DATA FROM SYNOPTIC WATER-QUALITY STUDIES ON THE COLORADO RIVER IN THE GRAND CANYON, ARIZONA, NOVEMBER 1990 AND JUNE 1991

By H.E. Taylor, D.B. Peart, R.C. Antweiler, T.I. Brinton, W.L. Campbell, J.R. Garbarino, D.A. Roth, R.J. Hart, and R.C. Averett

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CONTENTS

Page

ABSTRACT 1
INTRODUCTION 1
METHODS 2
  Field 6
  Laboratory 7
RESULTS 7
REFERENCES CITED 9
APPENDIX 154

FIGURES

Figure 1.--Location of sampling sites on the Colorado River and selected tributaries from Lake Powell to Lake Mead. 4
Figure 2.--Discharge hydrographs of the Colorado River for the November 1990 synoptic study 172
Figure 3.--Discharge hydrographs of the Colorado River for the June 1991 synoptic study 175

TABLES

Table 1.--Sampling site names and river kilometers for Colorado River synoptic studies 4
Table 2.--Measurement and constituent list for synoptic studies on Colorado River and major tributaries 5
Table 3.--Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study 11
Table 4.--Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study 16
Table 5.-- pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the November 1990 synoptic study 22
Table 6.-- pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the June 1991 synoptic study 25
Table 7.--Dissolved nutrient concentrations for the November 1990 synoptic study 28
Table 8.--Dissolved nutrient concentrations for the June 1991 synoptic study 31
Table 9.--Major constituent concentrations for the November 1990 synoptic study 34
Table 10.--Major constituent concentrations for the June 1991 synoptic study 37
Table 11.--Trace constituent concentrations for the November 1990 synoptic study 39
Table 12.--Trace constituent concentrations for the June 1991 synoptic study 48
Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona 57
Table 14.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona 110
Table 15.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot orifice Surber nets for the November 1990 synoptic study, Colorado River, Arizona 117
Table 16.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona 120
Table 17.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in a one square meter orifice kick net for the June 1991 synoptic study, Colorado River, Arizona 133

Page
Table 18.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot Surber nets for the June 1991 synoptic study, Colorado River, Arizona....135
Table 19.--Detrital biomass collected with 10 cm orifice diameter drift nets for the November 1990 synoptic study....137
Table 20.--Detrital biomass collected with 10 cm orifice diameter drift nets for the June 1991 synoptic study....140
Table 21.--Colorado River drift from nets having 0.5 meter diameter orifice....143
Table 22.--Water discharge of the Colorado River and selected tributaries for the November 1990 synoptic study....144
Table 23.--Water discharge of the Colorado River and selected tributaries for the June 1991 synoptic study....146
Table 24.--Suspended sediment concentrations at Colorado River and tributary cross-sections for the November 1990 synoptic study....148
Table 25.--Suspended sediment concentrations at Colorado River and tributary cross-sections for the June 1991 synoptic study....151

CONVERSION FACTORS

Multiply	By	To obtain
centimeter	0.3937	inch
cubic meter (m^3)	35.31	cubic foot
gram (g)	0.03527	ounce, avoirdupois
liter (l)	0.2642	gallon
meter (m)	3.281	foot
square kilometer (km^2)	0.3861	square mile
square meter (m^2)	10.76	square foot
cubic meter per second	35.314667	cubic foot per second (ft^3/s)
pound per square inch (psi)	703.1	kilogram per square meter

Degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

°F=9/5(°C)+32.

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ABSTRACT

Two water-quality synoptic studies were made on the Colorado River in the Grand Canyon, Arizona. Field measurements and the collection of water samples for laboratory analysis were made at 10 mainstem and 6 tributary sites every 6 hours for a 48-hour period on November 5-6, 1990, and again on June 18-20, 1991. Field measurements included discharge, alkalinity, water temperature, light penetration, pH, specific conductance, and dissolved oxygen. Water samples were collected for the laboratory analysis of major and minor ions (calcium, magnesium, sodium, potassium, strontium, chloride, sulfate, silica as SiO_2), trace elements (aluminum, arsenic, boron, barium, beryllium, cadmium, cobalt, chromium, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, thallium, uranium, vanadium and zinc), and nutrients (phosphate, nitrate, ammonium, nitrite, total dissolved nitrogen, total dissolved phosphorus and dissolved organic carbon). Biological measurements included drift (benthic invertebrates and detrital material), and benthic invertebrates from the river bottom.

INTRODUCTION

Studies concerned with large river systems, especially large impounded systems, have been limited (Petts, 1984; Ward and Stanford, 1979). Thus, there is an often meager understanding of physical, chemical, and biological water-quality constituents for any given downstream reach of the system that is affected by specific dam operations. The Colorado River is no exception. Originating in central Colorado, with its main tributary, the Green River, it flows through seven states and 2,250 river kilometers to the Gulf of Mexico. On its way to the sea, it drains a basin of about 647,500 square kilometers. Most of this drained area is in an arid climate where the annual precipitation is less than 25 centimeters (cm). Thus, the water of the Colorado River is extremely valuable from an agricultural and an urban standpoint. This high value of water has resulted in the construction of 13 storage reservoirs on the Colorado River and its tributaries. Lake Mead, perhaps the best known reservoir, was formed in 1936 when Hoover Dam was closed. Lake Powell, the most recent, was formed in 1963 when Glen Canyon Dam was closed.

Between Glen Canyon Dam and Lake Mead is the Grand Canyon of the Colorado River, which encompasses Grand Canyon National Park. There, the river flows through its bedrock channel between vertical canyon walls and over a number of rapids. The riverbed elevation drops about 210 meters within the 632 river kilometers between Lees Ferry, Arizona, and the mouth of Diamond Creek. Prior to 1960, before the closing of Glen Canyon Dam, fewer than 1,000 people had taken river trips through the Grand Canyon. Up to 1991, more than 25,000 people make the journey annually in rafts and boats. This use of the river has resulted in careful control of boaters and other users by the National Park Service. It also resulted in a need for camping sites along the river and an urgent need to evaluate human impact, including that of altering the quality of the river water.

In addition to human use of the river in the Grand Canyon is the operation of Glen Canyon Dam. The dam was constructed for flood control, power generation, and water storage to meet demands of the lower basin states and Mexico. Much controversy related to the dam is concerned with long daily fluctuations in water release for hydroelectric power generation. For example, within a 24-hour period, discharge from the dam commonly may range from 140 to 850 cubic meters per second (m^3/s). This flow variation causes erosion of the riverbank and sediment deposits used for camping and makes river rafting difficult. As a result, for more than a decade there has been public concern about the effects of Glen Canyon Dam on the Colorado River in the Grand Canyon. The dam and reservoir also have decreased sediment transport to the downriver area, which resulted in increased light penetration through the water. Water from Lake Powell is removed for electric power generation from penstocks

located in the upper part of the hypolimnion (elevation 322 m). This water has a temperature of about 8 degrees Celsius (°C) throughout the year. Pre-dam water temperatures ranged from about 0 to 26 °C (Ferrari, 1986).

Physical alterations in the river channel are not the only concern. Several fish native to the river are now on the U.S. Fish and Wildlife Service Endangered Species List, and increased light has permitted profuse production of the algae organism, *Cladophera glomerata,* especially in the Lees Ferry area. The *Cladophera* production has resulted in organic loading to the river. There also is evidence that nitrogen and phosphorus concentrations in the river have decreased since the filling of Lake Powell (Gloss and others, 1980). These chemical and biological water-quality concerns have been known since dam closure and have been the subject of past studies.

Mindful of public concern about discharge regulation from Glen Canyon Dam, the Congress directed the U.S. Bureau of Reclamation (USBR) to undertake studies of the river and its channels. The first Glen Canyon study began in 1982 and concluded in 1987. It was known as the Glen Canyon Environmental Study I (GCES-I). The study resulted in a number of scientific papers and a study summary (U.S. Department of the Interior, 1988). A review of GCES-I was provided by the National Academy of Science (Marzolf, 1987). In 1988 the Congress extended the GCES-I study (renamed GCES-II) to include a wider array of topics and to address specific studies that were inconclusive during the GCES-I study. Moreover, during the period of the GCES-II studies, the Congress ordered the Secretary of the Interior to propose and conduct adjusted flows, called interim flows, and to evaluate the consequences of these flows on the Grand Canyon environment. The interim flows were begun in August 1991.

During the winter of 1989-90, the U.S. Geological Survey (USGS) prepared a proposal for scientific investigations of the Colorado River. The USGS proposal included a number of studies to be conducted in the Grand Canyon and on Lake Powell near the dam. Among the water-quality work proposed was a study to determine the chemical and biological resources and characteristics of the river between Glen Canyon Dam and Lake Mead.

Past water-quality work, including that accomplished during GCES-I, provided some insight about the chemical and biological resources of the river in the Grand Canyon, but was inconclusive regarding river-reach understanding. As a result, synoptic studies were designed by USGS scientists to obtain selected chemical and biological information along the Grand Canyon corridor of the river including the major tributaries. The goal of the synoptic studies was to obtain a study-length (Lake Powell forebay to Lake Mead and major tributaries) understanding of selected chemical and biological constituents so process-oriented studies could be designed in the future. In addition, sampling was organized on a temporal basis so interpretive information could be obtained to develop a better understanding of the effect of variable discharge (daily, cyclic water releases from Glen Canyon Dam) and diel variation. The design of the studies was to make field measurements and collect samples every 6 hours for 48 hours. In the original plan, synoptic studies were to be conducted during low light, low tributary flow (November); high light, low tributary flow (June) and high light, high tributary flow (August). Synoptic studies were conducted on November 5-6, 1990, and June 18-20, 1991. A third synoptic study scheduled for August 1991 was canceled for lack of funding.

The authors of this report wish to thank the volunteers who assisted us on the river during the November 1990 and June 1991 synoptic studies. We especially wish to pay tribute to the team leaders for their diligence in making field measurements, collecting water samples, and caring for their people while the synoptic studies were underway. . We wish to thank Charles Patton, USGS, for assisting in performing nutrient determinations. We are saddened by the untimely passing of R.C. Averett during the preparation of this report. His insight and leadership was a tremendous contribution to this study.

METHODS

A total of ten mainstem river sites, six tributary sites, and one site in the forebay of Lake Powell, were selected for sampling during each synoptic study (fig. 1). To minimize sampling variance, the river sites were sampled immediately upstream from the tributary mouth to ensure the sampling of a thoroughly mixed reach and the tributary site sampled near its mouth (table 1). During the November 1990 synoptic study, the collection of water samples and field measurements began at 0600 hours on November 5 and ended at 2400 hours on November 6. In June 1991, the collection of water samples and field measurements began at 1200 hours on June 18 and

ended at 0600 hours on June 20. During each study, water samples were collected and field measurements were made eight times at 6-hour intervals Field measurements, sample collection, and the references for the technique used for analysis are shown in table 2. All water samples for chemical analysis were collected using the discharge-weighted depth- and width-integrated equal discharge increment (EDI) method (Edwards and Glysson, 1988). At cableways and non-wadable tributary sites, boats that had a boom and winch assembly were used, and samples were collected with a modified US D-77 sampler (Edwards and Glysson, 1988). At wadable tributary sites, a US DH-81 (hand held) sampler was used. The US D-77 sampler has a capacity of 2 L. A Teflon bag of that volume was placed in the sampler bottle to avoid metallic contamination. In addition, the sampler was coated with an epoxy paint. All sampling equipment was handled with Teflon gloves to avoid contamination. At each vertical in the river, 1-1.5 L of water were collected. At the boat-sampled mainstem sites, sampling verticals were located at predetermined flow centroids that had equally spaced areas. Sample collection at cableways was made at five centroids of flow that were predetermined for given stage/discharge relations. At wading stations, the five discharge centroids were determined from discharge measurements made at the time of sampling. After a sample was collected using the US D-77 or US DH-81 sampler, it was transferred to a graduated cylinder by passing the sample through a 63 micrometer (μm) mesh nylon screen to remove sand-sized suspended matter, and the volume was recorded. The water then was transferred into a Teflon-coated stainless steel churn splitter (U.S. Geological Survey, 1976) for compositing. When all five centroids of flow were sampled, the churn contained about 7.5 L of sample water. The churn with the contained water then was removed to a processing site (often within a tent) and aliquots were subsampled as the churn paddle was in motion, ensuring a mixed sample. Water for trace-element analysis (table 2) was filtered through a 0.4-μm Nuclepore filter housed in an all-Teflon vacuum sample holder using ultraclean techniques. Samples for nitrogen, phosphorus, and dissolved organic carbon were filtered through a 0.45-μm silver-membrane filter. Specific sample preparation protocol and field measurement procedures are described in Taylor, Averett, and Garbarino (see Appendix).

Table 1.–Sampling site names and river kilometers for Colorado River synoptic studies

[Note: Lees Ferry is river kilometer 0.0]

Sampling site	River kilometer	Site No. for fig. 1
Lake Powell Forebay	-25.5	1
Colorado River below Glen Canyon Dam	-20.0	2
Colorado River at Lees Ferry	0.0	3
Paria River near mouth	0.7	4
Colorado River above Little Colorado River	98.3	5
Little Colorado River near mouth	98.5	6
Colorado River at Grand Canyon	141.0	7
Bright Angel Creek near mouth	141.5	8
Colorado River above Kanab Creek	230.5	9
Kanab Creek near mouth	230.7	10
Colorado River above Havasu Creek (November 1990 only)	252.1	11
Havasu Creek near mouth	252.3	12
Colorado River at National Canyon	268.1	13
Colorado River above Diamond Creek	363.1	14
Diamond Creek near mouth	363.3	15
Colorado River near Travertine Cleft (June 1991 only)	428.8	16
Colorado River near Columbine Falls (November 1990 only)	439.2	17

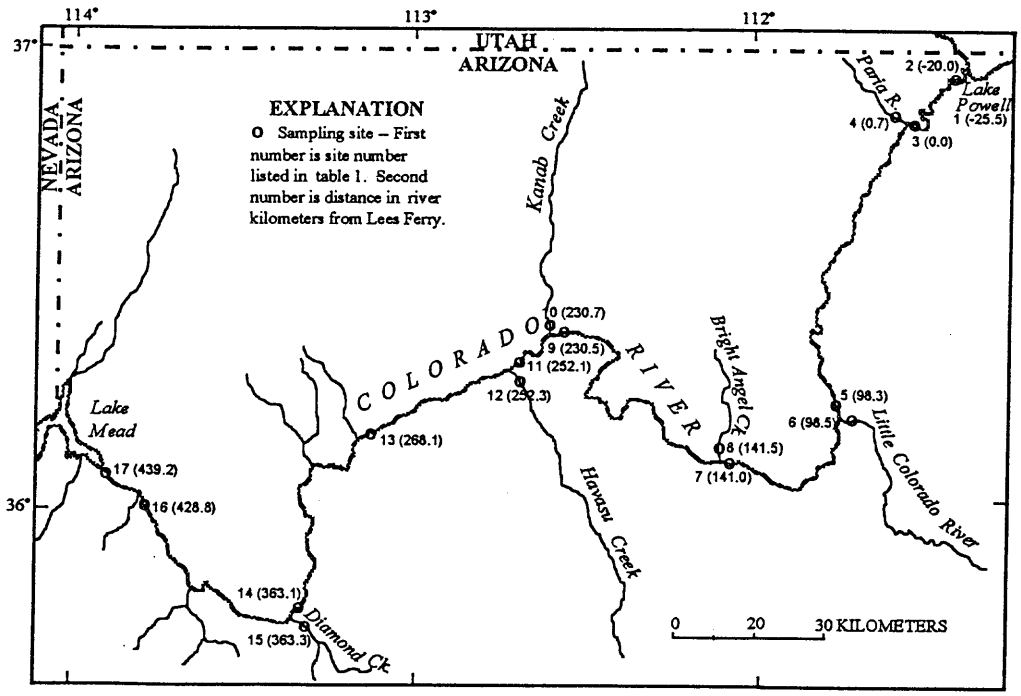

Figure 1.--Location of sampling sites on the Colorado River and selected tributaries from Lake Powell to Lake Mead.

Table 2.--Measurement and constituent list for synoptic studies on Colorado River and major tributaries

[AA, Atomic absorption spectrophotometry; AF, atomic fluorescence spectrometry; HNO_3, nitric acid; IC, ion chromatography; ICP-AES, inductively coupled plasma-atomic emission spectrometry; ICP-MS, inductively coupled plasma-mass spectrometry; IR, infrared absorption spectrophotometry, $K_2Cr_2O_7/HNO_3$, potassium dichromate/nitric acid solution; UV-VIS, ultraviolet-visible absorption spectrophotometry]

Measurement/ constituent	Filter pore size	Preservative	Instrument	Reference
FIELD MEASUREMENTS				
Discharge	none	n/a	Price current meter	Buchanan and Somers (1968)
Dissolved oxygen	none	n/a	Yellow Springs Inst. Model 54	Am. Public Health Assoc. (1985)
Light	none	n/a	Secchi Disk	Wetzel (1983)
Sample collection	none	n/a	US D-77 and US DH-81	Leenheer and others (1988)
pH	none	n/a	Orion Model SA 250	Am. Public Health Assoc. (1985)
Specific conductance	none	n/a	Amber Science Model 604	Hem (1982)
LABORATORY MEASUREMENTS				
Major ions				
Alkalinity	settled	n/a	Gran titration	Kramer (1982)
Calcium	0.4 µm	HNO_3	IPC-AES	Garbarino and Taylor (1979)
Magnesium	do	do	do	do
Sodium	do	do	do	do
Silica as SiO_2	do	do	do	do
Chloride	0.45 µm	n/a	IC	Fresenius and others (1988)
Sulfate	do	do	do	do
Potassium	0.4 µm	HNO_3	AA	Fishman and Friedman (1985)
Nutrients				
Phosphate	do	Chill	UV-Vis	Fishman and Friedman (1985)
Nitrate plus nitrite	do	do	do	do
Ammonium	do	do	do	do
Total dissolved nitrogen	do	do	do	do
Total dissolved phosphorus	do	do	do	do
Dissolved organic carbon	do	do	IR	Menzel and Vaccaro (1964)
Trace elements				
Aluminum	0.4 µm	HNO_3	ICP-MS	Taylor (1989); Garbarino and Taylor (1994); Taylor and others (1990); Taylor and Garbarino (1992)
Arsenic	do	do	do	
Boron	do	do	do	
Barium	do	do	do	
Beryllium	do	do	do	
Cadmium	do	do	do	
Cobalt	do	do	do	do
Chromium	do	do	do	do
Copper	do	do	do	do
Lead	do	do	do	do

Table 2.–Measurement and constituent list for synoptic studies on Colorado River and major tributaries–Continued

Measurement/ constituent	Filter pore size	Preservative	Instrument	Reference
Lithium	do	do	do	do
Manganese	do	do	do	do
Molybdenum	do	do	do	do
Selenium	do	do	do	do
Strontium	do	do	do	do
Thallium	do	do	do	do
Uranium	do	do	do	do
Vanadium	do	do	do	do
Zinc	do	do	do	do
Iron	do	do	ICP-AES	Garbarino and Taylor (1979)
BIOLOGICAL SAMPLES				
Drift	250 µm	ethanol		Britton and
Benthic invert.	0.5 mm	do		Greeson (1987)

Field

Field measurements included water temperature measured with a calibrated hand-held alcohol thermometer. Temperature measurements were made every 6 hours when water samples were collected, but also at more frequent periods when time permitted. Water temperature was measured near the river or tributary surface where each depth-integrated water sample was collected. Temperature was recorded to the nearest 0.5 °C, after a 3-minute thermometer-equilibration period. Water for the measurement of pH and specific conductance was taken at the surface (grab) from the stream cross-section, and the pH was determined immediately. The pH was measured using an Orion Model SA 250 digital meter that was calibrated using buffers of pH 4.01, 7.0, and 10.00. Specific conductance was measured using an Amber Science Model 604 meter with a 515 conductivity cell. Specific conductance was measured immediately after sample collection. Dissolved oxygen (DO) was measured in the river and tributaries using a Yellow Springs Meter Model 54. The DO was reported to the nearest 0.1 milligram per liter (mg/L). At boat sampling and measuring sites and in tributaries where wading was possible, discharge was measured directly using a Price current meter. Light was measured during daytime hours using a Secchi disk (black and white quadrants) 30 centimeters (cm) in diameter. At cableways, discharge was determined from stage readings and rating curves, because all cableways have historic stage/discharge records.

Biological samples consisted of drift (benthic invertebrates and detrital material), and benthic invertebrates from the river and tributary bottom. During the synoptic studies, drift was collected at each site using a net having a 250-µm mesh opening, a 10-cm orifice diameter, and measuring 90-cm in length. Two nets were set in parallel just below the water surface and held in place by steel rods driven into the stream bottom. The nets were set at the beginning of each 6-hour synoptic study period and remained in the stream for 1-hour. Because of rapidly fluctuating water levels, it often was necessary to adjust the depth of the net orifice during the hour of collection. Water velocity was measured in front of each net to facilitate calculation of the amount of water that passed through the net during the hour of collection. After collection, the contents of each net were composited into jars and preserved with a 50 percent mixture of water and ethanol. At selected sites a drift net having a mesh size of 250-µm, an orifice diameter of 0.5-m, and a length of 1.6-m was towed behind a boat in the river center for 15 minutes. While in tow, the top of the net orifice was just below the water surface.

Wide fluctuations in water levels in the Colorado River downstream from Glen Canyon Dam result in streamside areas that are wet for only a short period of each day, and thus, do not support benthic invertebrates. Therefore, sampling for benthic invertebrates was conducted on the stream bottom only during the lowest flow that occurred during the 48-hour synoptic study period. A kick net having a mesh opening of 0.5-mm and measuring 1.1 x 1.0-m was used for collection (Britton and Greeson, 1987, p. 152). A stream bottom area of 1-m^2 was disturbed and the material was washed into the net. In addition, one square foot Surber samplers were used in slow

moving water for the collection of bottom invertebrates. The invertebrates collected in the net were removed onsite and preserved in a 50 percent mixture of ethanol and water.

In the laboratory, benthic invertebrates were separated from detrital material and identified to genus and, whenever possible, to species at the University of Pittsburgh Pymatuning Laboratory of Ecology. Keys used for identification of the invertebrates were primarily from Merritt and Cummins (1984). The ash-free weight of the detrital material then was determined by using the technique described in Britton and Greeson (1987, p. 129-130).

Laboratory

Several laboratory instrumental methods were used for the analysis of samples collected during the synoptic studies. Techniques were selected based on their optimal use for specific measurement criteria, primarily accuracy, precision, sensitivity, and selectivity. These techniques have been developed over a period of several years for the specific application to environmental water analysis.

Alkalinity was determined using an automated Gran titration method (Kramer, 1982). Titrations were performed on a Radiometer auto-titrator using the supernatant portions of the sample after letting the sample settle for at least 24 hours and titrated with a 0.1 N standard sulfuric acid solution. Major cations were determined using inductively coupled plasma-atomic emission spectrometric (ICP-AES) analysis. Specific details of the method and techniques are described in Garbarino and Taylor (1979). The elements calcium, iron, magnesium, silica (as SiO_2), sodium, and strontium were determined simultaneously on a sample aliquot that had been filtered (0.4-µm) and acidified (HNO_3) in the field, using ultraclean procedures. Potassium was determined on the same aliquot by an air/acetylene flame atomic absorption spectrometric technique (Fishman and Friedman, 1985).

Selected trace elements including: aluminum, antimony, arsenic, boron, barium, beryllium, cadmium, cobalt, chromium, copper, lithium, manganese, molybdenum, nickel, lead, rubidium, selenium, silver, thallium, uranium, vanadium, and zinc were determined using state-of-the-art, inductively coupled plasma-mass spectrometric techniques described by Taylor (1989); Taylor and others (1990), Taylor and Garbarino, (1992),and Garbarino and Taylor (1993). These elements also were determined simultaneously on a single sample aliquot that was filtered in the field (0.4 µm) and acidified (HNO_3.

Nutrient determinations included dissolved ammonium ion, dissolved nitrate, dissolved nitrite, and dissolved orthophosphate. Ammonium, nitrate, nitrite, and phosphate were determined using the salicylate-hypochlorite absorption spectrophotometric procedure; sulfanilamide/N-1-napthylethylenediamine dihydrochloride with Cd reduction absorption spectrophotometric procedure; sulfanilamide/N-1-napthylethylenediamine dihydrochloride absorption spectrophotometric procedure; and phosphomolybdate absorption spectrophotometric procedure, respectively (Fishman and Friedman, 1985, and Antweiler and others, 1993).

RESULTS

Water temperature, specific conductance and DO at specific positions in the river cross section are listed for the November 1990 study in table 3 and for the June 1991 study in table 4.

Nutrient data for the November 1990 and June 1991 synoptics are listed in tables 7 and 8, respectively. The nutrient determinations are all made on dissolved constituents (that is, all samples filtered through a 0.45-µm silver membrane filter) and include the following specific determinations reported in mg/L as either nitrogen or phosphorus: ammonium (NH_4), nitrite ion (NO_2), nitrate ion (NO_3), total dissolved nitrogen, orthophosphate ion (PO_4), and total dissolved phosphorus.

pH, alkalinity, and dissolved organic carbon determinations are listed in table 5 for the November 1990 synoptic study and in table 6 for the June 1991 synoptic study. Major constituents are tabulated in table 9 for the November 1990 synoptic study and table 10 for the June 1991 synoptic study. These tables include calcium (Ca), magnesium (Mg), potassium (K), sodium (Na), sulfate (SO_4), chloride (Cl) and silica (SiO_2) and are reported in milligrams per liter.

Trace constituents are listed in tables 11 and 12 for the same respective synoptics and include: aluminum, arsenic, boron, barium, beryllium, cadmium, cobalt, chromium, copper, iron, lead, lithium, manganese,

molybdenum, nickel, thallium, uranium, vanadium, and zinc. All concentrations are reported in micrograms per liter (µg/L) except iron which is reported in milligrams per liter.

Results of the taxonomic, functional groupings, numbers, and biomass of benthic invertebrates from drift samples are listed in table 13 for the November 1990 sampling period, and in table 16 for the June 1991 sampling period. Similar information on invertebrates collected from kick nets is contained in table 14 for the November 1990 synoptic study and in table 17 for the June 1991 synoptic study. Similarly, data obtained from one square foot Surber nets are listed in table 15 for the November 1990 synoptic study and in table 18 for the June 1991 synoptic study. Detrital biomass collected with 10-cm diameter nets are reported in tables 19 and 20, for the respective synoptic studies. Results of similar detrital biomass determinations collected using 0.5-m diameter nets are listed in table 21 for the synoptic studies.

Tabulations of water discharge in cubic meters per second (m^3/s) during the synoptic sampling periods are listed in table 22 for November 1990 and table 23 for June 1991. Hydrographs for this period are plotted in figure 2 for the November 1990 synoptic study and in figure 3 for the June 1991 synoptic study. Suspended sediment concentrations are tabulated in table 24 for the November 1990 synoptic study and in table 25 for the June 1991 synoptic study.

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Table 3.–Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study

[Position is distance in feet from left edge of water. –, not determined; °C, degrees Celsius; µS, microsiemens per centimeter at 25°C; Comp, composite sample; DO, dissolved oxygen; mg/L milligrams per liter; REW, right edge of water; Sp. Cond. specific conductance]

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond (µS)	DO (mg/L)
Colorado River below Glen Canyon Dam	11-5-90	0600	600	9.0	798	6.6
			550	8.5	800	6.2
			500	8.5	800	6.3
			450	8.5	802	6.1
			400	8.5	803	6.1
			350	8.5	803	6.1
			300	8.5	808	6.0
			250	8.5	808	6.0
			200	8.5	804	6.2
		1200	600	8.5	808	6.1
			550	8.5	808	6.5
			500	8.5	809	6.4
			450	8.5	808	6.3
			400	8.5	808	6.3
			350	8.5	809	6.3
			300	8.5	809	6.4
			250	8.5	809	6.5
			200	8.5	809	6.4
		1800	600	8.5	811	6.4
			550	8.5	811	6.2
			500	8.5	810	6.2
			450	8.5	812	6.1
			400	8.5	813	6.2
			350	8.5	813	6.1
			300	–	814	6.2
			250	–	813	6.2
			200	9.0	813	6.2
		2400	550	8.5	817	6.4
			500	8.5	816	6.2
			450	8.5	816	6.4
			400	8.5	815	6.3
			350	8.5	815	6.4
			300	8.5	815	6.3
			250	8.5	815	6.3
	11-6-90	0600	550	8.5	800	9.8
			500	8.5	801	9.7
			450	8.5	802	9.6
			400	8.5	803	9.4
			350	8.5	803	9.3
			300	8.5	803	9.3
			250	8.5	804	9.3
		1200	600	8.5	824	6.1
			550	8.5	824	6.0
			500	8.5	825	6.0
			450	8.5	824	5.9
			400	8.5	825	5.9
			350	8.5	825	5.8
			300	8.5	824	5.8
			250	8.5	825	5.8
		1800	600	8.5	820	6.2
			550	8.5	820	6.1

Table 3.–Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River below Glen Canyon Dam (Continued)			500	8.5	821	6.2
			450	8.5	826	6.1
			400	8.5	824	6.1
			350	8.5	822	6.0
			300	8.5	823	6.0
			250	8.5	822	6.1
	11-6-90	2400	500	8.5	818	6.4
			450	8.5	818	6.5
			400	8.5	817	6.4
			350	8.5	818	6.4
Colorado River at Lees Ferry	11-5-90	0600	REW	7.9	792	–
		1200	REW	9.0	800	–
		1800	REW	8.5	786	10.4
		2400	REW	8.0	822	7.6
	11-6-90	0600	REW	7.0	870	–
		1200	REW	8.5	820	12.6
		1800	REW	8.5	822	7.3
		2400	REW	8.5	828	–
Paria River near mouth	11-5-90	0600	Comp	5.0	911	–
		1200	Comp	11.0	942	–
		1800	Comp	11.0	969	–
		2400	Comp	7.5	988	–
	11-6-90	0600	Comp	7.0	978	–
		1200	Comp	8.0	956	10.4
		1800	Comp	7.0	943	–
		2400	Comp	6.0	981	–
Colorado River above Little Colorado River	11-5-90	0600	REW	8.5	–	9.3
		1200	REW	8.5	726	9.4
		1800	REW	8.5	875	9.4
		2400	REW	8.8	863	9.2
	11-6-90	0600	REW	8.0	891	9.7
		1200	REW	8.2	864	10.4
		1800	REW	8.0	841	10.4
		2400	REW	8.0	842	10.2
Little Colorado River near mouth	11-5-90	0600	Comp	12.5	4,150	9.6
		1200	Comp	15.5	4,140	8.9
		1800	Comp	16.0	4,040	9.1
		2400	Comp	16.5	4,140	8.8
	11-6-90	0600	Comp	11.5	2,750	10.0
		1200	Comp	11.5	2,650	9.8
		1800	Comp	12.0	2,700	9.9
		2400	Comp	12.0	2,820	9.8
Colorado River at Grand Canyon	11-5-90	0600	Comp	9.4	943	6.7
		1200	Comp	9.0	971	8.4
		1800	Comp	–	874	–
		2400	Comp	–	1,040	10.6
	11-6-90	0600	Comp	9.0	1,060	9.0
		1200	Comp	8.5	1,120	10.8
		1800	Comp	9.0	1,200	10.2
		2400	Comp	8.5	915	12.0
Bright Angel Creek near mouth	11-5-90	0600	Comp	–	–	–
		1200	Comp	9.5	365	8.3
		1800	Comp	10.5	360	10.0
		2400	Comp	9.0	412	13.6
	11-6-90	0600	Comp	9.0	390	10.3

Table 3.–Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Bright Angel Creek near mouth		1200	Comp	9.0	369	9.6
(Continued)		1800	Comp	9.5	347	10.0
		2400	Comp	8.5	354	11.0
Colorado River above	11-5-90	0600	Comp	–	–	–
Kanab Creek		1200	Comp	–	–	–
		1800	Comp	–	–	–
		2400	Comp	–	–	–
	11-6-90	0600	Comp	–	–	–
		1200	Comp	–	–	–
		1800	Comp	–	–	–
		2400	Comp	–	–	–
Kanab Creek near mouth	11-5-90	0600	Comp	–	–	–
		1200	Comp	–	–	–
		1800	Comp	–	–	–
		2400	Comp	–	–	–
	11-6-90	0600	Comp	–	–	–
		1200	Comp	–	–	–
		1800	Comp	–	–	–
		2400	Comp	–	–	–
Colorado River above	11-5-90	0600	REW	10.9	932	
Havasu Creek			100	10.0	–	–
			80	–	–	–
			60	10.8	–	–
			20	10.0	–	–
		1200	100	9.8	–	–
			90	9.8	–	–
			60	10.0	–	–
			40	9.8	–	–
			20	9.9	–	–
		1800	105	10.0	–	–
			80	10.0	–	–
			60	10.0	–	–
			40	10.0	–	–
			20	10.0	–	–
		2400	105	10.0	–	–
			60	10.0	–	–
			30	10.0	–	–
			20	10.0	–	–
	11-6-90	0600	80	9.7	–	–
			60	9.7	–	–
			40	9.7	–	–
		1200	95	9.8	–	–
			60	9.7	–	–
			30	9.8	–	–
		1800	80	9.6	–	–
			60	9.6	–	–
			40	9.6	–	–
			20	9.6	–	–
		2400	75	9.5	–	–
			60	9.3	–	–
Havasu Creek near mouth	11-5-90	0600	Comp	12.5	730	10.0
		1200	Comp	13.5	729	9.9
		1800	Comp	14.0	729	9.6
		2400	Comp	13.5	723	9.7
	11-6-90	0600	Comp	13.0	720	9.7

Table 3.–Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Havasu Creek near mouth		1200	Comp	13.0	714	9.9
(Continued)		1800	Comp	12.5	729	10.0
		2400	Comp	12.5	734	9.8
Colorado River at National Canyon	11-5-90	0600	Comp	10.0	890	10.8
		1200	Comp	10.0	933	10.8
		1800	Comp	–	–	–
		2400	Comp	10.0	931	9.8
	11-6-90	0600	Comp	–	–	–
		1200	Comp	10.0	974	10.4
		1800	Comp	10.0	941	10.6
		2400	Comp	10.0	945	9.4
Colorado River above	11-5-90	0600	Comp	11.6	922	–
Diamond Creek		1200	Comp	11.7	963	–
		1800	Comp	10.5	962	–
		2400	Comp	11/0	958	–
	11-6-90	0600	Comp	10.4	984	–
		1200	Comp	10.4	1,003	10.3
		1800	Comp	12.0	965	–
		2400	Comp	10.0	922	–
Diamond Creek near mouth	11-5-90	0600	Comp	–	–	–
		1200	Comp	–	–	–
		1800	Comp	11.8	700	–
		2400	Comp	–	–	–
	11-6-90	0600	Comp	10.1	713	–
		1200	Comp	14	692	–
		1800	Comp	–	689	–
		2400	Comp	–	–	–
Colorado River near Columbine	11-5-90	0600	REW	10.5	956	10.6
Falls			27	10.5	946	9.9
			82	10.6	945	9.9
			138	10.5	945	10.6
			202	10.4	843	10.6
			267	10.5	944	10.6
		1200	REW	10.8	976	10.9
			27	11.0	925	10.8
			82	10.6	933	10.9
			138	10.6	932	11.0
			202	10.8	933	11.0
			267	11.0	935	10.9
		1800	REW	11.0	983	10.8
			27	11.0	947	10.7
			82	10.8	946	10.8
			138	10.9	944	10.9
			202	11.0	945	10.8
			267	11.1	945	10.8
		2400	REW	11.0	924	10.8
			27	11.0	917	10.7
			82	11.1	921	10.8
			138	11.0	913	10.8
			202	11.0	916	10.8
			267	11.0	914	10.8
	11-6-90	0600	REW	10.5	921	10.8
			27	10.5	886	10.8
			82	10.4	885	10.9
			138	10.5	886	10.9

Table 3.–Selected field measurements made at specific positions in the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River near Columbine Falls (Continued)			202	10.5	885	10.9
			267	10.5	886	10.8
		1200	REW	10.5	934	11.0
			27	10.5	894	10.9
			82	10.5	896	11.0
			138	10.3	897	11.0
			202	10.4	898	11.0
			267	10.5	897	11.0
		1800	REW	10.5	964	10.9
			27	10.5	924	10.8
			82	10.5	927	10.9
			138	10.6	928	10.9
			202	10.5	928	11.0
			267	10.5	928	10.9
		2400	REW	10.4	964	10.9
			27	10.5	937	10.8
			82	10.4	936	10.9
			138	10.5	938	11.0
			202	10.4	936	11.0
			267	10.3	934	11.0

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study

[Position is distance in feet from left edge of water. –, not determined; °C, degrees Celsius; mS, microsiemens per centimeter at 25°C; Comp, composite sample; DO, dissolved oxygen; mg/L milligrams per liter; REW, right edge of water; Sp. Cond. specific conductance; Right, ¼ the distance across stream from REW; Mid, ½ the distance across stream from REW; Left, ¾ the distance across stream from REW]

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River below Glen Canyon Dam	6-18-91	1200	225	7.5	967	9.6
			305	7.5	978	9.6
			375	7.5	959	9.6
			430	7.5	968	9.6
			495	7.5	959	9.6
		1800	225	7.0	959	8.1
			305	7.5	958	8.2
			375	8.0	969	8.2
			430	7.5	965	8.2
			495	8.0	969	8.2
		2400	265	7.7	945	9.0
			340	7.5	949	9.0
			390	7.5	949	9.0
			440	7.5	950	9.0
			490	7.5	955	9.0
	6-19-91	0600	270	7.5	943	8.6
			345	7.5	944	8.6
			395	7.5	945	8.7
			440	7.5	943	8.7
			495	7.5	946	8.7
		1200	225	7.5	961	7.6
			305	7.5	962	7.6
			375	8.0	958	7.6
			450	8.0	953	7.6
			495	8.0	955	7.6
		1800	225	7.5	958	7.8
			305	7.5	956	7.8
			375	7.5	954	7.8
			430	7.5	959	7.9
			495	7.5	950	7.9
		2400	275	7.5	938	7.9
			350	7.5	935	8.0
			395	7.5	939	8.0
			440	7.5	942	8.0
			495	7.5	941	7.8
	6-20-91	0600	275	7.5	946	7.7
			350	7.5	947	7.6
			395	7.5	949	7.6
			440	7.5	948	7.7
			495	7.5	948	7.7
Colorado River at Lees Ferry	6-18-91	1200	Comp	10.0	930	9.7
		1800	Comp	9.0	933	8.0
		2400	Comp	8.0	937	8.5
	6-19-91	0600	Comp	8.5	931	10.5
		1200	Comp	9.7	920	–
		1800	Comp	9.5	924	8.4
		2400	Comp	8.0	921	8.6
	6-20-91	0600	Comp	8.5	916	10.8
Paria River near mouth	6-18-91	1200	Comp	29.0	511	7.0
		1800	Comp	23.5	512	7.3
		2400	Comp	19.5	521	7.6

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Paria River near mouth (Cont.)	6-19-91	0600	Comp	17.5	519	8.2
		1200	Comp	28.5	509	6.8
		1800	Comp	24.4	513	7.1
		2400	Comp	17.5	521	8.0
	6-20-91	0600	Comp	14.0	518	8.7
Colorado River above	6-18-91	1200	440	10.2	949	10.1
Little Colorado River			380	10.1	950	10.1
			350	10.4	955	10.1
			295	10.2	942	10.1
			255	10.2	944	10.1
		1800	REW	12.0	975	9.8
		2400	REW	10.4	970	10.6
	6-19-91	0600	REW	9.3	983	13.1
		1200	REW	10.0	981	10.3
		1800	REW	10.5	995	9.9
		2400	REW	10.4	993	9.4
	6-20-91	0600	–	–	–	–
Little Colorado River near mouth	6-18-91	1200	0.8	21.0	4,400	8.2
			13.5	21.5	4,400	8.2
			27.0	21.0	4,400	8.2
			45.0	21.0	4,400	8.2
			69.5	21.0	4,400	8.2
		1800	45.0	23.0	4,400	7.4
		2400	30.0	22.0	4,600	6.5
	6-19-91	0600	30.0	21.0	4,500	8.0
		1200	7.5	23.0	4,500	7.7
		1800	0.8	23.5	4,400	7.0
		2400	0.8	21.0	4,500	7.8
	6-20-91	0600	–	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	Comp	12.0	972	9.8
		1800	Comp	12.0	950	9.9
		2400	Comp	12.0	900	10.0
	6-19-91	0600	Comp	12.0	950	9.5
		1200	Comp	11.2	900	10.8
		1800	Comp	12.0	900	10.7
		2400	Comp	12.0	900	10.1
	6-20-91	0600	Comp	12.0	950	10.9
Bright Angel Creek near mouth	6-18-91	1200	Left	20.5	310	8.3
			Mid	22.5	310	8.4
			Right	21.5	310	8.4
		1800	Mid	22.0	307	8.7
		2400	Mid	19.5	318	8.6
	6-19-91	0600	Mid	17.0	323	8.2
		1200	Mid	21.5	315	7.1
		1800	Mid	19.5	309	7.3
		2400	Mid	18.0	330	8.4
	6-20-91	0600	Mid	15.7	330	8.4
Colorado River above	6-18-91	1200	40	–	1,040	11.2
Kanab Creek			86	13.0	1,050	11.8
			101	13.0	1,044	11.2
			125	13.0	1,050	10.1
			180	13.0	1,038	10.2
		1800	40	13.0	–	11.1
			86	13.0	–	10.8
			101	13.0	–	11.1

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River above			125	13.0	–	11.0
Kanab Creek (Continued)			180	13.0	997	11.0
		2400	101	12.5	–	11.8
	6-19-91	0600	101	12.0	983	10.8
		1200	40	12.0	–	10.2
			86	12.0	–	12.7
			101	12.0	–	12.6
			125	12.0	–	12.4
			180	12.0	–	12.4
		1800	40	12.0	–	11.4
			86	12.0	–	11.4
			101	12.0	–	11.5
			125	12.0	–	11.6
			180	12.0	–	11.6
		2400	101	12.0	–	11.3
	6-20-91	0600	40	11.5	992	11.0
			86	11.0	991	10.9
			101	11.0	987	11.0
			125	11.0	992	11.0
			180	11.5	992	10.9
Kanab Creek near mouth	6-18-91	1200	5.3	27.0	1,190	7.4
			6.8	26.0	–	7.6
			7.4	26.0	–	7.5
			8.1	26.0	–	7.6
			9.6	27.0	–	7.5
		1800	4.6	21.5	1,203	6.9
			6.8	21.5	1,206	7.3
			7.5	21.5	1,204	7.3
			8.4	21.5	1,208	7.3
			10.3	21.5	1,210	7.2
		2400	4.6	22.0	1,219	7.5
	6-19-91	0600	4.6	21.0	1,199	7.1
			6.8	21.0	1,199	7.7
			7.5	21.0	1,198	7.7
			8.4	21.0	1,198	7.8
			10.3	21.0	1,199	7.8
		1200	4.6	26.5	1,201	6.9
			6.8	26.5	1,203	7.2
			7.5	26.5	1,203	7.1
			8.4	27.0	1,206	7.3
			10.3	27.0	1,202	6.9
		1800	4.6	21.0	1,221	7.4
			6.8	21.0	1,217	7.5
			7.5	21.0	1,219	7.7
			8.4	21.0	1,222	7.7
			10.3	21.0	1,227	7.5
		2400	4.6	20.5	1,245	7.6
			6.8	20.0	1,241	7.7
			7.5	20.0	1,244	7.9
			8.4	20.0	1,234	7.9
			10.3	20.5	1,250	7.7
	6-20-91	0600	4.6	19.0	1,234	7.8
			6.8	19.0	1,236	8.0
			7.5	19.0	1,229	8.0
			8.4	19.0	1,244	8.0

