the winter data for 1974; and briefly considers future plans and modifications for the field station.

FIELD STATION

Description

A 20-foot laboratory trailer, two robot water quality monitors, a 3-KW heavy-duty, diesel-powered generator and some climatological instruments were acquired as a preliminary step in establishing a field station

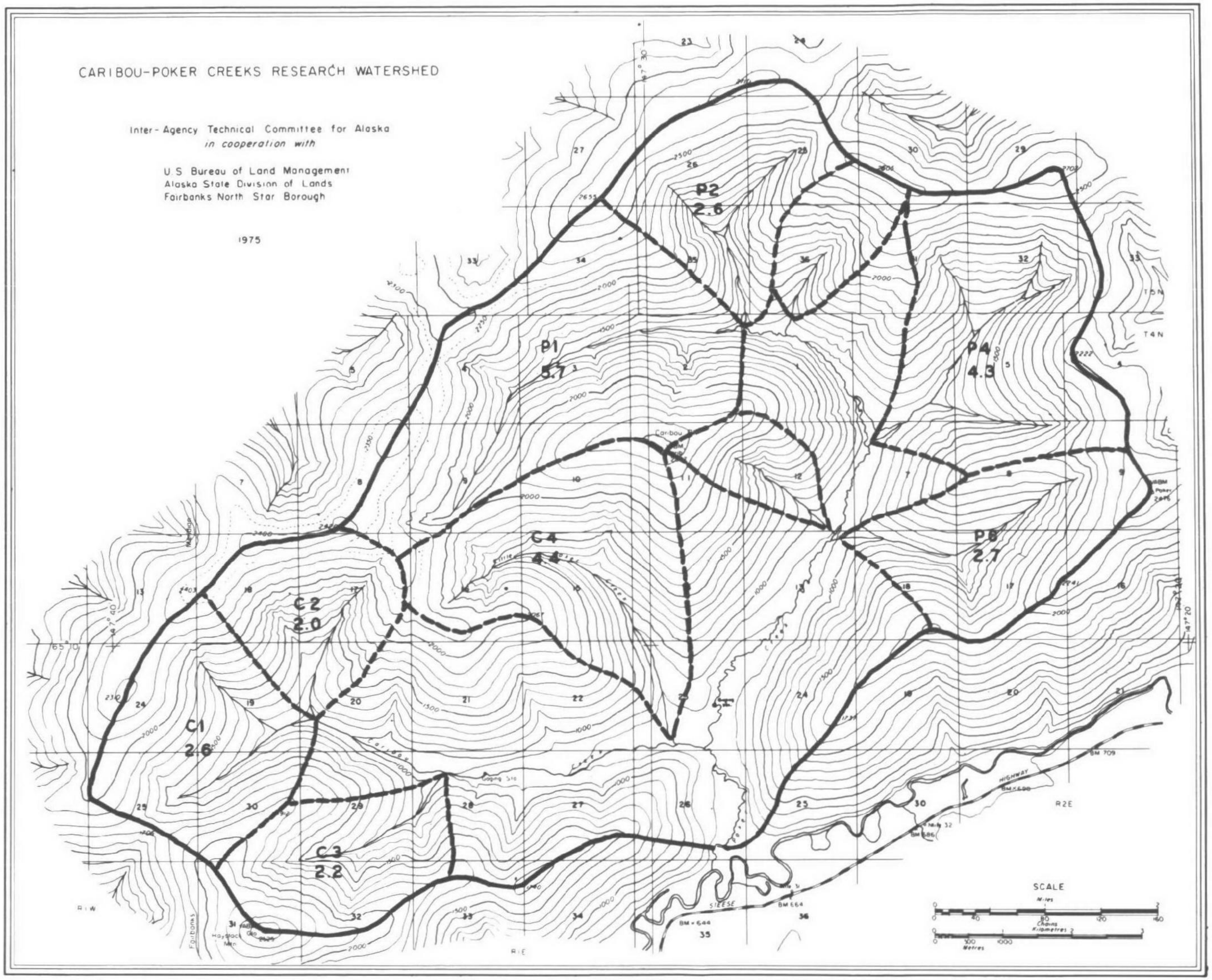

Figure 1. Topographic map of the Caribou-Poker Creeks Research Watershed. Heavy solid lines outline the entire basin; dashed lines outline sub-basins which are designated as C for Caribou and P for Poker Creek; number below each sub-basin designation is the area of that basin in square miles.

independent of commercial power. The confluence of Caribou and Poker Creeks was selected as the site which would permit continuous sampling of both streams with minimal effort. Figure 2 shows the summer appearance of the site before the trailer was installed. The trailer was equipped with a propane furnace and conventional laboratory furniture. The total weight was approximately 4 tons. Since the nearest road is more than 2 miles from the site, the trailer was airlifted by an Army Chinook helicopter (Figure 3) from a staging area at the University of Alaska Poker Flat Rocket Range. Three additional helicopter loads (Figure 4) brought in timbers and building material to construct housing for the generator, a 500-gallon fuel tank, the diesel-generator unit, and 12 drums of fuel. All equipment was flown in on October 19, 1972.

Ground access to the field station is over a trail that permits a tracked vehicle to reach the site from the Steese Highway, about 2 miles away. Although the trail fords the Chatanika River 0.5 miles from the highway, there are no problems during normal flow or in winter. However, during spring breakup and fall freezeup, a vehicle cannot be used to cross the river. During these periods visitors must walk in from the river after crossing it on foot or in a small boat.

Both the generator housing and the laboratory trailer were placed on timber foundations about 3 feet above ground to avoid icings common to this area in late winter and early spring. The generator shelter was insulated with 1 inch of styrofoam on the walls and 2 inches overhead. Figure 5 shows the site as it appeared in November 1972. Although the 1972-1973 winter was rather mild, below zero temperatures coupled with the short day-length, prolonged the time required to complete the installation. Thus, it was not until March 1973 that water was actually flowing through the water quality monitor.

In 1974 the Witte diesel-generator unit was moved to another shelter across Poker Creek opposite the utiliduct. This move reduced the fire hazard and will allow the old engine house to be used for storage. A second diesel unit (Onan, two-cylinder, air-cooled) was also placed in the engine shelter to provide a backup power source and for supplementary power during brief periods.

Instrumentation

A standard "Cotton Region" instrument shelter was erected December 12, 1972, and a set of maximum-minimum thermometers installed. From that date, weekly maximums, minimums, and temperature at time of observation were recorded. A Friez wind speed and direction recording anemometer was installed but, because of various delays, continuous records were not available until February 1973. Similar delays prevented the operation of a heated tipping bucket precipitation gauge. Thus, records of precipitation were not collected until May 1973 when an event recorder was installed which functioned satisfactorily. A Forest Service 8-inch diameter aluminum rain gauge, also installed in May 1973, supplemented the recording gauge.

A general description of the Schneider Water Quality Monitor and its installation follows: The instrument takes in water continuously through an immersion pump suspended in the stream, passes it through several sensors in its lower bay, and returns the sampled water to the stream via a

Figure 2. Confluence of Caribou and Poker Creeks; Caribou on the left, Poker on the right. Trailer site is just above this confluence and within 40-50 feet of each creek.

Figure 3. Airlifting the laboratory trailer by Chinook helicopter. This trailer weighed 4 tons and was placed within 5 feet of the marked landing area. Caribou-Poker Creeks Research Watershed.

Figure 4. Unloading the Chinook at the field site. Caribou-Poker Creeks Research Watershed.

Figure 5. Laboratory trailer and generator shelter established on timber foundation. The tracked vehicle is a Thiokol owned by the U.S. Forest Service. Caribou-Poker Creeks Research Watershed.

gravity drain. The instrument analyzes the water with electronic processing units located in the middle bay and can continuously record up to seven parameters (pH, temperature, turbidity, dissolved oxygen, temperature, radiation, and redox potential). A multipoint recorder is mounted at the top of the unit giving a total height of about 5 feet; floor space requirements are about 4 square feet.

A utiliduct was constructed of 1-inch lumber to connect the monitor with the stream. It was lined with 2 inches of styrofoam for insulation, with resulting interior dimensions of 3 x 4 inches. A 1-inch diameter plastic intake line carries the pumped water to the monitor and a 2-inch plastic pipe acts as the gravity drain. The intake line was wrapped with heat tape to protect against freezing. Poker Creek's utiliduct is about 50 feet long and Caribou Creek's is 110 feet. Immersion pumps are suspended beneath the utiliducts with their intakes located several inches above the stream bottom to avoid drawing in bottom sediments. A power cord leads from the trailer through the utiliduct to the pump.

Although a monitor was installed and operating by March 13, 1973, continuous records were not obtained until after April 6 because of a heat tape failure which resulted in a frozen intake line. After April 6, the monitor ran continuously, with some temporary clogging during high water, until October 12 when the pump stopped running. The pump was restarted but sometime between October 29 and November 2, the propane used for trailer heat was exhausted which caused the trailer to get cold enough to freeze the drain line. From this time, no monitoring data were generated for a variety of reasons, including frozen pipes, stream icing and engine failure.

The second monitor (Figure 6) was installed in June 1974 to monitor Caribou Creek. Five parameters were measured in the initial installation: conductivity, temperature, dissolved oxygen (D.O.), solar radiation, and pH. Although the monitor was outfitted with turbidity and redox potential modules, they were never used because of calibration problems. An experimental bubbler stream stage recorder was installed in Caribou Creek to obtain a continuous record of stream stage. However, electronic problems developed and the record is brief.

In September 1973, a data logger and transmitter (purchased by the U.S. National Weather Service) were installed in the laboratory trailer and a micromet station established nearby (Slaughter, Hofeditz, et al.). Data from this station will be transmitted by radio to the U.S. Forest Service Laboratory on the University of Alaska Campus via a radio repeater station (Figure 7) on Caribou Peak. Because of design problems and delays in installation of equipment, no data have been collected through the system to the date of this report. Ultimately, all data generated at the trailer site will pass through the system at the Forest Service base station in a standardized form permitting computerized analysis and storage. Eventually data from additional meteorological stations also will be transmitted through the system. All data generated within the watersheds will be in a mode facilitating electronic data processing and storage, thereby eliminating strip chart recorders and manual data reduction except as backup.

Figure 6. Interior of field laboratory in late 1974; both monitors on the right, data logger at extreme left, and several recorders on bench in the background. Caribou-Poker Creeks Research Watershed.

