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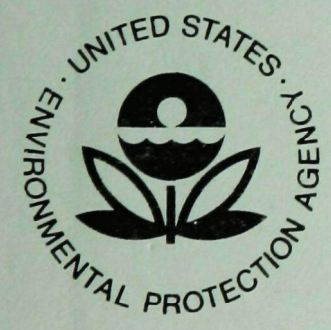
Effects of Chemical Variations in Aquatic Environments
Vol. I
Biota and Chemistry of Piceance Creek



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EPA-R3-73-011a
February 1973

EFFECTS OF CHEMICAL VARIATIONS IN AQUATIC ENVIRONMENTS:

Volume I

Biota and Chemistry of Piceance Creek

By

W. Harry Everhart
Bruce E. May
Colorado State University, Fort Collins, CO

Project 18050 DYC

Project Officer

J. Howard McCormick
National Water Quality Laboratory
6201 Congdon Blvd.
Duluth, Minnesota 55804

Prepared for

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ABSTRACT

Sampling a small stream in the rich oil shale country of northwestern Colorado confirmed distinct seasonal trends and habitat preference in invertebrate populations. Discharge was a major influence on invertebrates and chemical composition of the stream. Seasonal variations, biomass, and species composition of invertebrates appear characteristic of oil shale area streams.

This report was submitted in fulfillment of Grant Number WP-01398-01, under (partial) sponsorship of the U. S. Environmental Protection Agency.

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SECTION I

CONCLUSIONS

1. Biota and chemistry of Piceance Creek

    1. High discharge diluted filtrable solids and chemical parameters, and low discharge concentrated these parameters as with calcium, magnesium, sulphate, and chloride concentrations.

    2. Silica values were high and variable with no apparent systematic seasonal variation.

    3. Seasonal variations in abundance of insects were probably dependent on food abundance, water temperature, stream discharge, and seasonal emergence patterns. Aquatic communities in Piceance Creek were influenced more by stream discharge than any other factor as discharge determines the type of substrate. Maximum numbers were maintained between June and August with a secondary population peak during winter months. Minimum numbers occurred between April and May and September and October. Unstable fine gravel substrate was a limiting factor for aquatic invertebrates at the lower stations.

SECTION II

RECOMMENDATIONS

The Piceance oil shale country is very fragile and extremely susceptible to any habitat alteration. Further development of this country will have to consider discharge and the chemical composition of the water. Piceance basin streams drain into the White River and then into the Colorado River where valuable natural and industrial resources are represented. Any further increase in the salinity of the White River or the Colorado cannot be tolerated.

SECTION III

INTRODUCTION

The Piceance Creek study was undertaken to obtain information about physical, chemical, and biological parameters of a small stream in northwestern Colorado. Oil shale, abundant in this area, will likely be mined and processed in the future. Pollution from this exploitation could alter aquatic habitats in the Piceance basin, in the White River, and in the Colorado River.

Alteration of existing interactions between organisms and their environment may be the most realistic way to evaluate pollution conditions created by oil shale exploitation.

IV METHODS

Study area

Piceance basin is located in the center of Colorado's oil shale deposits and covers 3,496.5 km^2. The basin has four major drainages: White River, Piceance Creek, Yellow Creek, and Douglas Creek (Figure 1). Geomorphologically, the Green River formation in Piceance basin is composed of light gray to light brown shale and marlstone with some sandstone and limestone (CWCB and USGS, 1966). Ground cover consists of browse plants, Juniper, Douglas fir, and grasses.

Piceance Creek arises from springs located along the basin at an altitude of 2,050 meters and flows through the center of the basin to the White River. Piceance Creek is 80 km long with a discharge of 0.014 to 2.8 m^3/sec. During summer and fall months the upper fourth is usually dry. Extremes in width, depth, and discharge occur after heavy rainfalls and snow melt because of the geologic formation and sparce vegetation. Piceance Creek is a major source of water for agriculture in the area, and ponds located along the stream serve as irrigation storage and provide a limited fishery. The upper 4.8 km of permanent water is cold (0° to 11°C) and generally clear, while the remaining portion has higher temperatures and more turbidity.

Five permanent stations were established on Piceance Creek. (Figure 2). Selection of these stations was based on substrate type and possible variations caused by springs and other water sources.

Station I (NE¼ NE¼, Sec-18-T35-R95W, 6 PM) was located 120 m from a spring origin of permanent water. Substrate consisted of gravel with occasional large rocks (15-18 cm). There was an ooze or mud type bottom in some parts of the sampling area. Water depth ranged from 8.7 to 26 cm with no deep pools. Discharge was nearly uniform throughout the year. Water at this station remained cool and generally clear throughout the sampling period. Samples were taken at Station I to evaluate the physical and chemical environment and the macrobenthic community.

Station II, (NE¼ SE¼, Sec-11-T35-R95W, 6 PM) 2.8 km below Station I, was similar in substrate composition to Station I. There were more large rocks (15-18 cm) and deeper pools. Depth ranged (in sampling area) from 8 cm (riffle area) to 60.8 cm (large pool). Discharge was increased slightly because of several springs entering into Piceance Creek. Water at Station II remained cool and generally clear. Only samples to evaluate the macrobenthic community were taken at this station.

Station III (NE¼ SW¼, Sec-26-T25-R97W, 6 PM) was located approximately midway between the upper limits of Piceance Creek and its confluence with White River. Three intermittent tributary streams enter above this station adding to discharge and sediment load. Only water samples were taken to evaluate the physical and chemical environment of this station.

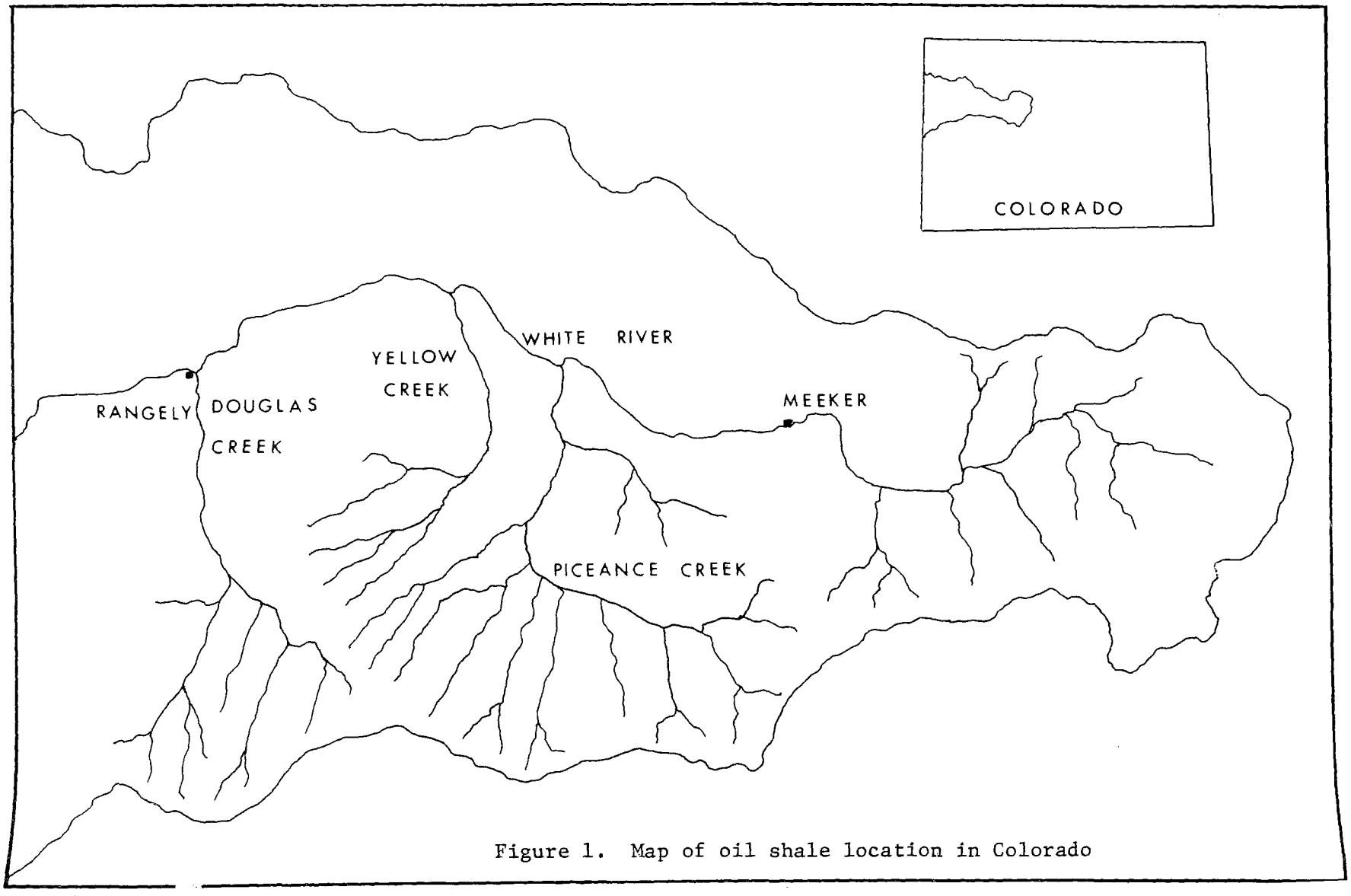

Figure 1. Map of oil shale location in Colorado

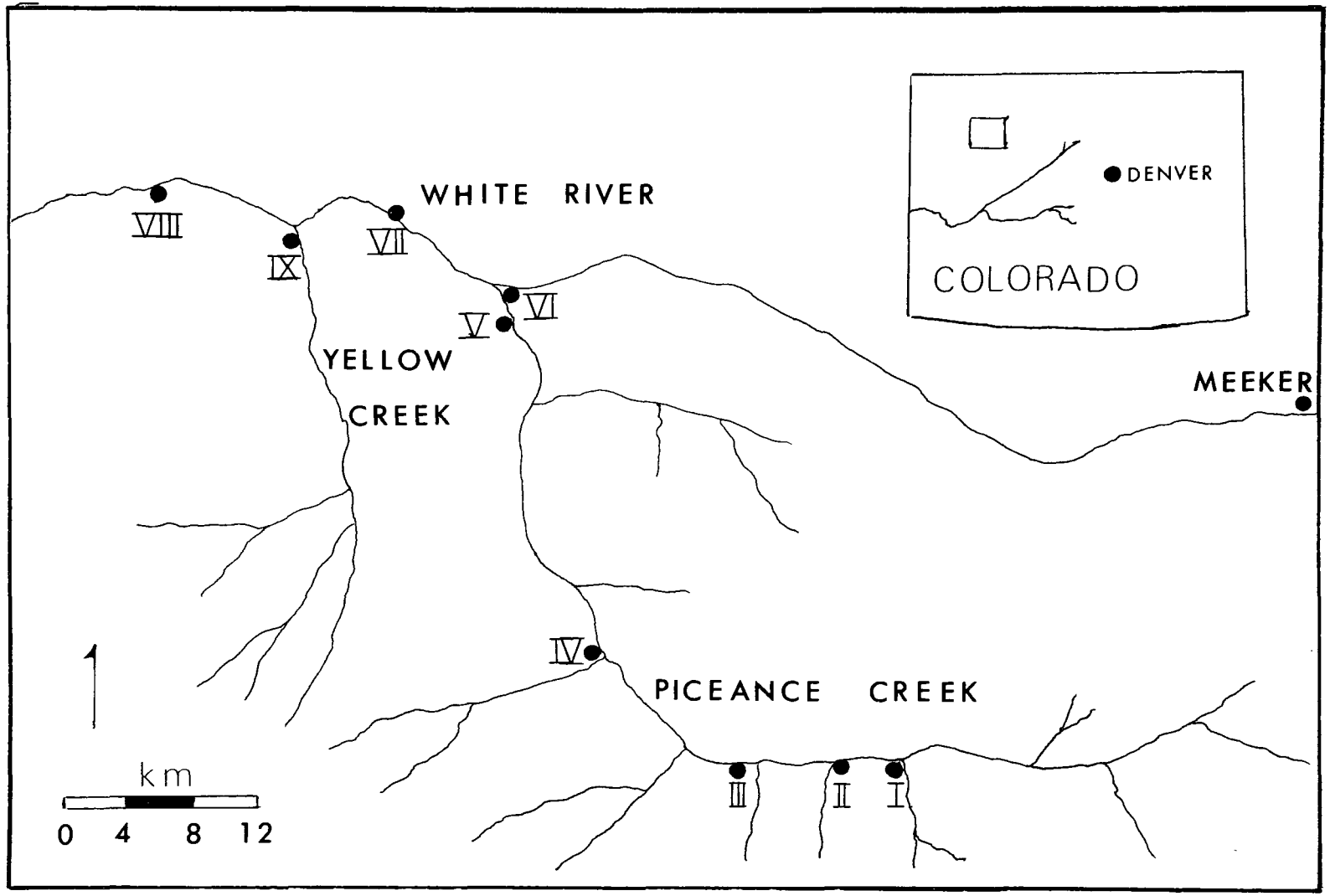

Figure 2. Map of Piceance Creek, White River, and Yellow Creek

Station IV, (SW¼ NW¼, Sec-33-T1S-R97W, 6 PM) approximately 8 km below Station III, was considerably different in substrate composition than Stations I and II. One tributary and the three intermittent streams enter Piceance Creek above this station. Bottom composition was comprised mostly of fine gravel (shale) with a few large rocks (15-18 cm). Depth was from 23 to 60.8 cm in large, long pools. There was very little riffle area at this station. Water samples were taken to evaluate physical and chemical environment and bottom samples to evaluate the macrobenthic community at this station.

Station V, (NE¼ NE¼, Sec-11-T1N-R97W, 6 PM), 1 km above confluence of Piceance Creek with the White River, was similar to Station IV. At this station the stream had just emerged from a narrow canyon characterized by many meanders and increased gradient. Substrate consisted of fine gravel (shale) which was very unstable. Depth and width varied seasonally because of the unstable bottom. Samples were taken to evaluate the physical and chemical environment and macrobenthic community.

White River, largest river in the oil shale area, contributes substantial discharge to the Colorado River system. White River supports a coldwater fishery in the head waters and a warmwater fishery in the oil shale area. The river is a source of water for agriculture and fishery and nonfishery recreation. The White River study area, 25 km long, was located above and below the confluence with Piceance Creek.

Three stations were located on White River. Station VI, (SW¼ SE¼, Sec-36-T2N-R97W, 6 PM), was just above the confluence of Piceance Creek and White River, Station VII, (SW¼ NE¼, Sec-12-T2N-R98W, 6 PM), 10 km below, and Station VIII, (NE¼ SE¼, Sec-32-T3N-R99W, 6 PM), 25 km below Station VI.

Yellow Creek, Rio Blanco County, Colorado, is a small stream, but discharge fluctuates greatly. Sediment and chemical components are carried into the White River during high flows. Low discharge limits Yellow Creek for agricultural and recreational uses.

One station was located on Yellow Creek near the bridge on Colorado Highway 64, (NE¼ SW¼, Sec-4-T2N-R98W, 6 PM).

Methods

Sampling Procedure

Physical factors, water samples for chemical analysis and biological samples were collected monthly. Water samples were collected for physical and chemical determinations at the stations indicated in Figure 2. Sampling was hindered by ice conditions in winter and by high discharge in spring and summer. More intensive sampling was conducted during summer, 1969. Some physical and chemical parameters were monitored weekly and biological sampling was intensified.

Physical Parameters

Physical characteristics have a great influence on species and abundance of organisms capable of surviving in a given environment. Monitoring these parameters provides information about the particular aquatic environment.

Important physical parameters of a stream are water temperature, discharge, and conductivity. Temperature readings were taken with a centigrade pocket-type thermometer. Air and water temperatures were taken monthly. Discharge records were supplied by the United States Geological Survey. Specific conductance was determined with a Beckman Model RC-16B2 conductivity bridge and reported as μ mho cm^{-1} at 25 C.

Chemical Parameters

All chemical analyses were carried out according to standard method APHA (1965) unless otherwise stated.

Dissolved oxygen was determined by the Alsterberg modification of the Winkler Method. Alkalinity was determined by the indicator method titrating with 0.02N H_2SO_4 to a pH 4.5 endpoint. Hydrogen ion concentration was determined with a Beckman Electromate glass electrode pH meter. Filtrable solids include all materials, liquid or solid, in solution or otherwise, which pass through a 0.45 μ filter and are not volatilized during drying (APHA, 1965). Filtrable solids and total solids were determined by evaporation at 103-105 C with filtration (using No. 40 Whatman filter paper) when sediments were visible. Nonfiltrable solids were calculated as the difference between filtrable and total solids. Settleable matter was estimated by volume using an Imhoff cone.

Cations (calcium, magnesium, sodium, and potassium) and trace elements (cadmium, copper, chromium, iron, lead,manganese, molybedenum, nickel, silver, and zinc) were determined by a Perkin-Elmer 303 atomic absorption spectrophotometer. All samples were preserved by adding hydrochloric acid to 1% of sample volume (FWPCA, 1969).

Anions (chloride, nitrate, silica, and sulfate) were determined by standard quantitative techniques. Chlorides were determined by the mercuric nitrate method. Nitrate was determined by the phenoldisulfonic acid method (APHA, 1965; Rainwater and Thatcher, 1968). Silica was determined by gravimetric method with ignition of residue; hydrochloric acid was added to prevent coprecipitation of other ions (APHA, 1965; Rainwater and Thatcher, 1968).

Biological Parameters

Bottom samples were collected from September, 1968 until December, 1969 with a regular sampling design from December, 1968 to December, 1969.

Stream bottom samples were collected with a standard square-foot bottom sampler (Surber, 1936) with 1 mm mesh. One sample was taken from Stations I, II, IV, and V, established on Piceance Creek, near the middle of each

month. Fifty samples, consisting of one-hundred eighty $0.09m^2$ subsamples, were taken from Piceance Creek (December, 1968 to December, 1969). One sample (0.36 m^2) was taken from Stations I, II, IV, and V except during the months of October and November (1969) when a sample consisted of 0.19 m^2. Subsamples were combined to reduce sampling variability. All organisms were stored in 70% alcohol.

Most organisms were identified to genus with the use of Pennak (1953) and Usinger (1967). Identifications were confirmed by Dr. T. O. Thatcher, Entomology Department, Colorado State University.

Abundance of each kind of organism was determined to establish relative abundance trends, habitat preference, and linear distribution within Piceance Creek. Volumes and (wet) weights were taken to estimate biomass (standing crop).

Fish populations were sampled when conditions permitted with extensive sampling on Piceance Creek during summer (1969). Portable back-pack electrofishing gear was used to capture fish.

Macrobenthos and fish populations were sampled on White River and Yellow Creek when conditions permitted. Qualitative aquatic invertebrates were collected, in White River and Yellow Creek, with a screen (1 m long, 0.7 m high) constructed from wire screen attached to two poles (1 m long). Samples were taken from approximately 2 m above the screen by overturning the bottom substrate causing organisms to drift into the screen.

V RESULTS

Physical parameters

Water temperature readings on Piceance Creek are given in Figure 3. Differences between stations in a single month depended on the day and time of day at which readings were taken. Temperatures for White River and Yellow Creek were similar to Piceance Creek, ranging from 0 to 23 C. Yellow Creek reached a maximum of 31 C in August (1969) and had a low of 0 C during winter (1968-1969).

Discharge of Piceance Creek is shown in Figure 4. Mean discharge for White River (near study area) ranged from 6.2 m^3/sec (February, 1969) to 42.5 m^3/sec (May, 1969). Yellow Creek discharge rates have not been monitored since 1965.

Specific conductance was measured in the laboratory after adjusting the water to 25 C (Tables 9, 10, 11, 12, 21, 22, 23, 63, 64, 65, and 74). Variations in specific conductance were similar to those found in 1965 by the United States Geological Survey (Table 1). Specific conductance in Yellow Creek ranged from 3,000 to 4,000 μ mho cm^{-1} at 25 C. White River specific conductance was more nearly constant (500-800 μ mho cm-1 at 25C) with values increasing with distance down stream.