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Kanab Creek near mouth-(Cont.)			10.3	19.0	1,237	7.6
Havasu Creek near mouth	6-18-91	1200	Comp	20.0	704	9.0
		1800	Comp	19.0	704	9.3
		2400	Comp	–	725	9.6
	6-19-91	0600	Comp	17.0	731	9.4
		1200	Comp	21.0	709	9.0
		1800	Comp	19.0	702	9.4
		2400	Comp	17.5	718	9.2
	6-20-91	0600	Comp	16.0	724	9.5
Colorado River at National Canyon	6-18-91	1200	180	14.0	1,087	9.1
			210	14.0	1,010	10.0
			243	14.0	1,087	9.7
			273	13.5	1,083	9.6
			313	13.5	993	9.7
		1800	170	13.8	1,025	9.5
			210	13.5	1,018	9.6
			250	13.5	1,012	12.8
			290	13.5	1,017	9.6
			325	13.5	1,022	9.8
		2400	170	13.3	968	10.4
			210	13.5	993	14.0
			250	13.5	966	10.5
			290	13.5	975	11.4
			325	13.5	965	9.7
	6-19-91	0600	185	13.0	990	–
			212	12.8	990	10.2
			244	12.8	991	–
			280	12.8	990	–
			320	12.5	990	–
		1200	190	13.5	986	10.1
			220	13.5	987	10.2
			250	13.5	978	10.4
			280	13.5	985	10.6
			320	13.5	983	10.1
		1800	185	13.5	933	10.5
			215	13.5	933	10.6
			250	13.5	932	10.1
			280	13.0	934	10.2
			315	–	936	10.2
		2400	185	12.8	937	10.6
			215	12.8	931	10.1
			250	12.8	935	10.7
			280	12.8	931	10.8
			315	12.8	930	10.5
	6-20-91	0600	170	12.7	958	11.3
			210	12.8	957	11.0
			245	12.9	962	11.2

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River at National Canyon			280	12.7	961	10.8
(Continued)			320	12.8	961	10.8
Colorado River above	6-18-91	1200	105	14.5	1,025	10.1
Diamond Creek			130	14.5	1,010	10.1
			145	14.5	1,022	10.1
			165	14.5	1,034	10.1
			190	14.5	1,011	10.1
		1800	105	14.5	1,005	12.7
			125	14.5	1,020	12.8
			145	14.5	1,011	12.8
			165	14.5	999	17.8
			190	14.5	1,011	12.7
		2400	105	14.5	1,012	10.7
			125	14.5	1,013	10.7
			145	14.5	1,010	10.5
			165	14.5	1,010	10.7
			190	14.5	1,015	10.4
	6-19-91	0600	100	14.5	1,040	11.2
			125	14.0	1,040	11.2
			145	14.0	1,040	11.2
			170	14.0	1,040	11.2
			195	14.0	1,043	11.0
	6-19-91	1200	105	13.5	1,057	9.8
			130	14.0	1,036	9.9
			145	13.5	1,050	9.9
			165	14.0	1,037	9.8
			190	14.0	1,049	10.0
		1800	105	14.5	1,042	10.2
			125	14.5	1,072	10.1
			145	14.5	1,193	10.1
			165	14.5	1,128	10.1
			190	14.5	1,086	10.1
		2400	105	14.5	1085	10.0
			125	14.5	986	10.0
			145	14.5	985	9.9
			165	14.5	987	9.9
			190	14.5	1,014	9.9
	6-20-91	0600	100	14.5	1,054	10.8
			125	14.0	1,010	10.8
			145	14.0	1,013	10.8
			170	14.0	1,016	10.7
			195	14.0	1,012	10.8
Diamond Creek near mouth	6-18-91	1200	Comp	28.5	753	8.4
		1800	Comp	23.5	772	8.0
		2400	Comp	21.0	783	7.9
	6-19-91	0600	Comp	20.0	781	8.3
		1200	Comp	28.5	761	8.9
		1800	Comp	22.0	791	8.4
		2400	1.5	20.0	790	8.2
	6-20-91	0600	2.5	18.0	785	8.8
Colorado River near Travertine	6-18-91	1200	70	21.4	1,080	9.7
Cleft			110	19.9	1,100	9.7
			170	19.7	1,080	9.7
			240	19.7	1,060	9.7
			320	19.9	1,080	9.6

Table 4.–Selected field measurements made at specific positions in the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	Position (ft.)	Temp. (°C)	Sp. Cond. (µS)	DO (mg/L)
Colorado River near Travertine Cleft (Continued)		1800	70	21.1	1,000	9.7
			110	19.4	1,020	9.7
			170	18.9	1,010	9.7
			240	19.6	1,025	9.6
			320	18.5	1,020	9.6
		2400	70	17.5	1,025	9.6
			110	17.3	1,025	9.7
			170	16.7	1,015	9.8
			240	16.9	1,020	9.8
			320	17.4	1,020	9.8
	6-19-91	0600	70	16.7	1,020	10.0
			110	16.1	1,020	10.0
			170	16.0	1,000	10.0
			240	16.2	1,000	10.0
			320	16.2	1,000	10.0
		1200	70	21.0	1,050	9.7
			110	20.5	1,470	9.7
			170	22.0	1,120	9.7
			240	21.5	1,060	9.6
			320	21.7	1,060	9.6
		1800	70	19.3	1,080	9.4
			110	19.3	1,050	8.9
			170	19.3	1,080	9.6
			240	19.0	1,070	9.7
			320	18.6	1,045	9.8
		2400	70	17.6	1,060	9.8
			110	16.9	1,060	9.8
			170	17.0	1,100	9.9
			240	16.8	1,100	9.8
			320	16.4	1,080	9.7
	6-20-91	0600	70	16.2	1,060	9.8
			110	16.2	1,050	9.9
			170	15.7	1,070	9.9
			240	15.8	1,070	9.8
			320	16.0	1,080	9.8

Table 5.– pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the November 1990 synoptic study

[–, not determined; µeq/L, microequivalents per Liter; mg C/L, milligrams of Carbon per Liter]

Site Name	Date	Time	pH	Alkalinity (µeq/L)	DOC (mg C/L)
Colorado River below Glen Canyon Dam	11-5-90	0600	8.26	2,680	2.5
		1200	8.12	2,604	2.9
		1800	8.25	2,851	2.8
		2400	8.06	2,674	2.6
	11-6-90	0600	8.23	2,645	2.6
		1200	8.18	2,731	3.1
		1800	8.08	2,701	2.8
		2400	8.12	2,721	2.7
Colorado River at Lees Ferry	11-5-90	0600	8.10	2,660	2.9
		1200	8.06	2,671	2.9
		1800	8.16	2,676	2.8
		2400	8.11	2,683	2.7
	11-6-90	0600	8.42	2,702	–
		1200	7.99	2,697	2.6
		1800	8.14	2,684	2.7
		2400	8.25	2,709	2.9
Paria River near mouth	11-5-90	0600	8.22	2,783	1.2
		1200	8.55	2,752	1.1
		1800	8.47	2,668	1.0
		2400	8.58	2,738	1.5
	11-6-90	0600	8.58	2,802	1.3
		1200	8.21	2,788	1.3
		1800	8.44	2,808	1.5
		2400	8.60	2,826	1.1
Colorado River above Little Colorado River	11-5-90	0600	8.02	2,659	3.0
		1200	8.12	2,782	3.1
		1800	8.14	2,706	2.6
		2400	7.63	2,729	2.9
	11-6-90	0600	8.83	2,830	2.6
		1200	7.68	2,867	2.9
		1800	7.74	2,821	2.9
		2400	7.85	2,801	2.7
Little Colorado River near mouth	11-5-90	0600	8.05	5,806	0.4
		1200	7.97	5,885	0.2
		1800	8.00	5,585	1.1
		2400	7.89	7,131	1.2
	11-6-90	0600	7.99	7,211	–
		1200	8.27	7,626	2.9
		1800	8.08	7,476	–
		2400	8.16	7,663	–
Colorado River at Grand Canyon	11-5-90	0600	8.12	2,826	–
		1200	7.98	2,788	2.4
		1800	8.41	2,744	2.6
		2400	8.53	2,727	1.8
	11-6-90	0600	8.37	2,878	2.8
		1200	7.79	2,774	2.6
		1800	8.28	3,239	2.8
		2400	8.16	3,019	2.8
Bright Angel Creek near mouth	11-5-90	0600	8.41	3,891	–
		1200	8.91	3,680	–
		1800	8.16	3,458	–
		2400	8.47	3,649	–

Table 5.– pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	pH	Alkalinity (µeq/L)	DOC (mg C/L)
Bright Angel Creek near mouth (Continued)	11-6-90	0600	8.47	3,425	–
		1200	8.50	3,575	–
		1800	8.38	3,322	–
		2400	8.53	3,657	–
Colorado River above Kanab Creek	11-5-90	0600	8.27	3,140	2.6
		1200	8.12	2,795	2.9
		1800	8.20	2,837	2.8
		2400	8.33	3,285	2.7
	11-6-90	0600	8.36	2,868	2.5
		1200	8.46	2,943	2.6
		1800	8.17	3,158	2.7
		2400	8.36	2,963	2.5
Kanab Creek near mouth	11-5-90	0600	8.40	2,879	0.6
		1200	8.45	2,670	0.8
		1800	8.44	2,866	0.5
		2400	8.45	2,863	0.3
	11-6-90	0600	8.40	2,880	0.5
		1200	8.56	2,560	0.5
		1800	8.31	2,812	0.4
		2400	8.41	2,839	0.5
Colorado River above Havasu Creek	11-5-90	0600	8.48	2,887	3.2
		1200	–	2,933	2.6
		1800	8.42	2,925	2.7
		2400	–	2,881	2.8
	11-6-90	0600	–	2,917	2.6
		1200	–	2,878	2.7
		1800	–	2,866	2.8
		2400	–	2,944	2.7
Havasu Creek near mouth	11-5-90	0600	8.46	5,394	2.0
		1200	7.88	5,346	1.5
		1800	8.41	5,415	1.4
		2400	8.43	5,252	1.9
	11-6-90	0600	8.44	5,330	2.4
		1200	8.37	5,307	1.0
		1800	8.44	5,305	1.3
		2400	8.49	5,382	2.6
Colorado River at National Canyon	11-5-90	0600	8.41	2,808	–
		1200	8.44	2,834	2.4
		1800	–	–	–
		2400	8.40	2,832	2.4
	11-6-90	0600	–	–	–
		1200	8.41	2,928	2.5
		1800	8.41	2,971	2.3
		2400	8.41	2,979	2.4
Colorado River above Diamond Creek	11-5-90	0600	8.42	–	2.5
		1200	8.47	2,853	2.7
		1800	8.19	2,944	2.8
		2400	8.39	3,078	2.3
	11-6-90	0600	8.44	2,934	2.4
		1200	8.40	3,056	3.0
		1800	8.23	2,956	2.6
		2400	8.35	–	2.5
Diamond Creek near mouth	11-5-90	0600	8.62	5,835	–
		1200	8.70	5,493	2.3
		1800	8.79	5,185	2.5

Table 5.– pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the November 1990 synoptic study–Continued

Site Name	Date	Time	pH	Alkalinity (μeq/L)	DOC (mg C/L)
Diamond Creek near mouth		2400	–	–	–
(Continued)	11-6-90	0600	8.71	5,537	<0.1
		1200	8.73	5,403	–
		1800	8.69	5,317	1.3
		2400	–	–	–
Colorado River near Columbine	11-5-90	0600	8.46	3,114	2.7
Falls		1200	8.43	3,365	2.7
		1800	8.45	3,052	2.7
		2400	8.43	2,970	2.5
	11-6-90	0600	8.49	2,985	2.6
		1200	8.42	3,019	2.9
		1800	8.43	3,035	2.5
		2400	8.44	3,056	2.6

Table 6.– pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the June 1991 synoptic study

[–, not determined; µeq/L, microequivalents per Liter; mg C/L, milligrams of Carbon per Liter]

Site Name	Date	Time	pH	Alkalinity (µeq/L)	DOC (mg C/L)
Colorado River below Glen Canyon Dam	6-18-91	1200	8.08	2,864	2.5
		1800	7.96	2,814	2.4
		2400	7.64	2,870	2.4
	6-19-91	0600	7.84	2,824	2.4
		1200	7.93	2,786	2.5
		1800	7.75	2,820	2.5
		2400	7.67	2,770	2.5
	6-20-91	0600	7.71	2,824	2.5
Colorado River at Lees Ferry	6-18-91	1200	8.09	2,747	2.6
		1800	8.10	2,800	2.6
		2400	8.04	2,756	2.6
	6-19-91	0600	8.14	2,793	2.6
		1200	8.10	2,760	2.8
		1800	8.16	2,789	2.7
		2400	8.03	2,780	2.6
	6-20-91	0600	8.26	2,758	2.5
Paria River near mouth	6-18-91	1200	8.50	2,114	0.9
		1800	8.63	2,083	1.2
		2400	8.49	2,123	0.8
	6-19-91	0600	8.42	2,212	1.2
		1200	8.56	2,104	0.8
		1800	8.46	2,067	1.3
		2400	8.44	2,157	1.3
	6-20-91	0600	8.41	2,163	1.0
Colorado River above Little Colorado River	6-18-91	1200	8.13	2,800	2.7
		1800	8.20	2,804	2.7
		2400	8.40	2,827	2.6
	6-19-91	0600	8.03	2,783	2.7
		1200	8.02	2,749	2.6
		1800	8.07	2,816	–
		2400	8.10	2,846	2.7
	6-20-91	0600	–	–	2.7
Little Colorado River near mouth	6-18-91	1200	8.02	6,797	0.7
		1800	8.02	6,660	–
		2400	7.88	6,607	1.2
	6-19-91	0600	8.25	7,257	0.5
		1200	7.98	6,641	0.3
		1800	8.13	6,595	0.1
		2400	8.06	6,591	0.1
	6-20-91	0600	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	8.16	2,817	2.7
		1800	8.17	2,804	2.6
		2400	8.19	2,861	2.6
	6-19-91	0600	8.25	2,917	2.6
		1200	8.19	2,882	2.7
		1800	8.15	2,863	2.9
		2400	8.20	2,866	2.6
	6-20-91	0600	8.18	3,007	2.5
Bright Angel Creek near mouth	6-18-91	1200	8.81	3,292	1.1
		1800	8.79	3,219	0.8
		2400	8.61	3,370	0.9
	6-19-91	0600	8.02	3,361	1.0

Table 6.– pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	pH	Alkalinity (µeq/L)	DOC (mg C/L)
Bright Angel Creek near mouth (Continued)		1200	8.87	3,309	1.0
		1800	8.77	3,291	1.0
		2400	8.65	2,900	1.0
	6-20-91	0600	8.70	3,444	0.9
Colorado River above Kanab Creek	6-18-91	1200	8.22	2,941	2.5
		1800	7.48	2,872	2.7
		2400	8.18	2,911	2.8
	6-19-91	0600	8.21	2,854	2.6
		1200	8.12	2,861	2.7
		1800	8.25	2,913	2.5
		2400	8.26	2,868	2.4
	6-20-91	0600	8.18	2,887	2.6
Kanab Creek near mouth	6-18-91	1200	8.30	2,169	0.8
		1800	8.24	2,131	1.0
		2400	8.23	2,382	0.9
	6-19-91	0600	8.03	2,439	0.9
		1200	8.42	2,219	0.9
		1800	8.37	2,291	0.8
		2400	8.09	2,475	0.9
	6-20-91	0600	8.22	2,521	0.9
Havasu Creek near mouth	6-18-91	1200	8.58	5,562	<0.1
		1800	8.42	5,534	1.1
		2400	8.42	4,813	<0.1
	6-19-91	0600	8.50	5,822	0.1
		1200	8.52	5,614	<0.1
		1800	8.54	5,571	0.1
		2400	8.60	5,796	1.1
	6-20-91	0600	8.58	5,915	0.9
Colorado River at National Canyon	6-18-91	1200	8.37	3,331	–
		1800	8.43	2,947	2.6
		2400	8.43	2,831	2.6
	6-19-91	0600	8.26	2,892	2.6
		1200	8.19	2,796	2.6
		1800	8.25	2,853	2.6
		2400	8.32	2,837	2.6
	6-20-91	0600	8.24	2,897	2.7
Colorado River above Diamond Creek	6-18-91	1200	8.29	2,978	2.8
		1800	8.28	3,160	3.1
		2400	8.31	2,942	2.6
	6-19-91	0600	8.34	3,097	2.5
		1200	8.32	2,909	2.7
		1800	8.32	2,981	2.8
		2400	8.38	3,028	3.2
	6-20-91	0600	8.32	2,930	2.9
Diamond Creek near mouth	6-18-91	1200	8.50	6,441	–
		1800	8.25	6,293	2.3
		2400	8.27	6,265	1.2

Table 6.–pH, alkalinity and dissolved organic carbon (DOC) determined from a composite of water samples from the river cross-section for the June 1991 synoptic study–Continued

Site Name	Date	Time	pH	Alkalinity (μeq/L)	DOC (mg C/L)
Diamond Creek near mouth (Continued)	6-19-91	0600	8.29	6,205	–
		1200	8.50	5,863	2.1
		1800	8.47	6,466	2.2
		2400	8.21	6,155	–
	6-20-91	0600	8.26	6,216	1.5
Colorado River near Travertine Cleft	6-18-91	1200	8.28	2,954	2.4
		1800	8.31	2,948	2.6
		2400	8.30	2,948	2.4
	6-19-91	0600	8.23	3,023	2.4
		1200	8.45	2,880	2.6
		1800	8.33	2,982	3.0
		2400	8.24	3,000	2.5
	6-20-91	0600	8.25	2,958	2.8

Table 7.–Dissolved nutrient concentrations for the November 1990 synoptic study

[L, liter; mg, milligrams; N, nitrogen; NO_3, nitrate; NO_2, nitrite; NH_4, ammonium; P, phosphorus; PO_4, orthophosphate; Tot. N, total dissolved nitrogen; Tot. P, total dissolved phosphorus]

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Colorado River below Glen Canyon Dam	11-5-90	0600	0.33	<0.01	<0.02	0.5	<0.01	0.002
		1200	0.34	<0.01	<0.02	0.4	<0.01	<0.001
		1800	0.34	<0.01	<0.02	0.5	<0.01	0.002
		2400	0.35	<0.01	<0.02	0.5	<0.01	<0.001
	11-6-90	0600	0.34	<0.01	<0.02	0.3	<0.01	0.001
		1200	0.35	<0.01	<0.02	0.2	<0.01	0.001
		1800	0.35	<0.01	<0.02	0.5	<0.01	<0.001
		2400	0.35	<0.01	<0.02	0.6	<0.01	<0.001
Colorado River at Lees Ferry	11-5-90	0600	0.34	<0.01	<0.02	0.4	<0.01	0.001
		1200	0.33	<0.01	<0.02	0.4	<0.01	<0.001
		1800	0.34	<0.01	<0.02	0.5	<0.01	0.001
		2400	0.35	<0.01	0.02	0.5	<0.01	0.001
	11-6-90	0600	0.35	<0.01	<0.02	0.5	<0.01	<0.001
		1200	0.35	<0.01	<0.02	0.4	<0.01	<0.001
		1800	0.34	<0.01	<0.02	0.5	<0.01	<0.001
		2400	0.35	<0.01	0.02	0.5	<0.01	<0.001
Paria River near mouth	11-5-90	0600	0.91	<0.01	0.04	1.0	<0.01	0.005
		1200	0.89	<0.01	<0.02	0.9	<0.01	0.001
		1800	0.85	0.05	0.03	1.0	0.06	0.040
		2400	0.92	<0.01	0.02	0.9	<0.01	0.053
	11-6-90	0600	0.91	<0.01	<0.02	1.0	<0.01	0.004
		1200	0.87	0.03	0.03	1.0	0.03	0.062
		1800	0.83	<0.01	<0.02	0.9	<0.01	0.038
		2400	0.87	0.02	<0.02	0.9	<0.01	0.108
Colorado River above Little Colorado River	11-5-90	0600	0.33	<0.01	<0.02	0.5	<0.01	0.004
		1200	0.33	<0.01	<0.02	0.6	<0.01	0.004
		1800	0.32	<0.01	<0.02	0.5	<0.01	<0.001
		2400	0.32	<0.01	<0.02	0.4	<0.01	<0.001
	11-6-90	0600	0.32	<0.01	<0.02	0.5	0.01	0.002
		1200	0.32	<0.01	<0.02	0.4	<0.01	0.020
		1800	0.32	<0.01	<0.02	0.5	<0.01	<0.001
		2400	0.34	<0.01	<0.02	0.4	<0.01	0.021
Little Colorado River near mouth	11-5-90	0600	0.32	<0.01	<0.02	0.4	0.01	0.018
		1200	0.32	<0.01	<0.02	0.4	<0.01	0.006
		1800	0.32	<0.01	<0.02	–	<0.01	–
		2400	0.32	<0.01	<0.02	–	0.02	–
	11-6-90	0600	1.01	0.08	<0.02	–	0.03	–
		1200	0.85	<0.01	<0.02	–	0.03	–
		1800	0.76	0.02	<0.02	–	0.03	–
		2400	0.71	0.03	<0.02	–	0.03	–
Colorado River at Grand Canyon	11-5-90	0600	0.35	<0.01	<0.02	0.6	<0.01	0.002
		1200	0.34	<0.01	<0.02	0.5	<0.01	0.021
		1800	0.34	<0.01	<0.02	0.4	<0.01	0.001
		2400	0.36	<0.01	<0.02	–	<0.01	0.008
		0600	0.35	<0.01	<0.02	0.4	<0.01	0.023
		1200	0.34	<0.01	<0.02	0.1	<0.01	0.001
		1800	0.36	<0.01	<0.02	0.6	0.03	0.045
		2400	0.35	<0.01	<0.02	0.7	0.03	0.022

Table 7.–Dissolved nutrient concentrations for the November 1990 synoptic study–Continued

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Colorado River	11-5-90	0600	0.30	0.02	0.02	0.6	0.05	<0.001
above		1200	0.32	<0.01	<0.02	0.5	<0.01	0.005
Kanab Creek		1800	0.32	<0.01	<0.02	0.5	<0.01	0.006
		2400	0.32	<0.01	<0.02	0.5	<0.01	0.011
	11-6-90	0600	0.32	<0.01	<0.02	0.5	<0.01	0.004
		1200	0.32	<0.01	<0.02	0.5	0.01	0.003
		1800	0.32	<0.01	<0.02	0.4	0.01	0.002
		2400	0.32	<0.01	<0.02	0.5	0.01	0.003
Kanab Creek	11-5-90	0600	0.19	<0.01	<0.02	0.5	<0.01	<0.001
near mouth		1200	0.16	<0.01	<0.02	0.3	<0.01	0.001
		1800	0.00	<0.01	<0.02	0.3	<0.01	0.003
		2400	0.20	<0.01	<0.02	0.3	<0.01	<0.001
	11-6-90	0600	0.20	<0.01	<0.02	0.3	<0.01	0.001
		1200	0.17	<0.01	<0.02	0.2	<0.01	0.004
		1800	0.19	<0.01	<0.02	0.3	<0.01	0.004
		2400	0.20	<0.01	<0.02	0.4	<0.01	0.002
Colorado River	11-5-90	0600	0.34	<0.01	<0.02	0.5	<0.01	0.007
above		1200	0.34	<0.01	<0.02	0.5	<0.01	<0.001
Havasu Creek		1800	0.33	<0.01	<0.02	0.6	<0.01	0.002
		2400	0.33	<0.01	<0.02	0.4	<0.01	0.002
	11-6-90	0600	0.33	<0.01	<0.02	0.4	<0.01	0.001
		1200	0.33	<0.01	0.02	0.5	0.02	0.003
		1800	0.32	<0.01	<0.02	0.5	<0.01	0.002
		2400	0.32	<0.01	<0.02	0.4	<0.01	0.005
Havasu Creek	11-5-90	0600	0.28	<0.01	<0.02	0.3	<0.01	0.001
near mouth		1200	0.26	<0.01	<0.02	0.2	<0.01	<0.001
		1800	0.26	<0.01	<0.02	0.3	<0.01	0.002
		2400	0.25	<0.01	<0.02	0.3	<0.01	0.001
	11-6-90	0600	0.27	<0.01	<0.02	0.3	<0.01	<0.001
		1200	0.26	<0.01	<0.02	0.3	<0.01	0.001
		1800	0.26	<0.01	<0.02	0.1	<0.01	0.002
		2400	0.25	<0.01	<0.02	0.3	<0.01	<0.001
Colorado River	11-5-90	0600	0.32	<0.01	<0.02	0.5	0.02	0.001
at National		1200	0.32	<0.01	<0.02	0.5	<0.01	0.004
Canyon		1800	–	–	–	–	–	–
		2400	0.32	<0.01	<0.02	0.5	<0.01	<0.001
	11-6-90	0600	–	–	–	–	–	–
		1200	0.31	0.01	0.02	0.4	0.03	0.003
		1800	0.32	<0.01	<0.02	0.5	0.01	0.007
		2400	0.32	<0.01	<0.02	0.4	<0.01	0.002
Colorado River	11-5-90	0600	0.32	<0.01	<0.02	0.5	<0.01	0.031
above		1200	0.33	<0.01	<0.02	0.4	0.01	0.003
Diamond Creek		1800	0.33	<0.01	<0.02	0.4	<0.01	0.004
		2400	0.33	<0.01	<0.02	0.4	<0.01	0.004
	11-6-90	0600	0.33	<0.01	<0.02	0.4	0.01	0.004
		1200	0.33	<0.01	<0.02	0.5	<0.01	0.005
		1800	0.33	<0.01	<0.02	0.4	<0.01	0.002
		2400	0.32	<0.01	<0.02	0.5	<0.01	0.003

Table 7.--Dissolved nutrient concentrations for the November 1990 synoptic study--Continued

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Diamond Creek near mouth	11-5-90	0600	–	–	–	–	–	–
		1200	0.33	<0.01	<0.02	0.3	<0.01	<0.001
		1800	0.34	<0.01	<0.02	0.2	<0.01	0.001
		2400	–	–	–	–	–	–
	11-6-90	0600	0.40	<0.01	<0.02	0.4	<0.01	<0.001
		1200	0.33	<0.01	<0.02	0.3	<0.01	0.003
		1800	0.33	<0.01	<0.02	0.5	<0.01	0.018
		2400	–	–	–	–	–	–
Colorado River near Columbine Falls	11-5-90	0600	0.32	<0.01	<0.02	0.5	<0.01	0.010
		1200	0.31	<0.01	0.02	0.5	0.02	0.007
		1800	0.31	<0.01	<0.02	0.4	<0.01	0.082
		2400	0.32	<0.01	<0.02	0.6	0.01	0.007
	11-6-90	0600	0.32	<0.01	<0.02	0.6	<0.01	0.004
		1200	0.33	<0.01	<0.02	0.5	<0.01	0.002
		1800	0.33	<0.01	<0.02	0.5	<0.01	0.002
		2400	0.33	<0.01	<0.02	0.5	<0.01	0.005

Table 8.—Dissolved nutrient concentrations for the June 1991 synoptic study

[L, liter; mg, milligrams; N, nitrogen; NO_3, nitrate; NO_2, nitrite; NH_4, ammonium; P, phosphorus; PO_4, orthophosphate; Tot. N, total dissolved nitrogen; Tot. P, total dissolved phosphorus]

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Colorado River	6-18-91	1200	0.39	<0.01	<0.02	0.40	0.01	0.004
below Glen		1800	0.38	<0.01	<0.02	0.49	<0.01	0.004
Canyon Dam		2400	0.37	<0.01	<0.02	0.37	<0.01	0.006
	6-19-91	0600	0.36	<0.01	<0.02	0.54	<0.01	0.004
		1200	0.35	<0.01	<0.02	0.58	<0.01	0.009
		1800	0.37	<0.01	<0.02	0.46	0.01	0.005
		2400	0.36	<0.01	<0.02	0.47	<0.01	0.011
	6-20-91	0600	0.38	<0.01	<0.02	0.42	<0.01	0.013
Colorado River	6-18-91	1200	0.38	<0.01	<0.02	0.85	<0.01	0.004
at Lees Ferry		1800	0.54	0.01	<0.02	0.80	<0.01	0.003
		2400	0.38	<0.01	<0.02	0.70	<0.01	0.002
	6-19-91	0600	0.37	<0.01	<0.02	0.50	<0.01	0.002
		1200	0.37	<0.01	<0.02	0.30	<0.01	0.005
		1800	0.38	<0.01	<0.02	0.46	<0.01	0.003
		2400	0.36	<0.01	0.03	0.41	<0.01	<0.001
	6-20-91	0600	0.37	<0.01	<0.02	0.50	<0.01	0.001
Paria River	6-18-91	1200	1.06	0.01	0.02	0.99	0.01	0.013
near mouth		1800	1.05	0.01	<0.02	1.14	<0.01	0.035
		2400	1.08	0.01	<0.02	0.95	<0.01	0.010
	6-19-91	0600	1.08	0.01	<0.02	1.04	0.01	0.008
		1200	1.04	0.01	<0.02	1.02	0.01	0.053
		1800	1.04	0.02	<0.02	0.90	0.01	0.015
		2400	1.04	0.01	<0.02	1.04	0.01	0.050
	6-20-91	0600	1.06	0.01	<0.02	1.01	0.01	0.031
Colorado River	6-18-91	1200	0.37	<0.01	0.02	0.51	<0.01	0.008
above Little		1800	0.36	<0.01	<0.02	0.51	<0.01	0.014
Colorado River		2400	0.35	<0.01	0.02	0.47	<0.01	0.017
	6-19-91	0600	0.39	<0.01	<0.02	0.45	<0.01	0.008
		1200	0.28	<0.01	<0.02	0.53	<0.01	0.008
		1800	0.37	<0.01	<0.02	0.37	<0.01	0.018
		2400	0.37	<0.01	<0.02	0.86	<0.01	0.010
	6-20-91	0600	0.34	<0.01	<0.02	0.66	<0.01	0.006
Little Colorado	6-18-91	1200	0.24	<0.01	0.02	0.18	<0.01	0.003
River near		1800	0.22	<0.01	<0.02	0.26	<0.01	<0.001
mouth		2400	0.16	<0.01	<0.02	0.18	<0.01	0.014
	6-19-91	0600	0.24	<0.01	<0.02	0.38	<0.01	0.013
		1200	0.22	<0.01	<0.02	0.25	<0.01	0.015
		1800	0.22	<0.01	0.02	0.28	<0.01	0.001
		2400	0.17	<0.01	<0.02	0.36	<0.01	0.001
	6-20-91	0600	–	–	–	–	–	–
Colorado River	6-18-91	1200	0.35	<0.01	0.02	0.35	<0.01	0.019
at Grand		1800	0.36	<0.01	0.02	0.41	<0.01	0.005
Canyon		2400	0.35	<0.01	0.02	0.45	0.01	0.010
	6-19-91	0600	0.37	<0.01	0.02	0.68	<0.01	0.007
		1200	0.38	<0.01	0.02	0.50	<0.01	0.006
		1800	0.39	<0.01	0.02	0.37	<0.01	0.009
		2400	0.36	<0.01	<0.02	0.47	<0.01	0.007
	6-20-91	0600	0.37	<0.01	<0.02	0.47	<0.01	0.001
Bright Angel	6-18-91	1200	<0.02	<0.01	<0.02	<0.10	0.01	0.033
Creek near		1800	<0.02	<0.01	<0.02	0.12	<0.01	0.036
mouth		2400	<0.02	<0.01	<0.02	<0.10	0.01	0.034
	6-19-91	0600	<0.02	<0.01	<0.02	<0.10	<0.01	0.032

Table 8.–Dissolved nutrient concentrations for the June 1991 synoptic study–Continued

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Bright Angel		1200	<0.02	<0.01	<0.02	<0.10	0.01	0.032
Creek near		1800	<0.02	<0.01	<0.02	0.16	<0.01	0.037
mouth (Cont.)		2400	<0.02	<0.01	<0.02	0.11	<0.01	0.029
	6-20-91	0600	<0.02	<0.01	<0.02	<0.10	<0.01	0.029
Colorado River	6-18-91	1200	0.36	<0.01	0.02	0.41	<0.01	0.014
above		1800	0.36	<0.01	0.02	0.49	<0.01	0.013
Kanab Creek		2400	0.37	<0.01	<0.02	0.51	<0.01	0.014
	6-19-91	0600	0.32	<0.01	0.02	0.47	<0.01	0.007
		1200	0.35	<0.01	0.02	0.42	<0.01	0.010
		1800	0.34	<0.01	0.02	0.57	<0.01	0.006
		2400	0.37	<0.01	0.02	0.68	<0.01	0.006
	6-20-91	0600	0.38	<0.01	0.02	0.51	<0.01	0.001
Kanab Creek	6-18-91	1200	<0.02	<0.01	0.02	<0.10	<0.01	0.017
near mouth		1800	<0.02	<0.01	<0.02	<0.10	<0.01	–
		2400	<0.02	<0.01	0.02	0.10	<0.01	0.014
	6-19-91	0600	<0.02	<0.01	<0.02	0.32	<0.01	0.001
		1200	<0.02	<0.01	<0.02	0.18	<0.01	0.004
		1800	<0.02	<0.01	<0.02	<0.10	<0.01	0.005
		2400	<0.02	<0.01	0.02	0.19	<0.01	0.002
	6-20-91	0600	<0.02	<0.01	<0.02	<0.10	0.01	0.013
Havasu Creek	6-18-91	1200	0.11	<0.01	<0.02	0.12	<0.01	0.015
near mouth		1800	0.08	<0.01	<0.02	0.11	<0.01	0.011
		2400	0.13	<0.01	<0.02	0.14	<0.01	0.009
	6-19-91	0600	0.14	<0.01	<0.02	0.15	<0.01	0.001
		1200	0.13	<0.01	<0.02	0.14	<0.01	0.011
		1800	0.13	<0.01	<0.02	0.12	<0.01	0.010
		2400	0.15	<0.01	<0.02	0.32	<0.01	0.009
	6-20-91	0600	0.16	<0.01	<0.02	0.16	<0.01	0.002
Colorado River	6-18-91	1200	0.39	<0.01	0.02	0.73	<0.01	0.002
at National		1800	0.39	<0.01	0.02	0.31	<0.01	0.007
Canyon		2400	0.36	<0.01	<0.02	0.41	<0.01	0.009
	6-19-91	0600	0.39	<0.01	0.02	0.44	<0.01	0.009
		1200	0.38	<0.01	<0.02	0.47	<0.01	0.009
		1800	0.35	<0.01	0.03	0.41	0.01	0.009
		2400	0.37	<0.01	0.03	0.81	<0.01	0.017
	6-20-91	0600	0.36	<0.01	0.02	0.49	<0.01	0.013
Colorado River	6-18-91	1200	0.38	<0.01	<0.02	0.48	0.01	0.004
above		1800	0.38	<0.01	<0.02	0.46	<0.01	0.011
Diamond Creek		2400	0.14	<0.01	<0.02	0.53	<0.01	0.005
	6-19-91	0600	0.38	<0.01	0.02	0.44	<0.01	0.012
		1200	–	–	–	0.46	–	0.056
		1800	0.37	<0.01	0.02	0.47	<0.01	0.034
		2400	0.36	<0.01	0.02	0.51	<0.01	0.041
	6-20-91	0600	0.52	<0.01	<0.02	0.53	0.01	0.005
Diamond Creek	6-18-91	1200	0.35	<0.01	<0.02	0.32	<0.01	0.003
near mouth		1800	0.34	<0.01	<0.02	0.35	<0.01	0.002
		2400	0.45	<0.01	<0.02	0.34	<0.01	0.005
	6-19-91	0600	0.42	<0.01	<0.02	0.48	<0.01	0.009
Diamond Creek		1200	–	–	–	0.37	–	<0.001
near mouth		1800	0.39	<0.01	<0.02	0.52	<0.01	<0.001
(Cont.)		2400	0.44	<0.01	<0.02	0.60	<0.01	0.002
	6-20-91	0600	0.42	<0.01	<0.02	0.44	<0.01	0.001

Table 8.--Dissolved nutrient concentrations for the June 1991 synoptic study--Continued

Site Name	Date	Time	NO_3 (mg N/L)	NO_2 (mg N/L)	NH_4 (mg N/L)	Tot. N (mg N/L)	PO_4 (mg P/L)	Tot. P (mg P/L)
Colorado River	6-18-91	1200	0.49	<0.01	0.02	0.45	<0.01	0.025
near Travertine		1800	0.37	<0.01	0.02	0.54	<0.01	0.010
Cleft		2400	0.38	<0.01	0.02	0.50	<0.01	0.007
	6-19-91	0600	0.38	<0.01	0.02	0.47	<0.01	0.006
		1200	0.35	<0.01	0.02	0.41	<0.01	0.019
		1800	0.36	<0.01	0.02	0.48	<0.01	0.017
		2400	0.36	<0.01	0.03	0.56	<0.01	0.007
	6-20-91	0600	0.34	<0.01	0.02	0.33	<0.01	0.006

Table 9.—Major constituent concentrations for the November 1990 synoptic study

[*, Slightly impacted by sediment contributions and is accurate to about ±10-20%; ‡, moderately impacted by sediment contributions and is accurate to about ±50%; –, not determined; Ca, calcium; Cl, chloride; Mg, magnesium; K, potassium; SiO_2, silica as silicon dioxide; Na, sodium; SO_4, sulfate; all units in milligrams per Liter]

Site	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Colorado River below Glen Canyon Dam	11-5-90	0600	61	43.6	23	3.4	7.64	59	217
		1200	66	45.6	25	3.6	8.30	67	221
		1800	63	46.3	24	3.7	8.04	61	228
		2400	71	46.2	26	3.6	8.39	70	228
	11-6-90	0600	72	45.4	27	3.7	8.56	71	230
		1200	66	49.1	25	3.1	7.68	67	235
		1800	65	47.5	24	3.7	7.86	67	231
		2400	80	47.4	27	3.4	9.31	80	232
Colorado River at Lees Ferry	11-5-90	0600	67	44.3	24	3.2	8.20	65	223
		1200	79	44.5	27	3.3	9.49	80	228
		1800	82	46.2	30	3.3	9.61	91	231
		2400	66	47.5	24	3.6	7.66	66	234
	11-6-90	0600	80	47.1	29	3.3	9.34	86	231
		1200	53	47.5	20	3.5	6.88	52	231
		1800	79	46.4	26	3.0	9.27	81	229
		2400	68	48.5	25	3.1	7.80	68	232
Paria River near mouth	11-5-90	0600	76	13.8	38*	4.0	10.6	62	345
		1200	93	13.7	42*	4.5	15‡	72	344
		1800	85	14.1	42*	4.2	11.7	70	368
		2400	88	13.9	42	4.5	11.5	76	374
	11-6-90	0600	80	13.9	37*	4.7	10.2	71	380
		1200	85	13.8	39*	4.4	12‡	73	355
		1800	89	14.3	42*	4.5	15‡	75	383
		2400	77	13.8	40	4.6	10.1	68	373
Colorado River above Little Colorado River	11-5-90	0600	85	51.2	30	3.5	9.44	91	227
		1200	63	51.5	23	3.5	7.67	62	227
		1800	74	53.3	25	3.4	8.30	76	235
		2400	80	53.3	29	3.4	8.72	89	233
	11-6-90	0600	75	56.7	24	3.7	8.33	78	238
		1200	84	54.8	27	3.4	9.02	86	228
		1800	81	51.6	29	3.5	9.2‡	87	233
		2400	64	50.3	23	3.4	7.40	66	230
Little Colorado River near mouth	11-5-90	0600	83	1,250	59	6.2	15.6	780	179
		1200	79	1,250	67	6.2	15.1	770	180
		1800	84	1,260	70	6.2	15.6	760	172
		2400	132	1,160	–	–	–	–	170
	11-6-90	0600	159	680	38	4.7	10.0	470	243
		1200	146	600	37	4.8	9.9	440	194
		1800	132	630	34	4.7	9.5	410	165
		2400	139	690	37	4.8	10.1	450	161
Colorado River at Grand Canyon	11-5-90	0600	66	77.4	25	3.5	8.98	80	228
		1200	77	79.0	28	3.4	8.38	97	227
		1800	–	84.1	–	3.6	–	–	233
		2400	57	93.6	22	3.6	6.86	74	234
	11-6-90	0600	90	102	30	3.7	10.8*	137	230
		1200	85	132	29	3.5	9.84	148	228
		1800	94	141	27	3.6	9.57*	158	226
		2400	–	81.7	–	3.8	–	–	221

Table 9.–Major constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Bright Angel Creek near mouth	11-5-90	0600	–	–	–	–	–	–	–
		1200	–	–	–	–	–	–	–
		1800	–	–	–	–	–	–	–
		2400	–	–	–	–	–	–	–
	11-6-90	0600	–	–	–	–	–	–	–
		1200	–	–	–	–	–	–	–
		1800	–	–	–	–	–	–	–
		2400	–	–	–	–	–	–	–
Colorado River above Kanab Creek	11-5-90	0600	73	80.5	27	3.6	9.5‡	87	224
		1200	62	90.8	24	3.4	7.57¥	83	227
		1800	69	92.7	27	3.7	7.92¥	94	226
		2400	78	86.7	29	3.7	8.65	105	227
	11-6-90	0600	64	80.4	25	3.6	7.99	80	219
		1200	74	83.1	28	3.5	8.51	94	224
		1800	63	85.0	24	3.5	7.57	82	215
		2400	83	89.9	30	3.7	9.67	119	222
Kanab Creek near mouth	11-5-90	0600	129	17.7	65	5.2	8.7	29	533
		1200	138	17.9	70	5.5	9.4	32	545
		1800	148	18.0	74	5.6	9.9	33	532
		2400	140	18.0	70	5.7	9.3	32	550
	11-6-90	0600	149	18.0	75	5.7	9.7	34	562
		1200	145	17.8	73	5.8	9.4	33	541
		1800	136	17.8	69	5.7	9.1	31	548
		2400	137	17.4	69	5.8	9.0	31	548
Colorado River above Havasu Creek	11-5-90	0600	86	78.5	28	3.6	9.75¥	109	231
		1200	80	84.3	29	3.3	12.‡	105	227
		1800	73	90.1	28	3.4	8.64¥	104	220
		2400	–	88.1	–	3.4	–	–	218
	11-6-90	0600	51	84.4	20	3.5	5.8‡	62	224
		1200	70	82.8	25	3.3	10.‡	82	226
		1800	74	83.1	27	3.5	8.8‡	92	223
		2400	67	90.7	25	3.4	8.1‡	84	219
Havasu Creek near mouth	11-5-90	0600	52	46.0	46	4.4	18	33	44
		1200	56	47.8	48	4.2	19	36	46
		1800	56	47.4	48	4.4	19	35	45
		2400	56	46.9	49	4.4	19	35	45
	11-6-90	0600	54	46.4	47	4.4	18	35	44
		1200	58	46.2	49	4.5	19	36	44
		1800	59	47.3	49	4.4	19	36	45
		2400	55	47.8	–	–	–	–	45
Colorado River at National Canyon	11-5-90	0600	72	70.4	26	3.8	8.6‡	87	215
		1200	71	72.3	26	3.6	8.44	83	217
		1800	–	–	–	–	–	–	–
		2400	60	86.2	23	3.4	7.4‡	76	221
	11-6-90	0600	–	–	–	–	–	–	–
		1200	75	87.6	28	3.5	8.74	103	213
		1800	81	82.0	31	3.5	9.60	114	209
		2400	50	82.1	20	3.6	6.70	60	219
Colorado River above Diamond Creek	11-5-90	0600	74	78.7	28	3.7	8.4‡	94	217
		1200	51	83.8	20	3.5	6.69	62	214
		1800	69	94.4	27	3.5	7.92	92	217
		2400	51	85.6	20	3.4	4.1‡	60	217
	11-6-90	0600	74	88.3	28	3.6	9.0‡	100	212
		1200	69	96.6	26	3.6	6.8‡	98	214
		1800	74	88.6	28	3.5	8.52	97	221
		2400	71	76.1	26	3.6	8.14	88	220

Table 9.–Major constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Diamond Creek near mouth	11-5-90	0600	–	49.0	–	–	–	–	28
		1200	–	47.3	–	–	–	–	27
		1800	36	48.2	38	4.3	23	70	28
		2400	–	–	–	–	–	–	–
	11-6-90	0600	38	48.3	37	4.4	23	68	28
		1200	37	47.8	38	4.6	24	71	28
		1800	35	48.4	37	4.0	23	68	27
		2400	–	–	–	–	–	–	–
Colorado River near Columbine Falls	11-5-90	0600	76	88.5	29	3.8	8.9‡	102	221
		1200	66	92.5	25	3.6	6.8‡	85	223
		1800	49	95.9	19	3.8	6.0‡	63	222
		2400	63	85.8	25	3.6	7.6‡	73	223
	11-6-90	0600	71	75.5	27	3.8	8.24¥	89	219
		1200	76	79.1	28	3.7	8.4‡	94	222
		1800	81	89.0	29	3.4	9.55	107	225
		2400	59	91.4	23	3.5	7.69	78	223

Table 10.—Major constituent concentrations for the June 1991 synoptic study

[¥, Slightly impacted by sediment contributions and is accurate to about ±10-20%; ‡, moderately impacted by sediment contributions and is accurate to about ±50%; –, not determined; Ca, calcium; Cl, chloride; Mg, magnesium; K, potassium; SiO_2, silica as silicon dioxide; Na, sodium; SO_4, sulfate; all concentrations in milligrams per Liter]