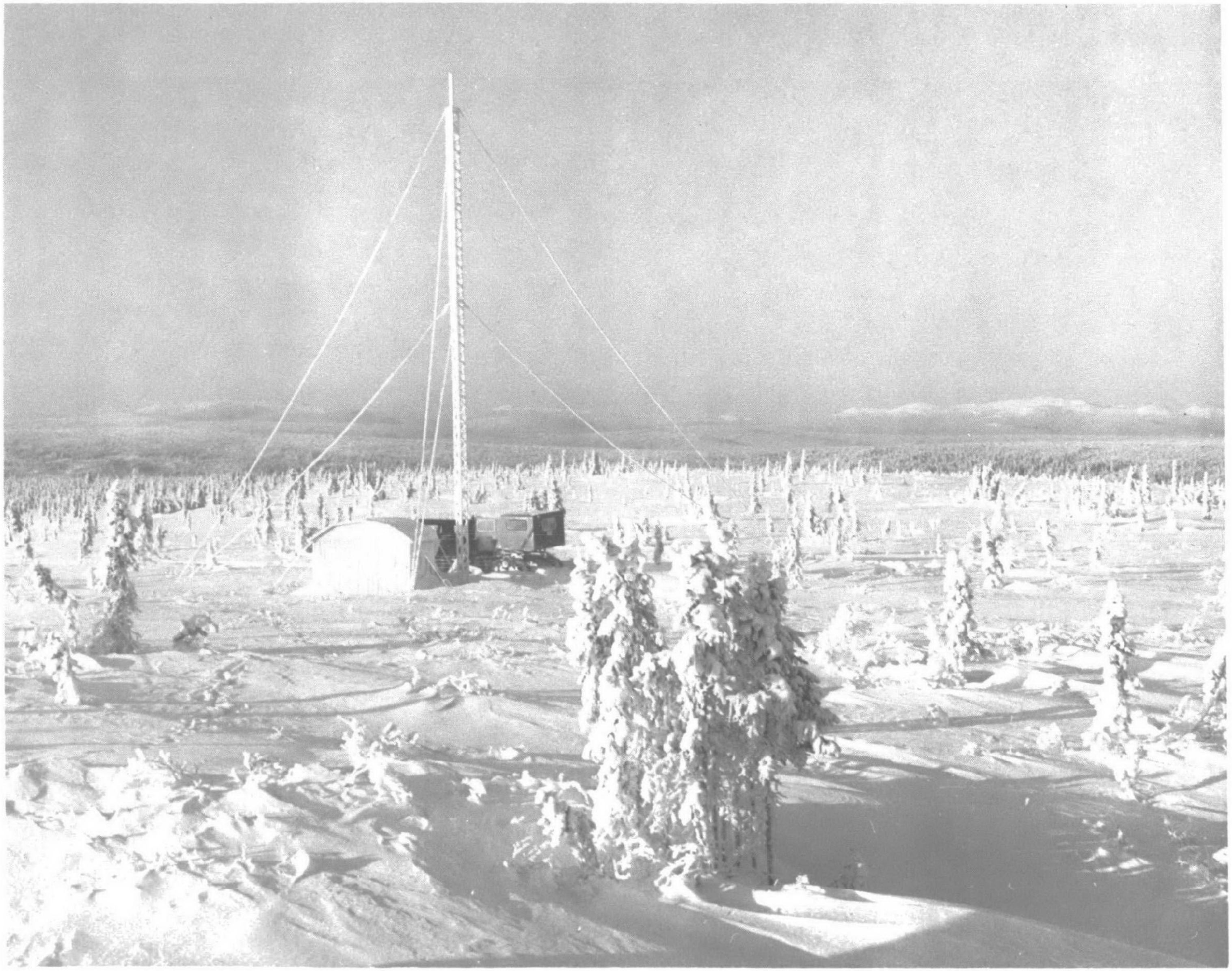

Figure 7. Caribou Peak in winter showing antenna and the shelter for radio relay gear. Caribou-Poker Creeks Research Watershed. (Photo by U.S. Forest Service)

CLIMATOLOGICAL MEASUREMENTS

Weekly observations of stream and air temperatures, precipitation, and winds at the field station provide some interesting data included in this section as figures with brief dicussion.

Water temperatures, measured at monthly intervals in 1971, indicated that during the summer, Poker Creek was consistently warmer than Caribou Creek. Figure 8, which summarizes weekly measurements from breakup to freezeup in 1973, demonstrates that Poker Creek remains warmer throughout the summer. Ice on Poker Creek went out during the week of May 10-17 and the water temperature in both creeks was first measured on May 29; at that time the temperature of Poker Creek was 5.4°C, compared to 3.6°C for Caribou. Similar differences persisted until late August when the creeks were within one degree of each other. In late September, water temperatures of both creeks were the same with freezeup occurring by October 16 when temperatures for both streams reached 0.0°C. Water temperature under ice in this environment remains within 0.2°C of freezing until breakup.

Without water temperature data for the tributaries, any explanation of the temperature difference between these streams is speculative and tentative. However, one possible explanation is the orientation of each stream to insolation. Poker Creek flows generally in a south-westerly direction in a flat valley and is exposed to afternoon sunlight throughout much of its length. Caribou Creek, on the other hand, flows mostly eastward; hence, it receives less direct insolation. Tributaries of Poker Creek, except P-1, also have a more favorable orientation to receive insolation than do those of Caribou Creek.

Figure 9 presents weekly maximum-minimum air temperatures from January 1 to December 21, 1973. The minimum recorded during this period was 48°C below zero and the maximum was 23°C. The maximum temperatures did not rise above freezing until the end of March and dropped below freezing during the last of October; thus, for about 5 months, maximum temperatures were below freezing. Minimum temperatures did not rise to freezing until the second week in June and then only for a two-week period; they again dropped below freezing in June and July. A second brief period of frost-free temperatures occurred in the second and third weeks of July, giving a total of about one month of frost-free weather throughout the summer. Even when minimums were above freezing, they never exceeded 2°C.

Figure 10 presents similar data for 1974; these curves closely follow those for 1973. Fairbanks data show that minimum temperatures are above freezing for about a 2-month period each year. Caribou-Poker Creeks watersheds definitely have a colder temperature regime than does Fairbanks which is situated on the broad Tanana Valley.

Continuous wind data are not available at this time. However, visual observations of the anemometer indicate that winds are light and variable except during passage of major fronts.

The direction of the light winds tends to alternate back and forth down the two stream valleys. Even when no velocity is being recorded, one notices the vane facing up one valley and then the other; seldom

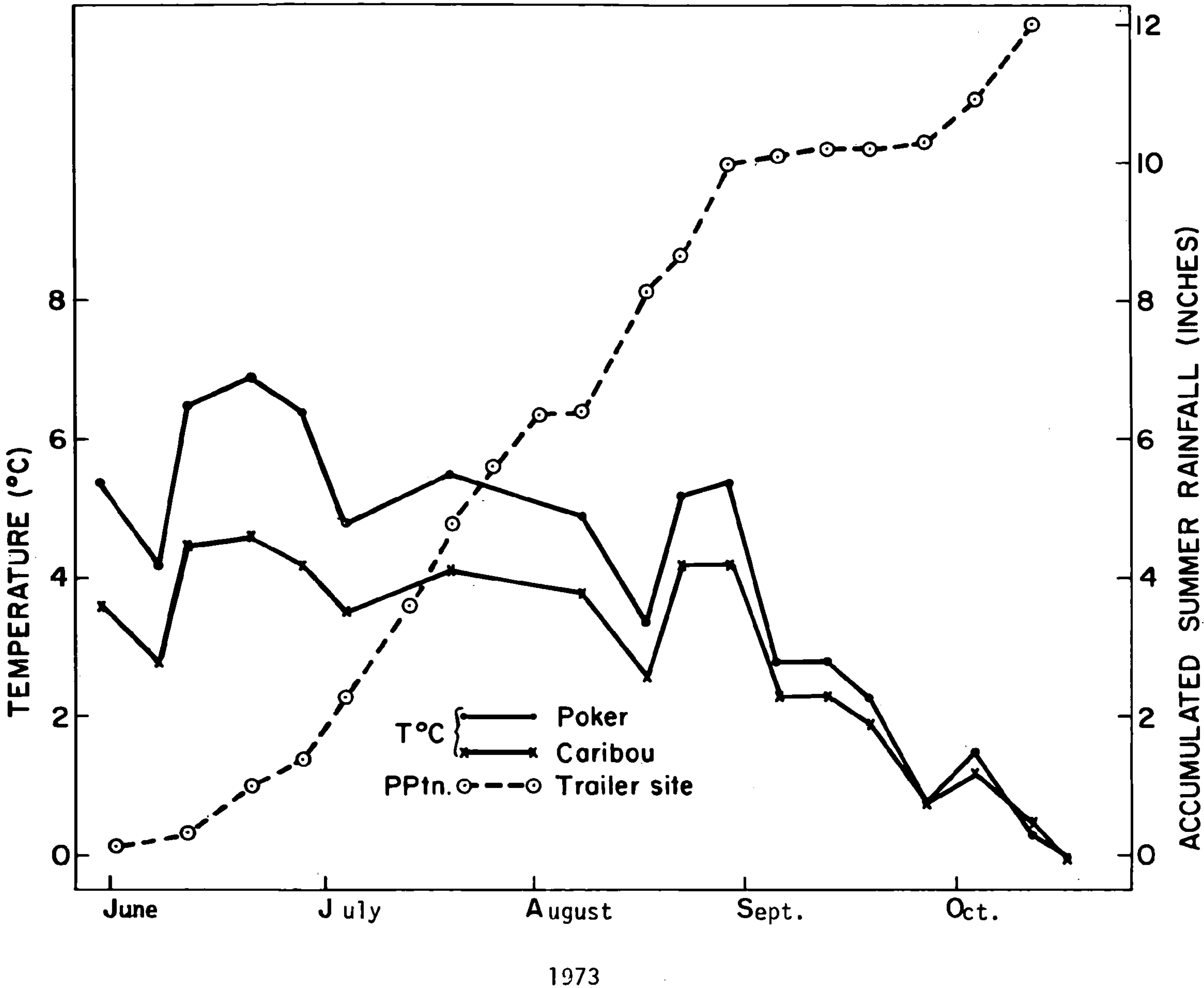

Figure 8. Summer water temperature for Caribou and Poker Creeks (1973) and precipitation from breakup to freezeup at field station. Caribou-Poker Creeks Research Watershed.

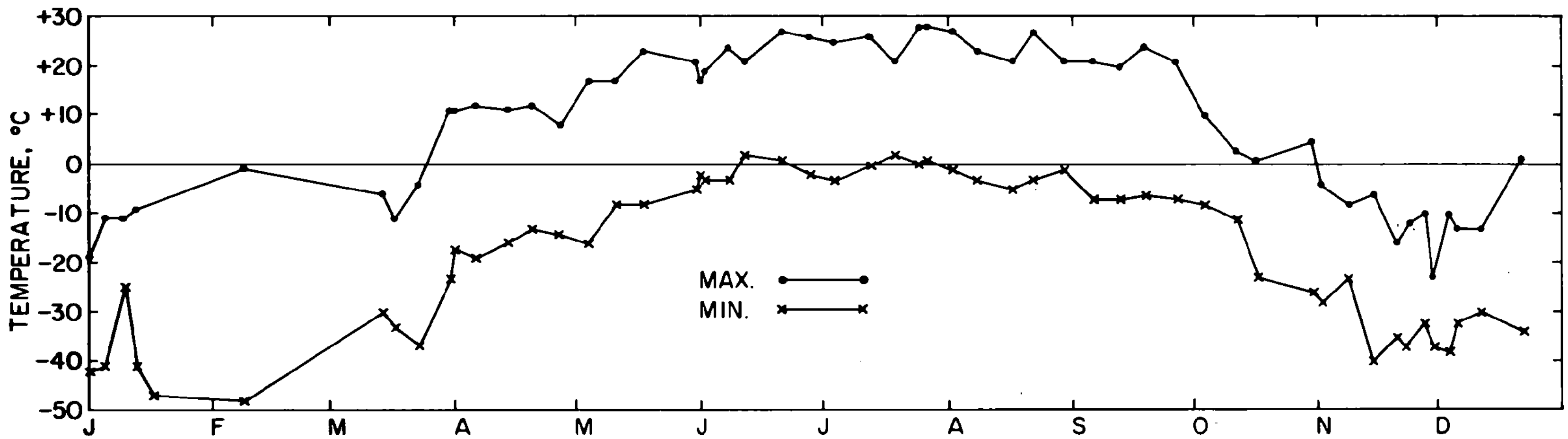

Figure 9. Air temperatures at the field station (1973). Caribou-Poker Creeks Research Watershed.