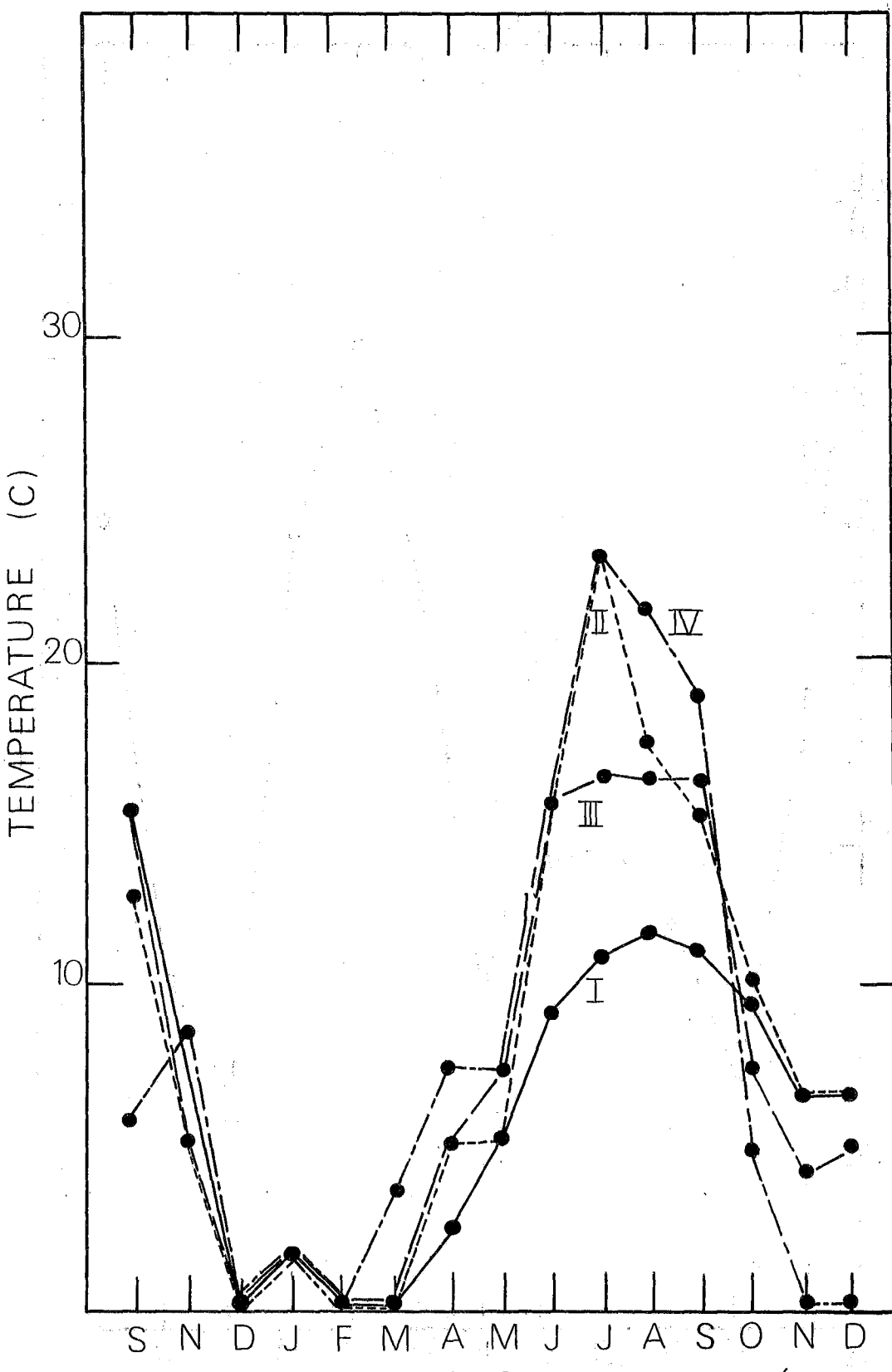

Figure 3. Monthly records of water temperatures (one reading per month) in Piceance Creek from September, 1968 to December, 1969. Roman numerals correspond to sampling sites. Fig. 2

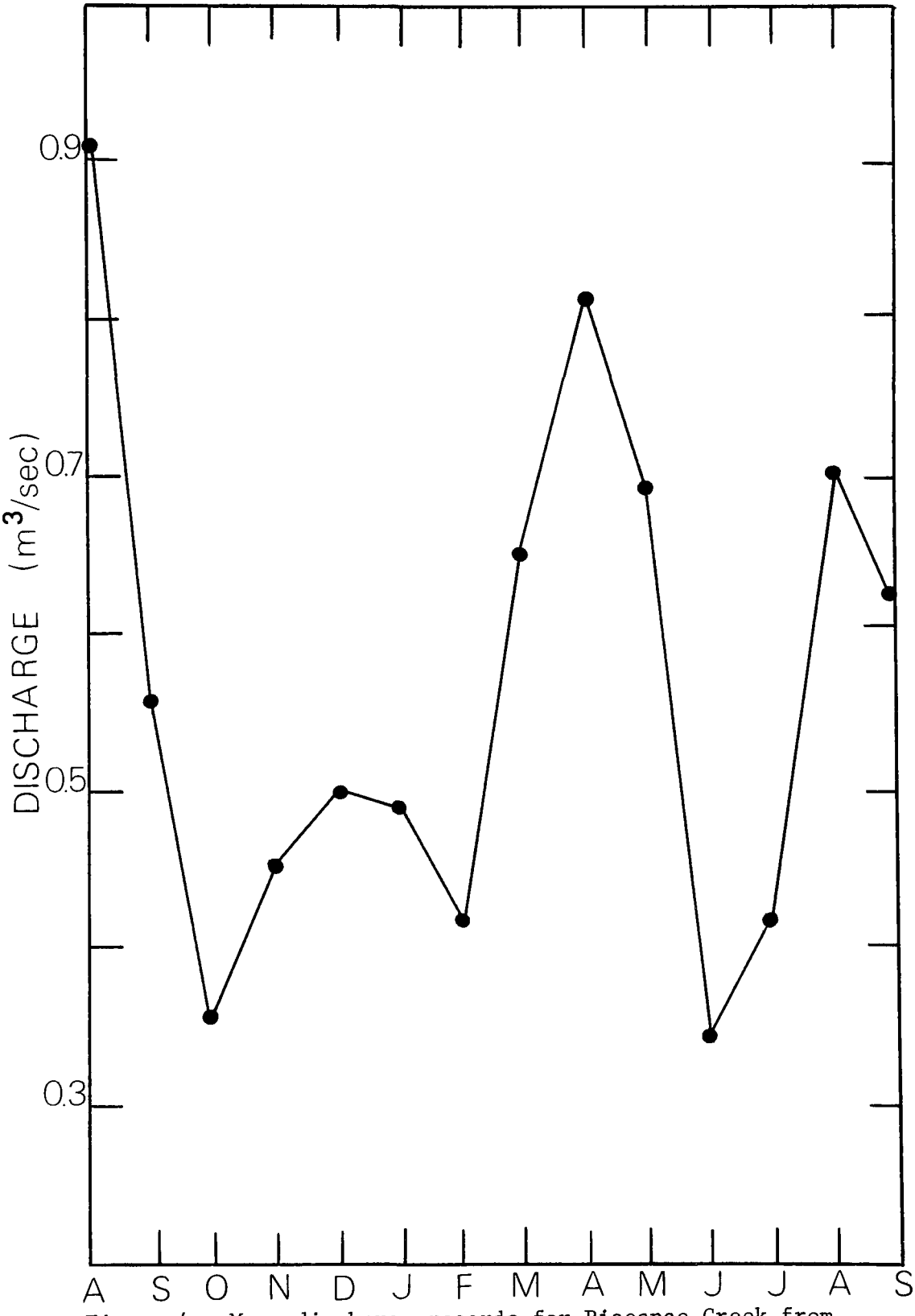

Figure 4. Mean discharge records for Piceance Creek from August, 1968 to September, 1969.

TABLE 1.--Specific conductance (μ mho cm^{-1} at 25 C) from various locations of Piceance Creek for three different years.

Station	Sample Date		
	6 Oct. 1965[1]	2 Nov. 1968	4 Oct. 1969
I	986	--	925
II	1,350	1,160	1,265
III	2,010	--	1,400
IV	2,680	2,250	2,000

[1]Analysis by USGS. Samples from the stations do not correspond exactly with those of 1968-69, but they were in the general area.

Chemical Parameters

Field Determinations:

Dissolved oxygen values of Piceance Creek were inversely related to temperature (Figure 5). Dissolved oxygen in White River and Yellow Creek showed this same inverse relationship. Because of higher concentration of dissolved salts in Piceance Creek and Yellow Creek, dissolved oxygen concentration at saturation was lower than for White River at the same temperature.

Total alkalinity for Piceance Creek ranged from 300 to 1,600 mg/l. Stations I, III, and IV were more homogeneous with concentration increasing with distance down stream. Station V was more concentrated, reaching a high in July (1969) of 1,600 mg/l. Total alkalinity values for White River were lower and more homogeneous (Tables 66, 68, and 70). Yellow Creek data showed a high degree of variability.

Hydrogen ion concentration in Piceance Creek ranged from pH 7.9 at Station I, to pH 8.4 at Station V. All pH readings were similar with only slight variations. This same homogeneity was found in White River and Yellow Creek. The pH of Yellow Creek was consistently higher (pH 8.5 to 8.8).

Filtrable solids from Piceance Creek showed some seasonal trends. There was an inverse relationship between discharge and filtrable solids (Figure 6). Total solids were not analyzed prior to March, 1969, and discharge data from October, 1969 to December, 1969 were unavailable; however, existing data indicated a direct relationship between total solids and discharge rate. (Figure 7). Non-filtrable solids data are listed in(Tables 13, 15, 17, 19, 21, 22, 23, 66, 68, 70, and 75).

Major Cations:

Piceance Creek dissolved calcium values showed a high degree of variability (26 mg/l December, 1968 to 180 mg/l June, 1969). White River and Yellow Creek calcium data showed similar variability (Tables 67, 69, 71, and 76).

Dissolved magnesium values indicated a seasonal trend. Magnesium concentration, when compared to discharge, indicated an indirect relationship (Figure 8). White River dissolved magnesium data were less variable, with concentrations ranging from 10 to 20 mg/l. Yellow Creek dissolved magnesium values were seven times those of White River (Table 76).

Sodium was the most concentrated cation in Piceance Creek, ranging from 150 to 2,950 mg/l. Station V had the highest concentration. A peak of 2,950 mg/l sodium was reached at Station V in August (1969), which coincided with a decrease in discharge. White River dissolved sodium values ranged from 20 to 100 mg/l; the majority of values found at the lower end of the range (Tables 67, 69, and 71). Yellow Creek had a low of 300 mg/l and a high of 3,710 mg/l (Table 76).

Potassium data for all three streams were highly variable (Tables 14, 16, 18, 20, 67, 69, 71, and 76).

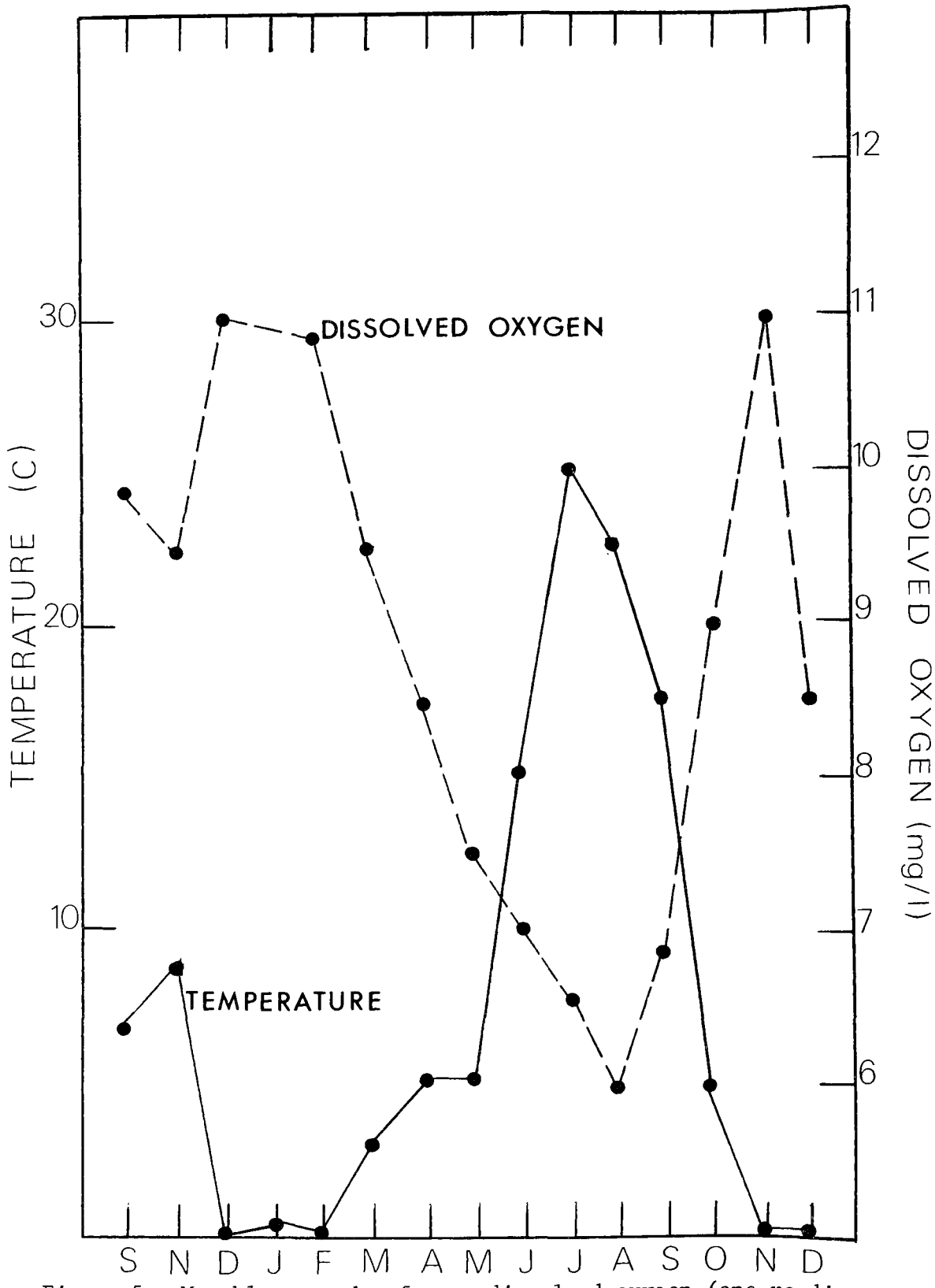

Figure 5. Monthly records of mean dissolved oxygen (one reading per month) and water temperature in Piceance Creek from September, 1968 to December, 1969.

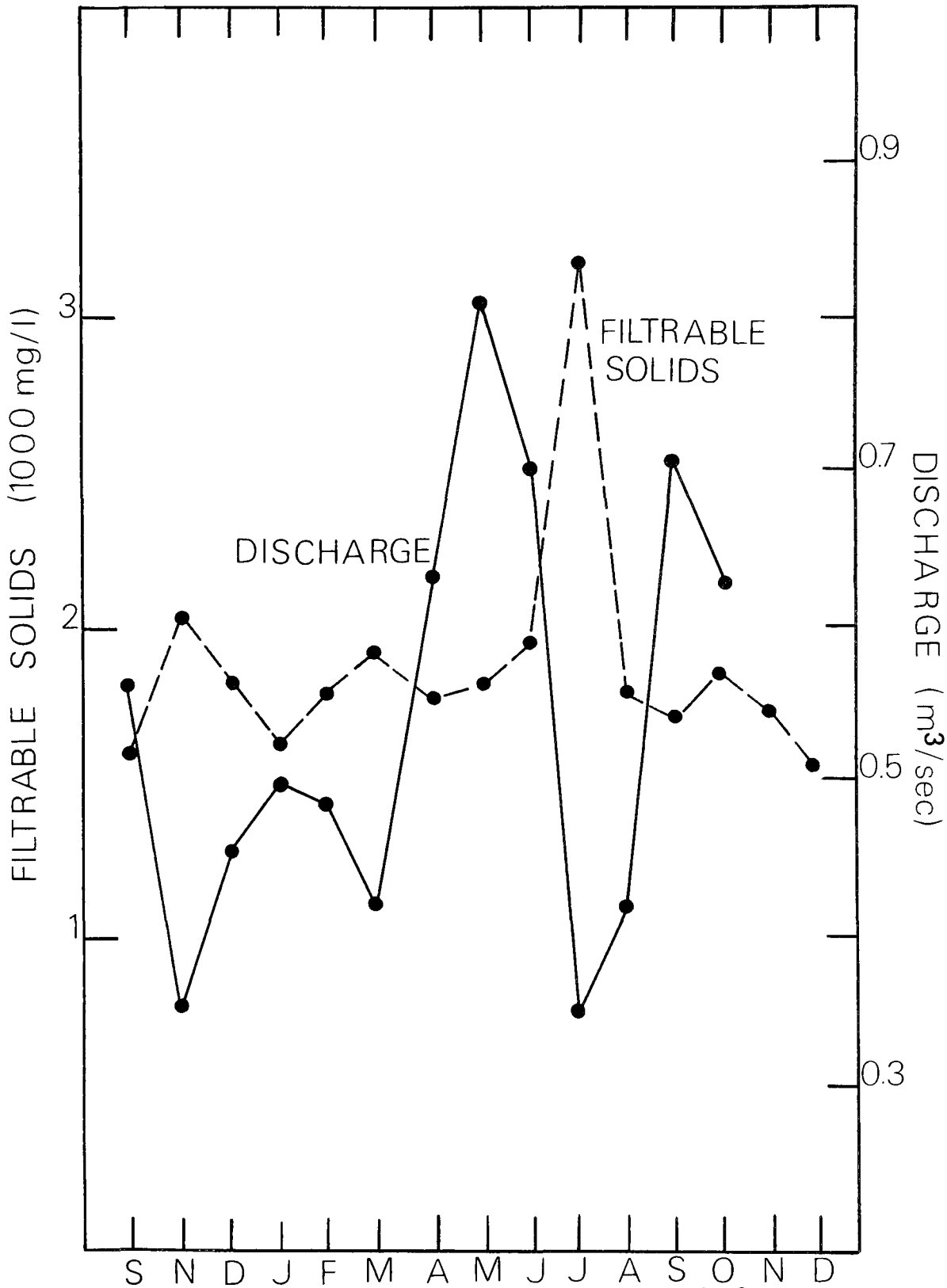

Figure 6. Filtrable solids and discharge records from Piceance Creek.