Site Name	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Colorado River at Glen Canyon Dam	6-18-91	1200	76	57.4	28	3.6	7.8	82	246
		1800	76	57.6	28	3.6	7.7	83	248
		2400	75	56.4	28	3.7	7.8	81	246
	6-19-91	0600	73	56.9	27	3.6	7.6	79	250
		1200	76	59.2	28	3.6	7.6	82	254
		1800	75	58.8	28	3.7	7.7	81	254
		2400	74	54.1	28	3.8	7.7	80	240
	6-20-91	0600	76	58.0	28	4.0	7.9	83	252
Colorado River at Lees Ferry	6-18-91	1200	75	58.1	27	3.7	7.5	82	250
		1800	75	57.3	28	3.6	7.6	81	244
		2400	76	57.7	28	3.7	7.7	81	246
	6-19-91	0600	73	59.0	27	3.6	7.5	79	254
		1200	73	56.7	27	3.7	7.4	79	249
		1800	74	58.4	28	3.7	7.5	80	252
		2400	74	55.3	28	3.7	7.6	79	240
	6-20-91	0600	74	57.0	28	3.7	7.5	80	250
Paria River near mouth	6-18-91	1200	39	11.2	22	3.4	8.5‡	31	128
		1800	38	11.1	22	3.6	8.9	32	125
		2400	38	11.2	22	3.3	8.3‡	32	130
	6-19-91	0600	40	11.2	22	3.1	7.8¥	31	130
		1200	–	11.3	–	–	–	–	127
		1800	38	11.9	22	3.6	8.3‡	33	134
		2400	39	11.7	23	3.3	8.3	34	136
	6-20-91	0600	39	11.4	22	3.2	7.9	32	133
Colorado River above Little Colorado River	6-18-91	1200	74	58.3	27	4.2	7.5	79	249
		1800	74	60.8	27	4.0	7.5	81	253
		2400	76	62.7	28	4.3	7.6	82	256
	6-19-91	0600	75	62.0	28	3.5	7.6	82	258
		1200	75	61.2	27	4.2	7.3¥	82	257
		1800	76	61.9	28	4.0	7.4¥	81	257
		2400	76	62.2	28	3.7	7.6	83	256
	6-20-91	0600	75	61.2	28	3.7	7.4	81	256
Little Colorado River near mouth	6-18-91	1200	93	1,290	64	6.2	14.9	750	174
		1800	90	1,310	60	6.8	14.9	740	179
		2400	92	1,320	65	6.0	15.1	760	174
	6-19-91	0600	101	1,310	61	6.2	14.6	740	177
		1200	94	1,300	65	6.1	14.9	740	180
		1800	93	1,300	66	3.2	15.3	770	179
		2400	98	1,260	65	6.2	15.5	760	183
	6-20-91	0600	–	–	–	–	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	75	68.6	28	3.9	7.6	87	252
		1800	74	70.2	28	3.6	7.5	85	253
		2400	75	72.0	28	3.6	7.6	88	256
	6-19-91	0600	76	89.7	29	3.8	7.8	97	257
		1200	77	70.5	29	3.9	7.8	88	253
		1800	76	74.3	28	3.8	7.6	88	267
		2400	74	71.9	28	3.8	7.5	86	249
	6-20-91	0600	76	95.0	29	4.4	7.8	98	261

Table 10.–Major constituent concentrations for the June 1991 synoptic study–Continued

Site Name	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Bright Angel Creek near mouth	6-18-91	1200	36	2.41	18	0.8	5.0	2.6	5.9
		1800	36	2.32	18	1.0	5.0	2.6	5.7
		2400	37	2.50	18	0.9	5.1	2.6	6.1
	6-19-91	0600	39	2.48	19	0.9	5.7	2.9	5.9
		1200	37	2.56	18	0.8	5.1	2.7	5.7
		1800	35	2.56	21	0.9	5.2	3.2	5.7
		2400	38	2.58	19	0.8	5.5	2.8	5.6
	6-20-91	0600	39	2.67	19	0.8	5.4	2.7	5.7
Colorado River above Kanab Creek	6-18-91	1200	76	100	30	3.7	7.5	98	255
		1800	76	76.0	30	3.8	7.8¥	93	257
		2400	77	79.1	29	3.9	7.8¥	97	248
	6-19-91	0600	76	70.2	29	4.3	8.0	90	254
		1200	78	68.6	29	3.8	7.1¥	88	253
		1800	76	68.0	29	3.7	8.1¥	92	247
		2400	76	82.7	30	4.2	8.0¥	98	254
	6-20-91	0600	75	71.1	29	3.6	8.0¥	90	256
Kanab Creek near mouth	6-18-91	1200	135	19.3	72	6.2	7.8	34	579
		1800	126	18.3	70	6.4	7.3	33	563
		2400	138	18.1	66	6.1	6.8	34	541
	6-19-91	0600	117	18.4	61	6.5	5.4	29	542
		1200	138	18.6	75	6.9	7.4	36	541
		1800	131	18.7	70	6.8	7.3	34	549
		2400	129	18.8	68	6.5	6.7	33	542
	6-20-91	0600	138	18.4	75	6.1	7.4	36	558
Havasu Creek near mouth	6-18-91	1200	49	47.4	42	4.8	18	34	35
		1800	45	47.5	40	4.8	17	32	35
		2400	46	46.8	38	4.7	16	31	35
	6-19-91	0600	56	47.1	44	4.6	18	35	35
		1200	52	48.0	44	4.6	19	36	35
		1800	47	47.6	41	4.7	17	33	35
		2400	46	47.9	37	4.5	13	30	35
	6-20-91	0600	49	48.8	39	4.5	16	31	36
Colorado River at National Canyon	6-18-91	1200	77	82	30	4.0	8.2	94	260
		1800	76	93	31	4.3	9.6	98	258
		2400	57	77	26	4.0	5.3	72	256
	6-19-91	0600	79	85	30	4.1	8.1	96	253
		1200	80	78	31	4.1	8.1	97	258
		1800	78	71	30	4.1	8.2	94	258
		2400	78	70	30	3.9	8.1	95	257
	6-20-91	0600	79	84	30	3.9	8.5	101	257
Colorado River above Diamond Creek	6-18-91	1200	77	70.8	29	4.7	8.5¥	89	248
		1800	77	71.1	30	5.1	8.4	93	246
		2400	79	76.0	30	4.5	8.1	94	245
	6-19-91	0600	79	79.0	30	4.2	8.4	93	243
		1200	80	81.9	31	5.7	8.4	104	243
		1800	78	92.7	30	16.0	8.3	102	243
		2400	72	76.6	30	6.1	7.7	94	252
	6-20-91	0600	77	83.6	30	7.8	8.0	96	251
Diamond Creek near mouth	6-18-91	1200	30	55.5	32	5.2	22	76	33
		1800	34	57.9	35	5.4	22	80	35
		2400	39	58.5	38	5.3	26	89	36
	6-19-91	0600	37	56.3	35	5.1	23	83	34
		1200	31	–	35	5.2	24	83	–
		1800	32	57.5	33	5.5	23	79	35
		2400	37	56.4	35	5.4	23	80	34
	6-20-91	0600	34	55.4	31	5.3	20	72	33
Colorado River near Travertine Cleft	6-18-91	1200	81	85	31	4.2	7.6	107	251
		1800	77	76	30	3.9	8.4¥	95	245

Table 10.—Major constituent concentrations for the June 1991 synoptic study—Continued

Site Name	Date	Time	Ca	Cl	Mg	K	SiO_2	Na	SO_4
Colorado River near		2400	75	72	30	3.8	8.3	91	252
Travertine Cleft (Cont.)	6-19-91	0600	77	73	30	4.0	8.5*	94	255
		1200	74	78	30	3.9	7.8	94	242
		1800	55	83	20	3.8	5.‡	74	258
		2400	79	87	30	4.2	8.0	98	258
	6-20-91	0600	76	94	30	4.1	7.9*	106	258

Table 11.—Trace constituent concentrations for the November 1990 synoptic study

[§, Not reported due to filtration artifacts; –, not determined; ICP-MS, inductively coupled plasma- mass spectrometry; ICP-AES, inductively coupled plasma-atomic emission spectrometry; all concentrations are micrograms per Liter except iron which is milligrams per Liter; † Severely impacted by sediment contributions and should be considered an approximate value only (± 100-200%). ‡ Moderately impacted by sediment contributions and is accurate to about ± 50%.; * Slightly impacted by sediment contributions and is accurate to about ±10-20%]

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Colorado River below Glen	11/5/90	0600	1.8	0.21	1.39	94	96	< 0.02
Canyon Dam		1200	0.9	0.23	1.71	90	95	< 0.02
		1800	1.7	0.21	1.62	95	102	< 0.02
		2400	0.9	0.22	1.62	92	99	< 0.02
	11/6/90	0600	1.1	0.24	1.61	93	101	< 0.02
		1200	3.1	0.26	1.63	98	99	< 0.02
		1800	0.7	0.25	1.69	98	100	< 0.02
		2400	0.7	0.23	1.58	93	98	< 0.02
Colorado River at Lees	11/5/90	0600	5.8	0.21	1.69	93	103	< 0.02
Ferry		1200	12.1	0.21	1.60	92	103	< 0.02
		1800	8.3	0.21	1.67	93	101	< 0.02
		2400	4.1	0.22	1.54	92	98	< 0.02
	11/6/90	0600	21.3	0.23	1.59	97	98	< 0.02
		1200	18.6	0.21	1.71	97	101	< 0.02
		1800	5.2	0.23	1.66	96	100	< 0.02
		2400	9.8	0.22	1.78	99	108	< 0.02
Paria River near mouth	11/5/90	0600	§	0.06	1.9*	103	71*	< 0.02
		1200	§	0.053	2.0*	102	65*	< 0.02
		1800	§	0.062	2.2‡	103	77*	< 0.02
		2400	12	0.070	2.3	107	75	< 0.02
	11/6/90	0600	§	0.053	2.3*	108	75*	< 0.02
		1200	§	0.042	2.0‡	110	67*	< 0.02
		1800	§	0.041	2.1	110	75‡	< 0.02
		2400	4.6	0.05	2.0	107	69	< 0.02
Colorado River above	11/5/90	0600	7.4	0.22	1.96	103	103	< 0.02
Little Colorado River		1200	7.2	0.22	1.88	100	99	< 0.02
		1800	5.6	0.19	1.81	98	106	< 0.02
		2400	5.3	0.20	1.77	92	99	< 0.02
	11/6/90	0600	§	0.22	1.95	104	102	< 0.02
		1200	11.4	0.21	2.02	108	102	< 0.02
		1800	§	0.22	1.91	101	102	< 0.02
		2400	§	0.20	1.73	96	102	< 0.02
Little Colorado River near	11/5/90	0600	< 40†	0.21	8.2	382	115	< 0.02
mouth		1200	< 40	0.03	7.5	367	97	< 0.02
		1800	< 40†	0.052	7.8	362	95	< 0.02
		2400	100†	0.11	4.5	384	191	< 0.02
	11/6/90	0600	< 40	0.20	1.9	231	364	< 0.02
		1200	< 40	0.22	2.1	197	326	< 0.02
		1800	< 40	0.22	2.1	238	267	< 0.02
		2400	< 40	0.17	2.1	262	251	< 0.02

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Colorado River at Grand Canyon	11/5/90	0600	9.3	0.22	1.95	118	98	< 0.02
		1200	2.5	0.20	2.13	121	98	< 0.02
		1800	–	–	–	–	–	–
		2400	§	0.22	2.24	118	100	< 0.02
	11/6/90	0600	§	0.21	2.46	125	103	< 0.02
		1200	6.5	0.20	2.30	126	94	< 0.02
		1800	§	0.20	1.58	140	145	< 0.02
		2400	–	–	–	–	–	–
Colorado River above Kanab Creek	11/5/90	0600	§	0.21	2.03 ¥	115	109	< 0.02 †
		1200	§	0.20	1.98	116	98	< 0.02
		1800	§	0.21	1.91	114	101	< 0.02
		2400	3.0	0.20	1.97	113	100	< 0.02
	11/6/90	0600	9.0	0.19	1.99	114	101	< 0.02
		1200	3.7	0.19	1.95	115	98	< 0.02
		1800	9.8	0.20	2.23	118	103	< 0.02
		2400	8.2	0.21	2.08	125	98	< 0.02
Kanab Creek near mouth	11/5/90	0600	3.8	0.04	1.50	114	38.8	< 0.02
		1200	2.5	0.04	1.62	115	38.0	< 0.02
		1800	5.1	0.04	1.50	117	37.8	< 0.02
		2400	2.2	0.03	1.50	117	37.3	< 0.02
	11/6/90	0600	4.7	0.05	1.45	113	36.7	< 0.02
		1200	1.8	0.04	1.54	113	36.3	< 0.02
		1800	6.3	0.04	1.52	117	37.7	< 0.02
		2400	6.8	0.04	1.49	117	38.6	< 0.02
Colorado River above Havasu Creek	11/5/90	0600	§	0.19	2.10	114	105	< 0.02
		1200	§	0.19	2.10 ¥	115	105	< 0.02
		1800	§	0.19	2.07	116	102	< 0.02
		2400	–	–	–	–	–	–
	11/6/90	0600	§	0.20	1.92	110	100	< 0.02
		1200	§	0.20 ¥	2.05 ¥	114	111	< 0.02 †
		1800	§	0.21	2.07	116	103	< 0.02 ¥
		2400	§	0.20	2.21 ¥	125	105	< 0.02 †
Havasu Creek near mouth	11/5/90	0600	1.00	0.019	11.8	355	115	< 0.02
		1200	3.1	0.021	11.8	347	110	< 0.02
		1800	1.26	0.025	12.0	298	114	< 0.02
		2400	1.12	0.022	11.9	316	112	< 0.02
	11/6/90	0600	1.22	0.026	12.0	299	111	< 0.02
		1200	0.84	0.023	11.4	296	111	< 0.02
		1800	2.5	0.027	11.6	299	112	< 0.02
		2400	1.06	0.029	11.2	295	113	< 0.02
Colorado River at National Canyon	11/5/90	0600	§	0.21	2.16	118	108	< 0.02
		1200	10.9	0.20	2.14	114	101	< 0.02
		1800	–	–	–	–	–	–
		2400	§	0.20	2.16	112	104	< 0.02
	11/6/90	0600	–	–	–	–	–	–
		1200	7.3	0.20	2.30	119	101	< 0.02
		1800	18.9	0.19	2.09	120	101	< 0.02
		2400	1.8	0.23	2.15	116	103	< 0.02
Colorado River above Diamond Creek	11/5/90	0600	§	0.21	2.12 ¥	121	113	< 0.02 ¥
		1200	9.3	0.18	2.14	128	108	< 0.02
		1800	12.7	0.19	2.09	124	110	< 0.02
		2400	§	0.21 ¥	2.11 ¥	127	112	0.03 †
	11/6/90	0600	§	0.20	2.25	135	109	< 0.02 ¥
		1200	§	0.21 ¥	2.26 ¥	135	114	< 0.02 †
		1800	17.1	0.21	2.11	135	102	< 0.02
		2400	4.2	0.21	2.16	128	102	< 0.02

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Diamond Creek near mouth	11/5/90	0600	–	–	–	–	–	–
		1200	–	–	–	–	–	–
		1800	40 †	0.07	13.9	506	89	< 0.02
		2400	–	–	–	–	–	–
	11/6/90	0600	12	0.06	14.3	508	90	< 0.02
		1200	§	0.06	14.7	514	87	< 0.02
		1800	9.7	0.05	13.8	511	85	< 0.02
		2400	–	–	–	–	–	–
Colorado River near Columbine Falls	11/5/90	0600	§	0.21	2.07 ¥	137	119	< 0.02 †
		1200	§	0.22	2.07 ¥	128	118	0.01 †
		1800	§	0.24	2.15	128	111	< 0.02
		2400	§	0.21	2.10 ¥	127	117	< 0.02 †
	11/6/90	0600	§	0.22	2.00	121	112	< 0.02
		1200	§	0.22	1.88	123	113	< 0.02 ¥
		1800	§	0.24	2.17	131	109	< 0.02
		2400	§	0.26	2.08	121	118	< 0.02

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Colorado River below Glen Canyon Dam	11/5/90	0600	< 0.02	0.65	< 0.1	0.95	< 0.007	31.1
		1200	< 0.02	0.46	< 0.1	0.84	< 0.007	31.5
		1800	< 0.02	0.48	< 0.1	0.97	< 0.007	33.0
		2400	< 0.02	0.40	< 0.1	1.00	< 0.007	31.7
	11/6/90	0600	< 0.02	0.53	< 0.1	1.26	< 0.007	31.7
		1200	< 0.02	0.43	< 0.1	1.31	< 0.007	33.3
		1800	< 0.02	0.49	< 0.1	1.20	< 0.007	34.1
		2400	< 0.02	0.33	< 0.1	1.23	< 0.007	32.6
Colorado River at Lees Ferry	11/5/90	0600	0.02	0.58	< 0.1	1.62	< 0.007	33.8
		1200	< 0.02	0.55	< 0.1	1.39	0.009	30.8
		1800	0.03	0.60	< 0.1	1.27	0.012	32.5
		2400	< 0.02	0.55	< 0.1	1.14	< 0.007	31.6
	11/6/90	0600	0.03	0.48	< 0.1	1.48	0.01 ‡	32.9
		1200	0.07	0.60	< 0.1	1.21	< 0.01	33.0
		1800	0.03	0.58	< 0.1	1.30	< 0.007	33.3
		2400	< 0.02	0.50	< 0.1	1.09	0.007	34.4
Paria River near mouth	11/5/90	0600	< 0.007	< 0.3	< 0.02	0.4 ‡	0.02 ‡	35.2 ¥
		1200	< 0.007 ‡	< 0.3	0.02 †	0.7 ‡	1 †	33.6 ¥
		1800	0.01 †	< 0.3	< 0.02 †	0.6 †	0.2 †	34.1 ¥
		2400	0.019	< 0.3	< 0.02	0.31	0.125	34.1
	11/6/90	0600	0.035 ‡	< 0.3	< 0.02 †	0.3 †	< 0.005	35.7 ¥
		1200	0.01 †	< 0.3	< 0.02 †	0.3 †	0.4 †	34.6 ¥
		1800	0.02 †	< 0.3	0.1 †	0.7 †	1 †	35.6 ‡
		2400	0.024	< 0.3	< 0.02	0.31	0.011	35.8
Colorado River above Little Colorado River	11/5/90	0600	< 0.02	0.57	< 0.1	1.33	0.011	40.6
		1200	< 0.02	0.58	< 0.1	1.64	< 0.007	38.8
		1800	< 0.02	0.57	< 0.1	2.24	0.010	37.7
		2400	< 0.02	0.60	< 0.1	1.01	0.009	36.8
	11/6/90	0600	< 0.02	0.57	< 0.1	1.07	0.01 ‡	41.6
		1200	< 0.02	0.51	< 0.1	1.24	0.013	45.2
		1800	< 0.02	0.62 ¥	< 0.1	1.52 ¥	0.04 †	39.3
		2400	< 0.02	0.55	< 0.1	1.37	0.01 ‡	35.7

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Little Colorado River near mouth	11/5/90	0600	< 0.02	0.6	< 0.1 †	1.00	< 0.005 †	171
		1200	< 0.02	< 0.6	< 0.1	< 0.2	0.048 ‡	160
		1800	< 0.02	< 0.6	< 0.1	< 0.2	< 0.005	162
		2400	< 0.02	< 0.6	< 0.1 †	0.18	–	165
	11/6/90	0600	< 0.02	< 0.6	< 0.1	1.86	< 0.005	54
		1200	< 0.02	1.2	< 0.1	1.59	< 0.005	54
		1800	< 0.02	0.8	< 0.1	1.47	< 0.005	69
		2400	< 0.02	< 0.6	< 0.1	1.39	< 0.005	77
Colorado River at Grand Canyon	11/5/90	0600	< 0.02	0.52	< 0.1	1.41	< 0.007	43.5
		1200	< 0.02	0.55	< 0.1	0.99	< 0.008	47.4
		1800	–	–	–	–	–	–
		2400	< 0.02	0.65	< 0.1	0.94	< 0.01 †	49.8
	11/6/90	0600	< 0.02	0.52 ¥	< 0.1	2.44	0.02 †	52.4
		1200	< 0.02	0.45	< 0.1	1.40	< 0.007	48.8
		1800	< 0.02	0.41 ¥	< 0.1	1.35	0.02 †	52.8
		2400	–	–	–	–	–	–
Colorado River above Kanab Creek	11/5/90	0600	0.03	0.5 ‡	< 0.2 †	1.7 ‡	0.05 †	45.6
		1200	0.17	0.53 ¥	< 0.1	1.32	< 0.01 †	43.6
		1800	0.03	0.43	< 0.1	1.20	< 0.01 †	44.9
		2400	< 0.02	0.43	< 0.1	1.05	< 0.007	43.9
	11/6/90	0600	< 0.02	0.45	< 0.1	1.14	< 0.007	44.9
		1200	< 0.02	0.46	< 0.1	1.04	< 0.007	46.4
		1800	< 0.02	0.57	< 0.1	1.00	< 0.007	49.1
		2400	0.03	0.47	< 0.1	1.29	< 0.007	49.9
Kanab Creek near mouth	11/5/90	0600	0.015	< 0.2	< 0.1	0.21	0.013	31
		1200	0.014	< 0.2	< 0.1	0.25	0.012	31
		1800	< 0.01	< 0.2	< 0.1	0.25	0.009	31
		2400	< 0.01	< 0.2	< 0.1	0.19	0.011	31
	11/6/90	0600	0.018	< 0.2	< 0.1	0.25	0.011	30
		1200	0.021	< 0.2	< 0.1	0.26	0.008	31
		1800	0.019	< 0.2	< 0.1	0.28	0.018	30
		2400	0.018	< 0.2	< 0.1	0.29	0.013	31
Colorado River above Havasu Creek	11/5/90	0600	< 0.02	0.54	< 0.1	1.09	0.009 †	47.7
		1200	< 0.02	0.7 ‡	< 0.2	0.98 ¥	0.04 †	45.7
		1800	< 0.02	0.68	< 0.1	1.09	0.01 †	45.3
		2400	–	–	–	–	–	–
	11/6/90	0600	< 0.02	0.6 ‡	< 0.1	1.20 ¥	< 0.06 †	43.0
		1200	< 0.02	< 0.3 †	< 0.1 †	1.6 ‡	0.3 †	47.4
		1800	< 0.02	0.5 ‡	< 0.1	1.19 ¥	0.03 †	47.0
		2400	< 0.02	0.6 ‡	< 0.2 †	1.3 ‡	0.02 †	51.8
Havasu Creek near mouth	11/5/90	0600	< 0.006	< 0.9	< 0.05	< 0.03	0.009	155
		1200	< 0.006	< 0.9	< 0.05	< 0.03	< 0.005	136
		1800	< 0.006	< 0.9	< 0.05	< 0.03	< 0.005	125
		2400	< 0.006	< 0.9	< 0.05	< 0.03	0.007	138
	11/6/90	0600	< 0.006	< 0.9	< 0.05	< 0.03	< 0.005	137
		1200	< 0.006	< 0.9	< 0.05	< 0.03	< 0.005	133
		1800	< 0.006	< 0.9	< 0.05	< 0.03	< 0.005	129
		2400	< 0.006	< 0.9	< 0.05	0.06	–	128
Colorado River at National Canyon	11/5/90	0600	< 0.02	1.6 ‡	< 0.1	1.28 ¥	< 0.03 †	47.2
		1200	< 0.02	1.14	< 0.1	1.16	< 0.01	46.3
		1800	–	–	–	–	–	–
		2400	< 0.02	0.60 ¥	< 0.1	1.02	< 0.01 †	44.5
	11/6/90	0600	–	–	–	–	–	–
		1200	< 0.02	0.68	< 0.1	1.27	< 0.008	46.6
		1800	< 0.02	0.54	< 0.1	0.80	0.01 ‡	46.6
		2400	< 0.02	0.46	< 0.1	1.00	< 0.007	45.9

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Colorado River above Diamond Creek	11/5/90	0600	< 0.02	0.5 †	< 0.2	1.27 ¥	0.04 †	48.8
		1200	< 0.02	0.58	< 0.1	0.86	< 0.007	50.1
		1800	< 0.02	0.51	< 0.1	0.94	< 0.01	48.7
		2400	< 0.02	0.6 †	< 0.2 †	1.2 ‡	< 0.2 †	50.0
	11/6/90	0600	< 0.02	0.5 ‡	< 0.1	1.16 ¥	0.04 †	52.9
		1200	< 0.02	0.7 †	< 0.2 †	1.2 ‡	0.04 †	55.5
		1800	< 0.02	0.47	< 0.1	0.99	0.008 ‡	53.7
		2400	< 0.02	0.51	< 0.1	0.68	< 0.008	49.9
Diamond Creek near mouth	11/5/90	0600	–	–	–	–	–	–
		1200	–	–	–	–	–	–
		1800	0.022 ‡	< 0.2	0.02 ‡	< 0.03	< 0.005	89
		2400	–	–	–	–	–	–
	11/6/90	0600	< 0.01	< 0.2	< 0.01	< 0.03	0.009	91
		1200	0.01 †	0.71	< 0.02	< 0.03	0.06 †	91
		1800	< 0.01	0.62	< 0.01	< 0.03	< 0.005	90
		2400	–	–	–	–	–	–
Colorado River near Columbine Falls	11/5/90	0600	< 0.02	0.7 ‡	< 0.2	1.21 ¥	0.04 †	55.6
		1200	< 0.02	0.6 ‡	< 0.1 †	1.1 ‡	< 0.1 †	52.2
		1800	< 0.02	0.57 ¥	< 0.1	0.89	< 0.03 †	53.0
		2400	< 0.02	0.5 †	< 0.2 †	1.1 ‡	0.1 †	52.2
	11/6/90	0600	< 0.02	0.48	< 0.1	1.05	0.007 †	48.8
		1200	< 0.02	0.58 ¥	< 0.1	0.98 ¥	< 0.02 †	51.0
		1800	< 0.02	0.65	< 0.1	0.88	0.009 †	51.8
		2400	< 0.02	0.60	< 0.1	0.83	< 0.01 †	48.4

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Colorado River below Glen Canyon Dam	11/5/90	0600	0.05	0.54	4.35	< 1	1.41	2.8
		1200	0.03	0.41	4.49	< 1	1.50	2.2
		1800	0.04	0.48	4.70	< 1	1.54	3.0
		2400	0.04	0.53	4.53	< 1	1.47	3.9
	11/6/90	0600	0.04	0.71	4.32	< 1	1.48	3.2
		1200	0.05	0.72	4.80	< 1	1.55	3.1
		1800	0.02	0.58	4.82	< 1	1.62	3.1
		2400	0.02	0.57	4.72	< 1	1.51	3.1
Colorado River at Lees Ferry	11/5/90	0600	0.09	1.72	4.61	< 1	1.58	2.8
		1200	0.08	1.55	4.62	< 1	1.54	3.0
		1800	0.06	1.13	4.51	< 1	1.54	3.3
		2400	0.03	0.79	4.54	< 1	1.48	3.5
	11/6/90	0600	0.14	1.29 ¥	4.51	< 1	1.54	3.2
		1200	0.09	1.33	4.55	< 1	1.57	3.3
		1800	0.08	0.96	4.66	< 1	1.60	4.2
		2400	0.05	0.97	4.53	< 0.1	1.63	3.7
Paria River near mouth	11/5/90	0600	0.1 †	7.6 ‡	1.60 ¥	< 1	1.5 ¥	0.85
		1200	0.1 †	7 †	1.47 ¥	< 1	1.5 ‡	0.97
		1800	0.1 †	6 †	1.48 ¥	< 1	1.5 ‡	0.99
		2400	< 0.04	7.1	1.52	< 1	1.5	0.92
	11/6/90	0600	0.1†	8 †	1.52 ¥	< 1	1.5 ‡	0.94
		1200	0.1†	7 †	1.42 ¥	< 1	1.3 †	0.88
		1800	0.4†	8 †	1.45 ¥	< 1	1.4 †	1.02
		2400	< 0.04	7.0	1.53	< 1	1.4	1.06

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Colorado River above	11/5/90	0600	2.65	3.26	4.78	3.8	2.35	2.3
Little Colorado River		1200	2.65	2.41	4.37	< 1	2.07	1.5
		1800	3.28	2.80	4.38	< 1	2.14	2.9
		2400	3.76	2.59	4.30	< 1	2.09	2.9
	11/6/90	0600	3.44	2.88 ¥	4.51	< 1	2.61	3.7
		1200	3.89	2.26	4.37	< 1	3.12	3.3
		1800	3.82	4.2 ‡	4.59	< 1	2.52 ¥	2.1
		2400	3.49	1.92 ¥	4.34	< 1	2.08	3.4
Little Colorado River near	11/5/90	0600	< 0.3 †	1 †	4 †	< 6	2.1 ‡	3.6 ‡
mouth		1200	2.9	1.60	1.67	< 6	15 ¥	4.7
		1800	2.0 ‡	1 †	1.7 ‡	< 6	13	4.1 ¥
		2400	0.3 †	33.5 ¥	3 †	< 6	1.1 ‡	4.0 ¥
	11/6/90	0600	< 0.3	0.51 ‡	4.06 ¥	< 6	0.83	2.2
		1200	< 0.3	0.46 ‡	4.49 ¥	< 6	0.75	2.4
		1800	< 0.3	0.59	3.87	< 6	0.88	2.6
		2400	< 0.3	0.59	3.36	< 6	0.95	3.8
Colorado River at Grand	11/5/90	0600	0.08	1.69	4.77	< 1	2.57	2.1
Canyon		1200	0.04	0.70	4.56	< 1	2.83	3.7
		1800	–	–	–	–	–	–
		2400	0.04	1.16 ¥	4.58	< 1	3.16	3.7
	11/6/90	0600	0.21 ¥	4.10 ¥	4.63	< 1	3.26	3.6
		1200	0.17	3.87	4.23	< 1	3.11	3.7
		1800	0.03 †	< 0.7 †	4.76	< 1	1.26 ¥	2.5
		2400	–	–	–	–	–	–
Colorado River above	11/5/90	0600	0.3 †	3 †	4.91 ¥	< 1	3.0 ‡	3.3
Kanab Creek		1200	0.03 ¥	0.4 †	4.66	< 1	2.62	3.0
		1800	0.02	0.5 ‡	4.40	< 1	2.63	3.3
		2400	0.02	0.50	4.61	< 1	2.48	2.7
	11/6/90	0600	0.02	0.92	4.45	< 1	2.47	2.2
		1200	0.01	0.78	4.35	< 1	2.57	1.7
		1800	0.04	1.05	4.38	< 1	2.71	2.6
		2400	0.03	1.29	4.40	< 1	2.92	2.3
Kanab Creek near mouth	11/5/90	0600	< 0.03	14.9	4.20	< 1	2.7	3.6
		1200	< 0.03	13.2	4.45	< 1	2.7	3.4
		1800	< 0.03	14.1	4.39	< 1	2.7	3.1
		2400	< 0.03	14.1	4.53	< 1	2.7	3.4
	11/6/90	0600	< 0.03	13.9	4.44	< 1	2.6	3.4
		1200	< 0.03	13.9	4.52	< 1	2.7	3.5
		1800	< 0.03	14.3	4.53	< 1	2.7	3.2
		2400	< 0.03	14.0	4.36	< 1	2.7	3.3
Colorado River above	11/5/90	0600	0.73	0.8 ‡	4.42	< 1	2.83	3.0
Havasu Creek		1200	< 0.06 †	< 2 †	5.03 ¥	< 1	2.8 ‡	2.6
		1800	0.01	0.4 ‡	4.88	< 1	2.66	3.2
		2400	–	–	–	–	–	–
	11/6/90	0600	0.02 †	1 †	4.59 ¥	< 1	2.6 ‡	2.6
		1200	0.1 †	6 †	4.9 ‡	< 1	3.1 ‡	2.9
		1800	< 0.02 †	1 †	4.70 ¥	< 1	2.7 ‡	3.5
		2400	0.04 †	4 †	4.72 ¥	< 1	3.3 ‡	3.2
Havasu Creek near mouth	11/5/90	0600	0.060	0.88	1.14	< 0.5	12.3	1.11
		1200	0.042	0.69	1.02	< 0.5	12.4	1.37
		1800	0.015	0.73	0.97	< 0.5	11.7	1.29
		2400	< 0.01	0.72	0.98	< 0.5	12.2	1.42
	11/6/90	0600	0.029	0.62	0.99	< 0.5	12.3	1.43
		1200	0.015	0.73	0.98	< 0.5	12.1	1.42
		1800	0.045	0.98	1.01	< 0.5	11.9	1.09
		2400	0.176	0.86	0.95	< 0.5	11.6	1.12

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Colorado River at National Canyon	11/5/90	0600	< 0.02 †	< 0.8 †	4.65 ¥	< 1	2.87 ¥	3.0
		1200	0.03	0.45	4.33	< 1	2.74	3.2
		1800	–	–	–	–	–	–
		2400	0.03 †	< 0.3 †	4.25	< 1	2.75 ¥	3.0
	11/6/90	0600	–	–	–	–	–	–
		1200	0.04	0.78	4.55	< 1	2.77	3.3
		1800	0.02	0.74 ¥	4.15	0.3	2.64	3.4
		2400	0.02	0.55	4.11	0.1	2.73	3.0
Colorado River above Diamond Creek	11/5/90	0600	0.07 †	< 0.3 †	4.28 ¥	< 1 ‡	2.8 ‡	3.5
		1200	0.03	0.59	4.29	< 0.1	2.69	3.6
		1800	0.06	0.45	4.33	0.2	2.66	3.4
		2400	< 0.02 †	< 0.6 †	4.5 ‡	0.2 †	2.8 ‡	3.5
	11/6/90	0600	< 0.02 †	< 0.9 †	4.34 ¥	< 1 ‡	2.7 ‡	3.3
		1200	< 0.02 †	< 2 †	4.5 ‡	0.4 †	3.1 ‡	3.0
		1800	0.03	0.53	4.23	0.2	2.60	1.8
		2400	0.02	0.51	4.20	0.2	2.56	3.4
Diamond Creek near mouth	11/5/90	0600	–	–	–	–	–	–
		1200	–	–	–	–	–	–
		1800	0.06 †	5.3	2.14	0.4	6.6	< 0.3
		2400	–	–	–	–	–	–
	11/6/90	0600	< 0.02	4.7	2.16	0.6	6.5	< 0.3
		1200	0.4 †	30 †	2.0 ‡	1 †	7.5 ‡	< 0.3
		1800	0.030	4.2	2.18	0.5	6.4	< 0.3
		2400	–	–	–	–	–	–
Colorado River near Columbine Falls	11/5/90	0600	< 0.04 †	< 2 †	4.47 ¥	0.3 †	2.4 ‡	3.0
		1200	< 0.02 †	< 0.9 †	4.35 ¥	< 1 †	2.5 ‡	2.8
		1800	< 0.02 †	< 0.3 †	4.49	0.4 ‡	2.25 ¥	3.5
		2400	0.04 †	< 1 †	4.4 ‡	< 1 †	2.4 ‡	3.4
	11/6/90	0600	0.02 ¥	1.1 ‡	4.38	< 1 ¥	2.19	3.0
		1200	< 0.02 †	1 †	4.29 ¥	< 1 ‡	2.24 ¥	2.6
		1800	0.76	2.02 ¥	4.47	< 1 ¥	2.19	3.1
		2400	1.17	1.39 ¥	4.24	< 1	2.29	2.1

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Colorado River below Glen Canyon Dam	11/5/90	0600	< 0.008	800	0.009	4.44	2.42	0.46
		1200	< 0.008	802	0.006	4.16	2.48	0.69
		1800	< 0.008	860	< 0.005	4.51	2.53	0.54
		2400	< 0.008	820	0.006	4.58	2.44	0.16
	11/6/90	0600	< 0.008	819	0.006	4.71	2.49	1.06
		1200	< 0.008	856	0.007	4.59	2.47	4.13
		1800	< 0.008	866	0.007	4.58	2.72	1.06
		2400	< 0.008	834	0.005	4.43	2.47	0.97
Colorado River at Lees Ferry	11/5/90	0600	< 0.008	850	0.007	4.63	2.65	1.25
		1200	< 0.008	853	0.007	4.41	2.46	0.70
		1800	< 0.008	850	0.007	4.33	2.59	1.17
		2400	< 0.008	828	0.006	4.57	2.52	0.35
	11/6/90	0600	< 0.008	829	0.005	4.61	2.55	1.33
		1200	< 0.008	828	0.007	4.64	2.47	1.03
		1800	< 0.008	859	0.007	4.52	2.55	2.09
		2400	< 0.01	932	0.006	4.66	2.40	0.78

Table 11.—Trace constituent concentrations for the November 1990 synoptic study—Continued

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Paria River near mouth	11/5/90	0600	< 0.09	1650	0.011 ¥	4.20 ¥	1.4 ‡	10 ‡
		1200	< 0.09	1700	0.012 ‡	4.12 ¥	1.6 †	0.9 †
		1800	< 0.09	1660	0.015 ‡	4.49 ¥	1.7 †	3 †
		2400	< 0.09	1610	0.011	4.71	1.3	1.0
	11/6/90	0600	< 0.09	1800	0.010 ‡	4.66 ¥	1.4 †	6 ‡
		1200	< 0.09	1600	0.012 ‡	4.28 ¥	1.3 †	< 1 †
		1800	< 0.09	1790	0.003 †	4.55 ‡	1.4 †	3 †
		2400	< 0.09	1690	0.011	4.56	1.0	0.73
Colorado River above Little Colorado River	11/5/90	0600	< 0.008	892	0.014	4.74	2.45	3.01
		1200	< 0.008	853	0.014	4.15	2.37	1.19
		1800	< 0.008	855	0.012	4.43	2.31	1.74
		2400	< 0.008	802	0.017	4.25	2.32	0.67
	11/6/90	0600	< 0.008	843	0.013	4.20	2.34	1.10
		1200	< 0.008	851	0.019	4.26	2.37	2.49
		1800	< 0.008	872	0.017	4.50	2.50 ¥	3.3 ‡
		2400	< 0.008	836	0.016	4.35	2.33	1.53
Little Colorado River near mouth	11/5/90	0600	< 0.3	1060	< 0.004 †	4.49	< 2 †	< 0.8 †
		1200	< 0.3	1030	0.086	4.16	0.26	1.1
		1800	< 0.3	980	0.083 ‡	4.22	< 0.8	< 0.8 ¥
		2400	< 0.3	1360	< 0.004 †	5.23	1 †	< 0.8 †
	11/6/90	0600	< 0.3	2850	0.013	25.6	1.3	< 0.8
		1200	< 0.3	2370	0.004 ¥	24.3	1.9 ¥	1.9
		1800	< 0.3	2450	0.007	20.2	2.2	< 0.8
		2400	< 0.3	2390	0.011	18.7	1.9	< 0.8
Colorado River at Grand Canyon	11/5/90	0600	0.009	881	0.009	4.57	2.35	1.51
		1200	< 0.008	906	0.012	4.48	2.35	1.32
		1800	–	–	–	–	–	–
		2400	< 0.008	891	0.011	4.65	2.32	1.15
	11/6/90	0600	< 0.008	938	0.012	4.63	2.53 ¥	3.93 ¥
		1200	< 0.008	852	0.011	4.25	2.28	1.03
		1800	< 0.008	1106	< 0.005	5.75	2.56 ¥	0.6 ‡
		2400	–	–	–	–	–	–
Colorado River above Kanab Creek	11/5/90	0600	< 0.008	889	0.007 †	4.69 ¥	2.5 ‡	0.6 †
		1200	< 0.008	896	0.010	4.51	2.39 ¥	0.82 ¥
		1800	< 0.008	887	0.009	4.58	2.27	1.62 ¥
		2400	< 0.008	889	0.008	4.49	2.29	0.39
	11/6/90	0600	< 0.008	874	0.008	4.60	2.31	0.63
		1200	< 0.008	889	0.011	4.47	2.26	0.46
		1800	< 0.008	885	0.009	4.44	2.38	1.27
		2400	0.008	873	0.018	4.54	2.24	0.97
Kanab Creek near mouth	11/5/90	0600	< 0.02	1560	0.038	5.34	0.70	< 0.08
		1200	< 0.02	1540	0.039	5.36	0.77	0.31
		1800	< 0.02	1600	0.037	5.33	0.70	< 0.08
		2400	< 0.02	1580	0.037	5.32	0.72	< 0.08
	11/6/90	0600	< 0.02	1530	0.036	5.27	0.69	0.20
		1200	< 0.02	1570	0.035	5.30	0.78	< 0.08
		1800	< 0.02	1530	0.039	5.33	0.73	0.27
		2400	< 0.02	1550	0.040	5.46	0.65	1.17
Colorado River above Havasu Creek	11/5/90	0600	< 0.008	893	0.008	4.44	2.38	8.03 ¥
		1200	< 0.008	909	0.008 ‡	4.51	2.5 ‡	0.7 †
		1800	< 0.008	904	0.009	4.50	2.45	0.81
		2400	–	–	–	–	–	–
	11/6/90	0600	< 0.008	883	0.005 ‡	4.53	2.3 ‡	2.82
		1200	0.008	900	< 0.005 †	4.54 ¥	2.7 ‡	1 †
		1800	< 0.008	883	0.009 ‡	4.39	2.5 ‡	0.5 †
		2400	< 0.008	907	0.007 †	4.58 ¥	2.5 ‡	0.7 †

Table 11.–Trace constituent concentrations for the November 1990 synoptic study–Continued

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Havasu Creek near mouth	11/5/90	0600	< 0.09	320	0.015	3.98	5.9	1.85
		1200	< 0.09	330	0.015	3.77	5.9	< 0.2
		1800	< 0.09	310	0.018	3.64	5.7	< 0.2
		2400	< 0.09	320	0.016	3.79	5.7	< 0.2
	11/6/90	0600	< 0.09	320	0.014	3.63	5.6	0.39
		1200	< 0.09	330	0.018	3.66	5.5	< 0.2
		1800	< 0.09	330	0.015	3.63	5.4	< 0.2.
		2400	< 0.09	320	0.021	3.76	5.2	1.32
Colorado River at National Canyon	11/5/90	0600	< 0.008	912	0.007¥	4.70	2.39¥	1.6‡
		1200	< 0.008	869	0.008	4.36	2.39	0.94
		1800	–	–	–	–	–	–
		2400	< 0.008	875	0.008	4.46	2.49¥	0.4‡
	11/6/90	0600	–	–	–	–	–	–
		1200	< 0.008	910	0.009	4.36	2.47	0.84
		1800	< 0.01	859	0.010	4.25	2.23	0.61
		2400	< 0.01	863	0.010	4.34	2.09	0.40
Colorado River above Diamond Creek	11/5/90	0600	< 0.01	915	0.007‡	4.33	2.3‡	0.5†
		1200	< 0.01	932	0.010	4.38	2.45	1.25
		1800	< 0.01	924	0.010	4.41	2.26	1.14
		2400	< 0.01	889	0.005†	4.50¥	2.5‡	< 0.1†
	11/6/90	0600	< 0.01	913	0.012	4.59	2.5‡	< 0.2†
		1200	0.011	884	0.006†	4.53¥	2.5‡	< 0.1†
		1800	0.022	881	0.010	4.43	2.31	0.71
		2400	< 0.01	867	0.010	4.53	2.23	0.31
Diamond Creek near mouth	11/5/90	0600	–	–	–	–	–	–
		1200	–	–	–	–	–	–
		1800	< 0.04	290	0.011	5.91	3.4	< 0.2
		2400	–	–	–	–	–	–
	11/6/90	0600	< 0.04	300	0.011	5.98	3.5	< 0.2
		1200	< 0.04	300	0.012	6.25	4.2‡	< 0.2
		1800	< 0.04	280	0.006	6.17	3.5	< 0.2
		2400	–	–	–	–	–	–
Colorado River near Columbine Falls	11/5/90	0600	< 0.01	898	< 0.005†	4.52¥	2.5‡	< 0.2†
		1200	< 0.01	882	0.005†	4.61¥	2.4‡	1†
		1800	< 0.01	871	0.006	4.47	2.48¥	0.6‡
		2400	< 0.01	879	0.005†	4.56¥	2.4‡	< 0.1†
	11/6/90	0600	< 0.01	876	0.005	4.60	2.31¥	0.31¥
		1200	< 0.01	895	0.008¥	4.41	2.30¥	< 0.1†
		1800	< 0.01	889	0.008	4.68	2.34	0.53
		2400	< 0.01	874	0.005	4.70	2.27	0.20