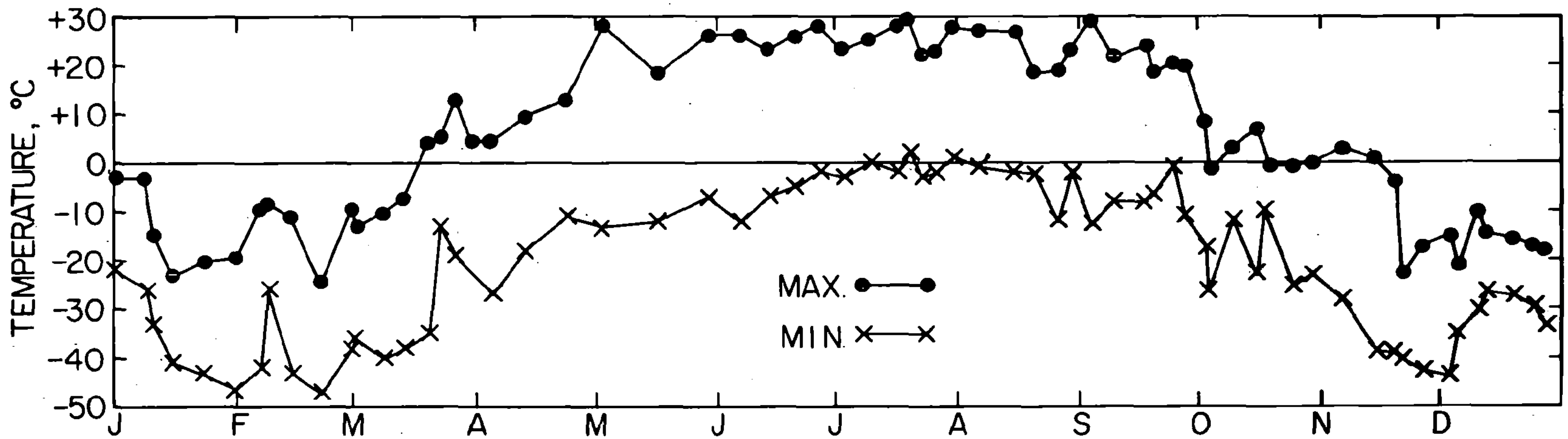

Figure 10. Air temperatures at the field station (1974). Caribou-Poker Creeks Research Watershed.

was it facing downstream toward the south. These generally light winds are in sharp contrast to the stronger winds on the surrounding peaks at 2400-2700 feet (Slaughter et al., 1974).

Rainfall measurements are also summarized in Figure 8 for 1973 as an accumulative curve from late May until freezeup in October. Total rainfall for that period was about 12 inches which is greater than the normal yearly rainfall for Fairbanks (the nearest weather station with long records). The only dry period that summer occurred in September; otherwise rainfall was well distributed. Data collected for 1974 show a similar pattern; however the total was only about 7 inches.

Table 1 shows the daily readings of the tipping bucket recording rain gauge for the summer of 1973 and for July 1974 through February 1975. These data clearly indicate that June, July and August 1973 were rainy with a relatively dry September. Accumulated rainfall measured with this gauge for a five-month period was about 2 inches more than measured with the non-recording gauge. No explanation for this discrepancy is offered at this time. The record for the period of December 1973 through June 1974 was not available for inclusion in this report. Accumulation for July through October 1974 was 5.2 inches.

The sketchy data presented here suggest that the climate at the Caribou-Poker watershed is considerably different from Fairbanks. These variations from the considered regional norm are valid reasons for conducting climatological research in small watersheds. The small, consistant differences in water temperature between the main stems of these streams clearly suggest that what may appear as a constant for small streams is not truly constant and small variations to orientation can cause significant temperature differences. This hypothesis needs to be verified by continued observations and expansion of the climatological and water sampling network.

WATER DATA

Field Measurements

Temperature, pH, conductivity, alkalinity, and dissolved oxygen were measured as soon as possible after collection. Whenever possible, samples were transported to a small tracked vehicle (Thiokol Imp) or the field station for analysis.

pH was measured with a Model 401 Orion Specific Ion Meter. Conductivity measurements were made using a Beckman Model RB3-338 bridge with an epoxy dip cell with a constant of 0.2. Alkalinity was measured by substituting methyl purple for the methyl orange indicator and then following the procedures specified in Standard Methods. Titration for alkalinity was performed with a 10 ml pipet controlled by a safety filler which allows drop-sized control. Dissolved oxygen was measured by two methods: a YSI D.O. meter and the Hach dry chemical pillow method using 300 ml bottles. In the Hach method, D.O. was fixed immediately after sampling and transported to the laboratory for final titration.

Discharge measurements were made using a Price type AA current meter and standard techniques outlined by the U.S. Geological Survey.

TABLE 1

DAILY PRECIPITATION (INCHES WATER EQUIVALENT)
CARIBOU-POKER CREEKS RESEARCH WATERSHED

Station: Confluence of Caribou and Poker Creeks — Elevation Approximately 725' msl

	1973								1974						1975	
MONTH	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Day																
1			.47			.18									.01	
2		.24	.35			.06				.28						
3		.47	.03	.01	.01	.09				.18			.07			
4		.01	.02		.01	.04						.09				
5				.01		.29						.04		.17		
6		.26	.67	.02		.07			.10			.01				
7			.02		.01		.05		.32			.02				
8			.01			.01			.06	.09		.05	.03			
9				.13	.10					.20		.03	.03	.04	.02	
10	.01	.17	.01	.88	.03		.50		.02	.01			.01			
11		.16	.16	.54			.02		.11				.16			
12		.02	.45	.21	.01	.86				.57			.17			
13			.48	.03						.25						
14		.50	.05	.02	.02				.07	.15		.14	.02		.01	
15			.48							.03		.01	.16	.02	.01	
16		.02							.06	.04	.14	.10		.01		
17			.01	.01								.19				
18	.12		.11	.16					--	--	--	--	--	--		
19			.78				.07		.10	.08						.08
20	.01		.15	.06			.03				.01					
21		.28		.82	.01						.11					
22				.37							.05					
23	.04	.04			.05				.20		.22	.04	.01			
24		.06	.10		.01				.04		.11		.05	.01		
25	.24			.04	.01				.01		.15					
26	--	--	--	--	--					.01	.04			.01	.22	
27			.01	.55						.16				.01	.29	
28		.02	.14		.03					.40					.06	
29		.01	.58		.10		.11		--	--	--	--	--	--	.01	
30	.09	.02	.02		.02				.09		.03				.	
31	.02		.08	.01										.08		
TOTAL:	.53	2.28	5.18	3.87	.55	1.60	.78		1.18	2.45	.86	.72	.71	.35	.64	.08

Summer

Similarities and differences among the tributaries are apparent in scrutinizing the summer field data for 1971 (Table 2). Water temperatures for 1973 were discussed earlier but these were from one site on each stream at weekly intervals. Temperature data in Table 2 show that tributaries of Caribou Creek are not consistently cooler than those of Poker Creek but, at the confluence of the streams, Poker Creek remains warmer than Caribou Creek until the end of the summer. At this time, all temperatures were less than 1.0°C except at station C-4 which remained above freezing at 1.8°. Similar trends occur in the summer data for 1972 (Table 3).

The pH range was within 2.0 units for all streams during both summers with no apparent trends or recurring patterns. This narrow range is indicative of the absence of unusual chemical factors and is nearly ideal for aquatic life.

Dissolved oxygen during the summer of 1971 was found to be high in all streams at the time of measurements. Data are insufficient to detect any seasonal trends or patterns among tributaries.

The waters of Caribou-Poker Creeks are quite clear at all times. Even at maximum discharge, suspended sediment was generally low. Discharges among streams show a considerable range which is a reflection of basin size. Seasonal range was considerable with maximums present in August 1971 and in May 1972; discharges measured in June and August 1972 were the minimum recorded.

Conductivity and alkalinity appear to be useful diagnostic tools to detect waters with different characteristics. Early in the course of the field work it was noted that Poker Creek appeared to have a higher conductivity and alkalinity than did Caribou Creek. The same was true for the tributaries although there was a wide range in the values among various basins with stations P-1 and P-6 usually higher than the others. An exception to this observation occurred on August 8, 1972, when conductivity and alkalinity were higher in Caribou than in Poker Creek at their confluence.

Winter

Systematic winter sampling for water quality was first attempted in these watersheds in the winter of 1974-1975. Because a trail network existed for only Caribou Creek, no attempt was made to sample Poker Creek except at the field station site. The winter schedule planned for monthly sampling of four tributaries of Caribou Creek, starting in October, and biweekly sampling of the mainstems of Caribou and Poker Creeks at the field station. No difficulty was experienced through December in sampling any of the small streams; however, by January, all of the tributaries exhibited heavy icings. Since the water surface under the deep ice might be shallow and only a few inches wide, an ice auger was an uncertain way of reaching the flowing water to extract samples. Therefore, no attempt was made to sample these small streams after December. Sampling of P-Main and C-Main was continued throughout the winter; however, the data after December are not reported here.

Field measurement methodology was the same as for the summer work except that dissolved oxygen was measured by the Winkler procedure using dry chemicals instead of solutions or a D.O. meter as in previous years. Samples

TABLE 2

FIELD DATA (1971)
CARIBOU-POKER CREEKS RESEARCH WATERSHED

STATION	DATE	WATER TEMP. °C	SPECIFIC CONDUCTANCE μmho/cm	pH	ALK. mg/l	D.O. mg/l	SUSP.* SEDIMENT mg/l	DISCHARGE cfs
P-1	07/20/71	4.9	135	7.8	45	10.8	1	7.9
P-2	"	4.3	110	8.2	38	11.6	4	7.4
P-4	"	5.0	78	7.6	29	10.6	3	6.2
P-6	"	5.0	115	7.0	41	10.8	4	3.1
C-1	07/21/71	4.7	49	6.8	19	9.2	2	----
C-2	"	4.1	78	7.2	27	11.7	5	----
C-3	"	3.9	62	6.9	19	11.7	7	----
C-4	"	4.6	100	7.7	39	11.6	6	----
P-Main	"	8.6	103	8.2	41	11.0	3	----
C-Main	"	6.6	84	7.5	32	11.3	4	----
P-C	07/20/71	8.1	100	7.0	39	10.2	2	43.9
P-1	08/14/71	3.2	95	7.4	38	----	2	14.1
P-2	"	3.1	105	7.3	38	----	4	13.5
P-4	"	2.9	70	6.9	28	----	1	8.3
P-6	"	2.9	105	7.3	38	----	5	4.4
C-1	"	3.6	29	7.2	15	----	3	5.5
C-2	"	4.1	63	7.1	22	----	7	7.9
C-3	"	3.0	50	6.7	15	----	3	4.3
C-4	"	4.2	95	7.3	35	----	11	5.6
P-Main	"	6.2	92	7.1	36	----	10	40.5
C-Main	"	4.9	36	7.1	32	----	6	25.2
P-C	"	6.0	85	6.6	32	----	5	58.2
P-1	09/08/71	2.3	125	7.2	49	----	2	8.1
P-2	"	2.5	54	7.4	43	----	3	3.9
P-4	"	2.5	80	7.1	32	----	3	5.6
P-6	"	2.3	120	7.5	54	----	--	3.2
C-1	"	2.6	46	7.1	18	----	14	3.1
C-2	"	3.5	75	6.1	26	----	2	2.6
C-3	"	2.3	60	6.7	20	----	3	3.0
C-4	"	3.5	98	6.3	41	----	7	6.0
P-Main	"	5.3	110	6.7	45	----	2	26.3
C-Main	"	3.9	80	6.1	31	----	7	20.4
P-C	"	4.8	98	7.1	38	----	2	44.8
P-1	09/28/71	0.4	125	7.3	53	13.2	2	5.4
P-2	"	0.8	105	7.7	42	12.8	1	2.2
P-4	"	0.8	80	7.4	36	14.0	4	4.0
P-6	"	0.6	120	7.0	46	13.3	4	2.1
C-1	09/29/71	0.6	46	---	19	13.2	--	1.8
C-2	"	0.9	70	---	28	13.8	2	----
C-3	09/28/71	0.6	65	---	23	14.1	3	1.7
C-4	"	1.8	95	---	41	13.6	3	4.1
P-Main	09/29/71	0.0	120	---	47	13.2	2	8.6
C-Main	"	0.1	83	---	36	12.7	2	6.4

