BIOLOGICAL AND ASSOCIATED WATER-QUALITY DATA FOR LOWER OLMOS CREEK AND UPPER SAN ANTONIO RIVER, SAN ANTONIO, TEXAS, MARCH–OCTOBER 1990

By R. Lynn Taylor

U.S. GEOLOGICAL SURVEY
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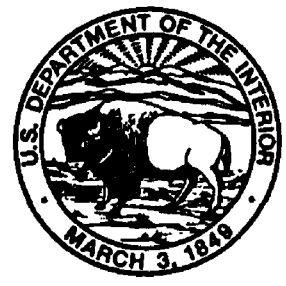

Prepared in cooperation with the
SAN ANTONIO WATER SYSTEM

Austin, Texas
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U.S. DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
centimeter (cm)	0.3937	inch
cubic meter per second (m^3/s)	35.31	cubic foot per second
gram (g)	0.03527	ounce, avoirdupois
kilometer (km)	0.6214	mile
meter (m)	3.281	foot
meter per second (m/s)	3.281	foot per second
milliliter (mL)	0.06102	cubic inch
millimeter (mm)	0.03937	inch
square centimeter (cm^2)	0.1550	square inch
square meter (m^2)	10.76	square foot
square millimeter (mm^2)	0.00155	square inch
	Temperature	
degree Celsius (°C)	1.8 x °C + 32	degree Fahrenheit

Abbreviated water-quality units:

µg/g, microgram per gram
µg/L, microgram per liter
mg/L, milligram per liter

Biological and Associated Water-Quality Data for Lower Olmos Creek and Upper San Antonio River, San Antonio, Texas, March–October 1990

By R. Lynn Taylor

Abstract

Biological and associated water-quality data were collected from lower Olmos Creek and upper San Antonio River in San Antonio, Texas, during March–October 1990, the second year of a multi-year data-collection program. The data will be used to document water-quality conditions prior to implementation of a proposal to reuse treated wastewater to irrigate city properties in Olmos Basin and Brackenridge Parks and to augment flows in the Olmos Creek/San Antonio River system.

Benthic macroinvertebrate, periphyton, and phytoplankton communities were sampled at three sites along a 4.2-kilometer reach of the Olmos Creek/San Antonio River system. Total mean densities of benthic macroinvertebrates for the three sites ranged from 1,000 to 15,000 organisms per square meter. The most abundant macroinvertebrates were the class Insecta (insects). Total densities of periphyton ranged from 700 to 86,000 cells per square millimeter. Cyanophyta (blue-green algae) and Bacillariophyta (diatoms) were the predominant periphyton organisms. Total densities of phytoplankton ranged from 940 to 21,000 cells per milliliter. Diatoms and Chlorophyta (green algae) made up most of the rest of the phytoplankton. Mean diversity index for the three sites ranged from 1.0 to 2.1 for benthic macroinvertebrates. The diversity index for all sites ranged from 1.5 to 3.1 for periphyton and 0.9 to 2.5 for phytoplankton.

Hardness ranged from 220 to 280 milligrams per liter as calcium carbonate, and alkalinity ranged from 173 to 213 milligrams per liter as calcium carbonate. The largest dissolved nitrate concentration was 1.68 milligrams per liter. Dissolved ammonia nitrogen generally was less than 0.100 milligram per liter. The largest total phosphorus concentration was 0.080 milligram per liter, over one-half of which was dissolved orthophosphate.

Total aluminum and total iron were the only trace elements in water to exceed the reporting threshold by large concentrations. Total aluminum concentrations ranged from 100 to 250 micrograms per liter, and total iron concentrations ranged from 70 to 280 micrograms per liter. Lead was the most prominent trace element in bottom-material samples with concentrations ranging from 40 to 190 micrograms per gram. The maximum copper concentration in the bottom material was 60 micrograms per gram at site 3 (the most downstream site).

Depths and velocities, measured at sample points after benthic macroinvertebrate sampling, ranged from 0.03 to 0.30 meter and from 0.06 to 1.2 meters per second, respectively. Measurable stream discharge ranged from 0.01 to 0.27 cubic meter per second. During two of the sampling periods, no flow was at site 1.

INTRODUCTION

Olmos Creek and the San Antonio River are the same channel hydrologically (fig. 1). Olmos Creek is an intermittent stream that runs through the northwest part of San Antonio, Tex. Historically, the San Antonio River began near Incarnate Word College, where springs fed into the channel and provided perennial

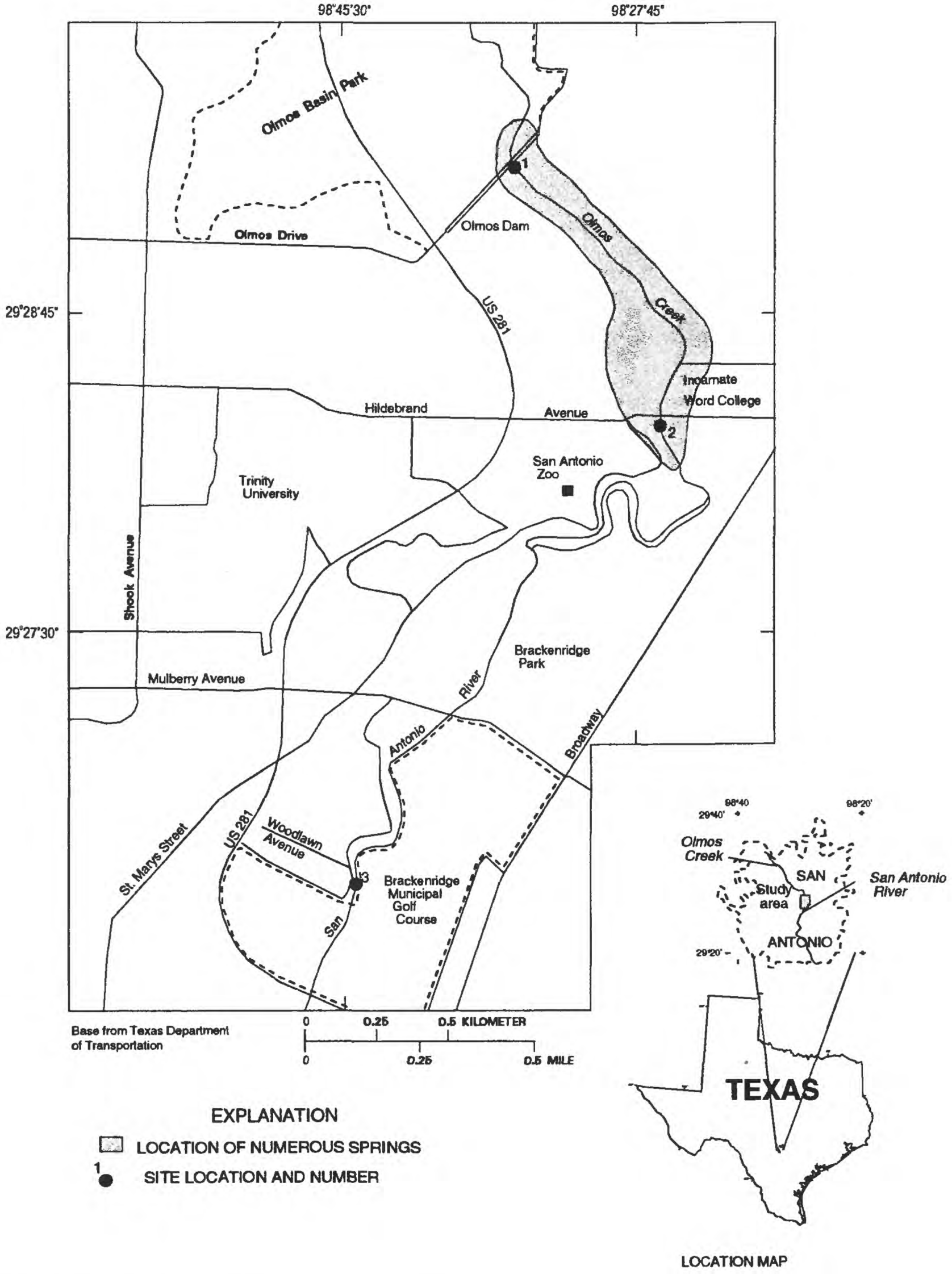

Figure 1. Location of study area.

flow. With increased water use, the springs periodically have gone dry. A well drilled at Hildebrand Avenue provides flow to the river when the springs are not discharging; Hildebrand Avenue is the present boundary between Olmos Creek and the San Antonio River.

The San Antonio River is a valuable aesthetic and economic resource to San Antonio. As a result of population growth and increased demand for water, San Antonio officials have considered the reuse of treated wastewater as part of its regional water-supply system. A proposed plan is to use treated wastewater to irrigate city properties in Olmos Basin and Brackenridge Parks and to augment flows in the Olmos Creek/San Antonio River system. The proposed area for discharging treated wastewater is upstream from the area influenced by Olmos Dam; however, an actual discharge point has not been determined. As a result of the reuse plan, the water-quality conditions in the Olmos Creek/San Antonio River system are to be documented before wastewater reuse. These water-quality conditions then could be compared to water-quality conditions after wastewater reuse to evaluate possible changes. The U.S. Geological Survey, in cooperation with the San Antonio Water System, is conducting a multi-year data-collection program to provide the data to document water-quality conditions in lower Olmos Creek and upper San Antonio River. The program includes collection of selected aquatic-organism and water-quality data. The first year of data collection was 1989.

Aquatic organisms have long been used as indicators of water quality (Averett, 1981). Initially, only single species were used, but this evolved into communities of organisms being used as indicators (Cummins, 1974). Frenzel (1988) used the benthic community in the Boise River to determine the effects of trace elements from two Boise, Idaho, wastewater-treatment facilities on the quality of the river. He determined that trace-element concentrations in effluents did not adversely affect benthic macroinvertebrate communities.

The three aquatic-organism communities sampled for this study were benthic macroinvertebrates, periphyton (algae attached to rocks and similar substrates), and phytoplankton (passively floating algae). Benthic macroinvertebrates are relatively immobile and have a wide range of individual tolerances to environmental stresses (Goodnight, 1973). These characteristics make benthic macroinvertebrates well suited as indicators of water quality. Periphyton also are relatively immobile and can be important as substrate for benthic macroinvertebrates (Hynes, 1970, p. 213). Phytoplankton generally are considered inhabitants of still water such as lakes, ponds, and large rivers (Wetzel, 1975, p. 288).

Stream reaches can be categorized as riffles, where the water is shallow and fast flowing, or as pools, where the water is deeper and slow flowing. In riffles, fast-flowing water carries much of the sand, silt, and clay through the reach, leaving a larger percentage of boulders, cobbles, and pebbles settled on the streambed. In pools, slower flows allow sand, silt, and clay to settle on the streambed, covering any larger material that might have been deposited during high flows.

The material covering the streambed of riffles and pools serves as substrate for colonization of aquatic organisms. The larger, more complex substrate in riffles provides a larger quantity and variety of habitat niches than the smaller, more uniform substrate in pools. Therefore, though pools might support large populations, they typically support a more limited variety of organisms than riffles (Hynes, 1970, p. 208–210). To compile a large data base of organisms, biological sampling was conducted in the riffles rather than in the pools of each site.

The water-quality properties and constituents of a stream are critical to the type and number of aquatic organisms present (Hynes, 1970). Changes in water quality can shift the species structure of an aquatic-organism community from a mixture of many intolerant and tolerant species toward a few species that can tolerate more adverse conditions (Cairns and Dickson, 1971). Properties and constituents determined during the study included specific conductance, pH, water temperature, dissolved oxygen, major cations and anions, suspended residue, selected dissolved and total nitrogen and phosphorus species, total organic carbon, and trace elements.

The chemical composition of fine bottom material being transported in a stream also is critical to the type of organisms present. Bottom material is moved during periods of increased flows (Colby, 1963) and is a major source of suspended sediment (Horowitz, 1984). Trace elements tend to be associated with the fine fraction of the sediment (Horowitz, 1984) and can be toxic to organisms. Therefore, fine bottom material was sampled to determine the potential availability of trace elements to organisms. In addition, riffle bottom-material size and distribution were determined because

of their influence on the type of aquatic-organism communities present.

Purpose and Scope

The purpose of this report is to present benthic macroinvertebrate, periphyton, and phytoplankton data, community characteristics, and associated water-quality data for lower Olmos Creek and upper San Antonio River. The data were collected during March–October 1990, the second year of data collection.

Location and Description of Study Area

The study area is within the San Antonio city limits and includes a 4.2-km reach of the Olmos Creek/San Antonio River system from Olmos Dam (a flood-control structure) down into Brackenridge Park (fig. 1). Three sites were selected for sampling. Site 1 is on Olmos Creek, immediately downstream from Olmos Dam, in the intermittent part of the system. Site 2 is 1.3 km below site 1, just downstream from Hildebrand Avenue, where the San Antonio River begins. Site 3 also is on the San Antonio River, about 2.9 km downstream from site 2, next to Brackenridge Municipal Golf Course near Woodlawn Avenue. Schematic diagrams of each site are shown in figures 2–4.

At site 1, ponded water is immediately downstream from Olmos Dam (fig. 2). The sampled reach begins at the lower end of this pond. Three riffle areas, designated as upper, middle, and lower, were sampled at this site because the riffles were too small individually to collect all the needed biological samples. The lower riffle is in two sections separated by a short stretch of deeper, slower water. The approximate area of each riffle, in downstream order, is 13, 5.6, and 6.8 m^2.

Site 2 is near the San Antonio Zoo (fig. 1), but is upstream from any discharges from the zoo. When the channel upstream from Hildebrand Avenue is dry, discharge in the river actually is from an off-channel pond fed by a spring or well (fig. 3), depending on hydrologic conditions. The sampled riffle is approximately 60 m downstream from the eastern outlet of the pond (fig. 3). The riffle is on the left side of the channel, between a heavily vegetated mid-channel bar and the left bank. Most of the flow is to the left side of the mid-channel bar over the riffle. The area of the riffle is 27 m^2.

Between sites 2 and 3, the river is ponded through the zoo area and again just upstream from site 3 by a low-water crossing. A box culvert connected to a storm drain enters the river just downstream from the low-water crossing (fig. 4). The sampled riffle is downstream from this culvert. The riffle has an area of 68 m^2 and extends 21 m down the right side of the channel. A mid-channel bar, overgrown with vegetation, splits the river into two channels. Most of the flow is over the riffle along the right bank.

Methods

Biological Sampling and Analysis

Biological sampling was conducted for three aquatic-organism communities—benthic macroinvertebrates, periphyton, and phytoplankton. Samples for benthic macroinvertebrate and periphyton analyses were collected during five sampling periods—at the end of March/beginning of April; the beginning of May; the end of June; the end of July/beginning of August; and the end of August. Samples for phytoplankton analysis were collected at the end of March/beginning of April, the end of June, and the end of August. Samples were preserved in the field according to methods described by Britton and Greeson (1988). Samples were analyzed by Chadwick and Associates, a private laboratory in Spotwood, Colo.; analyses consisted of species identification and enumeration. A description of the laboratory procedures (Chadwick and Associates, written commun., 1984) is available from the U.S. Geological Survey office in Austin or Chadwick and Associates upon request. Each organism reported was identified as distinctly different from other individuals in a sample, regardless of the taxonomic level reported. Organisms were identified to the species level whenever possible. In some instances the actual species could not be identified, but the species was determined to be distinctly different from other species in a sample. When this happened, the species was identified as "sp.," "sp. 1," and so on, for as many unnamed species as were present in a given genus. A library of these organisms is kept by the laboratory so that any of the same organisms found in the future can be matched and identification will remain consistent throughout the study (Chadwick and Associates, oral commun., 1989). Updates will be made as specimens are collected, making it possible to name previously unidentified species. Organisms in the pupal stages were reported, but were not counted as separate species or used in the computations of diversity index.

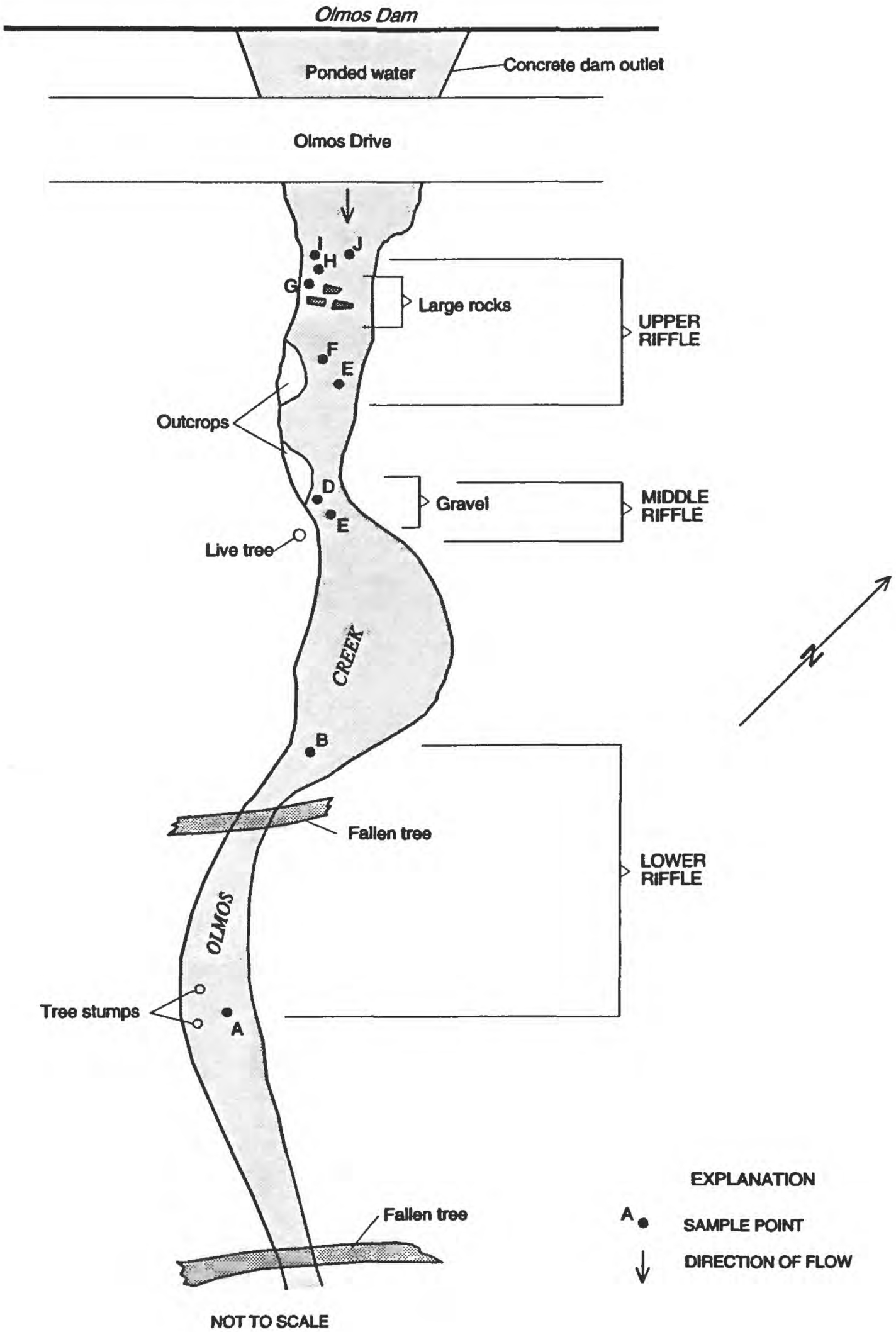

Figure 2. Sample points at site 1, lower Olmos Creek, San Antonio, Texas.

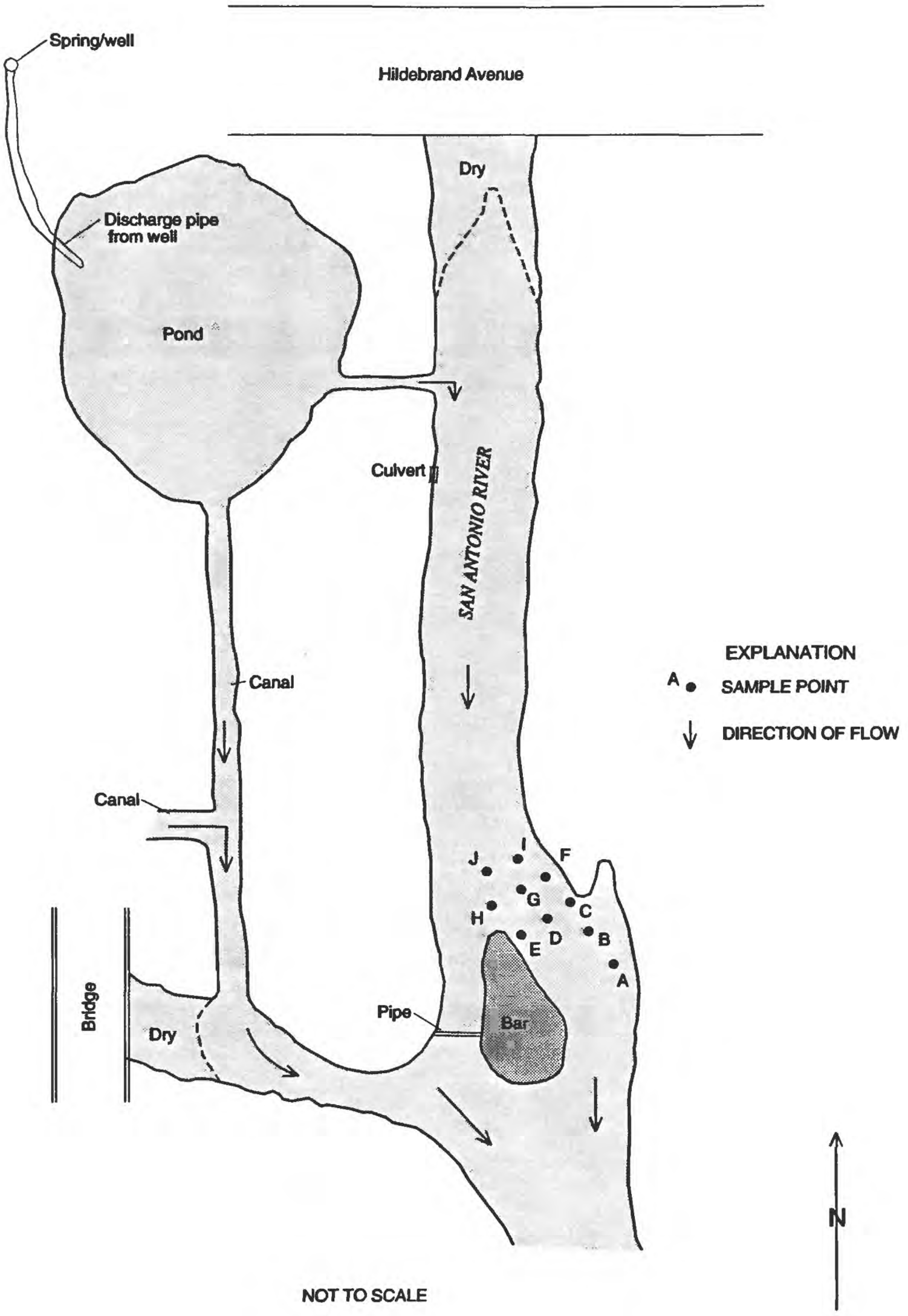

Figure 3. Sample points at site 2, upper San Antonio River, San Antonio, Texas.