Table 12.–Trace constituent concentrations for the June 1991 synoptic study

[ICP-MS, inductively coupled plasma- mass spectrometry; ICP-AES, inductively coupled plasma-atomic emission spectrometry; all concentrations are micrograms per Liter except iron which is milligrams per Liter; † Severely impacted by sediment contributions and should be considered an approximate value only (± 100-200%); ‡ Moderately impacted by sediment contributions and is accurate to about ± 50%; ¥ Slightly impacted by sediment contributions and is accurate to about ±10-20%]

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Colorado River below Glen Canyon Dam	6-18-91	1200	5.1	0.26	1.70	106	121	< 0.01
		1800	2.1	0.28	1.91	104	122	< 0.01
		2400	3.5	0.26	1.82	102	115	< 0.01
	6-19-91	0600	1.0	0.24	1.66	97	112	< 0.01
		1200	2.2	0.26	1.75	107	113	< 0.01
		1800	0.8	0.25	1.91	106	123	< 0.01
		2400	3.5	0.25	1.83	102	121	< 0.01
	6-20-91	0600	1.2	0.27	1.85	98	128	< 0.01
Colorado River at Lees Ferry	6-18-91	1200	3.3	0.25	1.71	98	115	< 0.01
		1800	4.5	0.26	1.75	98	115	< 0.01
		2400	1.9	0.26	1.76	106	117	< 0.01
	6-19-91	0600	2.2	0.25	1.78	106	115	< 0.01
		1200	1.7	0.26	1.79	109	112	< 0.01
		1800	2.1	0.25	1.74	105	115	< 0.01
		2400	3.1	0.23	1.72	108	113	< 0.01
	6-20-91	0600	1.5	0.24	1.70	102	116	< 0.01
Paria River near mouth	6-18-91	1200	< 30 †	0.07 ¥	2.4 ¥	71	72	< 0.02
		1800	6.1	0.06	2.5	70	64	< 0.02
		2400	< 30 †	0.07 ¥	2.4 ¥	67	75	< 0.02 ‡
	6-19-91	0600	13 ‡	0.06	2.1	66	75	< 0.02
		1200	–	–	–	–	–	–
		1800	§	0.05 ¥	2.1 ¥	99	62	< 0.02 ‡
		2400	6.5	0.06	2.4	73	66	< 0.02
	6-20-91	0600	5	0.06	2.2	73	77	< 0.02
Colorado River above Little Colorado River at	6-18-91	1200	26	0.27	1.70	95	114	< 0.01
		1800	§	0.27	1.69	95	122	< 0.01
		2400	17	0.26	1.73	102	118	< 0.01
	6-19-91	0600	19	0.25	1.73	96	117	< 0.01
		1200	§	0.26	1.69	100	120	< 0.01
		1800	§	0.35	1.75	100	120	< 0.01
		2400	56 ‡	0.27	1.82	104	118	< 0.01
	6-20-91	0600	13	0.27	1.68	103	114	< 0.01
Little Colorado River near mouth	6-18-91	1200	38 ‡	0.04	9.1	380 ¥	59	< 0.02
		1800	< 40	0.03	8.9	380	60	< 0.02
		2400	< 40	0.05	9.2	380	62	< 0.02
	6-19-91	0600	< 40	0.04	9.5	390	62	< 0.02
		1200	§	0.04	9.0	360 ‡	55 ¥	< 0.02
		1800	< 40	0.03	9.1	380	57	< 0.02
		2400	< 40	0.05	9.4	380	59	< 0.02
	6-20-91	0600	–	–	–	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	3.7	0.25	1.86	112	118	< 0.01
		1800	3.0	0.27	1.82	112	119	< 0.01
		2400	6.2	0.26	1.74	103	116	< 0.01
	6-19-91	0600	8.†	0.27	1.95	110	120	< 0.01
		1200	17	0.27	1.84	116	121	< 0.01
		1800	4.3	0.26	2.01	104	118	< 0.01
		2400	3.4	0.27	1.97	105	117	< 0.01
	6-20-91	0600	2.7	0.26	2.04	113	114	< 0.01

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Colorado River above Kanab Creek	6-18-91	1200	35‡	0.26	2.09	104	117	< 0.01
		1800	§	0.28	2.01	110	127	< 0.01‡
		2400	§	0.28	1.86	102	122	< 0.01
	6-19-91	0600	37†	0.27	1.90	103	125	< 0.01
		1200	§	0.27	1.72	102	118	< 0.01¥
		1800	§	0.32	1.83	99	124	< 0.01
		2400	§	0.26	1.74	107	120	< 0.01
	6-20-91	0600	§	0.31	1.79	97	126	< 0.01¥
Bright Angel Creek near mouth	6-18-91	1200	10.3	0.032	1.00	17	105	< 0.02
		1800	7.6	0.016	0.96	16	105	< 0.02
		2400	5.9	0.014	0.96	19	108	< 0.02
	6-19-91	0600	16.4	0.014	0.91	19	114	< 0.02
		1200	4.0	0.017	0.93	18	107	< 0.02
		1800	4.5	0.022	1.04	19	110	< 0.02
		2400	5.4	0.018	0.94	20	111	< 0.02
	6-20-91	0600	5.9	0.030	0.90	21	109	< 0.02
Kanab Creek near mouth	6-18-91	1200	9†	0.06	1.71¥	127	36.3¥	< 0.02
		1800	5.9	0.06	1.66	127	34.6	< 0.02
		2400	8.0	0.05	1.56	127	34.1	< 0.02
	6-19-91	0600	7.9	0.05	1.48	126	34.8	< 0.02
		1200	13	0.06	1.77	130	35.8	< 0.02
		1800	6.5	0.06	1.73	132	34.2	< 0.02
		2400	12	0.05	1.57	136	34.7	< 0.02
	6-20-91	0600	14	0.05	1.53	131	34.7	< 0.02
Havasu Creek near mouth	6-18-91	1200	3.8	0.030	11.3	320	112	< 0.02
		1800	2.3	0.022	10.8	310	107	< 0.02
		2400	4.1	0.025	10.9	320	121	< 0.02
	6-19-91	0600	4.2	0.025	11.3	330	124	< 0.02
		1200	8.0	0.021	11.4	320	112	< 0.02
		1800	4.7	0.030	11.2	320	106	< 0.02
		2400	5.1	0.023	10.9	310	116	< 0.02
	6-20-91	0600	5.4	0.024	11.2	320	120	< 0.02
Colorado River at National Canyon	6-18-91	1200	3.7	0.26	2.04	108	117	< 0.01
		1800	3.9	0.26	1.90	113	120	< 0.01
		2400	12.4	0.26	1.96	116	116	< 0.005
	6-19-91	0600	9.0	0.26	1.92	112	118	< 0.01
		1200	4.0	0.29	1.95	110	118	< 0.01
		1800	13.7	0.27	1.90	108	115	< 0.01
		2400	5.8	0.28	1.80	100	116	< 0.005
	6-20-91	0600	4.1	0.27	1.85	105	117	< 0.01
Colorado River above Diamond Creek	6-18-91	1200	21.†	0.28	1.87	117	117	< 0.01¥
		1800	7.5	0.26	1.82	108	117	< 0.01
		2400	3.9	0.25	1.99	115	116	< 0.01
	6-19-91	0600	11.1	0.26	1.95	105	118	< 0.01
		1200	5.7	0.28	1.84	108	120	< 0.005
		1800	25¥	0.29	1.92	107	119	< 0.01
		2400	2.7	0.27	1.86	108	120	< 0.01
	6-20-91	0600	7.2	0.29	1.90	111	122	< 0.01
Diamond Creek near mouth	6-18-91	1200	12	0.09	14.2	700	87	< 0.01
		1800	7.0	0.08	14.7	720	90	< 0.01
		2400	22	0.07	14.3	690	91	< 0.01
	6-19-91	0600	8.2	0.08	14.1	690	91	< 0.01
		1200	10.7	0.07	14.8	700	86	< 0.01
		1800	10	0.08	14.3	710	93	< 0.01
		2400	9	0.09	15.1	700	97	< 0.01
	6-20-91	0600	7	0.08	13.6	660	92	< 0.01

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Aluminum ICP-MS	Antimony ICP-MS	Arsenic ICP-MS	Boron ICP-MS	Barium ICP-MS	Beryllium ICP-MS
Colorado River near Columbine Falls	6-18-91	1200	37‡	0.28	2.02	109	121	< 0.01
		1800	45†	0.28	1.94	114	117	< 0.01
		2400	23†	0.26	1.87	99	118	< 0.01
	6-19-91	0600	8†	0.26	1.86	105	119	< 0.01
		1200	1.2	0.26	2.13	107	103	< 0.005
		1800	§	0.27	1.86	116	121	< 0.01
		2400	19¥	0.27	1.81	119	117	< 0.01
	6-20-91	0600	< 10†	0.26	1.91	107	119	< 0.01

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Colorado River below Glen Canyon Dam	6-18-91	1200	< 0.02	0.7	< 0.1	1.3	< 0.005	40
		1800	< 0.02	0.9	< 0.1	1.1	< 0.005	40
		2400	< 0.02	0.8	< 0.1	1.0	0.007	40
	6-19-91	0600	< 0.02	0.8	< 0.1	0.9	< 0.005	39
		1200	< 0.02	0.8	< 0.1	0.9	< 0.005	40
		1800	< 0.02	0.9	< 0.1	1.0	0.008	40
		2400	< 0.02	0.7	< 0.1	0.9	< 0.005	39
	6-20-91	0600	< 0.02	1.0	< 0.1	0.9	0.005	40
Colorado River at Lees Ferry	6-18-91	1200	0.04	0.6	< 0.02	1.2	0.004	37
		1800	0.03	0.5	< 0.02	1.1	0.008	38
		2400	< 0.01	0.5	< 0.02	1.2	< 0.005	37
	6-19-91	0600	< 0.01	0.7	< 0.02	1.3	< 0.005	38
		1200	< 0.01	0.5	< 0.02	1.2	< 0.005	36
		1800	< 0.01	0.6	< 0.02	0.9	0.004	37
		2400	< 0.01	0.6	< 0.02	0.9	0.006	36
	6-20-91	0600	< 0.01	0.6	< 0.02	1.0	< 0.005	36
Paria River near mouth	6-18-91	1200	0.012¥	< 0.3	< 0.02†	0.40‡	0.01†	18.7¥
		1800	< 0.007	< 0.3	< 0.02	0.35	< 0.005	19.3
		2400	0.008‡	< 0.3	< 0.02‡	0.33	< 0.005†	17.6¥
	6-19-91	0600	< 0.007	< 0.3	< 0.02	0.3†	0.011‡	18.4
		1200	–	–	–	–	–	–
		1800	< 0.007	< 0.3	0.03†	0.6¥	0.06†	20.9¥
		2400	< 0.007	< 0.3	< 0.02	0.40‡	0.007	21.4
	6-20-91	0600	< 0.007	< 0.3	< 0.02	0.46	0.009	20.6
Colorado River above Little Colorado River at	6-18-91	1200	< 0.01	0.7	0.03	0.8	0.017	37
		1800	< 0.01	1.2	0.01	0.7	< 0.02†	40
		2400	< 0.01	0.8	< 0.02	0.7	< 0.02	42
	6-19-91	0600	< 0.01	1.3	< 0.02	0.9	< 0.02	41
		1200	< 0.01	0.6	< 0.1	0.6¥	< 0.03†	40
		1800	< 0.01	1.6	0.05	0.7	< 0.02†	44
		2400	< 0.01	0.7	< 0.1	1.0	< 0.02	44
	6-20-91	0600	< 0.01	1.0	< 0.02	0.6	< 0.02	44
Little Colorado River near mouth	6-18-91	1200	< 0.02	< 0.6	< 0.1	0.31	< 0.005	168¥
		1800	< 0.02	0.6	< 0.1	< 0.2	< 0.005	164
		2400	< 0.02	< 0.6	< 0.1	< 0.2	< 0.005	173
	6-19-91	0600	< 0.02	< 0.6	< 0.1	0.22	< 0.005	178
		1200	< 0.02	< 0.6	< 0.1	0.20	0.021	161¥
		1800	< 0.02	< 0.6	< 0.1	< 0.2	0.007	167
		2400	< 0.02	0.6	< 0.1	0.28	0.009	166
	6-20-91	0600	–	–	–	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	< 0.01	1.0	0.05	0.9	< 0.005	45
		1800	< 0.01	1.0	0.02	0.8	0.008	44
		2400	< 0.01	1.2	< 0.02	0.8	0.008	43
	6-19-91	0600	0.05	0.9	< 0.1	1.0	< 0.02‡	47
		1200	< 0.01	1.0	0.04	0.9	0.006	47
		1800	< 0.01	1.1	< 0.02	0.8	< 0.005	46

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Colorado River at Grand		2400	< 0.01	1.2	< 0.02	0.7	< 0.005	46
Canyon (Cont.)	6-20-91	0600	< 0.01	1.2	< 0.02	0.7	< 0.005	47
Colorado River above	6-18-91	1200	< 0.01	0.5	< 0.1	0.9	< 0.02 ‡	48
Kanab Creek		1800	< 0.01	0.9	< 0.1 ‡	0.8 ¥	0.02 †	49
		2400	< 0.01	0.6	0.04 ¥	0.7 ¥	< 0.02 †	45
	6-19-91	0600	< 0.01	0.7	0.05	0.8	< 0.02 †	46
		1200	< 0.01	0.5	0.01 ¥	1.0 ¥	< 0.02 †	44
		1800	< 0.01	0.8	< 0.1 ¥	0.9 ¥	< 0.02 †	44
		2400	< 0.01	0.6	0.02	0.7	< 0.02 †	44
	6-20-91	0600	< 0.01	0.6	< 0.1	0.8	< 0.02 †	45
Bright Angel Creek near	6-18-91	1200	0.067	1.3	< 0.01	1.08	0.010	5.5
mouth		1800	0.030	0.9	< 0.01	0.19	0.005	5.2
		2400	< 0.01	1.0	< 0.01	< 0.04	0.010	5.6
	6-19-91	0600	< 0.01	0.8	< 0.01	< 0.04	0.014	5.7
		1200	< 0.01	0.9	< 0.01	0.06	0.005	5.5
		1800	< 0.01	1.2	< 0.01	< 0.04	0.013	5.5
		2400	< 0.01	1.1	< 0.01	< 0.04	0.010	5.8
	6-20-91	0600	< 0.01	1.2	< 0.01	< 0.04	< 0.005	6.2
Kanab Creek near mouth	6-18-91	1200	0.023	< 0.2	< 0.1	0.54	< 0.005 ‡	33
		1800	0.020	< 0.2	< 0.1	0.47	0.011	33
		2400	0.023	< 0.2	< 0.1	0.51	0.006	33
	6-19-91	0600	0.017	< 0.2	< 0.1	0.39	0.011	32
		1200	0.027	< 0.2	< 0.1	0.33	< 0.005	34
		1800	0.019	< 0.2	< 0.1	0.52	0.013	33
		2400	0.017	< 0.2	< 0.1	0.41	0.008	33
	6-20-91	0600	0.019	< 0.2	< 0.1	0.35	< 0.005	32
Havasu Creek near mouth	6-18-91	1200	0.020	0.8	< 0.05	0.09	< 0.005	138
		1800	0.008	0.8	< 0.05	1.11	0.008	132
		2400	0.007	0.8	< 0.05	< 0.03	0.006	136
	6-19-91	0600	0.008	1.0	< 0.05	< 0.03	0.006	141
		1200	0.011	1.0	< 0.05	0.90	0.011	141
		1800	< 0.006	0.9	< 0.05	1.08	0.007	140
		2400	< 0.006	0.7	< 0.05	0.31	< 0.005	130
	6-20-91	0600	< 0.006	0.8	< 0.05	< 0.03	0.008	136
Colorado River at National	6-18-91	1200	< 0.01	0.9	< 0.02	0.9	< 0.005	48
Canyon		1800	< 0.01	1.0	< 0.02	0.8	0.010	45
		2400	< 0.02	1.1	0.02	1.0	< 0.005	47
	6-19-91	0600	< 0.02	1.1	0.01	0.6	0.006	44
		1200	< 0.02	1.0	< 0.03	0.5	< 0.005	45
		1800	< 0.02	1.1	0.01	0.8	< 0.005	45
		2400	< 0.02	1.0	< 0.03	0.6	0.005	43
	6-20-91	0600	< 0.02	1.1	< 0.03	0.6	0.005	44
Colorado River above	6-18-91	1200	0.02	0.5	< 0.1	0.8	< 0.02 †	45
Diamond Creek		1800	< 0.02	0.5	< 0.03	0.6	< 0.005	42
		2400	< 0.02	0.5	< 0.03	0.7	< 0.005	45
	6-19-91	0600	< 0.02	0.4	0.06	0.5	0.012	48
		1200	< 0.02	0.5	0.08	0.5	0.004	47
		1800	< 0.02	0.5	0.05	0.9	0.006	48
		2400	< 0.02	0.5	< 0.03	0.7	0.009	47
	6-20-91	0600	< 0.02	0.8	0.04	0.9	< 0.005	48
Diamond Creek near mouth	6-18-91	1200	< 0.01	0.7	< 0.01	0.39	0.011	112
		1800	0.015	0.6	< 0.01	0.20	0.007	115
		2400	< 0.01	0.5	< 0.01	0.08	0.008	112
	6-19-91	0600	< 0.01	0.4	< 0.01	0.11	< 0.005	111
		1200	0.017	0.8	< 0.01	0.49	0.006	113
		1800	< 0.01	0.5	< 0.01	0.10	0.009	112
		2400	< 0.01	0.6	< 0.01	0.06	< 0.005	117

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Cadmium ICP-MS	Chromium ICP-MS	Cobalt ICP-MS	Copper ICP-MS	Iron ICP-AES	Lithium ICP-MS
Diamond Creek (Cont.)	6-20-91	0600	0.017	0.4	< 0.01	0.27	0.006	107
Colorado River near Travertine Cleft	6-18-91	1200	< 0.02	0.3	< 0.1	0.8	0.013 ¥	46
		1800	< 0.02	0.1	< 0.1	0.7	< 0.02 †	46
		2400	< 0.02	0.3	< 0.1	0.7	< 0.02 †	46
	6-19-91	0600	< 0.02	0.6	< 0.1	0.9	< 0.02 †	48
		1200	< 0.02	–	< 0.03	0.3	0.005	43
		1800	< 0.02	0.3	0.03	0.5	< 0.02 †	47
		2400	< 0.02	0.4	0.02	0.8	0.007	48
	6-20-91	0600	< 0.02	0.5	0.01	0.5	< 0.02 †	48

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Colorado River below Glen Canyon Dam	6-18-91	1200	0.07	0.5	5.4	0.6	1.9	4.0
		1800	0.04	0.4	5.6	0.5	2.0	4.1
		2400	0.06	0.4	5.3	0.1	1.8	3.9
	6-19-91	0600	0.06	0.3	5.0	0.2	1.7	3.8
		1200	0.05	0.4	5.4	0.4	1.8	3.8
		1800	0.03	0.3	5.5	0.2	2.0	4.0
		2400	0.04	0.3	5.4	0.7	1.8	4.1
	6-20-91	0600	0.06	0.3	5.6	0.8	2.0	4.1
Colorado River at Lees Ferry	6-18-91	1200	0.11	0.7	5.2	2.4	1.7	4.0
		1800	0.09	0.6	5.2	2.4	1.8	3.9
		2400	0.07	0.4	5.2	2.0	1.7	3.9
	6-19-91	0600	0.08	0.4	5.5	2.2	1.8	4.1
		1200	0.09	0.6	5.3	1.9	1.7	4.0
		1800	0.08	0.6	5.3	1.8	1.8	3.8
		2400	0.04	0.5	5.2	2.1	1.7	3.6
	6-20-91	0600	0.05	0.4	5.1	2.1	1.7	3.8
Paria River near mouth	6-18-91	1200	< 0.04 †	1 †	1.34	< 1	1.7 ‡	0.9
		1800	< 0.04	0.73	1.41	< 1	1.9	0.9
		2400	< 0.04 †	0.3 †	1.31	< 1	1.7 ‡	0.8
	6-19-91	0600	< 0.04	0.21 ‡	1.38	< 1	1.7 ¥	0.8
		1200	–	–	–	–	–	–
		1800	0.04 †	2 †	1.37	< 1 †	1.9 ‡	0.8
		2400	0.07	0.45	1.46	< 1	1.8	0.8
	6-20-91	0600	< 0.04	0.2	1.44	< 1	1.7	0.9
Colorado River above Little Colorado River	6-18-91	1200	3.7	7.4	5.1	2.1	1.9	3.7
		1800	9.0	5.8 ¥	5.3	2.0	1.9	3.9
		2400	0.05	4.6	5.3	1.9	2.0	3.8
	6-19-91	0600	1.5	4.8	5.4	1.7	2.0	3.8
		1200	2.4 ¥	3. ‡	5.3	1.6	1. ‡	3.8
		1800	13	5.0 ¥	5.7	2.1	1.8 ¥	3.6
		2400	0.11 ¥	4.2 ¥	5.0	1.7	1.8	3.8
	6-20-91	0600	0.10	4.5	5.3	1.6	2.0	3.8
Little Colorado River near mouth	6-18-91	1200	0.3	0.79	1.80 ¥	< 6	20.2 ¥	4.9
		1800	< 0.3	0.82	1.70	< 6	19.4	4.6
		2400	< 0.3	1.08	1.92	< 6	21.6	5.3
	6-19-91	0600	< 0.3	0.77	1.87	< 6	21.2	5.5
		1200	< 0.3	1.35	1.74 ¥	< 6	18.9 ‡	5.2
		1800	< 0.3	0.95	1.83	< 6	20.4	4.6
		2400	< 0.3	1.28	1.77	< 6	21.3	4.7
	6-20-91	0600	–	–	–	–	–	–

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Colorado River at Grand Canyon	6-18-91	1200	0.06	13.7	5.3	1.6	2.4	4.1
		1800	0.04	8.7	5.4	1.4	2.3	4.1
		2400	0.06	5.8	5.2	1.2	2.2	4.0
	6-19-91	0600	0.07	4.4	5.3	1.5	2.4	4.3
		1200	0.04	15.2	5.4	1.5	2.4	4.3
		1800	0.02	7.5	5.6	1.5	2.3	4.5
		2400	0.04	4.6	5.3	1.5	2.3	4.3
	6-20-91	0600	0.04	3.3	5.5	1.6	2.4	4.3
Colorado River above Kanab Creek	6-18-91	1200	0.07‡	2.4	5.3	1.0	2.7	3.6
		1800	< 0.02†	22.¥	5.2	1.5	2.‡	3.8
		2400	0.03†	7.‡	5.2	0.8	2.2¥	3.7
	6-19-91	0600	0.05†	7.1¥	5.4	0.6	2.4	3.8
		1200	0.1†	5.‡	5.1	0.6	2.‡	3.9
		1800	0.08†	5.‡	5.5	0.8	2.‡	4.0
		2400	0.03†	4.1¥	5.3	0.9	2.3¥	3.9
	6-20-91	0600	0.04†	4.‡	5.1	0.8	2.3¥	4.1
Bright Angel Creek near mouth	6-18-91	1200	0.27	1.42	0.16	0.35	1.16	< 0.3
		1800	0.14	1.14	0.12	0.34	1.15	< 0.3
		2400	0.06	1.00	< 0.1	0.25	1.15	< 0.3
	6-19-91	0600	0.08	1.17	< 0.1	< 0.05	1.14	0.33
		1200	0.05	1.09	0.13	0.31	1.07	0.30
		1800	0.05	1.20	< 0.1	0.82	1.26	0.27
		2400	0.08	1.02	< 0.1	0.20	1.17	< 0.3
	6-20-91	0600	0.06	1.01	0.12	0.38	1.09	0.28
Kanab Creek near mouth	6-18-91	1200	0.03‡	3.7¥	5.3¥	< 1	3.31¥	3.3
		1800	0.03	3.2	5.2	< 1	3.36	3.4
		2400	0.04	3.1	5.3	< 1	3.32	3.3
	6-19-91	0600	< 0.03	2.9	5.3	< 1	3.18	3.3
		1200	0.04	4.1	5.4	< 1	3.44	3.6
		1800	< 0.03	3.0	5.3	< 1	3.36	3.2
		2400	0.05	3.0	5.1	< 1	3.18	3.2
	6-20-91	0600	< 0.03	2.7	5.1	< 1	3.11	3.4
Havasu Creek near mouth	6-18-91	1200	0.047	0.31	1.05	< 0.5	12.9	1.37
		1800	0.030	0.21	1.02	< 0.5	12.4	1.11
		2400	0.084	0.26	1.03	< 0.5	12.6	1.30
	6-19-91	0600	0.030	0.28	1.06	< 0.5	13.1	1.12
		1200	0.046	0.32	1.05	< 0.5	12.6	1.34
		1800	0.040	0.35	1.10	< 0.5	12.7	1.31
		2400	< 0.01	0.29	1.02	< 0.5	12.3	1.28
	6-20-91	0600	0.033	0.31	1.05	< 0.5	12.6	1.33
Colorado River at National Canyon	6-18-91	1200	0.08	1.6	5.1	0.5	2.5	3.7
		1800	0.03	8.4	5.0	1.4	2.5	3.9
		2400	0.03	8.2	5.1	1.5	2.5	4.0
	6-19-91	0600	0.03	4.9	5.2	1.7	2.5	3.9
		1200	0.02	4.1	5.2	1.9	2.4	4.1
		1800	0.07	3.4	5.1	1.5	2.4	3.9
		2400	0.05	3.1	5.1	1.9	2.4	3.8
	6-20-91	0600	0.03	2.7	5.1	2.1	2.3	3.7
Colorado River above Diamond Creek	6-18-91	1200	0.08‡	3.‡	5.2	2.2	2.4¥	3.8
		1800	0.08	1.4	5.2	1.7	2.3	3.8
		2400	0.06	2.4	5.3	1.8	2.6	3.8
	6-19-91	0600	0.07	12.3	5.1	1.8	2.5	3.8
		1200	0.05	10.0	5.2	2.0	2.7	3.9
		1800	0.16	4.4	5.2	1.8	3.5	3.8
		2400	0.16	3.7	5.2	1.6	2.6	3.7
	6-20-91	0600	0.16	3.6	5.5	2.2	3.0	4.2

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Lead ICP-MS	Manganese ICP-MS	Molybdenum ICP-MS	Nickel ICP-MS	Rubidium ICP-MS	Selenium ICP-MS
Diamond Creek near mouth	6-18-91	1200	0.055	1.19	2.4	0.7	8.8	0.3
		1800	0.10	1.37	2.5	0.8	8.8	< 0.3
		2400	0.056	1.24	2.4	0.9	8.5	0.3
	6-19-91	0600	0.061	1.02	2.4	0.8	8.3	0.3
		1200	0.16	1.23	2.5	0.6	8.9	0.4
		1800	0.090	1.21	2.4	0.6	8.6	0.4
		2400	0.206	1.08	2.4	0.7	8.6	< 0.3
	6-20-91	0600	0.97	0.98	2.3	0.8	8.0	0.3
Colorado River near Travertine Cleft	6-18-91	1200	0.03	2.1	5.1	1.7	2.6	3.7
		1800	< 0.02‡	2.6¥	5.1	1.8	2.5¥	3.9
		2400	0.02¥	1.7¥	5.0	2.1	2.2	3.6
	6-19-91	0600	0.03‡	1.2¥	5.2	2.2	2.3¥	3.9
		1200	0.01	0.1	5.2	0.5	2.4	4.1
		1800	< 0.02‡	6.1¥	5.2	2.1	2.3¥	3.9
		2400	0.04	4.3	5.3	1.8	2.5	3.7
	6-20-91	0600	< 0.02‡	1.5¥	5.3	2.2	2.4¥	4.0

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Colorado River below Glen Canyon Dam	6-18-91	1200	< 0.01	993	0.011	5.4	2.3	3.2
		1800	< 0.01	994	0.007	5.4	2.4	3.3
		2400	< 0.01	991	0.009	5.4	2.3	2.8
	6-19-91	0600	< 0.01	964	0.006	5.3	2.3	2.2
		1200	< 0.01	982	0.007	5.0	2.2	1.9
		1800	< 0.01	979	0.006	5.4	2.4	2.3
		2400	< 0.01	962	0.007	5.3	2.4	1.2
	6-20-91	0600	< 0.01	965	0.009	5.3	2.5	2.6
Colorado River at Lees Ferry	6-18-91	1200	–	939	0.007	5.2	2.3	3.1
		1800	–	959	0.007	5.4	2.3	3.1
		2400	–	941	0.006	5.3	2.3	2.8
	6-19-91	0600	–	958	0.006	5.5	2.3	3.6
		1200	–	942	0.005	5.3	2.3	2.4
		1800	–	958	0.006	5.3	2.3	1.8
		2400	–	923	0.006	5.2	2.2	1.3
	6-20-91	0600	–	929	0.007	5.2	2.3	1.3
Paria River near mouth	6-18-91	1200	< 0.09	870	0.007‡	2.37¥	2.6‡	1.0‡
		1800	< 0.09	830	0.008	2.32	3.0	0.60
		2400	< 0.09	890	0.008‡	2.43¥	2.3†	0.4†
	6-19-91	0600	< 0.09	890	0.006	2.36¥	1.8	0.72¥
		1200	–	–	–	–	–	–
		1800	< 0.09	770	0.009¥	2.44¥	2.9‡	0.2†
		2400	< 0.09	870	0.008	2.49	2.6	1.0
	6-20-91	0600	< 0.09	860	0.007	2.44	2.0	0.5
Colorado River above Little Colorado River at	6-18-91	1200	< 0.02	929	0.005	5.2	2.1	3.0
		1800	< 0.02	972	0.009	5.4	2.1	3.9
		2400	< 0.02	971	0.010	5.3	2.0	2.9
	6-19-91	0600	< 0.02	970	0.007	5.2	2.1	6.9
		1200	< 0.02	958	0.006	5.5	2.0¥	4.4
		1800	< 0.02	998	0.010	5.4	2.2	5.5
		2400	< 0.02	972	0.011	5.3	2.2	6.3
	6-20-91	0600	< 0.02	979	0.005	5.4	2.1	6.8

Table 12.–Trace constituent concentrations for the June 1991 synoptic study–Continued

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Little Colorado River near mouth	6-18-91	1200	< 0.3	1040 ¥	0.128 ¥	4.62	< 0.2	0.8
		1800	< 0.3	980	0.125	4.29	< 0.2	< 0.8
		2400	< 0.3	1050	0.133	4.37	< 0.2	< 0.8
	6-19-91	0600	< 0.3	1110	0.128	4.32	0.2	0.9
		1200	< 0.3	970 ¥	0.123 ¥	4.57	< 0.2 †	1.4
		1800	< 0.3	1020	0.116	4.21	< 0.2	1.4
		2400	< 0.3	1010	0.136	4.29	0.6	< 0.8
	6-20-91	0600	–	–	–	–	–	–
Colorado River at Grand Canyon	6-18-91	1200	< 0.02	994	0.009	5.3	2.3	2.4
		1800	< 0.02	986	0.009	5.4	2.2	2.2
		2400	< 0.02	968	0.008	5.2	2.2	3.3
	6-19-91	0600	< 0.02	991	0.010	5.4	2.3	3.5
		1200	< 0.02	986	0.006	5.3	2.4	2.2
		1800	< 0.02	978	0.009	5.4	2.4	2.4
		2400	< 0.02	963	0.008	5.4	2.4	2.0
	6-20-91	0600	< 0.02	980	0.010	5.3	2.4	2.2
Bright Angel Creek near mouth	6-18-91	1200	< 0.04	48	0.003	0.57	0.99	3.3
		1800	< 0.04	45	0.003	0.56	0.98	0.8
		2400	< 0.04	47	0.004	0.53	0.85	1.2
	6-19-91	0600	< 0.04	49	< 0.002	0.55	0.79	0.5
		1200	< 0.04	46	0.003	0.55	0.85	1.2
		1800	< 0.04	47	0.004	0.55	1.05	1.5
		2400	< 0.04	47	0.004	0.54	0.87	0.9
	6-20-91	0600	< 0.04	49	0.004	0.54	0.77	1.0
Colorado River above Kanab Creek	6-18-91	1200	< 0.05	993	0.011	5.4	2.3	1.6
		1800	< 0.05	982	0.012	5.4	2.7 ¥	2.2
		2400	< 0.05	959	0.012	5.4	2.4 ¥	1.1
	6-19-91	0600	< 0.05	972	0.012	5.4	2.5	1.5
		1200	< 0.05	956	0.012	5.5	2.2 ¥	1.5
		1800	< 0.05	1001	0.013	5.6	2.4 ¥	1.6
		2400	< 0.05	987	0.011	5.3	2.2	1.1
	6-20-91	0600	< 0.05	989	0.013	5.5	2.2 ¥	1.2
Kanab Creek near mouth	6-18-91	1200	< 0.02	1590	0.043	5.02 ¥	1.31 ¥	1.07
		1800	< 0.02	1620	0.041	5.10	1.21	0.32
		2400	< 0.02	1650	0.040	4.94	1.08	0.57
	6-19-91	0600	< 0.02	1640	0.041	4.96	1.01	0.23
		1200	< 0.02	1640	0.043	5.31	1.30	0.38
		1800	< 0.02	1620	0.040	5.11	1.18	0.65
		2400	< 0.02	1570	0.042	5.00	1.03	1.86
	6-20-91	0600	< 0.02	1620	0.037	4.99	1.13	0.29
Havasu Creek near mouth	6-18-91	1200	< 0.09	320	0.013	3.90	5.9	0.24
		1800	< 0.09	310	0.015	3.66	5.6	< 0.2
		2400	< 0.09	330	0.014	3.72	5.6	< 0.2
	6-19-91	0600	< 0.09	340	0.014	3.82	5.8	0.54
		1200	< 0.09	320	0.014	3.80	5.8	0.52
		1800	< 0.09	320	0.016	3.76	5.8	0.21
		2400	< 0.09	320	0.016	3.70	5.5	< 0.2
	6-20-91	0600	< 0.09	340	0.012	3.78	5.8	< 0.2
Colorado River at National Canyon	6-18-91	1200	< 0.05	956	0.009	5.4	2.5 ¥	1.0
		1800	< 0.05	944	0.010	5.3	2.2	0.5
		2400	< 0.02	937	0.011	5.3	2.4	1.0
	6-19-91	0600	< 0.02	944	0.012	5.5	2.6	0.4
		1200	< 0.02	963	0.011	5.4	2.7	0.5
		1800	< 0.02	938	0.013	5.5	2.9	0.6
		2400	< 0.02	961	0.013	5.3	2.6	0.5
	6-20-91	0600	< 0.02	945	0.013	5.8	2.9	1.7

Table 12.—Trace constituent concentrations for the June 1991 synoptic study—Continued

Site	Date	Time	Silver ICP-MS	Strontium ICP-MS	Thallium ICP-MS	Uranium ICP-MS	Vanadium ICP-MS	Zinc ICP-MS
Colorado River above	6-18-91	1200	–	947	0.012	5.4	2.5*	1.0
Diamond Creek		1800	–	919	0.013	5.3	2.2	0.5
		2400	–	952	0.014	5.3	2.4	1.0
	6-19-91	0600	< 0.02	978	0.010	5.5	2.6	0.4
		1200	–	953	0.012	5.4	2.7	0.5
		1800	–	964	0.015	5.5	2.9	0.6
		2400	–	956	0.012	5.3	2.6	0.5
	6-20-91	0600	–	1010	0.014	5.8	2.9	1.7
Diamond Creek near mouth	6-18-91	1200	< 0.04	310	0.011	7.5	5.1	0.3
		1800	< 0.04	330	0.013	7.7	5.0	4.1
		2400	< 0.04	330	0.010	7.4	4. 7	< 0.2
	6-19-91	0600	< 0.04	330	0.008	7.5	4.6	< 0.2
		1200	< 0.04	320	0.011	7.6	5.3	1.9
		1800	< 0.04	320	0.013	7.8	4.9	< 0.2
		2400	< 0.04	340	0.011	7.7	4.7	0.4
	6-20-91	0600	< 0.04	320	0.010	7.5	4.4	< 0.2
Colorado River near	6-18-91	1200	< 0.02	980	0.011	5.5	2.8	0.6
Travertine Cleft		1800	< 0.02	966	0.013	5.6	2.7	0.6
		2400	< 0.02	956	0.010	5.4	2.4	1.4
	6-19-91	0600	< 0.02	978	0.009	5.6	2.4	2.4
		1200	< 0.02	886	0.009	4.8	3.2	0.1
		1800	< 0.02	969	0.014	5.6	2.8*	0.5
		2400	< 0.02	979	0.012	5.5	2.8	0.9
	6-20-91	0600	0.02	960	0.012	5.5	2.8*	0.8

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other; See Table 19 for volume data]

Colorado River below Glen Canyon Dam

11/5/1990 0850-0950 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	5,476	27.731
Daphnia	(1-2)	255	45.732
Hydra	(1-2)	167	8.114
Oligochaeta	(1-4)	146	12.685
Chydorid cladoceran	(0-1)	79	20.053
Chironomidae (adult)	(3-5)	3	0.563
Orthocladiinae	(0-3)	9	0.321
		Total 6,135	115.199

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	155	5,810	0	167	0	3	0	0
Weight	0	13.005	93.518	0	8.114	0	0.563	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	167	155	0	0	0	3	5,810	0	0
Weight	8.114	13.005	0	0	0	0.563	93.518	0	0

11/5/1990 1325-1425 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid	(0-2)	5,351	27.237
Daphnia	(1-2)	581	94.368
Hydra	(1-2)	14	0.573
Oligochaeta	(1-4)	51	5.621
Chydorid cladoceran	(0-1)	23	1.525
Chironomidae (pupae)	3	1	0.097
Terrestrial mite	1	1	0.122
		Total 6,022	129.543

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	51	5,955	0	15	0	0	1	0
Weight	0	5.621	123.131	0	0.694	0	0	0.097	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	14	51	1	0	1	0	5,955	0	0
Weight	0.573	5.621	0	0	0.122	0	123.131	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River below Glen Canyon Dam

11/5/1990 1905-2005 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-1)	23	0.100
Daphnia	(1-1)	10	1.971
Chironomidae (adult)	(0-1)	1	0.178
Thysanoptera (thrips)	(0-1)	1	0.010
		Total 35	2.259

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	33	0	0	0	2	0	0
Weight	0	0	2.071	0	0	0.	0.187	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	2	33	0	0
Weight	0	0	0	0	0	0.187	2.071	0	0

11/6/1990 0120-0220 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	5	1	0.794
Daphnia	(0-1)	5	0.608
Hydra	(0-1)	2	0.082
Oligochaeta	(0-1)	2	0.082
Orthocladiinae	(0-1)	2	0.006
		Total 12	1.572

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	4	5	0	2	0	0	0	0
Weight	0.794	0.088	0.608	0	0.082	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	5	0	0	0	0	5	0	0
Weight	0.082	0.883	0	0	0	0	0.608	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River below Glen Canyon Dam

11/6/1990 0735-0835 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	25	0.204
Daphnia	(0-2)	5	1.362
Hydra	(0-1)	3	0.110
Chironomidae (adult)	(3-5)	2	0.386
Chydorid cladoceran	3	1	0.006
Oligochaeta	3	1	0.083
Ostracoda	1	1	0.122
Aphidae	2	1	0.325
		Total 39	2.598

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	31	0	3	0	3	0	0
Weight	0	0.205	1.571	0	0.11	0	0.711	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	3	1	0	0	1	3	31	0	0
Weight	0.11	0.083	0	0	0.122	0.711	1.571	0	0

11/6/1990 1355-1455 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Daphnia	(0-2)	108	21.204
Hydra	(0-3)	6	0.323
Oligochaeta	10	1	1.007
Aphidae	(0-2)	2	0.194
Chydorid cladoceran	(0-1)	2	0.243
Cyclopoid copepod	(0-1)	1,311	5.540
Physa	1	1	0.003
		Total 1,431	28.514

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	1,421	1	6	0	2	0	0
Weight	0	1.007	26.987	0.003	0.323	0	0.194	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	7	1	0	0	0	2	1,421	0	0
Weight	0.326	1.007	0	0	0	0.194	26.987	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River below Glen Canyon Dam

11/6/1990 1855-1955 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	1,850	7.998
Daphnia	(0-1)	52	8.590
Chironomidae (adult)	(3-5)	3	0.675
Chydorid cladoceran	(0-1)	20	2.086
Oligochaeta	(1-4)	2	0.160
Graptoleberis (Cladocera)	(1-2)	21	3.309
Hydracarina	(0-1)	2	0.128
		Total 1,950	22.946

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	1,943	0	2	0	3	0	0
Weight	0	0.160	21.983	0	0.128	0	0.675	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	2	0	0	23	3	1,922	0	0
Weight	0	0.160	0	0	3.437	0.675	18.674	0	0

11/7/1990 0125-0225 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Daphnia	(0-2)	7	1.605
Chydorid cladoceran	(0-1)	3	0.365
Cyclopoid copepod	(0-1)	54	0.228
		Total 64	2.198

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	64	0	0	0	0	0	0
Weight	0	0	2.198	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	0	64	0	0
Weight	0	0	0	0	0	0	2.198	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry
11/5/1990 0641-0741 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	222	0.917
Chydorid cladoceran	(0-1)	1	0.122
Oligochaeta	(1-3)	9	0.498
Hydra	(0-1)	1	0.041
Aquatic Diptera (adults)	1	1	0.097
Gammarus	(3-8)	3	3.409
Orthocladiinae	(1-7)	24	0.907
Cnephia	(1-5)	23	1.036
Nematoda	(1-2)	8	2.104
		Total 292	9.131

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	41	246	0	1	0	1	0	0
Weight	3.409	3.509	2.075	0	0.041	0	0.097	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	24	44	0	0	0	1	223	0	0
Weight	1.077	6.918	0	0	0	0.097	1.039	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry
11/5/1990 1230-1330 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aquatic insect egg	(0-1)	62	0.364
Oligochaeta	(1-31)	41	3,080.673
Chironomidae (pupae)	(0-5)	15	1.454
Chironomidae (adult)	(0-3)	20	1.523
Orthocladiinae	(0-5)	64	2.910
Hydra	(0-1)	1	0.041
Gammarus	(0-7)	66	39.624
Collembola	(0-2)	3	0.089
Physa	(0-4)	5	0.138
Hydracarina	1	1	0.122
Lepidoptera (terrestrial and larvae)	6	1	1.128
Saldidae	2	1	0.399
Diptera (terrestrial and larvae)	(2-3)	2	0.142
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Limnaeidae (Gastropoda)	(1-6)	10	0.369
Daphnia	(0-2)	8	1.235
Chydorid cladoceran	(0-1)	4	0.487
Cyclopoid copepod	(0-2)	500	10.325
		Total 805	3,141.348

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	66	108	512	15	3	0	24	77	0
Weight	39.624	3,083.67	12.046	0.507	0.562	0	3.118	1.818	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	16	171	15	1	63	27	512	0	0
Weight	0.548	3,123.21	1.454	0.399	0.485	3.207	12.046	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry
11/5/1990 1830-1930 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	477	1.899
Chydorid cladoceran	(0-1)	1	0.122
Collembola	(0-3)	3	0.089
Oligochaeta	(2-8)	8	1.145
Hydra	(0-1)	3	0.123
Hydracarina	(0-1)	1	0.122
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	12	1.847
Aquatic Diptera adults	2	1	0.325
Aquatic Diptera pupae	2	2	0.006
Daphnia	1	1	0.122
Gammarus	3	1	0.199
Limnaeidae (Gastropoda)	(1-7)	18	0.602
Orthocladiinae	3	5	0.082
Physa	6	1	0.196
Chironomidae	(0-3)	4	0.225
Chironomidae (adult)	(2-3)	14	0.976
		Total 552	8.076

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	16	479	19	4	0	31	2	0
Weight	0.199	1.315	2.143	0.797	0.244	0	3.372	0.006	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	22	16	0	0	1	34	479	0	0
Weight	0.920	1.431	0	0	0.122	3.461	2.143	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry

11/6/1990 0005-0105 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(0-3)	6	0.202
Hydra	(0-2)	5	0.227
Collembola	(0-1)	1	0.009
Aphidae, Phylloxeridae (nymph and adult)	(0-1)	9	0.873
Limnaeidae (Gastropoda)	(1-8)	5	0.776
Daphnia	(0-1)	5	0.608
Cyclopoid copepod	(0-2)	21	0.119
Chironomidae (adult)	3	1	0.097
Nematoda	3	2	1.385
		Total 55	4.296

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	9	26	5	5	0	10	0	0
Weight	0	1.595	0.728	0.776	0.227	0	0.969	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	10	8	0	0	0	11	26	0	0
Weight	1.004	1.586	0	0	0	0.978	0.728	0	0