TABLE 3

FIELD DATA (1972)
CARIBOU-POKER CREEKS RESEARCH WATERSHED

STATION	DATE	WATER TEMP. °C	SPECIFIC CONDUCTANCE μmho/cm	pH	ALK. mg/l	SUSP.* SEDIMENT mg/l	DISCHARGE cfs
P-1	05/31/72	1.6	55	7.1	17.5	15	17.6
P-2	"	1.8	75	7.2	21.0	38	11.2
P-4	"	2.5	63	---	19.0	15	9.7
P-6	06/01/72	1.9	76	7.3	25.0	16	4.3
C-1	"	1.1	35	6.1	12.0	7	4.9
C-2	"	1.6	54	6.6	17.5	12	3.4
C-3	"	0.8	30	6.8	8.0	9	4.1
C-4	"	2.0	80	7.2	29.0	21	5.5
P-Main	05/31/72	4.5	75	---	23.5	25	49.3
C-Main	"	4.2	55	---	17.0	27	27.7
P-C	"	5.9	65	---	22.5	54	76.4
P-1	06/29/72	5.2	100	---	49.0	--	4.3
P-2	"	3.8	100	---	38.0	--	2.8
P-4	"	3.4	81	---	32.0	--	4.1
P-6	"	3.6	119	---	42.0	--	2.2
C-1	"	3.2	50	---	20.0	--	2.2
C-2	"	3.2	78	---	23.0	--	1.9
C-3	"	3.0	75	---	21.0	--	1.0
C-4	"	4.2	98	---	39.0	--	2.5
P-Main	"	8.5	114	---	46.0	--	17.6
C-Main	"	6.2	85	---	36.0	--	9.2
P-C	"	8.8	110	---	42.0	--	27.2
P-1	08/21/72	4.4	140	8.0	54.0	--	5.0
P-2	"	3.9	124	7.8	43.0	--	1.3
P-4	"	3.8	90	7.4	35.0	--	3.8
P-6	"	3.8	133	7.2	49.0	--	2.0
C-1	"	5.3	59	6.9	22.0	--	1.9
C-2	"	5.3	60	6.9	29.0	--	1.1
C-3	"	3.9	69	6.9	23.0	--	1.3
C-4	08/22/72	2.7	105	7.1	42.0	--	2.4
P-Main	"	4.9	78	7.3	35.0	--	14.2
C-Main	"	3.4	95	7.3	50.0	--	12.0
P-C	"	5.3	120	7.3	45.0	--	27.1

*This analysis was performed in the laboratory but is listed here for convenience.

for lab analyses were collected at the same stations where the field chemistry was done. Chemical measurements were made in the heated, rear compartment of the Thiokol and consisted of conductivity, pH and total alkalinity in addition to D.O. Figure 11 shows the inside of the Thiokol with the field gear assembled. One objective of the field chemistry was to make the measurements (as nearly as possible) at ambient water temperatures to which aquatic life is exposed. Conductivity was measured at +1°C, alkalinity at 2-4°C, and pH about 5°C. The pH meter was standardized to compensate for temperatures over the pH range of 7.0 to 9.2.

Sampling of the mainstems of Poker and Caribou Creeks became more difficult as winter progressed because overflow greatly increased the ice thickness. During the winter of 1973-1974, the entire area surrounding the confluence of Caribou-Poker Creeks was one expanse of ice averaging 8-10 feet thick over the stream channels. Unless one knows in advance where to drill in these small streams, the chances of hitting water instead of gravel is quite small because nothing remains above the ice to mark the channel. If gravel is hit, the auger bit cannot be reused without resharpening. Figure 12 shows these icings in March 1974; compare with Figure 5. Figure 13 shows the ice auger used to drill through 12 feet of ice. Since the location of the channel was known, excellent samples were obtained.

Variability among streams and seasonal trends for conductivity and alkalinity are shown in Figure 14. In plotting these curves, data from previous summers were used to show the seasonal trends as summer passed to winter. Freezeup is sometime in October when the stream water has cooled to 0°C and a continuous ice cover is present except in limited reaches with fast water.

Summer data for these two parameters were discussed earlier and will not be described here other than to point out the variability among streams of Caribou Watershed. Some of the variability among streams with respect to conductivity appears to be related to discharge, with low values at high flows and high values at low flows, when ground water has more influence with its higher electrolyte content. Data for Poker Creek tributaries are not plotted because winter data are nonexistent; only P-Main is shown on these curves. As noted earlier, Poker was always higher in conductivity than was Caribou Creek and this condition persisted into the winter. All streams tended to increase in conductivity as winter progressed, although C-4 showed a slight decrease from November after a marked increase in October. This continued increase in conductivity probably reflects the influence of ground water as winter progresses. By the end of the winter, the conductivity of Poker Creek exceeded 200 umho/cm.

Alkalinity showed similar trends with an abrupt increase at freezeup which later dropped but still remained higher than the summer values. That rather spectacular, surprising increase may be related to some phenomena associated with changes as winter conditions approach. The increase in alkalinity at freezeup requires validation and a concerted effort will be made to intensively sample these streams next year at freezeup.

Figure 11. Interior of Thiokol tracked vehicle while measuring conductivity, pH, and total alkalinity by field chemistry methods; titration for alkalinity underway.

Figure 12. Icings in late winter before breakup. Compare with Figure 5 to get some measure of the ice depth. Caribou-Poker Creeks Research Watershed.

Figure 13-A

Figure 13-B

Figure 13. Ice auger used to drill through 12' of ice prior to breakup when overflow has caused maximum ice depth. Caribou-Poker Creeks Research Watershed.

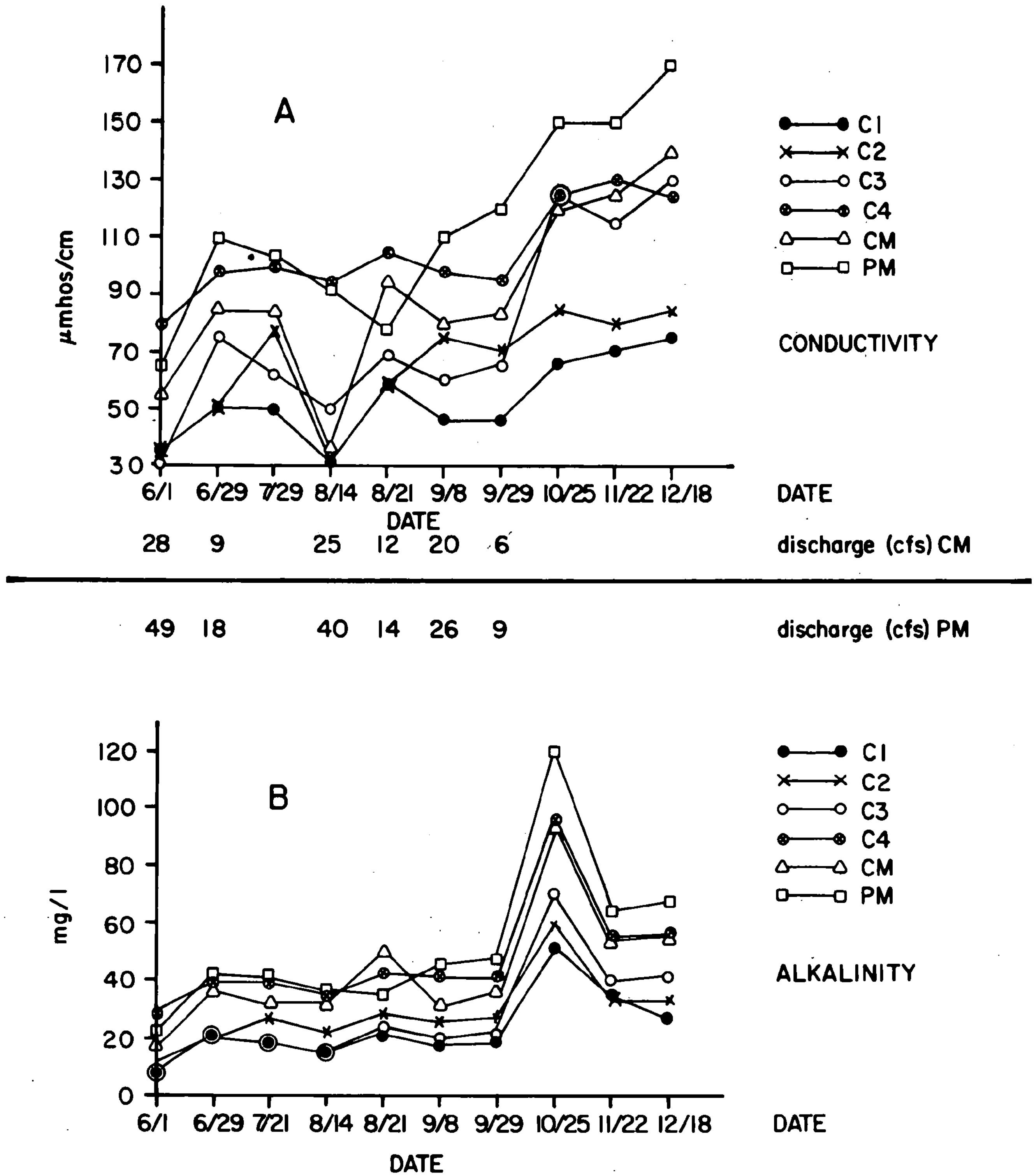

Figure 14. Conductivity and alkalinity data comparing summer and winter values. Summer values are from 1971 and 1972; winter data are from October-December 1974. Caribou-Poker Creeks Research Watershed.

Data for dissolved oxygen (Table 4) clearly show that all these streams were near saturation (12-13 mg/l) at freezeup and remained high as ice cover became continuous. Stations P-Main, C-Main, and C-4 were still near 11 mg/l or more in December; however, the remaining small streams decreased in D.O. as winter progressed with station C-1 at 6.9 mg/l in December. Such depletion in D.O. as winter progresses has been reported earlier (Schallock and Lotspeich, 1974) and is related to a thick, continuous ice cover. The icing phenomena with its attendant overflow is apparently a significant factor in winter D.O. levels.

pH remained relatively static or tended to decrease under winter conditions with most stations indicating near neutrality, the lowest being C-4 with 6.6 in December. All of the streams are near the optimum pH for aquatic life. These small variabilities suggest that no adverse effects should be caused by small changes in this parameter.

Laboratory Analysis

During 1971 and 1972, water samples were collected at the same stations where field chemistry was performed. These samples were analyzed in the laboratory for nutrients and trace elements (Tables 5 and 6). Additional samples were taken in 1974 (Table 7). Several ions were determined that do not appear in the tables. These ions where near the lower limits of detection and showed only slight variability in time or among streams. They included Mn, NO_2-N, O-PO_4-P, and NH_3-N: and will not be discussed further in this report.