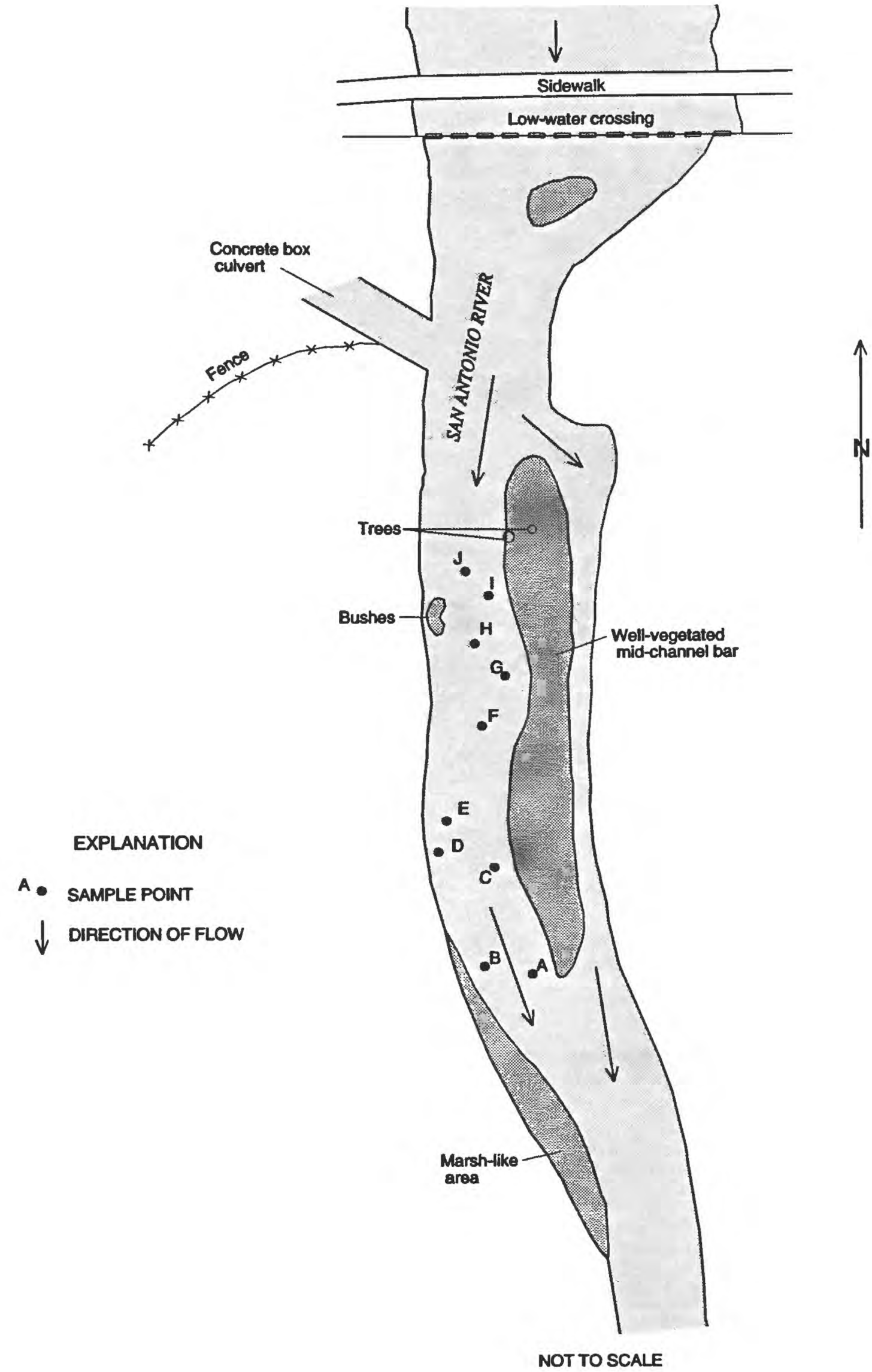

Figure 4. Sample points at site 3, upper San Antonio River, San Antonio, Texas.

Benthic macroinvertebrates were collected from each site using a 0.09-m^2 Surber Sampler by cleaning and stirring the bottom substrate to a depth of about 5 cm. Cleaning the bottom substrate consisted of gently scrubbing the larger rocks (larger than 5 cm) by hand at the mouth of the net. The bottom was then stirred up, allowing material to drift into the net. Dislodged organisms were caught in the Surber Sampler net, which had a 212-mm mesh-opening polyester-monofilament screen cloth. Contents of the net were backwashed into a large bucket of water, which was then poured into a U.S. standard 20-cm diameter, no. 70 sieve (210-mm mesh opening). The unsorted sample retained by the sieve was placed in a sample bottle. During each sampling period, data at 10 sample points (labeled A through J) were collected from each site and in the same general location as in the previous year. To avoid disturbing areas upstream from a given sample point, sampling was started at the downstream end of each riffle.

After each benthic macroinvertebrate sample was collected, depth and velocity measurements were made at the center of each sample point. Depths were taken with a wading rod. All samples were collected in areas where water depths generally were less than 0.3 m (the height of the Surber Sampler). Velocities were determined at a depth equal to 0.6 times the depth at each sample point, measured from the surface. Velocities were measured using a pygmy current meter with a standard rating (Smoot and Novak, 1968).

Periphyton samples were collected by scraping a 4-cm^2 area of material from the surface of randomly selected rocks. Transects were sampled at fixed intervals by dividing the stream into four equal sections and randomly choosing sections from which to select rocks. The number of rocks sampled from each transect and, therefore, the total number of rocks sampled, varied from site to site. All material from each site was composited into a single sample bottle.

Phytoplankton samples were collected as part of the water-quality samples. The equal-width-increment depth-integrated technique (Guy and Norman, 1970; Wells and others, 1990) was used to collect a composite sample. A sample for phytoplankton then was withdrawn from the composite sample.

Riffle bottom-material size distribution of coarse material (1 mm and larger) was determined at each site during the first and last sampling periods. Bottom-material size distribution also was determined whenever there were increased flows that might have moved the riffle material between sampling periods. The method to determine the size distribution of bottom material in the riffles was modified from Wolman (1954). This method involved choosing 100 rocks over the length of a reach and measuring the intermediate axis of the rock. Rocks from the streambed were selected from transects laid out in a grid pattern over the riffles. In each case, the first rock touched without looking down was measured in centimeters. The size of large rocks embedded in the streambed was estimated using a ruler, and particles smaller than 1 mm were reported as less than 0.1 cm. The cumulative-percentage distribution then was computed.

A descriptive statistic called diversity index was computed for each sample. This statistic is a summary of two properties of community structure—the number of different kinds of organisms present and their relative abundance (evenness). For two samples with the same number of taxa, the sample that has the most even distribution of organisms among taxa will have the largest diversity. Conversely, if the two samples have the same distribution of organisms among taxa, the sample with the most taxa will have the largest diversity. A modification of Shannon's equation (Shannon and Weaver, 1949) has been used widely (Wilhm and Dorris, 1968) and is presented in this report in the following form:

$$H' = -\sum_{i=1}^{s} \left(\frac{n_i}{n}\right) ln \left(\frac{n_i}{n}\right), \qquad (1)$$

where H' = diversity index or information content of the sample;

s = number of taxa in the sample;

n = total number of individuals in the collection;

n_i = number of individuals in the ith taxa; and

ln = natural logarithm.

The maximum diversity possible for the number of taxa in the sample is given as:

$$H(max) = -\sum_{i=1}^{s} \left(\frac{1}{s}\right) ln \left(\frac{1}{s}\right) = ln(s), \qquad (2)$$

where $H(max)$ = maximum diversity of the sample.

A measure of evenness of distribution of individuals among all the taxa in the sample is:

$$J = \frac{H'}{H(max)}, \qquad (3)$$

where J = evenness of taxa in the sample.

Water-Quality Sampling and Analysis

Water-quality sampling was conducted during five sampling periods—at the end of March/beginning of April; the beginning of May; the end of June; the end of July/beginning of August; and the end of August—using the equal-width-increment depth-integrated technique (Guy and Norman, 1970; Wells and others, 1990). Samples were collected from one cross section, as close as possible to the sampled riffles, where the flow was uniform. Equipment used to obtain samples for chemical analysis was washed with detergent and rinsed thoroughly with tap water and deionized water. Equipment used to collect samples for trace-element analysis was rinsed with a 10-percent hydrochloric acid solution, then with deionized water. All sampling equipment was given a final rinse with native water. Samples were filtered and treated in the field, stored at 4 °C, and shipped within 2 days of collection to the U.S. Geological Survey National Water Quality Laboratory, Arvada, Colo., for chemical analysis. Fixed-endpoint alkalinity and 5-day biochemical oxygen demand were determined at the U.S. Geological Survey office in San Antonio according to methods described by Wells and others (1990).

Stream discharge was measured at or near the sampled riffle using standard U.S. Geological Survey procedures after invertebrate sampling was completed. Water-quality properties, including specific conductance, pH, temperature, and dissolved oxygen, also were determined when discharge was measured.

Fine bottom-material samples were obtained from pools upstream from sampled riffles whenever water-quality samples were obtained. Each bottom-material sample was a composite of four to five scrapings from the top 5 cm of bed material. The bottom material was collected with a wide-mouth plastic jar and composited in a plastic dish. The composited bottom material was mixed, and 50 to 100 g were removed for the sample. Samples for trace-element analysis were shipped to the National Water Quality Laboratory within 2 days of collection.

During the first and last sampling periods, an additional sample was removed from the composited bottom material to determine fine bottom-material size distribution. Samples were analyzed at the U.S. Geological Survey office in Austin using a technique modified from Guy (1969). The material was placed in size classes: less than 0.0625 mm, 0.0625 to 0.125 mm, 0.125 to 0.25 mm, 0.25 to 0.5 mm, 0.5 to 1 mm, and larger than 1 mm. The percentage, by weight, of material was determined for each size class, and the cumulative-percentage distribution then was computed.

After the last water-quality sampling period, specific conductance, pH, temperature, and dissolved oxygen also were determined over a 24-hour period. These diel studies were undertaken when flows generally were lowest and temperatures were highest. Site 2 was sampled September 27–28, and site 3 was sampled October 5–6. Site 1 had no flow.

BIOLOGICAL DATA

All benthic macroinvertebrate data collected, except organisms in the pupal stage, are presented in tables 1–13 (at end of report). Total density, at the bottom of each table, is the sum of the organism densities at each sample point. Mean density represents the mean of organisms of that species per square meter for the 10 sample points. Total taxa is the total number of different taxa sampled at each site. The point depth and velocity, modified Shannon-Weaver diversity index, maximum diversity index, and evenness are presented at the bottom of each table. Densities for organisms in the pupal stage are presented in table 14 (at end of report).

Periphyton data are presented in tables 15–17 (at end of report), and phytoplankton data are presented in tables 18–20 (at end of report). The single density listed for each site on each date is a composite of all samples collected. The total density, total taxa, modified Shannon-Weaver diversity index, maximum diversity index, and evenness are summarized at the bottom of tables 15–20.

Site 1 was sampled for benthic macroinvertebrates and periphyton on March 27, May 10, and July 31, during only three sampling periods, because there was no surface flow over the riffle areas during the June and August sampling periods. Sampling with Surber nets requires flowing water to wash material into the net area (Britton and Greeson, 1988). Site 1 was sampled for phytoplankton only on March 27, also because of no-flow conditions during other sampling periods.

Benthic Macroinvertebrates

Total mean densities of benthic macroinvertebrates for the three sites ranged from 1,000 to 15,000 organisms/m^2 (fig. 5, tables 1–13). Site 1 had the largest total mean densities during the spring (8,800 organisms/m^2 in March and 12,000 organisms/m^2 in May). Site 3 had the largest total mean densities during the summer months, ranging from 10,000 organisms/m^2 in June to 15,000 organisms/m^2 in August. Site 2 consistently had the smallest total mean densities for each sampling period, ranging from 1,000 to 5,000 organisms/m^2. The Shannon-Weaver mean diversity index ranged from 1.0 to 2.1 (fig. 6, tables 1–13). Mean diversity index values at site 1 were 1.4 on March 27 and May 10 and 2.1 on July 31. Mean diversity index ranged from 1.1 to 2.0 at site 2 and from 1.0 to 1.6 at site 3.

The taxonomic structure of macroinvertebrates, broken down by class (except Mollusca) for each site, is shown in figures 7–9. The phylum Mollusca was used to simplify the figures, combining the classes Gastropoda (snails) and Pelecypoda (clams); classes of less than 1 percent are not shown. The most abundant macroinvertebrate at all three sites was the class Insecta (insects). At site 1 (fig. 7), the majority of the remaining organisms were snails and clams. At site 2 (fig. 8), the remaining organisms were mostly snails, clams, and Oligochaeta (worms). Small densities of *Turbellaria* (flatworms), *Crustacea*, and other classes were present in various samples. At site 3 (fig. 9), the remaining organisms were mostly flatworms, snails, clams, and worms.

Depths and velocities at sample points are included with benthic macroinvertebrate data in tables 1–13. Depths were 0.03 to 0.18 m at site 1, 0.06 to 0.27 m at site 2, and 0.09 to 0.30 m at site 3. Velocities were 0.07 to 0.67 m/s at site 1, 0.06 to 0.37 m/s at site 2, and 0.19 to 1.2 m/s at site 3.

Organisms in the pupal stage are presented in table 14. Diptera (true flies) were the only class of organisms for which the pupae could not be identified uniquely. They were, however, present and reported.

Periphyton

The total densities of periphyton for all sites are shown in figure 10 (tables 15–17). Site 1 had total densities of 7,100 cells/mm^2 on March 27, 29,000 cells/mm^2 on May 10, and 5,300 cells/mm^2 on July 31. Total densities ranged from 700 to 28,000 cells/mm^2 at site 2, and from 2,700 to 86,000 cells/mm^2 at site 3. The total density of periphyton in May was much larger than that for other sampling periods at all three sites. The Shannon-Weaver diversity index is shown in figure 11 (tables 15–17). Site 1 diversity index values were 2.1 on March 27, 3.0 on May 10, and 1.5 on July 31. Diversity index ranged from 1.5 to 2.9 at site 2 and from 1.6 to 3.1 at site 3.

The taxonomic structure of periphyton, broken down by division for each site, is shown in figures 12–14. The predominant periphyton organisms were members of the divisions Cyanophyta (blue-green algae) and Bacillariophyta (diatoms). Organisms in the division Chlorophyta (green algae) also were prevalent in many samples.

At site 1 (fig. 12), blue-green algae were the most abundant periphyton, ranging from less than one-half to more than three-fourths of the total densities. Green algae and diatoms accounted for most of the rest of the periphyton.

Blue-green algae and diatoms predominated in samples from site 2 (fig. 13). Green algae constituted less than one-third of the total densities. The only other division to contribute more than 5 percent of the total density in any sample was Chrysophyta (golden-brown algae), on August 1.

Site 3 (fig. 14) was dominated by blue-green algae on June 25 and August 1 and by diatoms on April 4 and May 8. Diatoms and green algae were the predominant periphyton on August 28.

Phytoplankton

Total densities of phytoplankton for all sites are shown in figure 15 (tables 18–20). Site 1 had a total density of 2,600 cells/mL on March 27. Total densities at site 2 were 2,500 cells/mL (April 3), 940 cells/mL (June 26), and 21,000 cells/mL (August 29). Site 3 had total densities of 1,900 cells/mL (April 4), 960 cells/mL (June 25), and 3,400 cells/mL (August 28). The Shannon-Weaver diversity index is shown in figure 16 (tables 18–20). The diversity index at site 1 was 2.4 on March 27. Diversity index values at site 2 were 1.4 (April 3), 2.5 (June 26), and 1.9 (August 29). Site 3 diversity index values were 2.0 (April 4), 2.3 (June 25), and 0.9 (August 28).

The taxonomic structure of phytoplankton, broken down by division for each site, is shown in figures 17–19. Blue-green algae predominated, accounting for more than one-half of the total density

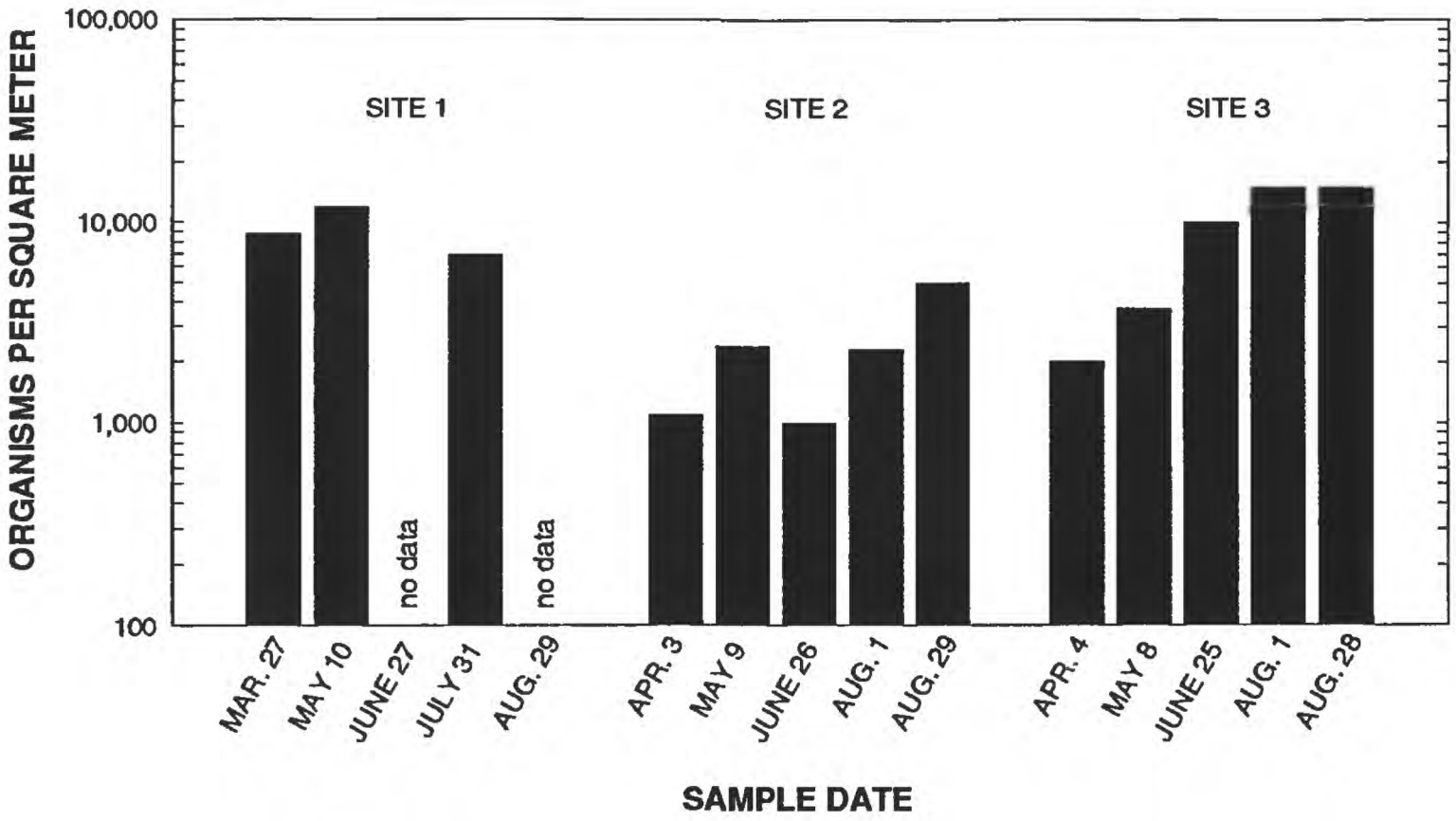

Figure 5. Total mean density of benthic macroinvertebrates for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

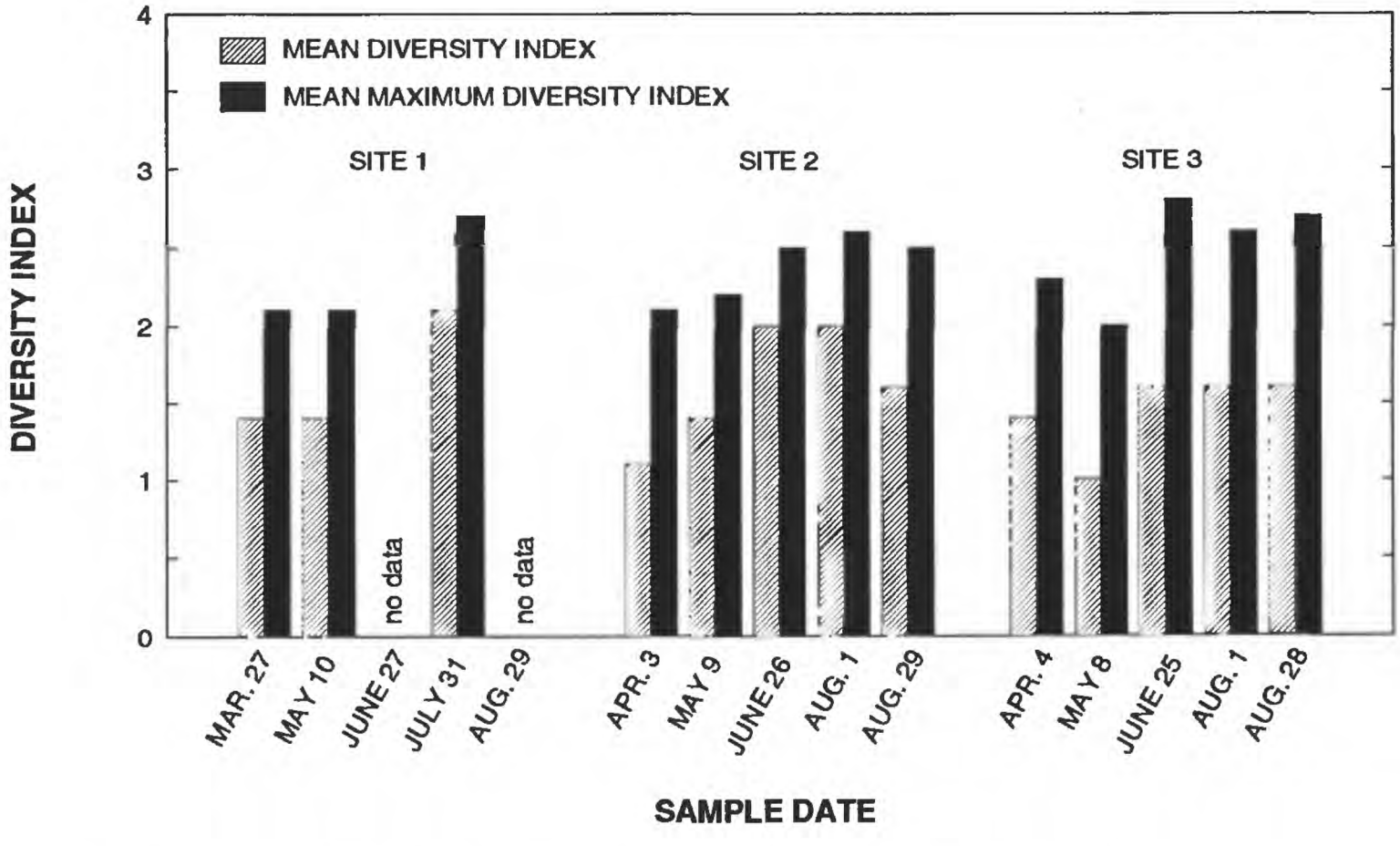

Figure 6. Mean diversity index and mean maximum diversity index of benthic macroinvertebrates for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas 1990.