11/6/1990 0825-0925 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Cyclopoid copepod	(0-2)	427	1.824
Collembola	2	1	0.040
Oligochaeta	(0-10)	41	2.959
Hydra	(0-3)	6	0.365
Aphidae Phylloxeridae (nymph and adult)	(0-1)	6	0.582
Daphnia	(0-3)	55	9.169
Gammarus	(3-5)	2	0.993
Limnaeidae (Gastropoda)	1	5	0.017
Orthocladinae	(0-6)	66	1.203
Tipulidae	1	1	0.000
Chironomidae (pupae)	1	1	0.289
Cnephia	(1-12)	8	6.264
		Total 619	23.705

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	108	490	5	6	0	6	1	0
Weight	0.994	4.202	17.257	0.017	0.365	0	0.582	0.289	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	19	110	1	0	0	7	482	0	0
Weight	6.647	5.156	0.289	0	0	0.622	10.992	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry

11/6/90 1155-1215 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-5)	7	0.491
Daphnia	(0-2)	7	1.606
Cyclopoid copepod	(0-2)	323	2.050
Chironomidae (adult)	(4-5)	5	1.111
Chironomidae (pupae)	(2-5)	3	0.621
Gammarus	(2-10)	27	11.324
Physa	6	1	0.196
Aquatic Diptera (pupae)	2	1	0.003
Chydorid cladoceran	1	1	0.122
		Total 375	17.524

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	27	7	331	1	0	0	5	4	0
Weight	11.324	0.491	1.777	0.196	0	0	1.111	0.624	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	35	3	0	0	5	331	0	0
Weight	0.196	11.818	0.621	0	0	1.111	3.777	0	0

11/6/1990 1830-1930 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-4)	3	0.099
Daphnia	1	1	0.122
Cyclopoid copepod	(0-2)	716	4.192
Oligochaeta	(2-4)	5	0.403
Chironomidae (adult)	2	3	0.128
Chironomidae (pupae)	2	1	0.043
Gammarus	2	1	0.071
Aquatic insect eggs	0	179	1.049
		Total 909	6.107

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	8	717	0	0	0	3	180	0
Weight	0.071	0.502	4.314	0	0	0	0.128	1.092	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	9	1	0	179	3	717	0	0
Weight	0	0.573	0.043	0	1.049	0.128	4.314	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Lees Ferry
11/7/1990 0013-0113 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-3)	3	0.085
Cyclopoid copepod	(1-2)	24	0.176
Chironomidae (adult)	3	1	0.097
Oligochaeta	(1-2)	4	2.210
		Total 32	2.568

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	7	24	0	0	0	1	0	0
Weight	0	2.295	0.176	0	0	0	0.097	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	7	0	0	0	1	24	0	0
Weight	0	2.295	0	0	0	0.097	0.176	0	0

Paria River near mouth
11/5/1990 0622-0722 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae Phylloxeridae (nymph and adult)	(1-2)	32	7.428
Chironomidae (adult)	(2-3)	14	1.084
Hydracarina	1	1	0.122
Baetis	3	1	0.109
Formicidae (ants)	1	1	0.188
Diptera (terrestrials and adults)	(1-2)	5	1.168
Thysanoptera (thrips)	1	1	0.010
		Total 55	10.109

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	0	0	1	0	53	0	0
Weight	0	0.109	0	0	0.122	0	9.878	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	1	0	1	53	0	0	0
Weight	0	0	0.109	0	0.122	9.878	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth

11/5/1990 1210-1310 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-3)	2	0.072
Chironomidae (adult)	(1-3)	24	1.266
Aquatic Diptera Adults	(1-2)	5	1.168
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	78	13.481
Cnephia	2	1	0.027
Hymenoptera (terrestrial, adult and nymph)	1	2	0.111
Homoptera (terrestrial, adult and nymphs)	2	1	0.433
Baetis sp.	4	3	0.645
Terrestrial mite	1	8	0.973
Thysanoptera (thrips)	1	5	0.084
		Total 129	18.260

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	5	1	0	8	0	115	0	0
Weight	0	0.717	0.027	0	0.973	0	16.542	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	2	3	0	8	115	0	0	0
Weight	0.027	0.072	0.645	0	0.973	16.542	0	0	0

11/5/1990 1855-1955 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-3)	21	3.797
Chironomidae (adult)	(2-3)	7	0.569
Baetis	(3-4)	2	0.377
Aquatic Diptera Adults	(1-2)	2	0.422
		Total 32	5.165

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	0	0	0	0	30	0	0
Weight	0	0.377	0	0	0	0	4.787	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	2	0	0	30	0	0	0
Weight	0	0	0.377	0	0	4.787	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth

11/6/1990 0022-0122 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(1-2)	9	0.601
Aquatic Hymenoptera	1	1	0.055
Aquatic Diptera (adult)	(1-2)	3	0.974
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	14	2.267
Baetis sp.	4	1	0.268
Baetidae	3	3	0.334
Terrestrial mite	1	1	0.122
Formicidae (ants)	1	1	0.050
Hydropsyche	(8-11)	2	5.113
		Total 35	9.784

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	4	2	0	1	0	27	0	1
Weight	0	0.602	5.113	0	0.122	0	3.893	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	0	4	1	1	27	0	0	0
Weight	5.113	0	0.602	0.055	0.122	3.893	0	0	0

11/6/1990 0805 0905 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(1-3)	12	0.537
Aquatic Hymenoptera	1	1	0.055
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	77	11.107
Baetis sp.	4	1	0.268
Terrestrial mite	1	5	0.608
Formicidae (ants)	2	1	0.188
Orthocladiinae	4	1	0.071
Hydracarina	1	1	0.122
Homoptera (terrestrials, adults and nymphs)	3	1	1.072
Thysanoptera	(1-2)	2	0.055
		Total 102	14.083

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	0	0	6	0	93	0	1
Weight	0	0.339	0	0	0.730	0	12.959	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	1	1	1	6	93	0	0	0
Weight	0	0.071	0.268	0.055	0.730	12.959	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth

11/6/1990 1215-1315 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(0-3)	4	0.387
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	21	4.084
Baetis sp.	4	2	0.536
Terrestrial mite	1	2	0.244
		Total 29	5.251

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	0	0	2	0	25	0	0
Weight	0	0.536	0	0	0.244	0	4.472	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	2	0	2	25	0	0	0
Weight	0	0	0.536	0	0.244	4.472	0	0	0

11/6/1990 1845-1945 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(2-4)	118	7.416
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	445	78.564
Aquatic Diptera (adults)	(2-3)	5	2.808
Formicidae (ants).	(2-3)	7	2.348
Petrophila (=Paragyractus)	2	3	0.077
Orthocladiinae	(2-3)	2	0.050
Diptera (terrestrials and adults)	(2-5)	6	4.700
Thysanoptera (thrips)	(1-2)	4	0.110
Baetis sp.	(3-5)	11	4.041
Hydracarina	1	1	0.122
Terrestrial Isopoda	11	1	7.596
Homoptera (terrestrials, nymphs & adults)	(3-4)	4	5.326
Arachnida	2	1	0.656
Hydropsyche	7	1	0.922
Terrestrial mite	1	1	0.122
		Total 610	114.858

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	13	1	3	2	0	591	0	0
Weight	0	4.091	0.922	0.077	0.244	0	109.523	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	2	11	0	2	591	0	0	0
Weight	0.999	0.050	4.041	0	0.244	109.523	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth

11/6/1990 2345-0045 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(2-3)	13	0.772
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	29	5.771
Plecoptera nymph (filipalian slender)	1	1	0.009
Baetis sp.	5	2	1.100
Hydropsyche	9	1	1.996
		Total 46	9.648

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	2	1	0	0	0	42	0	0
Weight	0.009	1.100	1.996	0	0	0	6.542	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	0	2	0	1	42	0	0	0
Weight	1.996	0	1.100	0	0.009	6.542	0	0	0

Colorado River above Little Colorado River

11/5/1990 0835-0935hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-5)	432	20.964
Orthocladiinae	(2-5)	6	0.215
Thysanoptera (thrips)	1	1	0.010
Cyclopoid copepod	(0-2)	316	1.733
Hydra	(1-2)	8	0.397
Daphnia	(1-2)	4	0.487
		Total 767	23.806

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	6	753	0	8	0	1	0	0
Weight	0	0.215	23.189	0	0.397	0	0.010	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	442	6	0	0	0	1	321	0	0
Weight	21.361	0.215	0	0	0	0.010	2.225	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River

11/5/1990 1352-1452hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-6)	1,023	24.640
Orthocladiinae	(2-5)	19	0.499
Cyclopoid copepod	(0-2)	386	2.124
Hydra	1	2	0.082
Gammarus	11	1	7.596
		Total 1,434	35.257

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	19	1,409	0	2	0	3	0	0
Weight	7.596	0.499	26.763	0	0.082	0	0.317	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1,025	20	0	0	0	3	386	0	0
Weight	24.721	8.095	0	0	0	0.317	2.124	0	0

11/5/1990 1915-2015 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-6)	126	9.862
Orthocladiinae	(2-8)	10	0.771
Thysanoptera (thrips)	1	2	0.020
Cyclopoid copepod	(0-2)	279	1.659
Hydra	(1-2)	10	0.461
Chironomidae (adult)	(2-3)	3	0.182
Chironomidae (pupae)	2	1	0.043
Gammarus	(3-5)	4	2.218
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.616
Cnephia	(1-7)	206	15.108
Coleoptera (terrestrials, adults & pupae)	1	1	1.362
Diptera (terrestrials & adults)	1	1	0.325
		Total 647	32.627

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	4	10	611	0	10	0	11	1	0
Weight	2.218	0.771	26.630	0	0.461	0	2.503	0.043	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	342	14	1	0	0	11	279	0	0
Weight	25.432	2.989	0.043	0	0	2.503	1.659	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River

11/6/1990 0105-0205 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(2-5)	12	1.061
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
Diptera (terrestrials and adults)	2	1	0.325
Orthocladiinae	3	1	0.036
		Total 15	1.519

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	12	0	0	0	2	0	0
Weight	0	0.036	1.061	0	0	0	0.422	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	12	1	0	0	0	2	0	0	0
Weight	1.061	0.036	0	0	0	0.422	0	0	0

11/6/1990 0705-0805 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(0-4)	299	6.482
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.616
Orthocladiinae	(1-6)	20	0.863
Chironomidae (adult)	(1-4)	5	0.372
Chironomidae (pupae)	(3-4)	5	0.808
Gammarus	(2-7)	5	0.547
Diamesinae	(1-6)	4	0.277
Cyclopoid copepod	(0-2)	916	4.480
Hydra	1	13	0.531
Hydracarina	1	1	0.122
Daphnia	1	1	0.122
Homoptera (nymphs, adults and terrestrials)	(1-2)	2	0.542
Oligochaeta	(1-3)	4	0.266
Thysanoptera (thrips)	(1-2)	8	0.113
Simuliidae (adults)	(4-5)	2	3.401
Aquatic Hymenoptera	1	2	0.111
		Total 1,291	22.600

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	5	28	1,216	0	14	0	21	5	0
Weight	3.547	1.355	11.082	0	0.653	0	5.043	0.808	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	316	29	5	2	1	21	917	0	0
Weight	7.240	4.675	0.808	0.111	0.122	5.043	4.601	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River
11/6/1990 1252-1352 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-6)	73	4.581
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	2	0.422
Orthocladiinae	(1-6)	15	0.692
Chironomidae (adult)	(2-4)	10	1.345
Chironomidae (pupae)	2	1	0.043
Gammarus	(2-4)	4	0.771
Cyclopoid copepod	(0-2)	773	4.137
Hydra	(0-2)	38	1.592
Daphnia	1	3	0.365
Oligochaeta	4	1	0.119
Thysanoptera (thrips)	(1-2)	34	0.399
Simuliidae (adults)	4	1	1.304
Diptera (terrestrial and adults)	2	1	0.325
Baetidae	3	1	0.109
Chydorid cladoceran	1	2	0.243
		Total 959	16.245

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	17	851	0	38	0	48	1	0
Weight	0.771	0.920	9.326	0	1.092	0	3.794	0.043	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	111	20	2	0	0	48	778	0	0
Weight	6.172	1.582	0.152	0	0	3.794	4.746	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River

11/6/1990 1900-2000 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-6)	209	8.478
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.746
Orthocladiinae	(1-5)	11	0.431
Chironomidae (adult)	(3-4)	2	0.275
Chironomidae (pupae)	3	1	0.097
Gammarus	6	1	1.325
Cyclopoid copepod	(0-2)	331	1.960
Hydra	(0-2)	27	1.179
Daphnia	(1-2)	5	1.362
Oligochaeta	(2-4)	3	0.260
Thysanoptera (thrips)	(1-2)	3	0.100
Aquatic Hymenoptera	1	1	0.055
Chydorid cladoceran	1	2	0.244
		Total 599	16.512

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	14	547	0	27	0	8	1	1
Weight	1.325	0.692	12.044	0	1.179	0	1.121	0.097	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	236	15	1	1	0	8	338	0	0
Weight	9.658	2.017	0.097	0.055	0	1.121	2.566	0	0

Colorado River above Little Colorado River

11/7/1990 0058-0158 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(0-7)	428	14.031
Orthocladiinae	(1-3)	16	0.269
Chironomidae (adult)	(2-5)	9	0.874
Cyclopoid copepod	(0-2)	2,204	11.327
Hydra	(1-2)	42	1.770
Daphnia	(1-2)	7	0.269
Oligochaeta	2	1	0.058
		Total 2,707	29.917

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	17	2,637	0	420	0	9	0	0
Weight	0	0.327	26.945	0	1.770	0	0.874	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	470	17	0	0	0	9	2,211	0	0
Weight	15.783	0.327	0	0	0	0.874	12.032	0	0

Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona--Continued

Little Colorado River near mouth

11/5/1990 0725-0825 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	8	1.459
		Total 8	1.459

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	0	0	0	0	8	0	0
Weight	0	0	0	0	0	0	1.459	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	8	0	0	0
Weight	0	0	0	0	0	1.459	0	0	0

11/6/1990 1240-1340 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium	(1-2)	3	0.058
Aphidae, Phylloxeridae (nymph and adult)	(2-3)	4	1.299
Orthocladiinae	4	1	0.071
Hydracarina	1	1	0.122
Hymenoptera	4	1	0.778
Chironomidae	(2-3)	2	0.139
		Total 12	2.467

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	3	0	1	0	7	0	0
Weight	0	0.071	0.058	0	0.122	0	2.217	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	3	1	0	0	1	7	0	0	0
Weight	0.058	0.071	0	0	0.122	2.217	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Little Colorado River near mouth

11/6/1990 0020-0120 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aquatic insect egg	0	85	0.498
Orthocladiinae	6	1	0.196
Ostracoda	1	1	0.122
		Total 87	0.816

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	0	0	0	0	0	85	0
Weight	0	0.317	0	0	0	0	0	0.498	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	1	0	0	86	0	0	0	0
Weight	0	0.196	0	0	0.620	0	0	0	0

Colorado River at Grand Canyon

11/5/1990 0630-0730 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	2	1	0.014
Cyclopoid copepod	1	2	0.011
Simulium tuberosa	(1-3)	4	0.119
Hydra	1	1	0.041
		Total 8	0.185

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	6	0	1	0	0	0	0
Weight	0	0.014	0.129	0	0.041	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	1	0	0	0	0	2	0	0
Weight	0.160	0.014	0	0	0	0	0.011	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Little Colorado River near mouth

11/6/1990 0020-0120 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aquatic insect egg	0	85	0.498
Orthocladiinae	6	1	0.196
Ostracoda	1	1	0.122
		Total 87	0.816

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	0	0	0	0	0	85	0
Weight	0	0.317	0	0	0	0	0	0.498	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	1	0	0	86	0	0	0	0
Weight	0	0.196	0	0	0.620	0	0	0	0

Colorado River at Grand Canyon

11/5/1990 0630-0730 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	2	1	0.014
Cyclopoid copepod	1	2	0.011
Simulium tuberosa	(1-3)	4	0.119
Hydra	1	1	0.041
		Total 8	0.185

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	6	0	1	0	0	0	0
Weight	0	0.014	0.129	0	0.041	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	1	0	0	0	0	2	0	0
Weight	0.160	0.014	0	0	0	0	0.011	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at Grand Canyon

11/5/1990 1210-1310 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(2-3)	3	0.236
Aphidae, Phylloxeridae Nymph and adult	(1-2)	3	0.518
Alisotrichia	2	1	0.104
Aquatic Diptera adults	1	1	0.097
Simulium tuberosa	(1-5)	337	14.852
Cyclopoid copepod	(0-2)	167	0.783
Daphnia	1	2	0.243
Empididae	3	1	0.036
Hydracarina	1	2	0.243
Hydra	(0-2)	11	0.490
Orthocladiinae	(2-6)	41	3.220
Tanypodinae	2	1	0.014
		Total 570	20.836

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	41	506	0	15	1	7	0	0
Weight	0	3.220	15.878	0	0.783	0.104	0.852	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	348	41	0	1	4	7	169	0	0
Weight	15.342	3.220	0	0.104	0.293	0.852	1.026	0	0

11/5/1990 1800-1900 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(3-7)	7	1.231
Cyclopoid copepod	(0-2)	51	0.330
Daphnia	1	1	0.122
Diptera (terrestrials and adults)	1	1	0.097
Gammarus	13	1	12.409
Diptera	2	2	0.649
Homoptera	4	1	2.111
Simulium	(1-6)	67	5.553
Thysanoptera (thrips)	1	1	0.010
		Total 130	22.512

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	7	119	0	0	0	5	0	0
Weight	12.409	1.231	6.005	0	0	0	2.866	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	67	8	0	0	0	5	52	0	0
Weight	5.553	13.640	0	0	0	2.866	0.451	0	0

Colorado River at Grand Canyon

11/6/1990 0000-0100 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	3	1	0.097
Chironomidae (pupae)	(3-4)	3	0.452
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Simulium tuberosa	(1-6)	24	2.342
Cyclopoid copepod	(0-2)	86	0.453
Gammarus	(5-8)	2	3.805
Hydracarina	(0-1)	3	0.249
Hydra	1	4	0.164
Orthocladiinae	(4-6)	4	0.586
Thysanoptera (thrips)	1	1	0.010
		Total 129	8.483

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	2	4	110	0	7	0	3	3	0
Weight	3.805	0.586	2.795	0	0.413	0	0.431	0.452	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	28	6	3	0	3	3	86	0	0
Weight	2.505	4.391	0.452	0	0.249	0.431	0.453	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/5/1990 0842-0942 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis	(1-5)	21	1.214
Orthocladiinae	(2-7)	16	0.880
Simulium	(1-4)	3	0.280
Ephemeroptera subimagos	(4-5)	2	0.818
Tanypodinae	2	3	0.042
Aphidae, Phylloxeridae (nymph and adult)	1	2	0.194
Chironomidae (adult)	(1-3)	7	0.323
Collembola	1	2	0.017
Ochrotrichia	(2-4)	3	1.281
Trichoptera (adults)	2	2	0.505
Ostracoda	(1-2)	9	2.226
Plecoptera nymph (filipalian, slender)	2	1	0.040
Glossosomatidae Culoptila	(1-2)	7	0.483
Micropcylloepus (larvae)	(2-3)	2	0.174
Petrophila (Paragyractus)	5	1	0.335
Oligochaeta	15	1	5.972
Aquatic insect eggs	0	19	0.111
		Total 101	14.895

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	49	3	10	3	3	13	19	0
Weight	0.040	10.309	0.280	0.991	0.042	1.281	1.84	0.111	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	13	17	21	3	32	15	0	0	0
Weight	1.271	6.851	1.214	1.281	2.420	1.857	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/5/1990 1434-1534 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(1-4)	40	2.281
Chironomidae (pupae)	(1-2)	2	0.055
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	13	3.309
Hydracarina	1	2	0.243
Thysanoptera (thrips)	1	1	0.010
Diptera(terrestrials and adults)	(1-5)	8	3.686
Baetis sp.	(1-4)	9	1.099
Ephemeroptera subimagos	(3-5)	6	2.014
Alisotrichia	(1-4)	4	0.995
Leucotrichia	(3-4)	4	2.047
Micropcylloepus larvae	2	4	0.159
Trichoptera adults	(2-4)	5	2.817
Ostracoda	(1-2)	5	0.985
Simulium	(0-4)	4	0.384
Collembola	1	2	0.017
Petrophila (Paragyractus)	(3-5)	5	1.095
Glossosomatidae Culoptila	(0-2)	5	0.356
Ochrotrichia	(2-3)	2	0.384
Thysanoptera (thrips)	1	1	0.010
Aquatic insect eggs	0	31	0.182
		Total 176	23.661

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	40	4	18	6	2	73	33	0
Weight	0	3.643	0.384	3.657	1.239	0.384	14.117	0.237	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	26	24	11	2	38	75	0	0	0
Weight	5.037	1.542	1.154	0.384	1.410	14.134	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/5/1990 1800-1900 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(1-4)	9	1.099
Orthocladiinae	(2-6)	24	1.542
Simulium	(1-4)	4	0.384
Ephemeroptera subimagos	(3-5)	6	2.014
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	13	3.309
Chironomidae (adult)	(1-4)	40	2.281
Chironomidae (pupae)	(1-2)	2	0.055
Collembola	1	2	0.017
Ochrotrichia	(2-3)	2	0.384
Trichoptera (adults)	(2-4)	5	2.817
Ostracoda	(1-2)	5	0.985
Glossosomatidae Culoptila	(1-2)	5	0.356
Micropcylloepus	2	4	0.159
Petrophila (Paragyractus	(3-5)	5	1.095
Aquatic insect eggs	0	31	0.182
Thysanoptera (thrips)	1	1	0.010
Diptera (terrestrials and adults)	(1-5)	8	3.686
Alisotrichia	(1-4)	4	0.995
Leucotrichia	(3-4)	4	2.047
Hydracarina	1	2	0.243
		Total 177	23.660

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	40	4	18	6	2	73	33	0
Weight	0	3.643	0.384	3.657	1.239	0.384	14.117	0.237	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	26	24	11	2	38	75	0	0	0
Weight	5.037	1.542	1.154	0.384	1.410	14.134	0	0	0

Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona--Continued

Bright Angel Creek near mouth
11/6/1990 0130-0230 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(2-3)	18	1.094
Chironomidae (pupae)	(2-3)	3	0.236
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	11	2.660
Diptera(terrestrials and adults)	(2-4)	9	4.691
Baetis sp.	(1-5)	26	3.879
Trichoptera adults	(2-3)	2	0.922
Ostracoda	(1-2)	5	1.739
Simuliidae (adults)	(1-5)	7	3.192
Collembola	1	2	0.017
Petrophila (Paragyractus)	(3-4)	2	0.251
Glossosomatidae Culoptila	1	1	0.023
Aquatic Diptera adults	5	1	0.720
Hydropsyche	3	1	0.077
Orthocladiinae	(2-3)	2	0.050
Stenelmis	2	1	0.040
		Total 91	19.590

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	35	1	4	0	0	48	3	0
Weight	0	5.685	0.077	0.313	0	0	13.279	0.236	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	2	29	0	5	50	0	0	0
Weight	0.390	0.050	4.115	0	1.739	13.296	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/6/1990 0836-0936 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(1-4)	7	0.458
Orthocladiinae	(2-4)	23	1.020
Simulium	(3-7)	3	1.243
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	5	0.712
Chironomidae (adult)	(1-3)	6	0.280
Chironomidae (pupae)	(1-3)	3	0.182
Ochrotrichia	3	1	0.280
Ostracoda	(1-2)	8	2.104
Micropcylloepus (larvae)	1	1	0.134
Petrophila (Paragyractus)	(3-5)	3	0.586
Physa	2	2	0.028
Oligochaeta	(10-11)	2	2.445
Leucotrichia	4	1	0.589
		Total 65	10.062

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	40	3	7	0	1	11	3	0
Weight	0	6.027	1.243	1.337	0	0.280	0.993	0.182	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	10	25	10	1	8	11	0	0	0
Weight	2.580	3.465	0.641	0.280	2.104	0.993	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/6/1990 1345-1445 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(1-6)	153	9.608
Chironomidae (pupae)	(1-4)	11	0.676
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	6	1.265
Baetis sp.	(1-3)	3	0.147
Trichoptera adults	(2-4)	12	10.503
Simulium	(2-4)	3	0.246
Petrophila (Paragyractus)	5	1	0.335
Glossosomatidae Culoptila	(2-3)	2	0.384
Orthocladiinae	(2-4)	8	0.334
Ephemeroptera	(4-6)	30	18.808
Alisotrichia	2	1	0.104
Ochrotrichia	2	1	0.104
Oligochaeta	4	1	0.119
Micropcylloepus	2	1	0.040
		Total 233	42.673

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	12	3	4	0	2	201	11	0
Weight	0	0.600	0.246	0.758	0	0.207	40.184	0.676	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	7	9	14	2	0	201	0	0	0
Weight	1.004	0.453	0.823	0.207	0	40.184	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/6/1990 1800-1900 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(0-6)	39	13.911
Orthocladiinae	(2-3)	14	0.598
Simulium	(5-6)	2	0.572
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
Chironomidae (adult)	(2-3)	3	0.236
Chironomidae (pupae)	(2-3)	3	0.236
Ostracoda	(1-2)	11	3.600
Micropcylloepus (larvae)	2	3	0.119
Petrophila (Paragyractus)	3	2	0.153
Collembola	1	1	0.009
Alisotrichia	1	1	0.023
Glossosomatidae Culoptila	2	2	0.207
Hydropsyche	7	1	0.922
Pisidium	1	1	0.122
Hemiptera (nymphs and adults)	3	1	0.857
Elmidae(larvae)	2	1	0.040
Oligochaeta	10	1	1.007
		Total 87	22.709

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	67	4	7	0	1	5	3	0
Weight	0	19.164	1.616	0.479	0	0.023	1.190	0.236	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	11	16	42	1	11	6	0	0	0
Weight	2.013	1.726	14.147	0.023	3.600	1.199	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/7/1990 0115-0215 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (pupae)	2	1	0.043
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	2	0.422
Baetis sp.	(1-6)	28	6.949
Trichoptera adults	3	1	0.670
Simulium	7	1	1.078
Petrophila (Paragyractus)	(3-4)	3	0.327
Orthocladiinae	(3-4)	3	0.178
Ostracoda	(1-2)	11	2.846
Leucotrichia	3	1	0.280
Tanypodinae	3	1	0.036
Collembola	1	1	0.009
Micropcylloepus (larvae)	(2-4)	3	0.506
Alisotrichia	1	1	0.023
Tipulidae	1	1	0.000
		Total 58	13.367

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	43	1	7	1	1	3	1	0
Weight	0	9.982	1.078	1.113	0.036	0.023	1.092	0.043	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	8	4	29	1	12	4	0	0	0
Weight	2.191	0.178	6.992	0.023	2.882	1.100	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Kanab Creek

11/5/1990 1242-1342 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simuliidae (pupae)	3	1	0.083
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	8	1.686
Simulium tuberosa	(1-3)	8	0.471
Cyclopoid copepod	(0-1)	32	0.158
Chironomidae (adult)	(1-3)	4	0.165
Chironomidae (pupae)	4	1	0.178
Thysanoptera (thrips)	1	2	0.019
Aquatic Hymenoptera	1	1	0.055
Diptera (terrestrial pupae)	2	1	0.058
		Total 58	2.873

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	40	0	0	0	15	2	1
Weight	0	0	0.628	0	0	0	1.928	0.260	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	9	0	1	1	0	15	32	0	0
Weight	0.553	0	0.178	0.055	0	1.928	0.158	0	0

11/5/1990 1815-1906 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	14	1	15.443
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Chironomidae (adult)	2	1	0.043
Cnephia	(1-3)	8	0.414
Thysanoptera (thrips)	1	1	0.010
Hydra	(1-2)	3	0.140
Tanypodinae	1	1	0.003
Petrophila (Paragyractus)	2	1	0.026
		Total 17	16.404

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	0	8	1	4	0	3	0	0
Weight	15.443	0	0.414	0.026	0.144	0	0.377	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	12	1	0	0	1	3	0	0	0
Weight	0.580	15.443	0	0	0.003	0.377	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Kanab Creek

11/5/1990 2316-0005 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simuliidae (pupae)	1	1	0.005
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.747
Cnephia	(2-5)	30	2.558
Cyclopoid copepod	1	3	0.016
Orthocladinae	(2-6)	5	0.383
Hydracarina	1	1	0.122
Hydra	1	3	0.123
Gammarus	(5-13)	3	13.997
		Total 49	17.951

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	5	34	0	4	0	3	0	0
Weight	13.997	0.383	2.579	0	0.245	0	0.747	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	34	8	0	0	1	3	3	0	0
Weight	2.686	14.380	0	0	0.122	0.747	0.016	0	0

11/6/1990 0705-0800 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	11	1	7.596
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
Hydracarina	1	3	0.364
Simulium tuberosa	(1-4)	26	1.128
Thysanoptera (thrips)	1	2	0.020
Hydra	(1-2)	2	0.099
Cyclopoid copepod	2	1	0.033
		Total 36	9.337

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	0	27	0	5	0	3	0	0
Weight	7.596	0	1.160	0	0.464	0	0.117	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	28	1	0	0	3	3	1	0	0
Weight	1.227	7.596	0	0	0.365	0.117	0.033	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Kanab Creek

11/6/1990 1211-1311 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(0-1)	2	0.104
Simulium tuberosa	(1-5)	83	4.517
Cyclopoid copepod	1	1	0.005
Hydra	1	2	0.082
Thysanoptera (thrips)	1	1	0.010
		Total 89	4.718

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	84	0	2	0	3	0	0
Weight	0	0	4.522	0	0.082	0	0.114	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	85	0	0	0	0	3	1	0	0
Weight	4.599	0	0	0	0	0.114	0.005	0	0

11/6/1990 1730-1830 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	12	1	9.804
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.615
Simulium tuberosa	(1-4)	21	0.980
		Total 26	11.399

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	0	21	0	0	0	4	0	0
Weight	9.804	0	0.980	0	0	0	0.615	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	21	1	0	0	0	4	0	0	0
Weight	0.980	9.804	0	0	0	0.615	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Kanab Creek
11/6/1990 2335-0100 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.518
Simulium tuberosa	(2-6)	14	2.096
Gammarus	9	1	4.232
Thysanoptera (thrips)	1	1	0.010
Baetis sp.	5	1	0.550
Orthocladiinae	(3-4)	3	0.230
Chironomidae (adult)	3	3	0.290
Chironomidae (pupae)	4	1	0.178
Antocha	3	1	0.009
		Total 28	8.113

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	5	14	0	0	0	7	1	0
Weight	4.232	0.789	2.096	0	0	0	0.818	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	15	4	2	0	0	7	0	0	0
Weight	2.105	4.463	0.728	0	0	0.818	0	0	0

Kanab Creek near mouth
11/5/1990 0638-0740 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Araneida (spiders)	1	1	0.147
		Total 1	0.147

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	0	0	0	0	1	0	0
Weight	0	0	0	0	0	0	0.147	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	1	0	0	0
Weight	0	0	0	0	0	0.147	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Kanab Creek near mouth

11/5/1990 1225-1325 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	1	3	0.291
Thysanoptera (thrips)	(1-2)	2	0.055
Orthocladiinae	(2-3)	11	0.234
Chironomidae (adult)	(1-2)	3	0.098
Aquatic Hymenoptera	1	3	0.166
Hydracarina	1	2	0.243
Simuliidae (larvae)	1	1	0.005
		Total 25	1.092

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	11	1	0	2	0	8	0	3
Weight	0	0.234	0.005	0	0.243	0	0.443	0	0.166

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	11	0	3	2	8	0	0	0
Weight	0.005	0.234	0	0.166	0.243	0.443	0	0	0

11/5/1990 1821-1927 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	5	0.712
Chironomidae (adult)	(1-3)	8	0.275
Chironomidae (pupae)	2	1	0.043
Simulium tuberosa	(2-4)	10	1.100
Thysanoptera (thrips)	1	4	0.038
Hydroptilidae	2	1	0.104
Aquatic Hymenoptera	(0-1)	4	0.170
Tanypodinae	2	1	0.014
Simulium	(3-5)	3	0.488
Orthocladiinae	(1-4)	9	0.173
		Total 46	3.117

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	9	13	0	1	1	17	1	4
Weight	0	0.173	1.588	0	0.014	0.104	1.026	0.043	0.17

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	14	9	1	4	1	17	0	0	0
Weight	1.692	0.173	0.043	0.170	0.014	1.026	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Kanab Creek near mouth

11/5/1990 2326-0023 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Simulium tuberosa	(2-3)	5	0.301
Hydracarina	0	1	0.006
Orthocladiinae	(1-3)	7	0.110
Chironomidae (adult)	3	1	0.097
Thysanoptera (thrips)	1	3	0.029
Aquatic Diptera adults	(1-5)	3	2.291
		Total 21	3.159

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	7	5	0	1	0	8	0	0
Weight	0	0.110	0.301	0	0.006	0	2.741	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	7	0	0	1	8	0	0	0
Weight	0.301	0.110	0	0	0.006	2.741	0	0	0

11/6/1990 0715-0815 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	11	1.294
Chironomidae (adult)	(1-2)	3	0.068
Cnephia	2	2	0.053
Thysanoptera (thrips)	1	4	0.039
Aquatic Hymenoptera	1	1	0.055
Orthocladiinae	(1-4)	7	0.188
Hydracarina	1	1	0.122
Diptera (terrestrial and adults)	3	1	0.720
Lepidoptera (terrestrial and larvae)	0	1	0.001
		Total 31	2.540

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	7	2	0	1	0	20	0	1
Weight	0	0.188	0.053	0	0.122	0	2.122	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	7	0	1	1	20	0	0	0
Weight	0.053	0.188	0	0.055	0.122	2.122	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Kanab Creek near mouth

11/6/1990 1247-1341 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	9	1.555
Orthocladiinae	(2-3)	12	0.255
Thysanoptera (thrips)	1	1	0.010
Tanypodinae	3	1	0.036
Cyclopoid copepod	2	1	0.033
Baetis sp.	1	1	0.005
		Total 25	1.894

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	13	1	0	1	0	10	0	0
Weight	0	0.260	0.033	0	0.036	0	1.565	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	12	1	0	1	10	1	0	0
Weight	0	0.255	0.005	0	0.036	1.565	0.033	0	0

11/6/1990 1748-1835 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	11	1.432
Chironomidae (adult)	(1-3)	4	0.195
Chironomidae (pupae)	2	1	0.043
Simulium tuberosa	(2-3)	2	0.109
Thysanoptera (thrips)	1	1	0.010
Orthocladiinae	(2-3)	6	0.128
Tanypodinae	(1-2)	2	0.018
		Total 27	1.935

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	6	2	0	2	0	16	1	0
Weight	0	0.128	0.109	0	0.018	0	1.637	0.043	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	6	1	0	2	16	0	0	0
Weight	0.109	0.128	0.043	0	0.018	1.637	0	0	0

Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona--Continued

Kanab Creek near mouth

11/6/1990 2345-0040 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.518
Orthocladiinae	(1-6)	18	1.196
Simulium tuberosa	(2-4)	2	0.219
Simuliidae (larvae)	1	2	0.009
Chironomidae (adult)	1	1	0.012
		Total 26	1.954

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	18	4	0	0	0	4	0	0
Weight	0	1.196	0.229	0	0	0	0.531	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	18	0	0	0	4	0	0	0
Weight	0.229	1.196	0	0	0	0.531	0	0	0

Colorado River above Havasu Creek

11/5/1990 0845-0945 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(5-11)	2	8.390
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	8	1.596
Chironomidae (adult)	(2-4)	3	0.183
Chironomidae (pupae)	4	1	0.178
Simulium tuberosa	(2-4)	6	0.660
Tipulidae adults	5	1	2.097
Hydra	1	8	0.327
Cyclopoid copepod	(0-3)	7	0.114
Orthocladiinae	4	1	0.071
Baetis	4	1	0.268
Homoptera (terrestrials, nymphs and adults)	4	1	2.111
		Total 39	15.994

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	2	2	13	0	8	0	13	1	0
Weight	8.390	0.339	0.773	0	0.327	0	5.986	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	14	3	2	0	0	13	7	0	0
Weight	0.987	8.461	0.446	0	0	5.986	0.114	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Havasu Creek

11/5/1990 1445-1545 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	6	1.265
Cnephia (S. Tuberosa)	2	2	0.053
Cyclopoid copepod	1	3	0.016
Hydra	(1-2)	5	0.222
Diptera (terrestrial and adults)	2	1	0.325
Chironomidae (adult)	(2-3)	2	0.139
Thysanoptera (thrips)	1	1	0.010
		Total 20	2.029

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	5	0	5	0	10	0	0
Weight	0	0	0.069	0	0.222	0	1.738	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	7	0	0	0	0	10	3	0	0
Weight	0.275	0	0	0	0	1.738	0.016	0	0

11/5/1990 1920-2025 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	8	1	3.011
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	11	1.750
Chironomidae (adult)	(2-4)	9	0.628
Simulium tuberosa	(2-9)	28	7.909
Cyclopoid copepod	(1-2)	4	0.076
Orthocladiinae	3	1	0.036
Homoptera (terrestrials, nymphs and adults)	2	1	0.433
Thysanoptera (thrips)	1	2	0.019
Diptera (terrestrials and adults)	2	2	0.650
Coleoptera (terrestrials adults and pupae)	3	1	1.362
Araneida (spiders)	1	1	0.147
Simuliidae	4	1	1.304
		Total 62	17.323

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	1	32	0	0	0	28	0	0
Weight	3.011	0.036	7.985	0	0	0	6.291	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	28	2	0	0	0	28	4	0	0
Weight	7.909	3.047	0	0	0	6.291	0.076	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Havasu Creek

11/6/1990 0855-0955 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	3	1	0.199
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.518
Chironomidae (adult)	(2-3)	2	0.139
Simulium tuberosa	(1-8)	92	10.575
Hydra	2	1	0.058
Cyclopoid copepod	(0-2)	37	0.244
Orthocladiinae	(1-6)	3	0.234
Homoptera (adult, nymph and terrestrial)	2	1	0.433
Thysanoptera (thrips)	1	5	0.048
Hydracarina	1	1	0.122
Aquatic Hymenoptera	1	1	0.055
Hymenoptera (adult, pupae and terrestrial)	1	1	0.055
Diptera (adult and terrestrial)	2	1	0.325
		Total 149	13.007

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	3	129	0	2	0	13	0	1
Weight	0.199	0.234	10.819	0	0.180	0	1.519	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	93	4	0	1	1	13	37	0	0
Weight	10.633	0.434	0	0.055	0.122	1.519	0.244	0	0

11/6/1990 1342-1442 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	10	2.563
Simulium tuberosa	(1-6)	66	8.146
Cyclopoid copepod	(0-2)	48	0.384
Hydra	1	2	0.082
Diptera (adult and terrestrial)	2	2	0.650
Chironomidae (adult)	(2-4)	5	0.538
Thysanoptera (thrips)	(1-2)	2	0.055
Simuliidae (adults)	4	1	1.304
Rhyacophilidae	2	1	0.017
Orthocladiinae	(3-6)	7	0.691
		Total 144	14.430

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	7	114	0	3	0	20	0	0
Weight	0	0.691	8.530	0	0.099	0	5.110	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	69	7	0	0	0	20	48	0	0
Weight	8.245	0.691	0	0	0	5.110	0.384	0	0

Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona--Continued

Colorado River above Havasu Creek

11/6/1990 1842-1942 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	18	3.111
Chironomidae (adult)	(1-3)	12	0.888
Chironomidae (pupae)	(2-3)	2	0.139
Simulium tuberosa	(2-5)	50	3.817
Hydra	1	1	0.041
Cyclopoid copepod	(1-2)	29	0.235
Orthocladiinae	(2-5)	10	0.493
Thysanoptera (thrips)	1	3	0.029
Hydracarina	(0-1)	6	0.614
Hydroptila	1	1	0.104
Diptera (adult and terrestrial)	2	4	1.298
		Total 136	10.769

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	10	79	0	7	1	37	2	0
Weight	0	0.493	4.052	0	0.655	0.104	5.325	0.139	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	52	10	2	0	6	37	29	0	0
Weight	3.962	0.493	0.139	0	0.614	5.325	0.235	0	0

11/7/1990 0100-0230 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	7	1.134
Simulium tuberosa	(1-7)	56	10.478
Cyclopoid copepod	(1-2)	19	0.237
Hymenoptera (terrestrial, adults and pupae)	4	1	0.778
Homoptera (terrestrial, nymphs and adults)	3	1	1.072
Chironomidae (adult)	(2-3)	5	0.321
Chironomidae (pupae)	3	2	0.194
Thysanoptera (thrips)	1	1	0.010
Coleoptera (terrestrials & larvae)	3	1	0.182
Gammarus	(2-10)	6	8.574
Empididae	3	1	0.036
Orthocladiinae	(2-6)	25	1.852
		Total 125	24.868

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	6	25	75	0	1	0	16	2	0
Weight	8.574	1.852	10.715	0	0.036	0	3.497	0.194	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	56	31	2	0	1	16	19	0	0
Weight	10.478	10.425	0.194	0	0.036	3.497	0.237	0	0

Table 13.--Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona--Continued

Havasu Creek near mouth

11/5/1990 0627-0727 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetidae	2	1	0.033
Baetis sp.	(2-5)	17	2.467
Chironomidae (adult)	2	2	0.086
Orthocladiinae	(2-6)	8	0.452
Tanypodinae	3	1	0.036
Formicidae (ants)	3	1	0.446
Simulium	(1-4)	15	0.633
Cyclopoid copepod	1	1	0.005
Heterelmis (adult)	2	3	1.657
		Total 49	5.814

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	29	16	0	1	0	3	0	0
Weight	0	4.608	0.638	0	0.036	0	0.532	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	18	8	18	0	1	3	1	0	0
Weight	2.290	0.452	2.499	0	0.036	0.532	0.005	0	0

11/5/1990 1241-1341 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Orthocladiinae	(2-4)	14	0.419
Simulium	(1-4)	15	0.689
Heterelmis (adult)	2	3	1.657
Baetis sp.	(1-4)	6	0.952
Chironomidae (adult)	(1-3)	6	0.320
Aquatic Hymenoptera	1	1	0.055
Thysanoptera (thrips)	(1-2)	5	0.084
		Total 51	4.400

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	23	15	0	0	0	12	0	1
Weight	0	3.028	0.689	0	0	0	0.628	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	18	14	6	1	0	12	0	0	0
Weight	2.346	0.419	0.952	0.055	0	0.628	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth
11/5/1990 1817-1917 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(0-2)	8	1.141
Baetis sp.	(1-5)	17	2.889
Chironomidae (adult)	(1-3)	3	0.152
Orthocladiinae	(2-5)	9	0.304
Simulium	(1-4)	5	0.333
Homoptera (terrestrials, nymphs and adults)	1	1	1.072
Heterelmis (adult)	(2-3)	9	6.591
Ephemeroptera subimagos	4	1	0.268
Anisoptera (nymph)	1	1	0.057
Diptera (terrestrials and adults)	1	2	0.194
		Total 56	13.001

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	35	5	0	1	0	15	0	0
Weight	0	9.784	0.333	0	0.057	0	2.827	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	14	10	17	0	0	15	0	0	0
Weight	6.924	0.361	2.889	0	0	2.827	0	0	0

Havasu Creek near mouth
11/6/1990 0019-0119 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	1	2	0.194
Orthocladiinae	(2-4)	9	0.306
Simulium tuberosa	(1-2)	5	0.090
Heterelmis (adult)	2	2	1.105
Baetis sp.	(1-5)	24	5.398
Chironomidae (adult)	3	2	0.194
Chironomidae (pupae)	4	1	0.178
Hymenoptera (terrestrial, adults and pupae)	2	1	0.189
Tanypodinae	5	1	0.123
		Total 47	7.775

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	35	5	0	1	0	5	1	0
Weight	0	6.808	0.090	0	0.123	0	0.577	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	7	9	25	0	1	5	0	0	0
Weight	1.195	0.306	5.576	0	0.123	0.577	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth

11/6/1990 0613-0713 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	2	0.422
Baetis sp.	(2-6)	37	2.734
Chironomidae (adult)	(2-4)	3	0.317
Chironomidae (pupae)	(2-4)	3	0.317
Orthocladiinae	(2-4)	8	0.291
Simulium tuberosa	(1-5)	15	1.248
Homoptera (terrestrials, nymphs and adults)	(1-2)	5	1.193
Formicidae (ants)	3	1	0.446
Trichoptera larvae	2	1	0.039
Hebrus(adult)	2	1	0.399
Heterelmis (adult)	2	4	2.210
Mayatrichia	1	1	0.023
Baetidae	1	1	0.005
		Total 82	19.646