Five elements, copper, lead, arsenic, manganese, and zinc were present in very low concentrations near the lower detection limits of our instrumentation. Three of these, copper, manganese and zinc are essential minor elements for aquatic life and their presence in all samples indicates that they should not limit life in these waters.

The two essential nutrients of the nitrogen cycle, phosphate and nitrate, were very low in these waters but they did show variability among streams, especially nitrate. Concentration levels of both ions were similar over the 3-year sampling period. Such similarity in data for widely spaced sampling periods suggests a high degree of reliability in sampling and analytical procedures.

Iron, another essential element, is present in low concentrations but does not show real trends among streams or with time. Chloride appears in these waters but in modest to low concentrations with Poker Creek being higher than all others; chloride seems to be highest in October just at freezeup.

A Technicon Auto-Analyzer I was used to determine NH_3-N, NO_2-N, NO_3-N, O-PO_4-P, T-PO_4-P, Cl and SiO_2 by EPA approved methods for automated analyses as found in Methods for Chemical Analysis of Water Wastes, 1971. The procedure for the sulfate determination is found in Standard Methods for the Examination of Water and Wastewater, 13th edition, p. 334, method 156C (1971). Total carbon was determined with a Beckman Model 915 Total Organic Carbon Analyzer. The remaining elements were determined with a Perkin-Elmer 303 Atomic Absorption Spectrophotometer and a Perkin-Elmer HGA-2000 graphite furnace.

TABLE 4

DISSOLVED OXYGEN (1974) mg/l
CARIBOU-POKER CREEKS RESEARCH WATERSHED

DATE	STREAM					
	C-1	C-2	C-3	C-4	C-M	P-M
* 4/12	----	----	----	----	11.3***	13.8
** 6/13	----	----	----	----	12.7	12.5
10/25	12.4	13.0	13.3	----	----	----
10/30	----	----	----	13.3	12.6	12.6
11/14	----	----	----	----	12.2	12.8
11/22	9.1	12.0	12.6	----	----	----
11/26	----	----	----	12.4	12.1	12.3
12/10	----	----	----	----	11.0	12.2
12/18	6.9	10.0	9.5	12.1	----	----
12/24	----	----	----	----	10.6	12.2

* Pre-breakup.
** Post-breakup.
*** Includes C-1 and C-2 only.

TABLE 5

LABORATORY ANALYTICAL DATA (SUMMER 1971) mg/l
CARIBOU-POKER CREEKS RESEARCH WATERSHED

STATION	DATE	SO_4	SiO_2	Ca	Mg	K	Na	Fe	T-PO_4-P	NO_3-N	Cl	TC
P-1	07/20/71	10.0	6.1	12.9	4.26	0.45	0.81	0.07	<0.01	0.24	16.8	14.4
P-2	"	9.0	6.3	11.7	3.68	0.38	0.70	F0.01	0.01	0.56	3.8	8.6
P-4	"	5.0	6.2	10.6	1.85	0.38	0.98	0.09	<0.01	0.31	2.0	8.3
P-6	"	12.0	6.6	17.2	2.94	0.42	1.10	0.21	<0.01	0.24	1.1	8.1
C-1	07/21/71	4.0	6.5	7.89	1.63	0.45	0.74	0.04	<0.01	0.21	1.2	7.2
C-2	"	6.0	6.7	9.32	3.09	0.27	0.79	0.04	0.02	0.44	1.1	7.9
C-3	"	8.0	5.0	15.0	1.66	0.25	0.96	0.08	0.03	0.29	0.1	14.9
C-4	"	7.0	7.0	14.5	3.79	1.09	5.73	0.06	0.02	0.54	1.0	8.4
P-Main	"	9.0	6.6	16.1	3.32	0.40	0.87	0.12	0.02	0.26	1.1	10.1
C-Main	"	7.0	6.8	12.4	2.51	0.38	1.04	0.14	0.02	0.26	0.9	11.6
P-C	07/20/71	8.0	6.6	14.2	2.96	0.47	0.89	0.08	0.01	0.29	1.1	9.7
P-1	08/14/71	8.0	5.7	5.56	3.97	0.55	0.21	0.16	0.06	0.22	0.34	15.5
P-2	"	9.0	6.6	6.22	5.06	0.57	0.23	0.11	0.04	0.56	0.44	13.3
P-4	"	4.0	5.5	4.36	2.28	0.63	0.22	0.18	0.06	0.30	0.29	13.8
P-6	"	11.5	5.4	4.88	3.32	0.61	0.27	0.20	0.06	0.30	0.34	12.4
C-1	"	2.5	4.0	2.38	1.79	0.34	0.15	0.20	0.07	0.24	0.35	7.8
C-2	"	4.0	5.6	3.28	2.98	0.48	0.18	0.06	0.05	0.66	0.88	6.7
C-3	"	8.0	2.8	3.35	0.75	0.37	0.24	0.06	0.06	0.33	0.63	10.9
C-4	"	6.0	6.7	5.97	3.10	0.67	0.31	0.09	0.07	0.34	0.37	6.8
P-Main	"	7.0	6.1	5.64	3.85	0.66	0.27	0.13	0.07	0.30	0.20	10.1
C-Main	"	5.0	4.4	3.34	2.45	0.52	0.23	0.11	0.08	0.26	0.29	8.3
P-C	"	8.0	5.7	4.08	3.32	0.58	0.27	0.10	0.09	0.29	0.29	12.1
P-1	09/08/71	5.0	7.1	10.50	4.66	0.75	0.77	0.34	<0.01	0.25	0.38	18.2
P-2	"	10.0	7.5	8.55	5.00	0.57	0.77	0.24	0.06	0.47	0.17	17.1
P-4	"	6.0	7.7	6.61	2.25	0.64	0.82	0.18	0.07	0.29	0.22	11.7
P-6	"	13.0	8.2	11.40	3.48	0.68	0.91	0.21	0.08	0.58	0.21	11.2
C-1	"	4.0	7.0	4.62	1.56	0.40	0.63	0.15	0.05	0.40	0.73	18.8
C-2	"	6.0	7.8	5.49	3.03	0.53	0.73	0.08	0.06	0.43	0.21	9.5
C-3	"	7.5	6.1	5.49	1.74	0.45	0.73	0.13	0.08	0.33	0.24	12.2
C-4	"	6.0	8.5	7.99	3.29	0.76	0.86	0.14	0.06	0.36	0.27	14.0
P-Main	"	8.0	7.8	9.36	3.94	0.70	0.82	0.18	0.07	0.26	0.22	14.0
C-Main	"	6.0	7.6	5.74	2.76	0.59	0.82	0.23	0.08	0.28	0.78	11.7
P-C	09/08/71	7.0	7.9	8.55	3.41	0.67	0.77	0.19	0.07	0.24	0.24	15.2
P-1	09/28/71	9.4	7.8	18.40	3.90	0.87	0.11	0.05	<0.01	0.26	0.26	17.5
P-2	"	9.1	7.9	17.40	4.50	0.80	0.11	0.28	0.10	0.43	0.30	21.8
P-4	"	3.9	8.5	13.20	1.90	0.75	0.12	0.20	0.06	0.27	0.27	14.3
P-6	"	11.6	8.6	21.3	3.00	0.83	0.14	0.16	0.06	0.28	0.30	15.8
C-1	09/29/71	3.0	8.0	8.3	1.40	0.44	0.09	0.28	0.04	0.22	0.30	13.6
C-2	"	4.4	8.1	9.60	2.70	0.63	0.97	0.09	0.04	0.41	0.30	10.1
C-3	09/28/71	7.2	7.6	16.80	1.80	0.56	0.11	0.12	0.04	0.36	0.30	19.6
C-4	"	6.1	8.7	13.9	2.80	0.88	1.30	0.29	0.07	0.40	0.30	18.6
P-Main	09/29/71	8.2	8.0	16.60	3.40	0.85	0.12	0.64	0.06	0.28	0.30	16.0
C-Main	"	5.4	8.4	12.30	2.50	0.75	0.14	0.20	0.07	0.27	0.30	20.8

TABLE 6

LABORATORY ANALYTICAL DATA (SUMMER 1972) mg/l
CARIBOU-POKER CREEKS RESEARCH WATERSHED

STATION	DATE	SO_4	SiO_2	Ca	Mg	K	Na	Fe	$T\text{-}PO_4\text{-}P$	$NO_3\text{-}N$	Cl	TC
P-1	05/31/72	7.2	1.2	7.6	2.2	0.6	0.7	0.79	0.08	0.15	3.8	15.2
P-2	"	8.6	3.3	9.2	3.6	0.6	1.1	0.94	0.07	0.49	0.5	14.4
P-4	"	3.8	3.1	11.7	1.7	0.7	1.1	0.47	0.05	0.34	10.3	10.3
P-6	06/01/72	9.7	2.8	11.8	2.4	0.7	1.3	1.21	0.09	0.25	0.4	12.0
C-1	"	3.0	2.0	5.9	1.4	0.4	1.2	0.40	0.07	0.24	0.3	9.8
C-2	"	3.8	3.3	6.6	2.3	0.5	1.3	0.21	0.08	0.60	1.7	7.8
C-3	"	5.5	0.6	4.4	1.0	0.4	0.8	0.33	0.07	0.13	5.2	12.2
C-4	"	5.7	3.5	11.3	2.4	0.7	1.6	0.56	0.07	0.44	6.0	9.6
P-Main	05/31/72	7.4	2.6	10.5	2.7	0.7	1.2	0.86	0.07	0.34	16.2	12.8
C-Main	"	5.7	2.1	7.1	2.1	0.6	1.2	0.86	0.09	0.24	2.7	12.0
P-C	"	6.6	2.5	8.9	2.5	0.6	1.1	1.23	0.08	0.28	0.4	12.0
P-1	06/29/72	10.0	2.8	21.8	4.3	0.6	1.4	0.06	0.04	0.32	11.2	----
P-2	"	12.0	2.9	18.9	4.0	0.4	1.3	0.09	0.05	0.78	11.1	----
P-4	"	6.4	1.4	17.9	2.0	0.5	1.5	0.11	0.05	0.31	7.6	----
P-6	"	13.0	3.9	19.7	3.0	0.6	1.8	0.22	0.05	0.30	4.5	----
C-1	"	4.1	1.5	9.6	1.1	0.4	1.9	0.07	0.03	0.19	0.2	----
C-2	"	6.9	3.2	13.6	3.1	0.4	1.3	0.04	0.03	0.52	2.4	----
C-3	"	9.6	2.0	10.8	1.8	0.4	1.5	0.03	0.04	0.32	1.0	----
C-4	"	7.6	3.2	17.1	2.9	0.6	1.8	0.11	0.03	0.47	10.4	----
P-Main	"	11.0	3.8	18.4	3.3	0.6	1.7	0.09	0.05	0.34	7.9	----
C-Main	"	15.0	3.5	17.1	2.8	0.6	2.0	0.52	0.06	0.29	6.2	----
P-C	"	11.0	3.9	22.5	3.2	0.6	2.6	0.19	0.06	0.30	0.3	----
P-1	08/21/72	4.0	8.5	19.1	3.8	0.6	1.3	0.17	0.11	0.38	0.2	8.0
P-2	"	5.0	8.2	15.2	4.1	0.5	1.3	0.09	0.07	0.61	0.2	6.0
P-4	"	4.0	9.1	12.8	2.0	0.6	1.6	0.13	0.12	0.37	0.3	7.0
P-6	"	7.8	9.4	19.4	3.2	0.7	1.9	0.60	0.09	0.27	0.5	8.0
C-1	"	3.8	8.6	7.9	1.6	0.4	1.3	0.06	0.13	0.17	0.3	6.0
C-2	"	3.8	8.8	9.6	3.0	0.5	1.3	0.41	0.14	0.42	0.2	5.0
C-3	"	4.4	8.2	9.9	1.6	0.4	1.5	0.08	0.11	0.42	0.4	7.0
C-4	08/22/72	5.4	8.9	15.1	2.8	0.7	1.8	0.11	0.13	0.52	1.6	8.0
P-Main	"	5.4	8.7	18.1	3.5	0.7	1.7	0.06	0.12	0.22	0.2	7.0
C-Main	"	5.6	3.7	13.0	2.6	0.6	1.7	0.19	0.12	0.27	5.0	6.0
P-C	"	4.7	3.5	17.5	3.2	0.6	1.8	1.03	0.12	0.34	0.9	8.0