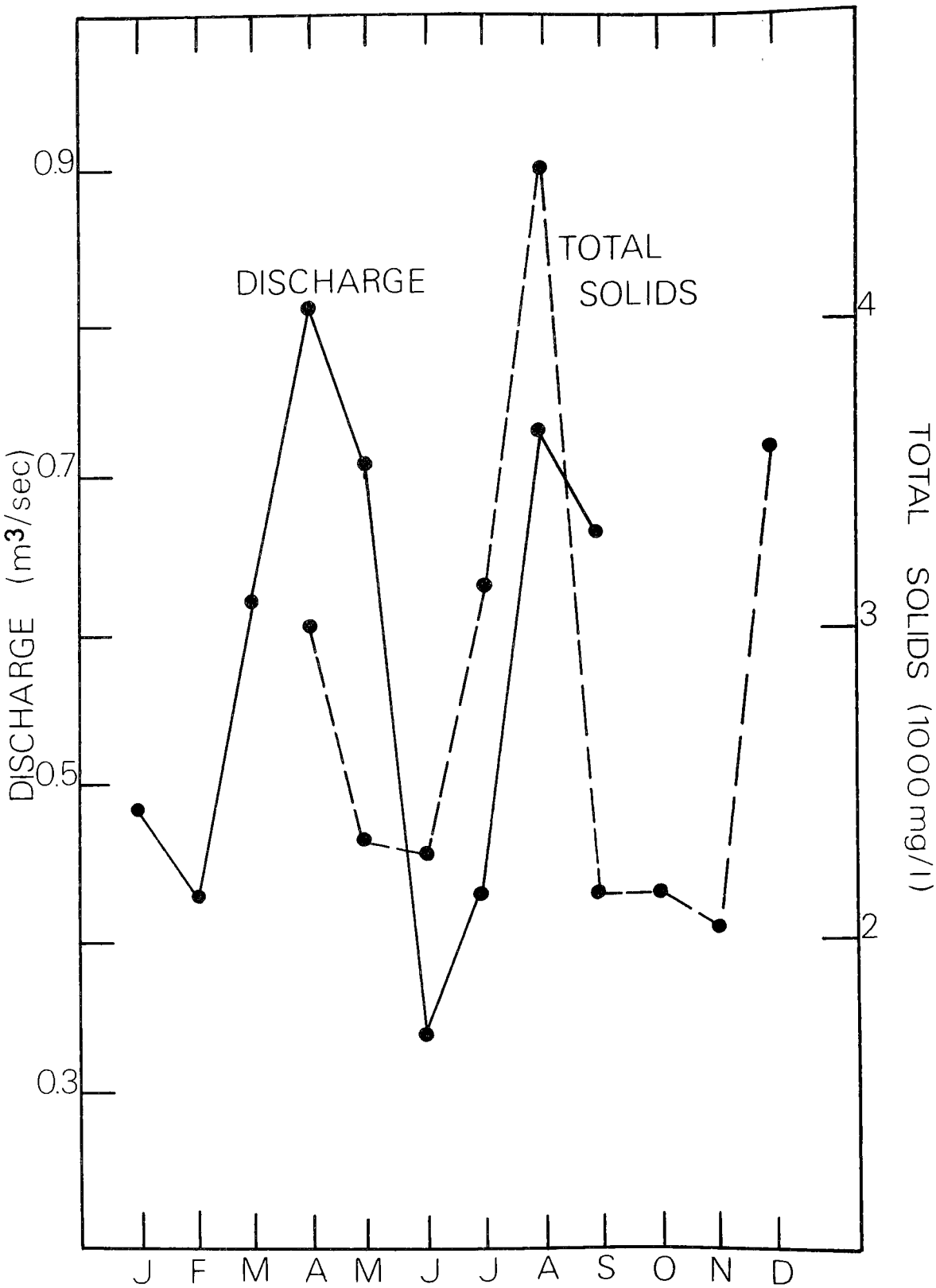

Figure 7. Total solids and discharge records from Piceance Creek from January, 1969 to December, 1969.

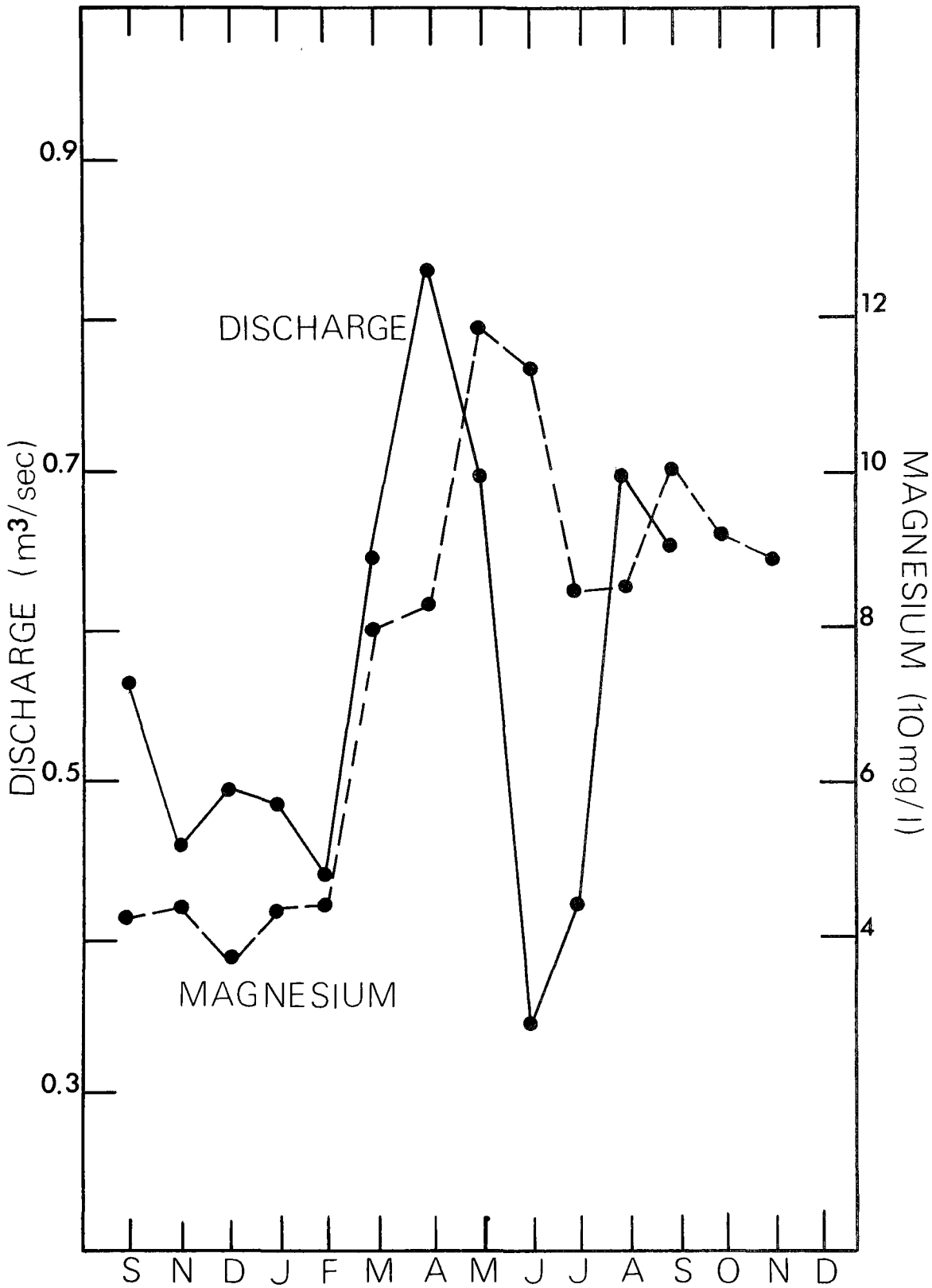

Figure 8, Magnesium concentration and discharge records in Piceance Creek from September, 1968 to December, 1969.

Anions:

Slight seasonal trends were observed in dissolved chloride concentrations. Chloride concentrations at Station V were inversely related to discharge. Chloride ranged from 7 to 135 mg/l in Piceance Creek, 2 to 25 mg/l in White River, and 75 to 174 mg/l in Yellow Creek (Tables 14, 16, 18, 20, 67, 69, 71, and 76).

Dissolved nitrate presented some analytical problems. Piceance Creek and Yellow Creek were consistently high in chloride which had a masking effect on nitrate. Colorometric analysis required removal of chloride, which was only partially possible without causing further sensitivity problems due to the removal agent. Concentrations of chloride in Piceance Creek and Yellow Creek ranged from 0.4 to 4.3 mg/l. White River during the winter (1968-1969) had a high of 6.6 mg/l, but generally remained at 0.2 to 1.2 mg/l.

Dissolved silica in Piceance Creek showed no seasonal trend. There was a high degree of within month variation between stations on Piceance Creek. White River and Yellow Creek showed similar results.

Dissolved sulfate values for Piceance Creek indicated seasonal variation. Concentrations increased with distance down stream (Figure 9). White River data indicated no seasonal trend. Yellow Creek sulfate values were highest and ranged from 501 to 892 mg/l.

Trace Elements:

Trace elements (cadmium, copper, chromium, iron, lead, manganese, molybdenum nickel, silver, and zinc) were less than 1 mg/l. There was no indication of seasonal trends in these elements.

Biological Parameters

Bottom samples yielded 10,505 benthic organisms. Peak total relative abundance of aquatic invertebrates in Piceance Creek occurred during June, 1969 (Figure 10). Mean monthly numbers ranged from 140 organisms per m^2 in April (1969) to 1,488 organisms per m^2 in June (1969).

Diptera and Ephemeroptera comprised the greatest number of organisms collected (Table 2). Dipterans were greatest in abundance and ranged from 47 to 58% of total organisms collected. Ephemeropterans, second in abundance, ranged from 17 to 27% of the total. Trichopterans, at Stations I, II, and V, ranged from 7 to 8% of the total at all stations except IV. Coleopterans ranged from 1 to 10% of the total. Plecopterans were least abundant of all aquatic insects collected. Noninsect aquatic invertebrates constituted the remaining organisms collected (Table 2). Oligochaetes contributed the largest number to this noninsect group and ranked third in total abundance. Table 2 also indicates the possibility of spacial distribution of organisms in Piceance Creek.

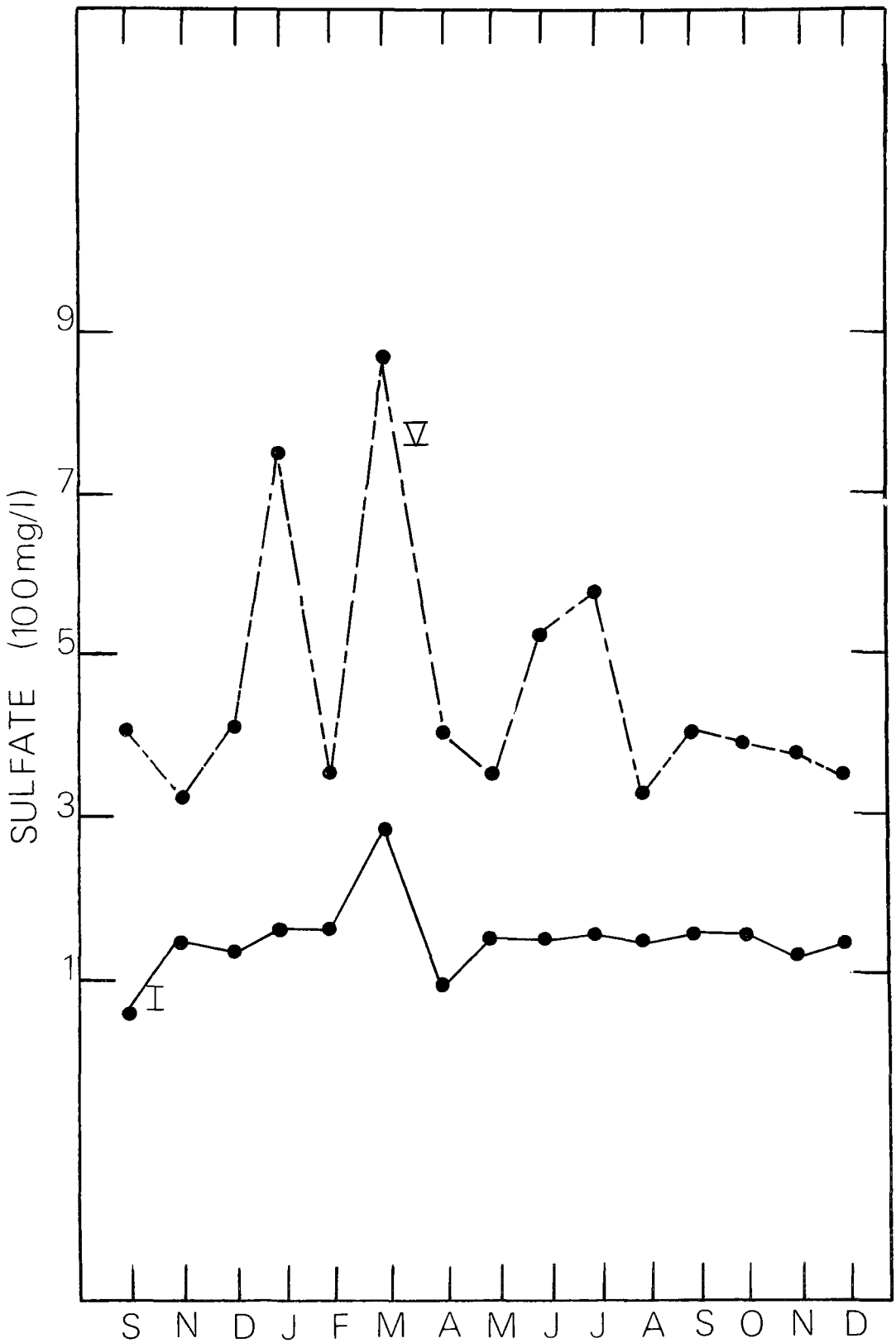

Figure 9. Sulfate concentration record in Piceance Creek from September, 1968 to December, 1969. Roman numerals indicate sampling site Fig. 2.

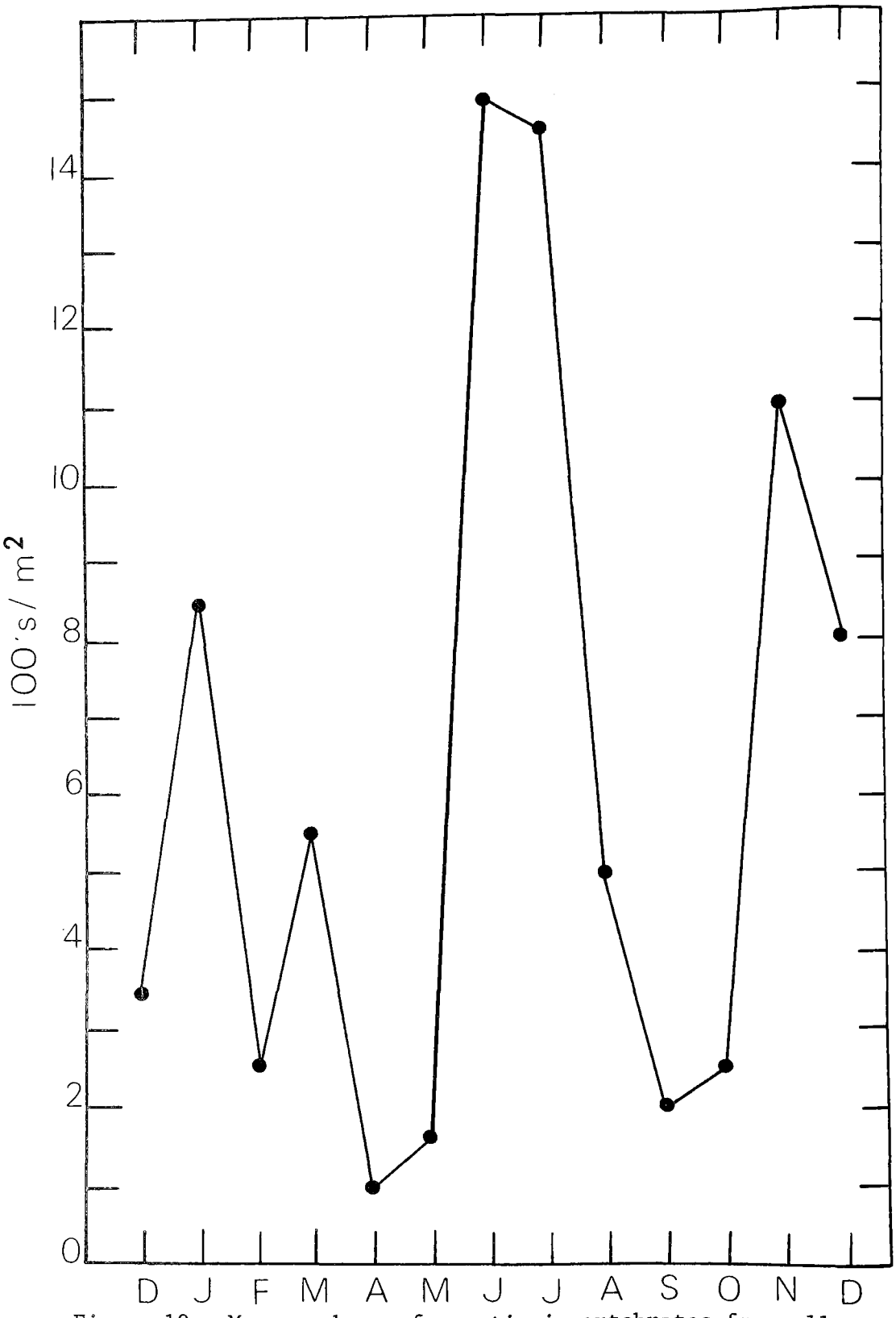

Figure 10. Mean numbers of aquatic invertebrates from all stations in Piceance Creek from December, 1968 to December, 1969.

TABLE 2.--Total number of aquatic invertebrates by major groups from each stream station[1] for a year period (December, 1968 to December, 1969)

Taxon	Station I		Station II		Station IV		Station V	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Ephemeroptera	933	20.7	1,275	27.4	188	17.4	49	17.9
Diptera	2,650	58.8	2,622	56.4	607	56.2	129	47.1
Trichoptera	339	7.5	360	7.7	9	0.8	20	7.3
Oligochaeta	235	5.2	194	4.2	187	17.3	29	10.6
Coleoptera	176	3.9	124	2.7	8	0.7	28	10.2
Plecoptera	4	0.1	23	0.7	65	6.0	--	--
Other[2]	167	3.7	38	0.8	16	1.5	19	6.9
Total	4,504		4,647		1,080		274	

[1]Station III was not sampled.

[2]Includes Gastropoda, Amphipoda, Hirudinea, and Odonata.

Tables 3 and 4 give the mean number, mean volume, and mean wet weight (all stations combined) for the sampling period. These data give a relative idea of total biomass. Coefficients of variation range from 35 to 92%, indicating the variation between stations.

Monthly biomass (standing crop) of total aquatic invertebrates ranged from 140 to 1,488 organisms per m^2 or from 0.8 to 15.0 grams wet weight per m^2. Volumes ranged from 1.1 to 16.8 ml/m^2.

Seasonal Trends

Diptera:

Diptera, represented by 12 families, was the most abundant order collected reaching its peak population during June (1969). There was a secondary peak in population during the months of December and January. A major low in numbers occurred during April and May and a secondary low in numbers during September (Figure 11).

Only eight families, of the 12 collected, were identified to genus and only one to species.

Simuliidae represented the greatest abundance of Dipterans. Individuals were identified to one genus, Simulium. Seasonal trends were evident (Figure 12) with a high number of individuals in June and low numbers in April, May, and September.

Chironomidae, second in dipteran abundance, showed a different type of seasonal population fluctuation (Figure 13). There were several population peaks of approximately the same magnitude with definite low numbers occurring during April, May, and September. All individuals were identified to one genus, Cardiocladius.

Tipulidae, third in dipteran abundance, had population peaks in January, March, and June (approximately 21 organisms per m^2) and low numbers in December and May (3 organisms per m^2). Three genera were identified, Tipula, Hexatoma, and Erioptera. Tipulidae contributed the greatest amount to the volume of organisms at each station.

Rhagionidae, fourth in dipteran abundance, peaked during summer months, and declined during the winter. The genus, Atherix, comprised the majority of individuals.

Tetanoceridae, Ephyridae, Ceratopogonidae, Culicidae, Tabanidae, Syphidae, and Stratiomyidae were collected in such small numbers they did not contribute to abundance or biomass. Seasonal trends were not apparent.

Ephemeroptera:

Ephemeroptera, represented by two families, Baetidae and Heptageniidae, were second in total abundance. Ephemeroptera populations had a primary high during June (1969) and a secondary high in January (1969). Low numbers were recorded during February, April, May, and September (1969).

TABLE 3.-- Mean number, volume, and wet weight of macrobenthos collected from stations on Piceance Creek, Rio Blanco County, Colorado (December, 1968 to June, 1969) Standard error values are between stations for a given month.