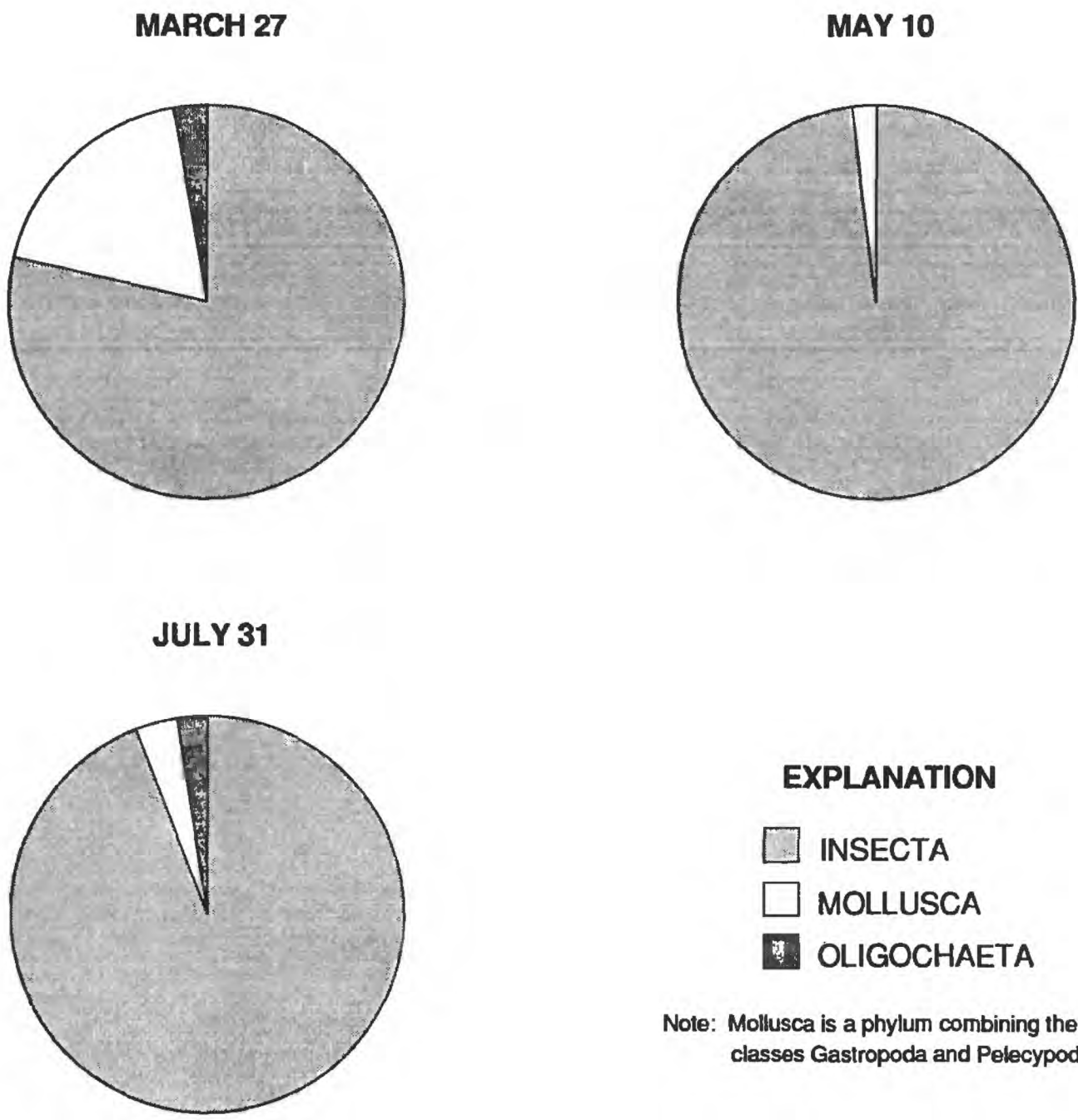

Figure 7. Benthic macroinvertebrate classes for site 1, lower Olmos Creek, San Antonio, Texas, 1990.

of phytoplankton in each sample. Diatoms and green algae made up most of the rest of the phytoplankton.

At site 1 (fig. 17), blue-green algae constituted about three-fourths of the total density. Diatoms and green algae constituted about one-fourth of the total density.

At site 2 (fig. 18), blue-green algae ranged from about one-half of the total density on June 26 to more than three-fourths on April 3. The remaining phytoplankton organisms at site 2 were either diatoms or green algae.

Blue-green algae ranged from more than one-half to more than three-fourths of the total densities at site 3 (fig. 19). Diatoms and green algae constituted most of the remaining phytoplankton. Diatoms accounted for less than 10 percent of the total density on April 4 and August 28 and about one-third on June 25. Green algae accounted for less than one-fourth of the total density on August 28.

The bottom material in riffles can influence the type of aquatic-organism communities present. Size distributions of bottom material collected from riffles at sites 1–3 are shown in figure 20. The May samples were collected to determine if high flows in April had affected the size distribution of the bottom material. These graphs show that the bottom substrate consisted predominantly of material less than 10 cm along the median axis.

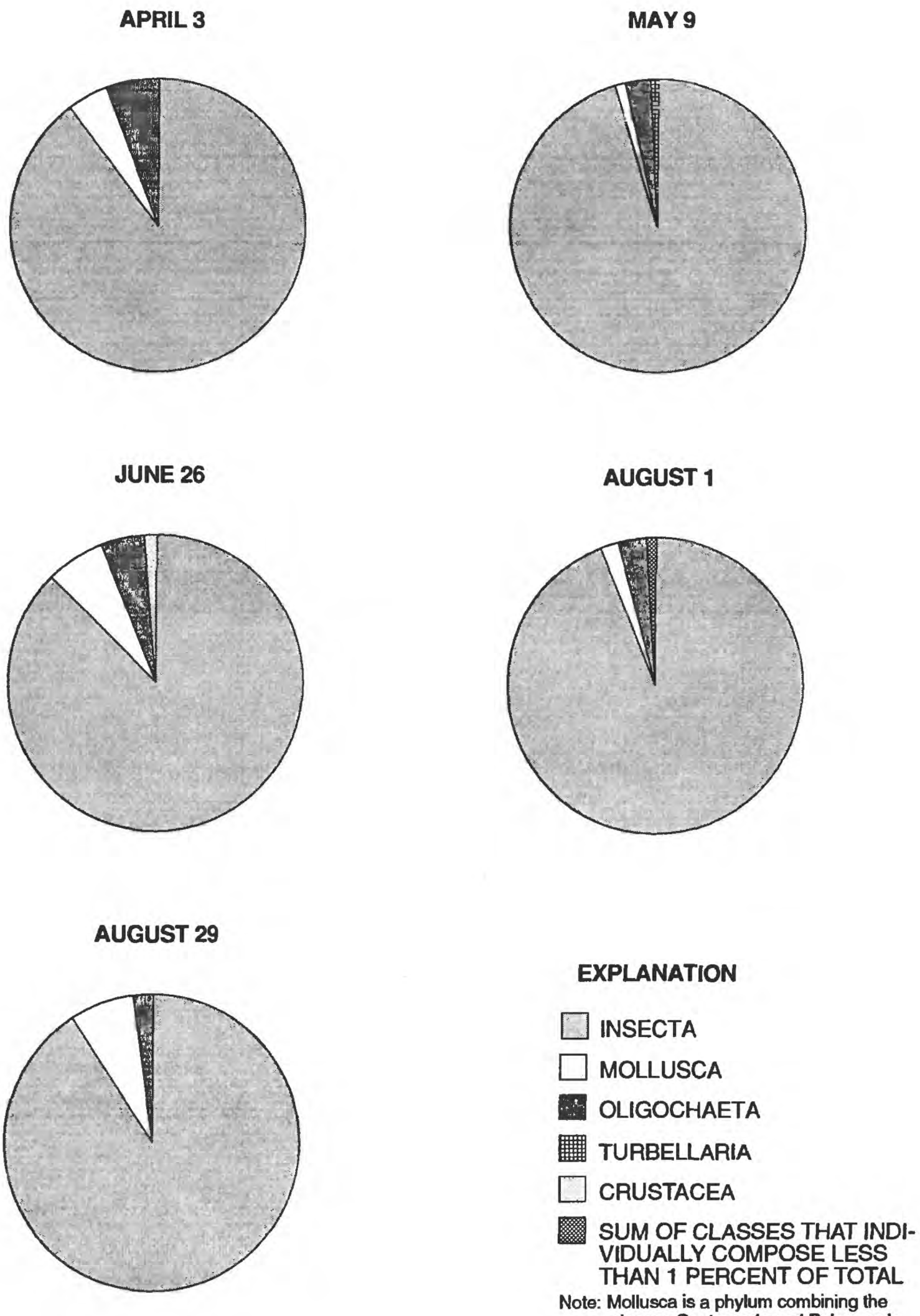

Figure 8. Benthic macroinvertebrate classes for site 2, upper San Antonio River, San Antonio, Texas, 1990.

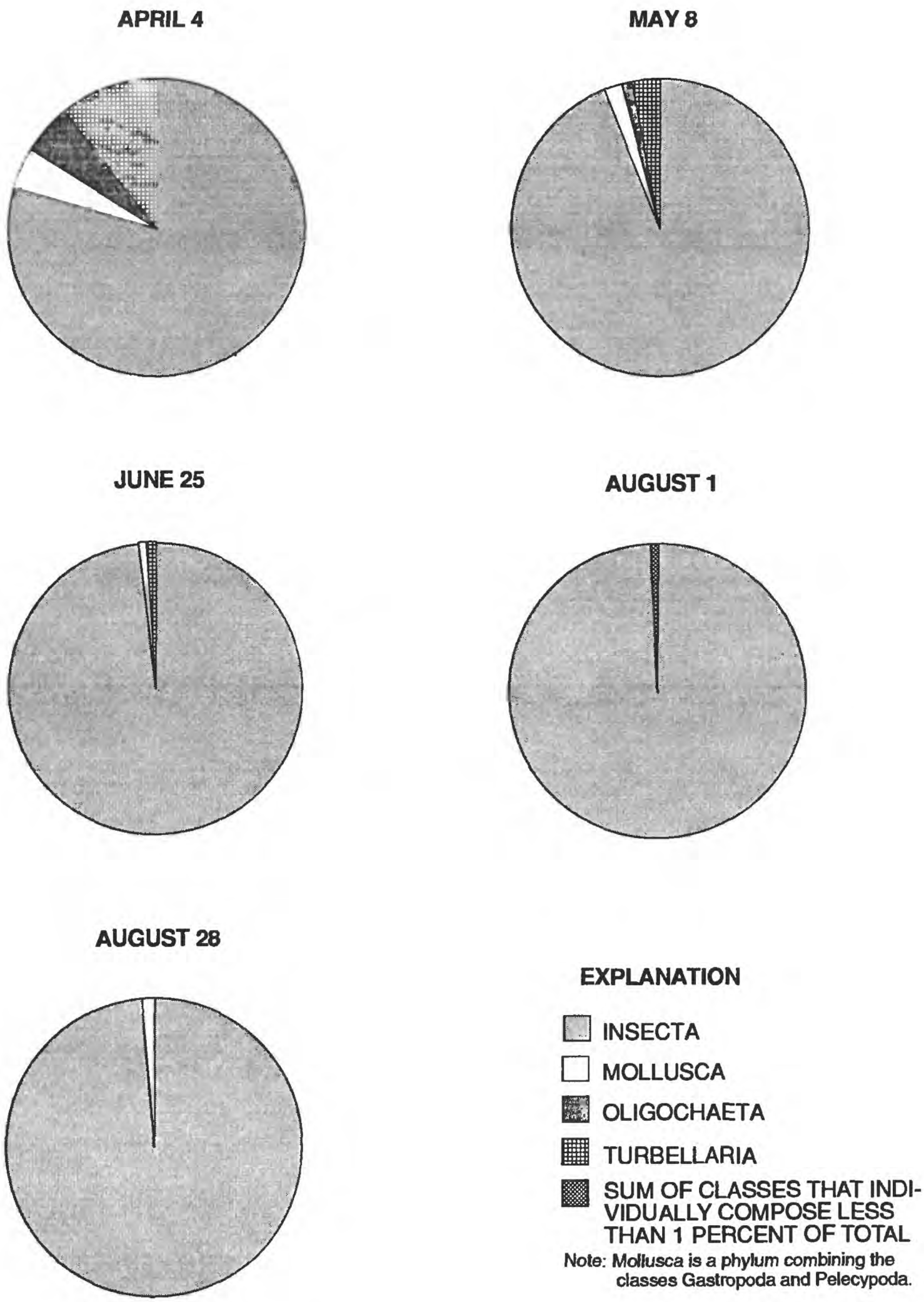

Figure 9. Benthic macroInvertebrate classes for site 3, upper San Antonio River, San Antonio, Texas, 1990.

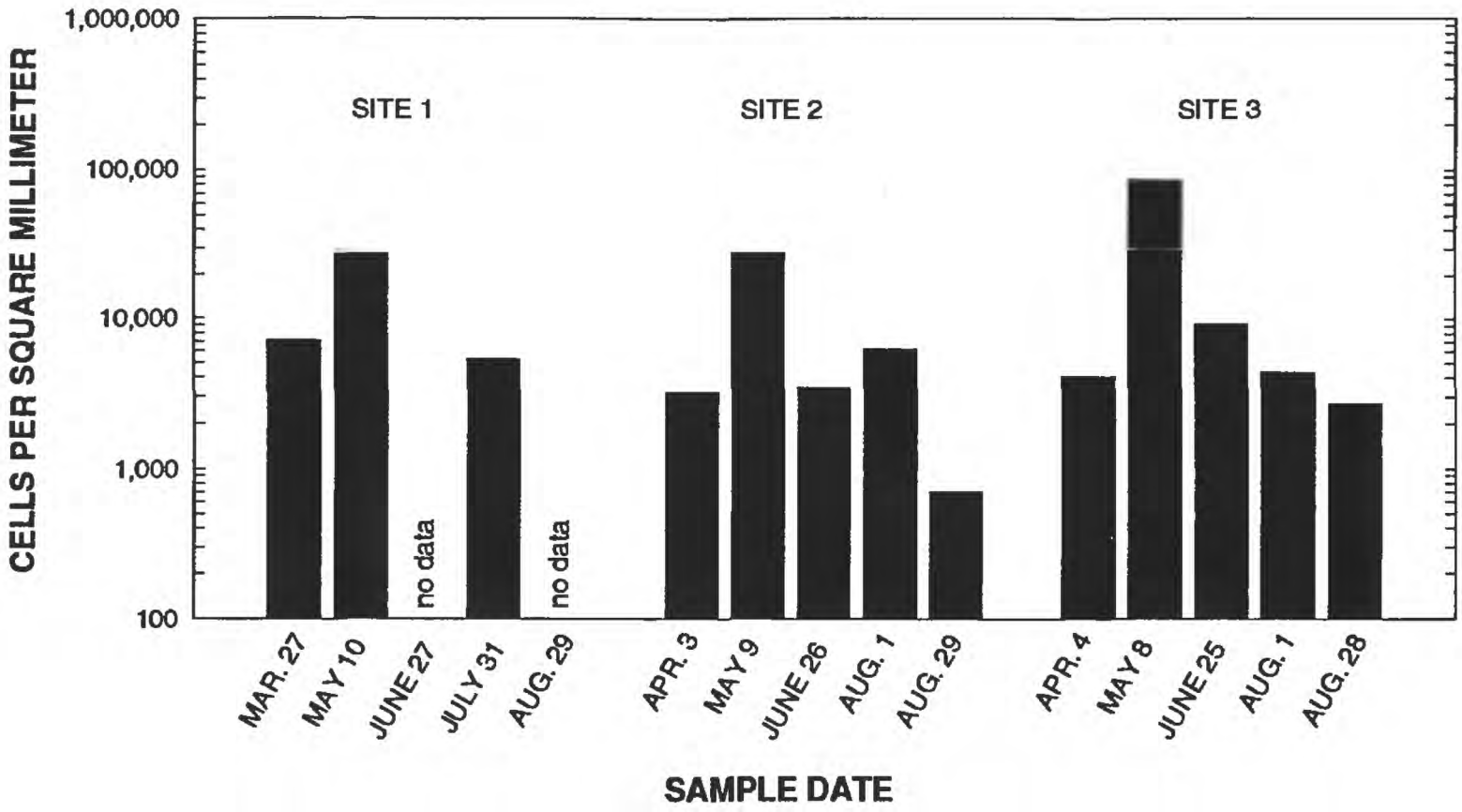

Figure 10. Total density of periphyton for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

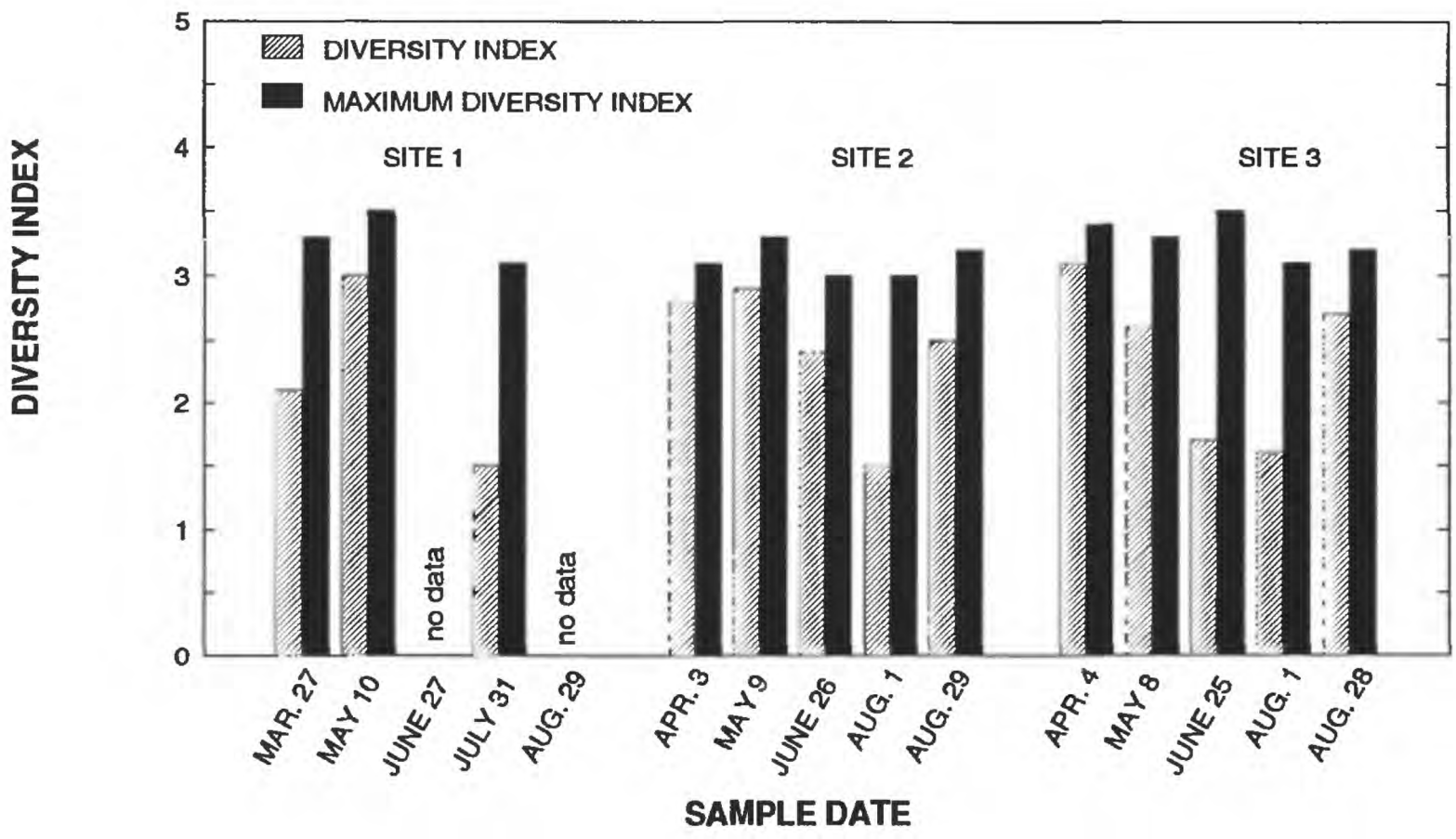

Figure 11. Diversity index and maximum diversity index of periphyton for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

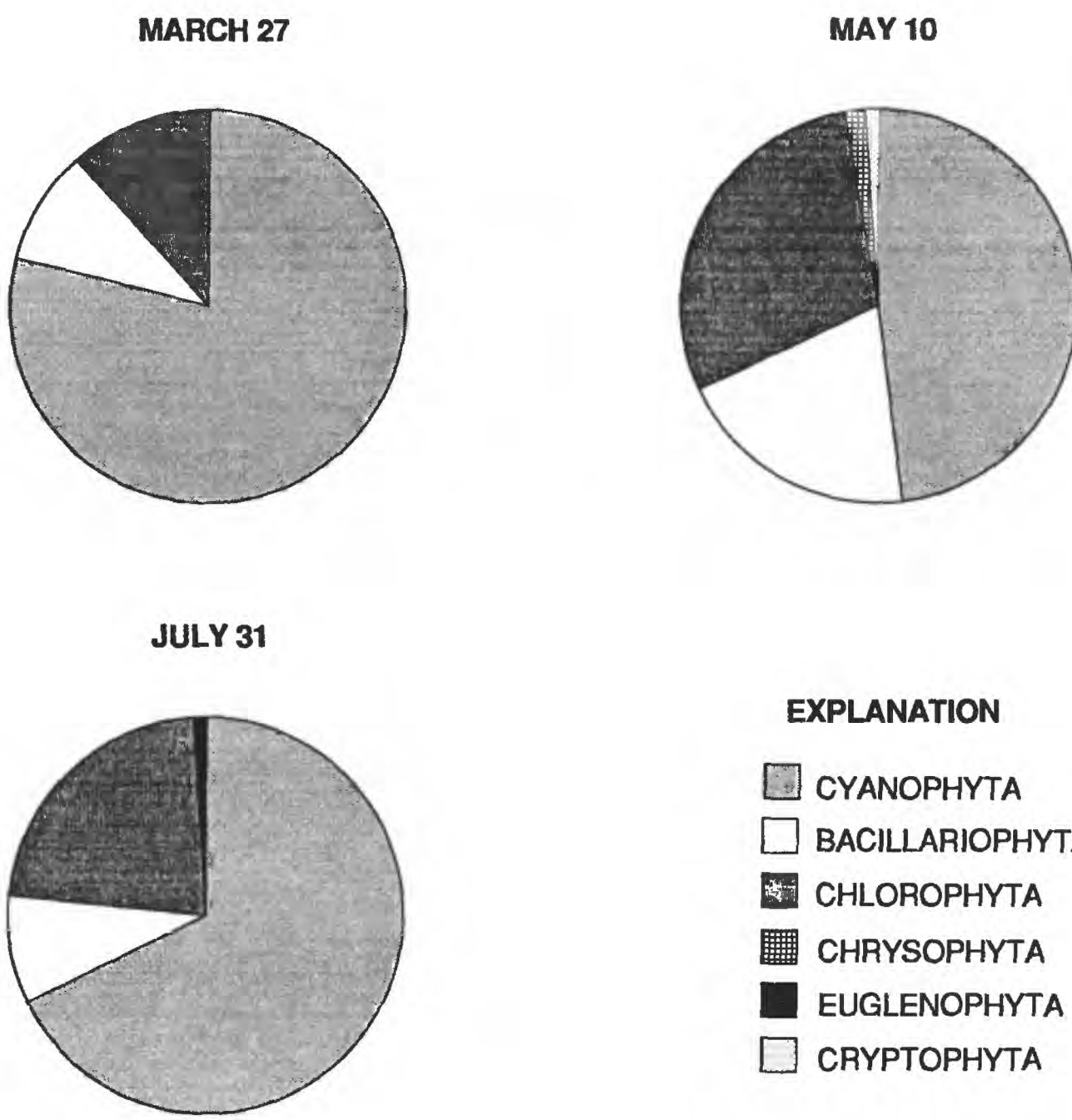

Figure 12. Periphyton divisions for site 1, lower Olmos Creek, San Antonio, Texas, 1990.

WATER-QUALITY DATA

Results of the chemical analyses are presented in tables 21–23 (at end of report). These tables present water-quality properties and constituents, including specific conductance, pH, temperature, dissolved oxygen, major ions, suspended residue, selected dissolved and total nitrogen and phosphorus species, total organic carbon, and trace elements in water and bottom material. Diel fluctuations of water-quality properties at sites 2 and 3 are presented in tables 24 and 25 (at end of report). Properties include specific conductance, pH, temperature, and dissolved oxygen.