TABLE 7

LABORATORY ANALYTICAL DATA (1974) mg/l
CARIBOU-POKER CREEKS RESEARCH WATERSHED

STATION	DATE	SO_4	SiO_2	Ca	Mg	K	Na	Fe	NO_3-N	Cl	TC	TOTAL HARD.	T-PO_4-P
C-Main	04/12/74*	7.5	8.8	13.4	3.3	1.0	1.5	1.16	0.21	---	3.0	143	0.01
"	06/13/74	4.5	8.9	14.1	2.6	0.9	1.3	0.13	0.25	---	12.0	44	0.02
"	10/30/74	9.5	8.0	17.1	3.3	0.7	2.1	0.12	0.38	0.8	----	30	0.02
"	11/14/74	8.6	8.0	17.8	4.1	0.9	2.2	0.15	0.38	0.4	----	54	0.03
"	11/26/74	9.0	8.0	18.3	4.0	0.7	2.2	0.34	0.39	0.5	13.6	62	0.02
"	12/10/74	8.9	8.0	18.5	4.3	0.8	1.8	0.43	0.39	0.5	13.8	62	0.03
"	12/24/74	8.7	7.8	19.2	4.3	1.0	1.9	0.40	0.38	0.5	13.6	66	0.03
P-Main	04/12/74**	14.4	8.0	22.0	4.0	1.3	1.7	0.19	0.20	---	3.0	295	0.01
"	06/13/74	9.0	6.1	16.3	2.9	1.0	1.3	0.42	0.24	---	15.0	46	0.01
"	10/30/74	10.8	7.5	23.6	4.1	0.8	2.2	0.24	0.44	1.4	----	51	0.02
"	11/14/74	11.5	7.0	23.3	4.9	0.9	2.1	0.08	0.43	5.7	----	84	0.02
"	11/26/74	11.2	7.5	22.6	4.9	0.8	2.1	0.08	0.90	1.1	16.9	73	0.02
"	12/10/74	11.1	7.2	23.8	5.1	0.9	1.7	0.14	0.45	1.9	16.9	79	0.03
"	12/24/74	10.9	7.2	23.5	5.0	1.0	1.8	0.16	0.50	0.9	15.9	75	0.03
C-1	10/25/74	4.3	8.0	9.0	1.9	0.4	1.4	0.19	0.48	1.8	----	41	0.02
"	11/22/74	5.6	7.5	9.4	2.6	0.4	1.5	0.26	0.23	0.7	----	36	0.02
"	12/18/74	4.9	7.3	9.7	2.7	0.4	1.3	0.56	0.21	0.6	7.0	32	0.02
C-2	10/25/74	6.6	8.0	10.7	3.3	0.5	1.3	0.08	0.98	1.1	----	46	0.02
"	11/22/74	7.4	7.5	10.0	4.0	0.4	1.4	0.16	0.64	0.4	----	44	0.02
"	12/18/74	6.6	7.2	10.0	4.0	0.4	1.1	0.11	0.58	0.3	7.6	40	0.03
C-3	10/25/74	14.1	7.0	17.1	2.4	0.6	1.8	0.20	0.53	0.5	----	24	0.03
"	11/22/74	15.1	7.0	18.5	3.0	0.6	1.8	0.05	0.52	0.6	----	54	0.02
"	12/18/74	15.6	7.0	19.4	3.0	0.6	1.4	0.20	0.94	0.6	9.1	56	0.02
C-4	10/30/74	7.1	8.0	17.3	3.1	0.7	2.0	0.12	0.65	0.8	----	27	0.04
"	11/26/74	6.6	8.0	18.4	3.8	0.7	2.1	0.08	1.4	0.4	14.0	57	0.03
"	12/18/74	7.2	7.9	18.7	4.0	0.8	1.5	0.26	0.64	0.5	13.8	67	0.03

* Data from C-1 and C-2 at bridge.
** Includes all tributaries, 2 miles above trailer.

Of the trace elements measured in these basins, only calcium and magnesium are present in high enough concentrations to influence conductivity. Calcium concentrations were always several times higher than were those of magnesium; however, the pattern of variability among streams and with time, was very similar. This high degree of similarity enables a simplification of analytical methods by substituting an EDTA total hardness titration for the complex instrumental procedures. This titration measures the sum of Ca and Mg which is adequate for baseline characterization once the relative levels have been established. Total Ca and Mg for the basins comprising Poker Creek Watershed was higher at all seasons than for the basins comprising Caribou Creek Watershed. There was a trend toward increasing concentration of these elements as winter progressed. However, considerable variability did exist with the basins of each watershed and with season. Calcium and magnesium were always higher in Poker than in Caribou Creek and validated the conductivity measurements. Evidently these two ions were the chief contributors to this simple measurement.

Total carbon content was moderate with little or no variablity pattern. Based on more recent analyses, it has been established that most of the total carbon present in these waters is the carbonate-bicarbonate form; dissolved organic carbon was very low. Total hardness is a summation of calcium and magnesium concentrations and should show close correlation among calcium, magnesium, and conductivity. Two values stand out: those measured in April, before breakup, in Caribou and Poker Creeks. These concentrations need validating but this high value in late winter, with an immediate decrease after breakup would indicate dilution of the groundwater flow during winter with runoff water at breakup.

Potassium, another essential trace element, was present in low concentrations and did not show any clear cut trends although Poker Creek appears to be somewhat higher than all others. Sodium, about double the concentration of potassium, showed no trends among streams or with time. Analyses from samples later in the winter might require a modification of this interpretation.

Although silica content was moderate for all streams of these basins, variability was very low and showed no pattern with time or season. Chlorides were present in all streams but there did not appear to be any variability pattern. Sulfate appeared to be the major anion in all these waters and ranged in concentration from a low of 3 mg/l to a high of 15 mg/l with considerable variability. Sulfate content was moderately high in both watersheds with Poker Creek consistently higher than Caribou Creek.

Schneider Continuous Monitor

Figure 15 is an example of daily recording by the monitor. Little or no differences are observable in conductivity or pH, whereas the diurnal changes in solar radiation, dissolved oxygen and temperature are readily apparent. As the summer progressed, the dissolved oxygen and temperature curves approached straight lines. Solar radiation gradually diminished in both intensity and duration, reflecting shorter days and lowering of the sun angle.

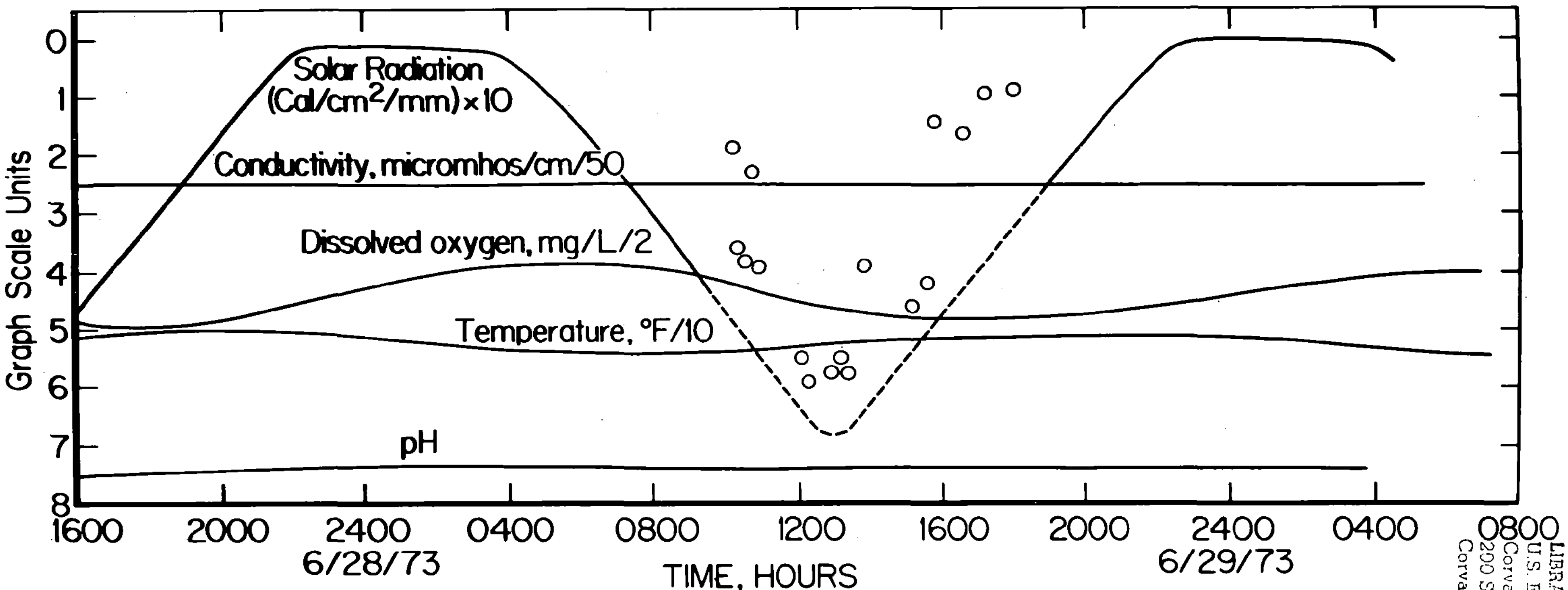

Figure 15. One day's data from the monitor on Poker Creek to illustrate diverse ranges in various parameters. Dots and the dashed line for solar radiation show how values bounce around during cloudy days.

Stream data generated by the Robot monitor is best interpreted in terms of relative changes rather than absolute values. Calibration problems, system failure or malfunction and transport of the stream water to the monitor contributed to error. These will be discussed where applicable. Periods of down time for the monitor are indicated in the tables by gaps in the daily recordings.

pH (Table 8) was difficult to calibrate because of electrode problems. Suspect data has been footnoted indicating that the unit was not responding properly at the time of calibration, but apparently stabilized sometime later. These data still permit inspection of daily changes even if some numbers were inaccurate. Less than 1 pH unit difference was observed over the entire monitoring period. No daily trends were found except a 0.1-0.2 pH unit change, with highs usually occurring in the afternoon. This variability is not considered significant enough to discuss in terms of stream changes because instrumentation or other errors might have been the cause.

Conductivity (Table 9) also exhibited little change over the monitoring period, ranging from about 100-125 umhos/cm. Again, no trends were found; the highs and lows did not occur in any pattern.

Solar radiation highs of about 0.6-0.7 cal/cm^2/min were observed through June to early August, decreasing to about 0.1-0.2 cal/cm^2/min by mid-October. The highs usually occurred at noon, but there could be great fluctuation during the day depending on the cloud cover. Solar radiation has an effect on stream measurements, especially temperature and D.O. However, no tables have been assembled for solar radiation data and it will be correlated only in a general manner.