Month	Total No. samples	Mean No. per m^2	Standard error	Mean Vol. ml per m^2	Mean Wt. mg per m^2
December (1968	4(4)[a]	356	326.52	4.6	823.6
January (1969)	4(4)	830	556.54	4.5	3663.0
February	4(4)	280	192.64	1.1	686.7
March	4(4)	550	194.59	2.5	2183.6
April	3(4)	140	65.39	3.8	472.7
May	4(4)	183	123.02	2.0	643.5
June	4(4)	1488	851.41	16.8	15008.3

[a]number of square feet per sample

TABLE 4.--Mean number, volume, and wet weight of macrobenthos collected from stations on Piceance Creek, Rio Blanco County, Colorado (July, 1969 to December, 1969)

Month	Total No. samples	Mean No. per m^2	Standard error	Mean Vol. ml per m^2	Mean Wet Wt. mg per m^2
July	3(4)[a]	1421	1237.59	4.7	7102.8
August	4(4)	550	285.22	1.7	1298.2
September	4(4)	216	129.65	1.6	1846.8
October	4(2)	302	160.65	8.9	3412.5
November	4(2)	1078	631.30	8.7	5492.4
December	4(4)	776	422.88	4.2	864.2

[a]Number of square feet per sample

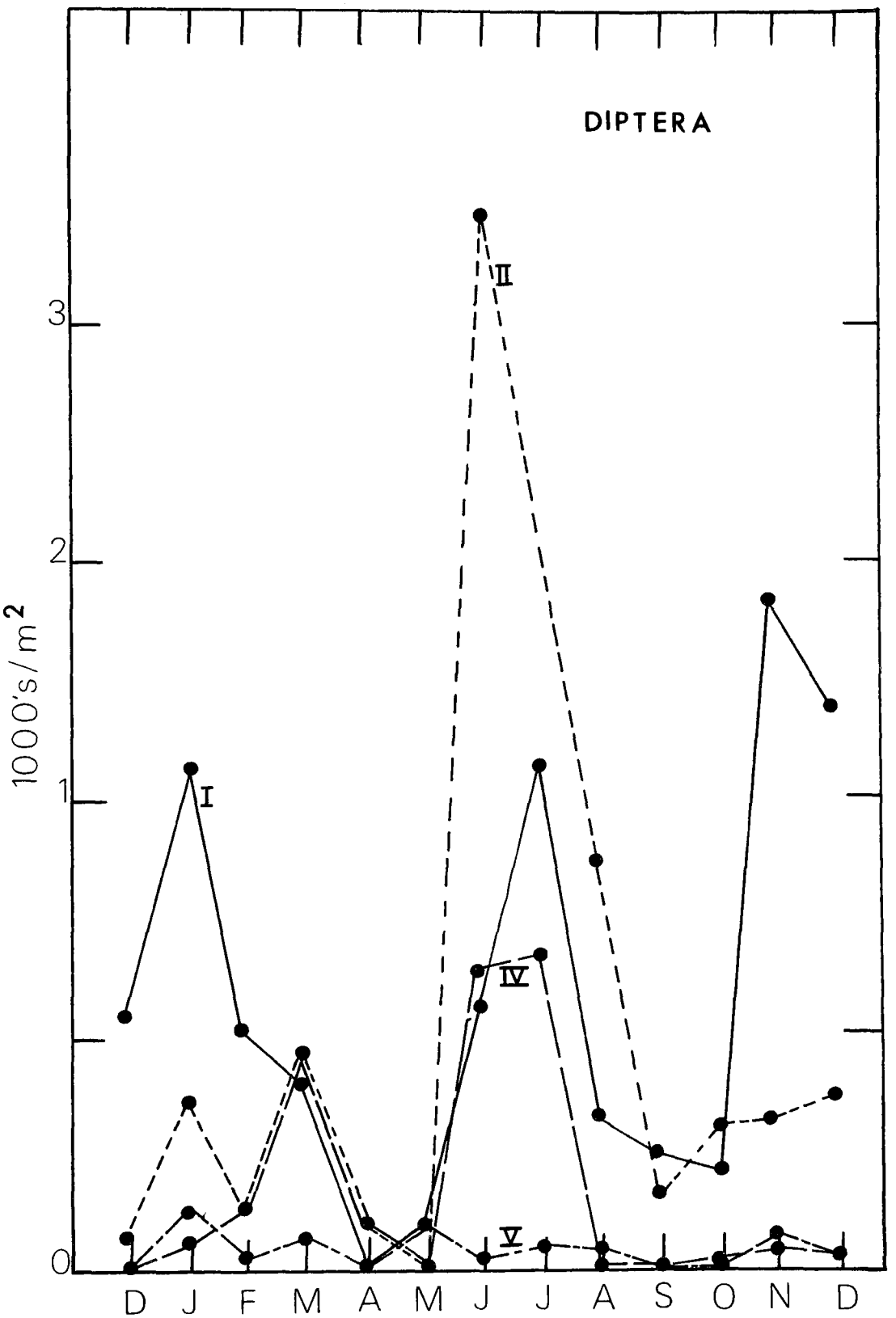

Figure 11. Monthly mean record for Diptera in Piceance Creek from December, 1968 to December, 1969. Roman numerals refer to sampling sites Fig. 2.

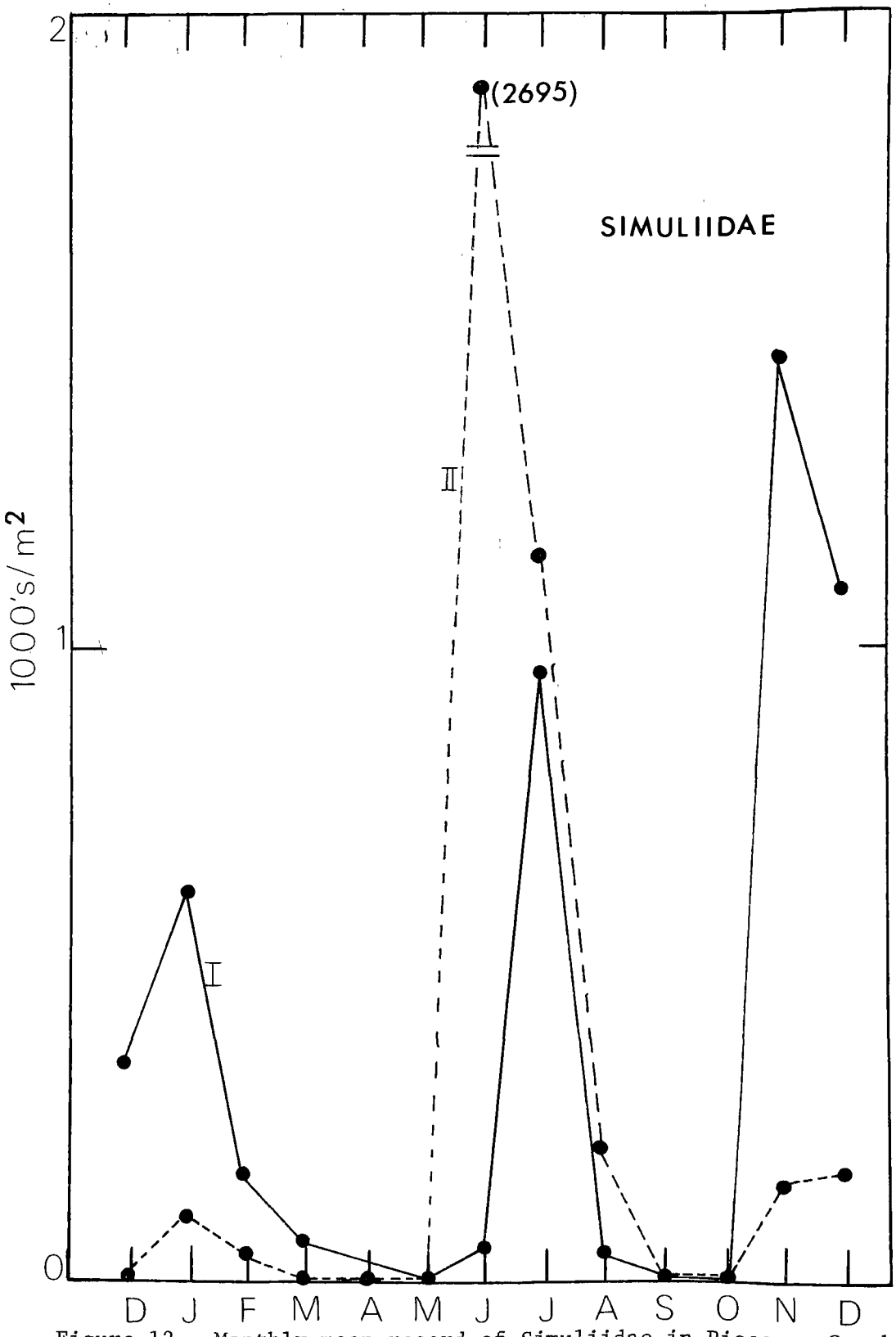

Figure 12. Monthly mean record of Simuliidae in Piceance Creek from Stations I and II.

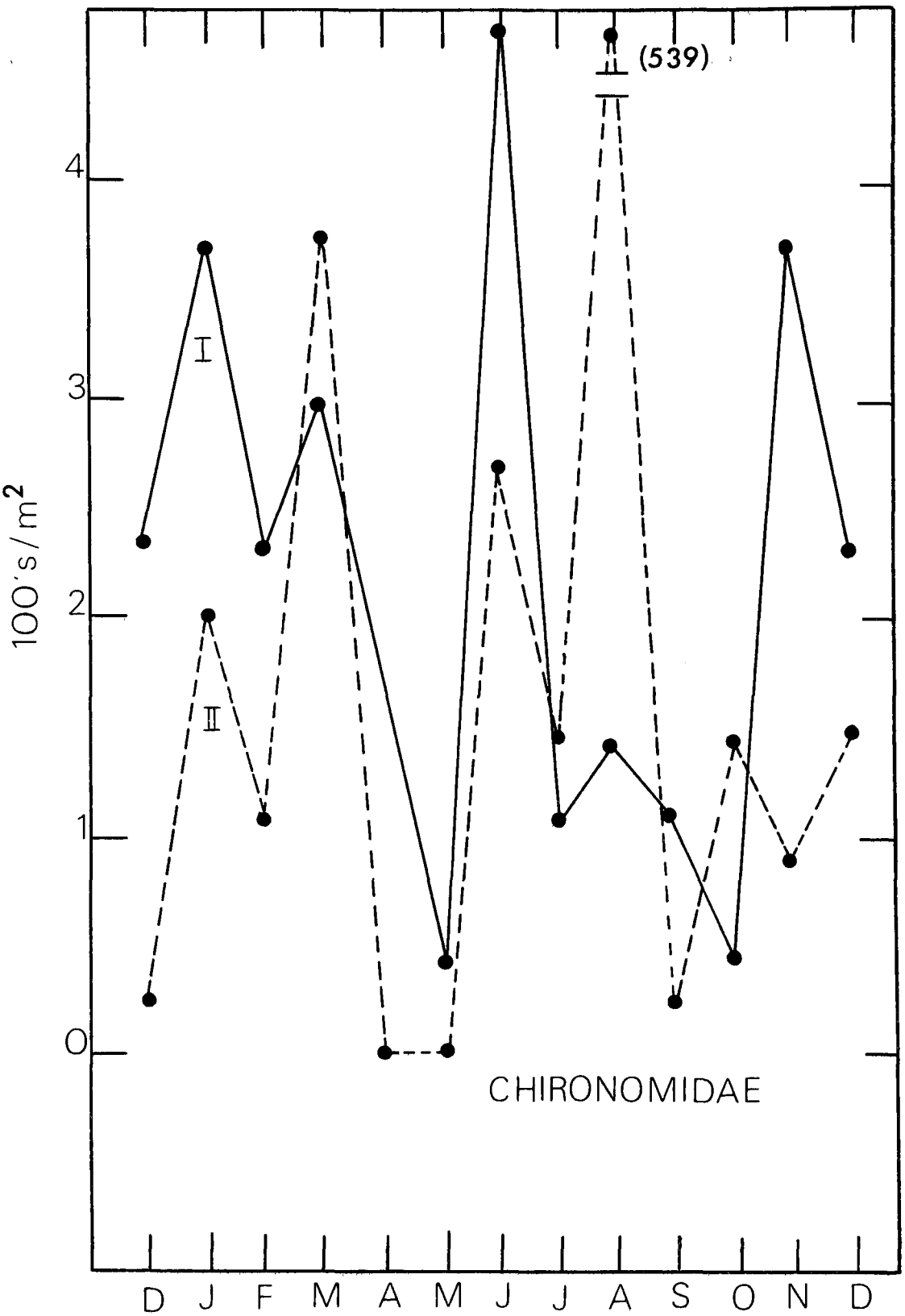

Figure 13. Monthly mean record of Chironomidae in Piceance Creek from Stations I and II.

Baetidae, the most abundant family, was represented by four genera, Ephemerella, Ameletus, Baetis, and Caenis. Figure 14 shows seasonal population trends exist for Baetidae,but there was variation between stations. Ameletus and Ephemerella comprised the majority of individuals in Baetidae.

Heptageniidae were collected to a lesser extent and Heptagenia was the only genus identified.

Trichoptera:

Trichoptera, third in total abundance, contained three families, Limnephilidae, Hydropsychidae, and Hydroptilidae. Each family contained one genus, Hesperophylax, Hydropsyche, and Hydroptila in order of families listed above. Peak abundance, for Trichoptera, was reached during December and January (1969) with low numbers occurring during March, April, and May (1969). Secondary population peaks were reached during the summer months (June and August, 1969).

Hydropsychidae were the most abundant Trichopterans collected. Seasonal trends were evident in this family (Figure 15). December and January (1969) exhibited the peak in abundance (260 organisms per m^2) with low number in April (1969).

Limnephilidae ranged from 0 to 76 organisms collected at Station II. Limnephilidae were generally less abundant than Hydropsychidae, with Stations I and II producing the majority of organisms.

Hydroptilidae did not contribute much to abundance or biomass.

Coleoptera:

Coleopterans showed a peak population during winter months (December, 1968 and January, 1969). A maximum of 194 organisms per m^2 was collected at Station I in January (1969). Secondary population peaks occurred during summer and early fall months. Few organisms were found in samples during March, April, and May; these months represented a seasonal low in numbers.

Oligochaeta:

Oligochaeta comprised a considerable portion of total biomass and abundance. Oligochaetes as a major group ranked fourth in abundance and ranged from 4.2 to 10.6% of total organisms collected. December (1968) samples produced no oligochaetes; this low was followed by an increase to a peak population in April (216 organisms per m^2). May, July, August, and December showed low numbers again with few organisms being collected.

Others:

Members of this group were: Gastropoda, Amphipoda, Hirudinea, and Odonata. No single component of the group was most abundant, but all seemed to appear occasionally during the sampling period. Station I produced the greatest abundance of this group.

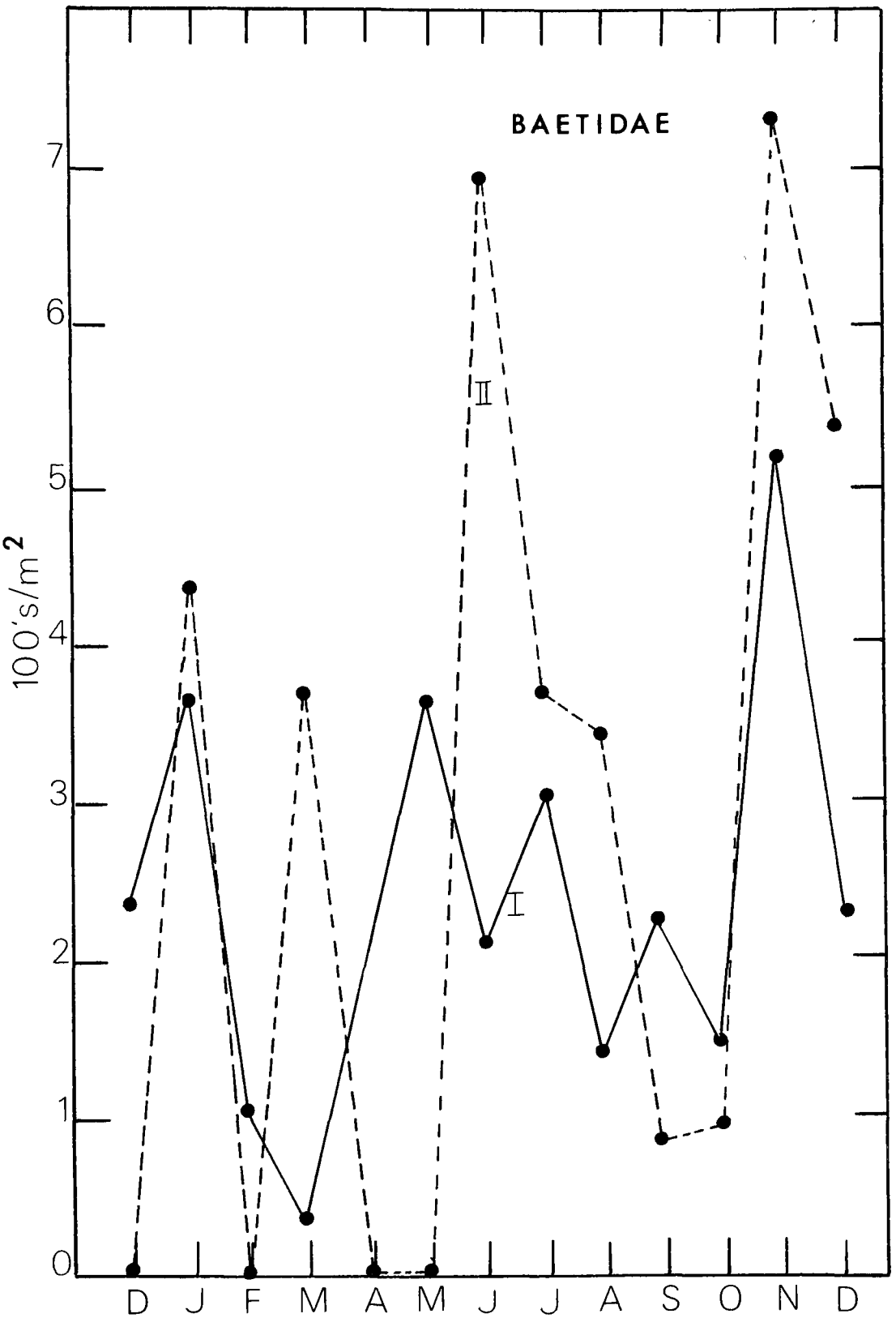

Figure 14. Monthly mean record of Baetidae in Piceance Creek from Stations I and II.