Measurable stream discharge ranged from 0.01 m^3/s at site 1 to 0.27 m^3/s at site 3 (tables 21–23). During the June and August sampling periods, there was no flow at site 1. The largest biochemical oxygen demand determined was 2.7 mg/L at site 1 on March 27. Biochemical oxygen demand ranged from 0.4 to 0.9 mg/L at site 2 and from 0.3 to 0.8 mg/L at site 3. Hardness ranged from 220 mg/L as $CaCO_3$ at site 2 to 280 mg/L as $CaCO_3$ at site 1. Alkalinity ranged from 173 mg/L as $CaCO_3$ at site 1 to 213 mg/L as $CaCO_3$ at site 2. Sites 2 and 3 had the largest dissolved nitrate concentrations, ranging from 1.08 to 1.68 mg/L. Most of the nitrite plus nitrate nitrogen was in the dissolved state for all three sites, and almost all was nitrate nitrogen. Dissolved ammonia nitrogen generally was less than 0.100 mg/L; however, concentrations were 0.134 mg/L at site 1 on

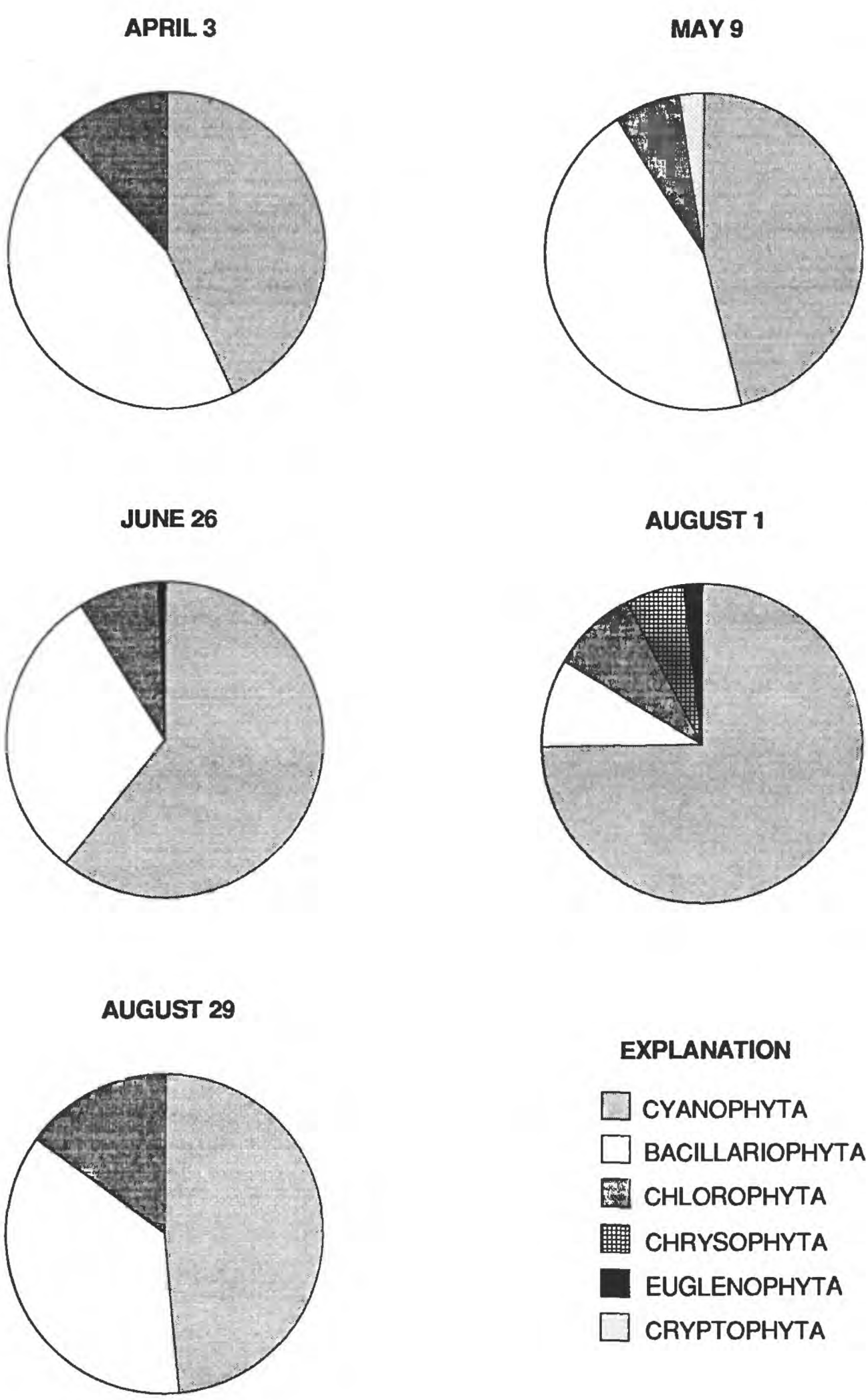

Figure 13. Periphyton divisions for site 2, upper San Antonio River, San Antonio, Texas, 1990.

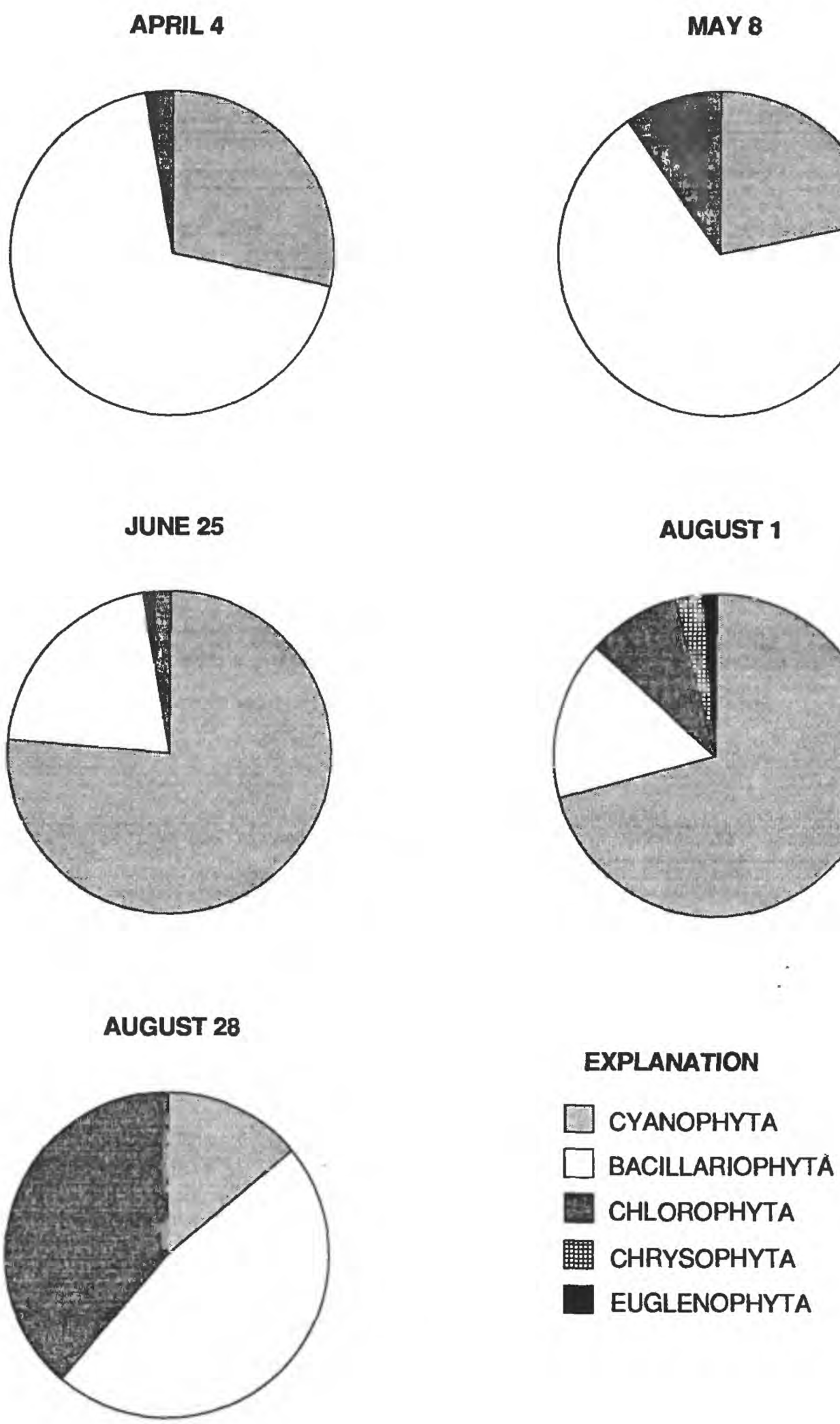

Figure 14. Periphyton divisions for site 3, upper San Antonio River, San Antonio, Texas, 1990.

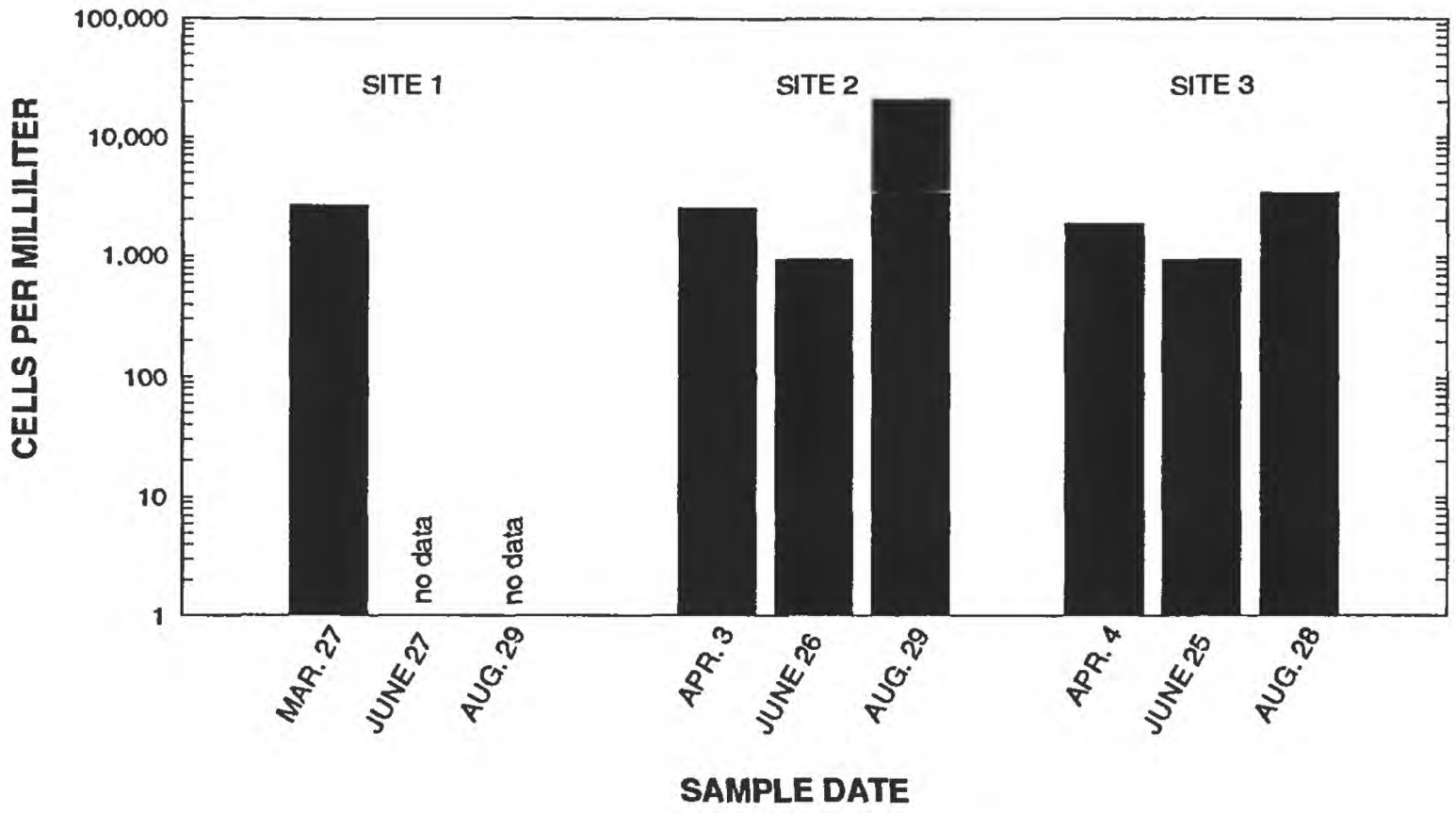

Figure 15. Total density of phytoplankton for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

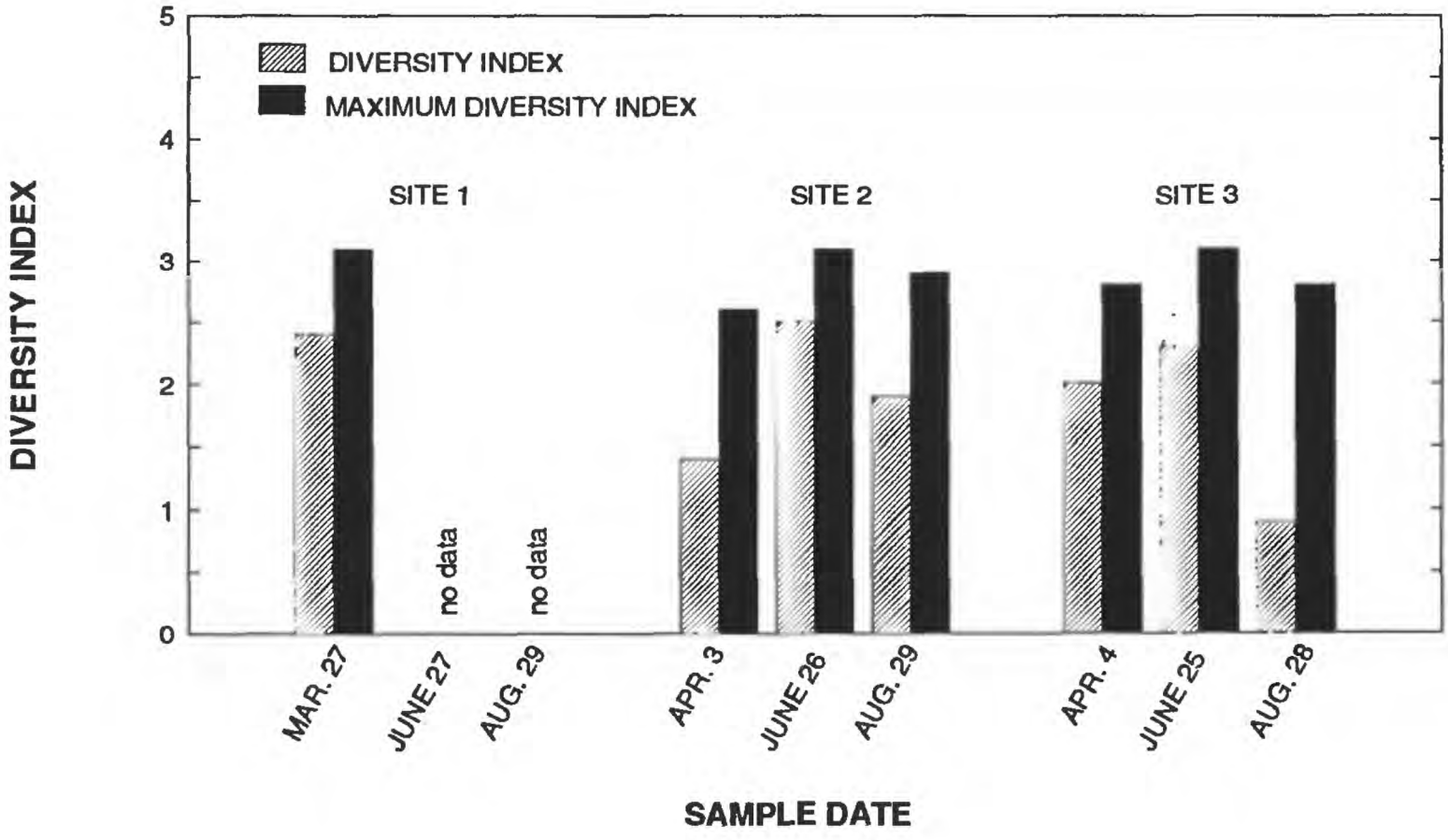

Figure 16. Diversity index and maximum diversity index of phytoplankton for sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

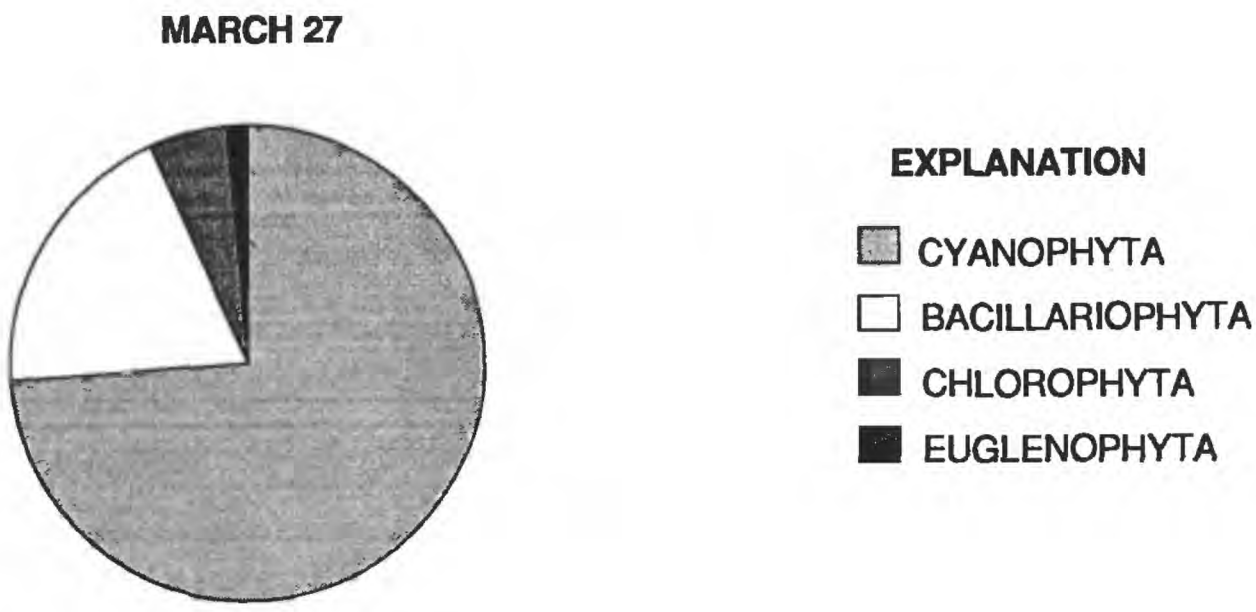

Figure 17. Phytoplankton divisions for site 1, lower Olmos Creek, San Antonio, Texas, 1990.

March 27, and 0.143 mg/L at site 3 on April 4. The total phosphorus concentration at site 1 on March 27 was 0.070 mg/L, about one-half of which was dissolved orthophosphate. Sites 2 and 3 had total phosphorus concentrations of less than 0.050 mg/L, except at site 3 on April 4, when the total phosphorus concentration was 0.080 mg/L. In most samples, at least one-half of the phosphorus was dissolved orthophosphate.

Water samples were analyzed for 14 trace elements, most of which were near or less than reporting thresholds. Total aluminum and total iron concentrations were the exceptions at all three sites. Total aluminum concentrations ranged from 100 to 250 µg/L, and total iron concentrations ranged from 70 to 280 µg/L.

Fine bottom-material samples were analyzed for eight trace elements. Trace elements in concentrations consistently above the reporting thresholds in bottom-material samples were arsenic, copper, and lead. The most prominent of these was lead, with concentrations ranging from 60 to 70 µg/g at sites 1 and 2 and 40 to 190 µg/g at site 3. The largest arsenic concentration was 7 µg/g at site 1. Copper concentrations generally were 10 µg/g or less, except for concentrations of 20 and 60 µg/g at site 3. Barium concentrations were greater than the reporting threshold in all but one sample. Cadmium, chromium, and mercury concentrations were at or only slightly greater than the reporting threshold in most samples.

Fine bottom-material samples also were collected to determine particle-size distribution. Particle-size distributions of the fine material collected from pooled areas at sites 1–3 are shown in figure 21.

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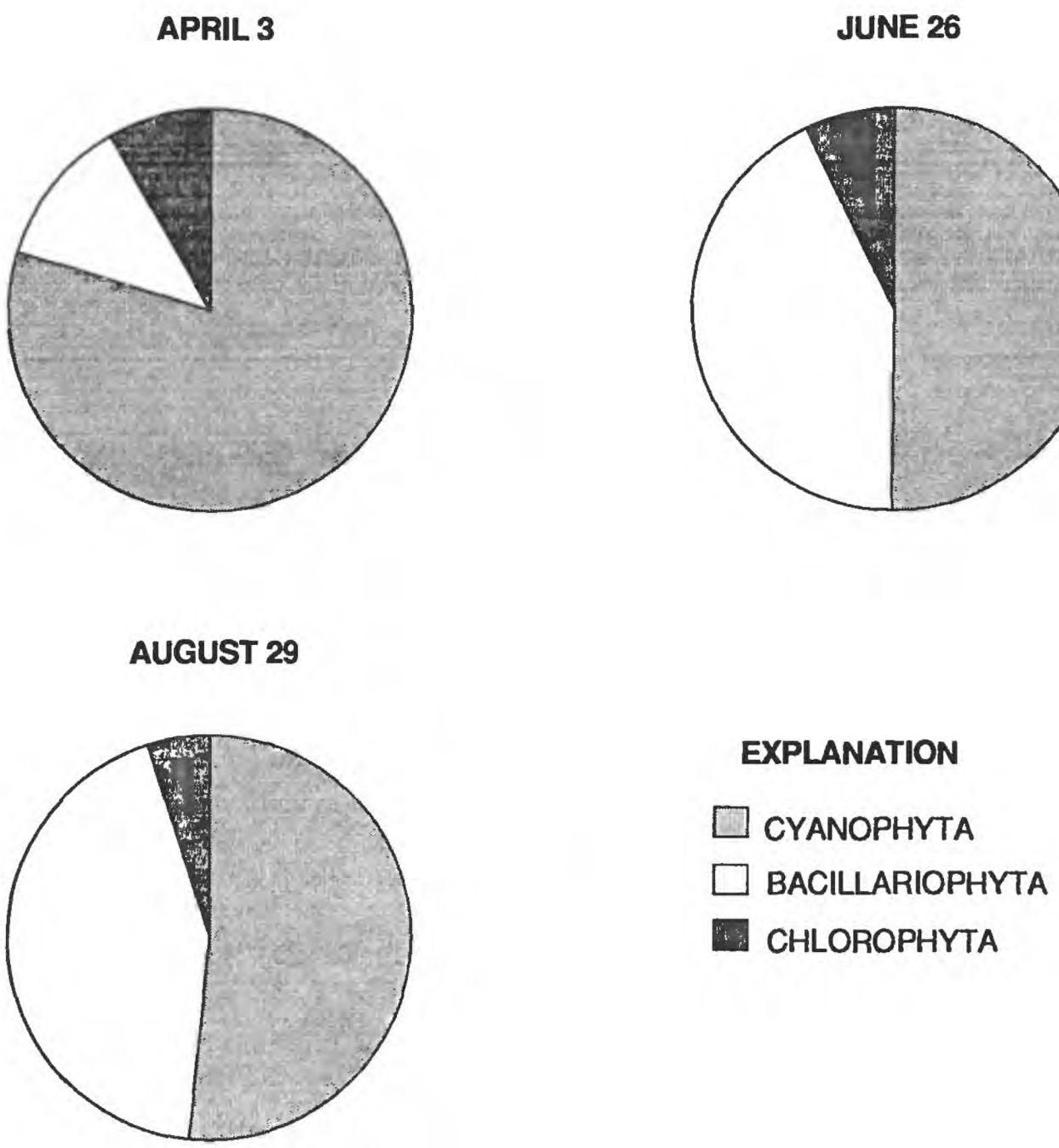

Figure 18. Phytoplankton divisions for site 2, upper San Antonio River, San Antonio, Texas, 1990.