In analyzing the temperature and dissolved oxygon data, it should be noted that the monitor measured these parameters after pumping the water 50 feet from Poker Creek. At times this affected these data (Table 10). Pump clogging or malfunction would result in elevated temperatures and correspondingly depressed D.O. Even under optimum conditions, heat transfer in the utiliduct system had an apparent effect. Calibration of the D.O. probe was carried out by drawing water from the monitor and performing a Winkler D.O. analysis. Difficulty was encountered with stability, especially when a probe was replaced, during the period from June 27 to August 16. It was never determined if the D.O. unit was properly calibrated within that period. In addition, excessively high temperatures indicated that a great deal of heat transfer was occurring within the utiliduct.

Of particular interest was the period of July 4-11 when the highest water temperatures were recorded. This period corresponded to a time when the highest solar radiation was recorded. The chart indicated the skies were clear or had very scattered clouds. Days at that time of the year are approximately 22 hours long. Since there was no indication of the pump malfunctioning, heat transfer seemed to be the most probable cause of the high temperatures and low D.O. recorded at the monitor. On July 10, the highest water temperature for the summer (20°C) was recorded by the monitor. This was undoubtedly erroneous since the highest temperature ever obtained with a thermometer in the stream was about 9°C. These data from the monitor are useful because they do show definite diurnal and seasonal changes, although the values for temperature and D.O. are not always accurate with respect to insitu conditions.

TABLE 8

SCHNEIDER MONITOR (SUMMER 1973)
CARIBOU-POKER CREEKS RESEARCH WATERSHED

pH

DATE	HIGH	LOW	DATE	HIGH	LOW	DATE	HIGH	LOW
*5/30	7.6	---	7/14	7.1	7.0	8/27	7.6	7.5
5/31	7.6	---	7/15	7.1	6.9	8/28	7.5	---
6/1	7.6	7.5	7/16	7.2	6.9	*8/30		
6/2	7.6	---	7/17	7.2	7.0	8/31	7.4	7.2
6/3	7.6	6.9	7/18	7.2	7.1	9/1	7.5	7.2
*6/11	7.4	---	**7/26			9/2	7.5	7.2
6/12	7.4	7.3	7/27	7.9	7.7	9/3	7.5	7.2
6/13	7.5	---	7/28	7.8	7.7	9/4	7.5	7.3
6/14	7.5	7.1	7/29	7.7	7.6	9/5	7.5	7.3
6/15	7.4	7.2	7/30	7.7	7.4	9/6	7.5	7.3
6/16	7.5	7.4	7/31	7.7	7.5	9/7	7.5	7.3
6/17	7.6	7.5	**8/1	7.5	7.4	9/8	7.5	7.3
6/18	7.6	7.5	8/2	7.1	6.9	9/9	7.5	7.3
6/19	7.6	---	8/3	7.0	6.9	9/10	7.5	7.3
*6/20	7.3	---	8/4	7.0	6.8	9/11	7.5	7.3
6/21	7.4	7.3	8/5	7.0	6.8	9/12	7.3	---
6/22	7.4	7.3	8/6	7.0	6.8	*9/18		7.5
6/23	7.4	7.3	*8/7	6.8	---	9/19	7.4	---
6/24	7.4	7.3	8/8	7.8	7.6	9/20	7.4	---
6/25	7.4	7.3	8/9	7.8	7.6	*9/26	7.5	---
6/26	7.4	7.3	8/10	7.8	7.7	9/27	7.4	
*6/27	7.4	---	8/11	7.5	7.4	9/28	7.4	7.3
6/27	7.5	7.4	8/12	7.5	7.4	9/29	7.4	7.3
6/28	7.5	7.4	8/13	7.6	7.3	9/30	7.4	---
6/29	7.5	7.4	8/14	7.6	7.5	10/1	7.4	---
6/30	7.5	7.4	8/15	7.7	7.5	10/2	7.4	---
7/1	7.4	7.3	*8/16	7.6	7.5	*10/3	7.4	---
7/4	7.3	7.1	8/17	7.8	7.6	10/4	7.5	---
7/5	7.3	7.1	8/18	7.7	7.6	10/5	7.5	---
7/6	7.3	7.2	8/19	7.8	7.6	10/6	7.5	---
7/7	7.2	7.0	8/20	7.9	7.6	10/7	7.5	---
7/8	7.3	7.1	*8/21	7.7	7.6	10/8	7.5	---
7/9	7.4	7.2	8/22	7.4	7.3	10/9	7.5	---
7/10	7.4	7.2	8/23	7.5	7.3	10/10	7.5	---
7/11	7.4	7.3	8/24	7.6	7.4	*10/11	7.5	---
**7/12	7.3	7.3	8/25	7.6	7.5	10/12	7.5	---
7/13	7.2	7.0	8/26	7.7	7.5			

*Calibration
**Calibration - Accuracy in doubt due to stability problems with electrodes.

TABLE 9

SCHNEIDER MONITOR (SUMMER 1973)
CARIBOU-POKER CREEKS RESEARCH WATERSHED
SPECIFIC CONDUCTANCE μmhos/cm

DATE	MAX.	MIN.	DATE	MAX.	MIN.	DATE	MAX.	MIN.
*5/30	---	---	7/14	98	93	8/26	108	105
5/31	110	108	7/15	98	88	8/27	108	95
6/1	113	110	7/16	98	88	8/28	95	---
6/2	113	110	7/17	105	98	*8/30	103	
*6/11	98		7/18	108	---	8/31	103	100
6/12	100	95	*7/26			9/1	103	100
6/13	105	103	7/27	120	115	9/2	110	108
6/14	108	80	7/28	118	115	9/3	110	110
6/15	95	85	7/29	118	95	9/4	113	110
6/16	105	98	7/30	103	95	9/5	113	110
6/17	108	105	7/31	108	105	9/6	113	---
6/18	115	110	8/1	108	---	9/7	113	---
6/19	115	---	*8/1			9/8	115	113
*6/20	118		8/2	115	113	9/9	115	---
6/21	118	---	8/3	118	115	9/10	115	---
6/22	120	118	8/4	118	---	9/11	115	---
6/23	120	120	8/5	120	118	9/12	115	---
6/24	120	120	8/6	120	120	*9/18	118	118
6/25	120	120	8/7	120	---	9/19	115	---
6/26	123	120	*8/7			9/20	113	---
6/27	123	123	8/8	120	120	*9/26		118
*6/27	125		8/9	120	---	9/27	118	115
6/28	125	---	8/10	120	---	9/28	115	113
6/29	125	---	8/14	100	95	9/29	115	---
6/30	125	---	8/15	105	100	9/30	118	115
7/1	118	115	*8/16	105	---	10/1	115	113
7/4	108	98	8/17	110	---	10/2	115	113
7/5	113	108	8/18	110	---	10/3	118	---
7/6	113	103	8/19	110	---	10/4	118	115
7/7	103	100	8/20	113	110	10/5	115	---
7/8	110	105	*8/21	113	---	10/6	115	---
7/9	115	110	8/21	110		10/7	118	---
7/10	120	115	8/22	95	88	10/8	120	118
7/11	120	120	8/23	98	90	10/9	120	118
*7/12	120	120	8/24	103	98	10/10	120	---
7/13	98	90	8/25	105	103	10/11	120	---
						10/12	123	120
						10/13	120	---

*Calibration

TABLE 10

SCHNEIDER MONITOR (SUMMER 1973)
CARIBOU-POKER CREEKS RESEARCH WATERSHED

DATE 1973	TEMPERATURE°C			DISSOLVED OXYGEN mg/l		
	MIN.	MAX.	TIME	MIN.	MAX.	TIME
*5/30	---	6.7	1900	11.4	----	2000
5/31	1.7	----	0600	----	12.2	0700
5/31	---	8.3	1900	11.0	----	2000
6/1	3.3	----	0600	----	11.8	0700
6/1	---	7.2	1800	10.3	----	1900
6/2	3.3	----	0600	----	11.6	0700
6/2	---	5.0	1800	11.6	----	1900
*6/11	---	7.2	1900	11.2	----	1000
6/12	3.9	----	0600	----	----	----
6/12	---	8.3	1700	11.6	----	1700
6/15	2.2	----	0600	----	11.6	0700
6/15	---	8.9	1700	10.2	----	1800
6/16	3.9	----	0600	----	11.2	0700
6/16	---	7.8	1700	10.2	----	1800
6/17	3.9	----	0600	----	11.2	0700
6/17	---	10.0	1800	9.6	----	1800
6/18	4.4	----	0700	----	10.4	0800
6/18	---	6.7	1900	10.6	----	2000
6/19	3.9	----	0600	----	11.4	0700
6/19	---	10.6	1700	10.2	----	1800
*6/20	4.4	----	0500	----	11.4	0500
6/20	---	10.0	1800	10.4	----	1900
6/21	4.4	----	0600	----	11.2	0700
6/21	---	10.0	1700	10.0	----	1800
6/22	5.0	----	0600	----	10.2	0700
6/22	---	10.0	1700	10.0	----	1700
6/23	5.0	----	0800	----	10.6	0900
6/23	---	7.2	1500	10.0	----	1600
6/24	3.3	----	0600	----	10.8	0700
6/24	---	6.1	1700	10.4	----	1800
6/25	3.9	----	0600	----	11.4	0200
6/25	---	7.2	1800	11.0	----	1900
6/26	3.3	----	0600	----	11.4	0700
6/26	---	9.4	1700	10.4	----	1800
*6/27	3.3	----	0500	----	11.4	0600
6/27	---	10.0	1800	10.0	----	1800
6/28	3.3	----	0600	----	10.8	0700
6/28	---	8.9	1700	10.2	10.8	0700
6/29	4.4	----	0600	----	10.8	0700
6/29	---	9.4	1800	10.0	----	1800
6/30	4.4	----	0700	----	10.8	0800
6/30	---	8.9	1800	10.2	----	1900
7/1	4.4	----	0600	----	10.6	0700
7/1	---	8.9	1800	9.6	----	1900
7/2	5.0	----	0700	----	10.6	0800

TABLE 10 CONTINUED

DATE 1973	TEMPERATURE°C MIN.	MAX.	TIME	DISSOLVED OXYGEN mg/l MIN.	MAX.	TIME
7/4	----	14.4	1700	6.6	----	1200
7/5	7.8	----	0700	----	7.6	0800
7/5	----	13.8	2000	6.6	----	2000
7/6	7.8	----	0700	----	7.4	0200
7/6	----	11.7	2000	7.0	----	2000
7/7	8.3	----	0700	----	7.4	0700
7/7	----	13.3	2200	6.8	----	2200
7/8	10.6	----	0900	----	7.4	0900
7/8	----	17.2	2100	6.2	----	2100
7/9	11.1	----	0800	----	7.2	0900
7/9	----	19.4	2200	5.8	----	2300
7/10	12.8	----	0800	----	6.4	0800
7/10	----	20.0	2200	5.2	----	2400
7/11	12.2	----	----	----	6.0	----
7/11	----	18.3	----	5.6	----	----
*7/12	----	----	----	----	----	----
7/14	5.0	----	----	----	7.8	----
7/14	----	10.6	----	7.2	----	----
7/15	7.8	----	----	----	7.8	----
7/15	----	----	----	----	----	----
7/17	----	5.0	----	7.4	----	----
7/17	11.1	----	----	----	6.8	----
*7/26	----	----	----	----	----	----
7/27	3.9	----	0700	----	9.6	0700
7/27	----	9.4	1800	8.8	----	1600
7/28	5.6	----	0800	----	9.4	0800
7/28	----	8.3	1900	9.0	----	2000
7/29	4.4	----	0700	----	9.4	0800
7/29	----	6.7	1800	9.4	----	1900
7/30	3.9	----	0600	----	7.6	0700
7/30	----	7.8	1800	9.7	----	1800
7/31	4.4	----	0700	----	9.8	0700
7/31	----	7.8	1800	9.4	----	1900
*8/1	3.9	----	0200	----	10.0	0800
8/1	----	7.8	1800	11.2	----	1900
8/2	2.8	----	0600	----	12.0	0700
8/2	----	7.2	1600	11.0	----	1700
8/3	3.9	----	0600	----	11.4	0700
8/3	----	6.7	1800	11.0	----	1800
8/4	4.4	----	0600	----	11.4	0700
8/4	----	7.2	1800	10.8	----	1900
8/5	3.9	----	0700	----	11.4	0800
8/5	----	7.8	1500	10.6	----	1700
8/6	4.4	----	0600	----	11.2	0800
8/6	----	7.8	1700	10.8	----	2000