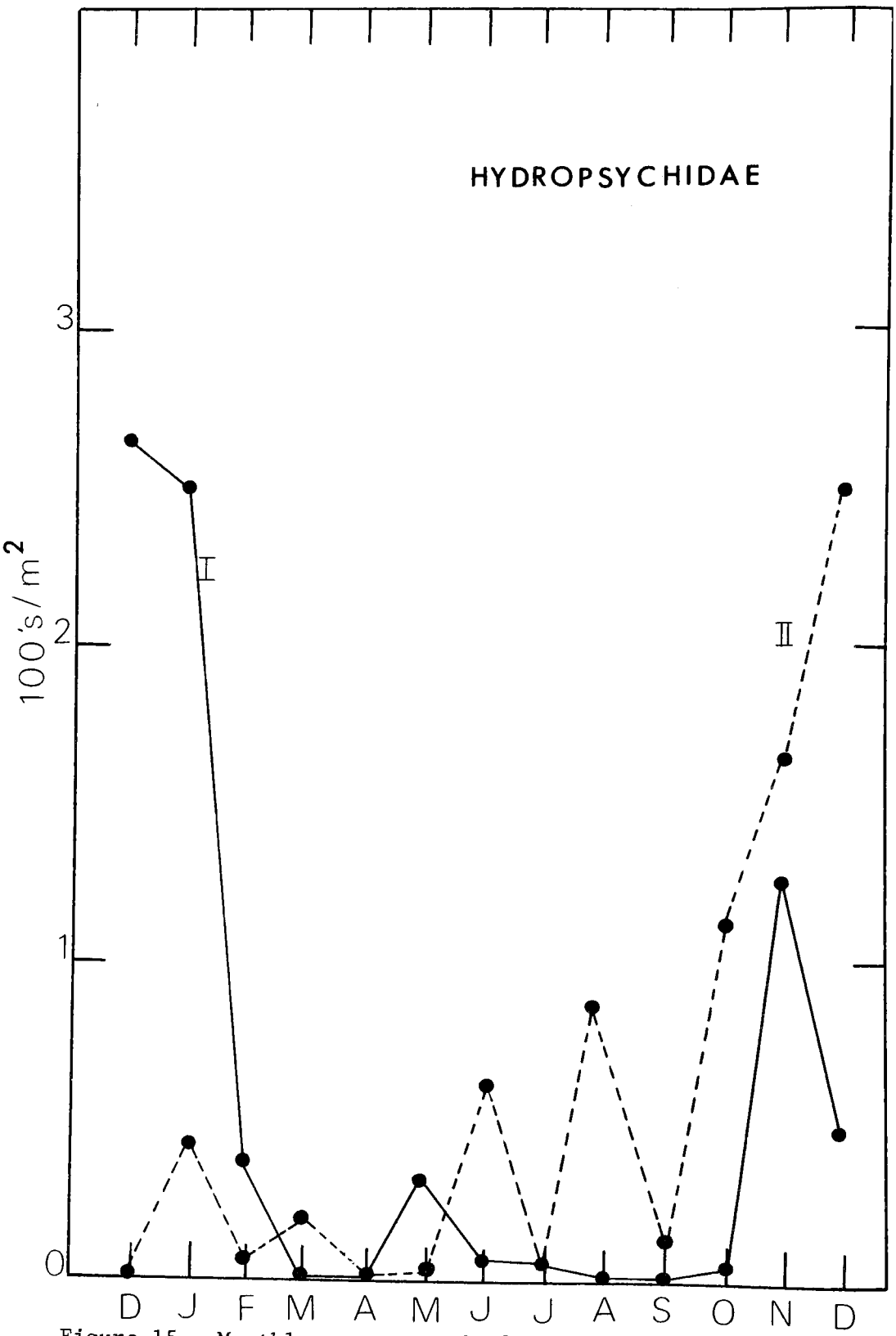

Figure 15. Monthly mean record of Hydropsychidae in Piceance Creek from Stations I and II.

Spatial Distribution

Aquatic invertebrates collected from Piceance Creek were generally equally abundant at Stations I and II, but this trend did not exist for the remaining stations. Abundance and composition tended to decrease from Station I to V in all the major groups (Tables 5-7).

Ten families of Diptera (Table 5) were found at Station I; only six families were found at Station IV. Simuliidae, most abundant dipteran, showed a marked spatial distribution between Stations I and V. Chironomidae (Table 1) showed this same distribution trend. Dipterans (Tetanoceridae, Ceratopogonidae, Tabanidae, and Stratiomyidae) were present at the upper stations (I and II) only, demonstrating a preference for the particular habitats at these stations.

Ephemeropterans (Table 1) ranged from four genera at Station I to two genera at Station V. Ameletus showed the greatest habitat tolerance, having higher numbers at all stations than other Ephemeropterans. Baetis and Caenis showed the least tolerance and inhabited Stations I and II respectively.

Trichopterans (Hesperophylax, Hydropsyche, and Hydroptila) were generally found in upper portions of Piceance Creek (Stations I and II). However, representatives of Hesperophylax and Hydropsyche (Table 6) were found in small numbers at Station IV and in even smaller numbers at Station V.

Six genera of Coleoptera were found at Station I, with only three genera found at Station V (Table 6). Halipus seemed to be more habitat tolerant, being found at all stations. Representatives of Elmidae and Dytiscidae were found primarily in the cooler, clear water of Stations I and II.

Isoperla (Plecoptera) showed the only reversal of spatial distribution in Piceance Creek (Table 6). Isoperla showed a definite increase in numbers from Stations I to IV. This trend, however, did not persist to Station V (no Plecopterans being found).

Gyraulus, a Gastropod, was confined to Stations I and II and also showed a decrease from Station I to Station II.

Hyalella, an Amphipod, was found at all four stations, but there was a marked decrease in numbers from Station I (49 organisms) to Station V (3 organisms).

Representatives of Odonata, Hirudinea, Pelecypoda, and Hydracarina (Table 7) were collected in such few numbers that spatial distribution was not evident.

Total monthly biomass indicated the same spatial distribution as abundance (Table 8). Total monthly volume was also quite similar with regard to spatial differences. For all months sampled, Stations I and II were higher in biomass than Stations IV and V.

TABLE 5.--Spatial distribution of Diptera and Ephemeroptera in Piceance Creek, from December, 1968 to December, 1969 on basis of total organisms collected.[1] *, <25; **, 25-100; ***, 101-200; 8888, >200; --, not observed.

Taxon	Stations			
	I	II	IV	V
Diptera				
Tipulidae				
Tipula	*	**	*	*
Hexatoma	*	**	*	--
Erioptera	*	--	--	*
Tetanoceridae	*	--	--	--
Ephydridae	*	--	*	*
Chironomidae				
Cardiocladius	****	****	****	**
Simuliidae				
Simulium	****	****	*	*
Ceratopogonidae	*	*	--	--
Culicidae	*	--	--	*
Rhagionidae				
Atherix	***	**	*	*
Tabanidae	*	--	--	--
Syphidae				
Eristalis teanix	--	--	--	*
Stratiomyidae				
Pachgaster	*	*	--	--
Ephemeroptera				
Baetidae				
Ephemerella	****	****	**	*
Ameletus	****	****	***	***
Baetis	*	--	--	--
Caenis	--	*	--	--
Heptageniidae				
Heptagenia	**	*	*	--

[1] Station III was not sampled.

TABLE 6.--Spatial distribution of Trichoptera, Plesiopora, Coleoptera, and Odonata in Piceance Creek, from December, 1968 to December, 1969 on basis of total organisms collected. *, <25; **, 26-100; ***, 101-200; ****, >200; --, not observed.

Taxon	Stations			
	I	II	IV	V
Trichoptera				
Limnephilidae				
Hesperophylax	*	**	*	--
Hydropsychidae				
Hydropsyche	****	****	*	*
Hydroptilidae				
Hydroptila	*	--	--	--
Coleoptera				
Halipidae				
Halipus	**	**	*	*
Brychius	*	--	--	--
Elmidae				
Limnius	**	*	--	*
Lara	*	**	*	--
Dytiscidae				
Agabus	*	*	--	--
Hydrovatus	*	--	--	--
Hydrophilidae				
Helophorus	--	--	--	*
Plecoptera				
Perlodidae				
Isoperla	*	*	**	--
Odonata				
Aeschnidae	*	--	*	*
Coengrionidae				
Ischnura	*	--	--	--
Gomphidae				
Ophiogomphus	--	--	--	*
Plesiopora				
Tubificidae	****	***	***	*

[1]Station III was not sampled.

TABLE 7.--Spatial distribution of Amphipoda, Pulmonata, Hirudinea, Pelecypoda, and Hydracarina in Piceance Creek, from December, 1968, to December, 1969 on basis of total organisms collected.[1] *, <25; **, 26-100; ***, 101-200; ****, >200; --, not observed.

Taxon	Stations			
	I	II	IV	V
Amphipoda				
Talitridae				
Hyalella	**	*	*	*
Pulmonata				
Planorbidae				
Gyraulus	*	*	--	--
Parapholyx	*	--	*	--
Lymnaeidae				
Lymnea	*	*	*	*
Physidae				
Physa	--	*	--	--
Hirudinea				
Rhynchobdellida	*	*	*	--
Pelecypoda				
Heterodonata				
Shaeriidae	*	*	*	*
Hydracarina				
Trombidiidae	*	--	*	--

[1]Station III was not sampled.

TABLE 8.-- Biomass (mg wet weight) of aquatic invertebrates from each station[1]. (December, 1968 to December, 1969).

Month	Stations			
	I	II	IV	V
December (1968)	2,766	26	--	34
January (1969)	10,646	3,414	711	64
February	2,253	334	86	21
March	743	4,851	2,457	86
April	--	1,196	140	86
May	2,037	183	107	194
June	3,826	44,003	16,525	21
July	5,001	14,865	1,670	--
August	1,185	3,158	366	743
September	3,913	6,123	10	--
October	636	9,862	2,630	--
November	10,456	10,941	474	14
December	1,894	4,117	937	571

[1]Station III was not sampled.

Macrobenthos samples taken from White River (Tables 72 and 77) indicated that diversity was uniform throughout the study area. Yellow Creek macrobenthos were less diverse than Piceance Creek or White River.

Fish

Species diversity of fish in Piceance Creek was low throughout the stream. Mountain sucker (Catostomus platyhynchus) and speckled dace (Rhinichthys osculus) were the predominant species present and existed along the length of Piceance Creek. Salmo gairdneri and Salvelinus fontinalis, occurred in the upper portion (4.8 km) of permanent water. Other species were found to a lesser extent in Piceance Creek (Table 62).

Fish populations sampled in White River were slightly more diverse than Piceance Creek (Table 73). There was a uniform distribution of species throughout the study area. Mountain whitefish were found at Station V Piceance Creek not in great numbers in either stream.

SECTION VI

ACKNOWLEDGMENTS

The Department of Fishery and Wildlife Biology, Colorado State University, initiated the grant proposal, and handled the administration. Dr. W. Harry Everhart, Professor and Chairman Fishery Major, was Project Director. Mr. Bruce May, Florida Game and Fresh Water Fish Commission, Eustis, Florida, completed the field work as part of his graduate work, and submitted the report as his Master's thesis to the Graduate School.

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The support of the project by the Water Quality Office, Environmental Protection Agency, and assistance from Mr. J. Howard McCormick, Grant Project Officer, are acknowledged.

SECTION VII

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SECTION IX

APPENDICES

TABLE 9.--Physical data collected at station I on Piceance Creek from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	--	15	--	--
November	--	--	--	--
December	29	0	1,000	--
January (1969)	21	1	950	--
February	9	0	1,000	--
March	1	0	756	--
April	38	2	750	--
May	--	5	--	--
June	60	10	920	--
July	73	11	860	<25
August	67	12	960	<25
September	65	11	890	<25
October	54	8	925	<25
November	53	5	860	<25
December	49	5	830	<25

TABLE 10.--Physical data collected at station III on Piceance Creek from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	52	12	1,000	--
November	47	6	1,100	--
December	36	1	1,300	--
January (1969)	39	1	1,250	--
February	20	0	1,300	--
March	26	0	1,400	--
April	42	5	1,150	--
May	--	5	--	--
June	62	15	1,400	--
July	84	19	1,440	<25
August	78	17	1,260	<25
September	75	14	1,140	<25
October	46	9	1,265	<25
November	58	5	1,240	<25
December	48	5	1,075	<25

TABLE 11.-- Physical data collected at station IV on Piceance Creek from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)	Discharge (cfs)
September (1968)	--	15	2,200	--	20.2
November	32	5	2,250	--	16.7
December	36	1	1,000	--	17.8
January (1969)	35	1	1,450	--	17.2
February	22	0	1,454	--	15.6
March	30	0	1,506	--	22.6
April	48	5	1,450	--	28.8
May	--	6	--	--	24.3
June	70	15	1,760	--	12.4
July	84	15	1,750	<25	15.2
August	78	15	1,360	<25	25.3
September	76	14	1,270	<25	22.4
October	38	7	1,400	32	--
November	37	3	1,360	<25	--
December	46	4	1,190	28	--

TABLE 12.--Physical data collected at station V on Piceance Creek from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	45	7	2,000	--
November	54	9	2,250	--
December	32	0	2,400	--
January (1969)	37	0	2,200	--
February	32	0	2,510	--
March	38	3	2,400	--
April	49	6	2,515	--
May	--	6	--	--
June	68	15	2,500	--
July	89	25	3,800	<25
August	84	22	1,875	63
September	76	17	1,850	38
October	34	6	2,000	36
November	28	0	1,750	28
December	38	0	1,525	110

List of Abbreviations and Their Meanings

DO - Dissolved Oxygen concentration (mg/l)

pH - Hydrogen ion concentration

phth - phenophthalein alkalinity (mg/l $CaCO_3$)

TA - Total Alkalinity (mg/l $CaCO_3$)

FS - Filtrable Solids (mg/l)

NFS - Nonfiltrable Solids (mg/l)

TR - Total Residue (mg/l)

SS - Settleable Solids (ml/l)

Ca - Calcium (mg/l)

Mg - Magnesium (mg/l)

Na - Sodium (mg/l)

K - Potassium (mg/l)

Cl - Chloride (mg/l)

SO_4 - Sulfate (mg/l)

SiO_2 - Silica (mg/l)

NO_3 - Nitrate (mg/l)

SC - Specific Conductance (μ mho cm^{-1})

T - Turbidity (JTU)

TABLE 13.--Chemical data from station I on Piceance Creek from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	10.2	8.4	0.0	270.0	480.0	--	--	--
November	7.7	8.2	0.0	500.0	728.0	--	--	--
December	10.3	7.8	0.0	376.0	674.0	--	--	--
January (1969)	6.5	7.9	0.0	436.0	706.0	--	--	--
February	10.1	8.0	0.0	400.0	660.0	--	--	--
March	11.2	8.0	0.0	380.0	688.0	--	--	0.1
April	9.0	7.6	0.0	304.0	506.0	1,014.0	1,520.0	1.3
May	9.6	7.8	8.0	350.0	598.0	70.0	668.0	0.1
June	8.3	8.0	0.0	392.0	656.0	4.0	660.0	0.0
July	10.4	7.9	0.0	368.0	614.0	12.0	626.0	0.0
August	9.4	7.9	0.0	396.0	653.0	2.0	655.0	0.0
September	10.0	7.8	0.0	412.0	647.0	5.0	652.0	0.0
October	10.0	8.0	12.0	406.0	675.0	53.0	718.0	0.0
November	10.6	7.9	0.0	400.0	661.0	3.0	664.0	0.0
December	10.2	7.8	0.0	404.0	542.0	128.0	670.0	0.0

TABLE 14.--Chemical data from station I on Piceance Creek from September, 1968 to December,1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	49.9	27.7	7.8	3.2	6.8	65.6	15.5	1.2
November	81.1	34.0	133.5	10.0	13.0	139.9	21.0	0.9
December	--	--	--	--	11.4	125.4	21.3	2.2
January (1969)	75.0	31.9	107.7	3.7	12.0	150.1	15.5	0.9
February	79.3	32.2	107.1	4.2	11.0	148.7	15.0	2.1
March	79.3	33.0	111.6	4.0	11.0	283.0	16.0	0.5
April	77.0	32.0	97.9	2.4	8.0	91.1	18.0	3.0
May	90.0	50.0	131.3	4.0	8.5	146.5	16.0	3.8
June	99.0	47.6	110.0	2.8	10.5	141.0	16.5	3.2
July	94.0	44.8	105.7	2.4	10.8	147.3	16.5	1.7
August	110.0	48.7	129.2	3.1	11.5	134.4	18.0	0.8
September	82.0	48.1	107.9	0.6	10.8	153.4	15.5	0.7
October	85.6	60.6	235.0	6.0	11.0	154.9	25.0	2.5
November	64.6	53.9	197.0	5.1	11.0	128.6	20.0	0.5
December	61.6	46.4	202.0	5.8	10.5	139.2	19.5	2.9

TABLE 15.--Chemical data from station III on Piceance Creek from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	8.1	8.2	0.0	396.0	650.0	--	--	--
November	7.7	8.2	0.0	500.0	728.0	--	--	--
December	10.3	7.8	0.0	376.0	674.0	--	--	--
January (1969)	7.0	8.2	0.0	480.0	454.0	--	--	--
February	10.4	8.2	0.0	500.0	948.0	--	--	--
March	10.7	8.0	0.0	492.0	1,014.0	--	--	0.8
April	8.3	7.8	0.0	424.0	760.0	865.0	1,625.0	1.3
May	8.2	7.8	12.0	496.0	902.0	178.0	1,080.0	0.2
June	8.1	7.9	0.0	552.0	1,064.0	4.0	1,108.0	0.1
July	8.4	8.0	4.0	532.0	1,122.0	13.0	1,135.0	0.1
August	8.0	8.1	0.0	496.0	900.0	200.0	1,100.0	0.3
September	9.0	7.9	0.0	468.0	837.0	101.0	938.0	0.1
October	9.0	8.0	12.0	582.0	954.0	135.0	1,089.0	0.1
November	10.8	8.0	0.0	508.0	945.0	49.0	994.0	0.1
December	10.0	7.9	0.0	496.0	842.0	116.0	958.0	0.2

TABLE 16.--Chemical data from station III on Piceance Creek from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	73.5	32.3	10.5	4.0	11.1	118.8	17.9	2.7
November	102.0	44.7	308.0	3.6	16.3	676.9	22.0	2.2
December	--	--	--	--	11.4	125.4	21.3	2.2
January (1969)	82.7	38.4	129.1	4.0	13.0	269.7	16.5	2.4
February	99.4	40.4	138.8	4.7	13.0	305.0	16.5	2.9
March	95.8	41.1	176.0	5.4	14.0	401.0	16.5	1.7
April	91.0	56.0	155.6	3.6	13.0	177.5	19.5	2.1
May	89.0	67.0	195.5	3.5	14.5	305.0	19.0	1.4
June	101.0	91.4	199.2	4.8	17.0	337.2	20.0	0.2
July	108.0	84.7	242.3	4.6	14.0	319.9	20.0	0.6
August	100.0	74.4	171.3	3.8	11.0	226.1	19.5	0.6
September	99.0	69.4	155.1	0.7	12.5	229.6	16.5	0.8
October	74.3	78.4	293.0	7.1	14.3	269.1	26.0	0.9
November	72.6	74.7	253.0	7.0	14.0	254.6	17.0	0.5
December	70.8	76.9	276.0	6.0	13.3	248.2	25.5	2.6

TABLE 17.--Chemical data from station IV on Piceance Creek from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	6.0	7.9	0.0	630.0	1,828.0	--	--	--
November	6.1	7.9	0.0	632.0	1,846.0	--	--	--
December	10.9	8.0	0.0	548.0	1,100.0	--	--	--
January (1969)	7.3	8.3	0.0	532.0	1,028.0	-	--	--
February	10.5	8.2	0.0	548.0	1,066.0	--	--	--
March	11.0	8.2	0.0	544.0	1,106.0	--	--	0.3
April	9.0	7.9	16.0	508.0	1,004.0	1,016.0	2,020.0	1.4
May	8.2	7.9	32.0	592.0	1,022.0	7,096.0	8,098.0	1.7
June	8.5	8.1	20.0	608.0	1,376.0	4.0	1,340.0	0.1
July	9.2	8.0	12.0	620.0	1,482.0	18.0	1,500.0	0.1
August	8.0	8.1	0.0	504.0	1,010.0	222.0	1,232.0	0.5
September	8.8	7.9	4.0	500.0	973.0	205.0	1,178.0	0.2
October	10.0	8.2	16.0	532.0	1,053.0	88.0	1,141.0	0.1
November	11.0	8.1	10.0	552.0	1,090.0	190.0	1,199.0	0.1
December	8.0	8.0	35.0	524.0	952.0	168.0	1,120.0	0.3