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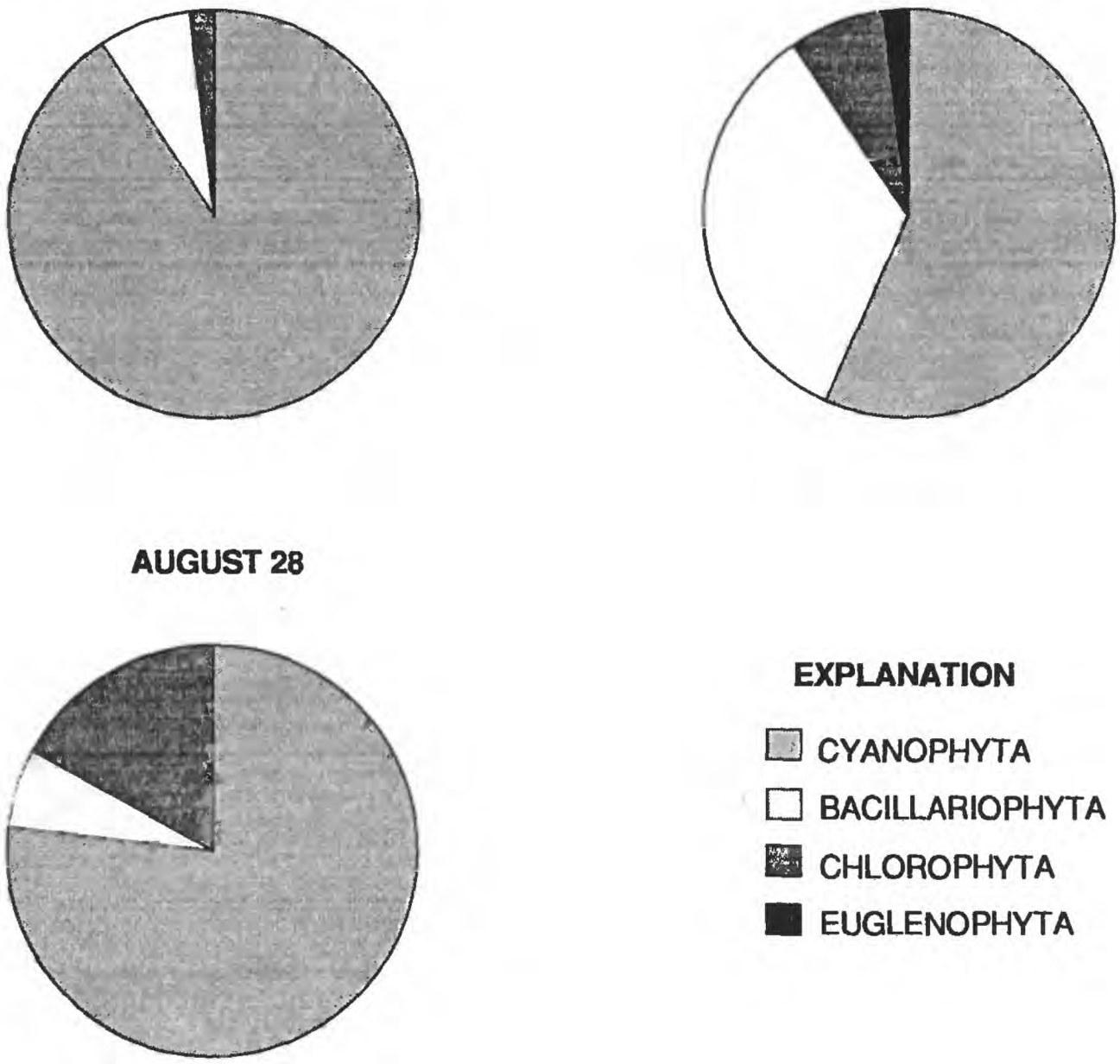

Figure 19. Phytoplankton divisions for site 3, upper San Antonio River, San Antonio, Texas, 1990.

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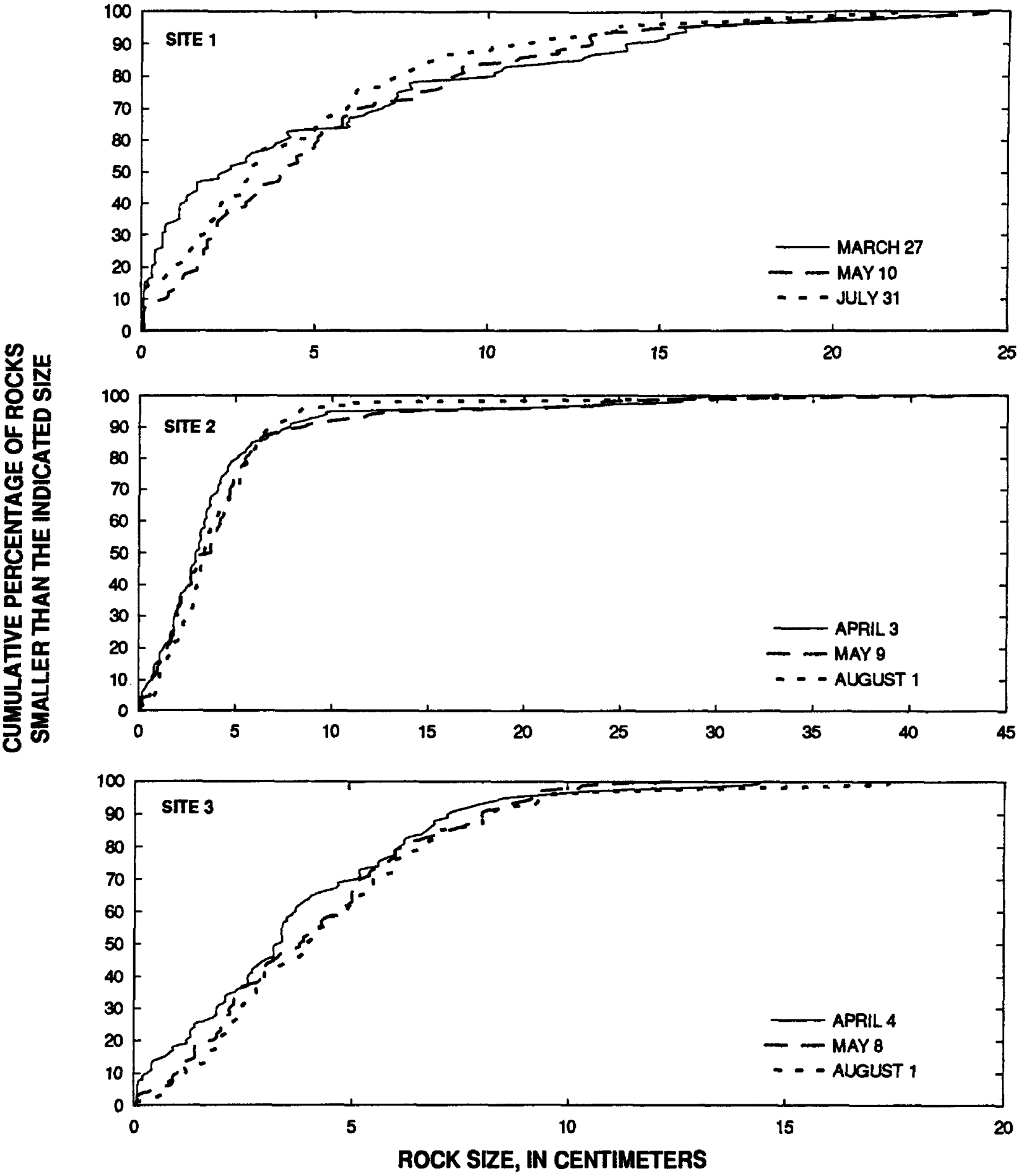

Figure 20. Cumulative-percentage size distribution of bottom material collected from riffles at sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.

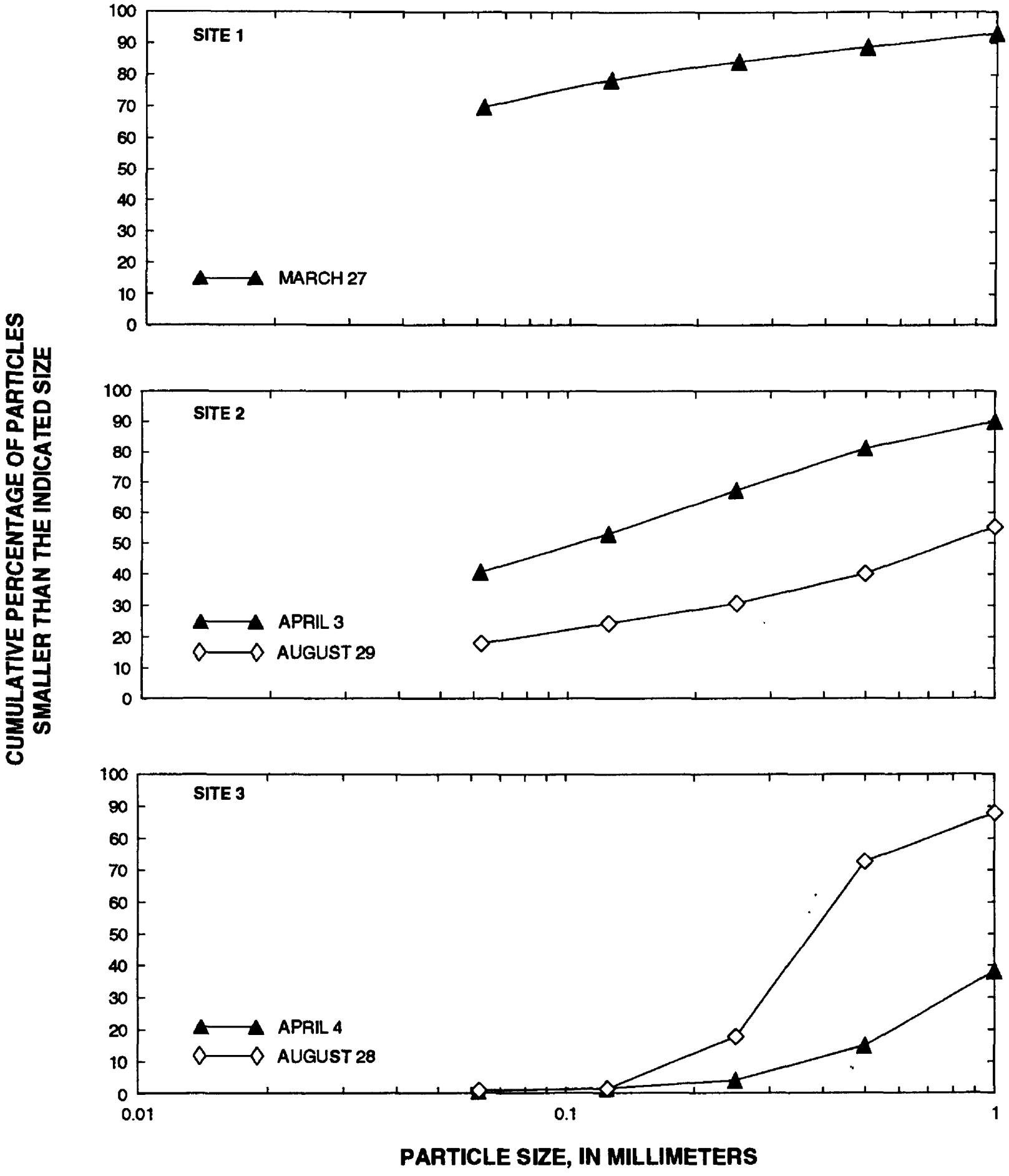

Figure 21. *Cumulative-percentage size distribution of bottom material collected from pools at sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990.*

Table 1. Benthic macroinvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, March 27, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Gyraulus sp.	--	--	43	--	--	--	--	--	--	--	4
Hebetancylus excentricus	--	--	--	--	--	43	--	--	--	--	4
Physa sp.	1,200	2,400	1,200	560	2,300	1,100	780	650	690	820	1,200
HIRUDINEA (leeches)											
Glossiphonia heteroclita	--	--	--	--	--	--	--	--	--	43	4
INSECTA (insects)											
Diptera (true flies)											
Cricotopus trifascia	5,000	2,400	3,600	3,000	880	4,300	9,200	4,100	1,800	3,000	3,700
Dicrotendipes sp.	--	110	75	86	22	--	150	--	--	150	59
Labrundinia sp.	--	110	--	43	22	75	--	--	--	--	25
Orthocladius sp. 1	--	--	--	--	22	150	--	--	--	75	25
Polypedilum sp.	670	2,000	1,000	470	450	2,400	2,800	3,800	2,700	2,600	1,900
Simulium sp.	990	1,800	990	1,300	110	1,100	2,200	1,600	86	--	1,000
Tanytarsus sp.	--	--	--	43	--	--	--	--	--	--	4
Thienemanniella sp.	--	54	--	--	--	--	--	--	--	--	5
Thienemannimyia sp.	--	--	--	--	--	--	460	190	86	300	100
Ephemeroptera (mayflies)											
Caenis sp.	43	43	--	--	22	--	--	--	43	86	24
Odonata (dragonflies and damselflies)											
Argia bipunctulata	--	--	--	--	43	--	--	--	43	43	13
OLIGOCHAETA (worms)											
Branchiura sowerbyi	--	--	--	43	22	--	260	--	--	--	32
Tubificidae G. sp.	--	130	--	170	22	--	1,300	--	--	260	190

Footnote at end of table.

Table 1. Benthic macroinvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, March 27, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
					Density (organisms per square meter)—Continued						
PELECYPODA (clams)											
Corbicula fluminea	--	--	--	--	--	--	86	--	--	--	9
Musculium sp.	300	130	43	43	190	--	1,400	300	1,500	690	460
Total (rounded)	8,200	9,200	7,000	5,800	4,100	9,200	19,000	11,000	6,900	8,100	8,800
Total taxa	6	10	7	10	12	7	10	6	8	11	--
Point depth, m	.09	.09	.06	.06	.06	.09	.06	.06	.06	.12	--
Point velocity, m/s	.34	.37	.20	.25	.30	.37	.21	.46	.28	.19	--
Diversity index	1.2	1.6	1.3	1.4	1.4	1.4	1.6	1.4	1.4	1.6	1.4
Maximum diversity index	1.8	2.3	1.9	2.3	2.5	1.9	2.3	1.8	2.1	2.4	2.1
Evenness	.7	.7	.7	.6	.6	.7	.7	.8	.7	.7	.7

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 2. Benthic macroinvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, May 10, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Physa sp.	--	86	86	43	43	--	170	86	130	--	64
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus pusillus	--	--	--	43	--	--	--	--	--	--	4
Diptera (true flies)											
Antocha sp.	--	--	--	--	--	--	--	43	--	--	4
Cricotopus trifascia	1,400	13,000	4,300	5,600	7,300	2,800	5,600	4,300	4,300	8,400	5,700
Cricotopus sp.	--	430	430	1,300	3,000	220	860	--	860	600	770
Dicrotendipes sp. 1	--	--	--	430	--	--	430	--	--	--	86
Dicrotendipes sp. 2	--	--	--	--	--	--	430	--	--	--	43
Orthocladius sp. 1	--	--	--	--	430	860	430	430	--	1,800	400
Orthocladius sp. 2	--	--	--	--	--	--	--	--	--	600	60
Polypedilum sp.	900	6,500	3,900	3,900	3,400	1,300	3,000	7,300	3,400	2,400	3,600
Simulium sp.	--	320	300	--	43	86	600	220	260	--	180
Tanytarsus sp.	--	--	--	--	--	220	--	--	--	600	82
Thienemannimyia sp.	390	--	--	860	1,300	--	430	860	430	600	490
Tipula sp.	--	--	--	--	--	22	--	--	--	--	2
Zavrelimyia sp.	260	1,300	430	860	--	--	--	1,300	1,300	--	540
Ephemeroptera (mayflies)											
Baetis alius	--	11	--	130	--	--	--	--	43	--	18
Trichoptera (caddisflies)											
Smicridea fasciatella	--	--	--	--	--	22	--	--	--	--	2

Footnote at end of table.

Table 2. Benthic macroinvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, May 10, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
					Density (organisms per square meter)—Continued						
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	--	11	--	--	--	--	--	--	--	--	1
Tubificidae G. sp.	--	--	--	--	--	--	--	--	43	--	4
PELECYPODA (clams)											
Musculium sp.	--	86	220	43	--	65	130	260	560	--	140
TURBELLARIA (flatworms)											
Phagocata sp.	--	--	--	--	--	22	--	--	--	--	2
Total (rounded)	3,000	22,000	9,700	13,000	16,000	5,600	12,000	15,000	11,000	15,000	12,000
Total taxa	4	9	7	10	7	10	10	9	10	7	--
Point depth, m	.18	.09	.06	.09	.12	.12	.09	.06	.06	.09	--
Point velocity, m/s	.12	.20	.67	.29	.23	.19	.46	.64	.58	.19	--
Diversity index	1.2	1.0	1.2	1.5	1.3	1.4	1.6	1.4	1.6	1.4	1.4
Maximum diversity index	1.4	2.2	1.9	2.3	1.9	2.3	2.3	2.2	2.3	1.9	2.1
Evenness	.9	.5	.6	.7	.7	.6	.7	.6	.7	.7	.7

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 3. Benthic macroInvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, July 31, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Hebetancylus excentricus	--	22	--	--	--	--	--	--	22	--	4
Physa sp.	220	170	300	--	150	97	290	65	170	220	170
HIRUDINEA (leeches)											
Helobdella fusca	--	22	--	43	--	--	--	22	--	43	13
INSECTA (insects)											
Coleoptera (beetles)											
Stenelmis sexlineata	130	130	43	--	65	32	11	110	86	86	69
Stenelmis sp.	--	--	--	43	--	--	--	--	--	--	4
Diptera (true flies)											
Corynoneura sp.	780	--	2,300	3,100	86	230	--	260	--	--	680
Cricotopus sp. 2	1,200	170	1,500	3,100	860	450	430	650	340	830	950
Dicrotendipes sp.	1,200	690	2,700	1,200	260	600	110	390	860	830	880
Einfeldia sp.	--	--	--	--	--	230	220	260	260	--	97
Hemerodromia sp.	--	--	--	43	--	--	--	--	--	--	4
Nanocladius sp.	--	--	--	--	--	--	54	--	170	240	46
Orthocladius sp. 1	780	--	--	--	600	450	110	390	340	120	280
Orthocladius sp. 2	390	--	780	--	86	--	--	--	--	--	130
Polypedilum sp.	5,400	2,600	3,900	2,300	260	300	650	1,000	780	1,200	1,800
Rheotanytarsus sp.	3,500	860	1,500	390	690	380	160	390	260	--	810
Simulium sp.	--	--	--	--	--	11	--	--	--	--	1
Tanytarsus sp.	780	--	--	--	--	--	--	--	--	--	78
Thienemannimyia sp.	--	170	--	--	--	--	--	--	--	120	29
Zavrelimyia sp.	390	170	780	390	--	--	54	130	86	240	220

Footnote at end of table.

Table 3. Benthic macroinvertebrate species list and density for site 1, lower Olmos Creek, San Antonio, Texas, July 31, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
Ephemeroptera (mayflies)											
Baetis alius	690	340	300	130	86	240	65	300	240	390	280
Caenis sp.	260	86	86	86	65	75	65	220	--	170	110
Odonata (dragonflies and damselflies)											
Argia sp.	43	--	43	--	--	11	11	22	--	--	13
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	170	--	--	43	--	--	--	--	--	43	26
Tubificidae G. sp.	130	--	520	86	150	65	--	130	43	340	150
PELECYPODA (clams)											
Musculium sp.	43	22	86	130	43	43	65	22	22	86	56
Total (rounded)	16,000	5,500	15,000	11,000	3,400	3,200	2,300	4,400	3,700	5,000	6,900
Total taxa	17	13	14	14	13	15	14	16	14	15	--
Point depth, m	.06	.06	.06	.03	.09	.06	.09	.09	.06	.06	--
Point velocity, m/s	.20	.58	.13	.07	.27	.46	.23	.43	.21	.11	--
Diversity index	2.1	1.7	2.1	1.8	2.1	2.3	2.2	2.4	2.2	2.3	2.1
Maximum diversity index	2.8	2.6	2.6	2.6	2.6	2.7	2.6	2.8	2.6	2.7	2.7
Evenness	.8	.7	.8	.7	.8	.9	.8	.9	.8	.9	.8

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 4. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, April 3, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
CRUSTACEA											
Decapoda (crayfish)											
Procambarus acutus	--	--	--	--	--	--	11	--	--	--	1
GASTROPODA (snails)											
Goniobasis sp. 1	11	--	120	75	--	--	97	11	22	32	37
Laevapex sp.	--	--	--	--	11	--	--	--	--	43	5
Physa sp.	--	--	--	--	--	--	11	--	--	--	1
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	--	--	11	43	22	11	32	11	32	22	18
Stenelmis sp.	--	--	22	--	--	--	--	--	--	--	2
Diptera (true flies)											
Cricotopus trifascia	530	720	440	530	500	780	1,000	390	790	1,400	710
Cryptochironomus sp.	11	--	--	--	--	--	--	--	--	--	1
Dicrotendipes sp.	130	140	43	200	250	22	97	--	54	150	110
Orthocladius sp.1	75	22	11	32	32	170	97	11	86	300	84
Polypedilum sp.	11	22	11	43	43	32	75	11	22	120	39
Tanytarsus sp.	11	--	--	--	--	--	--	--	--	--	1
Thienemannimyia sp.	11	--	--	11	11	--	--	--	--	--	3
Odonata (dragonflies and damselflies)											
Argia bipunctulata	--	--	--	--	--	11	--	--	--	--	1
Lepidoptera (aquatic caterpillars)											
Archanara sp.	--	11	--	--	--	--	--	--	--	--	1
Petrophila sp.	--	--	--	--	--	--	11	--	--	--	1

Footnote at end of table.

Table 4. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, April 3, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
OLIGOCHAETA (worms)											
Branchiura sowerbyi	430	43	--	--	--	--	11	--	11	22	52
Tubificidae G. sp.	--	--	--	11	--	--	32	22	22	--	9
PELECYPODA (clams)											
Corbicula fluminea	--	--	11	--	--	--	--	--	--	11	2
Musculium sp.	--	--	--	--	11	--	--	--	--	--	1
TURBELLARIA (flatworms)											
Phagocata sp.	--	--	--	11	11	--	--	--	--	--	2
Total (rounded)	1,200	960	670	960	890	1,000	1,500	460	1,000	2,100	1,100
Total taxa	9	6	8	9	9	6	11	6	8	9	--
Point depth, m	.21	.15	.18	.21	.27	.18	.12	.15	.15	.12	--
Point velocity, m/s	.15	.22	.30	.29	.12	.26	.30	.20	.24	.19	--
Diversity index	1.4	.9	1.1	1.4	1.3	.8	1.3	.6	1.0	1.2	1.1
Maximum diversity index	2.2	1.8	2.1	2.2	2.2	1.8	2.4	1.8	2.1	2.2	2.1
Evenness	.6	.5	.5	.6	.6	.4	.5	.3	.5	.5	.5

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 5. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, May 9, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Goniobasis sp. 1	22	--	--	11	--	--	--	--	22	22	8
Hebetancylus excentricus	--	11	--	32	32	--	43	--	--	--	12
Physa sp.	--	--	--	11	--	--	--	--	--	--	1
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	--	--	--	--	11	--	43	130	--	11	20
Stenelmis sp.	--	--	22	--	22	--	--	--	--	--	4
Diptera (true flies)											
Cricotopus trifascia	390	420	810	480	1,900	2,400	860	1,900	2,400	1,200	1,300
Cricotopus sp.	65	32	270	65	110	430	130	1,500	220	320	310
Dicrotendipes sp. 1	170	260	220	97	110	1,500	170	1,500	650	320	500
Orthocladius sp. 1	22	--	54	--	--	--	--	220	--	220	52
Polypedilum sp.	22	190	110	--	--	--	43	--	--	110	48
Tanytarsus sp.	22	--	54	--	54	--	--	--	--	110	24
Thienemannimyia sp.	--	--	--	--	--	--	--	220	110	--	33
Zavrelimyia sp.	--	65	--	--	--	--	--	--	110	110	28
Trichoptera (caddisflies)											
Hydroptila sp.	--	11	--	22	22	86	--	43	22	--	21
OLIGOCHAETA (worms)											
Branchiura sowerbyi	54	110	43	11	--	130	22	43	--	11	42
Lumbriculidae G. sp.	--	22	11	--	--	43	86	86	22	22	29
Tubificidae G. sp.	--	--	--	--	--	--	22	--	--	--	2

Footnote at end of table.