TABLE 10 CONTINUED

DATE 1973	TEMPERATURE °C MIN.	TEMPERATURE °C MAX.	TIME	DISSOLVED OXYGEN mg/l MIN.	DISSOLVED OXYGEN mg/l MAX.	TIME
*8/7	7.8	----	0500	----	11.4	0700
8/7	----	8.3	1800	10.6	----	2200
8/8	4.4	----	0700	----	11.0	0900
8/8	----	7.2	1800	10.4	----	2000
8/9	4.4	----	0700	----	10.8	0900
8/9	----	6.7	1800	10.4	----	2000
8/10	4.4	----	0700	----	10.6	1000
8/10	----	4.1	----	10.4	----	----
8/11	----	----	----	----	----	----
8/12	4.4	----	0800	----	10.4	0800
8/12	----	7.2	1700	9.8	----	1200
8/13	3.9	----	0700	----	10.4	0700
8/13	----	7.2	1900	9.8	----	2300
8/14	6.1	----	0700	----	10.0	0800
8/14	----	----	----	----	----	----
8/15	3.9	----	0600	----	10.8	0800
8/15	----	7.2	1800	9.8	----	2000
*8/16	3.3	----	0700	----	9.8	0700
8/16	----	5.6	1800	11.8	----	2000
8/17	2.8	----	0700	----	12.2	0900
8/17	----	5.0	1800	11.8	----	2000
8/18	2.2	----	0700	----	12.4	0800
8/18	----	3.9	2000	11.8	----	2200
8/19	4.4	----	0600	----	11.8	0800
8/19	----	5.6	1800	11.4	----	2000
8/20	3.3	----	0700	----	11.8	0900
8/20	----	7.8	1700	10.8	----	1900
*8/21	4.4	----	0700	----	11.4	0900
8/21	----	5.6	1700	11.2	----	1800
8/22	3.9	----	0500	----	11.6	0600
8/22	----	5.6	1700	11.2	----	1700
8/23	2.8	----	0700	----	11.8	0800
8/23	----	6.7	1600	11.0	----	1800
8/24	2.8	----	0500	----	11.6	0500
8/24	----	5.6	1600	11.0	----	1800
8/25	2.8	----	0500	----	11.6	0500
8/25	----	5.0	1600	11.0	----	1800
8/26	3.3	----	0500	----	11.4	0500
8/26	----	5.6	1500	10.8	----	1700
8/27	2.8	----	0500	----	11.4	0500
8/27	----	5.0	1400	10.8	----	1600
8/28	2.8	----	0200	----	11.0	0200
*8/30	----	----	----	----	----	----
8/31	1.1	----	0700	----	12.8	0800
8/31	----	5.0	1700	12.0	----	1800

TABLE 10 CONTINUED

DATE 1973	TEMPERATURE°C MIN.	MAX.	TIME	DISSOLVED OXYGEN mg/l MIN.	MAX.	TIME
9/1	1.1	---	0700	----	12.8	0900
9/1	---	5.0	1600	12.2	----	1800
9/2	0.6	---	0700	----	13.2	0900
9/2	---	3.9	1600	12.4	----	1800
9/3	0.6	---	0600	----	13.4	0800
9/3	---	5.0	1600	12.2	----	1800
9/4	0.6	---	0600	----	13.4	0800
9/4	---	5.0	1600	12.4	----	1900
9/5	1.7	---	0700	----	13.0	0800
9/5	---	5.6	1600	12.4	----	1600
9/6	1.7	---	0600	----	13.2	0800
9/6	---	5.6	1500	12.4	----	1600
9/7	1.1	---	0600	----	13.0	0800
9/7	---	5.0	1500	12.0	----	1700
9/8	1.7	---	0500	----	12.4	0700
9/9	2.8	---	0400	12.4	----	0700
9/9	---	4.4	1400	----	12.0	1600
9/10	1.7	---	0400	12.4	----	0600
9/10	---	4.4	1400	----	11.8	1600
9/11	0.6	---	0500	12.6	----	0700
9/11	---	4.4	1300	----	12.0	1500

TEMP. DATE	TEMPERATURE°C MIN.	MAX.	TIME	DISSOLVED OXYGEN DATE	DISSOLVED OXYGEN mg/l MIN.	MAX.	TIME
*9/18	---	---	1700	----	12.4	----	2100
9/19	0.6	---	0900	----	----	13.0	1100
9/19	---	1.7	2100	9/20	12.6	----	0100
9/20	0.6	---	0900	----	----	13.0	1200
*9/26	---	1.7	1900	----	12.6	----	2400
9/27	-0-	---	0900	----	----	13.0	1000
9/27	---	1.1	1800	----	12.6	----	2200
9/28	-0-	---	1000	----	----	13.0	1300
9/28	---	-0-	2100	----	12.6	----	0100
9/29	-0-	---	0800	----	----	12.8	1300
9/29	---	0.6	2000	----	12.4	----	0300
9/30	-0-	---	0300	----	----	12.6	0700
9/30	---	1.1	1600	10/1	12.2	----	2400
10/1	0.6	---	0100	----	----	12.4	0800
10/1	---	1.1	1500	----	12.0	----	2200
10/1	-0-	---	2300	----	12.2	----	0800
10/2	---	1.1	2000	----	12.2	----	----
*10/3	---	1.1	1600	----	12.6	----	----
10/4	-0-	---	0800	----	----	12.6	----
10/5	---	-0-	1700	----	12.4	----	----

Temperature and dissolved oxygen constant until shut down on 10/12

* Calibration

In general, the dissolved oxygen was always high, approaching 1 or 2 ppm of saturation. The diurnal change was usually less than 1 ppm. Minimum water temperatures in the monitor were 3-5°C until the end of August when they decreased, approaching 0°C by the middle of September. Maximum temperatures were up to 5°C higher than the minimums through June and July with the differences diminishing by August. In late September the change was about 1°C and from October 5 until the shut-down date on October 12, the water temperature was plus zero and essentially constant. Corresponding D.O. was constant and close to 13.0 ppm.

Maximum water temperatures were recorded during late afternoon, while minimums occurred in early morning. However, by mid-September, it became difficult to determine the maximum and minimum times for both temperatures and D.O. because of the low amplitude of their characteristic sinusoidal curve. The D.O. response to temperature appeared to lag by about an hour until mid-August after which the lag increased to about 2 hours. Again, broadening of the curves made it difficult to make accurate readings. The change in D.O. during the lag time was only 0.1-0.2 mg/l. It is uncertain whether the lag was the result of D.O. probe response or the kinetics involved in the system.

DISCUSSION AND CONCLUSIONS

One intended objective for installing the field station was to obtain continuous records of all parameters. This objective was not fully realized during the period covered by this report. This failure to achieve continuity, although discouraging, was not surprising when the total environmental conditions are placed in perspective. In fact, one subsidiary objective was to test, evaluate, and develop methods of coping with low winter temperatures (down to minus 50°C), stream ice and icings, and reliable transportation.

Continuous monitoring at remote sites is always a challenge, especially in the arctic and subarctic. It does not appear necessary to continuously monitor water quality parameters from freezeup to breakup unless there is some special reason to justify the effort. During the winter, changes in aquatic systems are gradual and periodic sampling can achieve the desired result since hydrologic events which might influence water quality simply do not occur. However, monitoring during rapidly changing conditions becomes vital if these trends are to be understood. Hence, continuous monitoring of Poker and Caribou Creeks may be desirable during times of watershed perturbations on Poker Creek. In addition to the five parameters measured in 1973, turbidity data would be of value.

Interpretation of field measurements and laboratory analyses during the summer periods validate the earlier tentative conclusions that Poker and Caribou Creeks have real differences in their water chemistry. Differences among streams, in either watershed, are sufficient to necessitate making careful conclusions in the future as one or more sub-basins is impacted by some planned perturbation. These baseline data now provide sufficient evidence of the natural variability among this group of eight sub-basins to guide further research.

Winter field and laboratory data show that some chemical parameters change with time as winter progresses, whereas others are little influenced. Conductivity and alkalinity are two chemical parameters whose values tend to increase with time whereas pH is little changed. Dissolved oxygen generally decreased under the prolonged ice cover in all streams but did not exhibit the expected characteristic depletion. Nutrients in the streams are in low concentrations and show little variability; the same is true for heavy metals. Total carbon data are incomplete so conclusions are no more than tentative; however, Poker shows higher concentrations than Caribou Creek which is probably a reflection of the total alkalinity measured in these streams.

A trail up Poker Creek, completed in 1975, provided access to this system and allowed winter sampling of the four tributaries. The construction of that trail completed the watershed network and permitted all-season ground access to the tributaries. It is contemplated that all streams draining each sub-basin (eight in all) will be sampled at monthly intervals during the next year to complete a baseline of water quality data before any planned disturbances in Poker Basin are initiated. Both creeks will be sampled by the monitors to verify that the system will function or can be repaired when air temperatures are extremely low and ice covers the pump. A new unit containing probes for all the stream parameters which can be placed directly in the stream will also be tested in Poker Creek.

REFERENCES

1. American Public Health Association. 1971. "Standard Methods for the Examination of Water and Wastewater," 13th Edition, New York.

2. Analytical Quality Control Laboratory. 1971. "Methods of Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, Cincinnati.

3. Jinkinson, William M., Frederick B. Lotspeich, and Ernst W. Mueller. 1973. "Water Quality of Caribou-Poker Creeks Research Watershed, Alaska," Working Paper No. 24, U.S. Environmental Protection Agency, Arctic Environmental Research Laboratory, College, Alaska.

4. Schallock, Eldor W., and Frederick B. Lotspeich. 1974. "Low Winter Dissolved Oxygen in Some Alaskan Streams," Ecological Research Series No. EPA-660/3-74-008, U.S. Environmental Protection Agency, Arctic Environmental Research Station, College, Alaska.

5. Slaughter, Charles W. 1971. "Caribou-Poker Creeks Research Watershed, Interior Alaska," Special Report No. 157, U.S. Army, Cold Regions Research and Engineering Laboratory, Ft. Wainwright, Alaska.

6. Slaughter, Charles W., and A. E. Helmers. 1974. "An Expanded Role for Subarctic Watershed Research," Water Research Bulletin, No. 10, pp. 256-265.

7. Slaughter, C. W., C. Hoffeditz, J. Morse, and D. McFarlane. 1974. "A Subarctic Microclimatology Station," CRREL Technical Note, U.S. Army, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.

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