TABLE 18.--Chemical data from station IV on Piceance Creek from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	100.7	44.6	308.5	3.7	16.5	656.3	22.0	4.3
November	76.0	42.3	528.0	7.6	53.5	320.1	29.0	1.8
December	--	--	--	--	11.4	125.4	21.3	2.2
January (1969)	75.0	31.9	107.7	3.7	12.0	150.1	15.5	0.9
February	95.1	41.6	202.0	4.9	14.5	358.0	16.5	3.3
March	88.2	41.9	268.5	5.1	15.0	441.0	16.5	1.5
April	93.0	80.0	199.7	4.3	15.8	294.3	20.0	1.8
May	100.0	87.0	190.8	5.7	16.8	358.0	19.0	2.6
June	113.0	119.9	233.7	4.9	19.0	471.3	20.0	0.3
July	95.0	109.0	242.3	4.5	19.8	460.6	19.5	0.4
August	86.0	83.8	165.0	3.4	11.8	314.7	20.0	0.6
September	96.0	85.2	164.2	0.8	9.5	302.3	19.5	1.2
October	100.4	101.4	287.0	7.3	13.3	344.0	30.0	0.6
November	76.7	91.2	274.0	7.8	15.0	341.8	17.0	0.6
December	73.2	83.2	281.0	7.6	14.5	320.4	24.0	2.6

TABLE 19.--Chemical data from station V on Piceance Creek from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1958)	9.7	8.2	0.0	834.0	1,654.0	--	--	--
November	9.1	8.2	0.0	1,036.0	1,930.0	--	--	--
December	10.9	8.0	0.0	976.0	1,794.0	--	--	--
January (1969)	6.8	8.3	16.0	888.0	1,610.0	--	--	--
February	10.6	8.3	0.0	888.0	1,682.0	--	--	--
March	9.5	8.4	44.0	942.0	1,786.0	1,806.0	3,592.0	--
April	8.8	8.1	48.0	836.0	1,562.0	1,358.0	2,920.0	1.4
May	7.6	8.3	6.0	800.0	1,640.0	708.0	2,348.0	0.7
June	7.4	8.4	44.0	916.0	1,911.0	379.0	2,290.0	0.6
July	6.8	8.5	90.0	1,620.0	3,159.0	16.0	3,175.0	0.0
August	6.2	8.2	28.0	716.0	1,560.0	2,780.0	4,340.0	17.0
September	7.2	8.1	20.0	768.0	1,530.0	1,438.0	2,168.0	0.7
October	9.6	8.3	36.0	856.0	1,621.0	471.0	2,150.0	0.5
November	11.4	8.3	44.0	810.0	1,480.0	491.0	1,971.0	0.6
December	8.0	8.0	48.0	738.0	1,266.0	1,240.0	3,506.0	3.0

TABLE 20.-- Chemical data from station V on Piceance Creek from September 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	53.5	61.3	411.5	6.1	40.7	409.0	21.0	2.2
February	78.4	41.7	--	6.2	55.0	338.0	16.5	--
March	54.8	41.6	494.0	6.8	63.0	885.0	16.3	--
April	71.0	90.0	385.1	5.1	44.5	392.0	19.5	1.6
May	67.0	101.0	394.1	0.9	39.5	348.0	19.5	1.4
June	180.0	117.7	512.0	6.0	49.8	538.2	20.0	0.7
July	82.0	105.1	1,544.0	7.6	136.0	584.3	15.5	0.5
August	74.0	80.1	295.7	5.6	37.0	327.6	19.5	1.1
September	89.0	88.4	325.3	1.4	38.5	395.9	19.5	0.7
October	115.6	101.5	400.0	8.1	13.3	344.0	30.0	0.6
November	67.3	93.9	365.0	8.4	39.0	352.2	17.0	0.7
December	25.5	2910	87.4	4.4	36.0	322.9	24.0	2.2

TABLE 21.--Weekly sampling data from all stations June 10, 1969 to June 23, 1969

Date	Station	pH	SC	FS	NSF	TR	T
1969							
June 10	1	8.0	889	714	6	720	<25
	2	7.9	1,550	1,041	93	1,134	<25
	3	8.2	1,900	1,352	6	1,358	<25
	4	8.4	3,800	2,946	262	3,208	<25
	5	8.0	410	216	2	218	<25
	6	8.0	439	--	--	--	<25
	7	8.2	450	--	--	--	<25
	8	8.6	3,850	2,565	545	3,110	<25
June 16	1	8.0	1,040	661	109	770	<25
	2	8.0	1,540	1,100	154	1,254	<25
	3	8.2	1,860	1,409	156	1,560	<25
	4	8.4	2,810	2,520	664	3,184	30
	5	8.0	465	329	261	590	<25
	6	8.1	525	367	240	616	30
	7	8.1	520	350	746	1,096	40
	8	8.8	3,750	2,949	335	3,284	<25
June 23	1	8.0	920	656	4	660	<25
	2	7.9	1,400	1,104	4	1,108	<25
	3	8.1	1,760	1,336	4	1,340	<25
	4	8.3	2,500	1,911	379	2,290	<25
	5	8.2	479	300	54	354	<25
	6	8.2	480	337	47	384	<25
	7	8.2	485	336	60	396	<25
	8	8.8	3,550	2,914	146	3,060	<25

TABLE 22.--Weekly sampling data from all stations July 10, 1959 to July 31, 1969

Date	Station	pH	SC	FS	NSF	TR	T
1969							
July 10	1	7.9	860	614	12	626	<25
	2	8.0	1,440	1,122	13	1,135	<25
	3	8.0	1,750	1,482	18	1,500	<25
	4	8.5	3,800	3,159	16	3,175	<25
	5	8.1	498	338	14	352	<25
	6	8.3	520	356	44	400	<25
	7	8.4	510	344	10	354	<25
	8	8.9	3,850	3,178	70	3,248	<25
July 17	1	7.9	880	648	8	656	<25
	2	7.9	1,490	1,048	44	1,122	<25
	3	8.1	1,790	1,398	6	1,404	<25
	4	8.5	3,600	2,948	144	3,092	<25
	5	8.2	580	418	8	426	<25
	6	8.3	615	450	26	476	<25
	7	8.3	605	448	28	446	<25
	8	8.6	3,800	3,070	10	3,080	<25
July 23	1	8.0	940	645	19	664	<25
	2	8.0	1,430	880	208	1,088	<25
	3	8.1	1,775	1,260	536	1,796	31
	4	8.4	3,005	2,225	153	2,378	<25
	5	8.1	640	415	60	475	<25
	6	8.3	690	445	83	527	<25
	7	8.3	725	447	137	584	<25
	8	8.6	4,019	3,056	200	3,256	<25
July 31	1	8.0	938	662	2	664	<25
	2	8.0	1,290	894	47	941	<25
	3	8.0	1,460	1,082	434	1,516	<25
	4	8.3	2,450	1,816	329	2,145	<25
	5	8.2	590	414	67	481	<25
	6	8.2	700	491	218	709	<25
	7	8.3	730	539	605	1,144	50
	8	8.6	3,750	2,879	425	3,304	<25

TABLE 23.--Weekly sampling data from all stations August 7, 1969 to August 29, 1969

Date	Station	pH	SC	FS	NSF	TR	T
1969							
Aug. 7-8	1	7.9	940	628	6	634	<25
	2	8.0	1,310	986	66	1,052	<25
	3	8.0	1,450	1,024	686	1,710	28
	4	8.2	2,150	1,664	253	1,917	32
	5	8.2	580	471	17	488	<25
	6	8.3	665	369	123	492	<25
	7	8.3	665	462	88	550	<25
	8	8.6	3,450	2,890	144	3,034	<25
Aug. 19	1	7.9	920	--	--	--	<25
	2	8.0	1,215	--	--	--	118
	3	8.1	1,360	--	--	--	255
	4	8.1	1,810	--	--	--	2,000
	5	8.1	690	410	310	720	162
	6	8.0	700	465	2,019	2,484	800
	7	8.0	800	--	--	--	1,400
	8	8.9	3,015	--	--	--	<25
Aug. 29	1	7.8	880	646	35	681	<25
	2	8.1	1,080	849	261	1,110	52
	3	8.2	1,150	916	890	1,806	38
	4	8.4	1,825	1,522	1,082	2,604	53
	5	8.2	580	444	215	659	27
	6	8.3	640	457	823	1,280	70
	7	8.3	680	480	347	827	40
	8	8.8	3,500	3,054	246	3,300	25

TABLE 24.--Macrobenthic data from station I_2 on Piceance Creek, December, 1968. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	2	<0.1	11.6	10.4
Hexatoma	1	<0.1	2.4	1.7
Chironomidae	90	<0.1	5.6	4.7
Simuliidae	112	0.5	76.4	13.1
Tetanoceridae	1	<0.1	12.6	11.4
Ephydridae	1	<0.1	2.6	2.5
Rhagionidae				
Atherix	2	<0.1	0.1	0.0
Ephemeroptera				
Baetidae				
Ameletus	92	0.1	84.1	24.1
Ephemerella	7	<0.1	6.7	4.8
Trichoptera				
Limnephilidae				
Hesperophylax	10	0.3	61.9	10.1
Hydropsychidae				
Hydropsyche	95	6.0	603.2	72.4
Hydroptilidae				
Hydroptila	18	<0.1	7.6	1.8
Coleoptera				
Haliplidae				
Haliplus	8	<0.1	25.1	12.8
Elmidae				
Limnius	34	<0.1	42.7	16.2
Lara	1	<0.1	40.2	5.6
Odonata				
Aeschnidae	1	<0.1	3.0	2.5
Pulmonata				
Planorbidae				
Gyraulus	1	<0.1	6.0	4.3
Lymnaeidae				
Lymnaea	5	<0.1	20.1	10.5
Amphipoda				
Talitridae				
Hyalella	11	<0.1	22.0	5.8
Rhynochobdellida	1	<0.1	8.5	2.0
Plesiopora	2	<0.1	22.3	1.3

TABLE 25.--Macrobenthic data from stations II, IV, and V on Piceance Creek, December, 1968. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
	Station II			
Diptera				
Chironomidae	13	<0.1	9.8	1.8
	Station IV			
No organisms collected in any sample				
	Station V			
Diptera				
Chironomidae	10	<0.1	5.9	1.4
Simuliidae	2	<0.1	0.6	0.1
Tipulidae				
Tipula	1	<0.1	6.0	1.3

TABLE 26.--Macrobenthic data from station I on Piceance Creek, January, 1969. Based on 4 ft^2 (036 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	12	1.5	1,377.9	67.0
Hexatoma	5	0.2	277.7	21.4
Chironomidae	137	0.5	162.5	17.4
Simuliidae	241	1.0	289.9	44.3
Rhagionidae				
Atherix	20	0.5	407.7	63.9
Ceratopogonidae	3	<0.1	4.9	3.9
Tetanoceridae	5	<0.1	17.4	3.7
Ephemeroptera				
Baetidae				
Ameletus	97	0.1	68.8	12.2
Ephemerella	34	<0.1	36.6	5.5
Baetis	3	<0.1	0.6	0.2
Trichoptera				
Hydropsychidae				
Hydropsyche	92	0.5	534.2	53.9
Limnephilidae				
Hesperophylax	9	<0.1	31.2	4.0
Hydroptilidae				
Hydroptila	18	<0.1	6.1	1.7
Coleoptera				
Haliplidae				
Haliplus	19	0.1	70.5	31.7
Elmidae				
Limnius	47	0.2	66.5	20.7
Lara	3	<0.1	4.4	0.4
Dytiscidae				
Hydrovatus	1	<0.1	7.3	0.6
Pulmonata				
Planorbidae				
Gyraulus	19	<0.1	114.3	43.5
Lynmaeidae				
Lymnaea	2	<0.1	10.7	7.2
Amphipoda				
Talitridae				
Hyalella	25	<0.1	75.3	7.1
Rhynchobdellida	1	<0.1	10.5	1.2
Oligochaeta				
Plesiopora	28	0.5	248.8	24.4

TABLE 27.--Macrobenthic data from station II on Piceance Creek, January, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	15	0.6	637.9	55.0
Hexatoma	2	<0.1	8.3	0.3
Chironomidae	80	<0.1	15.3	3.5
Simuliidae	29	<0.1	30.2	4.9
Rhagionidae				
Atherix	3	<0.1	43.8	7.1
Ephemeroptera				
Baetidae				
Ameletus	120	0.2	176.1	25.8
Ephemerella	71	0.1	109.8	17.3
Trichoptera				
Hydropsychidae				
Hydropsyche	16	0.1	141.8	14.7
Limnephilidae				
Hesperophylax	6	<0.1	35.9	3.3
Plecoptera				
Perlodidae				
Isoperla	5	<0.1	7.5	0.8
Coleoptera				
Elmidae				
Limnius	14	<0.1	19.0	5.4
Lara	1	<0.1	1.8	0.0
Amphipoda				
Talifridae				
Hyalella	5	<0.1	7.2	1.2
Pulmonata				
Lymnaeidae				
Lymnaea	2	<0.1	14.9	5.3
Planorbidae				
Gyraulus	1	<0.1	4.2	1.3
Plesiopora	22	<0.1	8.6	1.4

TABLE 28.--Macrobenthic data from station IV and V on Piceance Creek, January, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station IV		
Diptera				
Tipulidae				
Tipula	1	<0.1	206.7	8.1
Ephemeroptera				
Baetidae				
Ameletus	3	<0.1	4.1	0.6
Plecoptera				
Perlodidae				
Isoperla	1	<0.1	0.2	0.0
Amphipoda				
Talitridae				
Hyalella	1	<0.1	1.1	0.1
Plesiopora	28	<0.1	25.2	5.0
		Station V		
Diptera				
Tipulidae				
Tipula	1	<0.1	1.2	0.0
Erioptera	1	<0.1	--	--
Chironomidae	16	<0.1	3.2	0.0
Simnliidae	5	<0.1	2.4	0.4
Amphipoda				
Talitridae				
Hyalella	1	<0.1	0.0	0.0
Plesiopora	4	<0.1	3.9	0.7

TABLE 29.--Macrobenthic data from station I on Piceance Creek, February, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	2	<0.1	47.2	13.8
Hexatoma	1	<0.1	56.3	4.7
Chironomidae	91	<0.1	51.3	8.5
Simuliidae	72	0.3	107.0	16.2
Rhagionidae				
Atherix	8	0.1	180.9	32.8
Ceratopogonidae	1	<0.1	0.9	0.1
Ephemeroptera				
Baetidae				
Ameletus	17	<0.1	27.2	4.8
Ephemerella	23	<0.1	27.2	5.0
Trichoptera				
Hydropsychidae				
Hydropsyche	11	<0.1	122.2	16.3
Limnephilidae				
Hesperophylax	1	<0.1	34.6	4.3
Hydroptilidae				
Hydroptila	1	<0.1	0.7	0.2
Coleoptera				
Haliplidae				
Haliplus	13	<0.1	--	--
Elmidae				
Limnius	12	<0.1	19.6	6.6
Odonata				
Coenagrionidae				
Ischnura	1	<0.1	0.7	0.0
Amphipoda				
Talitridae				
Hyalella	10	<0.1	14.0	2.3
Plesiopora	39	<0.1	31.6	7.5
Pulmonata				
Planorbidae				
Gyraulus	12	<0.1	76.2	34.4
Parapholyx	1	<0.1	1.3	0.6
Pelecypoda				
Sphaeriidae	1	<0.1	4.6	2.8

TABLE 30.--Macrobenthic data from station II on Piceance Creek, February, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	4	<0.1	73.0	7.4
Chironomidae	21	<0.1	4.5	1.1
Simuliidae	9	<0.1	4.7	2.0
Ephemeroptera				
Baetidae				
Ameletus	3	<0.1	2.4	0.1
Ephemerella	2	<0.1	3.1	0.3
Trichoptera				
Hydropsychidae				
Hydropsyche	2	<0.1	26.0	6.1
Hydroptilidae				
Hydroptila	1	<0.1	0.3	0.0
Coleoptera				
Elmidae				
Limnius	1	<0.1	0.6	0.0
Pulmonata				
Planorbidae				
Gyraulus	1	<0.1	6.8	1.9
Pelecypoda				
Sphaeriidae	1	<0.1	7.7	4.1
Plesiopora	3	<0.1	0.6	0.0

TABLE 31.--Macrobenthic data from stations IV and V on Piceance Creek, February, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
	Station IV			
Diptera				
Chironomidae	32	<0.1	9.5	0.6
Simuliidae	1	<0.1	0.9	0.0
Ephemeroptera				
Baetidae				
Ameletus	3	<0.1	2.4	0.0
Ephemerella	1	<0.1	10.6	0.9
Trichoptera				
Hydropsychidae				
Hydropsyche	1	<0.1	3.7	1.2
Rhynchobdellia	1	<0.1	7.3	1.4
Pulmonata				
Planorbidae				
Parapholyx	1	<0.1	0.6	0.2
	Station V			
Diptera				
Chironomidae	3	<0.1	0.8	0.0
Simuliidae	2	<0.1	0.7	0.0
Pulmonata				
Planorbidae				
Parapholyx	1	<0.1	10.9	8.3

TABLE 32.--Macrobenthic data from station I on Piceance Creek, March, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Hexatoma	2	<0.1	58.1	5.6
Chironomidae	114	<0.1	56.7	10.3
Simuliidae	18	<0.1	34.5	6.2
Ceratopogonidae	2	<0.1	0.3	0.3
Ephemeroptera				
Baetidae				
Ephemerella	6	<0.1	9.0	1.4
Ameletus	4	<0.1	7.4	1.1
Trichoptera				
Hydroptilidae				
Hydroptila	1	<0.1	1.2	0.1
Coleoptera				
Elmidae				
Limnius	2	<0.1	3.6	0.5
Haliplidae				
Haliplus	1	<0.1	3.2	0.4
Amphipoda				
Talitridae				
Hyalella	1	<0.1	1.5	0.7
Pulmonata				
Planorbidae				
Gyraulus	1	<0.1	1.8	1.2
Lymnaeidae				
Lymnaea	1	<0.1	1.9	1.1
Rhynchobdellida	4	<0.1	46.7	3.6
Plesiopora	58	<0.1	57.2	11.2

TABLE 33.-- Macrobenthic data from station II on Piceance Creek, March, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	9	0.9	744.2	55.6
Hexatoma	15	0.7	566.8	59.5
Chironomidae	139	<0.1	30.6	5.8
Simuliidae	13	<0.1	38.0	4.2
Ceratopogonidae	1	<0.1	--	--
Ephemeroptera				
Baetidae				
Ameletus	44	0.1	133.6	20.2
Ephemerella	93	<0.1	93.8	15.7
Plecoptera				
Perlodidae				
Isoperla	8	<0.1	37.4	4.0
Odonata				
Gomphidae				
Ophiogomphus	1	<0.1	71.8	6.0
Plesiopora	66	<0.1	28.5	6.2
Amphipoda				
Talitridae				
Hyalella	6	<0.1	8.6	0.0
Pulmonata				
Planorbidae				
Gyraulus	1	<0.1	13.2	4.2
Lymnaeidae				
Lymnaea	1	<0.1	1.1	0.0
Physidae				
Physa	1	<0.1	37.1	8.3

TABLE 34.--Macrobenthic data from station IV on Piceance Creek, March 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	6	--	319.0	16.0
Hexatoma	1	--	50.9	4.8
Chironomidae	24	<0.1	12.2	1.9
Simuliidae	1	<0.1	--	--
Ephemeroptera				
Baetidae				
Ameletus	25	<0.1	68.3	9.5
Ephemerella	3	<0.1	5.4	0.3
Caenis	2	<0.1	1.1	0.0
Plesiopora	17	<0.1	98.3	10.1
Rhynchobdellida	4	<0.1	56.9	4.4
Odonata				
Gomphidae				
Ophiogomphus	1	<0.1	11.9	0.0
Trichoptera				
Limnephilidae				
Hesperophylax	1	<0.1	42.8	3.0
Pelecypoda				
Phaeriidae	1	<0.1	26.4	12.4

TABLE 35.--Macrobenthic data from station V on Piceance Creek, March, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Erioptera	1	<0.1	1.7	0.2
Chironomidae	26	<0.1	5.3	0.3
Simuliidae	3	<0.1	7.8	0.5
Ephemeroptera				
Baetidae				
Ameletus	2	<0.1	8.3	0.2
Coleoptera				
Haliplidae				
Haliplus	1	<0.1	1.6	0.1
Plesiopora	4	<0.1	13.2	1.5