Table 5. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, May 9, 1990—Continued

CLASS Order *Genus species*	Sample point A	B	C	D	E	F	G	H	I	J	Mean[1]
					Density (organisms per square meter)—Continued						
TURBELLARIA (flatworms)											
Phagocata sp.	--	--	11	43	--	--	43	43	--	--	14
Total (rounded)	770	1,100	1,600	770	2,300	4,600	1,500	5,700	3,600	2,500	2,400
Total taxa	8	9	10	9	8	6	10	10	8	11	--
Point depth, m	.27	.12	.09	.21	.15	.12	.15	.12	.12	.12	--
Point velocity, m/s	.17	.09	.34	.20	.37	.19	.18	.26	.23	.19	--
Diversity index	1.5	1.7	1.6	1.3	.7	1.1	1.5	1.6	1.1	1.6	1.4
Maximum diversity index	2.1	2.2	2.3	2.2	2.1	1.8	2.3	2.3	2.1	2.4	2.2
Evenness	.7	.8	.7	.6	.3	.6	.7	.7	.5	.7	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 6. *Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, June 26, 1990*

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
CRUSTACEA											
Decapoda (crayfish)											
Procambarus acutus	54	--	43	--	11	--	--	--	11	--	12
GASTROPODA (snails)											
Goniobasis sp.	--	--	--	--	86	22	130	75	65	22	40
Hebetancylus excentricus	32	22	43	--	--	75	11	54	11	11	26
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus pusillus	22	11	32	32	11	32	--	11	32	22	20
Diptera (true flies)											
Cricotopus trifascia	22	--	--	--	--	--	--	--	--	--	2
Cryptochironomus sp.	--	--	--	--	--	43	--	22	--	--	6
Dicrotendipes sp. 1	32	65	75	32	--	390	220	110	260	300	150
Dicrotendipes sp. 2	11	--	--	--	--	43	--	--	--	--	5
Eukiefferiella brehmi	--	--	32	--	--	--	--	--	--	--	3
Hemerodromia sp.	--	--	--	--	--	11	--	--	--	--	1
Micropsectra sp.	--	--	11	--	--	--	--	--	86	260	36
Orthocladius sp. 1	--	--	--	11	--	43	43	22	--	43	16
Paracladius sp.	11	11	54	11	--	170	300	170	260	170	120
Polypedilum sp.	22	54	150	--	--	220	43	22	--	--	51
Tanytarsus sp.	86	160	380	120	--	470	560	540	690	280	330
Thienemanniella sp.	--	--	--	--	--	43	86	22	--	--	15
Thienemannimyia sp.	11	--	--	--	--	--	--	--	43	--	5
Zavrelimyia sp.	75	11	120	43	--	130	300	130	86	43	94

Footnote at end of table.

Table 6. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, June 26, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
Ephemeroptera (mayflies)											
Baetis alius	--	--	11	--	--	--	11	--	--	--	2
Caenis sp.	11	22	22	22	11	--	43	11	--	22	16
Tricorythodes minutus	22	--	--	--	--	--	--	--	--	--	2
Odonata (dragonflies and damselflies)											
Argia sp.	75	11	54	22	22	22	43	11	11	--	27
Trichoptera (caddisflies)											
Ochrotrichia sp.	--	--	--	--	--	--	--	22	11	--	3
Smicridea fasciatella	--	--	11	--	--	--	--	--	--	--	1
OLIGOCHAETA (worms)											
Branchiura sowerbyi	32	32	22	22	75	130	--	97	--	22	43
Lumbriculidae G. sp.	--	--	--	--	--	--	--	--	--	22	2
Tubificidae G. sp.	--	--	32	11	--	--	--	--	--	--	4
TURBELLARIA (flatworms)											
Phagocata velata	--	--	--	--	11	--	--	--	--	--	1
Total (rounded)	520	400	1,100	330	230	1,800	1,800	1,300	1,600	1,200	1,000
Total taxa	15	10	16	10	7	15	12	15	12	12	--
Point depth, m	.18	.18	.21	.18	.18	.18	.18	.18	.18	.18	--
Point velocity, m/s	.09	.14	.06	.23	.09	.18	.19	.23	.14	.18	--
Diversity index	2.5	1.9	2.2	2.0	1.5	2.2	2.0	2.0	1.7	1.9	2.0
Maximum diversity index	2.7	2.3	2.8	2.3	1.9	2.7	2.5	2.7	2.5	2.5	2.5
Evenness	.9	.8	.8	.9	.8	.8	.8	.7	.7	.8	.8

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 7. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, August 1, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
CRUSTACEA											
Amphipoda (sideswimmers)											
Hyalella azteca	--	--	--	--	--	--	--	11	--	--	1
Decapoda (crayfish)											
Orconectes sp.	43	--	--	--	--	--	--	--	--	--	4
GASTROPODA (snails)											
Goniobasis sp. 1	--	--	22	--	--	--	22	--	--	--	4
Goniobasis sp. 2	--	11	--	65	--	--	--	170	--	--	25
Hebetancylus excentricus	--	22	--	22	--	22	11	22	11	--	11
Hydrobiidae G. sp.	--	--	--	--	43	--	--	--	--	22	6
INSECTA (insects)											
Coleoptera (beetles)											
Elmidae G. sp.	--	--	--	--	--	--	--	--	--	11	1
Microcylloepus sp.	--	22	11	65	--	--	22	22	32	11	18
Ordobrevia sp.	--	--	--	--	170	--	--	--	--	--	17
Stenelmis sexlineata	22	--	22	--	--	--	11	32	11	--	10
Diptera (true flies)											
Bezzia sp.	--	--	--	--	--	--	11	--	--	--	1
Corynoneura sp.	--	75	22	140	690	97	160	240	86	130	160
Cricotopus sp. 2	170	75	190	340	520	32	--	--	86	--	140
Dicrotendipes sp.	520	1,300	22	260	1,700	320	1,200	710	950	480	750
Microtendipes sp.	--	75	--	--	--	--	--	--	--	--	8
Nanocladius sp.	86	--	--	--	--	--	--	--	--	65	15
Orthocladius sp. 1	--	150	110	260	340	32	220	950	170	260	250
Orthocladius sp. 2	--	75	--	43	86	130	54	710	86	160	130
Polypedilum sp.	--	75	240	43	86	--	--	360	--	--	80
Rheotanytarsus sp.	1,000	300	86	86	430	--	110	--	43	--	210
Thienemannimyia sp.	170	75	--	130	--	--	--	120	--	65	56
Zavrelimyia sp.	340	75	86	--	170	--	110	240	86	130	120

Footnote at end of table.

Table 7. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, August 1, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
Ephemeroptera (mayflies)											
Baetis alius	--	54	120	220	470	97	65	200	11	11	120
Caenis sp.	--	65	11	43	--	43	75	54	43	11	34
Lepidoptera (aquatic caterpillars)											
Petrophila sp.	--	--	--	--	--	11	--	--	--	--	1
Odonata (dragonflies and damselflies)											
Argia sp.	--	--	32	--	--	--	22	22	--	--	8
Trichoptera (caddisflies)											
Hydroptila sp.	--	65	11	22	170	22	32	43	--	--	36
Ochrotrichia sp.	--	--	--	--	43	--	--	--	--	--	4
OLIGOCHAETA (worms)											
Branchiura sowerbyi	260	--	43	110	--	--	130	--	75	22	64
Lumbriculidae G. sp.	--	--	--	--	--	--	--	--	22	--	2
Tubificidae G. sp.	43	--	--	22	--	--	--	--	--	--	6
TURBELLARIA (flatworms)											
Dugesia tigrina	22	32	11	--	--	--	--	--	11	--	8
Total (rounded)	2,700	2,500	1,000	1,900	4,900	810	2,300	3,900	1,700	1,400	2,300
Total taxa	11	17	16	16	13	10	16	16	15	13	--
Point depth, m	.12	.09	.09	.12	.06	.12	.12	.09	.12	.12	--
Point velocity, m/s	.09	.11	.15	.24	.11	.20	.17	.13	.14	.11	--
Diversity index	1.8	1.9	2.3	2.4	2.1	1.8	1.8	2.2	1.7	2.0	2.0
Maximum diversity index	2.4	2.8	2.8	2.8	2.6	2.3	2.8	2.8	2.7	2.6	2.7
Evenness	.8	.7	.8	.9	.8	.8	.6	.8	.6	.8	.7

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 8. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, August 29, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
CRUSTACEA											
Decapoda (crayfish)											
Procambarus acutus	--	--	11	11	11	--	--	--	--	--	3
GASTROPODA (snails)											
Goniobasis sp. 1	--	--	300	300	340	900	560	65	230	--	270
Gyraulus sp.	--	--	--	--	--	22	--	--	--	--	2
Hebetancylus excentricus	--	65	86	--	130	43	43	43	86	190	69
Physa sp.	--	22	--	--	--	--	--	--	--	--	2
HIRUDINEA (leeches)											
Glossiphonia heteroclita	--	--	--	--	--	32	--	--	--	--	3
INSECTA (insects)											
Coleoptera (beetles)											
Stenelmis sexlineata	--	65	11	86	130	110	43	22	86	--	55
Diptera (true flies)											
Atrichopogon websteri	--	22	--	--	--	--	--	--	--	--	2
Cricotopus tremulus	--	110	--	860	--	--	--	--	--	--	97
Cricotopus trifascia	110	860	860	860	320	860	2,300	970	650	320	810
Cryptotendipes sp.	--	--	--	--	320	--	--	--	--	--	32
Einfeldia sp.	220	110	430	--	320	860	--	--	220	--	220
Larsia sp.	220	--	--	--	--	1,300	320	--	--	--	180
Palpomyia sp.	--	--	--	43	--	--	--	--	--	--	4
Paracladius sp.	--	--	--	--	320	--	--	--	--	--	32
Polypedilum sp.	220	320	430	430	320	--	--	--	--	--	170
Rheotanytarsus sp.	1,700	540	3,400	3,400	1,600	3,400	1,300	3,600	2,200	3,900	2,500
Thienemanniella sp.	--	--	--	430	--	--	650	--	--	320	140

Footnote at end of table.

Table 8. Benthic macroinvertebrate species list and density for site 2, upper San Antonio River, San Antonio, Texas, August 29, 1990—Continued

CLASS Order *Genus species*	Sample point A	B	C	D	E	F	G	H	I	J	Mean[1]
					Density (organisms per square meter)—Continued						
Ephemeroptera (mayflies)											
Baetis alius	110	130	130	130	130	65	110	--	43	65	91
Caenis sp.	450	43	260	43	130	22	65	43	130	43	120
Paraleptophlebia sp.	--	--	--	--	--	--	22	--	--	--	2
Tricorythodes minutus	--	22	--	--	--	--	--	--	--	22	4
Odonata (dragonflies and damselflies)											
Argia sp.	86	43	43	130	86	43	22	43	170	22	69
Trichoptera (caddisflies)											
Hydroptila sp.	--	--	--	--	--	86	--	--	--	--	9
Ochrotrichia sp.	--	22	11	--	170	--	43	110	--	--	36
Smicridea fasciatella	--	--	43	--	43	--	--	--	--	--	9
OLIGOCHAETA (worms)											
Branchiura sowerbyi	--	280	--	170	43	150	--	22	--	--	66
Lumbriculidae G. sp.	--	--	11	43	86	--	--	--	11	--	15
Tubificidae G. sp.	22	22	--	130	43	43	--	--	--	--	26
Total (rounded)	3,100	2,700	6,000	7,100	4,500	7,900	5,500	4,900	3,800	4,900	5,000
Total taxa	9	16	14	15	18	15	12	9	10	8	--
Point depth, m	.12	.06	.15	.15	.09	.09	.12	.12	.09	.12	--
Point velocity, m/s	.08	.14	.13	.17	.21	.24	.17	.12	.09	.14	--
Diversity index	1.5	2.1	1.5	1.8	2.3	1.8	1.6	.9	1.4	.8	1.6
Maximum diversity index	2.2	2.8	2.6	2.7	2.9	2.7	2.5	2.2	2.3	2.1	2.5
Evenness	.7	.8	.6	.7	.8	.7	.6	.4	.6	.4	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 9. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, April 4, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Goniobasis sp. 1	22	--	--	--	11	--	11	--	11	11	7
Laevapex sp.	43	--	22	--	11	--	--	--	--	22	10
HIRUDINEA (leeches)											
Erpobdella punctata	--	--	--	--	11	--	--	--	--	--	1
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	--	65	32	22	32	43	22	32	--	43	29
Stenelmis sp.	--	--	11	11	86	22	11	230	--	160	53
Diptera (true flies)											
Cricotopus trifascia	1,100	810	290	1,100	870	1,300	65	3,500	960	750	1,100
Eukiefferiella sp.	--	--	--	--	--	--	11	--	22	54	9
Hemerodromia sp.	--	--	--	--	11	22	--	--	--	--	3
Orthocladius sp. 1	190	200	65	75	120	250	22	1,400	130	--	250
Polypedilum sp.	43	54	--	--	--	--	11	--	--	--	11
Tanytarsus sp.	--	22	43	--	120	--	22	230	110	32	58
Thienemanniella sp.	--	--	--	--	--	--	22	110	--	--	13
Thienemannimyia sp.	--	--	22	22	22	32	32	110	22	22	28
Ephemeroptera (mayflies)											
Baetis alius	--	--	--	--	11	--	--	--	--	--	1
Trichoptera (caddisflies)											
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	11	--	1
Smicridea fasciatella	--	--	--	--	--	22	--	--	--	--	2

Footnote at end of table.

Table 9. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, April 4, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
Lepidoptera (aquatic caterpillars)											
Petrophila sp.	--	--	11	--	--	--	--	--	--	--	1
Megaloptera (alderflies and dobson flies)											
Corydalus cornutus	22	11	--	--	11	--	--	--	--	--	4
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	22	--	--	43	75	--	260	530	--	54	98
Tubificidae G. sp.	--	--	11	--	--	22	--	--	--	--	3
PELECYPODA (clams)											
Corbicula fluminea	--	--	11	22	54	--	190	290	--	97	66
Musculium sp.	22	--	11	--	--	--	--	--	--	--	3
TURBELLARIA (flatworms)											
Phagocata sp.	150	11	230	140	480	43	110	440	230	230	210
Total (rounded)	1,600	1,200	760	1,400	1,900	1,800	790	6,900	1,500	1,500	2,000
Total taxa	9	7	12	8	15	9	13	10	8	11	--
Point depth, m	.18	.12	.15	.21	.15	.21	.09	.12	.21	.15	--
Point velocity, m/s	.46	1.0	.73	.91	.49	.58	.88	.94	.55	.70	--
Diversity index	1.2	1.0	1.7	.9	1.7	1.0	2.0	1.6	1.2	1.6	1.4
Maximum diversity index	2.2	1.9	2.5	2.1	2.7	2.2	2.6	2.3	2.1	2.4	2.3
Evenness	.5	.5	.7	.4	.6	.5	.8	.7	.6	.7	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 10. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, May 8, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; +, dipterans for sample point I were lost; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Hebetancylus excentricus	43	--	--	43	130	43	--	130	--	--	39
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	43	--	--	--	--	--	--	--	--	--	4
Stenelmis sp.	--	--	--	--	43	--	--	--	--	--	4
Diptera (true flies)											
Bezzia sp.	--	--	--	--	--	--	43	--	+	--	5
Cricotopus trifascia	860	5,400	2,600	1,600	3,600	2,800	3,100	3,200	+	1,600	2,800
Cricotopus sp.	270	220	1,000	110	--	540	--	390	+	110	300
Hemerodromia sp.	43	--	--	22	--	--	--	--	+	22	10
Orthocladius sp. 1	54	--	--	320	--	--	340	130	+	--	94
Polypedilum sp.	--	--	170	220	170	--	--	--	+	--	62
Tanytarsus sp.	--	--	--	110	--	110	--	--	+	220	49
Thienemannimyia sp.	--	--	--	--	--	--	--	390	+	320	79
Ephemeroptera (mayflies)											
Baetis alius	--	--	--	--	--	22	--	--	22	--	4
Tricorythodes sp.	--	--	--	--	--	--	--	--	--	22	2
Trichoptera (caddisflies)											
Hydroptila sp.	130	--	86	86	86	86	--	--	--	--	47
Smicridea fasciatella	--	43	--	--	--	--	--	--	22	65	13
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	--	--	--	--	--	--	43	220	22	--	28
Tubificidae G. sp.	--	--	43	--	--	--	--	--	--	110	15

Footnote at end of table.

Table 10. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, May 8, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
PELECYPODA (clams)											
Corbicula fluminea	43	--	43	--	43	43	43	43	--	43	30
TURBELLARIA (flatworms)											
Phagocata sp.	260	43	170	43	130	22	170	170	--	22	100
Total (rounded)	1,700	5,700	4,100	2,600	4,200	3,700	3,700	4,700	+	2,500	3,700
Total taxa	9	4	7	9	7	8	6	8	+	10	--
Point depth, m	.15	.18	.21	.30	.21	.15	.24	.12	.18	.18	--
Point velocity, m/s	.61	.58	.67	.55	.70	.85	.64	.27	.52	.49	--
Diversity index	1.6	.3	1.1	1.3	.7	.8	.7	1.2	+	1.3	1.0
Maximum diversity index	2.2	1.4	1.9	2.2	1.9	2.1	1.8	2.1	+	2.3	2.0
Evenness	.7	.2	.6	.6	.4	.4	.4	.6	+	.6	.5

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 11. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, June 25, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected or not applicable; sp., species; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Hebetancylus excentricus	170	--	--	--	43	86	220	130	--	390	100
HYDRACARINA (water mites)											
Brachypoda sp.	43	--	--	--	--	--	--	--	--	--	4
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus pusillus	43	170	--	43	--	--	86	86	130	--	56
Optioservus quadrimaculatus	--	--	--	43	--	--	--	--	--	--	4
Psephenus herricki	86	43	130	--	--	--	43	--	22	--	32
Stenelmis sexlineata	43	43	170	86	--	--	43	--	86	300	77
Diptera (true flies)											
Chironomus sp.	--	43	--	--	--	--	--	22	--	--	6
Cladotanytarsus vanderwulpi	--	--	--	--	--	--	--	--	22	--	2
Cricotopus (Nostococladius) sp.	--	43	--	--	--	--	--	--	--	--	4
Cricotopus trifascia	43	43	300	86	86	--	130	170	11	43	91
Dicrotendipes sp. 1	11	--	--	--	43	--	43	--	--	--	10
Hemerodromia sp.	130	220	130	560	86	300	220	280	130	390	240
Micropsectra sp.	--	--	--	--	--	--	130	--	--	--	13
Orthocladius sp. 1	43	43	86	--	--	--	--	22	--	--	19
Parametriocnemus sp.	--	--	--	--	--	--	--	--	11	--	1
Polypedilum sp.	11	260	--	86	170	--	--	43	11	130	71
Simulium sp.	--	86	86	170	43	--	--	--	--	--	38
Tanytarsus sp.	22	340	600	43	260	560	430	150	43	170	260
Thienemannimyia sp.	54	390	260	130	170	130	130	370	130	560	230
Zavrelimyia sp.	11	260	--	220	--	340	130	43	11	130	110
Ephemeroptera (mayflies)											
Baetis alius	11,000	7,800	7,200	8,100	4,400	5,900	4,900	1,700	1,700	2,500	5,500
Tricorythodes minutus	1,100	2,400	1,300	2,500	820	340	470	580	220	86	980

Footnote at end of table.

Table 11. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, June 25, 1990—Continued

CLASS Order *Genus species*	Sample point A	B	C	D	E	F	G	H	I	J	Mean[1]
					Density (organisms per square meter)—Continued						
Lepidoptera (aquatic caterpillars)											
Petrophila sp.	--	560	130	220	--	170	43	--	65	43	120
Megaloptera (alderflies and dobson flies)											
Corydalus cornutus	11	--	--	11	--	--	--	--	--	--	2
Odonata (dragonflies and damselflies)											
Argia bipunctulata	43	220	86	130	130	--	170	190	190	470	160
Dythemis sp.	--	--	--	--	--	--	--	--	--	22	2
Trichoptera (caddisflies)											
Cheumatopsyche sp.	--	--	--	--	--	--	43	--	22	130	20
Chimarra sp.	--	--	--	--	43	--	--	22	--	86	15
Ochrotrichia sp.	300	430	520	300	86	130	340	130	130	43	240
Smicridea fasciatella	1,000	2,200	2,300	1,200	1,200	820	900	160	690	6,800	1,700
OLIGOCHAETA (worms)											
Tubificidae G. sp.	220	--	86	--	--	--	--	--	65	--	37
PELECYPODA (clams)											
Corbicula fluminea	--	--	--	--	--	--	--	--	--	11	1
Musculium sp.	--	--	--	--	--	--	--	22	--	--	2
TURBELLARIA (flatworms)											
Phagocata velata	130	--	--	130	--	43	300	--	43	220	87
Total (rounded)	15,000	16,000	13,000	14,000	7,600	8,800	8,800	4,100	3,700	13,000	10,000
Total taxa	21	19	15	18	14	11	19	17	20	19	--
Point depth, m	.21	.18	.18	.18	.21	.21	.21	.18	.21	.18	--
Point velocity, m/s	.61	.76	.91	.98	.73	.61	.55	.40	.43	.40	--
Diversity index	1.1	1.7	1.6	1.5	1.5	1.3	1.8	2.1	1.9	1.6	1.6
Maximum diversity index	3.0	2.9	2.7	2.9	2.6	2.4	2.9	2.8	3.0	2.9	2.8
Evenness	.4	.6	.6	.5	.6	.5	.6	.8	.6	.6	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 12. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, August 1, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Goniobasis sp. 2	--	--	--	--	--	43	--	--	--	--	4
Hebetancylus excentricus	--	--	--	--	--	--	65	86	65	--	22
Physa sp.	--	--	--	--	--	--	--	--	--	22	2
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	43	22	86	130	1,400	86	370	170	--	22	230
Ordobrevia sp.	--	--	--	--	--	--	--	--	540	--	54
Psephenus herricki	--	--	43	--	--	--	--	43	--	--	9
Stenelmis sexlineata	--	--	--	--	--	130	32	340	--	--	50
Stenelmis sp.	--	22	--	86	--	--	--	--	22	--	13
Diptera (true flies)											
Corynoneura sp.	--	--	--	--	600	--	190	430	340	--	160
Cricotopus sp. 2	520	690	--	3,600	5,400	2,400	1,400	1,100	--	2,800	1,800
Cryptochironomus sp.	--	--	730	--	--	--	--	--	170	--	90
Dicrotendipes sp.	--	--	--	--	600	--	190	--	690	260	170
Hemerodromia sp.	--	--	86	43	--	43	--	130	--	--	30
Nanocladius sp.	--	--	--	--	600	--	--	--	--	--	60
Orthocladius sp. 1	10,000	5,900	14,000	13,000	11,000	6,600	3,100	3,900	2,900	4,100	7,400
Orthocladius sp. 2	1,000	2,400	2,200	1,200	3,000	470	--	430	--	--	1,100
Polypedilum sp.	520	--	1,500	2,400	--	--	--	--	170	260	480
Rheotanytarsus sp.	--	--	730	600	--	--	--	650	--	--	200
Simulium sp.	300	580	1,300	560	--	43	11	--	--	--	280
Thienemannimyia sp.	--	--	--	--	--	--	--	430	340	--	77
Zavrelimyia sp.	--	340	--	--	1,800	1,400	390	220	--	--	420

Footnote at end of table.