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	50	15	0	1	1	11	3	0
Weight	0.039	15.241	1.249	0	0.399	0.023	2.378	0.317	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	19	8	41	2	0	12	0	0	0
Weight	3.459	0.291	13.056	0.062	0	2.778	0	0	0

11/6/1990 1213-1313 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	1	3	0.291
Orthocladiinae	(1-6)	18	0.671
Simulium tuberosa	(2-3)	6	0.216
Heterelmis (adult)	2	5	2.762
Baetis sp.	(2-4)	8	1.592
Chironomidae (adult)	(1-2)	9	0.348
Mayatrichia	1	1	0.023
Ephemeroptera subimagos	5	1	0.550
		Total 51	6.452

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	31	6	0	0	1	13	0	0
Weight	0	5.024	0.216	0	0	0.023	1.189	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	11	18	8	1	0	13	0	0	0
Weight	2.977	0.671	1.592	0.023	0	1.189	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth

11/6/1990 1816-1916 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(2-5)	8	1.873
Chironomidae (adult)	(1-4)	5	0.396
Chironomidae (pupae)	(3-4)	3	0.371
Orthocladiinae	(1-6)	20	0.773
Simulium tuberosa	(2-6)	9	1.749
Homoptera (terrestrials, nymphs and adults)	2	1	0.433
Heterelmis (adult)	(2-4)	6	6.243
Tanypodinae	2	1	0.014
Elmidae (larvae)	2	1	0.040
		Total 54	11.892

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	35	9	0	1	0	6	3	0
Weight	0	8.929	1.749	0	0.014	0	0.828	0.371	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	16	20	11	0	1	6	0	0	0
Weight	8.031	0.773	2.245	0	0.014	0.828	0	0	0

11/7/1990 0032-0132 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-7)	19	1.091
Simulium	(2-5)	9	0.925
Heterelmis (adult)	2	7	3.867
Baetis sp.	(3-5)	11	3.600
Baetidae	1	1	0.005
Chironomidae (adult)	(2-4)	6	0.716
Chironomidae (pupae)	4	1	0.178
Antocha	3	1	0.009
		Total 55	10.391

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	39	9	0	0	0	6	1	0
Weight	0	8.573	0.925	0	0	0	0.716	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	17	19	13	0	0	6	0	0	0
Weight	4.802	1.091	3.783	0	0	0.716	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at National Canyon

11/5/1990 0655-0755 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(3-16)	3	24.459
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	10	1.880
Chironomidae (adult)	(1-3)	4	0.249
Chironomidae (pupae)	4	1	0.178
Orthocladiinae	4	1	0.071
Simulium	(2-3)	5	0.301
Cyclopoid copepod	(0-2)	18	0.134
Thysanoptera (thrips)	(1-2)	5	0.120
Hydracarina	1	2	0.244
Heterelmis (larvae)	3	1	0.134
		Total 50	27.768

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	2	23	0	2	0	19	1	0
Weight	24.459	0.205	0.434	0	0.244	0	2.248	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	4	1	0	2	19	18	0	0
Weight	0.435	24.530	0.178	0	0.244	2.248	0.134	0	0

11/5/1990 1320-1420 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	7	1.361
Thysanoptera (thrips)	(1-2)	4	0.075
Chironomidae (adult)	2	1	0.043
Cyclopoid copepod	1	2	0.011
Aquatic Hymenoptera	1	1	0.055
Coleoptera (terrestrial and larvae)	3	1	0.182
Diptera (terrestrial and adults)	(2-3)	2	1.044
Hydracarina	1	1	0.122
		Total 19	2.892

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	2	0	1	0	15	0	1
Weight	0	0	0.011	0	0.122	0	2.705	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	1	1	15	2	0	0
Weight	0	0	0	0.055	0.122	2.705	0.011	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at National Canyon

11/6/1990 0045-0145 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	5	0.713
Chironomidae (adult)	(2-3)	4	0.333
Orthocladiinae	5	2	0.246
Simulium	(2-3)	8	0.437
Cyclopoid copepod	(0-2)	11	0.162
Hydra	1	1	0.041
		Total 31	1.932

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	19	0	1	0	9	0	0
Weight	0	0.246	0.599	0	0.041	0	1.046	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	9	2	0	0	0	9	11	0	0
Weight	0.478	0.246	0	0	0	1.046	0.162	0	0

11/6/1990 1254-1354 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.843
Thysanoptera (thrips)	(1-2)	6	0.094
Chironomidae (adult)	2	4	0.172
Cyclopoid copepod	(1-4)	16	0.244
Hydra	1	3	0.123
Hydracarina	1	3	0.365
Orthocladiinae	(4-5)	8	0.621
Rhyacophilidae	1	1	0.003
Simulium	(1-6)	24	3.282
		Total 69	5.745

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	8	40	0	7	0	14	0	0
Weight	0	0.621	3.525	0	0.490	0	1.108	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	28	8	0	0	3	14	16	0	0
Weight	3.407	0.621	0	0	0.365	1.108	0.244	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River at National Canyon

11/6/1990 1835-1935 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	10	1.653
Chironomidae (adult)	(2-3)	3	0.182
Orthocladiinae	(2-3)	2	0.050
Simulium	(1-7)	18	3.478
Cyclopoid copepod	(0-2)	6	0.081
Hydra	1	1	0.041
Thysanoptera (thrips)	1	3	0.029
		Total 43	5.513

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	24	0	1	0	16	0	0
Weight	0	0.050	3.559	0	0.041	0	1.863	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	19	2	0	0	0	16	6	0	0
Weight	3.519	0.050	0	0	0	1.863	0.081	0	0

11/7/1990 0036-0106 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	5	0.713
Chironomidae (adult)	(2-3)	5	0.322
Cyclopoid copepod	(0-1)	3	0.010
Orthocladiinae	1	1	0.036
Simulium	(2-4)	4	0.329
Collembola	1	1	0.009
		Total 19	1.418

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	7	0	0	0	10	0	0
Weight	0	0.044	0.339	0	0	0	1.035	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	1	0	0	0	11	3	0	0
Weight	0.329	0.036	0	0	0	1.043	0.010	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Diamond Creek

11/5/1990 0800-0900hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.843
Aquatic Hymenoptera	1	1	0.055
		Total 5	0.898

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	0	0	0	0	4	0	1
Weight	0	0	0	0	0	0	0.843	0	0.055

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	1	0	4	0	0	0
Weight	0	0	0	0.055	0	0.843	0	0	0

11/5/1990 1155-1350 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium tuberosa	(2-3)	4	0.218
Orthocladiinae	4	2	0.142
Hydra	1	1	0.041
Chelifera	2	1	0.014
		Total 8	0.415

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	4	0	2	0	0	0	0
Weight	0	0.142	0.218	0	0.055	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	2	0	0	1	0	0	0	0
Weight	0.259	0.142	0	0	0.014	0	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Diamond Creek

11/5/1990 1700-1800hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.325
		Total 1	0.325

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	0	0	0	0	1	0	0
Weight	0	0	0	0	0	0	0.325	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	1	0	0	0
Weight	0	0	0	0	0	0.325	0	0	0

11/6/1990 1220-1420 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Simulium tuberosa	4	1	0.193
Chironomidae (adult)	(2-3)	4	0.225
Trichoptera (adults)	2	1	0.252
Trichoptera (larvae)	2	1	0.039
Elmidae (larvae)	2	1	0.040
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	3	0.746
Thysanoptera (thrips)	1	1	0.010
		Total 12	1.504

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	1	1	0	2	0	9	0	0
Weight	0.039	0.040	0.193	0	0	0	1.233	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	0	0	1	0	9	0	0	0
Weight	0.232	0.142	0	0.039	0	1.233	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River near Columbine Falls

11/5/1990 0915-1015 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Diptera (terrestrials and adults)	4	1	1.304
		Total 2	1.629

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	0	0	0	0	2	0	0
Weight	0	0	0	0	0	0	1.629	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	0	0	0	0	2	0	0	0
Weight	0	0	0	0	0	1.629	0	0	0

11/5/1990 1330-1430 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	35	8.174
Thysanoptera (thrips)	(1-3)	6	0.245
Simulium	(2-6)	6	1.353
Chironomidae (adult)	(2-3)	2	0.140
Diptera (adult and terrestrial)	(1-2)	4	0.615
Orthocladinae	4	1	0.071
Collembola	1	1	0.009
Hydracarina	1	1	0.122
		Total 56	10.729

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	6	0	1	0	47	0	0
Weight	0	0.080	1.353	0	0.122	0	9.175	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	1	0	0	1	48	0	0	0
Weight	1.353	0.071	0	0	0.122	9.183	0	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River near Columbine Falls
11/5/1990 1925-2025 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (adult)	(3-4)	2	0.274
Chironomidae (pupae)	2	1	0.043
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	23	4.506
Thysanoptera (thrips)	(1-2)	9	0.158
Formicidae (ants)	(1-2)	2	0.238
Staphylinidae (adult only)	3	1	1.362
Corixidae	(4-6)	2	7.799
Orthocladiinae	(2-4)	2	0.085
Simulium	3	1	0.083
Diptera (adult and terrestrial)	1	1	0.097
		Total 44	14.645

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	1	0	1	2	37	1	0
Weight	0	0.085	0.083	0	1.362	7.799	5.274	0.043	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	2	3	0	0	37	0	0	0
Weight	1.445	0.085	7.842	0	0	5.274	0	0	0

11/6/1990 0100-0200 hrs (Single net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	5	1.395
Simulium	5	1	0.379
Diptera (terrestrial and adult)	1	1	0.097
Cyclopoid copepod	(1-2)	2	0.038
		Total 9	1.909

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	3	0	0	0	6	0	0
Weight	0	0	0.417	0	0	0	1.492	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	0	0	0	0	6	2	0	0
Weight	0.379	0	0	0	0	1.492	0.038	0	0

Table 13.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River near Columbine Falls

11/6/1990 0720-0820 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	10	2.563
Thysanoptera (thrips)	1	5	0.048
Simulium	(2-3)	5	0.411
Chironomidae (adult)	2	2	0.086
Micropcylloepus (larvae)	2	1	0.040
Diptera (terrestrial and adults)	1	1	0.097
Terrestrial mite	1	1	0.122
		Total 25	3.367

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	5	1	1	0	18	0	0
Weight	0	0	0.411	0.040	0.122	0	2.794	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	0	0	0	1	18	0	0	0
Weight	0.411	0	0	0	0.122	2.794	0	0	0

11/6/1990 1300-1400 hrs

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	24	6.425
Simulium	(3-5)	2	0.461
Diptera (adult and terrestrial)	2	3	0.974
Thysanoptera (thrips)	(1-2)	12	0.259
Orthocladiinae	(2-3)	4	0.209
Gammarus	2	1	0.071
Chironomidae (adult)	(1-3)	4	0.249
Trichoptera (pupae)	3	1	0.670
		Total 51	9.317

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	4	2	0	0	0	43	1	0
Weight	0.071	0.209	0.461	0	0	0	7.905	0.670	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	3	5	0	0	0	43	0	0	0
Weight	1.132	0.280	0	0	0	7.905	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other]

Colorado River below Glen Canyon Dam
11/4/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(6-22)	270	3,551.894
Physa	(7-9)	2	0.845
Oligochaeta	(12-28)	28	3,490.034
		Total 300	7,042.773

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	270	28	0	2	0	0	0	0	0
Weight	3,551.894	3,490.034	0	0.845	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	298	0	0	0	0	0	0	0
Weight	0.845	7,041.927	0	0	0	0	0	0	0

Colorado River at Lees Ferry
11/3/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(2-19)	227	1,612.007
Orthocladiinae	(3-5)	2	0.159
Nematoda	(35-39)	3	1,984.520
		Total 232	3,596.692

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	227	5	0	0	0	0	0	0	0
Weight	1,612.007	1,984.686	0	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	232	0	0	0	0	0	0	0
Weight	0	3,596.692	0	0	0	0	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Paria River near mouth

11/6/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	0.615
Orthocladiinae	(2-4)	2	0.085
Simulium	6	1	0.665
Capniinae	(2-4)	4	0.568
Hydropsyche	(6-15)	28	95.911
		Total 39	97.844

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	4	2	29	0	0	0	4	0	0
Weight	0.568	0.085	96.577	0	0	0	0.615	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	29	2	0	0	4	4	0	0	0
Weight	96.577	0.085	0	0	0.568	0.615	0	0	0

Colorado River above Little Colorado River

11/5/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(9-13)	5	43.845
Orthocladiinae	(3-7)	3	0.449
		Total 8	44.294

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	5	3	0	0	0	0	0	0	0
Weight	43.845	0.449	0	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	8	0	0	0	0	0	0	0
Weight	0	44.294	0	0	0	0	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Little Colorado River near mouth
11/5/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(0-7)	40	3.110
Hydropsyche	(6-15)	1	1.996
Diptera (terrestrials and adults)	1	1	0.097
Chironomidae (pupae)	4	1	0.178
Baetis sp.	5	1	0.550
Hydracarina	1	1	0.122
Hydroptilidae	1	1	0.023
Ochrotrichia	3	2	0.560
Gammarus	(11-14)	3	32.842
		Total 51	39.478

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	3	41	1	0	1	3	1	1	0
Weight	32.842	3.660	1.996	0	0.122	0.583	0.097	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	43	2	2	1	1	0	0	0
Weight	2.019	35.952	0.728	0.560	0.122	0.097	0	0	0

Colorado River at Grand Canyon
11/5/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(4-14)	26	143.936
Cnephia	9	1	2.392
Baetis sp.	(2-7)	74	54.178
Blepharoceridae Larvae	6	1	0.196
		Total 102	200.701

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	26	74	1	1	0	0	0	0	0
Weight	143.936	54.178	2.392	0.196	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	26	74	0	0	0	0	0	0
Weight	2.587	143.936	54.178	0	0	0	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Bright Angel Creek near mouth
11/4/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-7)	191	10.356
Hydropsyche	(0-16)	411	453.466
Chironomidae (adult)	(1-3)	3	0.206
Chironomidae (pupae)	(2-4)	56	4.607
Baetis sp.	(0-10)	675	183.909
Hydracarina	1	9	1.095
Ochrotrichia	(3-4)	5	2.636
Chimarra	(1-11)	213	196.422
Aquatic insect egg	(0-14)	86	164.240
Heptageniidae	3	1	0.227
Petrophila (=Paragyractus)	(3-9)	34	15.761
Argia	(2-8)	21	9.665
Simulium	(2-7)	201	44.921
Simuliidae (pupae)	(3-4)	9	1.183
Alisotrichia	(2-4)	33	8.889
Glossosomatidae Culoptilla	(1-2)	16	1.011
Ostracoda	(1-2)	28	11.700
Anisoptera (nymph)	4	1	1.0390
Tabanus	7	3	4.135
Tanypoeinae	(4-5)	3	0.266
Aphidae, Phylloxeridae (nymph and adult)	2	3	0.974
Trichoptera pupae	(3-4)	6	6.181
Hetaerina	(4-11)	3	5.923
Leucotrichia	4	3	1.767
Hymenoptera (terrestrial, adult and pupae)	9	1	4.702
Micropcylloepus (larvae)	(0-5)	605	146.809
Micropcylloepus (adult)	(2-3)	159	91.885
Helicopsyche	(2-4)	4	1.253
Anisoptera (nymph)	3	1	0.670
Physa	(1-3)	2	0.039
Corydalus	12	1	3.792
Oligochaeta	6	1	299.767
		Total 2,788	1679.496

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1,054	825	665	72	8	7	157	0
Weight	0	597.617	694.81	166.867	31.69	6.771	5.881	175.85	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1,698	194	731	29	129	7	0	0	0
Weight	973.606	312.18	188.516	18.229	181.224	5.881	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Colorado River above Kanab Creek
11/4/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	4	1.071
Chironomidae (adult)	2	2	0.086
Chironomidae (pupae)	3	1	0.097
Simulium tuberosa	(2-6)	35	12.054
Hydracarina	1	6	0.732
Orthocladiinae	(1-6)	32	2.030
Diptera (terrestrials and adults)	(1-2)	2	0.422
Tanypodinae	(4-6)	5	0.480
Baetis sp.	(1-7)	64	53.383
Cnephia	2	1	0.027
Limnophora	9	1	0.555
Gammarus	(3-13)	18	82.156
		Total 171	153.093

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	18	96	36	0	12	0	8	1	0
Weight	82.156	55.413	12.080	0	1.766	0	1.578	0.097	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	36	50	65	0	12	8	0	0	0
Weight	12.081	84.186	53.477	0	1.767	1.579	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Kanab Creek near mouth

11/6/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Gammarus	(8-15)	4	38.592
		Total 4	38.592

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	4	0	0	0	0	0	0	0	0
Weight	38.592	0	0	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	4	0	0	0	0	0	0	0
Weight	0	38.592	0	0	0	0	0	0	0

Havasu Creek near mouth

11/4/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydropsyche	9	2	3.992
Orthocladiinae	(2-7)	4	0.121
Tanypodinae	2	1	0.014
Baetis sp.	(2-6)	187	63.708
Ephemeroptera subimagos	5	1	0.550
Corydalus	(4-36)	3	168.271
		Total 198	236.656

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	191	2	0	4	0	1	0	0
Weight	0	63.829	3.992	0	168.285	0	0.550	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	4	187	0	1	1	0	0	0
Weight	172.263	0.121	63.708	0	0.014	0.550	0	0	0

Table 14.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in two square meter orifice kick nets for the November 1990 synoptic study, Colorado River, Arizona– Continued

Colorado River at National Canyon

11/6/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	6	0.809
Simulium tuberosa	(3-7)	14	5.352
Hydracarina	1	1	0.122
		Total 21	6.283

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	14	0	1	0	6	0	0
Weight	0	0	5.3525	0	0.122	0	0.809	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	14	0	0	0	1	6	0	0	0
Weight	5.352	0	0	0	0.122	0.809	0	0	0

Colorado River above Diamond Creek

11/4/1990

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydracarina	1	1	0.122
Gammarus	(3-13)	17	39.182
		Total 18	39.303

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	17	0	0	0	1	0	0	0	0
Weight	39.182	0	0	0	0.122	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	17	0	0	1	0	0	0	0
Weight	0	39.182	0	0	0.122	0	0	0	0

Table 15.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot orifice Surber nets for the November 1990 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other]

Colorado River at Grand Canyon
11/4/1990 ***5 Surber nets***

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydracarina	(0-1)	4	0.371
Gammarus	(3-14)	33	139.596
Optioservus (larvae)	5	1	0.685
Baetis sp.	(4-7)	3	2.938
Cnephia	(2-6)	3	0.885
Protoptila	3	1	0.280
Leucotrichia	3	1	0.280
Orthocladiinae	(2-6)	34	2.795
		Total 80	147.830

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	33	37	3	3	4	0	0	0	0
Weight	139.596	5.733	0.885	1.245	0.371	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	67	3	0	4	0	0	0	0
Weight	2.130	142.391	2.938	0	0.371	0	0	0	0

Table 15.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot orifice Surber nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
11/4/1990 5 Surber nets

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Trichoptera	2	1	0.252
Hydracarina	3	3	0.365
Baetis sp.	(1-6)	112	31.968
Orthocladiinae	(1-6)	188	9.912
Ostracoda	(1-2)	496	175.706
Argia	(1-13)	44	51.673
Hetaerina	(5-12)	8	12.951
Tanypodinae	(3-5)	3	0.195
Simulium tuberosa	(2-5)	15	2.360
Physa	(1-5)	44	1.452
Chironomidae (pupae)	(2-4)	13	1.230
Aphidae, Phylloxeridae (nymph and adult)	(1-2)	6	1.720
Petrophila (=Paragyractus)	(3-11)	15	12.474
Simuliidae (pupae)	4	1	0.193
Alisotrichia	(2-3)	7	1.607
Leucotrichia	3	5	1.047
Glossosomatidae Culoptila	(1-3)	42	3.637
Hydropsyche	(2-13)	33	45.878
Chimarra	(3-14)	16	27.745
Ochrotrichia	(4-5)	3	1.149
Helicopsyche	(2-4)	35	8.566
Hydroptilidae (pupae)	(2-4)	6	6.122
Tabanus	(8-21)	8	9.863
Thysanoptera (thrips)	2	1	0.045
Homoptera (terrestrials, nymphs and adults)	6	1	3.626
Micropcylloepus (larvae)	(1-5)	549	99.069
Micropcylloepus (adult)	3	46	25.412
Heptageniidae	5	1	0.514
Hydracarina	1	3	0.365
Oxethira	(2-3)	5	1.224
Oligochaeta	(4-25)	14	375.013
Corydalus	38	1	134.150
Aquatic insect egg	(0-10)	17	19.981
		Total 1,739	1,045.099

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	856	64	691	66	16	8	38	0
Weight	0	600.012	75.982	126.760	200.941	12.237	5.391	23.778	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	817	202	125	60	527	8	0	0	0
Weight	366.477	366.926	33.198	66.997	206.110	5.391	0	0	0

Table 15.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot orifice Surber nets for the November 1990 synoptic study, Colorado River, Arizona–Continued

Colorado River above Kanab Creek

11/4/1990 5 Surber nets

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Tanytarsini	7	1	0.290
Cnephia	2	1	0.027
		Total 2	0.316

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	2	0	0	0	0	0	0
Weight	0	0	0.316	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	1	0	0	0	0	0	0	0
Weight	0.027	0.290	0	0	0	0	0	0	0

Kanab Creek near mouth

11/4/1990 2 Surber nets

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis	(1-2)	2	0.038
Aphidae, Phylloxeridae (nymph and adult)	1	2	0.194
Orthocladiinae	(1-5)	32	0.753
Thysanoptera (thrips)	1	1	0.010
Simuliidae (larvae)	1	1	0.005
Simulium tuberosa	(2-6)	8	2.110
Cnephia	(1-3)	11	0.382
Clinocera	3	1	0.036
		Total 58	3.528

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	34	20	0	1	0	3	0	0
Weight	0	0.791	2.497	0	0.036	0	0.204	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	20	32	2	0	1	3	0	0	0
Weight	2.497	0.753	0.038	0	0.036	0.204	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other; See Table 20 for volume data]

Paria River near mouth

06/18/1991 1240-1340 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Ephemeroptera subimagos	3	1	0.109
Hydracarina	1	4	0.487
Ostracoda	1	1	0.122
Hydropsyche	4	1	0.174
		Total 7	0.892

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	1	0	4	0	1	0	0
Weight	0	0.122	0.174	0	0.487	0	0.109	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	0	0	0	5	1	0	0	0
Weight	0.174	0	0	0	0.608	0.109	0	0	0

06/18/1991 1828-1929 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis	(3-6)	7	3.578
Diptera (terrestrials and adults)	(1-3)	10	1.819
Hydracarina	1	15	1.825
Formicidae (ants)	2	1	0.188
Hydropsyche	(3-5)	6	0.816
Collembola	(1-2)	2	0.049
Chironomidae (pupae)	3	1	0.097
Thysanoptera (thrips)	(1-2)	3	0.064
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
Orthocladiinae	(2-4)	3	0.121
Baetis bicaudatus adults	4	2	0.536
Hemiptera (nymphs and adults)	1	1	0.125
		Total 52	9.316

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	12	6	0	15	0	18	1	0
Weight	0	3.748	0.816	0	1.825	0	2.830	0.097	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	3	8	0	15	20	0	0	0
Weight	0.816	0.121	3.674	0	1.825	2.879	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth

06/19/1991 0030-0130 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Diptera (terrestrial and adult)	(1-2)	4	2.615
Thysanoptera (thrips)	(1-2)	5	0.119
Chironomidae (adult)	3	1	0.097
Chironomidae (pupae)	(2-3)	2	0.139
Baetis bicaudatus adults	4	1	0.268
Coleoptera (terrestrials, adults, and pupae)	4	1	2.671
Baetis sp.	(4-5)	5	1.905
Tanypodinae	5	1	0.123
Hydropsyche	(2-5)	4	0.412
Hydracarina	1	20	2.434
Petrophila (Paragyractus)	2	1	0.026
Collembola	1	1	0.009
Hemiptera (nymph and adult)	2	3	1.198
Formicidae (ants)	(2-3)	2	0.634
Araneida (spiders)	1	1	0.147
		Total 52	12.797

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	6	4	1	21	0	18	2	0
Weight	0	1.913	0.412	0.026	2.558	0	7.750	0.139	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	0	7	0	21	19	0	0	0
Weight	0.437	0	2.044	0	2.558	7.758	0	0	0

06/19/1991 1231-1331 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydropsyche	(3-7)	2	0.999
Hydracarina	1	1	0.122
Thysanoptera (thrips)	2	2	0.091
Diptera (terrestrials and adults)	2	1	0.325
Collembola	1	1	0.009
Formicidae (ants)	3	1	0.446
		Total 8	1.991

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	1	2	0	1	0	4	0	0
Weight	0	0.009	0.999	0	0.122	0	0.862	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	0	0	0	1	5	0	0	0
Weight	0.999	0	0	0	0.122	0.870	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Paria River near mouth
06/20/1991 0631-0731 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydropsyche	(3-4)	2	0.251
Baetis sp.	4	2	0.536
Hydracarina	1	7	0.852
Trichoptera (adult)	2	1	0.252
Ochrotrichia	2	1	0.104
Diptera (terrestrials and adults)	1	1	0.097
		Total 14	2.092

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	2	2	0	7	1	2	0	0
Weight	0	0.536	0.251	0	0.852	0.104	0.349	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	0	2	1	7	2	0	0	0
Weight	0.251	0	0.536	0.104	0.852	0.349	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River
06/19/1991 unknown hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-6)	55	2.865
Cyclopoid copepod	(0-1)	128	0.569
Chironomidae (pupae)	4	2	0.355
Chironomidae (adult)	(3-4)	5	0.646
Thysanoptera (thrips)	(1-2)	2	0.055
Simuliidae (pupae)	5	1	0.379
Simulium tuberosa	1	1	0.005
Oligochaeta	(1-6)	6	0.542
Daphnia	(1-2)	8	1.350
Hydra	1	1	0.041
Gammarus	3	7	1.394
		Total 216	8.201

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	7	61	137	0	1	0	7	3	0
Weight	1.394	3.407	1.924	0	0.041	0	0.701	0.734	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	3	68	2	0	0	7	136	0	0
Weight	0.425	4.801	0.355	0	0	0.701	1.920	0	0

Colorado River above Little Colorado River
06/19/1991 0115-0215 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-7)	30	1.987
Cyclopoid copepod	(0-1)	235	1.131
Chironomidae (pupae)	(3-4)	3	0.371
Chironomidae (adult)	(2-3)	7	0.623
Thysanoptera (thrips)	1	1	0.010
Simulium tuberosa	(1-2)	3	0.058
Oligochaeta	(1-3)	3	0.183
Daphnia	(1-2)	12	1.837
Chydorid cladoceran	1	2	0.243
Hydra	(1-2)	8	0.345
Gammarus	(2-7)	7	4.476
		Total 311	11.263

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	7	33	252	0	8	0	8	3	0
Weight	4.476	2.169	3.270	0	0.345	0	0.633	0.371	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	11	40	3	0	0	8	249	0	0
Weight	0.402	6.645	0.371	0	0	0.633	3.212	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Colorado River above Little Colorado River
06/20/1991 0815-0915 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Aphidae, Phylloxeridae (nymph and adult)	(1-3)	3	1.141
Diptera (terrestrials and adults)	1	2	0.194
Orthocladiinae	(2-6)	61	3.814
Cyclopoid copepod	(0-1)	1,541	7.820
Chironomidae (pupae)	(2-4)	13	1.257
Chironomidae (adult)	(2-4)	16	1.494
Thysanoptera (thrips)	1	3	0.029
Simulium tuberosa	(1-6)	4	0.889
Oligochaeta	(3-5)	2	0.253
Staphylinidae (adult only)	2	1	0.552
Daphnia	1	41	4.989
Chydorid cladoceran	1	2	0.243
Hemiptera (nymphs and adults)	1	1	0.125
Hydra	1	1	0.041
Gammarus	(2-3)	9	1.536
Hydracarina	1	2	0.243
		Total 1,702	24.623

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	9	63	1,588	0	4	0	25	13	0
Weight	1.536	4.067	13.942	0	0.837	0	2.983	1.257	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	6	72	13	0	2	25	1,584	0	0
Weight	1.483	5.603	1.257	0	0.243	2.983	13.053	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Little Colorado River near mouth

06/18/1991 1210-1310 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(3-4)	11	0.427
Chironomidae (adult)	2	1	0.005
Hemerodromia (larvae)	3	1	0.036
Hydropsyche	1	1	0.005
Thysanoptera (thrips)	1	1	0.010
		Total 15	0.5201

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	11	1	0	1	0	2	0	0
Weight	0	0.427	0.005	0	0.036	0	0.052	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	11	0	0	1	2	0	0	0
Weight	0.005	0.427	0	0	0.036	0.052	0	0	0

06/18/1991 1745-1845 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-4)	41	1.094
Thysanoptera (thrips)	2	1	0.045
Simuliidae (larvae)	1	2	0.009
Chironomidae (pupae)	2	2	0.086
Chironomidae (adult)	(2-3)	5	0.322
Hemiptera (nymphs and adults)	1	1	0.125
Homoptera (terrestrials, nymphs, and adults)	2	1	0.433
Hemerodromia (larvae)	3	2	0.071
Hymenoptera (terrestrial, pupae, and adults)	2	2	0.378
Araneida (spiders)	1	1	0.147
Terrestrial mite	(0-1)	2	0.128
Hydracarina	1	1	0.122
Diptera (terrestrial and adult)	1	1	0.097
		Total 62	3.058

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	41	2	0	5	0	12	2	0
Weight	0	1.094	0.009	0	0.321	0	1.547	0.086	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	41	2	0	5	12	0	0	0
Weight	0.009	1.094	0.086	0	0.321	1.547	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Little Colorado River near mouth

06/19/1991 0555-0655 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-4)	24	0.593
Chironomidae (adult)	(2-3)	2	0.139
Hemerodromia (larvae)	(2-3)	2	0.050
Diptera (terrestrial and adult)	2	1	0.325
Aphidae, Phylloxeridae (nymph and adult)	2	1	0.325
Corydalus	5	1	0.264
		Total 31	1.695

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	24	0	0	3	0	4	0	0
Weight	0	0.593	0	0	0.314	0	0.789	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	24	0	0	2	4	0	0	0
Weight	0.264	0.593	0	0	0.050	0.789	0	0	0

06/19/1991 1130-1230 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-4)	32	1.160
Chironomidae (adult)	(1-2)	4	0.141
Chironomidae (pupae)	2	3	0.128
Thysanoptera (thrips)	(1-2)	6	0.129
Collembola	1	1	0.009
Diptera (terrestrial, and adults)	1	11	1.066
Staphylinidae (adult only)	3	1	1.362
Ephydridae	4	1	0.022
		Total 59	4.017

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	33	1	0	1	1	21	3	0
Weight	0	1.169	0.005	0	1.362	0.022	1.336	0.128	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	1	32	3	0	1	22	0	0	0
Weight	1.362	1.160	0.128	0	0.022	1.345	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Little Colorado River near mouth

06/19/1991 1800-1900 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-4)	17	0.362
Thysanoptera (thrips)	(1-2)	5	0.120
Hydracarina	1	2	0.243
Simuliidae (larvae)	1	2	0.010
Hemiptera (nymphs and adults)	1	1	0.125
Diptera (terrestrial and adults)	1	2	0.194
		Total 29	1.053

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	17	2	0	2	0	8	0	0
Weight	0	0.362	0.009	0	0.243	0	0.439	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	17	0	0	2	8	0	0	0
Weight	0.009	0.362	0	0	0.243	0.439	0	0	0

Bright Angel Creek near mouth

06/18/1991 1705-1805 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydropsyche	7	1	0.922
Baetis sp.	(1-3)	11	0.381
Orthocladiinae	(2-4)	52	1.906
Hydracarina	1	10	1.217
Chironomidae (pupae)	(2-3)	7	0.407
Chironomidae (adult)	(1-3)	7	0.377
Simulium tuberosa	(1-4)	18	0.825
Micropcylloepus (larvae)	(3-4)	4	0.734
Micropcylloepus (adult)	2	4	2.210
Ostracoda	2	2	0.997
Tanypodinae	7	1	0.290
Leucotrichia	4	1	0.589
Hydroptilidae	2	1	0.104
Diptera (terrestrials and adults)	1	1	0.097
		Total 120	11.055

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	69	19	5	11	1	8	7	0
Weight	0	5.494	1.747	1.323	1.507	0.104	0.474	0.407	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	29	52	18	0	13	8	0	0	0
Weight	5.383	1.906	0.789	0	2.504	0.474	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
06/19/1991 2305-2405 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hydropsyche	14	1	7.939
Baetis sp.	(1-5)	8	0.877
Orthocladiinae	(1-5)	53	2.292
Hydracarina	1	7	0.852
Chironomidae (pupae)	(2-3)	5	0.268
Chironomidae (adult)	(2-4)	4	0.360
Simulium tuberosa	(1-6)	45	8.001
Micropcylloepus (larvae)	(3-4)	7	1.531
Micropcylloepus (adult)	(2-3)	20	11.858
Ostracoda	2	1	0.499
Hydroptilidae	2	1	0.104
Heterelmis (adult)	(2-3)	2	1.914
Diptera (terrestrial and adult)	3	1	0.720
Oligochaeta	(3-5)	2	0.253
Formicidae (ants)	3	1	0.446
Terrestrial Isopoda	2	1	0.071
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
Collembola	2	1	0.040
Ochrotrichia	2	1	0.104
		Total 162	38.225

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	87	46	7	7	2	8	5	0
Weight	0	17.733	15.940	1.531	0.852	0.207	1.694	0.268	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	76	55	13	1	8	9	0	0	0
Weight	31.347	2.545	1.145	0.104	1.350	1.734	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
06/19/1991 1157-1257 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	3	1	0.109
Orthocladiinae	(2-5)	52	2.023
Hydracarina	1	1	0.122
Chironomidae (pupae)	(2-3)	3	0.236
Chironomidae (adult)	2	1	0.043
Simulium tuberosa	(2-5)	15	1.251
Micropcylloepus (larvae)	(3-5)	3	0.953
Micropcylloepus (adult)	2	1	0.552
Ostracoda	(1-2)	3	0.742
Oligochaeta	(2-7)	4	0.582
Isopoda-Asellus	2	1	0.071
Hydroptilidae	2	1	0.104
Tanypodinae	(2-3)	2	0.050
Leucotrichia	2	1	0.104
Diptera (terrestrials and adults)	1	1	0.097
Aphidae, Phylloxeridae (nymph and adult)	1	1	0.097
		Total 91	7.134

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	1	61	15	4	3	1	3	3	0
Weight	0.071	4.008	1.251	1.056	0.171	0.104	0.237	0.236	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	21	57	4	0	6	3	0	0	0
Weight	2.963	2.676	0.345	0	0.913	0.237	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Bright Angel Creek near mouth
06/20/1991 2330-2430 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(1-5)	75	26.613
Orthocladiinae	(2-7)	121	5.624
Hydracarina	(0-1)	11	0.950
Chironomidae (pupae)	(1-3)	11	0.464
Chironomidae (adult)	(1-4)	37	1.697
Simulium tuberosa	(1-6)	58	11.059
Micropcylloepus (larvae)	(2-5)	10	2.847
Micropcylloepus (adult)	(2-3)	31	18.744
Oligochaeta	(3-15)	9	14.457
Tanypodinae	(2-6)	8	0.337
Leucotrichia	32	1	0.280
Diptera (terrestrials and adults)	2	1	0.325
Formicidae (ants)	3	1	0.446
Hydropsyche	(4-5)	3	0.844
Ostracoda	(2-3)	4	1.241
Hydroptilidae	2	1	0.104
Collembola	1	1	0.009
Ochrotrichia	4	1	0.589
Terrestrial Isopoda	3	1	0.199
Corydalus	19	2	32.293
		Total 387	119.222

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	241	61	11	21	2	40	11	0
Weight	0	66.688	11.903	3.127	33.580	0.693	2.667	0.464	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	106	130	86	1	23	41	0	0	0
Weight	65.998	20.082	27.077	0.589	2.901	2.676	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth

06/18/1991 1230-1330 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-3)	4	0.078
		Total 4	0.078

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	4	0	0	0	0	0	0	0
Weight	0	0.078	0	0	0	0	0	0	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	0	4	0	0	0	0	0	0	0
Weight	0	0.078	0	0	0	0	0	0	0

06/19/1991 1140-1240 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-3)	35	0.388
Trichoptera (larvae)	(1-2)	4	0.063
Chironomidae (adult)	(1-20	4	0.080
Chironomidae (pupae)	(2-3)	2	0.139
Tanypodinae	(2-5)	2	0.138
Simulium tuberosa	1	1	0.005
Ostracoda	1	1	0.122
Hydroptilidae	2	2	0.208
Micropcylloepus (adult)	2	1	0.552
		Total 52	1.695

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	4	37	1	0	2	2	4	2	0
Weight	0.063	1.062	0.005	0	0.138	0.208	0.08	0.139	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	35	2	4	3	4	0	0	0
Weight	0.765	0.388	0.139	0.063	0.259	0.08	0	0	0

Table 16.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in 10 cm orifice diameter drift nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Colorado River at National Canyon
06/19/1991 0142-0242 hrs. (Single Net)

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-4)	9	0.295
Chironomidae (pupae)	(2-4)	11	1.307
Chironomidae (adult)	(2-4)	11	0.767
Tanypodinae	3	1	0.036
Simulium tuberosa	(2-3)	3	0.136
Simulium (pupae)	3	1	0.083
Thysanoptera (thrips)	2	1	0.045
Chydorid cladoceran	1	1	0.122
Collembola	1	1	0.009
		Total 39	2.800

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	10	4	0	1	0	12	12	0
Weight	0	0.304	0.257	0	0.036	0	0.813	1.390	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	9	11	0	1	13	1	0	0
Weight	0.218	0.295	1.307	0	0.036	0.821	0.122	0	0

Table 17.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in a one square meter orifice kick net for the June 1991 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other]

Bright Angel Creek near mouth
06/19/1991 1125 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(3-6)	12	5.455
Orthocladiinae	(2-5)	4	0.209
Chironomidae (pupae)	3	2	0.193
Micropcylloepus (larvae)	(3-5)	4	1.285
Micropcylloepus (adult)	2	4	2.210
Oligochaeta	(21-24)	5	423.386
Hydropsyche	(7-16)	2	13.028
Ochrotrichia	7	1	2.669
Corydalus	(15-24)	5	129.988
Tabanus	(11-12)	2	1.313
Argia	11	1	2.893
Trichoptera (adults)	2	1	0.252
Petrophila (=Paragyractus)	11	1	3.724
Helicopsyche	6	2	3.496
		Total 46	590.102

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	25	2	7	6	3	1	2	0
Weight	0	431.260	13.028	8.505	132.881	3.982	0.252	0.193	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	18	9	14	2	2	1	0	0	0
Weight	153.731	423.595	5.649	5.562	1.313	0.252	0	0	0

Table 17.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of drifting invertebrates captured in a one square meter orifice kick net for the June 1991 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth

06/19/1991 1115 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(1-7)	101	4.080
Trichoptera (larvae)	1	4	0.032
Chironomidae (adult)	(1-3)	3	0.152
Chironomidae (pupae)	(1-4)	23	1.655
Baetis sp.	(1-7)	34	8.549
Hydropsyche	(4-12)	6	14.592
Hydroptilidae	2	1	0.104
Petrophila (=Paragyractus)	5	1	0.335
Ostracoda	(1-2)	8	1.350
Hydracarina	1	1	0.122
Ochrotrichia	2	2	0.207
Tanypodinae	(3-5)	3	0.283
Hemerodromia (larvae)	(5-6)	2	0.319
Chelifera	3	2	0.071
Fish fry	(4-9)	2	22.414
Trichoptera (pupae)	9	1	12.164
		Total 194	66.429

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	4	143	6	1	10	3	3	24	0
Weight	0.032	13.980	14.592	0.335	23.209	0.311	0.152	13.819	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	9	101	59	6	16	3	0	0	0
Weight	27.194	4.080	32.618	0.239	2.145	0.152	0	0	0

Colorado River at National Canyon

06/17/1991 1850 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Chironomidae (pupae)	4	1	0.178
Simulium tuberosa	(4-8)	19	16.163
		Total 20	16.341

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	0	19	0	0	0	0	1	0
Weight	0	0	16.163	0	0	0	0	0.178	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	19	0	1	0	0	0	0	0	0
Weight	16.163	0	0.178	0	0	0	0	0	0

Table 18.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot Surber nets for the June 1991 synoptic study, Colorado River, Arizona

[SH, shredder; CG, collector/gatherer; CF, collector/feeder; SC, scraper; PR, predator; PI, piercer; TR, terrestrial; NF, non-feeder; PA, parasite; CL, clingers; BU, burrowers; SW, swimmers; CB, climbers; SP, sprawlers; SS, surface skaters; PL, plankton, OT, other]

Colorado River above Little Colorado River

06/18/1991 1800 hrs. 3 Surber nets.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Orthocladiinae	(2-5)	13	0.678
Thysanoptera (thrips)	1	2	0.019
Simuliidae (pupae)	(3-4)	2	0.275
Simulium tuberosa	(4-6)	3	1.237
Gammarus	(2-18)	37	210.510
Chironomidae (adult)	3	2	0.193
Cyclopoid copepod	1	3	0.016
		Total 62	212.928

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	37	13	6	0	0	0	4	2	0
Weight	210.510	0.678	1.253	0	0	0	0.213	0.275	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	5	50	0	0	0	4	3	0	0
Weight	1.512	211.188	0	0	0	0.213	0.016	0	0

Little Colorado River near mouth

06/17/1991 1542 hrs. 2 Surber nets

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Hemerodromia (larvae)	(2-4)	42	1.770
Baetis sp.	(1-6)	3	1.556
Orthocladiinae	(2-4)	14	0.655
Hydropsyche	3	2	0.153
Hydracarina	1	1	0.122
Diptera (terrestrials and adults)	1	1	0.097
Hemerodromia (pupae)	4	2	0.142
Chironomidae (pupae)	2	2	0.086
Chironomidae (adult)	2	1	0.043
		Total 68	4.623

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	17	2	0	43	0	2	4	0
Weight	0	2.210	0.153	0	1.892	0	0.140	0.228	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	2	14	5	0	45	2	0	0	0
Weight	0.153	0.655	1.641	0	2.034	0.140	0	0	0

Table 18.–Taxa, size range in millimeters, numbers, total weight (biomass), functional grouping, and mode of attachment of benthic invertebrates captured in one square foot Surber nets for the June 1991 synoptic study, Colorado River, Arizona–Continued

Havasu Creek near mouth
06/18/1991 1100 hrs.