TABLE 36.--Macrobenthic data from stations I and II on Piceance Creek, April, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station I		
No samples collected				
		Station II		
Diptera				
Tipulidae				
Tipula	9	1.5	117.1	5.6
Hexatoma	4	<0.1	66.4	3.6
Chironomidae	3	<0.1	16.9	0.6
Ephemeroptera				
Baetidae				
Ephemerella	1	<0.1	7.8	0.2
Ameletus	1	<0.1	1.6	0.0
Pulmonata				
Planorbidae				
Gyraulus	8	<0.1	49.0	22.5
Plesiopora	80	1.5	190.4	17.6

TABLE 37.--Macrobenthic data from stations IV and V on Piceance Creek, April, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station IV		
Diptera				
Tipulidae				
Tipula	1	<0.1	0.9	0.4
Chironomidae	15	<0.1	27.7	4.5
Ephydridae	1	<0.1	1.1	0.4
Simuliidae	1	<0.1	0.0	0.0
Plecoptera				
Perlodidae				
Isoperla	3	<0.1	9.8	0.5
Plesiopora	8	0.5	17.5	2.4
		Station V		
Diptera				
Chironomidae	1	<0.1	0.0	0.0
Simuliidae	2	<0.1	5.7	0.5
Ephemeroptera				
Baetidae				
Ameletus	1	<0.1	3.7	0.7
Coleoptera				
Haliplidae				
Haliplus	1	<0.1	2.9	1.3
Amphipoda				
Talitridae				
Hyalella	2	<0.1	1.9	0.1
Plesiopora	8	<0.1	5.9	0.9

TABLE 38.--Macrobenthic data from station I on Piceance Creek, May, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	1	<0.1	7.3	0.2
Hexatoma	2	<0.1	7.5	0.2
Erioptera	1	<0.1	3.1	0.0
Chironomidae	26	<0.1	13.8	1.8
Ephemeroptera				
Baetidae				
Ameletus	112	0.2	302.0	27.0
Ephemerella	30	0.2	152.2	15.9
Trichoptera				
Hydropsychidae				
Hydropsyche	11	0.2	180.5	23.6
Plecoptera				
Perlodidae				
Isoperla	1	<0.1	20.0	1.2
Coleoptera				
Haliplidae				
Haliplus	3	<0.1	4.1	0.1
Elmidae				
Limnius	1	<0.1	2.3	0.0
Pulmonata				
Lymnaeidae				
Lymnaea	3	<0.1	25.0	6.6
Pelecypoda				
Shaeriidae	1	0.5	4.0	1.4

TABLE 39.--Macrobenthic data from stations II and IV on Piceance Creek, May, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station II		
Diptera				
Chironomidae	2	<0.1	1.4	0.0
Ephemeroptera				
Baetidae				
Ephemerella	2	<0.1	4.8	0.0
Ameletus	4	<0.1	8.9	0.0
Trichoptera				
Hydropsychidae				
Hydropsyche	1	<0.1	20.7	2.1
Coleoptera				
Haliplidae				
Haliplus	4	<0.1	5.5	0.7
Pulmonata				
Lymnaeidae				
Lymnaea	1	<0.1	30.0	9.5
		Station IV		
Diptera				
Tipulidae				
Tipula	1	0.1	25.6	2.4
Chironomidae	1	<0.1	3.7	0.4
Ephemeroptera				
Baetidae				
Ameletus	1	<0.1	4.1	0.5
Plecoptera				
Perlodidae				
Isoperla	3	<0.1	9.5	1.5
Hydracarina	1	<0.1	1.2	0.8

TABLE 40.--Macrobenthic data from station V on Piceance Creek, May, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Culicidae	33	<0.1	34.8	4.9
Ephemeroptera				
Baetidae				
Ameletus	4	<0.1	2.0	0.7
Ephemerella	1	<0.1	2.3	0.0
Pulmonata				
Lymnaeidae				
Lymnaea	4	<0.1	30.7	12.3
Pelecypoda				
Shaeriidae	3	<0.1	4.4	4.4
Plesiopora	1	<0.1	1.0	0.2

TABLE 41.--Macrobenthic data from station I on Piceance Creek, June, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Hexatoma	4	0.2	116.0	7.0
Chironomidae	180	<0.1	36.5	--
Simuliidae	16	<0.1	78.5	1.9
Rhagionidae				
Atherix	19	<0.1	60.5	3.9
Ephemeroptera				
Baetidae				
Ameletus	55	<0.1	130.8	24.1
Ephemeroptera	23	<0.1	196.2	37.4
Heptageniidae				
Heptagenia	25	<0.1	66.6	8.9
Trichoptera				
Hydropsychidae				
Hydropsyche	1	<0.1	1.9	1.4
Coleoptera				
Dytiscidae				
Agabus	1	<0.1	29.2	6.3
Haliplidae				
Haliplus	3	<0.1	0.2	0.0
Pulmonata				
Lymnaeidae				
Lymnaea	10	0.6	571.0	206.5
Planorbidae				
Gyraulus	32	<0.1	140.7	46.5
Plesiopora	34	<0.1	--	--

TABLE 42.--Macrobenthic data from station II on Piceance Creek, June, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
Diptera				
Tipulidae				
Tipula	9	8.0	7,597.0	563.8
Hexatoma	11	0.6	639.5	72.3
Rhagionidae				
Atherix	9	0.1	182.8	21.7
Chironomidae	102	0.1	1,738.1	278.4
Simuliidae	1000	2.4	28.4	5.0
Ephemeroptera				
Baetidae				
Ameletus	134	0.2	816.2	152.3
Ephemerella	124	0.2	1,249.7	230.0
Trichoptera				
Limnephilidae				
Hesperophylax	14	1.2	1,183.6	191.2
Hydropsychidae				
Hydropsyche	24	1.4	1,099.9	208.3
Plecoptera				
Perlodidae				
Isoperla	2	<0.1	130.2	22.5
Odonata				
Aeschnidae	2	4.0	1,568.3	176.3
Amphipoda				
Talitridae				
Hyalella	1	<0.1	12.1	0.8
Rhynchobdellida	1	<0.1	8.7	0.6
Coleoptera				
Elmidae				
Lara	18	<0.1	23.2	8.2
Haliplidae				
Haliplus	1	<0.1	7.6	1.0
Pulmonata				
Lymnaeidae				
Lymnaea	1	<0.1	--	--

TABLE 43.-- Macrobenthic data from stations IV and V on Piceance Creek, June, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station IV		
Diptera				
Tipulidae				
Tipula	7	6.0	5,677.3	525.6
Rhagionidae				
Atherix	5	<0.1	33.6	6.9
Simuliidae	1	<0.1	0.4	0.2
Chironomidae	232	<0.1	47.6	11.5
Ephemeroptera				
Baetidae				
Ameletus	18	<0.1	137.8	22.8
Heptageniidae				
Heptagenia	1	<0.1	10.2	1.1
Trichoptera				
Hydropsychidae				
Hydropsyche	1	<0.1	17.3	8.8
Amphipoda				
Talitridae				
Hyalella	1	<0.1	2.3	0.6
Plesiopora	50	<0.1	80.6	16.5
		Station V		
Diptera				
Chironomidae	3	<0.1	1.4	1.1
Pulmonata				
Lymnaeidae				
Lymnaea	1	<0.1	4.3	0.0
Plesiopora	2	<0.1	4.9	1.6

TABLE 44.--Macrobenthic data from stations I and II on Piceance Creek, July, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station I		
Diptera				
Simuliidae	360	0.1	1,125.0	127.6
Chironomidae	40	<0.1	12.5	3.3
Rhagionidae				
Atherix	4	<0.1	40.6	4.4
Ephemeroptera				
Baetidae				
Ameletus	116	<0.1	408.0	130.9
Ephemerella	1	<0.1	13.9	1.0
Heptageniidae				
Heptagenia	14	<0.1	88.2	21.2
Coleoptera				
Elmidae				
Limnius	3	<0.1	0.5	0.0
Hydracarina	1	<0.1	1.0	0.0
Plesiopora	3	<0.1	115.2	32.2
		Station II		
Diptera				
Chironomidae	70	<0.1	4.0	2.0
Simuliidae	444	0.3	1,000.0	211.2
Tipulidae				
Tipula	4	3.0	3,694.3	212.4
Hexatoma	7	0.8	299.2	28.3
Rhagionidae				
Atherix	4	<0.1	33.4	3.7
Ephemeroptera				
Baetidae				
Ameletus	100	<0.1	355.9	60.0
Ephemerella	40	<0.1	105.9	16.7
Heptageniidae				
Heptagenia	9	<0.1	29.5	2.4

TABLE 45.--Macrobenthic data from stations IV, and V on Piceance Creek, July, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)	Dry Wt. (mg)
		Station IV		
Ephemeroptera				
Baetidae				
Ameletus	3	<0.1	15.7	0.3
Ephemerella	44	<0.1	87.5	12.5
Plecoptera				
Perlodidae				
Isoperla	6	<0.1	147.6	20.9
Plesiopora	28	<0.1	29.4	5.2
Diptera				
Chironomidae	250	<0.1	206.4	36.5
Simuliidae	3	<0.1	0.7	0.0
Ceratopogonidae	1	<0.1	0.7	0.0
Trichoptera				
Hydropsychidae				
Hydropsyche	2	<0.1	9.9	--
Limnephilidae				
Hesperphylax	1	<0.1	2.9	--
Coleoptera				
Haliplidae				
Haliplus	6	0.2	27.3	--
		Station V		
Improper preserving of sample				

TABLE 46.--Macrobenthic data from station I on Piceance Creek, August, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Ephemeroptera			
Baetidae			
Ameletus	58	<0.1	5.3
Haptageniidae			
Haptagenia	3	<0.1	134.9
Diptera			
Rhadionidae			
Atherix	5	<0.1	186.2
Simuliidae	2	<0.1	--
Chironomidae	98	<0.1	32.1
Rhynchobdellida	2	<0.1	82.6
Pulmonata			
Planorbidae			
Gyraulus	5	<0.1	1.3

TABLE 47.--Macrobenthic data from station II on Piceance Creek, August, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Plesiopora	10	<0.1	3.8
Trichoptera			
Hydropsychidae			
Hydropsyche	29	<0.1	4.5
Ephemeroptera			
Baetidae			
Ameletus	132	0.1	12.2
Amphipoda			
Talitridae			
Hyalella	3	<0.1	110.6
Coleoptera			
Dytiscidae			
Acilius	1	<0.1	4.1
Haliplidae			
Haliplus	18	<0.1	22.4
Elmidae			
Limnius	4	<0.1	0.6
Diptera			
Tipulidae			
Tipula	6	0.6	411.4
Hexatoma	10	0.1	251.3
Rhagionidae			
Atherix	15	0.2	121.3
Chironomidae	206	<0.1	123.3
Simuliidae	80	<0.1	112.4

TABLE 48.--Macrobenthic data from stations IV and V on Piceance Creek, August, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
	Station IV		
Amphipoda			
Talitridae			
Hyalella	1	<0.1	1.4
Plesiopora	15	<0.1	33.9
Ephemeroptera			
Baetidae			
Ameletus	38	<0.1	102.2
Ephemerella	25	<0.1	102.2
	Station V		
Plesiopora	4	<0.1	0.2
Coleoptera			
Hydrophilidae	1	<0.1	10.3
Diptera			
Ephydridae	2	<0.1	7.8
Simuliidae	2	<0.1	5.0
Rhadionidae			
Atherix	1	<0.1	1.6
Chironomidae	1	<0.1	--
Coleoptera			
Elmidae			
Limnius	1	<0.1	--
Ephemeroptera			
Baetidae			
Ameletus	40	<0.1	175.1
Odonata			
Aeschnidae	3	<0.1	79.8

TABLE 49.--Macrobenthic data from station I_2 on Piceance Creek, September, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Diptera			
Rhagionidae			
Atherix	30	0.5	365.3
Simuliidae	2	<0.1	0.2
Chironomidae	38	<0.1	0.5
Plesiopora	46	<0.1	12.8
Coleoptera			
Dytiscidae	5	<0.1	1.9
Haliplidae			
Haliplus	6	<0.1	1.6
Pulmonata			
Planorbidae			
Gyraulus	3	<0.1	3.5
Ephemeroptera			
Baetidae			
Ameletus	80	<0.1	71.2
Trichoptera			
Hydropsychidae			
Hydropsyche	1	<0.1	0.2

TABLE 50.--Macrobenthic data from station II on Piceance Creek, September, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Coleoptera			
Haliplidae			
Haliplidae	15	0.1	42.9
Elmidae			
Limnius	7	<0.1	3.0
Plesiopora	2	0.1	216.9
Trichoptera			
Hydropsychidae			
Hydropsyche	5	<0.1	102.7
Ephemeroptera			
Baetidae			
Ameletus	30	<0.1	12.8
Diptera			
Tipulidae			
Tipula	3	0.2	976.0
Hexatoma	16	1.0	801.5
Rhagionidae			
Atherix	5	0.1	121.1
Simuliidae	3	<0.1	0.2
Chironomidae	15	<0.1	0.7
Pulmonata			
Planorbidae			
Gyraulus	1	<0.1	0.0

TABLE 51.--Macrobenthic data from stations IV and V on Piceance Creek, September, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
	Station IV		
Ephemeroptera			
Baetidae			
Ameletus	2	<0.1	0.1
Ephemerella	8	<0.1	6.2
Pulmonata			
Lymnaeidae			
Lymnaea	1	<0.1	0.0
	Station V		
Ephemeroptera			
Baetidae			
Ameletus	1	<0.1	0.0
Plesiopora	5	<0.1	0.1

TABLE 52.--Macrobenthic data from station I on Piceance Creek, October, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Trichoptera			
Hydropsychidae			
Hydropsyche	1	<0.1	0.3
Ephemeroptera			
Baetidae			
Ameletus	5	<0.1	1.2
Ephemerella	3	<0.1	0.8
Diptera			
Tipulidae			
Tipula	1	0.5	101.0
Rhagionidae			
Atherix	17	0.5	97.5
Chironomidae	7	0.1	0.0
Coleoptera			
Haliplidae			
Haliplus	8	<0.1	5.9
Amphipoda			
Talitridae			
Hyalella	3	<0.1	1.0
Plesiopora	19	<0.1	5.9

TABLE 53.--Macrobenthic data from station II on Piceance Creek, October, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Trichoptera			
Hydropsychidae			
Hydropsyche	42	0.5	50.7
Limnephilidae			
Hesperophylax	4	<0.1	0.9
Plecoptera			
Perlodidae			
Isoperla	1	<0.1	0.2
Diptera			
Tipulidae			
Tipula	3	0.0	1,487.4
Hexatoma	3	<0.1	96.4
Rhagionidae			
Atherix	15	0.5	179.8
Simuliidae	1	<0.1	0.0
Chironomidae	25	<0.1	0.5
Ephemeroptera			
Baetidae			
Ameletus	15	<0.1	1.0
Ephemerella	3	<0.1	0.3
Coleoptera			
Haliplidae			
Haliplus	10	<0.1	14.5
Elmidae			
Lara	5	<0.1	1.7
Plesiopora	6	<0.1	--

TABLE 54.--Macrobenthic data from stations IV and V on Piceance Creek, October, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
	Station IV		
Ephemeroptera			
Baetidae			
Ameletus	2	<0.1	0.1
Ephemerella	3	<0.1	0.2
Plecoptera			
Perlodidae			
Isoperla	1	<0.1	0.6
Odonata			
Aeschnidae	1	<0.1	486.6
Plesiopora	15	<0.1	2.2
	Station V		
No organisms collected in samples			

TABLE 55.--Macrobenthic data from station I on Piceance Creek, November, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Diptera			
Tipulidae			
Tipula	2	<0.1	294.5
Rhagionidae			
Atherix	9	0.6	219.8
Chironomidae	60	0.2	269.6
Simuliidae	274	0.5	432.8
Trichoptera			
Hychopsychidae			
Hydropsyche	47	<0.1	672.4
Plecoptera			
Perlodidae			
Isoperla	1	<0.1	0.8
Ephemeroptera			
Baetidae			
Ameletus	31	<0.1	10.5
Ephemerella	65	--	44.1
Coleoptera			
Haliplidae			
Haliplus	1	<0.1	0.6
Plesiopora	6	<0.1	0.8

TABLE 56.--Macrobenthic data from station II on Piceance Creek, November, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Trichoptera			
Limnephilidae			
Hesperophylax	5	<0.1	11.0
Hydropsychidae			
Hydropsyche	60	1.5	951.7
Plecoptera			
Perlodidae			
Isoperla	1	<0.1	1.0
Diptera			
Rhagionidae			
Atherix	11	0.5	271.4
Tipulidae			
Tipula	3	0.7	464.3
Hexatoma	4	0.5	221.9
Chironomidae	15	<0.1	1.1
Simuliidae	29	<0.1	1.6
Ephemeroptera			
Heptageniidae	1	<0.1	0.7
Baetidae			
Ameletus	120	0.2	88.2
Ephemerella	15	<0.1	0.1
Coleoptera			
Haliplidae			
Haliplus	6	0.2	16.9
Elmidae	4	<0.1	4.1
Plesiopora	3	<0.1	1.8

TABLE 57.--Macrobenthic data from stations IV and V on Piceance Creek, November, 1969. Based on 2 ft^2 (0.19 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
	Station IV		
Plesiopora	7	<0.1	0.0
Coleoptera			
Elmidae	1	<0.1	2.5
Diptera			
Tipulidae			
Tipula	1	0.2	86.4
Rhagionidae			
Atherix	1	<0.1	0.4
Chironomidae	2	<0.1	0.0
Trichoptera			
Limnephilidae			
Hesperophylax	1	<0.1	0.9
Plecoptera			
Perlodidae			
Isoperla	1	<0.1	0.6
Ephemeroptera			
Baetidae			
Ameletus	3	<0.1	0.0
	Station V		
Pulmonata			
Planorbidae	1	<0.1	--
Diptera			
Simuliidae	4	<0.1	0.9
Chironomidae	2	<0.1	0.1
Odonata			
Aeschnidae	1	0.2	2.6

TABLE 58.--Macrobenthic data from station I on Piceance Creek, December, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Diptera			
Rhagionidae			
Atherix	4	<0.1	42.5
Simuliidae	408	<0.1	260.6
Chironomidae	99	<0.1	211.9
Ephemeroptera			
Baetidae			
Ameletus	75	<0.1	32.4
EPhemerella	15	<0.1	3.5
Heptageniidae			
Heptagenia	1	<0.1	0.7
Plecoptera			
Perlodidae			
Isoperla	2	<0.1	2.0
Trichoptera			
Hydropsychidae			
Hydropsyche	17	<0.1	145.8
Amphipoda			
Talitridae			
Hyalella	1	<0.1	0.0
Coleoptera			
Dytiscidae			
Acilius	1	<0.1	1.0
Haliplidae			
Haliplus	2	<0.1	2.7

TABLE 59.--Macrobenthic data from station II on Piceance Creek, December, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Diptera			
Chironomidae	59	<0.1	28.8
Simuliidae	60	<0.1	12.1
Tipulidae			
Tipula	1	<0.1	26.8
Ephemeroptera			
Baetidae			
Ameletus	124	<0.1	106.9
Ephemerella	84	<0.1	48.5
Heptagenidae			
Heptagenia	1	<0.1	0.0
Trichoptera			
Hydropsychidae			
Hydropsyche	92	3.0	137.1
Limnephilidae			
Hesperophylax	28	1.0	139.2
Plecoptera			
Perlodidae			
Isoperla	4	<0.1	6.9
Coleoptera			
Dytiscidae			
Acilius	8	<0.1	7.9
Haliplidae			
Haliplus	6	<0.1	20.8
Amphipoda			
Talitridae			
Hyalella	1	<0.1	0.0