Table 12. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, August 1, 1990—Continued

CLASS Order *Genus species*	Sample point A	B	C	D	E	F	G	H	I	J	Mean[1]
					Density (organisms per square meter)—Continued						
Ephemeroptera (mayflies)											
Baetis alius	1,600	900	4,100	2,500	4,500	2,900	230	730	370	43	1,800
Caenis sp.	--	22	130	170	430	--	43	86	--	--	88
Tricorythodes minutus	--	--	--	--	--	--	11	--	43	--	5
Odonata (dragonflies and damselflies)											
Argia sp.	--	--	43	86	--	43	11	130	22	--	34
Trichoptera (caddisflies)											
Cheumatopsyche sp.	--	--	--	170	110	--	43	--	86	--	41
Ochrotrichia sp.	--	43	43	43	--	--	--	--	22	--	15
Smicridea fasciatella	130	260	1,100	860	860	300	110	130	--	--	380
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	--	22	43	43	--	43	--	--	--	--	15
Tubificidae G. sp.	43	--	--	--	--	43	32	--	22	--	14
PELECYPODA (clams)											
Musculium sp.	--	--	--	--	--	43	43	--	--	--	9
TURBELLARIA (flatworms)											
Dugesia tigrina	--	--	--	--	--	86	130	--	22	22	26
Total (rounded)	14,000	11,000	26,000	25,000	30,000	15,000	6,400	9,000	5,800	7,500	15,000
Total taxa	9	12	15	16	12	16	18	16	16	8	--
Point depth, m	.18	.18	.15	.21	.18	.18	.30	.24	.21	.24	--
Point velocity, m/s	.37	1.1	1.2	.79	.60	.88	.55	.24	.19	.34	--
Diversity index	1.1	1.5	1.6	1.7	1.9	1.6	1.7	2.0	1.8	1.0	1.6
Maximum diversity index	2.2	2.5	2.7	2.8	2.5	2.8	2.9	2.8	2.8	2.1	2.6
Evenness	.5	.6	.6	.6	.8	.6	.6	.7	.6	.5	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 13. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, August 28, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). sp., species; --, not detected or not applicable; G., genus; m, meters; m/s, meters per second]

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)										
GASTROPODA (snails)											
Goniobasis sp. 1	11	220	11	22	--	--	--	--	--	--	26
Gyraulus sp.	11	220	11	--	--	11	--	--	--	--	25
Hebetancylus excentricus	--	--	--	--	--	--	--	43	430	110	58
HIRUDINEA (leeches)											
Helobdella sp.	--	--	--	--	--	--	--	--	11	--	1
INSECTA (insects)											
Coleoptera (beetles)											
Microcylloepus sp.	110	110	--	--	220	--	--	--	260	--	70
Psephenus sp.	--	110	540	--	--	--	--	--	--	--	65
Stenelmis sexlineata	--	--	650	--	110	11	530	110	--	430	180
Diptera (true flies)											
Cricotopus tremulus	220	220	220	430	--	--	--	--	--	--	110
Cricotopus trifascia	110	--	--	--	--	--	22	--	--	--	13
Einfeldia sp.	--	--	--	--	--	--	--	--	--	320	32
Eukiefferiella claripennis	--	--	220	--	--	--	--	--	--	--	22
Hemerodromia sp.	220	--	220	110	--	--	11	40	--	--	60
Larsia sp.	110	--	--	--	--	--	--	--	320	--	43
Polypedilum sp.	110	220	--	430	--	--	--	1,700	--	320	280
Prosimulium sp.	220	--	--	--	--	--	--	--	--	--	22
Rheotanytarsus sp.	430	650	2,200	220	860	320	22	860	430	320	630
Simulium sp.	--	--	--	--	--	--	11	--	--	--	1
Tanytarsus sp.	--	--	--	--	--	--	--	--	170	320	49
Thienemanniella sp.	430	--	--	--	--	110	--	--	--	--	54
Thienemannimyia sp.	220	650	220	1,100	1,100	750	170	1,700	430	2,900	920
Zavrelimyia sp.	--	220	--	--	--	--	--	--	340	320	88

Footnote at end of table.

Table 13. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, August 28, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
Ephemeroptera (mayflies)											
Baetis alius	12,000	17,000	18,000	15,000	9,000	7,200	430	300	1,100	2,500	8,300
Caenis sp.	--	--	--	--	--	--	11	65	600	--	68
Paraleptophlebia sp.	--	110	--	--	--	--	--	--	--	--	11
Tricorythodes minutus	970	750	650	430	2,400	970	180	580	1,400	1,700	1,000
Lepidoptera (aquatic caterpillars)											
Crambus sp.	--	--	--	--	--	--	--	--	86	--	9
Petrophila sp.	330	330	--	--	11	--	22	43	--	220	96
Megaloptera (alderflies and dobsonflies)											
Corydalus sp.	--	--	11	--	11	--	--	--	--	--	2
Odonata (dragonflies and damselflies)											
Argia sp.	110	43	32	22	340	110	32	22	32	540	130
Brechmorphoga sp.	--	--	--	--	--	--	--	--	--	110	11
Trichoptera (caddisflies)											
Cheumatopsyche sp.	--	--	1,200	--	--	--	75	--	--	--	130
Hydroptila sp.	--	--	--	--	--	--	--	--	--	110	11
Ochrotrichia sp.	220	--	650	320	320	--	--	220	--	540	230
Smicridea fasciatella	3,100	6,200	8,100	2,900	2,800	1,500	180	80	--	320	2,500
OLIGOCHAETA (worms)											
Lumbriculidae G. sp.	--	--	11	--	11	--	75	--	--	--	10
PELECYPODA (clams)											
Corbicula fluminea	--	--	--	--	--	--	--	--	--	110	11
Musculium sp.	--	--	--	--	--	--	11	22	86	650	77

Table 13. Benthic macroinvertebrate species list and density for site 3, upper San Antonio River, San Antonio, Texas, August 28, 1990—Continued

CLASS Order *Genus species*	Sample point										Mean[1]
	A	B	C	D	E	F	G	H	I	J	
	Density (organisms per square meter)—Continued										
TURBELLARIA (flatworms)											
Dugesia tigrina	--	--	--	110	--	220	11	--	--	--	34
Total (rounded)	19,000	27,000	33,000	21,000	17,000	11,000	1,800	5,800	5,700	12,000	15,000
Total taxa	18	15	17	12	12	10	16	14	14	18	--
Point depth, m	.18	.12	.12	.15	.18	.18	.27	.18	.24	.18	--
Point velocity, m/s	.94	.94	.67	.76	.61	.64	.49	.40	.49	.36	--
Diversity index	1.4	1.2	1.4	1.1	1.5	1.2	2.0	1.8	2.2	2.3	1.6
Maximum diversity index	2.9	2.7	2.8	2.5	2.5	2.3	2.8	2.6	2.6	2.9	2.7
Evenness	.5	.4	.5	.4	.6	.5	.7	.7	.8	.8	.6

[1] Mean total computed using mean densities of organisms. Mean evenness computed using mean diversity index and mean maximum diversity index.

Table 14. Pupae densities at sites 1-3, lower Olmos Creek and upper San Antonio River, San Antonio, Texas, 1990

[--, not detected; +, chironomids for sample point I were lost]

Organism / Sample date	Sample point A	B	C	D	E	F	G	H	I	J	Mean
					Density (organisms per square meter)						
Site 1											
Chironomidae pupae											
March 27	86	43	43	43	43	258	258	86	--	86	95
May 10	129	151	129	258	301	22	258	387	215	129	198
July 31	86	108	86	258	215	129	129	151	65	258	148
Site 2											
Chironomidae pupae											
April 3	11	11	22	11	--	11	54	22	22	54	22
May 9	--	11	32	11	43	43	22	43	22	43	27
June 26	--	--	--	--	--	--	11	11	11	22	6
August 1	129	75	11	108	172	11	65	118	32	75	80
August 29	--	--	129	43	43	129	--	--	258	215	82
Site 3											
Diptera pupae											
August 1	258	108	129	129	108	--	--	--	--	--	73
Chironomidae pupae											
April 4	--	--	--	--	--	--	11	11	--	11	3
May 8	86	--	129	65	129	22	129	--	+	65	69
June 25	--	--	--	43	--	129	--	86	22	46	33
August 1	--	--	--	--	--	172	22	--	65	43	30
August 28	--	--	215	--	--	--	22	43	--	323	60

Table 15. Periphyton species list and density for site 1, lower Olmos Creek, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected; ND, no data collected because of no-flow conditions; sp., species]

DIVISION *Genus species*	Sample date				
	March 27	May 10	June 27	July 31	August 29
	Density (cells per square millimeter)				
BACILLARIOPHYTA (diatoms)					
Achnanthes hungarica	--	--	ND	10	ND
Achnanthes minutissima	46	690	ND	--	ND
Amphora perpusilla	23	230	ND	2	ND
Amphora submontana	--	--	ND	15	ND
Caloneis ventricosa	--	230	ND	--	ND
Cocconeis placentula	46	--	ND	--	ND
Cyclotella meneghiniana	--	530	ND	--	ND
Cyclotella sp.	--	--	ND	230	ND
Cymbella lunata	11	--	ND	--	ND
Cymbella minuta	--	690	ND	--	ND
Cymbella sp.	11	--	ND	--	ND
Diatoma vulgare	--	--	ND	5	ND
Epithemia sp.	23	--	ND	--	ND
Gomphonema parvulum	34	--	ND	12	ND
Gyrosigma salproides	--	--	ND	87	ND
Navicula creuzburgensis	--	--	ND	36	ND
Navicula crucicula	--	--	ND	2	ND
Navicula cryptocephala	11	230	ND	--	ND
Navicula gregaria	--	--	ND	5	ND
Navicula grimmei	--	--	ND	15	ND
Navicula minuta	170	--	ND	--	ND
Navicula mutica	--	--	ND	7	ND
Navicula notha	--	--	ND	17	ND
Navicula pelliculosa	--	230	ND	--	ND
Navicula rhynchocephala	--	230	ND	--	ND
Navicula sp.	--	690	ND	--	ND
Nitzschia amphibia	34	--	ND	--	ND
Nitzschia fonticola	11	--	ND	--	ND
Nitzschia frustulum	57	230	ND	--	ND
Nitzschia kutzingiana	--	230	ND	--	ND
Nitzschia palea	11	920	ND	--	ND
Nitzschia sp.	11	230	ND	--	ND
Rhoicosphenia curvata	180	--	ND	--	ND
Rhopalodia sp.	--	230	ND	--	ND
Surirella ovata	--	230	ND	--	ND
Synedra sp. 1	--	--	ND	25	ND
CHLOROPHYTA (green algae)					
Chlamydomonas sp.	130	--	ND	440	ND
Chlorella ellipsoidea	310	530	ND	--	ND
Chlorococcum humicola	--	--	ND	410	ND

Table 15. Periphyton species list and density for site 1, lower Olmos Creek, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date				
	March 27	**May 10**	**June 27**	**July 31**	**August 29**
	Density (cells per square millimeter)—Continued				
Chodatella quadriseta	62	--	ND	--	ND
Cladophora glomerata	250	--	ND	--	ND
Coelastrum microporum	--	4,200	ND	--	ND
Crucigenia quadrata	--	--	ND	230	ND
Kirchneriella lunaris	--	270	ND	--	ND
Rhizoclonium hieroglyphicum	--	530	ND	--	ND
Scenedesmus armatus	--	--	ND	100	ND
Scenedesmus bijuga	--	1,100	ND	--	ND
Selenastrum minutum	62	270	ND	--	ND
Unknown chlorococcoid	--	1,600	ND	--	ND
CHRYSOPHYTA (golden-brown algae)					
Kephyrion sp.	--	270	ND	--	ND
Unknown flagellate	--	270	ND	--	ND
CRYPTOPHYTA (cryptophytes)					
Cryptomonas ovata	--	270	ND	--	ND
CYANOPHYTA (blue-green algae)					
Anabaena sp.	500	--	ND	--	ND
Chroococcus dispersus	--	2,600	ND	78	ND
Chroococcus limneticus	130	530	ND	--	ND
Chroococcus multicoloratus	370	--	ND	--	ND
Chroococcus sp.	--	790	ND	--	ND
Dactylococcopsis fascicularis	--	--	ND	130	ND
Lyngbya sp.	250	--	ND	--	ND
Lyngbya subtilis	2,900	790	ND	--	ND
Oscillatoria sp.	--	530	ND	--	ND
Oscillatoria subtilissima	1,500	--	ND	--	ND
Phormidium tenue	--	--	ND	3,400	ND
Pseudanabaena catenata	--	5,600	ND	--	ND
Synechococcus lineare	--	790	ND	--	ND
Synechococcus sp.	--	2,400	ND	--	ND
EUGLENOPHYTA (euglenoids)					
Euglena sp.	--	--	ND	52	ND
Total (rounded)	7,100	29,000	ND	5,300	ND
Total taxa	26	33	ND	22	ND
Diversity index	2.1	3.0	ND	1.5	ND
Maximum diversity index	3.3	3.5	ND	3.1	ND
Evenness	.6	.9	ND	.5	ND

Table 16. Periphyton species list and density for site 2, upper San Antonio River, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected; sp., species]

DIVISION *Genus species*	Sample date				
	April 3	May 9	June 26	August 1	August 29
	Density (cells per square millimeter)				
BACILLARIOPHYTA (diatoms)					
Achnanthes linearis f. curta	--	--	51	--	--
Achnanthes minutissima	120	1,800	150	--	--
Amphora perpusilla	120	--	51	--	3
Amphora sp.	--	--	--	--	12
Amphora venata	--	--	--	16	--
Caloneis sp.	--	360	--	--	--
Caloneis ventricosa	--	710	--	--	--
Cyclotella meneghiniana	--	1,300	--	--	--
Cyclotella pseudostelligera	130	--	--	--	--
Cyclotella stelligera	--	--	13	--	--
Cymbella minuta	--	710	--	--	--
Cymbella prostrata	--	--	--	32	--
Cymbella pusilla	--	--	--	79	--
Epithemia sp.	--	360	--	--	--
Fragilaria nitzschiodes	--	--	--	47	--
Fragilaria sp.	40	1,400	--	--	--
Gomphonema brasiliense	--	--	--	--	43
Gomphonema olivaceum	--	360	--	--	--
Gomphonema parvulum	--	--	--	47	--
Gomphonema sp.	100	--	150	--	--
Gyrosigma acuminatum	--	--	--	95	3
Gyrosigma attenatum	--	--	--	--	3
Gyrosigma obtusatum	--	--	100	--	3
Gyrosigma salproides	--	--	--	63	--
Gyrosigma sp.	100	--	--	--	--
Melosira distans	--	--	--	--	60
Navicula americana	--	--	--	16	--
Navicula arvensis	--	--	--	--	6
Navicula cryptocephala	--	360	--	--	--
Navicula gracilis	100	--	--	--	--
Navicula incomposita	--	--	--	--	17
Navicula minima	100	--	--	--	--
Navicula minuscula	--	--	--	--	12
Navicula notha	--	--	--	16	--
Navicula placentula	100	--	--	--	--
Navicula pupula	--	--	100	--	--
Navicula rhynchocephala	--	360	--	16	--
Navicula sanctaercrusis	--	--	--	--	12
Navicula sp.	120	1,100	100	--	12
Nitzschia amphibia	100	--	--	--	14

Table 16. Periphyton species list and density for site 2, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date				
	April 3	May 9	June 26	August 1	August 29
	Density (cells per square millimeter)—Continued				
Nitzschia filiformis	40	360	--	--	--
Nitzschia frustulum	--	1,100	51	--	--
Nitzschia palea	160	710	--	--	--
Nitzschia sp.	40	--	--	--	--
Nitzschia stagnorum	--	--	--	32	--
Nitzschia tryblionella	--	360	--	--	26
Pinnularia borealis	--	--	51	--	--
Pinnularia sp.	--	--	51	--	--
Reimeria sinuata	40	--	--	--	--
Rhopalodia sp.	--	360	--	--	--
Stephanodiscus sp.	22	--	--	--	--
Surirella elegans	--	360	--	--	--
Surirella ovalis	--	360	--	--	--
Surirella ovata	--	--	51	--	23
Surirella sp.	--	--	51	--	--
Synedra goulardi	--	--	--	32	--
Synedra sp. 1	--	--	--	63	--
Synedra ulna	--	--	--	--	3
Tabellaria fenestrata	--	--	--	--	3
Terpsinoe americana	--	--	67	--	--
CHLOROPHYTA (green algae)					
Chlamydomonas sp.	--	--	--	320	--
Chlorococcum humicola	--	--	--	150	--
Chlorococcum sp.	--	--	27	--	30
Rhizoclonium hieroglyphicum	310	--	240	--	73
Scenedesmus bijuga	--	--	--	58	--
Selenastrum minutum	52	--	--	--	--
Unknown chlorococcoid	--	1,900	--	--	--
CHRYSOPHYTA (golden-brown algae)					
Chlorochromonas minuta	--	--	--	350	--
CRYPTOPHYTA (cryptophytes)					
Cryptomonas ovata	--	650	--	--	--
CYANOPHYTA (blue-green algae)					
Anabaena helicoidea	--	--	--	820	--
Aphanocapsa delicatissima	--	--	--	3,800	150
Aphanothece clathrata	--	--	--	--	150
Chroococcus dispersus	--	650	--	--	--
Chroococcus pallidus	--	--	--	--	13
Lyngbya sp.	160	--	160	--	--
Lyngbya subtilis	--	3,200	--	--	--
Merismopedia tenuissima	210	--	--	--	--
Oscillatoria amphibia	630	--	230	--	17

Table 16. Periphyton species list and density for site 2, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date				
	April 3	May 9	June 26	August 1	August 29
	Density (cells per square millimeter)—Continued				
Oscillatoria sp. 1	--	650	--	--	--
Oscillatoria subtilissima	210	--	--	--	--
Oscillatoria tenuis	--	--	480	--	--
Phormidium tenue	--	--	1,200	--	10
Pseudanabaena catenata	--	3,200	--	--	--
Synechococcus lineare	--	3,900	--	--	--
Synechococcus sp.	160	1,300	--	--	--
EUGLENOPHYTA (euglenoids)					
Euglena sp.	--	--	27	120	3
Total (rounded)	3,200	28,000	3,400	6,200	700
Total taxa	23	26	21	20	25
Diversity index	2.8	2.9	2.4	1.5	2.5
Maximum diversity index	3.1	3.3	3.0	3.0	3.2
Evenness	.9	.9	.8	.5	.8

Table 17. Periphyton species list and density for site 3, upper San Antonio River, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected; sp., species]

DIVISION *Genus species*	Sample date				
	April 4	May 8	June 25	August 1	August 28
	Density (cells per square millimeter)				
BACILLARIOPHYTA (diatoms)					
Achnanthes affinis	170	--	--	--	--
Achnanthes lanceolata	43	--	--	--	--
Achnanthes minutissima	390	1,500	20	--	--
Amphora perpusilla	130	--	--	--	--
Biddulphia laevis	--	--	46	--	--
Cocconeis placentula	130	30,000	40	--	64
Coscinodiscus anguste-lineatus	--	--	--	--	100
Cyclotella kutzingiana	55	--	--	--	--
Cyclotella pseudostelligera	160	--	--	--	--
Cymbella affinis	--	--	40	--	--
Cymbella lunata	43	--	--	--	--
Cymbella pusilla	--	--	120	18	240
Cymbella sp.	--	3,900	--	--	--
Fragilaria sp.	--	--	600	--	--
Gomphonema brasiliense	--	--	79	--	76
Gomphonema olivaceum	--	--	20	--	--
Gomphonema parvulum	43	5,400	--	6	--
Gomphonema sp.	--	1,500	--	12	13
Gomphonema subclavatum	--	--	--	6	--
Gyrosigma acuminatum	--	--	--	60	--
Gyrosigma attenatum	--	--	--	--	25
Gyrosigma obtusatum	--	--	140	--	--
Gyrosigma salproides	--	--	--	12	--
Gyrosigma sp.	--	1,500	--	--	--
Melosira varians	--	470	--	--	--
Navicula americana	--	--	--	18	--
Navicula arvensis	--	--	20	--	51
Navicula circumtexa	--	--	--	--	25
Navicula grimmei	--	--	--	60	--
Navicula incomposita	--	--	--	--	51
Navicula minima	260	--	--	--	--
Navicula minuscula	--	--	--	--	89
Navicula mutica	--	--	--	18	--
Navicula pelliculosa	350	--	--	--	--
Navicula rhynchocephala	86	--	--	--	13

Table 17. Periphyton species list and density for site 3, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date				
	April 4	May 8	June 25	August 1	August 28
	Density (cells per square millimeter)—Continued				
Navicula sanctaecrucis	--	--	60	--	25
Navicula sp.	--	2,300	20	--	--
Navicula tripunctata	--	--	20	--	--
Navicula viridula	86	--	--	--	--
Nitzschia amphibia	86	770	60	--	64
Nitzschia capitellata	43	--	--	24	--
Nitzschia dissipata	86	--	--	--	--
Nitzschia filiformis	130	--	--	--	--
Nitzschia flexa	--	1,500	--	--	--
Nitzschia fonticola	43	--	20	--	--
Nitzschia frustulum	43	--	20	--	--
Nitzschia palea	86	5,400	20	--	--
Nitzschia sigmoidea	86	--	--	--	--
Nitzschia sp.	--	--	60	--	--
Nitzschia tryblionella	--	770	--	--	51
Pinnularia sp.	--	--	20	--	--
Rhoicosphenia curvata	43	--	--	--	--
Surirella angustata	--	770	--	--	--
Surirella ovalis	--	770	--	--	--
Surirella ovata	--	--	--	--	100
Synedra delicatissima	--	--	--	190	180
Synedra goulardi	--	--	--	30	38
Synedra sp. 1	--	--	--	24	76
Synedra sp. 2	--	--	--	12	--
Synedra ulna	220	--	420	--	--
Terpsinoe americana	--	1,900	91	200	--
CHLOROPHYTA (green algae)					
Chlamydomonas globosa	--	1,200	--	--	--
Chlamydomonas sp.	--	--	46	270	--
Chlorella ellipsoidea	--	--	23	--	350
Chlorococcum humicola	--	--	--	75	--
Chlorococcum sp.	--	--	92	--	24
Cladophora glomerata	73	3,100	46	--	590
Closterium sp.	--	--	23	--	--
Oocystis sp.	--	390	--	--	--
Raphidiopsis curvata	--	390	--	--	--
Rhizoclonium hieroglyphicum	--	--	23	--	71

Table 17. Periphyton species list and density for site 3, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date				
	April 4	May 8	June 25	August 1	August 28
	Density (cells per square millimeter)—Continued				
Scenedesmus armatus	--	--	--	50	--
Tetraedron sp.	37	--	--	--	--
Unknown chlorococcoid	--	3,100	--	--	--
CHRYSOPHYTA (golden-brown algae)					
Chlorochromonas minuta	--	--	--	130	--
Unknown flagellate	--	390	--	--	--
CYANOPHYTA (blue-green algae)					
Anabaena sp.	--	1,600	--	--	--
Aphanocapsa delicatissima	--	--	--	2,800	--
Chroococcus dispersus	--	1,900	--	--	--
Chroococcus limneticus	--	--	46	--	--
Chroococcus sp.	--	--	46	--	310
Lyngbya sp.	--	--	230	--	--
Lyngbya versicolor	--	3,900	--	--	--
Oscillatoria amphibia	180	1,900	5,900	--	--
Oscillatoria angustissima	--	--	--	25	--
Oscillatoria geminata	--	--	370	--	--
Oscillatoria sp.	220	--	--	--	--
Oscillatoria subtilissima	440	--	--	--	--
Oscillatoria tenuis	--	--	160	--	--
Phormidium tenue	--	--	340	270	71
Pseudanabaena catenata	--	5,400	--	--	--
Synechococcus lineare	290	780	--	--	--
Synechococcus sp.	37	3,100	--	--	--
EUGLENOPHYTA (euglenoids)					
Euglena sp.	--	--	--	50	--
Total (rounded)	4,100	86,000	9,300	4,400	2,700
Total taxa	30	28	34	23	24
Diversity index	3.1	2.6	1.7	1.6	2.7
Maximum diversity index	3.4	3.3	3.5	3.1	3.2
Evenness	.9	.8	.5	.5	.8