TAXA

Organism	Length range (mm)	Number	Weight (mg)
Baetis sp.	(1-7)	8	3.294
Orthocladiinae	(2-5)	15	0.600
Chironomidae (pupae)	2	1	0.043
Chironomidae (adult)	(1-3)	2	0.086
Trichoptera (pupae)	7	1	6.124
Simulium tuberosa	2	1	0.027
Hydropsyche	14	2	15.878
		Total 30	26.052

FUNCTIONAL GROUP

	SH	CG	CF	SC	PR	PI	TR	NF	PA
Number	0	23	3	0	0	0	2	2	0
Weight	0	3.894	15.904	0	0	0	0.086	6.167	0

MODE OF ATTACHMENT

	CL	BU	SW	CB	SP	SS	PL	PA	OT
Number	4	15	9	0	0	2	0	0	0
Weight	22.028	0.600	3.337	0	0	0.086	0	0	0

Table 19.–Detrital biomass collected with 10 cm orifice diameter drift nets for the November 1990 synoptic study

[LOI, loss on ignition; g, grams; L liters; mg/L, milligrams per liter; *, single net sample]

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River below Glen Canyon Dam				
11-5-90	0850-0950	Filamentous algae	2.5905	0.5957	23,700	0.0252
11-5-90	1325-1425	Filamentous algae few twigs & detritus	2.0926	0.2553	22,600	0.0113
11-5-90	1905-2005	Light green filamentous algae *	1.7390	0.0999	16,200	0.0062
11-6-90	0120-0220	Tan filamentous algae & detritus	1.7458	0.0325	3,160	0.0103
11-6-90	0735-0835	Algae light green tan & twigs	2.5675	0.5512	19,200	0.0287
11-6-90	1355-1455	Light green filamentous algae	1.8113	0.0890	12,500	0.0071
11-6-90	1855-1955	Light green filamentous algae & grass	0.9389	0.0546	11,100	0.0049
		Colorado River at Lees Ferry				
11-5-90	0641-0741	Light green filamentous algae*	1.0074	0.1210	43,700	0.0028
11-5-90	0830-0930	Long green filamentous algae & detritus*	2.4560	0.5455	25,600	0.0213
11-5-90	1230-1330	Filamentous algae & detritus	6.5343	3.1791	73,000	0.0436
11-5-90	1830-1930	Green filamentous algae twigs dark detritus	1.1949	0.2639	12,800	0.0206
11-6-90	0005-0105	Light green algae	0.9198	0.0588	19,600	0.0030
11-6-90	0825-0925	Light tan filamentous algae detritus & twigs	2.0890	0.2683	60,700	0.0044
11-6-90	1155-1215	Very coarse dark green filamentous algae	1.9619	1.5025	44,500	0.0338
11-6-90	1830-1930	Green filamentous algae twigs detritus	2.2079	0.3158	28,900	0.0109
11-7-90	0013-0113	Light green filamentous algae*	1.9224	0.1862	28,590	0.0126
		Paria River near mouth				
11-5-90	0622-0722	Brown tan filamentous algae leaves detritus	2.3915	0.6126	24,600	0.0249
11-5-90	1210-1310	Leaves twigs & coarse brown detritus	3.2817	1.4925	14,600	0.103
11-5-90	1855-1955	Leaf twigs & algae coarse detritus	2.0129	0.2049	24,600	0.0083
11-6-90	0022-0122	Leaves twigs leafy brown coarse detritus	3.2800	1.4380	24,600	0.0586
11-6-90	0805-0905	Twigs coarse detritus	4.1958	2.1141	38,300	0.0553
11-6-90	1215-1315	Leaves twigs grass coarse brown detritus	2.4583	0.5905	38,300	0.0154
11-6-90	1845-1945	Leaves grass twigs detritus	2.7467	1.2670	19,100	0.0662
11-6-90	2345-0045	Leaves twigs and very coarse detritus	5.2640	3.0247	38,300	0.0791
		Colorado River above Little Colorado River				
11-5-90	0835-0935	Light green filamentous algae dark detritus *	1.0097	0.1099	15,000	0.0073
11-5-90	1352-1452	Green filamentous algae	1.8517	0.1727	25,500	0.0068
11-5-90	1915-2015	Light green detritus & filamentous algae	2.2715	0.3588	14,700	0.0243
11-6-90	0105-0205	Dark green detritus	3.2037	0.9649	11,600	0.0829
11-6-90	0705-0805	Dark green filamentous algae dark detritus	3.2638	1.7351	16,800	0.103
11-6-90	1252-1352	Dark green detritus & filamentous algae	4.1361	1.6753	30,900	0.0543
11-6-90	1900-2000	Dark green filamentous algae	3.0262	1.0092	9,110	0.111
11-7-90	0058-0158	Dark green filamentous algae	2.6857	0.6734	31,000	0.0217
		Little Colorado River near mouth				
11-5-90	0725-0825	Dark green detritus	2.6040	0.5710	17,800	0.0321
11-5-90	1240-1340	Dark green detritus	2.4752	0.4795	17,800	0.0269
11-6-90	0020-0120	Dark green detritus	3.7923	1.9075	32,800	0.0581
11-6-90	0620-0720	Dark green detritus & grass	1.7464	0.6420	37,300	0.0172
11-6-90	1140-1240	Dark green detritus	1.8419	0.5572	11,600	0.0482

Table 19.—Detrital biomass collected with 10 cm orifice diameter drift nets for the November 1990 synoptic study—Continued

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River at Grand Canyon				
11-5-90	0630-0730	Very light green tan filamentous algae	0.8588	0.0549	15,700	0.0035
11-5-90	1210-1310	Very fine dark detritus	2.8927	1.3096	7,320	0.179
11-6-90	0000-0100	Gray green medium detritus	1.9605	0.7297	7,320	0.0997
11-6-90	0645-0745	Very fine dark detritus	1.8704	0.7322	8,260	0.0886
11-6-90	1200-1300	Coarse brown green detritus leaves	2.7086	1.3180	19,100	0.0689
		Bright Angel Creek near mouth				
11-5-90	0842-0942	Fine to medium gray green detritus	1.1452	0.1603	15,500	0.0103
11-5-90	1434-1534	Light green fine detritus small twigs	1.0034	0.1648	16,700	0.0099
11-6-90	0836-0936	Dark brown detritus & twigs	1.1543	0.2175	12,800	0.0170
11-6-90	1345-1445	Brown green twigs detritus piece equestrium	0.9238	0.0730	17,300	0.0042
11-6-90	1800-1900	Brown green twigs detritus piece equestrium	1.1354	0.2501	15,500	0.0161
11-7-90	0115-0215	Leaves twigs brown & tan detritus	1.2075	0.2487	15,500	0.0160
		Colorado River above Kanab Creek				
11-5-90	0702-0802	Very fine detritus dark gray green algae	2.5753	0.4238	8,860	0.0478
11-5-90	1242-1342	Very fine detritus dark gray green algae	3.2165	0.9492	21,400	0.0445
11-5-90	1815-1906	Filamentous algae & dark green detritus	1.9647	0.5036	11,300	0.0446
11-6-90	2316-0005	Dark green filamentous algae & detritus	1.9304	0.1787	11,500	0.0156
11-6-90	0705-0800	Tan grass seeds & dark detritus	1.6752	0.0408	7,590	0.0054
11-6-90	1211-1311	Very fine filamentous algae dark detritus	0.9340	0.0589	7,220	0.0082
11-6-90	1730-1830	Light tan medium fine detritus	0.9308	0.0410	5,690	0.0072
11-6-90	2335-0100	Fine detritus	4.0305	2.0354	21,300	0.0956
		Kanab Creek near mouth				
11-5-90	0638-0740	Tan detritus	1.7735	0.0287	13,800	0.0021
11-5-90	1225-1325	Medium fine dark detritus	1.7063	0.0061	11,900	0.0005
11-5-90	1821-1927	Fine reddish tan detritus twig & leaf	1.7720	0.0192	14,500	0.0013
11-5-90	2326-0023	Very fine detritus	0.8770	0.0035	5,390	0.0006
11-6-90	0715-0815	Brown detritus	1.7082	0.0144	9,640	0.0015
11-6-90	1247-1341	Very fine brown detritus	0.9051	0.0253	6,250	0.0040
11-6-90	1748-1835	Dark tan detritus	0.9178	0.0185	7,550	0.0025
11-6-90	2345-0040	Dark green filamentous algae & detritus	1.0796	0.1659	6,450	0.0257
		Colorado River above Havasu Creek				
11-5-90	0845-0945	Dark green filamentous algae & detritus	5.4050	2.4437	20,200	0.1210
11-5-90	1445-1515	Dark green filamentous algae & detritus	1.0475	0.1414	12,500	0.0113
11-5-90	1920-2025	Dark green filamentous algae	1.9944	0.8222	12,500	0.0658
11-6-90	0855-0955	Dark green filamentous algae & detritus	1.9196	0.1617	25,000	0.0065
11-6-90	1342-1442	Green detritus grass & filamentous algae	2.1618	0.3622	25,000	0.0145
11-6-90	1842-1942	Dark green filamentous algae & detritus	2.2037	0.3744	21,300	0.0175
11-7-90	0100-0230	Grass filamentous algae & detritus	4.2283	2.1464	29,600	0.0726
		Havasu Creek near mouth				
11-5-90	0627-0727	Dark detritus & leaves	1.8370	0.1003	22,300	0.0045
11-5-90	1241-1341	Dark detritus	1.7930	0.0548	26,900	0.0020
11-5-90	1817-1917	Dark detritus & leaves	1.8125	0.0935	24,600	0.0038
11-6-90	0019-0119	Dark detritus & leaves	1.9209	0.1604	25,100	0.0064
11-6-90	0613-0713	Leaves & fine detritus	1.8622	0.1532	25,100	0.0061
11-6-90	1213-1313	Net leaves detritus & twigs	1.8634	0.1972	19,900	0.0099
11-6-90	1816-1916	Leaf twig dark green detritus	1.8917	0.1758	24,100	0.0073
11-7-90	0032-0132	Tan & dark green detritus	1.8548	1.0450	12,300	0.0851

Table 19.–Detrital biomass collected with 10 cm orifice diameter drift nets for the November 1990 synoptic study–Continued

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River at National Canyon				
11-6-90	0045-0145	Filamentous dark green algae & detritus	2.7370	0.7151	32,800	0.0218
11-6-90	1254-1354	Dark green detritus filamentous algae	3.6875	1.2992	32,400	0.0401
11-6-90	1835-1935	Filamentous dark green detritus	2.4556	0.4940	36,000	0.0137
11-7-90	0036-0106	Filamentous algae & dark green detritus	2.3551	0.4844	29,500	0.0164
		Colorado River above Diamond Creek				
11-5-90	0800-0900	Dark detritus & twigs	2.9549	0.6323	15,300	0.0414
11-5-90	1155-1350	Dark green detritus & filamentous algae	2.3005	0.3230	6,140	0.0526
11-6-90	1220-1420	Fine green detritus seed pods & grass	3.3901	0.9168	39,100	0.0234
		Colorado River near Columbine Falls				
11-5-90	0915-1015	Fine detritus brown	2.1809	0.8783	15,600	0.0564
11-5-90	1330-1430	Fine green gray detritus	8.6795	2.5855	32,600	0.0794
11-5-90	1925-2025	Dark detritus	3.0404	0.6125	31,700	0.0193
11-6-90	0100-0200	Dark detritus	1.2705	0.3014	12,300	0.0245
11-6-90	0720-0820	Dark detritus	4.0505	1.4869	25,600	0.0581
11-6-90	1300-1400	Dark green gray fine detritus	8.3422	4.3662	24,600	0.178

Table 20.–Detrital biomass collected with 10 cm orifice diameter drift nets for the June 1991 synoptic study

[LOI, loss on ignition; g, grams; L liters; mg/L, milligrams per liter; *, single net sample]

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River below Glen Canyon Dam				
6-18-91	1332-1432	Tan detritus grass & leaves	1.646	0.605	21,100	0.029
6-18-91	1920-2020	Tan filamentous algae	0.968	0.159	11,200	0.014
6-19-91	0115-0215	Pink filamentous algae	0.840	0.028	6,170	0.005
6-19-91	0754-0819	Tan filamentous algae	0.937	0.064	5,730	0.011
6-19-91	1110-1215	Dark detritus twigs & algae	1.096	0.304	24,100	0.013
6-19-91	1815-1915	Tan detritus & twigs	1.224	0.332	17,800	0.019
6-19-91	2400-0100	Green filamentous algae	0.836	0.009	7,000	0.001
6-20-91	0754-0824	Green filamentous algae	0.857	0.034	6,060	0.006
		Colorado River below Glen Canyon Dam				
6-18-91	1424-1526	Detritus filamentous algae & leaves	2.584	0.738	16,300	0.045
6-18-91	1803-1903	Dark detritus & twigs	1.295	0.347	10,200	0.034
6-18-91	2400-0100	Dark green detritus	1.077	0.106	12,000	0.009
6-19-91	0600-0700	Filamentous algae & grass	0.850	0.035	23,400	0.001
6-19-91	1800-1900	Filamentous algae	2.375	1.404	14,900	0.094
6-20-91	0614-0714	Filamentous and grasses	0.891	0.026	14,900	0.002
		Paria River near mouth				
6-18-91	1240-1341	Tan filamentous algae & detritus	3.685	1.045	33,300	0.031
6-18-91	1828-1929	Tan filamentous algae dark detritus	3.453	1.184	33,300	0.036
6-19-91	0030-0130	Tan detritus & filamentous algae	2.659	0.578	29,200	0.020
6-19-91	0600-0700	Green detritus *	1.144	0.167	16,400	0.010
6-19-91	1231-1331	Tan detritus filamentous algae & twigs	6.173	2.458	18,700	0.132
6-19-91	1833-1933	Dark green tan detritus & leaves	8.638	5.007	29,700	0.168
6-20-91	0042-0142	Brown detritus *	1.557	0.623	13,000	0.048
6-20-91	0631-0731	Dark detritus twigs & algae	1.865	0.131	26,200	0.005
		Colorado River above Little Colorado River				
6-18-91	1415-1515	Dark detritus filamentous & leaf	13.094	7.359	21,400	0.345
6-18-91	1800-1900	Fine dark brown detritus	9.949	6.282	30,300	0.208
6-19-91	0115-0215	Dark green detritus filamentous algae	4.403	1.923	5,680	0.339
6-19-91	0600-0700	Green filamentous algae dark detritus	7.270	3.295	11,400	0.290
6-19-91	1312-1412	Dark green detritus & grass	7.159	2.443	4,840	0.505
6-19-91	1800-1900	Dark green detritus filamentous algae	7.178	3.617	76,200	0.047
6-20-91	0815-0915	Brown green detritus filamentous algae	7.745	3.728	32,400	0.115
		Little Colorado River near mouth				
6-18-91	1210-1310	Dark green detritus	0.915	0.014	7,940	0.002
6-18-91	1745-1845	Dark tan detritus	2.226	0.282	24,600	0.011
6-18-91	2345-0045	Dark green tan detritus	1.858	0.062	24,600	0.003
6-19-91	0555-0655	Tan filamentous detritus	1.810	0.058	23,200	0.003
6-19-91	1130-1230	Tan & dark green detritus	1.951	0.141	21,700	0.006
6-19-91	1800-1900	Dark green detritus	2.115	0.284	18,500	0.015
6-19-91	2350-0050	Dark detritus	0.914	0.020	9,560	0.002
6-20-91	0600-0700	Dark green detritus	1.048	0.079	8,800	0.009

Table 20.–Detrital biomass collected with 10 cm orifice diameter drift nets for the June 1991 synoptic study–Continued

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River at Grand Canyon				
6-18-91	1130-1230	Dark green detritus & twig	15.263	7.827	8,000	0.979
6-19-91	0013-0113	Brown green detritus filamentous algae	1.930	0.657	2,220	0.295
6-19-91	0605-0705	Dark green detritus & equestrium	3.739	1.091	34,900	0.031
6-19-91	1211-1311	Dark green detritus	4.445	2.223	11,100	0.200
6-19-91	1753-1855	Dark green detritus	5.066	2.253	68,500	0.033
6-19-91	2417-0117	Dark detritus filamentous algae	6.520	2.203	89,000	0.025
6-20-91	0550-0650	Dark green detritus	2.513	0.875	19,700	0.045
		Bright Angel Creek near mouth				
6-18-91	1100-1200	Dark detritus twigs & algae	2.513	0.669	40,800	0.016
6-18-91	1705-1805	Dark green detritus leaves twigs	2.825	0.821	17,800	0.046
6-18-91	2305-2405	Dark green detritus	2.725	0.691	31,300	0.022
6-19-91	0600-0700	Brown detritus grass & twigs	2.800	0.721	37,000	0.019
6-19-91	1157-1257	Dark green detritus & twigs	1.511	0.535	17,600	0.030
6-19-91	1805-1905	Brown green detritus & grass	2.330	0.342	28,800	0.012
6-19-91	2330-2430	Brown detritus and leaves	2.360	0.864	17,600	0.049
6-20-91	0600-0700	Brown green detritus moss	1.447	0.397	15,600	0.026
		Colorado River above Kanab Creek				
6-19-91	0630-0730	Dark green detritus twigs leaves	8.415	1.454	38,700	0.038
6-20-91	0643-0743	Dark green detritus	9.442	6.035	21,700	0.278
		Kanab Creek near mouth				
6-18-91	1237-1337	Reddish tan filamentous algae detritus	1.913	0.108	28,100	0.004
6-18-91	1836-1940	Tan detritus	1.770	0.060	34,200	0.002
6-19-91	0026-0126	Tan pink slime	1.860	0.059	45,800	0.001
6-19-91	0630-0730	Tan pink detritus	1.895	0.080	32,000	0.002
6-19-91	1214-1314	Tan detritus leaves twigs	1.934	0.202	30,100	0.007
6-19-91	1832-1932	Tan detritus & small twigs	1.741	0.078	35,600	0.002
6-20-91	0036-0136	Tan pink detritus	1.752	0.021	43,000	0.000
6-20-91	0646-0740	Tan detritus straw	0.890	0.006	16,200	0.000
		Havasu Creek near mouth				
6-18-91	1230-1330	Brown detritus	1.468	0.081	20,500	0.004
6-18-91	2347-0047	Tan detritus	0.879	0.010	23,800	0.000
6-19-91	0546-0646	Dark tan detritus	0.886	0.021	22,200	0.001
6-19-91	1140-1240	Detritus twigs	0.828	0.033	25,400	0.001
6-19-91	1800-1900	Tan detritus	0.901	0.007	24,000	0.000
6-19-91	2400-0030	Dark green detritus	0.889	0.006	22,500	0.000
		Colorado River at National Canyon				
6-18-91	1400-1450	Dark detritus & filamentous algae	10.737	6.389	18,700	0.342
6-18-91	1955-2010	Dark green brown detritus filamentous. Algae	26.032	13.442	11,100	1.21
6-19-91	0142-0202	Dark detritus & twigs	36.242	25.616	14,600	1.76
6-19-91	0752-812	Dark detritus & filamentous algae	8.144	5.809	5,810	0.999
6-19-91	1356-1426	Dark green detritus filamentous algae	18.265	11.487	17,900	0.642
6-19-91	1842-1857	Dark detritus	0.999	0.150	5,050	0.030
6-20-91	0112-0127	Dark green detritus	9.217	4.903	13,600	0.360
6-20-91	0715-0735	Dark detritus twigs	10.648	6.048	13,700	0.441

Table 20.—Detrital biomass collected with 10 cm orifice diameter drift nets for the June 1991 synoptic study—Continued

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume (L)	Biomass (mg/L)
		Colorado River above Diamond Creek				
6-18-91	1238-1338	Dark detritus filamentous algae	53.653	28.185	47,000	0.600
6-18-91	1907-2007	Dark green detritus filamentous algae	24.422	14.523	48,800	0.298
6-19-91	0113-0133	Dark detritus filamentous algae	10.916	5.846	40,800	0.143
6-19-91	0600-0700	Dark green detritus & twigs	19.833	6.483	69,700	0.093
6-19-91	1200-1300	Dark brown detritus	86.043	45.509	67,000	0.679
6-19-91	1800-1900	Dark green brown detritus filamentous Algae	28.276	16.624	28,800	0.577
6-19-91	2348-0048	Dark detritus	7.325	2.754	20,100	0.137
6-20-91	0600-0700	Dark detritus	24.869	10.310	75,400	0.137
		Colorado River near Travertine Cleft				
6-18-91	1235-1335	Dark green detritus	1.286	0.296	7,610	0.039
6-18-91	1807-1907	Dark detritus twigs	14.077	9.612	28,400	0.339
6-19-91	0055-0155	Brown green detritus	3.049	1.368	15,800	0.087
6-19-91	0625-0725	Fine dark brown detritus grass	11.893	5.780	56,400	0.102
6-19-91	1128-1228	Dark brown detritus *	6.803	3.527	13,600	0.259
6-19-91	1225-1330	Fine dark brown detritus *	7.132	4.158	7,610	0.547
6-19-91	1822-1922	Dark brown detritus grass	15.614	8.397	20,200	0.416
6-20-91	0035-0135	Dark green detritus small twigs	26.403	16.512	27,800	0.593
6-20-91	0645-0745	Very fine grained dark detritus	16.104	9.497	35,600	0.267

Table 21.--Colorado River drift from nets having 0.5 meter diameter orifice

[LOI, loss on ignition; g, grams; L liters; mg/L, milligrams per liter]

Date	Time	Sample Appearance	Dry. Weight (g)	LOI (g)	Water Volume* (L)	Biomass (mg/L)
		Colorado River at Lees Ferry				
11-5-90	1116-1131	Filamentous algae dark detritus	2.441	1.109	156,000	0.007
11-6-90	1445-1500	Filamemtous algae detritus	5.138	2.889	151,000	0.019
		Colorado River above Little Colorado River				
11-5-90	0800-0815	Green filamentous algae & twigs	2.747	1.097	113,000	0.010
11-5-90	1800-1815	Dark green filamentous algae	1.964	0.887	94,800	0.009
11-6-90	0123-0138	Dark green filamentous algae & twigs	1.772	0.788	130,000	0.006
		Colorado River above Diamond Creek				
11-5-90	1525-1540	Filamentous algae dark green detritus	4.331	2.174	151,000	0.014
11-5-90	2108-2123	Dark green detritus	7.568	4.745	110,000	0.043
11-6-90	0215-0233	Dark green detritus	7.468	4.871	155,000	0.032
11-6-90	1118-1133	Dark green detritus	8.044	4.977	108,000	0.046
11-6-90	2130-2145	Dark green detritus and algae	2.774	1.458	99,100	0.015
		Colorado River above Little Colorado River				
6-18-91	0800-0810	Green filamentous algae, detritus, twigs	1.229	1.081	183,000	0.0059
6-18-91	1305-1310	Dark detritus long filamentous algae	22.236	15.369	91,600	0.168
6-18-91	2010-2015	Filamentous algae dark green detritus	6.568	4.363	61,100	0.071
6-19-91	0215-0230	Dark green detritus	14.460	8.363	205,000	0.042
6-19-91	0800-0815	Dark detritus filamentous algae	10.428	8.002	280,000	0.029
6-19-91	1400-1410	Filamentous algae dark detritus	8.909	7.499	91,900	0.082
6-20-91	0230-0245	Dark detritus filamamentous algae twigs	28.361	20.685	205,000	0.101
		Colorado River above Diamond Creek				
6-18-91	1200-1215	Filamentous algae light brown detritus	1.541	1.384	189,000	0.007
6-18-91	1900-1915	Dark detritus & algae	21.972	15.783	189,000	0.084
6-19-91	0600-0615	Dark detritus filamentous algae sand	90.970	39.521	226,000	0.175

* Values estimated using velocities at centroid of flow (see text).

Table 22.—Water discharge of the Colorado River and selected tributaries for the November 1990 synoptic study

[Discharge in cubic meters per second; –, not determined]

Site Name	Date	Time	Discharge
Colorado River below Glen Canyon Dam	11-5-90	0600	51
		1200	314
		1800	357
		2400	88
	11-6-90	0600	49
		1200	259
		1800	337
		2400	89
Colorado River at Lees Ferry	11-5-90	0600	67
		1200	259
		1800	294
		2400	326
	11-6-90	0600	79
		1200	275
		1800	245
		2400	286
Paria River near mouth	Composite		0.27
Colorado River above Little Colorado River	11-5-90	0600	74
		1200	67
		1800	100
		2400	96
	11-6-90	0600	241
		1200	300
		1800	186
		2400	111
Little Colorado River near mouth	Composite		6.3
Colorado River at Grand Canyon	11-5-90	0600	138
		1200	107
		1800	107
		2400	116
	11-6-90	0600	122
		1200	286
		1800	320
		2400	214
Bright Angel Creek near mouth	Composite		0.40
Colorado River above Kanab Creek	11-5-90	0600	252
		1200	139
		1800	108
		2400	79
	11-6-90	0600	74
		1200	–
		1800	79
		2400	294
Kanab Creek near mouth	Composite		0.11

Table 22.–Water discharge of the Colorado River and selected tributaries for the November 1990 synoptic study–Continued

Site Name	Date	Time	Discharge
Colorado River above Havasu Creek	11-5-90	0600	–
		1200	241
		1800	204
		2400	164
	11-6-90	0600	119
		1200	130
		1800	156
		2400	–
Havasu Creek near mouth	Composite		2.12
Colorado River at National Canyon	11-5-90	0600	255
		1200	241
		1800	–
		2400	113
	11-6-90	0600	–
		1200	85
		1800	170
		2400	227
Colorado River above Diamond Creek	11-5-90	0600	146
		1200	174
		1800	193
		2400	177
	11-6-90	0600	153
		1200	168
		1800	159
		2400	142
Diamond Creek near mouth	Composite		0.045
Colorado River near Columbine Falls	11-5-90	0600	105
		1200	134
		1800	102
		2400	99
	11-6-90	0600	98
		1200	129
		1800	110
		2400	91

Table 23.–Water discharge of the Colorado River and selected tributaries for the June 1991 synoptic study

[Discharge in cubic meters per second; –, not determined]

Site Name	Date	Time	Discharge
Colorado River below Glen Canyon Dam	6-18-91	1200	821
		1800	799
		2400	213
	6-19-91	0600	190
		1200	813
		1800	801
		2400	189
	6-20-91	0600	189
Colorado River at Lees Ferry	6-18-91	1200	654
		1800	815
		2400	595
	6-19-91	0600	166
		1200	665
		1800	827
		2400	592
	6-20-91	0600	167
Paria River near mouth	Composite		0.093
Colorado River above Little Colorado River	6-18-91	1200	549
		1800	265
		2400	620
	6-19-91	0600	815
		1200	513
		1800	261
		2400	631
	6-20-91	0600	759
Little Colorado River near mouth	Composite		6.14
Colorado River at Grand Canyon	6-18-91	1200	745
		1800	462
		2400	274
	6-19-91	0600	742
		1200	688
		1800	450
		2400	270
	6-20-91	0600	753
Bright Angel Creek near mouth	Composite		0.62
Colorado River above Kanab Creek	6-18-91	1200	810
		1800	966
		2400	481
	6-19-91	0600	396
		1200	578
		1800	900
		2400	538
	6-20-91	0600	328
Kanab Creek near mouth	Composite		0.099
Colorado River above Havasu Creek	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Havasu Creek near mouth	Composite		1.87

Table 23.–Water discharge of the Colorado River and selected tributaries for the June 1991 synoptic study–Continued

Site Name	Date	Time	Discharge
Colorado River at National Canyon	6-18-91	1200	317
		1800	770
		2400	705
	6-19-91	0600	479
		1200	328
		1800	736
		2400	668
	6-20-91	0600	467
Colorado River above Diamond Creek	6-18-91	1200	561
		1800	496
		2400	391
	6-19-91	0600	841
		1200	705
		1800	532
		2400	405
	6-20-91	0600	813
Diamond Creek near mouth	Composite		0.051
Colorado River near Travertine Cleft	6-18-91	1200	303
		1800	388
		2400	402
	6-19-91	0600	425
		1200	671
		1800	546
		2400	450
	6-20-91	0600	510

Table 24.—Suspended sediment concentrations at Colorado River and tributary cross-sections for the November 1990 synoptic study

[Concentration in milligrams per liter; –, not determined]

Site Name	Date	Time	Concentration
Colorado River below Glen Canyon Dam	11-5-90	0600	30
		1200	10
		1800	20
		2400	10
	11-6-90	0600	<10
		1200	<10
		1800	<10
		2400	<10
Colorado River at Lees Ferry	11-5-90	0600	<10
		1200	<10
		1800	<10
		2400	10
	11-6-90	0600	<10
		1200	<10
		1800	20
		2400	20
Paria River near mouth	11-5-90	0600	80
		1200	160
		1800	120
		2400	170
	11-6-90	0600	186
		1200	200
		1800	190
		2400	460
Colorado River above Little Colorado River	11-5-90	0600	40
		1200	20
		1800	<10
		2400	<10
	11-6-90	0600	10
		1200	80
		1800	40
		2400	<10
Little Colorado River near mouth	11-5-90	0600	960
		1200	930
		1800	980
		2400	8,280
	11-6-90	0600	133,000
		1200	9,790
		1800	81,100
		2400	58,100
Colorado River at Grand Canyon	11-5-90	0600	150
		1200	20
		1800	60
		2400	10
	11-6-90	0600	60
		1200	100
		1800	6,600
		2400	5,040
Bright Angel Creek near mouth	11-5-90	1000	10
	11-6-90	0245	20
		1600	20
		unknown	<10

Table 24.--Suspended sediment concentrations at Colorado River and tributary cross-sections for the November 1990 synoptic study--Continued

Site Name	Date	Time	Concentration
Colorado River above Kanab Creek	11-5-90	0600	110
		1200	70
		1800	140
		2400	100
	11-6-90	0600	110
		1200	10
		1800	70
		2400	70
Kanab Creek near mouth	11-5-90	0600	10
		1200	10
		1800	30
		2400	190
	11-6-90	0600	<10
		1200	40
		1800	20
		2400	<10
Colorado River above Havasu Creek	11-5-90	0600	150
		1200	110
		1800	150
		2400	160
	11-6-90	0600	110
		1200	120
		1800	<10
		2400	110
Havasu Creek near mouth	11-5-90	0600	60
		1200	20
		1800	30
		2400	70
	11-6-90	0600	70
		1200	70
		1800	70
		2400	70
Colorado River at National Canyon	11-5-90	0600	120
		1200	130
		1800	--
		2400	110
	11-6-90	0600	--
		1200	140
		1800	60
		2400	70
Colorado River above Diamond Creek	11-5-90	0600	230
		1200	240
		1800	290
		2400	220
	11-6-90	0600	170
		1200	220
		1800	190
		2400	70
Diamond Creek near mouth	11-5-90	0600	30
		1200	10
		1800	20
		2400	--
	11-6-90	0600	30
		1200	250
		1800	60
		2400	--

Table 24.—Suspended sediment concentrations at Colorado River and tributary cross-sections for the November 1990 synoptic study—Continued

Site Name	Date	Time	Concentration
Colorado River near Columbine Falls	11-5-90	0600	470
		1200	460
		1800	250
		2400	380
	11-6-90	0600	300
		1200	330
		1800	370
		2400	290

Table 25.--Suspended sediment concentrations at Colorado River and tributary cross-sections for the June 1991 synoptic study

[Concentration in milligrams per liter; --, not determined]

Site Name	Date	Time	Concentration
Colorado River below Glen Canyon Dam	6-18-91	1200	--
		1800	--
		2400	--
	6-19-91	0600	--
		1200	--
		1800	--
		2400	--
	6-20-91	0600	--
Colorado River at Lees Ferry	6-18-91	1200	--
		1800	40
		2400	40
	6-19-91	0600	--
		1200	--
		1800	--
		2400	--
	6-20-91	0600	--
Paria River near mouth	6-18-91	1200	--
		1800	--
		2400	--
	6-19-91	0600	--
		1200	--
		1800	--
		2400	--
	6-20-91	0600	--
Colorado River above Little Colorado River	6-18-91	1200	--
		1800	80
		2400	40
	6-19-91	0600	110
		1200	110
		1800	30
		2400	20
	6-20-91	0600	50
Little Colorado River near mouth	6-18-91	1200	250
		1800	190
		2400	170
	6-19-91	0600	100
		1200	--
		1800	220
		2400	250
	6-20-91	0600	--
Colorado River at Grand Canyon	6-18-91	1200	--
		1800	--
		2400	--
	6-19-91	0600	--
		1200	--
		1800	--
		2400	--
	6-20-91	0600	--

Table 25.—Suspended sediment concentrations at Colorado River and tributary cross-sections for the June 1991 synoptic study—Continued

Site Name	Date	Time	Concentration
Bright Angel Creek near mouth	6-18-91	1200	–
		1800	30
		2400	60
	6-19-91	0600	80
		1200	–
		1800	20
		2400	50
	6-20-91	0600	30
Colorado River above Kanab Creek	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Kanab Creek near mouth	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Colorado River above Havasu Creek	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Havasu Creek near mouth	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Colorado River at National Canyon	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Colorado River above Diamond Creek	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–

Table 25.–Suspended sediment concentrations at Colorado River and tributary cross-sections for the June 1991 synoptic study–Continued

Site Name	Date	Time	Concentration
Diamond Creek near mouth	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–
Colorado River near Travertine Cleft	6-18-91	1200	–
		1800	–
		2400	–
	6-19-91	0600	–
		1200	–
		1800	–
		2400	–
	6-20-91	0600	–

APPENDIX

WATER QUALITY

SYNOPTIC EXPERIMENT FIELD GUIDE

U.S, Geological Survey

Water Resources Division

Colorado River Water-Quality Study

1991

Prepared by

H.E. Taylor, R.C. Averett and J.R. Garbarino

INTRODUCTION

In order to understand the water-quality of the river, the following measurements and water sample collection will be made as a part of the synoptic studies. During each synoptic period field measurements and water-sample collection will occur every 6 hours over a 48-hour period.

FIELD MEASUREMENTS

TEMPERATURE--Temperature will be measured each time samples are collected at each of the respective sampling locations. The general rule of thumb is "you never have too much temperature data"; therefore, whenever possible measure both the water temperature and ambient air temperature and record date, time, sampling site and measurement location on the provided form. All temperatures should be measured at the surface with a calibrated alcohol thermometer to the nearest 0.5 C. (NO mercury thermometers should be used in the Colorado River system). The thermometer should be allowed to equilibrate for at least 3 minutes prior to reading temperature. Care must be taken to read the thermometer while the bulb remains submerged.

Where possible horizontal temperature profiles (across stream) should be made at least once during each sampling period. A minimum of 3 and preferable 5 equally spaced temperatures should be measured across the river or stream, in a line perpendicular to the velocity vector of the stream. A minimum of elapsed time should be expended while making these measurements to insure that as close to a steady-state condition as possible exists during the cross-sectional profile measurement.

pH--pH is a measurement of the hydrogen ion activity or concentration in an aqueous solution. It is a logarithmic function which usually ranges from 1 to 14 units (acidic to alkaline, respectively). A pH of 7.00 represents a neutral solution. pH must be measured either *in situ* or rapidly after sample collection to minimize changes due to degassing of CO_2, precipitation (such as carbonates), or other chemical and physical reactions that cause the pH of the water sample to change.

The pH will be measured using an Orion Model SA 250 digital pH meter, with the appropriate combination electrode and automatic temperature compensation probe. The meter will be calibrated before **EACH** use with two buffers, pH 7.00 and pH 10.0 using the "autocalibration" mode. The following procedure is used to calibrate the pH meter:

1. Connect the electrode and ATC probe (if appropriate) to the appropriate connectors on the pH meter. Slide the mode switch to the pH 0.01 position. Check the saturated KCl level in the electrode and fill from supplied bottle, if necessary. Uncover filling solution hole in the electrode before measurements are made.
2. Rinse the electrode and probe thoroughly, and gently wipe dry with a tissue.
3. Transfer a small portion of pH 7.00 buffer to a clean cup and submerse electrode and probe stirring vigorously to dislodge bubbles.
4. Press the CAL button and observe the display alternating between 1 and approximately 7. Wait for a stable reading and press ENTER. The display will hold for about 3 seconds and then advance to 2, indicating that the meter is ready for the pH 10.00 buffer. Do not dispose of pH 7.00 buffer.
5. Rinse electrodes with deionized water and submerge in pH 10.00 buffer stirring to remove air bubbles. When stable pH is achieved press ENTER. After the second buffer has been entered, the letters pH will be displayed indicating the meter is ready for pH measurement.
6. Remove electrodes and rinse with deionized water. Dry electrodes with a tissue. Use a clean cup and transfer a small portion of the pH 4.01 buffer to a cup. Submerse electrodes with vigorous stirring to remove bubbles. Record pH value in the Field Notebook
7. Rinse electrode and probe with deionized water, dry and resubmerse in the pH 10.00 buffer. Record observed pH in the Field Notebook. Repeat same procedure with the pH 7.00 buffer.
8. Rinse and dry a final time and place in sample and measure pH.

NOTE - ALWAYS BE SURE METER READINGS HAVE STABILIZED BEFORE RECORDING FINAL pH READING.

All measured pH's should be recorded in the permanent record to the nearest 0.01 pH unit.

SPECIFIC CONDUCTANCE--Specific conductance is a measure of the total ionic strength of an aqueous solution. It is determined by the measurement of solution resistance, reference at 25° C. The determination is easily made in the field, and gives results that are useful for a general indication of the dissolved-solids concentration.

As with pH, specific conductance may change with time after sample collection, therefore, measurements should be made in situ, or as rapidly as possible after sample collection or compositing. When using the Model 515 dip cell, care must be used to insure that the cell is immersed to a depth of at least 5 cm above its bottom (the end opposite the cable connection). The cell should be rapidly moved in an up-and-down motion to dislodge any trapped air bubbles.

The calibration of the Model 604 Digital Conductivity Meter should be field checked by the following procedure:

1. Measure the provided specific conductance reference standard by submersing the cell to the proper depth in the standard solution and turn main power switch to the "on" position. Function switch should be placed to the "on 25 C" position and the range switch should be placed at "2000". At sites where the specific conductance is known to be high, appropriate adjustments to measuring procedures should be made to accommodate these types of samples.
2. After moving the cell up and down several times to dislodge air bubbles, read conductivity immediately after display stabilizes.
3. Record date, time and meter reading for the standard solution on the provided form.
4. Calibration standard should be checked before each sampling period.

Samples should be measured with the same meter settings as used in the calibration procedure. To prevent erroneous meter readings, care must be taken not to submerse the cell totally in water when readings are made. Each time a specific conductance measurement is made, water and air temperature should be recorded at the same location.

ALKALINITY--Alkalinity is the acid neutralizing capacity of an aqueous solution. Along with pH, it is the basis of measurement of carbonate and bicarbonate concentrations in natural waters. Carbon dioxide loss, precipitation and other chemical and physical reactions may cause the alkalinity of some waters to change dramatically within several hours or even minutes after sample collection. Consequently, field measurement of alkalinity is usually more reliable than when measured in the laboratory. If the pH of the sample is >8.3 then appreciable carbonate will be present, resulting in two endpoints for the Gran's titration curve.

All samples for alkalinity titration should be field filtered prior to titration. Filtration should be carried out using the supplied syringe filters attached to a 60 mL plastic syringe using the following procedure:

1. Remove the plunger from a clean syringe, attach a disk filter and fill to 55 mL with sample, avoiding contamination.
2. Expel sample through the filter until the syringe plunger is aligned with the 50 mL mark on the syringe barrel.
3. Expel exactly 50 mL of sample through the filter into the titration vessel (beaker).
4. Immediately rinse the syringe with deionized water and return the syringe to a plastic bag to prevent contamination.
5. If the filter plugs with suspended sediment, note the volume of sample transferred from the reading on the syringe barrel, refill the syringe as instructed in steps 1 and 2, expel additional sample into the titration vessel such that the total volume expelled equals exactly 50 mL.

Alkalinity on the filtered sample is determined by titration with a 0.16 N standard sulfuric acid solution to an end-point of pH 3.5. The following procedure must be used to perform the alkalinity titration and data recording:

1. Calibrate the pH meter according to the instructions under pH Section. Rinse electrodes thoroughly and dry lightly with a clean laboratory tissue.
2. Place electrode into 50 mL sample with stirring bar on magnetic stirrer and record initial pH.
3. Fill digital burette with 0.16 N H_2SO_4 or insert cartridge, where appropriate.
4. The delivery tube from the burette must be placed below the surface of the sample. Rotate the delivery knob of the burette so that a volume of acid is added to the sample.
5. After each increment of acid is added to the sample continue stirring for at least 30 seconds and then turn off stirring motor and read sample pH after the meter stabilizes.
6. Record both the volume increment of acid added and the pH after each addition. The pH of the sample will be extremely sensitive to small additions of acid, so great care must be used to insure accurate readings are obtained.
7. After reaching a pH of 5.5, add smaller increments of acid until reaching a pH of 4.5, this will usually be only 1 or 2 units on the digital pipette. (If starting pH is >8.3 then smaller increments will need to be added immediately continuing until reaching a pH of 7.5. Larger increments can then be added until reaching pH 5.5).
8. After completion of titration, thoroughly rinse all equipment with deionized water and store for next sampling period. Alkalinity, carbonate and bicarbonate values will be calculated from the titration data at a later time.

DISCHARGE--Use conventional stream discharge measurement procedures.

DISSOLVED OXYGEN--Oxygen dissolved in surface water is a combination of oxygen from the air (dissolved by diffusion) and oxygen produced from aquatic plants during the process of photosynthesis. The solubility of oxygen is dependent on the partial pressure of oxygen in the air, the temperature of the water, and the chemical composition of the water. The measurement of dissolved oxygen provides a great deal of insight to biological and chemical processes underway in a river or lake. The longitudinal extent of photosynthesis or respiration in a river can be estimated by measuring the *in situ* dissolved oxygen. With the use of a dissolved oxygen meter the task is simple. The meter probe is placed in flowing water in an area where the water surface is unbroken, and the dissolved oxygen measured and recorded.

Locate an area near the river bank that has a steady unbroken flow. Calibrate the dissolved oxygen meter and place the probe about 6-12 inches below the water surface and measure and record the dissolved oxygen. Measurements should be made at 1 hour intervals whenever possible. At times this can not be accomplished, as the meter will be used elsewhere, but whenever possible, make the measurements every hour. Record the data with date, military time, and note the light conditions, such as bright sunlight, cloudy, or dark. Also, qualitatively note the degree of darkness. This is important in the Grand Canyon, because of the influence of the steep canyon walls on light intensity.

Operate meter as follows:

1. Check "mechanical zero" on meter.
2. Turn meter on, allow at least 1 hour warm-up.
3. Check membrane for air bubbles and smoothness.
4. Dip calibration chamber in water and pour off excess.
5. Insert probe into wet chamber making sure no water leaks in and no droplets of water are on membrane.
6. Place in water and allow time for temperature of air in chamber to equilibrate.
7. Read barometric pressure and temperature in calibration chamber.
8. Determine the dissolved oxygen saturation value from Oxygen Solubility Table; apply a salinity correction if necessary. Record all information.
9. Check "redline" and zero; adjust if necessary.

10. Select scale and adjust calibration knob to DO value obtained from saturation table.

11. Remove probe from calibration chamber and place in water, making measurements in water velocities of at least 1 ft/sec.

12. Read and record value to nearest 0.1 mg/l.

SECCHI DISK--The measurement of light penetration through the water column provides insight to water clarity and depth of the euphotic zone. Under ideal circumstances a submarine photometer is used. This equipment is, however, expensive and delicate. We will use a photometer at several stations, including Lake Powell. At most river stations we will use a Secchi disk, which is simply a black and white disk that is lowered into the water and the depth at which it disappears is noted.

Locate a site where the water is slowly flowing, such as the site for the measurement of photosynthesis. Select as deep a site as possible, which often will mean working from the back of a boat, or from a vertical bank. Lower the Secchi disk into the water in a vertical manner until it disappears from sight. Then slowly raise the Secchi disk until it just reappears. Note and record the water depth in meters that the disk reappears to your sight; this is the Secchi disk reading.

PHOTOSYNTHESIS AND RESPIRATION--Photosynthesis (P) is the process whereby chlorophyll containing plants synthesize cellular material. Respiration (R) is the process whereby organisms break down cellular material to obtain energy. Photosynthesis occurs in the presence of light, whereas respiration occurs constantly in the light and in the dark. A useful measurement in determining processes in aquatic ecosystems is the "P/R ratio". Another useful measurement is that of primary production which can be measured by dissolved oxygen uptake and release during daylight hours. Primary production is simply gross and net photosynthesis and is measured either with the carbon-14 method, or more simply with the oxygen light-and-dark bottle method. The oxygen light-and-dark bottle method will be used during the Synoptic Studies on the Colorado River. This technique consists of using paired 300 mL biochemical oxygen demand (BOD) bottles filled with unfiltered river water. One bottle is left uncovered so that light may penetrate through the glass and trigger photosynthesis (light bottle). The other bottle (dark) is first covered with black electricians tape to prevent light passage, and then covered with aluminum foil to reflect heat. The initial dissolved oxygen (I_b) is determined for the bottles, and they are then suspend in the water. A general rule of thumb is to suspended two pairs of bottles (two light and two dark) every meter in depth from the surface to the bottom. After a period of incubation the bottles are retrieved, and the final dissolved oxygen (L_b and D_b) is determined.

Locate an area where the flow is minimal and at least one meter in depth. Obtain paired light and dark bottles. Fill a container having a capacity of 8-10 liters with water from the selected site, and let stand for 15-30 minutes. After this period determine the dissolved oxygen concentration which is the initial concentration and designated as I_b. Also record the water temperature. Carefully fill the light and dark bottles with water from the container being careful not to agitate and increase the dissolved oxygen concentration. Stopper the bottles insuring there are no bubbles or air space in the bottle. Immediately suspend the paired bottles, two pair (two light and two dark) per each meter of depth, starting just below the surface. Incubate the bottles for about 4 hours; (1000 to 1400 are generally the best hours). After incubation remove the bottles and immediately determine the dissolved oxygen in each bottle and record as D_b, or L_b. Construct a table as follows for the dissolved oxygen values:

Dissolved Oxygen **Temp.____**

Time in: Time out:

Depth	I_b	L_b	D_b
Surface	_____	_____	_____
1 meter	_____	_____	_____
2 meters	_____	_____	_____
do.	_____	_____	_____

Note that the I_b dissolved oxygen value will be the same for all bottles. The change in dissolved oxygen (absolute values) in the light bottle is net photosynthesis. The change in dissolved oxygen in the dark bottle is due to respiration. If we add the change in dissolved oxygen in the dark bottle to the change in dissolved oxygen in the

light bottle the result is gross photosynthesis. It is extremely important to measure the dissolved oxygen carefully, and immediately upon on retrieval of the bottles. The amount of dissolved oxygen in the water is a function of pressure and temperature. The meter must be calibrated to pressure and the temperature of the water determined at each reading. If you must hold the bottles out of the water for a short time either in establishing them for suspension or upon retrieval, keep them cool and in the dark. There are several ways to suspend the 300 mL BOD bottles. The best method is to suspend them in a horizontal manner.