TABLE 60.--Macrobenthic data from station IV on Piceance Creek, December, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Diptera			
Tipulidae			
Tipula	5	0.4	216.3
Chironomidae	1	<0.1	0.0
Ephemeroptera			
Baetidae			
Ameletus	3	<0.1	0.0
Heptageniidae			
Heptagenia	1	<0.1	--
Plecoptera			
Perlodidae			
Isoperla	12	0.2	82.1
Trichoptera			
Hydropsychiidae			
Hydropsyche	2	0.1	45.2
Limnephilidae			
Hesperophylax	1	<0.1	0.0
Plesiopora	15	<0.1	5.0
Rhynchobdellida	1	<0.1	0.0
Amphipoda			
Talitridae			
Hyalella	1	<0.1	0.0
Coleoptera			
Haliplidae			
Haliplus	1	<0.1	0.0

TABLE 61.--Macrobenthic data from station V on Piceance Creek, December, 1969. Based on 4 ft^2 (0.36 m^2)

Taxon	No.	Vol. (ml)	Wet Wt. (mg)
Trichoptera			
Hydropsychiidae			
Hydropsyche	2	<0.1	46.6
Odonata			
Aeschridae	1	<0.1	166.7
Diptera			
Chironomidae	4	<0.1	0.0
Simuliidae	1	<0.1	0.0

TABLE 62.--Fish sampled from Piceance Creek

Specific Name	Common Name
Catostomus latipinnis	Flannelmouth sucker
Catostomus platyrhynchus	Mountain sucker
Cottus bairdi	Mottled sculpin
Gila elegans	Bonytail chub
Ictalurus melas	Black bullhead
Notropis lutrensis	Red shiner
Prosopium williamsoni	Mountain whitefish
Rhinichthys osculus	Speckled dace
Salmo gairdneri	Rainbow trout
Salvelinus fontinalis	Brook trout

TABLE 63.--Physical data collected at station VI on White River from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)	Discharge (cfs)
September (1968)	59	12	700	--	335
November	52	7	665	--	383
December	28	0	700	--	394
January (1969)	40	0	650	--	353
February	36	0	585	--	294
March	38	1	658	--	356
April	48	5	450	--	769
May	--	5	--	--	2,024
June	68	15	479	--	1,224
July	89	21	498	<25	644
August	85	20	650	32	423
September	76	17	550	<25	420
October	49	8	512	<25	--
November	52	4	490	<25	--
December	12	0	465	<25	--

TABLE 64.--Physical data collected at station VII on White River from September, 1968 to December, 1969

Month	Air Temperature (f)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	65	11	748	--
November	46	7	710	--
December	24	0	750	--
January (1969)	36	0	715	--
February	36	0	550	--
March	36	1	720	--
April	42	5	450	--
May	--	5	--	--
June	67	15	480	--
July	86	22	520	<25
August	86	20	700	45
September	75	17	605	<25
October	45	8	590	<25
November	52	4	590	<25
December	12	0	520	<25

TABLE 65.--Physical data collected from station VIII on White River from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	75	12	700	--
November	32	4	710	--
December	28	0	760	--
January	32	0	750	--
February	34	0	650	--
March	35	0	690	--
April	42	5	500	--
May	--	5	--	--
June	68	15	485	--
July	83	24	510	<25
August	70	21	800	105
September	74	20	610	<25
October	44	8	600	<25
November	46	4	620	<25
December	12	0	522	<25

List of Abbreviations and Their Meanings

DO - Dissolved Oxygen concentration (mg/l)

pH - Hydrogen ion concentration

phth - phenophthalein alkalinity (mg/l $CaCO_3$)

TA - Total Alkalinity (mg/l $CaCO_3$)

FS - Filtrable Solids (mg/l)

NFS - Nonfiltrable Solids (mg/l)

TR - Total Residue (mg/l)

SS - Settleable Solids (ml/l)

Ca - Calcium (mg/l)

Mg - Magnesium (mg/l)

Na - Sodium (mg/l)

K - Potassium (mg/l)

Cl - Chloride (mg/l)

SO_4 - Sulfate (mg/l)

SiO_2 - Silica (mg/l)

NO_3 - Nitrate (mg/l)

TABLE 66.--Chemical data from station VI on White River from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	9.9	8.3	5.0	164.0	396.0	--	--	--
November	9.9	8.2	0.0	160.0	362.0	--	--	--
December	11.7	8.0	0.0	144.0	384.0	--	--	--
January (1969)	5.9	7.8	0.0	140.0	394.0	--	--	--
February	10.8	8.1	0.0	74.0	364.0	--	--	--
March	11.9	8.2	2.0	132.0	388.0	4.0	392.0	--
April	11.0	7.5	0.0	106.0	204.0	316.0	52.0	--
May	8.8	7.6	0.0	182.0	178.0	222.0	400.0	--
June	8.6	8.3	0.0	152.0	300.0	54.0	354.0	0.1
July	7.8	8.1	0.0	152.0	338.0	14.0	352.0	0.1
August	7.2	8.0	0.0	190.0	444.0	304.0	748.0	0.5
September	9.4	8.3	12.0	176.0	426.0	12.0	438.0	0.0
October	10.4	8.3	0.0	144.0	384.0	234.0	618.0	0.0
November	11.0	8.2	0.0	140.0	350.0	12.0	362.0	0.0
December	12.0	8.0	2.0	152.0	320.0	38.0	358.0	0.0

TABLE 67.--Chemical data from station VI on White River from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	84.1	21.2	3.0	1.8	12.3	98.2	18.0	0.0
November	77.9	18.9	29.2	2.0	11.3	22.9	15.5	0.5
December	--	--	--	--	13.8	141.0	15.2	0.4
January (1969)	73.8	18.5	31.5	3.2	15.5	149.8	15.4	6.5
February	77.0	17.8	28.8	2.1	14.5	123.0	14.5	0.9
March	84.6	18.4	28.1	2.2	12.0	170.0	15.0	0.2
April	37.9	8.8	16.4	0.8	5.3	51.6	14.5	1.4
May	37.1	8.0	13.6	0.9	3.8	116.0	12.0	1.0
June	63.8	17.0	17.2	1.5	19.8	83.9	15.5	0.2
July	67.8	18.8	72.2	1.3	12.8	108.4	15.5	0.2
August	81.3	24.0	30.3	3.9	19.5	124.3	21.0	1.2
September	76.9	21.6	25.6	0.5	18.5	130.9	13.5	0.6
October	63.0	17.9	26.9	4.4	17.3	115.2	22.5	0.3
November	64.1	17.9	24.7	4.2	17.0	110.0	14.5	1.2
December	60.9	16.9	28.3	5.0	20.5	118.9	18.5	0.2

TABLE 68.--Chemical data from station VII on White River from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	9.8	8.4	11.0	198.0	432.0	--	--	--
November	10.2	8.4	0.0	178.0	444.0	--	--	--
December	12.3	8.2	0.0	344.0	460.0	--	--	--
January (1969)	6.2	7.8	0.0	180.0	448.0	--	--	--
February	10.5	8.1	0.0	166.0	374.0	--	--	--
March	11.3	8.2	4.0	183.0	440.0	27.0	467.0	--
April	10.1	7.4	4.0	120.0	193.0	1,117.0	1,310.0	--
May	8.6	7.7	6.0	154.0	210.0	80.0	290.0	--
June	8.7	8.2	6.0	154.0	300.0	47.0	384.0	0.1
July	7.8	8.3	0.0	166.0	356.0	44.0	400.0	0.1
August	6.6	8.1	0.0	210.0	475.0	1,044.0	1,519.0	2.5
September	9.2	8.2	14.0	196.0	447.0	38.0	485.0	0.0
October	10.4	8.3	4.0	172.0	430.0	81.0	511.0	0.1
November	11.8	8.4	6.0	178.0	402.0	35.0	437.0	0.0
December	12.0	8.1	8.0	204.0	356.0	12.0	368.0	0.0

TABLE 69.--Chemical data from station VII on White River from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	80.4	23.5	5.0	3.1	14.2	128.1	20.0	0.3
November	77.6	21.8	51.1	2.4	15.6	148.4	16.4	0.5
December	--	--	--	--	17.7	158.6	17.1	0.4
January (1969)	76.7	21.6	51.9	4.0	17.5	154.4	15.5	1.1
February	76.8	19.9	46.3	2.6	16.0	116.8	14.0	0.9
March	80.3	22.4	59.6	2.9	19.5	188.0	16.0	0.2
April	40.8	10.7	22.6	1.2	6.3	52.9	14.0	1.6
May	41.9	9.6	19.0	1.0	4.8	132.5	12.0	1.2
June	59.9	18.8	25.8	1.4	10.0	98.2	14.5	0.2
July	68.9	19.5	29.1	1.4	13.4	109.5	18.0	0.3
August	77.5	26.4	80.2	0.8	22.0	145.1	18.0	1.0
September	76.1	24.6	118.2	0.5	20.0	142.9	13.5	0.7
October	62.7	20.3	33.8	4.5	19.3	135.4	27.0	0.4
November	47.3	21.1	43.4	4.9	19.5	143.2	13.5	0.2
December	66.4	21.5	50.8	4.5	22.0	174.6	21.0	0.1

TABLE 70.--Chemical data from station VIII on White River from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	9.8	8.4	14.0	200.0	482.0	--	--	--
November	9.7	8.2	0.0	185.0	312.0	--	--	--
December	11.8	8.0	0.0	95.0	488.0	--	--	--
January (1969)	6.3	7.8	0.0	182.0	482.0	--	--	--
February	10.9	8.3	0.0	210.0	534.0	--	--	--
March	10.5	8.2	4.0	70.0	450.0	--	--	0.1
April	9.0	7.5	4.0	124.0	209.0	891.0	1,100.0	1.2
May	8.6	7.8	10.0	156.0	234.0	298.0	532.0	0.6
June	8.1	8.2	10.0	156.0	336.0	60.0	396.0	0.1
July	7.8	8.4	8.0	156.0	344.0	10.0	354.0	0.1
August	5.6	8.1	2.0	240.0	572.0	3,989.0	4,561.0	18.0
September	9.0	8.3	22.0	190.0	436.0	54.0	490.0	0.0
October	10.0	8.2	4.0	178.0	442.0	97.0	539.0	0.2
November	11.2	8.3	4.0	188.0	417.0	26.0	443.0	0.0
December	11.8	8.2	12.0	206.0	354.0	20.0	374.0	0.0

TABLE 71.--Chemical data from station VIII on White River from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	82.7	24.2	5.3	3.1	15.6	98.2	19.5	0.3
November	77.4	21.8	55.7	3.6	16.7	146.8	16.4	05
December	--	--	--	--	20.6	161.9	16.9	6.7
January (1969)	70.3	28.9	58.2	4.6	18.0	165.9	15.8	0.8
February	90.1	24.8	63.8	3.5	23.0	186.8	17.5	1.2
March	80.9	21.4	52.9	2.6	19.5	184.0	15.5	1.2
April	36.4	9.7	21.7	4.1	6.8	54.6	14.5	1.5
May	40.8	9.8	21.0	1.1	5.3	177.5	13.0	0.9
June	60.3	18.9	27.9	1.5	12.0	101.2	15.5	0.2
July	62.5	18.6	28.8	1.3	14.5	109.7	15.5	0.2
August	83.7	27.9	101.4	0.6	23.0	179.1	18.0	1.3
September	76.4	25.7	61.4	0.7	20.7	142.9	13.5	0.7
October	76.2	21.2	3.9	5.3	25.0	130.6	22.5	0.4
November	62.4	21.4	46.4	4.9	20.0	128.1	13.5	0.2
December	37.7	12.9	25.5	3.7	22.0	129.0	23.5	0.2

TABLE 72.--Aquatic invertebrates recorded from White River.

ORDER EPHEMEROPTERA
(Mayflies)
Family Baetidae
Ephemerella
Ameletus
Bactis

ORDER DIPTERA
(Flies)
Family Tipulidae
Tipula
Hexatoma
Family Tetanoceridae
Family Ephydridae
Family Chironomidae
Family Simuliidae
Family Anthomyiidae
Family Ceratopogonidae
Family Rhadionidae
Atherix

ORDER TRICHOPTERA
(Caddis flies)
Family Limnephilidae
Hesperophylax
Family Hydropsychidae
Hydropsyche
Family Hydroptilidae
Hydroptila

ORDER PLECOPTERA
(stone flies)
Family Perlodidae
Isoperla
Family Taeniopterygidae
Brachyptera

ORDER COLEOPTERA
Family Halipidae
Halipus
Brychius
Family Elmidae
Limnius
Lara
Family Dytiscidae
Hydrovatus

ORDER PLESIOPORA
Family Tubificidae

SUBORDER ODONATA
Family Aeschnidae
Family Coenagrionidae
Ischnura
Family Gomphidae
Ophiogomphus

ORDER AMPHIPODA
Family Talitridae
Hyalella

ORDER PULMONATA
Family Planorbidae
Gyraulus
Paraphalyx
Family Lymnaeidae
Lymnea

ORDER HIRUDINEA
Family Rhynochobdellida

TABLE 73.--Fish sampled from White River.

Specific Name	Common Name
Catostomus latipinnis	Flannelmouth sucker
Catostomus platyrhynchus	Mountain sucker
Cottus bairdi	Mottled sculpin
Gila elegans	Bonytail chub
Ictalurus melas	Black bullhead
Ictalurus punctatus	Channel catfish
Notropis lutrensis	Red shiner
Prosopium williamsoni	Mountain whitefish
Ptychocheilus lucius	Colorado squawfish
Rhinichthys osculus	Speckled dace
Salmo trutta	Brown trout
Salmo gairdneri	Rainbow trout

TABLE 74.--Physical data collection at station IX on Yellow Creek from September, 1968 to December, 1969

Month	Air Temperature (F)	Water Temperature (C)	Specific Conductance (μ mho cm^{-1})	Turbidity (JTU)
September (1968)	73	19	3,400+	--
November	44	2	3,400+	--
December	14	0	3,400+	--
January (1969)	29	0	3,400+	--
February	32	0	3,400+	--
March	32	0	3,400+	--
April	42	--	3,400+	--
May	--	24	--	--
June	68	19	3,550	--
July	83	30	3,850	<25
August	87	31	3,000	<25
September	72	24	3,650	<25
October	44	11	3,500	<25
November	45	6	3,220	30
December	16	0	3,040	<25

List of Abbreviations and Their Meanings

DO	-	Dissolved Oxygen concentration (mg/l)
pH	-	Hydrogen ion concentration
phth	-	phenophthalein alkalinity (mg/l $CaCO_3$)
TA	-	Total Alkalinity (mg/l $CaCO_3$)
FS	-	Filtrable Solids (mg/l)
NFS	-	Nonfiltrable Solids (mg/l)
TR	-	Total Residue (mg/l)
SS	-	Settleable Solids (ml/l)
Ca	-	Calcium (mg/l)
Mg	-	Magnesium (mg/l)
Na	-	Sodium (mg/l)
K	-	Potassium mg/l)
Cl	-	Chloride (mg/l)
SO_4	-	Sulfate (mg/l)
SiO_2	-	Silica (mg/l)
NO_3	-	Nitrate (mg/l)

TABLE 75.--Chemical data from station IX on Yellow Creek from September, 1968 to December, 1969

Month	DO	pH	phth	TA	FS	NFS	TR	SS
September (1968)	8.8	8.7	141.0	1,948.0	2,816.0	--	--	--
November	11.7	8.5	0.0	1,847.0	2,780.0	--	--	--
December	11.4	8.3	0.0	1,544.0	2,838.0	--	--	--
January (1969)	6.9	8.3	50.0	1,520.0	3,092.0	--	--	--
February	11.6	8.5	15.0	912.0	2,648.0	--	--	--
March	10.6	8.5	64.0	1,108.0	2,312.0	48.0	2,360.0	--
April	8.2	8.4	176.0	1,420.0	2,556.0	1,644.0	4,200.0	--
May	7.2	8.6	152.0	1,464.0	2,370.0	678.0	3,048.0	--
June	9.3	8.8	152.0	1,464.0	2,914.0	146.0	3,060.0	0.0
July	7.6	8.9	264.0	1,600.0	3,178.0	70.0	3,248.0	0.1
August	7.0	8.9	128.0	1,052.0	2,446.0	144.0	2,590.0	0.0
September	6.8	8.8	240.0	1,888.0	3,043.0	152.0	3,195.0	0.0
October	10.5	8.7	174.0	1,616.0	2,860.0	115.0	2,975.0	0.0
November	9.6	8.5	100.0	1,464.0	2,600.0	512.0	3,112.0	0.6
December	12.0	8.4	112.0	1,716.0	3,016.0	60.0	3,076.0	0.0

TABLE 76.--Chemical data from station IX on Yellow Creek from September, 1968 to December, 1969

Month	Ca	Mg	Na	K	Cl	SO_4	SiO_2	NO_3
September (1968)	28.4	43.2	947.0	8.4	174.3	--	9.0	0.5
November	40.5	43.4	855.0	7.3	134.2	405.9	14.5	2.5
December	--	--	--	--	152.2	505.3	19.5	--
January (1969)	25.6	43.5	929.0	7.6	150.0	--	12.2	--
February	41.1	43.4	883.0	7.9	--	--	11.4	--
March	37.2	43.4	683.0	7.3	75.9	892.0	14.5	--
April	31.0	115.0	--	2.5	110.8	553.8	14.0	1.2
May	24.0	145.0	934.0	5.3	106.4	570.0	23.0	0.6
June	30.0	121.8	1,208.0	5.2	139.8	660.9	6.1	0.3
July	41.0	117.0	1,643.0	5.5	169.8	667.3	4.7	0.4
August	31.0	117.6	3,711.0	1.4	90.0	670.7	9.7	1.0
September	22.0	111.7	1,098.0	2.4	164.0	501.2	3.2	0.5
October	28.0	93.2	632.0	7.4	135.8	653.5	6.0	0.5
November	42.3	142.8	676.0	10.4	101.5	603.3	8.2	1.2
December	15.7	50.5	303.0	5.1	153.5	665.5	10.0	3.6

TABLE 77.--Aquatic invertebrates recorded from Yellow Creek

ORDER DIPTERA
(flies)
Family Tipulidae
Tipulae
Hexatoma
Family Tetanoceridae
Family Ephydridae
Family Chironomidae
Family Simuliidae
Family Anthomyiidae
Family Ceratopogonidae
Family Rhagionidae
Atherix

ORDER COLEOPTERA
Family Halipidae
Halipus
Brychius
Family Elmidae
Limnius
Lara
Family Dytiscidae
Hydrovatus

ORDER PLESIOPORA
Family Tubificidae

SUBORDER ODONATA
Family Aeschnidae
Family Coenagrionidae
Ischnura
Family Gomphidae
Ophiogomphus

ORDER AMPHIPODA
Family Talitridae
Hyalella

ORDER PULMONATA
Family Planorbidae
Gyraulus
Paraphalyx
Family Lymnaeidae
Lymnea

ORDER HIRUDINEA
Family Rhynochobdellida

*U.S. GOVERNMENT PRINTING OFFICE: 1973-514-154/265

1 Accession Number	2 Subject Field & Group	SELECTED WATER RESOURCES ABSTRACTS INPUT TRANSACTION FORM
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Department of Fishery and Wildlife Biology
Colorado State University
~~Fort Colllins, Colorado 80521~~

6 Title

EFFECTS OF CHEMICAL VARIATIONS IN AQUATIC ENVIRONMENTS:
Biota and Chemistry of Piceance Creek

10 Author(s)

Everhart, W. Harry; and
May, Bruce E.

16 Project Designation

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21 Note

22 Citation

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23 Descriptors (Starred First)

*Aquatic Insects, oligochaetes, gastropods, amphipods, leeches,
*water properties

25 Identifiers (Starred First)

*Stream fauna, *water chemistry, * Colorado oil shale

27 Abstract

Sampling a small stream in the rich oil shale country of northwestern Colorado confirmed distinct seasonal trends and habitat preference in invertebrate populations. Discharge was a major influence on invertebrates and chemical composition of the stream. Seasonal variations, biomass, and species composition of invertebrates appear characteristic of oil shale area streams.

Abstractor W. Harry Everhart | Institution Cornell University

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