Table 18. Phytoplankton species list and density for site 1, lower Olmos Creek, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). ND, no data collected because of no-flow conditions; sp., species]

DIVISION *Genus species*	Sample date		
	March 27	June 27	August 29
	Density (cells per milliliter)		
BACILLARIOPHYTA (diatoms)			
Cyclotella meneghiniana	150	ND	ND
Cyclotella pseudostelligera	150	ND	ND
Navicula atomus	11	ND	ND
Navicula minuta	11	ND	ND
Nitzschia acicularis	11	ND	ND
Nitzschia fonticola	11	ND	ND
Nitzschia gracilis	11	ND	ND
Nitzschia palea	110	ND	ND
Nitzschia sp.	21	ND	ND
Reimeria sinuata	11	ND	ND
Surirella ovalis	11	ND	ND
CHLOROPHYTA (green algae)			
Characium sp.	34	ND	ND
Kirchneriella lunaris	34	ND	ND
Micractinium pusillum	68	ND	ND
CYANOPHYTA (blue-green algae)			
Chroococcus sp.	340	ND	ND
Dactylococcopsis fascicularis	370	ND	ND
Oscillatoria limnetica	200	ND	ND
Oscillatoria sp.	170	ND	ND
Pseudanabaena cantenata	740	ND	ND
Synechococcus lineare	68	ND	ND
Synechococcus sp.	34	ND	ND
EUGLENOPHYTA (euglenoids)			
Trachleomonas volvocina	34	ND	ND
Total (rounded)	2,600	ND	ND
Total taxa	22	ND	ND
Diversity index	2.4	ND	ND
Maximum diversity index	3.1	ND	ND
Evenness	.8	ND	ND

Table 19. Phytoplankton species list and density for site 2, upper San Antonio River, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected; sp., species]

DIVISION *Genus species*	Sample date		
	April 3	June 26	August 29
	Density (cells per milliliter)		
BACILLARIOPHYTA (diatoms)			
Achnanthes exigua	--	22	--
Achnanthes linearis	--	22	--
Achnanthes microcephala	--	11	--
Achnanthes minutissima	4	65	--
Amphora ovalis	4	--	180
Amphora perpusilla	--	11	--
Cyclotella glomerata	--	--	700
Cyclotella meneghiniana	--	--	170
Cyclotella pseudostelligera	270	--	--
Cyclotella stelligera	--	67	--
Fragilaria sp.	--	--	91
Gomphonema brasiliense	--	22	--
Gyrosigma obtusatum	--	11	--
Melosira fennoscandica	--	--	230
Navicula arvensis	--	--	1,500
Navicula cryptocephala	--	11	--
Navicula incomposita	--	--	360
Navicula menisculus	--	11	--
Navicula minuscula	--	--	1,100
Navicula pupula	4	22	--
Navicula radiosa	--	22	--
Navicula sanctaercrusis	--	--	1,200
Navicula sp.	4	11	--
Nitzschia amphibia	--	11	450
Nitzschia brebissonii	--	--	1,500
Nitzschia palea	9	22	--
Nitzschia paleaceae	--	22	--
Nitzschia tryblionella	--	--	1,300
Pinnularia streptoraphe	--	11	--
Stephanodiscus astraea	--	--	120
Surirella sp.	--	11	--
Synedra delicatissima	--	22	180
Synedra ulna	--	--	91
CHLOROPHYTA (green algae)			
Chlamydomonas globosa	--	--	140
Chlamydomonas sp.	--	22	--
Chlorococcum humicola	23	--	610

Table 19. Phytoplankton species list and density for site 2, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date		
	April 3	June 26	August 29
	Density (cells per milliliter)—Continued		
Mesotaenium sp.	45	--	--
Scenedesmus bijuga	--	--	270
Scenedesmus communis	--	44	--
Selenastrum minutum	140	--	--
CYANOPHYTA (blue-green algae)			
Aphanocapsa delicatissima	180	--	--
Chroococcus sp.	110	--	--
Dactylococcopsis fascicularis	45	--	--
Oscillatoria subtilissima	1,600	--	--
Synechococcus sp.	68	--	--
Aphanocapsa delicatissima	--	--	11,000
Lyngbya sp.	--	270	--
Oscillatoria amphibia	--	200	--
Total (rounded)	2,500	940	21,000
Total taxa	14	23	19
Diversity index	1.4	2.5	1.9
Maximum diversity index	2.6	3.1	2.9
Evenness	.5	.8	.7

Table 20. Phytoplankton species list and density for site 3, upper San Antonio River, San Antonio, Texas, 1990

[Diversity index computed using a modified version of Shannon's equation (Shannon and Weaver, 1949). --, not detected; sp., species]

DIVISION *Genus species*	Sample date		
	April 4	June 25	August 28
	Density (cells per milliliter)		
BACILLARIOPHYTA (diatoms)			
Achnanthes microcephala	--	8	--
Achnanthes minutissima	12	25	--
Cocconeis placentula	6	16	6
Cyclotella pseudostelligera	58	--	--
Cyclotella sp.	10	--	--
Cyclotella stelligera	--	4	--
Cymbella pusilla	--	--	6
Fragilaria sp.	--	120	--
Gomphonema brasiliense	--	--	6
Gyrosigma obtusatum	--	16	--
Gyrosigma salproides	--	--	6
Melosira distans	--	5	28
Melosira italica	--	2	--
Navicula bicephala	--	8	--
Navicula circumtexa	--	--	6
Navicula festiva	--	8	--
Navicula incomposita	--	--	17
Navicula lateropunctata	--	8	--
Navicula luzonensis	--	58	--
Navicula minuscula	--	8	--
Navicula sanctaecrucis	--	16	--
Navicula sanctaerucis	--	--	23
Navicula sp.	12	8	--
Navicula tripunctata	6	--	--
Nitzschia amphibia	--	25	6
Nitzschia brebissonii	--	--	51
Nitzschia capitellata	25	--	--
Nitzschia sp.	6	--	--
Nitzschia tryblionella	--	16	23
Stephanodiscus astraea	--	--	6
Stephanodiscus sp.	--	4	--
Synedra delicatissima	--	--	17
Synedra ulna	--	--	6
CHLOROPHYTA (green algae)			
Chlorella ellipsoidea	--	--	470
Chlorella sp.	--	17	--
Chlorococcum humicola	--	--	100
Scenedesmus communis	--	34	--

Table 20. Phytoplankton species list and density for site 3, upper San Antonio River, San Antonio, Texas, 1990—Continued

DIVISION *Genus species*	Sample date		
	April 4	June 25	August 28
	Density (cells per milliliter)—Continued		
Selenastrum minutum	34	--	--
Tetraedron minimum	--	17	--
CYANOPHYTA (blue-green algae)			
Anabaena sp.	68	--	--
Aphanocapsa delicatissima	370	--	2,600
Aphanothece saxicola	34	--	--
Chroococcus sp.	34	--	--
Dactylococcopsis fascicularis	470	--	--
Lyngbya sp.	410	--	--
Oscillatoria amphibia	--	150	--
Oscillatoria subtilissima	340	--	--
Phormidium tenue	--	350	--
Synechococcus sp.	--	17	--
EUGLENOPHYTA (euglenoids)			
Euglena proxima	--	17	--
Total (rounded)	1,900	960	3,400
Total taxa	16	25	17
Diversity index	2.0	2.3	.9
Maximum diversity index	2.8	3.1	2.8
Evenness	.7	.7	.3

Table 21. Water-quality data for site 1, lower Olmos Creek, San Antonio, Texas, 1990

[m^3/s, cubic meters per second; µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; NTU, nephelometric turbidity unit; mg/L, milligrams per liter; mm, millimeters; Hg, mercury; $CaCO_3$, calcium carbonate; --, not determined; N, nitrogen; NO_2+NO_3, nitrite plus nitrate; P, phosphorus; µg/L, micrograms per liter; µg/g micrograms per gram; <, less than]

Date	Tima	Dis-charge, instan-taneous (m^3/s)	Specific conduct-ance (µS/cm)	pH (stand-ard units)	Temper-ature (°C)	Color (piat-inum-cobalt units)	Tur-bidity (NTU)	Oxygen, dis-solved (mg/L)	Baro-matric pressure (mm of Hg)	Oxygen, dissolved (percent sstu-ration)	Oxygen demand, biochem-ical, 5 day (mg/L)	Herd-ness, total (mg/L as $CaCO_3$)
Mar												
27...	1400	0.01	843	7.7	13.5	13	2.5	7.8	755	76	2.7	280
May												
10...	1145	.01	720	7.5	21.0	--	--	5.6	755	64	--	--
Jul												
31...	1000	.01	585	7.6	27.0	--	--	6.0	755	76	--	--

Date	Calcium, dis-solved (mg/L)	Magne-sium, dis-solved (mg/L)	Sodium, dis-solved (mg/L)	Sodium (percent)	Sodium adsorp-tion ratio	Potas-sium, dis-solved (mg/L)	Alka-linity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L)	Chlo-ride, dis-solved (mg/L)	Fluo-ride, dis-solved (mg/L)	Silica, dis-solved (mg/L)	Solids, sum of constit-uents, dis-solved (mg/L)
Mar												
27...	89	13	55	28	1	25	173	160	61	0.40	5.4	513
May												
10...	--	--	--	--	--	--	--	--	--	--	--	--
Jul												
31...	--	--	--	--	--	--	--	--	--	--	--	--

Date	Residue, total at 105 °C, sus-pended (mg/L)	Residue, volatile, sus-pended (mg/L)	Residue, fixed non-filter-able (mg/L)	Nitro-gen, nitrate, dis-solved (mg/L as N)	Nitro-gen, nitrite, dis-solved (mg/L as N)	Nitro-gen, NO_2+NO_3, total (mg/L as N)	Nitro-gen, NO_2+NO_3, dissolved (mg/L as N)	Nitro-gen, am-monia, dis-solved (mg/L as N)	Nitro-gen, am-monia + organic, total (mg/L as N)	Phos-phorus, total (mg/L as P)	Phos-phorus, ortho, dis-solved (mg/L as P)
Mar											
27...	12	12	0	0.019	0.081	0.100	0.100	0.134	0.60	0.070	0.039
May											
10...	--	--	--	--	--	--	--	--	--	--	--
Jul											
31...	--	--	--	--	--	--	--	--	--	--	--

Table 21. Water-quality data for site 1, lower Olmos Creek, San Antonio, Texas, 1990—Continued

Date	Carbon organic, total (mg/L)	Cyanide, total (mg/L)	Aluminum, total recoverable (µg/L)	Arsenic, total (µg/L)	Arsenic, total, in bottom material (µg/g)	Barium, total recoverable (µg/L)	Barium, recoverable from bottom material (µg/g)	Cadmium, total recoverable (µg/L)	Cadmium, recoverable from bottom materiel (µg/g)	Chromium, total recoverable (µg/L)	Chromium, recoverable from bottom material (µg/g)
Mar 27...	5.2	<0.010	100	2	7	<100	40	<1	1	2	10
May 10...	--	--	--	--	--	--	--	--	--	--	--
Jul 31...	--	--	--	--	--	--	--	--	--	--	--

Date	Copper, total recoverable (µg/L)	Copper, recoverable from bottom material (µg/g)	Iron, total recoverable (µg/L)	Lead, total recoverable (µg/L)	Lead, recoverable from bottom material (µg/g)	Marcury, total recoverable (µg/L)	Mercury, recoverable from bottom material (µg/g)	Nickel, total recoverable (µg/L)	Selenium, total (µg/L)	Selenium, total, in bottom material (µg/g)	Silver, total recoverable (µg/L)	Zinc, total recoverable (µg/L)
Mar 27...	3	10	280	3	60	<0.10	0.02	3	<1	<1	<1	10
May 10...	--	--	--	--	--	--	--	--	--	--	--	--
Jul 31...	--	--	--	--	--	--	--	--	--	--	--	--

Table 22. Water-quality data for site 2, upper San Antonio River, San Antonio, Texas, 1990

[m^3/s, cubic meters per second; µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; NTU, nephelometric turbidity unit; mg/L, milligrams per liter; mm, millimeters; Hg, mercury; $CaCO_3$, calcium carbonate; --, not determined; E, estimated; N, nitrogen; NO_2+NO_3, nitrite plus nitrate; P, phosphorus; µg/L, micrograms per liter; µg/g micrograms per gram; <, less than]

Date	Time	Discharge, instantaneous (m^3/s)	Specific conductence (µS/cm)	pH (standard units)	Temperature (°C)	Color (platinum-cobalt units)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Barometric pressure (mm of Hg)	Oxygen, dissolved (percent saturation)	Oxygen demand, biochemical, 5 day (mg/L)	Hardness, total (mg/L as $CaCO_3$)
Apr												
03...	1245	0.12	516	7.4	23.0	4	4.0	7.6	757	89	0.8	220
May												
09...	1100	.08	488	7.3	24.0	--	--	7.2	750	87	--	--
Jun												
26...	1030	.05	483	7.3	25.0	2	1.7	7.4	751	91	.9	240
Aug												
01...	1445	.07	480	7.3	25.0	--	--	8.4	752	103	--	--
29...	1115	.07	471	7.3	25.0	1	2.4	7.4	751	91	.4	240

Date	Calcium, dissolved (mg/L)	Megnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium (percent)	Sodium adsorption ratio	Potassium, dissolved (mg/L)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Solids, sum of constituenta, dissolved (mg/L)
Apr												
03...	65	14	11	9	0.3	7.4	202	31	19	0.20	11	287
May												
09...	--	--	--	--	--	--	--	--	--	--	--	--
Jun												
26...	70	16	9.1	8	.3	1.1	E203	17	25	.10	12	--
Aug												
01...	--	--	--	--	--	--	--	--	--	--	--	--
29...	69	16	9.1	8	.3	1.2	213	15	17	.20	12	272

Dste	Residue, total at 105 °C, suspended (mg/L)	Residue, volstile, suspended (mg/L)	Residue, fixed nonfilterable (mg/L)	Nitrogen, nitrate, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, NO_2+NO_3, total (mg/L as N)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Nitrogen, smmonis, dissolved (mg/L es N)	Nitrogen, ammonia + organic, total (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorua, ortho, dissolved (mg/L es P)
Apr											
03...	9	8	1	1.68	0.017	1.70	1.70	0.034	<0.20	0.030	0.021
May											
09...	--	--	--	--	--	--	--	--	--	--	--
Jun											
26...	11	8	3	1.60	.003	1.60	1.60	.020	.30	.010	.010
Aug											
01...	--	--	--	--	--	--	--	--	--	--	--
29...	10	8	2	1.09	.005	1.90	1.10	.014	.30	.020	.006

Table 22. Water-quality data for site 2, upper San Antonio River, San Antonio, Texas, 1990—Continued

Date	Carbon, organic, total (mg/L)	Cyanide, total (mg/L)	Aluminum, total recoverable (µg/L)	Arsenic, total (µg/L)	Arsenic, total, in bottom material (µg/g)	Barium, total recoverable (µg/L)	Barium, recoverable from bottom material (µg/g)	Cadmium, total recoverable (µg/L)	Cadmium, recoverable from bottom material (µg/g)	Chromium, total recoverable (µg/L)	Chromium, recoverable from bottom material (µg/g)
Apr											
03...	1.3	<0.010	210	<1	3	<100	<10	<1	1	1	10
May											
09...	--	--	--	--	--	--	--	--	--	--	--
Jun											
26...	.7	<.010	110	<1	6	<100	40	1	2	<1	10
Aug											
01...	--	--	--	--	--	--	--	--	--	--	--
29...	.4	<.010	100	<1	4	<100	30	<1	2	1	<10

Date	Copper, total recoverable (µg/L)	Copper, recoverable from bottom material (µg/g)	Iron, total recoverable (µg/L)	Lead, total recoverable (µg/L)	Lead, recoverable from bottom material (µg/g)	Mercury, total recoverable (µg/L)	Mercury, recoverable from bottom material (µg/g)	Nickel, total recoverable (µg/L)	Selenium, total (µg/L)	Selenium, total, in bottom material (µg/g)	Silver, total recoverable (µg/L)	Zinc, total recoverable (µg/L)
Apr												
03...	3	9	190	3	70	<0.10	0.02	1	<1	<1	<1	<10
May												
09...	--	--	--	--	--	--	--	--	--	--	--	--
Jun												
26...	3	9	80	1	70	<.10	.02	<1	<1	<1	<1	<10
Aug												
01...	--	--	--	--	--	--	--	--	--	--	--	--
29...	1	6	70	2	70	<.10	.03	1	<1	<1	<1	10

Table 23. Water-quality data for site 3, upper San Antonio River, San Antonio, Texas, 1990

[m^3/s, cubic meters per second; µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; NTU, nephelometric turbidity unit; mg/L, milligrams per liter; mm, millimeters; Hg, mercury; $CaCO_3$, calcium carbonate; --, not determined; N, nitrogen; NO_2+NO_3, nitrite plus nitrate; P, phosphorus; µg/L, micrograms per liter; µg/g micrograms per gram; <, less than]

Date	Tima	Discharge, instantaneous (m^3/s)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Color (platinum-cobalt units)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Barometric pressure (mm of Hg)	Oxygen, dissolved (percent saturation)	Oxygen demand, biochamical, 5 day (mg/L)	Hardness, total (mg/L as $CaCO_3$)
Apr												
04...	1315	0.26	520	7.6	21.0	2	4.5	7.1	752	81	0.3	240
May												
08...	1220	.27	517	7.5	23.0	--	--	6.9	750	82	--	--
Jun												
25...	1300	.19	482	7.6	27.5	2	3.3	7.4	755	95	.8	240
Aug												
01...	1100	.24	500	7.6	26.0	--	--	7.0	755	87	--	--
28...	1215	.20	487	7.6	27.5	2	4.0	6.9	752	89	.8	240

Date	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Sodium (percent)	Sodium edsorption ratio	Potassium, dissolved (mg/L)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)
Apr												
04...	72	14	12	10	0.3	7.3	202	30	19	0.20	12	295
May												
08...	--	--	--	--	--	--	--	--	--	--	--	--
Jun												
25...	69	16	9.5	8	.3	1.6	212	23	24	.30	11	287
Aug												
01...	--	--	--	--	--	--	--	--	--	--	--	--
28...	70	16	10	8	.3	1.7	211	18	19	.20	12	278

Date	Residue, total at 105 °C, suspended (mg/L)	Residue, volatile, suspended (mg/L)	Residue, fixed nonfilterable (mg/L)	Nitrogen, nitrate, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, NO_2+NO_3, total (mg/L as N)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + orgsnic, total (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)
Apr											
04...	7	7	0	1.52	0.075	1.60	1.60	0.143	0.40	0.080	0.052
May											
08...	--	--	--	--	--	--	--	--	--	--	--
Jun											
25...	15	4	11	1.17	.028	1.20	1.20	.058	.30	.020	.015
Aug											
01...	--	--	--	--	--	--	--	--	--	--	--
28...	20	7	13	1.08	.020	1.40	1.10	.048	.40	.030	.012

Table 23. Water-quality data for site 3, upper San Antonio River, San Antonio, Texas, 1990—Continued

Date	Carbon, organic, total (mg/L)	Cyanide, total (mg/L)	Aluminum, total recoverable (µg/L)	Arsenic, total (µg/L)	Arsenic, total, in bottom material (µg/g)	Barium, total recoverable (µg/L)	Barium, recoverable from bottom material (µg/g)	Cadmium, total recoverable (µg/L)	Cadmium, recoverable from bottom material (µg/g)	Chromium, total recoverable (µg/L)	Chromium, recoverable from bottom material (µg/g)
Apr											
04...	2.4	<0.010	250	1	3	<100	90	<1	1	3	10
May											
08...	--	--	--	--	--	--	--	--	--	--	--
Jun											
25...	1.5	<.010	180	1	4	<100	80	<1	3	<1	10
Aug											
01...	--	--	--	--	--	--	--	--	--	--	--
28...	1.2	<.010	190	<1	3	<100	30	<1	<1	1	<10

Data	Copper, total recoverable (µg/L)	Copper, recoverable from bottom material (µg/g)	Iron, total recoverable (µg/L)	Lead, total recoverable (µg/L)	Lead, recoverable from bottom material (µg/g)	Mercury, total recoverable (µg/L)	Marcury, recoverable from bottom material (µg/g)	Nickel, total recoverable (µg/L)	Selenium, total (µg/L)	Selenium, total, in bottom material (µg/g)	Silver, total recoverable (µg/L)	Zinc, total recoverable (µg/L)
Apr												
04...	4	60	230	9	140	<0.10	0.06	2	<1	<1	<1	30
May												
08...	--	--	--	--	--	--	--	--	--	--	--	--
Jun												
25...	1	20	170	3	40	<.10	.06	1	<1	<1	<1	10
Aug												
01...	--	--	--	--	--	--	--	--	--	--	--	--
28...	1	4	150	6	190	<.10	<.01	1	<1	<1	<1	10

Table 24. Diel fluctuations in water-quality properties at site 2, upper San Antonio River, San Antonio, Texas, September 27–28, 1990

[µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; mg/L, milligrams per liter]

Time (hour)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Dissolved oxygen (mg/L)
1400	501	7.3	24.0	7.6
1500	501	7.3	25.0	7.5
1600	500	7.3	25.0	7.4
1700	500	7.3	25.0	7.4
1800	499	7.3	25.0	7.3
1900	500	7.3	25.0	7.1
2000	500	7.3	24.5	7.0
2100	498	7.3	24.5	6.8
2200	498	7.3	24.5	6.8
2300	497	7.3	24.5	6.7
2400	498	7.3	24.0	6.7
0100	498	7.3	24.0	6.7
0200	498	7.3	24.0	6.6
0300	497	7.3	24.0	6.6
0400	497	7.3	24.0	6.6
0500	497	7.3	24.0	6.6
0600	496	7.3	24.0	6.7
0700	496	7.3	24.0	6.7
0800	496	7.3	24.0	6.7
0900	496	7.3	24.0	6.7
1000	496	7.3	24.0	6.8
1100	495	7.3	24.0	7.0
1200	493	7.3	24.5	7.2
1300	492	7.3	25.0	7.5
Minimum	492	7.3	24.0	6.6
Maximum	501	7.3	25.0	7.6

Table 25. Diel fluctuations in water-quality properties at site 3, upper San Antonio River, San Antonio, Texas, October 5–6, 1990

[µS/cm, microsiemens per centimeter at 25 °C; °C, degrees Celsius; mg/L, milligrams per liter]

Time (hour)	Specific conductance (µS/cm)	pH (standard units)	Temperature (°C)	Dissolved oxygen (mg/L)
1100	492	7.7	25.0	6.4
1200	492	7.7	25.0	6.6
1300	492	7.7	25.0	6.6
1400	493	7.7	25.5	6.8
1500	492	7.7	25.5	6.8
1600	492	7.7	25.5	6.8
1700	492	7.7	25.5	6.7
1800	492	7.7	25.5	6.7
1900	491	7.7	25.5	6.6
2000	491	7.7	25.5	6.6
2100	491	7.7	25.5	6.6
2200	492	7.7	25.5	6.7
2300	491	7.7	25.5	6.6
2400	492	7.7	25.5	6.6
0100	492	7.7	25.5	6.7
0200	492	7.7	25.5	6.7
0300	492	7.7	25.5	6.6
0400	492	7.7	25.5	6.5
0500	492	7.7	25.5	6.5
0600	492	7.7	25.5	6.3
0700	492	7.7	25.5	6.2
0800	493	7.7	25.5	6.2
0900	493	7.7	25.5	6.3
1000	493	7.7	25.5	6.4
Minimum	491	7.7	25.0	6.2
Maximum	493	7.7	25.5	6.8