FIELD OBSERVATIONS--One of the most important pieces of information a researcher can have is accurate field notes of observations made during a period of intense study such as the Synoptic studies. Such notes fill important gaps in our knowledge, and help explain anomalies in the data and findings. They also provide important insight to the data. There is no easy way to tell you what to record, nor what to look for as a part of your field notes. The best rules of thumb are threefold: 1) Field notes are extremely important and thus deserve dedicated time to record. Do not rely upon your memory. One way to remember as well as to extend the time between writing is to carry a small dictating devise and speak into it from time to time. Then, when the opportunity arises, you can record your notes on paper; 2) Watch the river. What is moving downstream? Is there a concentration of foam? Any insect activity above the river surface? Any unusual flow regimes?; 3) Observe the sampling and sample processing procedures. Often flow conditions require modifications. Be certain that such modifications are recorded. Also, if someone makes a measurement error that cannot be repeated, note that in your field notes. All researchers look for anomalies and high and low values in the data. We must be certain that such values are real, and not a sampling artifact. We ask that you specifically note the occurrence of fronds of *Cladophera* moving past your sampling site, the occurrence and time extent of sediment-laden water (which can occur from storms in the tributary drainages or along the mainstem below Glen Canyon Dam), and the time of extreme high and extreme low water. At the extreme high and low water measurements it is important to record the dissolved oxygen and water temperature. Finally, we must have the weather at the site recorded every three hours. Note cloud cover, periods and extent of rainstorms, and air temperature.

CHEMICAL SAMPLE COLLECTION

DISCHARGE WEIGHTED SAMPLING PROCEDURE--Sampling at all sections will be by the Equal Discharge Increment (EDI) method using the D-77 (metals and organics) sampler, with a Teflon bag liner inside the plastic bottle, at both cable and boat sampled mainstem sections. The DH-81 sampler, with a Teflon bag liner is used at tributary sections. In all cases, as nearly as possible equal volumes of sample (1 - 1.5 liters each) will be collected from verticals at the mid-points of each of five equal discharge increments in the cross-section.

At each cableway section, a table is provided in the appendix which, for a range of discharges, lists the five positions along the cable at which to locate the sampling verticals. Before sampling, determine the discharge at the station by reading the staff gage and consulting the rating table for the gage. Next determine the correct position of the sampling vertical by interpolation in the table provided. At the boat-sampled mainstem stations, sampling verticals will be located at the centroids of equal-area increments. This will necessitate measurement of a cross-sectional depth profile before the 48-hour sampling period begins. Plot the cross-section and determine the five approximate centroids of volume. Attempt to hold the boat at these same sampling verticals (distances from the bank) during each of the sampling periods.

At wading sections, the five centroids of discharge will be determined from the discharge measurements made at the time of sampling. Transit rates should be held as constant as possible within each vertical to insure that a representative depth-integrated sample is obtained. Do not allow the sampler to sit on the river bottom before retrieval (move at a constant transit rate). It is not necessary that transit rates for each vertical be the same, however; once a transit rate is selected for each vertical, it must remain constant for the entire upward or downward transit.

COMPOSITING--Samples from each vertical will be collected in Teflon bags. Be careful to insure samples and sampling equipment are handled with polyethylene gloves. Transfer sample from each vertical to the graduated cylinder (sieving the sample through the provided nylon sieves) and measure the volume and record. Also record the Price Current Meter clicks and total time of the vertical transect for each vertical. After recording volume, transfer sample to the Teflon-coated stainless steel churn for compositing. When all five verticals are completed,

about 7.5 liters of sample should be in the churn. Use standard churn splitting procedures, consulting the attached table for splitting procedures.

NOTE - "TAYLOR" DEIONIZED WATER MUST BE USED IN ALL SAMPLE PROCESSING PROCEDURES. OTHER DEIONIZED WATER MAY BE USED FOR TITRATIONS, ETC.

MAJOR CONSTITUENTS--The dissolved components of water samples can be classified according to their general indigenous concentration levels. Those constituents present at concentration levels generally greater than 1 mg/L comprise the bulk of ionic materials that contribute to the specific conductance and the dissolved solids. Accurate measurement of these materials are necessary to characterize the general water chemistry of the samples. Calcium, magnesium, sodium, and potassium are categorized as major constituent cations. Anions such as chloride, sulfate and silica (reported as SiO_2) are the corresponding counter ions. These coupled with hydrogen ion (determined from pH measurements) and carbonate/bicarbonate (determined from alkalinity titrations) represent the major water chemistry constituents. Even though these are dissolved materials and should be relatively homogeneously distributed in water samples, differences in surface and ground-water sources can result in rather significant concentration gradients of these materials in natural waters. Therefore, discharge weighted, depth and width-integrated sampling techniques are required to insure that statistically representative samples are obtained.

After sampling and compositing (see **CHEMICAL SAMPLE COLLECTION**), a 500 mL subsample for the major cations determination is split from the composite churn into a sample-rinsed Teflon bottle. This same subsample is used for trace metals processing, and the filtration process is described in that Section. A 250 mL subsample for major anion determination is split from the composite churn into a sample rinsed, black capped, polyethylene bottle which will not be preserved other than by chilling (keep sample on ice at approx. 4° C.). Rinse bottle with about 20 mL of sample and discard (this is a **MUST** for all subsamples), before filling to top, try not to leave an air space in bottle.

NUTRIENTS--Nutrients represent an important group of constituents that are extremely important in controlling the biological productivity of the river system. They consist of elements that are necessary for the growth of plants and ultimately animals. In excess, some nutrients can create potentially noxious situations by promoting algal blooms and other conditions and cause nuisance conditions such as taste and odor.

Nutrients, as discussed here, consist of nitrogen containing species, ammonium, nitrate, nitrite and organic nitrogen; and phosphorus expressed as both orthophosphate and total phosphorus species. **ALL** nutrients will be determined as present in the **DISSOLVED** phase. Therefore, all samples for nutrients analysis must be field **FILTERED.**

After sampling and compositing (in churn), a subsample will be filtered through a 0.45 µm silver-membrane filter (the same filtering procedure and apparatus used for dissolved organic carbon), into 3 precleaned, opaque, 250 mL polyethylene brown bottles. Discard the first 20 mL of sample filtered. The appropriate labels are affixed to the bottles and the samples are immediately stored chilled in an ice chest. One bottle will be labeled for "Nutrients", the second bottle, "Total Nitrogen" for organic nitrogen and the third bottle, "Total Phosphorus" for total phosphorus species. After filtering, the silver filter must be carefully removed from the holder and stored chilled in a labeled petri-dish for suspended organic carbon determinations. If possible, all samples should be filtered through a single silver membrane filter; however, if the suspended sediment concentration is so high that the filter clogs quickly, the filter may be changed (Note - only 3 silver filters have been provided for each sample period). See DOC section for specific instructions on using the pressure filtration apparatus.

DISSOLVED ORGANIC CARBON--Dissolved organic carbon (DOC) is the organic carbon passing through a 0.45 µm silver membrane filter. This measurement quantifies the chemically reactive fraction and gives the mass of organic carbon dissolved in a water sample. It is a reliable measure of the many simple and complex organic molecules making up the dissolved organic load. The procedure for processing sample for DOC involves pressure filtering the sample through a 0.45 µm silver membrane filter housed in a stainless steel pressure filtration apparatus (Gelman Instrument Model 4280).

The procedure for filtration is as follows:

1. A silver filter is inserted into the lower section of the barrel filter using forceps (care must be used to avoiding damage to the filter. Note - do **NOT** use the same Teflon coated forceps that are used to handle the Nuclepore filters described below.) Make sure the gaskets are properly aligned and hand tighten the middle section of sampler onto the base with filter.
2. About 150 mL of sample is poured into the filter apparatus and the top section is hand-threaded onto the top of the barrel and the gas line is connected to the nitrogen cylinder.
3. The regulator is carefully adjusted to 25 pounds per square inch (higher pressures may rupture cell walls, invalidating DOC measurements).
4. Sample is filtered into a 125 mL brown glass bottle. The first 20 - 25 mL of filtered sample is used to rinse the bottle and cap, and is subsequently discarded.
5. Fill the bottle completely and cap tightly. Label and chill immediately.
6. If the filter is not clogged sufficiently to inhibit filtration, this same filter and apparatus can be used to filter nutrient samples (see Section on nutrients above).

TRACE ELEMENTS--Inorganic materials in the dissolved aqueous phase at concentration levels below 1 mg/L are classified as trace elements. These consist of cationic or anionic species that pass through a filtration process with a particle size cutoff of 0.4 micrometers (μm).

Often biologically toxic inorganic materials are present at trace concentration levels. In addition, a complete understanding of water chemistry processes requires a general knowledge of the trace elemental composition of the dissolved phase. The following trace elements will be determined in the aqueous phase: Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Hg, Li, Mn, Mo, Ni, Pb, Se, Tl and U. Additional information on the association of trace metals with specific size-fractions of suspended material will be determined on the residues retained on filters, and the special samples collected for field flow fractionation (FFF) measurements.

Two subsamples of the discharge weighted depth- and width-integrated composite (from churn) are collected in a sample rinsed 500 mL Teflon holding bottle and a 250 mL Teflon holding bottle. These samples are filtered through 0.4 μm Nuclepore filters housed in an all Teflon apparatus. The procedure for filtration is as follows:

1. Extreme care must be used during filtration and when handling filter apparatus to avoid contamination. At all times equipment must be stored in plastic bags to prevent dust contamination, and plastic gloves must be worn by the operator.
2. Set up filtration apparatus using filter holder and vacuum system.
3. Place membrane filter in apparatus using Teflon-coated tweezers. Be careful to orient filter in the holder so that the shiny side is up. Filters are packed with shiny side down, between paper spacers. Use care to avoid puncturing the filter with the tweezers. Grip the filter at the edge and avoid wrinkling filter when tightening filter holder.
4. Rinse filter with about 50 mL of 0.1 % HNO_3, the rinse solution is prepared by dosing 0.5 mL of concentrated high purity HNO_3 from Teflon dosing bottle (1 dose) into the 500 mL bottle that is provided marked **ACID RINSE** (use safety glasses). Fill bottle with deionized water, and shake to mix thoroughly. Vacuum filter to dryness, then rinse filter with about 100 mL of deionized water (rinse water is prepackaged in each of the RED capped bottles) (vacuum filter to dryness). Dispose of acid-rinse and water-rinse into waste bottle and discard into provided waste storage.
5. Vigorously shake sample in Teflon holding bottle and pour about 20 mL into filter funnel. Filter into 250 mL RED capped bottle. Remove bottle from the apparatus, screw on cap and shake vigorously and discard.
6. Pour additional sample into filter funnel and continue filtering until bottle is approximately 7/8ths full. Cap bottle tightly and label. This will be the first trace element/major cation sample.

7. After filtration is completed, carefully remove sediment loaded filter with Teflon-coated tweezers from the filter holder and place in labeled Petri dish.

8. Repeat the identical procedures outlined in steps 3-7 to prepare the replicate trace element/major cation sample and its corresponding filter.

9. Repeat steps 3 and 4 to prepare a third filter for the Hg determination sample. Deionized rinse water is contained in the brown glass bottle. Use a 10 mL portion from the Hg determination holding bottle to rinse a 125 mL **CLEAR** glass bottle with filtered sample (7/8 full). Discard sample rinse and fill this bottle with filtered sample. After filtration is complete, rinse a 125 mL **BROWN** glass bottle with 10 milliliters of filtered sample, shake and discard, and then continue filtering from the "Hg determination holding bottle" until this bottle is 7/ 8 full.

10. If any of the filters are clogged sufficiently where the filtration process is slowed to the point of inhibiting further sample processing, use a new filter and go back to item 4, and rinse the new filter with 0.1 % HNO_3, deionized H_2O and sample.

11. After filtration is completed, carefully remove sediment loaded filter with Teflon-coated tweezers from the filter holder and place in labeled Petri dish. If extra filters were used in any of the steps, place them with the Hg filter in a third petri dish for later disposal. When completed there should be three Petri dishes with filters, one for each trace element sample and a third for disposal (includes Hg filter).

12. Both of the trace element/major cation sample bottles should be acidified with concentrated HNO_3, using the Teflon calibrated dosing bottle (be sure to wear safety glasses). Use <u>TWO</u> (2) doses of acid from the dosing bottle for each sample bottle. This represents a total of 1 mL of concentrated HNO_3 per 250 mL of sample (each dose from the HNO_3. dosing bottle is 1/2 mL). Tighten lids on bottles and shake to homogenize acid.

13. The **CLEAR** 125 mL Hg determination sample **ONLY** should be preserved with $K_2Cr_2O_4$-HNO_3 preservative. The brown 125 mL Hg determination sample is chilled.

14. When completed, there should be two RED capped sample bottles for trace element/major cations, one **CLEAR** glass Hg determination sample bottle and one **BROWN** glass Hg determination sample bottle, each appropriately labeled .

15. Each of the Petri dishes holding the filters from the filtration procedures should be identified and labeled with time, date, bar code numbers of samples processed through the filter and any comments in a corresponding fashion to the sample collected.

16. When all filtration is completed, thoroughly rinse all apparatus with deionized water and place in the appropriate plastic bags for storage.

17. Specific details of the entire procedure and the samples generated should be carefully recorded in the field notebook. Do not assume that information will be obvious, record **ALL** pertinent data.

<u>BLANKS</u>--Once per day, process a single portion of deionized water (as if it were a sample) through all sample handling procedures. This will generate a total of two blank samples for trace elements, nutrients, DOC, etc.

<u>FIELD FLOW FRACTIONATION SAMPLE</u>--A sample is collected for the study of colloidal size-fraction particles and their associated composition. These samples will be subsampled from the composited sample (from churn) directly into one of the small (60 mL) polyethylene screw capped bottles. Be sure and label the bottle immediately after filling and chill immediately.

<u>SEDIMENT SIZE DISTRIBUTION AND CONCENTRATION</u>--A sample is collected for the measurement of the size distribution and concentration of suspended matter (<63 mm). These samples are subsampled from the composited sample (from churn) into one of the 1 liter bottles. Use chloroform to preserve the samples, if available (10 mL per sample bottle). If it is not available, keep unpreserved sample chilled until transport to the laboratory. The bottle is tightly capped and labeled.

BIOLOGICAL SAMPLE COLLECTION

DRIFT--The term "drift" refers to material and organisms moving with the current. In many instances it is living benthic invertebrates, but also consists of parts of plants and animals. Most often we measure the near-surface drift, which consists mostly of organic material rather than bedload or other denser-than-water particles. The most common way to measure drift is to place nets having a given orifice and mesh size into the current of the stream for a given time period. In our case we place the nets near the shoreline (because of the water depth of the river) using reinforcement bar (rebar) driven into the river bottom to hold the nets. The nets we use have an orifice opening of 100 mm (4-inches) and a mesh having pore openings of 250 micrometers (μm). The top of the net orifice is maintained just below the surface of the water. Since the river stage rises and falls rapidly and on an irregular basis, the nets may need to be moved several times to keep them at the surface of the water. After being in the river for one hour the nets are removed and the contents placed into containers and preserved. Note - In order to quantify the drift it is necessary to know the velocity of the water entering the net in feet per second (fps). Thus, before the net or rebar are removed, this measurement must be made. Also, once the nets are in place there should be no upstream disturbance. The nets should only capture natural drift, not that caused by sampling or other upstream activity.

Locate a somewhat shallow area (<2 feet in depth) where the water is visibly moving downstream. Drive two rebar stakes about 4 inches apart into the river bottom until they are steady. Repeat the procedure at another similar site. Place the nets between the rebar with the top of the net just above the water line. Secure the nets with an elastic cord, by squeezing the rebar rods together against the opening of the net. Be certain that the safety cord of the net is looped over one of the rebar stakes to prevent loss of the net should it slip from between the two rebar rods. Note and record the time the net is set, using military time. Because of fluctuating river levels it may be necessary to raise or lower the nets on the two rebar stakes during the set period. After one hour, remove the nets from the river, and wash the contents into the plastic container attached to the end of the net. Remove the drift contents from the plastic container by unscrewing the lid, and place into a sample jar. Consolidate the contents of all nets into a single jar if possible. If not possible, use another jar and mark it "2 of 2" on the label. The velocity in feet per second must be measured and recorded on the label for each net. Preserve with a 50 % mixture of water and ethyl alcohol. Label the contents with the following information: 1) drift, 2) location of station, 3) time nets were set, 4) feet per second in front of nets and 5) date. Place the label **INSIDE** the sample bottle, and close the lid tightly. Finally, seal the lid to the bottle with a wrap or two of electrician's tape.

BIOLOGICAL PIGMENTS--The most useful biological pigment for determining phytoplankton biomass is Chlorophyll-α. This pigment is found in all oxygen-producing algae, both phytoplankton and periphyton. The major problem in collecting Chlorophyll-α in remote field areas such as the Grand Canyon is that the sample must be frozen immediately after collection. Thus we must by necessity limit the collection of Chlorophyll-α samples to specific sampling stations during our synoptic studies. The method consists of passing a known amount of water through a glass filter, rolling the filter with its contents inside, placing the rolled filter and contents into a darkened bottle or vial, and freezing until laboratory analysis with a spectrophotometer. Collect a water sample using a depth-integrated sampler, or a water bottle (sample may be removed from a churn splitter.) Place a glass 47-mm diameter filter onto a filter funnel and vacuum or pressure filter a known amount of water through the filter. Use no more than 25 psi with the pressure apparatus. Observe and record the amount of water passing through the filter. Remove the filter and roll tightly with the contents inside. Place in a darkened bottle or vial and immediately freeze. Keep frozen until analysis. The amount of water to pass through the filter is empirical, and must be determined for each sampling circumstance. Often the filter clogs when there is still water in the funnel. If this happens, note the amount of water that passed through the filter. Next, discard this water, save the filter, and the water in the funnel above the filter. With a new filter in place, add the saved water to the funnel and again filter. Another technique is to add water to the funnel in small amounts until the filter clogs. The goal is to filter as much water as possible, but under ideal circumstances a liter is sufficient.

BENTHIC INVERTEBRATES FROM STREAM BOTTOM--The benthic invertebrate community in the Colorado River is small and in some instances may be absent. The purpose of this sampling procedure is too obtain insight to their location, and the types that might be present. We do this with a "kick net", which is a qualitative sampler. The net is held in the stream by its brailles, and a person immediately upstream from the net dislodges the stream bottom material. This material with its associated organisms are washed into the net. The net is removed from the water and the organisms placed in a bottle containing 50 % mixture of alcohol and water.

Benthic organisms are most often the immature stages of aquatic insects. They must be in the water at all times, for they breathe through gills. Thus, they will not be found on the stream bottom between the high and low water areas of the river. If they are found at all, they will be on the stream bottom, especially riffle areas, that are present (wet) during low flows. Thus, sample for them **ONLY** during the lowest flow time of each day. This may be at night.

At low flow, select a riffle area less than a meter in depth. Have one person hold the net brailles, insuring that the bottom edge of the net is firm against the stream bottom. The second person disrupts the stream bottom in front of the net. Standard practice is to disrupt approximately a square meter of stream bottom. When completed raise the net upward and in an upstream direction. Be careful not to lose the contents. Place the net on a flat surface and remove the organisms with a pair of forceps. Place the organisms in a bottle containing a 50 % mixture of alcohol and water. Label the bottle, noting the date, time, depth of water, location of sampling site, size and type of stream bottom material, and approximate size of stream bottom area disturbed. Place the label inside of the bottle. Seal the bottle to the lid with electricians tape.

DISCHARGE AND SAMPLING TABLES FOR CABLEWAYS

[Q, discharge in cubic feet per second; Depth units are feet; Note: at flow of 15,000 & 27,000 vertical angles of 5 to 12 degrees occurred using a 100 pound suspension weight.]

09404200 Colorado River above Diamond Creek (approx 220' wide)

Centroids(ft)

Q=5,770

	LEW	110	130	150	170	190	REW
Velocity		1.5	1.9	2.0	2.0	1.5	
Depth		28	30	30	30	30	

Q=10,300

	LEW	105	125	145	165	190	REW
Velocity		2.2	3.2	3.2	3.0	2.5	
Depth		28	33	32	33	33	

Q=15,350

	LEW	105	130	145	165	190	REW
Velocity		3.3	4.0	4.0	4.0	3.6	
Depth		30	36	34	36	36	

Q=27,170

	LEW	100	125	145	170	195	REW
Velocity		4.5	6.0	6.3	6.0	5.1	
Depth		32	39	41	39	40	

Gage Height	Discharge In Cubic Feet Per Second										
(FEET)	0	1	2	3	4	5	6	7	8	9	10
40					2,500	3,260	4,020	5,280	6,670	8,700	14,700
50	11,300	14,000	17,000	19,800	22,700	25,900	29,500	33,400	37,600	42,000	35,300
60	46,600										

09404120 Colorado River at National Canyon (approx 250-280' wide)

Centroids(ft)

Q=5,800

	REW	75	105	140	170	210	LEW
Velocity		2.0	2.4	2.9	2.6	2.3	
Depth		16	15	14	14	13	

Q=8,630

	REW	90	120	150	180	220	LEW
Velocity		2.1	3.4	3.0	3.3	2.9	
Depth		20	17	17	17	16	

Q=13,030

	REW	70	110	145	180	220	LEW
Velocity		2.6	3.9	4.0	3.9	2.9	
Depth		22	19	20	19	19	

Q=15,530

	REW	85	120	155	180	225	LEW
Velocity		2.9	4.3	4.1	4.4	4.0	
Depth		24	22	21	21	20	

Q=20,440

	REW	85	115	150	180	215	LEW
Velocity		4.0	5.3	5.4	5.4	5.0	
Depth		25	24	24	23	23	

Q=26,880

	REW	70	110	150	190	225	LEW
Velocity		2.7	6.0	6.0	6.0	5.2	
Depth		28	27	26	25	25	

Gage Height (feet)	Discharge In Cubic Feet Per Second										
	0	1	2	3	4	5	6	7	8	9	10
30				1,780	2,290	2,900	3,610	4,430	5,360	6,410	8,300
40	7,590	8,920	10,400	12,000	13,800	15,800	17,900	20,300	22,800	25,500	20,900
50	28,500	31,900	35,500	39,500	43,700	48,200	53,100	58,100	63,400	69,000	46,500
60	75,000	81,300	87,900	94,900	102,000	110,000					

09383100 Colorado River above Little Colorado River (approx 310-350' wide)

Centroids(ft)

Q=5,520

	LEW	425	360	320	280	240	REW
Velocity		1.5	2.0	2.3	2.3	1.8	
Depth		9	12	13	12	13	

Q=7,070

	LEW	430	370	330	280	250	REW
Velocity		1.9	2.3	2.4	2.7	2.4	
Depth		10	11	13	13	15	

Q=13,320

	LEW	430	365	320	280	230	REW
Velocity		2.9	3.6	3.9	3.8	2.5	
Depth		12	15	17	16	17	

Q=17,200

	LEW	440	380	335	295	255	REW
Velocity		3.0	3.9	4.8	4.9	4.5	
Depth		13	15	17	17	18	

Gage Height (feet)	Discharge In Cubic Feet Per Second										
	0	1	2	3	4	5	6	7	8	9	10
20		2,870	3,990	5,100	6,700	8,900	11,000	14,100	17,300	20,800	23,800
30	24,300	28,100	32,000	36,000	40,800	45,700	50,900	56,300	61,800	65,500	45,000
40	69,300	73,100	76,800	80,600	84,400	88,200	92,000				

09402500 Colorado River at Grand Canyon
(approx 300' wide)

Centroids(ft)

Q=5,610

	REW	150	190	230	280	340	LEW
Velocity		1.5	2.0	1.8	1.8	1.3	
Depth		15	16	14	13	13	

Q=8,620

	REW	150	190	230	280	340	LEW
Velocity		2.1	2.3	2.3	2.2	1.8	
Depth		18	18	16	15	15	

Q=15,650

	REW	150	200	250	300	350	LEW
Velocity		2.8	3.4	3.3	3.4	3.2	
Depth		21	20	19	19	19	

Q=17,000

	REW	155	200	245	295	350	LEW
Velocity		3.2	3.6	3.6	3.5	3.1	
Depth		22	21	20	20	20	

Gage Height	Discharge In Cubic Feet Per Second										
(feet)	0	1	2	3	4	5	6	7	8	9	10
0			3,110	4,230	5,490	6,930	8,550	10,400	12,200	14,200	16,700
10	16,500	19,100	21,900	25,000	28,400	32,000	36,000	40,200	44,800	49,800	38,500
20	55,000	60,700	66,700	73,100	79,900	87,000					

09379910 Colorado River below Glen Canyon Dam
(approx 430'-490' wide)

Centroids(ft)

Q=5,060

	LEW	275	350	395	440	495	REW
Velocity		3.1	3.0	3.0	2.7	2.1	
Depth		4	6	8	8	7	

Q=11,600

	LEW	260	335	390	440	490	REW
Velocity		4.0	4.3	4.5	4.5	3.5	
Depth		6	9	11	11	10	

Q=13,700

	LEW	250	330	390	445	515	REW
Velocity		4.3	4.7	4.5	4.2	2.5	
Depth		7	10	11	11	11	

Q=15,300

	LEW	250	325	385	435	495	REW
Velocity		4.4	4.6	4.8	4.8	3.8	
Depth		7	10	12	12	12	

Q=26,300

	LEW	225	305	370	430	500	REW
Velocity		5.5	6.1	6.1	6.1	4.7	
Depth		9	13	14	15	14	

Q=27,400

	LEW	225	305	375	430	495	REW
Velocity		5.4	6.1	5.9	5.9	4.9	
Depth		9	13	15	16	15	

Gage Height (feet)	Discharge In Cubic Feet Per Second										
	0	1	2	3	4	5	6	7	8	9	10
20								563	1,570	3,110	4,400
30	4,890	6,900	8,940	11,700	14,600	17,800	21,300	25,000	29,200	34,000	34,700
40	39,600	45,400	52,000	58,100	65,000						

09380000 Colorado River at Lees Ferry
(approx 300' wide)

			Centroids(ft)				
			Q=3,140				
	REW	315	380	430	470	515	LEW
Velocity		0.50	0.70	0.70	0.60	0.72	
Depth		17	17	17	22	20	

				Q=9,040			
	LEW	320	385	435	480	520	REW
Velocity		1.2	1.6	1.6	1.8	1.8	
Depth		19	20	25	26	21	

				Q=13,400			
	LEW	300	360	415	465	515	REW
Velocity		2.1	2.1	2.3	2.2	2.1	
Depth		21	20	24	26	23	

				Q=16,500			
	LEW	290	350	405	455	510	REW
Velocity		2.5	2.7	2.7	2.4	2.3	
Depth		21	21	23	28	25	

				Q=26,600			
	LEW	280	345	405	460	510	REW
Velocity		3.3	3.6	3.7	3.5	3.5	
Depth		23	23	25	29	27	

Gage Height	Discharge In Cubic Feet Per Second										
(feet)	0	1	2	3	4	5	6	7	8	9	10
0						1,260	2,660	4,750	7,640	11,400	9,900
10	16,200	22,100	29,100	37,400	47,000	58,000	70,500	83,100	98,500	116,000	

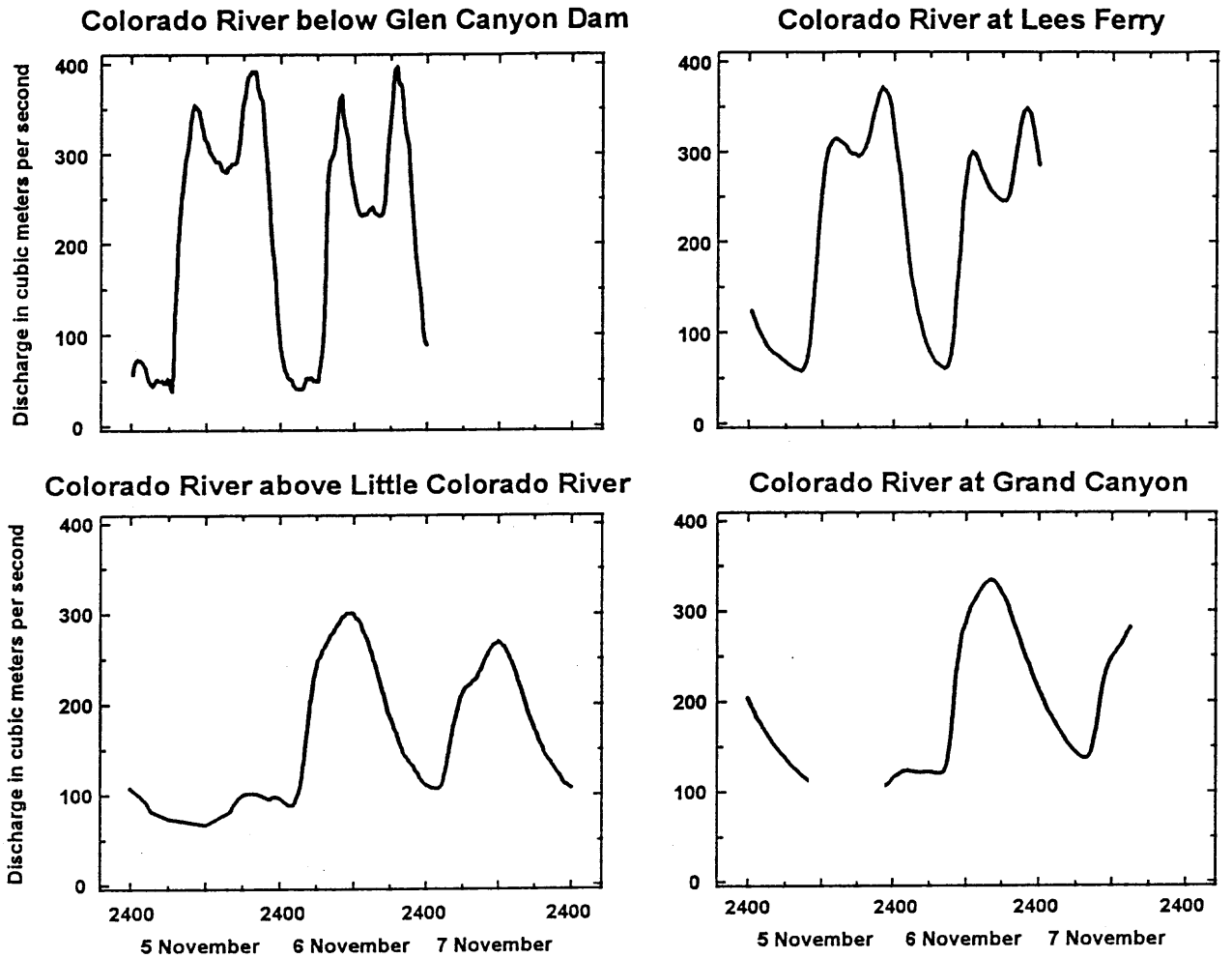
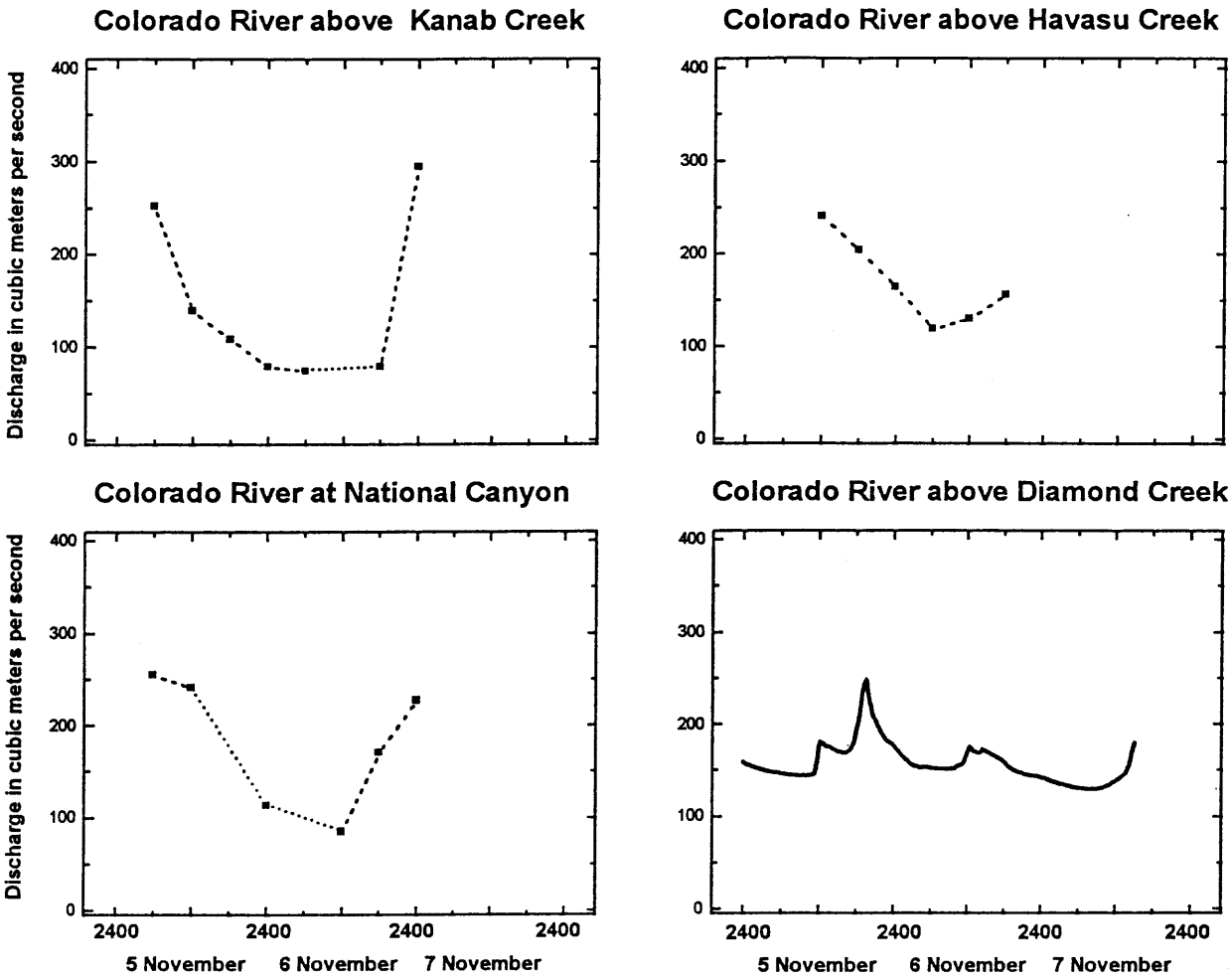


Figure 2.--Discharge hydrographs of the Colorado River for the November 1990 synoptic study. [Smooth hydrographs are data from USGS gaging station continuous records. Single data points are measured discharges during sampling.]



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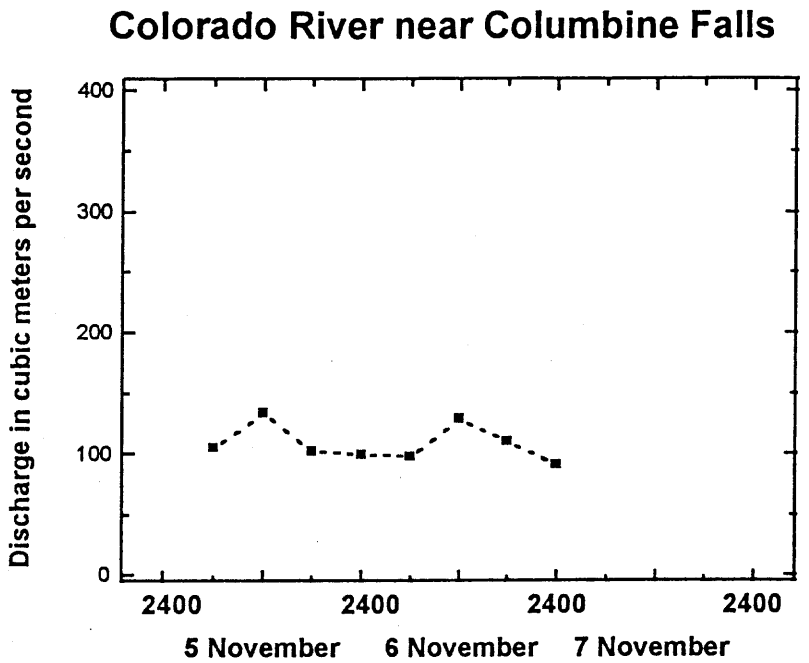

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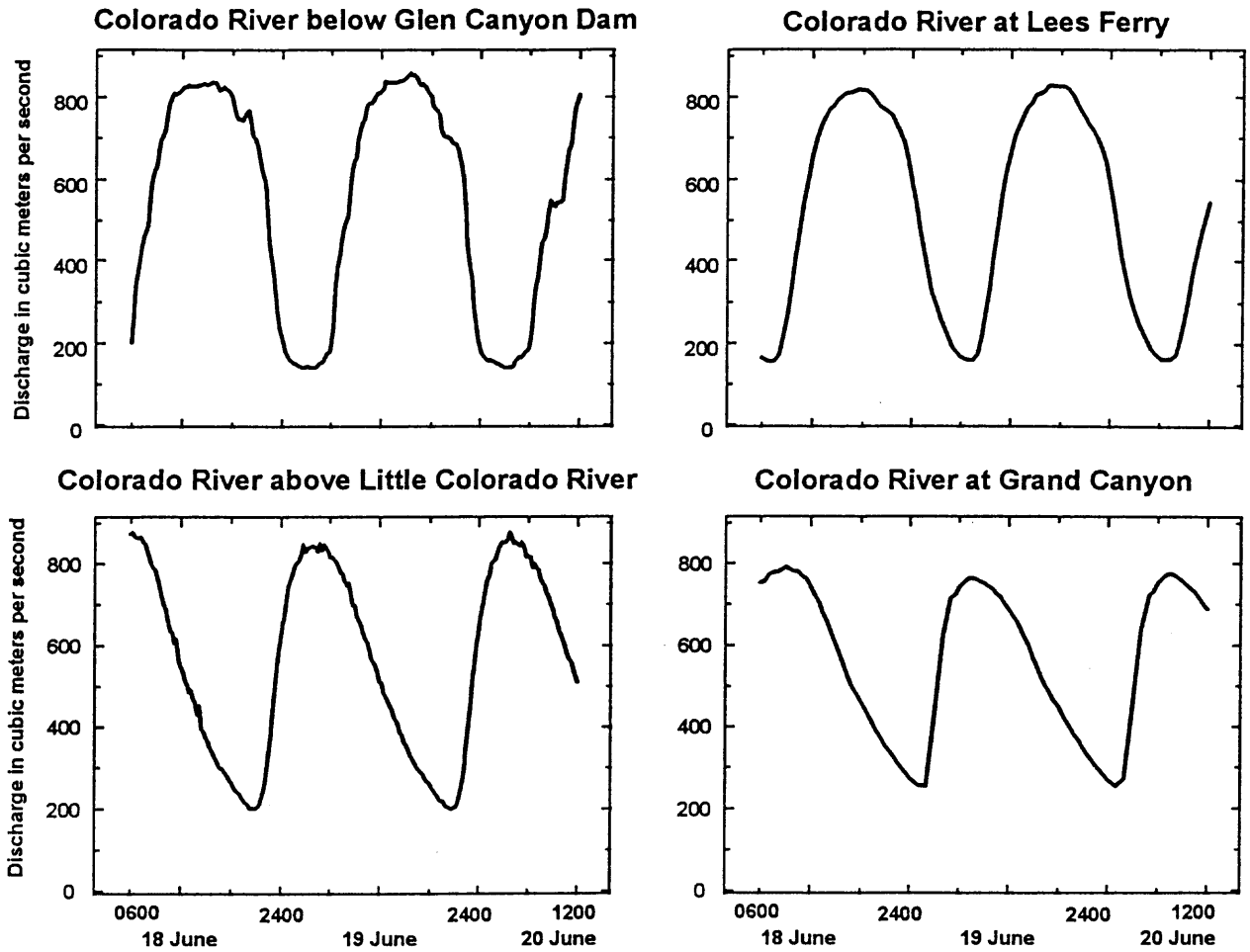

Figure 3.--Discharge hydrographs of the Colorado River for the June 1991 synoptic study. [Smooth hydrographs are data from USGS gaging station continuous records. Single data points are measured discharges during sampling.]

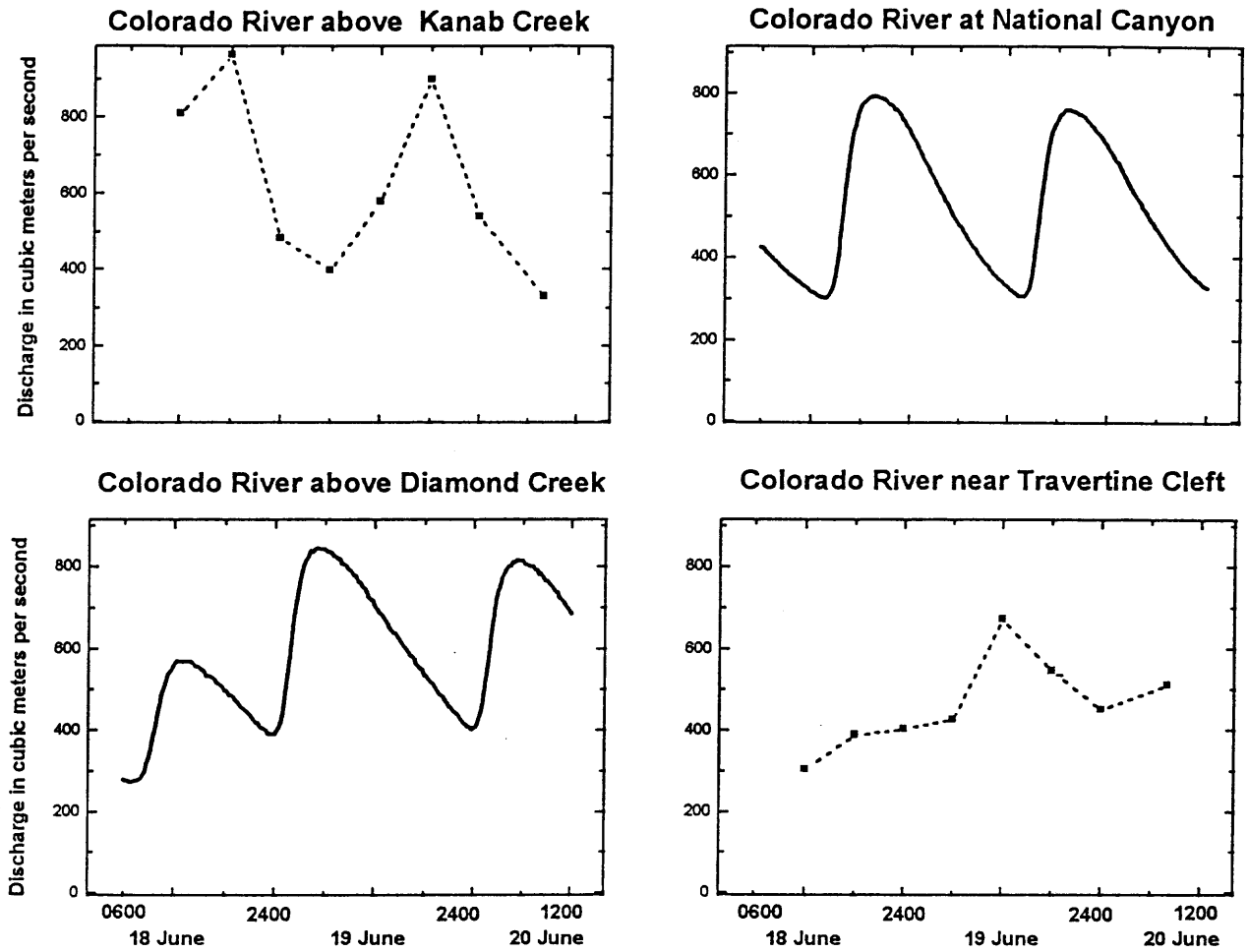

Figure 3.--Discharge hydrographs of the Colorado River for the June 1991 synoptic study. [Smooth hydrographs are data from USGS gaging station continuous records. Single data points are measured discharges during sampling.]